TORONTO ZOO

Request for Tenders for
Orangutan Outdoor Exhibit Construction

RFT No.: TZC T 57-2019-12

Contract No.:

Issued: 2019-12-17

TZC T 57-2019-12
ORANGUTAN OUTDOOR EXHIBIT
CONSTRUCTION

CLOSING DATE: 2020-01-17 at 12:00 p.m. local time

Bids are invited for Orangutan Outdoor Exhibit Construction all in accordance with this Request for Tender. This RFT is posted on the Toronto Zoo web site at http://www.torontozoo.com/business

SUBMISSION

The Tender submission must be sealed in an envelope using the attached mailing label and submitted to Supervisor, Purchasing & Supply c/o Reception, 361A Old Finch Ave., Toronto, ON M1B 5K7 by **2 0 2 0 - 0 1 - 1 7 at 12:00 hours, 12:00 p.m. local standard time** (hereinafter referred to as the "closing time")**.**

QUESTIONS REGARDING THIS RFT

Questions regarding this RFT must be submitted in writing only to Peter Vasilopoulos, Supervisor, Purchasing & Supply no later than **2020-01-08 at 4:00 p.m. local time.** Questions received later than this stated time and date may not be acknowledged or answered.

ADDENDA

All addenda to this RFT will be posted on the Toronto Zoo's Bid Opportunities Web Page: http://www.torontozoo.com/business. Addenda will not be posted until after the date for questions has closed. It is the Bidder's sole responsibility to check this Web Page to avail themselves of any posted addenda. Quotations submitted that do not include the first page, completed and signed, of all posted addenda will be rejected.

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PART 1: REQUEST FOR TENDERS PROCESS

SECTION 1 - RFT SPECIFIC PROCESS AND SUBMISSION INSTRUCTIONS

1.1 Introduction

.1 This RFT is an invitation by the Toronto Zoo to construct a new outdoor exhibit for orangutans, and:

.1 to prospective Suppliers to submit bids for the performance of the Work, as further described in Part 3 (DRAWINGS AND SPECIFICATIONS) and the Contract (the "Project").

.2 This RFT shall be interpreted in accordance with Section 3.123.3.10 (Governing Law) and 3.13 (RFT Definitions and Interpretation).

.3 Invitation to submit a Bid, including participation in any pre-qualification, request for information or other similar process or exchange of information prior to the RFT, does not imply that a Supplier is automatically prequalified to meet the requirements of the RFT or that the factors which were examined during such process or exchange may not be re-examined or re-evaluated by the Toronto Zoo during the consideration and selection process for this RFT. It will still be necessary for the Supplier to demonstrate its qualifications through the RFT process.

.4 The Successful Supplier will be required to execute the Contract with the Toronto Zoo for the provision of the Work. Suppliers should review the terms and conditions set out in Part 2 (FORM OF CONSTRUCTION AGREEMENT) to understand the Contract being entered into with the Toronto Zoo.

1.2 Procurement Contact

.1 The contact Person at the Toronto Zoo for all matters related to the RFT process (the "**Procurement Contact**") is set out below:

Name and Title
Name: Peter Vasilopoulos Title: Supervisor, Purchasing & Supply

.2 All communications relating to this RFT must be submitted to the Procurement Contact and only communications received by the Procurement Contact will be considered in the RFT process.

.3 All permitted communications with the Procurement Contact will be deemed as having been received by the Procurement Contact on the dates and times

1.3 RFT Documents

.1 This RFT is comprised of the following documents:

Part 1 – Request for Tender Process

Section 1 – RFT Process and Submission Instructions;

Section 2 – Evaluation, Acceptance and Execution;

Section 3 – Other RFT Terms and Conditions;

Part 2 – Form of Construction Agreement;

Part 3 – Drawings and Specifications;

Part 4 – Submission Forms, consisting of:

- Form A - Bid Submission Form;
- Form B - Bid Bond;
- Form C - Experience and Qualifications Form;
- Form D - List of Subcontractors Form;

Part 5 – Pricing Form; and all Addenda.

.2 Prior to submitting a Bid, Suppliers shall examine all components of the RFT (including all reference documents, appendices, forms and Addenda) and, in accordance with Section 1.8 (Questions) promptly notify the Procurement Contact of any perceived errors, omissions, conflicts, ambiguities or discrepancies in the RFT.

.3 While the Toronto Zoo has used considerable efforts to ensure an accurate representation of information in this RFT, the information contained in this RFT is supplied solely as a guide for Bidders. The information is not guaranteed or warranted to be accurate by the Toronto Zoo, nor is it necessarily comprehensive or exhaustive. Nothing in this RFT is intended to relieve Bidders from forming their own opinions and conclusions with respect to the matters addressed in this RFT.

.4 For clarity, no prequalification documents issued by the Toronto Zoo or prequalification submissions delivered by the Suppliers to the Toronto Zoo shall form a part of the RFT or the Contract.

.5 It shall be the responsibility of each Supplier to acquire, other sources or in person from the Procurement Contact, as specified in the RFT, any document that is referenced or mentioned in this RFT which is not included herein.

.6 The failure of any Supplier to acquire, receive or examine any document, form, Addendum, or policy shall not relieve the Supplier of any obligation with respect to its Bid or the Contract. The Toronto Zoo is not responsible for any misunderstanding on the part of any Supplier concerning this RFT or its processes.

1.4 Responding to the RFT and Prohibited Communications

Toronto Zoo website

.1 The RFT is available only through, the Toronto Zoo website at: https://www.toronto.ca/business

Prohibited Communications

.2 Suppliers (including potential Suppliers) shall not, and shall cause their representatives not to discuss, disclose or communicate, directly or indirectly, any details pertaining to or in connection with their Bid or this RFT to:

- any employee, official, agent, elected or appointed official or other representative of the Toronto Zoo other than the Procurement Contact; or
- anyone not specifically involved in their Bid (including, without limitation, any other Supplier),

except as may be authorized in writing by the Procurement Contact Other than the Procurement Contact, no Toronto Zoo representative, whether an official, agent or employee, is authorized to speak for the Toronto Zoo with respect to this RFT. Any Supplier who uses or relies on any representation, information, clarification, correspondence or other communication from any other Toronto Zoo representative does so entirely at the Supplier's own risk and the Toronto Zoo shall not be bound by such representation, information, clarification, correspondence or other communication.

.3 Without limiting any other provision of this Section 1.4. any attempt by a Supplier to bypass the RFT process may be grounds for rejection of its Bid.

1.5 RFT Timetable

.1 The Toronto Zoo's currently proposed schedule for each step in the RFT process is set out in below.

Event	Date /Time
Issue Date of RFT	2019-12-17
Site Visit / Pre-Bid Meeting	2019-12-19 at 0900 (9:00am local time)
Deadline for Questions	2020-01-08
Submission Deadline	2020-01-17 at 1200 (noon local time)
Bid Validity Period	90 days
Anticipated Award Date	2020-02-10

.2 The Toronto Zoo reserves the right to, in the Toronto Zoo's sole and absolute discretion, at any time:

- revise the RFT schedule, to accelerate, eliminate or postpone any of the dates or times set out in this RFT, including the Submission Deadline;

- to add to, delete or re-order any of the milestones set out in this RFT, at any time; or

- modify the RFT process.

1.6 In the event of an inconsistency or a conflict between the Submission Deadline as displayed in the Toronto Zoo Online Procurement System and the Submission Deadline as indicated in an Addendum, the SAP Ariba Discovery portal or any other source, document or location maintained by the Toronto Zoo (online or otherwise), the Submission Deadline as displayed in the Toronto Zoo Online Procurement System shall take precedence.

1.7 Site Meetings

.1 **Optional Site Meeting**

.1 All Suppliers are encouraged to attend an optional site meeting to familiarize themselves with the Project and ascertain the full extent of the Work required. The optional site meeting will take place at 9:00am local time on Thursday, 2019-12-19 at 361A Old Finch Ave, Toronto, ON M1B 5K7.

.2 No statement or information provided in such meeting by either the Toronto Zoo or the Suppliers will amend any provision of this RFT or the Contract, or may be relied upon by a Supplier in the RFT process or its Bid, except and to the extent such statement or information is later confirmed through the issuance of an Addendum.

1.7 <u>Addenda</u>

.1 The RFT may only be amended by Addendum in accordance with this Section 1.7 (Addenda). Prior to the Submission Deadline, the Toronto Zoo may at any time or times modify the RFT in whole or in part through the issuance of an Addenda, if deemed necessary by the Toronto Zoo. Each Addendum shall form an integral part of this RFT.

.2 All Addenda will be posted on the http://www.torontozoo.com/business and Toronto Zoo, the Toronto Zoo is not responsible for any failure of such notice system or for notices not received by Suppliers.

.3 Suppliers must check the Toronto Zoo's http://www.torontozoo.com/business frequently to inform themselves of any posted Addendum. Toronto Zoo. Suppliers shall be wholly responsible for checking and reviewing any posted Addenda and ensuring the completeness of the RFT (as amended) and their Bids (as impacted by such Addenda). The Toronto Zoo is not responsible for any incomplete or incorrect Bids resulting from the issuance of an Addendum or a Supplier's failure to update its Bid in response to an Addendum.

.4 The Toronto Zoo will make reasonable efforts to issue the final Addendum (if any) in a sufficient time prior to the Submission Deadline to allow Suppliers to submit their Bids. If any Addendum requires substantial amendments to the RFT, the Toronto Zoo may, in its sole and absolute discretion, extend the Submission Deadline.

.5 Other than documents issued as part of the RFT (including Addenda), the Toronto Zoo shall not be responsible for any explanations, instructions or interpretations even if provided by its actual or purported employees, designees or agents. No oral or written explanations, instructions or interpretations shall modify any of the requirements or provisions of the RFT unless in the form of an Addendum.

.6 Any reference in this RFT to any document comprising this RFT includes any amendments to such document made in accordance with this Section 1.7 (Addenda).

1.8 Questions

.1 Prospective Suppliers finding errors, omissions, conflicts, ambiguities or discrepancies in the RFT or having questions, comments or concerns regarding this RFT, its process and related matters ("**Questions**") may submit such Questions to the Procurement Contact using the Toronto Zoo QBD form attached. The Toronto Zoo will make reasonable efforts to respond to Questions received by the deadline for Questions set out in the RFT timetable in Section 1.5 (RFT Timetable). However, the Toronto Zoo shall have no obligation to respond to any or all Questions, and the Toronto Zoo's determination as to whether or not it will respond to any Question shall be in the Toronto Zoo's sole and absolute discretion. The onus is on each Supplier to confirm the Toronto Zoo has received all correspondence from the Supplier.

.2 Although it is the Toronto Zoo's practice to make available to all Questions received as well as responses to such Questions: (i) for Questions of an administrative nature; or (ii) where a prospective Supplier's Question is identified as commercially confidential in nature and where, the Toronto Zoo in its sole and absolute discretion deems the Question or response to be commercially confidential, the Toronto Zoo may provide a response only to that Supplier. The Toronto Zoo reserves the right to edit Questions for clarity and applicability to all Suppliers generally.

.3 Pursuant to Section 1.7.1 (Addenda), responses to Questions prepared and circulated by the Toronto Zoo are not RFT documents and do not amend the RFT, unless such responses form part of an Addendum.

1.9 Submission of Bids

.1 General

.1 Subject to Section 1.9.3 (Bid Bond) with respect to the submission of the Bid Bond, Bids must be in person Toronto Zoo prior to the Submission Deadline. Bids will be rejected as non-compliant if submitted by any other mechanism

including, but not limited to, post, courier, fax, e-mail or orally, unless specifically requested Toronto Zoo

.2 It is the Supplier's sole responsibility to ensure its Bid is received by the Submission Deadline in accordance with the requirements of this RFT. The receipt of Bids can be delayed due to a number of factors including "internet traffic", file transfer size and transmission speed. The Supplier should allow sufficient time to download, complete and upload, as applicable, the submission forms comprising its Bid and any attachments.

.3 A Bid will only be considered to be submitted once it has been received by the Toronto Zoo. The time of such receipt is reflected by the time stamped by the Toronto Zoo.

.4 Suppliers must submit their Bids in the format presented, prescribed and compatible with the requirements of the RFT and Toronto Zoo must include all attachments required by the Toronto Zoo. Failure to fully complete the forms presented in this RFT or to include and submit the required attachments or separate documentation, as applicable, may result in the bid being rejected as non-compliant.

.5 The forms, documents and other items outlined in this Section 1.9 (Submission of Bids) must be completed in their entirety and submitted in the format presented and prescribed by the Toronto Zoo in accordance with the requirements of the RFT. Failure to so submit any such items may result in the Bid being rejected as non-compliant.

.6 All Suppliers should exercise extreme care when completing their Bid submissions, as failure to complete the Bid fully or to comply with the requirements of this RFT may cause the Bid to be rejected as non-compliant.

.2 **Bid Submission Form**

.1 Suppliers shall complete and submit all information and respond to all items in the Bid submission form set out in Form A of Part 4 (Bid Submission Form) ("**Bid Submission Form**").

.2 The Bid Submission Form contains confirmatory statements and declarations in respect of the Toronto Zoo's Policies.

.3 **Bid Bond**

.1 In addition to the requirements set out in this RFT in respect of the submission of Toronto Zoo, each Supplier shall submit, a bid bond to secure the execution of the Contract by the Supplier ("**Bid Bond**").

.2 The Bid Bond shall be Toronto Zoo

.1 an original paper Bid Bond physically shall be enclosed with your submission before the Submission Deadline at the following address:

Attention: Purchasing & Supply

Toronto Zoo
361A Old Finch Ave
Toronto, ON
M1B 5K7

Re: Bid Bond for Request for Tender No. TZC T 57-2019-12

Submitting a photocopy of the original paper Bid Bond is not acceptable. For clarity, the Toronto Zoo will not accept any original paper Bid Bonds that are delivered after the Submission Deadline and any original paper Bid Bond received after the Submission Deadline shall result in the Bid being rejected as non-compliant. **[The determination of whether the original paper Bid Bond is delivered by or before the Submission Deadline shall be based on the time and date stamp the Supplier must ensure it receives from the Toronto Zoo at foregoing address]**

.3 The Bid Bond shall be in the amount and in the form provided in Part 4 – Submission Forms or in another substantially similar format approved by the Toronto Zoo prior to Bid submission; and

.4 The Bid Bond shall be signed and sealed by the Supplier and by a licensed surety company, authorized to carry on business in the Province of Ontario, and having a place of business in Ontario.

.5 Failure of a Supplier to submit a Bid Bond, in compliance with the requirements of Sections 1.9.3.1 and 1.9.3.2 (Bid Bonds) shall result in the Bid being rejected as non-compliant.

.4 **Experience and Qualifications Form List of Subcontractors Form (Not Applicable)**

.5 **List of Subcontractors Form**

.1 The Supplier shall complete and submit the form provided in Form D of Part 4 (List of Subcontractors Form) indicating the subcontractors it intends to employ to carry out each portion of the Work ("**Subcontractors**") indicated therein.

.2 Suppliers must not include companies under suspension by the Toronto Zoo on their list of Subcontractors.

.6 **Pricing Form**

.1 Each Supplier shall complete and submit the Pricing Form set out in Part 5 (PRICING FORM) according to the instructions contained in such form.

.2 In completing the Pricing Form, Suppliers must take into account compliance with all of the requirements of the RFT, including Part 3 (DRAWINGS AND SPECIFICATIONS) and the terms of the Contract. The Toronto Zoo will assume, in evaluating all Bids, that compliance with such requirements has been accounted for the in the completed Pricing Form.

1.10 Amendment of Bids

.1 Prior to the Submission Deadline, a Supplier may amend its Bid at any time after submission of the Bid Toronto Zoo and a Supplier may amend its Bid one or more times if it so wishes prior to the Submission Deadline.

.2 If a Supplier amends its Bid, the Supplier must resubmit the Bid prior to the Submission Deadline Toronto Zoo the most recently submitted version of the Bid as dated and stamped recorded Toronto Zoo, shall be irrevocable and binding in accordance with the provisions of the RFT, and may be accepted by the Toronto Zoo in its sole and absolute discretion unless such Bid has been properly withdrawn in accordance with Section 1.11 (Withdrawal of Bids).

1.11 Withdrawal of Bids

.1 A Bid may be withdrawn at any time prior to the Submission Deadline by delivering written notice of withdrawal to the Procurement Contact by means of email or in person Toronto Zoo before the Submission Deadline.

.2 For clarity, a Bid may only be withdrawn by delivering such notice to the Procurement Contact prior to the Submission Deadline and cannot be withdrawn by any other means. If a Supplier fails to properly withdraw a Bid, the Bid shall be considered to be the Supplier's submitted Bid, shall be irrevocable and binding in accordance with the provisions of the RFT, and may be accepted by the Toronto Zoo in its sole and absolute discretion, notwithstanding such failure.

.3 Any Bids that are properly withdrawn will not be examined or evaluated for the purpose of the RFT but shall be retained for the Toronto Zoo's record retention purposes.

1.12 Bid Validity Period

.1 Upon the Submission Deadline, each submitted Bid shall be irrevocable and binding on Suppliers for the period of time following the Submission Deadline as set out in the RFT timetable in Section 1.5 (RFT Timetable) ("**Bid Validity Period**").

.2 In exceptional circumstances, prior to the expiration of the Bid Validity Period, the Toronto Zoo may request Suppliers to extend the validity of their Bids and any accompanying Bid Bonds. The request and responses shall be made in writing by the Procurement Contact Toronto Zoo. A Supplier may refuse the Toronto Zoo's

request without rendering its Bid non-compliant. A Supplier granting the request shall not be required or permitted to modify its Bid.

SECTION 2 - EVALUATION, ACCEPTANCE AND EXECUTION

2.1 Evaluation

.1 **Evaluation Process**

.1 The Toronto Zoo will conduct the evaluation of Bids in the following two stages.

Stage 1: The Bids will be reviewed to determine whether they comply with all of the mandatory requirements of the RFT, including the requirements of Section 1.9 (Submission of Bids). Bids that that are substantially incomplete or do not substantially comply with the requirements of this RFT will be excluded from consideration in Stage 2.

Stage 2: The compliant Bids will be ranked on the basis of the submitted pricing of each in accordance with the price evaluation method set out in the Pricing Form.

.2 Subject to its reserved rights set out in this Part, the Toronto Zoo may at any time and from time to time, in its sole and absolute discretion, revisit, revise, confirm or adjust the evaluations of a Bid at any time during the RFT process.

.2 **Tied Bids**

In the event that the Toronto Zoo receives two (2) or more Bids identical in price, the Toronto Zoo reserves the right to select one of such Bids as set out the Toronto Zoo's Policies. The Tied Bid procedure allows Toronto Zoo the tie to be broken by way of coin toss or lottery.

.3 **Materially Unbalanced or Abnormally Low Bids**

.1 A Bid is materially unbalanced if:

- it is based on prices which are significantly less than cost for some items and prices which are significantly overstated in relation to cost for other items; and
- the Toronto Zoo has determined that the Bid may not result in the lowest overall cost to the Toronto Zoo even though it may be the lowest submitted Bid; or
- it is so unbalanced as to be tantamount to allowing an advance payment.

.2 A Bid is abnormally low if the pricing, in combination with other constituent elements of the Bid, appears unreasonably low to the extent that the pricing raises material concerns with the Toronto Zoo as to the capability of the Supplier to perform the Contract on the basis of the offered pricing.

.3 If a materially unbalanced Bid or an abnormally low Bid is identified, the Toronto Zoo may seek clarification from the Supplier, including a detailed price analysis of its pricing in relation to the subject matter of the Contract, the scope of Work, the estimated quantities, the schedule for the performance of the Work, the allocation of risks and responsibilities and any other requirements of RFT.

.4 If after evaluation of the price analysis, the Toronto Zoo determines that the Supplier has failed to demonstrate its capability to perform the Contract on the basis of the offered pricing, or that the offered pricing in constitutes a material risk to the Toronto Zoo, the Toronto Zoo may reject the Bid.

2.2 Rights of the Toronto Zoo

In addition to, but without limiting any other rights or options of the Toronto Zoo under this RFT, the Toronto Zoo may, in its sole and absolute discretion carry out the RFT process as it determines to be in the best interests of the Toronto Zoo and to be the most beneficial to Toronto Zoo. The Toronto Zoo may, in its sole and absolute discretion, exercise any or all of the following rights and options with respect to this RFT, at any time.

.1 The Toronto Zoo may waive minor irregularities in any Bid.

.2 The Toronto Zoo shall not be obliged to accept or reject any Bid (in whole or in part), including if:

- the Bid contents appear to be incorrect, inaccurate or inappropriate;
- the Supplier has engaged in conduct prohibited by the RFT; or
- the Supplier or any member of a Supplier's Joint Venture is or becomes bankrupt, insolvent, makes an assignment for the benefit of its creditors generally or has a receiver appointed over all or a substantial part of its assets.

.3 The Toronto Zoo may suspend, modify and/or cancel this RFT (with or without the substitution of another RFT) or the Project.

.4 The lowest quoted price may not necessarily be accepted by the Toronto Zoo.

.5 The Toronto Zoo may verify the validity of a Bid including the Supplier's statements, claims, qualifications or capabilities, by whatever means the Toronto Zoo deems appropriate including obtaining references other than those offered by the Supplier, and conduct investigations as to the qualifications of each Supplier.

.6 The Toronto Zoo may, at any time during the RFT process, require (within such time period as set by the Toronto Zoo) one, some or all of the Suppliers to:

- submit supplementary information or documentation clarifying any matters contained in their Bid;

- meet with the Toronto Zoo to clarify aspects of their Bid;
- acknowledge and agree to the Toronto Zoo's interpretation of any aspect of a Bid,

provided, however, that the Toronto Zoo is not obliged to seek clarification of any aspect of a Bid and may request clarification from some but not all Suppliers. Such clarification may be in respect of clarification with respect to whether a Bid meets the mandatory requirements of the RFT or whether the Supplier meets the necessary experience and performance qualifications set out in the RFT, if any. Any supplementary information and documents submitted by a Supplier which have been accepted by the Toronto Zoo and the interpretations prepared by the Toronto Zoo which have been acknowledged and agreed to by a Supplier shall be considered to form part of the Bid.

.7 The Toronto Zoo reserves the right to assess the ability of the Supplier to perform the Contract and may reject any Bid where, in the Toronto Zoo's sole determination, the personnel and/or resources of the Supplier are insufficient.

.8 Bids that are improperly prepared, not in compliance with all of the requirements or instructions of the RFT, incomplete, improperly signed, conditional, qualified, illegible, obscure or contain reservations, additions not called for, arithmetical errors, omissions, erasures, alterations, or irregularities of any kind may, be considered informal or irregular and may be rejected or be retained by the Toronto Zoo for consideration and acceptance.

.9 The Toronto Zoo may choose to meet with some or all of the Suppliers in connection with their Bids or the matters provided for in the RFT. The Toronto Zoo may visit the existing place or places of business of some or all Suppliers for purposes of clarification or verification.

.10 The Toronto Zoo may award one or more contracts for portions or all of the Work to as many Suppliers and/or Other Persons as it deems appropriate, including awarding a contract for Work less than the scope or quantity contemplated in the Successful Supplier's Bid or the RFT.

.11 The Toronto Zoo may issue a solicitation to one, some or all of the Suppliers and/or any Other Person.

.12 After the Submission Deadline, the Toronto Zoo may increase or decrease the quantity of any unit of Work in accordance with the Contract.

.13 The Toronto Zoo may exercise any other right or option provided for in, or in connection with, this RFT, including the rights and options set out in the Toronto Zoo's Policies.

.14 The Toronto Zoo may do nothing in relation to the Bids or this RFT.

2.3 Contract Execution

.1 Once a Bid has been accepted by the Toronto Zoo, the Procurement Contact will notify the Successful Supplier that it has been awarded the Contract.

.2 The Successful Supplier will be required to execute and deliver the Contract as well as the other documentation set out below in this Section 2.3.2 (Contract Execution) by taking the following steps within ten (10) Business Days after being notified by the Toronto Zoo that the Contract is ready for execution:

.1 execute and return the Contract, without any unilateral revisions to the Contract;

.2 obtain and deliver a performance bond and a labour and material payment bond for the due and proper performance of the Work, each in accordance with the requirements of the Contract and signed and sealed by the Supplier and its surety;

.3 arrange for the certificate of insurance in the form attached as a part of the Contract to be completed and signed (including stamp of insurance broker) and delivered to the Toronto Zoo;

.4 A letter from Workplace Safety and Insurance Board certifying that the Contractor is in good standing with the Board. A "letter of good standing" must be re-submitted throughout the Contract every 90 days.

.3 Should the Successful Supplier fail to execute and deliver the Contract and deliver the accompanying documents in accordance with the requirements of Section 2.3.2 (Contract Execution), the Successful Supplier shall be deemed to have abandoned all rights and interests in the Contract and the RFT and the Toronto Zoo may, without prejudice to any other remedy or right which it may have, exercise all or any one or more of the following rights:

- rescind its award of the Contract;
- call on the Bid Bond;
- accept the Bid of the next highest ranked Supplier and proceed to execute the Contract with such Supplier; or
- suspend the Successful Supplier from participating in other Toronto Zoo procurement processes for such period of time as may be determined under the Supplier Performance Evaluation .

2.4 Notification to Other Suppliers

Once the Successful Supplier is notified that the Toronto Zoo has awarded the Contract, the other Suppliers will be notified by the Toronto Zoo in writing Toronto Zooof the outcome of the RFT process.

2.5 Debriefing

Unsuccessful Suppliers may request a debriefing after receipt of a notification of the outcome of the selection process. All requests must be in writing to the Procurement Contact Toronto Zoo. The intent of the debriefing information session is to aid the Supplier in presenting a better bid in subsequent procurement opportunities. Any debriefing provided is at the sole and absolute discretion of the Toronto Zoo, and not for the purpose of providing an opportunity to challenge the RFT process.

SECTION 3 - GENERAL RFT TERMS AND CONDITIONS

3.1 General Process Terms and Conditions

.1 Suppliers acknowledge that their Bids are governed by the terms and conditions set out in this RFT as well as the by-laws, policies and procedures established by the Toronto Zoo (including the Toronto Zoo's Policies and Procedures) and any additional terms and conditions related to the provision of the Toronto Zoo and Suppliers will become familiar, and comply with, all of the foregoing. Each Supplier shall comply with the Toronto Zoo's Policies and Procedures including the specific policies set out in Form A of Part 4 – Bid Submission Form (Toronto Zoo's Policies and Procedures) and elsewhere in this RFT. It is the responsibility of the Supplier to review all such policies.

.2 Suppliers should structure their bids in accordance with the instructions in this RFT. Where information is requested in this RFT, any response made in a Bid should reference the applicable section numbers of this RFT.

.3 The Toronto Zoo will have no obligation to consider information, documentation or other content not included in a Bid for the purpose of evaluating the Bid. For clarity, the Toronto Zoo will not consider any content referred to in but not included in the Bid, including information referenced by links to websites or other external documents.

3.2 Suppliers Shall Bear Their Own Costs

Each Supplier shall bear all costs, expenses and financial obligations associated with or incurred by the Supplier to: (i) prepare and present its Bid or to otherwise participate in the RFT process including, if applicable, costs incurred for samples, interviews or demonstrations; or (ii) to establish a legally binding contract with the Toronto Zoo.

3.3 Limitation of Liability

.1 Notwithstanding anything in the RFT and any express or implied duties or obligations of the Toronto Zoo to the contrary, the Toronto Zoo and each of its agencies, boards, commissions, elected officials, officers, employees, servants, agents, volunteers, suppliers, advisers and contracted personnel will have no liability to any Person, including any Supplier and prospective Supplier for any damages, costs, liabilities, losses or expenses including direct, indirect, special or punitive damages, or for loss of profits, loss of opportunity or loss of reputation arising out of or otherwise relating to:

- this RFT,
- participation of any such Person in this RFT process;
- the provision and availability or lack of availability or accuracy of the Toronto Zoo RFT issued by the Toronto Zoo; or
- the Toronto Zoo's acts or omissions in connection with the conduct of this RFT process, including the acceptance, non-acceptance or delay in acceptance by the Toronto Zoo of any Bid.

.2 This limitation applies to all possible claims, whether arising in contract, tort, equity, or otherwise, including any claim for a breach by the Toronto Zoo of a duty of fairness, if

any, or relating to a failure of the Toronto Zooto comply with the rules set out in this RFT. By submitting a Bid to the Toronto Zoo, each Supplier irrevocably and unconditionally waives any claims for damages, costs, liabilities, losses and expenses, and shall not seek any order for injunctive relief or specific performance, against the Toronto Zoo, its agencies, boards, commissions, elected officials, officers, employees, servants, agents, volunteers, advisers and contracted personnel.

.3 Each Supplier agrees that, despite Section 3.3.1(Limitation of Liability) or any limitations of liability or releases in favour of Toronto Zoo, if the Toronto Zoo is found to be liable, in any way whatsoever, for any act or omission in respect of the RFT Toronto Zoo to any Supplier or any other Person participating in the RFT process, and the aggregate amount of damages recoverable against Toronto Zoo for any matter relating to or arising from any act or omission by the Toronto Zoo, whether based upon an action or claim in contract, warranty, equity, negligence, intended conduct or otherwise, including any action or claim arising from the acts or omissions, negligent or otherwise, of the Toronto Zoo shall be no greater than the Supplier's cost of preparing its Bid.

.4 Notwithstanding the Toronto Zoo's limitation of liability, the Supplier may seek a debriefing or may pursue a dispute of the RFT process in accordance with the Toronto Zoo's Policies and Legislation.

3.4 Joint Venture Bids

A Supplier may be a private legal entity or any combination of such entities in the form of a joint venture (**Joint Venture**) under and existing agreement or with the intent to enter into such an agreement as supported by a letter of intent. In the case of a Joint Venture, all members shall be jointly and severally liable for the execution of the entire contract if selected by the Toronto Zoo. The Joint Venture shall nominate a representative who shall have the authority to conduct all business on behalf of all members of the Joint Venture during the procurement process and for the execution and performance of any resulting contract.

3.5 Participation in Multiple Bids

Submission or participation in more than one Bid by a Supplier will result in the disqualification of all proposals in which the Supplier is involved. This does not limit the inclusion of the same subcontractor from being named in more than one Bid as a subcontractor only.

3.6 Toronto Zoo Materials

.1 The RFT and all correspondence, data, plans, materials, drawings, specifications, reports, estimates, summaries, photographs, models and all other information and documentation in any form provided or made available to any Supplier or prospective Supplier by, or on behalf of, the Toronto Zoo in connection with, or arising out of this RFT (collectively, the "**Toronto Zoo Materials**") and all intellectual property rights therein:

- are and shall remain the sole and absolute property of the Toronto Zoo;

- must be treated by Suppliers and prospective Suppliers as confidential and Suppliers must maintain such confidentiality;
- must not be disclosed without prior written authorization from the Toronto Zoo;
- must not be used for any purpose other than for replying to this RFT, and for fulfillment of the Contract or any related subsequent agreement; and
- immediately upon the request of the Toronto Zoo, must be returned by the Supplier to the Toronto Zoo and all electronic copies must be destroyed.

.2 Unless and to the extent provided otherwise in the Contract, the Toronto Zoo and its advisers make no representation or warranty as to the accuracy or completeness of the Toronto Zoo Materials. Any quantities shown or data contained in the Toronto Zoo Materials are estimates only and are for the sole purpose of indicating to Suppliers the general scale and scope of the Work. Use of or reliance by Suppliers on the Toronto Zoo Materials Toronto Zoo shall be at the Supplier's sole risk and without recourse against the Toronto Zoo.

.3 It is the Suppliers' responsibility to make their own independent investigations, due diligence, projections and conclusions, and consult their own advisors, to obtain all the information necessary to:

- verify and confirm the accuracy and completeness of the Toronto Zoo Materials, unless and to the extent provided otherwise in the Contract;
- Toronto Zoo satisfy themselves as to all existing conditions affecting the Project or the Contract; and
- prepare their Bids in response to this RFT.

3.7 Ownership of Bid Materials

.1 The documentation comprising any Bid, along with all correspondence, data, plans, materials, drawings, specifications, reports, estimates, summaries, photographs, models and all other information and documentation in any form provided or made available to the Toronto Zoo by, or on behalf of, any Supplier in connection with, or arising out of this RFT (collectively, the "**Bid Materials**") and all intellectual property rights therein, once received by the Toronto Zoo:

- shall become the sole and absolute property of the Toronto Zoo;
- shall become subject to MFIPPA, and the Toronto Zoo may be required to disclose the Bid Materials members of the public, pursuant to MFIPPA.

.2 Each Supplier:

- represents and warrants that the information contained in its Bid Materials does not infringe any intellectual property right of any third party;

- hereby assigns and transfer to the Toronto Zoo, and shall cause all its personnel and other third parties to assign and transfer to the Toronto Zoo, all right, title and interest in the Bid Materials, including intellectual property rights therein:

- shall cause all its personnel and other third parties to waive, for the benefit of the Toronto Zoo, their respective moral rights (and any similar rights to the extent that such rights exist) in and to the Bid Materials; and

- shall indemnify, defend and hold harmless the Toronto Zoo, City of Toronto and Toronto Regional Conservation Authority and its agencies, boards, commissions, elected officials, officers, employees, servants, agents, volunteers, advisers and contracted personnel, if any, against all claims, actions, suits and proceedings brought against, or losses, costs, expenses, damages suffered, sustained, or incurred by them which may be directly or indirectly attributable to, or arising or alleged to arise out of the infringement or alleged infringement of any patent, copyright, trademark, or other intellectual property right of a third party in connection with the Bid Materials.

.3 Suppliers are also advised that MFIPPA does provide protection for confidential and proprietary business information. For the purposes of the Toronto Zoo's compliance with MFIPPA, Suppliers are advised to identify in their Bid Materials material any scientific, technical, commercial, proprietary or similar confidential information, the disclosure of which could cause them injury.

.4 Each Supplier's name and total bid price may be made public. Bid Materials will, as necessary, be made available:

- on a confidential basis, to advisers retained by the Toronto Zoo to advise or assist with the RFT process;

- to members of Council in accordance with the Toronto Zoo's procedures; and

- to members of the public pursuant to MFIPPA.

.5 The Toronto Zoo will not return the Bid or any other Bid Materials.

3.8 Failure or Default of Supplier

.1 Without prejudice to any other right or remedy available to the Toronto Zoo under this RFT or at law, if the Supplier, for any reason, fails or defaults in respect of an obligation of the Supplier under the terms of the RFT, the Toronto Zoo may:

- disqualify the Supplier from the RFT and/or from competing for any future solicitations issued by the Toronto Zoo; and

- require the Supplier to pay the Toronto Zoo the difference between its Bid and any other Bid which the Toronto Zoo accepts, if the latter is for a greater amount and, in addition, to pay the Toronto Zoo any other cost

which the Toronto Zoo may incur by reason of the Supplier's failure or default.

.2 The Supplier shall be ineligible to submit a new bid for any solicitations that the Toronto Zoo is required to reissue as a result of the Supplier's failure or default under the Contract or where the Toronto Zoo deems that the Supplier has abandoned the Contract.

3.9 Trade Agreements

Suppliers should be aware that procurements falling within the scope of the Canadian Free Trade Agreement or other trade agreements applicable to the Toronto Zoo are subject to such agreements, but the rights and obligations of the parties will be governed by the specific terms of this RFT

3.10 Governing Law and Enforceability

.1 The terms and conditions of the RFT process are to be governed by and construed in accordance with the Toronto Zoo's Policies, the laws of the province of Ontario and the federal laws of Canada applicable therein.

.2 If any provision of the RFT or its application to any party or circumstance is unenforceable, the provision shall be ineffective only to the extent of the unenforceability without: (i) invalidating the remaining provisions of the RFT; (ii) changing the fundamental nature of the obligations assumed by the parties; and (iii) affecting its application to other parties or circumstances.

3.11 RFT Definitions and Interpretation

.1 **Definitions**

Throughout this RFT, unless inconsistent with the subject matter or context, the following definitions shall apply other than in respect of Part 2 (FORM OF CONSTRUCTION AGREEMENT).

.1 "**Addenda**" or "**Addendum**" means a document containing additional information and/or changes to the RFT issued by the Toronto Zoo on its website.

.2 "**Bid**" means an offer submitted by a Supplier in response to the RFT, which includes all of the documentation necessary to satisfy the submission requirements of the RFT and "**Bids**" shall have a corresponding meaning;

.3 "**Bid Bond**" has the meaning set out in Section 1.9.3 (Bid Bonds).

.4 "**Bid Materials**" has the meaning set out in Section 3.7.1 (Ownership of Bid Materials).

.5 "**Bid Submission Form**" has the meaning set out in Section 1.9.2 (Bid Submission Form).

.6 "**Bid Validity Period**" has the meaning set out in Section 1.12. (Bid Validity Period).

.7 "**Business Day**" means a day other than:

.1 a Saturday, Sunday, statutory holiday, or statutory vacation day that is observed by the Toronto Zoo of Toronto; or

.2 a day identified by the Toronto Zoo as a designated or statutory holiday

.8 "**Toronto Zoo**" means the Board of Management of the Toronto Zoo.

.9 "**Materials**" has the meaning set out in Section 3.6 (Toronto Zoo Materials).

.10 "**Contract**" means the contract in the form set out in Part 2 (FORM OF CONSTRUCTION AGREEMENT) to be executed by the Successful Supplier and the Toronto Zoo, which sets out the terms and conditions for the performance of the Work.

.11 "**Joint Venture**" has the meaning set out in Section 3.4 (Joint Venture Bids).

.12 "**MFIPPA**" means the *Municipal Freedom of Information and Protection of Privacy Act*, as amended, supplemented, re-enacted or replaced from time to time.

.13 "**Person**" means any individual, partnership, limited partnership, firm, joint venture, syndicate, company or corporation with or without share capital, trust, trustee, executor, administrator or other legal personal representative, governmental authority or entity however designated or constituted

.14 "**Procurement Contact**" has the meaning set out in Section 1.2 (Procurement Contact).

.15 "**Project**" has the meaning set out in Section 1.1 (Introduction).

.16 "**RFT**" means this RFT package in its entirety, including all documents listed in Section 1.3 (RFT Documents) and Addenda that may be issued by the Toronto Zoo.

.17 "**Subcontractor**" means a Person undertaking the execution of a part of the Work by virtue of an agreement with the Contractor.

.18 "**Submission Deadline**" means the specified deadline for Bids to be submitted to the Toronto Zoo as indicated in the RFT timetable in Section 1.5 (RFT Timetable).

.19 "**Successful Supplier**" means the Supplier that has been selected to enter into the Contract for the performance of the Work.

.20 "**Supplier**" means a Person, including, where applicable, a Joint Bid Team, that submits a Bid in response to this RFT and "**Suppliers**" shall have a corresponding meaning.

.21 "**Work**" means all work, services and deliverables to be provided by a Contractor in respect of the Project as described in this RFT.

.2 **Interpretation of the RFT**

.1 Except where otherwise requested, all documents relating to the Bid and all communications between Suppliers and the Toronto Zoo will be in the English language.

.2 Except where otherwise disclosed, all references to times in this RFT will mean local time in Toronto, Ontario, Canada.

.3 The phrase “includes” “, include” or “including” means “includes, without limitation” or “including” or “include, without limitation”.

.4 In the RFT, unless the context otherwise requires, words importing the singular include the plural and vice versa and words importing gender include all genders.

.5 Unless otherwise stated herein, all amounts in the RFT are in Canadian dollars, including any amounts provided in the Pricing Form.

.6 In addition to the words defined in Section 13.13.1 (Definitions), the other words used in this RFT shall be interpreted consistent with the definitions contained in the Toronto Zoo's Policies..

SUBMISSION LABEL

This address label should be affixed to the front of your sealed tender, quotation and proposal envelope/package submission. Toronto Zoo will not be held responsible for envelopes and packages that are not properly labelled or submitted to an address other than the one listed on this label.

Vendor Name _____

TZC T 57-2019-12 – Orangutan Outdoor Exhibit Construction
Closing: Friday, 2020-01-17, 12:00 (noon) local time

TO BE RETURNED TO

TORONTO ZOO
C/O SUPERVISOR, PURCHASING & SUPPLY
ADMINISTRATIVE SUPPORT CENTRE
361A OLD FINCH AVE.
TORONTO, ONTARIO
M1B 5K7

CONSTRUCTION AGREEMENT

CONTRACT TZC T 57-2019-12

for

Facilities & Infrastructure, Project Management Branch

Orangutan Outdoor Exhibit Construction

NOTICE RE: CONSTRUCTION ACT

* Parts I.1 (Prompt Payment) and II.1 (Adjudication) of the Construction Act apply with respect to this Agreement and all subcontracts thereunder.

* All claims for lien (Form 12) must be completed and submitted through the City of Toronto's website at www.toronto.ca/liens, pursuant to section 34(3.1) of the Construction Act and section 11.1 of O. Reg 304/18.

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AGREEMENT BETWEEN OWNER AND CONTRACTOR

This Agreement entered into on the Effective Date

between

The Board of Management of the Toronto Zoo

("Owner")

and

● **[Note to Finalization before Execution: Insert Legal Name of Contractor]**

("Contractor")

WHEREAS Parts I.1 (Prompt Payment) and II.1 (Adjudication) of the Construction Act apply with respect to this Agreement and all subcontracts thereunder as the Owner commenced a procurement process for the improvement that is subject of the Agreement ("**Procurement Process**") on or after October 1, 2019;

AND WHEREAS ● **[Note to Finalization before Execution: Complete recitals]**;

NOW THEREFORE in consideration of the mutual covenants herein contained, the Owner and the Contractor agree as follows:

1. THE WORK

The Contractor shall:

1.1 perform the Work required by the Agreement for the Project located at the Site; and

1.2 do and fulfill everything indicated by the Agreement; and

1.3 commence the Work on the Commencement Date and, subject to adjustment in Contract Time as provided for in the Agreement, attain Substantial Performance of the Work, by the Scheduled Date for Substantial Performance of the Work, and otherwise perform the Work in accordance with the Construction Schedule.

2. CONTRACT PRICE

2.1 The price for the Work (including any changes in the Work), which excludes Value Added Taxes, is the sum of, if applicable:

.1 in respect of the Fixed Price Work, the Fixed Price; plus

.2 in respect of the Unit Price Work, the Total Price of Unit Price Work; plus

.3 in respect of T&M Changes in the Work recorded in a Change Order, the T&M Price,

(the "**Contract Price**")**.**

2.2 Value Added Taxes in the percentage amount of thirteen percent (13%) are payable by the Owner to the Contractor.

2.3 The Contract Price shall only be subject to adjustment as provided in the Agreement.

2.4 All amounts in the Agreement are expressed and payable in Canadian currency, unless expressly noted otherwise.

3. DOCUMENTS COMPRISING THE AGREEMENT

3.1 The following documents whether attached hereto or referred to herein form an integral part of the Agreement:

- Schedule A – Information Sheet
- Schedule B – Pricing Form
- Schedule C – Definitions
- Schedule D – General Conditions
- Schedule E – Valuing Changes in the Work
- Schedule F – Owner Policies, Procedures, By-Laws and Other Requirements
- Schedule G – Forms
    - Form 1 – Proper Invoice
    - Form 2 – Certificate of Insurance
    - Form 3 – Tax Statutory Declaration
    - Form 4 – Notice of Adjudication
- Schedule H – Drawings and Specifications
- Construction Schedule
- Supplemental Instructions
- any other document identified elsewhere in the Agreement as a document forming part of the Agreement.

The parties hereto have executed this Agreement by the hands of their duly authorized representatives.

SIGNED AND DELIVERED
in the presence of:

The Board of Management of the Toronto Zoo

● [Note to Finalization before Execution: Authority stamp to be completed by the Owner]

By:

Name: ●
Title: ●
I have authority to bind the corporation

By:

Name: ●
Title: ●
I have authority to bind the corporation

● [Note to Finalization before Execution: Insert Legal Name of Contractor]

By:

Name: ●
Title: ●
I have authority to bind the corporation

By:

Name: ●
Title: ●
I have authority to bind the corporation

[Note to Finalization before RFT/Execution: If the Contractor is an individual, use the following signature block. Delete signature block not used. Consult Legal Services if needed.]

SIGNED, SEALED & DELIVERED
In the presence of:

Witness

Name

SCHEDULE A

INFORMATION SHEET

The following table provides information cross-referenced in the provisions of the Agreement. All reference to GCs are located in Schedule D – General Conditions.

Row	Input Information	Reference	Description
A. Names and Information			
A.1	Project	Sch. C, Definition 80 & GC 3.8.2.3(1)	Construct a new outdoor orangutan exhibit at the Toronto Zoo.
A.2	Site	Definition 91	Work under this contract will take place at: 361A Old Finch Ave, Toronto, ON M1B 5K7 Indo-Malayan Pavilion
A.3	Notice information	GC 1.6.1.2, GC 1.6.1.3 & GC 1.6.1.4	To be provided after award.
A.4	Identity of Contract Administrator	Sch. C, Definition 25	To be provided after award
A.5	Identity of Owner Representative	Sch. C, Definition 71	To be provided after award
A.6	Approved Subcontractors	GC 3.8.3, GC 3.8.3.1 & GC 3.8.3.2	To be entered after award.
B. Pricing, Markups and Liquidated Damages			
B.1	Contractor's Markup for negotiated fixed price and negotiated unit price changes in the Work performed by Contractor	Sch. E, s. 2.2.3.1	Not Applicable Note: All markups for Labour and Equipment shall be included in the Unit Bid Prices. No additional markups will be paid.
B.2	Total Cumulative Markup allowed for Contractor, Subcontractors, Suppliers and Sub-subcontractors on	Sch. E, s. 2.2.3.2	Zero percent (0%)

Row	Input Information	Reference	Description
	negotiated fixed price and negotiated unit price changes in the Work performed by Subcontractors, Suppliers or Sub-subcontractors (and not performed by the Contractor)		
B.3	T&M Percentage Markup for changes in the Work performed by Contractor	Sch. E, s. 3.3.1	Ten percent (10%)
B.4	Total Cumulative T&M Percentage Markup allowed for Contractor, Subcontractors, Suppliers and Sub-subcontractors on changes in the Work performed by Subcontractors, Suppliers or Sub-subcontractors (and not performed by the Contractor)	Sch. E, s. 3.3.2	Fifteen percent (15%)
B.5	Markup for Cash Allowance overages	GC 6.1.4	Ten percent (10%)
B.6	Amounts of Delay Liquidated Damages	GC 7.6.1	$2,600 per Calendar Day that is a weekday; $2,600 for Calendar Day that is a weekend day
B.7	Changes in the Work on a Time & Material Basis	Sch. E, s. 3	Vertical Approach
B.8	Schedule A Schedule of Prices for Changes in the Work	Sch. B	Not Applicable
B.9	Invoice Period	Sch. C, Definition 55	No change to default Invoice Period
B.10	Giving of a	GC 5.3.1	Proper Invoices shall be given to the Owner by

Row	Input Information	Reference	Description
	Proper Invoice		referencing GC 1.6.1.1
C. Dates, Time Periods and Deadlines			
C.1	Effective Date	Sch. C, Definition 41	To be finalized after award
C.2	Commencement Date	Sch. C, Definition 17 & GC 3.1.6	To be provided after execution of Agreement by written notice to the Contractor
C.3	Key Work Milestones	Sch. C, Definition 56	Not Applicable
C.4	Scheduled Date for Substantial Performance of the Work	Sch. C, Definition 87	August 07, 2020
C.5	Scheduled Date for Total Performance of the Work	Sch. C, Definition 88	September 04, 2020
C.6	Warranty Period	Sch. C, Definition 114	No change to default Warranty Period unless otherwise stated in the specifications (Part 3) of the tender package.
C.7	Working Days	Sch. C, Definition 116	No change to default Working Days
C.8	Number of Days for Contract Administrator to Issue a Certificate for Payment	GC 5.4.1.2	28 Calendar days after receipt of a Proper Invoice
C.9	Deadline to acknowledge a Contemplated Change Order	GC 7.2.1	No change to default of 10 Working Days.
C.10	Deadline to respond to a Change Directive	GC 7.3.5	5 Working Days
C.11	Suspension Period for Stop Work Orders	GC 11.2.1	No change to default of 60 Working Days.
D. Insurance, Contract Security, Bonds and Contractual Holdback			

Row	Input Information	Reference	Description
D.1	Insurance Coverages	GC 8.1.1.1, GC 8.1.1.2, GC 8.1.1.3 & GC 8.1.3	Automobile liability insurance shall have limits of not less than two million dollars ($2,000,000). Pollution Liability Insurance coverage is not required.
D.2	Additional Contract Security	GC 8.2.1	Not Applicable
D.3	Amount of the Contractual Holdback	GC 8.4.1	Not Applicable
D.4	Percentage by which Contractual Holdback is Reduced after Total Performance of the Work	GC 8.4.3	Not Applicable
D.5	Surety Bonds	GC 8.3.1	No change to requirements in GC 8.3.1
E. Miscellaneous			
E.1.	Alternate order of priority of the Agreement Documents	GC 1.1.7.1	No change to default order of priority
E.2.	Allowable Portion of the Work for Subcontracting	GC 3.8.1	Not Applicable
E.3.	Accuracy of Utilities and Structures	GC 4.1.4.1	Contractor to rely on accuracy of positions of Utilities and Structures provided in the Agreement, subject to the following tolerances: on any drawing, 2 metres horizontally, and 1 metre vertically.
E.4.	Fair Wage Schedule	Sch. F, if applicable	Fair Wage Policy is applicable. Use the City of Toronto's Fair Wage Policy available at https://www.toronto.ca/business-economy/doing-business-with-the-city/understanding-the-procurement-process/fair-wage-office-policy/fair-wage-policy/
E.5.	Workforce Development Plan	Sch. F, if included	There is no requirement for a Workforce Development Plan under this Agreement.

SCHEDULE B

PRICING FORM

Pricing Form is provided within the Tender Posting (Part 5) on the Toronto Zoo's Website

SCHEDULE C

DEFINITIONS

The following Definitions shall apply to the Agreement.

1. Adjudicable Dispute
A dispute respecting an Adjudicable Matter and that complies with GC 12.1.2.

2. Adjudicable Matter
Any matter:

1. referred to in s. 13.5(1) of the Construction Act, other than in paragraph 7;
2. that is prescribed under the Construction Act as referable to adjudication; or
3. agreed to by the parties pursuant to GC 12.2.1.2.

3. Adjudication
Adjudication means a construction dispute interim adjudication under Part B.1 of the Construction Act.

4. Adjudicator
Adjudicator means an individual who is qualified by the Authority as an adjudicator.

5. Agreement
Agreement means the agreement between Owner and Contractor and the Schedules attached thereto, as the same may be amended, supplemented, restated or replaced from time to time in writing upon the mutual agreement of the parties or as may be otherwise provided for in the Agreement.

6. Allowance
Allowance means a Cash Allowance or Provisional Allowance, as applicable.

7. As-Built Drawings
As-Built Drawings has the meaning set out in GC 3.10.2.

8. Authority
Authority means the Authorized Nominating Authority designated under the Construction Act.

9. Calendar Day
Calendar Day means a calendar day.

10. Cash Allowance
Cash Allowance means the allowances, if any, identified in the Pricing Form for known items included in the Work where the actual cost was unknown at the time of tender. The Contractor's overhead and profit is excluded from Cash Allowance and is carried in other pricing as set out in GC 6.1.2.

11. Certificate of Recognition (COR™)

Certificate of Recognition (COR™) means the nationally recognized occupational health and safety certification granted to qualifying firms by the Infrastructure Health and Safety Association (IHSA) of Ontario or its successor.

12. Change Directive

A Change Directive means a written instruction, which shall be deemed incorporated into and forming part of the Agreement, prepared by the Contract Administrator and signed by the Owner directing the Contractor to proceed with a change in the Work prior to or in the absence of the Owner and the Contractor agreeing upon adjustments in the Contract Price and the Contract Time.

13. Change Order

A Change Order means a written amendment to the Agreement, which shall be deemed incorporated into and forming part of the Agreement, prepared by the Contract Administrator and signed by the Owner and the Contractor stating their agreement upon:

1. a change in the Work;

2. the method of adjustment or the amount of the adjustment in the Contract Price, if any; and

3. the extent of the adjustment in the Contract Time, if any.

14. City

City means the City of Toronto. The words “City” or “City of Toronto” wherever used in the Agreement shall be regarded as synonymous.

15. Claims

Claims means any and all actual, threatened or potential claims, demands, proceedings, complaints, grievances, actions, adjudications, litigation, applications, suits, causes of action, orders, charges, arbitrations or other similar process, of whatsoever kind or nature (whether civil, administrative, regulatory, arbitral or otherwise), and Losses in respect of the foregoing matters.

16. Claim Notice

Claim Notice has the meaning set out in GC 7.7.1.

17. Commencement Date

Commencement Date means the commencement date for the performance of the Work as set out in row C.2 of the Information Sheet, or if no such date is set out, the date described in the Notice in Writing issued by the Owner to the Contractor, pursuant to GC 3.1.6 directing the Contractor to commence the performance of the Work.

18. Confidential Information

Confidential Information means any and all (as the context requires) information of the disclosing party (including information in respect of or in connection with the Project or the performance of the Work) that is confidential to the disclosing party, or would reasonably be considered confidential, and that is disclosed orally or in writing by or on behalf of the disclosing party, to the receiving party pursuant to the Agreement, including

during the performance of the Work, regardless of whether the Information is specifically identified or marked as “Confidential”, “Restricted” or “Secret”. For the purposes of the Agreement, all Personal Information shall constitute Confidential Information.

19. Conflict of Interest

Conflict of Interest means any situation or circumstance where in relation to the performance of its obligations under the Agreement, the Contractor’s other commitments, relationships or financial interests:

1. could or could be seen to exercise an improper influence over the objective, unbiased and impartial exercise of its independent judgment; or

2. could or could be seen to compromise, impair or be incompatible with the effective performance of its contractual obligations.

20. Construction Act

Construction Act means the *Construction Act*, RSO 1990, c. C 30.

21. Construction Equipment

Construction Equipment means all tools, machinery and equipment, either operated or not operated, that is required for preparing, fabricating, conveying, erecting, or otherwise performing the Work but is not incorporated into the Work.

22. Construction Schedule

Construction Schedule has the meaning set out in GC 3.5.1.1.

23. Contemplated Change Order

Contemplated Change Order has the meaning set out in GC 7.2.1.

24. Contract Administrator

Contract Administrator means the Person designated by the Owner in row A.4 of the Information Sheet to be the Owner’s day to day administrator for the purposes of the Agreement or such other Person as may be designated by the Owner, from time to time. The words “Engineer”, “Architect” or “Consultant” wherever used in the Agreement shall be regarded as synonymous with the Contract Administrator, unless identified otherwise in row A.4 of the Information Sheet or if the Owner notifies the Contractor otherwise in writing.

25. Contract Price

Contract Price has the meaning set out in paragraph 2.1 of Section 2 of the Agreement – CONTRACT PRICE.

26. Contract Time

Contract Time means the time stipulated in paragraph 1.3 of Section 1 of the Agreement - THE WORK from the Commencement Date to the Scheduled Date for Substantial Performance of the Work.

27. Contractor
Contractor means the Person identified as such on page 1 of the Agreement. The term Contractor means the Contractor or the Contractor's authorized representative as designated to the Owner in writing.

28. Contractor Parties
Contractor Parties means the Contractor, Subcontractors, Suppliers and Sub-subcontractors and their respective Personnel.

29. Contractor Project Manager
Contractor Project Manager has the meaning set out in GC 3.7.3.1.

30. Contractor Records
Contractor Records means the Contractor's books, payrolls, accounts, invoices, purchase orders, receipts or other information or documentation.

31. Contractor Site Supervisor
Contractor Site Supervisor has the meaning set out in GC 3.7.3.2.

32. Contractual Holdback
Contractual Holdback has the meaning set out in GC 8.4.1.

33. Contractor Prepared Documents
Contractor Prepared Documents has the meaning set out in GC 13.3.1.

34. Current Schedule
Current Schedule means the Contractor's most up-to-date working schedule, prepared based on the Construction Schedule, indicating for a specific reporting period the actual progress of the Work and forecasting of future progress and performance to complete the Work.

35. Daily Contractor Work Records
Daily Contractor Work Records mean daily Contractor Records detailing labour (including the number and categories of Personnel and hours worked or on standby) and Construction Equipment (including types and quantities) employed and Product (including descriptions and quantities) used.

36. Deficiency or Deficient
Deficiency or Deficient means any aspect of the Work (including Products) that fails to comply with, or conform to, the requirements of the Agreement including Laws and the Standard of Care, whether or not such non-compliance or non-conformances occur, or are discovered, prior to or during the Warranty Period. Deficiency or Deficient includes deficiencies in application, engineering, manufacture, installation, construction, workmanship or materials (to the extent the Work includes such elements) and deficiencies in Products.

37. Delay Liquidated Damages
Delay Liquidated Damages has the meaning set out in GC 7.6.1.

38. Dispute

Dispute means all disputes between the parties arising out of or in connection with the Agreement including as to:

1. the interpretation, application or administration of the Agreement;
2. findings or determinations under the Agreement, including under GC 7.7.6; or
3. the performance of the Work.

39. Drawings

Drawings means the graphic and pictorial portions of the Agreement as attached or listed in Schedule H – Drawings and Specifications or elsewhere in the Agreement wherever located and whenever issued, showing the design, location and dimensions of the Work, generally including plans, elevations, sections, details, and diagrams, as the same may be amended, supplemented or replaced from time to time by the Owner.

40. Effective Date

Effective Date means the effective date of the Agreement as set out in row C.1 of the Information Sheet.

41. Equivalent OHS Certification

Equivalent OHS Certification means an occupational health and safety certification issued to qualifying firms by an independent third-party organization and accepted by the Owner (in the Owner's sole discretion) as equivalent to the Certificate of Recognition (COR ™).

42. Estimate of Units

Estimate of Units means an estimate of the total units performed during the identified period for each item of the Unit Price Work, as may be amended by the Contract Administrator or Owner Representative.

43. Estimate of Units for Completion

Estimate of Units for Completion means the Estimate of Units as of the Effective Date for the total performance of the applicable item of Unit Price Work, as may be set out in the Pricing Form.

44. Extended Warranty Periods

Extended Warranty Periods has the meaning set out in GC 9.3.6.

45. Fair Wage Policy

Fair Wage Policy means the Owner’s Fair Wage Policy, if any such policy is identified in Schedule F - Owner Policies, Procedures, By-Laws and Other Requirements.

46. Final Acceptance Certificate

Final Acceptance Certificate has the meaning set out in GC 5.8.1.

47. Fixed Price

Fixed Price means the fixed price for the Fixed Price Work set out in the Pricing Form, and as may be adjusted by Change Order.

48. Fixed Price Work
Fixed Price Work means the portion of the Work paid for on a Fixed Price basis.

49. GC
GC means the General Conditions.

50. Governmental Authority
Governmental Authority means any federal, provincial or municipal government, parliament or legislature, or any regulatory authority, agency, tribunal, commission, board or department of any such government, parliament or legislature, or any court or other law, regulation or rule-making entity, each having jurisdiction in the relevant circumstances, including, for clarity, any Person acting under the authority of any Governmental Authority and, with respect to taxes, whether domestic or foreign.

51. Hazardous Material
Hazardous Material means any contaminant, pollutant, dangerous substance, potentially dangerous substance, noxious substance, toxic substance, hazardous waste, flammable material, explosive material, radioactive material, urea formaldehyde foam insulation, asbestos, polychlorinated biphenyls, coal tar and any other biological or chemical agent, substance or material named, described, declared or defined to be hazardous, toxic, or a contaminant or pollutant in, or pursuant to, any applicable Laws.

52. Highway
Highway means a common and public highway, any part of which is intended for or used by the general public for the passage of vehicles and includes the area between the lateral property lines thereof.

53. Indemnitees
Indemnitees has the meaning set out in GC 9.1.1.

54. Invoice Period
Unless otherwise specified in row B.9 of the Information Sheet, Invoice Period means the one-month long period which commences on the Commencement Date and ends on the day prior to the same date as the Commencement Date in the next successive calendar month and each subsequent one-month long period thereafter.

55. Key Work Milestones
Key Work Milestones means the major milestones for the performance of the Work as set out in row C.3 of the Information Sheet, if any, as such milestones may be revised by Change Order or Change Directive.

56. Laws
Laws means all:

1. laws, orders-in-council, by-laws, codes, rules, regulations and statutes of any Governmental Authority;

2. orders, decisions, judgments, injunctions, decrees, awards, directives, rulings and writs of any court, tribunal, arbitrator, Governmental Authority or other Person having jurisdiction;

3. legally enforceable consents, approvals, policies and guidelines of any Governmental Authority; and

4. any requirements under or prescribed by applicable common law,

which are applicable to the Owner, Contractor, the Project, Site, Work or obligations under the Agreement.

57. Lien Holdback
Lien Holdback means the ten percent (10%) holdback retained pursuant to Part IV of the Construction Act.

58. Losses
Losses means any and all losses, debts, expenses, liabilities, damages, obligations, payments, fines and costs.

59. Major Item
Major Item means any item of Unit Price Work that has a value, calculated on the basis of its Estimate of Units for Completion multiplied by its Unit Price, which is equal to or greater than the lesser of:

1. $100,000; and

2. 5% of the estimated Total Price of Unit Price Work (calculated using the Estimate of Units for Completion for all items of Unit Price Work).

60. MFIPPA
MFIPPA means the *Municipal Freedom of Information and Protection of Privacy Act*.

61. Notice in Writing
A Notice in Writing means a written communication between the parties or between them and the Contract Administrator that is transmitted in accordance with the provisions of GC 1.6.1 and GC 1.6.2.

62. Notice of Adjudication
Notice of Adjudication means a written notice of Adjudication, which:

1. complies with Section 13.7(1) of the Construction Act; and

2. is substantially in the form attached as Form 4 of Schedule G – Forms, including the submission of all applicable attachments.

63. Notice of Negotiations
Notice of Negotiations has the meaning set out in GC 12.3.1.

64. OHSA
OHSA means the *Occupational Health and Safety Act* (Ontario).

65. OPS
OPS means the Ontario Provincial Standards.

66. Other Work
Other Work has the meaning set out in GC 4.2.1.3.

67. Owner
The Owner means the City of Toronto or its agency, board or commission as more particularly set out on page 1 of the Agreement.

68. Owner Documents
Owner Documents means, collectively, the Owner Prepared Documents and Contractor Prepared Documents.

69. Owner Prepared Documents
Owner Prepared Documents has the meaning set out in GC 1.1.11.

70. Owner Representative
The Owner Representative means the Person designated by the Owner in row A.5 of the Information Sheet to have the authority to bind the Owner for the purposes of the Agreement or such other Person as may be designated by the Owner, from time to time.

71. Owner Supplied Material
Owner Supplied Material means the material and/or equipment identified or referenced in the Drawings, Specifications or elsewhere in the Agreement as supplied by the Owner for incorporation into the Project, which is to be installed, tested, commissioned and otherwise dealt with, as applicable, by the Contractor in accordance with the Agreement.

72. Owner's Policies, Procedures and By-laws
Owner's Policies, Procedures and By-Laws means the policies and procedures of the Owner and the by-laws of the City of Toronto, as may be amended, supplemented or replaced from time to time, including the policies, procedures and by-laws referenced in Schedule F - Owner Policies, Procedures, By-Laws and Other Requirements.

73. Person
Person means any individual, partnership, limited partnership, joint venture, syndicate, company or corporation with or without share capital, trust, trustee, executor, administrator or other legal personal representative, Governmental Authority or entity however designated or constituted.

74. Personal Information
Personal Information means all information captured by the definition of "personal information" contained in MFIPPA, regardless of whether MFIPPA is applicable to such information.

75. Personnel
Personnel means with respect to a Person, its employees, invitees, directors, officers, representatives and agents, and any other person for whom the Person is directly or indirectly responsible under contract or law.

76. Pricing Form
Pricing Form means the pricing form set out in Schedule B – Pricing Form.

77. Procurement Process
Procurement Process has the meaning set out in the recitals to the Agreement.

78. Product
Product or Products means products, goods, material, machinery, devices, equipment, and fixtures forming the Work or any part thereof, but does not include Construction Equipment and Owner Supplied Material.

79. Project
Project means the project as described in row A.1 of the Information Sheet, of which the Work may be the whole or a part.

80. Proper Invoice
Proper Invoice means an invoice from the Contractor to the Owner on account as provided in 5.2 - OWNER'S OBLIGATION TO PAY, which is in compliance with the requirements of 5.3.

81. Provide
Provide means to supply and install.

82. Provisional Allowance
Provisional Allowance means the allowances, if any, identified in a schedule of prices in the Pricing Form for alterations, extras and deductions. Provisional Allowance items include overhead and profit.

83. QA/QC Plan
QA/QC Plan has the meaning set out in GC 3.13.2.

84. Recovery Plan
Recovery Plan has the meaning set out in GC 7.5.6.1.

85. Rules
Rules means the *Rules of Civil Procedure*, RRO 1990, Reg 194.

86. Scheduled Date for Substantial Performance of the Work
Scheduled Date for Substantial Performance of the Work means the scheduled date for Substantial Performance of the Work as set out in row C.4 of the Information Sheet, or if no such date is set out, the number of Calendar Days or Working Days after the Commencement Date specified in row C.4 of the Information Sheet.

87. Scheduled Date for Total Performance of the Work
Scheduled Date for Total Performance of the Work means the scheduled date for Total Performance of the Work as set out in row C.5 of the Information Sheet, or if no such date is set out, the number of Calendar Days or Working Days after the Commencement Date specified in row C.5 of the Information Sheet.

88. Schedules
Schedules means the schedules to the Agreement listed in paragraph 3.1 of Section 3 of the Agreement – DOCUMENTS COMPRISING THE AGREEMENT and includes any appendices thereto.

89. Shop Drawings
Shop Drawings means the drawings, diagrams, illustrations, schedules, performance charts, brochures, Product data, and other data which the Contractor provides to illustrate details of portions of the Work.

90. Site
Site means the designated site or location of the Work identified in row A.2 of the Information Sheet.

91. Special Specification
Special Specification means a Specification containing requirements specific to the Work that are not included in any Standard Specification or which are intended to amend, supplement or replace part or all of a Standard Specification, as the same may be amended, supplemented or replaced from time to time by the Owner.

92. Specifications
Specifications means that portion of the Agreement as attached or listed in Schedule H – Drawings and Specifications or elsewhere in the Agreement, wherever located and whenever issued, consisting of the written descriptions, requirements, instructions and standards for Products, systems, performance, installation, workmanship, quality, and the services necessary for the performance of the Work, as the same may be amended, supplemented or replaced from time to time by the Owner.

93. Standard Drawing
Standard Drawing means a Drawing listed in the Schedule H – Drawings and Specifications as a standard drawing, as the same may be amended, supplemented or replaced from time to time by the Owner. The City of Toronto's Standard Drawings can be found on-line at www.toronto.ca/ecs-standards. Any of the OPS' Standard Drawings can be acquired from the OPS. Information about OPS can be found at www.ops.on.ca.

94. Standard of Care
Standard of Care has the meaning set out in GC 3.13.1.

95. Standard Specification
Standard Specification means a Specification listed in Schedule H – Drawings and Specifications as a standard Specification, as the same may be amended, supplemented or replaced from time to time by the Owner. The City of Toronto's Standard Specifications can be found on-line at www.toronto.ca/ecs-standards. Any of the OPS' Standard Specifications can be acquired from the OPS.

96. Subcontractor
Subcontractor means a Person having a direct contract with the Contractor to perform a part or parts of the Work at the Site.

97. Subject Matter of Indemnity

Subject Matter of Indemnity has the meaning set out in GC 9.1.1.

98. Submittals

Submittals means documents or items required by the Agreement to be provided by the Contractor in accordance with the Agreement such as:

1. Shop Drawings, samples, models, mock-ups to indicate details or characteristics, before the portion of the Work that they represent can be incorporated into the Work; and

2. As-Built Drawings and manuals to provide instructions as to the operation and maintenance of the Work.

99. Substantial Performance of the Work

Substantial Performance of the Work means:

1. the requirements set out in the Construction Act for a contract to be "substantially performed" have been met, including the Work being ready for use. For clarity, the Work shall not be "ready for use" until it has satisfied all the requirements for "ready for use" in the Specifications or elsewhere in the Agreement; and

2. the Contractor has submitted to the Contract Administrator all items required by the Specifications for Substantial Performance of the Work.

100. Substitution

Substitution has the meaning set out in GC 3.9.4.2.

101. Sub-subcontractor

Sub-subcontractor means a Person having a direct contract with a Subcontractor or Supplier or any other subcontractor or supplier at any tier, to perform a part or parts of the Work, or to supply Products. For greater certainty, Sub-subcontractors do not include the Subcontractors or the Suppliers.

102. Supplemental Instruction

A Supplemental Instruction means an instruction issued in writing, not involving adjustment in the Contract Price or Contract Time, in the form of Specifications, Drawings, schedules, samples, models or written instructions, which are consistent with the intent of the Agreement and issued by the Contract Administrator to supplement the Agreement as required for the performance of the Work.

103. Supplier

Supplier means a Person having a direct contract with the Contractor to supply Products.

104. Temporary Work

Temporary Work means temporary supports, structures, facilities, services, and other temporary items, excluding Construction Equipment, required for the execution of the Work but not incorporated into the Work.

105. Total Performance of the Work or Totally Performed

Total Performance of the Work or Totally Performed means when the entire Work (except for the correction of Deficiencies that are identified after the receipt of the Proper Invoice for payment, in accordance with 5.7) has been fully and totally performed to the requirements of the Agreement (including completion in accordance with the Construction Act and the correction of all Deficiencies that were identified prior to the receipt of such Proper Invoice) as certified by the Contract Administrator in the certificate of payment issued to the Owner pursuant to GC 5.7.1.4.

106. Total Price of Unit Price Work

Total Price of Unit Price Work means the aggregate amount of, for all items of Unit Price Work, the total units required by the Owner under the Agreement for each item of Unit Price Work multiplied by the Unit Price of each such item.

107. T&M Changes in the Work

T&M Changes in the Work means changes in the Work performed on a time and material basis in accordance with Section 3 of Schedule E – Valuing Changes in the Work.

108. T&M Price

T&M has the meaning set out in section 3.1 of Schedule E – Valuing Changes in the Work.

109. Unit Price

Unit Price means the unit price for an item of Unit Price Work set out in the Pricing Form.

110. Unit Price Work

Unit Price Work means the portion of the Work paid for on a Unit Price basis.

111. Utilities and Structures

Utilities and Structures has the meaning set out in GC 4.1.4.1.

112. Value Added Taxes

Value Added Taxes means such sum as shall be levied upon the Contract Price by the Federal or any Provincial or Territorial Government and is computed as a percentage of the Contract Price and includes the Goods and Services Tax, the Harmonized Sales Tax, and any similar tax, the collection of which have been imposed on the Contractor by the tax legislation.

113. Warranty Period

Warranty Period means the warranty period under the Agreement in respect of the Work (except for the Extended Warranty Periods as described in GC 9.3.6), which is two (2) years from the date of Substantial Performance of the Work or such other period as may be specified in row C.6 of the Information Sheet or elsewhere in the Agreement.

114. Work

The Work means the total construction, Products, installation, commissioning, checkout, start-up, testing and related services, deliverables and other obligations as set out in,

required by, reasonably inferable from or described in the Agreement. For clarity, the Work does not include the supply of Owner Supplied Material.

115. Working Day

Unless otherwise specified in row C.7 of the Information Sheet, Working Day means a Calendar Day other than:

1. a Saturday, Sunday, statutory holiday that is observed by the construction industry in the area of the Site; or

2. a Calendar Day identified by the City of Toronto as a designated or statutory holiday.

116. WSIB

WSIB means the Workplace Safety & Insurance Board.

SCHEDULE D

GENERAL CONDITIONS

1. GENERAL PROVISIONS

1.1 INTERPRETATION

1.1.1 The intent of the Agreement is to include the labour, Products and services required for the performance and completion of the Work by the Contractor in accordance with the Agreement or properly inferable from them.

1.1.2 If, subsequent to the Effective Date, changes are made by the Owner to any Standard Specifications, Special Specifications, Standard Drawings or any other Drawing or Specification which affect the cost of the performance of the Work or Contract Time, any claim by the Contractor must be submitted in accordance with the requirements of 7.7 - CLAIMS PROCEDURE and the Owner may submit a change in accordance with the requirements of 7.1 – OWNER'S RIGHT TO MAKE CHANGES.

1.1.3 Subject to any rights or remedies which may be available to the Owner, nothing contained in the Agreement shall create any contractual relationship between:

.1 the Owner and a Contractor Party performing any portion of the Work;

.2 the Contract Administrator and a Contractor Party performing any portion of the Work; or

.3 the Owner Representative and a Contractor Party performing any portion of the Work.

1.1.4 Words and abbreviations which have well known technical or trade meanings are used in the Agreement in accordance with such recognized meanings.

1.1.5 In the Agreement, unless the context otherwise requires, words importing the singular include the plural and vice versa and words importing gender include all gender.

1.1.6 Neither the organization of the Specifications nor the arrangement of Drawings shall control the Contractor in dividing the Work among Subcontractors and Suppliers.

1.1.7 Subject to GC 1.1.9, if there is an inconsistency or a conflict within the Agreement:

.1 the order of priority of documents, from highest to lowest, shall be, unless otherwise provided for in row E.1 of the Information Sheet:

(1) any amendment to the Agreement made in accordance with the terms and conditions of the Agreement, shall take precedence only over those specific provisions of the Agreement expressly amended, in order of most recent date issued (if any),

(2) Schedule A - Information Sheet and Schedule B – Pricing Form,

(3) the Agreement (excluding the Schedules),

(4) the Schedules of Agreement in the following order: Schedule F – Owner Policies, Procedures, By-Laws and Other Requirements, Schedule D – General Conditions and all remaining Schedules other than Schedule H – Drawings and Specifications,

(5) Supplemental Instructions,

(6) the summary of the Work as described in the Specifications,

(7) the Specifications (other than the summary of the Work and the material and finishing schedules in the Specifications),

(8) material and finishing schedules in the Drawings and Specifications,

(9) the Drawings (other than the material and finishing schedules in the Drawings),

(10) Construction Schedule, and

(11) any other document identified elsewhere in the Agreement as a document forming part of the Agreement

.2 Drawings of larger scale shall govern over those of smaller scale of the same date;

.3 dimensions shown on Drawings shall govern over dimensions scaled from Drawings;

.4 detailed Drawings shall govern over general Drawings;

.5 later dated documents shall govern over earlier documents of the same type; and

.6 Special Specifications shall govern over Standard Specifications.

1.1.8 Subject to GC 1.1.9, if there is an inconsistency or a conflict within the contents of Standard Specifications and Standard Drawings, the order of priority from highest to lowest shall be:

.1 City of Toronto Standard Specifications and City of Toronto Standard Drawings, including any amendments; then

.2 OPS Standard Specifications and OPS Standard Drawings, including any amendments; then

.3 other Standard Specifications and Standard Drawings referenced in the City of Toronto Standard Specifications and City of Toronto Standard Drawings or OPS Standard Specifications and OPS Standard Drawings, including, as applicable, those produced by Canadian Standards Association, Canadian General

Standards Board, American Society for Testing and Materials and American National Standards Institute.

1.1.9 Notwithstanding GC 1.1.7 and 1.1.8, any provision within the Agreement establishing a higher standard of safety, reliability, durability, performance, service or quality shall take precedence over a provision establishing a lower standard of safety, reliability, durability, performance, service or quality.

1.1.10 The Owner shall provide the Contractor, without charge, one (1) electronic copy and up to three (3) hard copies of the Agreement other than the specifications of Canadian, United States of America or internationally recognized standards associations (including the Standard Specifications and Standard Drawings), in which case, such documents are the responsibility of the Contractor to obtain as the case may be. If requested by the Contractor, the Owner shall provide additional copies and the Contractor shall be responsible for the cost of printing, handling and shipping.

1.1.11 All Specifications, Drawings, models and other applicable Agreement documents and any other correspondence, data, plans, drawings, specifications, reports, estimates, summaries, photographs, models, mock-ups, information and documentation in any form, and copies thereof, furnished by the Contract Administrator or the Owner (collectively, the "**Owner Prepared Documents**") are not the property of the Contractor. All Owner Prepared Documents furnished by the Contract Administrator or Owner are to be used by the Contractor only with respect to the Work and are not to be used on other work. The Owner Prepared Documents are not to be copied or altered in any manner by the Contractor without the written authorization of the Contract Administrator or the Owner.

1.1.12 The Owner may issue to the Contractor one or more purchase orders in respect of the Work and/or Agreement. Any such purchase order shall be solely for the convenience of the Owner in administering its internal procedures, and notwithstanding any of the provisions set out in such purchase order, shall not create any binding obligations of either party or in any way be deemed to amend, restate, supplement or replace any of the Agreement or otherwise be considered to form a part of the Agreement.

1.2 ENTIRE AGREEMENT AND AMENDMENTS

1.2.1 The Agreement embodies and constitutes the sole and entire agreement between the parties hereto. There are no terms, obligations, covenants or conditions between the parties hereto, other than as contained herein. The Agreement is complementary and what is required by any:

.1 part thereof shall be considered as being required by the whole; and

.2 one document forming a part of the Agreement shall be as binding as if required by all. The Agreement supersedes all prior negotiations, representations or agreements, either written or verbal, relating in any manner to the Work, including the documents from the Procurement Process.

1.2.2 The Agreement may be amended only as provided in the Agreement. No amendment of the Agreement shall be valid unless executed by an instrument in writing by the parties, except as provided for in the Agreement. Neither the Agreement, nor any term hereof, can be amended in whole or in part, except by such instrument in writing, except as provided for in the Agreement, and no subsequent verbal agreement shall have any validity whatsoever.

1.2.3 Unless expressly provided otherwise in the Agreement including GC 2.4.1:

.1 no verbal arrangement or agreement, relating to the Work, the Agreement or any other matter concerning the Agreement or Work, will be of any force or effect unless it is in writing and signed by duly authorized representative of the Owner; and

.2 the Owner and the Contract Administrator shall not be bound by any verbal communication or representation or conduct whatsoever, including any instruction, amendment or clarification of the Agreement, or any representation, information, advice, inference or suggestion, from any Person (including but not limited to an elected official, Personnel, independent contractor or any other Person acting on the behalf of or at the direction of the Owner or Owner Representative or other representative of the Owner including the Contract Administrator) concerning the Agreement, or any other matter concerning the Agreement or Work. Where in the Agreement a reference is made to the express written agreement, approval or consent of the Owner or the Contract Administrator, it shall be understood that the Owner or the Contract Administrator, as applicable, shall not be deemed or construed to have agreed to any stipulation, specification, exclusion, limitation or other term or condition that deviates from or amends a provision set out in the Agreement, unless that deviation or amendment is expressly confirmed in the executed Agreement or in a written and express amendment to the Agreement by a duly authorized representative of the Owner.

1.3 LAW OF THE AGREEMENT AND INTERPRETATION

1.3.1 The laws of the Province of Ontario and the federal laws of Canada applicable therein shall govern the interpretation of the Agreement.

1.3.2 The phrase “includes”, “include” or “including” means “includes, without limitation” or “including” or “include, without limitation,”.

1.3.3 If any provision of the Agreement or its application to any party or circumstance is unenforceable, the provision shall be ineffective only to the extent of the unenforceability without: (.1) invalidating the remaining provisions of the Agreement; (.2) changing the fundamental nature of the obligations assumed by the parties; and (.3) affecting its application to other parties or circumstances.

1.3.4 Except as otherwise expressly provided for in the Agreement, any reference in the Agreement to a statute or code or rule promulgated under a statute or to any provision of a statute, code or rule promulgated under a statute shall be a reference to the statute, code, rule or provision, as amended, supplemented, re-enacted or

replaced from time to time. Any reference to a statute shall be a reference to the statute and its underlying regulations.

1.3.5 The terms of the Agreement, which expressly or by their nature are intended to survive the termination or discharge of the Agreement (including all indemnities, representations and warranties of the Contractor) shall survive such termination or discharge.

1.3.6 For the purposes of the Agreement, all documents and communications pertaining to the Agreement shall be in the English language.

1.4 RIGHTS AND REMEDIES

1.4.1 Except as expressly provided in the Agreement, the duties and obligations imposed by the Agreement and the rights and remedies available thereunder shall be in addition to and not a limitation of any duties, obligations, rights, and remedies otherwise imposed or available by Laws.

1.4.2 No act or failure to act by the Owner, the Contract Administrator or Contractor shall, except as may be specifically agreed:

.1 constitute a waiver of any right or duty afforded any of them under the Agreement;

.2 constitute an approval of or acquiescence in any breach, default or non-observance thereunder; or

.3 operate as a waiver of any such right or duty of the Owner in respect of any continuing or subsequent default, breach or non-observance, or so as to defeat or affect in any way such right or duty in respect of any such continuing or subsequent default, breach or non-observance.

1.4.3 The Contractor acknowledges and agrees that the exercise by the Owner of any of its rights or remedies under the Agreement, including the Owner's rights and remedies under 11. DEFAULT, TERMINATION AND SUSPENSION shall not result in irreparable harm to the Contractor and the Contractor shall not seek any order for injunctive relief, specific performance, certiorari or mandamus from any arbitral tribunal or court of law in relation to such exercise.

1.5 ASSIGNMENT AND SUCCESSION

1.5.1 The Contractor shall not assign the Agreement, either in whole or in part, without the written consent of the Owner, which consent may be withheld or given subject to such terms and conditions as the Owner deems appropriate.

1.5.2 Notwithstanding the foregoing, the Contractor acknowledges and agrees that the Owner may assign the Agreement, or any portion thereof, without the consent of the Contractor.

1.5.3 The Agreement shall enure to the benefit of and be binding upon the parties hereto, their respective heirs, legal representatives, successors, and permitted assigns.

1.6 RECEIPT OF AND ADDRESSES FOR NOTICES AND DOCUMENTATION

1.6.1 Subject to GC 1.6.3, the parties agree that any Notice in Writing required to be given or that may be given under this Agreement shall be given in writing only by one of the following methods:

.1 electronic mail to the name and address set out in row A.3 of the Information Sheet, including the name and telephone number of a person at the sender to contact in the event of a transmission problem;

.2 delivery by hand to the name and address set out in row A.3 of the Information Sheet;

.3 registered mail to the name and address set out in row A.3 of the Information Sheet; or

.4 courier to the name and address set out set out in row A.3 of the Information Sheet.

1.6.2 For purposes of this Agreement:

.1 a Notice in Writing sent by electronic mail which is transmitted prior to 5:00 p.m. on a Working Day, shall be deemed to have been received by the recipient on that Calendar Day, or on the next Working Day, if delivered after 5:00 p.m. or on a Calendar Day which is not a Working Day; provided that during the transmission of which no indication of failure of receipt is communicated to the sender;

.2 a Notice in Writing delivered by hand or courier prior to 5:00 p.m. on a Working Day, shall be deemed to have been received by the recipient on such Calendar Day of delivery, or on the next Working Day, if delivered after 5:00 p.m. or on a Calendar Day which is not a Working Day; or

.3 a Notice in Writing which is sent by registered mail is deemed to be received by the party to whom the Notice in Writing is addressed on the fifth (5th) Working Day after the date of mailing, where the date appearing on the postal registration receipt shall be deemed conclusively to be the date of mailing.

1.6.3 Notwithstanding GC 1.6.1, the parties agree that documents and notices required to be given or that may be given under the Construction Act shall be given in writing by a means or method permitted for under the Construction Act unless such means or methods are stipulated elsewhere in the Agreement.

1.6.4 Either Party may change its address or other contact particulars as set out in GC 1.6.1 by giving a Notice in Writing to the other in the manner set out in GC 1.6.1.

1.7 CONFLICTS OF INTEREST

1.7.1 The Contractor shall:

.1 avoid any Conflict of Interest in the performance of its contractual obligations;

.2 disclose to the Owner without delay any actual or potential Conflict of Interest that arises during the performance of its contractual obligations;

.3 comply with any reasonable requirements prescribed by the Owner to resolve any Conflict of Interest; and

.4 comply with the other requirements of Chapter 195, Purchasing, of the Toronto Municipal Code in respect of conflicts of interest and unfair advantages (as defined therein).

For clarity, the Owner shall be entitled to exercise any rights or remedies which may be available to the City of Toronto pursuant to Chapter 195, Purchasing, of the Toronto Municipal Code in respect of conflicts of interest and unfair advantages (as defined therein).

1.8 MISCELLANEOUS

1.8.1 The Contractor is an independent contractor and is not an agent of the Owner.

1.8.2 The Contractor shall not publish, issue or make any statements or news release, electronic, graphic, pictorial or otherwise, concerning the Agreement, the Work, or the Project, without the express prior written consent of the Owner.

2. ADMINISTRATION OF THE AGREEMENT

2.1 AUTHORITY OF THE CONTRACT ADMINISTRATOR AND THE OWNER REPRESENTATIVE

2.1.1 The Contract Administrator shall have no authority to bind the Owner, unless otherwise provided for in writing by the Owner.

2.1.2 The Owner Representative shall be the Owner's representative during construction and until the issuance by the Contract Administrator of the Final Acceptance Certificate. Only the Owner Representative shall have the authority to bind the Owner for the purposes of the Agreement. The Owner Representative may be a Personnel of the Owner or any other Person including the same Person as the Contract Administrator.

2.1.3 The Owner Representative will execute Change Orders and Change Directives as provided in 7.2 - CHANGE ORDER and 7.3 - CHANGE DIRECTIVE.

2.1.4 All instructions and documents issued to the Contractor will be issued by the Contract Administrator or the Owner Representative, as the case may be, and the Contractor shall not recognize instructions issued by other Personnel of the Owner or any other

document issued by other Personnel of the Owner as amending, supplementing or clarifying the Agreement.

2.2 ROLE OF THE CONTRACT ADMINISTRATOR

2.2.1 The Contract Administrator will provide administration of the Agreement as described in the Agreement. The Contract Administrator may be a third party, including an architect or engineer or other consultant, or a Personnel of the Owner.

2.2.2 The Contract Administrator will visit the Site at intervals appropriate to the progress of construction to become familiar with the progress and quality of the Work and to determine if the Work is proceeding in general conformity with the Agreement.

2.2.3 If the Owner and the Contract Administrator agree, the Contract Administrator will provide at the Site, one or more project representatives to assist in carrying out the Contract Administrator's responsibilities.

2.2.4 The Contract Administrator will promptly inform the Owner of the date of receipt of Proper Invoices as provided in 5.4 - PROGRESS PAYMENT.

2.2.5 The Contract Administrator will review the Work for its conformity with the Agreement and record the necessary data to establish payment quantities under the schedule of quantities and Unit Prices for Unit Price Work or to assess the value of the Work completed in the case of Fixed Price Work. Based on such records and the Contract Administrator's evaluation of the Proper Invoices, the Contract Administrator will determine the amounts owing to the Contractor under the Agreement and will issue certificates for payment as provided in 5. CONTRACT PRICE AND PAYMENT.

2.2.6 The Contract Administrator will not be responsible for and will not have control, charge or supervision of construction means, methods, techniques, sequences, or procedures, or for health and safety precautions and programs required in connection with the Work in accordance with the applicable health and safety Laws or general construction practice. The Contract Administrator will not be responsible for the Contractor's failure to carry out the Work in accordance with the Agreement. The Contract Administrator will not have control over, charge of or be responsible for the acts or omissions of the Contractor Parties performing portions of the Work.

2.2.7 The Contract Administrator will be, in the first instance, the interpreter of the requirements of the Agreement.

2.2.8 Matters in question relating to the performance of the Work or the interpretation of the Agreement shall be initially referred in writing to the Contract Administrator by the party raising the question for interpretations and findings and copied to the other party.

2.2.9 Interpretations and findings of the Contract Administrator shall be consistent with the intent of the Agreement. In making such interpretations and findings, the Contract Administrator will not show partiality to either the Owner or the Contractor.

2.2.10 The Contract Administrator's interpretations and findings will be given in writing to the parties within a reasonable time and shall be subject to either party's right to dispute such interpretations and findings in accordance with 12. DISPUTE RESOLUTION.

2.2.11 The Contract Administrator will investigate all Claim Notices made by the Contractor pursuant to 7.7 - CLAIMS PROCEDURE and will make findings as set out in 7.7 - CLAIMS PROCEDURE and issue appropriate instructions.

2.2.12 During the progress of the Work the Contract Administrator will provide Supplemental Instructions to the Contractor with reasonable promptness or in accordance with a schedule for such Supplemental Instructions agreed to by the Contract Administrator and the Contractor.

2.2.13 The Contract Administrator will review and take appropriate action upon Shop Drawings, samples and other Contractor's Submittals and submissions, in accordance with the Agreement.

2.2.14 The Contract Administrator will prepare Change Orders and Change Directives as provided in 7.2 - CHANGE ORDER and 7.3 - CHANGE DIRECTIVE. For clarity, Change Directives must be signed by the Owner and Change Orders must be signed by both the Owner and the Contractor.

2.2.15 The Contract Administrator and the Contractor will jointly conduct reviews of the Work to determine the date of Substantial Performance of the Work and Total Performance of the Work as provided in 5.5 - SUBSTANTIAL PERFORMANCE OF THE WORK and 5.7 - PAYMENTS UPON TOTAL PERFORMANCE OF THE WORK, respectively.

2.2.16 All certificates issued by the Contract Administrator will be to the best of the Contract Administrator's knowledge, information and belief. By issuing any certificate, the Contract Administrator does not guarantee the Work is correct or complete.

2.2.17 The Contract Administrator will receive and review written warranties and related documents required by the Agreement and provided by the Contractor.

2.2.18 If the Contract Administrator observes that any Personnel of the Contractor, Subcontractors, Suppliers or Sub-subcontractors is potentially incompetent, disorderly or a detriment to the Project, then the Contract Administrator shall provide Notice in Writing to the Contractor and the Contractor, at the Contractor's cost and without any extension of the Contract Time, shall, in accordance with its obligations under the Agreement, immediately remove such Personnel from the Site if the Contractor determines that such Personnel should be immediately removed from the Site. If such Personnel is removed, the Contractor, at the Contractor's cost and without any extension of the Contract Time, shall provide replacement Personnel acceptable to the Contract Administrator. Such incompetent, disorderly or detrimental Personnel shall not return to the Site without the prior written consent of the Contract Administrator.

2.2.19 The Contract Administrator shall have the authority to temporarily suspend the Work for such reasonable time as may be necessary, for the following reasons:

.1 for the Contractor to remedy its non-compliance with the provisions of the Agreement;

.2 to facilitate the checking of any portion of the Contractor's construction layout;

.3 to facilitate the inspection of any portion of the Work by the Contract Administrator.

The Contractor shall not be entitled to any increase in the Contract Price or extension of the Contract Time in these circumstances.

2.3 REVIEW AND INSPECTION OF THE WORK

2.3.1 The Owner and the Contract Administrator shall have access to the Work at all times. The Contractor shall provide sufficient, safe and proper facilities and assistance at all times for the review of the Work by the Contract Administrator and Owner and the inspection of the Work by Governmental Authorities and quasi-governmental authorities. If parts of the Work are in preparation at locations other than the Site, the Owner and the Contract Administrator shall be given access to such Work whenever it is in progress.

2.3.2 If tests, inspections or approvals for the Work are required by the Agreement, or by the Contract Administrator's instructions, or by Laws, the Contractor shall give the Contract Administrator no less than three (3) Working Days notification of when the Work will be ready for review and inspection and make available for inspection or testing a sample of any Product. All inspection, sampling, and testing of Products shall be carried out on a random basis in accordance with the standard inspection or testing methods required for the Product. The Contractor shall arrange for and shall give the Contract Administrator reasonable notification of the date and time of inspections by other authorities and shall notify the Contract Administrator of the sources of supply of Products sufficiently in advance of the Product shipping dates to enable the Contract Administrator to perform any required inspection, sampling and testing. The Contractor shall obtain for the Contract Administrator the right to enter onto the premises of the Product manufacturer or supplier to carry out such inspection, sampling and testing. The Owner shall not be responsible for any delays to the performance of the Work where the Contractor fails to give sufficient advance notice to the Contract Administrator to enable the Contract Administrator to carry out the required inspection, sampling and testing.

2.3.3 The Contractor shall furnish promptly to the Contract Administrator, and in no event later than within fourteen (14) Calendar Days after receipt thereof, two copies of certificates and inspection reports relating to the Work prepared by Governmental Authorities and quasi-governmental authorities.

2.3.4 If the Contractor covers, or permits to be covered, Work that has been designated for special tests, inspections or approvals before such special tests, inspections or approvals are made, given or completed, the Contractor shall, if so directed, uncover such Work, have the inspections or tests satisfactorily completed, and make good covering Work at the Contractor's cost and without any extension of the Contract Time.

2.3.5 Subject to GC 2.3.4, the Contract Administrator may order any portion or portions of the Work to be examined to confirm that such Work is in accordance with the requirements of the Agreement. If the Work is not in accordance with the requirements of the Agreement, the Contractor shall correct the Work and pay the cost of examination and correction and without any extension of the Contract Time. If the Work is in accordance with the requirements of the Agreement, the Owner shall pay the cost of examination and restoration.

2.3.6 The Contractor shall pay the cost of making any test or inspection whether to be performed by the Contractor, Contract Administrator, Owner, Governmental Authorities or quasi-governmental authorities, including the cost of samples required for such test or inspection, if such test or inspection is required by the Agreement or is required by Laws.

2.3.7 If any portion or portions of the Work is found to be Deficient in initial tests or inspections as determined by the Contractor, Owner, Contract Administrator, Governmental Authorities or quasi-governmental authorities, the costs of re-testing and re-inspections shall be borne by the Contractor and with no adjustment in the Contract Price or any extension of the Contract Time.

2.3.8 The Contractor shall provide any documentation requested by the Owner, where that documentation relates to any of the Work. The Contractor shall ensure that all such documentation is provided no later than ten (10) Calendar Days following the receipt of any such request.

2.3.9 The Contract Administrator and Owner will each have authority to reject any portion of the Work which in the Contract Administrator's or Owner's opinion is Deficient. Whenever the Contract Administrator or Owner considers it necessary or advisable, the Contract Administrator or Owner will have authority to require inspection or testing of Work, whether or not such Work is fabricated, installed or completed.

2.3.10 Any review, inspection, comment, acceptance, approval**,** audit, survey or rejection, or failure to review, inspect, comment, accept, approve, audit, survey or reject, by the Owner or the Contract Administrator of the Work (including Products or any documents prepared by the Contractor, Subcontractors, Suppliers or Sub-subcontractors, in whole or in part) or the issuance of any certificates or the making of any payment by the Owner or the presence of the Owner or the Contract Administrator at the Site or the receipt or taking delivery by the Owner of any Products, shall not:

.1 constitute acceptance of the Work (including Products) or any Deficiencies or relieve the Contractor of its responsibility therefor;

.2 impose on the Owner or the Contract Administrator the responsibility for the sequencing, scheduling or progress of the Work;

.3 be deemed to confirm that any schedule is a reasonable plan for providing the Work in accordance with the relevant Construction Schedule;

.4 constitute an approval, disapproval, endorsement or confirmation of any Work (including Products or any document prepared by the Contractor, Subcontractors, Suppliers or Sub-subcontractors, in whole or in part) or an acknowledgment by the Owner or the Contract Administrator that any Work (including Products and such documents) satisfies the requirements of the Agreement;

.5 affect or change the Contractor's obligation to perform the Work in accordance with the Agreement and relieve the Contractor from any liability arising from its failure to properly perform the Work;

.6 give rise to any duty or responsibility of the Owner or the Contract Administrator to the Contractor Parties performing any of the Work; or

.7 except as otherwise provided in the Agreement, have the effect of waiving or diminishing any obligation of, or limiting any liability of, the Contractor or of transferring any obligation under the Agreement from the Contractor to the Owner or the Contract Administrator or otherwise have the effect of amending the Agreement.

Any review or approval by the Owner and/or Contract Administrator is intended only to ascertain that the document or the performance of the Contractor's duties, liabilities, responsibilities or obligations under the Agreement including the Work generally meets the intention of the Agreement and is not an assurance or confirmation of the adequacy, quality, fitness, suitability or correctness of the Contractor's obligations, responsibilities, duties and liabilities under the Agreement including the Work, for which the Contractor is solely responsible in accordance with the Agreement.

2.3.11 Any Deficiencies arising from Work done by the Contractor without consulting the Contract Administrator or the Owner when the Work required the acceptance of or review with same, or when the Contractor should have sought the acceptance of Contract Administrator or Owner, shall be corrected at the cost of the Contractor (without increase in the Fixed Price or Unit Prices) and without any extension of the Contract Time.

2.4 EMERGENCY SITUATIONS

2.4.1 If the Contract Administrator or Owner determines, in their sole and absolute discretion, that there is an emergency situation, then the Contract Administrator or Owner, as applicable, may instruct the Contractor to take action to remedy the situation verbally or in writing. If such instruction is verbal, the Contract Administrator or Owner, as applicable, shall provide timely confirmation of such instruction in writing. If the Contractor does not take timely action, or if the Contractor is not available, the Contract Administrator or Owner may direct others to remedy the situation. If the emergency situation is the fault of the Contractor, the remedial Work shall be done at the cost of the Contractor and without any extension of the Contract Time.

2.5 DEFICIENCIES

2.5.1 The Contractor shall promptly correct all Deficiencies, including Deficiencies that have been identified by the Contract Administrator and/or Owner, at the Contractor's cost (and with no adjustment in the Fixed Price or Unit Prices) and without any extension of the Contract Time, whether or not the Deficiency has been incorporated in the Work and whether or not the Deficiency is the result of poor workmanship, use of Deficient products or damage through carelessness or other act or omission of a Contractor Personnel, provided that:

.1 the Contractor shall correct, in a manner acceptable to the Owner or the Contract Administrator, all Deficiencies, whether or not they are specifically identified by the Contract Administrator or Owner; and

.2 the Contractor shall prioritize the correction of any Deficiencies which, in the sole discretion of the Owner, adversely affects the work or operations of the Owner or other contractors or there is a risk of bodily injury to any individual or physical loss of or damage to property.

2.5.2 The Contractor shall remove rejected Products from the Site expeditiously after the notification to that effect from the Contract Administrator or Owner. Where the Contractor fails to comply with such notice, the Contract Administrator or Owner may cause the rejected Products to be removed from the Site and disposed of in what the Contract Administrator or Owner considers to be the most appropriate manner, and the Contractor shall pay the costs of disposal.

2.5.3 The Contractor shall promptly make good damage or destruction to the Owner's or other contractors' work, other property of the Owner, or any other property as a result of Deficiencies or the correction of Deficiencies at the Contractor's cost (and with no adjustment in the Fixed Price or Unit Prices) and without any extension of the Contract Time.

2.5.4 If the Contractor fails to promptly carry out the correction of Deficiencies or make good damage or destruction to the Owner's or other contractors' work, other property of the Owner, or any other property as required by this 2.5 – DEFICIENCIES, the Owner may correct the Deficiencies or make good such work or property and hold the Contractor responsible for all costs thereof.

2.5.5 If in the opinion of the Contract Administrator or Owner it is not expedient to correct a Deficiency, the Owner may, in accordance with 5.10 – OWNER'S SET-OFF, set-off the greater of (i) the difference in value between the Work as performed and that called for by the Agreement and (ii) the cost to correct such Deficiency. If the Owner and the Contractor do not agree on the difference in value or the cost to correct such Deficiency, they shall refer the matter to the Contract Administrator for determination.

2.5.6 No payment by the Owner under the Agreement nor partial or entire use or occupancy of the Work by the Owner shall constitute an acceptance of any portion of the Work (including Products) which is Deficient.

2.6 CONTRACTOR RECORDS

2.6.1 Prior to the issuance of the final certificate for payment, and thereafter until the later of two (2) years after the end of the Warranty Period, or all Claims in respect of the Agreement being settled, the Contractor shall maintain and keep accurate Contractor Records in respect of Work (including in respect of Fixed Price Work, Construction Equipment, Products, component costs reflecting the taxes and customs duties, including excise taxes and changes in the Work). Without limiting the generality of the foregoing, the Contractor Records shall be of sufficient detail to support the total cost of any Work (other than Fixed Price Work), changes in the Work, Cash Allowances expenditures and taxes and duties. For Fixed Price Work, the Contractor Records shall be of sufficient detail for the Owner to ascertain the Contractor's compliance with the Fair Wage Policy, if any.

2.6.2 The Contractor shall cause the Subcontractors, Suppliers and Sub-subcontractors, to:

.1 maintain and keep accurate Contractor Records in respect of all items for which the Contractor is required by the Agreement to maintain and keep Contractor Records; and

.2 allow the Owner to inspect and audit such Contractor Records, for the same period of time.

2.6.3 Without limiting the generality of 13.3, the Owner may inspect and audit the Contractor Records at any time during the period in which the Contractor is required to maintain and keep such Contractor Records. The Contractor shall, at its cost, supply certified copies (and notarized if maintained outside of Ontario) of any part of the Contractor Records required whenever requested by the Owner.

3. EXECUTION OF THE WORK

3.1 CONTROL AND COMMENCEMENT OF THE WORK

3.1.1 The Contractor shall, and shall cause the Subcontractors, Suppliers and Sub-subcontractors to, perform the Work in accordance with the Agreement and comply with the Agreement. The Contractor shall have total control of the Work and shall effectively direct and supervise the Work so as to ensure conformity with the Agreement.

3.1.2 The Contractor shall be solely responsible for construction means, methods, techniques, sequences, and procedures and for co-ordinating the various parts of the Work under the Agreement, even if such means, methods, techniques, sequences or procedures are set out in the Owner Prepared Documents.

3.1.3 The Contractor shall not enter upon or occupy any property of a third party for any purpose, unless the Contractor has received prior written permission from the property owner.

3.1.4 Except for such Work as may be required by the Contract Administrator to maintain the Work in a safe and satisfactory condition or as otherwise expressly allowed by the

Agreement, the Contractor shall not carry on Work at the Site on Calendar Days other than Working Days without permission in writing from the Contract Administrator.

3.1.5 The Contractor shall, at all times and as part of the Work, fully assist, co-operate, consult and co-ordinate with the Contract Administrator, the Owner Representative and any other Persons retained or identified by the Owner which are related to or connected with the Project or performing work at or near the Site. The objective of such assistance, co-operation, consultation and co-ordination is to make certain the Work is properly co-ordinated with and integrated with the work, services and operations of such entities.

3.1.6 The Contractor shall not commence the Work or deliver anything to the Site prior to the Commencement Date. If no date is set out for the Commencement Date in row C.2 of the Information Sheet, the Owner shall be entitled to issue a Notice in Writing to the Contractor directing the Contractor to commence the performance of the Work on the date described therein.

3.2 SUPPLEMENTAL INSTRUCTIONS

3.2.1 The Contract Administrator may, during the progress of the Work, issue Supplemental Instructions, which shall be deemed incorporated into and forming part of the Agreement. Supplemental Instructions shall only be issued by the Contract Administrator.

3.2.2 Upon receipt of a Supplemental Instruction, the Contractor shall immediately proceed to perform the Work in accordance with such Supplemental Instruction and otherwise in accordance with the Agreement, unless the Contractor is of the opinion that such Supplemental Instructions require a change in the Contract Price and/or extension of the Contract Time, in which case the Contractor shall proceed in accordance with GC 3.2.3.

3.2.3 If the Contractor, after receiving Supplemental Instructions, is of an opinion that such Supplemental Instructions require a change in the Contract Price and/or extension of the Contract Time, then the Contractor shall promptly notify the Owner and Contract Administrator of such and submit a Claim Notice in accordance with the requirements of 7.7 - CLAIMS PROCEDURE. The Contractor shall not proceed with the Work in respect of such Supplemental Instruction until it has received further instruction from the Contract Administrator. If, pursuant to 7.7 - CLAIMS PROCEDURE it is subsequently determined that the Claim Notice in respect of such Supplemental Instructions is valid, then such determination shall be reflected in a Change Directive issued pursuant to 7.3 – CHANGE DIRECTIVE.

3.3 CONSTRUCTION BY OWNER OR OTHER CONTRACTORS

3.3.1 The Owner reserves the right to award separate contracts in connection with other parts of the Project to other contractors and to perform work with its Personnel. Such work by other contractors or Owner’s Personnel may include utility relocation and surveying, testing, sampling and quality assurance estimates prior to, and possibly during, the Work.

3.3.2 Subject to and without limitation to 4.2 – HEALTH AND SAFETY, when separate contracts are awarded for other parts of the Project, or when work is performed by the Owner's Personnel, the Contractor shall:

.1 co-ordinate, schedule and sequence the activities and work of other contractors and Owner's Personnel on the Project with the Work; and

.2 promptly report to the Contract Administrator in writing, and in no event later than within five (5) Working Days of discovery thereof, any apparent deficiencies in the work of other contractors or of the Owner's Personnel, where such work affects the proper execution of any portion of the Work, prior to proceeding with that portion of the Work. Failure by the Contractor to so report shall invalidate any Claims against the Owner by reason of deficiencies in the work of other contractors or Owner's Personnel except those deficiencies not then reasonably discoverable,

3.3.3 Where the Agreement identifies work to be performed by other contractors or the Owner's Personnel, the Contractor shall co-ordinate the Construction Schedule (and access to the Site) with the work of other contractors and the Owner's Personnel so as to mitigate the risk of delay and disruption under the Agreement and for the other contractors and the Owner's Personnel.

3.3.4 Disputes and other matters in question between the Contractor and other contractors shall be dealt with as provided in 12. DISPUTE RESOLUTION provided the other contractors have reciprocal obligations. The Contractor shall be deemed to have consented to arbitration of any dispute with any other contractor whose contract with the Owner contains a similar agreement to arbitrate.

3.3.5 Notwithstanding that the Owner may award separate contracts in connection with other parts of the Project to other contractors and perform work with its Personnel, the performance of such work or connection of such work onto the Work, by the Owner's Personnel or by other contractors, will not limit or relieve the Contractor of its obligations and responsibilities under the Agreement (including warranty) unless a Deficiency has been created by the Owner's Personnel or Owner's other contractors.

3.3.6 When requested in writing by the Contract Administrator or Owner, the Contractor shall stop Work on the Project so as to avoid interference with work being performed at adjacent or impacted construction projects of the Owner that are unrelated to the Project. The Contractor shall not be entitled to an extension of the Contract Time or to an increase in the Contract Price unless, and only to the extent, the event which caused the cessation of the Work would entitle the Contractor to an extension of the Contract Time or the reimbursement of the Contractor's Losses as provided in GC 7.5.1, 7.5.2 or 7.5.3.

3.4 TEMPORARY WORK

3.4.1 The Contractor shall have the sole responsibility for the design, erection, operation, maintenance, removal and repair of Temporary Work.

3.4.2 The Contractor shall engage and pay for registered professional engineering Personnel skilled in the appropriate disciplines to perform those functions referred to in GC 3.4.1 where required by Laws or by the Agreement and in all cases where such Temporary Work is of such a nature that professional engineering skill is required or prudent to produce safe and satisfactory results.

3.4.3 Notwithstanding the provisions of 3.1 - CONTROL OF THE WORK, GC 3.4.1 and 3.4.2 or provisions to the contrary elsewhere in the Agreement, but subject to 3.6 – DOCUMENT REVIEW, where the Agreement includes designs for Temporary Work:

.1 such designs shall be considered to be part of the design of the Work and the Contractor shall not be held responsible for that part of the design; and

.2 the Contractor shall, however, be responsible for the execution of such design in the same manner as for the execution of the Work.

3.4.4 2.3 - REVIEW AND INSPECTION OF THE WORK and the requirements for Shop Drawings in 3.11 – SHOP DRAWINGS also apply to the Temporary Work.

3.5 CONSTRUCTION SCHEDULE

3.5.1 The Contractor shall:

.1 prepare and submit to the Owner and the Contract Administrator within seven (7) Calendar Days from the Commencement Date, unless otherwise stipulated elsewhere in the Agreement or agreed to by the Contract Administrator, a construction schedule for their review and acceptance that indicates the timing of the major activities of the Work and provides sufficient detail of the critical events and their inter-relationship to demonstrate the Work shall be performed in conformity with the Contract Time. The construction schedule shall:

(1) take into account the phasing and sequencing of construction and the completion dates contained in the Agreement or as otherwise required by the Contract Administrator or the Owner;

(2) include and conform to the Key Work Milestones or any other milestones for the performance of the Work set out in the Agreement;

(3) be of a computerised type and provided in both electronic format and hard copy;

(4) show the Project critical path and the critical path must be identified in a contrasting colour (red) from the other activities;

(5) clearly show, in weekly intervals, the logic and timing of major activities, proposed start dates and estimated duration for activities; and

(6) have a level of detail sufficient to identify the Contractor and each specific Subcontractor and their respective parts of the Work and the specific location thereof.

Once approved by the Owner and the Contract Administrator, the construction schedule submitted by the Contractor under this GC 3.5.1.1, as updated by the Contractor and approved by the Owner and Contract Administrator, shall become the "**Construction Schedule**". The Construction Schedule (and any approved updates) shall be the benchmark against which the progress of the Work is to be measured for the purposes of the Agreement;

.2 monitor the progress of the Work relative to the Construction Schedule;

.3 maintain a Current Schedule and update the Current Schedule every two (2) weeks, unless otherwise stipulated elsewhere in the Agreement or agreed to by the Contract Administrator, and provide the updated Current Schedule to the Owner and Contract Administrator. For clarity, the Current Schedule shall be used for information purposes only;

.4 advise the Contract Administrator of any revisions required to the Construction Schedule as the result of extensions of the Contract Time as provided in 7.CHANGES IN THE WORK and provide the Owner and Contract Administrator for approval, an updated Construction Schedule reflecting such extensions; and

.5 perform the Work in accordance with the Construction Schedule including the Key Work Milestones.

3.5.2 If the Contractor fails to submit the initial or any updated Construction Schedule satisfactory to the Contract Administrator, the Owner shall be entitled to withhold or delay payments under the Agreement until the Contractor complies with the requirements of GC 3.5.1.

3.6 DOCUMENT REVIEW AND EXAMINATION OF SITE

3.6.1 The Contractor shall review the Agreement in accordance with the Standard of Care. The Contractor shall report to the Contract Administrator, no later than three (3) Working Days after discovery by the Contractor, any error, inconsistency or omission the Contractor may discover. The Contractor shall not be liable for Losses resulting from errors, inconsistencies or omissions in the Agreement, which the Contractor did not discover, provided that the Contractor exercised such Standard of Care. The Contractor shall be liable and responsible for Losses (and without any extension of the Contract Time) resulting from errors, inconsistencies or omissions in the Agreement if it recognizes, or should have recognized, exercising such Standard of Care, such errors, inconsistencies or omissions, yet fails to raise such errors, inconsistencies or omissions to the Contract Administrator's attention prior to performing the affected portion of the Work.

3.6.2 If the Contractor does discover any error, inconsistency or omission in the Agreement or has any doubt as to the meaning or intent of any part thereof, the Contractor shall not proceed with the Work affected until the Contractor has reported to the Contract Administrator and received corrected or missing information, instructions or explanations from the Contract Administrator in writing. The Contractor shall comply with such information, instructions or explanations. The Contractor shall cooperate in good faith with the Owner and the Contract Administrator to resolve any error, omission or inconsistency in the Agreement in a manner that will not result in increased cost to the Owner or any extension of the Contract Time.

3.6.3 The Owner makes no representation, warranty or guarantee about the accuracy, completeness, feasibility or any other aspect of the documents or information provided by the Owner including interpretations of data or opinions expressed in any subsurface report or geotechnical report. Accordingly, the Contractor shall review and otherwise deal with such documents or information in accordance with the requirements of GC 3.6.1 and 3.6.2.

3.6.4 Without limitation to any specific obligations in the Drawings and Specifications in respect of the examination of the Site and surrounding area, the Contractor represents and warrants that in entering into the Agreement with the Owner and acting in accordance with the Standard of Care, it has examined the Site and surrounding area and it has satisfied itself as to the scope and character of the Work, all conditions and information affecting the Work, including the nature of the Work and the Site, access to the Site and weather conditions or that, not having acted in such a manner, the Contractor has assumed and does hereby assume all risk of conditions now existing or arising in the course of the Work which might or could make the Work more expensive or more onerous to fulfil and which a contractor acting in accordance with the Standard of Care would have discovered. The cost and time of all conditions referred to in this GC 3.6.4 form part of the Fixed Price and Unit Prices and the Contract Time and shall not be the basis for an increase in the Fixed Price or Unit Prices or any extension of the Contract Time.

3.7 SUPERVISION

3.7.1 The Contractor shall provide all necessary supervision.

3.7.2 The Contractor shall:

.1 furnish competent and adequate Personnel, who shall be in attendance at the Site at all times, as necessary, for the proper administration, co-ordination, supervision and superintendence of the Work;

.2 organize the procurement of all Products and Construction Equipment so that they will be available in advance of the time they are needed for the Work; and

.3 keep an adequate force of skilled Personnel on the job to complete the Work in accordance with all requirements of the Agreement.

3.7.3 Prior to commencement of the Work, unless otherwise stipulated elsewhere in the Agreement or agreed to by the Contract Administrator, the Contractor shall select a competent and experienced:

.1 Project manager (the "**Contractor Project Manager**") who shall:

(1) be in attendance at the Site or otherwise engaged in the Work at all times, or for such other period of attendance as required by the Agreement including the Specifications;

(2) have full responsibility for the prosecution of the Work, with full authority to act in all matters as may be necessary for the proper co-ordination, supervision, direction and technical administration of the Work;

(3) attend site meetings in order to render reports on the progress of the Work; and

(4) have authority to bind the Contractor in all matters related to the Agreement; and

.2 supervisor of the Site (the "**Contractor Site Supervisor**") who shall be in attendance at the Site at all times while Work is being performed, or for such other period of attendance as required by the Agreement including the Specifications and shall have full responsibility for the day to day field supervision and superintendence of the Work.

3.7.4 The Contractor Project Manager and the Contractor Site Supervisor, if applicable:

.1 shall represent the Contractor at the Site; and

.2 may be the same individual if specified as such in the Specifications.

3.7.5 Information, notices and instructions given to the Contractor Project Manager and/or the Contractor Site Supervisor, if applicable, shall be deemed to have been received by the Contractor, other than notices that are required to be delivered in accordance with 1.6 - RECEIPT OF AND ADDRESSES FOR NOTICES AND DOCUMENTATION.

3.7.6 At the request of the Owner, the Contractor shall supply complete information including written job-specific qualification records for any Personnel of the Contractor,

Subcontractors, Suppliers or Sub-subcontractors. Such records will detail the activities that each such Personnel has been trained and qualified to perform.

3.7.7 If the Owner observes that any Personnel of the Contractor, Subcontractors, suppliers or Sub-subcontractors is potentially incompetent, disorderly or a detriment to the Project, then the Owner shall provide Notice in Writing to the Contractor and the Contractor, at the Contractor's cost and without any extension of the Contract Time, shall, in accordance with its obligations under the Agreement, immediately remove such Personnel from the Site if the Contractor determines that such Personnel should be immediately removed from the Site. If such Personnel is removed, the Contractor, at the Contractor's cost and without any extension of the Contract Time, shall provide replacement Personnel acceptable to the Owner. Such incompetent, disorderly or detrimental Personnel shall not return to the Site without the prior written consent of the Owner or Contract Administrator.

3.7.8 Without limiting the obligations of the Contractor described in 3.3 – CONSTRUCTION BY OWNER OR OTHER CONTRACTORS and 4.2 – HEALTH AND SAFETY, if the Owner or Contract Administrator observes that any Personnel of the Contractor, Subcontractors, Suppliers or Sub-subcontractors poses an imminent risk to the health and safety of other persons, then the Owner or Contract Administrator can require the Contractor to immediately remove such Personnel from the Site at the Contractor's cost and without any extension of the Contract Time, and in accordance with its obligations under the Agreement. The Contractor, at the Contractor's cost and without any extension of the Contract Time, shall provide replacement Personnel acceptable to the Owner. The Personnel that posed an imminent risk to the health and safety of other persons shall not return to the Site without the prior written consent of the Owner or Contract Administrator.

3.7.9 The Contractor shall provide the Owner and the Contract Administrator with the names, work addresses and mobile telephone numbers of the Contractor Project Manager, the Contractor Site Supervisor and other responsible field Personnel who may be contacted for emergency and other reasons during non-working hours and update as necessary.

3.8 SUBCONTRACTORS AND SUPPLIERS

3.8.1 The Contractor may, subject to this 3.8 – SUBCONTRACTORS AND SUPPLIERS, subcontract portions of the Work, which shall not exceed the portion set out in row E.2 of the Information Sheet, to Subcontractors and Suppliers. The Contractor shall, and shall cause the Subcontractors, Suppliers and Sub-subcontractors to, perform the Work in accordance with the Agreement. The Contractor shall be fully responsible to the Owner for the Subcontractors', Suppliers' and Sub-subcontractors' failure to abide by the obligations of the Agreement.

3.8.2 The Contractor shall preserve and protect the rights of the parties under the Agreement with respect to the portion of the Work to be performed under subcontract, and shall:

.1 enter into subcontracts with Subcontractors and Suppliers to require them to perform their portion of the Work as provided in the Agreement;

.2 provide the Owner or Contract Administrator with a redacted copy of any subcontract with a Subcontractor or Supplier, and all applicable amendments and changes, promptly upon request of the Owner, and in no event later than within five (5) Working Days of such request.

.3 incorporate, or cause to be incorporated, into all subcontracts with Subcontractors and Suppliers the terms and conditions of the Agreement, including:

(1) the contract number set out on the cover page of the Agreement and Project description set out in row A.1 of the Information Sheet;

(2) 9.3 – WARRANTY, GC 13.2.4 and Schedule F - Owner Policies, Procedures, By-Laws and Other Requirements;

(3) a provision requiring the Subcontractor or Supplier to provide adequate notice to the Contractor in order for the Contractor to fulfill its obligations under GC 12.2.16. For clarity, such provision shall include a requirement that the Subcontractor or Supplier include a similar provision in all its subcontracts with Sub-subcontractors and all such Sub-subcontractors to include a similar provision in all their subcontracts with their Sub-subcontractors and so on within every tier of the construction pyramid; and

(4) a provision that permits the Contractor's interest in the subcontract to be immediately assigned, at the same price and in the Owner's sole and absolute discretion, to the Owner or the Owner's designee upon Notice in Writing thereof given by the Owner to both Contractor and Subcontractor or Supplier, as the case may be, for nominal consideration of $5.00, provided, however, that until the Owner has given such Notice in Writing, nothing herein contained shall be deemed to create any contractual or other liability upon the Owner for the performance of obligations under such subcontracts and the Contractor shall be fully responsible and liable for all of its obligations and liabilities (if any) under such subcontracts; and

.4 have control over, charge of, and be fully responsible to the Owner for, the acts and omissions of Subcontractors, Suppliers and their Personnel and for the acts and omissions of Personnel of the Contractor even if such Subcontractor or Supplier was approved or selected by the Owner.

3.8.3 Unless expressly stated otherwise in row A.6 of the Information Sheet, the Contractor may only use the Subcontractors and Suppliers identified in row A.6 of the Information Sheet for the specific portion of the Work which they are identified as performing for the Project. Contractor shall not:

.1 change any of such identified Subcontractors or Supplier or let any subcontracts for the performance of the Work to Subcontractors and Suppliers that have not been identified in row A.6 of the Information Sheet;

.2 use a Subcontractor or Supplier to perform Work which has not been identified in row A.6 of the Information Sheet as being performed by such Subcontractor or Supplier,

without the prior written approval of the Owner. The Owner shall be entitled to a minimum of ten (10) Working Days to review and approve any such request for approval by the Contractor. Without limiting the generality of the factors or criteria which the Owner and Contract Administrator may consider during such review and approval process, the Owner shall be entitled to consider the proposed Subcontractor's or Supplier's compliance with the Owner's Policies, Procedures and By-laws. Any approved replacement of a Subcontractor or Supplier shall be made with no increase in the Contract Price and extension of the Contract Time and any costs incurred by the Owner for the services of the Contract Administrator in reviewing such proposed replacement shall be borne by the Contractor.

3.8.4 The Owner's consent to subcontracting by the Contractor shall not be construed as relieving the Contractor from any obligation under the Agreement and shall not impose any liability on the Owner.

3.8.5 The Owner, through the Contract Administrator, may provide to a Subcontractor, Supplier and Sub-subcontractor information as to the percentage of the Subcontractor's or Supplier's Work which has been certified for payment.

3.8.6 The Contractor shall pay the Subcontractors and Suppliers on a timely basis in accordance with the terms of their respective subcontracts and applicable Laws.

3.9 LABOUR AND PRODUCTS

3.9.1 The Contractor shall provide and pay for labour, Products, Construction Equipment, water, heat, light, power, transportation, and other facilities and services necessary for the performance of the Work in accordance with the Agreement. Without limiting the generality of the foregoing, the Contractor shall pay its Personnel, and shall cause the Subcontractors and Suppliers to pay their Personnel, performing the Work, in accordance with the labour related provisions set out in the Agreement and at intervals no less than those required by such Personnel's employment or labour agreements.

3.9.2 The Contractor covenants and agrees that the Work, including all Products and components thereof, shall conform to the Agreement in all respects, and, unless otherwise specified in the Agreement, shall be of merchantable quality and fit for their intended purpose as described in the Contract Documents and shall be new and free from Deficiencies. Products which are not specified shall be of a quality consistent with those specified and the use of such Products shall be subject to the acceptance of the Contract Administrator or Owner. This GC 3.9.2 shall be in addition to and not in limitation of any other right or remedy granted by the Agreement or otherwise available to the Owner.

3.9.3 Title to the Work including the Products (and each portion thereof) shall pass to the Owner immediately upon payment therefore (subject to applicable holdback that is not then due) or upon incorporation of the Products into the Work at the Site,

whichever first occurs, free and clear of all liens, charges and encumbrances (subject to any rights or remedies provided by the Construction Act, if applicable). Notwithstanding any transfer of title to the Work or any portion thereof to the Owner, the Contractor shall be responsible for and bear the risk of Loss with respect to the Work (including Products delivered to the Site, whether or not incorporated into the Work) until the date of Total Performance of the Work. Title to Owner Supplied Material shall remain with the Owner at all times.

3.9.4 Substitutions

.1 The Contractor shall not substitute any Product without the prior written approval of the Contract Administrator and the Owner.

.2 Where the Agreement requires the Contractor to supply a Product, the Contractor may apply to the Contract Administrator to propose a substitution for such Product ("**Substitution**") that equals or exceeds the quality, suitability, reliability, durability and performance of the Product designated in the Agreement. The application by the Contractor to the Contract Administrator for a Substitution shall be:

(1) in writing and include complete data as to the quality, suitability, reliability, durability, performance and projected cost or cost savings of the Substitution, impact on the Construction Schedule and such other information as the Contract Administrator may require; and

(2) made in such time as to ensure that the review and approval process by the Contract Administrator and the Owner shall not adversely impact the Construction Schedule.

The burden of proving the quality, suitability, reliability, durability and performance of a Substitution shall be upon the Contractor.

.3 The approval or rejection of a Substitution shall be made at the sole and absolute discretion of the Contract Administrator and the Owner. Notwithstanding the foregoing, the Contractor shall not be entitled to any increase in Contract Price or extension of the Contract Time as a result of the review, approval or rejection of a Substitution by the Contract Administrator or the Owner.

.4 Approval of a Substitution will only be for the specific circumstances set out in the application and shall not change or modify any other requirement contained in the Agreement or establish approval for the Substitution to be used in any other portion of the Work that is unrelated to the subject approval.

3.9.5 All surplus Products which have not been used in the performance of the Work shall be removed from the Site when notified in writing to do so by the Contract Administrator. The cost for such surplus Products shall be credited to the Fixed Price or Total Price of Unit Price Work under the Proper Invoice submitted pursuant to GC 5.7.1.1, to the extent the Owner has paid for such surplus Products.

3.9.6 The cost of overtime Work (including overtime rates):

.1 required beyond the normal working day at the Site (as may be described in the Specifications) to complete individual construction operations of a continuous nature in respect of Fixed Price Work or Unit Price Work, such as pouring or finishing of concrete or similar Work; or

.2 in respect of Fixed Price Work or Unit Price Work that the Contractor elects to perform without the Owner or the Contract Administrator requesting such overtime Work; or

.3 except as expressly provided for in the Specifications as a part of the Contract Price,

shall not be chargeable to the Owner and shall be at the cost of the Contractor and without adjustment in the Fixed Price or Unit Prices.

3.9.7 The Contractor shall maintain good order and discipline among the Contractor Parties engaged on the Work and shall not employ on the Work anyone not skilled in the tasks assigned.

3.10 DOCUMENTS AT THE SITE

3.10.1 The Contractor shall control, store and retain copies (one of which must be in hardcopy) of the Agreement, Submittals, reports, and records of meetings at the Site, in good order and readily available to the Owner and the Contract Administrator. Upon the request of the Owner, the Contractor shall provide hard copies and electronic copies of all the foregoing documents to the Owner, at the Owner's cost, except to the extent the delivery of such document already forms part of the Fixed Price Work.

3.10.2 The Contractor shall accurately and continuously note on the Drawings and Specifications kept by the Contractor at the Site, (1) all approved changes and deviations made during the Work which differ from that shown or specified in the Agreement and reviewed Shop Drawings indicating, in a neat, accurate and legible manner the Work as actually installed; (2) the exact location and detail of buried, embedded or concealed as-built conditions and all other as-built conditions of the Work (including the location of all asbestos abatement Work dealing with such matters as floor tiles and pipe insulation); and (3) the exact location and detail of Work installed on a "field run" basis (collectively, the "**As-Built Drawings**"). If any Work is performed otherwise than as shown in the Agreement, the Contractor shall note on such As-Built Drawings the Work as installed, including with respect to the mechanical, electrical and fire protection Work. The As-Built Drawings shall be made available for review by the Owner and the Contract Administrator at all times. The Contractor shall deliver the As-Built Drawings to the Owner on or before Substantial Performance of the Work, in the following format: (A) one complete set of reproducible final versions; and (B) one complete set stored on the latest edition of AutoCAD or such other format required by the Owner.

3.11 SHOP DRAWINGS

3.11.1 The Contractor shall provide Shop Drawings if required by the Agreement or as the Contract Administrator may reasonably request. The Shop Drawings shall meet the requirements of the Agreement (including this 3.11, unless otherwise stipulated elsewhere in the Agreement or agreed to by the Contract Administrator) and the Contractor shall carry out the Work in accordance with Shop Drawings which meet such requirements. The Contractor shall not perform any portion of the Work covered by or affected by Shop Drawings until the Contract Administrator has completed its review of such Shop Drawings for construction in accordance with the procedure referred to in the Agreement.

3.11.2 The Contractor shall provide Shop Drawings to the Contract Administrator to review in orderly sequence and sufficiently in advance so as to cause no delay in the Work or in the work of other contractors.

3.11.3 Upon request of the Contractor or the Contract Administrator, they shall jointly prepare a schedule of the dates for provision, review and return of Shop Drawings.

3.11.4 The Contractor shall provide Shop Drawings in the form specified, or if not specified, as directed by the Contract Administrator.

3.11.5 Shop Drawings provided by the Contractor to the Contract Administrator shall indicate by stamp, date and signature of the Person responsible for the review that the Contractor has reviewed each one of them.

3.11.6 The Contract Administrator's review is for conformity to the design concept and for general arrangement only and shall not relieve the Contractor of responsibility for errors or omissions in the Shop Drawings or for meeting all requirements of the Agreement.

3.11.7 Shop Drawings which require approval of any legally constituted authority having jurisdiction shall be provided to such authority by the Contractor for approval.

3.11.8 The Contractor shall review all Shop Drawings before providing them to the Contract Administrator. The Contractor represents by this review that:

.1 the Contractor has determined and verified all applicable field measurements, field construction conditions, Product and Owner Supplied Material requirements, catalogue numbers and similar data, or will do so, and

.2 the Contractor has checked and co-ordinated each Shop Drawing with the requirements of the Work and of the Agreement.

3.11.9 At the time of providing Shop Drawings, the Contractor shall expressly advise the Contract Administrator in writing of any deviations in a Shop Drawing from the requirements of the Agreement. The Contract Administrator shall indicate the acceptance or rejection of such deviation expressly in writing.

3.11.10 The Contractor shall provide revised Shop Drawings to correct those which the Contract Administrator rejects as inconsistent with the Agreement, unless otherwise directed by the Contract Administrator. The Contractor shall notify the Contract

Administrator in writing of any revisions to the Shop Drawings other than those requested by the Contract Administrator.

3.11.11 The Contract Administrator shall review and return Shop Drawings in accordance with the schedule agreed upon, or, in the absence of such schedule, with reasonable promptness so as to cause no delay in the performance of the Work.

3.11.12 The Contractor shall provide the Owner with a "specification compliance report" from the manufacture or Supplier of each item of equipment forming part of the Products. The specification compliance report shall provide details which demonstrate that all applicable requirements of the Drawings and Specifications have been satisfied. Any deviations from such requirements must be addressed in the specification compliance report to the satisfaction of the Owner, as confirmed by the Owner. For clarity, any deviation set out in the specification compliance report is not accepted by the Owner, except to the extent such acceptance has been confirmed in writing by the Owner.

3.12 USE OF THE WORK

3.12.1 The Contractor shall confine Construction Equipment, Temporary Work, storage of Products, Owner Supplied Material, waste products and debris, and operations of Contractor Parties to limits indicated by Laws or the Agreement and shall not unreasonably encumber the Site. All Products and Owner Supplied Equipment shall be stored under suitable conditions to prevent damage, deterioration, and contamination.

3.12.2 The Contractor shall not load or permit to be loaded any part of the Work or any part of the Site with a weight or force that shall or could be considered to endanger the safety or integrity of the Work or any part of the Site, individuals and the area adjacent to the Site.

3.13 STANDARD OF CARE, QUALITY ASSURANCE AND QUALITY CONTROL

3.13.1 In performing the Work, the Contractor shall exercise a standard of care, skill and diligence that would normally be provided by an experienced, qualified and prudent contractor supplying similar work for similar projects ("**Standard of Care**"). The Contractor acknowledges and agrees that throughout the term of the Agreement, the Contractor's obligations, duties and responsibilities shall be interpreted in accordance with the Standard of Care. The Contractor shall exercise the Standard of Care in respect of any Products and Personnel which it may recommend to the Owner.

3.13.2 If required by the Specifications, the Contractor shall develop and maintain a quality assurance and quality control plan ("**QA/QC Plan"**), in accordance with the Specifications, to ensure that the Work, including the performance of the Work is in accordance with the Agreement.

3.13.3 As of the Effective Date, the Contractor represents and warrants that there are no pending, threatened or anticipated Claims that would have a material effect on the financial ability of the Contractor to perform the Work. The Contractor shall immediately notify the Owner of any such Claims that arise after the Effective Date

and shall take all necessary and prudent steps to remedy or resolve such Claims to ensure that the performance of the Work is unaffected.

3.14 USE AND OCCUPANCY OF THE WORK PRIOR TO SUBSTANTIAL PERFORMANCE OF THE WORK

3.14.1 Without limitation to any other right of the Owner in the Agreement, the Owner shall, at any and all times, have the right to enter, occupy and use the Work or any part thereof prior to Substantial Performance of the Work if such entry and occupancy does not materially interfere with the Contractor's performance and the completion of the Work within the Contract Time. Should the Owner wish to use or occupy part or all of the Work prior to Substantial Performance of the Work, the Owner shall give thirty (30) Calendar Days' Notice in Writing to the Contractor of the intended purpose and extent of such use or occupancy.

3.14.2 If the Owner exercises the right of occupancy and/or use of the Work in accordance with GC 3.14.1, it agrees to do so in a manner that does not materially interfere with the Contractor's performance and the completion of the Work within the Contract Time and with the understanding that the Owner will be occupying premises within a construction site which will require compliance with all normal construction site requirements including health and safety requirements.

3.14.3 The use or occupancy of the Work or any part thereof by the Owner prior to Substantial Performance of the Work shall not constitute an acceptance of the Work or parts so occupied. Such use or occupancy of the Work shall not:

.1 relieve or limit the Contractor or its surety from any responsibilities under the Agreement or liability that has arisen, or may arise, from the performance of the Work;

.2 waive the Owner's right to charge the Contractor liquidated damages (including Delay Liquidated Damages) in accordance with the terms of the Agreement; or

.3 affect the Warranty Period or the warranties set out in the Agreement.

3.14.4 Within five (5) Working Days of receiving the Notice in Writing referred to in GC 3.14.1, the Contractor shall notify the Owner in writing of the additional premium cost, if any, to maintain all risk property insurance coverage (including boiler coverage). The cost of such additional premium shall be paid by the Owner (but without any markup by the Contractor) through the issuance of a Change Order, provided that the Owner's need to use or occupy the space did not arise as a result of the Work being behind schedule for a reason other than as described in GC 7.5.1 , 7.5.2 or 7.5.3. If because of such use or occupancy the Contractor is unable to provide such additional coverage, the Owner shall provide, maintain and pay for all risk property insurance coverage (including boiler coverage) insuring the full value of the used or occupied portion of the Work, including coverage for such use or occupancy, and shall provide the Contractor with proof of such insurance. The Contractor shall refund to the Owner the unearned premiums applicable to the Contractor's policies upon termination of coverage.

3.15 ACCESS TO PROPERTIES ADJOINING THE WORK AND INTERRUPTION OF OPERATIONS

3.15.1 The Contractor shall provide, at all times and at no extra cost to the Owner and without extension of the Contract Time, access to fire hydrants, water and gas valves, and all other Utilities and Structures and access to any existing equipment located at the Site which remains in operation by the Owner over the duration of the Project. The operation of any such Utilities and Structures and equipment shall take precedence over the Work in the case of conflicts.

3.15.2 The Contractor acknowledges that during the term of the Contract, the Place of the Work and the area in the vicinity of the Place of the Work may be occupied by the Owner and other Persons and that, if so occupied, such Persons will continue to carry out their normal operation and use of Place of the Work and shall be allowed to maintain their services and business continuity. The Contractor shall perform the Work in the least intrusive manner possible so as to avoid interfering with any such operations in the vicinity of the Work. The Contractor shall not disrupt the use or enjoyment of the Place of the Work and the vicinity by the Owner and other Persons.

4. PROTECTION OF PERSONS, WORK AND PROPERTY

4.1 PROTECTION OF WORK AND PROPERTY

4.1.1 The Contractor shall protect the Work, Persons and the Owner's property and property adjacent to, in the vicinity of or proximate to the Site from damage which may arise as the result of the Work (including from settlement of ground, flow of water, vibration or shock), and the Contractor shall, and shall cause the other Contractor Parties to, take all precautions to avoid such damage. The Contractor shall be responsible for making good any such damage, at its cost, except damage which occurs as the result of:

.1 subject to 3.6 – DOCUMENT REVIEW, errors, inconsistencies or omissions in the Agreement; and

.2 negligent acts or omissions by the Owner, the Owner Representative, the Contract Administrator, any other contractors (other than the Contractor Parties), and their respective Personnel.

4.1.2 Should damage occur to the Work or Owner's property for which the Contractor is not responsible for pursuant to the Agreement, the Contractor shall make good such damage to the Work and, if the Owner so directs, to the Owner's property. The Contract Price and Contract Time shall be adjusted as provided in 7.1 - OWNER'S RIGHT TO MAKE CHANGES, 7.2 - CHANGE ORDER and 7.3 - CHANGE DIRECTIVE.

4.1.3 Construction Affecting Railway Property or Third Party Operations

.1 The Contractor shall be required to conduct the Work in such a manner as to avoid the possibility of damaging or interfering with any railway property in the vicinity of the Work. Every reasonable precaution shall be taken by the

Contractor to ensure the safety and protection of all Contractor Parties and Construction Equipment and railway property (at track crossings or otherwise) and users thereof throughout the performance of the Work.

.2 The Owner shall pay the costs of all flagging and other traffic control measures required and provided by a railway company unless such costs are solely a function of the Contractor's chosen method of completing the Work.

4.1.4 Operational Risk

.1 The position of all pole lines, conduits, pipes, watermains, sewers and other covered, underground and overground utilities and structures in, on, adjacent to under or over the Site (collectively, the "**Utilities and Structures**") are not necessarily provided in the Agreement, and where provided, the accuracy of the position of such Utilities and Structures is not guaranteed and the Owner disclaims all liability with respect to same except to the extent explicitly stated otherwise in row E.3 of the Information Sheet. The Contractor shall be liable for damages to the Utilities and Structures as a result of any act or omission, whether or not the result of negligence, by the Contractor Parties and the Losses relating to such damage shall not be chargeable to the Owner and shall be at the cost of the Contractor.

.2 Without limiting the generality of GC 4.1.4.1, before commencing any Work, the Contractor shall inform itself of the existence and exact condition, size, depth and location of all Utilities and Structures in accordance with the Standard of Care and the Specifications, if applicable, and such process shall occur in conjunction with the Contractor's review of the Agreement pursuant to GC 3.6.1. For clarity, to the extent the Owner is required to provide such information to the Contractor as a part of its obligation under Laws, including the *Ontario Underground Infrastructure Notification System Act, 2012*, any work required to obtain such information shall be performed by the Contractor as a part of the Work without any increase to the Contract Price or extension of the Contract Time.

.3 As a part of, and in co-ordination with, the Work, the Contractor shall provide for the removal, protection, support, temporary and permanent relocation and restoration of the Utilities and Structures to the satisfaction of the owners of the Utilities and Structures, and in performing such Work, the Contractor shall comply with the requirements of the owners of the Utilities and Structures. The Contractor shall arrange with the appropriate owners for the stake out of all Utility and Structure connections that may be affected by the Work. The Contractor shall maintain records of such stake outs and make such records available to the Owner upon request. The Contractor shall observe the location of such stake outs, prior to commencing the Work, and in the event that there is a discrepancy between the location of such stake outs and the locations provided in the Agreement, that may affect the Work, the Contractor shall, prior to performing the affected portion of the Work, immediately notify the Contract Administrator and the affected owners of the Utilities and Structures, in order to resolve the discrepancy.

.4 Where any interruptions in the supply of utility services are required and are authorized by the Contract Administrator, the Contractor shall, in consultation with the Owner, give the affected property owners notice in accordance with the Specifications, and shall arrange such interruptions so as to create a minimum of interference to those affected.

4.1.5 Without in any way limiting the Contractor's obligations under 4.1, should the Contractor or any Subcontractor, Supplier or Sub-subcontractor cause Losses to trees or other plantings, whether owned by the Owner or third parties, the Contractor shall be liable for the replacement cost of the trees or other plantings damaged, including the cost of any arborist or other consultant, and such Losses may be set-off in accordance with 5.10 – OWNER'S SET-OFF.

4.1.6 The Contractor shall immediately inform the Contract Administrator of all damage that occurs during the term of the Agreement. The Contractor shall then investigate and report back to the Contract Administrator and Owner within fifteen (15) Calendar Days of the occurrence of such damage. Such reports shall include all details as the Owner and Contract Administrator require. The Contractor shall neither undertake to repair and/or replace any damage whatsoever to the Work of other contractors, or to adjoining property, nor acknowledge the same was caused or occasioned by the Contractor, without first consulting the Owner and receiving written instructions as to the course of action to be followed from either the Owner or the Contract Administrator. However, where there is imminent danger to life or public safety, the Contractor shall take such emergency action as it deems necessary to remove the danger. The Contractor shall notify the Owner of such imminent danger as promptly as is practicable under the circumstances. The Contract Administrator may conduct its own investigation and the Contractor shall provide all assistance to the Contract Administrator and Owner as may be necessary for that purpose.

4.1.7 The Contractor shall immediately upon becoming aware of a complaint or Claim made by a resident or property owner, inform the Contract Administrator and the Owner.

4.2 HEALTH AND SAFETY

4.2.1 The Contractor shall, until Total Performance of the Work, be solely responsible for:

.1 construction health and safety at the Site;

.2 compliance with the Laws and practices which relate to construction health and safety, including OHSA; and

.3 initiating, maintaining, and supervising all safety precautions and programs in connection with the performance of the Work and the other work performed by the Owner's Personnel and other contractors at the Site (collectively, the "**Other Work**").

4.2.2 Without restricting the generality of any other provision in the Agreement, the Contractor shall, for the purposes of the OHSA, be deemed, construed and designated as the "constructor" for the Work (including the Work of the

Subcontractors, Suppliers and Sub-subcontractors and the Other Work of the Owner's Personnel and other contractors at the Site) and shall assume and fulfill all of the responsibilities of constructor as set out in OHSA in respect of the Work and the Other Work and the Site from the Commencement Date until Total Performance of the Work. Unless explicitly stated otherwise in the Agreement, nothing in the Agreement shall be deemed or construed as making the Owner the "employer" (as defined in OHSA) or the "constructor" (as defined in OHSA), either instead of or jointly with the Contractor.

4.2.3 The Contractor shall establish and administer a health and safety plan for the performance of the Work at the Site, which shall comply with the requirements of all Governmental Authorities having jurisdiction and all Laws. The Contractor shall provide the Owner with a copy of the health and safety plan prior to the Commencement Date. The Contractor shall ensure the Contractor Parties, Owner's Personnel and other contractors at the Site comply with the health and safety plan. As part of its reporting obligations on the progress of the Work described in the Specifications, the Contractor shall provide information on the ongoing implementation of its health and safety plan.

4.2.4 Prior to the Commencement Date, the Contractor shall submit to the Owner:

.1 a current WSIB clearance certificate;

.2 a tax statutory declaration in the form attached as Form 3 of Schedule G – Forms;

.3 documentation of the Contractor's in-house corporate level health and safety program;

.4 a copy of the Notice of Project filed with the Ministry of Labour naming itself as "constructor" under OHSA; and

4.2.5 The Contractor shall possess and maintain a valid Certificate of Recognition (COR™) or an Equivalent OHS Certification for the duration of performance of the Agreement. The Contractor shall provide the Contract Administrator with a new Certificate of Recognition (COR™) or Equivalent OHS Certification immediately upon the expiry of the previous Certificate of Recognition or Equivalent OHS Certification or otherwise upon demand by the Contract Administrator.

4.2.6 The Contractor shall report to the Owner all health and safety incidents at the Site including the Contractor's response. Without limiting the foregoing, the Contractor shall report any such incident occurring on or off the Site that relates to its Work or Other Work immediately, and shall, in addition, in no event later than forty-eight (48) hours give written notice of such incident

4.2.7 During the course of the Work, the Contractor shall furnish forthwith to the Contract Administrator a copy of all correspondence, reports, orders or charges respecting health and safety, including under OHSA, the *Technical Standards and Safety Act*, 2000, the *Highway Traffic Act,* the *Environmental Protection Act,* the *Workplace Safety and Insurance Act, 1997*, the *Employment Standards Act, 2000* and the

Criminal Code, which are received by, or which come to the notice of, the Contractor that apply or are relevant to any of the Work or activities conducted under the terms of the Agreement. The Contractor shall immediately take all corrective measures necessary to address the issues identified or arising out of any such correspondence, report, order or charges.

4.2.8 Without limiting the obligations of the Contractor described in 3.3 – CONSTRUCTION BY OWNER OR OTHER CONTRACTORS and this 4.2 – HEALTH AND SAFETY, the Owner or Contract Administrator may, by written notice, direct the Contractor to stop the Work where the Owner or Contract Administrator determines that there is an imminent risk to the safety of individuals or property at the Site. In the event that the Contractor receives such written notice, it shall immediately stop the Work and secure the Site. The Contractor shall not be entitled to an extension of the Contract Time or to an increase in the Contract Price unless, and only to the extent, the event which caused such imminent risk would entitle the Contractor to an extension of the Contract Time or the reimbursement of the Contractor's Losses as provided in GC 7.5.1, 7.5.2 or 7.5.3.

4.2.9 Nothing in the Agreement shall be construed as requiring the Contract Administrator or Owner to monitor or approve the health and safety practices of the Contractor.

4.3 HAZARDOUS MATERIALS

4.3.1 Unless expressly permitted in the Agreement, the Contractor shall, and shall cause the other Contractor Parties to, not bring onto the Site any Hazardous Materials without the prior written authorization of the Contract Administrator. No later than five (5) Working Days following execution of the Agreement and prior to the Contractor mobilizing to the Site, the Contractor shall provide to the Owner, a list of all Hazardous Materials, including safety data sheets, which the Contractor expects to use for the Work, for the Owner's review, and update the Owner with any changes made to the list. The Contractor shall also comply with all other provisions under OHSA related to Hazardous Materials.

4.3.2 The Contractor shall use all reasonable care to avoid spilling or disturbing any Hazardous Materials during the performance of the Work. In the case of a "spill" as defined in the *Environmental Protection Act*, the Contractor shall immediately notify the Owner and the Contract Administrator of the location and details of such spill and report the spill to the relevant Governmental Authority. Reporting a spill to the Owner shall not relieve the Contractor of its legislated responsibilities regarding spills or discharges.

4.3.3 If the Contractor or the Owner encounters Hazardous Materials at the Site or has reasonable grounds to believe that Hazardous Materials are present at the Site, which were not:

.1 brought to the Site by the Contractor Parties;

.2 disclosed by the Owner or in the Agreement; or

.3 discovered by the Contractor through the fulfillment of its responsibilities pursuant to 3.6 - EXAMINATION OF SITE,

the Contractor shall:

.4 take all necessary steps, in accordance with Laws, including stopping the Work, to

(1) manage, remove, dispose of, store or otherwise render harmless such Hazardous Materials;

(2) ensure that no individual's exposure to any Hazardous Materials exceeds any applicable time weighted levels prescribed by Laws (including O Reg 833 under OHSA); and

(3) ensure that no property is damaged or destroyed as a result of exposure to, or the presence of, such Hazardous Materials; and

.5 immediately report the circumstances to the Contract Administrator and the other party in writing.

4.3.4 If the Owner and Contractor do not agree on:

.1 the existence and significance of the Hazardous Materials described in GC 4.3.3;

.2 if such Hazardous Materials were brought onto the Site by a Contractor Party;

.3 if such Hazardous Materials were disclosed by the Owner or in the Agreement; or

.4 if such Hazardous Materials should have been discovered by the Contractor through the fulfillment of its responsibilities pursuant to 3.6 - EXAMINATION OF SITE,

the Owner shall retain and pay for an independent qualified expert to investigate and determine such matters. The expert's report shall be delivered to the Owner and the Contractor.

4.3.5 If the Owner and Contractor agree or if the expert referred to in GC 4.3.4 determines that the Hazardous Materials were not brought onto the Site by a Contractor Party and were not disclosed by the Owner or in the Agreement and would not have been discovered by the Contractor through the fulfillment of its responsibilities pursuant to 3.6 - EXAMINATION OF SITE, the Owner shall immediately at the Owner's own cost:

.1 reimburse the Contractor for the costs of all steps taken pursuant to GC 4.3.3; and

.2 extend the Contract Time for such reasonable time as the Contract Administrator may recommend in consultation with the Contractor and the expert referred to in 4.3.4 and reimburse the Contractor for reasonable Losses incurred as a result of

the delay, but excluding any consequential, indirect or special damages and loss of profit, loss of opportunity or loss of productivity resulting from such delay.

4.3.6 If the Owner and Contractor agree or if the expert referred to in GC 4.3.4 determines that the Hazardous Materials were brought onto the Site by a Contractor Party and were not disclosed by the Owner or in the Agreement and would not have been discovered by the Contractor through the fulfillment of its responsibilities pursuant to 3.6 - EXAMINATION OF SITE, the Contractor shall immediately at the Contractor's own cost and without extension of the Contract Time:

.1 make good any damage to the Work, the Owner's property or property adjacent to the Site as provided in GC 4.1.1; and

.2 reimburse the Owner for reasonable Losses incurred under GC 4.3.4 but excluding any consequential, indirect or special damages and loss of profit, loss of opportunity or loss of productivity.

4.3.7 If either party does not accept the expert's findings under GC 4.3.4, the disagreement shall be settled in accordance with12. DISPUTE RESOLUTION. If such disagreement is not resolved within thirty (30) Calendar Days, the parties shall act immediately in accordance with the expert's determination and take the steps required by GC 4.3.5 or GC 4.3.6 it being understood that by so doing, neither party will jeopardize any claim that party may have to be reimbursed as provided by 4.3 - HAZARDOUS MATERIALS.

4.4 MOULD

4.4.1 If the Contractor or Owner observes or reasonably suspects the presence of mould at the Site, the remediation of which is not expressly part of the Work:

.1 the observing party shall immediately report the circumstances to the other party in writing;

.2 the Contractor shall immediately take all reasonable steps, including stopping the Work if necessary, to ensure that no individual suffers injury, sickness or death and that no property is damaged as a result of exposure to or the presence of the mould; and

.3 if the Owner and Contractor do not agree on the existence, significance or cause of the mould or as to what steps need be taken to deal with it, the Owner shall retain and pay for an independent qualified expert to investigate and determine such matters. The expert's report shall be delivered to the Owner and Contractor.

4.4.2 If the Owner and Contractor agree, or if the expert referred to in GC 4.4.1.3 determines that the presence of mould was caused by the Contractor's operations under the Agreement, the Contractor shall promptly, and in no event later than within ten (10) Working Days after such agreement or determination, as applicable, at the Contractor's own cost:

.1 take all reasonable and necessary steps to safely remediate or dispose of the mould;

.2 make good any damage to the Work, the Owner's property or property adjacent to the Site as provided in GC 4.1.1; and

.3 reimburse the Owner for reasonable Losses incurred under GC 4.4.1.3.

4.4.3 If the Owner and Contractor agree, or if the expert referred to in GC 4.4.1.3 determines that the presence of mould was not caused by the Contractor's operations under the Agreement, the Owner shall promptly, and in no event later than within ten (10) Working Days after such agreement or determination, as applicable, at the Owner's own cost:

.1 take all reasonable and necessary steps to safely remediate or dispose of the mould;

.2 reimburse the Contractor for the cost of taking the steps under GC 4.4.1.2 and making good any damage to the Work as provided in GC 4.1.2; and

.3 extend the Contract Time for such reasonable time as the Contract Administrator may recommend in consultation with the Contractor and the expert referred to in GC 4.4.1.3 and reimburse the Contractor for reasonable Losses incurred as a result of the delay but excluding any consequential, indirect or special damages and loss of profit, loss of opportunity or loss of productivity.

4.4.4 If either party does not accept the expert's finding under GC 4.4.1.3, the disagreement may be settled in accordance with 12. DISPUTE RESOLUTION. If such disagreement is not resolved within thirty (30) Calendar Days, the parties shall act immediately in accordance with the expert's determination and take the steps required by GC 4.4.2 or 4.4.3, it being understood that by so doing neither party will jeopardize any Claim the party may have to be reimbursed as provided by 4.4 - MOULD.

4.5 ARTIFACTS AND FOSSILS

4.5.1 Fossils, coins, articles of value or antiquity, structures and other remains or things of scientific or historic interest discovered at the Place or Work shall, as between the Owner and the Contractor, be deemed to be the absolute property of the Owner.

4.5.2 The Contractor shall take all reasonable precautions to prevent removal or damage to discoveries as identified in GC 4.5.1, and shall immediately notify the Contract Administrator upon discovery of such items and shall suspend the Work within any area identified by the Contract Administrator. Initial notification may be verbal provided that such notice is confirmed in writing by the Contractor within two (2) Calendar Days of discovery.

4.5.3 The Contract Administrator will investigate the impact on the Work of the discoveries identified in GC 4.5.1. If conditions are found that would cause an increase or decrease in the Contractor's cost or time to perform the Work, the Contract

Administrator, with the Owner's approval, will issue appropriate instructions for a change in the Work as provided in 7.2 - CHANGE ORDER or 7.3 - CHANGE DIRECTIVE.

5. CONTRACT PRICE AND PAYMENT

5.1 CONTRACT PRICE

5.1.1 The Contract Price, which excludes Value Added Taxes, is described in paragraph 2.1 of Section 2 of the Agreement – CONTRACT PRICE.

5.2 OWNER'S OBLIGATION TO PAY

5.2.1 Subject to the provisions of the Agreement, and in accordance with the Construction Act, the Owner shall:

.1 in respect of Fixed Price Work, make progress payments and, if any, milestone payments to the Contractor for amounts undisputed by the Owner on account of the Fixed Price when due, together with such Value Added Taxes as may be applicable to such payments;

.2 in respect of Unit Price Work, make progress payments to the Contractor for amounts undisputed by the Owner on account of the Total Price of Unit Price Work when due, together with such Value Added Taxes as may be applicable to such payments;

.3 upon Substantial Performance of the Work, pay to the Contractor the unpaid balance of the ten percent (10%) portion of the Lien Holdback when due together with such Value Added Taxes as may be applicable to such payment; and

.4 upon Total Performance of the Work, pay to the Contractor the unpaid amount of the Contract Price and the finishing portion of the Lien Holdback when due together with such Value Added Taxes as may be applicable to such payments.

5.2.2 Payment of the Contract Price shall be full compensation for all labour, services, Contractor Parties, Construction Equipment and Products required in the performance of the Unit Price Work, including, hand tools, supplies and other incidentals.

5.2.3 The Unit Prices shall not be adjusted during the term of the Agreement other than as provided for in Schedule B – Pricing Form.

5.2.4 Payment for any Unit Price Work not specifically detailed as part of any one item of Unit Price Work and without specified details of payment shall be deemed to be included in the items of Unit Price Work with which it is associated.

5.2.5 Advance payments for Products not yet incorporated into the Work (whether or not delivered to the Site) shall not be made by the Owner without the prior written consent of the Owner, in its sole and absolute discretion. Any such advance payment shall be made on terms as agreed to by the Owner and Contractor (such terms may

include transfer of title, the Contractor's responsibility for risk of Loss and off-site storage requirements).

5.2.6 In the event of Losses occurring where payment becomes due under the all risk property insurance policies, payments shall be made to the Contractor in accordance with the provisions of 8.1 – INSURANCE.

5.3 PROPER INVOICES

5.3.1 After the Commencement Date, Proper Invoices shall be given to the Owner monthly for each Invoice Period as the Work progresses, unless otherwise specified in row B.9 of the Information Sheet. Proper Invoices shall be given to the Owner by giving it to the Owner Representative in accordance with row B.10 of the Information Sheet.

5.3.2 If the Contractor is performing Unit Price Work, the Contract Administrator or Owner Representative shall make an Estimate of Units once an Invoice Period, in writing. The first Estimate of Units shall be in respect of the Unit Price Work performed since the Contractor commenced the Unit Price Work, and every subsequent Estimate of Units, except the final one, shall be in respect of the Unit Price Work performed since the preceding Estimate of Units was made. The Contract Administrator or Owner Representative, as applicable, shall provide a copy of each such Estimate of Units to the Contractor on or before the 5th Calendar Day after the end of the Invoice Period (or the next Working Day following such date if such date is not a Working Day).

5.3.3 For all Work, the Contractor shall submit a draft invoice to the Contract Administrator:

.1 at the invoice meeting held on or before the 7th Calendar Day after the end of the Invoice Period (or the next Working Day following such date if such date is not a Working Day) to which the Proper Invoice relates; or

.2 on or before the 7th Calendar Day after the end of the Invoice Period (or the next Working Day following such date if such date is not a Working Day) to which the Proper Invoice relates, in such form of written or electronic communication as agreed to by the parties.

If the Contractor submits the draft invoice in accordance with GC 5.3.3.1, then the Contract Administrator, the Owner and the Contractor shall review such draft invoice at such meeting or, if the Contractor submits the draft invoice in accordance with GC 5.3.3.2, then the Contractor Administrator and the Owner shall review such draft invoice and, prior to the 14th Calendar Day after the end of such Invoice Period, the Owner and the Contract Administrator may provide the Contractor with suggested revisions to the draft invoice based upon the progress of the Work, the Contract Administrator's or Owner Representative's, as applicable, Estimate of Units and other relevant considerations. The draft invoice shall be submitted in the same format (and with the same content) as the Proper Invoice.

5.3.4 On the 14th Calendar Day after the end of the Invoice Period to which the Proper Invoice relates, the Contractor shall give a Proper Invoice to the Owner. In preparing the Proper Invoice, the Contractor should take into consideration revisions proposed by the Contract Administrator and the Owner from the draft invoice process including

any reconciliations with the Contract Administrator's or Owner Representative's, as applicable, Estimate of Units. Incorporating such revisions will reduce the likelihood of the Owner issuing a notice of non-payment pursuant to GC 5.4.1.3 but is without prejudice to any rights or remedies of the Owner under the Agreement or otherwise. For clarity:

.1 a Proper Invoice shall not be rendered incompliant with the requirements of the Agreement solely by reason of a failure to incorporate any such proposed revisions including any reconciliation with the Contract Administrator's or Owner Representative's, as applicable, Estimate of Units; and

.2 the Contractor may only give to the Owner a Proper Invoice on the 14th Calendar Day after the end of the Invoice Period to which the Proper Invoice relates, and the Contractor shall not give to the Owner a Proper Invoice on any other Calendar Day. Any Proper Invoice received by the Owner on any Calendar Day:

(1) earlier than the 14th Calendar Day after the end of such Invoice Period shall be deemed to have been received by the Owner on the 14th Calendar Day after the end of such Invoice Period; or

(2) later than the 14th Calendar Day after the end of such Invoice Period shall be deemed to have been received by the Owner on the Calendar Day of such delivery,

and if the date on which the Proper Invoice is received under GC 5.3.4.2, or is deemed to have been received under GC 5.3.4.2(1) or (2), is not a Working Day, then it shall be deemed to be received on the next Working Day.

5.3.5 The amount applied for in each Proper Invoice shall be:

.1 for Fixed Price Work:

(1) relating to milestones set out in the Agreement, the portion of the Fixed Price attributable to the milestones which the Owner has agreed have been completed on or before the last Calendar Day of the Invoice Period to which the Proper Invoice relates except for milestones dealt with in prior Proper Invoices;

(2) not relating to milestones set out in the Agreement, the value, proportionate to the Fixed Price not attributable to the milestones, of such Fixed Price Work performed to the last Calendar Day of the Invoice Period to which the Proper Invoice relates less the value of such Fixed Price Work previously invoiced in prior Proper Invoices;

.2 for Unit Price Work, the aggregate of the total units for each item of the Unit Price Work performed to the last Calendar Day of the Invoice Period to which the Proper Invoice relates multiplied by the applicable Unit Price of each such item, less the value of all Unit Price Work previously invoiced in prior Proper Invoices; and

.3 for T&M Changes in the Work, an amount equal to:

(1) the total T&M Price of all T&M Changes in the Work performed to the last Calendar Day of the month to which the Proper Invoice relates; less

(2) the total T&M Price of all T&M Changes in the Work in respect of all prior Proper Invoices,

calculated in accordance with Section 3 of Schedule E – Valuing Changes in the Work.

For clarity, the amount applied for in each Proper Invoice shall not include any amounts included in any Claim Notice unless and until the Owner or the Contract Administrator, as the case may be, has issued a determination to the Contractor regarding the validity of such Claim Notice pursuant to GC 7.7.6.

5.3.6 Schedule of Values

.1 The Contractor shall submit to the Contract Administrator, within fourteen (14) Calendar Days of the Effective Date and prior to the first Proper Invoice, a schedule of values with a detailed breakdown of the Fixed Price Work not relating to milestones, aggregating the total amount of the Fixed Price not attributable to the milestones, so as to facilitate evaluation of Proper Invoices.

.2 The schedule of values shall:

(1) be made out in such form and supported by such evidence as the Contract Administrator may reasonably direct;

(2) include a fair and reasonable value for the preparation and completion of the As-Built Drawings; and

(3) include the fixed price for the bonds and insurance to be maintained by the Contractor in compliance with the requirements of the Agreement and provide for the payment of such fixed price for the bonds and insurance in amounts proportionate to the payment of the Fixed Price not attributable to the milestones unless otherwise agreed to by the Contract Administrator.

.3 When accepted by the Contract Administrator, the schedule of values shall be used as the basis for evaluating Fixed Price Work not relating to the milestones in Proper Invoices, unless both parties agree the schedule of values is in error.

.4 The Owner, acting reasonably, reserves the right to modify costs allocated to the various breakdown items in the schedule of values during the performance of the Work to prevent front loading.

5.3.7 The Proper Invoice shall be in a form similar to Form 1 of Schedule G – Sample Proper Invoice and shall, to the extent applicable:

.1 include the following information, to the extent such information is not included in any schedule of values:

(1) the Contractor's name, telephone number and mailing address, and contact information of the Contractor Project Manager;

(2) remittance payment information;

(3) Proper Invoice number;

(4) the date of the Proper Invoice and the Invoice Period during which the Work was performed;

(5) the Contract number;

(6) purchase order number

(7) contact information of the Owner's Representative and Contract Administrator;

(8) a description of the Project;

(9) percentage of Work completed to date;

(10) a description of the Work performed during the Invoice Period and a specific itemization of the Work with quantities where appropriate including:

(A) the Contract Administrator's or Owner Representative's, as applicable, Estimate of Units; and

(B) the Contractor's Estimate of Units;

(11) the total Contract Price and the amount of the Contract Price previously paid;

(12) the value of Work and changes in the Work performed to date itemized by Change Order; and

(13) the amount payable for the Work and changes in the Work performed during the Invoice Period;

.2 include the schedule of values;

.3 include a detailed description of expenditures under the Cash Allowance and Provisional Allowance;

.4 include Daily Contractor Work Records;

.5 include evidence of compliance with worker's compensation legislation including a WSIB clearance certificate;

.6 include a statutory declaration using the latest form CCDC 9A - 2018 Statutory Declaration of Progress Payment Distribution by Contractor, confirming that all accounts of the Contractor have been paid in full up to and including the latest progress payment received;

.7 for advance payment, if applicable, for Products not yet incorporated into the Work:

(1) list such Products (and the advance payment calculations in respect thereof) as a separate line item; and

(2) be supported by invoices and such other evidence as the Contract Administrator may reasonably request to establish the value and delivery of such Products;

.8 list the Lien Holdback, Contractual Holdback and any other holdbacks provided for under this Contract as a separate line item;

.9 include the Contractor's registration number for Value Added Taxes and list the total amount of Value Added Taxes separate from the total Contract Price;

.10 include a copy of the latest Current Schedule delivered in compliance with the applicable requirements of 3.5 – CONSTRUCTION SCHEDULE; and

.11 include such other information and documents: (1) identified elsewhere in the Agreement; or (2) as required under the Construction Act.

5.3.8 A Proper Invoice may be revised by the Contractor after it has submitted the Proper Invoice to the Owner, if:

.1 the Owner agrees in advance to the revision;

.2 the date of the Proper Invoice is not changed; and

.3 the Proper Invoice continues to be in compliance with the requirements of GC 5.3.7.

5.4 PROGRESS PAYMENT

5.4.1 After receipt by the Contract Administrator of a Proper Invoice submitted by the Contractor in accordance with 5.3 – PROPER INVOICES:

.1 the Contract Administrator shall promptly inform the Owner of the date of receipt of the Proper Invoice;

.2 the Contract Administrator shall, no later than the number of Calendar Days or Working Days, as applicable, after the receipt of the Proper Invoice identified in row C.8 of the Information Sheet, issue to the Owner and copy to the Contractor, a certificate for payment in the amount applied for, or in such other undisputed amount as the Contract Administrator determines to be properly due; and

.3 if the Contract Administrator, or the Owner independent of the Contract Administrator, disputes all or any portion of the amount applied for in such Proper Invoice, the Owner shall promptly, but no later than fourteen (14) Calendar Days after the Contract Administrator's receipt of the Proper Invoice from the Contractor, provide the Contractor a notice of non-payment in the form and manner prescribed by the Construction Act specifying the amount that is not being paid and detailing all of the reasons for such non-payment.

5.4.2 The Owner shall, no later than twenty-eight (28) Calendar Days after the receipt of the Proper Invoice, make payment to the Contractor of the amount set out in the Proper Invoice less the amount disputed by the Contract Administrator or the Owner independent of the Contract Administrator, as applicable, that is set out in the notice of non-payment issued pursuant to GC 5.4.1.3. For clarity, progress payments for Unit Price Work shall be based on Estimates and as such shall be construed and held to be approximate. Subject to section 1.1 of Schedule E – Valuing Changes in the Work, the final quantities of total units for each item of the Unit Price Work performed for the Proper Invoice submitted pursuant to GC 5.7.1.1 shall be based on actual field measurements of the Unit Price Work completed. The Owner shall retain the Contractual Holdback, Lien Holdback and any other holdbacks provided for under this Contract as a separate line item from such payment and may retain any other amount pursuant to 5.10 - OWNER'S SET-OFF. Unless otherwise specified in the Agreement, no letter of credit or demand-worded holdback shall be accepted or used to retain any part of the Lien Holdback.

5.4.3 For clarity, if the Contractor fails to submit a Proper Invoice to the Contract Administrator which is in compliance with the requirements of GC 5.3.7, the Owner shall not be required to make payment to the Contractor within the twenty-eight (28) Calendar Day period set out in GC 5.4.2. Such twenty-eight (28) Calendar Day period shall not commence until such time as the Contract Administrator has received from the Contractor a Proper Invoice in compliance with the requirements of GC 5.3.7.

5.5 SUBSTANTIAL PERFORMANCE OF THE WORK

5.5.1 When the Contractor considers that Substantial Performance of the Work has been attained the Contractor shall, within one (1) Working Day, deliver to the Contract Administrator and to the Owner a comprehensive list of items to be completed or corrected, together with a written application for a review by the Contract Administrator to establish Substantial Performance of the Work. Failure to include an item on the list does not alter the responsibility of the Contractor to complete the Agreement. Such written application shall include the proof required by the Agreement including the Specifications to demonstrate that the Work has been substantially performed in conformance with the requirements of the Construction Act.

5.5.2 The Contract Administrator shall review the Work to verify the validity of the written application for Substantial Performance of the Work and shall promptly, and in any event, no later than twenty (20) Calendar Days after receipt of the Contractor's list and application:

.1 advise the Contractor in writing that the Work is not substantially performed and give reasons why, or

.2 set out the date of Substantial Performance of the Work in the certificate of Substantial Performance of the Work and issue a copy of such certificate to each of the Owner and the Contractor within seven (7) Calendar Days after signing such certificate. The certificate of Substantial Performance of the Work shall be in the form prescribed by the Construction Act.

5.5.3 Immediately following the issuance of the certificate of Substantial Performance of the Work, the Contractor shall prepare and submit to the Owner and the Contract Administrator a schedule for completing the Work and correcting all Deficiencies, which establishes the date for the Total Performance of the Work. Upon the Owner and the Contract Administrator's approval of such schedule, the Construction Schedule shall be deemed to be amended to include such schedule. The date for Total Performance of the Work identified in such schedule shall not be later than the Scheduled Date for Total Performance of the Work.

5.5.4 Upon receipt of a copy of the certificate of Substantial Performance of the Work, the Contractor shall forthwith, as required by section 32(1) of the Construction Act, publish a copy of the certificate in the manner set out in the regulations. If the Contractor fails to publish a copy of the certificate of Substantial Performance of the Work within seven (7) Calendar Days after receiving a copy of such certificate, the Owner may publish a copy of such certificate at the Contractor's cost.

5.6 PAYMENT OF LIEN HOLDBACK UPON SUBSTANTIAL PERFORMANCE OF THE WORK

5.6.1 After the date on which all liens that may be claimed against the Lien Holdback have expired or been satisfied, discharged or otherwise provided for under the Construction Act and provided the certificate of Substantial Performance of the Work has been published in accordance with 5.5, the Contractor shall submit a Proper Invoice for the Lien Holdback, which shall, in addition to complying with the requirements of GC 5.3.7, include the following items in order to be considered a "Proper Invoice" for the purposes of GC 5.6.2:

.1 the list of Claims required by GC 9.2.1;

.2 the value of outstanding or incomplete Work; and

.3 a representation and warranty from the Contractor that, as of the date of the Proper Invoice, the only Adjudications in respect of disputes as described in GC 12.2.16 are Adjudications which the Contractor has provided Notice in Writing of to the Owner in accordance with GC 12.2.16.

5.6.2 After the receipt of a Proper Invoice from the Contractor in compliance with the requirements of GC 5.6.1, the Contract Administrator shall issue a certificate for payment of the Lien Holdback.

5.6.3 Subject to GC 5.6.4 and the Construction Act, the Owner shall, no later than fifteen (15) Working Days after the receipt of the Proper Invoice, make payment to the Contractor of the amount of the Lien Holdback set out in the Proper Invoice. Subject to the Construction Act, the Owner may retain out of the Lien Holdback any sums

required by law to satisfy any liens against the Work and any other amount pursuant to 5.10 - OWNER'S SET-OFF.

5.6.4 The Owner may refuse to pay some or all of the Lien Holdback the Owner is required to pay to the Contractor pursuant to GC 5.6.3 if:

.1 no later than forty (40) Calendar Days after publication of the certificate of Substantial Performance of the Work in accordance with GC 5.5.4, the Owner publishes, in the manner set out in the Construction Act, a notice in the form prescribed by the Construction Act, specifying the amount of the Lien Holdback that the Owner refuses to pay; and

.2 the Owner notifies the Contractor, in accordance with the Construction Act, of the publication of such notice.

5.6.5 For clarity, if the Contractor fails to submit a Proper Invoice to the Contract Administrator which is in compliance with the requirements of GC 5.6.1, the Owner shall not be required to make payment to the Contractor within the fifteen (15) Working Day period set out in GC 5.6.3. Such fifteen (15) Working Day period shall not commence until such time as the Contract Administrator has received from the Contractor a Proper Invoice in compliance with the requirements of GC 5.6.1.

5.7 PAYMENTS UPON TOTAL PERFORMANCE OF THE WORK

5.7.1 Payment Upon Total Performance of the Work

.1 When the Contractor considers that the Work is Totally Performed, the Contractor shall submit a Proper Invoice for payment of the unpaid amount of the Contract Price other than the finishing portion of the Lien Holdback.

.2 The Contractor's Proper Invoice submitted in accordance with GC 5.7.1.1 shall, in addition to complying with the applicable requirements of GC 5.3.7, include the list of Claims required by GC 9.2.2 in order to be considered a "Proper Invoice" for the purposes of GC 5.7.1.5.

.3 The Contract Administrator shall, no later than ten (10) Calendar Days after the receipt of a Proper Invoice from the Contractor submitted in accordance with GC 5.7.1.1, review the Work to verify the validity of such Proper Invoice. If the Contract Administrator, or the Owner independent of the Contract Administrator, disputes the validity of such Proper Invoice, the Owner shall promptly, but no later than fourteen (14) Calendar Days after the Contract Administrator's receipt of such Proper Invoice from the Contractor, provide the Contractor a notice of non-payment in the form and manner prescribed by the Construction Act specifying the amount that is not being paid and detailing all of the reasons why such Proper Invoice is invalid. No later than twenty-eight (28) Calendar Days after the receipt by the Contract Administrator of such Proper Invoice, the Owner shall make payment to the Contractor of the amount set out in such Proper Invoice less the amount disputed by the Contract Administrator or the Owner independent of the Contract Administrator, as applicable, that is set out in a notice of non-payment. If such Proper Invoice is invalid, then the Contractor shall

then submit another Proper Invoice when it considers that the Work is Totally Performed and the process described in this GC 5.7.1 shall repeat.

.4 When the Contract Administrator finds the Proper Invoice submitted in accordance with GC 5.7.1.1 is valid and in compliance with the requirements of GC 5.7.1.2, the Contract Administrator shall promptly issue a certificate for payment which shall set out the date of Total Performance of the Work.

.5 The Owner shall, no later than twenty-eight (28) Calendar Days after the receipt by the Contract Administrator of a Proper Invoice submitted in accordance with GC 5.7.1.1 pay the Contractor as provided in 5.2 - OWNER'S OBLIGATION TO PAY less any amount disputed by the Contract Administrator or the Owner independent of the Contract Administrator, as applicable, that is set out in a notice of non-payment issued pursuant to GC 5.4.1.3 (including amounts in respect of Deficiencies identified after the receipt of the Proper Invoice).

.6 For clarity, if the Contractor fails to submit a Proper Invoice to the Contract Administrator which is in compliance with the requirements of GC 5.7.1.1, the Owner shall not be required to make payment to the Contractor within the twenty-eight (28) Calendar Day period set out in GC 5.6.3. Such twenty-eight (28) Calendar Day period shall not commence until such time as the Contract Administrator has received from the Contractor a Proper Invoice in compliance with the requirements of GC 5.7.1.1.

5.7.2 Payment of the Finishing Portion of the Lien Holdback

.1 After the date on which all liens that may be claimed against the finishing portion of the Lien Holdback have expired or been satisfied, discharged or otherwise provided for under the Construction Act and provided the Contract Administrator has certified that the Work is Totally Performed in accordance with GC 5.7.1, the Contractor shall submit a Proper Invoice for the finishing portion of the Lien Holdback.

.2 When the Contract Administrator finds the Proper Invoice submitted in accordance with GC 5.7.2.1 is valid and in compliance with the requirements of GC 5.7.2.1, the Contract Administrator shall promptly issue a certificate of payment for the finishing portion of the Lien Holdback.

.3 Subject to GC 5.7.2.4 and the Construction Act, the Owner shall, no later than fifteen (15) Working Days after the receipt of the Proper Invoice, make payment to the Contractor of the amount of the finishing portion of the Lien Holdback set out in the Proper Invoice. Subject to the Construction Act, the Owner may retain out of the finishing portion of the Lien Holdback any sums required by law to satisfy any liens against the Work and any other amount pursuant to 5.10 - OWNER'S SET-OFF.

.4 The Owner may refuse to pay some or all of the finishing portion of the Lien Holdback the Owner is required to pay to the Contractor pursuant to GC 5.7.2.3 if:

(1) no later than forty (40) Calendar Days after the date of Total Performance of the Work, the Owner publishes, in the manner set out in the Construction Act, a notice in the form prescribed by the Construction Act, specifying the amount of the finishing portion of the Lien Holdback that the Owner refuses to pay; and

(2) the Owner notifies the Contractor, in accordance with the Construction Act, of the publication of such notice.

.5 For clarity, if the Contractor fails to submit a Proper Invoice to the Contract Administrator which is in compliance with the requirements of GC 5.7.2.1, the Owner shall not be required to make payment to the Contractor within the fifteen (15) Working Day period set out in GC 5.6.3. Such fifteen (15) Working Day period shall not commence until such time as the Contract Administrator has received from the Contractor a Proper Invoice in compliance with the requirements of GC 5.7.2.1.

5.8 FINAL ACCEPTANCE CERTIFICATE

5.8.1 The Contract Administrator shall issue the final acceptance certificate ("**Final Acceptance Certificate**") after the later of the:

.1 date on which the Contract Administrator determines that the Work has passed all inspection and testing requirements and is satisfied that the Contractor has corrected all Deficiencies and has discharged all of the Contractor's obligations under the Agreement; and

.2 expiry of the Warranty Period.

The Contract Administrator shall have no obligation to issue the Final Acceptance Certificate until all known Deficiencies have been corrected and the Contractor has discharged all obligations under the Agreement.

5.9 CONTRACTOR DISCHARGE OF LIABILITIES

5.9.1 In addition to the obligations assumed by the Contractor pursuant to 3.8 – SUBCONTRACTORS AND SUPPLIERS, the Contractor agrees to discharge all liabilities and obligations for the Work including in respect of labour, services, Contractor Parties, Construction Equipment and Products, except for amounts withheld by reason of legitimate dispute and which have been identified to the party or parties, from whom payment has been withheld.

5.10 OWNER'S SET-OFF

5.10.1 In addition to and without limiting any other rights the Owner may have under the Agreement and at law or otherwise, the Owner may set-off and deduct from any amount owing to the Contractor under the Agreement (including any payments by the Owner pursuant to GC 5.4.2, GC 5.6.3, GC 5.7.1.5, GC 5.7.2.3 and determinations pursuant to an Adjudication) an amount sufficient to cover:

.1 any outstanding or disputed liabilities or obligations of the Contractor to the Owner (including unpaid liquidated damages), or to the Indemnities pursuant to 9.1 – INDEMNIFICATION;

.2 any Losses or amounts for which the Owner is expressly entitled in the Agreement to set-off or retain including GC 2.5.5, GC 5.4.2, GC 5.6.3, GC 5.7.2.3, GC 11.1.5.1, GC 11.1.5.2, GC 4.1.5, GC 10.2.5, GC 8.1.11.3, GC 9.1.3 GC 9.1.6, GC 13.2.1.2 and GC 13.2.2;

.3 any of the following:

(1) any assessment due to the Workplace Safety and Insurance Board relating to the Work; and

(2) any amount necessary to satisfy Contractor's obligations under 5.9 – CONTRACTOR DISCHARGE OF LIABILITIES;

.4 any other amounts owed by the Contractor to the Owner under the Agreement; and

.5 if the Contractor becomes insolvent, all outstanding Claims and Losses of the Owner whether or not related to the Agreement.

If there is an insufficient amount owing by the Owner to the Contractor, then the Contractor shall reimburse the Owner for all of the aforementioned Claims and Losses.

6. ALLOWANCES

6.1 ALLOWANCES

6.1.1 The Fixed Price or Total Price of Unit Price Work includes the Allowances, if any. The Allowances include all taxes and duties (except only Value Added Taxes).

6.1.2 The Contractor's overhead and profit for the Cash Allowance is included in the Fixed Price or Total Price of Unit Price Work, and not in the Cash Allowance itself. Each Provisional Allowance item includes the Contractor's overhead and profit in connection with such Provisional Allowance. The Contractor shall not be paid any additional overhead and profit in connection with the Allowances other than as provided for in this 6.1 - ALLOWANCES.

6.1.3 Expenditures under Allowances shall be pre-authorized by the Owner in writing through the Contract Administrator.

6.1.4 Where the actual cost of the Work under any individual Cash Allowance exceeds the amount of such Cash Allowance, any unexpended amounts from other Cash Allowances may be reallocated, at the Owner's direction, to cover the shortfall, and, in that case, there shall be no additional amount added to the Fixed Price for overhead and profit. Only where the actual cost of the Work under all Cash Allowances exceeds the total amount of all Cash Allowances shall the Contractor be

compensated for the excess incurred and substantiated, plus an amount for overhead and profit on such excess, as set out in row B.5 of the Information Sheet, and the Fixed Price shall be adjusted accordingly by Change Order.

6.1.5 The total amount of any unexpended Allowances shall be deducted from the Fixed Price or Total Price of Unit Price Work by Change Order, after providing for any reallocation contemplated in GC 6.1.4. For Provisional Allowances, such deduction includes the Contractor's overhead and profit included in such total amount. For clarity, no adjustment shall be made for the Contractor's overhead and profit included in the Fixed Price or Total Price of Unit Price Work on such total amount deducted in respect of Cash Allowances.

6.1.6 The value of the Work performed under an Allowance is eligible to be included in Proper Invoices.

6.1.7 The Contractor and the Contract Administrator shall jointly prepare a schedule that shows when the Contract Administrator and Owner must authorize ordering of items called for under Allowances to avoid delaying the progress of the Work.

6.1.8 The Contractor shall extend to the Owner all refunds and trade, quantity and cash discounts, rebates and refunds which may be received in purchasing under Allowances.

6.1.9 The Owner reserves the right to call, or to have the Contractor call, competitive bids or other types of procurements for portions of the Work to be paid for from Allowances. If the Owner determines to proceed with competitive bids, the Contractor shall comply with the directions of the Owner.

6.1.10 The Contractor shall include copies of Contractor Records substantiating purchases under Allowances.

7. CHANGES IN THE WORK

7.1 OWNER'S RIGHT TO MAKE CHANGES

7.1.1 The Owner, through the Contract Administrator, without invalidating the Agreement, may make:

.1 changes in the Work consisting of additions, deletions or other revisions to the Work by Change Order or Change Directive; and

.2 changes to the Contract Time for the Work, or any part thereof, by Change Order or Change Directive.

7.1.2 The Contractor shall not perform a change in the Work without a Change Order or a Change Directive. To the extent the Contractor performs any such change in the Work, the Contractor does so at its own risk and without any liability or obligation on the part of the Owner. There shall be no change in the Contract Price (including delay prolongation costs, remobilization costs or other compensation), extension of the Contract Time or other amendment to the Agreement on account of any change in

the Work unless specified in, and initiated through, a Change Order or a Change Directive.

7.1.3 There shall be no extension of the Contract Time or increase in the Contract Price or payment of any kind whatsoever (including for loss of productivity) based on the aggregate quantity, scope or value of changes in the Work whether resulting from Change Order or Change Directive. The Contractor agrees that in connection with any Change Order or Change Directive it shall co-operate with the Owner and the Contract Administrator and shall carry out such Change Order or Change Directive in such a manner as to avoid incurring or to minimize any additional Losses to be incurred as a result of such Change Order or Change Directive or delay in the performance of the Work.

7.1.4 The value of a change shall be determined as follows, at the sole discretion of the Owner, as indicated in the Contemplated Change Order or Change Directive, as applicable:

.1 if the change relates to items for which the Unit Prices set out in the Agreement are applicable, in accordance with Section 1 of Schedule E – Valuing Changes in the Work; or

.2 in the absence of applicable Unit Prices set out in the Agreement:

(1) on either a negotiated fixed price or unit price basis, in accordance with the provisions in Section 2 of Schedule E – Valuing Changes in the Work; or

(2) if the Parties are unable to agree on a fixed price or unit price pursuant to GC 7.1.4.2(1), on a time and material basis, in accordance with the provisions in Section 3 of Schedule E – Valuing Changes in the Work.

7.1.5 Without limiting the entitlement of the Contractor pursuant to GC 11.1.9.2 when there is a termination for convenience pursuant to GC 11.1.9.1, if any change in the Work is made by which the amount of Work to be done is decreased, or any portion of the Work is dispensed with, the Owner shall not be liable to the Contractor for any consequential, indirect or special damages and loss of profit, loss of opportunity or loss of productivity.

7.1.6 Subject to any entitlement of the Contractor expressly provided for under the Agreement, no course of conduct or dealing between the parties, no express or implied acceptance of additions, deletions or other revisions to the Work, and no Claims that the Owner has been unjustly enriched by any addition, deletion or other revision to the Work, whether in fact there is any such unjust enrichment or not, shall be the basis of a Claim Notice or any other Claim for additional payment under the Agreement or a Claim Notice for any extension of the Contract Time or any other Claim.

7.2 CHANGE ORDER

7.2.1 When a change in the Work is proposed or required by the Owner, the Contract Administrator will provide the Contractor with a written description of the proposed

change in the Work (a "**Contemplated Change Order**"). The Contractor shall promptly but in no event later than ten (10) Working Days (or such other period set out in row C.9 of the Information Sheet) after receipt of a Contemplated Change Order submit, in a form acceptable to the Contract Administrator, a method of adjustment or an amount of adjustment for the Contract Price, if any, and the adjustment in the Contract Time, if any, for the proposed change in the Work.

7.2.2 Subject to GC 7.1.4, when the Owner and Contractor agree to the adjustments in the Contract Price and Contract Time or to the method to be used to determine the adjustments, such agreement shall be reflected in a Change Order. The value of the Work performed as the result of a Change Order shall be included in the Proper Invoice.

7.2.3 A Change Order shall be a final determination or adjustment in the Contract Time, Contract Price and any other amendment to the Agreement as a result of the change in the Work and shall constitute a full and final settlement and satisfaction of all consequences to the Contractor of such change in the Work and shall be deemed to compensate Contractor fully for all effects of such change in the Work. For clarity, if a Change Order does not address an adjustment in the Contract Time, Contract Price or any other amendment to the Agreement, as the case may be, there shall be no adjustment in the Contract Time, Contract Price or any other amendment to the Agreement, as the case may be as a result of the change in the Work provided for in such Change Order.

7.3 CHANGE DIRECTIVE

7.3.1 If the Owner requires the Contractor to proceed with a change in the Work prior to the Owner and the Contractor agreeing upon the corresponding adjustment in Contract Price and/or Contract Time the Owner, through the Contract Administrator, shall issue a Change Directive.

7.3.2 Without limiting GC 7.3.1, a Change Directive may be used to direct a change in the Work that is only a change in the Construction Schedule or Contract Time.

7.3.3 Upon receipt of a Change Directive, the Contractor shall proceed immediately with the change in the Work.

7.3.4 The adjustment in the Contract Price, if any, for a change carried out by way of a Change Directive shall be determined in accordance with GC 7.1.4.

7.3.5 Without limitation to GC 7.3.3, upon receipt of a Change Directive, the Contractor shall promptly provide the Owner with an estimate of the cost of the performance of the change in the Work contemplated in the Change Directive and the impact on the Construction Schedule, if applicable, but in no event later than ten (10) Working Days (or such other period set out in row C.10 of the Information Sheet) after receipt of the Change Directive. If the Contractor, acting reasonably, requires more time to provide an estimate, it may notify the Owner of the date when the estimate will be provided.

7.3.6 Without limitation to GC 7.3.3, when the Owner and the Contractor reach agreement in respect of a Change Directive on the adjustment to the Contract Price and to the

Contract Time, if any, such agreement shall be reflected in a Change Order. The Contractor shall not be entitled to include the value of the change in the Work performed as the result of such Change Directive in its Proper Invoices until, and unless, such Change Order has been executed.

7.4 CONCEALED OR UNKNOWN CONDITIONS

7.4.1 If the Owner or the Contractor discover conditions at the Site which are:

.1 subsurface or otherwise concealed physical conditions which existed before the commencement of the Work which differ materially from those indicated in, or inferable from, the Agreement; or

.2 physical conditions, other than conditions due to weather, that are of a nature which differ materially from those ordinarily found to exist and generally recognized as inherent in construction activities of the character provided for in the Agreement,

then the observing party shall give Notice in Writing to the other party of such conditions before they are disturbed and in no event later than five (5) Working Days after first observance of the conditions.

7.4.2 The Contract Administrator will promptly, and in no event later than within twenty (20) Working Days after discovery thereof by the Owner or the Contractor, investigate such conditions and make a finding having regard to and subject to the liabilities and responsibilities assumed by the Contractor pursuant to 3.6 - EXAMINATION OF SITE and GC 4.1.4. If the finding is that the conditions differ materially and, having regard to and subject to the liabilities and responsibilities assumed by the Contractor pursuant to 3.6 - EXAMINATION OF SITE and GC 4.1.4, this would cause an increase or decrease in the Contract Time or Contract Price, the Contract Administrator, with the Owner's approval, will issue appropriate instructions for a change in the Work as provided in 7.2 - CHANGE ORDER or 7.3 - CHANGE DIRECTIVE. For clarity, the Contractor's entitlement to such change in the Work shall be determined by the Contract Administrator taking into account the respective liabilities assumed by the Owner and Contractor pursuant to 3.6 - EXAMINATION OF SITE and GC 4.1.4.

7.4.3 If the Contract Administrator finds that the conditions at the Site are not materially different or that no change in the Contract Price or extension of the Contract Time is justified, the Contract Administrator will report the reasons for this finding to the Owner and the Contractor in writing.

7.4.4 If such concealed or unknown conditions relate to Hazardous Materials, artifacts and fossils, or mould, the parties will be governed by the provisions of 4.3 - HAZARDOUS MATERIALS, 4.5 - ARTIFACTS AND FOSSILS and 4.4 – MOULD, as applicable.

7.5 DELAYS

7.5.1 If the Contractor is delayed in the completion of a critical path Work activity by:

.1 subject to GC 7.5.3, an act or omission of the Owner, the Owner Representative, the Contract Administrator or anyone employed or engaged by them directly or indirectly, which is contrary to the provisions of the Agreement; or

.2 by a stop work order issued by a court or other public authority,

then, except to the extent such event results from the negligent act or omission of the Contractor Parties or the default or breach of the Contractor's obligations under the Agreement or any other act or fault of the Contractor Parties, the Contract Time shall be extended for such reasonable time as agreed to by the Parties, taking into account such time period as recommended by the Contract Administrator and the Contract Price shall be adjusted to account for reasonable Losses incurred by the Contractor as the result of such delay including the Losses referred to in GC 7.5.8, as applicable, but excluding any consequential, indirect or special damages and loss of profit, loss of opportunity or loss of productivity resulting from such delay.

7.5.2 If the Contractor is delayed in the completion of a critical path Work activity by any cause beyond the Contractor's control, including:

.1 war, blockades, and civil commotions;

.2 labour disputes, strikes and lock-outs (other than lock-outs described in GC 7.5.3);

.3 fire, unusual delay by common carriers or unavoidable casualties; or

.4 abnormally adverse weather conditions at the Site which are different from those normally and customarily experienced at the Site (as documented by weather data from Environment Canada) over the past ten (10) years taking into consideration severity, duration and time of year conditions,

except to the extent such event results from the negligent act or omission of the Contractor Parties or the default or breach of the Contractor's obligations under the Agreement, then the Contract Time shall be extended for such reasonable time as agreed to by the Parties, taking into account such time period as recommended by the Contract Administrator. The extension of time shall not be less than the time lost as the result of the event causing the delay, unless the Contractor agrees to a shorter extension. The Contractor shall not be entitled to payment for Losses incurred by such delays except to the extent the Contractor would be entitled to reasonable Losses in accordance with GC 7.5.1 or if such delay is the cause of the stop work order in connection with the Contractor's termination of the Agreement pursuant to GC 11.2.1.

7.5.3 If the Contractor is delayed in the completion of a critical path Work activity by a lock-out of the Owner or the City of Toronto, except to the extent such event results from the negligent act or omission of the Contractor Parties or the default or breach of the Contractor's obligations under the Agreement:

.1 the Contract Time shall be extended for the duration of such lock-out, provided that if the duration of such lock-out exceeds five (5) Working Days, the Contract

Time shall be extended by the duration of such lock-out plus an additional (5) Working Days; and

.2 the Contract Price shall only be adjusted to account for direct reasonable costs the Contractor incurs for leased Construction Equipment as a result of such lock-out, but excluding any consequential, indirect or special damages and loss of profit, loss of opportunity or loss of productivity resulting from such delay.

7.5.4 No extension of the Contract Time shall be made for delay unless Notice in Writing of the cause of delay is given to the Contract Administrator and Owner in accordance with 7.7.1.

7.5.5 If no:

.1 schedule is made under GC 2.2.12 for the Contract Administrator to provide Supplemental Instruction; or

.2 time period is provided elsewhere in the Agreement where the Contract Administrator is to provide instructions to the Contractor,

then no request for an extension of the Contract Time shall be made by the Contractor because of failure of the Contract Administrator to provide such Supplemental Instructions or other instructions, as applicable, until fifteen (15) Working Days after demand for such Supplemental Instructions or other instructions, as applicable, has been made or such longer period of time reasonably required under the circumstances.

7.5.6 If the Work is behind schedule for a reason other than as described in GC 7.5.1, 7.5.2 or 7.5.3, the Contractor, at its expense and subject to GC 7.5.7, shall:

.1 prepare and present to the Contract Administrator and Owner, for review and approval, a recovery plan ("**Recovery Plan**") as soon as practical, but not later than three (3) Working Days after the earlier of the Contractor becoming aware of the Work being behind schedule or the Owner notifying the Contractor that the Work is behind schedule. Such Recovery Plan shall include information and details required by the Contract Administrator and Owner, acting reasonably, and shall demonstrate how the Contractor shall achieve the recovery of the schedule and bring the Work back on schedule. Any costs incurred by the Owner for the services of the Contract Administrator in reviewing multiple submissions of the Recovery Plan shall be borne by the Contractor; and

.2 commence the implementation of the Recovery Plan approved by the Contract Administrator and Owner as soon as practical, but not later than within two (2) Working Days of the Contract Administrator and Owner providing approval of the Recovery Plan; and

.3 otherwise take all measures necessary to bring the Work back on schedule (including expediting, increasing the labour force, supervisors and equipment, and working overtime).

For clarity, this GC 7.5.6 shall not limit the other provisions of 7.5.

7.5.7 For greater certainty and without limiting any other provision in the Agreement, there shall be no extension of the Contract Time or increase in the Fixed Price or Unit Prices to the extent a delay was caused by the negligent act or omission of the Contractor Parties or by the Contractor's default or breach of the Agreement. Without limiting any other provision in the Agreement, the Owner shall be reimbursed by the Contractor for all Losses incurred by the Owner as the result of such delay, including all services required by the Owner from the Contract Administrator and Owner Representative as a result of such delay by the Contractor and, in particular, the costs of the Contract Administrator's and Owner Representative's services during the period between the Scheduled Date for Substantial Performance of the Work as the same may be extended through the provisions of the GC and the actual date of Substantial Performance of the Work achieved by the Contractor. For clarity, such costs shall be in addition to any Delay Liquidated Damages payable by the Contractor.

7.5.8 The Contractor shall be responsible for the care, maintenance and protection of the Work in the event of any suspension of construction as a result of the delay described in GC 7.5.1, 7.5.2 or 7.5.3. In the event of such suspension, the Contractor shall be reimbursed by the Owner for the reasonable Losses incurred by the Contractor for such care, maintenance and protection, but excluding the costs of the Contractor's head office Personnel and any consequential, indirect or special damages and loss of profit, loss of opportunity or loss of productivity.

7.5.9 Without limiting the generality of any other provision in the Agreement, the Contractor shall use best efforts to mitigate the impact of any delay events dealt with by GC 7.5.1, 7.5.2 or 7.5.3 and any other matters dealt with in a Claim Notice upon the performance of the Work, the Contract Time and the Contract Price. If the Contractor does not exercise such best efforts, the Contractor's entitlements under any applicable Claim Notice will be reduced or invalidated to reflect impacts that would have been avoided by such mitigation.

7.5.10 Any extension of the Contract Time or adjustment in the Contract Price provided for in this 7.5 – DELAYS shall be authorized in accordance with 7.2 - CHANGE ORDER.

7.6 DELAY LIQUIDATED DAMAGES

7.6.1 The Contractor acknowledges and agrees that the Owner will suffer financial Loss if the Work is not completed within the time specified in the Agreement. The Contractor also recognizes the delays, costs and difficulties involved in proving the actual Loss suffered by the Owner if the Work is not completed on time. Accordingly, instead of requiring any such proof, the Contractor agrees that if the date of Substantial Performance of the Work is delayed past the Scheduled Date for Substantial Performance of the Work, subject to any adjustment in Contract Time as provided for in the Agreement, the Contractor shall pay Owner liquidated damages in the amount designated in row B.6 of the Information Sheet ("**Delay Liquidated Damages**") for each and every Calendar Day or Working Day, as applicable, of delay until the Contractor has attained Substantial Performance of the Work. The Contractor further

expressly acknowledges and agrees that Delay Liquidated Damages payable by the Contractor are:

.1 not intended to be a penalty and are a reasonable and genuine pre-estimate of the actual damage that will be incurred by the Owner if the Contractor fails to achieve Substantial Performance of the Work in accordance with the requirements of the Agreement (including paragraph 1.3 of Section 1 of the Agreement);

.2 in addition to, and without prejudice to, any other right or remedy available to the Owner under the Agreement or otherwise and does not limit or reduce any obligation or liability of the Contractor under the Agreement or otherwise; and

.3 not a cap on the damages payable by, or liability of, the Contractor, if the Contractor fails to achieve Substantial Performance of the Work in accordance with the requirements of the Agreement (including paragraph 1.3 of Section 1 of the Agreement).

7.6.2 If there is a delay in attaining Substantial Performance of the Work, in spite of the payment of Delay Liquidated Damages in accordance with GC 7.6.1, the Contractor shall continue to perform and expedite the Work in accordance with the Agreement.

7.6.3 The Contractor shall pay Delay Liquidated Damages pursuant to 7.6.1 on a monthly basis as they accrue.

7.7 CLAIMS PROCEDURE

7.7.1 The Contractor shall provide a Notice in Writing to the Owner and the Contract Administrator of any claim for a change in the Contract Price, extension of the Contract Time or other changes to the Work or amendments to the Agreement ("**Claim Notice**") within ten (10) Working Days after the Contractor knows, or should know applying the Standard of Care, of the event or circumstance giving rise to such claim. Any Claims by the Contractor in respect of such claim or Claim Notice shall be irrevocably barred, and waived and released by the Contractor unless the Contractor has strictly complied with the applicable requirements of 7.CHANGES IN THE WORK and the Contractor has provided such Claim Notice within the prescribed time period.

7.7.2 Without limiting the generality of any other provision in the Agreement, the Contractor shall immediately upon commencing Work that may result in a Claim Notice, keep such Contractor Records that relate to such Work (including any T&M Change in the Work) and the Claim Notice arising therefrom (including Daily Contractor Work Records) as may be necessary to support and substantiate such Claim Notice. The Contractor shall attempt, on a daily basis, to reconcile its Daily Contractor Work Records with the records of the Contract Administrator or Owner Representative, as applicable and have the Daily Contractor Work Records signed by the Contract Administrator or Owner Representative, as applicable. For clarity, the reconciling of the Contractor's Daily Work Records with the records of the Contract Administrator or Owner Representative, as applicable, shall not be construed to be acceptance of a Claim Notice. If it is not possible to reconcile the Daily Contractor Work Records, then the Contractor shall submit the un-reconciled Daily Contractor Work Records with its

Claim Notice, whereby the resolution of the dispute about the Daily Contractor Work Records shall not be resolved until there is a resolution of the applicable Claim Notice.

7.7.3 Subject to GC 7.7.4, the Claim Notice shall:

.1 identify the item or items in respect of which the Claim Notice arises;

.2 include the date the Contractor first became aware of the event or circumstance giving rise to the Claim Notice;

.3 state the grounds, contractual or otherwise, upon which the Claim Notice is made;

.4 provide sufficient and detailed information and documentation to allow the Contract Administrator and the Owner to properly consider the Claim Notice of the Contractor including:

(1) a description of the portions of the Work affected thereby;

(2) the cause of the change in the Contract Time, a description of such change, an assessment of the impact such change will have on the Construction Schedule (including an explanation as to how the critical path will be affected) and a reasonable estimate of the number of Calendar Days by which the Work will be delayed and date and time when the delay was experienced;

(3) a detailed account of the amount claimed and a breakdown of the change in the Contract Price;

(4) details of mitigation strategies applied; and

(5) all other pertinent details and backup information and documents; and

.5 include the Contractor Records (including Daily Contractor Work Records) maintained by the Contractor supporting such Claim Notice.

The Contractor shall submit further updates on the Claim Notice to the Owner and the Contract Administrator as they become available, but in no event shall the Contractor submit any further updates within the fourteen (14) Calendar Days prior to the deadline for the Contract Administrator to issue its determination pursuant to GC 7.7.6.

7.7.4 Where the event giving rise to the Claim Notice has a continuing effect, the Claim Notice submitted under GC 7.7.2 shall be considered to be an interim Claim Notice and the Contractor shall, submit further updates on the Claim Notice at such intervals as the Owner or Contract Administrator may reasonably require. Such updates shall give the accumulated amount of the Claim Notice and any further grounds upon which it is based, as a part of the information and documents which the Contractor is required to provide in accordance with GC 7.7.2. The Contractor shall submit a final

Claim Notice after the end of the effects resulting from the event as a part of the information and documents which the Contractor is required to provide in accordance with GC 7.7.2.

7.7.5 The Contract Administrator may, from time to time, request the Contractor to submit any further and other particulars as the Contract Administrator considers necessary to assess the Claim Notice. The Contractor shall submit the requested information within thirty (30) Calendar Days of receipt of such request or such shorter time as required by the Contract Administrator.

7.7.6 Within ninety (90) Calendar Days of initial receipt of the Claim Notice pursuant to GC 7.7.1, or such longer period of time required by Owner, the Owner, or if authorized by the Owner, the Contract Administrator, shall prepare and issue a determination to the Contractor regarding the validity of the Claim Notice. Such determination may be reflected in a Change Order or Change Directive to the extent required pursuant to GC 7.1.2. The Contractor shall be conclusively deemed to have accepted such determination of the Owner, or the Contract Administrator, as the case may be, and to have expressly waived and released the Owner from all Claims in respect of the Claim Notice including the particular matter dealt with in that determination unless, within fifteen (15) Working Days after receipt of that determination, the Contractor provides a revised Claim Notice or disputes that determination in accordance with 12.DISPUTE RESOLUTION.

7.8 SERVICE STANDARDS FOR CONTRACTOR IN RESPONDING TO THIRD PARTY CLAIMANTS

7.8.1 For the purposes of this 7.8 - SERVICE STANDARDS FOR CONTRACTOR IN RESPONDING TO THIRD PARTY CLAIMANTS, “Third Party Claimant” means any Person asserting a Claim that is not a party to the Agreement other than a Subcontractor, Supplier or Sub-subcontractor asserting a Claim in respect of the Work or the Project:

.1 for which such Subcontractor, Supplier or Sub-subcontractor is entitled to assert rights (including lien rights) under the Construction Act against the Owner; or

.2 which relate to a Claim the Contractor is asserting against the Indemnitees.

7.8.2 Without limiting the obligations of the Contractor under 7.7 – CLAIMS PROCEDURE and GC 7.8.3 or elsewhere in the Agreement, the Contractor shall, or shall cause the Contractor's insurer to, in the manner and extent requested by the Owner:

.1 respond to all Third Party Claimants in a timely manner;

.2 ensure that Third Party Claimants are provided with accurate information about the status of their Claim, and

.3 where appropriate, notify Third Party Claimants of the relevant activity on their Claims and provide them with information.

7.8.3 If the Contractor receives notice of a Claim of a Third Party Claimant relating to or arising out of the Agreement, the Contractor shall immediately forward the notice of Claim to the City of Toronto Clerk's office at claims@toronto.ca.

7.8.4 Once the Contractor receives notice of a Claim of a Third Party Claimant relating to or arising out of the Agreement (including any notice from the City of Toronto's adjuster), the Contractor shall, or shall cause the Contractor's insurer to, in the manner and extent requested by the Owner:

.1 within five (5) Working Days of receiving notice of such Claim, send a letter to the Third Party Claimant acknowledging receipt of such Claim and provide the Third Party Claimant with the contact information of the Contractor Project Manager, or another Person representing the Contractor, to whom the Third Party Claimant can refer questions regarding such Claim;

.2 conduct an investigation of such Claim and make a decision regarding such Claim that is based on a proper consideration of the facts; and

.3 within twenty-five (25) Working Days of receiving notice of such Claim, provide the Third Party Claimant with a letter advising of the results of the investigation and clearly explaining the Contractor's decision regarding such Claim or should the Contractor require the involvement of their insurance company to resolve such Claim, this shall be forwarded to the insurance company and the Third Party Claimant shall be notified within the allotted period of time above.

7.8.5 The Owner may, in writing, provide an extension of time for responding to the Claim of a Third Party Claimant pursuant to this 7.8- SERVICE STANDARDS FOR CONTRACTOR IN RESPONDING TO THIRD PARTY CLAIMANTS if the Contractor or the Contractor's insurer, in writing, provides the Owner with a request for an extension as well as the reasons for the extension. In considering whether to provide such an extension, the Owner shall consider the Contractor's, or the Contractor's insurer's, reasons for the request and all of the surrounding circumstances including good customer service standards. Once the Contractor forwards such Claim to its insurer, the resolution of such Claim shall follow the insurance industry standards for claim investigation.

7.8.6 If an extension of time is provided under GC 7.8.5, the Contractor, or the Contractor's insurer, shall write to the Third Party Claimant advising that the investigation is on-going, advise of the date by which the Contractor or its insurer will report the results of the investigation to the Third Party Claimant, and explain the reasons why additional time is required to make a decision on the Claim.

7.8.7 A copy of all letters sent to a Third Party Claimant by or on behalf of the Contractor, including letters sent by the Contractor's insurer, pursuant to this 7.8- SERVICE STANDARDS FOR CONTRACTOR IN RESPONDING TO THIRD PARTY CLAIMANTS, shall be copied to the Owner, and the City of Toronto's adjuster.

7.8.8 Where appropriate, the Contractor shall ensure its insurer takes all of the appropriate steps to meet the obligations under GC 7.8.1 to 7.8.7.

7.8.9 The Contractor shall provide to the Owner monthly updates on the status of all Claims received from Third Party Claimants until resolution of such Claims.

7.8.10 If the Contractor fails to meet any of its obligations under this 7.8 - SERVICE STANDARDS FOR CONTRACTOR IN RESPONDING TO THIRD PARTY CLAIMANTS, the Owner may provide the Contractor with Notice in Writing that the relevant obligations have not been fulfilled. If the Contractor does not fulfil such obligations within five (5) Working Days from receipt of such Notice in Writing, the Owner, without prejudice to any other right or remedy, may hold back an amount of $10,000.00 from monies payable to the Contractor under the Agreement. The Owner may exercise its right of holdback under this section for each Claims of a Third Party Claimant for which the Contractor fails to meet its obligations under 7.8 - SERVICE STANDARDS FOR CONTRACTOR IN RESPONDING TO THIRD PARTY CLAIMANTS. Without limiting any of the Owner's other rights of holdback or set-off, the Owner will release the monies held back pursuant to this GC 7.8.10 once it has received evidence that the Contractor has sent the Third Party Claimant a letter(s) in accordance with GC 7.8.4.1 and 7.8.4.3.

8. INSURANCE, CONTRACT SECURITY, BONDS AND CONTRACTUAL HOLDBACK

8.1 INSURANCE

8.1.1 Without restricting the generality of 9.1 – INDEMNIFICATION or any other provision of the Agreement, the Contractor shall provide, maintain and pay:

.1 for the insurance coverages listed in this 8.1 - INSURANCE under GCs 8.1.2, 8.1.4, 8.1.5, 8.1.6, 8.1.7, 8.1.8 and 8.1.9 as such coverages may be modified by Row D.1 of the Information Sheet;

.2 if required by row D.1 of the Information Sheet, coverage under GC 8.1.3; and

.3 such additional insurance coverages as required by Row D.1 of the Information Sheet.

8.1.2 Commercial General Liability Insurance:

(1) in the amount of five million dollars ($5,000,000) per occurrence;

(2) that includes the Indemnitees and such other Persons identified by the Owner from time to time as additional insureds with respect to liability arising out of the operation of the Contractor with regard to the Agreement; and

(3) that provides for a cross liability and/or severability of interest, contractual liability, Owner's and Contractor's protective liability, broad form property damage, contingent/and or employer's liability, products and completed operations, non-owned automobile liability and, if applicable to the insured operations as detailed in the Agreement, coverage for blasting, explosion, shoring, underpinning, underground works, pile driving and collapse; and

(4) which includes completed operations coverage for a period of six (6) years from the date of Substantial Performance of the Work, unless otherwise indicated in the Agreement. If the Contractor fails to comply with the requirements of this GC 8.1.2(4) or to maintain such coverage any contractual period for claiming indemnity described in the Agreement will not be binding on the Owner.

8.1.3 Contractor's Pollution Liability Insurance

.1 If specified in row D.1 of the Information Sheet, pollution liability insurance. The policy shall have a limit of not less than Two Million Dollars ($2,000,000) per claim limit. The policy shall cover third-party injury and property damage claims, including clean-up costs, as a result of pollution conditions arising from the Contractor's, Subcontractor's, Sub-subcontractor's or Supplier's operations and completed operations (i.e. Work performed). If written as a single project policy, the policy shall include an extended reporting period of 24 months. If written as an annual policy, the policy should be kept in force for 24 months from the date of the later of the: issuance of the Final Acceptance Certificate or termination of the Agreement, as the case may be. The Owner shall be included as an additional insured on this policy.

8.1.4 All Risk Property Insurance

.1 All risk property insurance shall be written on a replacement cost basis based on the Contract Price, on the building or structure while in the course of construction, and on all Products, Construction Equipment, supplies and/or systems, including boiler and machinery, and pressure vessels if applicable, that form part of the Work or are used in the performance of the Work. The policy may be written separately in the form of a Builder's Risk or Installation Floater; and Boiler and Machinery policy and/or Contractor's Equipment policy, as appropriate to the Project. The Owner shall be included as an additional insured and a joint loss payee on these policies, except for the Contractor's Equipment policy. This GC 8.1.4 is subject to GC 3.14.4.

.2 The all risk property insurance shall provide that, in the event of a loss or damage:

(1) unless directed otherwise by the Owner in its sole and absolute discretion, the Contractor shall act on behalf of both the Owner and the Contractor for the purpose of adjusting the amount of such loss or damage payment with the insurers and payment shall be made to the Owner and the Contractor as their respective interests may appear;

(2) when the extent of the loss or damage is determined the Contractor shall proceed to restore the Work. Loss or damage shall not affect the rights and obligations of either party under the Agreement except that the Contract Time may be extended relative to the extent of the loss or damage in accordance with 7.5 – DELAYS; and

(3) the Contractor shall be entitled to receive from the Owner, in addition to the amount due under the Agreement, the amount at which the Owner's interest in restoration of the Work has been appraised, such amount to be paid as the restoration of the Work proceeds and in accordance with the requirements of 5. CONTRACT PRICE AND PAYMENT. In addition, the Contractor shall be entitled to receive from the payments made by the insurers the amount of the Contractor's interest in the restoration of the Work.

8.1.5 Automobile Liability Insurance

.1 Automobile liability insurance in respect of all licensed owned/leased vehicles that will be utilized in the performance of the Work, unless otherwise required by the Agreement. Such automobile liability insurance shall have limits of not less than five million dollars ($5,000,000).

8.1.6 Professional Liability Insurance

.1 If providing specialized consulting services including architectural, design, mechanical engineering, or other engineering professional services as a part of the Work, the Contractor shall provide and/or cause any Subcontractor or Sub-subcontractor, where such Subcontractor or Sub-subcontractor is under a professional obligation to maintain the same, Professional Liability Insurance or Errors and Omissions Insurance in the amount of not less than five million dollars ($5,000,000) and shall continue for twenty-four (24) months following the date of the earlier of the issuance of the Final Acceptance Certificate or termination of the Agreement, as the case may be.

8.1.7 Aviation Liability Insurance

.1 If used directly or indirectly in performance of the Work by the Contractor, Subcontractor, Sub-subcontractor or Supplier, aviation liability insurance with respect to owned or non-owned aircraft, remotely piloted aircraft, unmanned aerial vehicles or drones including the use of additional premises, and shall include, if applicable, coverage for bodily injury, death, aircraft passenger hazard, and damage to property including loss of use thereof. Such insurance shall have limits of not less than five million dollars ($5,000,000).

8.1.8 Watercraft Liability Insurance

.1 If used directly or indirectly in performance of the Work by the Contractor, Subcontractor, Sub-subcontractor or Supplier, watercraft liability insurance with respect to owned or non-owned watercraft including the use of additional premises, and shall include coverage for bodily injury, death, and damage to property including loss of use thereof. Such insurance shall have limits of not less than five million dollars ($5,000,000).

8.1.9 Marine Insurance

.1 If carrying out any ocean, coastal and inland waterway shipments, the Contractor shall ensure a marine insurance policy is in place to fully insure the full replacement value of the shipment, insurance, and freight plus 10% and should cover the cargo on an "All Risks" basis from the point of origin of shipment until delivery in Toronto, Ontario, including the risk of unloading at the delivery point.

.2 The Contractor shall maintain or cause to be maintained, if applicable, hull and machinery insurance covering the full replacement cost of all barges, scows and other watercraft owned, rented or leased by the Contractor or any Subcontractor or Sub-subcontractor.

8.1.10 The Contractor shall be responsible for all deductible and self-insured retention amounts under the policies required by this 8.1 - INSURANCE.

8.1.11 Insurance Requirements and Duration

.1 Unless specified otherwise in this 8.1 - INSURANCE, the duration of each insurance policy shall be from on or before Commencement Date until the date of the earlier of the issuance of the Final Acceptance Certificate or termination of the Agreement, as the case may be.

.2 Prior to the execution of the Agreement, and upon placement and at amendment or extension of all or any part of the insurance, the Contractor shall within five (5) Working Days provide the Owner with confirmation of coverage on the Owner's certificate of insurance form as attached as Form 2 of Schedule G – Forms or on a form acceptable to the Owner, without notice or demand by the Owner. Prior to the expiration date of all or any part of the insurance the Contractor shall submit to the Owner such confirmation of coverage or a replacement policy without notice or demand by the Owner. The insurance documents required by this GC 8.1.11.2 shall be signed by the insurer or an authorized representative of the insurer.

.3 If the Owner receives notice of cancellation for nonpayment of the insurance premium, the Owner may, but is not obliged to, pay the premium of any policy of insurance required to be maintained herein and make a formal demand for reimbursement of such costs from the Contractor. If the Contractor fails to pay the cost of the insurance placed by the Owner within fifteen (15) Calendar Days of the date on which the Owner made a formal demand for reimbursement of such costs, the Owner may set-off the costs thereof in accordance with 5.10 – OWNER'S SET-OFF.

.4 The Contractor shall, on request, within five (5) Working Days provide the Owner with a certified true copy of each insurance policy exclusive of information pertaining to premium or premium bases used by the insurer to determine the cost of the insurance. The certified true copy shall include a signature of the insurer or the underwriter or the broker.

.5 All insurance policies taken out by the Contractor shall be placed with insurers satisfactory to the Owner in its sole and absolute discretion. Without limiting the generality of the foregoing, all insurers must be licensed to underwrite insurance in the Province of Ontario, except to the extent the Owner waives such requirement in writing.

.6 The insurance policies required pursuant to this GC shall:

(1) be primary and shall not call into contribution any insurance available to the Owner; and

(2) contain a waiver of subrogation rights which the insurers may have against the Owner or any other additional insured, except for the Automobile Liability and Professional Liability policies.

.7 The amount of the deductible for the purpose of the Agreement shall not be more than $25,000.00. Following the award of the Agreement, the Owner reserves the right to negotiate a higher or lower deductible, as appropriate.

.8 In addition to the insurance required by 8.1 – INSURANCE, the Contractor shall, at its cost, maintain such other forms of insurance as the Owner, acting reasonably, may require from time to time, in amounts and for risks against which a prudent contractor would insure.

.9 Each policy (except for the policy of automobile liability insurance required under GC 8.1.5) shall contain an endorsement requiring the insurer(s) to notify the Owner in writing, by registered mail, at least thirty (30) Calendar Days (fifteen (15) Calendar Days if cancellation is due to non-payment of premium), prior to any cancellation of the Contractor's insurance.

.10 "Claims made" insurance policies shall not be permitted, except for the Professional Liability and Contractor's Pollution Liability policy.

.11 The insurance coverages required by 8.1 – INSURANCE shall allow for partial or total use and occupancy by the Owner prior to Substantial Performance of the Work in accordance with 3.14.

8.1.12 The Contractor shall cause the Subcontractors and Suppliers to provide and maintain, at the expense of the Subcontractors and Suppliers, the insurance set out in GC 8.1.3 and 8.1.5.

8.2 CONTRACT SECURITY

8.2.1 The Contractor shall, prior to the Commencement Date or within the specified time, provide to the Owner any contract security specified in row D.2 of the Information Sheet.

8.3 SURETY BONDS

8.3.1 Unless expressly indicated otherwise in row D.5 of the Information Sheet, the Contractor shall provide surety bonds, which shall be:

.1 a performance bond with a coverage limit of fifty percent (50%) of the aggregate amount of the Fixed Price and the estimated Total Price of Unit Price Work (calculated using the Estimate of Units for Completion), plus Value Added Taxes; and a labour and material payment bond with a coverage limit of fifty percent (50%) of such aggregate amount;

.2 in compliance with the requirements of the Construction Act and in the form prescribed by the Construction Act; and

.3 delivered to the Owner prior to the execution of the Agreement by both the Owner and the Contractor.

8.3.2 The premiums for the bonds required by the Agreement are included in the Fixed Price and Unit Prices.

8.3.3 If the Contract Price increases during the Performance of the Work, the Owner shall have the right, in its sole discretion and at any time, to require riders be provided to the existing bonds, to increase the value of the bonds to fifty percent (50%) of the total of the Contract Price plus Value Added Taxes.

8.4 CONTRACTUAL HOLDBACK

8.4.1 The Owner shall retain a contractual holdback equal to the amount(s) identified in row D.3 of the Information Sheet (the aggregate of such amounts retained by the Owner being the "**Contractual Holdback**"). For clarity, the Owner shall not retain Contractual Holdback in respect of the payment of Lien Holdback pursuant to 5.6 - PAYMENT OF LIEN HOLDBACK UPON SUBSTANTIAL PERFORMANCE OF THE WORK or the payments pursuant to 5.7 – PAYMENTS UPON TOTAL PERFORMANCE OF THE WORK.

8.4.2 The Owner, without prejudice to any other right or remedy, shall be entitled to apply the Contractual Holdback towards Losses the Owner may suffer, sustain or incur in connection with the:

.1 exercise of its rights in respect of the Contractor's failure to correct a default pursuant to GC 11.1.5;

.2 failure of Contractor to complete the Work and correct deficient Work after the issuance of the certificate of Substantial Performance of the Work in accordance with the completion schedule established pursuant to GC 5.5.3; and

.3 exercise of its right to correct Deficiencies or make good damaged work or property pursuant to GC 2.5.4 and 9.3.5.

8.4.3 Upon the Total Performance of the Work, the portion of the Contractual Holdback which remains after the Owner has exercised its rights pursuant to 8.4.2, if any, shall be reduced by the percentage amount identified in row D.4 of the Information Sheet. The reduced amount of the Contractual Holdback (without any interest owed by the Owner) shall be eligible to be included in the Proper Invoice submitted pursuant to GC 5.7.1.1.

8.4.4 After the issuance of the Final Acceptance Certificate, the Contractor may submit a Proper Invoice to the Owner in accordance with the applicable requirements of 5.3 – PROPER INVOICES requesting release of the portion of the Contractual Holdback which remains after the Owner has exercised its rights pursuant to GC 8.4.2, if any. The Owner shall make payment to the Contractor of such remaining portion of the Contractual Holdback (without any interest owed by the Owner) in accordance with the applicable requirements of 5.4 – PROGRESS PAYMENT.

9. INDEMNIFICATION, WAIVER OF CLAIMS AND WARRANTY

9.1 INDEMNIFICATION

9.1.1 The Contractor shall indemnify, defend and hold harmless the Owner, the mayor of the City of Toronto and each of the City of Toronto's agencies, boards, commissions, Personnel, elected officials, servants, volunteers and advisers (including the Contract Administrator and the Owner Representative), and their respective successors and assigns (collectively as the "**Indemnitees**") from and against all Claims brought against, or Losses suffered, sustained, or incurred by, the Indemnitees which may be directly or indirectly attributable to, or arising or alleged to arise out of:

.1 the negligent acts or omissions of the Contractor Parties;

.2 any deliberate act of wrongdoing or wilful misconduct or fraud of a Contractor Party including intentional misrepresentation; or

.3 the performance of or the failure to perform any of the Contractor's obligations under the Agreement

(collectively, the "**Subject Matter of Indemnity**"). The Subject Matter of Indemnity includes:

.4 all Losses that any of the Indemnitees may suffer, sustain or incur arising in respect of bodily injury, illness or death of any individual or physical loss of or damage to tangible property (including all or any part of the Site or any other tangible property related thereto); and

.5 all Claims arising in respect of bodily injury, illness or death of any individual or physical loss of or damage to tangible property.

9.1.2 Without limiting the generality of any other provision in the Agreement, the Contractor shall indemnify, defend and hold harmless the Indemnitees from and against all Claims brought against, or Losses suffered, sustained, or incurred by the Indemnitees which may be directly or indirectly attributable to, or arising or alleged to arise out of:

.1 a lien or subsequent lawsuit brought in connection with any lien by a Subcontractor, Sub-subcontractor or Supplier;

.2 the infringement or an alleged infringement of any patented invention or copyright by the Contractor Parties in connection with the Work including the Products;

.3 the Contractor's failure to comply with the requirements of 4.3 – HAZARDOUS MATERIALS;

.4 the Contractor's failure to comply with the requirements of OHSA and the duties, responsibilities and obligations of the constructor under OHSA;

.5 the Contractor's failure to comply with the requirements of GC 12.2.16 or 3.8.2.3(3);

.6 a Subcontractor, Supplier or Sub-subcontractor's failure to comply with the requirements of GC 3.8.2.3(3);

.7 the presence of mould caused by the Contractor's operations under the Agreement as determined in accordance with GC 4.4.2; or

.8 the Contractor's failure to comply with the requirements of GC 10.1.6.

9.1.3 The Contractor shall pay to the Indemnitees, or any of them, on demand the amount of all Losses and Claims for which the Contractor is obligated to indemnify the Indemnitees and any moneys paid or payable by the Indemnitees in settlement or in discharge or on account thereof. If the Contractor fails to make such payments within ten (10) Working Days after such demand, the Owner may set-off such payments in accordance with 5.10 – OWNER'S SET-OFF.

9.1.4 The Owner shall indemnify, defend and hold harmless the Contractor from and against all Claims brought against the Contractor by third parties, or Losses suffered, sustained, or incurred by the Contractor in respect of such third party Claims, that are attributable to, or arise out of, the Contractor's direct involvement in the Agreement, provided such third party Claims are directly caused by the negligent act or omission of the Owner in the performance of the Owner's obligations under the Agreement, and then only to the extent the Losses was caused by the Owner.

9.1.5 The Owner shall indemnify, defend and hold harmless the Contractor from and against all Claims brought against the Contractor, or Losses suffered, sustained, or incurred by the Contractor arising out of the Contractor's performance of its obligations under the Agreement which are attributable to, or arise out of

.1 a lack of or defect in title or an alleged lack of or defect in title to the Site; or

.2 an infringement of a patent of invention directly resulting from the use of a model, plan or design that was supplied to the Contractor by the Owner as part of the Agreement,

but excluding any consequential, indirect or special damages and loss of profit, loss of opportunity or loss of productivity. The Contractor expressly waives the right to indemnity for Claims other than those stated above.

9.1.6 The Contractor hereby authorizes and empowers the Owner or its solicitor to defend, settle or compromise any of the Claims described in GC 9.1.1 and 9.1.2 as the Owner or its solicitor may deem expedient. The Contractor shall ratify and confirm all the acts of the Owner and its solicitor undertaken pursuant to this GC 9.1.6 and shall pay to such solicitor on demand his or her reasonable costs of any such defense, settlement and/or compromise. If the Contractor fails to make such payments to the solicitor, the Owner may set-off such payments in accordance with 5.10 – OWNER'S SET-OFF.

9.1.7 The Contractor shall not settle or compromise any of the Claims described in GC 9.1.1 or 9.1.2, for which it is liable to indemnify, defend and hold harmless the Owner without first obtaining the consent of the Owner with such consent not to be unreasonably withheld or delayed.

9.1.8 The Contractor acknowledges that the Owner holds the benefit of any covenant, release or indemnity in the Agreement, including the covenants of the Contractor in GC 9.1.1, 9.1.2 and 9.1.3, that is expressly intended to extend to include the Indemnitees (other than the Owner) as third party beneficiaries as trustee and agent for such Indemnitees. The Owner shall be entitled to enforce the rights of such Indemnitees as third party beneficiaries under such covenant and indemnities.

9.1.9 9.1 - INDEMNIFICATION in no way limits any other liability or obligation of the parties in respect of the Agreement.

9.2 WAIVER OF CLAIMS

9.2.1 With its Proper Invoice for the Lien Holdback submitted in accordance with 5.6 - PAYMENT OF LIEN HOLDBACK UPON SUBSTANTIAL PERFORMANCE OF THE WORK, the Contractor shall include a list setting out the status of all outstanding Claim Notices which have been submitted in strict compliance with 7.7 – CLAIMS PROCEDURE. For clarity, notwithstanding any other provision of the Agreement to the contrary:

.1 any Claim Notices submitted prior to such Proper Invoice, but which are not set out in such list shall be deemed to be irrevocably barred, and waived and released by Contractor; and

.2 any Claims not included in such list shall be deemed to be irrevocably and unconditionally barred, and waived and released by Contractor, except for payment of the Lien Holdback which is the subject matter of such Proper Invoice, payment of the Contractual Holdback and any Claims in respect of Work to be performed sixty (60) Days prior to the date of Substantial Performance and on and after the date of Substantial Performance of the Work.

9.2.2 With its Proper Invoice submitted pursuant to GC 5.7.1.1 the Contractor shall include a list setting out the status of all outstanding Claim Notices which have been

submitted in strict compliance with 7.7 – CLAIMS PROCEDURE. For clarity, notwithstanding any other provision of the Agreement to the contrary:

.1 any Claim Notices submitted prior to such Proper Invoice, but which are not set out in such list shall be deemed to be irrevocably barred, and waived and released by Contractor; and

.2 any Claims not included in such list shall be deemed to be irrevocably and unconditionally barred, and waived and released by Contractor, except for payment of any remaining Lien Holdback and the payment which is the subject matter of such Proper Invoice.

9.3 WARRANTY

9.3.1 The Contractor warrants that all Work shall be free of Deficiencies including in materials and workmanship and conform to the requirements of the Agreement during the Warranty Period. Except as expressly provided elsewhere in the Agreement, the Contractor does not warrant that the Owner Supplied Materials are free of Deficiencies. For clarity, this does not limit any warranty obligations of the Contractor for Work in respect of, or in connection with, the Owner Supplied Materials.

9.3.2 The Owner or Contract Administrator shall promptly give the Contractor Notice in Writing of observed Deficiencies which occur during the Warranty Period.

9.3.3 The Contractor shall, at the Contractor's cost, commence correction of Deficiencies in the Work which appear prior to and during the Warranty Period promptly, and in no event later than within ten (10) Working Days after receipt of Notice in Writing from the Owner or Contract Administrator of observed Deficiencies, and promptly complete the correction of such Deficiencies. The obligation of the Contractor to perform the corrective Work in accordance with this 9.3 – WARRANTY shall include the provision of all necessary labour and materials and the removal and replacement of covering materials. The carrying out of the correction of Deficiencies shall be executed at times convenient with the Owner which may entail overtime Work on the part of, and at the cost of, the Contractor. For greater certainty, if the Contractor is notified of Deficiencies prior to the end of the Warranty Period, then the Contractor shall make good the Deficiencies, notwithstanding that the warranty Work may commence or extend beyond the end of the Warranty Period.

9.3.4 The Contractor shall, at its cost, make good or pay for damage or destruction to other parts of the Work, the Owner's or other contractors' property or any other property caused by the Deficiencies during the Warranty Period or the correction of such Deficiencies.

9.3.5 If after receipt of the Owner's or Contract Administrator's Notice in Writing, the Contractor fails to, within the required period, commence and complete the correction of Deficiencies or make good damage or destruction to other parts of the Work, the Owner's or other contractors' property or any other property as required by this 9.3 – WARRANTY, the Owner may correct the Deficiencies or make good such damage and destruction and hold the Contractor responsible for all costs thereof.

9.3.6 Any extension of the warranty beyond the Warranty Period shall be as specified in the Agreement ("**Extended Warranty Periods**"). Without limiting the Contractor's warranty under 9.3 – WARRANTY, the Extended Warranty Periods shall be issued by the warrantor to the benefit of the Owner. The Contractor's responsibility with respect to the Extended Warranty Periods shall be limited to obtaining any of the Extended Warranty Periods from the warrantor and assisting the Owner in the administration of the Extended Warranty Periods to the extent reasonably required by the Owner. The obligations under the Extended Warranty Periods are solely the responsibilities of the warrantor. For clarity, this GC 9.3.6 does not limit any responsibility or liability of the Contractor in respect of Deficiencies which appear prior to and during the Warranty Period.

9.3.7 Any Product or equipment requiring excessive servicing during the Warranty Period (or free maintenance period, if applicable) shall be considered Deficient and the warranty (or free maintenance period) shall be deemed to take effect from the time that the Deficiency has been corrected so as to cause excessive servicing to terminate.

9.3.8 Within thirty (30) Calendar Days after Substantial Performance of the Work, and without limiting the Contractor's warranty under this 9.3 – WARRANTY, the Contractor shall assign to the Owner, to the extent assignable, the benefit of all warranties and guarantees relating to the Work. The assignment shall:

.1 expressly reserve the right of the Contractor to make any claims under such warranties and guarantees;

.2 in no way prejudice any rights of or benefits accruing to the Contractor pursuant to such warranties and guarantees; and

.3 be in a form acceptable to the Owner.

9.3.9 The provisions of 9.3 – WARRANTY shall not deprive the Owner of any action, right or remedy otherwise available to the Owner for the Contractor's failure to fulfill its obligations or responsibilities under the Agreement and shall not be construed as a waiver of Claims in favour of the Contractor or as a limitation on the time in which the Owner may pursue such other action, right or remedy. The warranties set out in the Agreement are not supplemental to and do not limit or preclude the application of any other conditions and warranties, express or implied, by law, trade usage or otherwise.

10. GOVERNING REGULATIONS

10.1 LAWS, NOTICES, PERMITS, AND FEES

10.1.1 The Owner shall obtain and pay for development approvals, building permit, easements, rights of servitude, and all other necessary approvals and permits, except for the permits and fees referred to in GC 10.1.2 or for which the Agreement specify as the responsibility of the Contractor.

10.1.2 The Contractor shall be responsible for the procurement of permits, licences, inspections, and certificates, which are necessary for the performance of the Work

(including dewatering permits/agreements) and customarily obtained by contractors in the jurisdiction of the Site after the issuance of the building permit. The Contract Price includes the cost of these permits, licences, inspections, certificates and agreements, and their procurement.

10.1.3 The Contractor shall, and shall cause all Subcontractors, Suppliers and Sub-subcontractors to give the notices required by, and comply with, the Laws which are or come into force during the performance of the Work and which relate to the Work, to the preservation of health and safety.

10.1.4 Without limiting GC 10.1.3, the Contractor shall notify the Chief Building Official or the registered code agency where applicable, of the readiness, substantial completion, and completion of the stages of construction set out in the Ontario Building Code. The Contractor shall be present at each site inspection by an inspector or registered code agency as applicable under the Ontario Building Code.

10.1.5 Subject to 3.6 – DOCUMENT REVIEW AND EXAMINATION OF SITE, the Contractor shall not be responsible for verifying that the Agreement is in compliance with the Laws relating to the Work. If the Agreement is at variance therewith, or if, subsequent to the Effective Date, changes are made to the applicable Laws which require modification to the Agreement, the Contractor shall advise the Contract Administrator in writing requesting direction immediately upon such variance or change becoming known. The Contract Administrator will make the changes required to the Agreement as provided in 7.1 - OWNER'S RIGHT TO MAKE CHANGES, 7.2 - CHANGE ORDER and 7.3 - CHANGE DIRECTIVE.

10.1.6 If the Contractor:

.1 fails to notify the Owner and the Contract Administrator in writing of changes made to the applicable Laws (other than Owner's Policies, Procedures and By-laws) in accordance with GC 10.1.5;

.2 fails to obtain direction as required in GC 10.1.5; or

.3 performs Work that it knows or should have known, applying the Standard of Care, contravenes any Laws,

the Contractor shall be responsible for and shall correct the violations of such Laws, and shall be responsible for the Losses and delay attributable to the failure to comply with the provisions of such Laws, and, notwithstanding any limitations described in GC 9.1.1.

10.1.7 Notwithstanding GC 7.5.2, if subsequent to the Effective Date, changes are made to Laws (other than Owner's Policies, Procedures and By-laws) which increase or decrease the cost of the performance of the Work or Contract Time then:

.1 any claim by the Contractor must be submitted in accordance with the requirements of 7.7 - CLAIMS PROCEDURE; and

.2 the Owner may submit a change in accordance with the requirements of 7.1 – OWNER'S RIGHT TO MAKE CHANGES.

10.1.8 Without limiting the generality of any other provision in the Agreement, the Contractor shall cause all certificates to be furnished that are required or given by the appropriate Governmental Authorities or quasi-governmental authorities as evidence that the Work as installed conforms with the Laws, including certificates of compliance for the Owner's occupancy or partial occupancy. The certificates are to be final certificates giving complete clearance of the Work, in the event that such Governmental Authorities or quasi-governmental authorities furnish such certificates.

10.2 TAXES AND DUTIES

10.2.1 Subject to GC 10.2.3, the Fixed Prices and Unit Prices shall include all taxes and customs duties except for Value Added Taxes payable by the Owner to the Contractor. For clarity, there shall be no adjustment in the Fixed Price or Unit Prices as a result of inflation or currency fluctuation.

10.2.2 The Contractor shall provide a detailed breakdown of additional taxes and duties if requested by the Owner in a form satisfactory to the Owner.

10.2.3 Any increase or decrease in costs to the Contractor due to changes in Canadian federal and provincial taxes and custom duties after the Effective Date shall increase or decrease the Fixed Prices and Unit Prices accordingly. For greater certainty, the Contractor shall not be entitled to any markup for overhead or profit on any increase in such taxes and duties.

10.2.4 The Contractor represents and warrants that it is:

.1 not a non-resident Canadian; or

.2 has notified the Owner in writing, prior to execution of the Agreement that it is a non-resident Canadian,

for the purposes of the *Income Tax Act* (Canada). Notwithstanding anything to the contrary, all amounts payable by the Owner shall be subject to the *Income Tax Act* (Canada) (including applicable deductions from payments by the Owner on account of withholding against tax). Without limiting the generality of the foregoing, if any Laws requires that any taxes or other amounts be deducted or withheld from any payments to be made by the Owner under the Agreement, the Owner shall deduct such taxes or other amounts and remit such taxes or other amounts directly to the applicable Governmental Authority, including the Canada Revenue Agency, on or before the applicable due date and the Owner shall not be required to compensate or otherwise indemnify the Contractor with respect to such taxes or other amount.

10.2.5 Any taxes or customs duties applicable to the Agreement, including any sales taxes, excise taxes or Value Added Taxes, whether or not paid, which are found to be inapplicable or for which refund, exemption or recovery may be obtained, are the sole and exclusive property of the Owner. The Contractor agrees to, and to cause all Subcontractors, Suppliers and Sub-subcontractors to, cooperate with the Owner in

the application for any refund, exemption or recovery of any taxes or customs duties, which cooperation shall include, making or concurring in the making of an application for any such refund, exemption or recovery, and providing to the Owner copies, or where required, originals of Contractor Records or other documents necessary to support such applications for refunds, exemptions or recoveries. All such refunds, exemptions or recoveries shall either be paid to the Owner, or shall be a credit to the Owner against the Contract Price in accordance with 5.10 – OWNER'S SET-OFF, in the Owner's discretion. The Contractor agrees to endorse over to the Owner any cheques received from the federal or provincial governments, or any other taxing authority, as may be required to give effect to this GC. The Contractor agrees to enable, assist with and submit to any reasonable audit requested by the Owner with respect the potential refunds, exemptions or recoveries under this GC.

10.2.6 Customs duties penalties, or any other penalty, fine or assessment levied against the Contractor, shall not be treated as a tax or customs duty for the purpose of this 10.2 – TAXES AND DUTIES.

10.3 PATENT FEES

10.3.1 The Contractor shall pay the royalties and patent licence fees required for the performance of the Agreement.

10.4 WORKERS' COMPENSATION

10.4.1 Prior to commencing the Work, and again with the Proper Invoice for the Lien Holdback following Substantial Performance of the Work and the Contractor's Proper Invoice submitted pursuant to GC 5.7.1.1, the Contractor shall provide evidence of compliance with workers' compensation Laws, including payments due thereunder by the Contractor.

10.4.2 At any time during the term of the Agreement, when requested by the Owner, the Contractor shall provide evidence of compliance with workers' compensation Laws by the Contractor and Subcontractors.

11. DEFAULT, TERMINATION AND SUSPENSION

11.1 OWNER'S RIGHT TO PERFORM THE WORK, TERMINATE THE CONTRACTOR'S RIGHT TO CONTINUE WITH THE WORK, TERMINATE THE AGREEMENT OR SUSPEND THE WORK

11.1.1 If the Contractor is adjudged bankrupt, or makes a general assignment for the benefit of creditors because of the Contractor's insolvency, or if a receiver is appointed because of the Contractor's insolvency, the Owner may, without prejudice to any other right or remedy the Owner may have, immediately terminate the Contractor's right to continue with the Work or immediately terminate the Agreement, by giving the Contractor or receiver or trustee in bankruptcy Notice in Writing to that effect specifying the date upon which such termination becomes effective.

11.1.2 If the Contractor:

.1 fails to comply with the requirements of 1.7 – CONFLICTS OF INTEREST or if the parties are unable to resolve a Conflict of Interest of the Contractor to the satisfaction of the Owner;

.2 fails to provide a Recovery Plan in accordance with GC 7.5.6.1 or comply with the requirements in respect of a Recovery Plan under GC 7.5.6.2 and 7.5.6.3; or

.3 is found or determined to have committed any offence that qualifies as an "indictable offence" under the *Criminal Code* (Canada) or any offence of a similar nature with substantially similar penalties under any quasi-criminal provisions of another Law or any fraudulent act in any way related to the Work or the Agreement,

the Owner may, without prejudice to any other right or remedy the Owner may have, immediately terminate the Contractor's right to continue with the Work or immediately terminate the Agreement, by giving the Contractor Notice in Writing to that effect specifying the date upon which such termination becomes effective.

11.1.3 Subject to GC 11.1.1 and GC 11.1.2, if the Contractor:

.1 fails to commence the Work by the Commencement Date;

.2 neglects to prosecute the Work properly or fails or neglects to maintain the latest Construction Schedule; or

.3 otherwise fails to comply with the requirements of the Agreement,

the Owner may, without prejudice to any other right or remedy the Owner may have, give the Contractor Notice in Writing that the Contractor is in default of the Contractor's contractual obligations and instruct the Contractor to correct the default in the five (5) Working Days immediately following the receipt of such Notice in Writing. Failure by the Owner to provide such Notice in Writing in a timely manner after the default has occurred shall not constitute condonation of the default.

11.1.4 If the Owner determines that the default referred to in GC 11.1.3 cannot be corrected in the five (5) Working Days specified or in such other time period as may be subsequently agreed in writing by the parties, the Contractor shall be in compliance with the Owner's instructions if the Contractor:

.1 commences the correction of the default within the specified time;

.2 provides the Owner with an acceptable schedule for such correction; and

.3 corrects the default in accordance with the Agreement terms and with such schedule.

11.1.5 If the Contractor fails to correct the default referred to in GC 11.1.3 in the time specified or in such other time period as may be subsequently agreed in writing by

the parties, without prejudice to any other right or remedy the Owner may have, the Owner may:

.1 correct such default and set-off the cost thereof in accordance with 5.10 – OWNER'S SET-OFF provided the Contract Administrator has certified such cost to the Owner and the Contractor;

.2 charge the Contractor for any Losses suffered, sustained or incurred by the Owner as a result of such default and/or set-off such Losses in accordance with 5.10 – OWNER'S SET-OFF; or

.3 immediately terminate the Contractor's right to continue with the Work in whole or in part or immediately terminate the Agreement by giving the Contractor Notice in Writing to that effect specifying the date upon which such termination becomes effective.

11.1.6 If the Owner terminates the Contractor's right to continue with the Work or terminates the Agreement as provided in GC 11.1.1, 11.1.2 and 11.1.5, without prejudice to any other right or remedy which the Owner may have, the Owner may, at its sole option:

.1 take possession of the Work, Products and Owner Supplied Material at the Site;

.2 subject to the rights of third parties, utilize the Construction Equipment at the Site;

.3 finish the Work by whatever method the Owner may consider expedient, but without undue delay or cost;

.4 require Contractor to provide such reasonable assistance as required to properly and safely transition the Work to the Owner or its other contractors;

.5 withhold further payment to the Contractor until a final certificate for payment is issued;

.6 charge the Contractor the amount by which the full cost of finishing:

(1) any Fixed Price Work as certified by the Contract Administrator exceeds the unpaid balance of the Fixed Price; and

(2) any Unit Price Work as certified by the Contract Administrator exceeds the portion of the Total Price of Unit Price Work that would have been paid to the Contractor on the completion of such Unit Price Work (calculated based on the number of units required to complete the Unit Price Work after the effective date of termination).

plus compensation to the Contract Administrator for the Contract Administrator's additional services and a reasonable allowance as determined by the Contract Administrator to cover the cost of corrections to Work performed by the Contractor that may be required under 9.3 - WARRANTY;

.7 on expiry of the Warranty Period, charge the Contractor the amount by which the cost of corrections to the Contractor's Work under 9.3 - WARRANTY exceeds the allowance provided for such corrections, or if the cost of such corrections is less than the allowance, pay the Contractor the difference; and

.8 charge the Contractor for any Losses suffered, sustained or incurred by the Owner as a result of such termination and/or set-off such Losses in accordance with 5.10 – OWNER'S SET-OFF.

For clarity, any one or more of the Owner's rights in GC 11.1.6 shall also apply to the portions of the Work that the Owner has terminated the Contractor's right to continue pursuant to GC 11.1.5.3, *mutatis mutandis*.

11.1.7 Upon receipt of Notice in Writing from the Owner terminating the Agreement, the Contractor shall:

.1 subject to GC 11.1.6.4, cease Work on the effective date of the termination;

.2 place no additional orders (and if requested by the Owner, the Contractor shall cancel existing orders and subcontracts specified by the Owner upon terms satisfactory to the Owner); and

.3 preserve and protect the Products (at the Site or in transit), Owner Supplied Material and Work completed and in progress pending the Owner's instructions, and the Contractor shall dispose of same in accordance with the Owner's instructions.

11.1.8 The Contractor's obligation under the Agreement as to quality, correction and warranty of the Work performed by the Contractor up to the time of termination shall continue after such termination of the Agreement.

11.1.9 Termination for Convenience

.1 Notwithstanding any other term or condition in the Agreement, the Owner may (at any time) terminate the Contractor's right to continue with the Work or terminate the Agreement without cause and in its sole and absolute discretion by giving a Notice in Writing to the Contractor, specifying the date upon which such termination becomes effective, provided that such termination date may not be less than seven (7) Calendar Days from the date on which the Contractor is deemed to have received such Notice in Writing.

.2 In the event of termination pursuant to GC 11.1.9.1, the Owner shall be entitled to take possession of the Site, the Work, the Products and the Owner Supplied Material, and the Contractor shall be entitled to be paid for the following, without duplication, but subject to the other requirements in the Agreement to be satisfied by the Contractor prior to payment:

(1) the value proportionate to the Contract Price, of the Work performed up to the effective date of termination;

(2) reasonable demobilization costs paid by the Contractor which have been pre-approved by the Owner in writing;

(3) reasonable costs incurred in connection with the preservation or protection of the Work; and

(4) Subcontractor and Supplier cancellation costs reasonably paid by the Contractor as a result of such termination which have been pre-approved by the Owner in writing and could not have been reasonably mitigated by the Contractor.

For greater certainty, the amounts payable pursuant to GC 11.1.9.2(1) are less any previous amounts paid or properly withheld on account of the Contract Price and except for the amounts referred to in this GC 11.1.9.2, the Contractor shall not be entitled to any additional Losses resulting from the termination in accordance with GC 11.1.9.1 including any consequential, indirect or special damages and loss of profit, loss of opportunity or loss of productivity.

11.1.10 Notwithstanding any other provision in the Agreement, the Contractor shall accept, and not dispute, the termination of the Agreement or the Contractor's right to continue with the Work in whole or in part by the Owner under GC 11.1.1, 11.1.2 or 11.1.5.3, provided that the Contractor is entitled to dispute the existence of the underlying default or event giving the Owner the right to terminate the Agreement, or the Contractor's right to continue with the Work in whole or in part, in accordance with 12. DISPUTE RESOLUTION. However, if the Agreement is terminated under GC 11.1.1, 11.1.2 or 11.1.5.3 and it is later determined that there was no default or other event giving the Owner the right to terminate the Agreement or the Contractor's right to continue with the Work in whole or in part, as applicable, such termination shall be deemed to have been a termination for convenience and the rights and obligations of GC 11.1.9 shall apply to such termination.

11.1.11 Suspension

.1 The Owner, from time to time, may suspend any portion or the whole of the Work for any reason for such time as the Owner may notify the Contractor in a Notice in Writing. In addition to suspending any portion or the whole of the Work, the Owner shall be entitled to instruct the Contractor in the Notice in Writing to take such other action as may be reasonably required in respect of the suspension.

.2 The Contractor shall, upon receipt of such Notice in Writing, suspend the Work referred to in such Notice in Writing (except for Work which, in the reasonable opinion of the Contractor is necessary for the safety and security of people or property) and such suspended Work shall not be resumed until the Owner so directs in writing.

.3 Subject to GC 2.2.19, upon resumption of the suspended Work and provided the suspension of the Work was not as a result of the negligent act or omission of the Contractor Parties or the default or breach of the Contractor's obligations under the Agreement or any other act or fault of the Contractor Parties, the Contract Time shall be extended for such reasonable time as agreed to by the Parties,

taking into account such time period as recommended by the Contract Administrator and the Contract Price shall be adjusted to account for reasonable Losses incurred by the Contractor as the result of such suspension but excluding any consequential, indirect or special damages and loss of profit, loss of opportunity or loss of productivity resulting from such suspension.

11.1.12 The Contractor acknowledges that remedies at law may be inadequate to provide the Owner with full compensation if the Contractor breaches its obligations under this 11.1 - OWNER'S RIGHT TO PERFORM THE WORK, TERMINATE THE CONTRACTOR'S RIGHT TO CONTINUE WITH THE WORK, TERMINATE THE CONTRACT OR SUSPEND THE WORK and that any such breach of such obligations by the Contractor may cause the Owner irreparable harm. As a result, the Owner will be entitled, without prejudice to any other right or remedy it may have at law or in equity, to seek injunctive relief, specific performance, or any other equitable remedy if the Contractor breaches such obligations or takes steps that reasonably will result in a breach of such obligations.

11.2 CONTRACTOR'S RIGHT TO TERMINATE THE AGREEMENT

11.2.1 If the Work is suspended or otherwise delayed for a period of sixty (60) Working Days (or such alternate period under row C.11 of the Information Sheet) or more, by a stop work order issued by a court or other public authority (other than the City of Toronto) and providing that such order was not issued as the result of an act or fault of a Contractor Party, the Contractor may terminate the Agreement by giving the Owner Notice in Writing to that effect specifying the date upon which such termination becomes effective.

11.2.2 The Contractor may give Notice in Writing to the Owner, with a copy to the Contract Administrator, that the Owner is in default of the Owner's contractual obligations if:

.1 the Contract Administrator fails to issue a certificate for payment as provided in 5.4 - PROGRESS PAYMENT; or

.2 the Owner fails to pay the Contractor an amount: (1) which is due and payable under the Agreement, subject to the Owner's right to set-off pursuant to 5.10 – OWNER'S SET-OFF; or (2) awarded by arbitration or court; or

.3 the Owner fails to comply with a material requirement of the Agreement,

and instruct the Owner to correct the default in the fifteen (15) Working Days immediately following the receipt of such Notice in Writing.

11.2.3 If the default cannot be corrected within the fifteen (15) Working Days specified in GC 11.2.2, the Owner shall be in compliance with the Contractor's instructions if the Owner:

.1 commences the correction of the default within the specified time;

.2 provides the Contractor with an acceptable schedule for such correction; and

.3 completes the correction in accordance with such schedule.

11.2.4 If the Owner fails to correct the default in the time specified or subsequently agreed upon, the Contractor may, without prejudice to any other right or remedy the Contractor may have, terminate the Agreement by giving the Owner Notice in Writing to that effect specifying the date upon which such termination becomes effective.

11.2.5 If the Contractor terminates the Agreement under the conditions described in this 11.2 - CONTRACTOR'S RIGHT TO TERMINATE THE AGREEMENT, the Contractor shall be entitled to be paid for all Work performed to the date of termination. The Contractor shall also be entitled to recover the reasonable Losses associated with termination, including the costs of demobilization, but excluding any consequential, indirect or special damages and loss of profit, loss of opportunity or loss of productivity resulting from such termination.

11.3 OTHER TERMINATION OBLIGATIONS

11.3.1 If the Agreement is terminated, by the Owner or Contractor, as the case may be:

.1 the party terminating the Agreement shall publish, in the manner set out in the Construction Act, a notice of the termination in the form prescribed by the Construction Act and, for the purposes of this section, the date on which the Agreement is terminated is the termination date specified in the Notice in Writing delivered by such party to the other party pursuant to the Agreement; and

.2 the Contractor shall:

(1) comply with the requirements in GC 13.5.7 in respect of Confidential Information;

(2) stop, and cause all Subcontractors, Suppliers and Sub-subcontractors to stop, all Work in progress and refrain from undertaking any further commitments;

(3) except for subcontracts to be assigned to the Owner pursuant to GC 3.8.2.3(4), terminate any subcontracts related to the Work;

(4) minimize all costs resulting from the termination of the Agreement; and

(5) at the Owner's option, deliver, or cause to be delivered, to the Owner all Work-in-process obtained or performed by the Contractor and the Subcontractors, Suppliers and Sub-subcontractors up to the effective date of termination (including all Work-in-process situate at locations other than the Site and Contractor Prepared Documents).

12. DISPUTE RESOLUTION

12.1 DISPUTE RESOLUTION

12.1.1 Unless the Agreement has been terminated or completed, the Contractor shall in every case, notwithstanding any Claim Notice or the occurrence of a Dispute, continue to proceed with the Work with due diligence and expedition. Such continuance shall not jeopardize the Contractor's entitlement in respect of such Claim Notice or Dispute, provided the Contractor has complied with all other requirements of the Agreement.

12.1.2 The parties acknowledge and agree that, for the purposes of Part II.1 of the Construction Act, there shall be no dispute with respect to an Adjudicable Matter that is also the subject matter of a Claim Notice, unless and until a Claim Notice in accordance with GC 7.7 – CLAIMS PROCEDURE has been received by the Owner and the Contract Administrator, and the Owner or the Contract Administrator, as the case may be, has issued a determination to the Contractor regarding the validity of the Claim Notice pursuant to GC 7.7.6.

12.1.3 The parties acknowledge that no arbitration, action, suit or other proceeding shall be brought, nor any mediation undertaken, with respect to the subject matter of a Claim Notice unless and until a Claim Notice in accordance with GC 7.7 has been received by the Owner and the Contract Administrator, and the Owner or the Contract Administrator, as the case may be, has issued a determination to the Contractor regarding the validity of the Claim Notice pursuant to GC 7.7.6.

12.2 ADJUDICATION

12.2.1 The parties acknowledge and agree that, for the purposes of paragraph 7 of s. 13.5(1) of the Construction Act:

.1 neither the Agreement nor any Schedule sets out "any other matter" that the parties agree may be referred to an Adjudication; and

.2 the parties may agree after the commencement of the Agreement to "any other matter" that may be referred to an Adjudication provided such agreement is in writing and explicitly identifies and refers to the other matter to refer to an Adjudication.

12.2.2 All Adjudications shall proceed in accordance with the provisions of the Construction Act and the additional procedures set out in this 12.2 - ADJUDICATION, subject to the exercise of the powers provided to the Adjudicator under section 13.12 of the Construction Act.

12.2.3 Subject to GC 7.7 – CLAIMS PROCEDURE and GC 12.1.2, at any time prior to the completion of the Agreement, either party may refer an Adjudicable Dispute to Adjudication, by giving a Notice of Adjudication to the other party.

12.2.4 If the party issuing the Notice of Adjudication is the:

.1 Contractor, the Notice of Adjudication shall be given to:

City of Toronto
Adjudication Unit

C/O City Solicitor's Office
Metro Hall, 26th Floor
55 John Street
Toronto, Ontario M5V 3C6

.2 Owner, the Notice of Adjudication shall be given to the person at the address set out in row A.3 of the Information Sheet.

The Notice of Adjudication shall be given to the other party by registered mail, courier or hand delivery.

12.2.5 Delivery of the Notice of Adjudication by registered mail is deemed given on the fifth day after the Notice of Adjudication is mailed.

12.2.6 Delivery of the Notice of Adjudication by courier is deemed given on the second day following the day the courier was given the document, unless the second day is a holiday, in which case the Notice of Adjudication is deemed given on the next day that is not a holiday.

12.2.7 The seat of the Adjudication shall be in Toronto, Ontario.

12.2.8 In addition to the requirements of section 13.8 of the Construction Act, if an Adjudication between the Owner and the Contractor is with respect to an Adjudicable Matter that is the same or includes the subject matter of disputes that can be referred to adjudication between:

.1 the Contractor and Subcontractors and/or Suppliers that are to be adjudicated in separate Adjudications, if a Subcontractor and/or Supplier does not agree to a consolidated Adjudication, the Owner shall be entitled, in its sole and absolute discretion, to direct the Contractor to, and the Contractor shall, require the consolidation of the Adjudication through the exercise of the Contractor’s right pursuant to section 13.8(2) of the Construction Act; or

.2 the Owner and other contractors engaged by the Owner to perform work on the improvement that are to be adjudicated in separate Adjudications, the Contractor hereby acknowledges and agrees to the consolidation of the separate Adjudications if the Owner requires the consolidation of the separate Adjudications and such other contractors have also agreed to the consolidation of the separate Adjudications.

12.2.9 The Adjudicator nominated by the party issuing the Notice of Adjudication shall:

.1 have relevant qualifications and experience with respect to the Project or projects of a similar nature and magnitude, to the Project;

.2 be independent of and at arm’s length to Contractor, Owner and any other person having an interest in the Project or any of the documents comprising the Agreement; and

.3 have no conflict of interest relating to the parties or the Dispute.

12.2.10 In addition to the requirements of section 13.11 of the Construction Act, the copy of the contract and any other documents delivered to the party that received the Notice of Adjudication pursuant to section 13.11 of the Construction Act shall:

.1 be delivered to such party by the other party in the manner as required by the Adjudicator;

.2 if the contract and such documents have an aggregate file size in excess of twenty (20) MB, be delivered to such party by the other party on a USB flash drive or using a secure electronic document exchange service in a searchable format; and

.3 include an index of documents with identifying information (for example, date, document description, author/recipient).

12.2.11 The Contractor and Owner hereby acknowledge and agree that:

.1 they shall, immediately after the appointment of the Adjudicator, either through the agreement of the parties or by the Authorized Nominating Authority ("**ANA**"), deliver a written agreement requesting that the Adjudicator provide the party that received the Notice of Adjudication no less than fourteen (14) Calendar Days from the date of receipt of the documents pursuant to section 13.11 of the Construction Act to respond;

.2 if the documents delivered pursuant to section 13.11 of the Construction Act:

(1) exceed 100 documents or 1000 pages in the aggregate, excluding the Agreement and all Schedules; or

(2) seek monetary relief in excess of one million dollars ($1,000,000) exclusive of Value Added Taxes,

they shall, immediately after the receipt of such documents, deliver to the Adjudicator a written agreement requesting that the Adjudicator provide the party that received the Notice of Adjudication no less than sixty (60) Calendar Days from the date of receipt of such documents to respond and extend the deadline for the Adjudicator to make its determination to no less than thirty (30) Calendar Days after the deadline for the delivery of the response by such party; and

.3 if the documents delivered pursuant to section 13.11 of the Construction Act are delivered at any time between the Friday prior to December 25th in a given year and the first Monday of January of the following year, they shall, immediately after the receipt of such documents, deliver to the Adjudicator a written agreement requesting that the Adjudicator exclude the period between the date of delivery of such documents and that first Monday of January from the counting of Calendar Days for the purposes of the Adjudication and, as necessary to give effect to such exclusion, extend the deadline for the party that received the Notice of Adjudication to respond and the deadline for the Adjudicator to make its determination.

12.2.12 The Adjudicator shall be entitled to grant any remedy or relief which is consistent with the intentions of the parties expressed under the Agreement but shall not be entitled to exercise the power of prerogative writs.

12.2.13 In addition to the requirements of section 13.19(1) of the Construction Act, a requirement to pay an amount in accordance with section 13.19 of the Construction Act is subject to GC 13.2.1.2.

12.2.14 Other than in accordance with the Construction Act, any determination and reasons of an Adjudicator on the Project shall not be relied upon by either party on any other projects. The determination and reasons of any adjudicators on any other projects shall not be relied upon by the parties in any Adjudication on the Project.

12.2.15 If an Adjudicable Dispute is referred to Adjudication and such Adjudicable Dispute is already the subject of a mediation pursuant to GC 12.4 - MEDIATION, an arbitration pursuant to GC 12.5 - ARBITRATION or a court proceeding, which has not been finally determined, the party responding to the Notice of Adjudication shall be entitled, in its sole and absolute discretion, to choose to:

.1 terminate, suspend or proceed with such mediation or arbitration, as applicable, and if the responding party elects to terminate such mediation or arbitration, as applicable, the party referring the Adjudicable Dispute to Adjudication shall be responsible for all costs of the mediator or arbitrator, as applicable, up to the date of receipt of the Notice of Adjudication; or

.2 stay or proceed with such court proceeding, and if the responding party elects to stay such court proceeding, the party referring the Adjudicable Dispute to Adjudication shall execute all further documents and do all other lawful things necessary to give full effect to such stay, and after the Adjudicator makes its determination, either party may move to lift such stay, which the other party shall consent to.

12.2.16 The Contractor shall, in respect of any dispute between:

.1 the Contractor and a Subcontractor or Supplier;

.2 a Sub-subcontractor and a Subcontractor or Supplier; or

.3 a Sub-subcontractor and another Sub-subcontractor,

no later than two (2) Working Days after the receipt by the Adjudicator of the documents under section 13.11 of the Construction Act in respect of such dispute, deliver a Notice in Writing to the Contract Administrator and Owner setting out the date which such Adjudicator received such documents.

12.3 NEGOTIATIONS

12.3.1 Either party may initiate negotiations of any Dispute by giving written notice to the other party ("**Notice of Negotiations**") with reasonable particulars of the Dispute. After the receipt of a Notice of Negotiations the parties shall make all reasonable

efforts to resolve the Dispute by amicable negotiations and the parties agree to provide, without prejudice, open and timely disclosure of relevant facts, information, and documents to facilitate such negotiations.

12.3.2 Any applicable negotiations shall be completed as soon as possible and shall be limited to a period of no more than ninety (90) Calendar Days following the delivery of a Notice of Negotiations, or such other period of time as the Parties agree in writing.

12.4 MEDIATION

12.4.1 Subject to GC 12.1.3, the parties, by mutual written agreement, may submit any Dispute to mediation. Such mediation shall proceed in accordance with this 12.4 – Mediation and such other terms and conditions agreed to by the parties.

12.4.2 The mediator shall be mutually agreed upon by the Owner and Contractor.

12.4.3 Subject to GC 12.2.15.1, each party is responsible for its own costs related to the mediation. The costs of the mediator shall be equally shared by the Owner and Contractor.

12.5 ARBITRATION

12.5.1 Subject to GC 12.1.3, the parties, by mutual written agreement, may submit any Dispute to be finally determined by arbitration before a sole arbitrator, who shall also be agreed to as a part of such mutual agreement. The provisions of the *Arbitration Act, 1991* (ON) shall apply to such arbitration, including the provisions for appeal therein except as otherwise provided in this 12.5 - ARBITRATION and such arbitration shall be subject to such other terms and conditions agreed to by the parties.

12.5.2 If the parties agree to arbitration to resolve a Dispute, the Owner shall notify the Contract Administrator in writing within fifteen (15) Calendar Days of the written agreement to arbitrate.

12.5.3 Subject to GC 12.2.15.1, unless otherwise agreed to in the written agreement to arbitrate, each party is responsible for its own costs related to the arbitration and the arbitrator shall not have the discretion to award costs related to the arbitration. The costs of the arbitrator and any other Persons appointed to assist the arbitrator (including independent experts) shall be equally shared by the Owner and Contractor.

12.5.4 The arbitrator’s reasoned decision shall be made in writing within ninety (90) Calendar Days of the conclusion of the hearing. An extension of time to make a decision may be granted with consent of both parties.

12.5.5 The resolution of Disputes pursuant to this 12.5 - ARBITRATION shall be final and binding upon the parties, and there shall be no appeal therefrom, including any appeal to a court of law on a question of law, a question of fact, or a question of mixed fact and law.

12.6 RIGHTS OF BOTH PARTIES

12.6.1 Unless the parties agree otherwise, no action taken under GC 12.1 to GC 12.5 by either party shall be construed as a renunciation or waiver of any of the rights or recourse available to the parties.

13. OTHER PROVISIONS

13.1 OWNERSHIP OF EXISTING MATERIALS AND EQUIPMENT

13.1.1 Unless otherwise specified, all materials, equipment and other property existing at the Site at the time of execution of the Agreement shall remain the property of the Owner or any other Person identified by the Owner.

13.2 CONSTRUCTION LIENS

13.2.1 Upon the receipt of a written notice of lien, claim for lien or a certificate of action under the Construction Act, arising from the performance of the Work by any Subcontractor, Supplier or Sub-subcontractor:

.1 the Contractor at its sole cost, shall take whatever steps are necessary to discharge, release or vacate such claim for lien or certificate of action, or withdraw the written notice of a lien within ten (10) Calendar Days of it coming to the notice of the Contractor. If the claim for lien or certificate of action is merely vacated, the Contractor shall, if requested, undertake the Owner's defence of any subsequent lawsuit commenced in respect of the claim for lien or certificate of action at the Contractor's sole cost; and

.2 the Owner may retain an amount sufficient to satisfy such claim for lien, certificate of action or written notice of a lien, including an amount sufficient to cover potential costs, in accordance with GC 5.10 – OWNER'S SET-OFF.

13.2.2 If the Contractor fails or refuses to vacate or discharge the claim for lien or certificate of action, or cause the withdrawal of the written notice of a lien, within the time period required by 13.2.1, the Owner shall at its option, be entitled (but not obliged) to take whatever steps are necessary to vacate and/or discharge the claim for lien or certificate of action, or cause the withdrawal of the written notice of a lien and all Losses incurred by the Owner in so doing (including all legal fees and disbursements) may be set-off by the Owner in accordance with 5.10 – OWNER'S SET-OFF.

13.2.3 After the Contractor or the Owner, as the case may be, has vacated and/or discharged the claim for lien or certificate of action, or caused the withdrawal of the written notice of a lien, then any amount retained by the Owner pursuant to GC 13.2.1.2 in respect of such claim for lien, certificate of action or written notice of lien shall be eligible to be included in the next Proper Invoice submitted by the Contractor.

13.2.4 The Contractor acknowledges that all claims for lien shall be given to the Clerk of the City of Toronto through its web portal at www.toronto.ca/liens.

13.2.5 This 13.2 – CONSTRUCTION LIENS does not apply to any claim for lien or certificate of action to the extent arising from a payment default of the Owner under the Agreement.

13.3 OWNERSHIP OF CONTRACTOR DOCUMENTS

13.3.1 Subject to GC, 1.1.11, all correspondence, data, plans, drawings, specifications, reports, estimates, summaries, photographs, models, mockups, Contractor Records and all other information and documentation in any form (an whether in draft or final format) prepared by or for the Contractor in connection with, or arising out of the Work or the Agreement (collectively, the "**Contractor Prepared Documents**") shall be the exclusive property of the Owner, provided the Contractor shall retain the copyright in the Contractor Prepared Documents prepared by the Contractor. The Contractor grants the Owner an irrevocable, perpetual, royalty free and cost free license to use, amend and copy the Contractor Prepared Documents in any manner it chooses including the construction, design, testing, refurbishment, use, modification, expansion, occupancy, operation, maintenance, renovation, management, sale, extension, alteration and repair of the Work, the Site, the Project or any part thereof or any other project or any work including providing the Contractor Prepared Documents to consultants, design-builders, construction managers, contractors, suppliers and others for such purposes. Such license shall survive the termination of the Agreement.

13.3.2 In the event of any termination of the Agreement or as requested by the Owner, from time to time, the Contractor agrees to promptly, and in no event later than within ten (10) Working Days after such termination, deliver the Contractor Prepared Documents to the Owner.

13.4 OWNER SUPPLIED MATERIAL

13.4.1 The Contractor shall, in advance of receipt of shipments of Owner Supplied Material, provide adequate and proper storage facilities acceptable to the Contract Administrator and on the receipt of the Owner Supplied Material shall immediately place it in storage except where it is to be incorporated forthwith into the Work.

13.4.2 The Contractor shall be responsible for acceptance of Owner Supplied Material, at the specified delivery point. All Owner Supplied Material in each shipment shall be accounted for by the Contractor. Immediately upon receipt of each shipment, the Contractor shall provide the Contract Administrator with copies of bills of lading, or such other documentation the Contract Administrator may require to substantiate and reconcile the quantities of Owner Supplied Material received. Where Owner Supplied Material arrives at the delivery point in a damaged condition or where there are discrepancies between the quantities received and the quantities shown on the bills of lading, the Contractor shall immediately report such damage or discrepancies to the Contract Administrator who shall arrange for an immediate inspection of the shipment. Where damage or deficiencies are not so reported, it shall be assumed that the shipment arrived in good condition and order, and any damage or deficiencies reported thereafter shall be made good by the Contractor at no extra cost to the Owner and without any extension of the Contract Time.

13.4.3 Once accepted by the Contractor, notwithstanding that title to the Owner Supplied Equipment shall be held by the Owner, the risk of Loss to the Owner Supplied Material shall be borne by the Contractor. If after accepting delivery, such Owner Supplied Material is damaged or lost while under the control of the Contractor, it shall be replaced or repaired by the Contractor at no cost to the Owner, and to the satisfaction of the Contract Administrator. If such Owner Supplied Material is rejected by the Contract Administrator for reasons that are not the fault of the Contractor, it shall remain in the care and at the risk of the Contractor until its disposition has been determined by the Contract Administrator.

13.4.4 Owner Supplied Material shall not, except with the written permission of the Contract Administrator, be used by the Contractor for purposes other than the performance of the Work under the Agreement. Contractor shall store, operate, maintain, repair and otherwise deal with the Owner Supplied Material in the same manner as would a prudent owner of such material and equipment, and in accordance with the Agreement and the applicable operating and maintenance manuals, and using suitably qualified and experienced Personnel, until returned to the Owner.

13.4.5 Empty reels, crates, containers and other types of packaging from Owner Supplied Material shall become the property of the Contractor when they are no longer required for their original purpose and shall be disposed of by the Contractor at the Contractor's cost unless otherwise specified in the Agreement or directed by the Owner.

13.4.6 Where Owner Supplied Material supplied by the Owner is ordered and stockpiled prior to the award of the Agreement, the Contractor shall, at no extra cost to the Owner, immediately upon commencement of operations, check the Owner Supplied Material, report any damage or deficiencies to the Contract Administrator and take charge of the Owner Supplied Material at the stockpile site. Where damage or deficiencies are not so recorded by the Contractor, it shall be assumed that the stockpile was in good condition and order when the Contractor took charge of it, and any damage or deficiencies reported thereafter shall be made good by the Contractor at no extra cost to the Owner and without any extension of the Contract Time.

13.5 CONFIDENTIAL INFORMATION AND PERSONAL INFORMATION

13.5.1 The parties acknowledge and agree that MFIPPA applies to the Owner and the Owner Documents and that the Owner is required to fully comply with MFIPPA. The Contractor shall retain and preserve Owner Documents in a secure and accessible manner to enable the Owner to fulfill its obligations under MFIPPA and the Owner’s Policies, Procedures and By-laws.

13.5.2 Notwithstanding anything else in the Agreement to the contrary, the Contractor acknowledges and agrees that the Owner has a right to disclose or publish the Agreement (including any or all terms hereof), any or all Owner Documents and any information derived from the Owner Documents as the Owner, in its sole discretion, may consider appropriate.

13.5.3 Each party acknowledges the importance of maintaining the confidentiality and privacy of Confidential Information. Except as authorized hereunder, each receiving

party shall, with respect to Confidential Information it receives from or on behalf of any disclosing party at all times:

.1 hold such Confidential Information in strict confidence, under and in accordance with all applicable requirements of the Agreement including the Specifications, if any;

.2 implement and use, appropriate technical, organizational and physical security measures to protect and secure such Confidential Information, whether in storage or in use, with no less than the same degree of care as the receiving party uses to protect its own Confidential Information against loss, theft and unauthorized access, use, copying, modification, disclosure, publication or dissemination or disposal, but in no case with less than a reasonable degree of care. Further, the Contractor shall comply, if requested by the Owner, with a document control and security protocol approved by the Owner, which protocol shall prescribe limitations on the use, disclosure and storage of such Confidential Information;

.3 comply with all applicable requirements of Laws, including MFIPPA, the *Personal Information Protection and Electronic Documents Act* (Canada), and any other Laws now in force or that may in the future come into force governing the collection, use, disclosure and protection of Personal Information applicable to the Contractor;

.4 not disclose to a third party and not permit any third party any manner of access to, whether directly or indirectly, such Confidential Information without the prior written approval of the disclosing party in each instance, except as provided for in this 13.5 – CONFIDENTIAL INFORMATION AND PERSONAL INFORMATION; and

.5 not to use such Confidential Information for any purpose whatsoever other than in connection with the rights conferred under the Agreement as permitted by the Agreement.

13.5.4 The parties agree that:

.1 the receiving party may disclose Confidential Information of the disclosing party received by it pursuant to the Agreement:

(1) to its Personnel if and when such Personnel have a need to know such Confidential Information so that such receiving party may exercise its rights and/or meet its obligations under the Agreement or comply with Laws, provided that such Personnel are advised of the confidential nature of the Confidential Information and, by virtue of the terms of their employment, engagement or retainer or as a result of an agreement in writing, are bound by confidentiality obligations substantially no less restrictive than those imposed on the receiving party pursuant to the Agreement;

(2) to the extent such disclosure is required pursuant to Laws or any Governmental Authority, provided that, where circumstances permit, prior to

such disclosure the receiving party shall to the extent it is legally permitted to do so give the disclosing party a notice of the potential disclosure and allow the disclosing party the opportunity to contest the requirement for disclosure or seek a protective order or ruling in connection with such potential disclosure;

(3) as necessary in connection with any dispute resolution commenced pursuant to the Agreement; and

(4) as may be permitted or required under the *City of Toronto Act, 2006*;

.2 the Contractor may disclose Confidential Information of the Owner to its professional advisors, Subcontractors, Suppliers or Sub-subcontractors, to the extent necessary, to enable that party to perform, to cause to be performed the Work, or to enforce, its rights or obligations under the Agreement, provided that such parties are advised of the confidential nature of the Confidential Information and bound in writing to confidentiality obligations in favour of both the Owner and Contractor substantially no less restrictive than those imposed on Contractor by the Agreement;

.3 the Owner may disclose Confidential Information of the Contractor to its professional advisors, consultants, other contractors, Personnel and any other party providing or potentially providing services to the Owner to enable the Owner to perform any of its obligations or exercise any of its rights under the Agreement, provided that such parties are advised of the confidential nature of the Confidential Information and bound in writing to confidentiality obligations substantially no less restrictive than those imposed on the Owner by the Agreement; and

.4 any disclosure of Confidential Information allowed pursuant to this 13.5 - CONFIDENTIAL INFORMATION AND PERSONAL INFORMATION shall be limited to that which is necessary to satisfy the need for such disclosure.

13.5.5 The Contractor acknowledges that the Owner may use the Confidential Information of Contractor for purposes not specific to the Project, but for other general governmental purposes.

13.5.6 Each receiving party shall immediately provide Notice in Writing to a disclosing party in the event that it becomes aware of any actual or suspected loss, theft or accidental or unauthorized access, disclosure, copying, use, modification or destruction of Confidential Information by a receiving party or any party to which a receiving party has disclosed any Confidential Information.

13.5.7 The Contractor shall allow the Owner on reasonable Notice in Writing to inspect any Confidential Information in the custody or possession of a Contractor Party and to audit compliance with this GC including the measures used to protect Confidential Information, and otherwise properly respond to all reasonable inquiries of the Owner with respect to handling of Confidential Information within five (5) Working Days.

13.5.8 The Contractor shall provide, and shall cause each of its professional advisors, Subcontractors, Suppliers or Sub-subcontractors to provide, in a timely manner, all necessary and reasonable information and co-operation to the Owner and to any Governmental Authorities with jurisdiction or oversight over Laws governing the collection, use, disclosure and protection of Personal Information in connection with any investigations, audits or inquiries made by any such bodies or authorities under such legislation.

13.5.9 Subject to any applicable requirement of Laws, the Contractor shall on the earliest of the date of Total Performance of the Work, termination or expiry of the Agreement or upon the written request of the Owner, immediately cease all use of and return to the Owner or, at the direction of the Owner, dispose of, destroy, or render permanently anonymous, all Confidential Information, in each case using appropriate technical, organizational and physical security measures to protect Confidential Information against loss, theft and unauthorized access, disclosure, copying, use or modification.

13.5.10 This 13.5 – CONFIDENTIAL INFORMATION AND PERSONAL INFORMATION shall not apply in respect of information (except for Personal Information), if such information:

.1 was lawfully acquired by the receiving party prior to the Effective Date without any restrictions as to use or disclosure or any obligation of confidentiality;

.2 is lawfully, and without any restrictions as to use or disclosure or any obligation of confidentiality, provided to a receiving party by a third party, except where the third party is known or should reasonably have been suspected of being subject to an obligation to the disclosing party to maintain such information in confidence;

.3 is independently created, developed or acquired by or for the receiving party without reference to the Confidential Information provided by the disclosing party or through third parties to whom the Confidential Information had not been disclosed; or

.4 is released from the confidentiality provisions of the Agreement by the written authorization of the disclosing party.

13.5.11 The obligations in this 13.5 – CONFIDENTIAL INFORMATION AND PERSONAL INFORMATION shall survive the termination of the Agreement. To the extent of any conflict or inconsistency between this GC and any other provision of the Agreement, this GC shall prevail.

SCHEDULE E

VALUING CHANGES IN THE WORK

1. CHANGES IN THE WORK BASED ON UNIT PRICES SET OUT IN THE AGREEMENT

1.1 Notwithstanding that the number of units of an item of Unit Price Work to be performed shall exceed or be less than the Estimate of Units for Completion, subject to section 1.2 of this Schedule E, the Contractor shall proceed to perform the applicable Unit Price Work and payment shall be made for the final quantities of total units for such item in accordance with GC 5.3.5.2.

1.2 When the number of units of a Major Item of Unit Price Work exceeds the Estimate of Units for Completion for such item by more than 30%, the Contractor shall not proceed with the portion of such Major Item of Unit Price Work in excess of 130%, but the Owner shall have the right, in its sole discretion, to require that the portion of the applicable Unit Price Work for such Major Item which exceeds 130% of the Estimate of Units be performed and paid for as a T&M Change in the Work, in accordance with Section 3 of this Schedule E and if the Owner so elects, the Contract Administrator shall issue a Change Directive pursuant to GC 7.3 – CHANGE DIRECTIVE, or the parties shall sign a Change Order pursuant to GC 7.2 – CHANGE ORDER, reflecting the change for this portion of the Unit Price Work. For clarity:

1.2.1 where the number of units of a Major Item exceeds 100% of the applicable Estimate of Units for Completion for such Major Item, the units of such Major Item which are less than 130% of the Estimate of Units for Completion of such Major Item shall be paid for at the Unit Prices in accordance with GC 5.3.5.2;

1.2.2 where the number of units of an item of Unit Price Work (other than Major Items) exceeds 100% of the Estimate of Units for Completion for such item, all units of such item (including any units in excess of 130% of the applicable Estimate of Units for Completion) shall be paid for at the Unit Prices in accordance with GC 5.3.5.2; and

1.2.3 the Unit Prices under "Schedule A Schedule of Prices for Changes in the Work", if attached to Schedule B - Pricing Form, shall apply to an item of Unit Price Work if there is no corresponding Unit Price set out elsewhere in Schedule B – Pricing Form for such item.

2. CHANGES IN THE WORK ON A NEGOTIATED FIXED PRICE OR NEGOTIATED UNIT PRICE BASIS

2.1 The negotiated fixed price for a change in the Work or negotiated unit price(s) for the components of a change in the Work, as the case may be, whether performed by the Contractor or a Subcontractor, Supplier or Sub-subcontractor, shall be inclusive of all costs, charges, expenses, fees and taxes whatsoever required or related to the performance of such change in the Work and markup as provided for in section 2.2.3 of this Schedule E, with the exception of Value Added Taxes.

2.2 The negotiated fixed price for a change in the Work or negotiated unit price(s) for the components of a change in the Work, as the case may be, shall be the sum of the following:

2.2.1 the negotiated fixed price or negotiated unit price(s), as applicable, for the portions of the change in the Work to be carried out by the Contractor's Personnel, without markup by the Contractor;

2.2.2 the negotiated fixed price or negotiated unit price(s), as applicable for the portions of the change in the Work to be carried out by the Subcontractors, Suppliers or Sub-subcontractors, without markup by the Contractor, Subcontractor, Supplier or Sub-subcontractor; and

2.2.3 markup calculated as follows:

.1 multiplying the negotiated amount set out in section 2.2.1 of this Schedule E by the percentage amount described in row B.1 of the Information Sheet; and

.2 multiplying the negotiated amount set out in section 2.2.2 of this Schedule E by the percentage amount described in row B.2 of the Information Sheet.

Such markup percentages shall not be adjusted during the term of the Agreement. Notwithstanding any other provision in the Agreement, the cumulative total percentage markup charged by the Contractor, Subcontractors, Suppliers and Sub-subcontractors pursuant to section 2.2.3.2 of this Schedule E shall not exceed the percentage amount set out in row B.2 of the Information Sheet, regardless of the extent to which the change in the Work is performed by a Subcontractor, Supplier or Sub-subcontractor. For greater certainty, such markup percentage shall not apply to Value Added Taxes. Any change in Work performed by a Subcontractor, Supplier and Sub-subcontractor that is an "associate" (as defined by the Securities Act) of the Contractor shall be treated as if such change in the Work was performed by the Contractor for the purposes of calculating the markup and, in such an instance, the markup in section 2.2.3.1 of this Schedule E is applicable, not the markup in section 2.2.3.2 of this Schedule E.

2.3 The Contractor shall provide written quotes identifying each amount to be charged by the Contractor and each Subcontractor, Supplier and Sub-subcontractor, including for each of the foregoing, a detailed breakdown of amounts for transportation, labour, Product, Construction Equipment, services. The Value Added Taxes, as applicable, shall be identified separately in a manner satisfactory to the Owner. The Contractor shall also provide any other detail reasonably required by the Owner to evaluate the proposed fixed price of the change in the Work.

2.4 Where such change in the Work requires the rental of Construction Equipment, any rental charges for the actual operation time required for the performance of the change in the Work must be agreed upon by the parties before the Contractor commences the change in the Work.

2.5 The markups provided for in section 2.2.3 of this Schedule E shall constitute the only compensation the Contractor shall be entitled to for any and all overhead, profit, incidental and administrative costs whatsoever related to the change, including, costs relating to superintendence and supervision, shop drawing production, estimating, site office and home office expenses, tools of Personnel, temporary facilities and controls, and coordination of any and all Work-related activities.

2.6 If such change in the Work results in a net decrease in the Fixed Price, the Fixed Price shall be decreased by an amount proportionate to the reduction in the Fixed Price Work, provided that such reduction shall not include any amounts for portions of the Fixed Price relating to the fixed overhead costs incurred by the Contractor as reasonably substantiated by the Contractor.

3. CHANGES IN THE WORK ON A TIME AND MATERIAL BASIS – VERTICAL APPROACH

3.1 For the purposes of this Section 3 of this Schedule E, the following definitions apply:

3.1.1 "**T&M Costs"** has the meaning set out in section 3.2.1 of this Schedule E;

3.1.2 "**T&M Markup"** has the meaning set out in section 3.4.2 of this Schedule E;

3.1.3 "**T&M Percentage Markup**" has the meaning set out in section 3.2.2 of this Schedule E;

3.1.4 "**T&M Price**" means, in respect of a T&M Change in the Work, the total T&M Costs plus the T&M Markup.

3.2 For T&M Changes in the Work, the following shall apply:

3.2.1 the cost of performing the T&M Change in the Work shall be calculated using the provisions of section 3.5 of this Schedule E, subject to all applicable credits being deducted and section 3.11 of this Schedule E ("**T&M Costs**"); and

3.2.2 the percentage markup shall be determined in accordance with section 3.3 of this Schedule E ("**T&M Percentage Markup**").

3.3 The T&M Percentage Markup applicable to T&M Change in the Work shall be determined as follows:

3.3.1 on T&M Changes in the Work performed by Contractor: the percentage amount set out in row B.3 of the Information Sheet; and

3.3.2 on T&M Changes in the Work performed by the Subcontractor or Supplier or Sub-subcontractors: the percentage amount set out in row B.4 of the Information Sheet.

The T&M Percentage Markup shall not be adjusted during the term of the Agreement. Notwithstanding any other provision in the Agreement, the cumulative total percentage markup charged by the Contractor, Subcontractors, Suppliers and all Sub-

subcontractors pursuant to section 3.3.2 of this Schedule E shall not exceed the amount set out in row B.4 of the Information Sheet, regardless of the extent to which the change in the Work is performed by a Subcontractor, Supplier or Sub-subcontractor. For greater certainty, the percentage markup shall not apply to Value Added Taxes. Any change in Work performed by a Subcontractor, Supplier and Sub-subcontractor that is an "associate" (as defined by the Securities Act) of the Contractor shall be treated as if such change in the Work was performed by the Contractor for the purposes of calculating the T&M Percentage Markup and, in such an instance, the T&M Percentage Markup in section 3.3.1 of this Schedule E is applicable, not the markup in section 3.3.2 of this Schedule E.

3.4 If the T&M Change in the Work results in a net increase in the Contractor's cost, the Contract Price shall be increased by:

3.4.1 the T&M Costs; plus

3.4.2 the T&M Percentage Markup multiplied by the T&M Costs ("**T&M Markup**"),

3.5 The T&M Costs shall be the actual reasonable costs to the extent directly paid by the Contractor in performing such T&M Change in the Work in accordance with the Agreement (without any markup) and, subject to section 3.11 of this Schedule E, is limited to the actual reasonable costs of the following:

3.5.1 salaries, wages and benefits paid to Personnel in the direct employ of the Contractor applying the labour rates as agreed in writing between the Owner and Contractor for Personnel:

.1 carrying out the T&M Change in the Work, including, to the extent the T&M Change in the Work results in an extension of the Contract Time, project managers, superintendents, assistants, watch persons and administrative Personnel;

.2 engaged in expediting the production or transportation of material or equipment, at shops or on the road; or

.3 engaged in the preparation of Shop Drawings, fabrication drawings, coordination drawings and As-Built Drawings.

The Contractor acknowledges that the agreed upon labour rates (including the underlying salaries, wages and benefits on which the labour rates were calculated) shall be subject to audit and verification by the Owner in accordance with GC 2.6 and adjustment as appropriate.

3.5.2 contributions, assessments or taxes incurred for such items as employment insurance, provincial or territorial health insurance, workers' compensation, and Canada or Quebec Pension Plan, insofar as such cost is based on wages, salaries or other remuneration paid to Personnel of the Contractor and included in the cost of the Work as provided in section 3.5.1 of this Schedule E;

3.5.3 all Products including cost of transportation thereof;

3.5.4 materials and supplies, including transportation and maintenance thereof, which are consumed in the performance of the Work; and cost less salvage value on such materials and supplies used but not consumed, which remain the property of the Contractor;

3.5.5 all Construction Equipment, exclusive of hand tools, and Temporary Work, used in the performance of the Work, whether rented from or provided by the Contractor or others, including installation, minor repairs and replacements, dismantling, removal, transportation, and delivery cost thereof, which for clarity, excludes the labour costs for directly operating such items included in section 3.5.1 of this Schedule E;

3.5.6 all equipment and services required for the Contractor's field office;

3.5.7 deposits lost provided that they were not lost by acts or omissions of the Contractor's Personnel;

3.5.8 subject to the Owner's prior written approval for amounts in excess of $10,000, the value of subcontracts with Subcontractors and Suppliers, provided however that any time and material costs included in such amounts shall be limited to the actual costs of the items described in this section 3.5 of this Schedule E changing "Contractor" to "Subcontractor" or "Supplier" as necessary";

3.5.9 quality assurance required by the Agreement such as inspection and testing services, charges levied by authorities, provided such costs are pre-approved in writing by the Owner;

3.5.10 legal costs, incurred by the Contractor, in relation to the performance of the T&M Change in the Work provided that they are not related to or arising from a dispute between the Owner and the Contractor unless such costs are part of a settlement or awarded by adjudication, arbitration or court;

3.5.11 charges levied by authorities having jurisdiction at the Site;

3.5.12 royalties, patent licence fees and Losses for infringement of patents and cost of defending suits therefor subject always to the Contractor's obligations to indemnify the Owner as provided in GC 9.1.2.2;

3.5.13 any adjustment, attributable to the T&M Change in the Work, in premiums for all bonds and insurance which the Contractor is required, by the Agreement, to purchase and maintain;

3.5.14 any adjustment in taxes, other than Value Added Taxes and those relating to the Contractor's income or real or personal property;

3.5.15 duties for which the Contractor is liable;

3.5.16 charges for long distance telephone and facsimile communications, courier services, expressage, and petty cash items incurred in relation to the performance of the Work;

3.5.17 removal and disposal of waste products and debris; and

3.5.18 safety measures and requirements.

All other costs attributable to the T&M Change in the Work are included in the percentage markup calculated in accordance with the provisions of section 3.3 of this Schedule E.

3.6 Notwithstanding any other provisions contained in the Agreement (other than section 3.11 of this Schedule E), it is the intention of the parties that the cost of any item under any cost element referred to in section 3.5 of this Schedule E shall cover and include any and all costs or liabilities attributable to the T&M Change in the Work other than those which are the result of or occasioned by any failure on the part of the Contractor to perform the change in the Work in accordance with the Standard of Care. Any cost due to failure on the part of the Contractor to perform the change in the Work in accordance with the Standard of Care shall be borne by the Contractor.

3.7 The Contractor shall prepare and maintain complete and accurate Daily Contractor Work Records for T&M Changes in the Work.

3.8 All trade, quantity and cash discounts and rebates and refunds accrue to the Owner, including all returns from sale of surplus materials and equipment applicable to the T&M Change in the Work, and the Contractor shall make provisions for them to be secured without delay.

3.9 Pending determination of the final amount of a T&M Change in the Work, the undisputed value of the T&M Change in the Work performed:

3.9.1 as the result of a Change Order, is eligible to be included in Proper Invoices; and

3.9.2 as the result of a Change Directive, is not eligible to be included in Proper Invoices except to the extent that it is dealt with in a Change Order.

3.10 If the Owner and the Contractor do not agree on the proposed adjustment in the Contract Time attributable to the T&M Change in the Work, or the method of determining it, the adjustment shall be referred to the Contract Administrator for determination.

3.11 Notwithstanding any other provisions contained in the Agreement, the T&M Costs shall not include, and no payment shall be made by the Owner for:

3.11.1 head office salaries, wages and benefits and all other overhead or general expenses;

3.11.2 capital expenses and interest on capital;

3.11.3 general clean-up, except where the performance of the T&M Change in the Work causes specific additional clean-up requirements;

3.11.4 salaries, wages and benefits paid for project managers, superintendents, assistants, watch persons and administrative Personnel except only for the

salaries, wages and benefits of Personnel described in section 3.5.1 of this Schedule E and the related contributions, assessments or taxes referred to in section 3.5.2 of this Schedule E;

3.11.5 salaries, wages, benefits, rentals, or other expenses that exceed the rates that are standard in the locality of the Site that are otherwise deemed unreasonable by the Contract Administrator;

3.11.6 any Losses attributable to Deficiencies, the negligent acts or omissions of the Contractor Parties or the Contractor's failure to perform any of its obligations under the Agreement;

3.11.7 any costs noted in the Agreement as non-reimbursable by the Owner; or

3.11.8 any costs noted in the Agreement as paid or incurred at the Contractor's expense.

SCHEDULE F

OWNER'S POLICIES, PROCEDURES, BY-LAWS AND OTHER REQUIREMENTS

The following Toronto Zoo Official Policy Statements and procedures are included in this RFT, are applicable for this project.

SAFE-001	Occupational Health & Safety
SAFE-002	Health & Safety Hazard Reporting
SAFE-005	Hazardous Materials
SAFE-007	Confined Space
SAFE-013	Lock Out / Tag Out Procedure
SAFE-017	Contractor Safety
SAFE-018	Vehicles on Site
SAFE-025	Hot Work
SAFE-026	Scaffold & Ladder Safety

City of Toronto Fair Wage Policy: https://www.toronto.ca/business-economy/doing-business-with-the-city/understanding-the-procurement-process/fair-wage-office-policy/fair-wage-policy/

Toronto Zoo's Commitment to the City of Toronto's Corporate Smog Alert Response Plan.

Toronto Zoo's Accessible Customer Service Training Requirements: Contractors, Consultants and other Service Providers

Schedule G

FORMS

Schedule G is comprised of the following forms:

Form 1: Sample Proper Invoice

Form 2: Certificate of Insurance

Form 3: Tax Statutory Declaration

Form 4: Notice of Adjudication

FORM 1: SAMPLE PROPER INVOICE

Contractor Company Logo

INVOICE

BILL TO:

Owner:	*City of Toronto*
Street Address:	*55 John Street, 20th Floor*
City:	*Toronto, Ontario*
Postal Code:	*M5V 3C6*
Division:	*Engineering & Construction Services*
Owner Representative	*John Doe*
Tel. #:	*416-39X-XXXX*
Email:	*John.Doe@toronto.ca*

REMIT TO:

Vendor Name	*Vendor*
Vendor Number	*123456789*
Street Address	*123 Toronto Street, Unit 12*
City	*Toronto, Ontario*
Postal Code	*XXX XXX*
Contractor Project Manager	*John Doe*
Tel. #	*416-39X-XXXX*
Email	*John.Doe@Vendor.ca*

INVOICE DATE: *September 19, 2019*
INVOICE # *12548*

Contract #:	*Contract Number*
Blanket Contract #: (if any)	*XXXXXXX*
PO #/ CRO#/ DPO#:	*XXXXXXX*
Project Description:	*Project Description*
Invoice Period:	*(Start) to (End)*
Progress Payment Certificate#:	*PR-XX*

HST Registration No. _____
Currency _____

Item	Contract Price	Progress To Date		Previous Billing	Current Billing
		%	$		
A	B	C = (D / B)	D	E	F = (D - E)
Base Contract	$0.00	0.00%	$0.00	$0.00	$0.00
Allowances	$0.00	0.00%	$0.00	$0.00	$0.00
Approved Change Orders (non-Allowance)	$0.00	0.00%	$0.00	$0.00	$0.00
Gross Amount	**$0.00**	**0.00%**	**$0.00**	**$0.00**	**$0.00**
Less: Statutory Lien Holdback			$(0.00)	$(0.00)	$(0.00)
Less: Contractual Holdbacks			$(0.00)	$(0.00)	$(0.00)
Net Amount			$0.00	$0.00	$0.00
HST 13%			$0.00	$0.00	$0.00
Less: Other Taxes			$(0.00)	$(0.00)	$(0.00)
Total Amount Due					**$0.00**

Name: _____ Signature: _____

Title: Date:

☑ Additional information to be included/attached

FORM 2: CERTIFICATE OF INSURANCE

To be completed only by the insurer or by its representative.

Name of Insured:	Toronto Zoo Contact Name, Address, and Telephone Number:
Address and Telephone Number of Insured:	

Operations of Named Insured for which certificate is issued:

(NOTE: Provide specific project information including the Toronto Zoo contract number)

1. Commercial General Liability: Deductible $_____

Insuring Company	**Policy Number**	**Policy Limit(s) $** (per occurrence)	**Effective Date** (yyyy-mm-dd)	**Expiry Date** (yyyy-mm-dd)
Primary Insurer:				
Umbrella/Excess Insurer: □ **Applicable to Auto Coverage**				
Contractor's Pollution Liability, Sudden and Accidental and Gradual, if applicable				

Commercial General Liability policy provisions:

a) The CITY OF TORONTO, ITS BOARDS, AGENCIES, COMMISSIONS OR SUBSIDIARY OPERATIONS, AS APPLICABLE, the TORONTO AND REGION CONSERVATION AUTHORITY and the CONSULTANT are included as Additional Insureds but only with respect to liability arising out of the operations of the Insured for which a contract or proposal is issued by the Toronto Zoo.

b) The policy includes a Cross-Liability and Severability of Interest, Blanket Form Contractual Liability, Owner's and Contractor's Protective Liability, Broad Form Property Damage, Contingent and/or Employer's Liability, Non-Owned Automobile Liability, Products/Completed Operations and any other provision relevant to the contract work. If applicable to the insured operations, coverage for Blasting, Pile Driving and Collapse.

c) The Commercial General Liability Policy(ies) identified above shall apply as primary insurance and not excess to any other insurance available to the City.

2. Automobile Liability, if applicable: **Deductible $** _____

Insuring Company	**Policy Number**	**Policy Limit(s) ($)**	**Effective Date (yyyy-mm-dd)**	**Expiry Date (yyyy-mm-dd)**

3. Contractor's Equipment Property Insurance: Deductible $ _____

Contractor's tools & equipment , materials & supplies in an amount to reflect the replacement cost.
Policy includes a Waiver of Subrogation Clause in favour of the City.

Insuring Company	Policy Number	All-Risk Property Limit(s) ($)	Effective Date (yyyy-mm-dd)	Expiry Date (yyyy-mm-dd)

4. Builder's Risk or Installation Floater - Products, supplies and equipment and/or systems, including boiler and machinery, if applicable, that forms part of the Work. Deductible $ _____

Identify Policy Type:

Builder's Risk □

Installation Floater □

The Owner shall be included as an additional insured and a joint loss payee.

Insuring Company	Policy Number	Limit of Coverage ($)	Effective Date (yyyy-mm-dd)	Expiry Date (yyyy-mm-dd)

5. Other (Specify) _____. Deductible $ _____

Insuring Company	Policy Number	Policy Limit(s) ($)	Effective Date (yyyy-mm-dd)	Expiry Date (yyyy-mm-dd)

6. Other (Specify) _____. Deductible $ _____

Insuring Company	Policy Number	Policy Limit(s) ($)	Effective Date (yyyy-mm-dd)	Expiry Date (yyyy-mm-dd)

All of the above policies (with the exception of the Automobile Insurance, Section 2 above) must include a clause that states that if the policy is cancelled during the period of coverage, as stated herein, thirty (30) days, (fifteen (15) days if cancellation is due to non-payment of premium), prior written notice by registered mail will be given by the Insurer(s) to the City of Toronto.

CERTIFICATION

I certify that the insurance is in effect as stated in this Certificate and that I have authorization to issue this Certificate for and on behalf of the Insurer(s). This Certificate is valid until the expiration date(s) stated in the “Expiry Date” provision, unless notice is given in writing in accordance with the provision of this Certificate.

Date	Broker’s or Insurer’s Name and Address	Signature and Stamp of Certifying Official

FORM 3: TAX STATUTORY DECLARATION

CANADA, PROVINCE OF ONTARIO, JUDICIAL DISTRICT OF YORK	) IN THE MATTER OF the annexed Agreement) made between)))) – and –)) **[OWNER]**)) this _____ day of _____, 20___.) with respect to)

I, _____, of the CITY / TOWN / VILLAGE of _____

in the Province of _____, do solemnly declare as follows:

1. I am _____ of _____
   (If an incorporated Company, state" President", "Secretary", or as the case may be) (Company Name)
   referred to above (hereinafter called "the Contractor"), and as such have knowledge of the matters hereinafter declared to.

2. The Contractor has paid all taxes and/or penalties imposed on it by the Corporation Tax Act, R.S.O. 1990, c. C.40, as may be amended.

AND I MAKE this solemn Declaration conscientiously believing it to be true and knowing that it is of the same force and effect as if made under oath.

DECLARED before me at the _____ of _____ in the City of Toronto this _____ day of _____ 20___	} } } } } } } _____ } Signing Officer of Company } }

A Commissioner, etc.

FORM 4: NOTICE OF ADJUDICATION

IN THE MATTER OF AN ADJUDICATION PURSUANT TO PART II.1 OF THE *CONSTRUCTION ACT*, R.S.O. 1990, c. C.30, as amended

Notice of Adjudication

Date

Agreement Information

Contract Number
Project

Information of Party Initiating the Adjudication

Corporate Name		
Corporate Address		
City/Town	Province	Corporate Phone No.
Postal Code	Email (if applicable)	Corporate Fax No.

Information of Party Receiving the Notice of Adjudication

Corporate Name		
Corporate Address		
City/Town	Province	Corporate Phone No.
Postal Code	Email (if applicable)	Corporate Fax No.

Contractor Information

Contractor Project Manager, if applicable
Contractor Site Supervisor, if applicable

Owner Information

Owner Representative
Contract Administrator

Adjudication Claim Information

Claimed Amount, exclusive H.S.T.

Please indicate which Adjudicable Matter the Adjudication is in respect of:

☐ Valuation of services or materials provided under the Agreement
☐ Payment under the Agreement
☐ Dispute regarding a Notice of Non-Payment
☐ Amounts Set-off by Owner
☐ Non-payment of Lien Holdback

If applicable, please identify relevant:

☐ Change Directive Number: _____
☐ Change Order Number: _____
☐ Proper Invoice Number: _____
☐ Claim Notice reference number and date: _____

Please provide the nature and a brief description of the dispute, including details respecting how and when the dispute arose and the nature of the redress sought (attach a separate sheet if necessary):

Requested Adjudicator

First and Last Name		
Address		
City/Town	Province	Phone No.
Postal Code	Website (if applicable)	Email

Consolidation

☐ The dispute which is the subject matter of this Notice of Adjudication is proposed to be consolidated with the disputes which are the subject matter of the notices of adjudication attached as "**Attachment 1**"

Delivery

See GC 12.2.4 for method of delivery of the Notice of Adjudication and address for delivery.

Attachments

Please attach a copy of any notices of adjudication for adjudications proposed to be consolidated to this Notice of Adjudication as **"Attachment 1".**

Please attach a copy of SCHEDULE A – INFORMATION SHEET to this Notice of Adjudication as "**Attachment 2**".

SCHEDULE H

DRAWINGS AND SPECIFICATIONS

[Note to Finalization before Execution: Attach or list the Drawings and Specifications (which includes, for clarity, the Standard Drawings, the Standard Specifications and Special Specifications and material and finishing schedules).]

PART 3 – DRAWINGS AND SPECIFICATIONS

RFT No. TZC T 57-2019-12

DRAWING LIST

ARCHITECTURAL - GENERAL

AR-000	COVER PAGE-OVERALL KEY PLAN
AR-001	ABBREVIATIONS, GENERAL NOTES, LEGENDS & WALL TYPES, ROOM FINISHES
AR-002	SCHEDULES : DOOR, WINDOW,
AR-003	SITE SURVEY- HABITAT 1
AR-004	SITE SURVEY- HABITAT 2
AR-005	SETTING OUT PLAN FOR STRUCT.
AR-006	SETTING OUT PLAN FOR POLES
AR-007	SETTING OUT PLAN FOR CASSION LAGGING & RETAINING WALLS
AR-010	VIEWING GLASS DETAILS
AR-010A	ORANGUTAN DOOR DETAILS
AR-011	CAGING DETAIL
AR-012	CAGING DETAIL

ARCHITECTURAL - HABITAT 1

AR-100	DEMOLITION PLAN
AR-101	LAYOUT AND MATERIAL PLAN
AR-102	SITE SECTIONS
AR-103	SITE SECTIONS
AR-104	CLIMBING POLE DETAILS
AR-105	CLIMBING POLE PLATFORM DETAILS
AR-106	FEEDER DETAILS (FOR HABITAT 1 & 2)
AR-110	DAYROOM PLAN & EXISTING PLANS
AR-111	DAYROOM SECTIONS
AR-112	DAYROOM ELEVATIONS
AR-120	VIEWING/RESEARCH STATION - CONSTRUCTION & RCP PLANS
AR-121	VIEWING/RESEARCH STATION - PLANS
AR-122	VIEWING/RESEARCH STATION - SECTIONS
AR-123	VIEWING/RESEARCH STATIONS - ELEVATIONS
AR-124	VIEWING/RESEARCH STATION - DETAILS
AR-125	OUTDOOR GLASS TRAINING WALL
AR-130	GLASS VIEWING TRELLIS PLAN
AR-131	GLASS VIEWING TRELLIS SECTIONS
AR-140	TREE HOUSE - PLANS
AR-141	TREE HOUSE - SECTIONS & ELEVATIONS
AR-150	BOARDWALK PLANS
AR-151	BOARDWALK SECTIONS & ELEVATIONS
AR-152	BOARDWALK DETAILS
AR-180	DETAILED SECTIONS

ARCHITECTURAL - HABITAT 2

AR-200	LAYOUT AND MATERIAL PLAN
AR-201	PAVILION PLAN
AR-202	SITE SECTIONS

AR-205	CHUTES
AR-206	SECTIONAL DETAIL
AR-210	CHUTES DETAILS
AR-211	CLIMBING POLE DETAILS

STRUCTURAL

S-000	COVER PAGE
S-100	GENERAL NOTES & TYPICAL DETAILS
S-101	GENERAL NOTES & TYPICAL DETAILS
S-102	GENERAL NOTES & TYPICAL DETAILS
S-103	GENERAL NOTES & TYPICAL DETAILS
S-104	GENERAL NOTES & TYPICAL DETAILS
S-105	GENERAL NOTES & TYPICAL DETAILS
S-106	GENERAL NOTES & TYPICAL DETAILS
S-107	GENERAL NOTES & TYPICAL DETAILS
S-108	GENERAL NOTES & TYPICAL DETAILS
S-109	GENERAL NOTES & TYPICAL DETAILS
S-110	GENERAL NOTES & TYPICAL DETAILS
S-111	GENERAL NOTES & TYPICAL DETAILS
S-112	GENERAL NOTES & TYPICAL DETAILS
S-200	OVERALL FOUNDATION PLAN
S-200A	FOUNDATION PLAN - HABITAT 1
S-200B	FOUNDATION PLAN - HABITAT 2
S-200C	FOUNDATION PLAN - SHORING
S-210	BOARDWALK & TREEHOUSE FRAMING PLANS - HABITAT 1
S-220	TRELLIS FRAMING PLANS
S-230	RESEARCH CENTRE FRAMING PLANS - HABITAT 1
S-240	DAYROOM FRAMING PLANS
S-250	PARTIAL FLOOR FRAMING PLAN - HABITAT 2
S-300	SCHEDULES
S-700	FOUNDATION SHORING SECTION & DETAILS
S-800	SECTION AND DETAILS
S-810	BOARDWALK & TREEHOUSE SECTIONS & DETAILS - HABITAT 1
S-820	TRELLIS SECTIONS & DETAILS
S-830	RESEARCH CENTRE SECTIONS & DETAILS - HABITAT 1
S-831	RESEARCH CENTRE SECTIONS & DETAILS- HABITAT 1
S-832	RESEARCH CENTRE SECTIONS & DETAILS - HABITAT 1
S-840	DAYROOM SECTIONS & DETAILS
S-841	DAYROOM SECTIONS & DETAILS
S-850	SECTIONS & DETAILS - HABITAT 2
S-851	SECTIONS & DETAILS - HABITAT 2
S-852	SECTIONS & DETAILS - HABITAT 2

MECHANICAL

MA-100	MECHANICAL SYMBOLS AND DRAWING LIST
MA-101	MECHANICAL SCHEDULES - HABITAT 1 NEW WORK PLAN
MP-101	PLUMBING - HABITAT 1 - NEW WORK PLAN
MP-102	PLUMBING - HABITAT 1 - ENLARGED NEW WORK PLAN

MP-103	PLUMBING - HABITAT 1 - ENLARGED NEW WORK PLAN
MV-101	HVAC - HABITAT 1 - ENLARGED NEW WORK PLAN
MX-100	MECHANICAL DETAILS

ELECTRICAL

EA-100	ELECTRICAL SYMBOLS AND DRAWING LIST
EP-101	POWER AND SYSTEMS - HABITAT 1 - NEW WORK
EP-102	"POWER AND SYSTEMS RESEARCH STATION ENLARGED NEW WORK PLAN"
EP-103	"ELECTRICAL POWER AND SYSTEMS – BOARDWALK NEW WORK"
EP-104	"ELECTRICAL POWER AND SYSTEMS - PATHWAY NEW WORK"
EP-105	"LIGHTING RESEARCH STATION ENLARGE NEW WORK PLAN"
EP-107	POWER AND SYSTEMS - HABITAT 2 - NEW WORK
EX-101	ELECTRICAL SCHEDULE AND DETAILS
EX-102	ELECTRICAL DETAILS

CIVIL

CV-001	EROSION AND SEDIMENT CONTROL PLAN
CV-002	SERVICING PLAN
CV-003	GRADING PLAN
CV-004	DETAIL AND NOTES PLAN

LANDSCAPE

LA1	LAYOUTS & MATERIALS PLAN - HABITAT 1
LA1.1	PLAZA LAYOUTS & MATERIALS PLAN - HABITAT 1
LA1.2	PLANTING PLAN - HABITAT 1 - TREES & GROUNDCOVERS
LA1.3	PLANTING PLAN - HABITAT 1 - SHRUBS
LA1.4	PLANTING LIST - HABITAT 1
LA1.5	IRRIGATION PLAN - HABITAT 1
LA1.6	IRRIGATION DETAILS - HABITAT 1
LA3	LANDSCAPE DETAILS
LA4	LANDSCAPE DETAILS
LA5	LANDSCAPE DETAILS

GENERATOR DRAWINGS

COVER SHEET	
E-1	LEGENDS AND SITE PLAN
E-2	SINGLE LINE DIAGRAM – DEMOLITION AND NEW
E-3	ELECTRICAL ROOM LAYOUT
E-4	GENERATOR ENCLOSURE LAYOUT
E-5	DETAILS
E-6	PHOTOS
E-7	CUSTOM 2000A SPLITTER ‘SPL’
S1.0	GENERAL NOTES, GRADING PLAN, SLAB PLAN, SECTIONS AND DETAILS

PART 3 – DRAWINGS AND SPECIFICATIONS

RFT No. TZC T 57-2019-12

SPECIFICATIONS

- TORONTO ZOO ORANGUTAN EXHIBITS SPECIFICATIONS
- GENERATOR REPLACEMENT INDO-MALAYA PAVILION SPECIFICATIONS

CLIENT

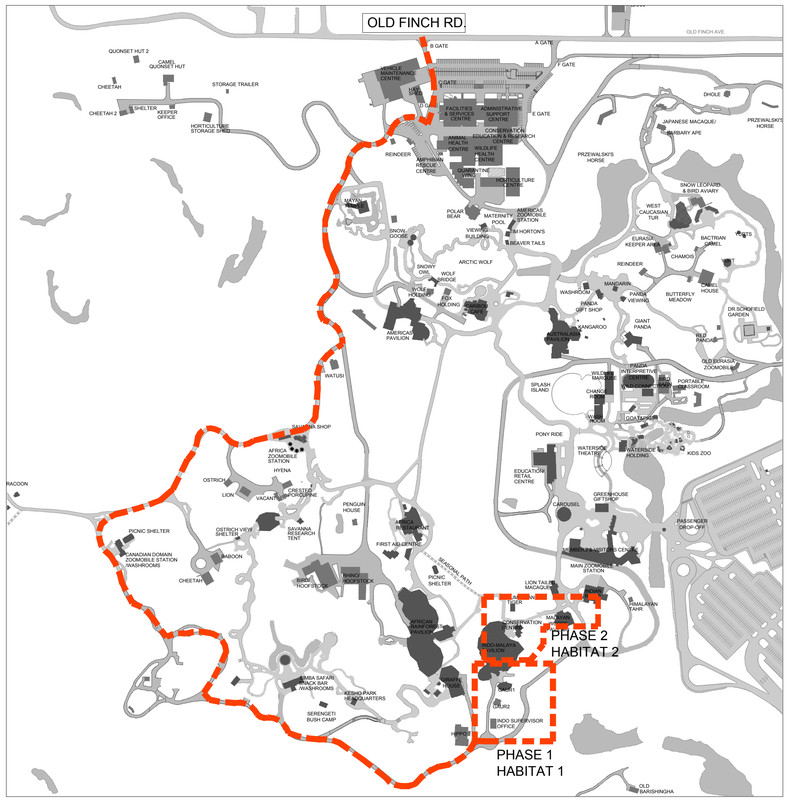
TORONTO ZOO

361A Old Finch Ave,
Toronto ON M1B 5K7

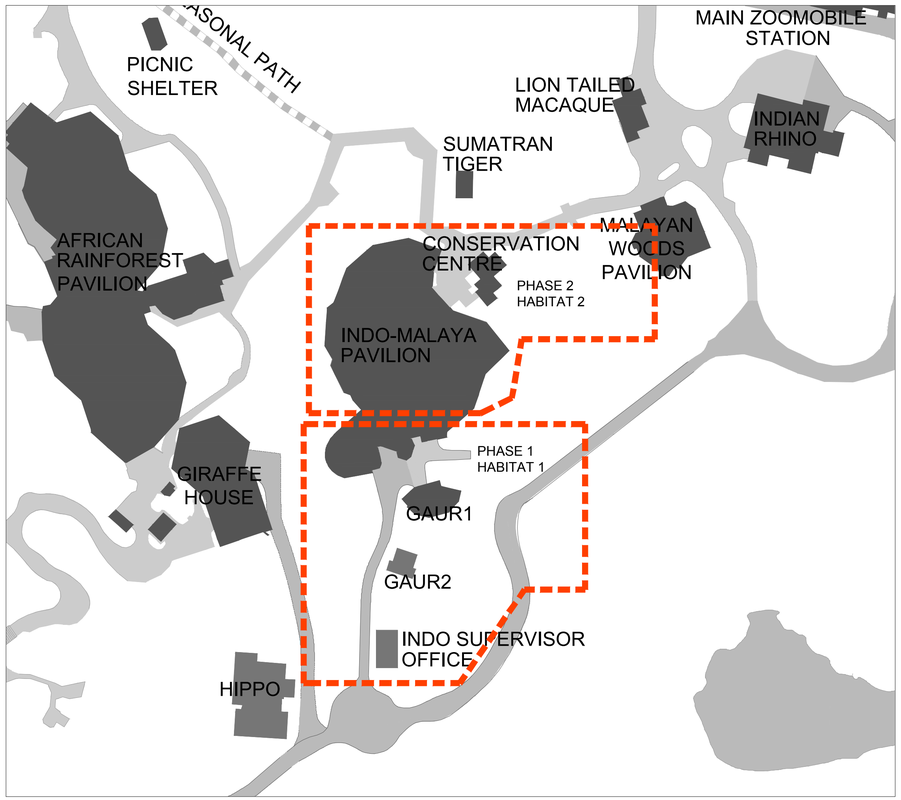
ISSUED FOR TENDER

DATE ISSUED : DECEMBER 11, 2019

LOCATION PLAN



KEY PLAN - HABITAT 1 & 2



CONSULTANTS

ARCHITECTS
ZEIDLER PARTNERSHIP ARCHITECTS
315 QUEEN STREET WEST
TORONTO, ONTARIO M5V 2X2
T:416 596-8300 F: 416 596-1408

STRUCTURAL
READ JONES CHRISTOFFERSEN LTD.
100 UNIVERSITY AVENUE
TORONTO, ONTARIO M5H4HZ
T:416 977-5335

MECHANICAL AND ELECTRICAL
QUASAR CONSULTING GROUP
250 ROWNTREE DAIRY RD.
WOODBRIDGE, ONTARIO L4L 9J7
T:905 507-0081 F:905 507-0081

CIVIL ENGINEER
MGM CONSULTING INC.
400 BRONTE STREET SOUTH
MILTON, ONTARIO L9T 0H7
T:905 567-8678 F:905 875-1339

LANDSCAPE ARCHITECT
NAK DESIGN STRATEGIES
421 RONCESVALLES AVENUE
TORONTO, ONTARIO M6R 2N1
T:416 340-8700 F:416 340-7100

GEOTECHNICAL CONSULTANTS
SOIL ENGINEERS LTD.
100 NUGGET AVENUE
TORONTO, ONTARIO M1S 3A7
T:416 754-8515 F:416 754-8516

DESIGN CONSULTANTS
JONES AND JONES
ARCHITECTS AND LANDSCAPE ARCHITECTS LTD.
105 SOUTH MAIN STREET, SUITE 300
SEATTLE, WASHINGTON
USA, 98104
T:206 624-5702 F:206 624-5923

GENERAL INFORMATION

MUNICIPAL ADDRESS: 361A Old Finch Ave, Toronto ON M1B 5K7 · 416-392-5929

TOTAL SITE AREA OF RENOVATION: 4,351 M2
TOTAL FLOOR AREA OF RENOVATION: 109 M2
BUILDING CODE REFERENCE: O.B.C. 2012

BUILDING CODE SUMMARY

OCCUPANCY TYPE: GROUP X DIVISION XX
NUMBER OF STOREYS: 1

SPRINKLERED: N/A
FIRE HOSE CABINETS: N/A

DRAWING INDEX

Architectural Drawing List

DWG. # GENERAL

- AR-000 COVER PAGE-OVERALL KEY PLAN
- AR-001 ABBREVIATIONS, GENERAL NOTES, LEGENDS & WALL TYPES, RM FINISHES SCHEDULE
- AR-002 SCHEDULES : DOOR, WINDOW
- AR-002A SCHEDULES : DOOR
- AR-003 SITE SURVEY- HABITAT 1
- AR-004 SITE SURVEY- HABITAT 2
- AR-005 SETTING OUT PLAN FOR STRUCT.
- AR-006 SETTING OUT PLAN FOR POLES
- AR-007 SETTING OUT PLAN FOR CASSION LAGGING
- AR-010 VIEWING GLASS DETAILS
- AR-010A ORANGUTAN DOOR DETAILS
- AR-011 CAGING DETAILS
- AR-012 CAGING DETAILS

DWG. # HABITAT 1

- AR-100 DEMOLITION PLAN
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- AR-150 BOARDWALK PLANS
- AR-151 BOARDWALK SECTIONS & ELEVATIONS
- AR-152 BOARDWALK DETAILS
- AR-180 DETAILED SECTIONS

DWG. # HABITAT 2

- AR-200 LAYOUT AND MATERIAL PLAN
- AR-201 PAVILION PLAN
- AR-202 SITE SECTIONS
- AR-205 CHUTES
- AR-206 SECTIONAL DETAILS
- AR-210 CHUTES DETAILS
- AR-211 CLIMBING POLES DETAILS

NO.	REV.	ISSUED FOR	DATE
1		PERMIT	2019-11-14
2		TENDER REVIEW	2019-12-06
3		TENDER	2019-12-11

*LOCAL COORDINATES SHOWN IN THIS DRAWING ARE +39.49 TO ACHIEVE GEODETIC COORDINATES

NORTH

ARCHITECT'S STAMP

CONTRACTOR SHALL CHECK ALL DIMENSIONS ON THE WORK AND REPORT ANY DISCREPANCY TO THE CONSULTANT BEFORE PROCEEDING. THIS DRAWING IS NOT TO BE USED FOR CONSTRUCTION UNTIL AUTHORIZED IN WRITING BY CONSULTANT.

JONES JONES
ARCHITECTS AND LANDSCAPE ARCHITECTS, LTD.
105 SOUTH MAIN STREET
SUITE 300
SEATTLE, WASHINGTON
USA 98104
TEL 206.624.5702
FAX 206.624.5923
WWW.JONESANDJONES.COM

zeidler
Zeidler Architecture Inc.
315 Queen St. West, Suite 200
Toronto, Ontario, Canada M5V 2X2
t 416.596.8300 f 416.5596-1408

CLIENT: **TORONTO ZOO**

toronto zoo
361A Old Finch Ave, Toronto, ON M1B 5K7 · 416-392-5929

PROJECT:
ORANGUTAN EXHIBITS

DRAWING NAME :

COVER PAGE
& OVERALL KEY PLAN

PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	LL	LC

SCALE:
AS NOTED
DECEMBER 11,2019

DRAWING NUMBER:

AR-000

ABBREVIATION LEGEND

ACT	ACOUSTIC TILE
AC	ACOUSTIC
AD	AREA DRAIN
ADO	AUTOMATIC DOOR OPENER
AESS	ARCHITECTURAL EXPOSED STRUCTURAL STEEL
AJ	ACOUSTIC JOINT
ALUMN	ALUMINUM
AN	AS NOTED
ANOD	ANODIZED
AP	ACESS PANEL
APPROX	APPROXIMATELY
ARCH	ARCHITECTURAL
AFF	ABOVE FINISHED FLOOR
A/V	AIR / VAPOUR BARRIER
@	AT
BCT	BABY CHANGING STATION
BLK	BLOCK
BLDG	BUILDING
BM	BENCH MARK
BTWN	BETWEEN
BW	BOTTOM OF WALL
CAR	CARPET
CB	CATCH BASIN or CONCRETE BLOCK
CF	CUBIC FEET
CG	CORNER GUARD
℄	CENTRE LINE
CL OPG	CLEAR OPENING
CM	CENTIMETRE
COL	COLUMN
CONC	CONCRETE
CONC BLK	CONCRETE BLOCK
CONSTR	CONSTRUCTION
CONT	CONTINUOUS
CJ	CONTROL JOINT
CMU	CONCRETE MASONRY UNIT
CNR	CORNER
CORR	CORRIDOR
C.T.C.	CENTER TO CENTER
CT	CERAMIC TILE
CY	CUBIC YARD
C/W	COMPLETE WITH

DET	DETAIL
DF	DRINKING FOUNTAIN
DIA	DIAMETER
DIAG	DIAGRAM, DIAGONAL
DIM	DIMENSION
DIV	DIVISION
DN	DOWN
DTP	DISPENSER OF TOILET PAPER
DO	DITTO
DND	DISPENSER OF PAPER
DWG	DRAWING
E, EL	ELEVATION
ELEC	ELECTRICAL
ELEV	ELEVATOR, ELEVATION
ENCL	ENCLOSURE
EOS	EDGE OF SLAB
EP	ELECTRICAL PANEL
EQ	EQUAL
EQUIP	EQUIPMENT
ES	EMERGENCY SHOWER
EXIST.	EXISTING
EXP	EXPOSED
EXJ	EXPANSION JOINT
EXT	EXTERIOR
EXTN	EXTENSION
EW	EYE WASH
FA	FRESH AIR, FIRE ALARM
FCP	FABRIC COVERED PANEL
FD	FLOOR DRAIN
FDN	FOUNDATION
FDV	FIRE DEPARTMENT VALVE
FE	FIRE EXTINGUISHER
FHC	FIRE HOSE CABINET
FHR	FIRE HOSE RACK
FIN	FINISH (ED)
FL	FLOOR or PLYWOOD FORM LINE
FLEX	FLEXIBLE
FLUOR	FLUORESCENT
FRP	FIBERGLASS REINFORCED PLASTIC
FT	FOOT
FOF	FACE OF FRAME
FTG	FOOTING

GA	GAUGE
GAL	GALLON
GALV	GALVANIZED
GALV ST	GALVANIZED STEEL
GB	GRAB BAR
GC	GENERAL CONTRACTOR
GL	GLASS
GR	GROUND, GRADE
GT	GRANITE
GWB	GYPSUM WALLBOARD
GWG	GEORGIAN WIRED GLASS
HC	HANDICAPPED
HEX	HEXAGONAL
HKP'G	HOUSEKEEPING
HM	HOLLOW METAL
HOR	HORIZONTAL
H.P.	HIGH POINT
HSS	HOLLOW STEEL SECTION
HT	HEIGHT, HIGH
ID	INTERIOR DIAMETER
INCAND	INCANDESCENT
INS	INSULATION, INSULATED
INS GL	INSULATED GLASS
INT	INTERIOR
JAN CL	JANITOR'S CLOSET
JT	JOINT
L	LENGTH, LONG, ANGLE
LAB	LABORATORY
LAM	LAMINATED
LAV	LAVATORY
LB	POUND
LH	LEFT HAND
LIN	LINEAR
LP	LIGHTING PANEL, LOW PRESSURE
L.P.	LOW POINT
LSSJ	LONG SPAN STEEL JOIST
MAT	MATERIAL
MAX	MAXIMUM
MECH	MECHANICAL
MH	MANHOLE
MIN	MINIMUM
MISC	MISCELLANEOUS
M.O.	MASONRY OPENING
MOD	MODULE, MODULAR
MP	METAL PANEL
M2	METRE SQUARED
MT	METAL

ND	NAPKIN DISPOSAL
NIC	NOT IN CONTRACT
N℺	NUMBER
NTS	NOT TO SCALE
NV	NAPKIN VENDOR
O/C	ON CENTRE
OD	OUTSIDE DIAMETER
OH	OVERHEAD
OPP	OPPOSITE
O.T.O	OUT TO OUT
OWSJ	OPEN WEB STEEL JOIST
PA	PUBLIC ADDRESS SYSTEM
PART'N	PARTITION
PB	PUSH BUTTON, PANEL BOARD
PC	PRECAST CONCRETE
PD	PLANTER DRAIN
PLAS	PLASTER (ED), PLATE
PL	PLASTIC LAMINATE
PLYWD	PLYWOOD
POL	POLISHED
POLYC	POLYCARBONATE
PP	POWER PANEL
PR	PAIR, PLUMBING RISER
PREFAB	PREFABRICATED
PS	PRESSED STEEL
PT	PAINT (ED)
PTD	PAPER TOWEL DISPENSER
PVC	POLYVINYL CHLORIDE
QTY	QUANTITY
R	RISER, RADIUS
R/A	RETURN AIR
RAD	RADIUS, RADIATOR
RB	RUBBER BASE
RBR	RUBBER
RC	REINFORCED CONCRETE
RD	ROOF DRAIN, ROUND
REF	REFERENCE DIMENSIONS
REINF	REINFORCED, REINFORCING
REQ'D	REQUIRED
REV	REVERSE
RH	RIGHT HAND
R INSUL	RIGID INSULATION
RM	ROOM
R.O.	ROUGH OPENING
RSF	RESILIENT SHEET FLOORING
RV	REVEAL
RWL	RAIN WATER LEADER

S	SINK
S/A	SUPPLY AIR
SC	SEALED CONC.
SD	SCUPPER DRAIN
SH	SHOWER COMPARTMENT
SJT	SILICONE JOINT
SLL	SOUND&LIGHT LOCK
SPEC	SPECIFICATION
SQ	SQUARE
SQ FT	SQUARE FOOT
SQ YD	SQUARE YARD
SSTL	STAINLESS STEEL
STL	STEEL
SIM	SIMILAR
STOR	STORAGE
STR	STRUCTURE
STRUCT	STRUCTURE, STRUCTURAL
SUSP	SUSPENDED, SUSPENSION
SW	SWITCH
T	TREAD
TB	TOWEL BAR : TB-18 (457MM WIDE) : TB-24 (600MM WIDE)
TC	TOP OF CURB
TD	TOWEL DISPENSER
TEL	TELEPHONE
THK	THICK, THICKNESS
T&G	TONGUE & GROOVE
TPH	TOILET PAPER HOLDER
TS	TUBE STEEL SECTION
TV	TELEVISION, TRAVERTINE
TW	TOP OF WALL
TYP	TYPICAL
TZ	TERRAZZO
T.O.B.	TOP OF BEAM
ULC	UNDERWRITERS LABORATORIES OF CAN.
U/S	UNDERSIDE
V	VOLT
VB	VAPOUR BARRIER
VIF	VERIFY IN FIELD
VRT	VINYL REINFORCED TILE
VERT	VERTICAL
VEST	VESTIBULE
VP	VAPOR BARRIER
VW	VINYL WALL COVERING
W	WIDE, WIDTH, WATT, WITH
WC	WASHROOM
WC	WALLCOVERING
WD	WOOD
WDS	WOOD STAIN COLOUR
WP	WORKING POINT, WATERPROOFING
WPF'G	WATERPROOFING
WWM	WOVEN WIRE MESH
W/	WITH
WRT	WITH RESPECT TO
YD	YARD

NOTE: SEE SPECIFICATION DOCUMENT FOR LEGEND OF FINISHES ABBREVIATION.

MATERIALS AND FINISHES LEGEND

SYMBOL	DESCRIPTION	MANUFAC11TURER / DISTRIBUTOR	REMARKS / LOCATION
ACOUSTICAL TILE CEILING			
ACT	ARMSTRONG FINISH: WHITE SEE SPECS		OFFICE
LINOLEUM			
LINO	-- FINISH: -- SEE SPECS		OFFICE
METAL			
MT1	STAINLESS STEEL TYPE: 316 XL-BLEND S FINISH: BRUSHED SEE SPECS		HANDRAIL, DOOR HARDWARE
MT2	STEEL COLOR: -- FINISH: --SEE SPECS		---
PAINT			
PT1	SHERWIN WILLIAMS COLOR: SNOWBOUND SW 7004 FINISH: FLAT INTERIOR GRADE PAINT, SEE SPECS		INTERIOR DRYWALL
PT2	SHERWIN WILLIAMS COLOR: DARK BROWN FINISH: SEMI-GLOSS EXTERIOR GRADE PAINT, SEE SPECS		HM DOORS & FRAMES
PT3	COMPANY COLOR: DARK BROWN FINISH: EPOXY PAINT FOR STEEL, SEE SPECS		STEEL WINDOW & DOOR FRAME
PT4	SHERWIN WILLIAMS COLOR: DARK BROWN FINISH: -- EXTERIOR GRADE PAINT, SEE SPECS		WIRE MESH WALL, CEILING & FRAME
PT5	SHERWIN WILLIAMS COLOR: BLACK FINISH: EXTERIOR GRADE PAINT, SEE SPECS		GUARDRAIL STEEL POST
PT6	SHERWIN WILLIAMS COLOR TO MATCH WD-STAIN FINISH: EXTERIOR GRADE PAINT, SEE SPECS		STRUCTURAL STEEL COLUMNS & BEAMS
PT10	SHERWIN WILLIAMS COLOR: BEIGE FINISH: - EPOXY COATING, SEE SPECS		ORANGUTAN ROOM & RESEARCH ROOM INTERIOR
WOOD STAIN			
WD-STAIN	MANUFACTURER COLOR: -- FINISH: -- SEE SPECS		ALL EXPOSED WOOD CEILING JOIST, BEAM, COLUMN, POST, SIDING ETC.

GENERAL NOTES:
ALL EXPOSED CONCRETE TO BE ARCHITECTURAL CONCRETE
FINISH: COLOUR: INTERSTAR CHAPS (BN2520R) TO MATCH
LAZA CONCRETE PAVER

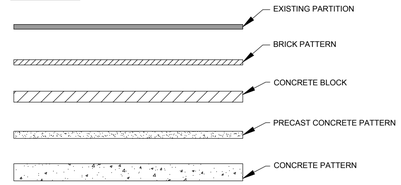
Room Schedule - HABITAT 1

AREA NAME	Room Number	Room Name	Floor Material	Floor Finish	Wall Material	Wall Finish	Wall Base Finish	Ceiling Material	Ceiling Finish	Remarks
HABITAT 1 (PHASE 1)										
GLASS VIEWING AREA 1	100	GLASS VIEWING AREA 1	CONC	SEE LANDSCAPE	CONC	SC	SC	WOOD/STEEL WOOD SLAT	STAIN / PT STAIN	ALL EXPOSED CONCRETE TO BE COLOURED ARCHITECTURAL CONCRETE FINISH
RESEARCH STATION BUILDING	101	OFFICE	CONC	LINOLEUM	CB/GB	PT-1	RB	ACT	-	
	102	ORANGUTAN ROOM	CONC	EPOXY	CONC	EPOXY / SC	EPOXY	WOOD / METAL MESH - SEE RCP	STAIN / PT	ALL EXPOSED CONCRETE TO BE COLOURED ARCHITECTURAL CONCRETE FINISH
	103	RESEARCH ROOM	CONC	EPOXY	CONC	EPOXY / SC	EPOXY	EXPOSED WOOD	STAIN	ALL EXPOSED CONCRETE TO BE COLOURED ARCHITECTURAL CONCRETE FINISH
	104	SERVICE ACCESS	CONC	SC	CONC / MESH/STEEL	SC / PT	CONC BASE	MESH	PT	
DAYROOM	105	DAYROOM	CONC	SC	CONC / STEEL / MESH	SC/ PT	PT	MESH	PT	PAINT - SEE SPECS; RESTORE BUILDING CLADDING AT EXIST. PAVILION FACADE AROUND NEW ORANG DOOR.
	106	OUTDOOR CORRIDOR	CONC	SC	CONC /STEEL/ MESH	SC /PT	PT	MESH	PT	ALL EXPOSED CONCRETE TO BE COLOURED ARCHITECTURAL CONCRETE FINISH.
	107	ACCESS TOWER	CONC	SC	STEEL/ MESH	PT	PT	MESH	PT	
	108	VESTIBULE	CONC	SC	CONC /STEEL/ MESH	SC /PT	PT	MESH	PT	
TRELLIS GLASS VIEWING	---	GLASS VIEWING	CONC	SEE LANDSCAPE	CONC / STEEL	SC / PT	SC / PT	WOOD/STEEL	STAIN / PT	ALL EXPOSED CONCRETE TO BE COLOURED ARCHITECTURAL CONCRETE FINISH
TREE HOUSE	---	BOARDWALK LEVEL	CONC	SEE LANDSCAPE	WOOD/STEEL	STAIN / PT	STAIN / PT	WOOD/STEEL	STAIN / PT	ALL EXPOSED CONCRETE TO BE COLOURED ARCHITECTURAL CONCRETE FINISH
	---	UPPER LEVEL	CONC	SAME AS BOARDWALK	WOOD/STEEL	STAIN / PT	STAIN / PT	WOOD/STEEL	STAIN / PT	ALL EXPOSED CONCRETE TO BE COLOURED ARCHITECTURAL CONCRETE FINISH

ROOM FINISHES SCHEDULE - GENERAL NOTES

1. THE ROOM SCHEDULE IS TO BE READ IN CONJUNCTION WITH THE ARCHITECTURAL DRAWINGS AND SPECIFICATIONS
2. REFER TO ARCHITECTURAL DRAWING AR-001 FOR ABBREVIATIONS.
3. REFER TO PARTIAL PLANS & INDIVIDUAL LARGE SCALE PLANS FOR ROOM LAYOUTS AND DIMENSIONS.
4. REFER TO REFLECTED CEILING PLANS FOR FINISHED CEILING LAYOUTS, HEIGHTS AND MATERIALS.
5. REFER TO INTERIOR ELEVATIONS FOR LOCATION AND EXTENT OF WALL FINISHES
6. ALL INTERIOR EXPOSED COLUMN SHOULD HAVE ARCH. CONCRETE FINISH.
7. EXCEPT FOR NOTE 6, PREFINISHED SURFACES & SURFACES WITH SPRAYED FIREPROOFING, ALL EXPOSED BUILDING SURFACES SHALL BE PAINTED OR STAINED.
8. WALL MATERIALS AND FINISHES IN ROOM SCHEDULE EXCLUDES EXTERIOR GLAZED WALLS, WHERE APPLICABLE.
9. ALL WALLS TO BE PAINTED PT-1 UNLESS OTHERWISE NOTED.
10. ALL DOORS AND FRAMES TO BE PAINTED PT-2, UNLESS OTHERWISE NOTED.
11 ALL GLASS WINDOW FRAME TO BE EPOXY PAINT; COLOR: DARK BROWN PT-3

LEGEND



HIGH POINT + EL 200.000 — ELEVATION TARGET

2750 AFF — CEILING HEIGHT

ORANGUTAN ROOM 103 — ROOM NAME

PT2 — MATERIAL TAG

W1 — WALL TYPE

139.50 m LEVEL L1 — FLOOR ELEVATION

101 — DOOR NUMBER

WP1 — WORK POINT SYMBOL

W-1 — WINDOW NUMBER

EOS — EDGE OF SLAB

PARTITION TYPE

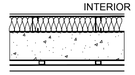
INTERIOR

EXTERIOR

NEW EXTERIOR WALL
WALL TYPE W2

CAST IN PLACE CONCRETE
VAPOUR BARRIER ON
RIGID INSULATION / GAP
VERTICAL WOOD SIDING

INTERIOR



EXTERIOR

NEW EXTERIOR WALL
WALL TYPE W3

16MM GYPSUM WALL BOARD
6MM POLY VAPOUR BARRIER ON
102 MM METAL STUDS @ 400MM O.C WITH
102 MM THERMAL INSULATION
15 LBS BUILDING PAPER ON
CAST IN PLACE CONCRETE
VERTICAL WOOD SIDING

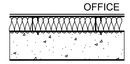
INTERIOR

EXTERIOR

NEW EXTERIOR WALL
WALL TYPE W4

EPOXY COATING OVERTOP
CAST IN PLACE CONCRETE
EXTERIOR GRADE PAINT
OR CONCRETE SEALER

OFFICE

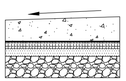


RESEARCH STATION/
ORANG ROOM

NEW INTERIOR WALL
WALL TYPE W5

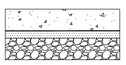
16MM GYPSUM WALL BOARD
6MM POLY VAPOUR BARRIER ON
102 MM METAL STUDS @ 400MM O.C WITH
102 MM THERMAL INSULATION ON
CAST IN PLACE CONCRETE
EPOXY COATING (SEE ROOM SCHEDULE)

FLOOR TYPE



FLOOR TYPE F1

CONCRETE SEALER OR EPOXY COATING (SEE FINISH SCHEDULE)
POURED CONCRETE SLAB
SLOPED TO DRAIN
15 mil. POLY ON
50mm RIGID INSULATION WHERE SLAB ON GRADE (SOG) IS ABOVE SURROUNDING GRADE.
50.8mm SAND BASE
152.4mm GRANULAR FILL
(SEE GEOTECH REPORT RECOMMENDATION)



FLOOR TYPE F2

CONCRETE SEALER
POURED CONCRETE SLAB
50.8mm SAND BASE
152.4mm GRANULAR FILL
(SEE GEOTECH REPORT RECOMMENDATION)

NO.	REV.	ISSUED FOR	DATE
1		PERMIT	2019-11-14
2		TENDER REVIEW	2019-12-06
3		TENDER	2019-12-11

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CLIENT: **TORONTO ZOO**

toronto zoo
361A Old Finch Ave, Toronto, ON M1B 5K7 · 416-392-5929

PROJECT:
ORANGUTAN EXHIBITS

DRAWING NAME :

ABBREVIATIONS, GENERAL NOTES, LEGENDS, WALL TYPES & ROOM FINISH SCHEDULE

PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	LL	LC

DRAWING NUMBER:

SCALE:
AS NOTED
DECEMBER 11,2019

AR-001

Door Schedule - HABITATS 1 & 2

DOOR NUMBER	ROOM NAME	ROOM NO.	DOOR SIZE Width	DOOR SIZE Height	DOOR THK	DOOR TYPE	DOOR MATL	DOOR FINISH	VISION TYPE	FRAME TYPE	FRAME MATL	FRAME FINISH	DETAIL REF.	HARDWARE GROUP	REMARKS
HABITAT 1: RESEARCH BUILDING															
101	OFFICE	101	915	2135	45	B	HM	PT	GL	1	PS	PT	-		EXTERIOR INSULATED DOOR
102	ORANGUTAN ROOM	102	915	2135	50	C	INS STEEL	GALV	LAM	2	STEEL	GALV	14/AR-012		-
102A1	ORANGUTAN ROOM	102	*865	*1070	50	J	MESH	GALV	-	-	STEEL	GALV	9/AR-010A		* SAME AS BELOW
102A2	ORANGUTAN ROOM	102	*865	*1070	50	K	POLYC	CLR FACTORY FINISH	-	-	STEEL	GALV	9/AR-010A		* MASONRY OPENING SIZE; PART OF DOUBLE DOOR SYSTEM. REMOTE DOOR OPERATOR @ 1200 FROM GRADE, SEE PLAN FOR LOCATION
102B	ORANGUTAN ROOM	102	*865	*1070	50	K	POLYC	CLR FACTORY FINISH	-	-	STEEL	GALV	10/AR-010A		* MASONRY OPENING SIZE; REMOTE DOOR OPERATOR @ 1200 FROM GRADE, SEE PLAN FOR LOCATION
102C	ORANGUTAN ROOM	102	2 X 915	2135	50	D	INS STEEL	GALV	LAM	2	STEEL	GALV	14/AR-012		-
103	RESEARCH ROOM	103	915	2135	45	B	HM	PT	GL	1	PS	PT	-		EXTERIOR INSULATED DOOR
104	SERVICE ACCESS	104	915	2135	50	E	MESH	GALV	-	-	STEEL	GALV	AR-011 & AR-012		MESH DOOR - SEE ELEVATION
104A	SERVICE ACCESS	104	915	2135	50	C1	STEEL	GALV	LAM	-	STEEL	GALV	AR-011 & AR-012		STEEL DOOR - SEE ELEVATION
HABITAT 1: DAYROOM															
105	DAYROOM	105	915	2135	50	E	MESH	GALV	-	-	STEEL	GALV	AR-011 & AR-012		MESH DOOR - SEE ELEVATION
105A1	DAYROOM	105	*865	*1070	50	J	MESH	GALV	-	-	STEEL	GALV	9/AR-010A		* SAME AS BELOW
105A2	DAYROOM	105	*865	*1070	50	K	POLYC	CLR FACTORY FINISH	-	-	STEEL	GALV	9/AR-010A		* MASONRY OPENING SIZE; PART OF DOUBLE DOOR SYSTEM. REMOTE DOOR OPERATOR @ 1200 FROM GRADE, SEE PLAN FOR LOCATION
105B	DAYROOM	105	*865	*1070	50	L	MESH	GALV	-	-	STEEL	GALV	SIM TO 7&8/AR-010A		* OPENING SIZE; REMOTE DOOR OPERATOR @ 1200 FROM GRADE, SEE PLAN FOR LOCATION
106	OUTDOOR CORRIDOR	106	915	2135	50	E	MESH	GALV	-	-	STEEL	GALV	AR-011 & AR-012		MESH DOOR - SEE ELEVATION
106A	OUTDOOR CORRIDOR	106	EXIST	EXIST	EXIST	A	EXIST	PT	-	EXIST	EXIST	PT	-		
107	ACCESS TOWER	107	*865	*1070	50	L	MESH	GALV	-	-	STEEL	GALV	SIM TO 7&8/AR-010A		* OPENING SIZE; REMOTE DOOR OPERATOR @ 1200 FROM GRADE, SEE PLAN FOR LOCATION
108	VESTIBULE	108	915	2135	50	E	MESH	GALV	-	-	STEEL	GALV	AR-011 & AR-012		MESH DOOR - SEE ELEVATION
HABITAT 2 (INSIDE INDO MALAYA PAVILION)															
200	INDOOR CHUTE ACCESS	200	*865	*1070	50	N	POLYC	CLR FACTORY FINISH	-	-	STEEL	GALV	SIM TO 7&8/AR-010A		* OPENING SIZE; REMOTE DOOR OPERATOR @ 1200 AFF, SEE PLAN FOR LOCATION
200A	INDOOR CHUTE ACCESS	200	*865	*1070	50	M	INS STEEL	GALV	-	-	STEEL	GALV	SIM TO 7&8/AR-010A		* OPENING SIZE; REMOTE DOOR OPERATOR @ 1200 FROM GRADE , SEE PLAN FOR LOCATION
HABITAT 2 OUTDOOR															
201	OUTDOOR DAYROOM	201	610	1200	50	G	MESH	GALV	-	-	STEEL	GALV	-		MESH DOOR FOR KEEPER - SEE ELEVATION
201A	OUTDOOR DAYROOM	201	*865	*1070	50	L	MESH	GALV	-	-	STEEL	GALV	SIM TO 7&8/AR-010A		* OPENING SIZE; REMOTE DOOR OPERATOR @ 1200 FROM GRADE, SEE PLAN FOR LOCATION

WINDOW SCHEDULE

WINDOW #	TYPE	WINDOW SIZE Width	WINDOW SIZE Height	GLAZING PLY	GLAZING NOTES	FRAME TYPE	FRAME MATL	FRAME FINISH	DETAIL REF.	NOT USED	HARDWARE GROUP	REMARKS
W-1	SINGLE	SEE PLAN	SEE ELEV	2	INSULATED GLASS UNIT	---	WD	PT	1/AR-124			WOOD SCREEN ON EXTERIOR SIDE
W-2	DOUBLE	SEE PLAN	SEE ELEV	2	INSULATED GLASS UNIT	---	WD	PT	1/AR-124			WOOD SCREEN ON EXTERIOR SIDE
W-3	QUADRUPLE	SEE PLAN	SEE ELEV	2	INSULATED GLASS UNIT	--	STEEL	GALV	-			MESH PROTECTION ON INTERIOR SIDE
W-4	MESH- TRAINING WALL	SEE PLAN	SEE ELEV			-	STEEL	GALV	SIM TO 3/AR-011			18"x18" MEDICAL PORT WITH COVER & LOCK
W-10	GLASS VIEWING AREA 1	SEE PLAN	SEE ELEV	LAMINATED	SEE SPECS 08 80 01	-	STEEL	GALV	1/AR-010			-
W-11	GLASS VIEWING AREA 1	SEE PLAN	SEE ELEV	LAMINATED	SEE SPECS 08 80 01	-	STEEL	GALV	6/AR-010			-
W-12	GLASS VIEWING AREA 1	SEE PLAN	SEE ELEV	LAMINATED	SEE SPECS 08 80 01	-	STEEL	GALV	6/AR-010			-
W-15	OUTDOOR TRAINING WALL	SEE PLAN	SEE ELEV	LAMINATED	SEE SPECS 08 80 01	-	STEEL	GALV	6/AR-010			-
W-16	GLASS VIEWING TRELLIS	SEE PLAN	SEE ELEV	LAMINATED	SEE SPECS 08 80 01	-	STEEL	GALV	1/AR-010			-

GENERAL NOTES FOR DOOR:

1 THE DOOR SCHEDULE IS TO BE READ IN CONJUNCTION WITH THE ARCHITECTURAL DRAWINGS AND SPECIFICATIONS.

2 REFER TO ARCHITECTURAL DRAWING AR-001 FOR ABBREVIATIONS.

3 REFER TO ARCHITECTURAL DRAWING AR-002 FOR DOOR AND FRAME TYPES.

4 REFER TO SPECIFICATIONS (SECTION 08 80 00) FOR GLAZING DESIGNATIONS DENOTED IN THE DOOR SCHEDULE.

5 REFER TO SPECIFICATIONS (SECTION 08 70 00) FOR HARDWARE GROUP DESIGNATIONS DENOTED IN THE DOOR SCHEDULE.

6 REFER TO DRAWINGS FOR REQUIRED DIRECTION OF DOOR SWINGS.

7 REFER TO DETAIL AND SPECIFICATIONS FOR ACOUSTIC GASKETS, ACOUSTIC DROP SEALS AND ACOUSTIC ASTRAGALS NOTED IN THE DOOR SCHEDULE.

8 PROVIDE UNDERCUTS FOR DOORS AS REQUIRED TO SUIT MECHANICAL REQUIREMENTS. REFER TO MECHANICAL DRAWINGS AND SPECIFICATIONS.

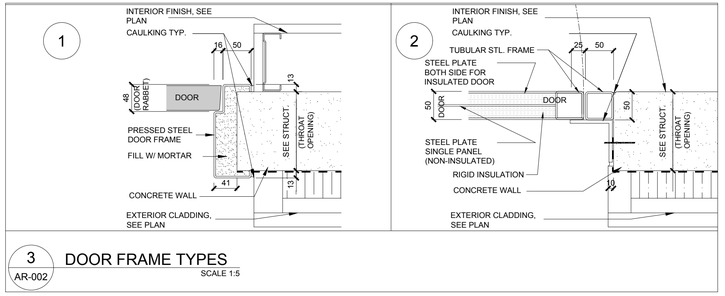
9 PROVIDE WEATHER-STRIPPING AND SEALS AT ALL EXTERIOR DOORS AND FRAMES AS REQUIRED. PROVIDE WEATHER-SEALED ALUMINUM THRESHOLDS AT ALL EXTERIOR DOORS. FOR DOORS WITH THRESHOLDS, DOOR SIZING TO ALLOW FOR THRESHOLD.

10 FOR SWINGING DOUBLE DOORS, PROVIDE DOUBLE SET OF HARDWARE.

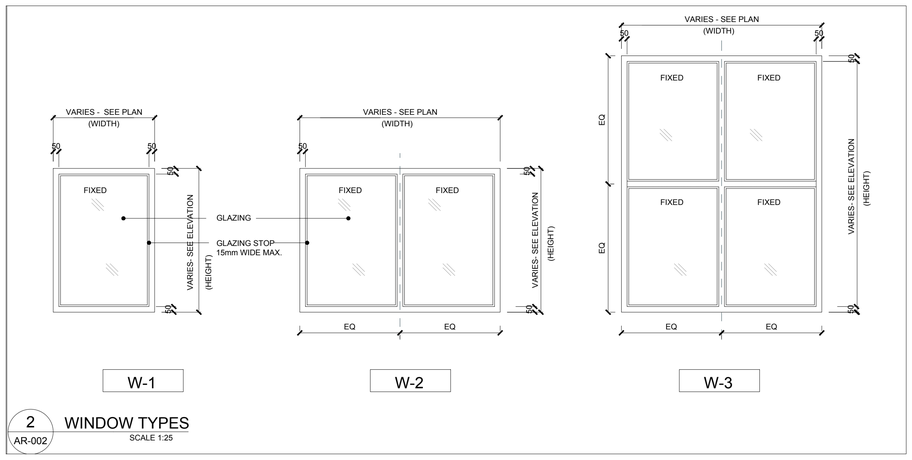
11 PREPARE DOORS AND FRAMES FOR ANY SECURITY REQUIREMENTS.

12 ALL MANUALLY CONTROLLED ANIMAL DOORS REQUIRE A BRAKE IN DOOR (NOT OPERATOR) THAT PREVENTS ORANGUTANS FROM BEING ABLE TO THROW DOOR OPEN DURING OPERATION.

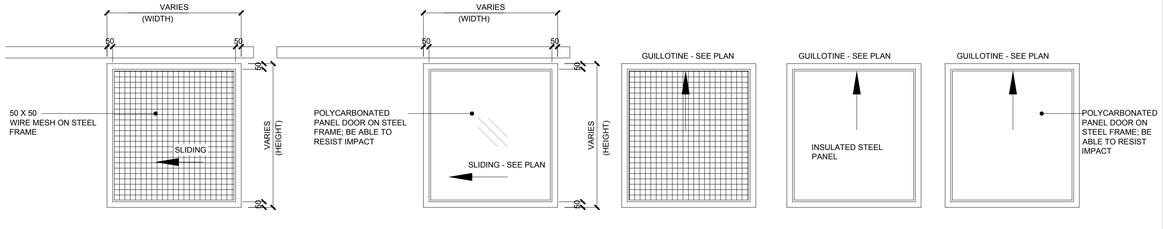
13. ALL MANUALLY CONTROLLED ANIMAL DOORS HAVE WHEEL WINCH CONTROL.

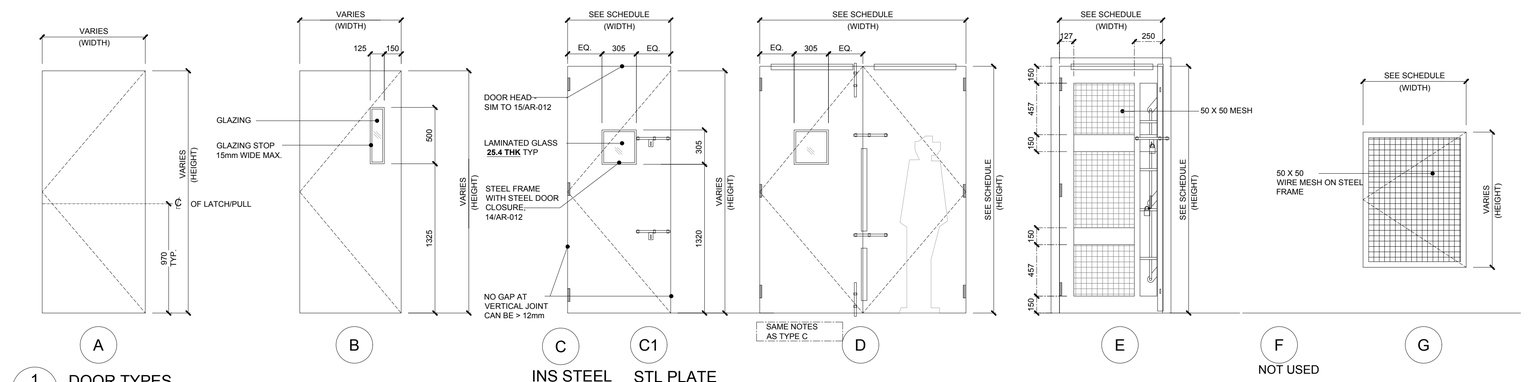


3 AR-002 DOOR FRAME TYPES
SCALE 1:5



2 AR-002 WINDOW TYPES
SCALE 1:25





1 AR-002 DOOR TYPES
SCALE 1:25

NO.	REV.	ISSUED FOR	DATE
1		PERMIT	2019-11-14
2		TENDER REVIEW	2019-12-06
3		TENDER	2019-12-11

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CLIENT: **TORONTO ZOO**

toronto zoo
361A Old Finch Ave, Toronto, ON M1B 5K7 · 416-392-5929

PROJECT:
ORANGUTAN EXHIBITS

DRAWING NAME :

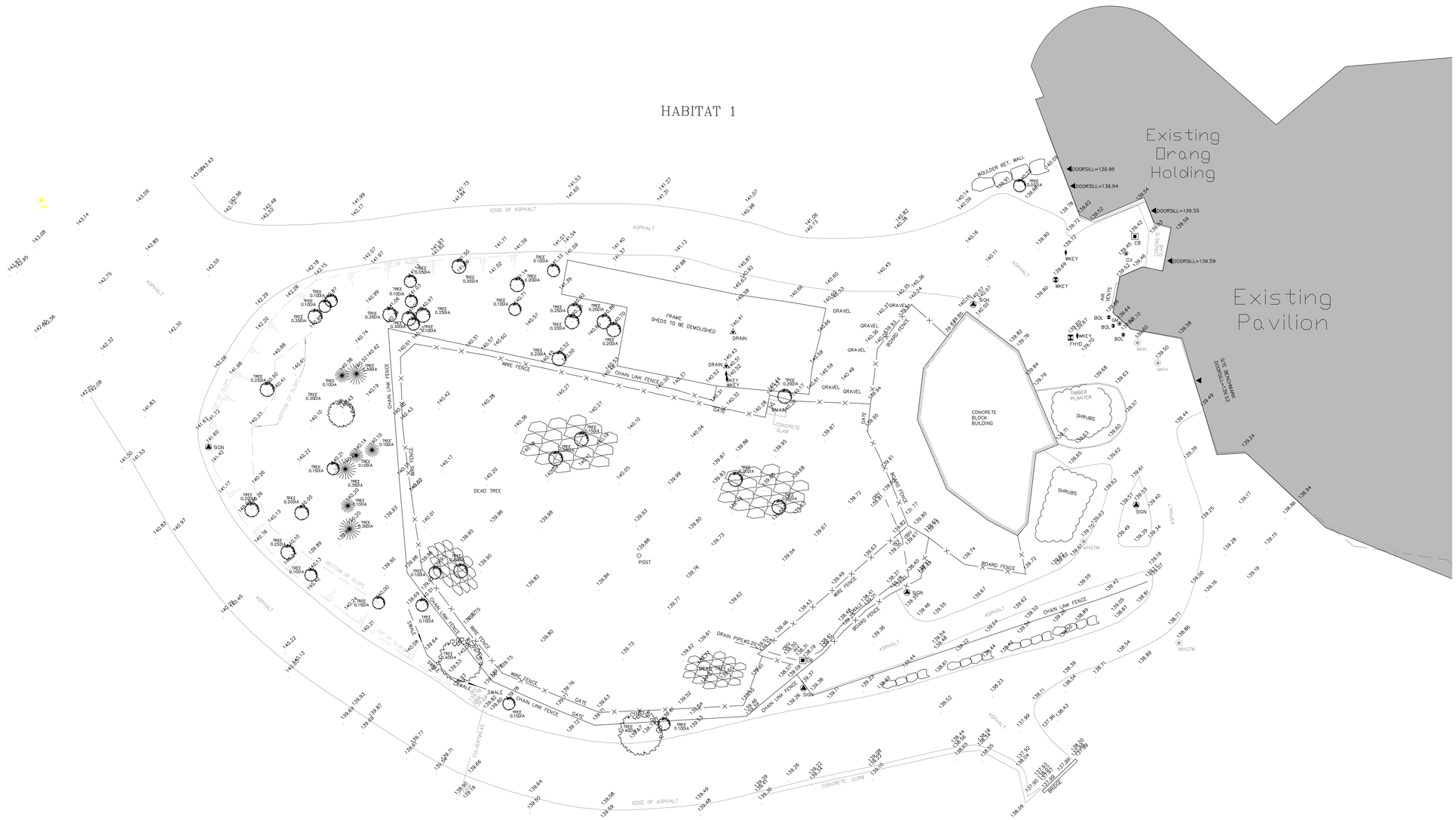
SCHEDULES:
DOOR & WINDOW

PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	LL	LC

SCALE:
AS NOTED
DECEMBER 11,2019

DRAWING NUMBER:
AR-002

HABITAT 1



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CLIENT: **TORONTO ZOO**

toronto zoo

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PROJECT:
ORANGUTAN EXHIBITS

DRAWING NAME :

HABITAT 1
SITE SURVEY

PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	LL	LC

DRAWING NUMBER:

SCALE:
AS NOTED
DECEMBER 11,2019

AR-003

SURVEYOR'S CERTIFICATE

I CERTIFIY THAT:
THE FIELDWORK WAS COMPLETED ON THE 31st DAY OF JULY, 2019

DATE: AUGUST 9, 2019

T. A. SENKUS
ONTARIO LAND SURVEYOR

HABITAT 1 COMPILED OCT. 27, 2016

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PHONE: (416) 237-1893
E-MAIL: tomsenkus@rogers.com
FILE:16-44
CAD FILE:ZOO-ADDITION

NOTES AND LEGEND

CB	DENOTES CATCH BASIN
WV	DENOTES WATER VALVE
FHYD	DENOTES FIRE HYDRANT
WKEY	DENOTES WATER KEY
LS	DENOTES LAMP STANDARD
MH	DENOTES MANHOLE
DIA	DENOTES DIAMETER
MHH	DENOTES MANHOLE (HYDRO)
MHSTM	DENOTES MANHOLE (STORM)
GV	DENOTES GAS VALVE
GM	DENOTES GAS MAIN
BOL	DENOTES BOLLARD
INV	DENOTES INVERT
OBV	DENOTES OBVERT
NL	DENOTES NAIL
BOT	DENOTES BOTTOM

ALL CURB ELEVATIONS ARE TAKEN TO THE BACK OF CURB

ELEVATION NOTE

ELEVATIONS ARE GEODETIC AND ARE REFERRED TO THE CITY OF TORONTO BENCHMARK 050053 HAVING A PUBLISHED ELEVATION OF 142.492 METRES.

PLAN SHOWING TOPOGRAPHIY
PART OF THE TORONTO ZOO
(ORANGUTAN EXHIBITS)

SCALE 1:200

0 5 10 15 metres

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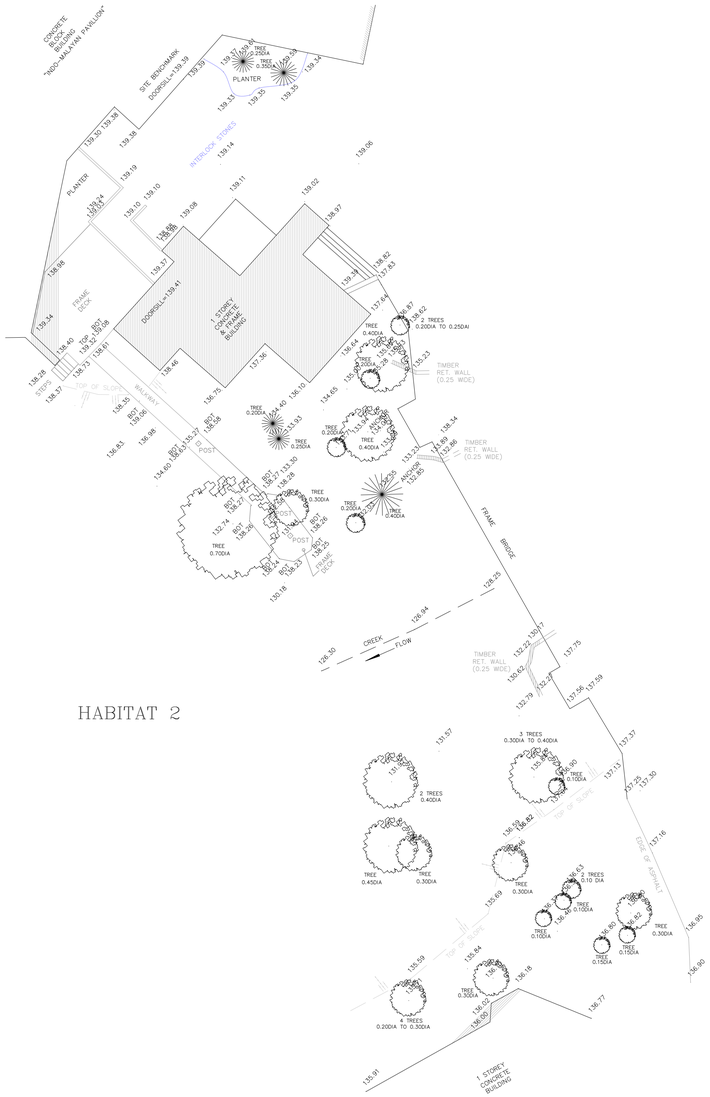
METRIC
DISTANCES SHOWN ON THIS PLAN ARE IN METRES AND CAN BE CONVERTED TO FEET BY DIVIDING BY 0.3048.



HABITAT 2

PLAN SHOWING TOPOGRAPHIY

PART OF THE TORONTO ZOO
(ORANGUTAN EXHIBITS)

SCALE 1:200

0 5 10 15 metres

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NO.	REV.	ISSUED FOR	DATE
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2		TENDER REVIEW	2019-12-06
3		TENDER	2019-12-11

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PROJECT:
ORANGUTAN EXHIBITS

DRAWING NAME :

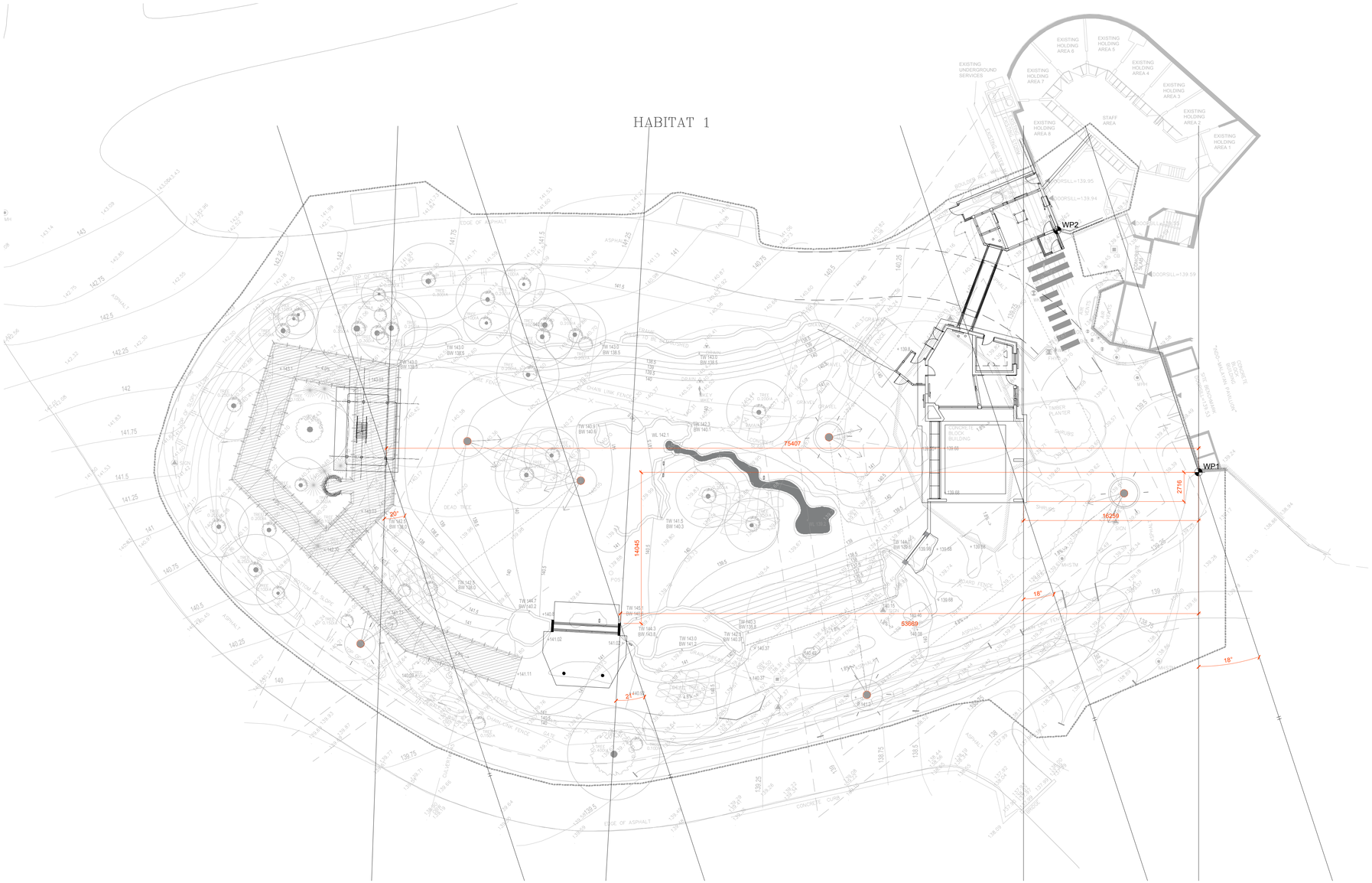
HABITAT 2
SITE SURVEY

PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	LL	LC

DRAWING NUMBER:

SCALE:
AS NOTED
DECEMBER 11,2019

AR-004



1 AR-005 HABITAT 1: SETTING OUT FOR STRUCTURE

SCALE - 1: 200

GENERAL NOTES:

1.FOR GRADING,
SEE CIVIL DWGS.

NO.	REV.	ISSUED FOR	DATE
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2		TENDER REVIEW	2019-12-06
3		TENDER	2019-12-11

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PROJECT:
ORANGUTAN EXHIBITS

DRAWING NAME :

HABITAT 1
SETTING OUT PLAN FOR STRUCT.

PROJECT NO.:	DRAWN BY :	CHECKED BY:
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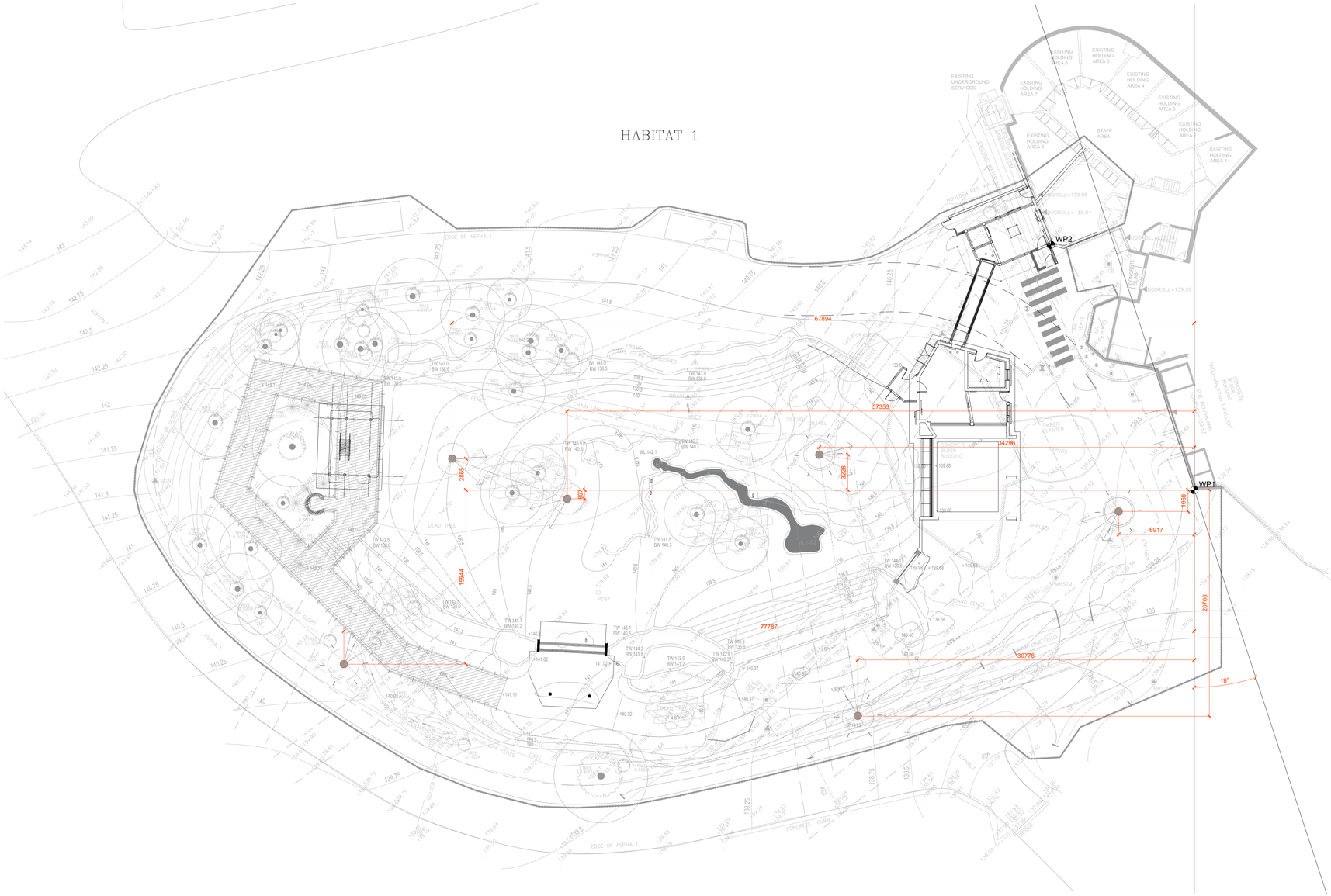
DRAWING NUMBER:

SCALE:
AS NOTED
DECEMBER 11,2019

AR-005



1 AR-006 HABITAT 1: SETTING OUT FOR POLES

SCALE - 1: 200

GENERAL NOTES:

1.FOR GRADING,
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PROJECT:
ORANGUTAN EXHIBITS

DRAWING NAME :

HABITAT 1
SETTING OUT PLAN FOR POLE

PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	LL	LC

DRAWING NUMBER:

SCALE:
AS NOTED
DECEMBER 11,2019

AR-006

1 AR-007 HABITAT 1: SETTING OUT PLAN FOR LAGGING & RETAINING WALL

SCALE - 1: 200

GENERAL NOTES:

1.FOR GRADING,
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1		PERMIT	2019-11-14
2		TENDER REVIEW	2019-12-06
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PROJECT:
ORANGUTAN EXHIBITS

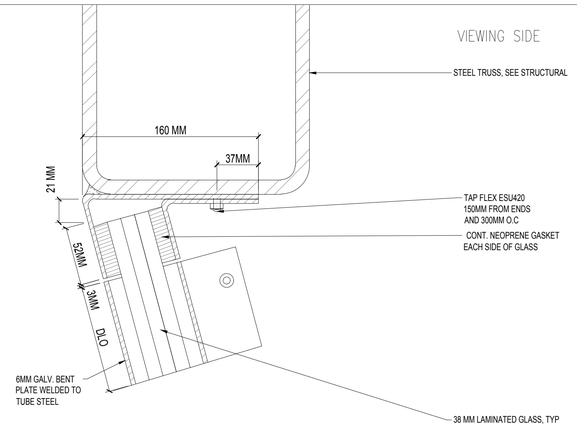
DRAWING NAME :

HABITAT 1
SETTING OUT PLAN FOR CAISSON LAGGING & RETAINING WALL

PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	LL	LC

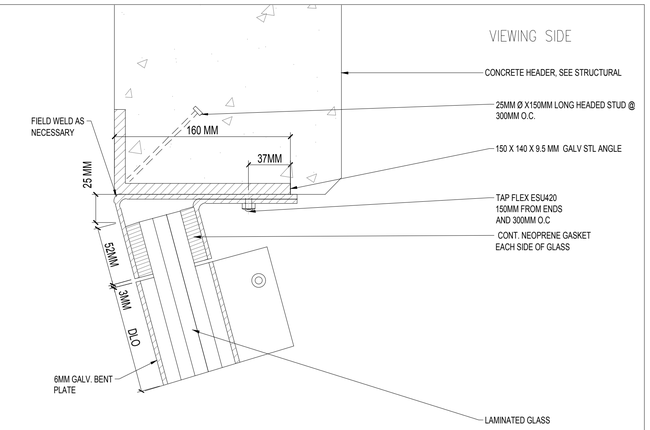
SCALE:
AS NOTED
DECEMBER 11,2019

DRAWING NUMBER:
AR-007



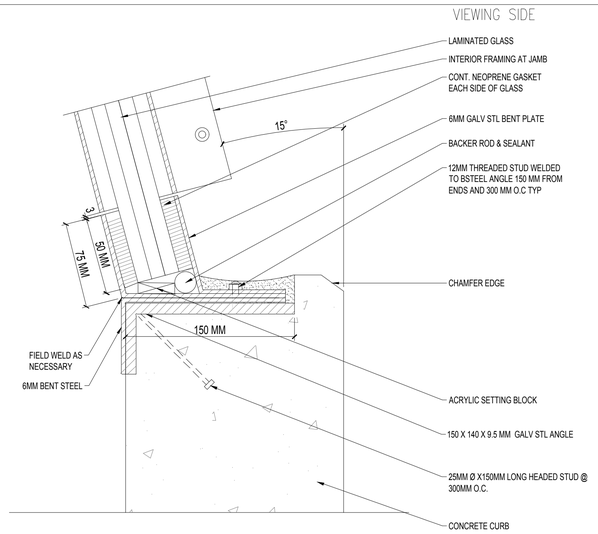
1 VIEWING GLASS HEAD

SCALE: 1:2.5



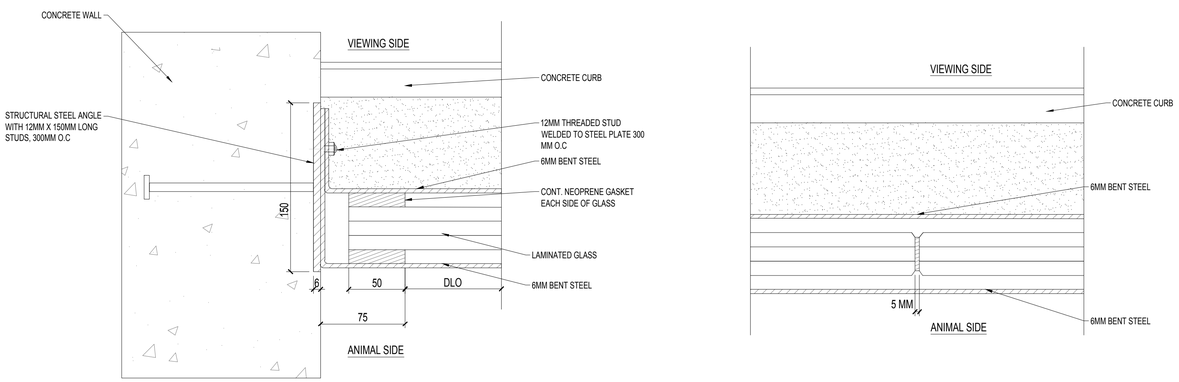
2 VIEWING GLASS @ CONCRETE HEAD

SCALE: 1:2.5



4 VIEWING GLASS SILL

SCALE: 1:2.5

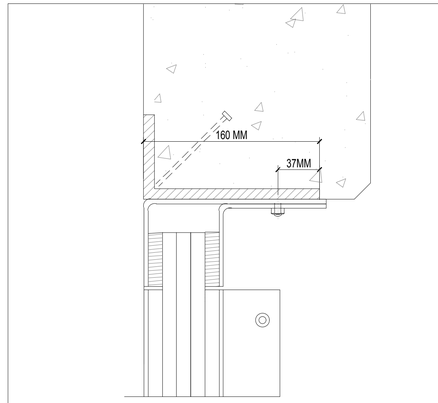


3 JAMB DETAIL

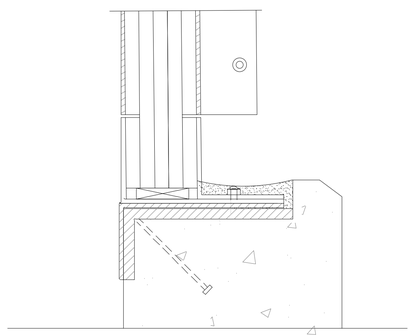
SCALE: 1:2.5

5 JOINT DETAIL

SCALE: 1:2.5



SEE NOTES ON DETAIL 2 & 4



6 VIEWING GLASS @ OUTDOOR TRAINING WALL

SCALE: 1:2.5

NO.	REV.	ISSUED FOR	DATE
1		PERMIT	2019-11-14
2		TENDER REVIEW	2019-12-06
3		TENDER	2019-12-11

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PROJECT:
ORANGUTAN EXHIBITS

DRAWING NAME :

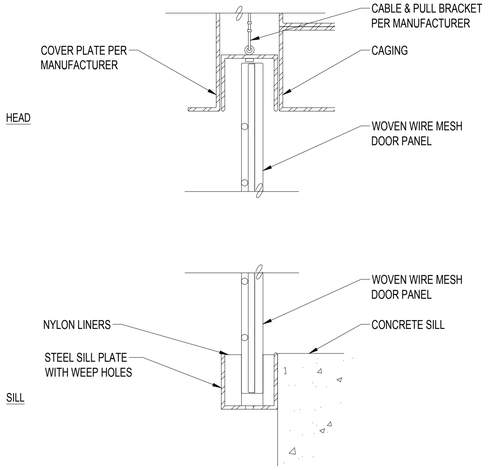
HABITAT 1
VIEWING GLASS DETAILS

PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	LL	LC

DRAWING NUMBER:

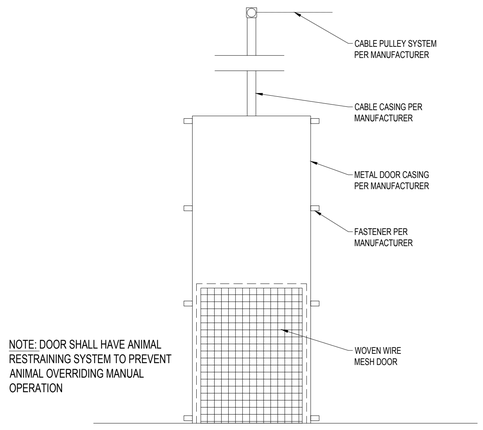
SCALE:
1 : 2.5
DECEMBER 11,2019

AR-010



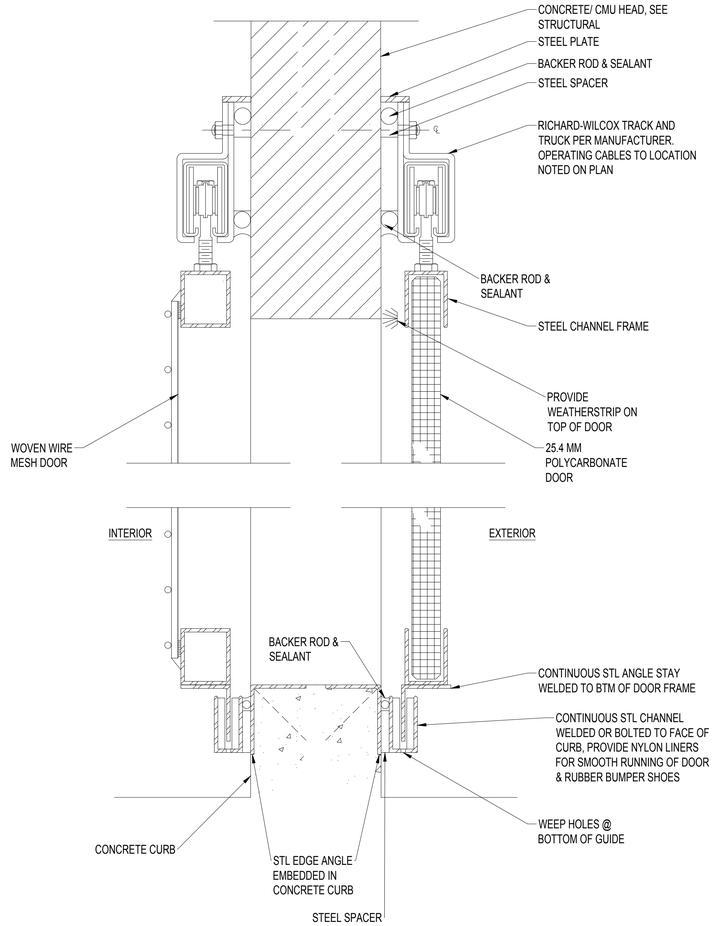
7 GUILLOTINE DOOR HEAD/ SILL

SCALE: 1:2.5



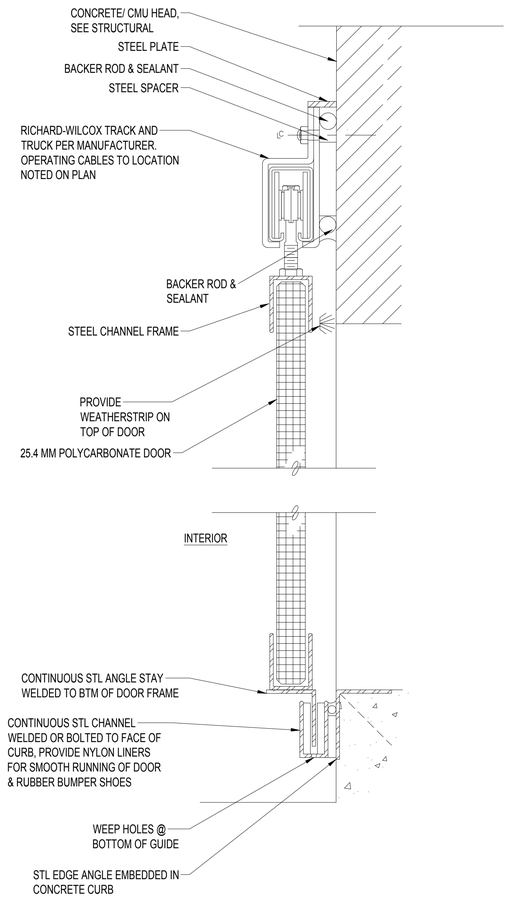
8 GUILLOTINE DOOR ELEVATION

SCALE: NTS



9 SLIDING DOOR HEAD/SILL

1: 2.5



10 SLIDING DOOR HEAD/SILL- INTERIOR

1: 2.5

NO.	REV.	ISSUED FOR	DATE
1		PERMIT	2019-11-14
2		TENDER REVIEW	2019-12-06
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PROJECT:
ORANGUTAN EXHIBITS

DRAWING NAME :

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ORANGUTAN DOOR DETAILS

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DRAWING NUMBER:

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AS NOTED
DECEMBER 11,2019

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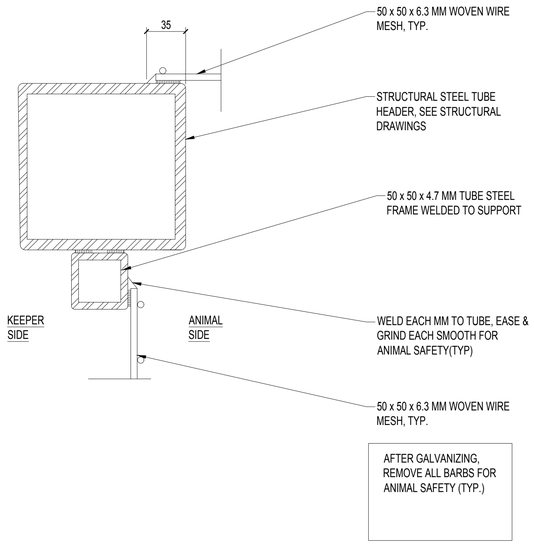
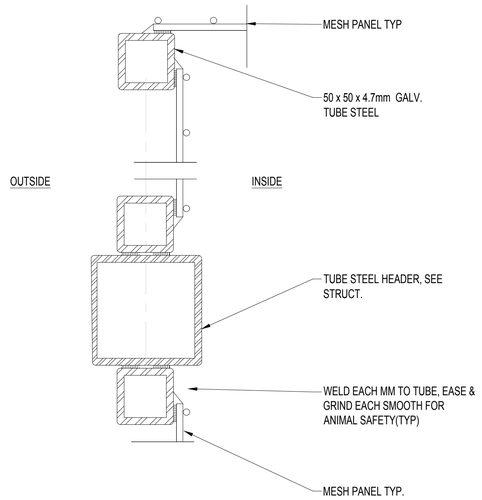


AFTER GALVANIZING, REMOVE ALL BARBS FOR ANIMAL SAFETY (TYP.)

1 CAGING HEAD DETAIL
SCALE: 1:2.5

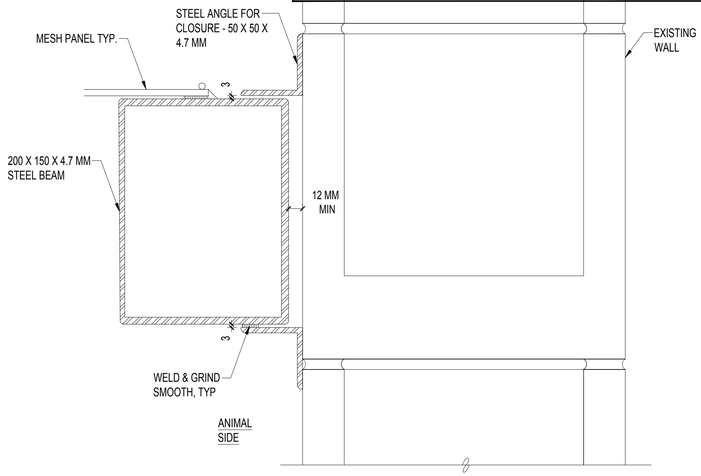
REF: 1/AR-205



2 CAGING HEAD @ VESTIBULE DETAIL
SCALE: 1:2.5

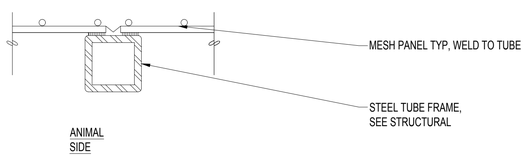
REF: 1/AR-112

GENERAL NOTES:
1. ALL INFILL ARE MESH UNLESS OTHERWISE NOTED IN PLAN & ELEVATION. FOR EXAMPLE, SERVICE ACCESS (ROOM#104) FACADE FACING ANIMAL SIDE WILL BE SOLID STEEL PANEL THROUGHOUT.



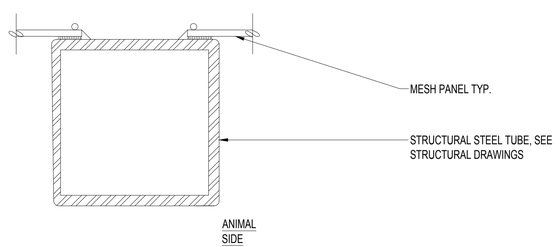
3 CAGING TO CMU DETAIL
SCALE: 1:2.5

REF: 1/AR-110, 2/AR-111



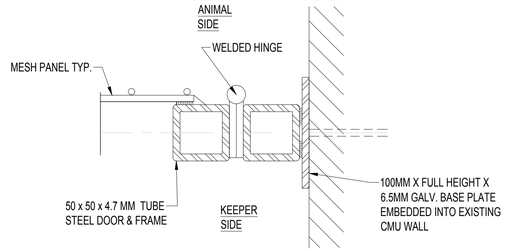
4 CAGING MID-ROOF SUPPORT DETAIL
SCALE: 1:2.5

REF: 3/AR-110, 1& 2/AR-111



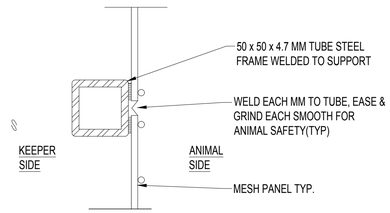
5 CAGING ROOF DETAIL
SCALE: 1:2.5

REF: 3/AR-110



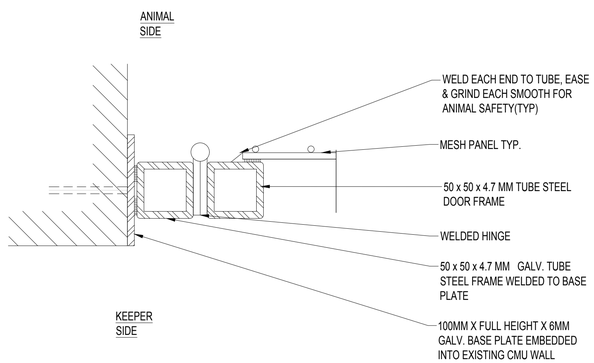
6 CAGING DOOR JAMB DETAIL
SCALE: 1:2.5

REF: 1/AR-110



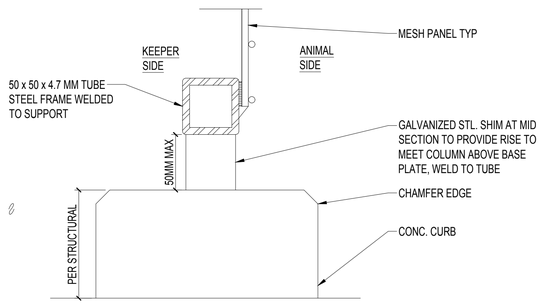
7 CAGING MID-SUPPORT DETAIL
SCALE: 1:2.5

REF: 1/AR-111, 4/AR-122



8 CAGING DOOR JAMB DETAIL
SCALE: 1:2.5

REF: 1/AR-112



9 CAGING SILL DETAIL
SCALE: 1:2.5

REF: 1/AR-111

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2		TENDER REVIEW	2019-12-06
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PROJECT:
ORANGUTAN EXHIBITS

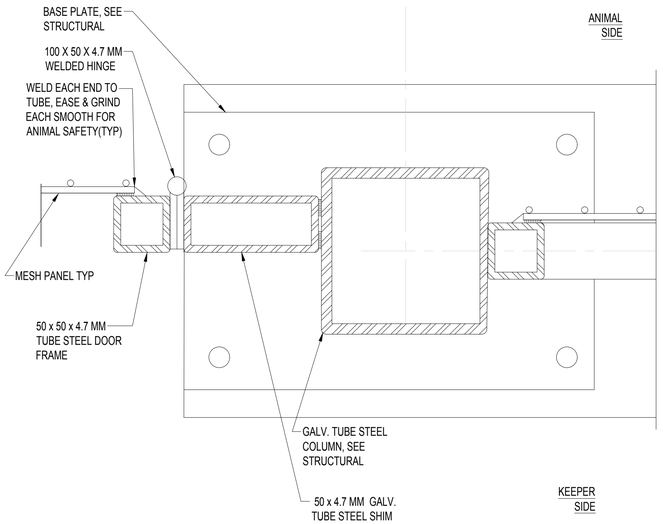
DRAWING NAME :

HABITAT 1
CAGING DETAILS

PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	LL	LC

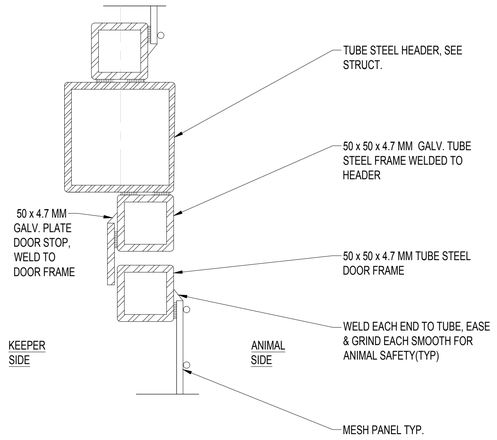
SCALE:
1 : 2.5
DECEMBER 11,2019

DRAWING NUMBER:
AR-011



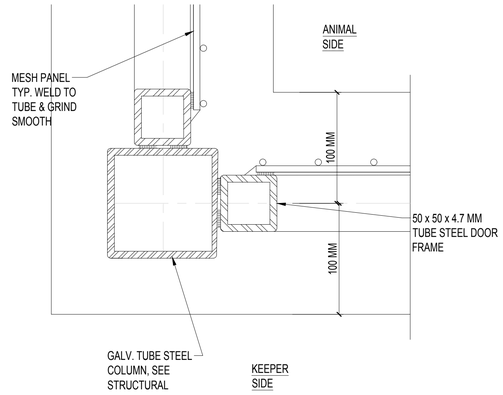
10 CAGING DOOR JAMB DETAIL
SCALE: 1:2.5

REF: 1/AR-122



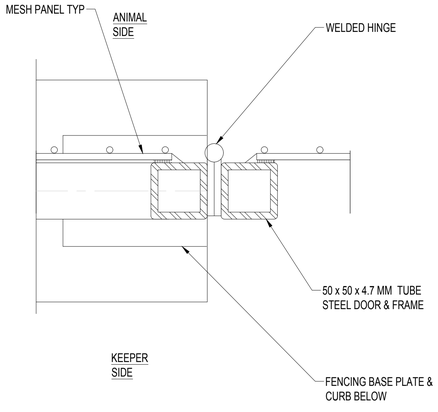
11 CAGING DOOR HEAD DETAIL
SCALE: 1:2.5

REF: 3/AR-123



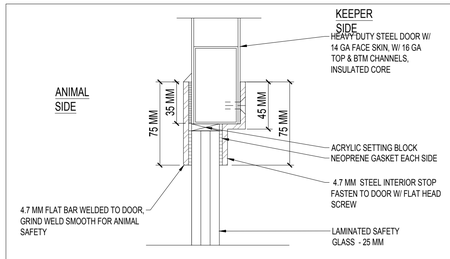
12 CAGING VESTIBULE CORNER DETAIL
SCALE: 1:2.5

REF: 1/AR-110



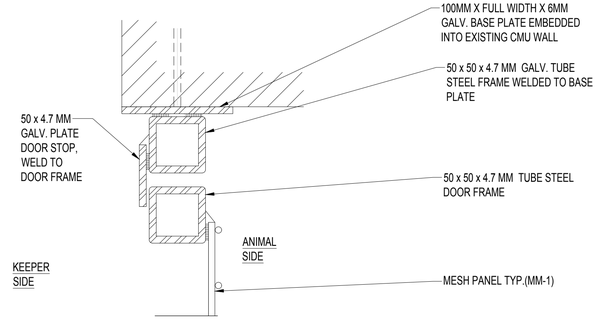
13 CAGING DOOR JAMB DETAIL
SCALE: 1:2.5

REF: 3/AR-123



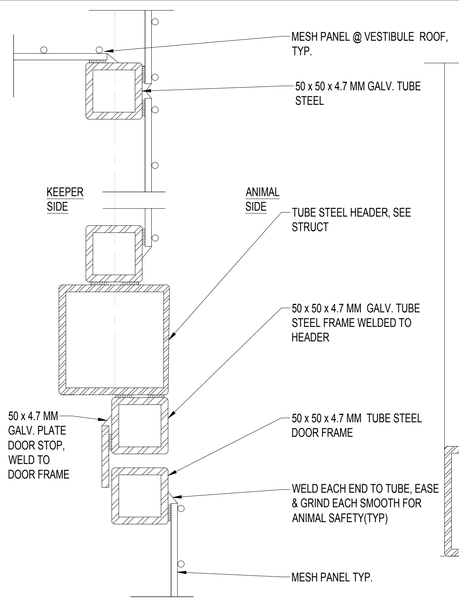
14 SAFETY GLASS AT ORANG. DOOR HEAD/JAMB
SCALE: 1:2.5

REF: 1/AR-123



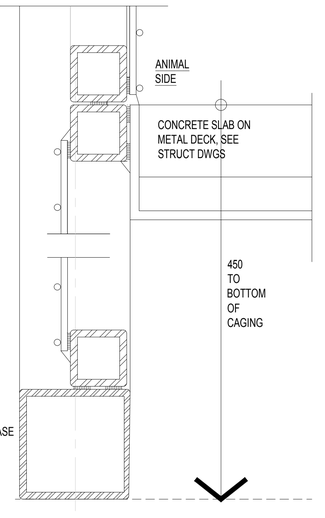
15 CAGING DOOR HEAD DETAIL
SCALE:1: 2.5

REF: 1/AR-123



16 CAGING DOOR HEAD @ VESTIBULE DETAIL
SCALE: 1:2.5

REF: 2/AR-122



17 CAGING HEAD & SILL @ HABITAT 2 DAYRM
SCALE: 1:2.5

REF: 1/AR-205

NO.	REV.	ISSUED FOR	DATE
1		PERMIT	2019-11-14
2		TENDER REVIEW	2019-12-06
3		TENDER	2019-12-11

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CLIENT: **TORONTO ZOO**

toronto zoo
361A Old Finch Ave, Toronto, ON M1B 5K7 · 416-392-5929

PROJECT:
ORANGUTAN EXHIBITS

DRAWING NAME :

HABITAT 1
CAGING DETAILS

PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	LL	LC

SCALE:
1 : 2.5
DECEMBER 11,2019

DRAWING NUMBER:
AR-012

HABITAT 1

rough opening for Orang door in existing Pavilion wall; provide lintel for new opening

existing door to remain

new door opening

preserve existing utils outside habitat, typ

tree to remain, typ (protect)

demolish building

fire hydrant to remain

demolish building

remove rocks & turnover to zoo

tree to be removed, typ see Arborist Report

demolish or relocate utilities in habitat, typ

remove asphalt paving and prepare area for planting

remove and re-use rock for new walls

"INDO-MALAYAN PAVILLIX"

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PROJECT:
ORANGUTAN EXHIBITS

DRAWING NAME :

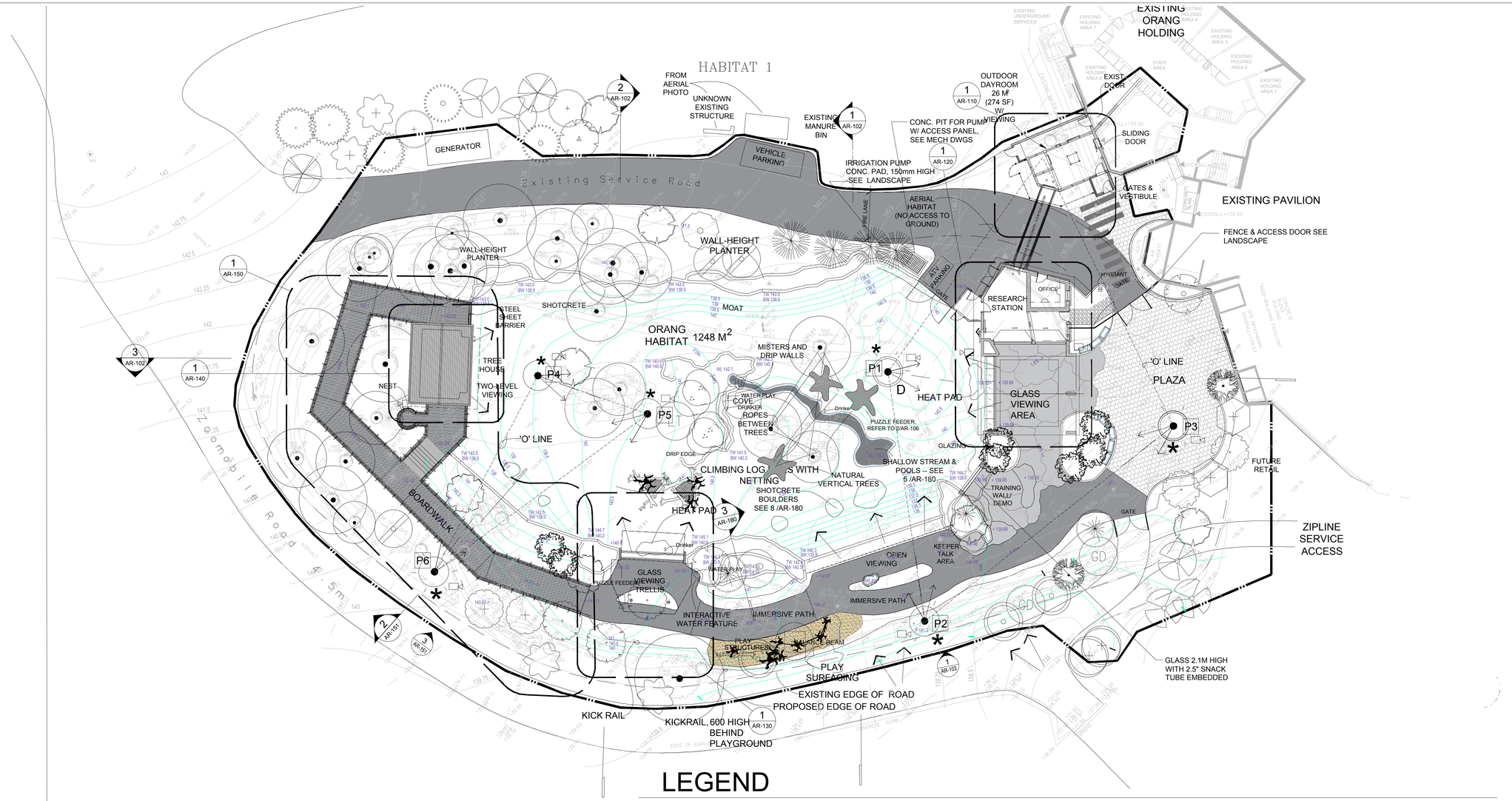
HABITAT 1
DEMOLITION PLAN

PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	LL	LC

DRAWING NUMBER:

SCALE:
AS NOTED
DECEMBER 11,2019

AR-100



1 AR-101 HABITAT 1: LAYOUT & MATERIAL PLAN
SCALE - 1: 200

LEGEND

'O' LINE (AERIAL HABITAT)

ROPE (AERIAL HABITAT)

CLIMBING POLE, upper platform with hotwire

POLE W/ HOTWIRE

CLIMBING POLE

FEEDER (AT TOP OF POLE) *

DRINKER AT TOP OF POLE D

POLE # (SEE AR-104 & AR-105) P1

VIDEO FEE (TOP OF POLE) OR SECURITY CAMERA

VIDEO FEED CAMERA ANGLE

VIEWING GUARDRAIL
SEE 6 /AR-180

GUARDRAIL / KICK RAIL
SEE 1 & 2/ AR-180

BARRIER FENCE
SEE 3 /AR-111

LIMIT OF WORK

CONCRETE PAVING W/ COLOR & TEXTURE, see landscape

ASHPALTIC PAVING, see landscape

CONCRETE PAVERS, see landscape

BENCH W/ BACKREST

HEAT PAD-MINIMUM 2M X 4M

GENERAL NOTES:

1.FOR GRADING, SEE CIVIL DWGS.

2.FOR PAVING MATERIAL SEE LANDSCAPE

3.DRINKERS & HOSE BIBS LOCATION, SEE MECH . PLUMBING DWGS.

4. SECURITY CAMERA LOCATION, SEE ELEC. DWGS

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PROJECT:
ORANGUTAN EXHIBITS

DRAWING NAME :

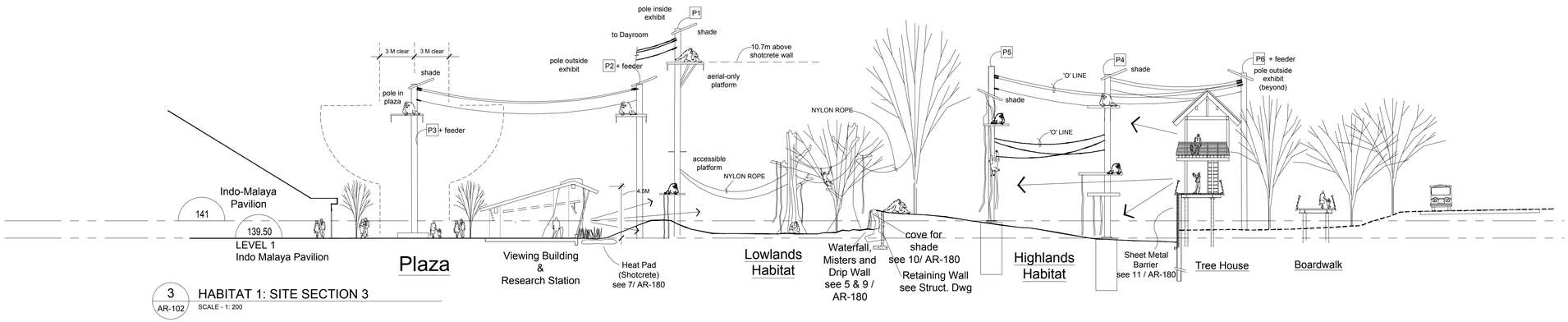
HABITAT 1
LAYOUT & MATERIAL PLAN

PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	LL	LC

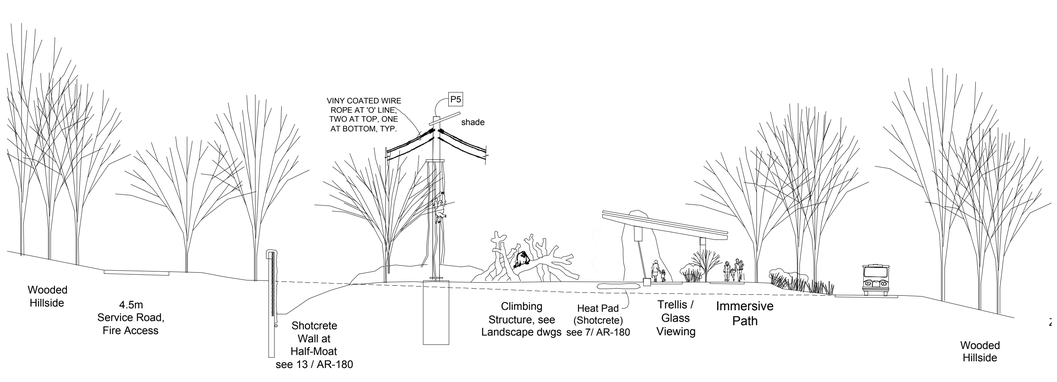
SCALE:
AS NOTED
DECEMBER 11,2019

DRAWING NUMBER:
AR-101

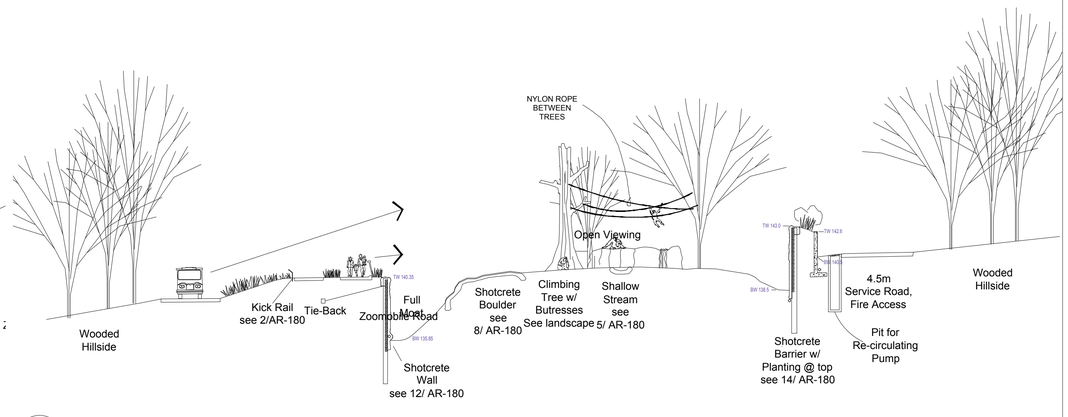
GENERAL NOTE:
FOR ALL POLES, SEE AR-104 & AR-105



3 AR-102 HABITAT 1: SITE SECTION 3
SCALE - 1: 200



2 AR-102 HABITAT 1: SITE SECTION 2
SCALE - 1: 200



1 AR-102 HABITAT 1: SITE SECTION 1
SCALE - 1: 200

NO.	REV.	ISSUED FOR	DATE
1		PERMIT	2019-11-14
2		TENDER REVIEW	2019-12-06
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PROJECT:
ORANGUTAN EXHIBITS

DRAWING NAME :

HABITAT 1
SITE SECTION

PROJECT NO.:	DRAWN BY :	CHECKED BY:
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SCALE:
1 : 200
DECEMBER 11,2019

DRAWING NUMBER:
AR-102

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PROJECT:
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HABITAT 1
SITE SECTION

PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	LL	LC

DRAWING NUMBER:

SCALE:
AS NOTED
DECEMBER 11,2019

AR-103

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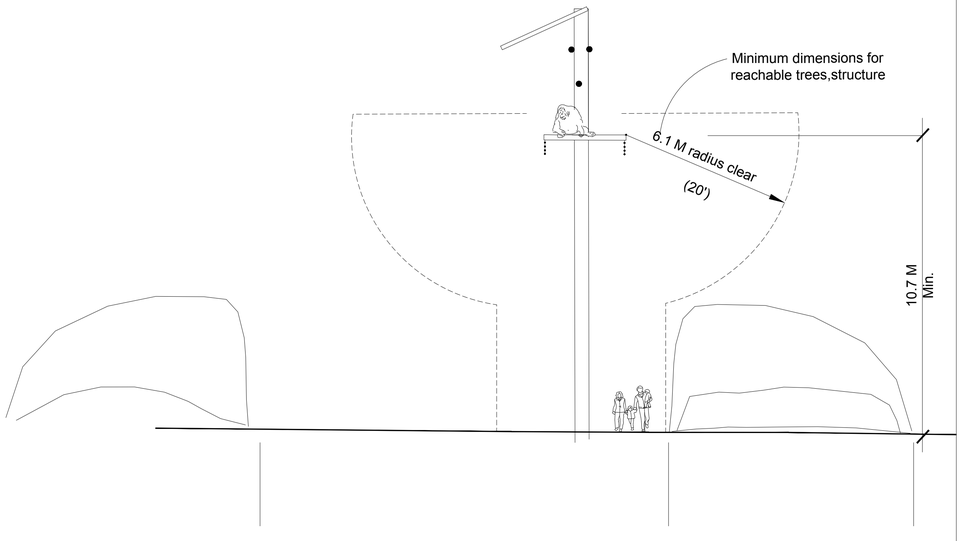
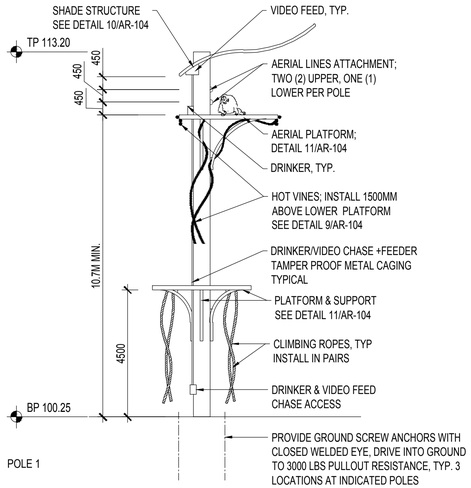
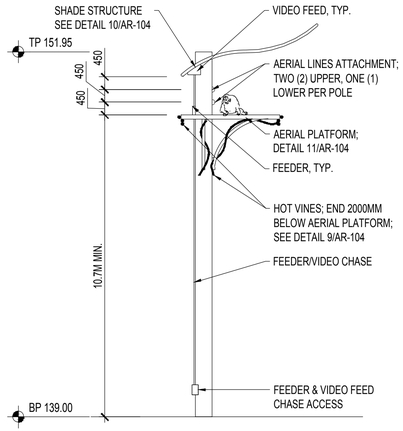


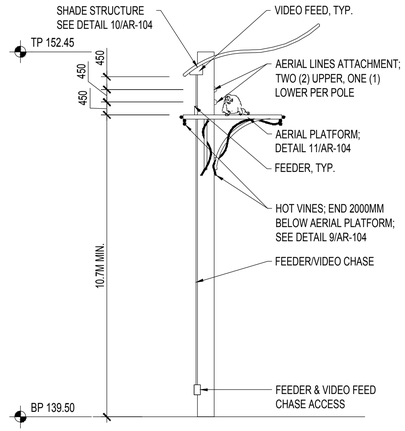
1 / AR-103 HABITAT 1: TYPICAL SECTION
SCALE - 1: 100



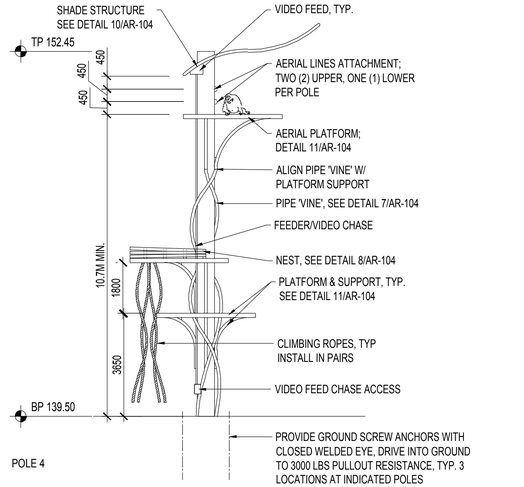
1 POLE 1
SCALE:1:100



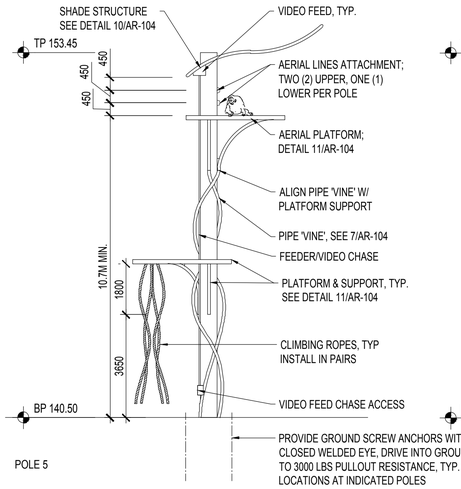
2 POLE 2
SCALE:1:100



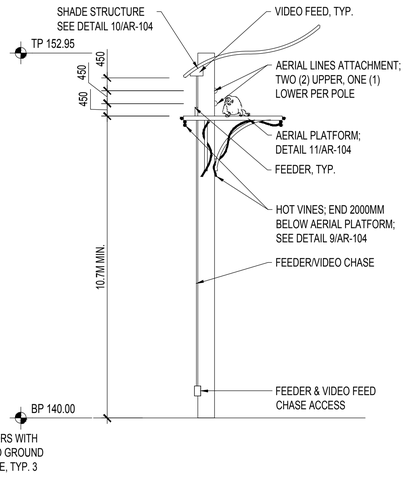
3 POLE 3
SCALE:1:100



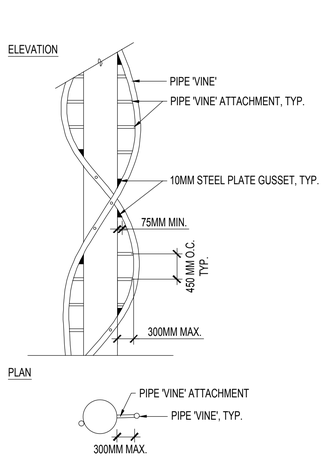
4 POLE 4
SCALE:1:100



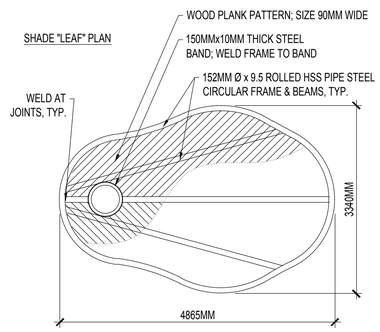
5 POLE 5
SCALE:1:100

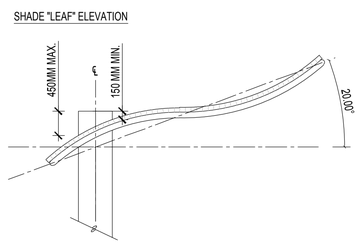


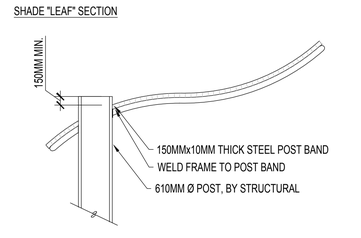
6 POLE 6
SCALE:1:100

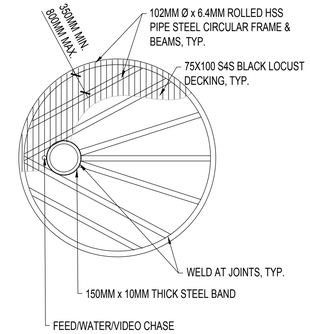


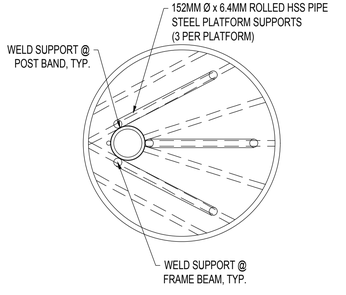
7 PIPE 'VINE' ATTACHMENT
SCALE:1:50

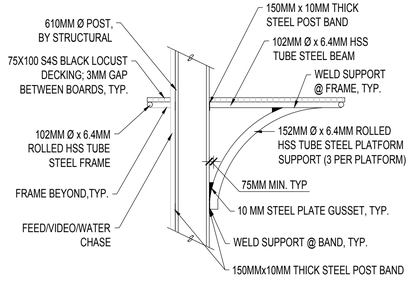




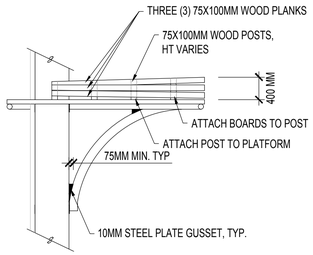




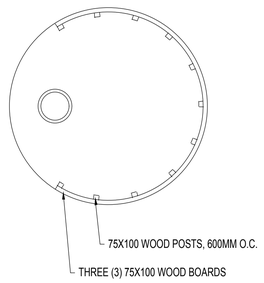


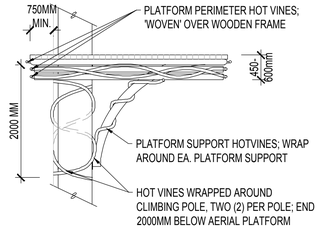


NEST ELEVATION



NEST PLAN





8 NEST
SCALE:1:50

9 HOTVINES
SCALE:1:50

10 SHADE "LEAF" PLAN & SECTION
SCALE:1:50

11 PLATFORM PLANS & SECTION
SCALE:1:50

NO.	REV.	ISSUED FOR	DATE
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2		TENDER REVIEW	2019-12-06
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PROJECT:
ORANGUTAN EXHIBITS

DRAWING NAME :

HABITAT 1
CLIMBING POLES DETAILS

PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	LL	LC

SCALE:
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DECEMBER 11,2019

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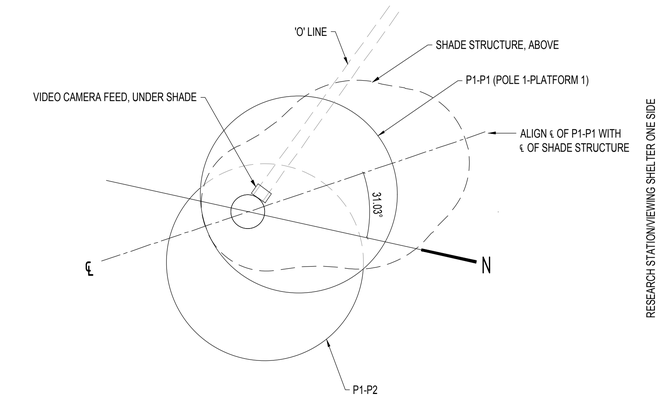
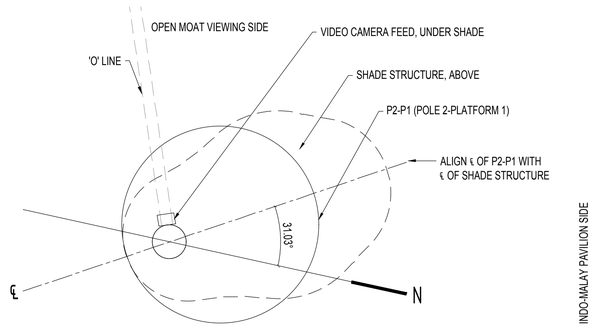


1 POLE 1
SCALE:1:50



2 POLE 2
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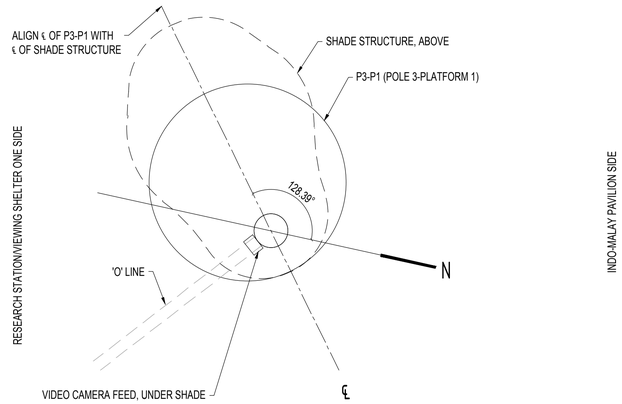
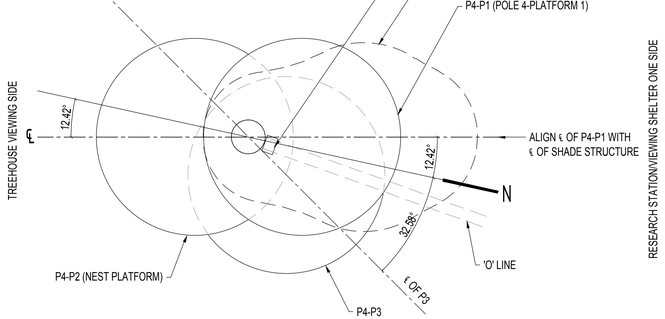
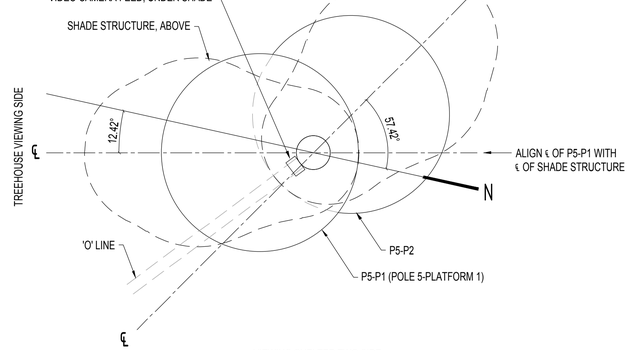


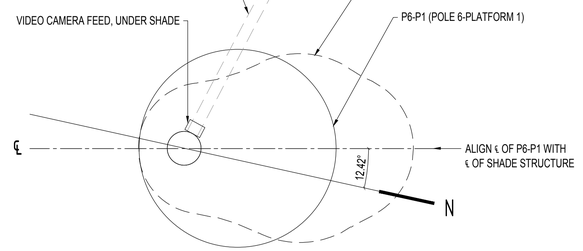
3 POLE 3
SCALE:1:50



4 POLE 4
SCALE:1:50



5 POLE 5
SCALE:1:50



6 POLE 6
SCALE:1:50

FOR FEEDER DETAIL. SEE AR-106

NO.	REV.	ISSUED FOR	DATE
1		PERMIT	2019-11-14
2		TENDER REVIEW	2019-12-06
3		TENDER	2019-12-11

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CLIENT: **TORONTO ZOO**

toronto zoo

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PROJECT:
ORANGUTAN EXHIBITS

DRAWING NAME :

HABITAT 1
CLIMBING POLE PLATFORM SCHEME

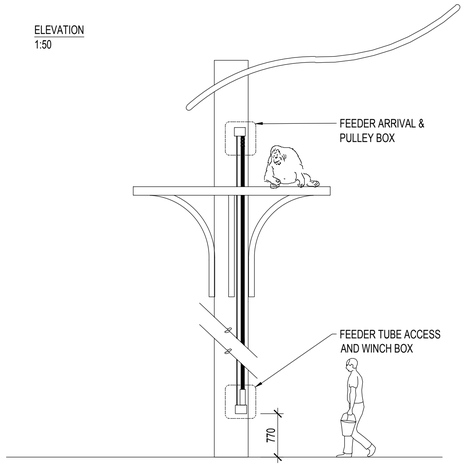
PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	LL	LC

DRAWING NUMBER:

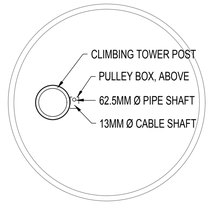
SCALE:
AS NOTED
DECEMBER 11,2019

AR-105

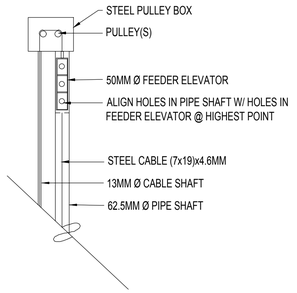
ELEVATION
1:50



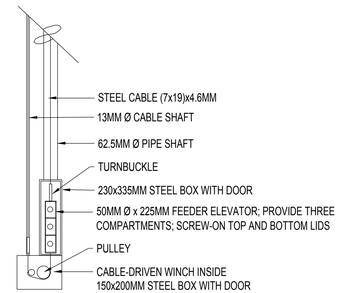
PLAN @ PLATFORM
1:50



FEEDER ARRIVAL & PULLEY BOX
NTS

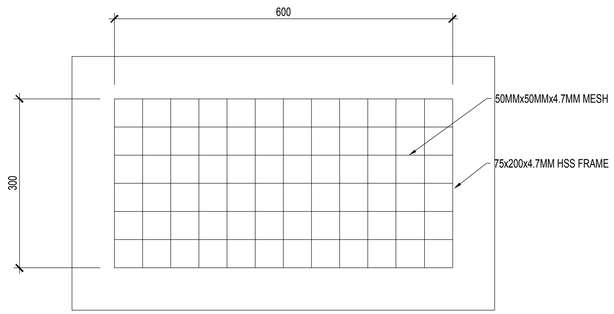


FEEDER TUBE ACCESS & WINCH BOX
NTS

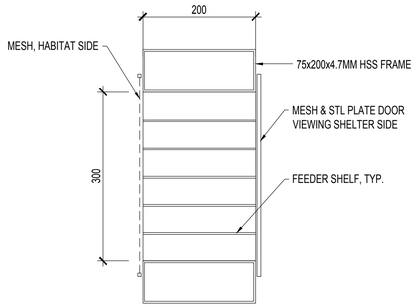


1 FEEDER AT CLIMBING POLE
SCALE 1 : 50

ELEVATION



SECTION



2 PUZZLE FEEDER
SCALE 1 : 5

NO.	REV.	ISSUED FOR	DATE
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2		TENDER REVIEW	2019-12-06
3		TENDER	2019-12-11

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PROJECT:
ORANGUTAN EXHIBITS

DRAWING NAME :

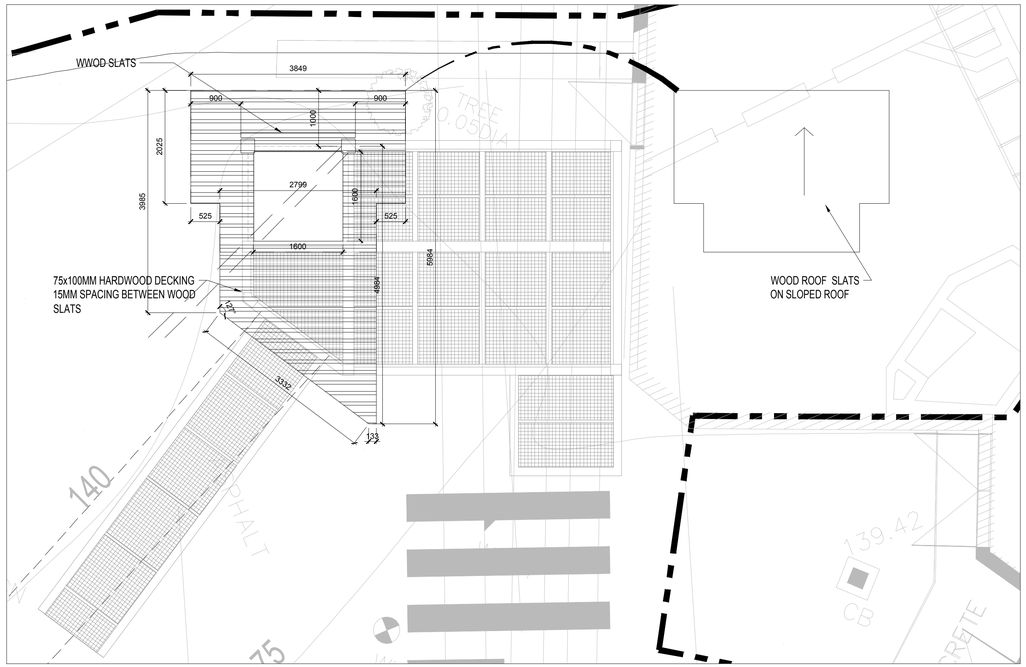
HABITAT 1 & 2
FEEDER DETAILS

PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	LL	LC

DRAWING NUMBER:

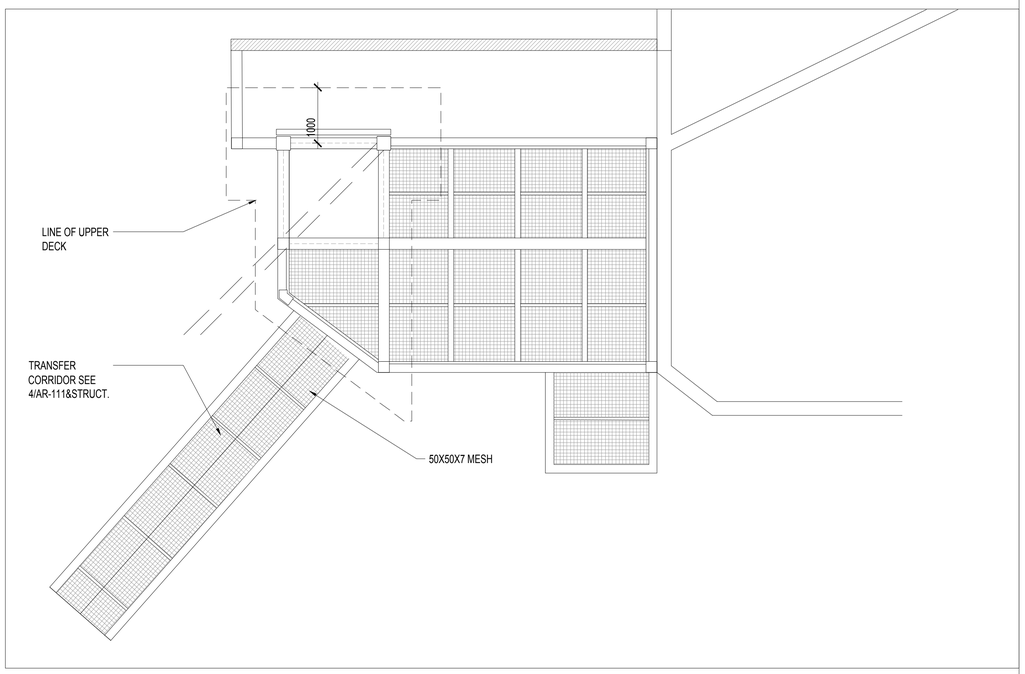
SCALE:
AS NOTED
DECEMBER 11,2019

AR-106



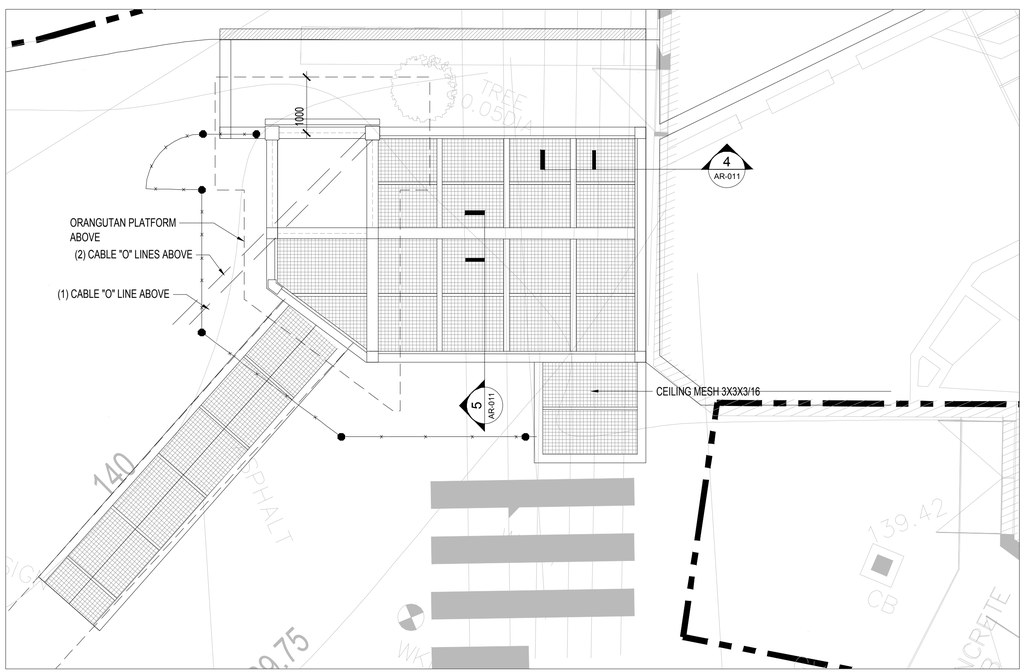
4 AR-110 UPPER DECK PLATFORM PLAN

SCALE - 1:50



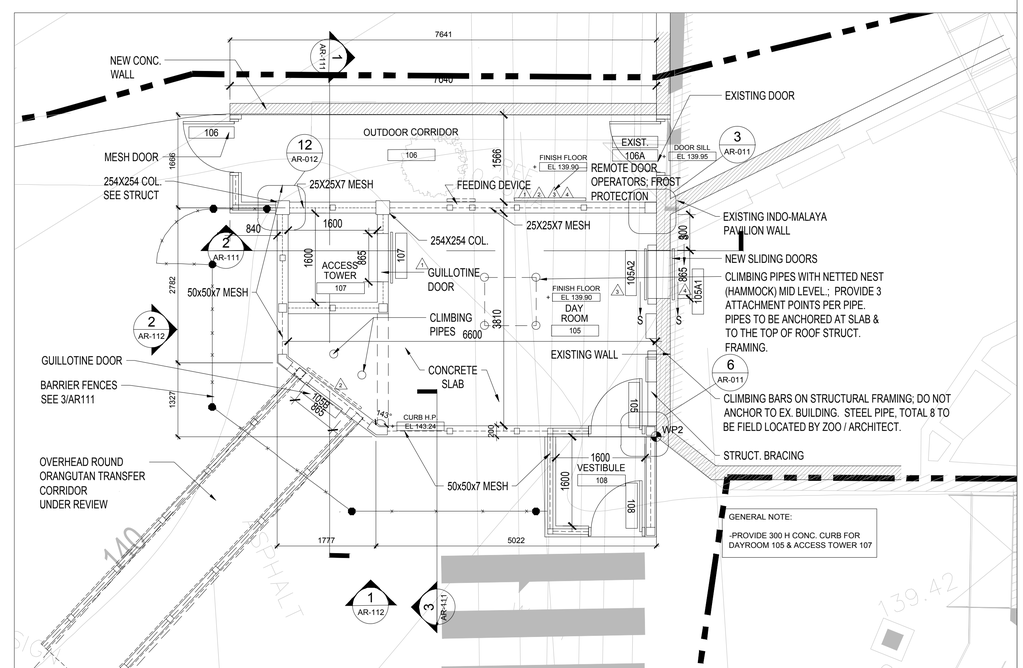
2 AR-110 REFELCTED CEILING PLAN

SCALE - 1:50



3 AR-110 LOWER ROOF PLAN

SCALE - 1:50



1 AR-110 CONSTRUCTION PLAN

SCALE - 1:50

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2		TENDER REVIEW	2019-12-06
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PROJECT:
ORANGUTAN EXHIBITS

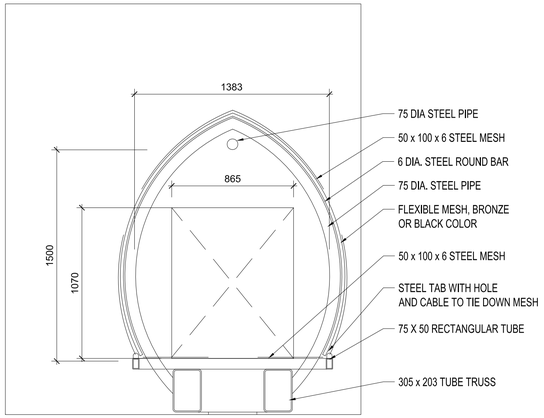
DRAWING NAME :

HABITAT 1
DAYROOM AND EXISTING PLANS

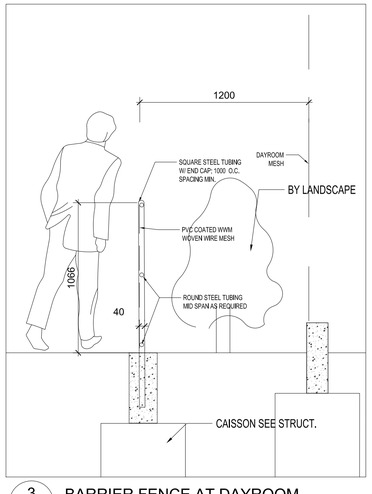
PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	LL	LC

SCALE:
AS NOTED
DECEMBER 11,2019

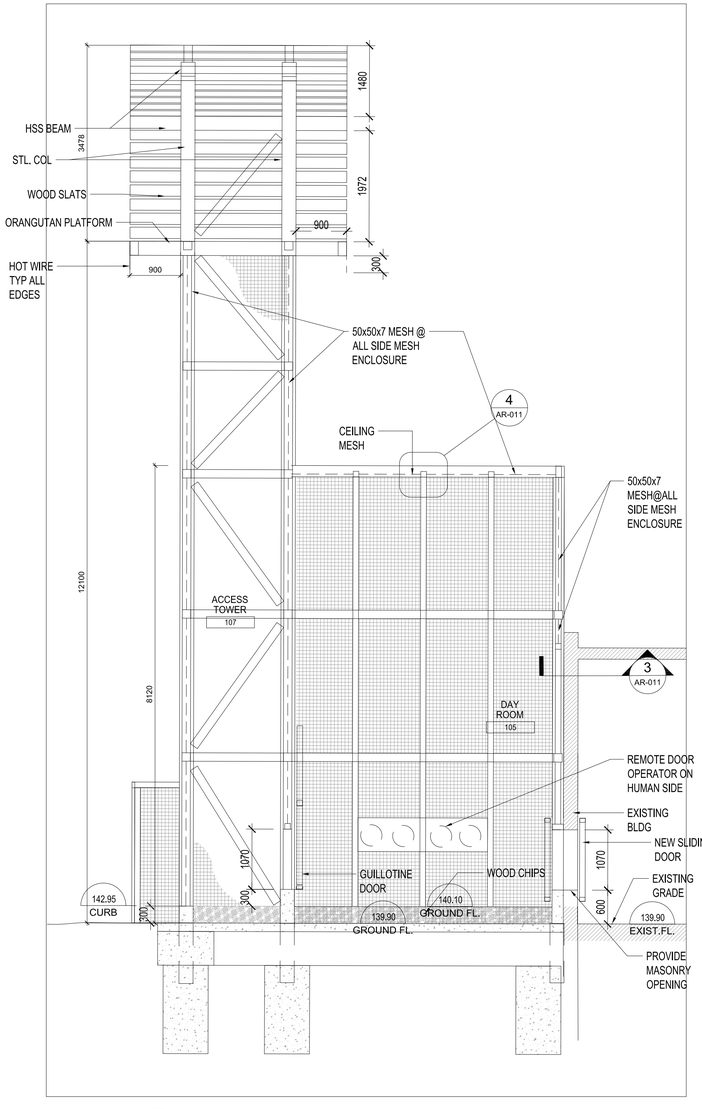
DRAWING NUMBER:
AR-110



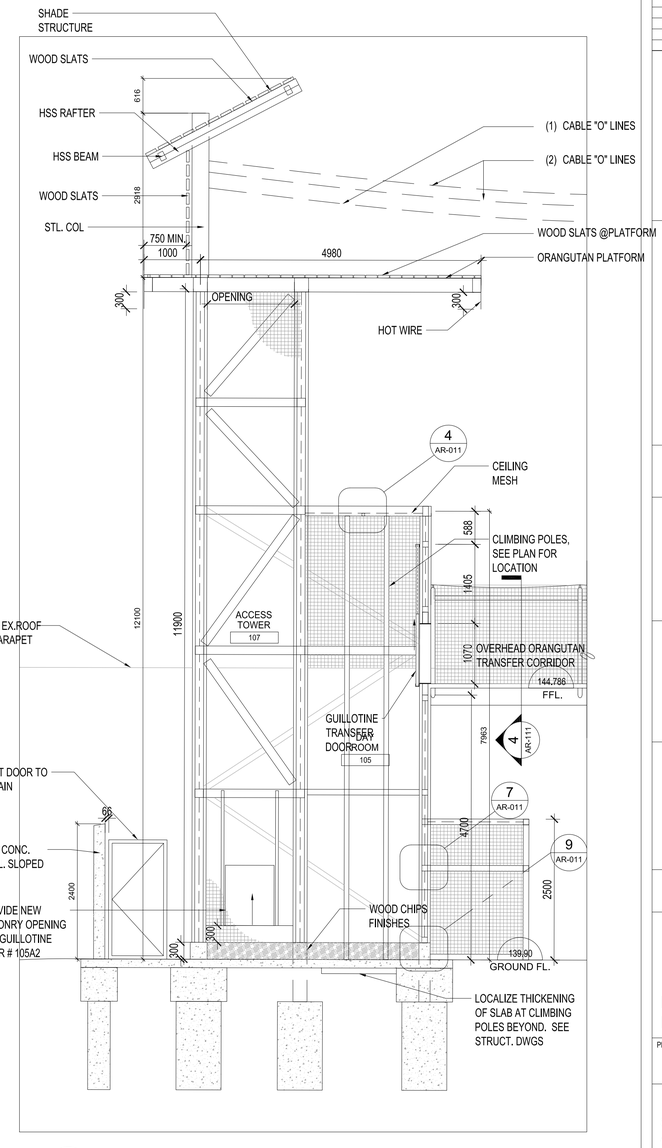
4 AR-111 SECTION AT CHUTE
SCALE - 1:20



3 AR-111 BARRIER FENCE AT DAYROOM
SCALE - 1:20



2 AR-111 SECTION
SCALE - 1:50



1 AR-111 SECTION
SCALE - 1:50

NO.	REV.	ISSUED FOR	DATE
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PROJECT:
ORANGUTAN EXHIBITS

DRAWING NAME :

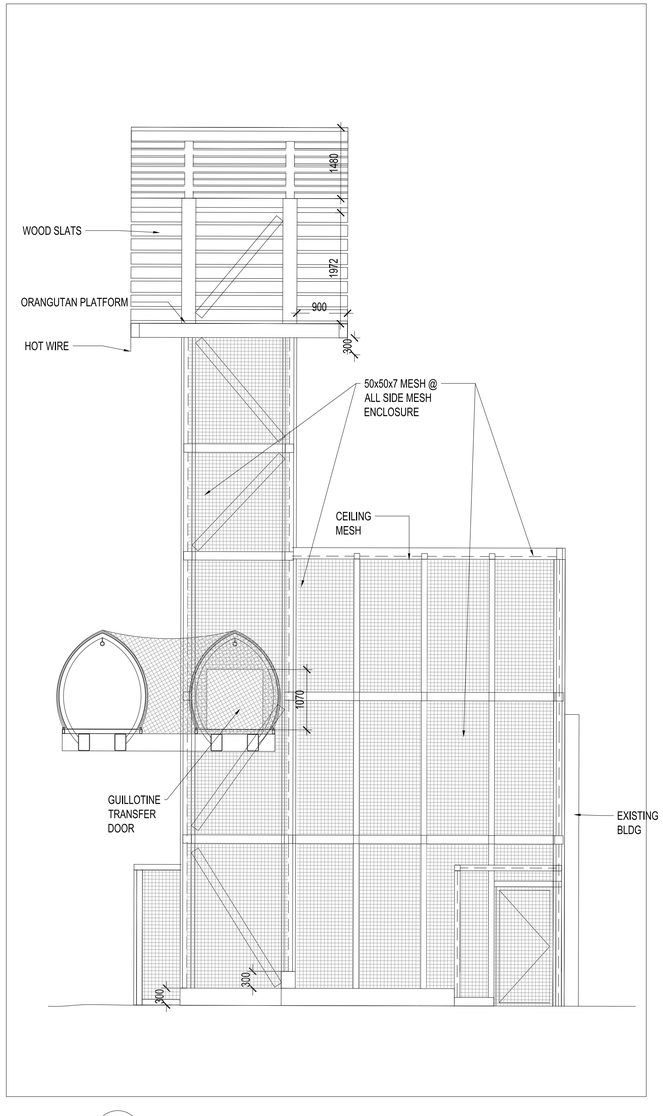
HABITAT 1
DAYROOM SECTIONS

PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	LL	LC

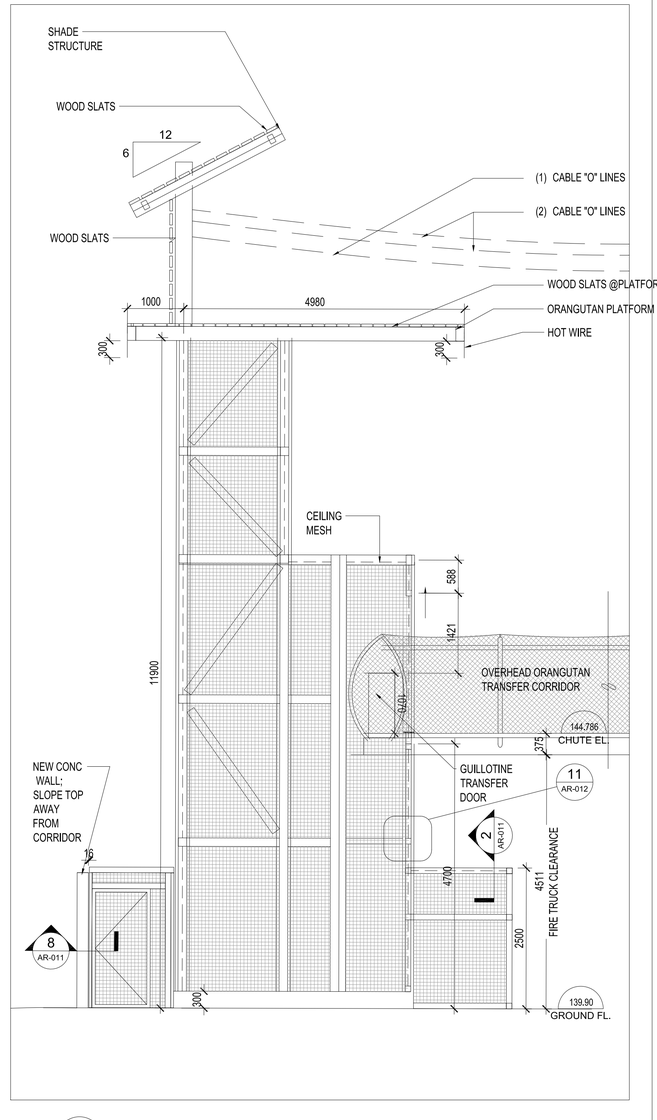
DRAWING NUMBER:

SCALE:
AS NOTED
DECEMBER 11,2019

AR-111



2 AR-112 ELEVATION
SCALE - 1:50



1 AR-112 ELEVATION
SCALE - 1:50

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1		PERMIT	2019-11-14
2		TENDER REVIEW	2019-12-06
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PROJECT:
ORANGUTAN EXHIBITS

DRAWING NAME :

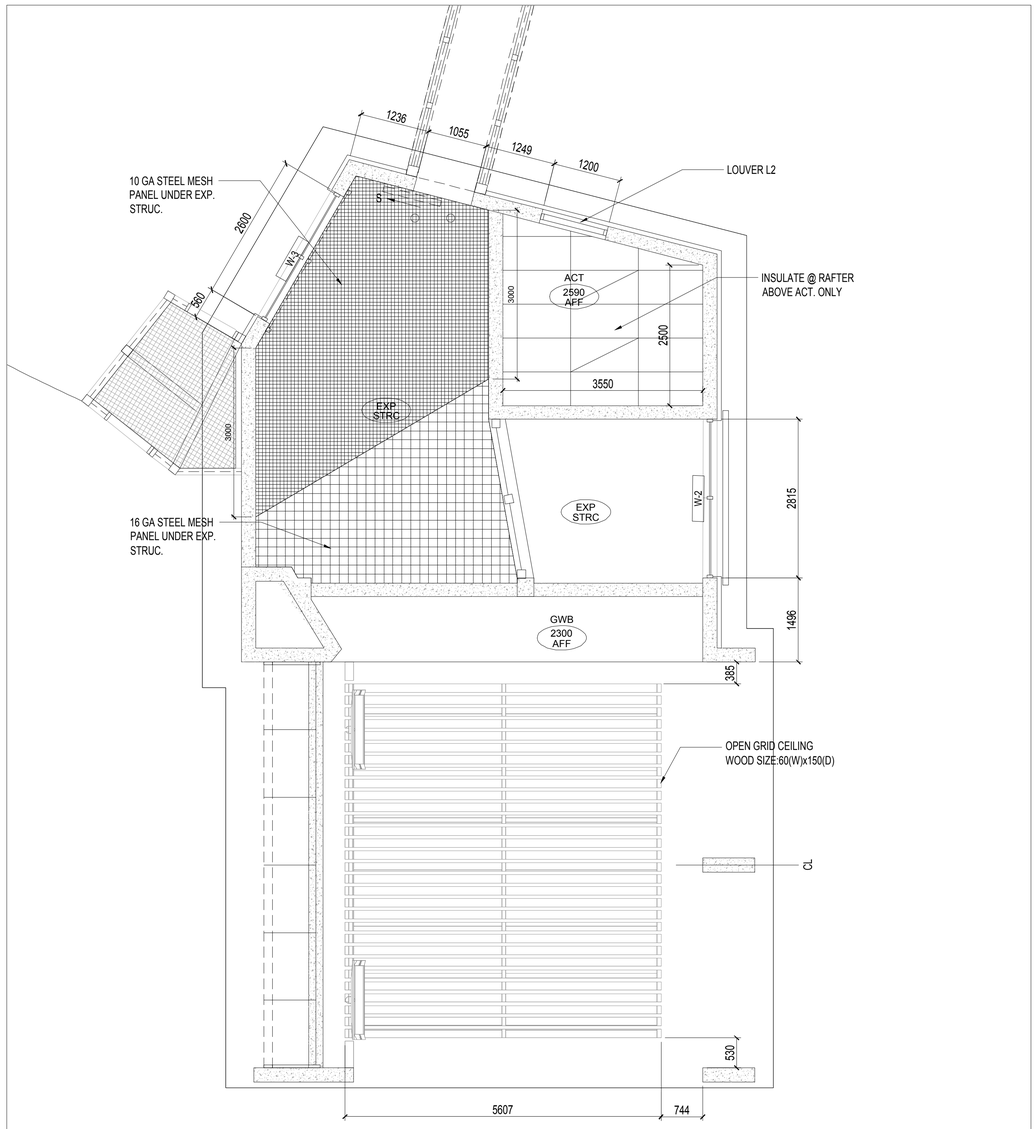
HABITAT 1
DAY ROOM ELEVATIONS

PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	LL	LC

DRAWING NUMBER:

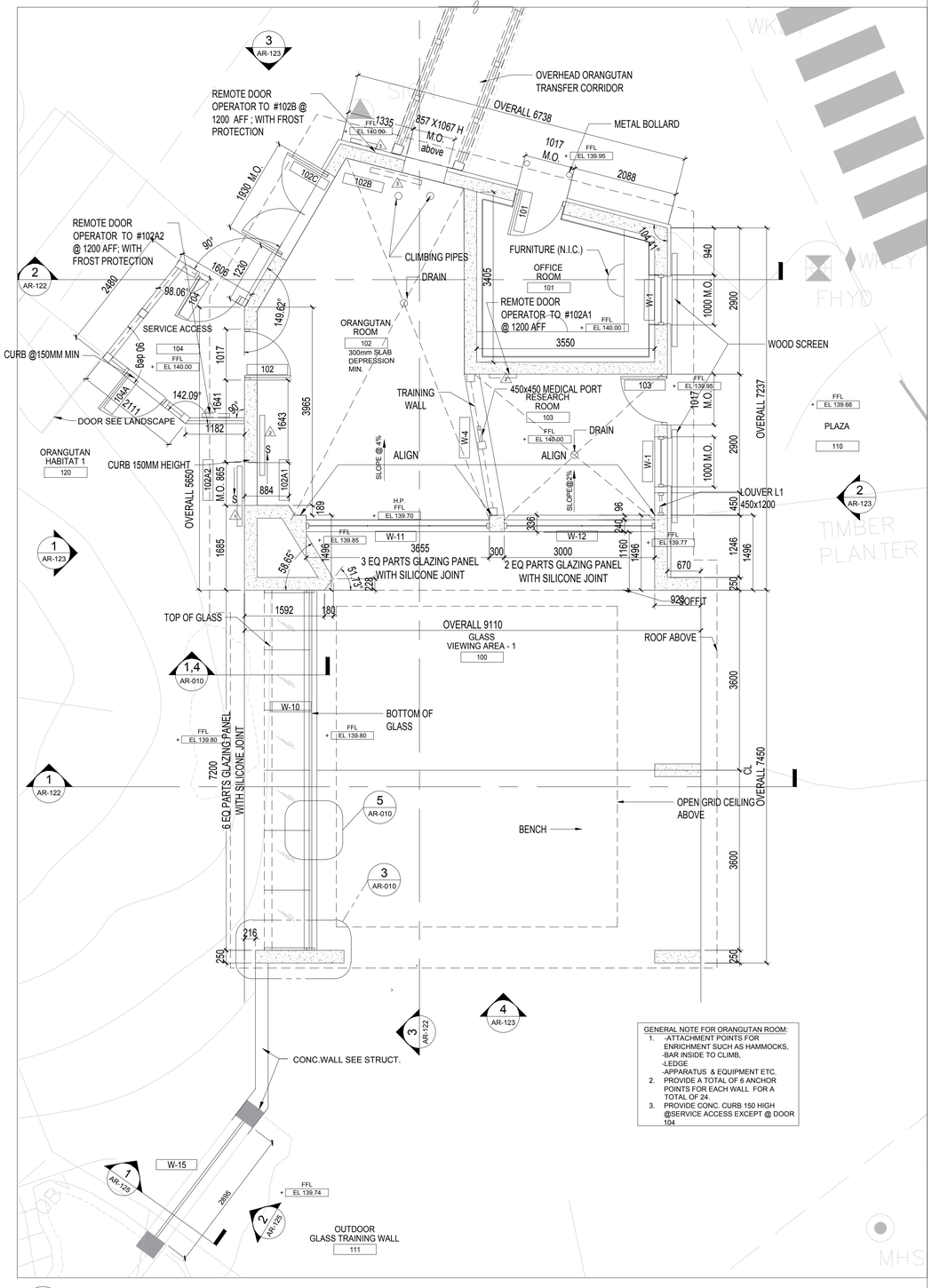
SCALE:
AS NOTED
DECEMBER 11,2019

AR-112



2 AR-120 REFELCTED CEILING PLAN

SCALE - 1:50



1 AR-120 CONSTRUCTION PLAN

SCALE - 1:50

NO.	REV.	ISSUED FOR	DATE
1		PERMIT	2019-11-14
2		TENDER REVIEW	2019-12-06
3		TENDER	2019-12-11

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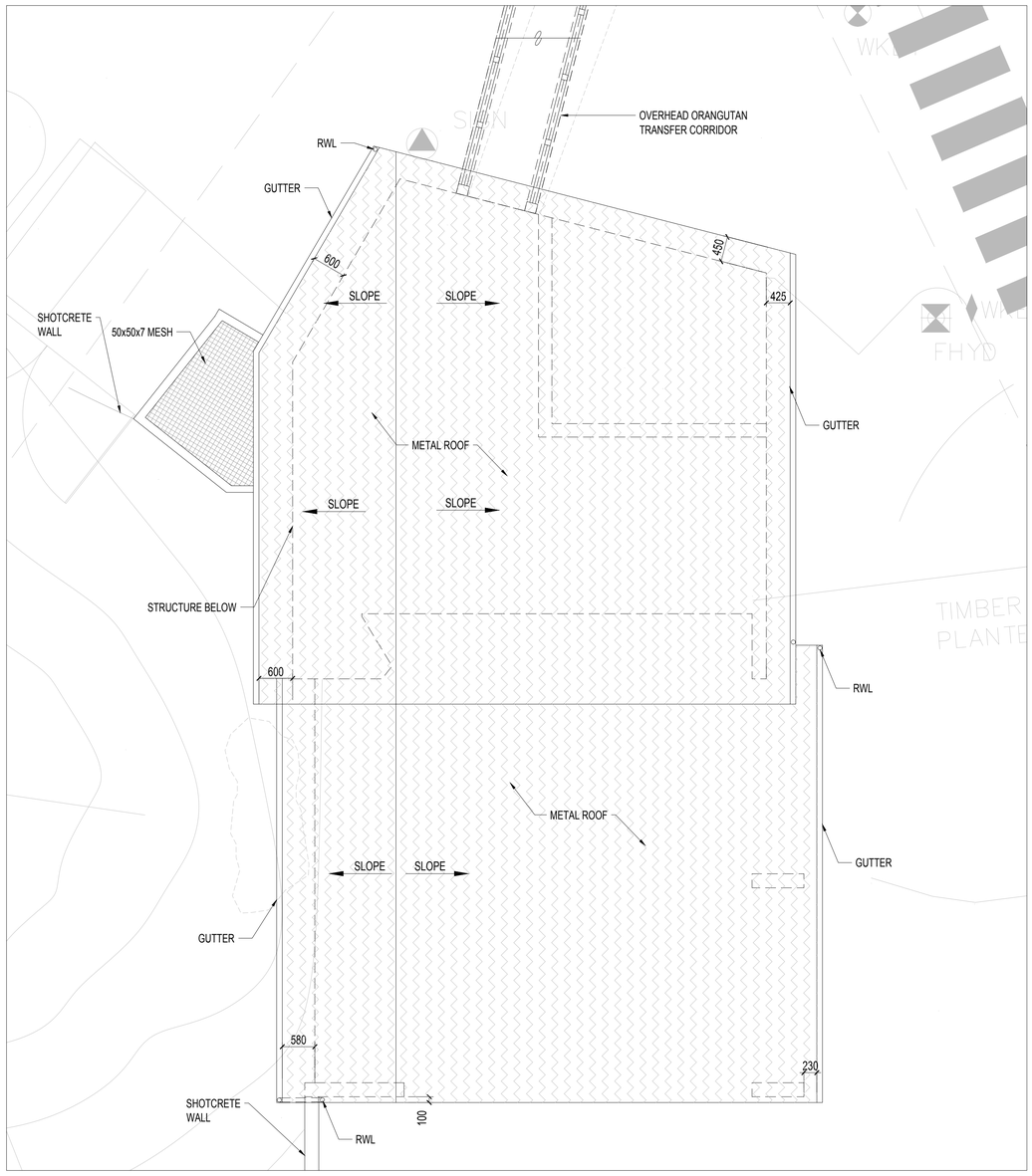
DRAWING NAME :

HABITAT 1
VIEWING/RESEARCH STATION PLANS

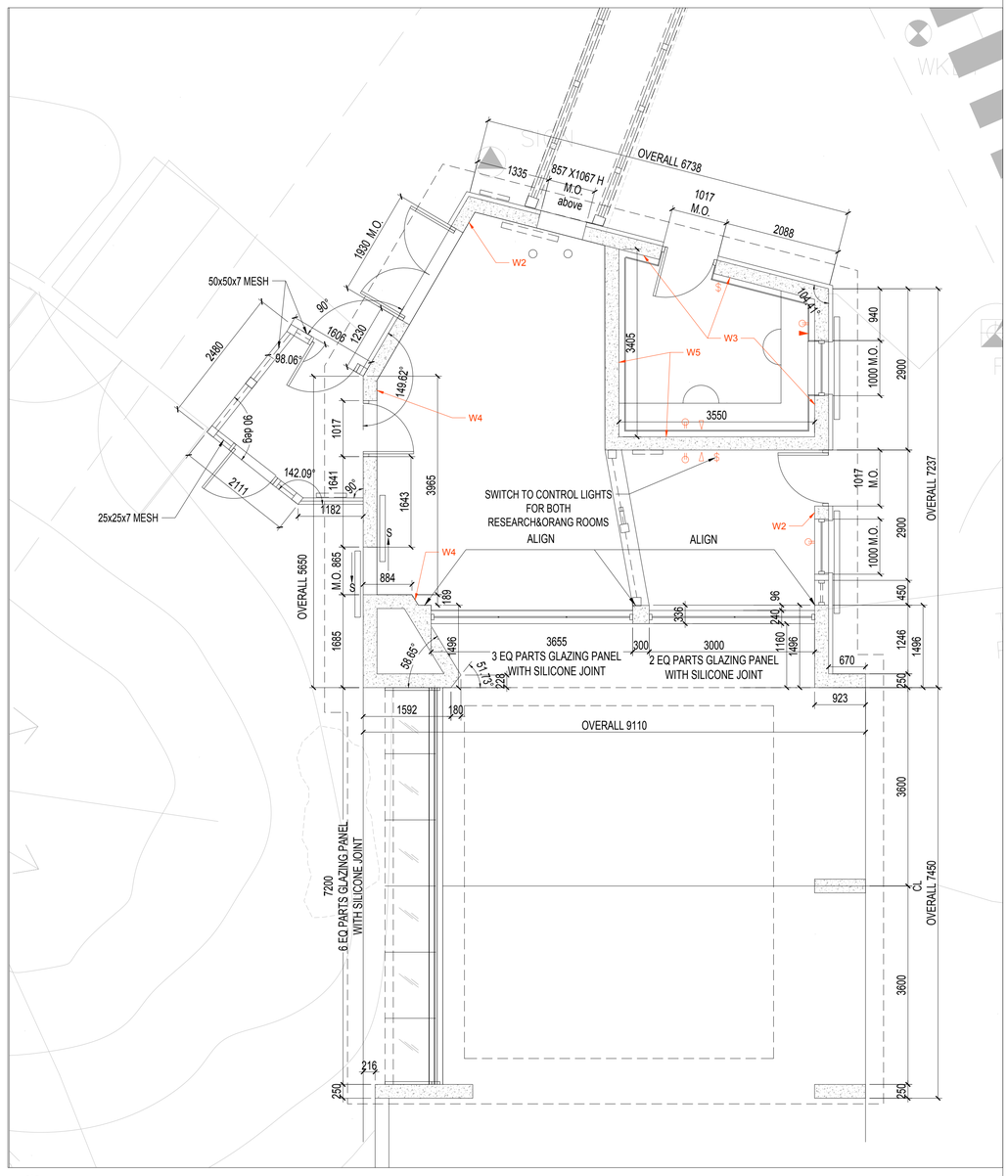
PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	LL	LC

SCALE:
AS NOTED
DECEMBER 11,2019

DRAWING NUMBER:
AR-120



2 AR-121 ROOF PLAN
SCALE - 1:50



1 AR-121 POWER & COMMUNICATIONS & FINISHES PLAN
SCALE - 1:50

NO.	REV.	ISSUED FOR	DATE
1		PERMIT	2019-11-14
2		TENDER REVIEW	2019-12-06
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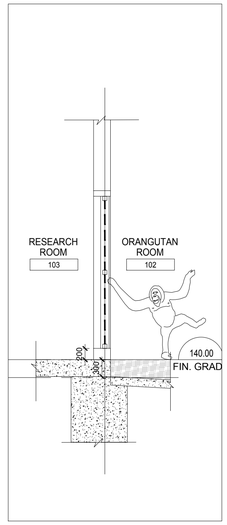
PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	LL	LC

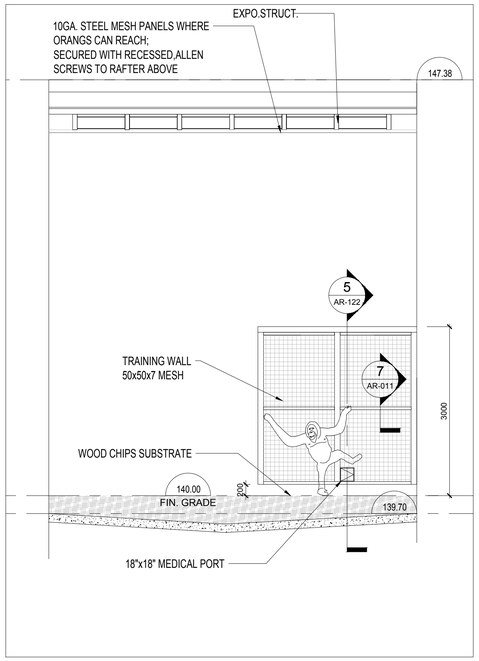
DRAWING NUMBER:

SCALE:
AS NOTED
DECEMBER 11,2019

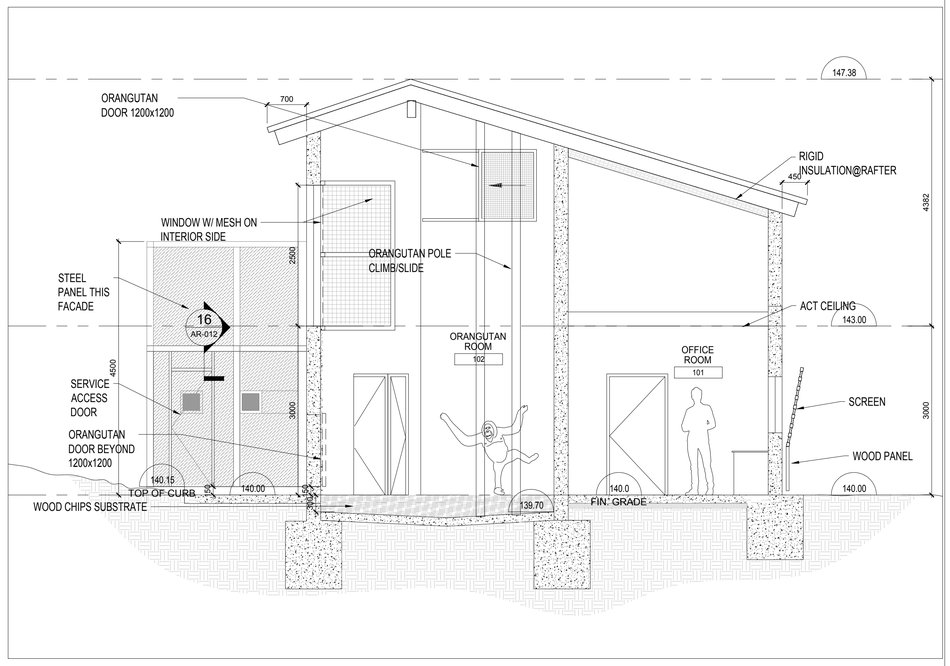
AR-121



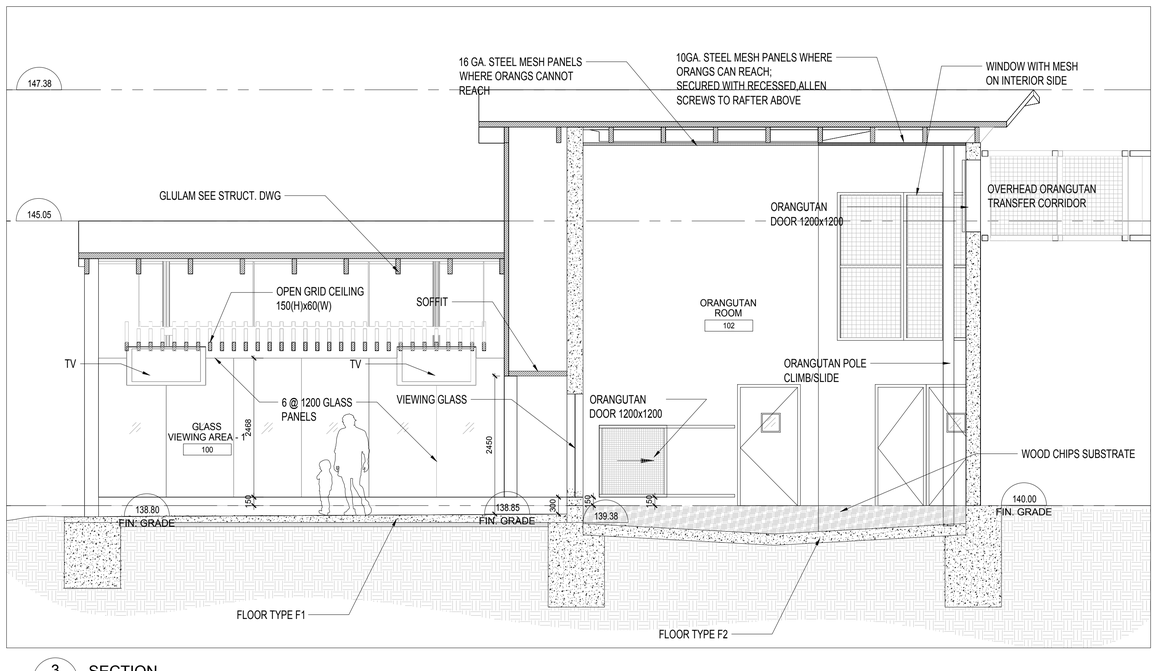
5 AR-122 SECTION @ TRAINING WALL
SCALE - 1:50



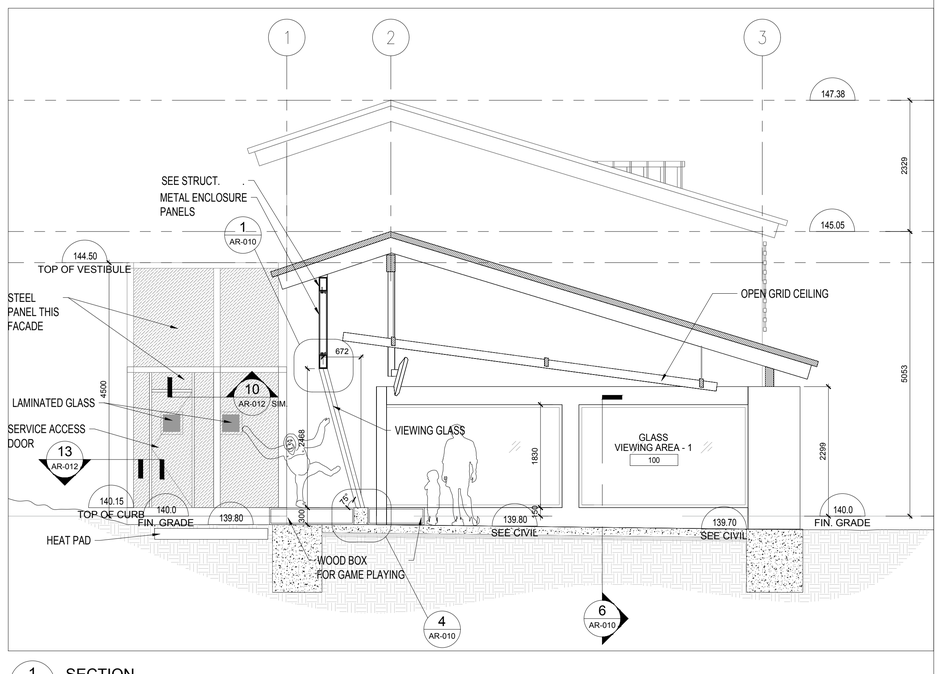
4 AR-122 INTERIOR ELEVATION
SCALE - 1:50



2 AR-122 SECTION
SCALE - 1:50



3 AR-122 SECTION
SCALE - 1:50



1 AR-122 SECTION
SCALE - 1:50

NO.	REV.	ISSUED FOR	DATE
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PROJECT:
ORANGUTAN EXHIBITS

DRAWING NAME :

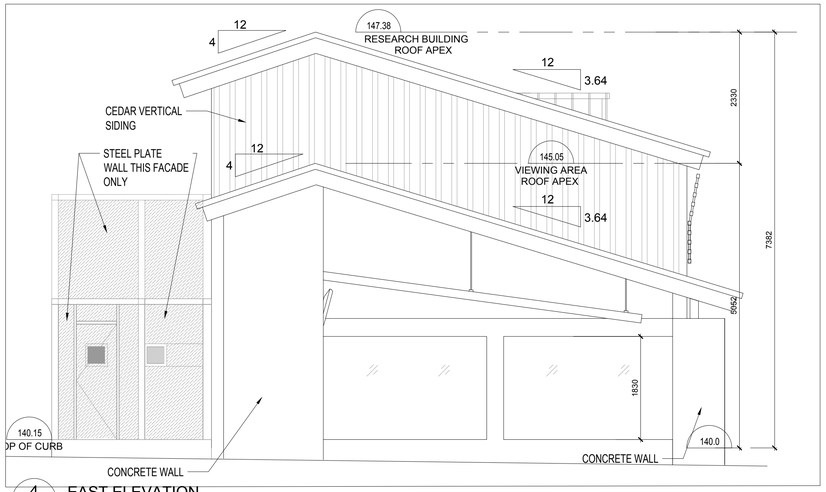
HABITAT 1
VIEWING/RESEARCH SECTIONS

PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	LL	LC

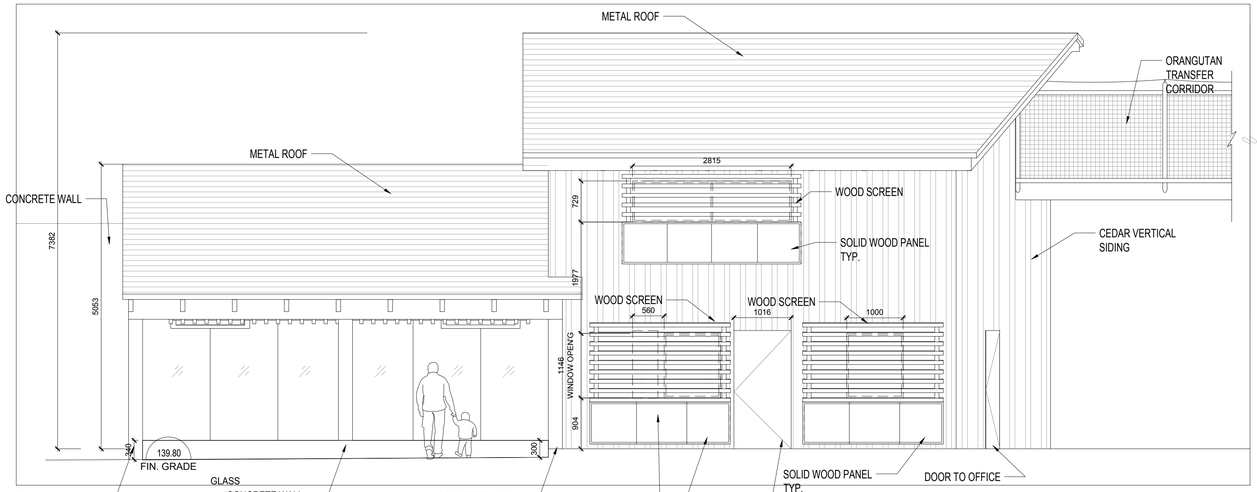
SCALE:
AS NOTED
DECEMBER 11,2019

DRAWING NUMBER:
AR-122

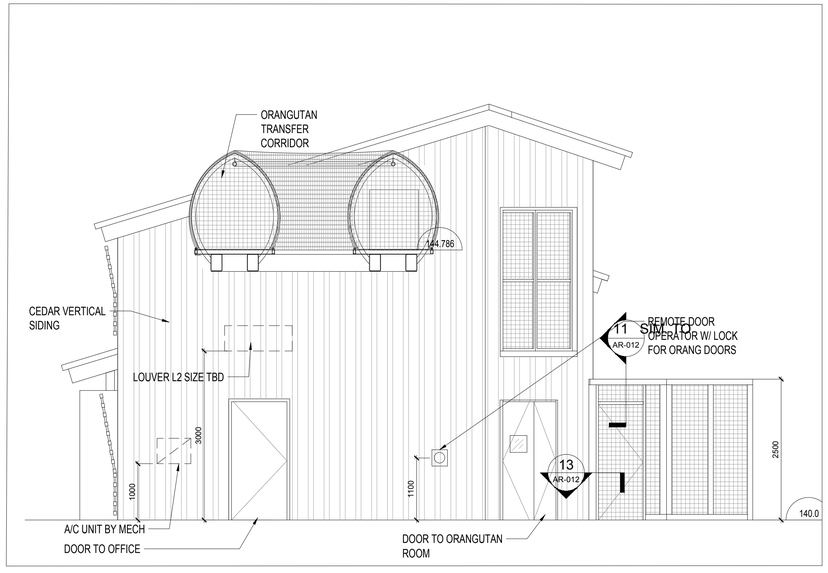
GENERAL NOTES:
1. ALL EXPOSED CONCRETE IN RESEARCH BUILDING & GLASS VIEWING AREA TO BE INTEGRAL PIGMENTED CONCRETE BY INTERSTAR
COLOUR: CHPAPS BN2520R ; TO MATCH PLAZA CONC. PAVING COLOUR.
2. .ALL WINDOW OR GLAZING FRAME TO BE DARK BROWN (COLOUR TBD).



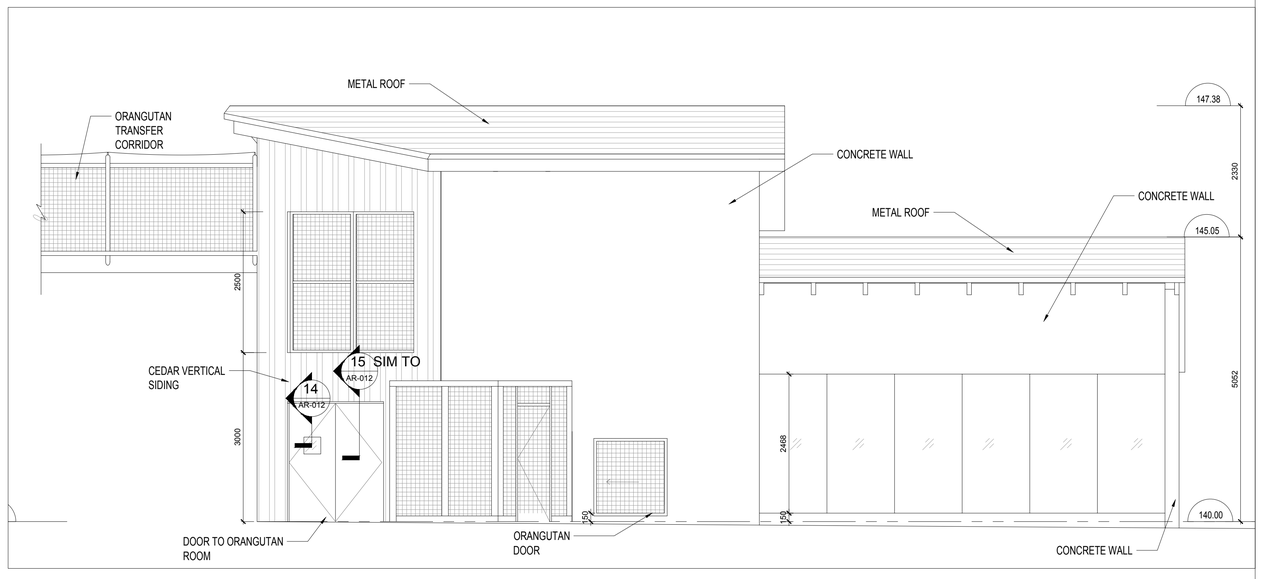
4 AR-123 EAST ELEVATION
SCALE - 1:50



2 AR-123 NORTH ELEVATION
SCALE - 1:50



3 AR-123 WEST ELEVATION
SCALE - 1:50



1 AR-123 SOUTH ELEVATION
SCALE - 1:50

NO.	REV.	ISSUED FOR	DATE
1		PERMIT	2019-11-14
2		TENDER REVIEW	2019-12-06
3		TENDER	2019-12-11

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PROJECT:
ORANGUTAN EXHIBITS

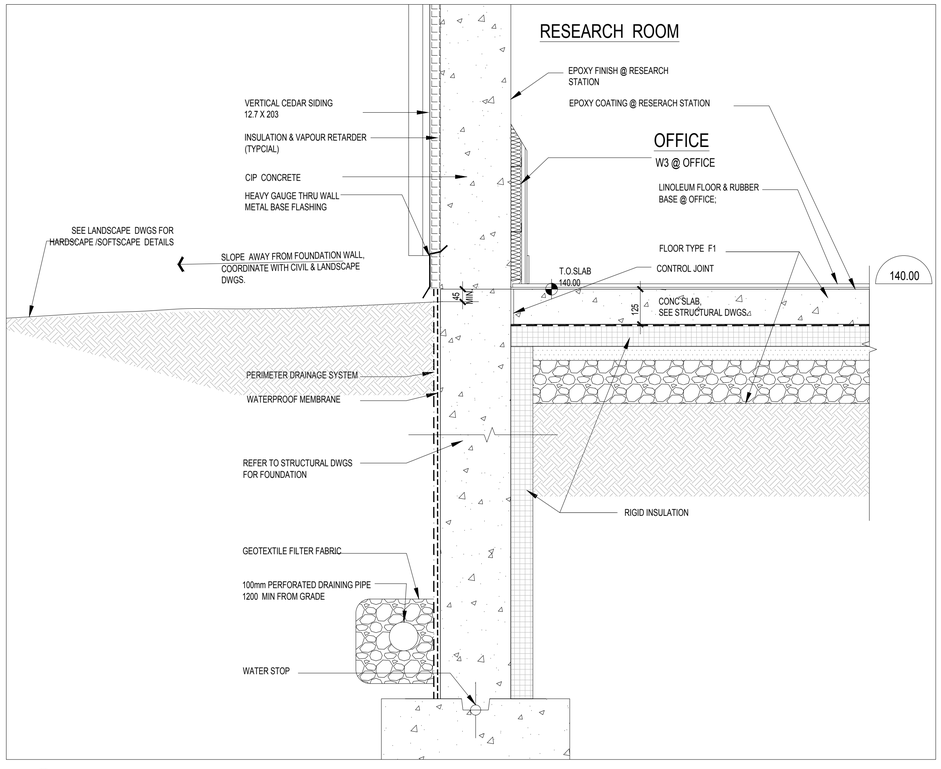
DRAWING NAME :

HABITAT 1 VIEWING/RESEARCH ELEVATIONS

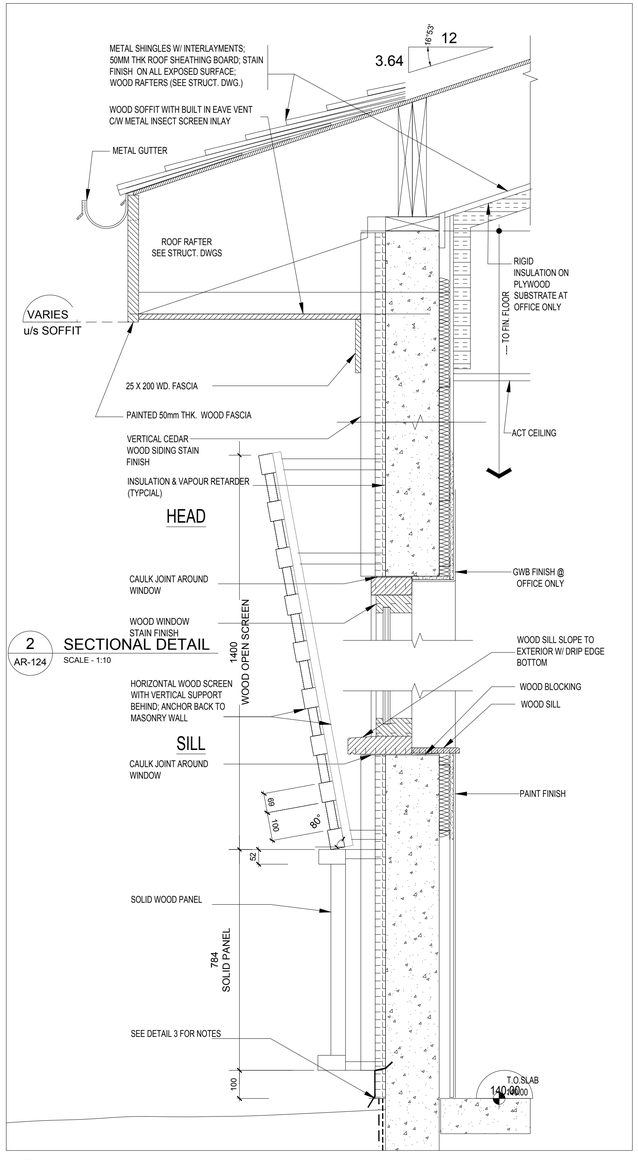
PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	LL	LC

SCALE:
AS NOTED
DECEMBER 11,2019

DRAWING NUMBER:
AR-123



3 AR-124 SECTION AT FOUNDATION WALL
SCALE - 1:10



2 AR-124 SECTIONAL DETAIL
SCALE - 1:10

1 AR-124 SECTION AT ROOF & WOOD WINDOW
SCALE - 1:10

NO.	REV.	ISSUED FOR	DATE
1		PERMIT	2019-11-14
2		TENDER REVIEW	2019-12-06
3		TENDER	2019-12-11

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PROJECT:
ORANGUTAN EXHIBITS

DRAWING NAME :

HABITAT 1
VIEWING/RESEARCH DETAILS

PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	LL	LC

DRAWING NUMBER:

SCALE:
AS NOTED
DECEMBER 11,2019

AR-124

NO.	REV.	ISSUED FOR	DATE
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PROJECT:
ORANGUTAN EXHIBITS

DRAWING NAME :

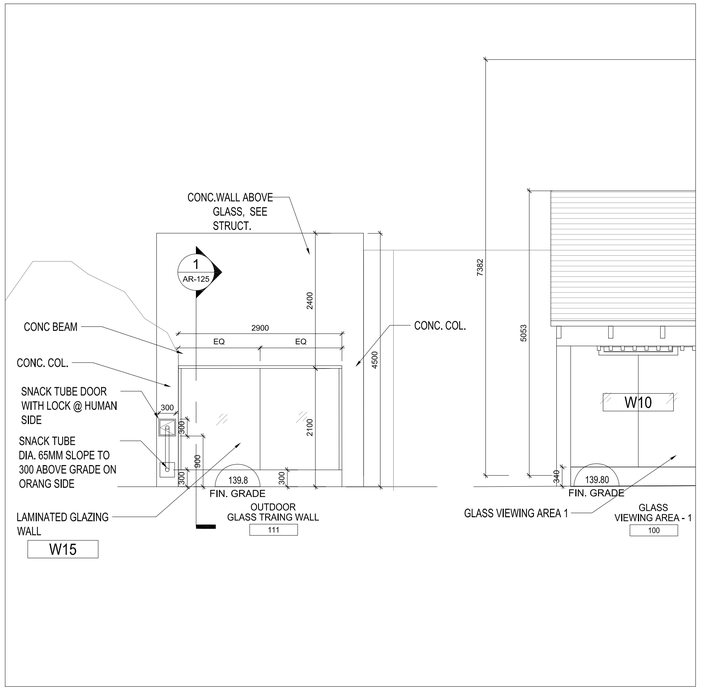
HABITAT 1
OUTDOOR GLASS TRAINING WALL

PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	LL	LC

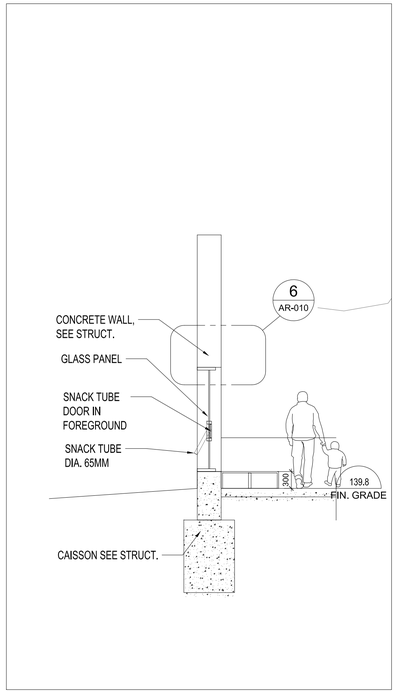
DRAWING NUMBER:

SCALE:
AS NOTED
DECEMBER 11,2019

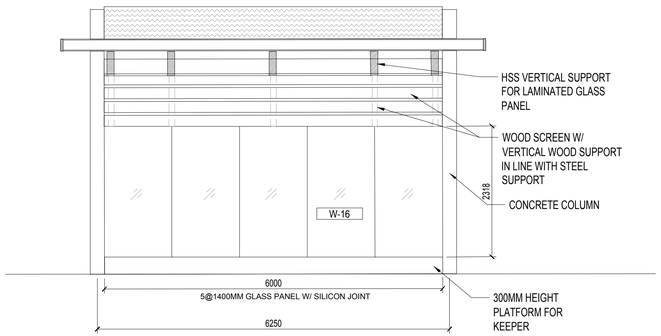
AR-125



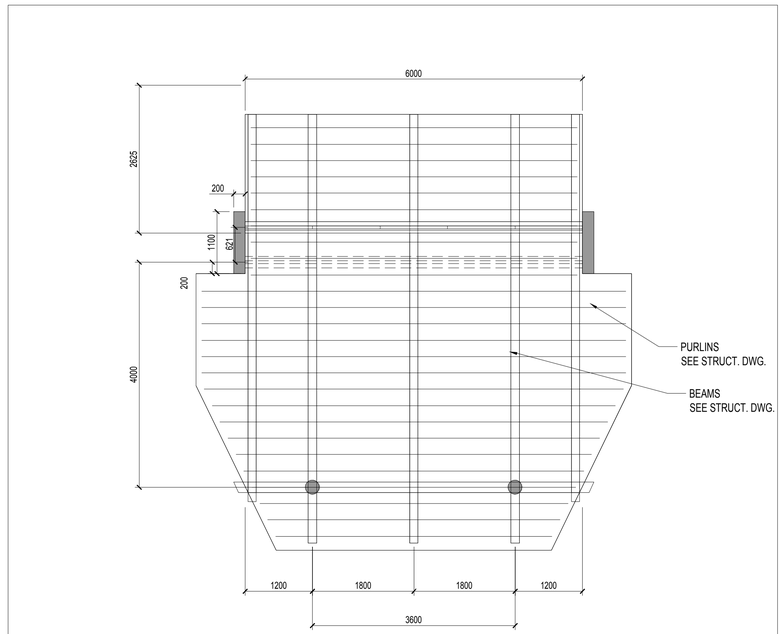
2 AR-125 ELEVATION OF TRAINING WALL
SCALE - 1:50



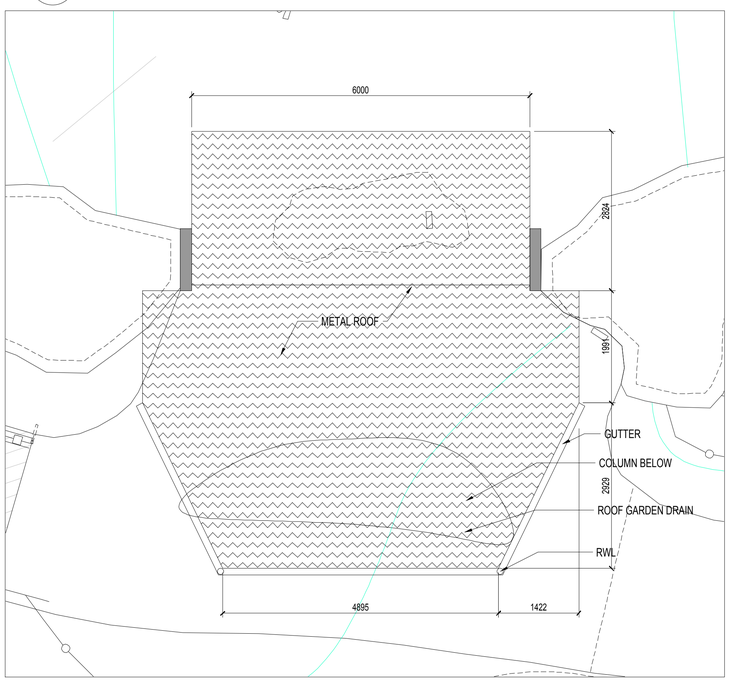
1 AR-125 SECTIONAL DETAIL
SCALE - 1:10



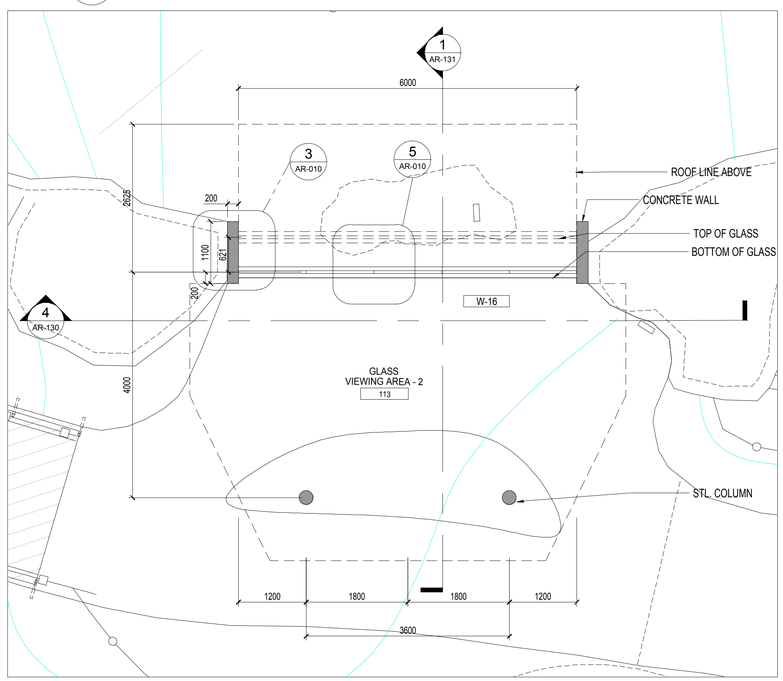
4 AR-130 SECTION
SCALE - 1:50



2 AR-130 REFELCTED CEILING PLAN
SCALE - 1:50



3 AR-130 ROOF PLAN
SCALE - 1:50



1 AR-130 CONSTRUCTION PLAN
SCALE - 1:50

NO.	REV.	ISSUED FOR	DATE
1		PERMIT	2019-11-14
2		TENDER REVIEW	2019-12-06
3		TENDER	2019-12-11

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PROJECT:
ORANGUTAN EXHIBITS

DRAWING NAME :

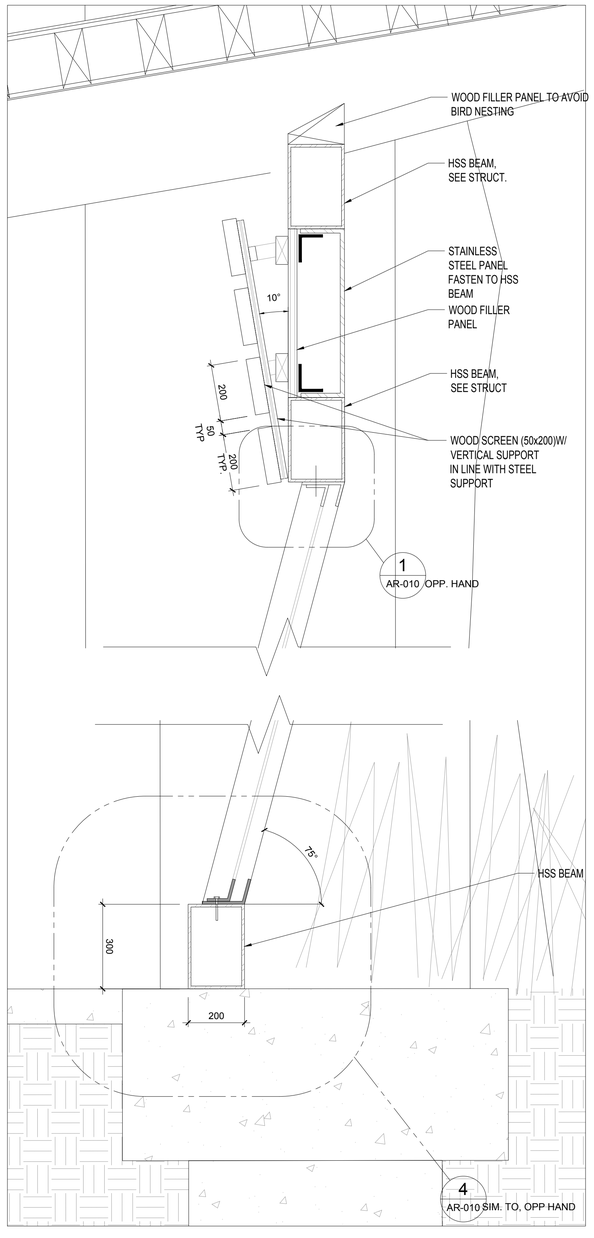
HABITAT 1
GLASS VIEWING TRELLIS PLANS

PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	LL	LC

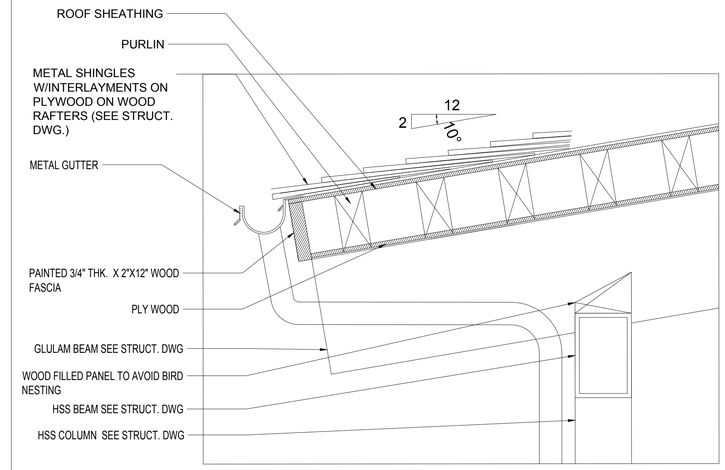
DRAWING NUMBER:

SCALE:
AS NOTED
DECEMBER 11,2019

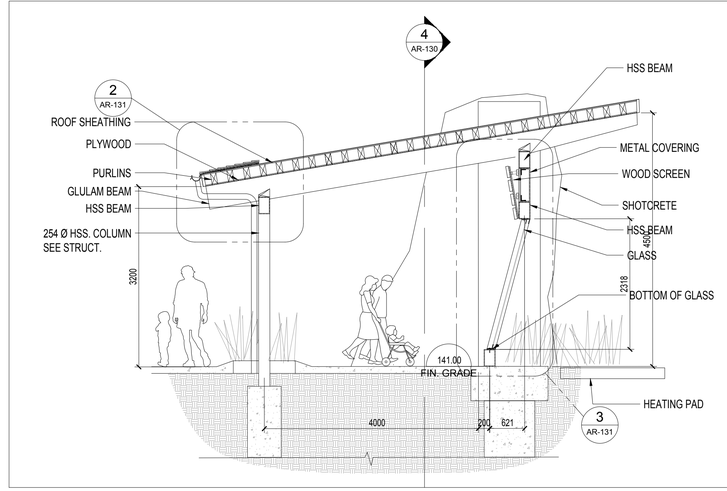
AR-130



3 AR-131 DETAIL SECTION @ GLAZING
SCALE-1:10



2 AR-131 DETAIL SECTION@ ROOF
SCALE - 1:10



1 AR-131 SECTION
SCALE - 1:50

NO.	REV.	ISSUED FOR	DATE
1		PERMIT	2019-11-14
2		TENDER REVIEW	2019-12-06
3		TENDER	2019-12-11

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PROJECT:
ORANGUTAN EXHIBITS

DRAWING NAME :

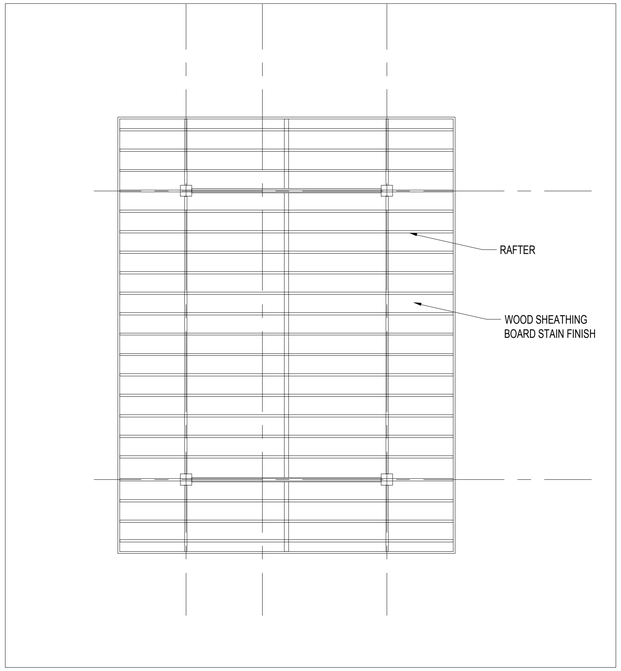
HABITAT 1
GLASS VIEWING TRELLIS SECTIONS

PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	LL	LC

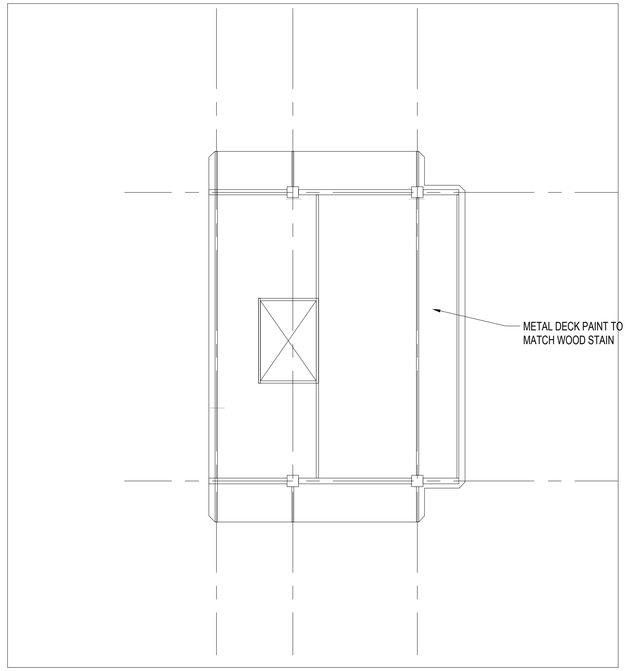
DRAWING NUMBER:

SCALE:
AS NOTED
DECEMBER 11,2019

AR-131



4 AR-140 REFELCTED CEILING PLAN - UPPER LEVEL
SCALE - 1:50



2 AR-140 REFELCTED CEILING PLAN - LOWER LEVEL
SCALE - 1:50

NO.	REV.	ISSUED FOR	DATE
1		PERMIT	2019-11-14
2		TENDER REVIEW	2019-12-06
3		TENDER	2019-12-11

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PROJECT:
ORANGUTAN EXHIBITS

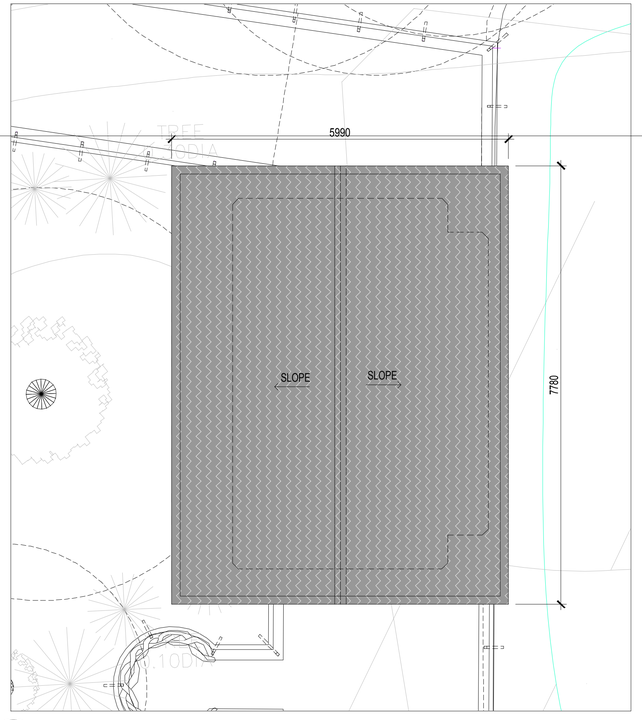
DRAWING NAME :

HABITAT 1
TREE HOUSE PLANS

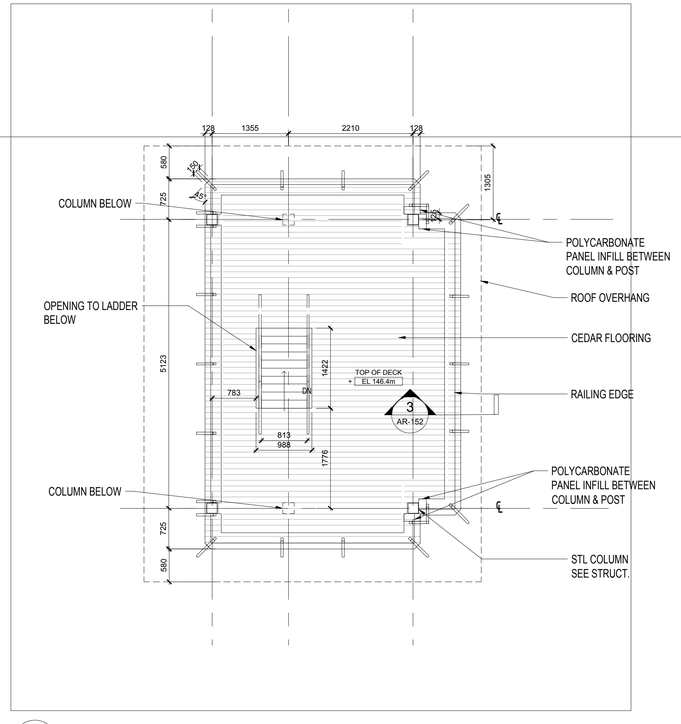
PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	LL	LC

SCALE:
AS NOTED
DECEMBER 11,2019

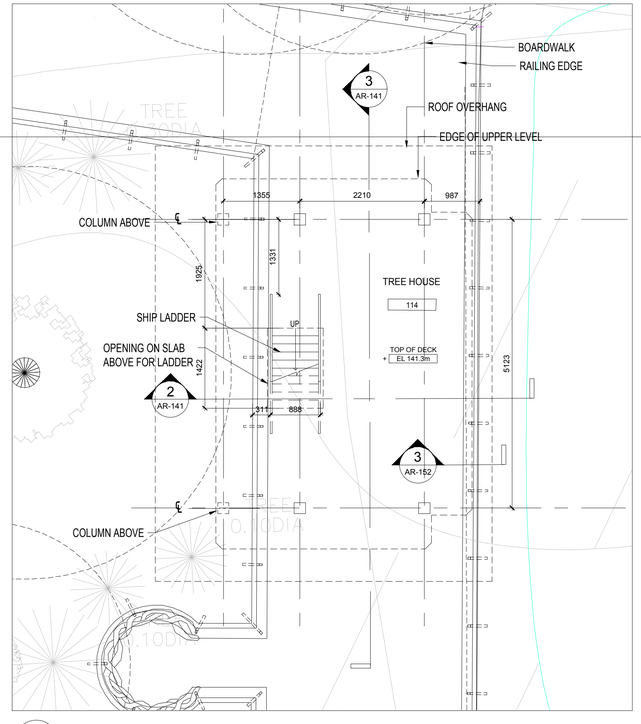
DRAWING NUMBER:
AR-140



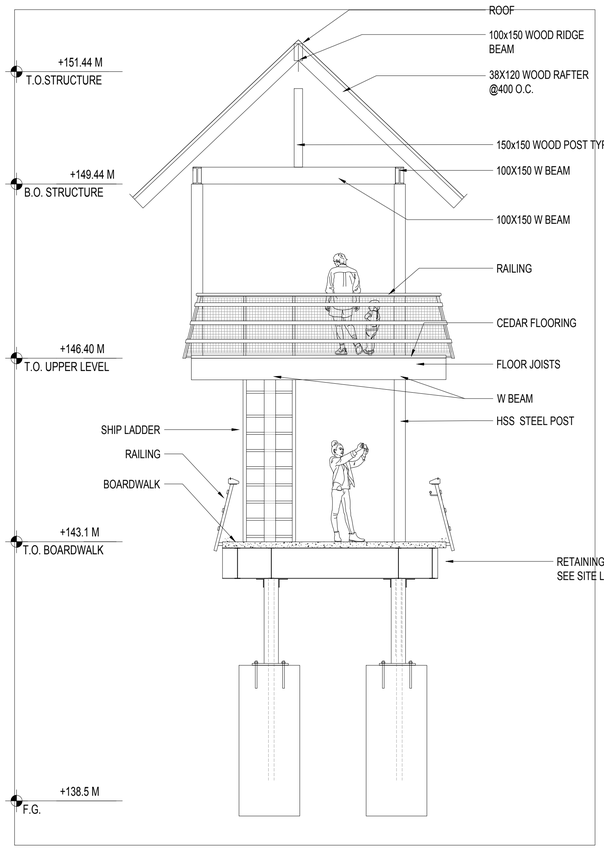
5 AR-140 ROOF PLAN
SCALE - 1:50



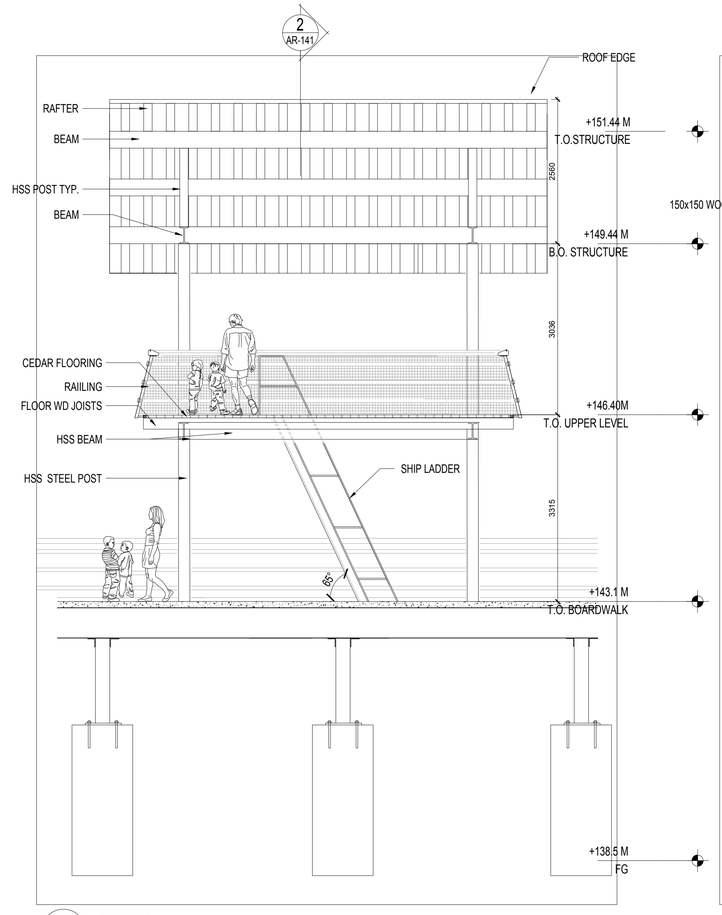
3 AR-140 CONSTRUCTION PLAN - UPPER LEVEL
SCALE - 1:50



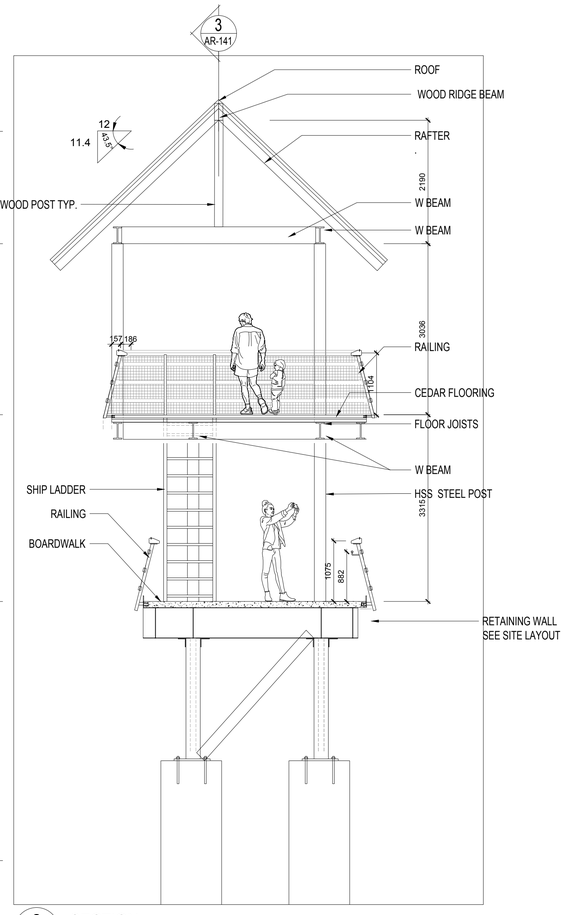
1 AR-140 CONSTRUCTION PLAN - LOWER LEVEL
SCALE - 1:50



4 AR-141 ELEVATION
SCALE - 1:50



3 AR-141 SECTION
SCALE - 1:50



2 AR-141 SECTION
SCALE - 1:50

NO.	REV.	ISSUED FOR	DATE
1		PERMIT	2019-11-14
2		TENDER REVIEW	2019-12-06
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PROJECT:
ORANGUTAN EXHIBITS

DRAWING NAME :

HABITAT 1

TREE HOUSE SECTIONS AND ELEVATIONS

PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	LL	LC

SCALE:
AS NOTED
DECEMBER 11,2019

DRAWING NUMBER:
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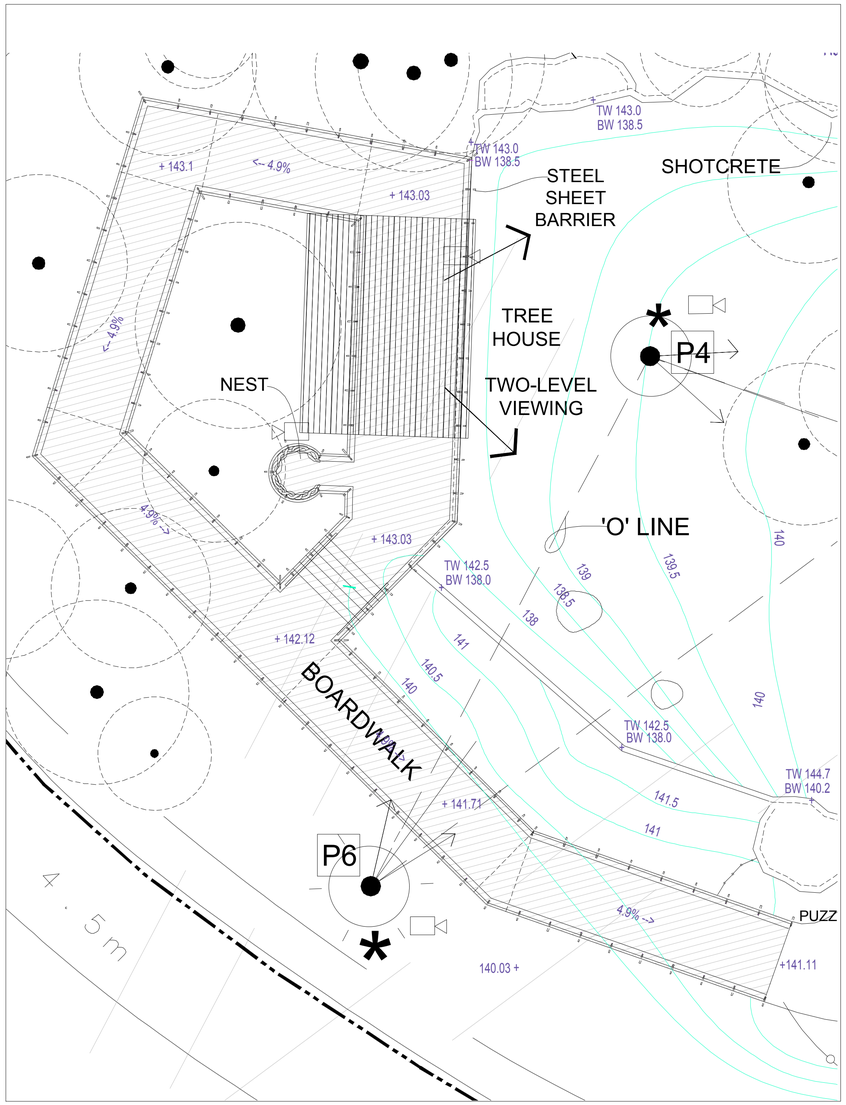
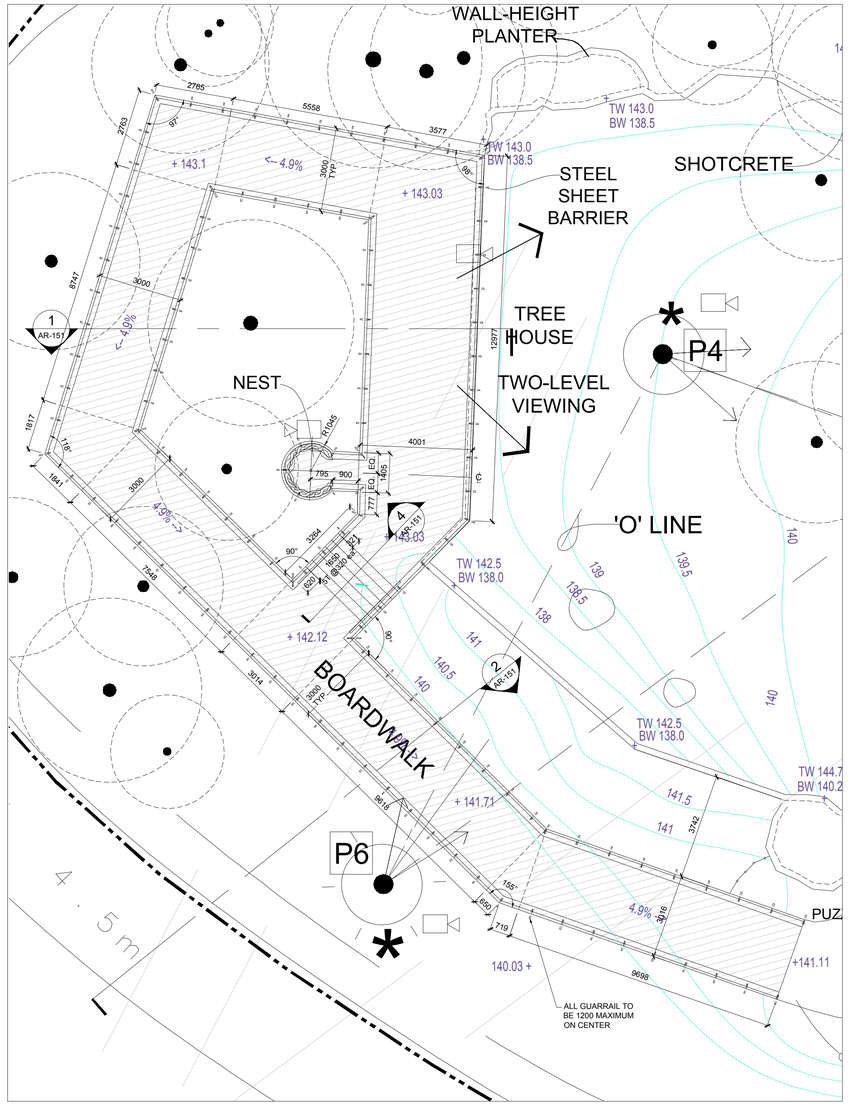


2 AR-150 ROOF PLAN
SCALE - 1:50



1 AR-150 CONSTRUCTION PLAN
SCALE - 1:50

NO.	REV.	ISSUED FOR	DATE
1		PERMIT	2019-11-14
2		TENDER REVIEW	2019-12-06
3		TENDER	2019-12-11

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PROJECT:
ORANGUTAN EXHIBITS

DRAWING NAME :

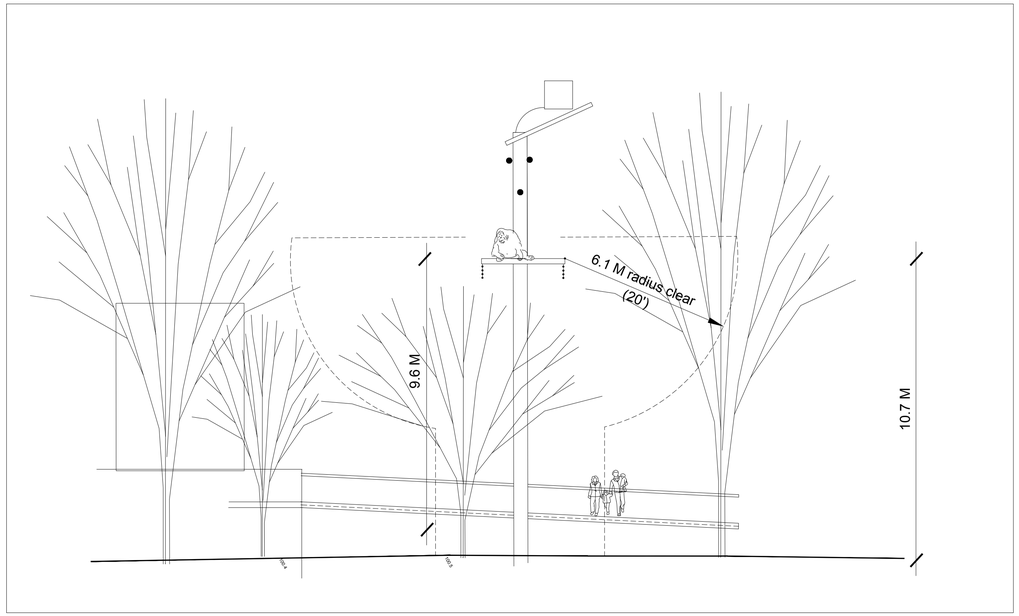
HABITAT 1
BOARDWALK PLANS

PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	LL	LC

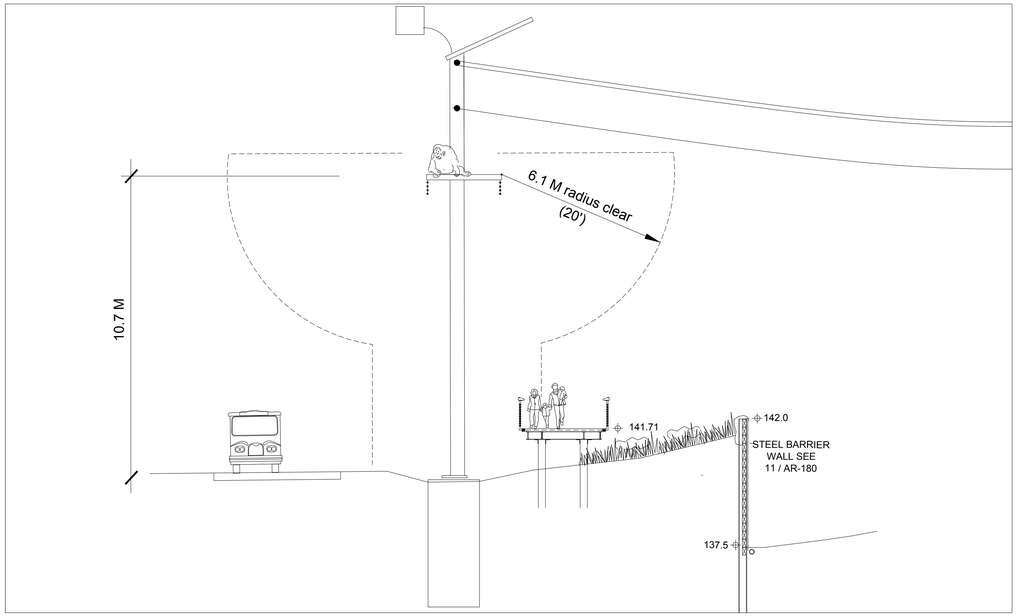
DRAWING NUMBER:

SCALE:
AS NOTED
DECEMBER 11,2019

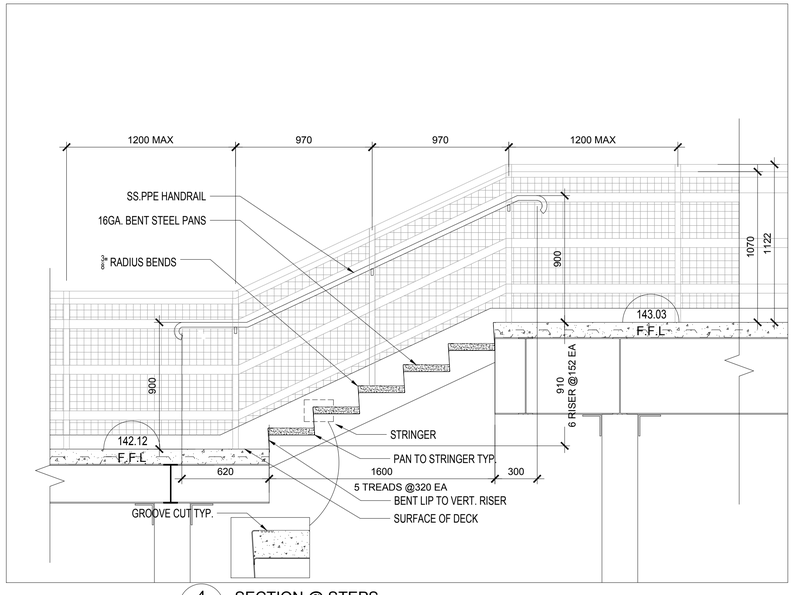
AR-150



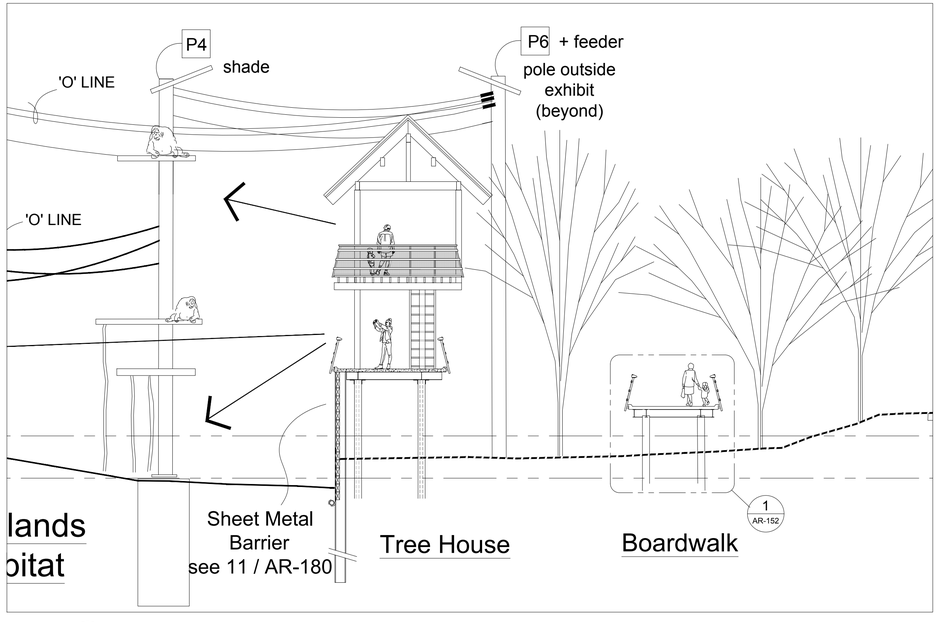
3 AR-151 ELEVATION
SCALE - 1:50



2 AR-151 SECTION
SCALE - 1:50



4 AR-151 SECTION @ STEPS
SCALE - 1:20



1 AR-151 SECTION
SCALE - 1:50

NO.	REV.	ISSUED FOR	DATE
1	1	PERMIT	2019-11-14
2		TENDER REVIEW	2019-12-06
3		TENDER	2019-12-11

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PROJECT:
ORANGUTAN EXHIBITS

DRAWING NAME :

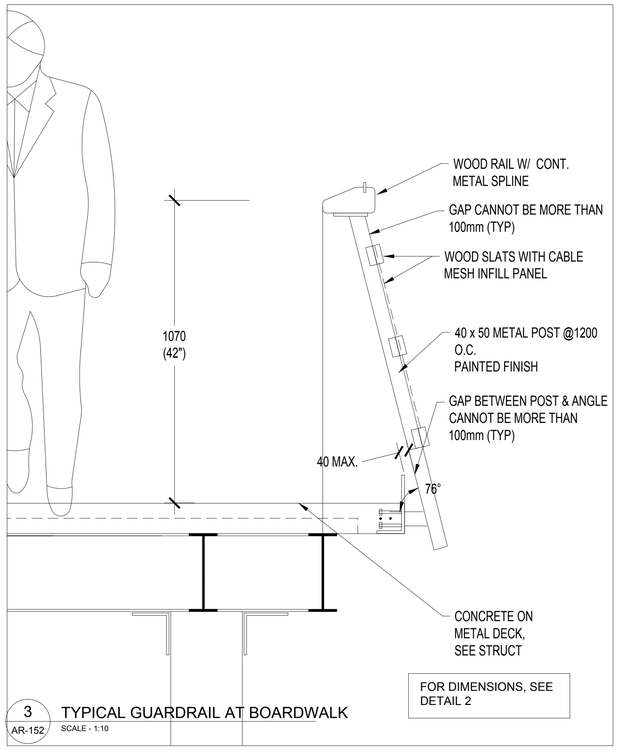
HABITAT 1

BOARDWALK SECTIONS &ELEVATIONS

PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	LL	LC

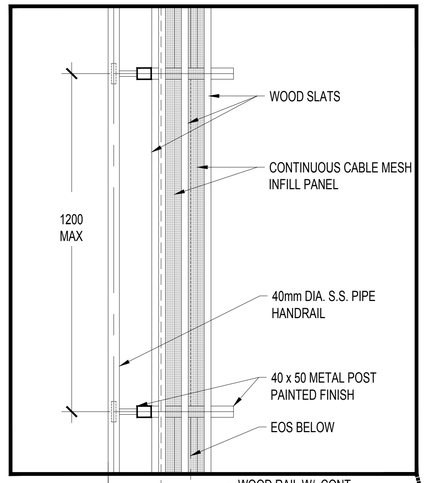
SCALE:
AS NOTED
DECEMBER 11,2019

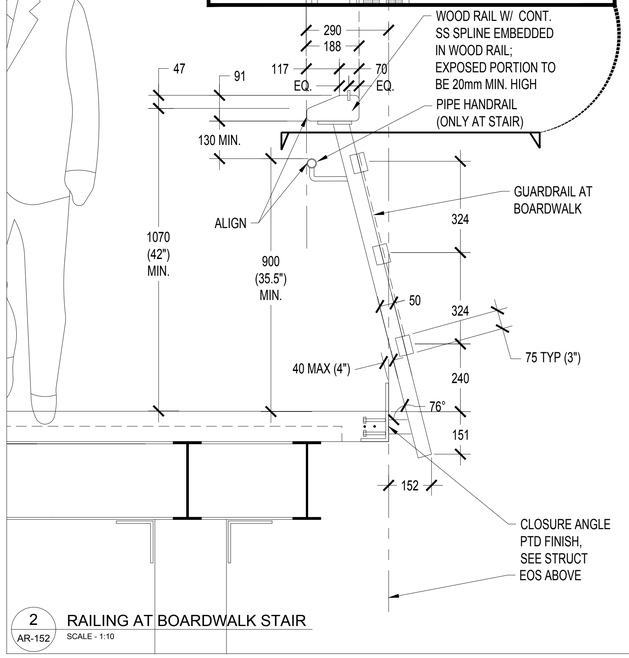
DRAWING NUMBER:
AR-151



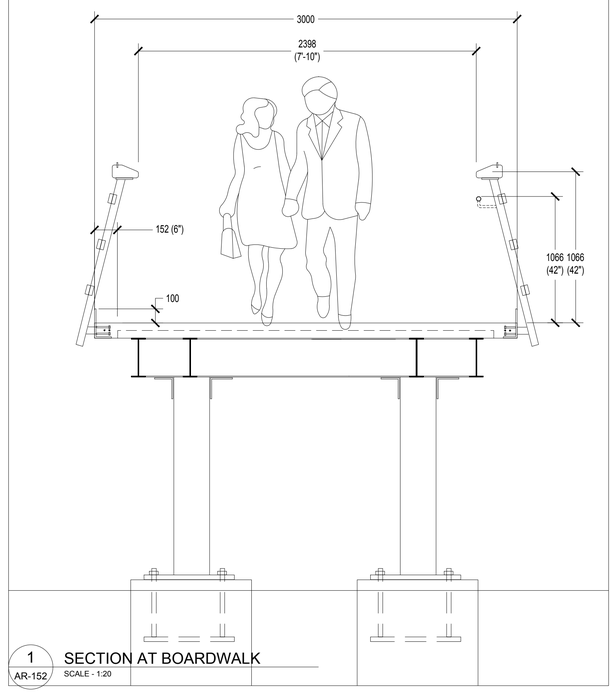
3 AR-152 TYPICAL GUARDRAIL AT BOARDWALK
SCALE - 1:10

PLAN DETAIL OF GUARDRAIL & HANDRAIL





2 AR-152 RAILING AT BOARDWALK STAIR
SCALE - 1:10



1 AR-152 SECTION AT BOARDWALK
SCALE - 1:20

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2		TENDER REVIEW	2019-12-06
3		TENDER	2019-12-11

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PROJECT:
ORANGUTAN EXHIBITS

DRAWING NAME :

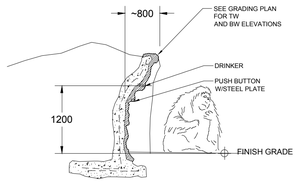
HABITAT 1
BOARDWALK DETAILS

PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	LL	LC

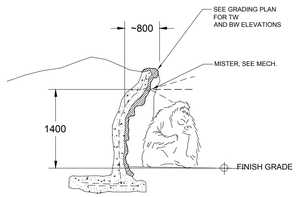
DRAWING NUMBER:

SCALE:
AS NOTED
DECEMBER 11,2019

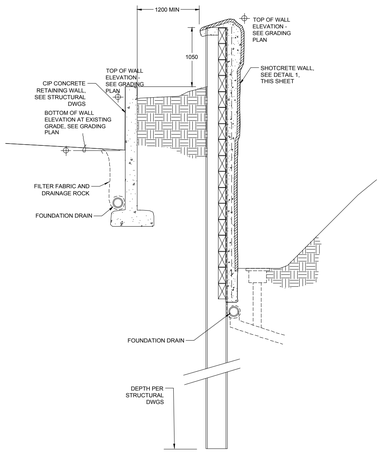
AR-152



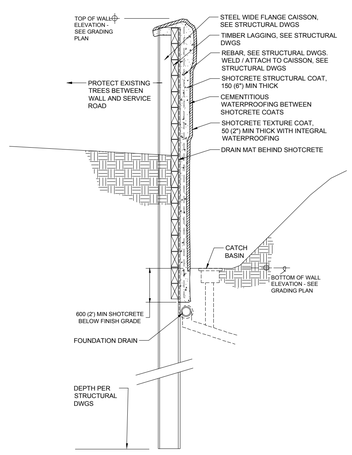
16 AR-180 ORANG DRINKER
SCALE - 1:50



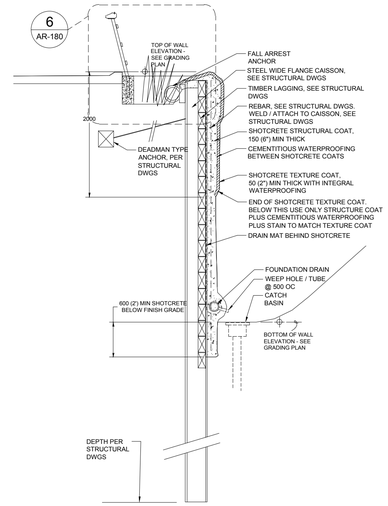
15 AR-180 ORANG MISTER
SCALE - 1:50



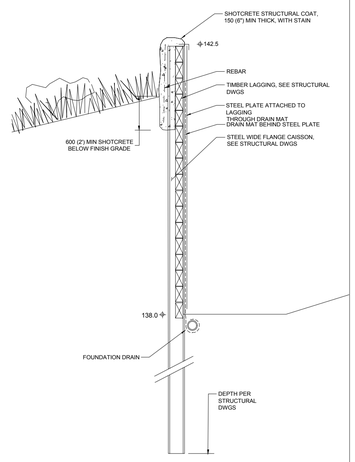
14 AR-180 HALF MOAT WALL W/ PLANTER
SCALE - 1:50



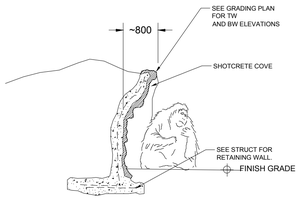
13 AR-180 HALF MOAT WALL
SCALE - 1:50



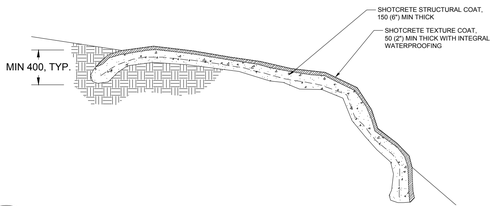
12 AR-180 FULL MOAT WALL
SCALE - 1:50



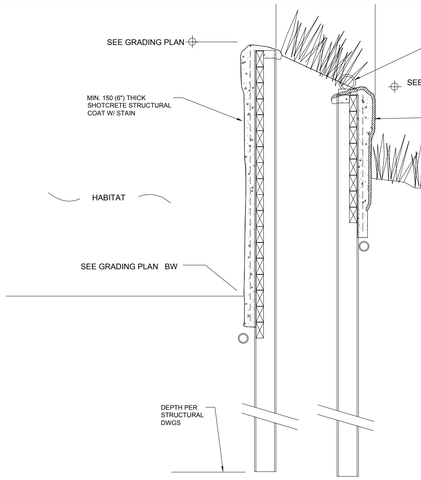
11 AR-180 STEEL METAL WALL
SCALE - 1:50



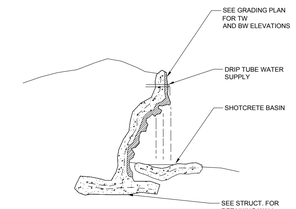
10 AR-180 SHOTCRETE COVE
SCALE - 1:50



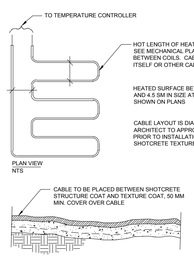
8 AR-180 SHOTCRETE BOULDER
SCALE - 1:50



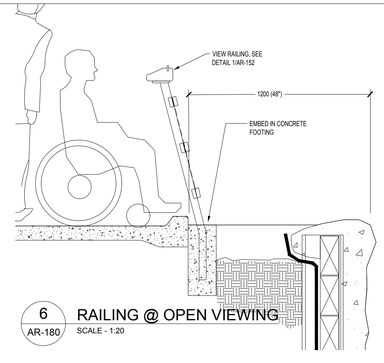
3 AR-180 RAILING @ OPEN VIEWING
SCALE - 1:50



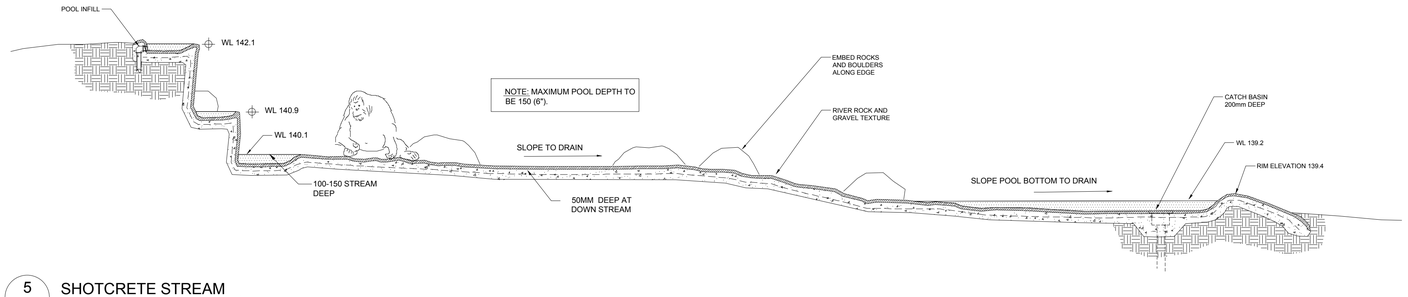
9 AR-180 SHOTCRETE DRIP EDGE
SCALE - 1:50



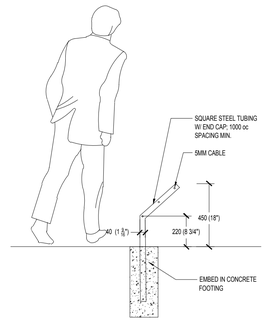
7 AR-180 SHOTCRETE HEAT PAD
SCALE - 1:50



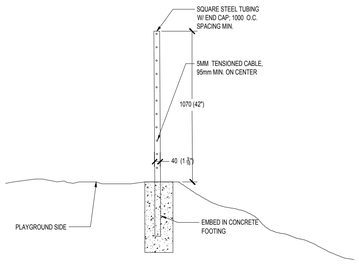
6 AR-180 RAILING @ OPEN VIEWING
SCALE - 1:20



5 AR-180 SHOTCRETE STREAM
SCALE - 1:50



2 AR-180 KICK RAIL
SCALE - 1:20



1 AR-180 GUARDRAIL @ PLAYGROUND
SCALE - 1:20

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PROJECT:
ORANGUTAN EXHIBITS

DRAWING NAME :

HABITAT 1
DETAILED SECTIONS

PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	LL	LC

SCALE:
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DECEMBER 11,2019

DRAWING NUMBER:
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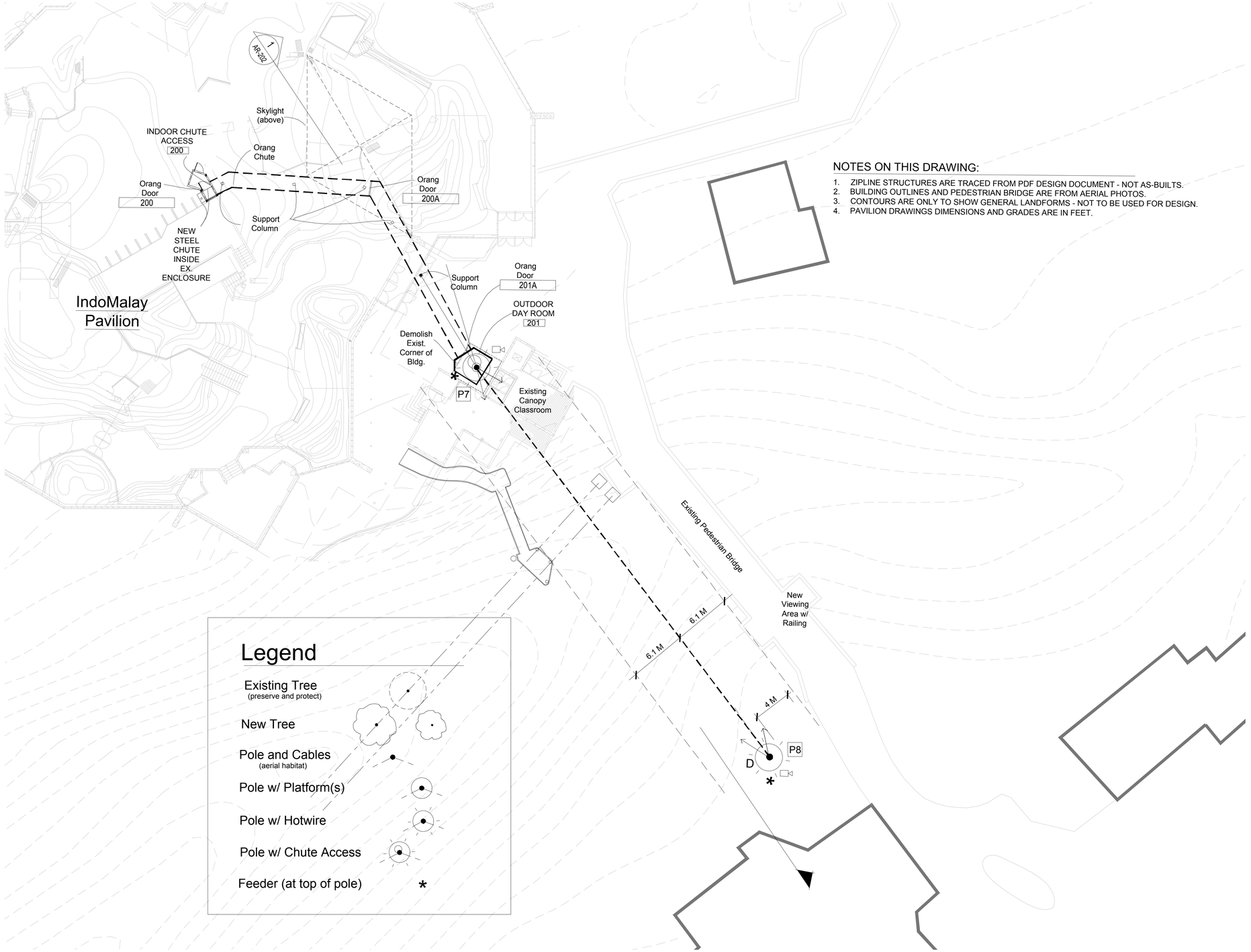

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1. ZIPLINE STRUCTURES ARE TRACED FROM PDF DESIGN DOCUMENT - NOT AS-BUILTS.
2. BUILDING OUTLINES AND PEDESTRIAN BRIDGE ARE FROM AERIAL PHOTOS.
3. CONTOURS ARE ONLY TO SHOW GENERAL LANDFORMS - NOT TO BE USED FOR DESIGN.
4. PAVILION DRAWINGS DIMENSIONS AND GRADES ARE IN FEET.

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PROJECT:
ORANGUTAN EXHIBITS

DRAWING NAME :

HABITAT 2
LAYOUT & MATERIALS PLAN

PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	LL	LC

DRAWING NUMBER:

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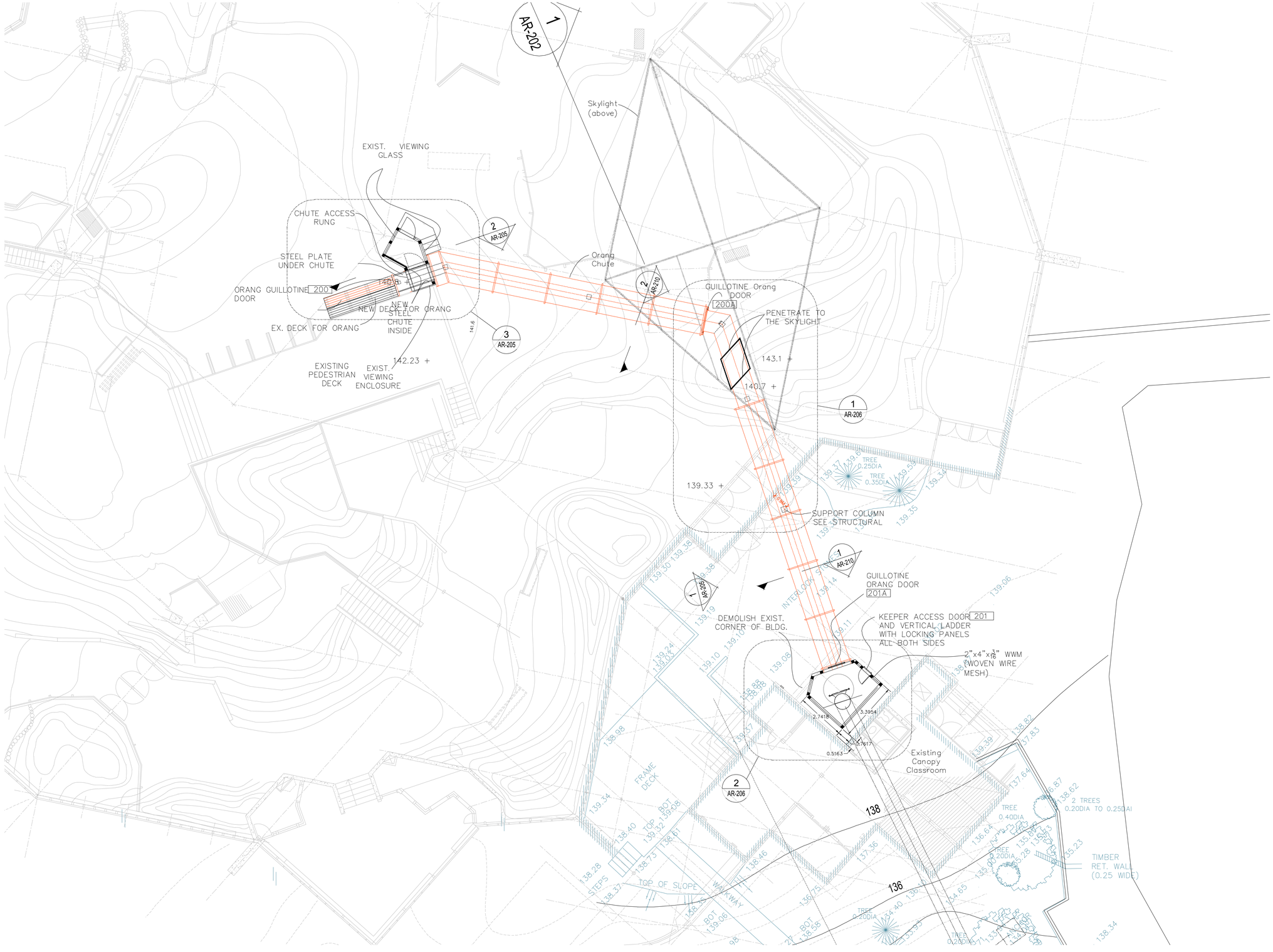
1 : 200
DECEMBER 11,2019

AR-200



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PROJECT:
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1 : 100
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PROJECT:
ORANGUTAN EXHIBITS

DRAWING NAME :

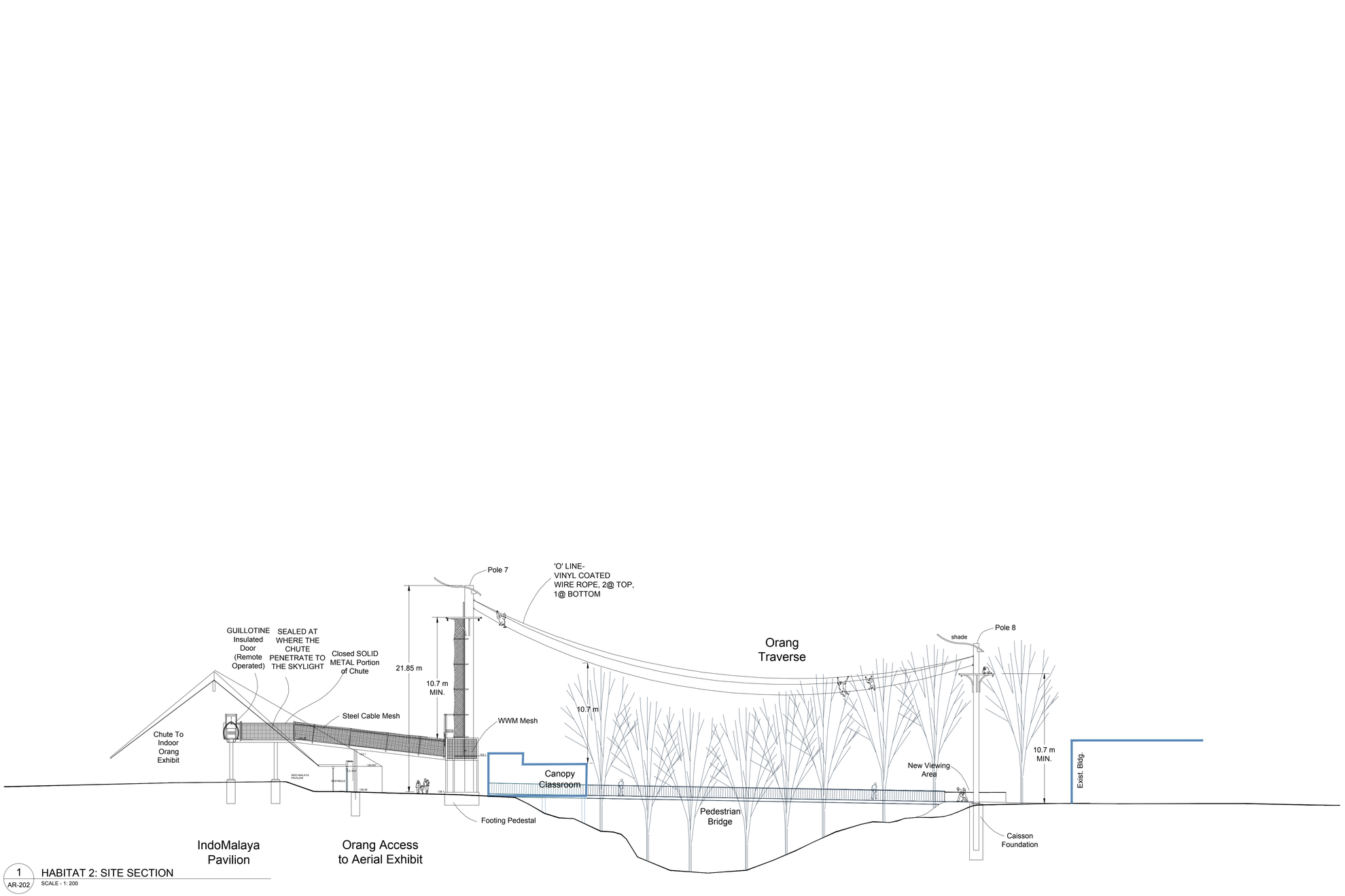
HABITAT 2
SITE SECTION

PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	LL	LC

DRAWING NUMBER:

SCALE:
1 : 200
DECEMBER 11,2019

AR-202



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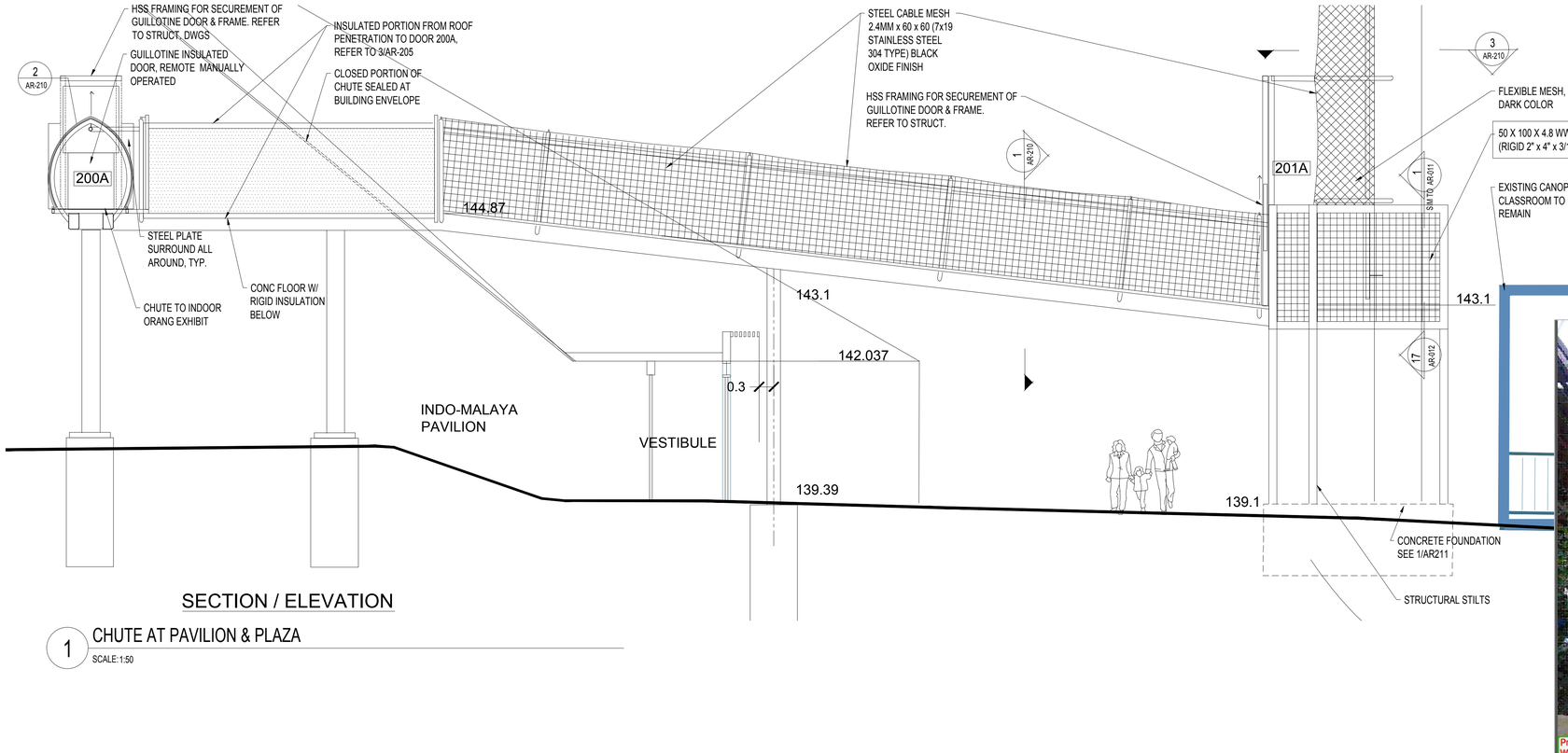
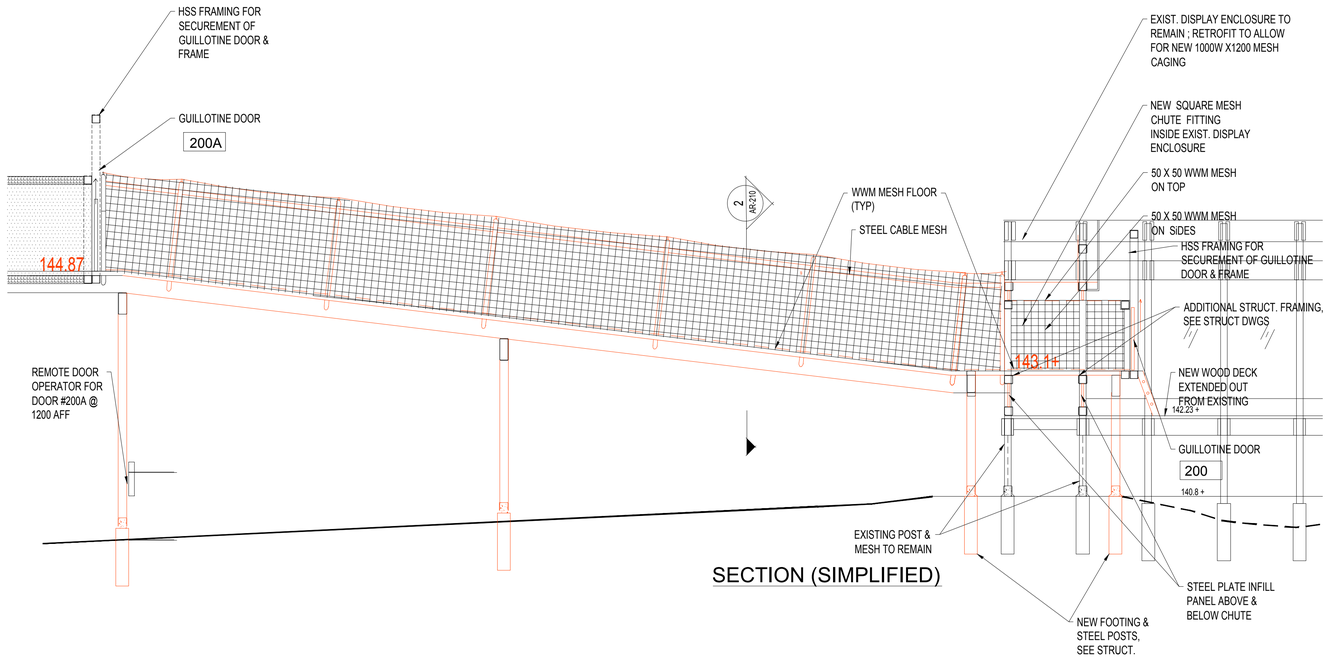
AR-202
HABITAT 2: SITE SECTION
SCALE - 1: 200



SECTION / ELEVATION

1 CHUTE AT PAVILION & PLAZA

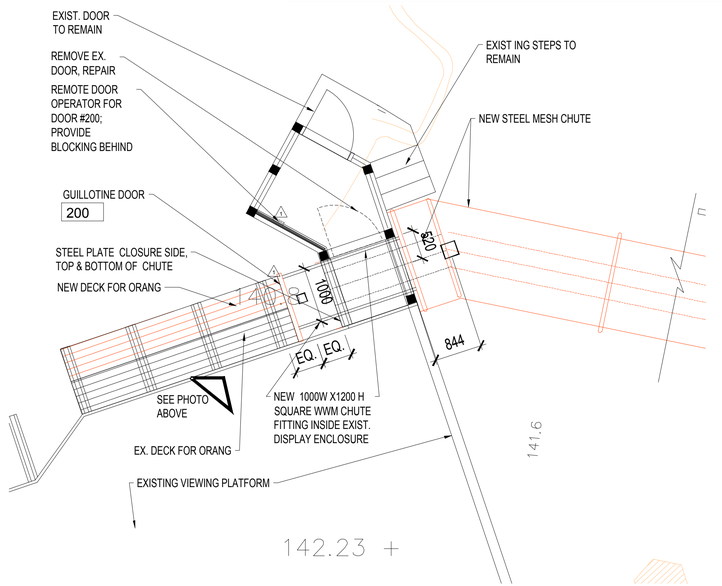
SCALE: 1:50



SECTION (SIMPLIFIED)

2 ACCESS TOWER AT EXISTING VIEWING PLATFORM, SECTION

SCALE: 1:50



3 ACCESS CHUTE AT EXISTING VIEWING PLATFORM PLAN

SCALE: 1:50

NO.	REV.	ISSUED FOR	DATE
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2		TENDER REVIEW	2019-12-06
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PROJECT:
ORANGUTAN EXHIBITS

DRAWING NAME :

HABITAT 2
CHUTES

PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	LL	LC

DRAWING NUMBER:

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DECEMBER 11,2019

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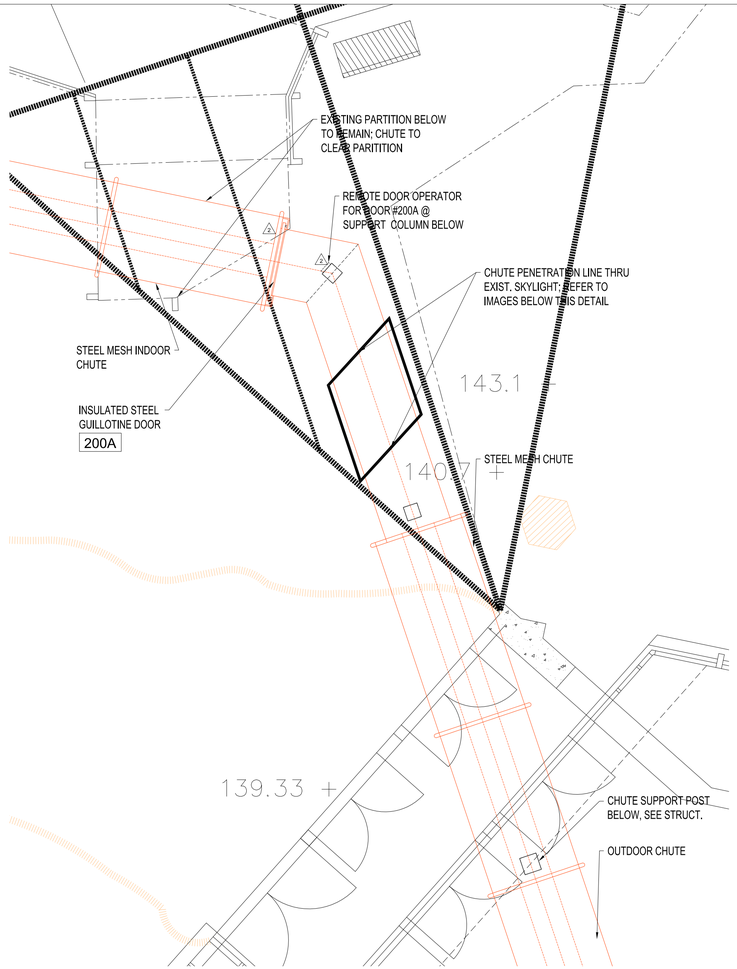
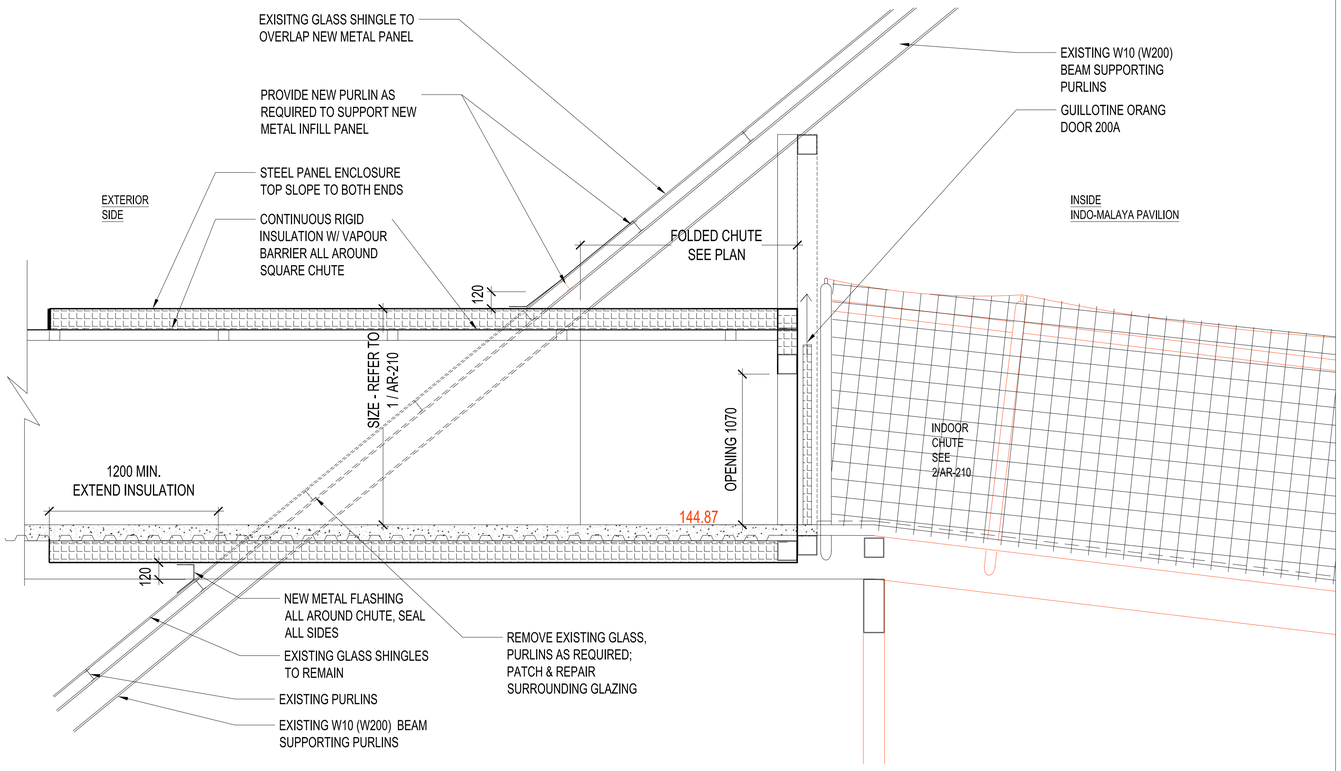


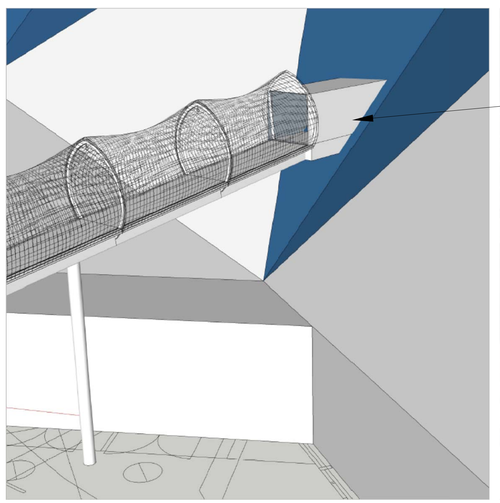
1 PLAN: CHUTE THRU SKYLIGHT

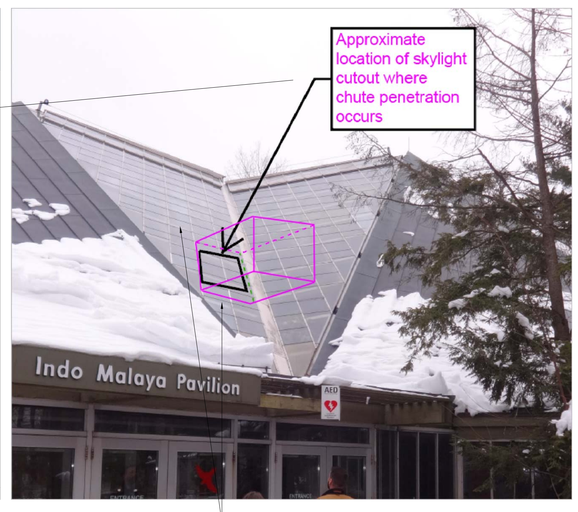
SCALE: 1:50



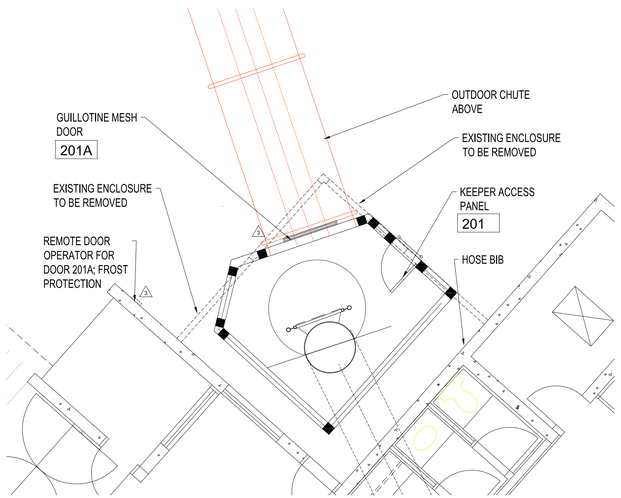
3 DETAIL: CHUTE PENETRATION @SKYLIGHT

SCALE: 1: 20





PROVIDE SS PANELS SIDES, BOTTOM & TOP OF OPENING WHERE GLASS SHINGLES ARE REMOVED. COMPLETELY SEAL CHUTE TO METAL PANELS; SEE DETAIL 3 OF THIS SHEET



2 PLAN: HABITAT 2 OUTDOOR DAYROOM

SCALE: 1:50

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1		PERMIT	2019-11-14
2		TENDER REVIEW	2019-12-06
3		TENDER	2019-12-11

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CLIENT: **TORONTO ZOO**

toronto zoo

361A Old Finch Ave, Toronto, ON M1B 5K7 · 416-392-5929

PROJECT:
ORANGUTAN EXHIBITS

DRAWING NAME :

HABITAT 2
SECTIONAL DETAILS

PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	LL	LC

SCALE:
AS NOTED
DECEMBER 11,2019

DRAWING NUMBER:
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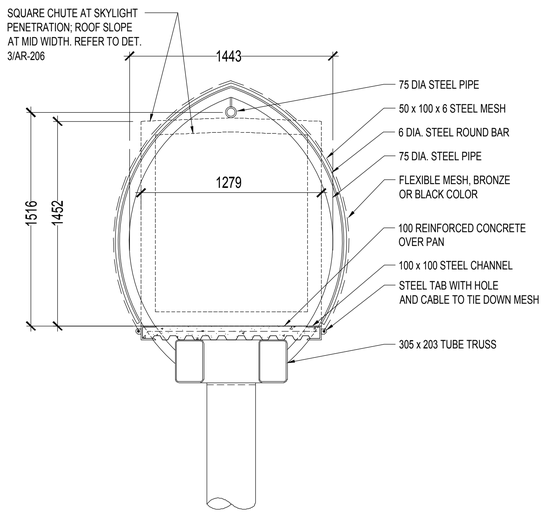
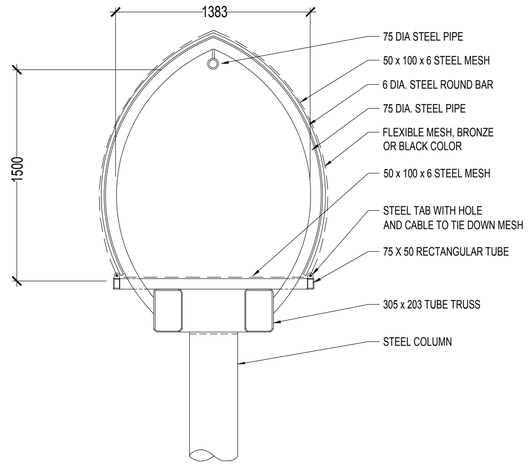


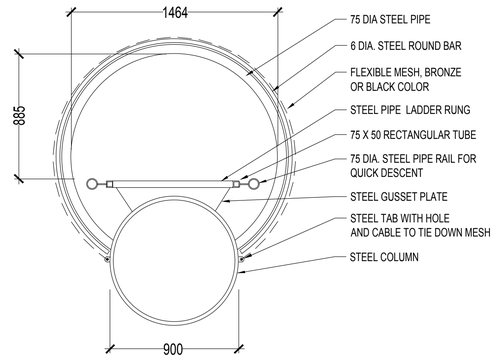
1 CHUTE W/ CONC WALKWAY (OUTDOOR)

scale: 1:20



2 CHUTE W/ MESH WALKWAY (INDOOR)

scale: 1:20



3 VERTICAL CHUTE AT LARGE POLE

scale: 1:20

GENERAL NOTES:

1. ALL EXTERIOR METAL TO BE EITHER GALVANIZED OR STAINLESS STEEL TYPE 304

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2		TENDER REVIEW	2019-12-06
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PROJECT:
ORANGUTAN EXHIBITS

DRAWING NAME :

HABITAT 2
CHUTES DETAILS

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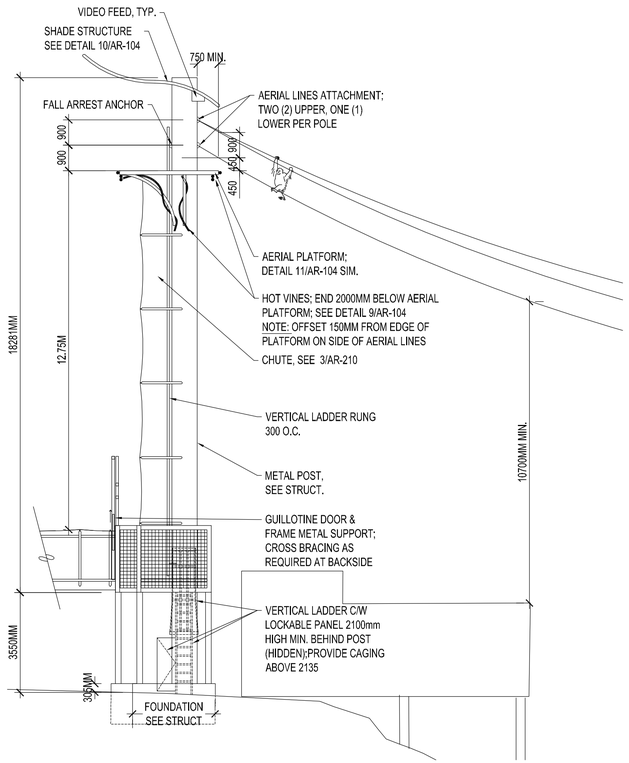
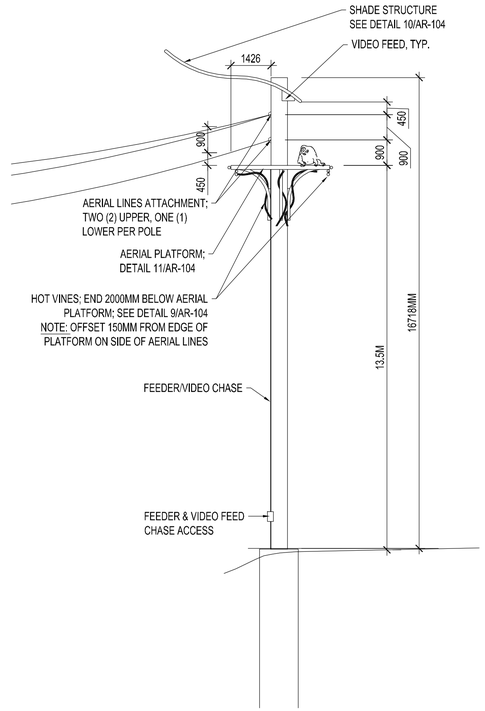
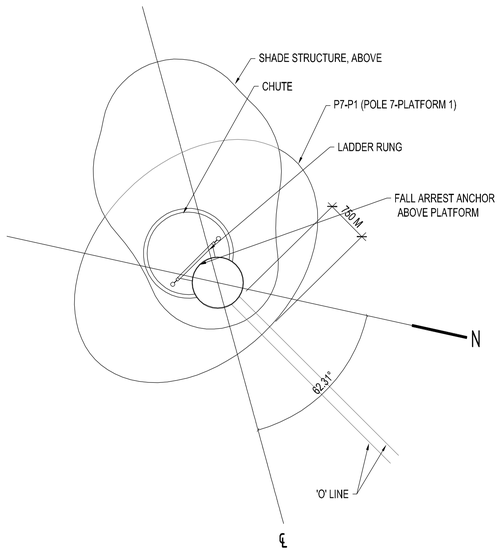
FOR FEEDER DETAILS, SEE AR-106



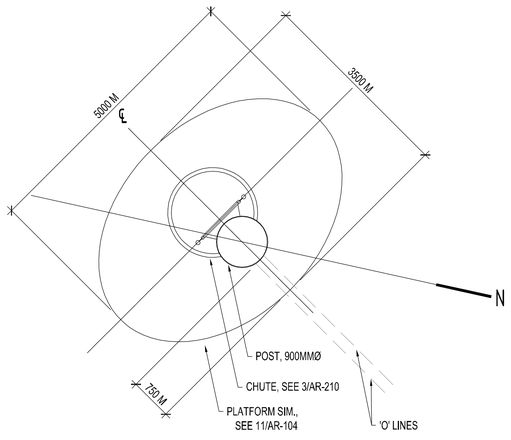
1 POLE 7
SCALE:1:100



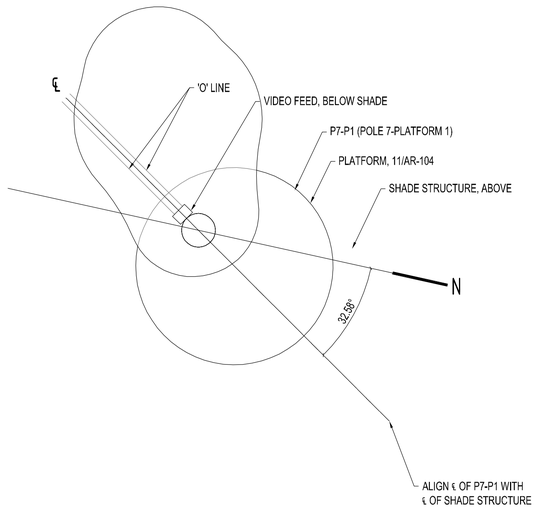
2 POLE 8
SCALE:1:100



3 POLE 7 PLATFORM SCHEMATIC PLAN
SCALE:1:50



4 POLE 7 PLAN WITH CHUTE
SCALE:1:50



5 POLE 8 SCHEMATIC PLAN
SCALE:1:50

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PROJECT:
ORANGUTAN EXHIBITS

DRAWING NAME :

HABITAT 2
CLIMBING POLE DETAIL

PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	LL	LC

DRAWING NUMBER:

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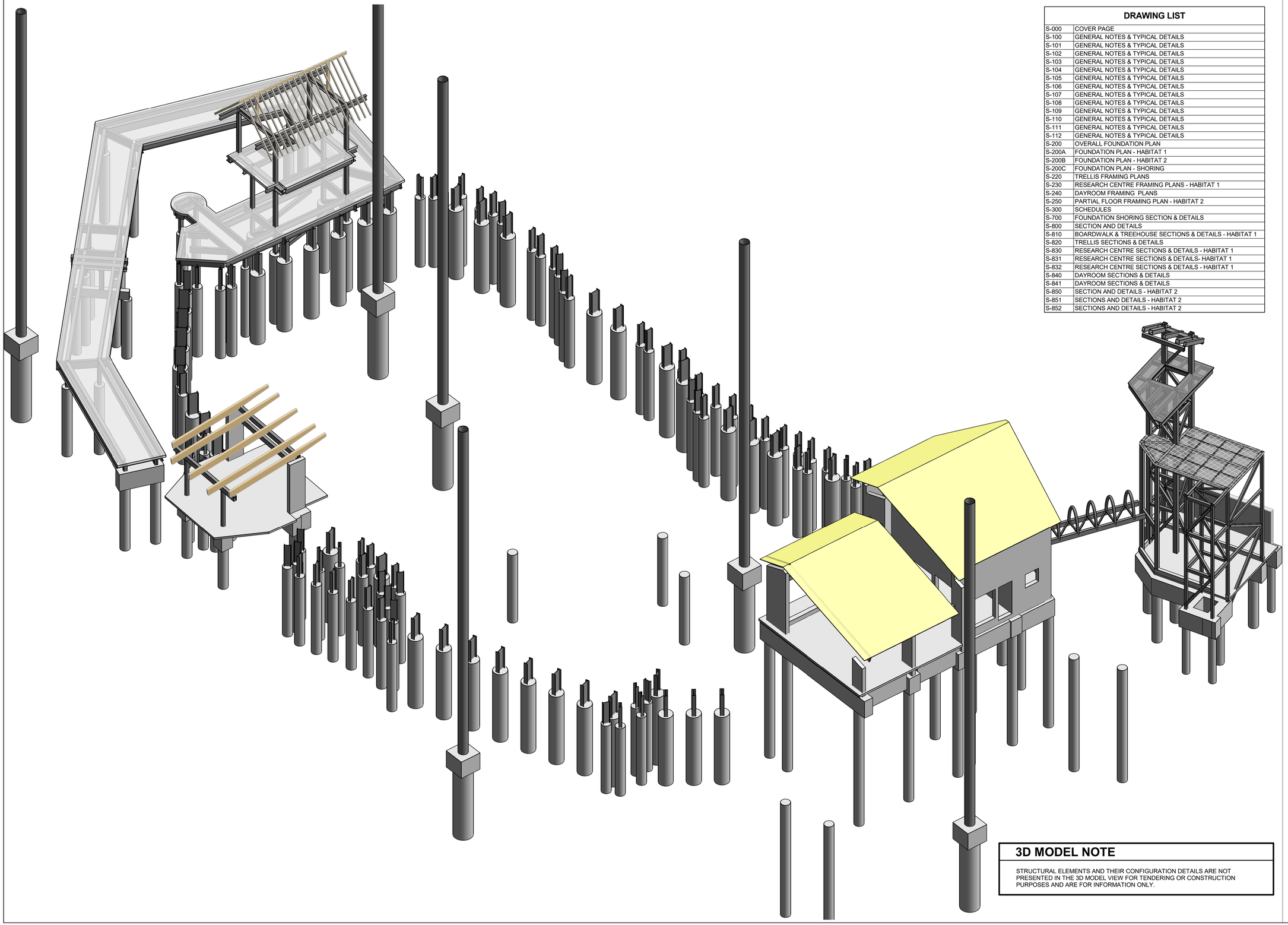

DRAWING LIST

S-000	COVER PAGE
S-100	GENERAL NOTES & TYPICAL DETAILS
S-101	GENERAL NOTES & TYPICAL DETAILS
S-102	GENERAL NOTES & TYPICAL DETAILS
S-103	GENERAL NOTES & TYPICAL DETAILS
S-104	GENERAL NOTES & TYPICAL DETAILS
S-105	GENERAL NOTES & TYPICAL DETAILS
S-106	GENERAL NOTES & TYPICAL DETAILS
S-107	GENERAL NOTES & TYPICAL DETAILS
S-108	GENERAL NOTES & TYPICAL DETAILS
S-109	GENERAL NOTES & TYPICAL DETAILS
S-110	GENERAL NOTES & TYPICAL DETAILS
S-111	GENERAL NOTES & TYPICAL DETAILS
S-112	GENERAL NOTES & TYPICAL DETAILS
S-200	OVERALL FOUNDATION PLAN
S-200A	FOUNDATION PLAN - HABITAT 1
S-200B	FOUNDATION PLAN - HABITAT 2
S-200C	FOUNDATION PLAN - SHORING
S-220	TRELLIS FRAMING PLANS
S-230	RESEARCH CENTRE FRAMING PLANS - HABITAT 1
S-240	DAYROOM FRAMING PLANS
S-250	PARTIAL FLOOR FRAMING PLAN - HABITAT 2
S-300	SCHEDULES
S-700	FOUNDATION SHORING SECTION & DETAILS
S-800	SECTION AND DETAILS
S-810	BOARDWALK & TREEHOUSE SECTIONS & DETAILS - HABITAT 1
S-820	TRELLIS SECTIONS & DETAILS
S-830	RESEARCH CENTRE SECTIONS & DETAILS - HABITAT 1
S-831	RESEARCH CENTRE SECTIONS & DETAILS- HABITAT 1
S-832	RESEARCH CENTRE SECTIONS & DETAILS - HABITAT 1
S-840	DAYROOM SECTIONS & DETAILS
S-841	DAYROOM SECTIONS & DETAILS
S-850	SECTION AND DETAILS - HABITAT 2
S-851	SECTIONS AND DETAILS - HABITAT 2
S-852	SECTIONS AND DETAILS - HABITAT 2

3D MODEL NOTE

STRUCTURAL ELEMENTS AND THEIR CONFIGURATION DETAILS ARE NOT PRESENTED IN THE 3D MODEL VIEW FOR TENDERING OR CONSTRUCTION PURPOSES AND ARE FOR INFORMATION ONLY.

NO.	REV.	ISSUED FOR	DATE
1	1	100% DD	2019-10-02
2	2	PROGRESS	2019-10-17
3	3	60% CD	2019-10-25
4	4	100% CD	2019-11-12
5	5	ISSUED FOR PERMIT	2019-11-14
6	6	ISSUED FOR TENDER REVIEW	2019-12-06
7	7	ISSUED FOR TENDER	2019-12-11

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NON-STRUCTURAL ELEMENTS

1. "NON-STRUCTURAL" OR "SECONDARY STRUCTURAL" ELEMENTS ARE NOT PART OF THE STRUCTURAL DESIGN SHOWN ON THESE DRAWINGS. SUCH ELEMENTS ARE DESIGNED, DETAILED AND REVIEWED IN THE FIELD BY OTHERS. THEY APPEAR ON DRAWINGS OTHER THAN THESE DRAWINGS OF READ JONES CHRISTOFFERSEN LTD., WHERE STRUCTURAL ENGINEERING RESPONSIBILITY IS REQUIRED FOR THESE ELEMENTS, THIS SHALL BE PROVIDED BY SPECIALTY STRUCTURAL ENGINEERS, WHO SHALL ALSO PROVIDE ANY LETTERS REQUIRED BY BUILDING PERMIT AUTHORITIES.

2. EXAMPLES OF NON-STRUCTURAL ELEMENTS INCLUDE, BUT ARE NOT LIMITED TO:

   A. ARCHITECTURAL COMPONENTS SUCH AS GUARDRAILS, HANDRAILS, FLAG POSTS, CANOPIES, CEILINGS, MILLWORK, ETC.
   B. LANDSCAPE ELEMENTS SUCH AS BENCHES, LIGHT POSTS, PLANTERS, ETC.
   C. CLADDING, GLAZING, WINDOW MULLIONS, INTERIOR STUD WALLS AND EXTERIOR STUD WALLS.
   D. ARCHITECTURAL PRECAST, PRECAST CLADDING.
   E. SKYLIGHTS.
   F. MECHANICAL AND ELECTRICAL EQUIPMENT, COMPONENTS, AND THEIR ATTACHMENT DETAILS.
   G. WINDOW WASHING EQUIPMENT AND ITS ATTACHMENTS.
   H. ESCALATORS, ELEVATORS, AND CONVEYING SYSTEMS.
   I. GLASS BLOCK AND ITS ATTACHMENTS.
   J. BRICK OR BLOCK VENEERS AND THEIR ATTACHMENTS.
   K. NON-LOAD BEARING MASONRY.
   L. NON-STRUCTURAL CONCRETE TOPPINGS.

3. SHOP DRAWINGS FOR NON-STRUCTURAL ELEMENTS WHICH MAY AFFECT THE PRIMARY STRUCTURAL SYSTEM SHALL BE SUBMITTED TO READ JONES CHRISTOFFERSEN LTD. THESE DRAWINGS WILL BE REVIEWED ONLY FOR THE EFFECT OF THE ELEMENT ON THE PRIMARY STRUCTURAL SYSTEM.

CALCULATED STRUCTURAL MOVEMENTS

THIS STRUCTURE WILL UNDERGO NORMAL TYPES OF MOVEMENT AND DEFLECTION, AND THE FOLLOWING ARE ESTIMATES FOR THIS STRUCTURE. NON-STRUCTURAL COMPONENTS MUST BE DETAILED TO ACCOMM0DATE THIS. DESIGN, DETAILING, AND FIELD REVIEW OF THESE NON-STRUCTURAL ELEMENTS IS BY OTHERS, AND NOT READ JONES CHRISTOFFERSEN LTD.

1. DIFFERENTIAL VERTICAL MOVEMENTS BETWEEN ADJACENT COLUMNS AND BETWEEN ADJACENT COLUMNS AND WALLS = APPROXIMATELY 25 mm IN ACCORDANCE WITH GEOTECHNICAL REPORT

2. VERTICAL DEFLECTION OF COLUMNS AND WALLS DUE TO SHRINKAGE AND CREEP = APPROXIMATELY 3.5 mm PER 3600 mm OF HEIGHT.

3. VERTICAL FLOOR/ ROOF DEFLECTIONS HAVE BEEN DESIGNED TO MEET THE FOLLOWING CRITERIA, BUT NOT TO EXCEED MAXIMUM DEFLECTION OF 25mm.

TYPE OF MEMBER	DEFLECTION TO BE CONSIDERED	CALCULATED DEFLECTION LIMITATIONS
REINFORCED CONCRETE MEMBERS		
ROOF OR FLOOR CONSTRUCTION SUPPORTING NONSTRUCTURAL ELEMENTS **NOT** LIKELY TO BE DAMAGED BY LARGE DEFLECTIONS	SUM OF THE LONG-TERM DEFLECTIONS DUE TO ALL SUSTAINED LOADS AND THE IMMEDIATE DEFLECTION DUE TO ANY DDITIONAL LIVE LOAD	L/240
ROOF OR FLOOR CONSTRUCTION SUPPORTING NONSTRUCTURAL ELEMENTS **NOT** LIKELY TO BE DAMAGED BY LARGE DEFLECTIONS	IMMEDIATE DEFLECTION DUE TO SPECIFIED LIVE LOAD	L/360
ROOF OR FLOOR CONSTRUCTION SUPPORTING NONSTRUCTURAL ELEMENTS LIKELY TO BE DAMAGED BY LARGE DEFLECTIONS	THAT PART OF THE TOTAL DEFLECTION OCCURRING AFTER ATTACHMENT OF NONSTRUCTURAL ELEMENTS	L/480
STRUCTURAL STEEL MEMBERS		
SIMPLE SPAN MEMBERS OF FLOORS AND ROOFS SUPPORTING CONSTRUCTION AND FINISHES NOT SUSCEPTIBLE TO CRACKING	LIVE LOAD	L/300
SIMPLE SPAN MEMBERS OF FLOORS AND ROOFS SUPPORTING CONSTRUCTION AND FINISHES SUSCEPTIBLE TO CRACKING	LIVE LOAD	L/360

4. THE STRUCTURE HAS BEEN DESIGNED ASSUMING THAT THE INSTALLATION OF NONSTRUCTURAL ELEMENTS SUCH AS CLADDING, MECHANICAL AND ELECTRICAL SERVICES AND THE LIKE, WILL NOT COMMENCE UNTIL AT LEAST ONE MONTH AFTER THE REINFORCED CONCRETE SLAB SUPPORTING THE NONSTRUCTURAL ELEMENTS HAS BEEN POURED AND THE RESHORING REMOVED.

5. THE STRUCTURE HAS BEEN DESIGNED TO LIMIT THE MAXIMUM INTERSTOREY DRIFT UNDER SERVICEABILITY LIMIT STATE (SLS) AVERAGE HOURLY WIND PRESSURE TO H/400 WHERE H IS THE FLOOR TO FLOOR HEIGHT BETWEEN TO ADJACENT FLOORS, UNDER SEISMIC LOADS, THE INTERSTOREY DRIFT HAS BEEN LIMITED TO 0.025 Hs, WHERE Hs IS THE HEIGHT OF THE STOREY.

6. DIFFERENTIAL DEFLECTIONS OF EDGE BEAMS AND EDGES OF SLABS ARE APPROXIMATELY:
   - TYPICAL FLOOR: 12mm
   - 2ND FLOOR (FLOOR ABOVE RIGID FLOOR): 20mm.

7. NONSTRUCTURAL ELEMENTS SUCH AS CLADDING, MECHANICAL AND ELECTRICAL SERVICES AND SUPPORTS AND THE LIKE, MUST BE DESIGNED AND DETAILED TO ACCOMMODATE THE ANTICIPATED MOVEMENTS NOTED ABOVE.

8. MOVEMENT AT EXPANSION JOINTS - SEE DETAIL AND PLANS

9. HORIZONTAL SHRINKAGE MOVEMENTS OF POST-TENSIONED SLABS = APPROXIMATELY 10 mm PER 30000 mm OF LENGTH.

ALL STRUCTURES ARE ALSO SUBJECT TO CONSTRUCTION TOLERANCES. THIS SHOULD BE ALLOWED FOR IN DETAILING NON-STRUCTURAL COMPONENTS IN ADDITION TO THE ABOVE MOVEMENTS.

DESIGN LOADS

1. FLOOR PLAN LOADING IS SHOWN ON PLANS.

2. CLADDING LOADS:

   A. CURTAIN AND WINDOW WALL - 1.0 kPa VERTICAL SURFACE

3. SPECIFIED CONCENTRATED LOADS ARE AS FOLLOWS U.N.O. ON PLAN:
   A. ROOFS ----------1.3 kN

4. SEISMIC AND WIND DESIGN:

   THE LATERAL SYSTEM FOR THIS PROJECT CONSISTS OF MOMENT FRAMES AND BRACED FRAMES WHEN STEEL CONSTRUCTION IS USED AND SHEAR WALLS WHEN CONSCRETE CONSTRUCTION IS USED. THE LATERAL SYSTEMS ARE DESIGNED FOR THE FOLLOWING EARTHQUAKE FACTORS:

4a. EARTHQUAKE DESIGN PARAMETERS

Sa (0.2) = 0.19	SITE CLASSIFICATION: SITE CLASS D	
Sa (0.5) = 0.110	Ie = 1.0	Fa = 1.3
Sa (1.0) = 0.068	Rd = 1.5	Fv = 1.4
Sa (2.0) = 0.022	Ro = 1.3	Ta = PER PLAN
Sa (0.2)Fale = 0.247		

4b. WIND DESIGN PARAMETERS:

Ce, Cg, and Cp ARE BASED ON OBC CL. 4.1.7.
q50 = 0.47 kPa, Iw = 1.0 ULS, 0.75 SLS

WIND UPLIFT LOADS ON STEEL OR WOOD ROOFS SHALL BE 1 kPa NET UNLESS NOTED OTHERWISE ON PLAN.

4c. FACTORED BASE FORCES.

MAXIMUM BASE SHEARS AND OVERTURNING MOMENT FOR THE STRUCTURE THROUGH STATIC ANALYSIS ARE NOTED ON PLAN.

WIND - NORTH/SOUTH DIRECTION -
- EAST/WEST DIRECTION -

SEISMIC - NORTH/SOUTH DIRECTION -
- EAST/WEST DIRECTION -

5. LATERAL LOADS ON FOUNDATION WALLS.

A. FOUNDATION WALLS RETAINING EARTH ARE DESIGNED TO RESIST A HORIZONTAL PRESSURE AT ANY DEPTH PER THE GEOTECHNICAL REPORT BASED ON FOLLOWING:

EARTHQUAKE SOIL PRESSURE----------: PE = N/A
SOIL PRESSURE COEFFICIENT----------: K = 0.5
DEPTH BELOW GROUND WATER LEVEL------: Hw = 0 (Free draining)
DRY UNIT WEIGHT OF SOIL----------: q = 21.5 kPa
SURFACE SURCHARGE----------: q = 4.8 kPa

B. THE SUBSTRUCTURE HAS BEEN DESIGNED TO RESIST UNBALANCED SOIL PRESSURE ACTING ON FOUNDATION WALLS AND RESISTED BY THE SHEAR WALLS AND FOUNDATION WALLS. THE UNBALANCED SOIL PRESSURE HAS BEEN CALCULATED BASED ON THE SOILS REPORT, AND IT IS A CONSEQUENCE OF:

- FINISHED GRADE ELEVATION

C. DO NOT BACKFILL WALLS UNTIL LATERALLY SUPPORTED BY COMPLETED FLOOR AND/ OR ROOF STRUCTURE.

6. WATER TABLE: THIS BUILDING IS NOT DESIGNED AS A TANKED STRUCTURE.

7. LOADS TO EXISTING STRUCTURES:

A. SNOW DRIFTING AS NOTED ON PLAN

TEMPORARY WORKS

1. THE CONTRACTOR SHALL DESIGN, PROVIDE, ERECT, MAINTAIN, REMOVE AND ASSUME FULL AND SOLE RESPONSIBILITY FOR ALL TEMPORARY WORKS REQUIRED FOR THE SAFE AND COMPLETE EXECUTION OF THE WORKS.

2. IN THE EXECUTION OF THE TEMPORARY WORKS AND FOR THE DURATION OF THE CONTRACT, THE CONTRACTOR SHALL MAKE ADEQUATE PROVISION FOR ALL LIKELY CONSTRUCTION LOADING AND PROVIDE SUFFICIENT BRACING AND PROPS TO KEEP THE WORKS IN PLUMB AND ALIGNMENT AND FREE FROM EXCESSIVE DEFLECTION.

3. ACCESS OF HEAVY CONSTRUCTION EQUIPMENT AND ACCUMULATION OF CONSTRUCTION MATERIALS ON THE FLOORS ARE NOT PERMITTED, UNLESS SUCH HAVE BEEN CATERED FOR IN THE CONTRACTOR'S TEMPORARY WORK DESIGN TO THE SATISFACTION OF THE ARCHITECT & ENGINEER.

4. COSTS OF ALL TEMPORARY WORKS ARE DEEMED TO HAVE BEEN INCLUDED IN THE CONTRACT PRICE.

5. SUBMIT SHOP DRAWINGS FOR ALL TEMPORARY WORKS FOR REVIEW BEFORE FABRICATION COMMENCES. SHOP DRAWINGS SHALL BE SEALED BY A PROFESSIONAL ENGINEER REGISTERED AND LICENSED TO PRACTICE BY THE PROFESSIONAL ENGINEERING ASSOCIATION HAVING JURISDICTION IN THE AREA WHERE THE STRUCTURE IS TO BE BUILT.

6. ANY CONSTRUCTION SEQUENCES SHOWN ON THE DRAWINGS SHALL BE PART OF TEMPORARY WORKS AND ARE FOR THE CONTRACTOR'S CONSIDERATION ONLY. THE CONTRACTOR IS AT LIBERTY TO USE ANY OTHER SEQUENCE AS HE DEEMS APPROPRIATE, BUT AT NO TIME SHALL THE SAFETY AND INTEGRITY OF THE WORKS AND THE STRUCTURE BE COMPROMISED. IF THE CONTRACTOR ADAPTS THE SUGGESTED SEQUENCE, SUCH SEQUENCE SHALL BE DEEMED AS THE CONTRACTOR'S OWN SELECTION OF METHOD, AND THE CONTRACTOR SHALL ASSUME FULL AND SOLE RESPONSIBILITY FOR IT, AS STATED IN (1) ABOVE. THE CONTRACTOR SHALL INFORM THE ARCHITECT IF HE WISHES TO DEVIATE FROM ANY SUGGESTED SEQUENCE.

7. SEE ALSO CONCRETE FORMWORK STRIPPING AND SHORING NOTES.

GENERAL CONTINUED...

GALV. ----- GALVANIZED
G.L. ---------- GRID LINE
H.1.E.------- HOOK ONE END
H.2.E. ------ HOOK 2 ENDS
H & V ------- HORIZONTAL AND VERTICAL
H, HOR. --- HORIZONTAL
HSC --------- HORIZONTALLY SLOTTED CONNECTION
Hf ---------- FACTORED HORIZONTAL SHEAR FORCE
HORZ. ----- HORIZONTAL
HORIZ ---- HORIZONTAL
HP -------- HIGH POINT
INT. ---------- INTERIOR
JT. ---------- JOINT
LG. --------- LONG
L.L. --------- LIVE LOAD
T.J. --------- TIE JOIST
T.O. -------- TOP OF
T.O.C. ------ TOP OF CONCRETE
T.O.S.S.---- TOP OF STRUCT. STEEL
T.O.S. ------ TOP OF SLAB
T.U.L. ------ TOP UPPER LAYER
TYP -------- TYPICAL
U.N.O. ------ UNLESS NOTED OTHERWISE
ULS --------- ULTIMATE LIMIT STATE
SLS --------- SERVICEABILITY LIMIT STATE
U/S ---------- UNDERSIDE
V., VERT. -- VERTICAL
Vf ---------- FACTORED SHEAR FORCE
VXB---------- VERTICAL BRACING, VERTICAL CROSS BRACING
W.P. -------- WORK POINT

12. DEFINITIONS:

A. RJC: READ JONES CHRISTOFFERSEN OR ITS REPRESENTATIVE.

B. SPECIALTY STRUCTURAL ENGINEER: A STRUCTURAL ENGINEER REGISTERED AND LICENSED TO PRACTICE BY THE PROFESSIONAL ENGINEERING ASSOCIATION HAVING JURISDICTION IN THE AREA WHERE THE STRUCTURE IS TO BE BUILT AND WHO IS RESPONSIBLE FOR THE DESIGN AND FIELD REVIEW OF:

- STRUCTURAL ELEMENTS DESIGNED BY THE CONTRACTOR OR SUBCONTRACTORS, SUCH AS OPEN WEB STEEL JOISTS, PRECAST DOUBLE TEES, PRECAST PLANKS, STRUCTURAL STEEL CONNECTIONS, LIGHT WOOD FRAME ROOF TRUSSES, ETC.
- SECONDARY STRUCTURAL ELEMENTS AND NON-STRUCTURAL ELEMENTS. SEE ALSO "NON-STRUCTURAL ELEMENTS" GENERAL NOTES.

C. CONTINUOUS: FULL TENSION SPLICE AND TENSION DEVELOPMENT LENGTH.

D. EMBEDMENT: UNLESS NOTED OTHERWISE COMPRESSION EMBEDMENT MEANS A COMPRESSION DEVELOPMENT LENGTH AND TENSION EMBEDMENT MEANS A TENSION DEVELOPMENT LENGTH AS PER CAN/CSA-A23.3 AND AS SHOWN ON THESE GENERAL NOTES DRAWINGS.

E. GENERAL CONTRACTOR: FOR THE PURPOSES OF THESE DRAWINGS, THE USE OF THE TERM "CONTRACTOR" OR "GENERAL CONTRACTOR" SHALL REFER TO THE PRIME PERSON OR COMPANY RESPONSIBLE FOR CONSTRUCTION OF THE PROJECT AND THE COORDINATION OF TRADES AND SUBCONTRACTORS. THIS MAY BE THE GENERAL CONTRACTOR, OR A CONSTRUCTION MANAGER.

DESIGN CODE

1. THE COMPLETED BASE BUILDING STRUCTURE SHOWN ON THE STRUCTURAL DRAWINGS HAS BEEN DESIGNED IN SUBSTANTIAL ACCORDANCE WITH THE ONTARIO BUILDING CODE 2012 WHICH IS BASED ON THE NATIONAL BUILDING CODE OF CANADA 2010.

FIELD REVIEW BY READ JONES CHRISTOFFERSEN (RJC)

1. READ JONES CHRISTOFFERSEN PROVIDES FIELD REVIEW ONLY FOR THE WORK SHOWN ON THESE STRUCTURAL DRAWINGS. THIS REVIEW IS NOT A "FULL TIME" REVIEW BUT IS CONDUCTED WITH SUCH FREQUENCY AS RJC DEEMS APPROPRIATE TO OBSERVE VARIOUS STAGES OF THE WORK AND TO ASCERTAIN THAT THE WORK IS IN GENERAL CONFORMANCE WITH THE PLANS AND SUPPORTING DOCUMENTS PREPARED BY READ JONES CHRISTOFFERSEN. FIELD REVIEW BY READ JONES CHRISTOFFERSEN IS NOT CARRIED OUT FOR THE CONTRACTOR'S BENEFIT, NOR DOES IT MAKE READ JONES CHRISTOFFERSEN GUARANTORS OF THE CONTRACTOR'S WORK. IT REMAINS THE CONTRACTOR'S RESPONSIBILITY TO BUILD THE WORK IN CONFORMANCE WITH THE CONTRACT DOCUMENTS. RJC SHALL NOT BE RESPONSIBLE FOR THE ACTS OR OMISSIONS OF THE CONTRACTOR, SUB-CONTRACTOR, OR ANY OTHER PERSONS PERFORMING ANY OF THE WORK OR FOR THE FAILURE OF ANY OF THEM TO CARRY OUT THE WORK IN ACCORDANCE WITH THE CONTRACT DOCUMENTS.

   RJC WILL REVIEW SHOP DRAWINGS PERTAINING TO WORK SHOWN ON RJC'S DRAWINGS. THE EXTENT OF THIS REVIEW IS AT THE SOLE DISCRETION OF RJC'S ENGINEER AND IS FOR THE SOLE PURPOSE OF ASCERTAINING GENERAL CONFORMANCE WITH THE STRUCTURAL DESIGN CONCEPT. THE REVIEW IS NOT AN APPROVAL OF THE DESIGN, DETAILS, AND DIMENSIONS INHERENT IN THE SHOP DRAWINGS, RESPONSIBILITY FOR WHICH SHALL REMAIN WITH THE CONTRACTOR OR SUBCONTRACTOR SUBMITTING THEM. SUCH REVIEW SHALL NOT RELIEVE THE CONTRACTOR OR SUBCONTRACTOR OF HIS OR HER RESPONSIBILITY FOR ERRORS AND OMISSIONS IN THE SHOP DRAWINGS OR FOR MEETING ALL REQUIREMENTS OF THE CONTRACT DOCUMENTS.

2. PROVIDE 24 HOURS ADVANCE NOTICE OF EACH REQUIRED FIELD REVIEW. FIELD REVIEWS SHALL BE SCHEDULED TO BE CARRIED OUT DURING NORMAL BUSINESS HOURS UNLESS SPECIAL ARRANGEMENTS ARE MADE WITH RJC.

3. THE WORK TO BE REVIEWED SHALL BE GENERALLY COMPLETE.

DRAWINGS

1. THE USE OF THESE DRAWINGS IS LIMITED TO THAT IDENTIFIED IN THE REVISIONS COLUMN. DO NOT CONSTRUCT FROM THESE DRAWINGS UNLESS MARKED "ISSUED FOR CONSTRUCTION" IN THE REVISIONS COLUMN, BY READ JONES CHRISTOFFERSEN LTD. THE DRAWINGS SHALL NOT BE USED FOR PRICING, COSTING, OR TENDER UNLESS SO INDICATED IN THE REVISION COLUMN. PRICING OR COSTING DRAWINGS ARE NOT COMPLETE AND ANY PRICES BASED ON PRICING OR COSTING DRAWINGS MUST INCLUDE ALLOWANCES FOR THIS.

2. THE INFORMATION ON THESE DRAWINGS SHALL NOT BE USED FOR ANY OTHER PROJECT OR WORKS. THE INFORMATION ON THESE DRAWINGS APPLIES SOLELY TO THIS PROJECT.

3. THE DRAWINGS DO NOT SHOW COMPONENTS THAT MAY BE NECESSARY FOR CONSTRUCTION SAFETY. THE GENERAL CONTRACTOR IS RESPONSIBLE FOR SAFETY IN AND ABOUT THE JOB SITE DURING CONSTRUCTION, AND THE DESIGN AND ERECTION OF ALL TEMPORARY STRUCTURES, FORMWORK, FALSE WORK, SHORING, ETC. REQUIRED TO COMPLETE THE WORK.

GENERAL

1. SECTION MARK SHOWN THUS 4/S301 MEANS SECTION #4 ON DRAWING S301.

2. SEE ARCHITECTURAL, MECHANICAL AND ELECTRICAL DRAWINGS FOR SLEEVES, NAILERS, INSERTS, ETC., TO BE ENCASED IN CONCRETE.

3. SEE ARCHITECTURAL DRAWINGS FOR FLOOR AND ROOF ELEVATIONS, RECESSES, DRAINAGE SLOPES, ETC.

4. THE GENERAL CONTRACTOR SHALL REVIEW ALL THE DRAWINGS AND CHECK DIMENSIONS BEFORE CONSTRUCTION. REPORT DISCREPANCIES BETWEEN STRUCTURAL AND OTHER DISCIPLINES DRAWINGS FOR CLARIFICATION.

5. DESIGN FORCES INDICATED ON DRAWINGS FOR STRUCTURAL STEEL WORK ARE FACTORED FORCES UNLESS NOTED OTHERWISE. FORCES ARE VERTICAL SHEAR FORCES U.N.O.

   A. FORCES ---------- kN
   B. MOMENTS ---------- kN-m
   C. LINE LOADS ---------- kN/m
   D. DISTRIBUTED LOADS ---------- kPa

   SEE "GENERAL NOTES - LOADS" FOR DEFINITIONS AND VALUES OF LIVE LOAD, DEAD LOAD AND SUPERIMPOSED DEAD LOAD. SEE ALSO PLANS FOR OTHER LOAD/FORCE REQUIREMENTS.

6. CONCRETE WORK
   SHALL CONFORM TO CAN/CSA-A23.1, CAN/CSA-A23.2, CAN/CSA-A23.3 AND REFERENCED DOCUMENTS.

7. STRUCTURAL STEEL WORK
   SHALL CONFORM TO CAN/CSA-S16 AND REFERENCED DOCUMENTS

8. FIRE RESISTANCE RATINGS
   SEE ARCHITECTURAL DRAWINGS AND SPECIFICATIONS FOR PRECISE LOCATION OF REQUIRED FIRE RESISTANCE RATINGS.

9. DO NOT CUT OR DRILL ANY OPENINGS IN STRUCTURAL MEMBERS WITHOUT WRITTEN PERMISSION OF RJC.

10. REFER TO ARCHITECTURAL, MECHANICAL, ELECTRICAL, AND LANDSCAPE DRAWINGS FOR LOCATIONS, CONFIGURATIONS, EXTENT, AND SIZES OF ALL CURBS, UPSTANDS, DOWNTURNS; AND FOR OPENINGS THROUGH FLOORS AND WALLS FOR DUCTS, CONDUIT AND PIPING. PROVIDE FOR SAME.

11. ABBREVIATIONS:

75 ---------- MOMENT CONNECTION PASS THROUGH FORCE [kN]
A.B. -------- ANCHOR BOLT
A.E.S.S.----- ARCHITECTURALLY EXPOSED STRUCTURAL STEEL
ALT. -------- ALTERNATE
ARCH. ------ ARCHITECTURAL
B.C.E. ------ BOTTOM CHORD EXTENSION
BEW ------- BOTTOM EACH WAY
B.L.L. ------ BOTTOM LOWER LAYER
BLW ------- BOTTOM LONG WAY
BSW ------- BOTTOM SHORT WAY
B, BOT. ---- BOTTOM
B.U.L. ------ BOTTOM UPPER LAYER
CA ---------- COLUMN ABOVE
CANT. ------ CANTILEVER
CB ---------- COLUMN BELOW
CBM -------- COUPLING BEAM
Cf ---------- FACTORED AXIAL FORCE COMPRESSION
C.I.P. ------- CAST IN PLACE
C.J. --------- CONTROL JOINT
CL. ---------- CENTER LINE
CLR. -------- CLEAR
CONC. ------ CONCRETE
CONT. ------ CONTINUOUS
C.P. --------- COMPLETE PENETRATION
CTRS. ------ CENTRES
C/W --------- COMPLETE WITH
DBM -------- DIVIDER BEAM
DET. -------- DETAIL
D.L. --------- DEAD LOAD
D.O. --------- DO OVER - (DITTO)
DP. ---------- DEEP (I.E. DEPTH OF BEAM)
D.T.S. ------ DEPTH TO SUIT
DWG. ------ DRAWING
DWLS. ----- DOWELS
E.E. --------- EACH END
E.F. --------- EACH FACE
EL. ---------- ELEVATION
ELEV. ------ ELEVATION
ELEC. ------ ELECTRICAL
E.S. --------- EACH SIDE
E.WAY ----- EACH WAY
E.W. -------- EACH WAY
EXIST. ------ EXISTING
EXT. -------- EXTERIOR
EXP. JT. --- EXPANSION JOINT
F.D. --------- FLOOR DRAIN
F.S. --------- FAR SIDE
L.L.B.B. ---- LONG LEGS BACK TO BACK
L.L.H. ------ LONG LEG HORIZONTAL
L.L.V. ------ LONG LEG VERTICAL
LS.H. ------ LONG SIDE HORIZONTAL
L.S.V. ------ LONG SIDE VERTICAL
L.W. --------- LONG WAY
LP ---------- LOW POINT
MAX. -------- MAXIMUM
MECH. ------ MECHANICAL
Mf ---------- FACTORED BENDING MOMENT
Mfx ---------- STRONG AXIS BENDING MOMENT
Mfy ---------- WEAK AXIS BENDING MOMENT
MIN. --------- MINIMUM
Mtf ---------- FACTORED TORSION
N.I.C. ------ NOT IN CONTRACT
N.S. --------- NEAR SIDE
N.T.S. ------ NOT TO SCALE
O.C. --------- ON CENTRE
O/C --------- ON CENTRE
OPP. -------- OPPOSITE
O.W.S.J. --- OPEN WEB STEEL JOIST
P.P. --------- PARTIAL PENETRATION
P/T ---------- POST-TENSIONING
R.D. --------- ROOF DRAIN
RTN. -------- RETURN
R/W --------- REINFORCED WITH
S.D.L. ------ SUPERIMPOSED DEAD LOAD
S.D.F. ------ STEP DOWN FOOTING
SIM. --------- SIMILAR
S.L. ---------- SNOW LOAD
S.L.B.B. ---- SHORT LEGS BACK TO BACK
S.O.G. ------ SLAB ON GRADE
SPEC. ------ SPECIFICATIONS
SR ---------- STUD RAIL
ST. --------- STAGGER
STIR. ------- STIRRUP
S.W. --------- SHORT WAY
SYM. ------- SYMMETRICAL
TEW -------- TOP EACH WAY
Tf ---------- FACTORED AXIAL TENSION FORCE
THK. -------- THICK
THRU ------ THROUGH
T.L.L. ------- TOP LOWER LAYER
T & B ------- TOP AND BOTTOM
T & C ------- TENSION AND COMPRESSION
T & G ------- TONGUE AND GROOVE

NO.	REV.	ISSUED FOR	DATE
1	4	100% CD	2019-11-12
2	5	ISSUED FOR PERMIT	2019-11-14
3	6	ISSUED FOR TENDER REVIEW	2019-12-06
4	7	ISSUED FOR TENDER	2019-12-11

N

STAMP

CONTRACTOR SHALL CHECK ALL DIMENSIONS ON THE WORK AND REPORT ANY DISCREPANCY TO THE CONSULTANT BEFORE PROCEEDING. THIS DRAWING IS NOT TO BE USED FOR CONSTRUCTION UNTIL AUTHORIZED IN WRITING BY CONSULTANT.

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CLIENT: TORONTO ZOO
toronto zoo
361A Old Finch Ave, Toronto ON M1B 5K7 · 416-392-5929

PROJECT:

DRAWING NAME:
GENERAL NOTES & TYPICAL DETAILS

PROJECT NO:	DRAWN BY:	CHECKED BY:
TOR.113946.0011	JP	NB

Scale: As indicated

DRAWING NUMBER:
S-100

EXCAVATIONS

1. DESIGN AND FIELD REVIEW OF EXCAVATION, SHORING, AND BACKFILL IS NOT DONE BY READ JONES CHRISTOFFERSEN.

FOUNDATIONS

1. FOOTINGS HAVE BEEN DESIGNED FOR THE FOLLOWING BEARING RESISTANCES IN ACCORDANCE WITH THE SOILS REPORT.
   PREPARED BY: SOIL ENGINEERS LTD.
   DATED: OCTOBER 15, 2019

   A. STRIP FOOTINGS: ULS: 640 kPa, SLS: 400 kPa
   B. SPREAD FOOTINGS: ULS: 640kPa, SLS: 400 kPa

2. BEARING SURFACES MUST BE APPROVED BY THE SOILS ENGINEER IMMEDIATELY BEFORE FOOTING CONCRETE IS PLACED. RJC IS NOT RESPONSIBLE FOR CONFIRMING BEARING CAPACITIES OF SOILS.

3. REFER TO SOILS REPORT FOR OTHER SPECIFIC DESIGN REQUIREMENTS FOR FOOTINGS, SOIL SLOPES, FROST PROTECTION, MINIMUM COVER, ETC.

4. UNLESS OTHERWISE SHOWN, CENTER FOOTINGS UNDER COLUMNS AND WALLS.

5. DOWELS SHALL BE PLACED BEFORE CONCRETE IS PLACED. TEMPLATES SHALL BE USED TO ENSURE CORRECT PLACEMENT OF DOWELS.

6. PROVIDE 50 mm GROUND SEAL/ SKIM COAT, MUD SLAB UNDER FOOTINGS AS REQUIRED BY SOIL CONDITIONS.

7. FOR GROUND ELEVATIONS AND DRAINAGE SLOPES, SEE ARCHITECT'S DRAWINGS.

8. VARY FOOTING ELEVATIONS WHERE REQUIRED IN ACCORDANCE WITH DETAIL FOR "TYPICAL STEPPED FOOTING"(S.D.F.), SHOWN ON STRUCTURAL DRAWINGS.

9. FOOTINGS MAY HAVE TO BE LOWERED TO ACCOMMODATE MECHANICAL OR ELECTRICAL SERVICES. SEE MECHANICAL AND ELECTRICAL DRAWINGS FOR ELEVATIONS OF SAME. FOOTINGS ARE NOT TO BE UNDERMINED BY EXCAVATIONS FOR SERVICES, PITS, ETC.

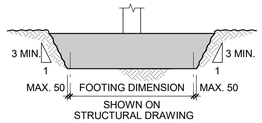
10. FOOTING ELEVATIONS, IF SHOWN, ARE FOR PRICE ESTIMATING PURPOSES ONLY, ARE NOT FINAL, AND MAY VARY ACCORDING TO SITE CONDITIONS OR AS REQUIRED BY SERVICES. ALL FOOTINGS MUST BE TAKEN TO A BEARING LAYER APPROVED BY THE SOILS ENGINEER.

11. BEARING SURFACES MUST BE PROTECTED FROM FREEZING BEFORE AND AFTER FOOTINGS ARE POURED.

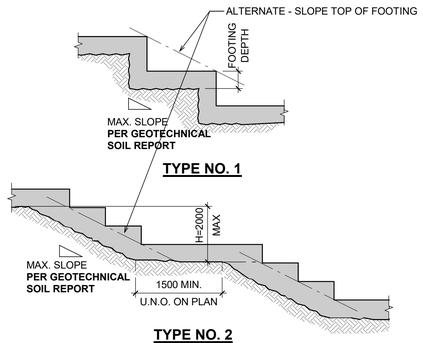
12. SUB-BASE DESIGN OF SOIL UNDER THE SLAB ON GRADE SHALL BE IN ACCORDANCE WITH THE SOIL REPORT.

13. CONCRETE PLACED UNDER WATER SHALL CONFORM TO CAN/CSA-A23.1.

14. FOOTINGS CAST DIRECTLY INTO EXCAVATIONS (WITHOUT SIDE FORMS) SHALL NOT BE LARGER THAN SHOWN BELOW:



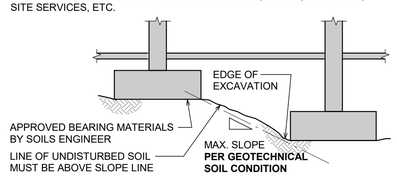
TYPICAL STEPPED FOOTINGS *ON SOIL* (WALLS)



NOTE: IF TOTAL STEPPING 'H' EXCEEDED PROVIDE INTERMEDIATE FLAT HORIZONTAL SECTION BETWEEN SLOPED FOOTINGS U.N.O. ON PLAN

TYPICAL FOOTING ADJACENT TO EXCAVATION

EDGE OF ADJACENT EXCAVATION FOR FOOTINGS, SUMPS, BASEMENT, SITE SERVICES, ETC.



CONCRETE ANCHORS

1. EXCEPT WHERE INDICATED ON THE DRAWINGS, ANCHORS SHALL CONSIST OF THE FOLLOWING ANCHOR TYPES AS PROVIDED BY HILTI (CANADA) LTD. CONTACT HILTI AT (800) 363-4458 FOR PRODUCT RELATED QUESTIONS.

   - "EPOXY OR ADHESIVE ANCHOR" MEANS A:
     - HIT-HY 200 SAFE SET SYSTEM OR HIT-HY 200 FOR FAST CURE APPLICATIONS.
     - HIT-RE 500 OR HIT-RE 500 SD ADHESIVE ANCHOR FOR SLOW . CURE APPLICATIONS.
   - "SCREENED EPOXY ANCHOR" MEANS A "HIT-HY 70 ADHESIVE ANCHOR".
   - "KWIK BOLT" MEANS A "KWIK BOLT TZ OR KWIK BOLT 3 EXPANSION ANCHOR", TO BE SELECTED BASED ON APPLICATION REQUIREMENTS.
   - "HSL" MEANS AN "HSL-3 HEAVY-DUTY EXPANSION ANCHOR".

2. ANCHOR CAPACITY USED IN DESIGN IS BASED ON GUIDELINES PUBLISHED BY HILTI. ALTERNATE FASTENING SYSTEMS PROPOSED BY THE CONTRACTOR SHALL BE SUBMITTED TO THE STRUCTURAL ENGINEER FOR REVIEW AND APPROVAL. ALTERNATE ADHESIVE ANCHORS MUST BE EQUAL CONSIDERING LOAD RESISTANCE, IN SERVICE AND INSTALLATION TEMPERATURE, AVAILABILITY OF COMPREHENSIVE INSTALLATION INSTRUCTIONS, CREEP TESTING, SEISMIC TESTING, AND APPROPRIATE ON SITE TRAINING.

3. INSTALL AS PER THE MANUFACTURER'S INSTRUCTIONS AS INCLUDED IN THE ANCHOR PACKAGING. WEDGE ANCHORS TO HAVE HOLES CLEANED WITH HIGH PRESSURE AIR BLAST. ADHESIVE (EPOXY) ANCHORS TO HAVE HOLES WELL CLEANED PER MANUFACTURER'S INSTRUCTIONS WHICH INCLUDES HIGH PRESSURE AIR BLAST FOLLOWED BY BRUSHING THEN HIGH PRESSURE AIR BLAST SEQUENCE. USE STEEL WIRE BRUSH ON CONCRETE AND MASONRY.

4. OVERHEAD ADHESIVE ANCHORS MUST BE INSTALLED USING THE HILTI PROFI SYSTEM.

5. <u>ON-SITE TRAINING AND REVIEW BY HILTI:</u>

   THE CONTRACTOR SHALL RETAIN A HILTI REPRESENTATIVE TO PROVIDE ON-SITE ANCHOR INSTALLATION TRAINING FOR ALL OF THE HILTI PRODUCTS SPECIFIED. THE CONTRACTORS PERSONNEL MUST BE TRAINED PRIOR TO THE COMMENCEMENT OF INSTALLING ANCHORS. LETTERS OF TRAINING FOR INSTALLERS TO BE SUBMITTED TO RJC.

   THE CONTRACTOR MAY RETAIN AN INDEPENDANT TESTING AGENCY TO PROVIDE AN ON-GOING SERVICE OF ON-SITE QUALITY CONTROL REVIEWS TO ENSURE THAT ANCHORS ARE BEING INSTALLED IN ACCORDANCE TO HILTI (CANADA) LIMITED'S SPECIFICATIONS. QUALITY ASSURANCE REPORTS FROM THE INDEPENDANT INSPECTION AGENCY ARE TO BE SUBMITTED TO RJC AFTER EACH SITE VISIT.

6. A REPRESENTATIVE SAMPLE OF ANCHORS ARE TO BE TESTED FOR EACH TYPE OF ANCHOR SPECIFIED BY AN INDEPENDANT PROJECT MATERIALS CONSULTANT/ TESTING AGENCY. ANCHORS WHICH FAIL THE LOAD TEST SHALL BE REPLACED BY THE CONTRACTOR AT THE CONTRACTOR'S COST.

7. <u>TESTING OF EPOXY ANCHORS:</u>

   PROVIDE TESTING OF EPOXY ANCHORS BY THE PROJECT MATERIALS CONSULTANT / TESTING AGENCY AS FOLLOWS:

   - PROOF LOAD TEST 10% OF EPOXY ANCHORS TO MANUFACTURER'S SPECIFIED CAPACITY.
   - RANDOMLY SELECT 2% OF EPOXY ANCHORS (3 MINIMUM) FOR TESTING TO FAILURE. CONTRACTOR TO REPLACE ANCHORS AT CONTRACTOR'S COST.

   THE ABOVE TESTING IS PAID FOR BY THE OWNER. THE FOLLOWING TESTING IS PAID FOR BY THE CONTRACTOR:

   - IF ANY PROOF LOAD TEST FAILS, TEST 100% OF ANCHORS.
   - IF ANY ANCHORS ARE FOUND TO BE INSTALLED WITHOUT COMPLETE EPOXY OR ARE EMBEDDED LESS THAN 90% OF THE DEPTH SHOWN ON THE DRAWINGS, THEN PROOF LOAD TEST 100% OF THE ANCHORS.
   - PROVIDE FULL TIME FIELD REVIEW OF ALL REPAIRS BY MATERIALS CONSULTANT / TESTING AGENCY.

   THE TESTING AGENCY IS TO PROVIDE A TESTING AND REPAIR REPORT SEALED BY A PROFESSIONAL ENGINEER REGISTERED IN THE PROVINCE OR TERRITORY WHERE THE WORK IS DONE.

8. ANCHOR CAPACITY IS DEPENDENT UPON SPACING BETWEEN ADJACENT ANCHORS AND PROXIMITY OF ANCHORS TO EDGE OF CONCRETE. INSTALL ANCHORS IN ACCORDANCE WITH SPACING AND EDGE CLEARANCES INDICATED ON THE DRAWINGS.

9. DO NOT CUT REINFORCING BARS TO INSTALL ANCHORS UNLESS THE STRUCTURAL DRAWINGS SPECIFICALLY NOTE FOR A PARTICULAR DETAIL THAT THE REINFORCING BARS IN THE CONCRETE CAN BE CUT.

10. EXISTING REINFORCING BARS IN THE CONCRETE STRUCTURE MAY CONFLICT WITH SPECIFIC ANCHOR LOCATIONS. UNLESS NOTED ON THE DRAWINGS THAT THE BARS CAN BE CUT, THE CONTRACTOR SHALL REVIEW THE EXISTING STRUCTURAL DRAWINGS AND SHALL UNDERTAKE TO LOCATE THE POSITION OF THE REINFORCING BARS AT THE LOCATIONS OF CONCRETE ANCHORS, BY HILTI FERROSCAN, HILTI PS 1000, GPR, X-RAY, CHIPPING OR OTHER MEANS, BEFORE ANY HOLES ARE DRILLED.

11. WHEN ANCHORS ARE USED TO ATTACH STRUCTURAL STEEL, THE CONTRACTOR SHALL USE A TEMPLATE TO LOCATE THE ANCHOR HOLES. IF THIS IS NOT DONE, THEN UPON COMPLETION OF ANCHOR INSTALLATION, THE CONTRACTOR SHALL PREPARE TEMPLATES OF THE AS-BUILT ANCHOR POSITIONS. THE CONTRACTOR SHALL REFER TO THESE TEMPLATES FOR THE FABRICATION OF THE STEEL STRUCTURE.

    AT LOCATIONS OF INTERFERENCE BETWEEN CONCRETE ANCHORS AND EXISTING REINFORCEMENT, ADJUST PROPOSED LOCATIONS OF ANCHORS AS REQUIRED TO AVOID CUTTING REINFORCEMENT. SUBMIT A PROPOSED ANCHOR LAYOUT TO RJC FOR REVIEW AND APPROVAL BEFORE INSTALLING ANCHORS.

12. DO NOT OVERSIZE HOLES IN STEEL MATERIAL TO FIT ANCHOR LOCATIONS EXCEPT FOR COLUMN BASE PLATE HOLES WHICH ARE FABRICATED SLIGHTLY OVERSIZED AS PER STANDARD PRACTICE.

SHOP DRAWING REVIEW RESPONSIBILITIES

1. AS PART OF FIELD SERVICES, RJC WILL REVIEW SHOP DRAWINGS PERTAINING TO WORK SHOWN ON RJC'S DRAWINGS BY MEANS OF APPROPRIATE RATIONAL SAMPLING PROCEDURES AND COMMENT ON THE ACCURACY WITH WHICH THE CONTRACTOR PREPARED THE DRAWINGS. REVIEW OF SHOP DRAWINGS IS FOR THE SOLE PURPOSE OF ASCERTAINING CONFORMANCE WITH THE GENERAL DESIGN CONCEPT AND IS NOT AN APPROVAL OF THE DETAIL DESIGN INHERENT IN THE SHOP DRAWINGS. RESPONSIBILITY FOR WHICH SHALL REMAIN WITH THE CONTRACTOR SUBMITTING THEM. SUCH REVIEW SHALL NOT RELIEVE THE CONTRACTOR OF HIS RESPONSIBILITY FOR ERRORS AND OMISSIONS IN THE SHOP DRAWINGS OR FOR MEETING ALL REQUIREMENTS OF THE CONTRACT DOCUMENTS. THE CONTRACTOR IS SOLELY RESPONSIBLE FOR INFORMATION PERTAINING TO THE FABRICATION PROCESS TECHNIQUES OF CONSTRUCTION AND INSTALLATION AND FOR CO-ORDINATION OF THE WORK OF ALL SUB-TRADES.

2. ALL CONNECTIONS TO BE DESIGNED BY FABRICATOR UNLESS NOTED OTHERWISE. ALL BEAM CONNECTIONS TO BE STANDARD FRAME BEAM CONNECTIONS OR EQUIVALENT, UNLESS NOTED OTHERWISE.
   THE FABRICATOR SHALL SUBMIT SUMMARY DESIGN DRAWINGS FOR REVIEW SHOWING IN DETAIL THE "STANDARD" CONNECTIONS AND THEIR CAPACITIES THAT IS INTENDED FOR USE ON THE PROJECT.
   THESE DRAWINGS ARE IN ADDITION TO THE REGULAR SHOP DRAWINGS, AND SHALL PRECEDE THEM.

   A. SHOP DRAWINGS SHALL BE PREPARED UNDER THE DIRECTION OF A SPECIALTY STRUCTURAL ENGINEER. FOR THOSE CONNECTIONS AND COMPONENTS DESIGNED BY THE FABRICATOR. THIS ENGINEER OR THEIR REPRESENTATIVE SHALL VISIT THE SITE TO REVIEW IN PLACE THE CONNECTIONS AND COMPONENTS DESIGNED BY THIS ENGINEER TO SATISFY THEMSELVES THAT THESE CONNECTIONS AND COMPONENTS COMPLY WITH THEIR DESIGN ON THE SHOP DRAWINGS. THIS ENGINEER SHALL PROVIDE A LETTER TO RJC TO THIS EFFECT. THIS ENGINEER SHALL ALSO PROVIDE SEALED SKETCHES FOR ALL FIELD MODIFICATIONS MADE TO THEIR DESIGN.

   B. BEFORE THE SUBMISSION OF SHOP DRAWINGS NOTIFY RJC AS TO WHO THE ENGINEER WILL BE THAT WILL BE DESIGNING AND PROVIDING FIELD REVIEW FOR THE CONNECTIONS AND COMPONENTS DESIGNED BY THE CONTRACTOR.

   C. PRIOR TO SUBMITTING SHOP DRAWINGS THE CONTRACTOR SHALL NOTIFY RJC IN WRITING THAT THE FABRICATOR IS CERTIFIED TO A MINIMUM OF DIVISION 2 OF CSA W47.1.

   D. DRAWINGS OF COMPONENTS AND CONNECTIONS DESIGNED BY THE FABRICATOR'S SPECIALTY STRUCTURAL ENGINEER SHALL BE SIGNED AND SEALED BY THIS ENGINEER OR A LETTER SHALL BE SUBMITTED AT THE END OF SHOP DRAWING PRODUCTION SIGNED AND SEALED BY THIS ENGINEER, IDENTIFYING WHAT WAS DESIGNED AND LISTING THE FINAL DRAWINGS WITH DATES AND REVISION NUMBERS.

   E. REQUEST BY THE FABRICATOR MUST BE ACCEPTABLE TO RJC AND DETAILED ON THE SHOP DRAWINGS. TESTING OF THESE CONNECTIONS SHALL BE AT THE DISCRETION OF RJC AND TO THE CONTRACTORS ACCOUNT.

   F. SUBMIT SHOP DRAWINGS FOR REVIEW PRIOR TO START OF STEEL FABRICATION.

   G. FABRICATION, ERECTION, STRUCTURAL DESIGN, AND DETAILING OF ALL STEEL SHALL BE IN ACCORDANCE WITH CAN/CSA-S16.

RENOVATIONS

1. THE CONTRACT DOCUMENTS ARE BASED ON ASSUMED AS-BUILT DIMENSIONS FOR THE EXISTING BUILDING STRUCTURE AND ASSUMPTIONS ACCORDANCE WITH DETAILING AND PLACING PRACTICE. THESE ASSUMPTIONS MAY VARY FROM THE ACTUAL ON-SITE CONDITIONS. THE CONTRACTOR SHALL IMMEDIATELY INFORM THE CONSULTANT OF ANY ACTUAL VARIATIONS FROM THE ASSUMED CONDITIONS.

2. MINOR MODIFICATIONS TO SUIT TOLERANCES OF +/- 50mm WILL BE REQUIRED TO THE WORK INDICATED ON THESE DRAWINGS TO REFLECT ACTUAL SITE CONDITIONS. THE CONTRACTOR WILL COOPERATE WITH THE CONSULTANT AND RJC IN THIS REGARD. MINOR MODIFICATIONS WILL BECOME THE RESPONSIBILITY OF THE CONTRACTOR AND WILL NOT RESULT IN A CHANGE IN THE CONTRACT PRICE.

3. ENSURE THAT ALL NECESSARY JOB DIMENSIONS ARE TAKEN AND ALL TRADES ARE COORDINATED FOR THE PROPER EXECUTION OF THE WORK. THE CONTRACTOR SHALL ASSUME COMPLETE RESPONSIBILITY FOR THE ACCURACY AND COMPLETENESS OF SUCH DIMENSIONS, AND FOR COORDINATION.

4. PRIOR TO FABRICATION OF ANY STRUCTURAL MEMBERS, THE CONTRACTOR SHALL COMPLETE THIS SITE REVIEW OF CRITICAL "TIE-IN" DIMENSIONS AND CONFIRM ALL DIMENSIONS TO ENSURE PROPER FIT OF NEW WORK TO EXISTING. REPORT ANY DISCREPANCIES TO RJC PRIOR TO STARTING WORK.

5. COMMENCEMENT OF CONSTRUCTION OR ANY PART THEREOF CONSTITUTES ACCEPTANCE OF EXISTING CONDITIONS AND MEANS DIMENSIONS AND ELEVATIONS HAVE BEEN CONSIDERED, VERIFIED AND ARE ACCEPTABLE.

6. ANY OPENINGS THAT ARE NOT SHOWN OR INDICATED ON THE STRUCTURAL DRAWINGS SHALL BE REPORTED TO RJC FOR REVIEW. THESE OPENINGS MAY NOT BE ALLOWED, MAY HAVE TO BE MOVED, OR MAY REQUIRE ADDITIONAL STRUCTURAL WORK AND DETAILING. DO NOT PROCEED WITH THESE OPENINGS WITHOUT WRITTEN PERMISSION FROM RJC.

7. UNLESS NOTED OTHERWISE ON THE STRUCTURAL DRAWINGS, THE CORING OR CUTTING OF OPENINGS AND HOLES SHOWN ON THE STRUCTURAL DRAWINGS THROUGH THE EXISTING STRUCTURE SHALL NOT CUT ANY REINFORCING BARS. THE CONTRACTOR SHALL LOCATE THE LOCATION, SIZE, LENGTH, ORIENTATION AND POSITION OF EXISTING REINFORCING AND PROVIDE RJC WITH HARD COPIES OF SUCH FOR OUR REVIEW IN THE VICINITY OF THE HOLES AND SLEEVES TO BE CUT OR CORED, AND THE HOLES AND SLEEVES SHALL BE LOCATED TO AVOID CUTTING OF REINFORCING BARS. WHERE THIS IS NOT POSSIBLE, IT SHALL BE REPORTED TO RJC FOR REVIEW.

8. NEW OPENINGS TO BE CUT THROUGH EXISTING FLOOR SLAB OR WALLS SHALL BE CLEARLY MARKED OUT BY THE CONTRACTOR. THE CONTRACTOR SHALL NOTIFY RJC ONCE THE MARKING OUT HAS BEEN COMPLETED SO THAT RJC CAN REVIEW THE PROPOSED LOCATIONS OF ALL NEW OPENINGS. DO NOT PROCEED WITH CUTTING OF NEW OPENINGS WITHOUT THE APPROVAL OF RJC.

9. UNLESS NOTED OTHERWISE ON THE DRAWINGS NEW STRAIGHT SIDED OPENINGS THROUGH EXISTING SLABS AND WALLS SHALL BE SAWCUT WITH NO OVERCUTS. USE CORED HOLES AT THE CORNERS. JACKHAMMERING SHALL NOT BE PERMITTED. REFER TO THE DETAILS AND PROCEDURES INDICATED ON THE STRUCTURAL DRAWINGS FOR THE NEW OPENINGS. ALTERNATES TO THE ABOVE PROCEDURES MUST BE REVIEWED BY RJC PRIOR TO THE START OF DEMOLITION OR CONSTRUCTION.

10. UNLESS NOTED OTHERWISE AT ALL LOCATIONS WHERE NEW CONCRETE WILL BE IN CONTACT WITH EXISTING CONCRETE SURFACES, THE EXISTING CONCRETE SURFACE IS TO BE COMPLETELY CLEANED AND ROUGHENED BY HYDRODEMOLITION, BUSH HAMMERING, (OR APPROVED EQUAL) TO AN AMPLITUDE OF 6 mm (1/4").

11. CONNECTIONS FOR NEW STRUCTURAL STEEL FRAMING TO EXISTING STRUCTURAL STEEL SHALL BE ACHIEVED THROUGH WELDED CONNECTIONS UNLESS OTHERWISE NOTED. WELDING OF NEW STEEL TO "OLD" STEEL (STEEL PRODUCED IN EARLY 20TH CENTURY) MAY REQUIRE MODIFICATIONS TO THE STANDARD WELDING PROCEDURES. PROCEDURES OF WELDING NEW STEEL TO "OLD" STEEL SHALL BE PREPARED BY THE CONTRACTOR'S SPECIALTY STRUCTURAL ENGINEER AND REVIEWED AND APPROVED BY RJC. CONTRACTOR TO ALSO PROVIDE A REPORT FROM MATERIALS TESTING COMPANY COMMENTING ON CHEMICAL COMPOSITION AND WELDABILITY OF OLD STEEL.

12. CONTRACTOR TO ENSURE THAT UNDERGROUND OR IN-SLAB SERVICES ARE NOT DAMAGED THROUGH DEMOLITION, SAWCUTTING, HOLE AUGURING, OR OTHER CONSTRUCTION ACTIVITIES. SEE SPECIFICATION FOR TESTING/LOCATING REQUIREMENTS.

13. FASTENING TO EXISTING MATERIALS:

    UNLESS NOTED OTHERWISE, THE FOLLOWING REQUIREMENTS APPLY TO ALL CONNECTIONS BETWEEN EXISTING AND NEW MATERIALS:

    A. USE ONLY PRODUCTS AS SPECIFIED UNLESS ALTERNATES HAVE BEEN PRE-APPROVED BY RJC IN WRITING.

    B. ON SITE TRAINING - THE CONTRACTOR SHALL RETAIN A MANUFACTURER'S REPRESENTATIVE TO PROVIDE ON-SITE ANCHOR INSTALLATION TRAINING FOR ALL PROPRIETARY PRODUCTS SPECIFIED. THE CONTRACTOR'S PERSONNEL MUST BE TRAINED PRIOR TO THE COMMENCEMENT OF INSTALLING ANCHORS.

    C. THE CONTRACTOR IS TO RETAIN A THIRD PARTY MATERIALS TESTING AGENCY EXPERIENCED WITH THE INSTALLATION OF ANCHORS TO PROVIDE AN ON-GOING SERVICE OF ON-SITE QUALITY CONTROL REVIEWS TO ENSURE THAT ANCHORS ARE BEING INSTALLED IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDED SPECIFICATIONS AND INSTALLATION PROCEDURES. QUALITY ASSURANCE REPORTS FROM THE TESTING AGENCY ARE TO BE SUBMITTED TO RJC AFTER EACH SITE VISIT. AT THE END OF THE PROJECT, THE TESTING AGENCY IS TO PROVIDE A LETTER SIGNED BY A REGISTERED ENGINEER STATING THAT THE GENERAL INSTALLATION OF ANCHORS FOR THE PROJECT IS IN ACCORDANCE WITH THE RECOMMENDED INSTALLATION PRACTICE AS SPECIFIED BY THE MANUFACTURER.

    D. A REPRESENTATIVE SAMPLE OF ANCHORS IS TO BE TESTED FOR EACH TYPE OF ANCHOR SPECIFIED. TESTING SHALL BE CARRIED OUT BY A TESTING AGENCY APPOINTED AND PAID FOR BY THE OWNER. ANCHORS WHICH FAIL THE LOAD TEST SHALL BE REPLACED BY THE CONTRACTOR AT THE CONTRACTOR'S COST. IF THE FAILURE RATE EXCEEDS 1 IN 10 FOR A TYPE OF ANCHORS, ALL ANCHORS ARE TO BE TESTED.

    E. SEE ALSO CONCRETE ANCHORS NOTE.

14. DRILL AND SITE MEASURE BOLT HOLES IN EXISTING STRUCTURE PRIOR TO FABRICATING STEEL CONNECTION PLATES. BOLT HOLES MAY HAVE TO BE MOVED FROM WHAT IS SHOWN ON THE DRAWINGS TO AVOID CUTTING EXISTING REINFORCING OR TO AVOID OTHER SITE CONDITIONS. SITE MODIFICATION OF STEEL CONNECTION PLATES WILL NOT BE ACCEPTED WITHOUT THE PRIOR APPROVAL OF RJC.

NO.	REV.	ISSUED FOR	DATE
1	4	100% CD	2019-11-12
2	5	ISSUED FOR PERMIT	2019-11-14
3	6	ISSUED FOR TENDER REVIEW	2019-12-06
4	7	ISSUED FOR TENDER	2019-12-11

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STAMP

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PROJECT:

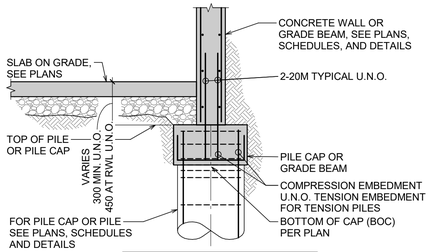
DRAWING NAME:
GENERAL NOTES & TYPICAL DETAILS

PROJECT NO:	DRAWN BY:	CHECKED BY:
TOR.113946.0011	JP	NB

Scale: As indicated

DRAWING NUMBER:
S-101

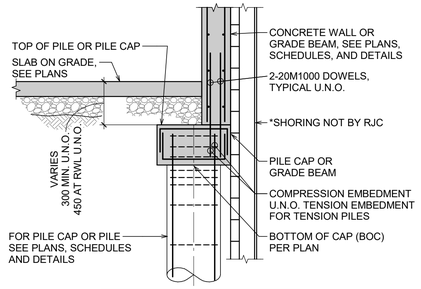
TYPICAL INTERIOR WALL ON PILE OR PILE CAP - U.N.O.



WALL PLACED BEFORE SLAB POURED

NOTE: PROVIDE MINIMUM FROST COVER AT FROST SUSCEPTIBLE LOCATIONS PER GEOTECHNICAL RECOMMENDATIONS.

TYPICAL EXTERIOR WALL ON PILE OR PILE CAP WITH SHORING- U.N.O.



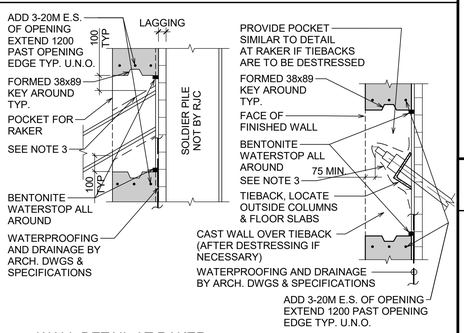
WALL PLACED BEFORE SLAB POURED

NOTE: PROVIDE MINIMUM FROST COVER AT FROST SUSCEPTIBLE LOCATIONS PER GEOTECHNICAL RECOMMENDATIONS.

PLACING OF CONCRETE IN STEEL PILES

1. CONCRETE MAY BE PLACED IN STEEL PILES AND CAISSONS BY DROPPING FROM TOP.
2. PILE DRIVING OPERATIONS MUST NOT DISTURB ADJACENT CONCRETE PLACED IN PILES, PILE CAPS, GRADE BEAMS, SLABS, ETC. BETWEEN THE TIME THE CONCRETE STARTS ITS INITIAL SET AND UNTIL IT REACHES 10 MPa STRENGTH.

EXCAVATION SUPPORT SYSTEMS & FOUNDATION WALLS



WALL DETAIL AT RAKER

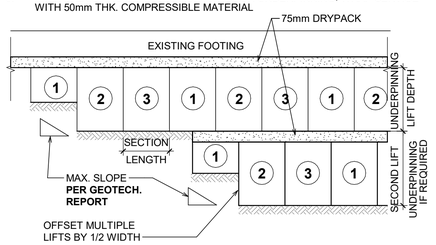
DETAIL @ TIEBACKS (NO WALER)

NOTES:

1. PROVE VERTICAL CONTROL JOINT IN LINE WITH TIE BACK AND RAKER LOCATIONS.
2. DESIGN OF SHORING SYSTEM IS BY THE SHORING CONSULTANT.
3. PAINT/ MASKING/ COATING PER ARCH DWGS & SPECIFICATIONS.

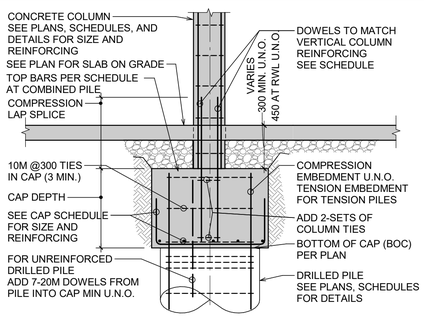
UNDERPINNING NOTES

1. CONCRETE SHALL HAVE 28 DAY STRENGTH OF 25 MPa AND A MAX. SLUMP OF 75mm (3"). DRYPACK GROUT TO BE NON-SHRINK MIN. F'c=35 MPa.
2. UNDERPINNING SHALL BE DONE IN 1200mm (4'-0") LONG SECTIONS MAX. U.N.O.
3. NUMBERS OF PANELS INDICATE STAGES IN WHICH UNDERPINNING SHALL PROCEED, I.E. ALL SECTIONS MARKED #1 FOLLOWED BY ALL SECTIONS #2 ETC. POUR CONCRETE IN PLACE AND LEAVE FOR 24 HRS. BEFORE CLEANING UNDERSIDE EXISTING FOOTING, DRYPACKING AND PROCEEDING WITH NEXT STAGE.
4. PROVIDE ALL NECESSARY SHORING/ BRACING TO EXISTING STRUCTURE REQUIRED TO CARRY OUT THIS WORK. CONTRACTOR TO ENSURE EXISTING WALL ABOVE IS STABLE PRIOR TO PROCEEDING WITH WORK.
5. FOOTING AND UNDERPINNING EXCAVATIONS SHALL BE INSPECTED BY A GEOTECHNICAL ENGINEER PRIOR TO POURING CONCRETE TO CONFIRM ADEQUACY OF SUB-GRADE.
6. MAX. HEIGHT OF UNDERPINNING SHALL NOT EXCEED 1200mm (4'-0") TYPICAL IN ONE LIFT. IF UNDERPINNING DEPTH IS LARGER, MULTIPLE LIFTS ARE REQUIRED. EACH LIFT TO BE COMPLETED AND FULLY CURED PRIOR TO SUBSEQUENT LIFT PROCEEDING. UNDERPINNING WIDTH TO MATCH EXISTING FOUNDATION WIDTH U.N.O.
7. CLEAN UNDERSIDE OF EXISTING FOOTING/WALL.
8. DO NOT LEAVE OPEN EXCAVATION OVERNIGHT.
9. WHERE EXISTING SERVICES RUN THROUGH UNDERPINNING, WRAP SERVICE WITH 50mm THK. COMPRESSIBLE MATERIAL



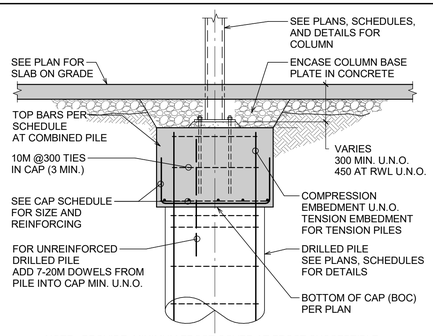
ELEVATION

TYPICAL SINGLE INTERIOR CONCRETE COLUMN ON PILE OR PILE CAP - U.N.O.



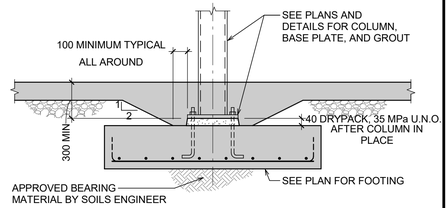
NOTES:
1. COLUMN PLACED BEFORE SLAB POURED. IF SLAB ON GRADE IS POURED WITH INTEGRAL PEDESTAL TO TOP OF PILE CAP, REVISE COMPRESSION LAP TO MEASURE FROM TOP OF SLAB ON GRADE. PROVIDE MINIMUM FROST COVER AT FROST SUSCEPTIBLE LOCATIONS PER GEOTECHNICAL RECOMMENDATIONS.

TYPICAL SINGLE STEEL COLUMN ON INTERIOR PILE OR PILE CAP - U.N.O.

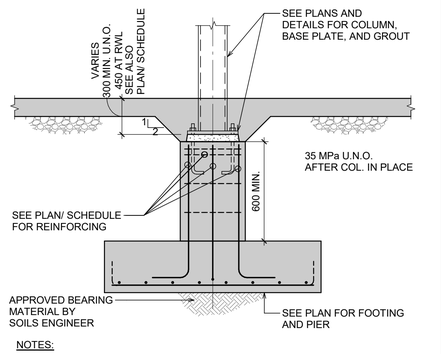


NOTE: PROVIDE MINIMUM FROST COVER AT FROST SUSCEPTIBLE LOCATIONS PER GEOTECHNICAL RECOMMENDATIONS

TYPICAL INTERIOR STEEL COLUMN ON FOOTING DETAILS - U.N.O.



STEEL COLUMN BEARING DIRECTLY ON FOOTING

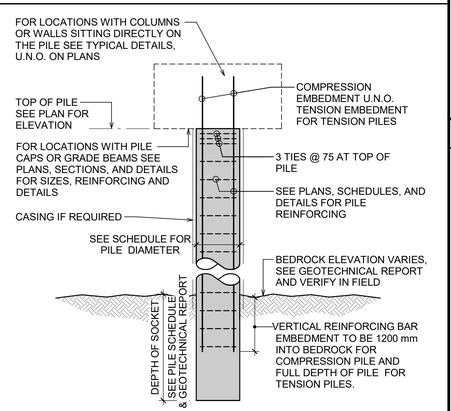


NOTES:

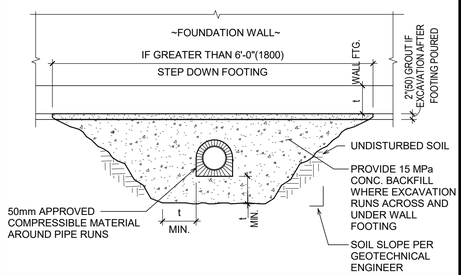
1. 15M VERTS WITH C15M DOWELS (LAP SPLICE 600) MAY BE USED. DO NOT WET SET DOWELS OR C15M VERTS.
2. DRYPACK - PREMIXED OR NON-PREMIXED COMPOSITION OF NON-METALLIC AGGREGATE, CEMENT AND SUFFICIENT WATER FOR THE MIXTURE TO RETAIN ITS SHAPE WHEN MADE INTO A BALL BY HAND AND CAPABLE OF DEVELOPING COMPRESSIVE STRENGTH OF 35 MPa AT 28 DAYS.
3. PROVIDE MINIMUM FROST COVER AT FROST SUSCEPTABLE LOCATIONS PER GEOTECHNICAL RECOMMENDATIONS.

STEEL COLUMN ON PEDESTAL ON FOOTING

TYPICAL ROCK SOCKETED DRILLED PILE

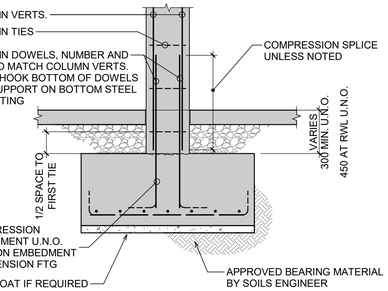


TYPICAL PIPE UNDER WALL FOOTING DETAIL



TYPICAL INTERIOR COLUMN FOOTING

EXCEPT AS NOTED:
- FOR SPLICE LENGTHS, SEE TABLES ON STRUCTURAL DRAWINGS.
- FOOTING SHALL BE CENTERED UNDER COLUMN U.N.O.

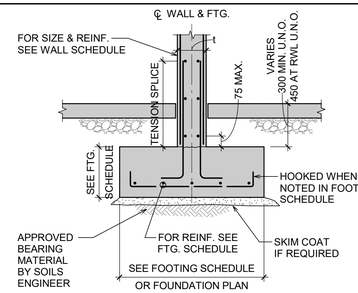


WITHOUT PEDESTAL

NOTES:

1. PROVIDE MINIMUM 8-20M DOWELS UNLESS NOTED OTHERWISE IN SCHEDULE.
2. EXTEND DOWELS INTO FOOTING BELOW WHEN HEIGHT OF PEDESTAL IS LESS THAN THE COMPRESSION DEVELOPMENT LENGTH OF THE DOWELS BEING DEVELOPED.
3. PROVIDE MINIMUM FROST COVER AT FROST SUSCEPTABLE LOCATIONS PER GEOTECHNICAL RECOMMENDATIONS.

TYPICAL INTERIOR SHEAR WALL FOOTINGS



DOWELS TO MATCH VERTICAL WALL REINFORCING U.N.O.

SHEAR WALL FOOTING WITHOUT PEDESTAL

DRILLED PILE FOUNDATIONS

1. FOUNDATION DESIGN IS BASED ON THE GEOTECHNICAL REPORT ..... PREPARED BY: SOIL ENGINEERS LTD. DATED: OCTOBER 15, 2019 REFER TO THE REPORT FOR ANY PARTICULARS AS TO SOILS CONDITIONS AND FOUNDATIONS RECOMMENDATIONS.
2. ENSURE THAT THE REQUIREMENTS OUTLINED IN THIS REPORT ARE READ AND UNDERSTOOD PRIOR TO COMMENCING WITH FOUNDATION WORK.
3. CONCRETE CAST-IN-PLACE DRILLED PILES HAVE BEEN DESIGNED ON THE BASIS OF THE FOLLOWING FACTORED SKIN FRICTION RESISTANCE VALUES, AND FACTORED END BEARING RESISTANCE VALUES:

DEPTH BELOW GRADE	SKIN FRICTION (SLS)	FACTORED END BEARING
0 m TO 2.1 m	0 kPa	N/A
BELOW 2.1 m	60 kPa	N/A

4. PRIOR TO PLACING CONCRETE FOR PILE FOUNDATIONS, BEARING STRATA FOR PILES SHALL BE INSPECTED BY A GEOTECHNICAL CONSULTANT TO CONFIRM THE BEARING CAPACITY OF THE SOIL. READ JONES CHRISTOFFERSEN LTD. IS NOT RESPONSIBLE FOR CONFIRMING FOUNDATION CAPACITIES OF SOILS.
5. UNLESS OTHERWISE SHOWN, CENTER PILES UNDER COLUMNS AND WALLS.
6. ALL DOWELS AND ANCHOR RODS SHALL BE PLACED BEFORE CONCRETE IS POURED. TEMPLATES SHALL BE USED TO ENSURE CORRECT PLACEMENT OF DOWELS AND ANCHOR RODS.
7. UNLESS OTHERWISE INDICATED, PROVIDE A MINIMUM OF 4-20M DOWELS INTO GRADE BEAM ABOVE.
8. PROVIDE DOWELS TO MATCH VERTICAL REINFORCEMENT IN SUPERSTRUCTURE ABOVE.
9. DRILLED PILES SHALL BE PLACED WITH THE FOLLOWING TOLERANCES:
   A. NOT MORE THAN 2% OF ITS LENGTH OUT OF PLUMB FOR VERTICAL PILES.
   B. NOT MORE THAN 75 mm OFF CENTER AT THE TOP.
10. SUB-BASE DESIGN OF SOIL UNDER THE SLAB ON GRADE SHALL BE IN ACCORDANCE WITH THE GEOTECHNICAL REPORT.
11. FOR GROUND ELEVATIONS AND DRAINAGE SLOPES, SEE ARCHITECTURAL DRAWINGS.

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4	7	ISSUED FOR TENDER	2019-12-11

N

STAMP

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TOR.113946.0011	JP	NB

Scale: As indicated

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S-102

DEMOLITION OF STRUCTURAL ELEMENTS CONTINUED.....

H. PROVIDE SHORING TO SUPPORT THE SLAB WHEN REMOVALS REDUCE ITS LOAD-CARRYING CAPACITY, AS DIRECTED BY THE ENGINEER. NO PAYMENT WILL BE MADE FOR SUCH SHORING AS IT IS TO BE INCLUDED IN THE COST OF REPAIR AS OUTLINED IN THESE DOCUMENTS.

I. DEMOLITION PROCEDURES AND EQUIPMENT SHALL MEET ALL APPLICABLE NOISE-CONTROL BY-LAWS AND REGULATIONS OF THE LOCATION OF THE WORK.

J. REFER TO TEMPORARY WORKS AND RENOVATION NOTES FOR ADDITIONAL DRAWINGS TO BE PREPARED UNDER THE DIRECTION OF A SPECIALTY STRUCTURAL ENGINEER. FOR THOSE CONNECTIONS AND COMPONENTS DESIGNED BY THE FABRICATOR, THIS ENGINEER OR THEIR REPRESENTATIVE SHALL VISIT THE SITE TO REVIEW IN PLACE THE CONNECTIONS AND COMPONENTS DESIGNED BY THIS ENGINEER TO SATISFY THEMSELVES THAT THESE CONNECTIONS AND COMPONENTS COMPLY WITH THEIR DESIGN ON THE SHOP DRAWINGS. THIS ENGINEER SHALL PROVIDE A LETTER TO RJC TO THIS EFFECT. THIS ENGINEER SHALL ALSO PROVIDE SEALED SKETCHES FOR ALL FIELD MODIFICATIONS MADE TO THEIR DESIGN.

DEMOLITION OF STRUCTURAL ELEMENTS

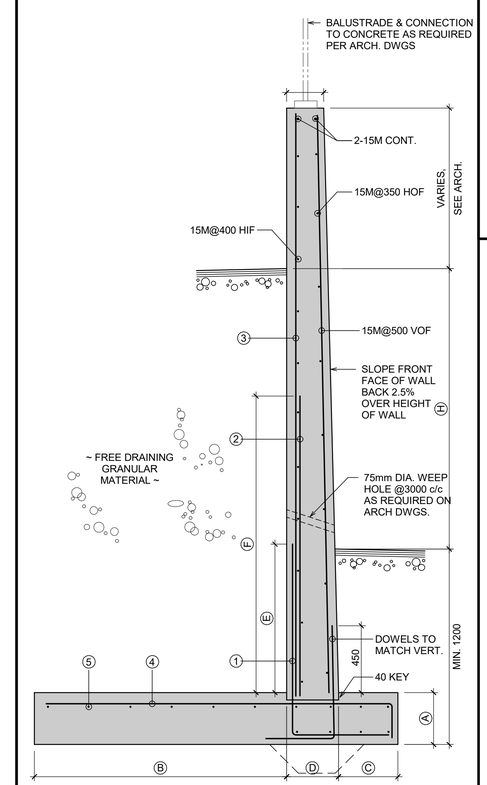
1. SEE TEMPORARY WORKS NOTES.
2. THESE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH ALL OTHER DRAWINGS AND SPECIFICATIONS FORMING THE TENDER PACKAGE.
3. THE DRAWINGS ILLUSTRATE SCHEMATIC APPROACH TO THE TEMPORARY BRACING OF THE EXISTING STRUCTURE AND IS PREPARED FOR CONTRACTOR CONSIDERATION ONLY. THE CONTRACTOR MAY ADOPT THE ILLUSTRATED APPROACH AT HIS SOLE DISCRETION OR PROPOSE ANY OTHER METHOD HE DEEMS APPROPRIATE TO PROVIDE TEMPORARY BRACING, BUT IN NO TIME SHALL THE SAFETY AND INTEGRITY OF THE EXISTING STRUCTURE BE COMPROMISED.
4. THE CONTRACTOR SHALL DESIGN, PROVIDE, CONSTRUCT AND MAINTAIN, REMOVE AND ASSUME FULL AND SOLE RESPONSIBILITY FOR THE TEMPORARY WORKS.
5. SUBMIT SHOP DRAWINGS, DIAGRAMS AND DETAILS SHOWING SEQUENCE OF DEMOLITION WORK AND SUPPORTING STRUCTURES AND UNDERPINNING. SUBMIT CALCULATIONS TO THE CONSULTANT. DRAWINGS AND CALCULATIONS SUBMITTED SHALL BEAR SIGNATURE AND STAMP OF QUALIFIED PROFESSIONAL ENGINEER REGISTERED IN THE PROVINCE OF ONTARIO.
6. THE PROFESSIONAL ENGINEER EMPLOYED TO DESIGN THE TEMPORARY SHORING, BRACING, NEEDLING AND THE SAME ENGINEER SHALL ALSO BE EMPLOYED TO FULLY SUPERVISE THEIR INSTALLATION AND REMOVAL AND SHALL SUBMIT WEEKLY REPORTS TO THE CONSULTANT, AND OWNER REGARDING THIS WORK.
7. GENERAL CONTRACTOR MUST EXAMINE DRAWINGS OF ALL DISCIPLINES AND COORDINATE THE STRUCTURAL DEMOLITION WORK TO ASSURE THAT THE ADOPTED SEQUENCE OF DEMOLITION WORK PROVIDES FOR SUBSEQUENT CONSTRUCTION OF ALL ELEMENTS OF THE PROJECT WITHOUT INTERFERENCE.
8. IT IS GENERAL CONTRACTOR RESPONSIBILITY TO COORDINATE THE STRUCTURAL DEMOLITION WORK WITH OTHER DEMOLITION REQUIRED BY ARCHITECTURAL AND MECHANICAL DISCIPLINES AND ASSIGN COORDINATED SCOPE OF WORK TO THE SUBTRADES.
9. THE EXISTING STRUCTURE SHOWN ON THE DRAWINGS IS BASED ON THE ORIGINAL DRAWINGS AND LIMITED INFORMATION AVAILABLE AT THE TIME OF DESIGN. THE DEMOLITION SCOPE OF WORK SHALL INCLUDE REMOVAL OF ALL STRUCTURAL AND NON-STRUCTURAL ELEMENTS IN THE AREAS MARKED ON DRAWINGS AND AS INDICATED BY THE ARCHITECT.
10. PROTECTION:
    - A. PREVENT MOVEMENT, SETTLEMENT OR DAMAGE OF ELEMENTS OF EXISTING BUILDING TO REMAIN. PROVIDE BRACING, SHORING AS REQUIRED. PROTECT ALL EXISTING SURFACES NOT TO BE RESTORED FROM DAMAGE DURING REMOVAL PROCEDURE. REMOVE OR PROTECT IN PLACE ALL SURFACE- MOUNTED OR PERMANENT ELECTRICAL FIXTURES AND ALL CONDUIT, FIXTURES, EQUIPMENT, ETC. NOT TO BE DEMOLISHED. UPON COMPLETION OF THE REPAIR WORK, REINSTALL ALL EXISTING EQUIPMENT AND FIXTURES DESIGNATED TO REMAIN. MAKE GOOD DAMAGE CAUSED BY DEMOLITION.
    - B. TAKE PRECAUTIONS TO SUPPORT AND, IF SAFETY OF ELEMENTS NOT SLATED FOR DEMOLITION APPEARS TO BE ENDANGERED, CEASE OPERATIONS AND NOTIFY ENGINEER IMMEDIATELY.
    - C. PREVENT DEBRIS FROM BLOCKING SURFACE DRAINAGE SYSTEM, MECHANICAL, AND ELECTRICAL SYSTEMS WHICH MUST REMAIN IN OPERATION.
11. INSPECTION:
    - A. VISIT AND EXAMINE THE SITE AND NOTE ALL CHARACTERISTICS AND FEATURES AFFECTING THE WORK OF THIS SECTION.
    - B. ENSURE ALL SERVICES, WHETHER BURIED, BUILT-IN OR EXPOSED ARE PROPERLY IDENTIFIED AS TO POSITION, TYPE OF SERVICE, SIZE, DIRECTION OF FLOW. SLABS MUST BE SCANNED OR X-RAYED FOR EMBEDDED SERVICES AT REPAIR LOCATIONS PRIOR TO UNDERTAKING THE REPAIR WORK SUCH THAT THESE SERVICES CAN BE RELOCATED. CONTRACTOR WILL BE RESPONSIBLE FOR DAMAGES TO ALL EMBEDDED SERVICES.
    - C. INSPECT MATERIALS, EQUIPMENT, COMPONENTS TO BE RE-USED OR TURNED OVER TO THE OWNER. NOTE THEIR CONDITION AND ADVISE ARCHITECT IN WRITING OF ANY DEFECTS OR CONDITIONS WHICH WOULD AFFECT THEIR REMOVAL AND RE-USE.
12. PREPARATION:
    - A. DO NOT DISRUPT ACTIVE OR ENERGIZED UTILITIES DESIGNATED TO REMAIN UNDISTURBED.
    - B. RELOCATE EXISTING SERVICES PRIOR TO START OF WORK AS REQUIRED, BUT DO NOT AFFECT THE SERVICES OF AREAS NOT UNDER CONSTRUCTION OR ESSENTIAL TO THE ONGOING OPERATION OF THE BUILDING.
    - C. PROTECT ALL SURFACE-MOUNTED FIXTURES FROM DAMAGE.
    - D. IN ALL CASES, EXERCISE ALL REASONABLE CARE DURING REMOVAL OPERATIONS TO AVOID DAMAGING ITEMS TO BE SALVAGED, RE-USED, OR ITEMS THAT ARE NOT PART OF THE SCOPE OF WORK.
13. DEMOLITION, SALVAGE AND DISPOSAL:
    - A. DEMOLISH PARTS OF STRUCTURE TO PERMIT REMEDIAL WORK AS INDICATED.
    - B. REMOVE EXISTING EQUIPMENT, SERVICES, AND OBSTACLES WHERE REQUIRED FOR REFINISHING OR MAKING GOOD OF EXISTING SURFACES, AND REPLACE AS WORK PROGRESSES.
    - C. AT END OF EACH DAY'S WORK, LEAVE WORK IN SAFE CONDITION SO THAT NO PART IS IN DANGER OF CAUSING INJURY OR DAMAGE.
    - D. DEMOLISH TO MINIMIZE DUSTING. KEEP DUSTY MATERIALS WETTED, WHERE POSSIBLE.
    - E. DEMOLISH CONCRETE IN SMALL SECTIONS. CAREFULLY REMOVE AND LOWER HEAVY OR LARGE OBJECTS.
    - F. THE CONTRACTOR IS TO TAKE CARE NOT TO DAMAGE THE SURFACE OF SOUND CONCRETE WHICH IS TO REMAIN THROUGH THE REMOVAL OPERATION. WHERE ANY SUCH DAMAGE IS DONE TO SOUND MATERIAL, IT IS TO BE REPAIRED BY THE CONTRACTOR AT THEIR OWN EXPENSE TO THE APPROVAL OF THE ENGINEER.
    - G. WHERE NEW CONCRETE IS TO BE APPLIED TO EXISTING CONCRETE, THE SURFACE IS TO BE LEFT CLEAN AND SOUND.

FREESTANDING RETAINING WALL NOTES & DETAILS

1. RETAINING WALLS ARE DESIGNED IN ACCORDANCE WITH THE RECOMMENDATIONS OF THE SOILS REPORT NOTED UNDER FOUNDATION GENERAL NOTES PLUS A 2.4 kPa LATERAL LOAD ALLOWANCE FOR A VERTICAL SURCHARGE OF 4.8 kPa. SEE ALSO DESIGN LOADS IN GENERAL NOTES.
2. RETAINING WALLS ARE DESIGNED FOR A FREE DRAINING AND WELL DRAINED BACKFILL. SEE ARCHITECTURAL AND PLUMBING SPECIFICATIONS AND DRAWINGS FOR DRAINAGE REQUIREMENTS.
3. SEE ARCHITECTURAL DRAWINGS AND SPECIFICATIONS FOR DAMPROOFING OR WATERPROOFING REQUIREMENTS.
4. SEE ALSO ARCHITECTURAL AND CIVIL/ LANDSCAPING DWGS FOR EXTENT OF FOR RETAINING STRUCTURES.
5. BACKFILL MATERIALS AND METHODS TO BE REVIEWED BY SOILS CONSULTANT TO BE ENSURE COMPLIANCE TO THE RECOMMENDATIONS AS NOTED IN THE GEOTECHNICAL REPORT.
6. DESIGN AND FIELD REVIEW OF BACKFILL IS BY SOILS CONSULTANT AND NOT BY READ JONES CHRISTOFFERSEN.
7. UNLESS NOTED OTHERWISE, ALL RETAINING WALLS BELOW GRADE AND ALL EXTERIOR WALLS EXPOSED TO THE WEATHER ABOVE GRADE SHALL HAVE CONTROL JOINTS. SEE CONTROL JOINT DETAIL. CONSTRUCTION JOINT MAY REPLACE CONTROL JOINT WHERE REQUIRED. THE LOCATION OF CONTROL JOINTS IN EXPOSED CONCRETE WALLS SHALL BE SUBMITTED TO THE ARCHITECT FOR REVIEW.
8. VERTICAL CONTROL JOINTS AND CONSTRUCTION JOINTS PER WALL TYPICAL DETAILS.

RETAINING WALL DETAIL

	Ⓗ	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	Ⓕ	①	②	③	④	⑤
1A	3500 MAX	400	2500	450	400	1000	3500	20M@160	20M@300	15M@250	20M@180	15M@250
1B	3000 MAX	400	2200	400	400	1000	—	20M@240	—	20M@300	20M@240	15M@250
1C	2800 MAX	350	2000	400	350	800	2800	20M@140	20M@320	15M@320	20M@140	15M@280
1D	2500 MAX	350	1800	400	350	800	2500	20M@180	20M@360	15M@360	20M@180	15M@280
1E	2000 MAX	350	1500	400	350	800	2000	20M@200	20M@400	15M@400	20M@200	15M@280
1F	1500 MAX	350	1200	400	350	800	—	20M@300	—	20M@300	20M@300	15M@280
1G	1000 MAX	350	900	300	300	800	1500	15M@250	15M@500	15M@500	15M@250	15M@280
1H	500 MAX	300	600	300	300	800	—	15M@300	—	15M@300	15M@300	15M@300

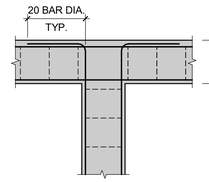


GRADE BEAM REINFORCEMENT

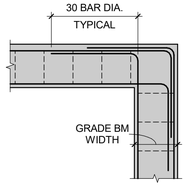
1. UNLESS OTHERWISE NOTED ALL GRADE BEAM REINFORCEMENT SHALL CONSIST OF THE FOLLOWING:

   2-20M TOP AND BOTTOM
   10M @ 300 STIRRUPS
   15M @ 200 HORIZ. EACH FACE MIN. U.N.O.

2. HOOK HORIZONTAL BEAM REINFORCING OR PROVIDE CORNER BARS AT ALL BEAM INTERSECTIONS AND CORNERS.
3. UNLESS NOTED OTHERWISE BEAM REINFORCEMENT SHALL BE CONTINUOUS:
   - A. TOP REINFORCEMENT SHALL BE SPLICED AT MIDSPAN AND SHALL HAVE LAPS OF 600 mm. HOOK TOP REINFORCEMENT AT END SUPPORTS AND PROVIDE ADDITIONAL TOP BARS WHERE REINFORCEMENT IS INTERUPTED BY RECESSED COLUMN OR BASEPLATE DETAILS.
   - B. BOTTOM REINFORCEMENT SHALL BE SPLICED AT PILE LOCATIONS AND SHALL HAVE LAPS 450 mm.
   - C. ALL REINFORCEMENT TO BE CONTINUOUS THROUGH PILE CAPS OR INTERSECTING GRADE BEAMS.
4. UNLESS OTHERWISE NOTED MAXIMUM LENGTH OF POUR SHALL NOT EXCEED 30 m. LOCATIONS AND DETAILS OF CONSTRUCTION JOINTS SHALL BE SUBMITTED TO THE CONSULTANT FOR REVIEW PRIOR TO CONSTRUCTION.
5. REFER TO STRUCTURAL DRAWINGS FOR DETAILS OF GRADE BEAM CONSTRUCTION JOINTS AND CONTROL JOINTS.



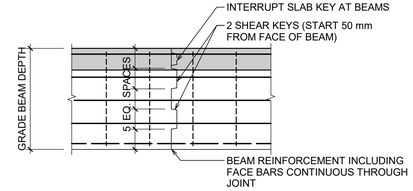
TEE INTERSECTION (PLAN VIEW)



CORNER (PLAN VIEW)

CONSTRUCTION JOINT THROUGH GRADE BEAMS

NOTE: LOCATIONS OF CONSTRUCTION JOINTS TO BE PRE-APPROVED BY THE STRUCTURAL ENGINEER.



BEAM ELEVATION

NO.	REV.	ISSUED FOR	DATE
1	4	100% CD	2019-11-12
2	5	ISSUED FOR PERMIT	2019-11-14
3	6	ISSUED FOR TENDER REVIEW	2019-12-06
4	7	ISSUED FOR TENDER	2019-12-11

N

STAMP

CONTRACTOR SHALL CHECK ALL DIMENSIONS ON THE WORK AND REPORT ANY DISCREPANCY TO THE CONSULTANT BEFORE PROCEEDING. THIS DRAWING IS NOT TO BE USED FOR CONSTRUCTION UNTIL AUTHORIZED IN WRITING BY CONSULTANT.

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PROJECT:

DRAWING NAME:

GENERAL NOTES & TYPICAL DETAILS

PROJECT NO:	DRAWN BY:	CHECKED BY:
TOR.113946.0011	JP	NB

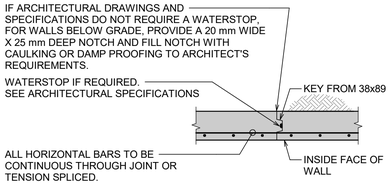
Scale: As indicated

DRAWING NUMBER:

S-103

WALL CONSTRUCTION JOINT

(CONSTRUCTION JOINT CAN REPLACE CONTROL JOINT)

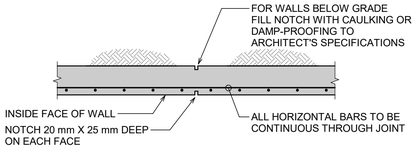


PLAN

WALL CONTROL JOINT

UNLESS NOTED OTHERWISE FOR EXTERIOR WALLS BELOW GRADE AND EXTERIOR WALLS EXPOSED TO WEATHER ABOVE GRADE.

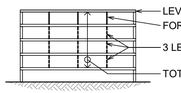
SPACE AT 6000 mm CENTERS MAXIMUM UNLESS OTHERWISE NOTED ON PLAN.



PLAN

CONCRETE FORMWORK STRIPPING AND SHORING

1. THE DESIGN AND FIELD REVIEW OF FORMWORK, SHORING AND RESHORING IS THE RESPONSIBILITY OF THE CONTRACTOR. RESHORING DRAWINGS SHALL BE SUBMITTED TO RJC FOR THE EFFECT ON THE BASE BUILDING STRUCTURE ONLY.
2. NO COLUMN OR WALL FORMS SHALL BE REMOVED BEFORE CONCRETE HAS REACHED 10 MPa FOR ARCHITECTURAL CONCRETE OR 8 MPa FOR OTHER COLUMNS OR WALLS.
3. NO SLABFORMS OR BEAMFORMS SHALL BE REMOVED BEFORE CONCRETE HAS REACHED 75% OF THE 28 DAY STRENGTH BEFORE STRIPPING / RESHORING.
4. STRENGTH OF CONCRETE FOR STRIPPING TO BE DETERMINED USING CYLINDERS STORED ON SITE IN A PROTECTED ENCLOSURE THAT MAINTAINS A SIMILAR TEMPERATURE AND HUMIDITY AS THE STRUCTURAL ELEMENTS REPRESENTED. ALTERNATE METHODS, IF ACCEPTABLE TO RJC, MAY BE USED.
5. ALL SLABS, BEAMS, GIRDERS ETC. TO BE SHORED UNTIL CONCRETE REACHES DESIGN STRENGTH.
6. SOME MULTI LEVEL OR HANGER ASSEMBLIES REQUIRE FULL SHORING FOR A NUMBER OF LEVELS. SEE STRUCTURAL DRAWINGS FOR SPECIAL SHORING REQUIREMENTS.
7. NO CONCRETE MAY BE REMOVED WITH PERCUSSIVE METHODS SUCH AS CHIPPING OR JACK-HAMMERING WITHOUT PRIOR APPROVAL BY RJC.
8. SHORING:
   - A. COMMON / TYPICAL CONSTRUCTION PRACTICE TO SHORE THE FRESH WEIGHT OF FLOORS HAS BEEN ASSUMED.
   - B. THE FRESH WEIGHT OF THE TYPICAL SLABS / FLOORS, BEAMS, GIRDERS, ETC. TO BE SHORED AT LEAST 4 LEVELS BELOW THE FLOOR BEING POURED. SHORING MUST DESIGNED BY A SPECIALTY STRUCTURAL ENGINEER.



   - C. FLOORS WITH NON-TYPICAL DEPTHS MAY HAVE TO BE SHORED TO MORE THAN 4 FLOORS.
   - D. LOADING APPLIES TO COMPONENTS OF THE BASE BUILDING STRUCTURE (SLABS. COLUMNS, ETC.) BY THE FORMWORK, SHORES, OR RESHORES SHALL NOT EXCEED THE DESIGN LOAD FOR THOSE BASE BUILDING COMPONENTS. WHEN THIS LOADING IS APPLIED BEFORE THE CONCRETE STRENGTH IN THE BASE BUILDING COMPONENTS HAS REACHED THE SPECIFIED COMPRESSIVE STRENGTH, PRORATE THE COMPONENT CAPACITY BY THE RATIO OF ACTUAL CONCRETE STRENGTH TO SPECIFIED CONCRETE STRENGTH.
   - E. AT NO TIME SHALL THE FACTORED CONSTRUCTION LOAD EXCEED THE FACTORED DESIGN LOAD ON FLOORS.
   - F. CONSIDER THE SEQUENCE OF POST-TENSIONING OF VARIOUS FLOOR ELEMENTS WHEN DESIGNING FORMWORK AND SHORING FOR POST-TENSIONED FLOORS.
   - G. TRANSFER GIRDERS, SLABS, OR SUSPENDED AREAS WHERE THE SUPPORTING STRUCTURE IS NOT YET IN PLACE MAY HAVE TO BE RESHORED ALL THE WAY TO LOWEST SLAB ON GRADE LEVEL. IN SUCH CASES THE GENERAL CONTRACTOR IS TO HAVE THE SUBGRADE PREPARED TO SUIT THE LOADS SPECIFIED BY THE TEMPORARY WORKS FORMWORK SUPPLIERS' SPECIALTY STRUCTURAL ENGINEER AND THE METHOD SPECIFIED BY THE GEOTECHNICAL CONSULTANT. SETTLEMENTS OF THE SLAB ON GRADE UNDER SHORING LOADS SHALL NOT EXCEED 5 mm.
   - [H. TOWER CRANES ASSUMED TO BE RESHORED OVER MINIMUM 10 FLOORS UNLESS NOTED OTHERWISE.]

CONCRETE REINFORCEMENT

1. REINFORCEMENT SHALL CONFORM TO THE FOLLOWING STANDARDS:
   - A. CAN/CSA-G30.18R - GRADE 400 MPa - 10M AND LARGER (U.N.O.)
   - B. CSA STANDARD G30.5 - GRADE 400 MPa - WELDED WIRE REINFORCEMENT
   - C. CAN/CSA-G30.18W - GRADE 400 MPa - ALL REINFORCING THAT WILL BE WELDED OR IS PART OF THE SEISMIC RESISTING ELEMENTS; REINFORCING FOR SHEAR WALLS, HEADERS AND ZONES (INCLUDING ZONE TIES AND HEADER TIES/STIRRUPS) AND MOMENT FRAME COLUMNS AND BEAMS (INCLUDING COLUMN TIES AND BEAM STIRRUPS).
   - D. CSA STANDARD G279 - PRESTRESSING STRANDS
   - E. EPOXY REINFORCING - ASTM A775M AND ASTM D3963
   - F. GALVANIZED REBAR

   (NOTE: G30.18W MAY BE SUBSTITUTED FOR G30.18R)
2. UNLESS OTHERWISE NOTED CONCRETE COVER TO REINFORCEMENT SHALL BE:
   - A. FOR FIRE RATINGS:

GENERAL (AREAS NOT INCLUDING PARKING)				
ELEMENT		FIRE RATINGS		
		0-2 HOURS	3 HOURS	4 HOURS
COLUMNS AND FORMED PILES (TO TIES)		40 mm	40 mm	55 mm
WALLS-NON-RETAINING AND EXPOSED TO FIRE ON 2 SIDES (TO ZONE TIES/OUTER CURTAIN LAYER)		40 mm	40 mm	40 mm
WALLS-NON-RETAINING AND EXPOSED TO FIRE ON 1 SIDE (TO ZONE TIES/OUTER CURTAIN LAYER)		20 mm *1	20 mm *1	20 mm *1
BEAMS AND GIRDERS		40 mm (TO STIR.) 50 mm (NO STIR.)	40 mm (TO STIR.) 50 mm (NO STIR.)	40 mm (TO STIR.) 50 mm (NO STIR.)
SLABS AND SLAB BANDS, STIRRUPS IN SLAB BANDS		25 mm *1	35 mm	40 mm
STRUCTURAL SLAB-ON-GRADE	TOP COVER	25 mm *1	N/A	N/A
	BOT. COVER	30 mm *1	N/A	N/A
RETAINING/FOUNDATION WALLS (F-2 EXPOSURE)	INSIDE FACE	25 mm *1	N/A	N/A
	GROUND OR EARTH SIDE	40 mm *2	N/A	N/A

   *1 - SEE NOTE B FOR BAR DIA ≥ 30M
   *2 - SEE NOTE E FOR BAR DIA ≥ 30M
   - B. UNLESS NOTED OTHERWISE IN NOTES C THROUGH E MINIMUM CONCRETE COVER----------1.0d
   - C. CONCRETE CAST AGAINST EARTH OR GROUND ---------- 75 mm
   - D. CONCRETE WITH NO MEMBRANE (NON-PARKING) ---------- 60 mm OR 2d (WHICHEVER IS GREATER) AND EXPOSED TO CHLORIDES - EXPOSURE CLASS C-XL, C1 AND C3.
   - E. FORMED FINISHED CONCRETE EXPOSED TO ---------- 40 mm OR 1.5d (WHICHEVER IS GREATER) WEATHER, - EXPOSURE CLASS F1, F2, S1 AND S2

   NOTES:

   LARGEST COVER REQUIRED GOVERNS.

   SEE ARCHITECTURAL DRAWINGS AND STRUCTURAL DRAWINGS FOR AREAS WHICH MAY REQUIRE 3 HOUR RATINGS OR GREATER.

   SEE STRUCTURAL DRAWINGS FOR AREAS CLASSIFIED AS (C) or (D) ABOVE FOR WEATHER EXPOSURE.
3. DESIGNATION OF REINFORCING BARS:
   - A. BARS SHOWN THUS —— —— —— IN BOTTOM OF BEAMS OR SLABS OR IN FAR FACE OF WALL

     BARS SHOWN THUS ———— IN TOP OF BEAMS OR SLABS OR IN FAR FACE OF WALL
   - B. STRAIGHT BARS:

     E.G. **6-10M4200** MEANS 6-10M BARS 4200 mm LONG. ————

     E.G. **20M4000 @ 300 ST 600** MEANS 600 END OFFSET FOR EACH 20M4000 BAR SPACED AT 300mm c/c IF STAGGER NOT SHOWN SEE SLAB REINFORCING LAYOUT TYP. DETAILS.

     BENT BARS:

     E.G. **6-C15M4000 @300** MEANS 6-15M BARS 4000 mm LONG INCLUDING HOOK LENGTH H.1.E. 90° AND SPACED AT 300mm c/c

     E.G. **6-A15M3000 @300** MEANS 6-15M BARS 3000 mm LONG INCLUDING HOOK LENGTH H.1.E. 180° AND SPACED AT 300mm

     E.G. **15M @300 H2E** MEANS 15M BARS SPACED AT 300mm c/c WITH H.1.E. 90° AT EACH END.
   - C. EPOXY COATED STRAIGHT AND HOOKED BARS:

     E.G. **E15M @400 BEW** MEANS 15M BARS EPOXY COATED SPACED AT 400mm c/c AT BOTTOM OF SLAB IN BOTH DIRECTIONS. —— —— ——

     E.G. **6-EC15M4000 @300** MEANS 6-15M BARS EPOXY COATED 4000 mm LONG INCLUDING HOOK LENGTH H.1.E. 90° AND SPACED AT 300mm.
4. DO NOT SUBSTITUTE DEFORMED WIRE FOR REINFORCING BARS WITHOUT PRIOR APPROVAL OF THE RJC.
5. SUPPORT REINFORCING WITH CHAIRS, ACCESSORIES, OR REINFORCING BARS AS REQUIRED. BARS USED AS SUPPORT BARS SHALL BE CONSIDERED AS ACCESSORIES.
6. PROVIDE SUFFICIENT SUPPORTS TO MAINTAIN CONCRETE COVER AS SPECIFIED. ALL SUPPORTS AND BARS MUST BE TIED TOGETHER TO MAINTAIN REINFORCING STEEL SECURELY IN PLACE DURING CONCRETE PLACEMENT.
7. TESTING OF REINFORCING STEEL SHALL CONFORM TO THE SPECIFICATIONS.

CONCRETE CONTINUED...

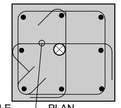
17. CORROSION INHIBITORS ARE TO BE USED IN CONCRETE IN AREAS NOTED ON THE STRUCTURAL DRAWINGS, AS WELL AS IN STAIRS AND STAIR LANDINGS WITHIN PARKADES. USE 10 L/m³ OF "DCI S" BY GRACE CONSTRUCTION PRODUCTS OR "MASTERLIFE CI 30" BY BASF CONSTRUCTION CHEMICALS. ALTERNATIVELY, USE C-XL CONCRETE WITH CURING TYPE 3 (EXTENDED) PER CSA A23.1.
18. ALL BOTTOM EDGES OF EXPOSED SLABS AND BEAMS, AS WELL AS EDGES OF WALLS AND COLUMNS, TO BE CHAMFERED 20 mm X 20 mm. ALL TOP EDGES OF EXPOSED SLABS, BEAMS, UPSTANDS AND STAIRS TO BE TOOLED UNLESS NOTED OTHERWISE. SEE ALSO ARCHITECTURAL DRAWINGS AND SPECIFICATIONS FOR OTHER FINISH REQUIREMENTS.
19. NO CALCIUM CHLORIDE IS PERMITTED, IN ANY FORM, IN ANY CONCRETE MIX WITHOUT THE EXPRESS WRITTEN CONSENT OF READ JONES CHRISTOFFERSEN LTD.
20. CURING AND PROTECTION OF CONCRETE FOR HOT, COLD OR DRY WEATHER IS TO BE AS PER CSA A23.1 AS A MINIMUM. SEE ALSO "CONCRETE COLD WEATHER REQUIREMENTS" IN THE STRUCTURAL DRAWINGS.

CONDUITS, PIPES AND SLEEVES EMBEDDED IN CONCRETE

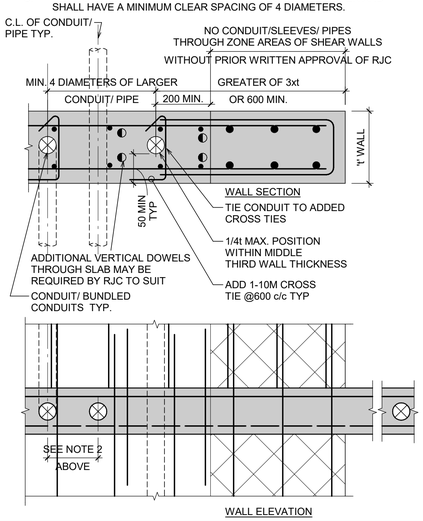
EXCEPT WHEN APPROVED BY RJC, PIPES, CONDUITS, AND SLEEVES EMBEDDED IN CONCRETE SHALL BE INSTALLED IN ACCORDANCE WITH CSA STANDARD A23.1 AND THE FOLLOWING GUIDELINES:

1. GENERAL
   - **A. SLEEVING DRAWINGS FOR ALL ELEMENTS SHALL BE SUBMITTED TO RJC FOR REVIEW PRIOR TO CONSTRUCTION.**
   - B. NOT WITHSTANDING THE SATISFYING OF THESE GUIDELINES, THE CONDUIT, SLEEVES, PIPES, ETC. SHALL NOT IMPAIR THE STRUCTURAL STRENGTH AND SHALL BE MOVED IF SO DIRECTED BY RJC.
   - C. CENTERLINE SPACING TO BE NOT LESS THAN 3 DIAMETERS OF LARGER CONDUIT/ PIPE, UNLESS NOTED OTHERWISE.
   - D. ADD REINFORCING AT POINTS OF CONGESTION AS DIRECTED BY THE STRUCTURAL ENGINEER.
   - E. NO CONDUITS, IN-SLAB DUCTS, SLEEVES, ETC., SHALL BE PLACED NEAR POST-TENSIONING ANCHORAGES
   - F. METAL CONDUIT, PIPES, ETC., SHALL NOT BE PLACED IN PARKING SLABS. NO CONDUIT, PIPES, ETC. SHALL BE PLACED IN PARKING TOPPING.
   - G. SLEEVES, PIPES OR CONDUITS OF UNCOATED ALUMINUM SHALL NOT BE USED.
   - H. CONDUITS AND PIPES ARE NOT ALLOWED IN THE CONCRETE TOPPING ON TOP OF STEEL DECK UNLESS APPROVED BY THE STRUCTURAL ENGINEER. FOR TOPPINGS ON STEEL DECK, THE CONCRETE THICKNESS IS MEASURED FROM THE TOP OF THE DECK FLUTE. SHOP DRAWINGS OF PROPOSED EMBEDDED ELEMENTS TO BE SUBMITTED TO RJC FOR REVIEW PRIOR TO CONSTRUCTION.
4. COLUMNS
   - A. FOR COLUMNS - BOXES, CONDUIT, SLEEVES OR EMBEDDED PIPES ARE NOT ALLOWED WITHOUT THE WRITTEN APPROVAL OF RJC.
   - B. WHERE ACCEPTED BY RJC, THE TOTAL AREA OF EMBEDDED CONDUITS OR FITTINGS SHALL NOT EXCEED 1% OF GROSS COLUMN AREA. SECURE CONDUITS TO COLUMN TIES.LOCATE AS CLOSE TO CENTRE OF SECTION AS POSSIBLE. DO NOT TIE ALONG VERTICAL BAR.

     ADD 1-10M TIE @600 c/c MIN. FOR COLUMN WITH NO STRUCTURAL TIES REQUIREMENTS ACROSS CENTRE OF SECTION



5. BEAMS - THE TOTAL MAXIMUM SIZE OF HORIZONTAL CONDUIT OR PIPES PARALLEL TO THE BEAM NOT TO EXCEED 4% OF THE AREA. NO SLEEVES THROUGH ANY BEAMS OR SLAB BANDS UNLESS APPROVED IN WRITING BY RJC.
6. WALLS - CONDUIT, SLEEVES OR EMBEDDED PIPES:
   - A. MAXIMUM DIAMETER = 1/4 WALL THICKNESS
   - B. NO HORIZONTAL RUNS PERMITTED
   - C. VERTICAL RUNS TO HAVE MINIMUM 50 mm CONCRETE COVER AND SHALL HAVE A MINIMUM CLEAR SPACING OF 4 DIAMETERS.



CONCRETE

1. CONCRETE IS SPECIFIED AS PER THE "PERFORMANCE" ALTERNATE AS OUTLINED IN CSA A23.1. CONCRETE IS TO BE CAST-IN-PLACE. THE USE OF SHOTCRETE FOR ANY ELEMENTS REQUIRES APPROVAL BY THE ENGINEER. ANY COSTS ASSOCIATED WITH CHANGES TO BE MADE TO THE CONTRACT DOCUMENTS TO ACCOMMODATE SHOTCRETE AS WELL AS ANY ADDITIONAL TESTING IS TO BE PAID FOR BY THE CONTRACTOR.
2. THE GENERAL CONTRACTOR IS RESPONSIBLE FOR WORKING WITH THE CONCRETE SUPPLIER TO ENSURE THAT THE PLASTIC AND HARDENED MIX PROPERTIES MEET SITE REQUIREMENTS FOR PLACING, FINISHING, AND THE OWNERS' SPECIFIED PERFORMANCE REQUIREMENTS. THE GENERAL CONTRACTOR SHALL MEET THE DOCUMENTATION AND QUALITY CONTROL REQUIREMENTS OUTLINED UNDER THE "PERFORMANCE" ALTERNATE OF CSA A23.1.
3. THE SUPPLIER SHALL MEET ALL CERTIFICATION AND DOCUMENTATION REQUIREMENTS AS OUTLINED UNDER THE "PERFORMANCE" ALTERNATE OF CSA A23.1.
4. THE CONCRETE SUPPLIER SHALL BE CERTIFIED BY THE [READY MIXED CONCRETE ASSOCIATION OF ONTARIO][ALBERTA READY MIXED CONCRETE ASSOCIATION].
5. CONCRETE PROPERTIES:

GENERAL (AREAS NOT INCLUDING PARKING)			
ELEMENT	COMPRESSIVE STRENGTH (MPa) 28 DAY U.N.O.	EXPOSURE CLASS	COMMENTS
PILE CAPS/ FOOTINGS/ GRADE BEAMS	35 MPa	N	.
CAST-IN-PLACE DRILLED PILES	32 MPa (56 DAY)	F-2	
SLAB ON GRADE (INTERIOR)	25 MPa	N	.
SLAB ON GRADE (EXTERIOR)	32 MPa	C-2	.
RETAINING WALLS / FOUNDATION WALLS/ SHOTCRETE	25 MPa	F-2	.
WALLS	35 MPa (56 DAY)	N/F-2	.
COLUMNS	35 MPa	N/F-2	.
TOPPING ON STEEL DECK	25 MPa	N	.
MECHANICAL HOUSEKEEPING PADS	20 MPa	N	.
NON-POST-TENSIONED SLABS, BEAMS, AND SLAB BANDS	25 MPa (28 DAY) 35 MPa (90 DAY)	N	.

   NOTES:

   WHERE EXPOSURE CLASS LISTED AS N/F-1/F-2:
   - A. USE N EXPOSURE FOR INTERIOR CONCRETE LOCATED WITHIN AN INSULATED BUILDING ENVELOPE (E.G. DRY AND NOT SUBJECTED TO FREEZING AND THAWING).
   - B. USE F-1 EXPOSURE FOR HORIZONTAL AND SLOPED CONCRETE MEMBERS EXTERIOR TO THE BUILDING INSULATION AND NOT PROTECTED BY A MEMBRANE AND DRIP EDGE (E.G. WET AND SUBJECT TO FREEZING AND THAWING).
   - C. USE F-2 EXPOSURE FOR HORIZONTAL AND SLOPED CONCRETE MEMBERS EXTERIOR TO THE BUILDING INSULATION AND PROTECTED BY A MEMBRANE AND DRIP EDGE (E.G. DRY AND SUBJECT TO FREEZING AND THAWING).
   - D. USE F-2 FOR VERTICAL CONCRETE MEMBERS EXTERIOR TO THE BUILDING INSULATION.
6. PORTLAND CEMENT SHALL BE TYPE GU UNLESS NOTED OTHERWISE.
7. CEMENT TYPE FOR EXPOSURE CLASSES S-1, S-2, AND S-3 SHALL BE AS OUTLINED IN CSA A23.1.
8. CONCRETE SHALL HAVE A UNIT WEIGHT OF 23±1 kN/m³ (145±5 PCF) UNLESS NOTED OTHERWISE.
9. THE CONCRETE PROPERTIES USED IN DESIGN ARE BASED ON A MAXIMUM COARSE AGGREGATE SIZE OF NOT LESS THAN 19 mm, UNLESS NOTED OTHERWISE. ALL LOCATIONS PROPOSED BY THE CONTRACTOR FOR USE OF CONCRETE MIX DESIGNS WITH A MAXIMUM COARSE AGGREGATE SIZE SMALLER THAN 19 mm SHALL BE SUBMITTED TO THE STRUCTURAL ENGINEER FOR REVIEW AND APPROVAL. ANY INCREASE IN REQUIRED CONCRETE STRENGTH OR INCREASE IN QUANTITY OF REINFORCEMENT DUE TO PROPOSED USE OF CONCRETE MIX WITH MAXIMUM COARSE AGGREGATE SIZE SMALLER THAN 19 mm TO BE PAID FOR BY THE CONTRACTOR.
10. RECYCLED AGGREGATE IS NOT TO BE USED WITHOUT WRITTEN APPROVAL BY THE ENGINEER.
11. SLUMP AND AGGREGATE SIZE TO BE DETERMINED BY THE GENERAL CONTRACTOR AND SUPPLIER TO MEET PLACEMENT, AND FINISHING REQUIREMENTS WITHOUT SEGREGATION WHILE MEETING ALL OWNER SPECIFICATIONS.
12. MAXIMUM WATER/CEMENT RATIO AND AIR CONTENT TO MEET THE REQUIREMENTS FOR THE EXPOSURE CLASS AS OUTLINED IN CSA A23.1.
13. CHLORIDE ION PENETRABILITY FOR EXPOSURE CLASS C-1 AND C-XL SHALL MEET THE REQUIREMENTS OF CSA A23.1.
14. AT THE REQUEST OF THE OWNER, THE SUPPLIER WILL FURNISH TEST DATA RESULTS (LESS THAN 3 MONTHS OLD) FOR EACH PROPOSED MIX DESIGN DEMONSTRATING THAT THEY MEET THE STRENGTH, DURABILITY, AND SHRINKAGE REQUIREMENTS SPECIFIED.
15. FOR 56 DAY [OR 90 DAY] STRENGTH SPECIFICATIONS, THE SUPPLIER WILL FURNISH THE OWNER WITH ACCELERATED STRENGTH TEST DATA FOR EACH PROPOSED MIX DESIGN, OR OTHER DOCUMENTATION ACCEPTABLE TO THE OWNER, SUCH THAT THE ANTICIPATED 56 DAY [OR 90 DAY] STRENGTH OF THE MIX AS PLACED ON SITE CAN BE EVALUATED WITHIN 14 DAYS OF PLACEMENT.
16. CURING OF CONCRETE TO MEET THE REQUIREMENTS FOR THE EXPOSURE CLASS AS OUTLINED IN CSA A23.1. CURING COMPOUNDS ARE NOT PERMITTED FOR SUSPENDED PARKING SLABS OR EXPOSURE CLASS C-XL CONCRETE. PARKING SLABS AND REINFORCED SLAB ON GRADES IN PARKING AREAS ARE TO BE CURED FOR MINIMUM 7 DAYS.

NO.	REV.	ISSUED FOR	DATE
1	4	100% CD	2019-11-12
2	5	ISSUED FOR PERMIT	2019-11-14
3	6	ISSUED FOR TENDER REVIEW	2019-12-06
4	7	ISSUED FOR TENDER	2019-12-11

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STAMP

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PROJECT:

DRAWING NAME:

GENERAL NOTES & TYPICAL DETAILS

PROJECT NO:	DRAWN BY:	CHECKED BY:
TOR.113946.0011	JP	NB

Scale: As indicated

DRAWING NUMBER:

S-104

DEVELOPMENT OF STANDARD HOOKS IN TENSION

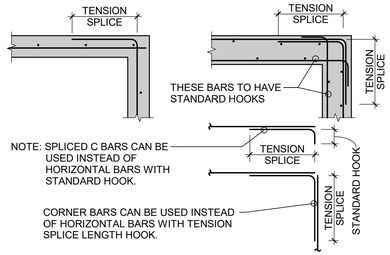
BASED ON CSA A23.3.

CONCRETE STRENGTH	REBAR DESIGNATION (GRADE 400 LENGTHS)					
	10M	15M	20M	25M	30M	35M
20 MPa	225	340	450	560	675	785
25 MPa	200	300	400	500	600	700
30 MPa	185	275	370	460	550	640
35 MPa	170	255	340	425	510	595
40 MPa	160	240	320	400	475	555
45 MPa	150	225	300	375	450	525
50 MPa	150	215	285	355	425	495
55 MPa	150	205	270	340	405	475
60 MPa	150	195	260	325	390	455
65 MPa & GREATER	150	190	250	315	375	440

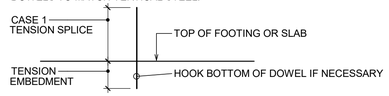
NOTES:

1. TABLE SHOWS DEVELOPMENT LENGTHS FOR GRADE 400 REINFORCEMENT. INCREASE TABLE LENGTHS BY 1.25 FOR GRADE 500 REINFORCEMENT.
2. INCREASE TABLE LENGTHS BY 1.2 FOR EPOXY COATED REINFORCEMENT.

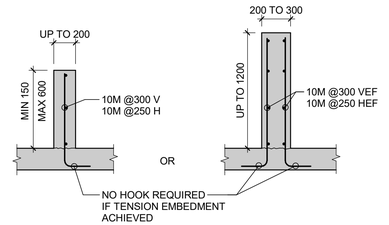
CONCRETE WALLS CONTINUED...



5. ENDS OF ALL WALLS SHALL HAVE 2-15M VERTICAL LAPPED 625 UNLESS OTHERWISE NOTED ON DRAWINGS.
6. ADD 2-15M PARALLEL TO ALL EDGES AND EXTENDING 625 BEYOND CORNERS AT OPENINGS IN WALLS.
7. UNLESS NOTED OTHERWISE, PROVIDE DOWELS AT BOTTOM OF WALLS (I.E. AT FOOTINGS OR WHEREVER WALL BEGINS) AS SHOWN BELOW. DOWELS TO MATCH VERTICAL STEEL.

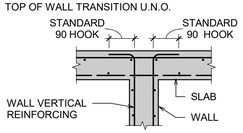


9. SEE ARCHITECTURAL DRAWINGS FOR EXTENT, THICKNESS AND LOCATION OF CONCRETE UPSTAND WALLS, PLANTER WALLS AND CURBS. BELOW ARE TYPICAL DETAILS WHERE NOT INDICATED ON PLAN.

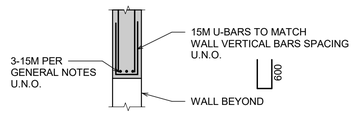


10. UNLESS NOTED OTHERWISE, ALL RETAINING WALLS BELOW GRADE AND ALL EXTERIOR WALLS EXPOSED TO THE WEATHER ABOVE GRADE SHALL HAVE CONTROL JOINTS. SEE CONTROL JOINT DETAIL. CONSTRUCTION JOINT MAY REPLACE CONTROL JOINT WHERE REQUIRED. THE LOCATION OF CONTROL JOINTS IN EXPOSED CONCRETE WALLS SHALL BE SUBMITTED TO THE ARCHITECT FOR REVIEW.
11. UNLESS NOTED OTHERWISE, PLACE TOP OF WALLS 0 mm TO 12 mm BELOW SOFFIT OF SUPPORTED CONCRETE STRUCTURE. IF TOP OF WALL PLACED ABOVE SOFFIT, CAREFULLY CHIP DOWN MIN 3 DAYS AFTER ELEMENT POURED AND AS REQUIRED BY RJC.

12. TOP OF WALL TRANSITION U.N.O.



13. ABOVE NOMINAL WALL OPENINGS U.N.O.



EMBEDMENT / DEVELOPMENT LENGTHS AND SPLICE LENGTHS CONTINUED...

CASE 2 TENSION EMBEDMENT AND SPLICE CONDITIONS

TENSION EMBEDMENT AND SPLICE LENGTHS CONFORMING TO CSA A23.3 TABLE 12.1 ($0.6\ k_1k_2k_3k_4f_yd_b / \sqrt{f'_c}$) ARE TO BE AS PER THE FOLLOWING TABLE FOR MEMBERS NOT SATISFYING CASE 1 CONDITIONS AS SET OUT ABOVE. FOR EXAMPLE:

- ONE WAY SLAB TOP BARS (SEE TOP BAR NOTE).
- SLAB BAND BOTTOM BARS.
- BARS (EXCLUDING THE SPLICE) SPACED CLOSER TOGETHER THAN 2 BAR DIAMETERS.
- STIRRUPS IN BEAMS AND GIRDERS.
- SEE ALSO NOTES ON TOP BARS AND EPOXY COATED REINFORCEMENT.

CONCRETE STRENGTH	FUNCTION	REBAR DESIGNATION (GRADE 400 LENGTHS)					
		10M	15M	20M	25M	30M	35M
20 MPa	EMBEDMENT	430	645	860	1345	1610	1880
	(SPLICE)	(560)	(840)	(1120)	(1745)	(2095)	(2445)
25 MPa	EMBEDMENT	385	580	770	1200	1440	1680
	(SPLICE)	(500)	(750)	(1000)	(1560)	(1875)	(2185)
30 MPa	EMBEDMENT	355	530	705	1100	1315	1535
	(SPLICE)	(460)	(685)	(915)	(1425)	(1710)	(1995)
35 MPa	EMBEDMENT	325	490	650	1015	1220	1420
	(SPLICE)	(425)	(635)	(845)	(1320)	(1585)	(1850)
40 MPa	EMBEDMENT	305	460	610	950	1140	1330
	(SPLICE)	(395)	(595)	(790)	(1235)	(1480)	(1730)
45 MPa	EMBEDMENT	300	430	575	895	1075	1255
	(SPLICE)	(390)	(560)	(745)	(1165)	(1400)	(1630)
50 MPa	EMBEDMENT	300	410	545	850	1020	1190
	(SPLICE)	(390)	(530)	(710)	(1105)	(1325)	(1545)
55 MPa	EMBEDMENT	300	390	520	810	975	1135
	(SPLICE)	(390)	(505)	(675)	(1055)	(1265)	(1475)
60 MPa	EMBEDMENT	300	375	500	775	930	1085
	(SPLICE)	(390)	(485)	(645)	(1010)	(1210)	(1410)
65 MPa & GREATER	EMBEDMENT	300	360	480	750	900	1050
	(SPLICE)	(390)	(470)	(625)	(975)	(1170)	(1365)

NOTES:

1. "TOP BAR" VALUES ARE 1.3 TIMES THE ABOVE LENGTHS. "TOP BAR" APPLIES TO HORIZONTAL REINFORCEMENT CAST WITH 300 mm OR MORE OF CONCRETE BELOW THE BAR.
2. INCREASE THESE TABLE LENGTHS BY 1.5 TIMES FOR EPOXY COATED REINFORCEMENT. INCREASE THESE TABLE LENGTHS BY 1.7 TIMES FOR EPOXY COATED TOP REINFORCEMENT.
3. TABLE SHOWS LENGTHS FOR GRADE 400 REINFORCEMENT. MULTIPLY VALUES BY 1.25 FOR GRADE 500 REINFORCEMENT.
4. WHERE A TENSION SPLICE IS SPECIFIED BETWEEN TWO BARS OF DIFFERENT DIAMETERS, THE MINIMUM SPLICE LENGTH SHALL BE THE LESSER OF THE SPLICE LENGTH FOR THE SMALLER DIAMETER BAR AND THE EMBEDMENT LENGTH OF THE LARGER DIAMETER BAR.

CONCRETE WALLS

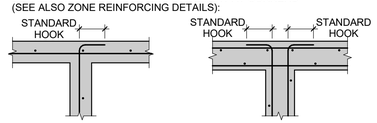
1. THESE NOTES APPLY SPECIFICALLY TO CONCRETE WALLS NOT CLASSIFIED AS SHEAR WALLS. SEE ALSO CONC. SHEAR WALL NOTES.

   UNLESS OTHERWISE NOTED, WALLS SHALL BE REINFORCED AS FOLLOWS:

WALL THICKNESS	REINFORCING	
150mm	10M @450 V	10M @330 H
200mm	10M @330 V	10M @250 H OR 15M @500 H
200mm	10M @500 VEF	10M @500 HEF
250mm	10M @500 VEF	10M @400 HEF
300mm	10M @440 VEF	10M @330 HEF
350mm	10M @380 VEF	10M @280 HEF
400mm	10M @330 VEF	10M @250 HEF OR 15M @500 HEF

   FOR OTHER THICKNESSES, REINFORCEMENT TO BE PROPORTIONAL TO ABOVE.

   15M @ 500 MAY BE SUBSTITUTED FOR 10M @ 330 ONLY WITH THE APPROVAL OF RJC. FOR WALLS WITH A SINGLE LAYER OF STEEL, THE WALL REINFORCING SHALL BE PLACED IN THE CENTRE OF THE WALL U.N.O.
2. PLACE HORIZONTAL REINFORCEMENT IN OUTTER LAYERS OF THE CURTAINS AND VERTICALS AS 2ND INSIDE LAYER (BEHIND HORIZONTALS).
3. ALL WALL REINFORCING SHALL BE CONTINUOUS, WITH HOOKS OR CORNER BARS USED AT ALL WALL JUNCTIONS. EXTEND HOOKS TO FAR FACE OF WALL. CORNER BARS TO BE LOCATED ON OUTSIDE FACE OR CENTRE OF WALL.
4. HORIZONTAL AND VERTICAL SPLICES SHALL BE CASE 1 TENSION SPLICES. U.N.O. HORIZONTAL BARS NEED NOT BE CONSIDERED TOP BARS.
5. DETAILS OF HORIZONTAL REINFORCEMENT AT CORNERS (SEE ALSO ZONE REINFORCING DETAILS):



EMBEDMENT / DEVELOPMENT LENGTHS AND SPLICE LENGTHS

BASED ON CSA A23.3

WHERE EMBEDMENT OR SPLICES ARE DIMENSIONED ON THE DRAWINGS, SUCH DIMENSION SHALL APPLY.

WHERE THE DRAWINGS INDICATE A COMPRESSION EMBEDMENT, IT IS A COMPRESSION EMBEDMENT LENGTH AND IT SHALL BE AS NOTED BELOW.

WHERE THE DRAWINGS INDICATE A TENSION EMBEDMENT, IT IS A TENSION EMBEDMENT LENGTH AND SHALL BE AS NOTED BELOW.

WHERE NO EMBEDMENT OR EMBEDMENT TYPE IS CALLED FOR ON THESE DRAWINGS, IT SHALL BE A TENSION EMBEDMENT, EXCEPT FOR COLUMNS WHICH SHALL BE A COMPRESSION EMBEDMENT.

WHERE NO SPLICE OR SPLICE TYPE IS CALLED FOR ON THESE DRAWINGS, IT SHALL BE A TENSION SPLICE, EXCEPT FOR COLUMNS WHICH SHALL BE A COMPRESSION SPLICE.

IN TABLES BELOW, EMBEDMENT LENGTHS ARE SHOWN WITHOUT BRACKETS, AND SPLICE LENGTHS ARE SHOWN IN BRACKETS.

ALL TENSION SPLICE LENGTHS ARE CLASS "B" (1.3 ℓd).

COMPRESSION EMBEDMENT AND SPLICE LENGTHS

- COMPRESSION EMBEDMENT REFERS TO THE LENGTH REQUIRED TO PROVIDE THE "COMPRESSION DEVELOPMENT LENGTH" AS DEFINED IN CSA A23.3 CLAUSE 12.3.2.
- SPLICE LENGTH REFERS TO THE MINIMUM LAP LENGTH REQUIRED FOR A COMPRESSION SPLICE AS DEFINED IN CSA A23.3 CLAUSE 12.16.1.

CONCRETE STRENGTH	FUNCTION	REBAR DESIGNATION (GRADE 400 LENGTHS)					
		10M	15M	20M	25M	30M	35M
20 MPa	EMBEDMENT	215	325	430	540	645	755
	(SPLICE)	(300)	(440)	(585)	(730)	(880)	(1025)
25 MPa	EMBEDMENT	200	290	385	480	580	675
	(SPLICE)	(300)	(440)	(585)	(730)	(880)	(1025)
30 MPa & GREATER	EMBEDMENT	200	265	355	440	530	620
	(SPLICE)	(300)	(440)	(585)	(730)	(880)	(1025)

NOTES:

1. TABLE SHOWS LENGTHS FOR GRADE 400 REINFORCEMENT. MULTIPLY VALUES BY 1.46 FOR GRADE 500 REINFORCEMENT.
2. WHERE A COMPRESSION SPLICE IS SPECIFIED BETWEEN TWO BARS OF DIFFERENT DIAMETERS, THE MINIMUM SPLICE LENGTH SHALL BE THE LESSER OF THE SPLICE LENGTH FOR THE SMALLER DIAMETER BAR AND THE EMBEDMENT LENGTH OF THE LARGER DIAMETER BAR.

TENSION EMBEDMENT AND SPLICE LENGTHS

- TENSION EMBEDMENT REFERS TO THE LENGTH REQUIRED TO PROVIDE A "TENSION DEVELOPMENT LENGTH" AS DEFINED IN CSA A23.3 CLAUSE 12.2.3.
- SPLICE LENGTH REFERS TO THE MINIMUM LAP LENGTH REQUIRED FOR A CLASS 'B' TENSION SPLICE (1.3ℓd) AS PER CSA A23.3 CLAUSE 12.15.

CASE 1 TENSION EMBEDMENT AND SPLICE CONDITIONS

TENSION EMBEDMENT AND SPLICE LENGTHS CONFORMING TO CSA A23.3 TABLE 12.1 ($0.45\ k_1k_2k_3k_4f_yd_b\ \sqrt{f'_c}$) ARE TO BE AS PER THE FOLLOWING TABLE FOR:

- COLUMNS.
- BEAM AND GIRDER TOP AND BOTTOM BARS.
- SLAB BAND TOP BARS.
- TWO WAY SLAB TOP AND BOTTOM BARS.
- ONE WAY SLAB BOTTOM BARS.
- WALL HORIZONTAL AND VERTICAL DISTRIBUTED REINFORCING.
- SEE ALSO NOTES ON TOP BARS AND EPOXY COATED REINFORCEMENT.
- MEMBERS WHICH DO NOT SATISFY THE ABOVE CONDITIONS SHALL HAVE TENSION EMBEDMENTS AND SPLICES AS PER CASE 2 TABLE BELOW.

CONCRETE STRENGTH	FUNCTION	REBAR DESIGNATION (GRADE 400 LENGTHS)					
		10M	15M	20M	25M	30M	35M
20 MPa	EMBEDMENT	325	485	645	1010	1210	1410
	(SPLICE)	(420)	(630)	(840)	(1310)	(1570)	(1835)
25 MPa	EMBEDMENT	300	435	580	900	1080	1260
	(SPLICE)	(390)	(565)	(750)	(1170)	(1405)	(1640)
30 MPa	EMBEDMENT	300	395	530	825	990	1155
	(SPLICE)	(390)	(515)	(685)	(1070)	(1285)	(1500)
35 MPa	EMBEDMENT	300	370	490	765	915	1065
	(SPLICE)	(390)	(475)	(635)	(990)	(1190)	(1385)
40 MPa	EMBEDMENT	300	345	460	715	855	1000
	(SPLICE)	(390)	(445)	(595)	(925)	(1110)	(1295)
45 MPa	EMBEDMENT	300	325	430	675	805	940
	(SPLICE)	(390)	(420)	(560)	(875)	(1050)	(1225)
50 MPa	EMBEDMENT	300	310	410	640	765	895
	(SPLICE)	(390)	(400)	(530)	(830)	(995)	(1160)
55 MPa	EMBEDMENT	300	300	390	610	730	850
	(SPLICE)	(390)	(390)	(505)	(790)	(950)	(1105)
60 MPa	EMBEDMENT	300	300	375	585	700	815
	(SPLICE)	(390)	(390)	(485)	(760)	(910)	(1060)
65 MPa & GREATER	EMBEDMENT	300	300	360	565	675	790
	(SPLICE)	(390)	(390)	(470)	(735)	(880)	(1025)

NOTES:

1. "TOP BAR" VALUES ARE 1.3 TIMES THE ABOVE LENGTHS. "TOP BAR" APPLIES TO HORIZONTAL REINFORCEMENT CAST WITH 300 mm OR MORE OF CONCRETE BELOW THE BAR.
2. "TOP BAR" FACTOR DOES NOT APPLY TO HORIZONTAL WALL REINFORCEMENT IN WALLS THAT ARE NOT VIBRATED.
3. INCREASE THESE TABLE LENGTHS BY 1.5 TIMES FOR EPOXY COATED REINFORCEMENT. INCREASE THESE TABLE LENGTHS BY 1.7 TIMES FOR EPOXY COATED TOP REINFORCEMENT.
4. TABLE SHOWS LENGTHS FOR GRADE 400 REINFORCEMENT. MULTIPLY VALUES BY 1.25 FOR GRADE 500 REINFORCEMENT.
5. WHERE A TENSION SPLICE IS SPECIFIED BETWEEN TWO BARS OF DIFFERENT DIAMETERS, THE MINIMUM SPLICE LENGTH SHALL BE THE LESSER OF THE SPLICE LENGTH FOR THE SMALLER DIAMETER BAR AND THE EMBEDMENT LENGTH OF THE LARGER DIAMETER BAR.

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1	4	100% CD	2019-11-12
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3	6	ISSUED FOR TENDER REVIEW	2019-12-06
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PROJECT:

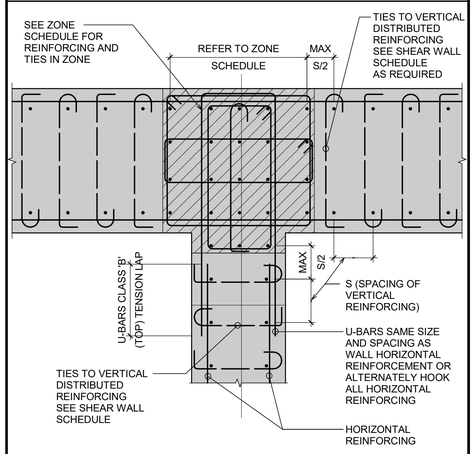
DRAWING NAME:
GENERAL NOTES & TYPICAL DETAILS

PROJECT NO:	DRAWN BY:	CHECKED BY:
TOR.113946.0011	JP	NB

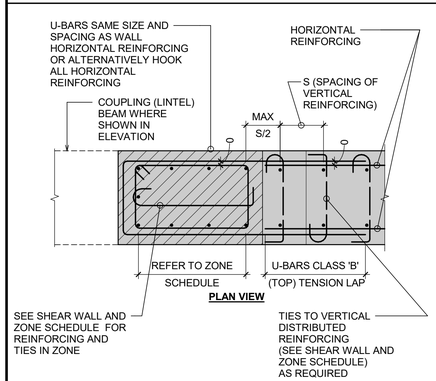
Scale: As indicated

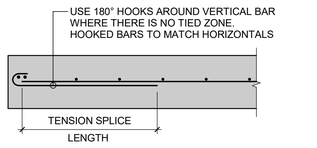
DRAWING NUMBER:
S-105

TYPICAL WALL ZONE DETAILS - INTERSECTION



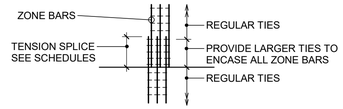
TYPICAL END OF WALL ZONE DETAILS





ZONE TIES

1. ALL ZONE TIES 10M BARS UNLESS NOTED OTHERWISE.
2. TIE SPACINGS ARE ON CENTRE UNLESS NOTED OTHERWISE.
3. SEE "SEISMIC TIES (HOOPS) AND SEISMIC CROSS TIES" FOR ADDITIONAL TIE REQUIREMENTS.
4. SEE ZONE SCHEDULE FOR ZONE TIE SPACING.
5. OPTION A:
   ZONE TIES AT ZONE SPLICES TO BE AS FOLLOWS:

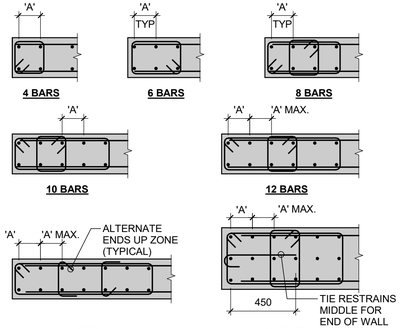


   NOTE: ZONE VERTICALS MAY BE CRANKED

   OPTION B:
   ZONE BARS MAY BE SPLICED WITH BENT BAR OFFSETS. IF THIS OPTION IS SELECTED SPLICE DETAILS ARE TO FOLLOW THOSE FOR "COLUMN SPLICE DETAILS". WITH CLASS 'B' TENSION LAP SPLICES THROUGHOUT, AND INCLUDING ADDITIONAL SETS OF TIES AT BAR CRANK LOCATION.
6. AT WALL THICKNESS TRANSITIONS, ZONE BAR OFFSETS DETAILS ARE TO FOLLOW THOSE FOR "COLUMN SPLICE DETAILS", WITH CLASS 'B' TENSION LAP SPLICES THROUGHOUT, AND INCLUDING ADDITIONAL SETS OF TIES AT BAR CRANK LOCATION, IF APPLICABLE.
7. TYPICAL ZONE TIE ARRANGEMENTS:

   SEISMIC CROSS TIES ALTERNATING END FOR END UP THE ZONE MAY BE SUBSTITUTED FOR EACH LEG OF A CLOSED INTERIOR TIE (TYPICAL U.N.O.)

   'A' = 150 UNLESS NOTED OTHERWISE ON DETAILS.



TYPICAL WALL ZONE DETAILS CORNER

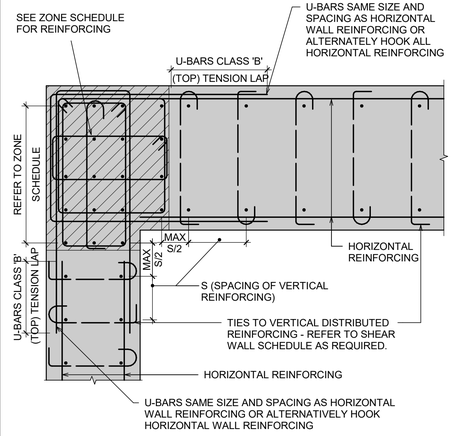


TABLE 1

MINIMUM SHEAR WALL DISTRIBUTED REINFORCING

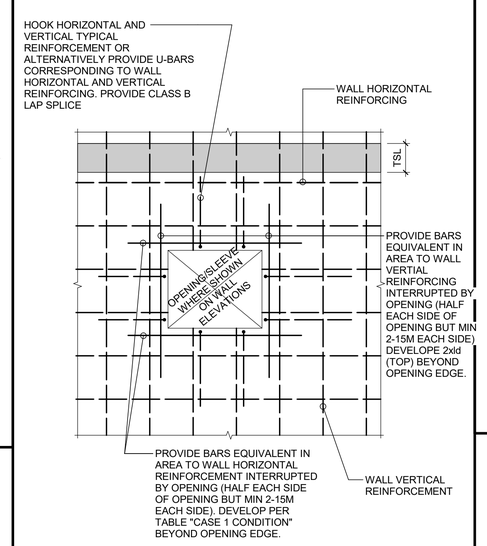
WALL THICKNESS	REINFORCING IN CENTRE		NOTES
150mm	10M @450 V	10M @330 H	
200mm	10M @330 H	10M @250 H OR 15M @500 H	
WALL THICKNESS	REINFORCING AT EACH FACE		
200mm	10M @500 VEF	10M @500 HEF	
250mm	10M @500 VEF	10M @400 HEF	
300mm	10M @440 VEF	10M @330 HEF	
350mm	10M @380 VEF	10M @280 HEF	
400mm	10M @330 VEF OR 15M @500 VEF	10M @250 HEF OR 15M @500 HEF	
450mm	10M @300 VEF OR 15M @500 VEF	10M @220 HEF OR 15M @440 HEF	
500mm	10M @260 VEF OR 15M @500 VEF	10M @200 HEF OR 15M @400 HEF	
550mm	15M @480 VEF	15M @360 HEF	
600mm	15M @440 VEF	15M @330 HEF	
700mm	15M @380 VEF	15M @280 HEF	
800mm	15M @330 VEF OR 20M @500 VEF	15M @250 HEF OR 20M @375 HEF	
900mm	20M @440 VEF	20M @330 HEF	
1000mm	20M @400 VEF	20M @300 HEF	

TABLE 2

MAXIMUM VERTICAL SPACING OF 10M TIES IN WALLS, COLUMNS AND END ZONES (mm)

WALL THICKNESS/ COLUMN SMALLER DIMENSION, OR END ZONE THICKNESS	f'c ≤ 50 MPa					f'c > 50 MPa				
	15M	20M	25M	30M	35M 45M	15M	20M	25M	30M	35M 45M
200mm	200	200	200	200	200	150	150	150	150	150
250mm	250	250	250	250	250	180	180	180	180	180
300mm	250	300	300	300	300	180	225	225	225	225
350mm	250	310	350	350	350	180	230	260	260	260
400mm	250	310	400	400	400	180	230	300	300	300
450mm	250	310	400	450	450	180	230	300	330	330
500mm	250	310	400	480	480	180	230	300	360	360
550mm	250	310	400	480	480	180	230	300	360	360
600mm	250	310	400	480	480	180	230	300	360	360
700mm	250	310	400	480	480	180	230	300	360	360
800mm	250	310	400	480	480	180	230	300	360	360
900mm	250	310	400	480	480	180	230	300	360	360
1000mm	250	310	400	480	480	180	230	300	360	360

TYPICAL ADDITIONAL REINFORCEMENT FOR WALL OPENINGS UP TO 750mm x 750mm SIZE



NOTE: FOR LARGER OPENINGS SEE REINFORCEMENT ON WALL ELEVATIONS.

CONCRETE SHEAR WALLS

GENERAL

1. THESE NOTES APPLY TO WALLS SHOWN ON THE SHEAR WALL SCHEDULE OR OTHERWISE INDICATED AS "SHEAR WALLS" ON THE DRAWINGS. PROVIDE REINFORCING AS DEFINED ON WALL ELEVATIONS OR SHEAR WALL SCHEDULES, SHEAR WALL DETAILS AND TABLES 1 AND 2.
2. SHEAR WALL ELEVATIONS SERVE THE PURPOSE OF DEFINING THE ZONES, WALL DISTRIBUTED AND COUPLING BEAM REINFORCING, SIZE OF SHEAR WALLS, COUPLING BEAMS (THICKNESS, DEPTH, ETC) AND CONCRETE STRENGTH. SHEAR WALL ELEVATIONS SHOULD BE READ IN CONJUNCTION WITH SCHEDULES AND TYPICAL SHEAR WALL DETAILS. THE GRAVITY ELEMENTS (SLAB, BEAMS, FOUNDATION SYSTEMS, ETC.) ARE SHOWN CONCEPTUALLY FOR CLARIFICATION ONLY. FOR SIZE, GEOMETRY, STEPS ETC. OF THE GRAVITY ELEMENTS REFER TO PLANS, DETAILS AND SCHEDULES.
3. UNLESS OTHERWISE NOTED ON THESE DRAWINGS, ALL HORIZONTAL & VERTICAL LAP SPLICE LENGTHS SHALL BE CLASS 'B' TENSION LAP SPLICES. SPLICE LENGTH AND DEVELOPMENT (EMBEDMENT) LENGTHS SHALL BE AS PER TABLE FOR "CASE 1 CONDITION".
4. UNLESS NOTED OTHERWISE, REFER TO ARCHITECTURAL, MECHANICAL AND ELECTRICAL DRAWINGS FOR EXACT DIMENSIONS AND LOCATIONS OF WALL OPENINGS. ANY OPENINGS NOT SHOWN ON THE WALL ELEVATIONS CAN NOT BE ADDED WITHOUT RJC'S APPROVAL.
5. SEE ALSO WALL NOTES.

REINFORCING

(FOR SHEAR WALLS WITH "Rd" GREATER THAN 2.0)

1. REINFORCEMENT FOR SHEAR WALLS SHALL BE WELDABLE CAN/CSA-G30.18W REINFORCEMENT UNLESS NOTED OTHERWISE ON THE DRAWINGS. THIS INCLUDES HORIZONTAL AND VERTICAL DISTRIBUTED STEEL, ZONE STEEL, ZONE TIES, HEADER STEEL AND HEADER TIES/STIRRUPS.

DISTRIBUTED REINFORCEMENT

1. WHERE NO DISTRIBUTED WALL REINFORCING IS INDICATED ON WALL ELEVATIONS OR SCHEDULE, PROVIDE MINIMUM WALL REINFORCING AS PER TABLE 1.
2. WHERE THERE ARE TWO CURTAINS OF REINFORCEMENT SHOWN, THE HORIZONTAL BARS SHALL BE ON THE OUTSIDE OF THE VERTICAL BARS.
3. VERTICAL SPLICES SHALL TYPICALLY OCCUR AT FLOOR LEVELS. OTHER SPLICES OF HORIZONTAL AND VERTICAL REINFORCEMENT ARE NOT ALLOWED EXCEPT WHERE NECESSARY. THESE CASES MUST BE REVIEWED AND APPROVED BY RJC BEFORE USE AND, IF APPROVED, THE SPLICES MUST BE STAGGERED WITHIN EACH CURTAIN. DO NOT CRANK VERTICAL BARS ANYWHERE.
4. FOOTING DOWELS ARE TO MATCH VERTICAL WALL REINFORCEMENT. EMBEDMENT SHALL BE AS PER TABLE "CASE 1 CONDITION". SEE ALSO OTHER NOTES AND DETAILS ON THESE DRAWINGS.

ZONE REINFORCEMENT

1. ZONE REINFORCING IS CALLED UP IN ZONE REINFORCING SCHEDULE OR ON SHEAR WALL ELEVATIONS.
2. ZONE DOWELS TO MATCH SIZE AND NUMBER OF VERTICAL BARS IN ZONE, UNLESS NOTED OTHERWISE. EXTEND DOWELS TO BOTTOM OF FOOTING AND PROVIDE STANDARD 90 DEG. HOOK.
3. WHERE TWO LIFT ZONES ARE USED, THE "LONG" ZONE GOING THROUGH A WALL STEP SHALL BE DETAILED TO FIT THE SMALLER WALL SIZE ABOVE.

TIES FOR DISTRIBUTED BARS AND ZONE REINFORCING

1. PROVIDE TIES FOR WALL ZONE REINFORCING AS PER TABLE 2 OR WHERE NOTED ON WALL ELEVATIONS.

COUPLING BEAMS

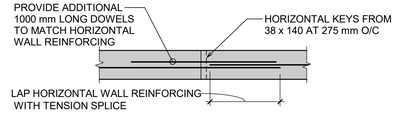
1. CONFIRM COUPLING BEAM DEPTHS WITH ROUGH OPENINGS REQUIRED FOR DOORS, DUCTS, ETC. MINIMUM DEPTHS ARE INDICATED ON DRAWINGS.
2. COUPLING BEAM WIDTH TO MATCH ADJACENT WALLS UNLESS NOTED OTHERWISE.
3. COUPLING BEAMS TO BE PLACED WITH WALLS.

HORIZONTAL CONSTRUCTION JOINTS IN SHEAR WALLS

1. THE TOP OF THE WALL SHALL BE LEFT ROUGH (OR SHALL BE ROUGHENED) AND SHALL BE CLEANED OF LAITANCE AND LOOSE MATERIAL BY SUITABLE METHODS BEFORE THE SLAB OR WALL OVER IS PLACED.
2. SLABS WHERE WALLS ARE TO BE PLACED SHALL BE LEFT ROUGH AND CLEAN AND FREE OF LAITANCE. WHERE THIS IS NOT THE CASE, THE SLAB SURFACE SHALL BE CLEANED TO SOUND, ROUGH CONCRETE BY SUITABLE METHODS.
3. SUITABLE METHODS OF CLEANING SHALL BE HIGH PRESSURE WATER BLAST, SAND BLASTING, ETC.

VERTICAL CONSTRUCTION JOINTS IN SHEAR WALLS

1. LOCATION OF VERTICAL CONSTRUCTION JOINTS MUST BE APPROVED BY RJC. USE THE FOLLOWING DETAIL.



NO.	REV.	ISSUED FOR	DATE
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2	5	ISSUED FOR PERMIT	2019-11-14
3	6	ISSUED FOR TENDER REVIEW	2019-12-06
4	7	ISSUED FOR TENDER	2019-12-11

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STAMP

CONTRACTOR SHALL CHECK ALL DIMENSIONS ON THE WORK AND REPORT ANY DISCREPANCY TO THE CONSULTANT BEFORE PROCEEDING. THIS DRAWING IS NOT TO BE USED FOR CONSTRUCTION UNTIL AUTHORIZED IN WRITING BY CONSULTANT.

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PROJECT:

DRAWING NAME:

GENERAL NOTES & TYPICAL DETAILS

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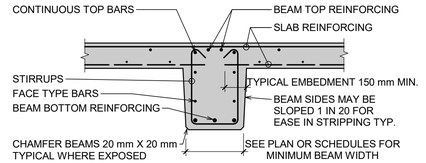
Scale: 1 : 20

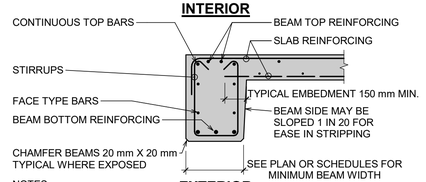
DRAWING NUMBER:

S-106

CONCRETE BEAMS



INTERIOR

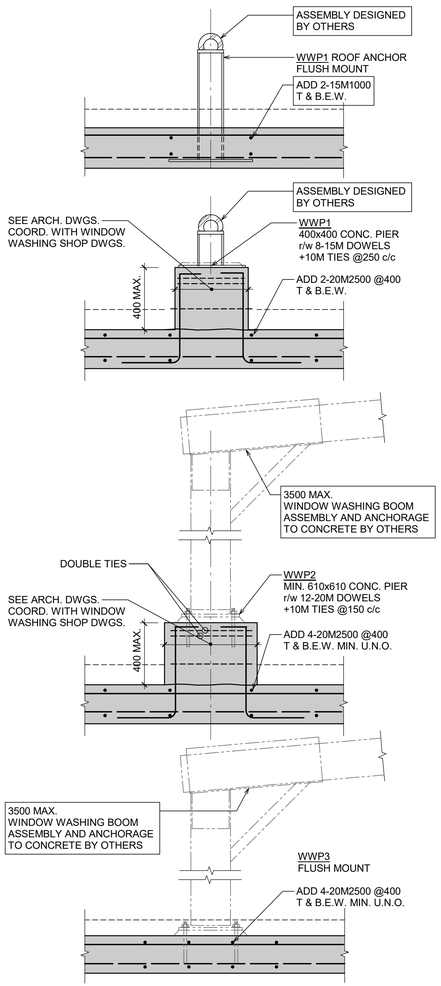


EXTERIOR

NOTES:

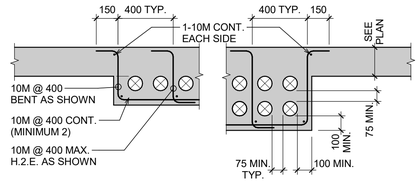
1. CAMBERS AS PER SLAB NOTES.
2. ADDITIONAL STIRRUPS MAY BE REQUIRED SHOULD HORIZONTAL POUR BREAK BE INTRODUCED. ALL POUR BREAKS PROPOSED BY CONTRACTOR TO BE REVIEWED BY RJC PRIOR TO CONSTRUCTION.

WINDOW WASHING EQUIPMENT/PIERS

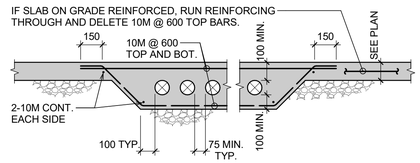


NOTES:
1. SEE WINDOW WASHING PLAN DRAWINGS BY OTHERS FOR LOCATIONS TYP.
2. SLAB STEEL PER PLAN, NOT SHOWN FOR CLARITY.

TYPICAL CONCRETE ENCASEMENT OF ELECTRICAL MAIN FEEDERS - U.N.O.



FEEDERS UNDER SUSPENDED SLABS AND WALLS, U.N.O.



FEEDERS UNDER SLAB ON GRADE, U.N.O.

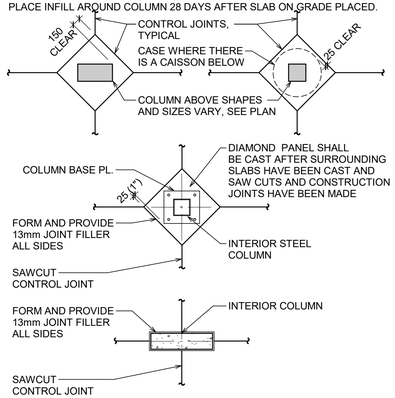
NOTE: SEE ARCHITECTURAL AND ELECTRICAL DRAWINGS FOR LOCATION, EXTENT AND NUMBER OF ELECTRICAL DUCTS.

SLAB ON GRADE REINFORCEMENT AND CONTROL JOINTS

1. SLAB ON GRADE SHALL BE PLACED ON SOIL CAPABLE OF SUSTAINING 25.0 kPa MIN. WITHOUT SETTLEMENT RELATIVE TO THE BUILDINGS FOOTINGS. IN AREAS WHERE S.O.G. USED TO SUPPORT TEMPORARY SHORING LOADS, LARGER SUBGRADE CAPACITIES MAY BE REQUIRED PER LOADS SUPPLIED BY TEMPORARY WORKS ENGINEER.
2. REINFORCE SLAB ON GRADE PER TABLE BELOW LOCATED 40mm FROM TOP OF SLAB WITH PROPER CHAIRS.

S.O.G. THICKNESS	MIN. REINFORCING U.N.O. ON PLAN
≤ 125mm	152x152 MW 18.7 x MW 18.7
126mm TO 175mm	10M @400 E.W.
>176mm	15M @400 E.W.

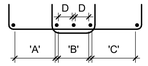
3. UNLESS MORE RIGOROUS REQUIREMENTS ARE INDICATED ELSEWHERE ON THE STRUCTURAL AND ARCHITECTURAL DRAWINGS AND SPECIFICATIONS, SPACE CONTROL JOINTS AT 4500 mm O/C MAXIMUM.
4. SAWCUT JOINTS 4mm WIDE AND 38 mm DEEP AS SOON AS PRACTICAL, BUT NO LATER THAN 12 HOURS AFTER PLACEMENT OF SLAB. USE EQUIPMENT THAT DOES NOT "RAVEL" THE EDGES OF THE CUT, SEAL AS REQUIRED.
5. UNLESS NOTED OTHERWISE ON THE STRUCTURAL DRAWINGS, RUN ANY SLAB ON GRADE REINFORCEMENT THROUGH THE JOINTS.
6. UNLESS NOTED OTHERWISE, SAWCUT DIAMOND PATTERN AROUND COLUMNS, 150 mm CLEAR OF COLUMNS.
7. UNLESS NOTED OTHERWISE, FORM A DIAMOND SHAPE AROUND COLUMNS, 150 mm CLEAR, AND DO NOT RUN REINFORCEMENT THROUGH. PLACE INFILL AROUND COLUMN 28 DAYS AFTER SLAB ON GRADE PLACED.



8. APPROVAL OF ARCHITECT IS REQUIRED TO SUBSTITUTE "ZIP STRIPS" FOR SAWCUTS.
9. REINFORCEMENT AS SPECIFIED IN NOTE #2 ABOVE TO CROSS AND LAP MIN 400mm AT COLD JOINTS. FOR UNREINFORCED SLAB ON GRADE PROVIDE 38x38mm DEEP CONTINUOUS SHEAR KEY IN S.O.G. FACE.

COLUMN TIE ARRANGEMENTS - U.N.O.

TYPE	TYPE 1	TYPE 2	TYPE 3	TYPE 4
4 BAR COLUMN				
6 BAR COLUMN				
8 BAR COLUMN				
10 BAR COLUMN				
12 BAR COLUMN				
14 BAR COLUMN				
16 BAR COLUMN				
20 BAR COLUMN				
WALL LIKE COLUMN				



'A', 'C' = 500 MAX.
'B' = 300 MAX.
TYPICAL AT ALL TIES - ANY SIDE OF COLUMN

TYPICAL ROUND OR OCTAGONAL COLUMN TIES
6 VERTICAL BARS MIN.

NOTES:

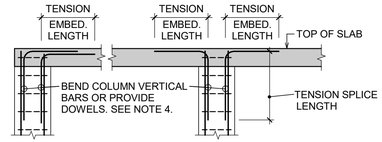
1. SEE TABLE 2 FOR VERTICAL TIE SPACING REQUIREMENTS.
2. MAXIMUM CLEAR DISTANCE BETWEEN VERTICAL BARS ENCLOSED BY THE CORNER OF A TIE, AND WITHOUT AN INTERMEDIATE BAR, IS 500 mm.
3. MAXIMUM ONE BAR MAY BE PLACED BETWEEN TIED BARS. MAXIMUM CLEAR DISTANCE BETWEEN TIED VERTICAL BARS FOR THIS CASE IS 300 mm.
4. ALL TIES SHALL HAVE 135° HOOKS, EXCEPT FOR SINGLE CROSS TIES WHERE ONE HOOK IS 135°AND THE OTHER IS 90°.
5. CLOSED TIES MAY ALWAYS BE SUBSTITUTED FOR CROSS-TIES.
6. ADD SINGLE CROSS TIES WHEN D > 150mm.
7. THE 90° HOOKS OF SUCCESSIVE TIES HORIZONTALLY AND VERTICALLY SHALL BE ALTERNATED END FOR END.
8. ALL COLUMN TIE ARRANGEMENTS ARE TYPE 1 U.N.O. IN COLUMN SCHEDULE.

COLUMNS

1. UNLESS NOTED OTHERWISE, CONCRETE STRENGTH IN COLUMNS IS INDICATED IN COLUMN SCHEDULE.
2. TIE COLUMN CAGES TO FORMS AND SQUARE BEFORE PLACING CONCRETE.
3. CONDUITS, BOXES OR OTHER INSERTS MAY NOT BE PLACED IN COLUMNS UNLESS APPROVED IN WRITING BY RJC.
4. UNLESS OTHERWISE NOTED ON COLUMN SCHEDULE, ALL COLUMN SPLICES SHALL BE AS PER TYPICAL DETAILS SHOWN ON THE STRUCTURAL DRAWINGS.
5. ALL EXPOSED CORNERS OF COLUMNS SHALL BE CHAMFERED 20 mm X 20 mm UNLESS NOTED OTHERWISE BY ARCHITECT.
6. UNLESS NOTED OTHERWISE, ALL COLUMN SPLICES SHALL BE COMPRESSION SPLICES.
7. UNLESS NOTED OTHERWISE, COLUMNS SHOULD BE CENTERED ON COLUMNS BELOW.
8. UNLESS NOTED OTHERWISE, COLUMNS SHALL BE CENTERED ON GRID LINES.
9. UNLESS NOTED OTHERWISE, PLACE TOP OF COLUMNS 0 mm TO 12 mm BELOW SOFFIT OF SUPPORTED CONCRETE STRUCTURE. IF TOP OF COLUMN PLACED ABOVE SOFFIT, CAREFULLY CHIP DOWN MINIMUM 3 DAYS AFTER ELEMENT POURED AND AS REQUIRED BY RJC.

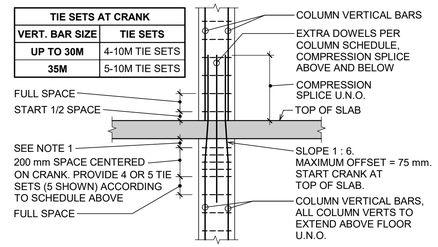
10. WHERE COLUMN VERTICALS DO NOT EXTEND OVER, REFER TO "COLUMN SPLICE AND DOWEL DETAILS" NOTE.

COLUMN SPLICE AND DOWEL DETAILS

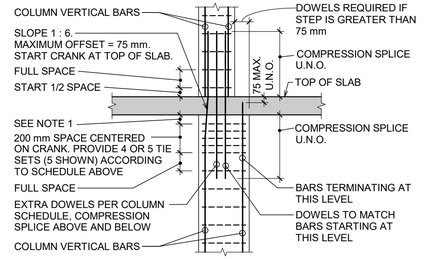


TYPICAL TOP OF CONCRETE COLUMN DETAIL

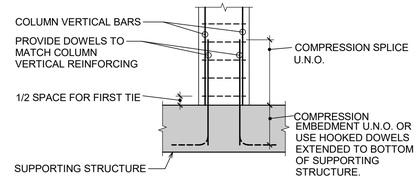
TIE SETS AT CRANK	
VERT. BAR SIZE	TIE SETS
UP TO 30M	4-10M TIE SETS
35M	5-10M TIE SETS



TYPICAL COLUMN REINFORCING SPLICE DETAIL WHERE MAXIMUM COLUMN FACE OFFSET LESS THAN 75 mm



TYPICAL COLUMN REINFORCING SPLICE DETAIL WHERE COLUMN FACE OFFSET GREATER THAN 75 mm



TYPICAL COLUMN REINFORCING DOWELS AT SUPPORTING STRUCTURE

NOTES:

1. ADD ADDITIONAL SETS OF TIES AT 1/2 TIE SPACING MAXIMUM IF THIS DISTANCE IS MORE THAN 1/2 TIE SPACE.
2. CONTINUE COLUMN TIES THROUGH BEAM/COLUMN JOINT UNLESS BEAMS OR SLABS OF EQUAL DEPTH FRAME INTO ALL FOUR SIDES OF COLUMN. COLUMN TIES TO CONTINUE THROUGH JOINT IF COLUMN WIDTH ON ANY SIDE EXCEEDS BEAM WIDTH ON SAME SIDE.
3. WHERE COLUMN VERTICALS DO NOT EXTEND INTO A COLUMN ABOVE, EXTEND VERTICAL REINFORCING 600 mm MINIMUM INTO UNDERSIDE OF BEAMS OR TO WITHIN 25 mm OF TOP OF SLABS UNLESS CLEAR COVER REQUIREMENTS ARE GREATER.
4. WHERE COLUMN VERTICALS WITH NO HOOK OR WITH STANDARD HOOK DO NOT HAVE FULL TENSION EMBEDMENT INTO MEMBER ABOVE, PROVIDE HOOKED DOWELS SAME SIZE AND NUMBER AS VERTICAL COLUMN REINFORCEMENT UNLESS NOTED OTHERWISE IN COLUMN SCHEDULE. HOOKS TO EXTEND TO TOP OF SLAB AND PLACED IN THE SAME LAYER AS AND PARALLEL TO SLAB REINFORCING IN TOP UPPER LAYER U.N.O.
5. DO NOT CRANK COLUMN VERTICAL BARS GREATER THAN 35M.

NO.	REV.	ISSUED FOR	DATE
1	4	100% CD	2019-11-12
2	5	ISSUED FOR PERMIT	2019-11-14
3	6	ISSUED FOR TENDER REVIEW	2019-12-06
4	7	ISSUED FOR TENDER	2019-12-11

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PROJECT:

DRAWING NAME:
GENERAL NOTES & TYPICAL DETAILS

PROJECT NO:	DRAWN BY:	CHECKED BY:
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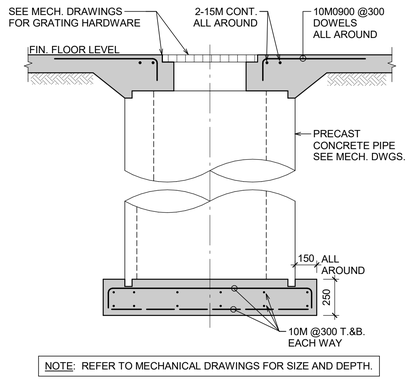
Scale: As indicated

DRAWING NUMBER:
S-107

TYPICAL PRECAST MECHANICAL PIT-U.N.O.



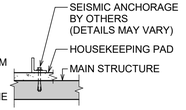
NOTE: REFER TO MECHANICAL DRAWINGS FOR SIZE AND DEPTH.

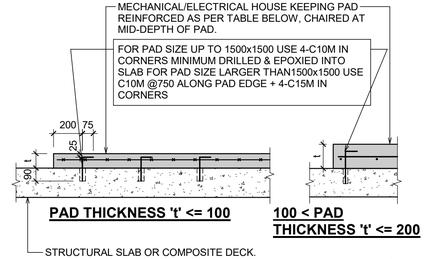
STRUCTURAL SHOTCRETE

1. SHOTCRETE SHALL ONLY BE USED FOR STRUCTURAL BUILDING COMPONENTS WHERE REVIEWED AND CONFIRMED BY THE ENGINEER.
2. SHOTCRETING SHALL CONFORM TO ALL REQUIREMENTS OF "SPECIFICATIONS FOR MATERIALS, PROPORTIONS, AND APPLICATION OF SHOTCRETE" ACI-506.2-13 & ACI-506R-05.
3. NOZZLEMEN SHALL HAVE CERTIFICATION TO ACI 506.3R-91, OR A MINIMUM OF 3000 HOURS EXPERIENCE AS A NOZZLEMAN WITH WET-MIX/DRY-MIX PROCESS AND COMPLETED AT LEAST ONE SIMILAR APPLICATION AS A NOZZLEMAN. PREPARE TEST PANEL AND TEST SECTION FOR EXAMINATION AND TESTING PRIOR TO PROCEEDING WITH PRODUCTION OF WORK TO CONFIRM PERFORMANCE AND MATERIAL PROPERTIES OF THE MIX DESIGN.
4. PORTLAND CEMENT AND BLENDED HYDRAULIC CEMENTING MATERIAL SHALL CONFORM TO CAN/CSA-A3000-08.
5. LAP SPLICES IN REINFORCING BARS SHALL BE DETAILED WITH AT LEAST 50mm CLEARANCE BETWEEN BARS. CONTACT LAP SPLICES ARE PERMITTED WHEN WET -MIX SHOTCRETE IS UTILIZED, PROVIDED IT CAN BE DEMONSTRATED BY MEANS OF PRE-CONSTRUCTION TESTING, THAT ADEQUATE ENCASEMENT OF THE BARS AT THE SPLICE CAN BE ACHIEVED. WHERE NECESSARY, PLACE SPLICES SO THAT A LINE THROUGH THE CENTER OF THE TWO SPLICED BARS IS PERPENDICULAR TO THE SURFACE OF THE SHOTCRETE WORK. IN THIS CONFIGURATION, DOWELS ARE TO BE THE INNER BAR, LEAVING PRIMARY VERTICAL BARS AT OUTSIDE LAYER, IF DRY-MIX SHOTCRETE IS USED, LAP SPLICES SHALL BE BY THE NON-CONTACT LAP SPLICE METHOD.
6. ANY REBOUND OR ACCUMULATED LOOSE AGGREGATE SHALL BE REMOVED FROM THE SURFACES TO BE COVERED PRIOR TO PLACING THE INITIAL OR ANY SUCCEEDING LAYERS OF SHOTCRETE. REBOUND SHALL NOT BE USED AS AGGREGATE.
7. UNFINISHED WORK SHALL NOT BE ALLOWED TO STAND FOR MORE THAN 30 MINUTES. SHOTCRETE SHALL BE APPLIED NO LATER THAN 90 MINUTES AFTER BATCHING.
8. IN PLACE SHOTCRETE WHICH EXHIBITS SAGS OR SLOUGHS, SEGREGATION, HONEYCOMBING, SAND POCKETS OR OTHER OBVIOUS DEFECTS SHALL BE REMOVED AND REPLACED. SHOTCRETE ABOVE SAGS AND SLOUGHS SHALL BE REMOVED AND REPLACED WHILE STILL PLASTIC.
9. DURING THE CURING PERIODS SPECIFIED HEREIN,
   - SHOTCRETE SHALL BE MAINTAINED ABOVE 5 DEGREES C AND IN MOIST CONDITION.
   - IN INITIAL CURING, SHOTCRETE SHALL BE KEPT CONTINUOUSLY MOIST FOR 24 HOURS AFTER PLACEMENT IS COMPLETE.
   - FINAL CURING SHALL CONTINUE FOR 7 DAYS AFTER SHOTCRETING.
   - FINAL CURING SHALL CONSIST OF A FOG SPRAY OR AN APPROVED MOISTURE RETAINING COVER OR MEMBRANE.
10. STRENGTH TEST FOR SHOTCRETE SHALL BE MADE BY AN APPROVED AGENCY ON SPECIMENS WHICH ARE REPRESENTATIVE OF AND IN ACCORDANCE WITH THE ACI-506.2-13.
11. WHEN SHOTCRETE IS USED FOR STRUCTURAL MEMBERS, CONTINUOUS INSPECTION BY A MATERIALS INSPECTION AGENCY IS REQUIRED. THE AGENCY SHALL OBSERVE PLACEMENT OF REINFORCING AND SHOTCRETING AND SHALL SUBMIT A STATEMENT INDICATING COMPLIANCE WITH THE PLANS AND SPECIFICATIONS UPON COMPLETION OF OBSERVED ELEMENTS. MATERIALS TESTING AS OUTLINED IN ACI-506.2-13 IS REQUIRED.
12. VERTICAL CONSTRUCTION JOINTS OR END-OF-THE- DAY JOINTS SHALL BE TAPERED AT AN APPROXIMATE 45-DEGREE ANGLE. SURFACES SHALL BE ROUGH GUN FINISH. BEFORE PLACING ADJOINING WORK, THE PREVIOUSLY PLACED SHOTCRETE SHALL BE THOROUGHLY CLEANED AND LAITANCE, REBOUND, AND OTHER LOOSE MATERIAL REMOVED WITH COMPRESSED AIR.
13. HORIZONTAL CONSTRUCTION JOINTS BETWEEN FLOOR LEVELS ARE NOT PERMITTED WITHOUT PRIOR APPROVAL BY RJC.
14. MINIMUM AGGREGATE SIZE IN THE SHOTCRETE MIX DESIGN TO BE 10mm. INCREASE THE 28-DAY COMPRESSIVE STRENGTH OF THE MIX, AS NOTED IN THE GENERAL NOTES FOR CONCRETE, TO COMPENSATE FOR REDUCED SHEAR STRENGTH OF CONCRETE WITH AGGREGATE SMALLER THAN 20mm.

TYPICAL MECHANICAL / ELECTRICAL HOUSEKEEPING PAD & FLOATING SLAB

1. SEE MECHANICAL AND ELECTRICAL DRAWINGS FOR LOCATION, EXTENT, AND THICKNESS OF HOUSEKEEPING PADS.
2. THIS DETAIL PROVIDES RESISTANCE TO HORIZONTAL (SLIDING) FORCES ONLY FROM EARTHQUAKE LOADING ON PAD AND EQUIPMENT. ADDITIONAL CONNECTIONS FOR UPLIFT FORCES FROM EQUIPMENT TO BE DESIGNED AND DETAILED BY SPECIALTY ENGINEER AND WILL REQUIRE ANCHORING THROUGH THE PAD AND INTO OR THROUGH THE STRUCTURAL SLAB. IN POST-TENSIONED FLOORS, LOCATE TENDONS BEFORE DRILLING HOLES.

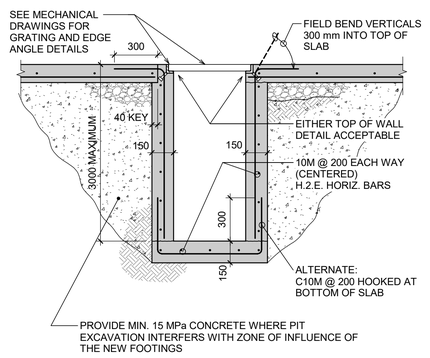




PAD THICKNESS 't'	REINFORCEMENT
50	152x152MW18.7xMW18.7WWF 1 LAYER
100	152x152MW18.7xMW18.7WWF 1 LAYER
150	10M @300 EW AT CENTRE
200	10M @400 T&BEW

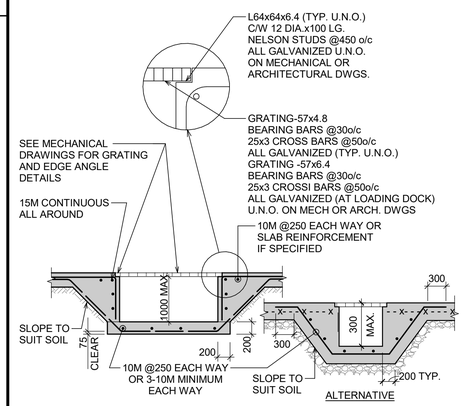
FLOATING SLAB DETAIL

TYPICAL SUMP / ACCESS PIT - U.N.O.



NOTE:
1. SEE MECHANICAL AND ARCHITECTURAL DRAWINGS FOR SIZE, LOCATION AND WATERPROOFING REQUIREMENTS.
2. PRECAST ALTERNATIVE ACCEPTABLE.

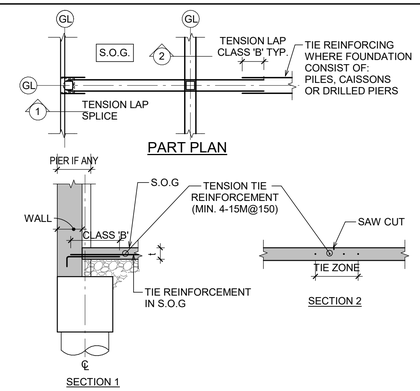
TYPICAL PIT OR TRENCH DETAIL-U.N.O.



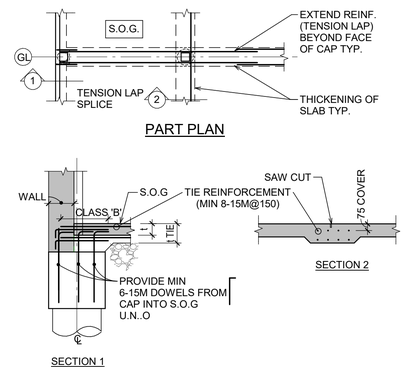
PROVIDE SHORING IN TRENCHES OVER 1200mm IN DEPTH DURING BACKFILLING

NOTE: THE USE OF PRECAST TRENCHES IS ACCEPTABLE PROVIDED THEY ARE SUPPLIED WITH A CONCRETE BASE.

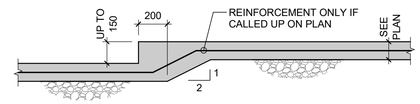
TIE BEAMS IN S.O.G.



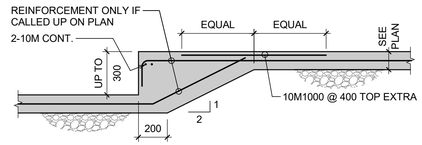
S.O.G. THICKENING ALTERNATIVE



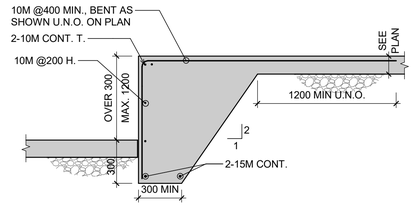
TYPICAL SLAB ON GRADE STEP DETAILS - U.N.O.



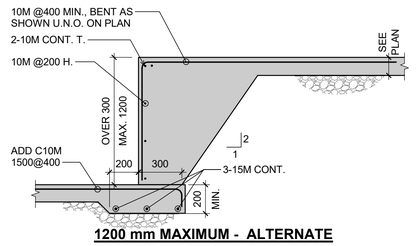
150 mm MAXIMUM STEP



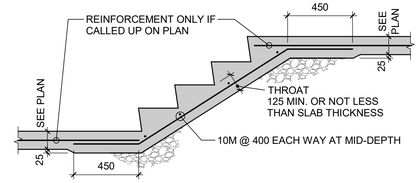
300 mm MAXIMUM STEP



1200 mm MAXIMUM STEP
RETAINING WALL IS ALTERNATE

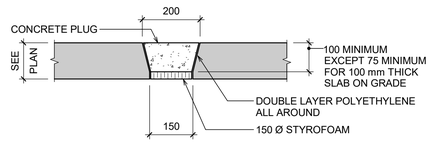


1200 mm MAXIMUM - ALTERNATE



STAIRS

TYPICAL PRESSURE RELIEF PLUG DETAIL - U.N.O.



LOCATIONS OF PRESSURE RELIEF PLUGS SHOWN THUS ⊗ ON PLAN.

NO.	REV.	ISSUED FOR	DATE
1	4	100% CD	2019-11-12
2	5	ISSUED FOR PERMIT	2019-11-14
3	6	ISSUED FOR TENDER REVIEW	2019-12-06
4	7	ISSUED FOR TENDER	2019-12-11

N

STAMP

CONTRACTOR SHALL CHECK ALL DIMENSIONS ON THE WORK AND REPORT ANY DISCREPANCY TO THE CONSULTANT BEFORE PROCEEDING. THIS DRAWING IS NOT TO BE USED FOR CONSTRUCTION UNTIL AUTHORIZED IN WRITING BY CONSULTANT.

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toronto zoo
361A Old Finch Ave, Toronto ON M1B 5K7 · 416-392-5929

PROJECT:

DRAWING NAME:
GENERAL NOTES & TYPICAL DETAILS

PROJECT NO:	DRAWN BY:	CHECKED BY:
TOR.113946.0011	JP	NB

Scale: As indicated

DRAWING NUMBER:
S-108

STEEL DECK

1. STEEL DECKING SHALL CONFORM TO CAN/CSA-S136.
2. STEEL DECKING SHALL CONFORM TO CSSBI SPECIFICATION 10M MINIMUM GRADE 230 ZINC COATED STRUCTURAL QUALITY STEEL FOR ROOF AND FLOOR DECK. BASE STEEL NOMINAL THICKNESSES INDICATED ON THE DRAWINGS ARE MINIMUM REQUIREMENTS ONLY.
3. INTERIOR EXPOSURE DECK SHALL BE ZINC COATED WIPE COAT ZF075 FOR FLOORS AND FOR ROOFS. EXTERIOR EXPOSURE DECK SHALL BE Z275 ZINC COATED UNLESS NOTED OTHERWISE.
4. FOR DECKS WITH CONCRETE TOPPING, SEE ALSO "STEEL DECK (WITH CONCRETE TOPPING)" NOTES.
5. STEEL DECKING SHALL BE INSTALLED SUCH THAT SHEETS ARE SET FOR A MINIMUM OF THREE SPANS CONTINUOUS UNLESS NOTED OTHERWISE. LAPS OF DECKING SHALL BE LIMITED OR DETAILED TO PREVENT UNDUE VERTICAL DEFORMATIONS AT THE END OF THE DECK DUE TO END ROTATIONS.
6. SEE DRAWINGS FOR DECK PROFILE AND THICKNESSES OR DESIGN LOADS. DECK THICKNESS INDICATED ON DRAWINGS ARE MINIMUM REQUIREMENTS ONLY.
7. WHERE DECK IS CALLED UP ON THE DRAWINGS, ALTERNATES MUST BE THE SAME DEPTH, BE EQUIVALENT FOR DEFLECTIONS, VERTICAL LOAD, AND SHEAR CAPACITY AND BE PRE-APPROVED.
8. SUBMIT SHOP DRAWINGS INDICATING THE DECK SPANS, THICKNESSES, PROFILES, AND DETAILS. WHERE THE DECK THICKNESSES AND CONNECTIONS ARE NOT SHOWN ON THE DRAWINGS, THE FABRICATOR SHALL DESIGN THE DECK AND CONNECTIONS FOR THE VERTICAL LOADS AND THE SHEAR/DIAPHRAGM LOADS NOTED ON THE DRAWINGS AND HAVE THE SHOP DRAWINGS SEALED BY THE CONTRACTOR'S SPECIALTY STRUCTURAL ENGINEER.
[SPECIALTY STRUCTURAL ENGINEER SHALL SUBMIT SCHEDULE SB AND SC]
9. FASTENINGS – MINIMUM REQUIREMENTS UNLESS NOTED OTHERWISE ON DRAWINGS.
   A. SIDE LAPS MECHANICALLY FASTENED (CLINCHED) AT NOT MORE THAN 600 mm O/C.
   B. 20 mm DIAMETER FUSION WELDS AT DECK SUPPORTS SHALL BE AT 300 mm O/C ALONG SIDE EDGES AND AT EVERY 2ND FLUTE.
10. WHERE HILTI NAILS ARE SPECIFIED:
    A. ATTACH WITH HILTI X-ENP-19 FASTENERS TO STRUCTURAL STEEL WITH THICKNESS GREATER THAN OR EQUAL TO 6 mm.
    B. ATTACH WITH HILTI X-HSN-24 FASTENERS TO STRUCTURAL STEEL OR OWSJ'S WITH THICKNESS LESS THAN 6 mm.
11. IF NOT SHOWN OTHERWISE, ALL EDGES OF STEEL DECKING SHALL BE SUPPORTED ON CONTINUOUS ANGLE L76x76x4.8.
12. SEE ALSO MECHANICAL, ELECTRICAL AND ARCHITECTURAL DRAWINGS FOR ALL OPENINGS IN DECK.
13. STEEL DECK TO BE DESIGNED FOR A MINIMUM DIAPHRAGM SHEAR OF 3.5 kN/m, U.N.O.

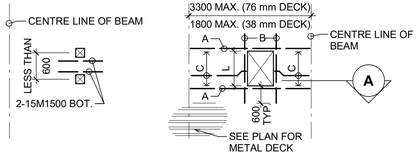
STEEL DECK NOTES (WITH CONCRETE TOPPING)

1. REFER TO STEEL DECK NOTE FOR ADDITIONAL REQUIREMENTS.
2. STEEL DECK TO BE AS NOTED ON DRAWINGS. UNLESS NOTED OTHERWISE ALL DECK RECEIVING CONCRETE TOPPING TO BE COMPOSITE DECK.
3. IT IS INTENDED THAT ALL STEEL DECK BE UNSHORED DURING CONSTRUCTION U.N.O.
4. THE STEEL DECK THICKNESS SHALL BE AS REQUIRED TO CARRY THE WET CONCRETE WITHOUT SHORING AND TO MEET THE LOADING REQUIREMENTS LISTED BELOW, AND WILL DEPEND ON THE ACTUAL PROFILE AND LAYOUT OF DECK USED. TOPPING THICKNESS ON THE DRAWINGS ARE MEASURED FROM THE TOP OF DECK FLUTE (SEE "CONCRETE TOPPING ON STEEL DECK" NOTES).
5. DESIGN FLOOR LOADS (SPECIFIED OR UNFACTORED):
   CONSTRUCTION DEAD LOAD = WEIGHT OF WET CONCRETE
   CONSTRUCTION LIVE LOAD = 1 kPa
   SUPERIMPOSED DEAD LOAD = AS INDICATED ON DRAWINGS
   LIVE LOAD = AS INDICATED ON DRAWINGS
6. ALL DECK TO BE THREE SPAN MINIMUM WHERE POSSIBLE.
7. THE STEEL DECK PROFILES SHALL BE AS REQUIRED TO ACHIEVE FIRE SEPARATIONS AS SPECIFIED ON THE ARCHITECTURAL DRAWINGS. IN ADDITION, ALL COMPOSITE FLOOR DECK PROFILES SHALL HAVE AN AVERAGE BOTTOM FLUTE WIDTH AT LEAST 2 X DECK DEPTH WHERE USED ON COMPOSITE BEAMS WITH SHEAR STUDS.
8. THE CONTRACTOR IS RESPONSIBLE FOR COORDINATING WITH SUBTRADES FOR PROVIDING STEEL DECK AS INDICATED ON THE DRAWINGS, AND ALL NECESSARY FORMING AT THE DECK EDGES FOR THE FULL DECK AND CONCRETE DEPTH TO PREVENT LEAKING OF THE CONCRETE TOPPING. THIS INCLUDES BUT IS NOT LIMITED TO ALL SLAB EDGES AT THE BUILDING EDGE AND ALL SLAB OPENINGS, INCLUDING ELEVATOR SHAFTS AND STAIRWELLS AND AROUND THE WEBS AND FLANGES OF ALL COLUMNS.
9. BEAMS NOTED AS COMPOSITE ON THE DRAWINGS REQUIRE STUD SHEAR CONNECTIONS, SEE ALSO SHEAR CONNECTOR NOTES. SEE ALSO PLANS, SECTIONS, DETAILS AND SCHEDULES FOR STUDS SHOWN ON BEAMS/GIRDERS/DRAG-STRUTS ETC. OTHER THAN COMPOSITE BEAMS. THE CONTRACTOR SHALL CO-ORDINATE THE DESIGN, SUPPLY, AND INSTALLATION OF ALL STUDS.
10. FOR OPENINGS THAT MAY BE CUT AFTER TOPPING PLACED, SEE STANDARD DETAILS ON STRUCTURAL DRAWING.
11. SEE ALSO MECHANICAL AND ARCHITECTURAL DRAWINGS FOR OPENINGS, HOLES ETC. IN DECKING.
12. SUBMIT SHOP DRAWINGS SEALED BY A SPECIALTY STRUCTURAL ENGINEER FOR DESIGN OF DECK AND SHEAR STUDS.

ARCHITECTURALLY EXPOSED STRUCTURAL STEEL NOTES

1. DRAWINGS
   A. WORK SHALL BE IN ACCORDANCE WITH THE "CISC GUIDE FOR SPECIFYING ARCHITECTURALLY EXPOSED STRUCTURAL STEEL".
   B. SEE ARCHITECTURAL AND STRUCTURAL PLANS, DETAILS, AND SPECIFICATIONS, FOR LOCATION AND CATEGORY OF ARCHITECTURALLY EXPOSED STRUCTURAL STEEL (AESS.)
2. FABRICATION
   A. SEE SPECIFICATIONS, TYPICAL.
3. WELDING
   A. FOR WELDING CRITERIA SEE PLANS AND SPECIFICATIONS FOR CATEGORY AND LOCATION OF AESS. AND USE APPLICABLE LEVEL AS PER CISC GUIDE FOR A.E.SS AND SPECIFICATIONS.
4. PAINTING
   A. SEE ARCHITECTURAL AND STRUCTURAL DRAWINGS AND SPECIFICATIONS
   B. SURFACES WITHIN 50 mm OF ANY FIELD WELD LOCATION SHALL BE FREE OF MATERIALS THAT WOULD PREVENT PROPER WELDING OR PRODUCE OBJECTIONABLE FUMES WHILE WELDING IS BEING DONE. IF SHOP PAINTED, SURFACES TO BE WELDED SHALL BE WIRE BRUSHED IN THE FIELD BEFORE WELDING TO REDUCE THE PAINT FILM TO A MINIMUM. LEVEL OF WORKMANSHIP AND QUALITY CONTROL AS PER SPECIFICATION AND CISC GUIDE FOR AESS.
5. ERECTION
   A. THE ERECTOR SHALL USE SPECIAL CARE IN UNLOADING, HANDLING, AND ERECTING THE STEEL TO AVOID BENDING, TWISTING, OR OTHERWISE DISTORTING THE STEEL MEMBERS. THE ERECTOR SHALL HANDLE THE MATERIAL IN SUCH A WAY AS TO MINIMIZE THE DAMAGE TO SHOP COAT OF PAINT. LEVEL OF CARE AS OUTLINED IN CISC GUIDE FOR AESS. FOR SPECIFIED CATEGORY OF AESS.
   B. IF TEMPORARY BRACES OR ERECTION CLIPS ARE EMPLOYED, CARE SHALL BE TAKEN TO AVOID UNSIGHTLINESS UPON REMOVAL. TACK WELDS SHALL BE GROUND SMOOTH AND HOLES SHALL BE FILLED WITH WELD METAL OR BODY SOLDER AND SMOOTHED BY GRINDING OR FILING.
   C. PAINT ALL AREAS SCRATCHED, MARRED, OR LEFT UNPAINTED FOR ERECTION PURPOSES.

TYPICAL OPENING THROUGH STEEL DECK WITH CONCRETE TOPPING

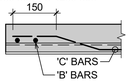


PLAN
FOR OPENINGS LESS THAN 150 mm AT LESS THAN 600 mm O/C

PROCEDURE:

1. BULKHEAD SLAB.
2. INSTALL REINFORCING.
3. PLACE CONCRETE.
4. WHEN CONCRETE HAS REACHED THE DESIGN STRENGTH, CUT OUT THE METAL DECK WITHIN THE OPENING.

PLAN
FOR OPENINGS 150 mm TO 1200 mm



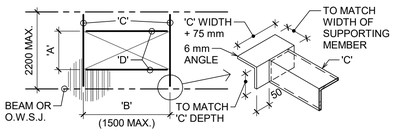
SECTION 'A'

OPENING REINFORCING SCHEDULE			
DIMENSION 'L'	'A' BARS BOTTOM OF FLUTE	'B' BARS TOP OF DECK	'C' BARS BOTTOM OF FLUTE
150 TO 600	1-15M EACH SIDE	1-15M EACH SIDE	1-10M/FLUTE
600 TO 1200	2-15M EACH SIDE	2-15M EACH SIDE	2-10M/FLUTE
ABOVE 1200	STRUCTURAL STEEL FRAMING REQUIRED		

NOTE: OPENINGS LARGER THAN 600 mm IN EITHER DIRECTION WHICH ARE NOT SHOWN ON THE STRUCTURAL DRAWINGS SHALL BE APPROVED BY RJC PRIOR TO PLACING CONCRETE.

TYPICAL FRAMING AROUND OPENINGS IN STEEL DECK WITHOUT CONCRETE TOPPING

1. SEE ALSO MECHANICAL, ELECTRICAL AND ARCHITECTURAL DRAWINGS FOR ALL OPENINGS IN DECK.
2. U.N.O. REINFORCE OPENINGS WITHOUT MECHANICAL UNITS BETWEEN 150 mm TO 450 mm MAXIMUM DIMENSION WITH L76x76x4.8 X 1200 mm LONG. FASTEN TO EVERY FLUTE. MIN. 600 CLEAR BETWEEN OPENINGS. OPENINGS LESS THAN 150mm IF 300 CLEAR BETWEEN OPENINGS NEED NOT BE REINFORCED. I.E.
3. TYPICAL DETAILS FOR SMALL MECHANICAL UNITS AND/OR OPENINGS IN DECK UNLESS NOTED OTHERWISE ON PLANS AND DETAILS:

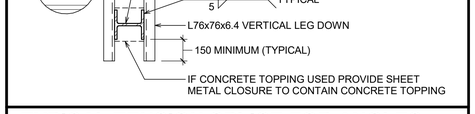


CONNECT ANGLES FOR MAXIMUM FACTORED VERTICAL LOAD OF 6 kN.

MECH. UNIT OR OPENING SIZE 'A' x 'B'	ANGLE 'C'	ANGLE 'D'	MECHANICAL UNIT WEIGHT (SPECIFIED)
150 X 150 TO 450 X 450	L76x76x6.4	L76x76x4.8	0.25 kN TO 1.0 kN
450 X 450 TO 1500 X 1500	L102x102x6.4	L76x76x4.8	NO UNIT
450 X 450 TO 1500 X 900	L102x102x6.4	L76x76x6.4	LESS THAN OR EQUAL TO 2 kN (1500 mm MAX. HIGH)
450 X 900 TO 1500 X 1500	L102x102x6.4	L102x102x6.4	LESS THAN OR EQUAL TO 2 kN (1500 mm MAX. HIGH)

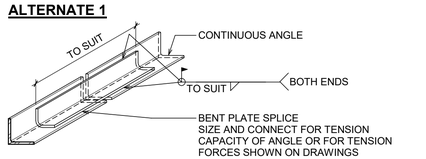
4. WHERE AN OPENING IN DECK IS UNDER A MECHANICAL UNIT AND IS SMALLER THAN THE FRAMING REQUIRED TO SUPPORT THE MECHANICAL UNIT, REINFORCE THE OPENING WITH L76x76x4.8 ON ALL FOUR SIDES SPANNING BETWEEN THE MECHANICAL UNIT SUPPORT MEMBERS. SEE NOTE 3, PLANS AND DETAILS FOR MECHANICAL UNIT SUPPORT FRAMING.

TYPICAL DECK SUPPORT AT COLUMNS

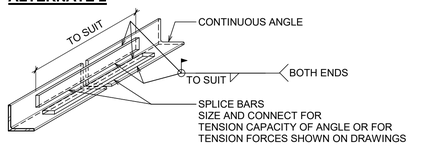


TYPICAL TENSION SPLICE FOR ANGLES

ALTERNATE 1



ALTERNATE 2

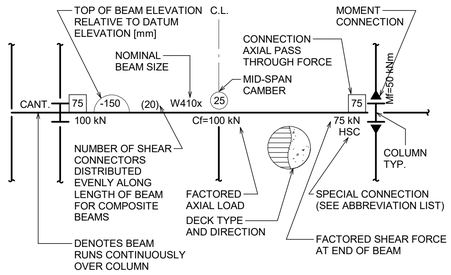


MINIMUM BEND RADIUS FOR STEEL PLATES

"T" (PLATE THICKNESS)	"R" (MINIMUM INSIDE RADIUS)
0 mm TO 6 mm	3 x "T"
6 mm TO 12 mm	4 x "T"

STRUCTURAL STEEL

1. STRUCTURAL STEEL SECTIONS SHALL BE NEW AND CONFORM TO THE FOLLOWING:
   A. FABRICATION, ERECTION, STRUCTURAL DESIGN, AND DETAILING OF ALL STEEL SHALL BE IN ACCORDANCE WITH ------ CAN/CSA-S16.
   B. WIDE FLANGE BEAMS AND WWF SECTIONS --- CSA G40.21 350W
   C. MISCELLANEOUS ROLLED SECTIONS (EXCEPT WIDE FLANGES) ---------- CSA G40.21 350W
   D. HOLLOW STRUCTURAL SECTIONS ---------- ASTM A500 GRADE C
   E. ROLLED PLATES ---------- CSA G40.21 300W
   F. BOLTS (SEE PLANS AND DETAILS) ---------- ASTM A325 OR ASTM A490
   G. STRUCTURAL STEEL ANCHOR RODS (U.N.O.) -- ASTM F1554 GRADE 36 MINIMUM
   H. REINFORCING BAR ANCHOR BOLTS ---------- CAN/CSA-G30.18R, GRADE 400
2. FILLET WELDS SHALL BE 5 mm MINIMUM U.N.O.
3. BOLTS SHALL BE A325 19 mm Ø MINIMUM U.N.O.
4. BOLTED CONNECTIONS SHALL HAVE A MINIMUM OF TWO BOLTS IN EACH CONNECTED PIECE AND BE DESIGNED AS BEARING CONNECTIONS, U.N.O.
5. ALL WELDED HEADED STUDS AND WELDED DEFORMED BAR ANCHORS SHALL BE INSTALLED AS PER THE MANUFACTURERS SPECIFICATIONS AND RECOMMENDATIONS OR SHOP FILLET WELDED. ANY FIELD FILLET WELDED DEFORMED BARS OR STUDS WILL BE REJECTED. SEE PLANS, SECTIONS, DETAILS, AND SCHEDULES FOR LOCATIONS ETC., THE CONTRACTOR SHALL CO-ORDINATE THE DESIGN, SUPPLY, AND INSTALLATION OF ALL STUDS AND ANCHORS, INCLUDING, BUT NOT LIMITED TO STUDS AND DEFORMED BAR ANCHORS ON COMPOSITE BEAMS, DRAG STRUTS, EMBEDDED PLATES, ETC.
6. STEEL IN THE SEISMIC ENERGY DISSIPATION SYSTEM SHALL SATISFY THE LIMITS OF Fy, Fu, AND CHARPY V-NOTCH IMPACT REQUIREMENTS AS NOTED IN CAN/CSA S16 CLAUSE 27.
7. ALL WELDS AND WELD MATERIAL IN THE SEISMIC ENERGY DISSIPATION SYSTEM SHALL SATISFY THE CHARPY REQUIREMENTS AS NOTED IN CAN/CSA S16 CLAUSE 27.
8. UNLESS NOTED OTHERWISE, COLUMN CAP PLATES SHALL BE 16 mm THICK AND COLUMN BASE PLATES SHALL BE 20 mm MINIMUM THICK.
9. PROVIDE 6 mm CAP PLATES FOR ALL HSS MEMBERS U.N.O.
10. CONNECTION DETAILS SHOWN ON THE STRUCTURAL DRAWINGS SHALL NOT BE ALTERED BY THE CONTRACTOR WITHOUT WRITTEN APPROVAL FROM READ JONES CHRISTOFFERSEN LTD.
11. FRAME ALL ROOF AND FLOOR OPENINGS IN ACCORDANCE WITH THE DETAILS IN THE GENERAL NOTES UNLESS NOTED OTHERWISE ON THE PLANS.
12. UNLESS NOTED OTHERWISE ON THE PLANS, REFER TO THE DETAILS IN THE GENERAL NOTES FOR FRAMING FOR SUPPORT OF ROOF TOP MECHANICAL EQUIPMENT.
13. STEEL SHALL BE PREPARED AND FINISHED IN ACCORDANCE WITH THE CSA STANDARD S16 AND THE ARCHITECTURAL DRAWINGS AND SPECIFICATION. MAY INCLUDE ADDITIONAL CLEANING AND PRIMING REQUIREMENTS.
14. ALL STRUCTURAL STEEL OUTSIDE OF THE BUILDING ENVELOPE TO BE HOT DIPPED GALVANIZED UNLESS NOTED OTHERWISE
15. DESIGN DRAWINGS INCLUDE ARCHITECTURAL, MECHANICAL, AND ELECTRICAL DRAWINGS. SEE ALSO ARCHITECTURAL DRAWINGS FOR ROOF AND FLOOR ELEVATIONS, ROOF SLOPES, EDGE DETAILS, AND ADDITIONAL DIMENSIONS AND DETAILS. WHERE ELEVATIONS, ROOF SLOPES, ETC., ARE SHOWN ON THE STRUCTURAL DRAWINGS, THEY MUST BE CONFIRMED WITH THE ARCHITECTURAL DRAWINGS.
16. UNLESS NOTED OTHERWISE, DO NOT OVERSIZE HOLES IN STEEL TO FIT ANY ANCHOR LOCATIONS. FOR COLUMN BASE PLATE HOLES, UNLESS NOTED OTHERWISE ON DRAWINGS, FOLLOW STANDARD PRACTICE WHICH IS TO USE SLIGHTLY OVERSIZED HOLES. USE 6 mm OVERSIZED HOLE DIAMETER FOR COLUMN ANCHOR RODS UP TO AND INCLUDING 27 mm DIAMETER, AND 12 mm OVERSIZED HOLE DIAMETER FOR COLUMN ANCHOR RODS GREATER THAN 27 mm DIAMETER.
16. THIS SYMBOL: MEANS BEAM IS MOMENT CONNECTED THROUGH SUPPORTING BEAM OR COLUMN. PROVIDE FULL CAPACITY MOMENT CONNECTION U.N.O.
17. **BEAMS - PLAN PRESENTATION**



NO.	REV.	ISSUED FOR	DATE
1	4	100% CD	2019-11-12
2	5	ISSUED FOR PERMIT	2019-11-14
3	6	ISSUED FOR TENDER REVIEW	2019-12-06
4	7	ISSUED FOR TENDER	2019-12-11

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PROJECT:

DRAWING NAME:
GENERAL NOTES & TYPICAL DETAILS

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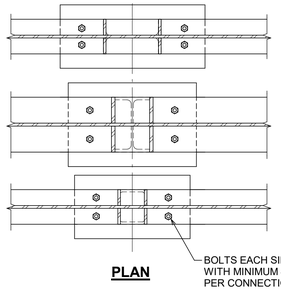
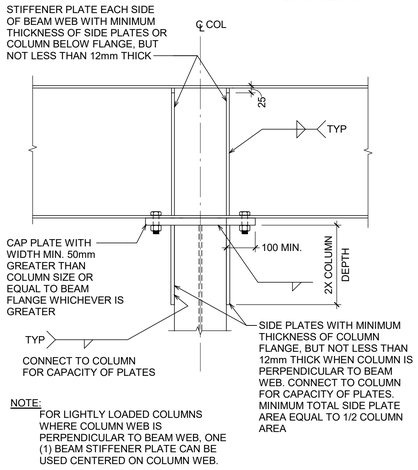
S-109

BEAM TO COLUMN BELOW CONNECTION

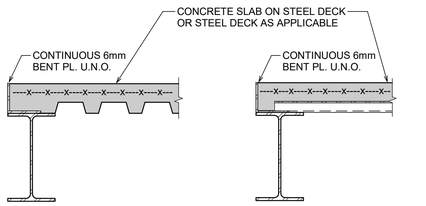


PLAN



NOTE:
FOR LIGHTLY LOADED COLUMNS WHERE COLUMN WEB IS PERPENDICULAR TO BEAM WEB, ONE (1) BEAM STIFFENER PLATE CAN BE USED CENTERED ON COLUMN WEB.

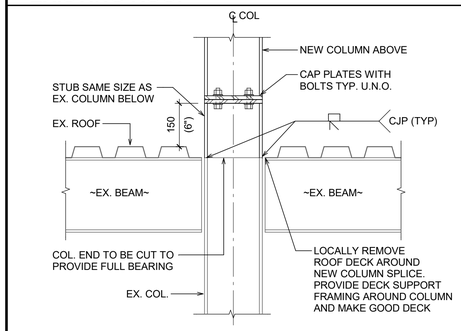
EDGE CONDITION DETAILS



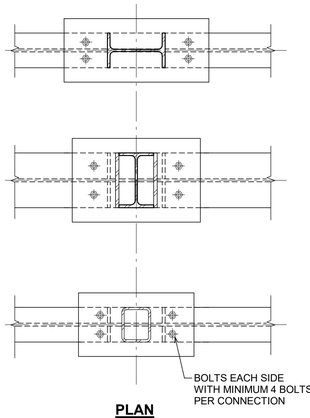
DECK SPANNING PARALLEL TO BEAM

DECK SPANNING PERPENDICULAR TO BEAM

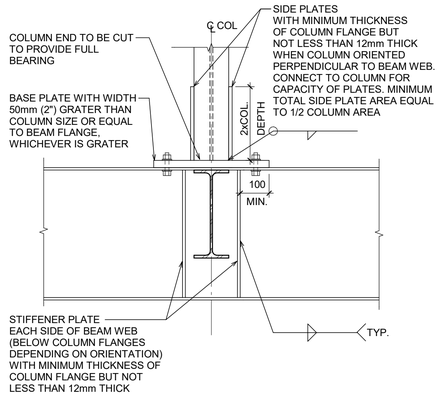
STEEL COLUMN SPLICE ABOVE EXISTING ROOF



BEAM TO COLUMN ABOVE CONNECTION

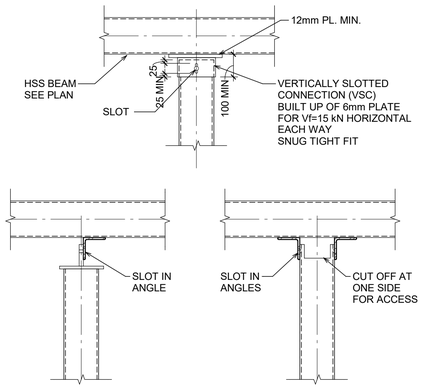


PLAN

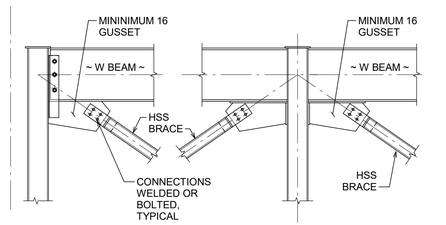


VERTICALLY SLOTTED CONNECTION DETAIL

1. VERTICAL SLOTTED CONNECTIONS TO HAVE VERTICAL DEFLECTION ALLOWANCE OF +/- 25mm U.N.O.

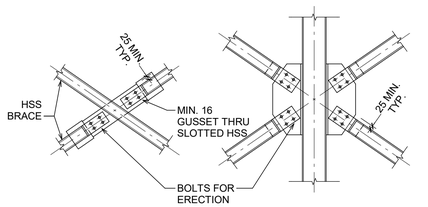


TYPICAL BRACE CONNECTION DETAILS (LOADS FOR CONNECTION DESIGN TO BE SHOWN ON ELEVATION TYPICAL)



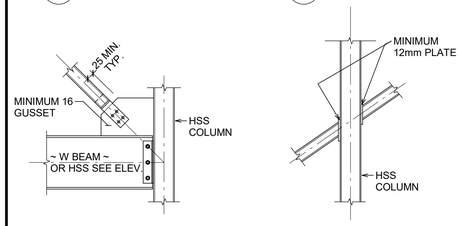
1 CONNECT FOR FORCES AS PER ELEVATIONS

2 CONNECT FOR FORCES AS PER ELEVATIONS



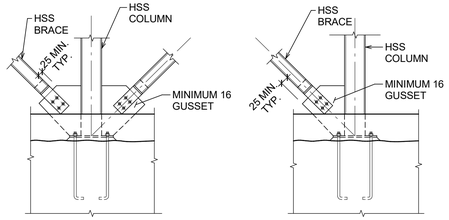
3 CONNECT FOR FORCES AS PER ELEVATIONS

4 CONNECT FOR FORCES AS PER ELEVATIONS



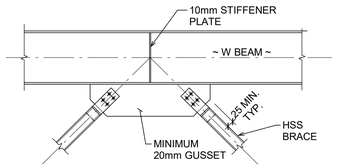
5 CONNECT FOR FORCES AS PER ELEVATIONS

6 CONNECT FOR FORCES AS PER ELEVATIONS



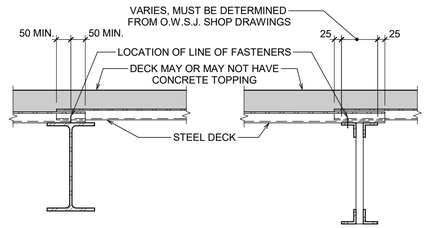
7 CONNECT FOR FORCES AS PER ELEVATIONS

8 CONNECT FOR FORCES AS PER ELEVATIONS



9 CONNECT FOR FORCES AS PER ELEVATIONS

STEEL DECK LAP OVER SUPPORTING MEMBERS



TYPICAL DETAIL AT SUPPORTING MEMBER WITH UNBROKEN TOP SURFACE

TYPICAL DETAIL AT MEMBER WITH INTERRUPTED TOP SURFACE

CONCRETE TOPPING NOTES (ON STEEL DECK)

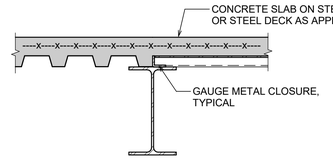
1. ALL CONCRETE TOPPING ON STEEL DECK WHICH IS SHOWN ON THE STRUCTURAL DRAWINGS SHALL BE STRUCTURAL CONCRETE TOPPING. TOPPING OR COVER SLAB THICKNESSES SHOWN ARE MEASURED FROM TOP OF DECK. TOTAL THICKNESS IS MEASURED FROM BOTTOM OF DECK TO TOP OF COVER SLAB.

2. CONCRETE IS TO BE WELL VIBRATED, ESPECIALLY AT COLUMNS AND AROUND EMBEDDED METAL.
3. ALL POUR JOINT LOCATIONS SHALL BE PRE-APPROVED. EXCEPT AT SLAB EDGES AND EXPANSION JOINTS, POUR JOINTS SHALL GENERALLY BE AT LOCATIONS WHICH ARE AT THE MID-SPAN OF BOTH BEAM AND DECK.
4. SCREEDING SHALL CONFORM TO CAMBERS IN STRUCTURAL STEEL, TO MAINTAIN THE REQUIRED CONCRETE THICKNESSES. HOWEVER, ALLOWANCE SHOULD BE MADE FOR ADDITIONAL CONCRETE REQUIRED DUE TO STEEL DECK DEFLECTION AND STRUCTURAL STEEL TOLERANCES.
5. ALL CONCRETE TOPPING SHALL BE REINFORCED. WHERE NO REINFORCING IS SHOWN ON THE DRAWINGS, USE THE FOLLOWING:

65 mm COVER SLAB	-	WWR 152 X 152 - MW9.1 X MW9.1
75 mm COVER SLAB	-	WWR 152 X 152 - MW11.1 X MW11.1
90 mm COVER SLAB	-	WWR 152 X 152 - MW13.3 X MW13.3
100 mm COVER SLAB	-	WWR 152 X 152 - MW16.0 X MW16.0 OR 10M @ 400 EACH WAY (25 mm COVER FROM TOP)

6. WELDED WIRE REINFORCEMENT SHALL BE SUPPORTED TO ENSURE ADEQUATE COVER IS MAINTANED. LAP WIRE REINFORCEMENT A MINIMUM OF 2 CROSS WIRES + 50 mm.
7. U.N.O. PROVIDE 15M1000 @ 300 ADDITIONAL TOP REINFORCING CENTERED OVER ALL SUPPORTS WHERE THE STEEL DECK IS NOT A CONTINUOUS SHEET. THIS SHALL INCLUDE BUT NOT BE LIMITED TO THE FOLLOWING LOCATIONS:
   - AT SUPPORTS WHERE THE DECK IS LAPPED.
   - AT SUPPORTS WHERE THE DECK CHANGES DIRECTION.
   - AT SUPPORTS WHERE CHANGES IN DECK ELEVATION OCCUR.
   - AT SUPPORTS WHERE THE CONCRETE TOPPING MEETS A FORMED CONCRETE SLAB.
   - AT EDGE OF SLAB.
8. U.N.O. PROVIDE 15M1500 @ 500 ADDITIONAL TOP REINFORCING CENTERED OVER ALL INTERIOR GIRDERS.
9. AT ALL OPENINGS GREATER THAN 150 mm, REINFORCE EACH SIDE OF THE OPENING WITH REINFORCING BARS, SEE ALSO STANDARD DETAIL AND FLOOR PLANS.
10. OPENINGS SMALLER THAN 150 mm X 150 mm WHICH ARE CLOSER THAN 600 mm SPACING SHALL HAVE 2-15M1500 PLACED BETWEEN THEM.
11. ALL EXTRA REINFORCING SHOWN ON PLANS, TOP AND BOTTOM, SHALL BE CHAIRED, U.N.O.
12. AT ALL RE-ENTRANT CORNERS OF BUILDING PERIMETER, PROVIDE 2-15M1500 ALONG EACH EDGE EXTENDING 600 mm BEYOND THE CORNER.
13. CONDUITS AND PIPES ARE NOT ALLOWED IN THE CONCRETE TOPPING ON TOP OF STEEL DECK UNLESS APPROVED BY THE STRUCTURAL ENGINEER.

TYPICAL CHANGE IN STEEL DECK ORIENTATION



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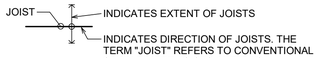
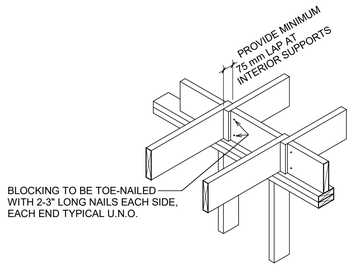
JOISTS

1. REFER TO PLAN AND JOIST SCHEDULE FOR JOIST TYPE, SIZE, AND SPACING.

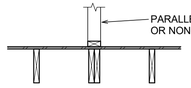


2. DIMENSIONAL LUMBER JOISTS SHALL HAVE CROSS-BRIDGING OR FULL-DEPTH BLOCKING AT 1800 mm O/C ALONG THE SPAN FOR ALL SPANS GREATER THAN 3600 mm. CROSS BRIDGING SHALL CONSIST OF 38 X 38 TIMBER OR APPROVED STEEL BRIDGING. TJI JOISTS SHALL BE BLOCKED AS PER MANUFACTURERS REQUIREMENTS. JOISTS SHALL HAVE FULL-DEPTH BLOCKING OVER LOAD BEARING WALLS, DROPPED BEAMS OR HEADERS. SEE TYPICAL LOAD BEARING WALL AND SHEAR WALL CONNECTIONS BETWEEN FLOORS FOR ADDITIONAL BLOCKING REQUIREMENTS.

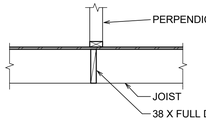


3. TRIM OPENINGS IN FLOORS AND ROOFS (E.G. STAIRS, FIREPLACES, SKYLIGHTS, ETC.) WITH DOUBLE JOISTS UNLESS NOTED OTHERWISE.

4. PROVIDE DOUBLE JOISTS UNDER PARALLEL FRAME WALLS UNLESS NOTED OTHERWISE.



5. PROVIDE 38 X FULL DEPTH BLOCKING BETWEEN JOISTS UNDER PERPENDICULAR FRAME WALLS UNLESS NOTED OTHERWISE.



6. STAIRS AND STRINGERS SHALL BE FRAMED IN ACCORDANCE WITH THE BUILDING CODE PART 9, UNLESS NOTED OTHERWISE.

7. JOISTS ARE TO BE FLUSH UNLESS NOTED OTHERWISE. USE JOIST HANGERS OR FRAMING ANCHORS TO CONNECT JOISTS.

8. UNLESS NOTED OTHERWISE JOIST HANGERS OR FRAMING ANCHORS SHALL BE CAPABLE OF DEVELOPING THE SHEAR STRENGTH OF THE SUPPORTED MEMBER. FOR DIMENSIONAL LUMBER JOISTS, THE FOLLOWING CAPACITIES ARE REQUIRED:

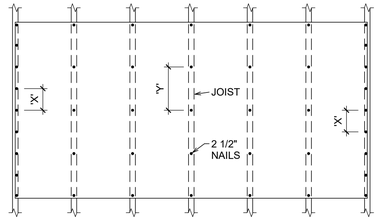
JOIST SIZE	REQUIRED SHEAR RESISTANCE (kN)	
	WORKING LOAD	FACTORED LOAD
38 X 89	5.5	7.2
38 X 140	7.2	9.4
38 X 184	8.2	10.6
38 X 235	9.53	12.4
38 X 286	10.5	13.7

FOR I-JOISTS, HANGERS SHALL BE SPECIFIED ON ENGINEERED SHOP DRAWINGS PROVIDED BY THE JOIST SUPPLIER.

NAILING

1. NAILING SHALL CONFORM TO THE BUILDING CODE PART 9, AND "WOOD BUILDING TECHNOLOGY" PUBLISHED BY THE CANADIAN WOOD COUNCIL. NAILING CALLED UP ON THESE DRAWINGS (E.G. FOR SHEATHING) IS BASED ON COMMON NAILS. SEE NOTE 10 UNDER MATERIALS FOR COMMON NAIL SIZES.

2. UNLESS NOTED OTHERWISE NAIL ALL WALL, FLOOR, AND ROOF SHEATHING TO FRAMING MEMBERS WITH 2 1/2" NAILS. SPACE NAILS AT 150 mm O/C AT ALL SUPPORTED EDGES OF SHEATHING SHEETS. AT INTERMEDIATE SUPPORTS SPACE NAILS AT 250 mm O/C FOR FLOORS AND WALLS AND AT 300 mm O/C FOR ROOFS. FLOOR SHEATHING SHALL BE GLUED TO THE JOISTS IN ADDITION TO NAILING. SEE SHEAR WALL SCHEDULE OR DIAPHRAGM NAILING SCHEDULE FOR ADDITIONAL REQUIREMENTS.



'X' = 150 mm O/C (WALLS, FLOORS, AND ROOF)
'Y' = 250 mm O/C (WALLS AND FLOORS), 300 mm O/C (ROOF)

SHEATHING NAILING PATTERN

3. DO NOT OVERDRIVE NAILS. NAILS OVERDRIVEN BY MORE THAN 10% OF PANEL THICKNESS MAY BE REJECTED.

4. ALL PNEUMATICALLY DRIVEN NAILS ARE TO HAVE FULL ROUND HEADS. PNEUMATIC NAILS THAT HAVE CLIPPED OR MOON SHAPED HEADS ARE NOT PERMITTED. MOST STRIP STYLE NAILERS USE CLIPPED OR MOON SHAPED HEADS. THEREFORE, ONLY COIL STYLE NAILERS THAT USE NAILS WITH FULL ROUND HEADS SHALL BE USED.

PERMITTED **NOT PERMITTED**

5. DO NOT USE PNEUMATICALLY DRIVEN NAILS WITH JOIST HANGERS OR CONNECTING HARDWARE. NAILS FOR HARDWARE SHOULD BE AS SPECIFIED OR SUPPLIED BY MANUFACTURER.

SHEATHING

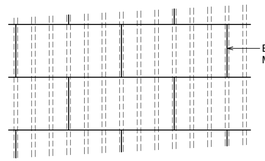
1. A. ROOF SHEATHING — SLOPED ROOF (SLOPE GREATER THAN 15%) 12.5 mm PLYWOOD WITH H-CLIPS AT UNSUPPORTED JOINTS. FLAT ROOF (SLOPE 15% MAXIMUM) 15.5 mm TONGUE AND GROOVE PLYWOOD.

   B. FLOOR SHEATHING — 15.5 mm TONGUE AND GROOVE PLYWOOD IF NO CONCRETE TOPPING IS USED. (ANY JOINT WITHOUT A TONGUE AND GROOVE CONNECTION SHALL BE BLOCKED WITH A 38 X 89). 15.5 mm BUTT JOINT PLYWOOD IF 38 mm CONCRETE TOPPING IS USED.

   C. EXTERIOR WALL SHEATHING — 9.5 mm PLYWOOD ON EXTERIOR SIDE TYP. 12.5 mm PLYWOOD SHEATHING IF WALLS CLAD WITH VERTICAL STRAPPING OR BRICK VENEER. SEE ALSO ARCHITECTURAL FOR ADDITIONAL SHEATHING REQUIREMENTS.

   D. SHEAR WALL SHEATHING — SEE SHEAR WALL SCHEDULE FOR SHEATHING REQUIREMENTS AT SHEAR WALL LOCATIONS.

2. LAY FLOOR AND ROOF SHEATHING WITH THE SURFACE GRAIN AT RIGHT ANGLES TO THE JOISTS. STAGGER THE JOINTS PARALLEL TO THE JOISTS.



3. DRYWALL OR SHEATHING ON LOAD BEARING WALLS OR SHEAR WALLS SHALL BE FASTENED DIRECTLY TO THE STUDS, WITHOUT THE USE OF RESILIENT METAL CHANNELS.

MATERIALS

1. STUDS AND BUILT-UP POSTS TO BE S-P-F NO.1/NO. 2 GRADE OR BETTER EXCEPT IN SHEAR WALLS WHERE D.FIR NO. 2 OR BETTER GRADE IS REQUIRED. STUDS MAY BE FINGER-JOINTED (MAXIMUM 3 JOINTS PER STUD) EXCEPT IN SHEAR WALLS. REFER TO WOOD SHEAR WALL NOTES FOR ADDITIONAL REQUIREMENTS. FINGER JOINTED STUDS IN FIRE SEPARATIONS SHALL HAVE HEAT RESISTANT ADHESIVE (HSA).

2. JOISTS TO BE S-P-F NO.1/NO. 2 GRADE OR BETTER.

3. BUILT-UP BEAMS AND HEADERS TO BE S-P-F NO.1/NO. 2 GRADE OR BETTER.

4. WALL PLATES TO BE S-P-F NO.1/NO. 2 GRADE OR BETTER EXCEPT IN SHEAR WALLS WHERE D.FIR NO. 2 OR BETTER GRADE IS REQUIRED. REFER TO WOOD SHEAR WALL NOTES FOR ADDITIONAL REQUIREMENTS. WALL PLATES SHALL BE KILN-DRIED AND MAY BE FINGER JOINTED EXCEPT IN SHEAR WALLS.

5. POSTS AND BEAMS TO BE S-P-F NO. 2 GRADE OR BETTER.

6. ALL DIMENSION LUMBER TO BE SURFACED FOUR SIDES ("S4S").

7. PLYWOOD TO BE DOUGLAS FIR SHEATHING GRADE.

8. TIMBER CONNECTION HARDWARE TO BE SIMPSON STRONG-TIE, OR EQUIVALENT APPROVED BY RJC. COMPLETE WITH NAILS SUPPLIED BY MANUFACTURER. DO NOT USE P NAILS.

9. NAILS SHALL BE COMMON ROUND STEEL WIRE NAILS OR PNEUMATIC NAILS (P NAILS) WITH MINIMUM DIAMETERS PER THE FOLLOWING TABLE. NAILS ARE CALLED UP BY LENGTH AND SHALL CONFORM TO THE FOLLOWING TABLE:

LENGTH	COMMON NAIL DIAMETER	P NAIL DIAMETER
2" (51 mm)	0.112" (2.84 mm)	0.113" (2.87 mm)
2 1/2" (64 mm)	0.128" (3.25 mm)	0.131" (3.33 mm)
3" (76 mm)	0.144" (3.66 mm)	0.148" (3.76 mm)
3 1/4" (83 mm)	0.144" (3.66 mm)	0.148" (3.76 mm)
3 1/2" (89 mm)	0.160" (4.06 mm)	0.162" (4.11 mm)
4" (102 mm)	0.192" (4.88 mm)	NOT APPLICABLE
4 1/2" (114 mm)	0.212" (5.38 mm)	NOT APPLICABLE
5" (127 mm)	0.232" (5.89 mm)	NOT APPLICABLE

NOTE: 3" P NAILS WITH A 0.131" (3.33 mm) DIAMETER MAY BE SUBSTITUTED FOR 3" COMMON NAILS PROVIDED ADDITIONAL NAILS ARE USED OR THE SPECIFIED NAIL SPACING IS REDUCED PER THE FOLLOWING TABLE:

3" X 0.144" COMMON NAIL SPACING SPECIFIED ON DRAWINGS	3" X 0.131" P NAIL SPACING (20% MORE NAILS REQUIRED)
300 mm	250 mm
250 mm	200 mm
200 mm	150 mm
150 mm	125 mm
100 mm	75 mm
75 mm	64 mm
50 mm	NOT APPLICABLE

11. MISCELLANEOUS STEEL TO BE CSA G40.21 OR APPROVED EQUAL.

12. ANCHOR RODS SHALL BE ASTM F1554 GRADE 36 OR APPROVED EQUIVALENT. ANCHOR RODS SHALL BE DEFORMED, THREADED ALONG THEIR FULL LENGTH OR HOOKED 40 mm AT THE BOTTOM.

13. BOLTS SHALL BE ASTM A325 OR APPROVED EQUAL, USED WITH STANDARD CUT STEEL WASHERS UNLESS NOTED OTHERWISE ON DRAWINGS.

14. MOISTURE CONTENT OF ALL TIMBER ELEMENTS SHALL NOT EXCEED 19% AT THE TIME OF CONSTRUCTION OR FABRICATION.

15. ALL FASTENERS AND CONNECTION HARDWARE THROUGH PRESERVATIVE TREATED MATERIALS OR OUTSIDE OF THE MOISTURE BARRIER TO BE HOT DIPPED GALVANIZED OR STAINLESS STEEL STEEL AS SPECIFIED.

MOISTURE BARRIERS

1. PROVIDE A MOISTURE BARRIER BETWEEN WOOD ELEMENTS AND ALL CONCRETE OR MASONRY. THIS CAN BE A SHEET OF LIGHT-GAUGE (0.61 mm MINIMUM) GALVANIZED METAL, ASPHALT IMPREGNATED BUILDING PAPER (7.5 kg PER 10 m²), CLOSED-CELL FOAM GASKET MATERIAL, TYPE S ROLL ROOFING. SHEET POLYETHYLENE NOT PERMITTED. ALL JUNCTIONS AND TERMINATIONS TO BE LAPPED (50 mm MINIMUM) AND SEALED. BUTT JOINTS IN MOISTURE BARRIERS NOT PERMITTED.

WOOD FRAMING

GENERAL

1. ALL DESIGN, DETAILS, MATERIALS AND CONSTRUCTION PROCEDURES SHALL CONFORM TO CURRENT EDITIONS OF THE FOLLOWING AS A MINIMUM:
   - ONTARIO BUILDING CODE 2012 - PART 9
   - CSA O86 - ENGINEERING DESIGN IN WOOD
   - CSA O121 - DOUGLAS FIR PLYWOOD
   - CAN/CSA-O122 - STRUCTURAL GLUED-LAMINATED TIMBER
   - CAN/CSA-O177 - QUALIFICATION CODE FOR MANUFACTURERS OF STRUCTURAL GLUED-LAMINATED TIMBER
   - CAN/CSA-O437 SERIES - STANDARDS FOR OSB AND WAFERBOARD
   - CSA B111 - WIRE NAILS, SPIKES AND STAPLES
   - ASTM D5456 - STANDARD SPECIFICATION FOR EVALUATION OF STRUCTURAL COMPOSITE LUMBER PRODUCTS
   - CANADIAN WOOD-FRAME HOUSE CONSTRUCTION-CMHC
   - "WOOD DESIGN MANUAL" - CANADIAN WOOD COUNCIL
   - "WOOD BUILDING TECHNOLOGY" - CANADIAN WOOD COUNCIL

2. ANY CHANGES TO THE FRAMING SHOWN ON THESE DRAWINGS SHALL HAVE PRIOR WRITTEN APPROVAL OF RJC. FRAMING CHANGES WHICH HAVE NOT BEEN SO APPROVED WILL BE REJECTED.

3. CONFIRM ALL DIMENSIONS AND OUTLINES WITH THE ARCHITECTURAL DRAWINGS. SEE ARCHITECTURAL DRAWINGS FOR ADDITIONAL DIMENSIONS, ELEVATIONS AND DETAILS.

4. ANY TIMBER NOT GRADE MARKED WILL BE REJECTED.

5. FINISHES SHALL BE DETAILED TO ACCOMMODATE SHRINKAGE OF THE TIMBER OVER TIME.

6. DO NOT COVER WOOD FRAMING WITH FINISHES UNTIL RJC'S FRAMING REVIEW IS COMPLETE. PROVIDE 24 HOURS ADVANCE NOTIFICATION WHEN FRAMING REVIEWS ARE REQUIRED.

7. NOTCHING AND DRILLING OF STRUCTURAL ELEMENTS SHALL FOLLOW THE GUIDELINES SET FORTH IN THE BUILDING CODE PART 9, UNLESS OTHERWISE APPROVED IN WRITING BY RJC.

8. ALL TIMBER ELEMENTS ARE DESIGNED FOR DRY-SERVICE CONDITIONS. SEE ARCHITECTURAL DRAWINGS FOR WATERPROOFING AND VENTILATION DETAILS.

9. ALL WOOD FRAME CONSTRUCTION SHALL SATISFY THE FOLLOWING CONSTRUCTION TOLERANCES AS A MINIMUM. REFER TO ARCHITECTURAL AND WARRANTY REQUIREMENTS FOR ADDITIONAL TOLERANCE SPECIFICATIONS.
   - A. FLOORS - NOT MORE THAN 6 mm IN 3 m OUT OF LEVEL.
   - B. WALLS - NOT MORE THAN 6 mm IN 2.4 m OUT OF PLUMB. - NOT MORE THAN 6 mm IN 3 m FOR ANY BOWING.
   - C. OVERALL - BUILDING WALLS AND FLOORS SHALL NOT BE MORE THAN 10 mm DIFFERENCE IN MEASUREMENT FROM DIMENSIONS SHOWN ON CONTRACT DOCUMENTS.

CONTRACTOR REQUIREMENTS

1. PRIOR TO INSTALLING ANY WOOD FRAME, THE CONTRACTOR IS TO SURVEY THE SUPPORTING CONCRETE SLAB FOR LEVELNESS. WHERE THE FLOOR IS OUT OF LEVEL BY MORE THAN 13 mm FROM A HORIZONTAL DATUM BETWEEN ADJACENT HIGH POINTS, CONTRACTOR IS TO EITHER LEVEL THE SLAB WITH A SELF LEVELING COMPOUND OR POUR LEVELING CURBS UNDER ALL BEARING WALLS.

2. THE CONTRACTOR IS TO ENSURE THAT SHOP DRAWINGS FOR ALL SYSTEMS AND COMPONENTS THAT ARE DESIGNED BY OTHERS ARE PREPARED AHEAD AND SUBMITTED FOR REVIEW BY RJC AND THE ARCHITECT PRIOR TO INSTALLATION. THIS INCLUDES ENGINEERED WOOD SHOP DRAWINGS, ROOF ANCHORS, ROOF TOP MECHANICAL UNITS, OR OTHER ELEMENTS DESIGNED BY THE CONTRACTOR'S TRADES WHICH MAY AFFECT THE WOOD FRAME.

3. THE CONTRACTOR IS TO COORDINATE A MEETING WITH THEIR TRADES AND RJC TO REVIEW THE ANTICIPATED BUILDING MOVEMENTS WHICH CAN OCCUR DURING CONSTRUCTION AND CONTINUE AFTER THE BUILDING IS IN SERVICE DUE TO WOOD SHRINKAGE. THE CONTRACTOR IS TO ENSURE THAT ALL TRADES ARE AWARE OF THE POTENTIAL BUILDING MOVEMENT AND HOW MUCH THEY NEED TO ACCOMMODATE FOR IN THEIR DETAILS AND CONNECTIONS. SEE SHRINKAGE NOTES.

4. ALL FRAMING INCLUDING BACK FRAMING AND THE REMEDIATION OF ALL DEFICIENCIES IS TO BE SIGNED OFF BY RJC PRIOR TO INSTALLING ANY CONCRETE TOPPING.

5. THE CONTRACTOR IS TO ENGAGE THE BUILDING ENVELOPE CONSULTANT TO MONITOR THE GENERAL MOISTURE CONTENT OF THE WOOD STRUCTURE DURING CONSTRUCTION INCLUDING BOTH THE INTERIOR FRAMING AND EXTERIOR WALLS. THE WOOD STRUCTURE IS TO BE DRIED SUCH THAT THE MAXIMUM MOISTURE CONTENT IS BELOW 19% FOR ALL WOOD ELEMENTS PRIOR TO APPLYING FINISHES OR CLOSING IN ANY OF THE WOOD COMPONENTS. THE WOOD SHOULD BE LEFT TO DRY WITH AT LEAST ONE EXPOSED FACE UNTIL THE BUILDING ENVELOPE CONSULTANT HAS PROVIDED APPROVAL.

NO.	REV.	ISSUED FOR	DATE
1	4	100% CD	2019-11-12
2	5	ISSUED FOR PERMIT	2019-11-14
3	6	ISSUED FOR TENDER REVIEW	2019-12-06
4	7	ISSUED FOR TENDER	2019-12-11

N

STAMP

CONTRACTOR SHALL CHECK ALL DIMENSIONS ON THE WORK AND REPORT ANY DISCREPANCY TO THE CONSULTANT BEFORE PROCEEDING. THIS DRAWING IS NOT TO BE USED FOR CONSTRUCTION UNTIL AUTHORIZED IN WRITING BY CONSULTANT.

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PROJECT:

DRAWING NAME:
GENERAL NOTES & TYPICAL DETAILS

PROJECT NO:	DRAWN BY:	CHECKED BY:
TOR.113946.0011	JP	NB

Scale: As indicated

DRAWING NUMBER:
S-111

170 MINI PILES / SOIL ANCHORS

GENERAL

1. NEW MINI PILE / SOIL ANCHOR FOUNDATION DESIGN IS BASED ON THE GEOTECHNICAL REPORT BY: SOIL ENGINEER LTD.
   DATED: OCTOBER 15, 2019
2. ENSURE THAT THE REQUIREMENTS OUTLINED IN THE GEOTECHNICAL REPORT AND SHOWN ON THE STRUCTURAL DRAWINGS AND IN THE SPECIFICATION ARE UNDERSTOOD PRIOR TO COMMENCING WITH FOUNDATION WORK.
3. ALL MINI PILES TO BE [#18 (57 mm Ø)] DYWIDAG BARS (OR APPROVED EQUIVALENT), DOUBLE CORROSION PROTECTED, Fy = 517 MPa (75 KSI), IN 200 mm MINIMUM [CASED] DRILLED HOLES, PRESSURE GROUTED. DO NOT WELD TO MINI PILE BARS.
4. SEE GEOTECHNICAL REPORT FOR SPECIFIC REQUIREMENTS ON MATERIALS, INSTALLATION PROCEDURES, TESTING, PRE-LOADING, ETC.
5. SEE GEOTECHNICAL REPORT FOR CASING REQUIREMENTS.
6. HOLES THROUGH EXISTING PILECAPS OR FOOTINGS TO ALLOW MINI PILE INSTALLATION ARE TO BE MADE WITH HYDRODEMOLITION OR OTHER APPROVED METHODS WHICH WILL NOT DISTURB THE EXISTING PILECAP REINFORCEMENT OR SOIL BELOW EXISTING FOUNDATIONS.
7. SEE DETAIL 3/S-850 FOR TYPICAL MINI PILE CONFIGURATION AT PILECAP OR GRADE BEAM.
8. UNLESS OTHERWISE SHOWN, CENTER MINI PILES UNDER COLUMNS, BEAMS AND WALLS.
9. MINI PILES SHALL BE PLACED WITH THE FOLLOWING TOLERANCES:
   A. NOT MORE THAN 2% OF ITS LENGTH OUT OF PLUMB FOR VERTICAL MINI PILES.
   B. NOT MORE THAN 75 mm OFF CENTER AT THE TOP.
10. NOTIFY RJC OF ANY INSTALLED PILES WHICH DO NOT CONFORM TO THESE SPECIFICATIONS, OR WHICH ARE MISPLACED BY MORE THAN ± 75 mm.
11. ALL MINI PILES TO RESIST TENSION AND COMPRESSION FORCES UNLESS NOTED OTHERWISE.
12. UNLESS NOTED OTHERWISE, EACH MINI PILE TO HAVE MINIMUM CAPACITY AT THE SERVICEABILITY LIMITS STATES (SLS) AND ULTIMATE LIMITS STATES (ULS) OF THE FOLLOWING:

SOIL ANCHOR / MINI PILE TYPE	RESISTANCE AT SLS	MAXIMUM ELONGATION AT SLS	FACTORED RESISTANCE AT ULS	MAXIMUM ELONGATION AT ULS
COMPRESSION	750 kN	12 mm	1100 kN	19 mm
TENSION	750 kN	12 mm	1100 kN	19 mm

13. ALL SPLICES ARE TO BE MADE FOR THE FULL STRENGTH OF THE BAR USING DYWIDAG COUPLERS.
14. REGARDLESS OF THE CONTRACTOR'S DESIGN CALCULATIONS, ALL MINI PILES SHALL MEET THE REQUIREMENTS NOTED IN THE GEOTECHNICAL REPORT.
15. THE CONTRACTOR SHALL SUBMIT SHOP DRAWINGS OF THE MINI PILE ASSEMBLY AND THE INSTALLATION PROCEDURE FOR REVIEW BY THE STRUCTURAL ENGINEER AND THE GEOTECHNICAL CONSULTANT. THE ANCHOR ASSEMBLY SHOP DRAWINGS SHALL BE SEALED BY A PROFESSIONAL ENGINEER REGISTERED IN ONTARIO.

INSTALLATION AND TESTING

16. PRIOR TO COMMENCING INSTALLATION OF PERMANENT MINI PILES, CONTRACTOR TO CONDUCT TESTING PROGRAM WITH A MINIMUM OF TWO TEST PILES AS DESCRIBED IN THE GEOTECHNICAL REPORT.
17. EACH MINI PILE SHALL BE TESTED IN ACCORDANCE TO THE SPECIFICATIONS GIVEN [ON THE GEOTECHNICAL DRAWINGS][IN THE GEOTECHNICAL REPORT]. THE MINIMUM TEST LOAD SHALL BE 133% OF THE WORKING CAPACITY HELD FOR A MINIMUM OF 10 MINUTES WITH A CREEP LESS THAN 1 mm. THE LOCK-OFF LOAD SHALL BE [____ kN] [25% OF THE FACTORED CAPACITY] AFTER TESTING.
18. THE MINI PILE TESTS SHALL BE CARRIED OUT BY THE CONTRACTOR, AND MONITORED BY THE GEOTECHNICAL ENGINEER.
19. THE CONTRACTOR SHOULD PROVIDE MINIMUM 24 HOURS NOTICE OF ANCHOR TESTING.
20. APPROPRIATE GAUGES AND TESTING EQUIPMENT, INCLUDING THE JACKING EQUIPMENT, MUST BE PROVIDED BY THE CONTRACTOR.
21. APPROVAL OF THE MINI PILES WILL BE BY THE GEOTECHNICAL CONSULTANT.

ALTERNATE DESIGNS

22. RE-DESIGN OR REVIEW OF MINI PILES BY RJC TO UTILIZE ALTERNATE MINI PILE LAYOUT, MINI PILE CAPACITIES OR MATERIALS REQUESTED BY THE CONTRACTOR TO BE PAID FOR BY THE CONTRACTOR.

GLUED-LAMINATED TIMBER (GLULAM)

1. GLULAM MEMBERS SHALL SATISFY THE FOLLOWING:
   A. DOUGLAS FIR/LARCH
   B. STRESS GRADE : 24 f-Ex
   C. APPEARANCE GRADE : QUALITY
   D. MOISTURE CONTENT : 15% MAXIMUM
   E. SERVICE GRADE : EXTERIOR SERVICE GRADE
2. GLULAM MEMBERS SHALL BE MANUFACTURED BY A CSA APPROVED PLANT MEETING THE REQUIREMENTS OF CAN/CSA-O177.
3. GLULAM MEMBERS SHALL BE KEPT DRY AND PROTECTED FROM THE ENVIRONMENT DURING STORAGE ON OR OFF THE PROJECT SITE AS PER THE MANUFACTURES REQUIREMENTS.

IMPERIAL EQUIVALENTS

STRUCTURAL ELEMENTS SPECIFIED IN METRIC UNITS HAVE THE FOLLOWING EQUIVALENT IMPERIAL UNITS.

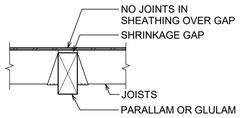
JOISTS	SHEATHING
38 x 89 = 2 x 4	6 mm = 1/4"
38 x 140 = 2 x 6	9.5 mm = 3/8"
38 x 184 = 2 x 8	12.5 mm = 1/2"
38 x 235 = 2 x 10	15.5 mm = 5/8"
38 x 286 = 2 x 12	19 mm = 3/4"
	22.5 mm = 7/8"

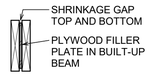
WOOD DECKING

1. WOOD DECKING TO BE [SELECT] GRADE [DOUGLAS FIR] KILN DRY PLANKS TO [19]% MAXIMUM MOISTURE CONTENT.
2. 64 mm X 133 mm AND 89 mm X 133 mm WOOD DECKING SHALL BE PRE DRILLED WITH 6 mm Ø HOLES AT 760 mm O/C FOR LATERAL SPIKING WITH DOUBLE TONGUE AND GROOVE.
3. DECKING LENGTHS TO BE 1800 mm TO 6000 mm OR LONGER WITH A MINIMUM OF 90% OF THE PLANKS EXCEEDING 3000 mm AND A MINIMUM OF 50% OF THE PLANKS EXCEEDING 5000 mm. FOR SINGLE SPANS SHORTER THAN 3000 mm, USE PLANKS OF SAME LENGTH AND SPAN.
4. INSTALL PLANK DECKS TO CSA O86 CONTROLLED RANDOM PATTERN. EXCEPT AS NOTED.
5. PROVIDE MINIMUM OF ONE BEARING SUPPORT FOR EACH PLANK (EXCEPT FOR CANTILEVERS OR SIMPLE SPANS WHICH SHALL EXTEND OVER TWO SUPPORTS AND TWO SPAN CONTINUOUS WHICH SHALL EXTEND OVER THREE SUPPORTS). INSTALL SLOPING DECKS WITH TONGUES UP.
6. STAGGER END JOINTS IN ADJACENT PLANKS MINIMUM OF 500 mm SEPARATE JOINTS IN SAME AREA BY AT LEAST TWO INTERVENING COURSES. NO END JOINTS IN FIRST HALF OF END SPANS. MINIMIZE JOINTS IN MIDDLE THIRD OF ANY SPAN.
7. NAIL ALL 64 mm AND 89 mm PLANKS TOGETHER LATERALLY WITH 8" SPIRAL SPIKES THROUGH PRE DRILLED 6 mm HOLES AT 760 mm O/C.
8. CONNECT EACH 64 mm AND 89 mm PLANK TO SUPPORTING MEMBERS WITH ONE 5" NAIL, TOE-NAILED, AND ONE 6" NAIL, FACE-NAILED, EXCEPT AS NOTED ON PLAN.
9. PLANKS PARALLEL TO SPAN OF SUPPORTING MEMBERS TO BE CONNECTED TO THE SUPPORTING MEMBERS WITH 6" NAILS FACE-NAILED AT 300 mm O/C, EXCEPT AS NOTED ON PLAN.
10. CONNECT EACH 38 mm PLANK TO SUPPORTING MEMBERS WITH ONE 3" NAIL, TOE-NAILED, AND ONE 3" NAIL, FACE-NAILED.

SHRINKAGE

1. THE WOOD FRAME STRUCTURE WILL UNDERGO MOVEMENT DUE TO SHRINKAGE. SHRINKAGE OCCURS AS THE MOISTURE CONTENT IN WOOD DECREASES AS IT DRIES.
2. KILN DRIED WOOD IS INITIALLY DRIED TO A MOISTURE CONTENT OF 19%. WOOD MAY TAKE ON MOISTURE DURING CONSTRUCTION DUE TO WEATHER.
3. THE CONTRACTOR IS TO TAKE ALL REASONABLE MEASURES TO PROTECT WOOD FROM MOISTURE WHILE IT IS STORED ON SITE. THIS INCLUDES KEEPING WOOD STORED IN A DRY AREA OR PROTECTED WITH A MOISTURE RESISTANT COVER. THE CONTRACTOR SHOULD ALSO TAKE REASONABLE MEASURES TO CLOSE IN THE STRUCTURE AS QUICKLY AS POSSIBLE TO REDUCE THE EXPOSURE OF WOOD TO MOISTURE DURING CONSTRUCTION. BEAMS IN BALCONIES SHOULD ALSO BE COVERED AS LONG AS POSSIBLE.
4. THE BUILDING WILL SEE TWO STAGES OF CHANGE IN MOISTURE CONTENT IN THE WOOD. THE FIRST BEING THE CHANGE IN MOISTURE CONTENT UNTIL WHICH TIME THE STRUCTURE IS DRIED TO 19%. IT IS ASSUMED INITIALLY THE WOOD MAY BE AT 30% MOISTURE CONTENT. THE SECOND BEING THE CHANGE FROM 19% MOISTURE CONTENT TO THE EQUILIBRIUM MOISTURE CONTENT OF 8% WHICH IS THE ANTICIPATED FINAL MOISTURE CONTENT EXPECTED DURING THE SERVICE OF THE BUILDING.
5. THE TOTAL PER FLOOR SHRINKAGE TO BE TAKEN AS 12.7 mm BASED ON SHRINKAGE FROM 30% TO 8%.
6. THE TOTAL PER FLOOR SHRINKAGE TO BE TAKEN AS 6.4 mm BASED ON SHRINKAGE FROM 19% TO 8%.
7. FOR SYSTEMS OR COMPONENTS THAT ARE INSTALLED EARLY ON BEFORE THE BUILDING HAS BEEN DRIED TO 19%, ALLOW FOR THE FULL SHRINKAGE FROM 30% TO 8%. FOR SYSTEMS OR COMPONENTS THAT ARE ADDED AFTER THE BUILDING HAS BEEN DRIED TO 19%, ALLOW FOR THE SHRINKAGE BETWEEN 19% AND 8%.
8. MOST OF THE SHRINKAGE OCCURS PERPENDICULAR TO THE GRAIN OF THE LUMBER OR CROSS GRAIN. THUS MOST OF THE SHRINKAGE OCCURS IN THE WALL PLATES AND FLOOR SYSTEM ITSELF WHERE THE WOOD IS STACKED IN PERPENDICULAR TO GRAIN LOADING. THE STRUCTURE SHRINKS VERY LITTLE OVER THE HEIGHT OF THE STUDS.
9. FRAMING DETAILS SHALL ENSURE UNIFORM VERTICAL SHRINKAGE. ADJACENT PORTIONS OF STRUCTURE SHALL BE SUPPORTED ON ROUGHLY EQUIVALENT AMOUNTS OF HORIZONTAL TIMBER (JOISTS AND SILL PLATES). DO NOT MIX KILN-DRIED AND NON-KILN DRIED JOISTS IN ANY GIVEN FLOOR.
10. FRAMING DETAILS AROUND NON-SHRINKING STRUCTURAL ELEMENTS (CONCRETE, STEEL, PARALLAMS, GLULAMS, MICROLLAMS, PLYWOOD ETC.) SHALL TAKE INTO ACCOUNT THE SHRINKAGE OF THE TIMBER. EXAMPLES:





ENGINEERED WOOD PRODUCTS (E.W.P.)

1. ENGINEERED WOOD PRODUCTS INCLUDE ALL PRE-MANUFACTURED BEAMS, COLUMNS, AND I-JOISTS BY WEYERHAEUSER TRUS JOIST AS SHOWN ON PLAN.
2. BEAMS EXPOSED TO VIEW IN FINISHED BUILDING SHALL BE SANDED APPEARANCE GRADE WITH STAMPS IN COVERED LOCATIONS.
3. ALL MANUFACTURED BEAMS AND I-JOISTS SHALL HAVE A MOISTURE CONTENT OF LESS THAN 12%. ALL WOOD SHALL BE WRAPPED AND PROTECTED FROM MOISTURE UNTIL IT IS INSTALLED.
4. SIZES OF BEAMS AND POSTS SHALL BE AS SPECIFIED ON PLAN.
5. BEAMS: MINIMUM STRENGTHS OF BEAMS AS SPECIFIED ON PLAN.

TRUS JOIST DESIGNATION	MODULUS OF ELASTICITY	SHEAR RESISTANCE (f_v)	BENDING RESISTANCE (f_b)	BEARING RESISTANCE (f_{cp})
LVL	2.0E (13790 MPa)	3.6 MPa	33.1 MPa	9.4 MPa

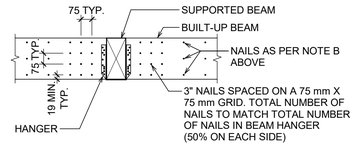
BEAMS DEFLECTIONS ARE TO BE LIMITED TO LIVE LOAD SPAN/360 AND TOTAL LOAD SPAN/240.

LSL - LAMINATED STRAND LUMBER (TRUS JOIST TIMBERSTRAND)
LVL - LAMINATED VENEER LUMBER (TRUS JOIST MICROLLAM)
PSL - PARALLEL STRAND LUMBER (TRUS JOIST PARALLAM)

6. COLUMNS: COLUMNS SHALL BE PSL 1.8E BY WEYERHAEUSER TRUS JOIST OR PRE-APPROVED EQUIVALENT.
7. UNLESS NOTED OTHERWISE ON PLAN STEEL CONNECTING HARDWARE FOR LSL, LVL, AND PSL BEAMS SHALL BE CAPABLE OF DEVELOPING 100% OF THE BEAM SHEAR CAPACITY.
8. PRODUCT SUBSTITUTIONS MUST BE PRE-APPROVED.
9. DO NOT SUBSTITUTE BUILT-UP MEMBERS OF SAWN TIMBER FOR ENGINEERED WOOD PRODUCTS.
10. PSL USED IN EXTERIOR APPLICATIONS SHALL MEET THE EXPOSURE REQUIREMENTS SPECIFIED BY THE MANUFACTURER. DO NOT USE LSL OR LVL FOR EXTERIOR APPLICATIONS.
11. ALL ENGINEERED WOOD PRODUCTS SHALL BE KEPT DRY AND PROTECTED FROM THE ENVIRONMENT DURING STORAGE ON OR OFF THE PROJECT SITE AS PER THE MANUFACTURER'S REQUIREMENTS. STORE MATERIAL ELEVATED FROM GROUND AND WRAPPED TO SHED MOISTURE.

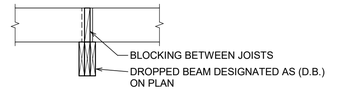
BEAMS

1. BUILT-UP SAWN LUMBER BEAMS (E.G. 3-38 X 235) SHALL HAVE EACH PLY NAILED TOGETHER WITH COMMON NAILS AS FOLLOWS:
   A. FOR TOP LOADED BEAMS: 2 ROWS OF 3" NAILS AT 300 mm O/C.
   B. FOR BEAMS SIDE LOADED WITH UNIFORM JOISTS:
      - BEAM DEPTH < 235 mm: 2 ROWS OF 3" NAILS AT 150 mm O/C.
      - BEAM DEPTH ≥ 235 mm: 3 ROWS OF 3" NAILS AT 150 mm O/C.
   C. FOR BEAMS SIDE LOADED WITH A BEAM (POINT LOAD):

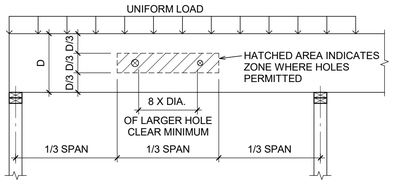


   INDIVIDUAL MEMBERS MAY NOT BE SPLICED BETWEEN SUPPORTS.
2. FOR ENGINEERED PRODUCTS, NAILING REQUIREMENTS OF LAMINATES SHALL BE SPECIFIED ON ENGINEERED SHOP DRAWINGS PROVIDED BY BEAM SUPPLIER.
3. FLUSH BEAMS:

4. DROPPED BEAMS:



NO POINT LOADS FROM POSTS ABOVE



NOTES:

1. MAXIMUM 3 HOLES PER SPAN.
2. CONTACT RJC FOR OTHER CONDITONS.

BEAM DEPTH	MAXIMUM HOLE DIAMETER
89 mm	19 mm
140 mm	29 mm
184 mm	38 mm
> 184 mm	51 mm

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1	4	100% CD	2019-11-12
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toronto zoo
361A Old Finch Ave, Toronto ON M1B 5K7 · 416-392-5929

PROJECT:

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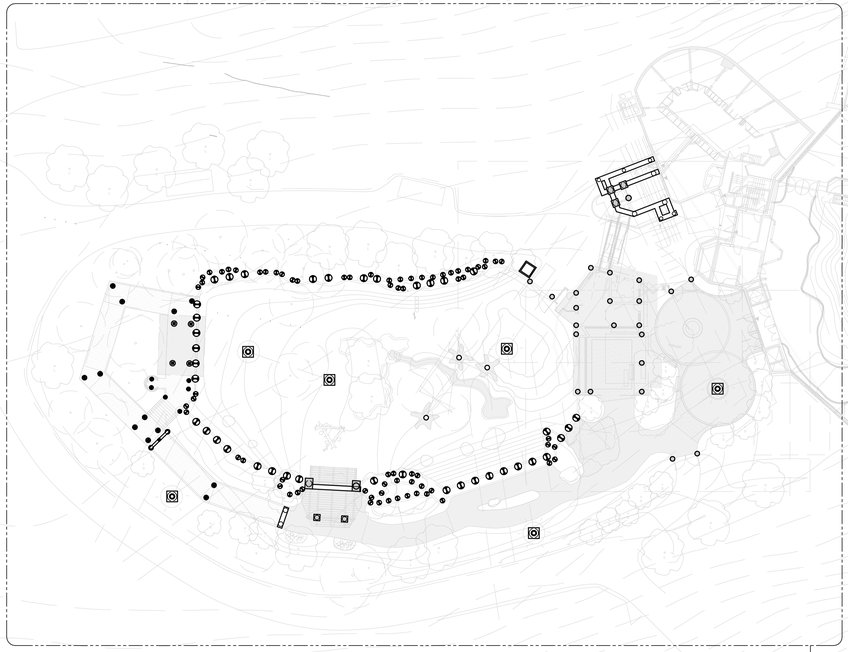
DRAWING NUMBER:
S-112



HABITAT 1

1
S-200A

HABITAT 2

1
S-200B

OVERALL FOUNDATION PLAN
1 : 375

NO.	REV.	ISSUED FOR	DATE
1	1	100% DD	2019-10-02
2	2	PROGRESS	2019-10-17
3	3	60% CD	2019-10-25
4	4	100% CD	2019-11-12
5	5	ISSUED FOR PERMIT	2019-11-14
6	6	ISSUED FOR TENDER REVIEW	2019-12-06
7	7	ISSUED FOR TENDER	2019-12-11

N

STAMP

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CLIENT:
TORONTO ZOO
toronto zoo
361A Old Finch Ave, Toronto ON M1B 5K7 · 416-392-5929

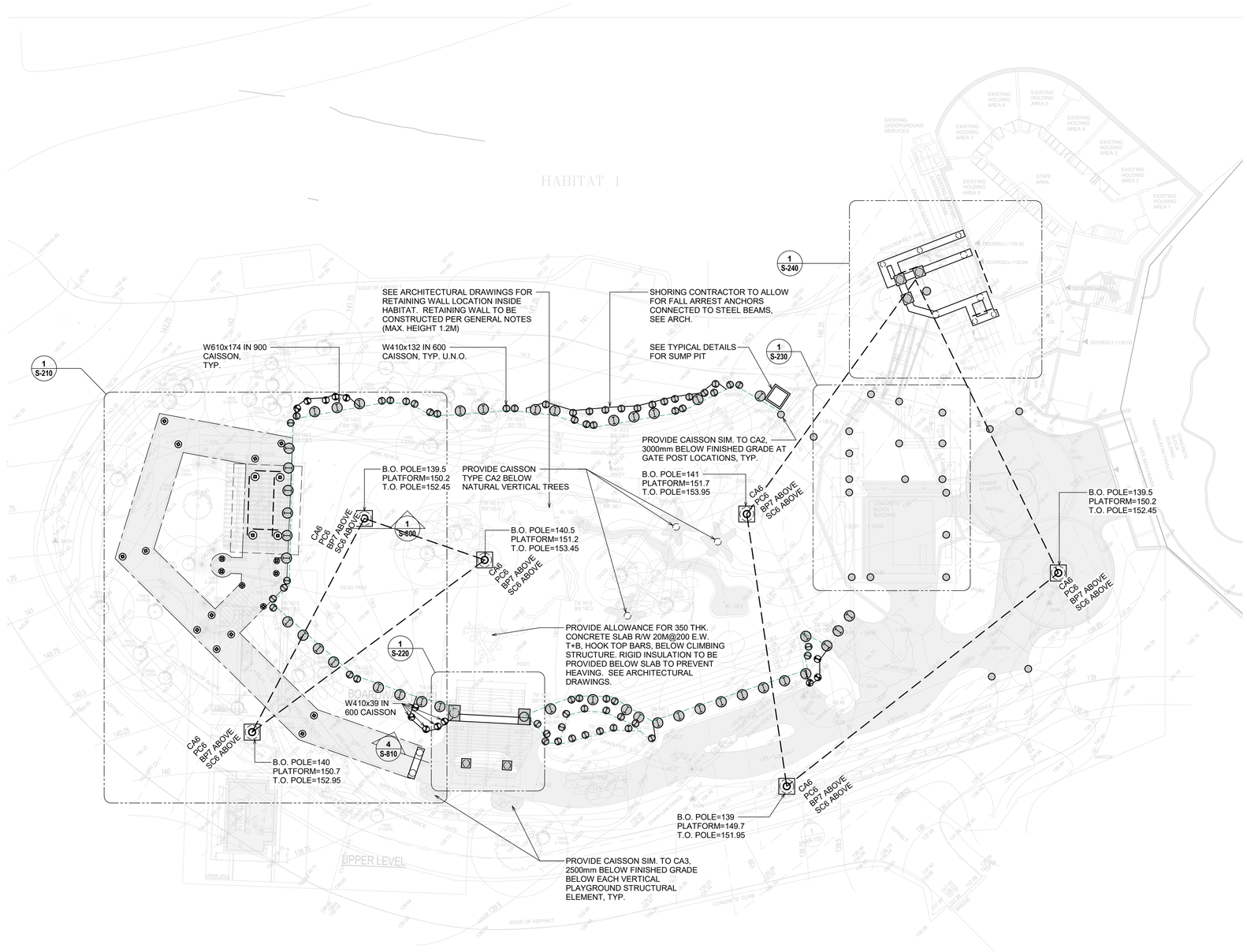
PROJECT:

DRAWING NAME:
OVERALL FOUNDATION PLAN

PROJECT NO:	DRAWN BY:	CHECKED BY:
TOR.113946.0011	JP	NB

Scale: 1 : 375

DRAWING NUMBER:
S-200



FOUNDATION PLAN - HABITAT 1

1 : 200

Notes:

1. CAISSON EMBEDMENT DEPTHS BELOW FINISHED GRADE ARE SHOWN ON SCHEDULE, SEE S-300 SERIES
2. CAISSON HAVE BEEN DESIGNED ASSUMING SKIN FRICTION CAPACITY OF 60KPA (SLS), NEGLECTING THE TOP 1.2M OF SHAFT DEPTH BELOW FINISHED GRADE. WHERE A PILE CAP IS USED ATOP THE CAISSON, THE 1.2M OF NEGLECTED SHAFT DEPTH INCLUDES THE DEPTH OF THE CAP AND IS NOT IN ADDITION TO IT.
3. CAISSON EMBEDMENT DEPTHS TO BE VERIFIED BY GEOTECHNICAL ENGINEER ON SITE AND MAY HAVE TO BE ADJUSTED TO SUIT DESIGN REQUIREMENTS.
4. CENTER ALL CAPS, PIERS, CAISSONS AND FOOTINGS UNDER COLUMNS EXCEPT WHERE NOTED OTHERWISE ON PLAN.
5. REFER TO THE FOLLOWING DRAWINGS:
   a. GENERAL NOTES – S-100 SERIES
   b. SCHEDULES – S-300 SERIES
   c. FOUNDATION PLAN – SHORING – S200C

NO.	REV.	ISSUED FOR	DATE
1	1	100% DD	2019-10-02
2	2	PROGRESS	2019-10-17
3	3	60% CD	2019-10-25
4	4	100% CD	2019-11-12
5	5	ISSUED FOR PERMIT	2019-11-14
6	6	ISSUED FOR TENDER REVIEW	2019-12-06
7	7	ISSUED FOR TENDER	2019-12-11

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PROJECT:

DRAWING NAME:

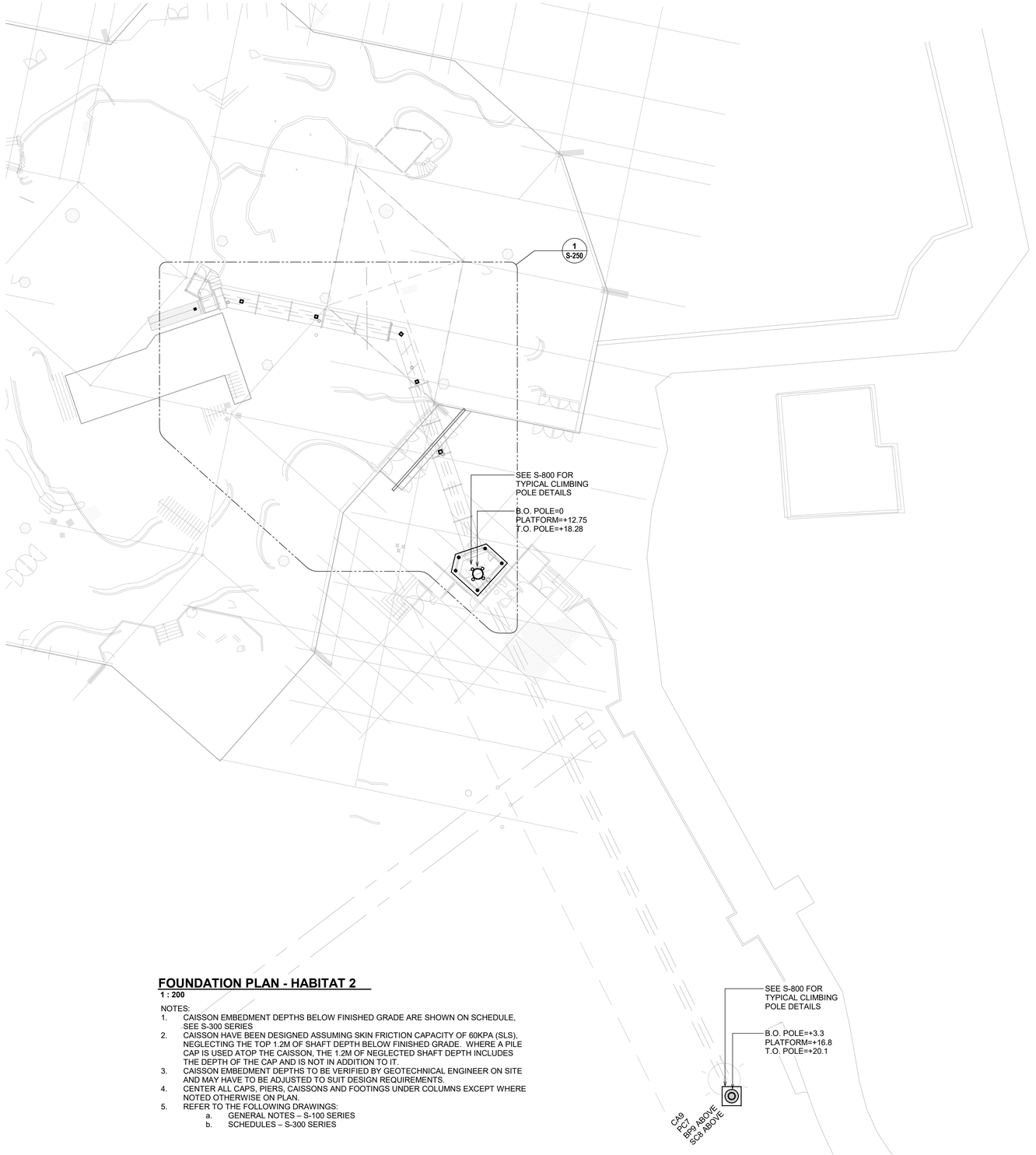
FOUNDATION PLAN - HABITAT 1

PROJECT NO:	DRAWN BY:	CHECKED BY:
TOR.113946.0011	JP	NB

Scale: 1 : 200

DRAWING NUMBER:

S-200A



FOUNDATION PLAN - HABITAT 2

1 : 200

NOTES:

1. CAISSON EMBEDMENT DEPTHS BELOW FINISHED GRADE ARE SHOWN ON SCHEDULE, SEE S-300 SERIES
2. CAISSON HAVE BEEN DESIGNED ASSUMING SKIN FRICTION CAPACITY OF 60KPA (SLS), NEGLECTING THE TOP 1.2M OF SHAFT DEPTH BELOW FINISHED GRADE. WHERE A PILE CAP IS USED ATOP THE CAISSON, THE 1.2M OF NEGLECTED SHAFT DEPTH INCLUDES THE DEPTH OF THE CAP AND IS NOT IN ADDITION TO IT.
3. CAISSON EMBEDMENT DEPTHS TO BE VERIFIED BY GEOTECHNICAL ENGINEER ON SITE AND MAY HAVE TO BE ADJUSTED TO SUIT DESIGN REQUIREMENTS.
4. CENTER ALL CAPS, PIERS, CAISSONS AND FOOTINGS UNDER COLUMNS EXCEPT WHERE NOTED OTHERWISE ON PLAN.
5. REFER TO THE FOLLOWING DRAWINGS:
   a. GENERAL NOTES – S-100 SERIES
   b. SCHEDULES – S-300 SERIES

NO.	REV.	ISSUED FOR	DATE
1	1	100% DD	2019-10-02
2	2	PROGRESS	2019-10-17
3	3	60% CD	2019-10-25
4	4	100% CD	2019-11-12
5	5	ISSUED FOR PERMIT	2019-11-14
6	6	ISSUED FOR TENDER REVIEW	2019-12-06
7	7	ISSUED FOR TENDER	2019-12-11

N

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PROJECT:

DRAWING NAME:

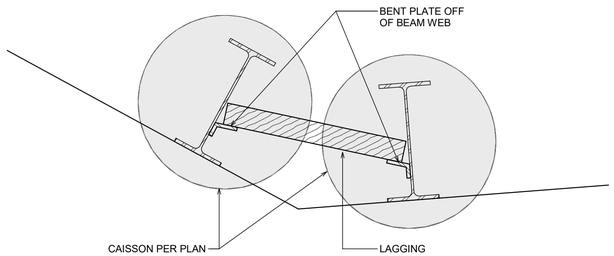
FOUNDATION PLAN - HABITAT 2

PROJECT NO:	DRAWN BY:	CHECKED BY:
TOR.113946.0011	JP	NB

Scale: 1 : 200

DRAWING NUMBER:

S-200B



2
S-200C 1 : 10

FOUNDATION PLAN - SHORING

1 : 100

NOTES:

1. SOLDIER PILE SHORING SCHEME IS SHOWN FOR CONCEPT AND INTENDED TO BE USED FOR COSTING PURPOSES ONLY.
2. FINAL SHORING DESIGN IS TO BE COMPLETED BY THE SHORING CONTRACTOR.
3. DESIGN ASSUMPTIONS ARE AS FOLLOWS:
   a. ACTIVE LATERAL EARTH PRESSURE COEFFICIENT, KA=0.4
   b. AT REST LATERAL EARTH PRESSURE COEFFICIENT, KO=0.5
   c. PASSIVE LATERAL EARTH PRESSURE COEFFICIENT, KP=2.86
   d. BULK UNIT WEIGHT OF BACKFILL, Γ=21.5 KN/M³
1. REFER TO GEOTECHNICAL REPORT, NOTED IN GENERAL NOTES, FOR ADDITIONAL INFORMATION REQUIRED FOR DESIGN.
2. REFER TO THE FOLLOWING DRAWINGS:
   a. GENERAL NOTES – S-100 SERIES
   b. FOUNDATION SHORING SECTIONS AND DETAILS – S700 SERIES

NO.	REV.	ISSUED FOR	DATE
1	4	100% CD	2019-11-12
2	5	ISSUED FOR PERMIT	2019-11-14
3	6	ISSUED FOR TENDER REVIEW	2019-12-06
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PROJECT:

DRAWING NAME:

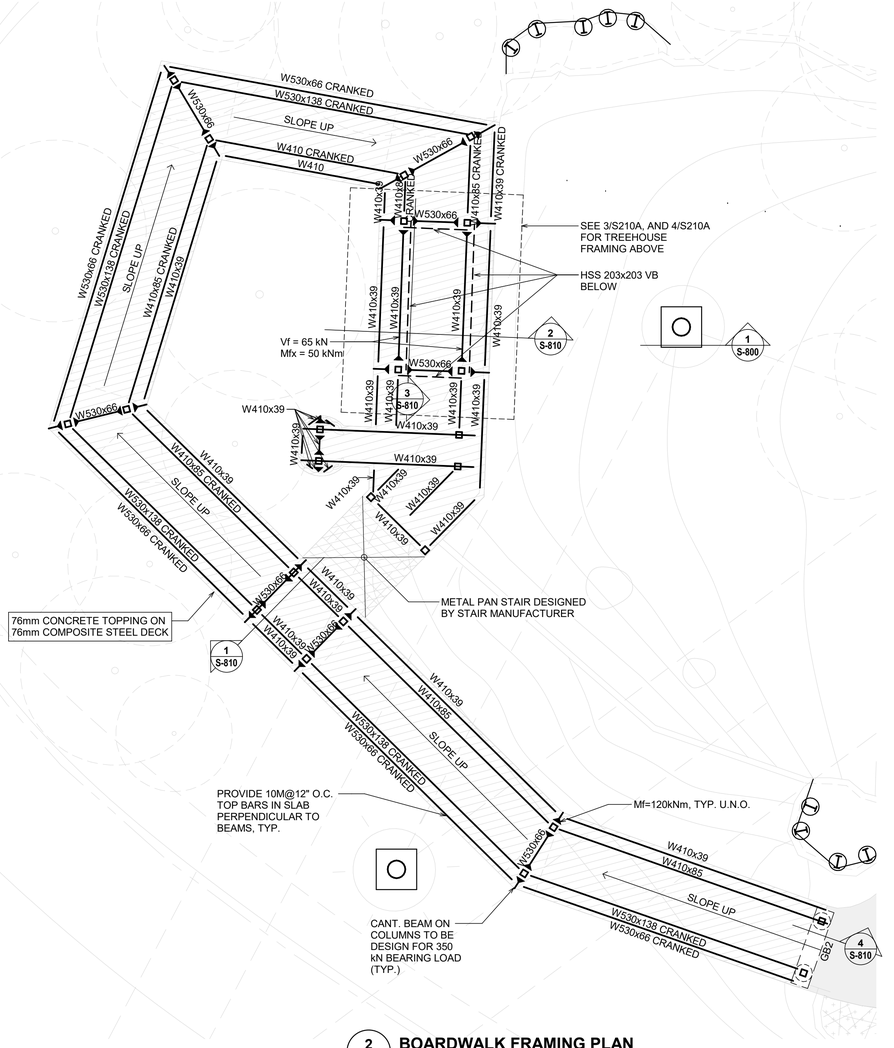
FOUNDATION PLAN - SHORING

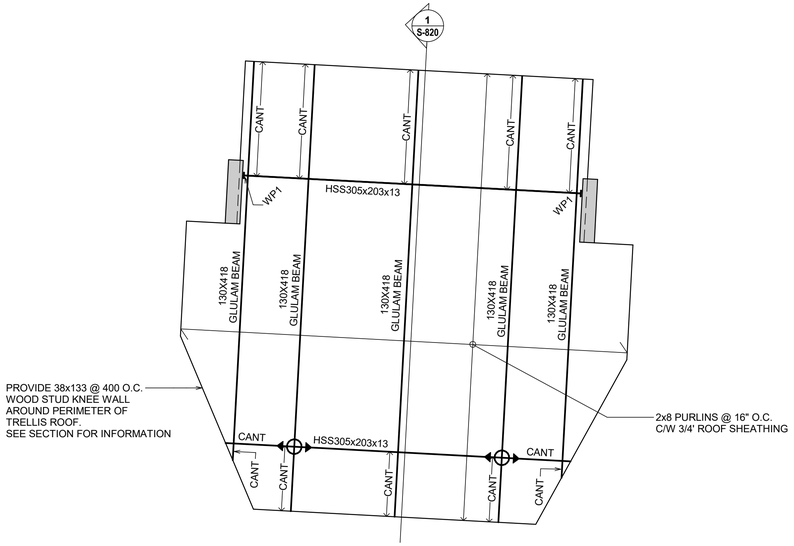
PROJECT NO:	DRAWN BY:	CHECKED BY:
TOR.113946.0011	JP	NB

Scale: As indicated

DRAWING NUMBER:

S-200C


W530x66 CRANKED
W530x138 CRANKED
SLOPE UP
W410 CRANKED
W410
W530x66
W530x66 CRANKED
W530x138 CRANKED
SLOPE UP
W410x85 CRANKED
W410x39
W410x85 CRANKED
W410x39 CRANKED
W530x66
SEE 3/S210A, AND 4/S210A FOR TREEHOUSE FRAMING ABOVE
HSS 203x203 VB BELOW
Vf = 65 kN
Mfx = 50 kNm
W530x66
W410x39
W530x66
W410x39
W410x39
W410x39

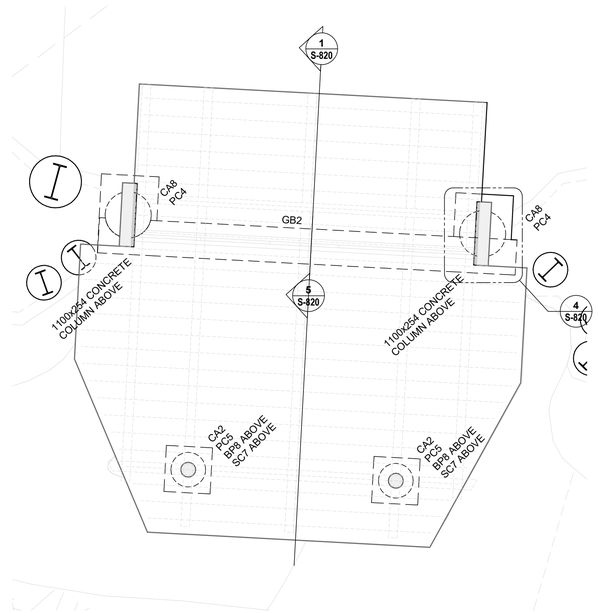


2 S-220 TRELLIS ROOF FRAMING PLAN

1 : 50

NOTES:

1. SEE ARCHITECTURAL DRAWINGS FOR TOP OF ROOF ELEVATIONS, SLOPES, DIMENSIONS, CURBS, AND SLAB EDGES.
2. SEE S820 SERIES FOR SECTIONS TO BE USED IN CONJUNCTION WITH ARCHITECTURAL DRAWINGS TO DETERMINE TOP OF STRUCTURAL FRAMING ELEVATIONS.
3. DESIGN LIVE LOADS ARE AS FOLLOWS UNLESS CROSSED AND NOTED ON PLAN:
   a. SNOW LOAD 1.3KPA
   b. GREEN ROOF 1.3KPA
4. DESIGN SUPERIMPOSED DEAD LOADS ARE AS FOLLOWS UNLESS CROSSED AND NOTED ON PLAN:
   a. ROOF FINISHES 0.5KPA
   b. CEILING/SERVICES 0.6KPA
5. DESIGN STEEL BEAM CONNECTIONS FOR FORCES SHOWN ON PLAN. WHERE NO FORCE IS INDICATED, DESIGN CONNECTIONS FOR VF =150KN.
6. SEE GENERAL NOTES FOR WOOD FRAMING INFORMATION.
7. ALL STRUCTURAL STEEL OUTSIDE OF THE BUILDING ENVELOPE TO BE HOT DIPPED GALVANIZED UNLESS NOTED OTHERWISE.
8. GENERAL CONTRACTOR TO VERIFY SITE CONDITIONS AND DIMENSIONS PRIOR TO COMMENCEMENT OF WORK.
9. REFER TO THE FOLLOWING DRAWINGS:
   a. GENERAL NOTES – S-100 SERIES
   b. SCHEDULES – S-300 SERIES
   c. TRELLIS SECTIONS AND DETAILS – S-820 SERIES



1 S-220 TRELLIS FOUNDATION PLAN

1 : 50

NOTES:

1. CAISSON EMBEDMENT DEPTHS BELOW FINISHED GRADE ARE SHOWN ON SCHEDULE, SEE S-300 SERIES
2. CAISSON HAVE BEEN DESIGNED ASSUMING SKIN FRICTION CAPACITY OF 60KPA (SLS), NEGLECTING THE TOP 1.2M OF SHAFT DEPTH BELOW FINISHED GRADE. WHERE A PILE CAP IS USED ATOP THE CAISSON, THE 1.2M OF NEGLECTED SHAFT DEPTH INCLUDES THE DEPTH OF THE CAP AND IS NOT IN ADDITION TO IT.
3. CAISSON EMBEDMENT DEPTHS TO BE VERIFIED BY GEOTECHNICAL ENGINEER ON SITE AND MAY HAVE TO BE ADJUSTED TO SUIT DESIGN REQUIREMENTS.
4. CENTER ALL CAPS, PIERS, CAISSONS AND FOOTINGS UNDER COLUMNS EXCEPT WHERE NOTED OTHERWISE ON PLAN.
5. GENERAL CONTRACTOR TO VERIFY SITE CONDITIONS AND DIMENSIONS PRIOR TO COMMENCEMENT OF WORK.
6. REFER TO THE FOLLOWING DRAWINGS:
   a. GENERAL NOTES – S-100 SERIES
   b. SCHEDULES – S-300 SERIES
   c. TRELLIS SECTIONS AND DETAILS – S-820 SERIES

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1	1	100% DD	2019-10-02
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CLIENT:

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toronto zoo
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PROJECT:

DRAWING NAME:

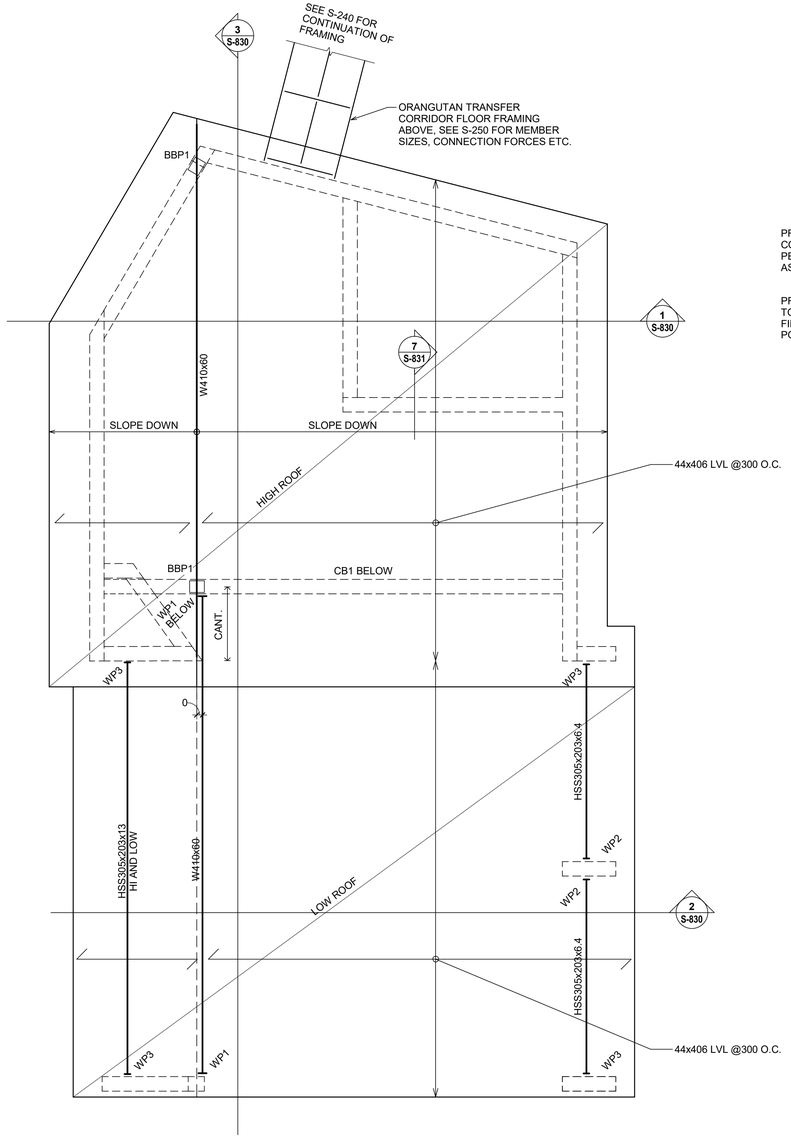
TRELLIS FRAMING PLANS

PROJECT NO:	DRAWN BY:	CHECKED BY:
TOR.113946.0011	JP	NB

Scale: 1 : 50

DRAWING NUMBER:

S-220

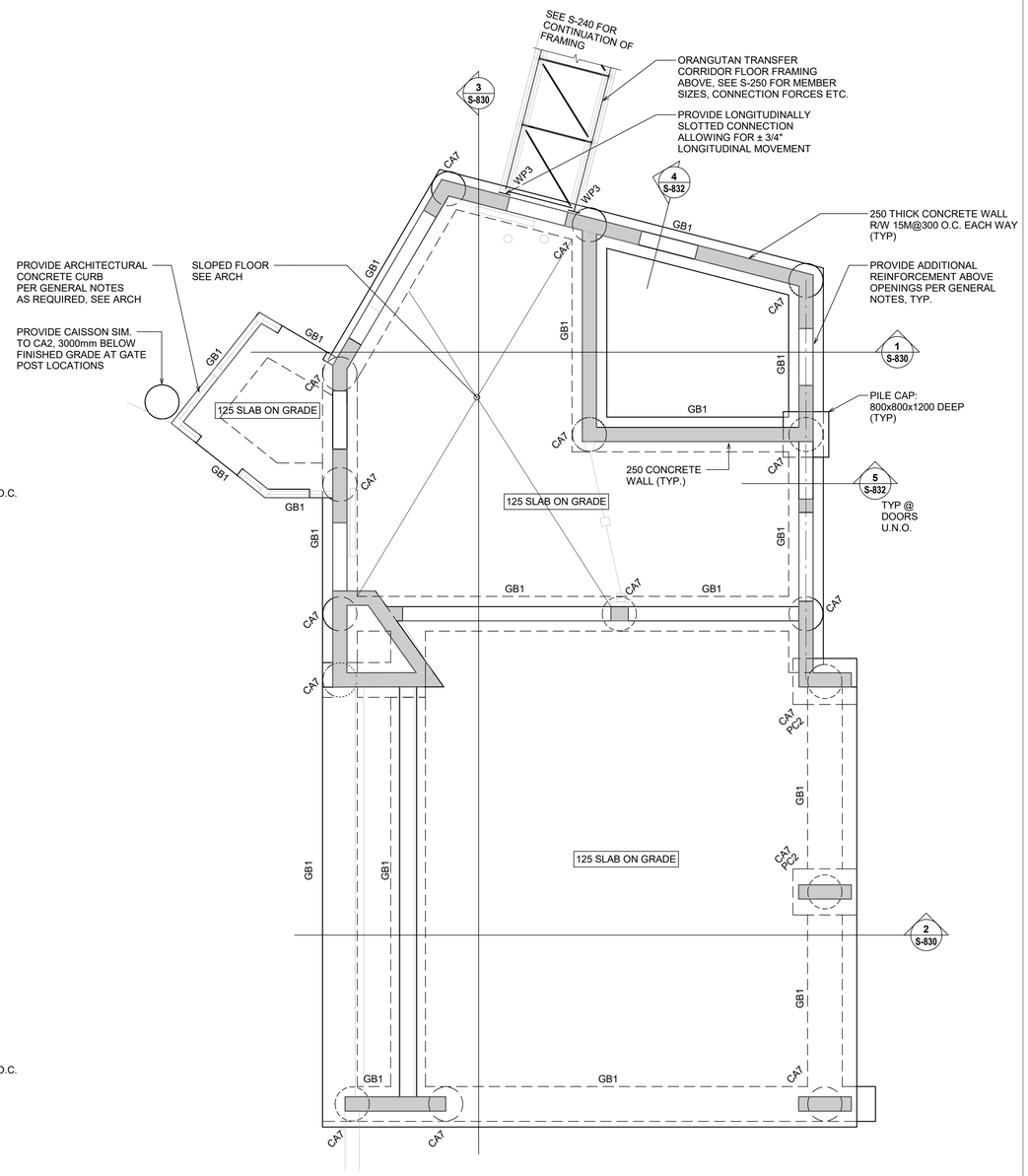


2 S-230 RESEARCH CENTRE FOUNDATION AND TRANSFER CORRIDOR ROOF FRAMING PLAN

1 : 50

NOTES:

1. SEE ARCHITECTURAL DRAWINGS FOR TOP OF ROOF ELEVATIONS, SLOPES, DIMENSIONS, CURBS, AND SLAB EDGES.
2. SEE S830 SERIES FOR SECTIONS TO BE USED IN CONJUNCTION WITH ARCHITECTURAL DRAWINGS TO DETERMINE TOP OF STRUCTURAL FRAMING ELEVATIONS.
3. DESIGN LIVE LOADS ARE AS FOLLOWS UNLESS CROSSED AND NOTED ON PLAN:
   a. SNOW LOAD 1.3KPA
4. DESIGN SUPERIMPOSED DEAD LOADS ARE AS FOLLOWS UNLESS CROSSED AND NOTED ON PLAN:
   RESEARCH CENTRE
   a. ROOF FINISHES 0.5KPA
   b. CEILING/SERVICES 0.6KPA
   TRANSFER CORRIDOR
   a. FINISHES 0.3KPA
5. SEE GENERAL NOTES FOR WOOD FRAMING INFORMATION.
6. GENERAL CONTRACTOR TO VERIFY SITE CONDITIONS AND DIMENSIONS PRIOR TO COMMENCEMENT OF WORK.
7. REFER TO THE FOLLOWING DRAWINGS:
   a. GENERAL NOTES – S-100 SERIES
   b. SCHEDULES – S-300 SERIES
   c. RESEARCH CENTRE SECTIONS AND DETAILS – S-830 SERIES



1 S-230 RESEARCH CENTRE FOUNDATION AND TRANSFER CORRIDOR FLOOR FRAMING PLAN

1 : 50

NOTES:

1. SEE ARCHITECTURAL DRAWINGS FOR TOP OF SLAB ELEVATIONS, SLOPES, DIMENSIONS, CURBS, AND SLAB EDGES
2. DESIGN LIVE LOADS ARE AS FOLLOWS UNLESS CROSSED AND NOTED ON PLAN:
   RESEARCH CENTRE
   a. LIVE LOAD 4.8KPA
   TRANSFER CORRIDOR
   a. LIVE LOAD 1.0KPA
3. DESIGN SUPERIMPOSED DEAD LOADS AS FOLLOWS UNLESS CROSSED AND NOTED ON PLAN:
   TRANSFER CORRIDOR
   a. FINISHES 0.3KPA
4. SLAB ON GRADE TO BE REINFORCED IN ACCORDANCE WITH GENERAL NOTES.
5. CAISSON EMBEDMENT DEPTHS BELOW FINISHED GRADE ARE SHOWN ON SCHEDULE, SEE S-300 SERIES
6. CAISSON HAVE BEEN DESIGNED ASSUMING SKIN FRICTION CAPACITY OF 60KPA (SLS), NEGLECTING THE TOP 1.2M OF SHAFT DEPTH BELOW FINISHED GRADE. WHERE A PILE CAP IS USED ATOP THE CAISSON, THE 1.2M OF NEGLECTED SHAFT DEPTH INCLUDES THE DEPTH OF THE CAP AND IS NOT IN ADDITION TO IT.
7. CAISSON EMBEDMENT DEPTHS TO BE VERIFIED BY GEOTECHNICAL ENGINEER ON SITE AND MAY HAVE TO BE ADJUSTED TO SUIT DESIGN REQUIREMENTS.
8. CENTER ALL CAPS, PIERS, CAISSONS AND FOOTINGS UNDER COLUMNS EXCEPT WHERE NOTED OTHERWISE ON PLAN.
9. GENERAL CONTRACTOR TO VERIFY SITE CONDITIONS AND DIMENSIONS PRIOR TO COMMENCEMENT OF WORK.
10. REFER TO THE FOLLOWING DRAWINGS:
    a. GENERAL NOTES – S-100 SERIES
    b. SCHEDULES – S-300 SERIES
    c. RESEARCH CENTRE SECTIONS AND DETAILS – S-830 SERIES

NO.	REV.	ISSUED FOR	DATE
1	2	PROGRESS	2019-10-17
2	3	60% CD	2019-10-25
3	4	100% CD	2019-11-12
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6	7	ISSUED FOR TENDER	2019-12-11

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PROJECT:

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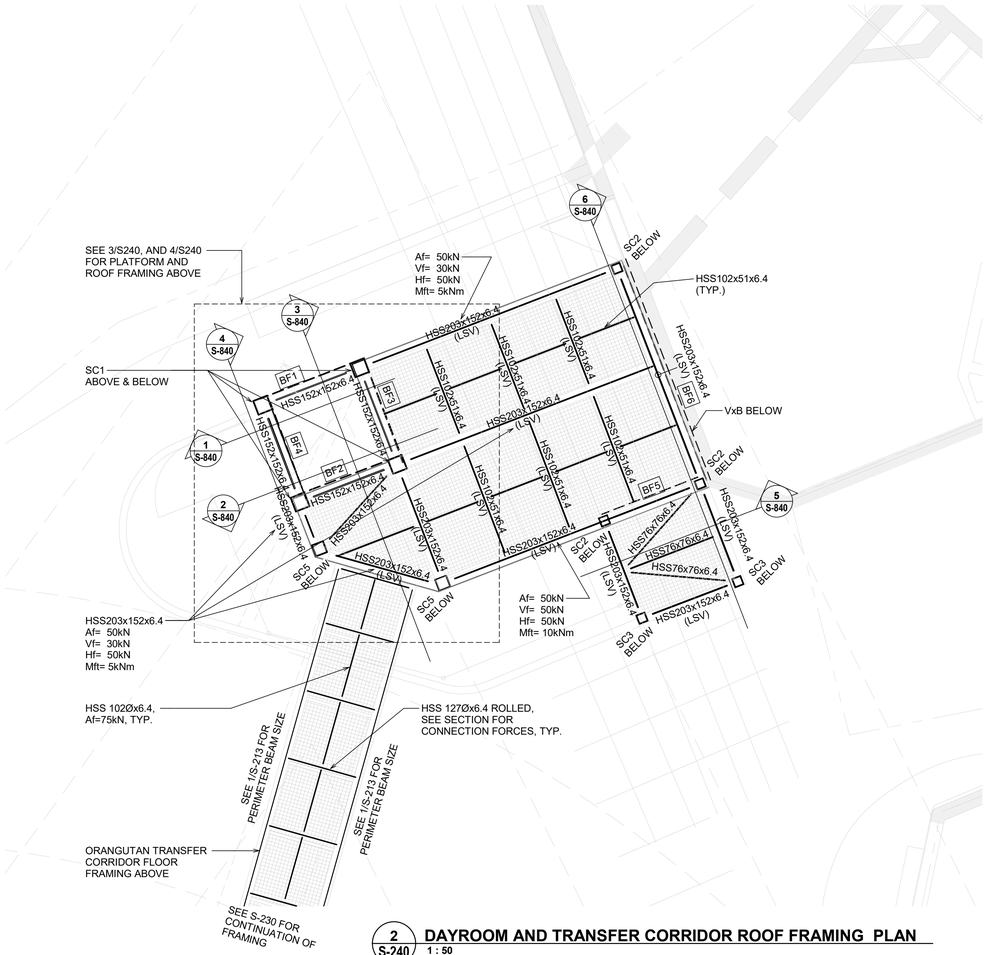
RESEARCH CENTRE FRAMING PLANS - HABITAT 1

PROJECT NO:	DRAWN BY:	CHECKED BY:
TOR.113946.0011	JP	NB

Scale: 1 : 50

DRAWING NUMBER:
S-230

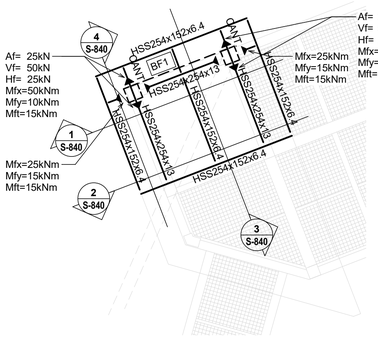


2 S-240 DAYROOM AND TRANSFER CORRIDOR ROOF FRAMING PLAN

1 : 50

NOTES:
1. ALL FRAMING CONNECTIONS TO BE DESIGNED FOR Af=25kN, Vf=50kN, Hf=25kN, Mtf=10kNm IN ADDITION TO Mfx AND Mfy SHOWN ON THE DRAWINGS U.N.O.

NOTES:
1. SEE ARCHITECTURAL DRAWINGS FOR TOP OF ROOF ELEVATIONS, SLOPES, DIMENSIONS, CURBS, AND SLAB EDGES.
2. SEE S840 SERIES FOR SECTIONS TO BE USED IN CONJUNCTION WITH ARCHITECTURAL DRAWINGS TO DETERMINE TOP OF STRUCTURAL FRAMING ELEVATIONS.
3. DESIGN LIVE LOADS ARE AS FOLLOWS UNLESS CROSSED AND NOTED ON PLAN:
   a. SNOW LOAD 1.3KPA
4. DESIGN SUPERIMPOSED DEAD LOADS ARE AS FOLLOWS UNLESS CROSSED AND NOTED ON PLAN:
   RESEARCH CENTRE
   a. ROOF FINISHES 0.5KPA
   b. CEILING/SERVICES 0.6KPA
   TRANSFER CORRIDOR
   a. FINISHES 0.3KPA
5. GENERAL CONTRACTOR TO VERIFY SITE CONDITIONS AND DIMENSIONS PRIOR TO COMMENCEMENT OF WORK.
6. REFER TO THE FOLLOWING DRAWINGS:
   a. GENERAL NOTES – S-100 SERIES
   b. SCHEDULES – S-300 SERIES
   c. RESEARCH CENTRE SECTIONS AND DETAILS – S-840 SERIES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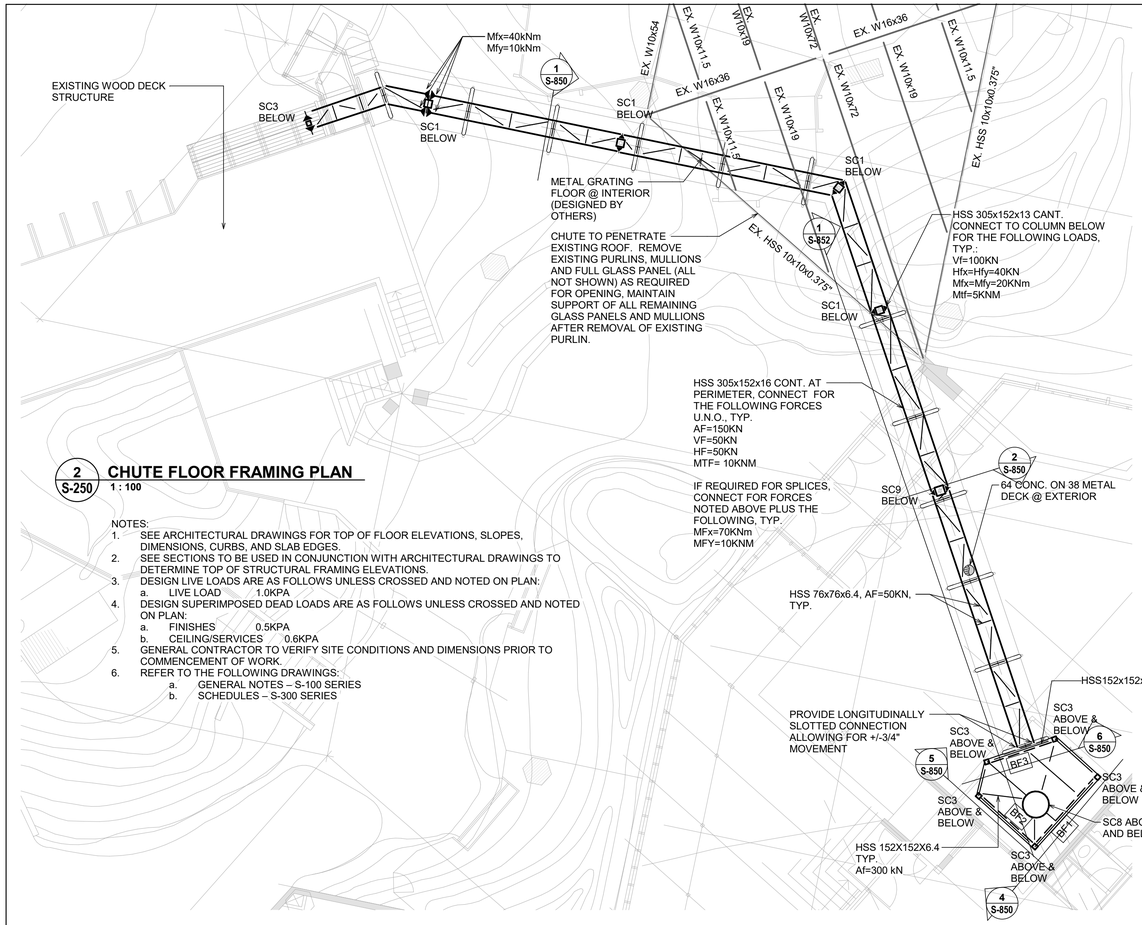
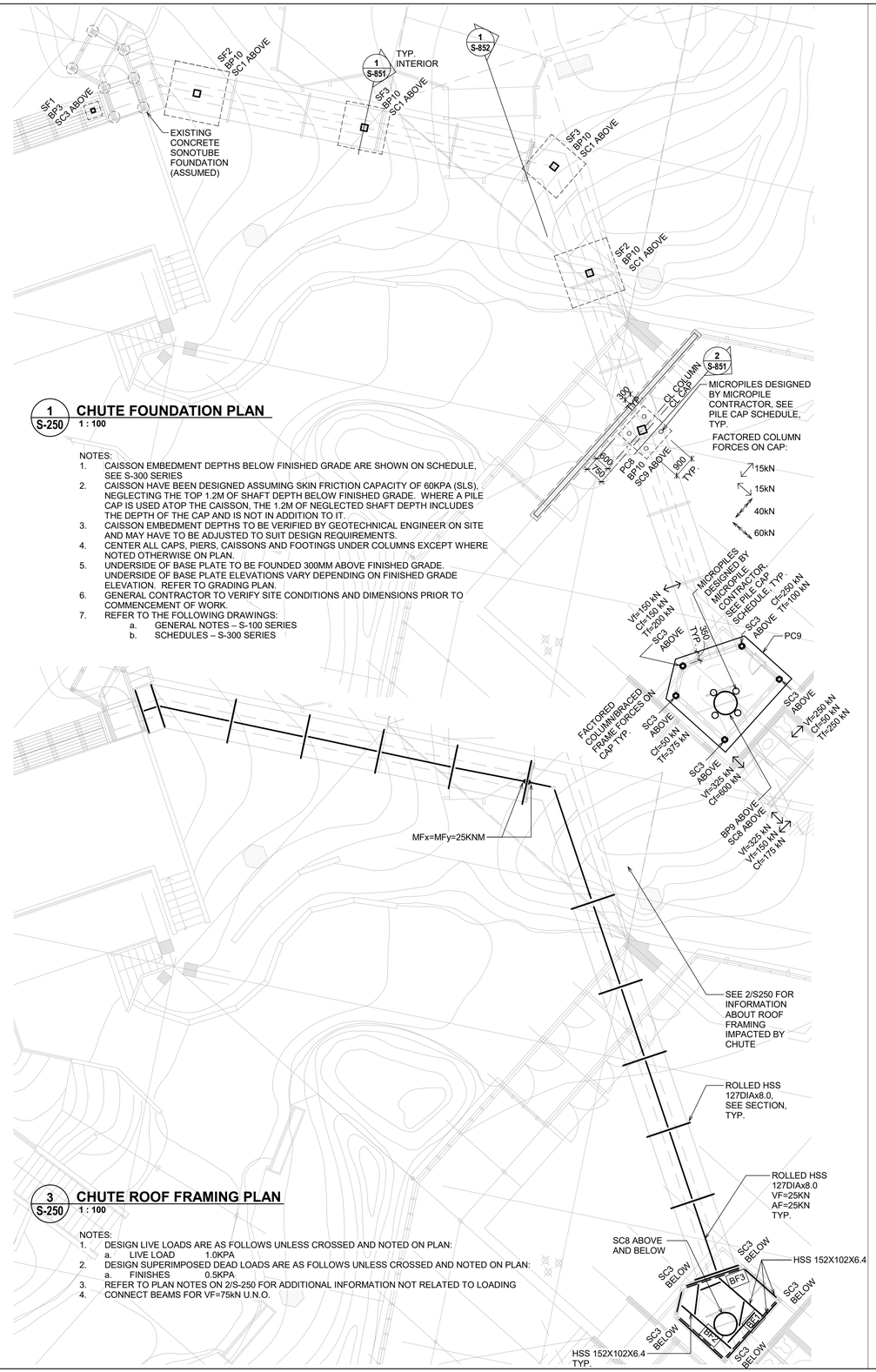


2 S-250 CHUTE FLOOR FRAMING PLAN

1 : 100

NOTES:
1. SEE ARCHITECTURAL DRAWINGS FOR TOP OF FLOOR ELEVATIONS, SLOPES, DIMENSIONS, CURBS, AND SLAB EDGES.
2. SEE SECTIONS TO BE USED IN CONJUNCTION WITH ARCHITECTURAL DRAWINGS TO DETERMINE TOP OF STRUCTURAL FRAMING ELEVATIONS.
3. DESIGN LIVE LOADS ARE AS FOLLOWS UNLESS CROSSED AND NOTED ON PLAN:
   a. LIVE LOAD 1.0KPA
4. DESIGN SUPERIMPOSED DEAD LOADS ARE AS FOLLOWS UNLESS CROSSED AND NOTED ON PLAN:
   a. FINISHES 0.5KPA
   b. CEILING/SERVICES 0.6KPA
5. GENERAL CONTRACTOR TO VERIFY SITE CONDITIONS AND DIMENSIONS PRIOR TO COMMENCEMENT OF WORK.
6. REFER TO THE FOLLOWING DRAWINGS:
   a. GENERAL NOTES – S-100 SERIES
   b. SCHEDULES – S-300 SERIES



1 S-250 CHUTE FOUNDATION PLAN

1 : 100

NOTES:
1. CAISSON EMBEDMENT DEPTHS BELOW FINISHED GRADE ARE SHOWN ON SCHEDULE, SEE S-300 SERIES
2. CAISSON HAVE BEEN DESIGNED ASSUMING SKIN FRICTION CAPACITY OF 60KPA (SLS), NEGLECTING THE TOP 1.2M OF SHAFT DEPTH BELOW FINISHED GRADE. WHERE A PILE CAP IS USED ATOP THE CAISSON, THE 1.2M OF NEGLECTED SHAFT DEPTH INCLUDES THE DEPTH OF THE CAP AND IS NOT IN ADDITION TO IT.
3. CAISSON EMBEDMENT DEPTHS TO BE VERIFIED BY GEOTECHNICAL ENGINEER ON SITE AND MAY HAVE TO BE ADJUSTED TO SUIT DESIGN REQUIREMENTS.
4. CENTER ALL CAPS, PIERS, CAISSONS AND FOOTINGS UNDER COLUMNS EXCEPT WHERE NOTED OTHERWISE ON PLAN.
5. UNDERSIDE OF BASE PLATE TO BE FOUNDED 300MM ABOVE FINISHED GRADE. UNDERSIDE OF BASE PLATE ELEVATIONS VARY DEPENDING ON FINISHED GRADE ELEVATION. REFER TO GRADING PLAN.
6. GENERAL CONTRACTOR TO VERIFY SITE CONDITIONS AND DIMENSIONS PRIOR TO COMMENCEMENT OF WORK.
7. REFER TO THE FOLLOWING DRAWINGS:
   a. GENERAL NOTES – S-100 SERIES
   b. SCHEDULES – S-300 SERIES

3 S-250 CHUTE ROOF FRAMING PLAN

1 : 100

NOTES:
1. DESIGN LIVE LOADS ARE AS FOLLOWS UNLESS CROSSED AND NOTED ON PLAN:
   a. LIVE LOAD 1.0KPA
2. DESIGN SUPERIMPOSED DEAD LOADS ARE AS FOLLOWS UNLESS CROSSED AND NOTED ON PLAN:
   a. FINISHES 0.5KPA
3. REFER TO PLAN NOTES ON 2/S-250 FOR ADDITIONAL INFORMATION NOT RELATED TO LOADING
4. CONNECT BEAMS FOR VF=75kN U.N.O.

NO.	REV.	ISSUED FOR	DATE
1	4	100% CD	2019-11-12
2	5	ISSUED FOR PERMIT	2019-11-14
3	6	ISSUED FOR TENDER REVIEW	2019-12-06
4	7	ISSUED FOR TENDER	2019-12-11

N

STAMP

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CLIENT: TORONTO ZOO
361A Old Finch Ave, Toronto ON M1B 5K7 · 416-392-5929

PROJECT:

DRAWING NAME:
PARTIAL FLOOR FRAMING PLAN
- HABITAT 2

PROJECT NO:	DRAWN BY:	CHECKED BY:
TOR.113946.0011	JP	NB

Scale: 1 : 100

DRAWING NUMBER:
S-250

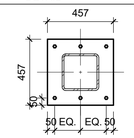
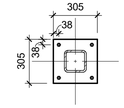
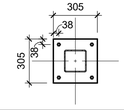
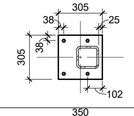
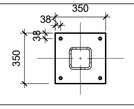
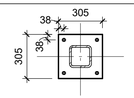
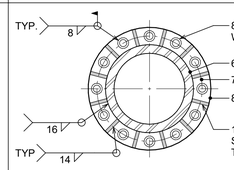
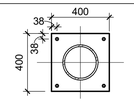
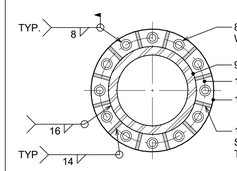
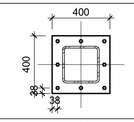
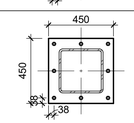
STEEL COLUMN SCHEDULE

MARK	SIZE (mm)	REMARKS
SC1	HSS 254x254x13	
SC2	HSS 152x152x13	
SC3	HSS 152x152x6.4	
SC4	HSS 203x203x6.4	
SC5	HSS 203x203x13	
SC6	HSS 610Øx59.5	ASTM A53 GRADE B
SC7	HSS 245Øx13	
SC8	HSS 915Øx25	ASTM A53 GRADE B
SC9	HSS 305x305x13	

SPREAD FOOTING SCHEDULE

MARK	SIZE (mm)	REINFORCING
SF1	600x600x300	4-15M B.E.W. H2E
SF2	2200x2200x1200	12-25M T+B.E.W. H2E
SF3	1800x1800x900	8-25M T+B.E.W. H2E

BASE PLATE SCHEDULE

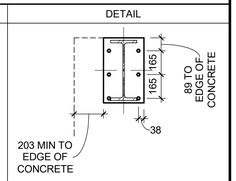
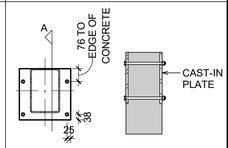
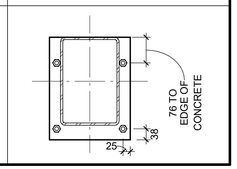
MARK	SIZE (mm)	ANCHORS	DETAIL
BP1	457x457x28 THICK	(6) 25mmØ ASTM F1554 GR. 55 915mm EMBEDMENT C/W DOUBLE NUT AND WASHER	
BP2	305x305x19 THICK	(4) 19mmØ ASTM F1554 GR. 55 915mm EMBEDMENT C/W DOUBLE NUT AND WASHER	
BP3	305x305x19 THICK	(4) 19mmØ ASTM F1554 GR. 55 406mm EMBEDMENT C/W DOUBLE NUT AND WASHER	
BP4	305x305x22 THICK	(4) 19mmØ ASTM F1554 GR. 55 915mm EMBEDMENT C/W DOUBLE NUT AND WASHER	
BP5	350x350x19 THICK	(4) 19mmØ ASTM F1554 GR. 55 915mm EMBEDMENT C/W DOUBLE NUT AND WASHER	
BP6	350x350x19 THICK	(4) 19mmØ ASTM F1554 GR. 55 915mm EMBEDMENT C/W DOUBLE NUT AND WASHER	
BP7	850Øx51 THICK (350 MPa)	(12) 38mmØ ASTM F1554 GR. 105, 915mm EMBEDMENT C/W 89mmØ x19mm THICK WELDED WASHERS AND DOUBLE NUT AT TOP, 910mmØ x25mm THICK 350 MPa PLATE C/W DOUBLE NUT AT BASE SEE S-800 FOR SECTION	
BP8	400x400x19 THICK	(4) 19mmØ ASTM F1554 GR. 55 915mm EMBEDMENT C/W DOUBLE NUT AND WASHER	
BP9	1170Øx51 THICK (350 MPa)	(12) 38mmØ ASTM F1554 GR. 105, 915mm EMBEDMENT C/W 89mmØ x19mm THICK WELDED WASHERS AND DOUBLE NUT AT TOP, 910mmØ x25mm THICK 350 MPa PLATE C/W DOUBLE NUT AT BASE SEE S-800 FOR SECTION	
BP10	400x400x25 THICK	(8) 19mmØ ASTM F1554 GR. 55 600mm EMBEDMENT C/W DOUBLE NUT AND WASHER	
BP11	450x450x25 THICK	(8) 19mmØ ASTM F1554 GR. 55 600mm EMBEDMENT C/W DOUBLE NUT AND WASHER	

NOTES:
1. PLACE STEEL COLUMN / BASEPLATES ON 1" DRYPACK GROUT U.N.O.
2. NO REINFORCING STEEL WITHIN EXISTING STRUCTURE IS TO BE CUT OR DAMAGED.
3. ALL EXISTING CONCRETE ANCHORING SURFACES MUST BE SCANNED BY CONTRACTOR TO LOCATE EXISTING REINFORCING STEEL.
4. LOCATE BASE PLATE BOLT HOLES TO AVOID EMBEDDED REINFORCING STEEL PRIOR TO FABRICATION OF BASE PLATES.
5. BASE PLATE BOLT HOLES MAY BE RELOCATED MAX 15mm FROM POSITION SHOWN ON BASE PLATE DETAILS TO ACCOMMODATE SITE CONDITIONS.
6. WHERE BASEPLATE IS LOCATED ON CONCRETE WALL, ANCHORS SHALL BE LOCATED AT THE CENTERLINE OF THE WALL

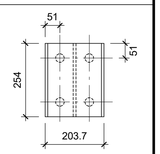
CAISSON SCHEDULE

MARK	SIZE (mm)	REINFORCING	DEPTH BELOW FINISH GRADE
CA1	700	12-25M VERT 10M TIES @ 300 (3) ADDITIONAL 10M TIES @ 150 AT TOP	9000
CA2	600	12-25M VERT 10M TIES @ 300 (3) ADDITIONAL 10M TIES @ 150 AT TOP	4600
CA3	450	8-15M VERT 10M TIES @ 300 (3) ADDITIONAL 10M TIES @ 150 AT TOP	4600
CA4	700	12-25M VERT 10M TIES @ 300 (3) ADDITIONAL 10M TIES @ 150 AT TOP	4600
CA5	500	10-20M VERT 10M TIES @ 300 (3) ADDITIONAL 10M TIES @ 150 AT TOP	3200
CA6	1200	18-30M VERT 10M TIES @ 300 (3) ADDITIONAL 10M TIES @ 100 AT TOP	9000
CA7	600	12-25M VERT 10M TIES @ 300 (3) ADDITIONAL 10M TIES @ 100 AT TOP	6200
CA8	800	12-25M VERT 10M TIES @ 300 (3) ADDITIONAL 10M TIES @ 100 AT TOP	4600
CA9	1500	26-30M VERT 10M TIES @ 300 (3) ADDITIONAL 10M TIES @ 100 AT TOP	7000

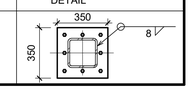
WALL PLATE SCHEDULE

MARK	SIZE (mm)	ANCHORS	DETAIL
WP1	450x280	19mm CAST-IN PLACE PLATE W/ (6) D1.1 GRADE B 19mm HEADED STUD WITH 150mm EMBEDMENT	
WP2	355x355	(2) 19mm CAST-IN PLACE PLATE WITH (4) 19mm THREADED RODS C/W NUTS AND WASHERS	
WP3	355x280	19mm CAST-IN PLACE PLATE WITH (4) D1.1 GRADE B 19mm HEADED STUD WITH 150mm EMBEDMENT	

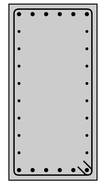
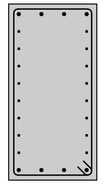
BEAM BEARING PLATE SCHEDULE

MARK	SIZE (mm)	ANCHORS	DETAIL
BBP1	254x203	19mm CAST-IN PLACE PLATE W/ (4) 19mmØ ASTM F1554 GR55 W/ 400mm EMBEDMENT AND 75 HOOK	

BASE PLATE SCHEDULE

MARK	SIZE (mm)	ANCHORS	DETAIL
BP12	350x350x25	(8) 25.4mmØ ASTM F1554 GR. 55 915mm EMBEDMENT C/W DOUBLE NUT AND WASHER	

GRADE BEAM SCHEDULE

MARK	SIZE (mm)	REINFORCING	DETAIL
GB1	610x1220	6-25M T+B 15M@300 CLOSED STIRRUPS 15M@150 FACE STEEL	
GB2	610x1220	4-25M T+B 15M@300 CLOSED STIRRUPS 15M@150 FACE STEEL	

PILE CAP SCHEDULE

MARK	SIZE (mm)	REINFORCING	REMARKS
PC1	900x900x1200	8-25M H2E. EW. T+B	WHERE PILE CAP IS ADJACENT TO A GRADE BEAM, CONTINUE LONGITUDINAL PILE CAP REINFORCEMENT INTO GARDE BEAM. PILE CAP LONGITUDINAL REINFORCEMENT NEED NOT BE HOOKED AT ENDS WHERE IT WILL CONTINUE INTO GARDE BEAM.
PC2	810x1120x1200	8-25M H2E T+B	WHERE PILE CAP IS ADJACENT TO A GRADE BEAM, CONTINUE LONGITUDINAL PILE CAP REINFORCEMENT INTO GARDE BEAM. PILE CAP LONGITUDINAL REINFORCEMENT NEED NOT BE HOOKED AT ENDS WHERE IT WILL CONTINUE INTO GARDE BEAM.
PC3	810x1975x1200	8-25M H2E T+B	WHERE PILE CAP IS ADJACENT TO A GRADE BEAM, CONTINUE LONGITUDINAL PILE CAP REINFORCEMENT INTO GARDE BEAM. PILE CAP LONGITUDINAL REINFORCEMENT NEED NOT BE HOOKED AT ENDS WHERE IT WILL CONTINUE INTO GARDE BEAM.
PC4	1370x1000x1200	8-25M H2E, EW, T+B LONG DIRECTION 6-25M H2E, EW, T+B SHORT DIRECTION	WHERE PILE CAP IS ADJACENT TO A GRADE BEAM, CONTINUE LONGITUDINAL PILE CAP REINFORCEMENT INTO GARDE BEAM. PILE CAP LONGITUDINAL REINFORCEMENT NEED NOT BE HOOKED AT ENDS WHERE IT WILL CONTINUE INTO GARDE BEAM.
PC5	800x800x1200	8-20M H2E, EW, T+B	
PC6	1400x1400x1200	8-25M H2E, EW, T+B	
PC7	1700x1700x1200	12-25M H2E, EW, T+B	
PC8	1500x1500	REINFORCING TO BE DESIGNED BY MICROPILE CONTRACTOR	MICROPILE CONTRACTOR TO DESIGN PILE CAP FOR FORCES NOTED ON PLAN. COORDINATE ANCHOR REINFORCEMENT WITH RJC
PC9	DIMENSION PER PLAN	REINFORCING TO BE DESIGNED BY MICROPILE CONTRACTOR	MICROPILE CONTRACTOR TO DESIGN PILE CAP FOR FORCES NOTED ON PLAN. COORDINATE ANCHOR REINFORCEMENT WITH RJC

NO.	REV.	ISSUED FOR	DATE
1	4	100% CD	2019-11-12
2	5	ISSUED FOR PERMIT	2019-11-14
3	6	ISSUED FOR TENDER REVIEW	2019-12-06
4	7	ISSUED FOR TENDER	2019-12-11

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t 416.596.8300 f 416.596-1408

CLIENT: TORONTO ZOO
toronto zoo
361A Old Finch Ave, Toronto ON M1B 5K7 · 416-392-5929

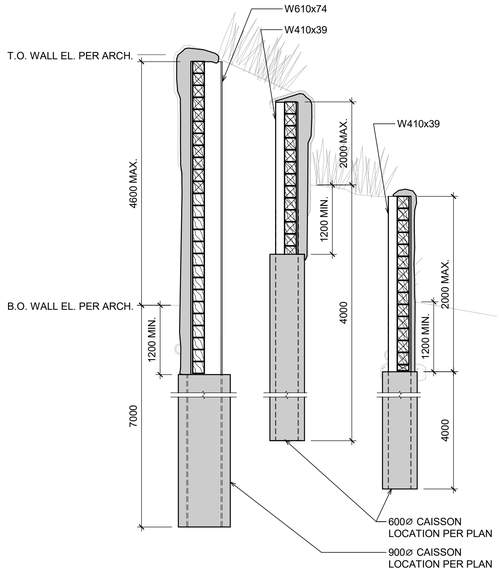
PROJECT:

DRAWING NAME:
SCHEDULES

PROJECT NO:	DRAWN BY:	CHECKED BY:
TOR.113946.0011	JP	NB

Scale: As indicated

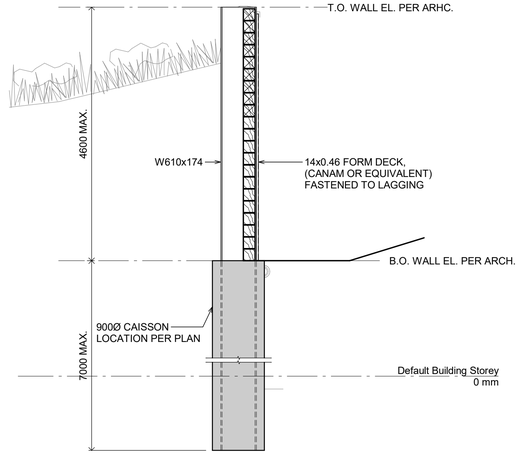
DRAWING NUMBER:
S-300



3 S-700 THREE LEVEL RETAINING WALL

1 : 50

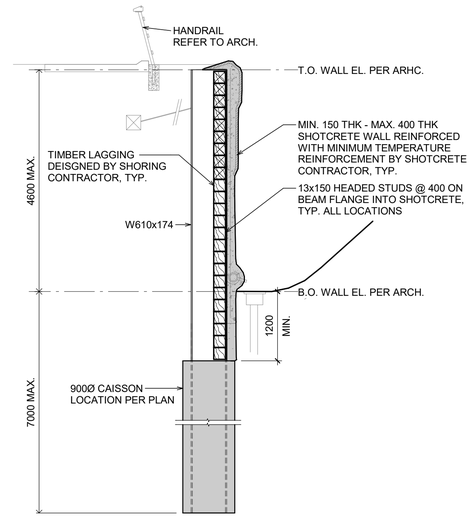
NOTES:
1. SEE 1/S700 FOR MISSING INFORMATION.
1. DETAILS SHOWN FOR CONCEPT AND PRICING ONLY. SHORING AND SHOTCRETE TO BE DESIGNED BY SHORING CONTRACTOR.



2 S-700 SHEET METAL WALL

1 : 50

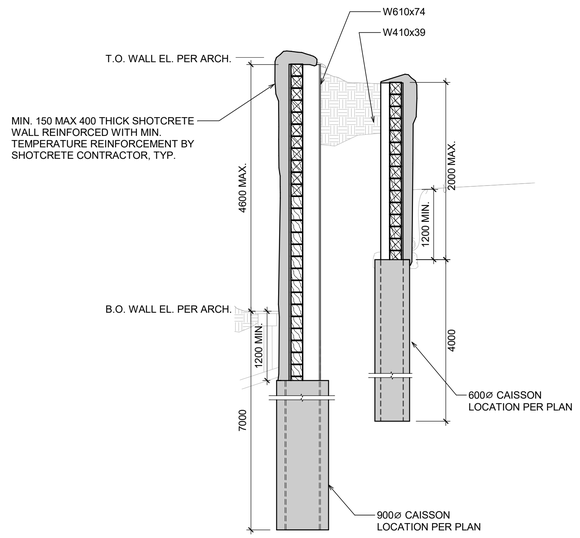
NOTES:
1. SEE 1/S700 FOR MISSING INFORMATION
2. DETAILS SHOWN FOR CONCEPT AND PRICING ONLY. SHORING AND SHOTCRETE TO BE DESIGNED BY SHORING CONTRACTOR



1 S-700 FULL MOAT WALL

1 : 50

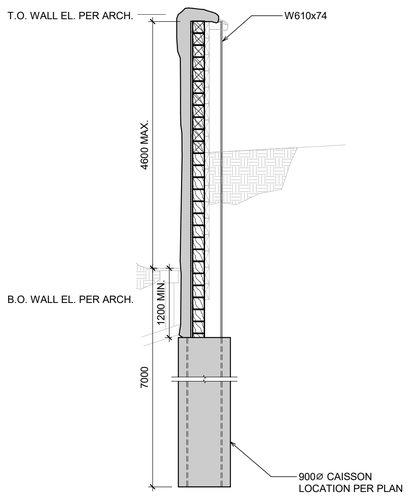
NOTES:
1. DETAILS SHOWN FOR CONCEPT AND PRICING ONLY. SHORING AND SHOTCRETE TO BE DESIGNED BY SHORING CONTRACTOR



5 S-700 HALF MOAT WALL WITH PLANTER

1 : 50

NOTES:
1. SEE 1/S700 FOR MISSING INFORMATION.
2. DETAILS SHOWN FOR CONCEPT AND PRICING ONLY. SHORING AND SHOTCRETE TO BE DESIGNED BY SHORING CONTRACTOR.



4 S-700 HALF MOAT WALL WITH PLANTER

1 : 50

NOTES:
1. SEE 1/S700 FOR MISSING INFORMATION.
2. DETAILS SHOWN FOR CONCEPT AND PRICING ONLY. SHORING AND SHOTCRETE TO BE DESIGNED BY SHORING CONTRACTOR.

NO.	REV.	ISSUED FOR	DATE
1	1	100% DD	2019-10-02
2	2	PROGRESS	2019-10-17
3	3	60% CD	2019-10-25
4	4	100% CD	2019-11-12
5	5	ISSUED FOR PERMIT	2019-11-14
6	6	ISSUED FOR TENDER REVIEW	2019-12-06
7	7	ISSUED FOR TENDER	2019-12-11

N

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toronto zoo
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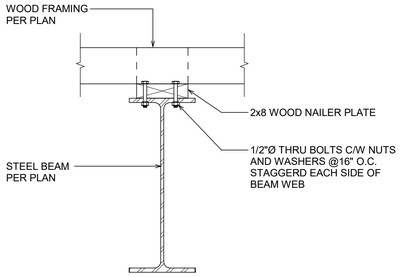
PROJECT:

DRAWING NAME:
FOUNDATION SHORING
SECTION & DETAILS

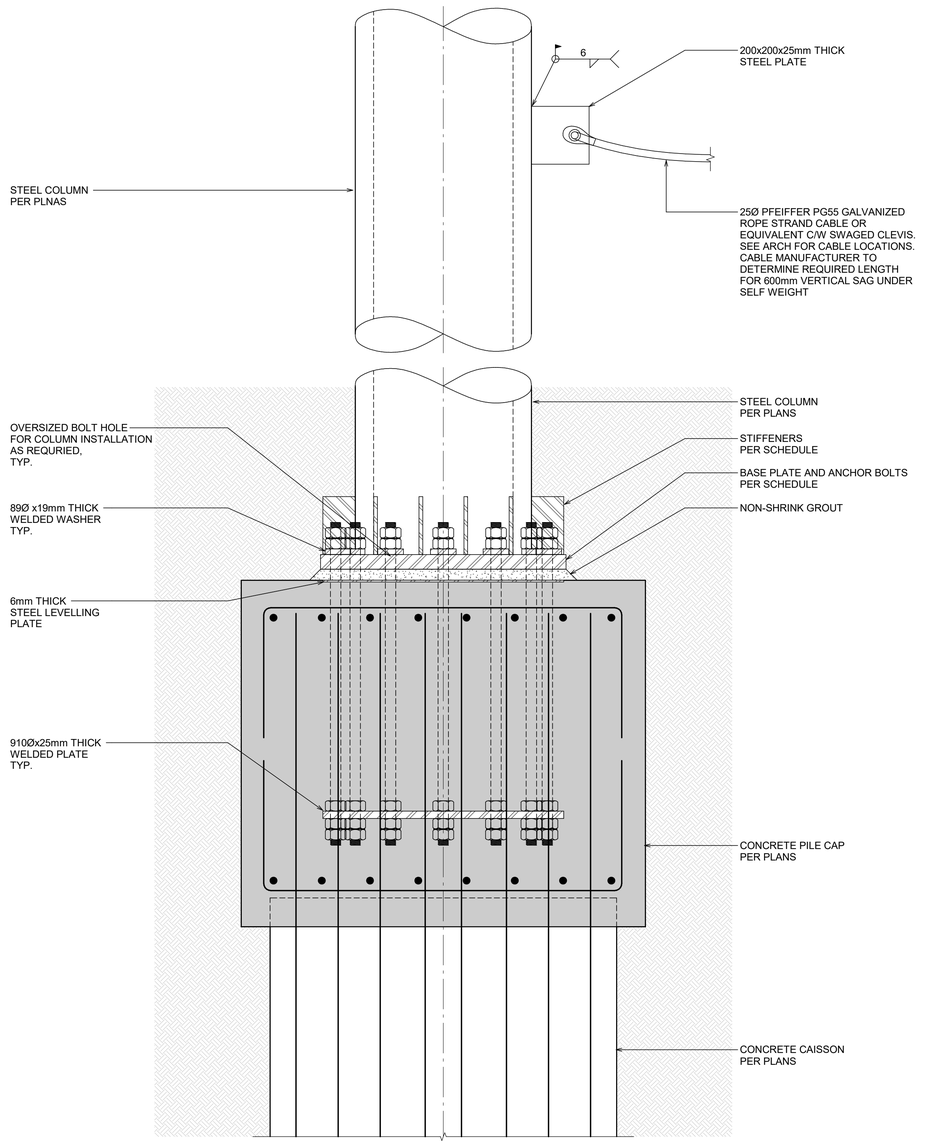
PROJECT NO:	DRAWN BY:	CHECKED BY:
TOR.113946.0011	JP	NB

Scale: 1 : 50

DRAWING NUMBER:
S-700



2 / S-800 **TYPICAL STEEL BEAM SUPPORTING WOOD FRAMING**
1 : 10



1 / S-800 **TYPICAL CLIMBING POLE FOUNDATION & CABLE CONNECTION DETAIL**
1 : 10

NO.	REV.	ISSUED FOR	DATE
1	4	100% CD	2019-11-12
2	5	ISSUED FOR PERMIT	2019-11-14
3	6	ISSUED FOR TENDER REVIEW	2019-12-06
4	7	ISSUED FOR TENDER	2019-12-11

N

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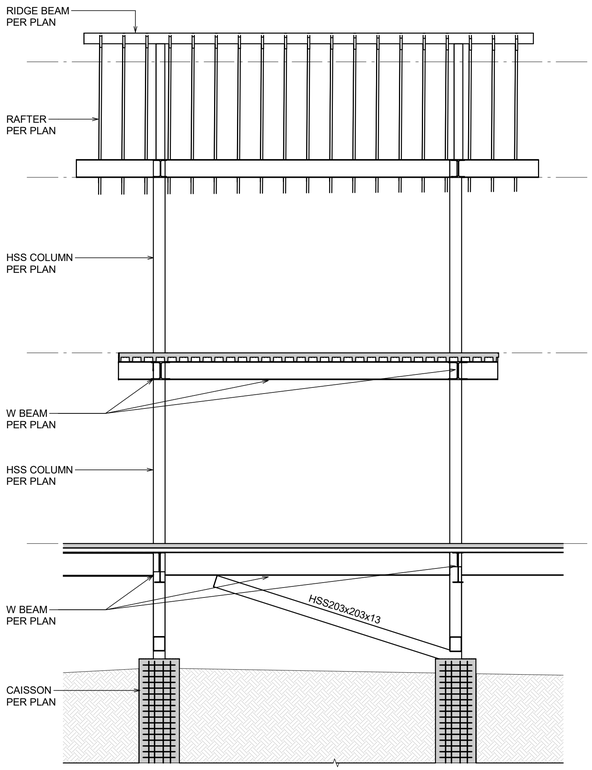
PROJECT:

DRAWING NAME:
SECTION AND DETAILS

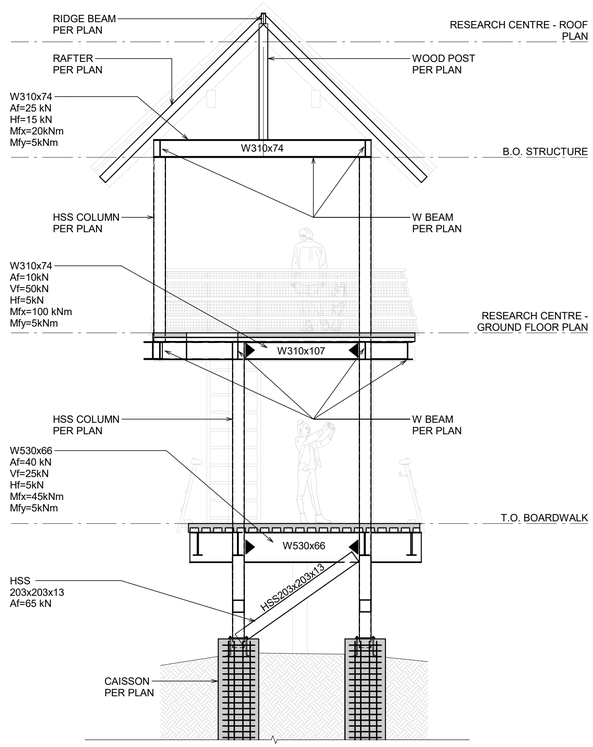
PROJECT NO:	DRAWN BY:	CHECKED BY:
TOR.113946.0011	JP	NB

Scale: 1 : 10

DRAWING NUMBER:
S-800



3 S-810 **TREEHOUSE SECTION**
1 : 50



2 S-810 **TREEHOUSE SECTION**
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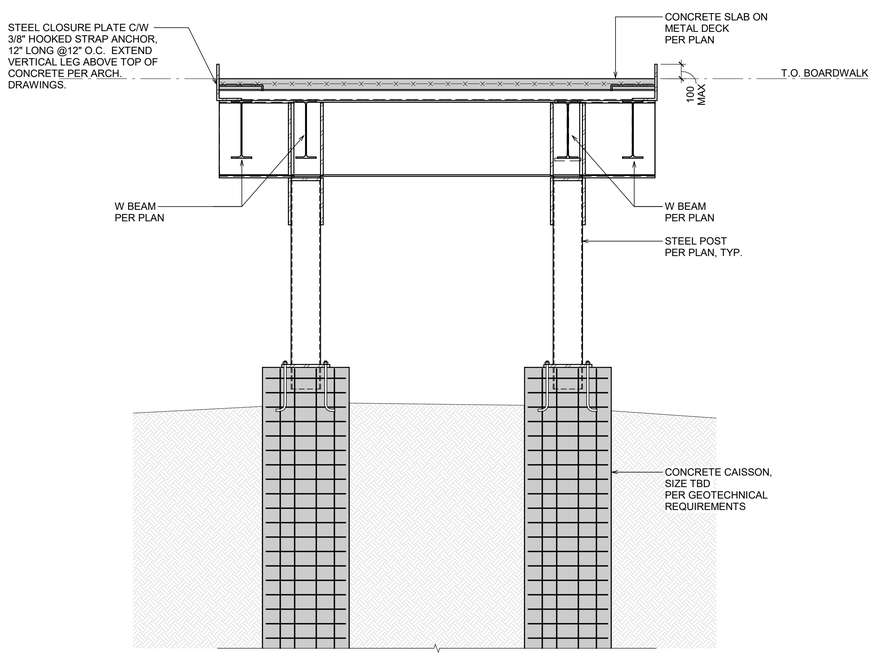

1 S-810 **BOARDWALK SECTION**
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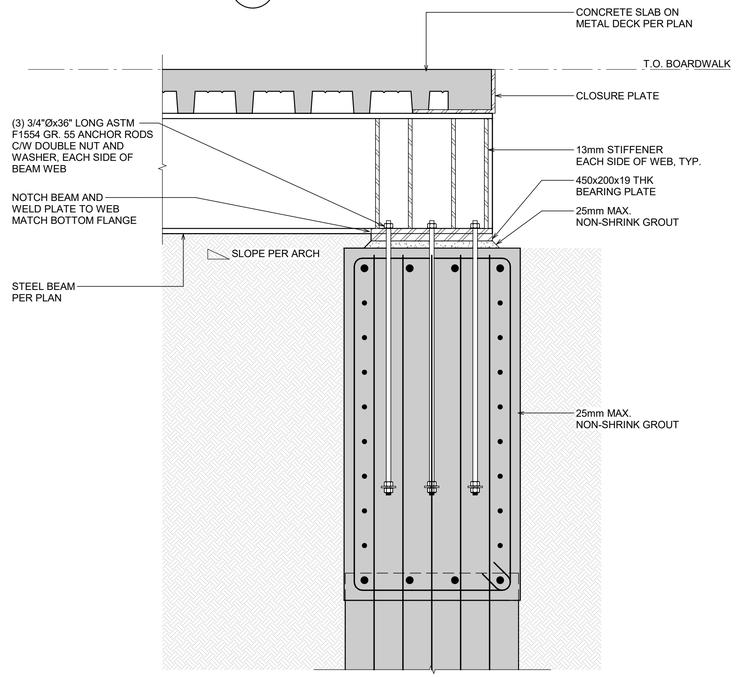

4 S-810 **1 : 10**

NO.	REV.	ISSUED FOR	DATE
1	1	100% DD	2019-10-02
2	2	PROGRESS	2019-10-17
3	3	60% CD	2019-10-25
4	4	100% CD	2019-11-12
5	5	ISSUED FOR PERMIT	2019-11-14
6	6	ISSUED FOR TENDER REVIEW	2019-12-06
7	7	ISSUED FOR TENDER	2019-12-11

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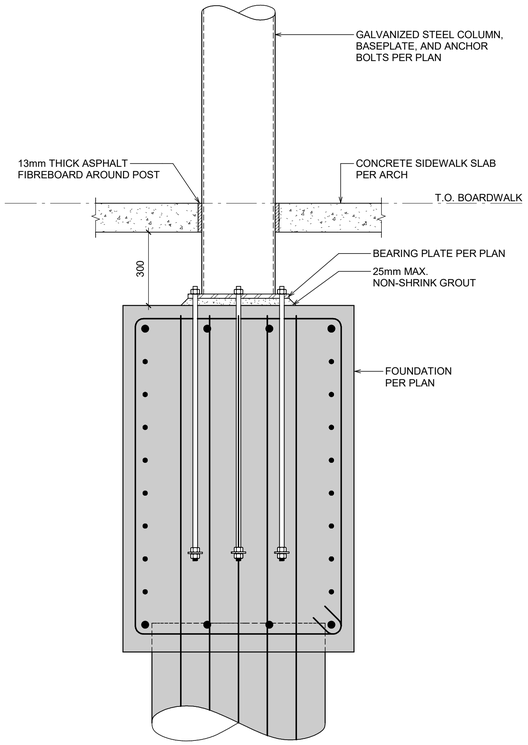
PROJECT:

DRAWING NAME:
BOARDWALK & TREEHOUSE SECTIONS & DETAILS - HABITAT 1

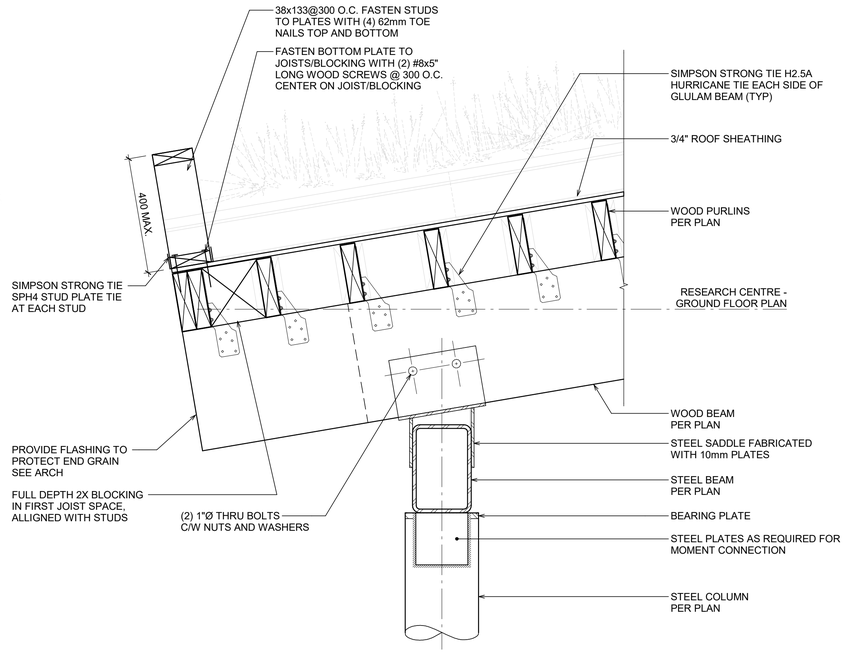
PROJECT NO:	DRAWN BY:	CHECKED BY:
TOR.113946.0011	JP	NB

Scale: As indicated

DRAWING NUMBER:
S-810



3 / S-820 1 : 10



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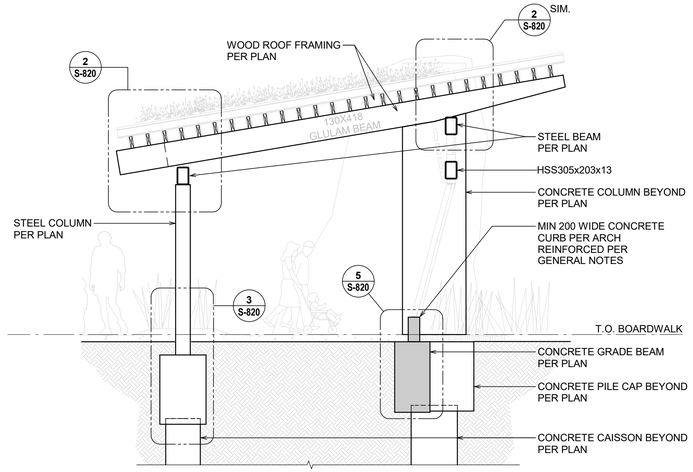
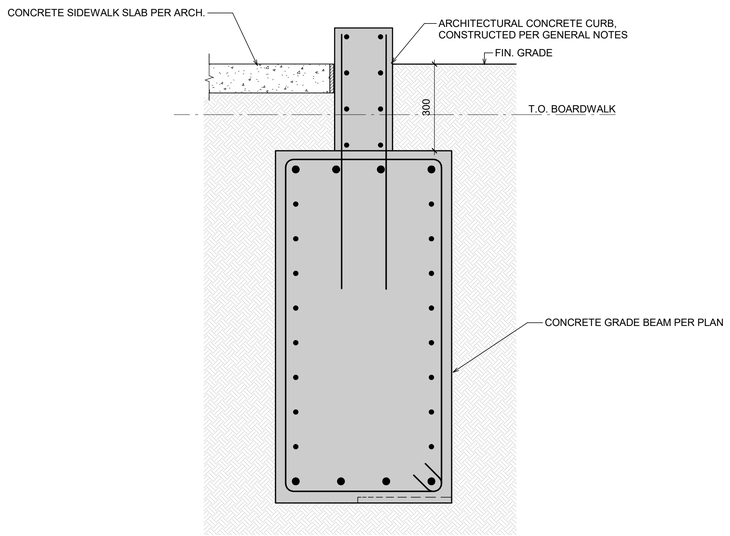
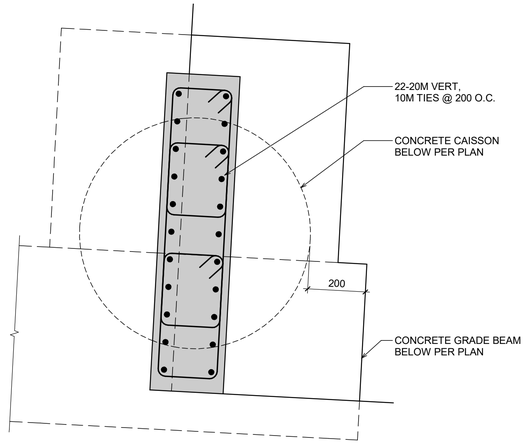


1 / S-820 SECTION 1 : 50



5 / S-820 1 : 10



4 / S-820 1 : 10

NO.	REV.	ISSUED FOR	DATE
1	4	100% CD	2019-11-12
2	5	ISSUED FOR PERMIT	2019-11-14
3	6	ISSUED FOR TENDER REVIEW	2019-12-06
4	7	ISSUED FOR TENDER	2019-12-11

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PROJECT:

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TRELLIS SECTIONS & DETAILS

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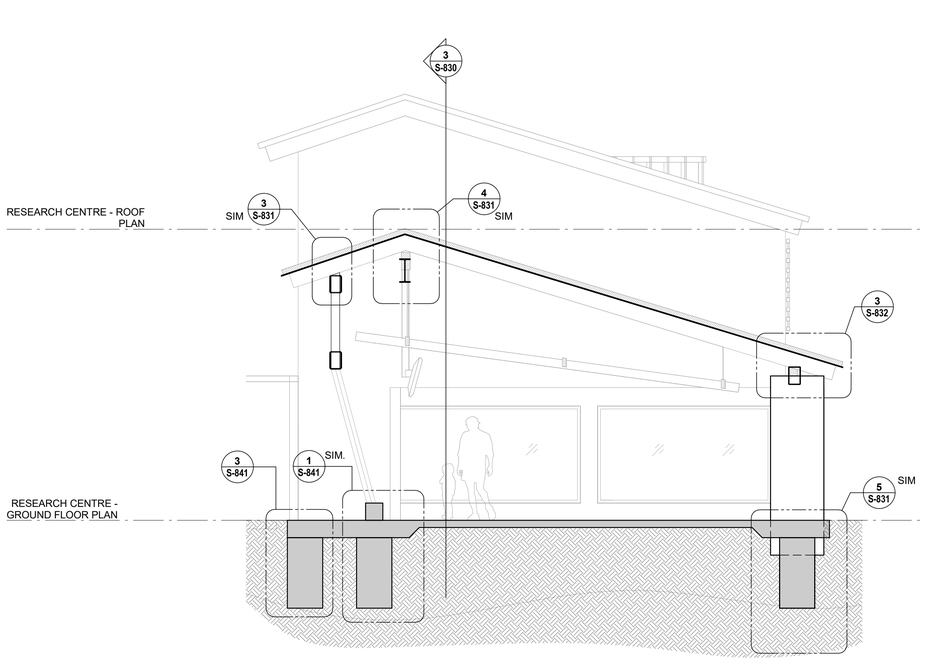
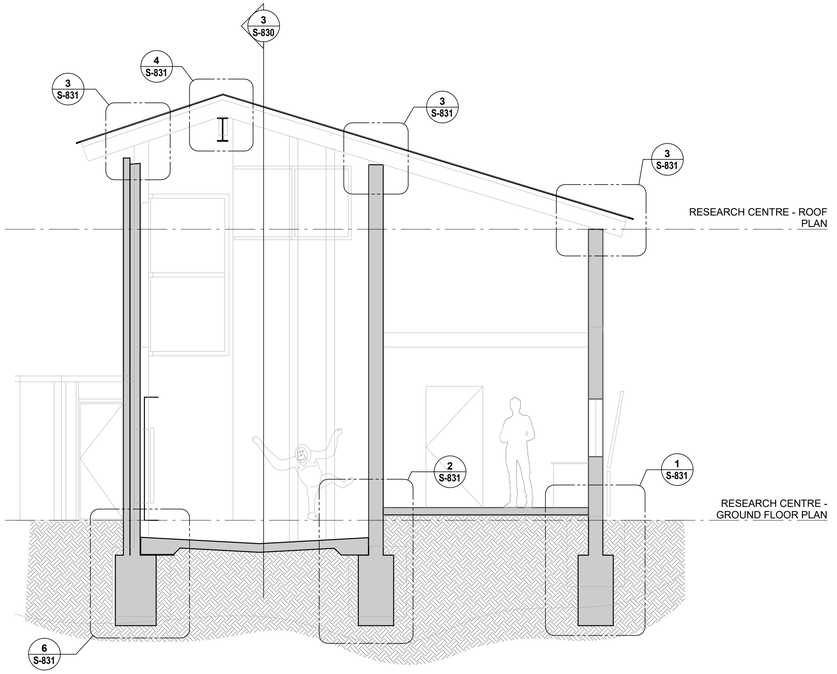
Scale: As indicated

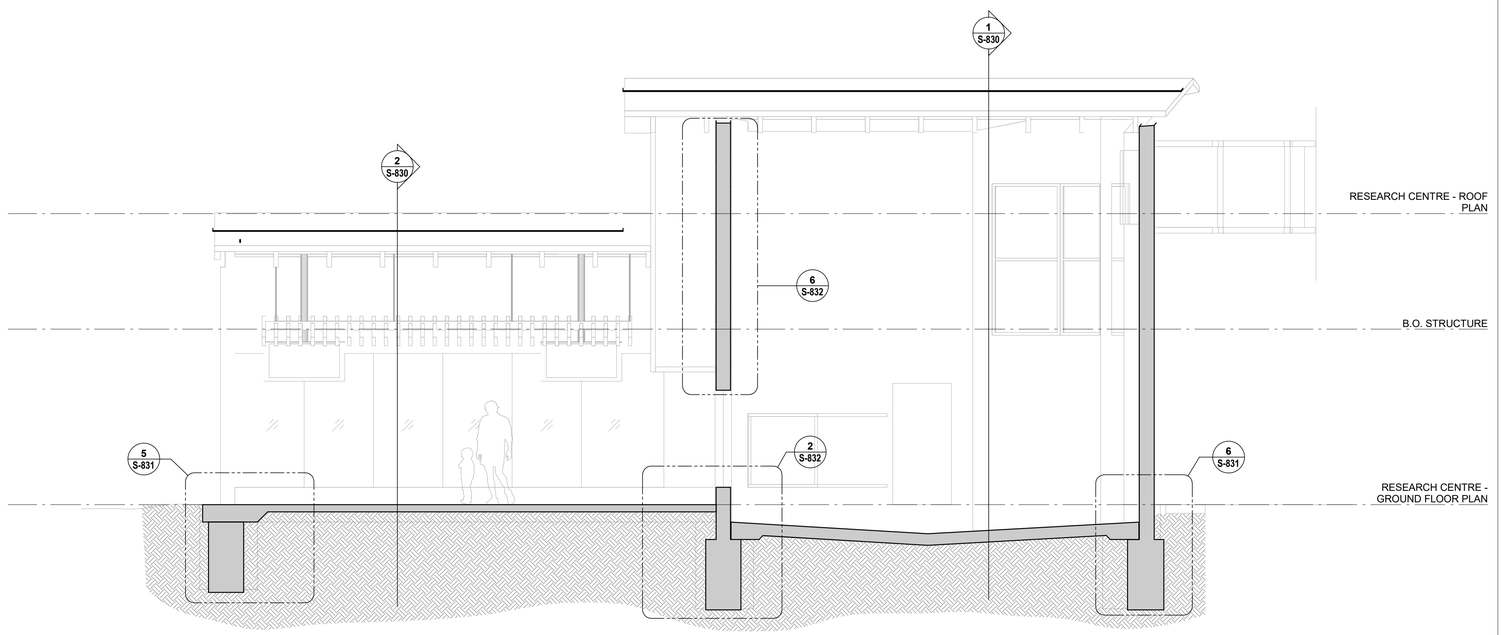
DRAWING NUMBER:
S-820



2 S-830 **SECTION** 1 : 50



1 S-830 **SECTION** 1 : 50



3 S-830 **SECTION** 1 : 50

NO.	REV.	ISSUED FOR	DATE
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2	3	60% CD	2019-10-25
3	4	100% CD	2019-11-12
4	5	ISSUED FOR PERMIT	2019-11-14
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PROJECT:

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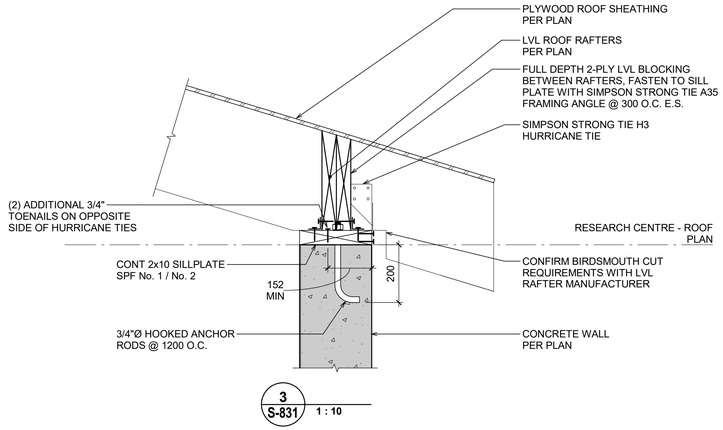
PROJECT NO:	DRAWN BY:	CHECKED BY:
TOR.113946.0011	JP	NB

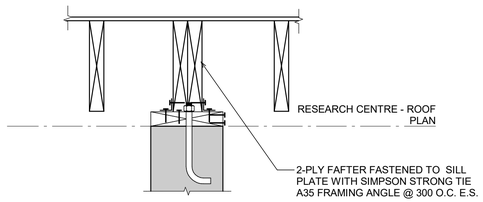
Scale: 1 : 50

DRAWING NUMBER:

S-830

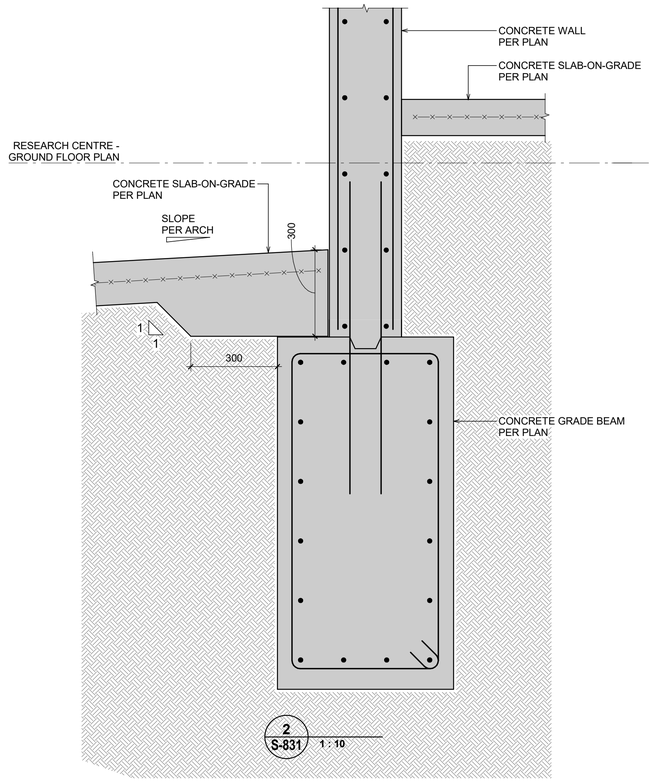


3 S-831 1 : 10



7 S-831 1 : 10

NOTE:
1. SEE 3/S831 FOR MISSING INFORMATION



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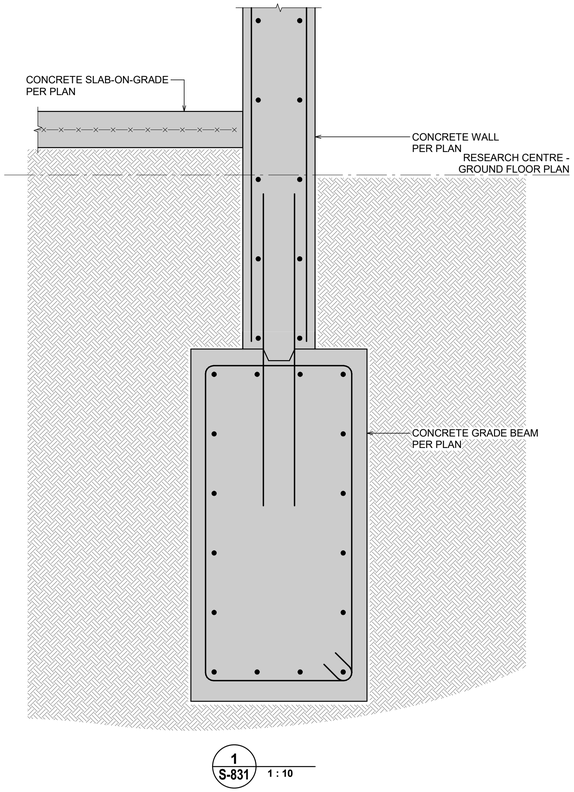

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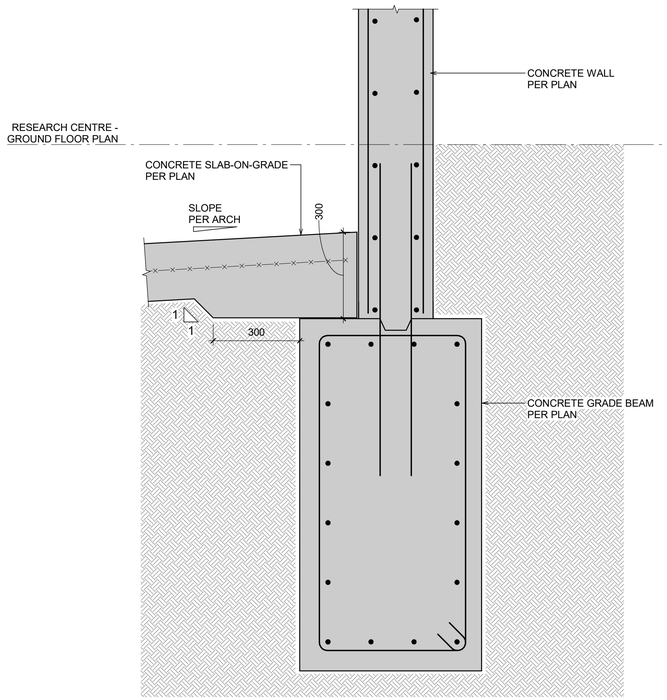
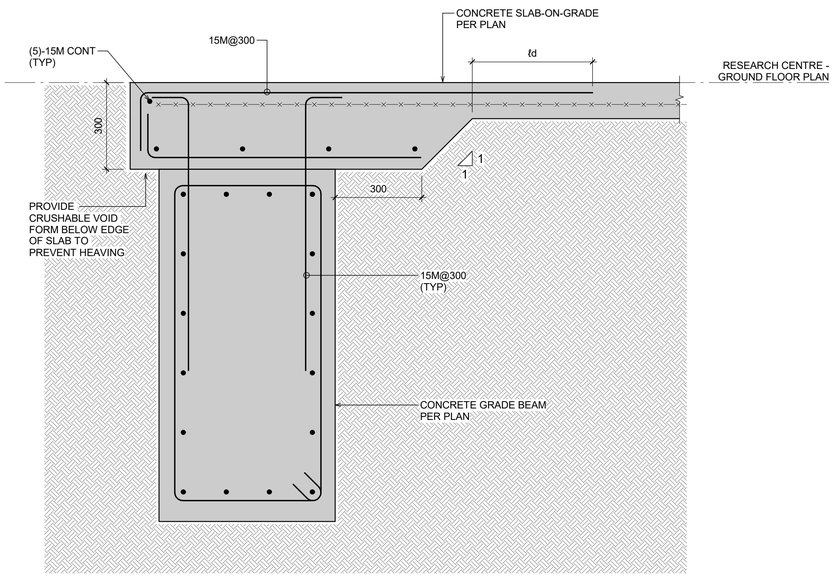


6 S-831 1 : 10



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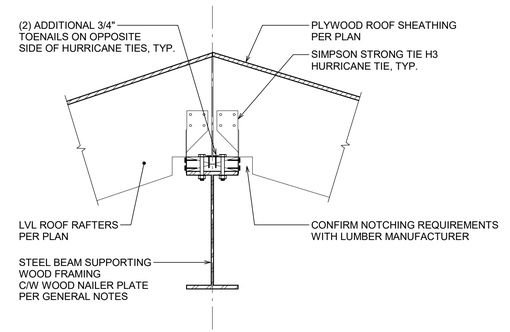

4 S-831 1 : 10

NO.	REV.	ISSUED FOR	DATE
1	4	100% CD	2019-11-12
2	5	ISSUED FOR PERMIT	2019-11-14
3	6	ISSUED FOR TENDER REVIEW	2019-12-06
4	7	ISSUED FOR TENDER	2019-12-11

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toronto zoo
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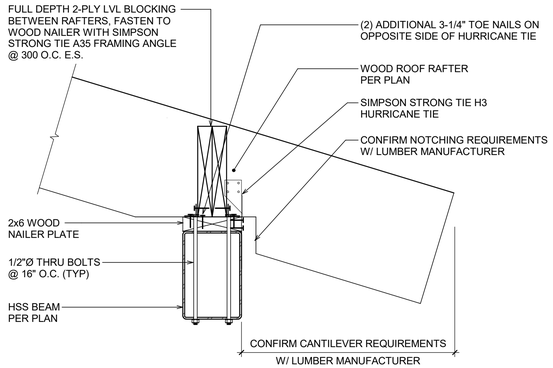
PROJECT:

DRAWING NAME:
RESEARCH CENTRE SECTIONS
& DETAILS- HABITAT 1

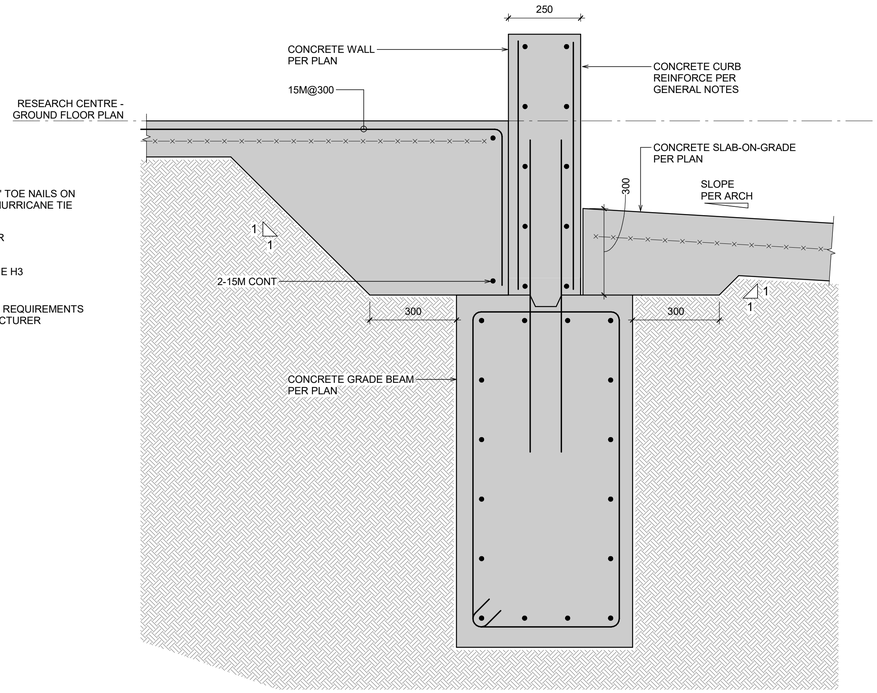
PROJECT NO:	DRAWN BY:	CHECKED BY:
TOR.113946.0011	JP	NB

Scale: 1 : 10

DRAWING NUMBER:
S-831



3 S-832 1 : 10



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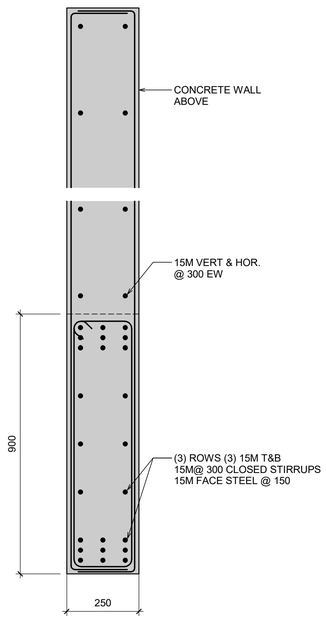

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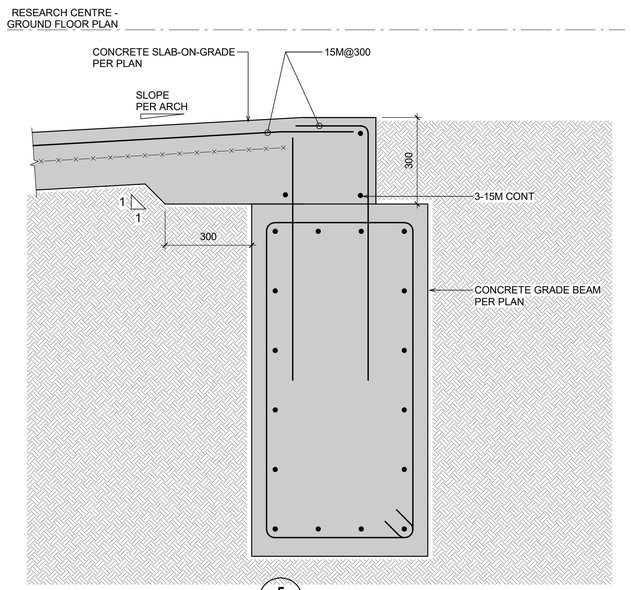

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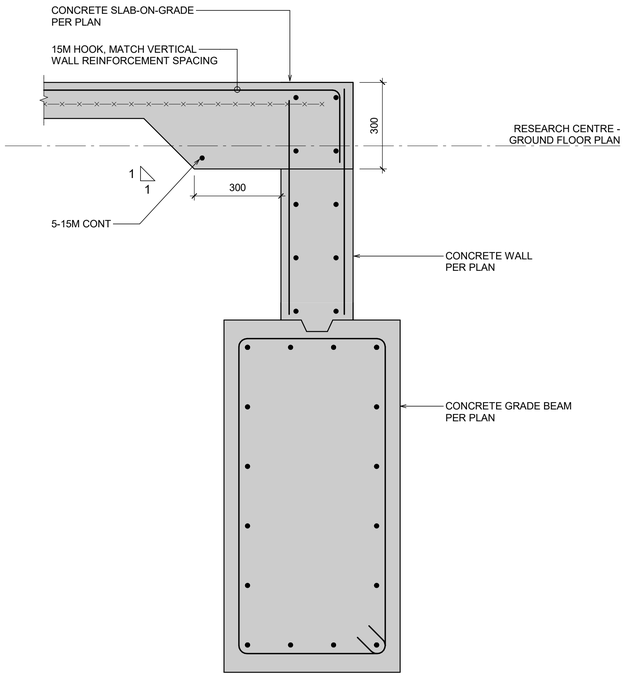

4 S-832 1 : 10

NO.	REV.	ISSUED FOR	DATE
1	4	100% CD	2019-11-12
2	5	ISSUED FOR PERMIT	2019-11-14
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PROJECT:

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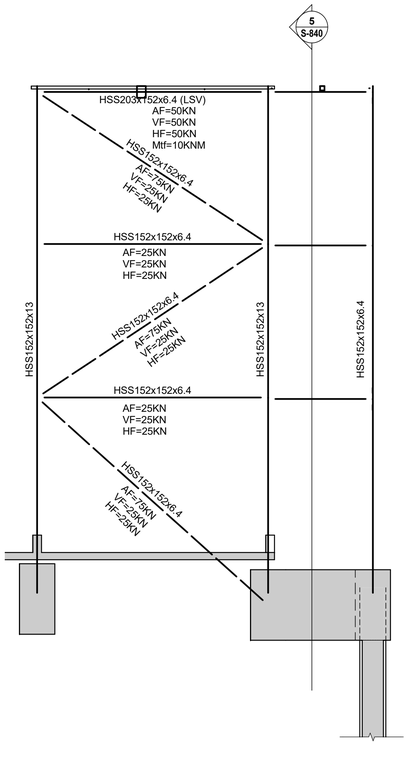
RESEARCH CENTRE SECTIONS & DETAILS - HABITAT 1

PROJECT NO:	DRAWN BY:	CHECKED BY:
TOR.113946.0011	JP	NB

Scale: 1 : 10

DRAWING NUMBER:
S-832



6 S-840 BF6 FRAMING ELEVATION
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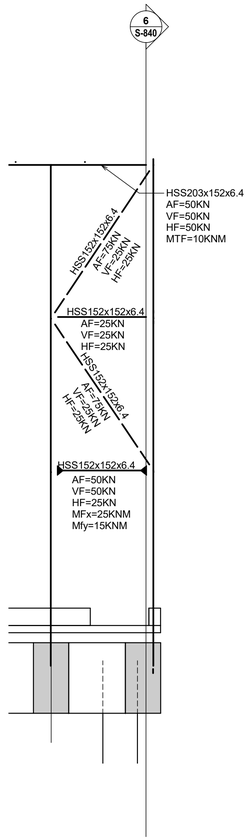

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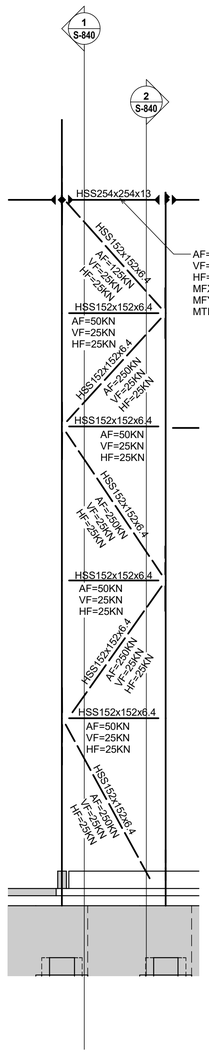

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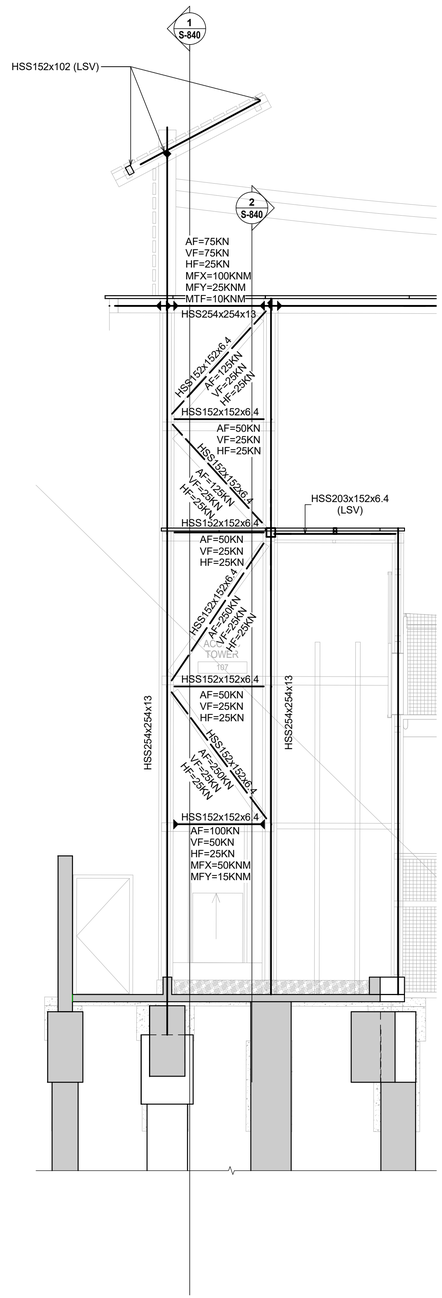

3 S-840 BF3 FRAMING ELEVATION
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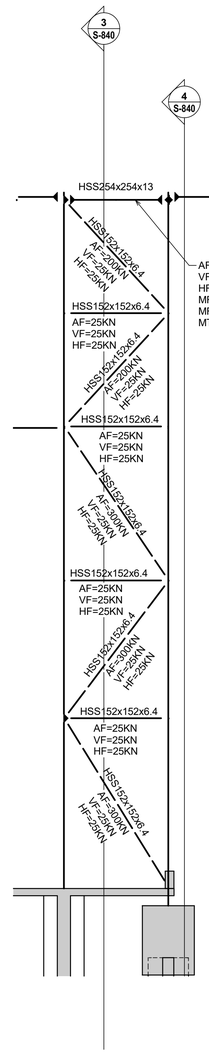

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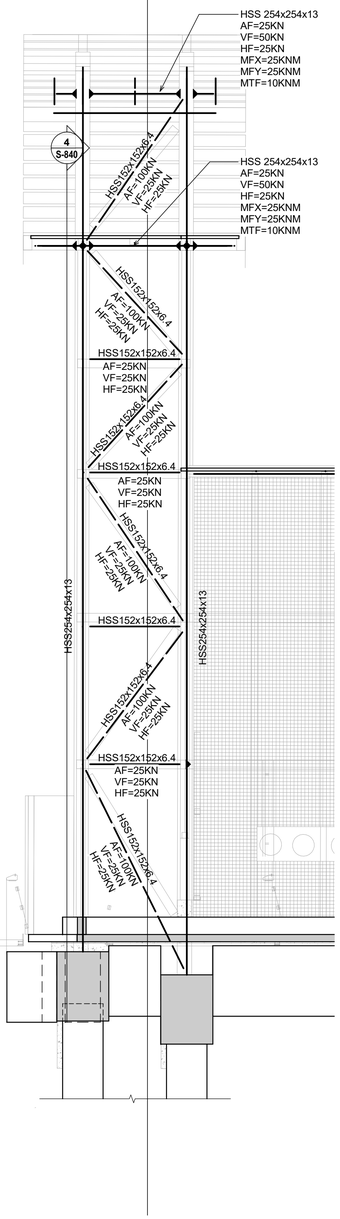

1 S-840 BF1 FRAMING ELEVATION
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NO.	REV.	ISSUED FOR	DATE
1	1	100% DD	2019-10-02
2	2	PROGRESS	2019-10-17
3	3	60% CD	2019-10-25
4	4	100% CD	2019-11-12
5	5	ISSUED FOR PERMIT	2019-11-14
6	6	ISSUED FOR TENDER REVIEW	2019-12-06
7	7	ISSUED FOR TENDER	2019-12-11

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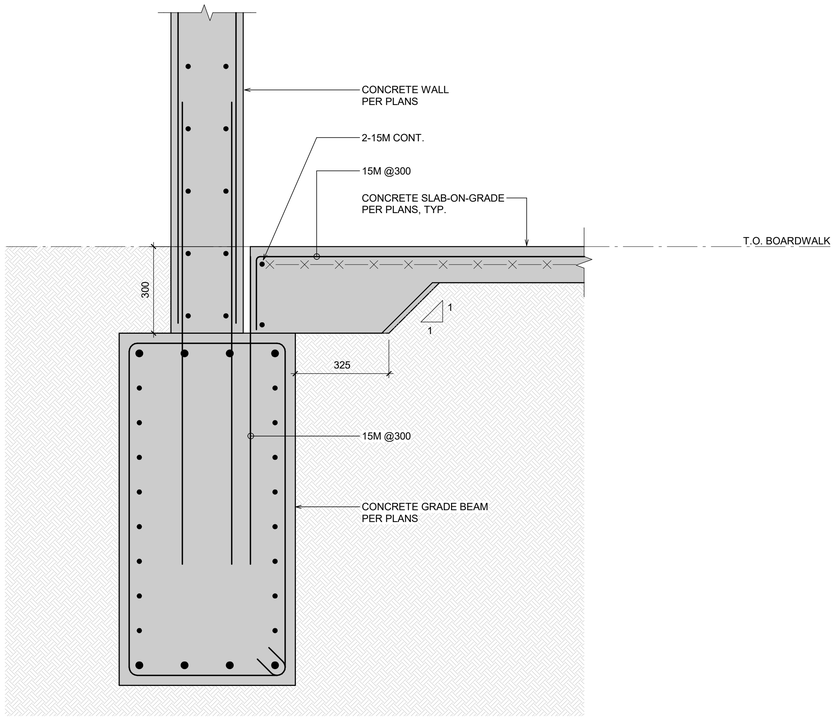
PROJECT:

DRAWING NAME:
DAYROOM SECTIONS & DETAILS

PROJECT NO:	DRAWN BY:	CHECKED BY:
TOR.113946.0011	JP	NB

Scale: 1 : 50

DRAWING NUMBER:
S-840



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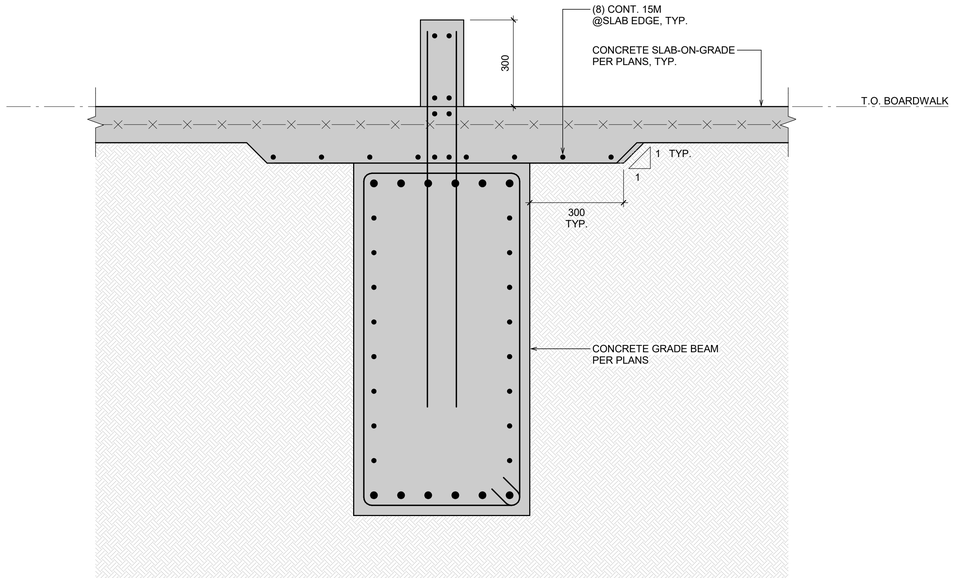

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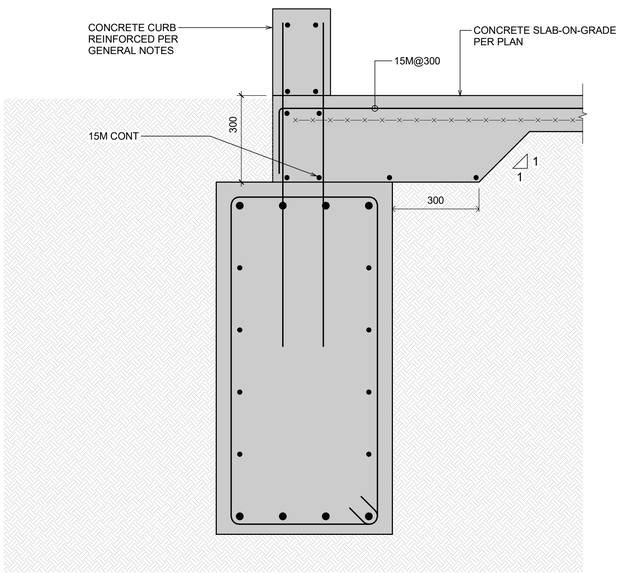
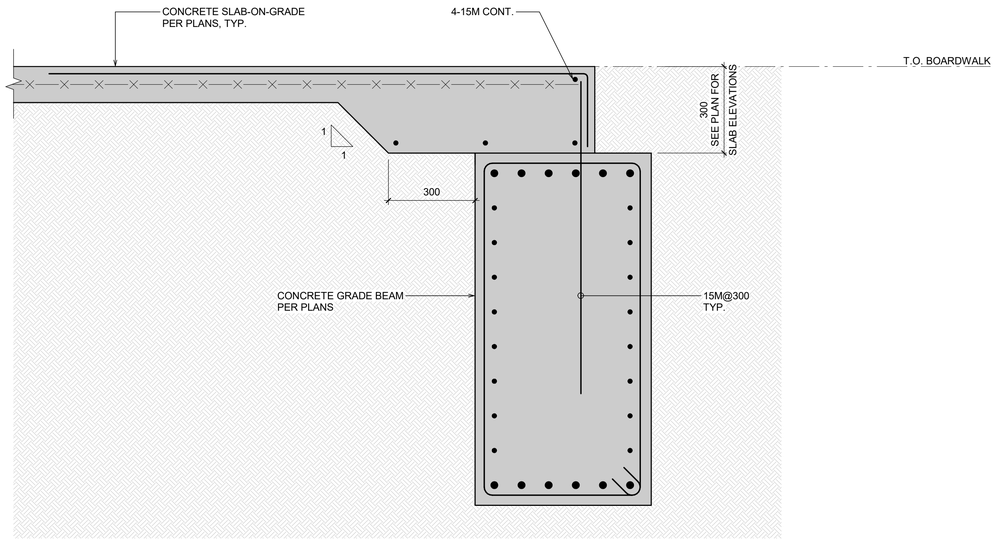


4 / S-841 1 : 10



3 / S-841 1 : 10

NO.	REV.	ISSUED FOR	DATE
1	4	100% CD	2019-11-12
2	5	ISSUED FOR PERMIT	2019-11-14
3	6	ISSUED FOR TENDER REVIEW	2019-12-06
4	7	ISSUED FOR TENDER	2019-12-11

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PROJECT:

DRAWING NAME:

DAYROOM SECTIONS & DETAILS

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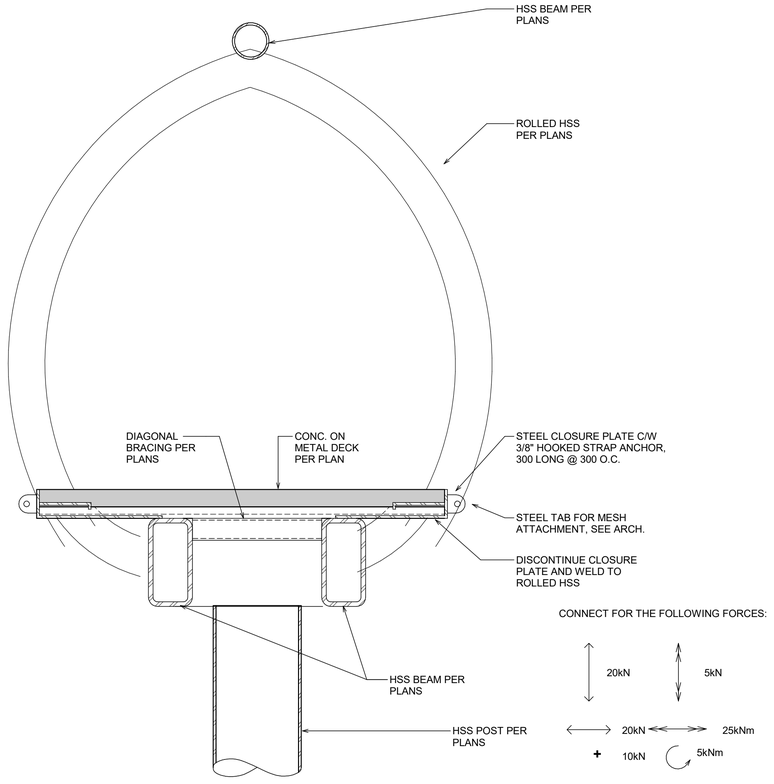
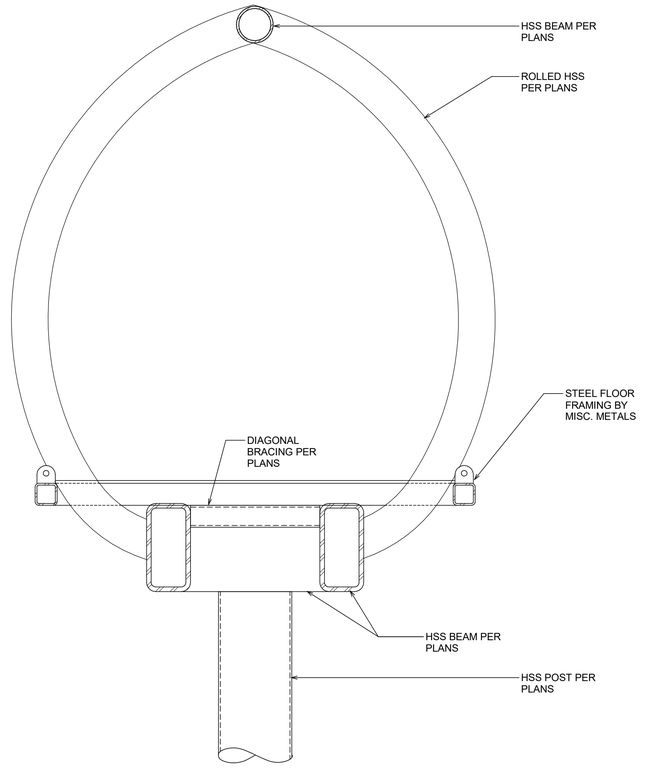
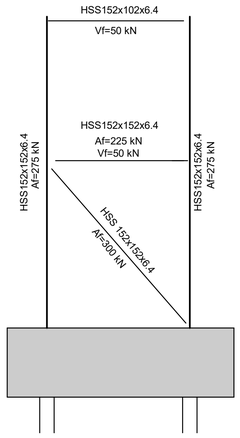


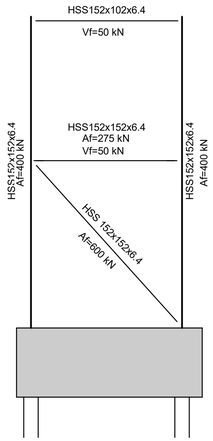
2 S-850 **TYPICAL CHUTE OUTDOOR SECTION**
1 : 10



1 S-850 **TYPICAL CHUTE INDOOR SECTION**
1 : 10



6 S-850 **BF-3**
1 : 50



5 S-850 **BF-2**
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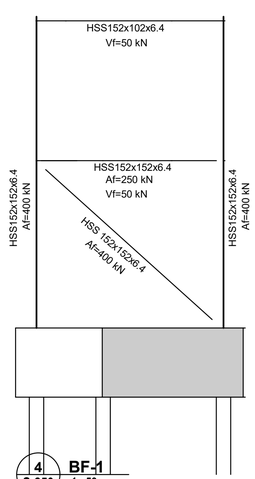
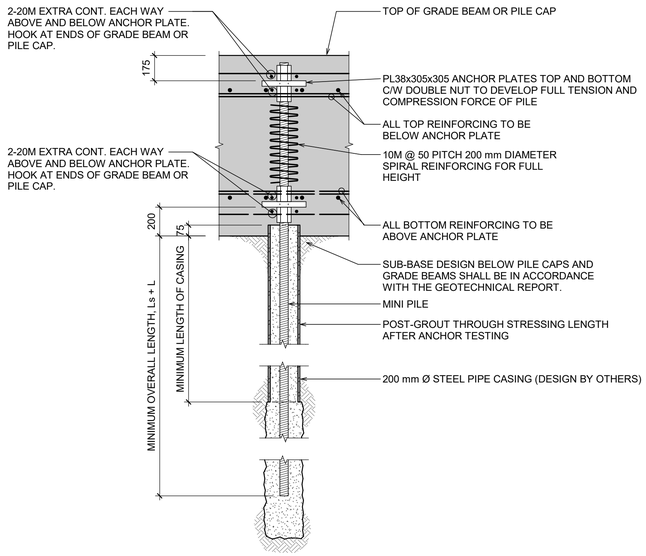


4 S-850 **BF-1**
1 : 50



3 S-850 **TYPICAL TENSION / COMPRESSION MINI PILE DETAIL**
1 : 20

NO.	REV.	ISSUED FOR	DATE
1	6	ISSUED FOR TENDER REVIEW	2019-12-06
2	7	ISSUED FOR TENDER	2019-12-11

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PROJECT:

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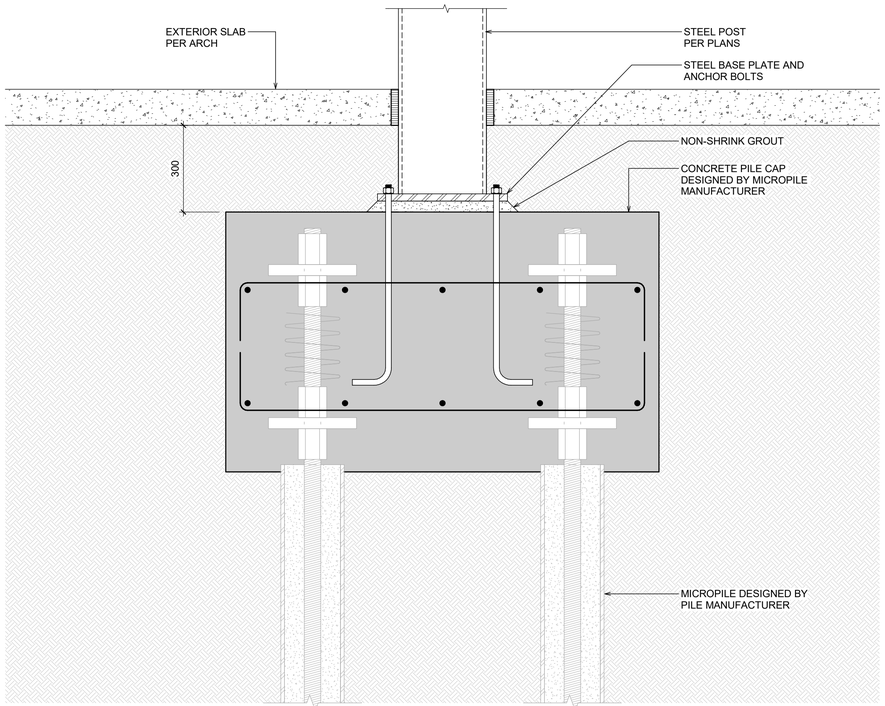
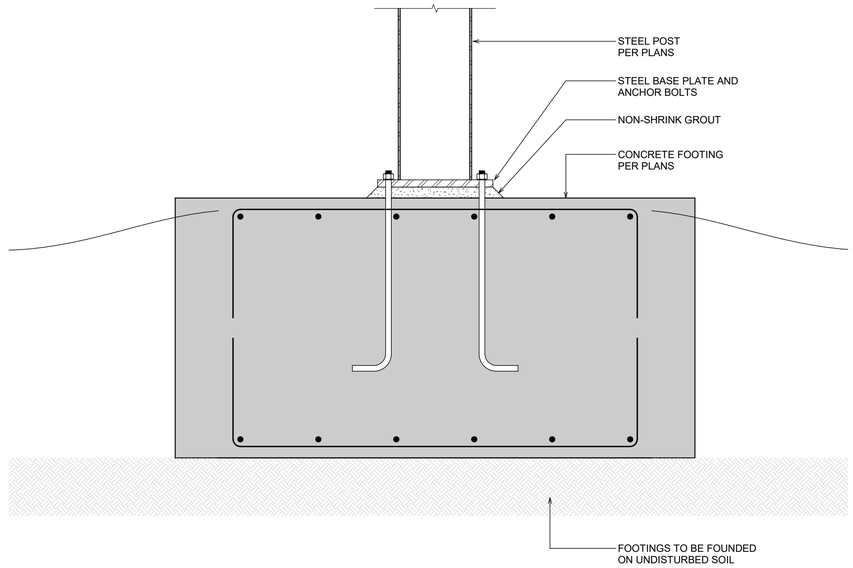
S-850



2 S-851 **EXTERIOR COLUMN DETAIL - HABITAT 2**
1 : 10



1 S-851 **TYPICAL INTERIOR COLUMN DETAIL - HABITAT 2**
1 : 10

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1	7	ISSUED FOR TENDER	2019-12-11

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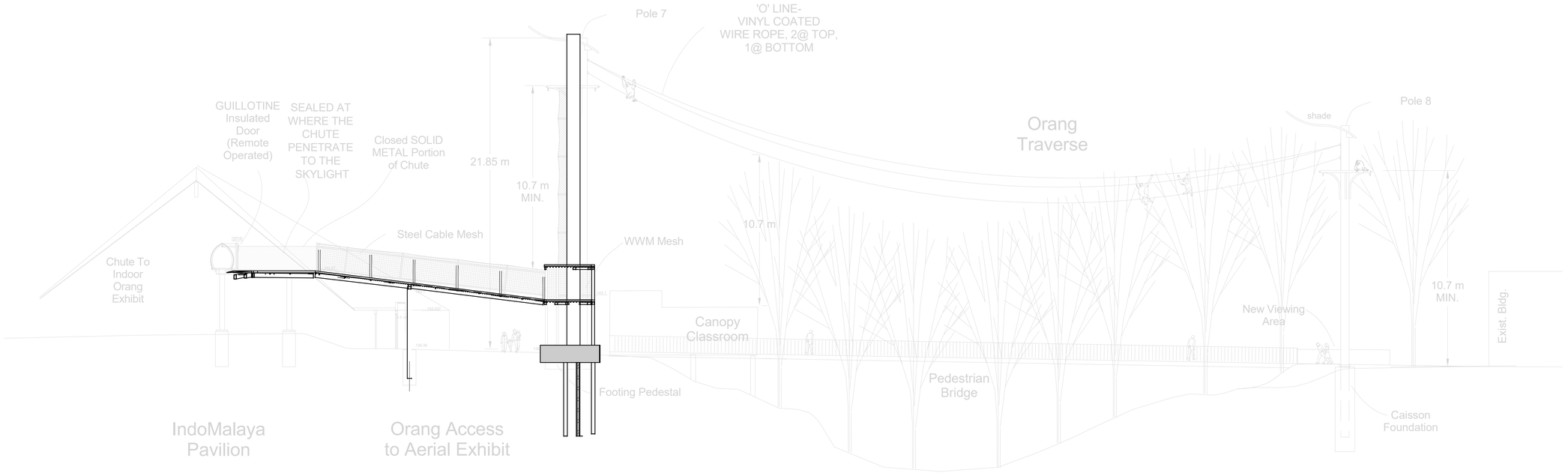
Scale: 1 : 10

DRAWING NUMBER:
S-851



1 S-852 **SECTION**
1 : 150

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1	7	ISSUED FOR TENDER	2019-12-11

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PROJECT:

DRAWING NAME:
SECTIONS AND DETAILS -
HABITAT 2

PROJECT NO:	DRAWN BY:	CHECKED BY:
TOR.113946.0011	JP	NB

Scale: 1 : 150

DRAWING NUMBER:
S-852

CONTROLS

SYMBOL	DESCRIPTION
SF	SUPPLY FAN
RF	RETURN EXHAUST FAN
EF	EXHAUST FAN
H/C	HEATING COIL
C/C	COOLING COIL
P/C	PRE-HEAT COIL
	FILTERS
	HUMIDIFIER
	THERMOMETER
SA	SUPPLY AIR
EA	EXHAUST AIR
OA	OUTDOOR AIR
RA	RETURN AIR
MD	MOTORIZED DAMPER
MSP	MOTOR STARTER PANEL
MCC	MOTOR CONTROL CENTER
VFD	VARIABLE FREQUENCY DRIVE
NO	NORMALLY OPEN
NC	NORMALLY CLOSED
EP	ELECTRO-PNEUMATIC SWITCH
PE	PRESSURE ELECTRIC SWITCH
H	HUMIDITY SENSOR
T	TEMPERATURE SENSOR
BAS	BUILDING AUTOMATED SYSTEM
AI	ANALOG INPUT
AO	ANALOG OUTPUT
DI	DIGITAL INPUT
DO	DIGITAL OUTPUT
GP	BAS GRAPHICS POINT
CO	CARBON MONOXIDE SENSOR
NO2	NOX SENSOR
O	OXYGEN SENSOR
OS	OCCUPANCY SENSOR
GDP	GAS DETECTION SYSTEM CONTROL PANEL

PLUMBING

SYMBOL	DESCRIPTION
SAN	SANITARY DRAINAGE - ABOVE GROUND
SAN	SANITARY DRAINAGE - UNDERGROUND
SAN(AR)	SANITARY DRAINAGE (ACID RESISTANT) - ABOVE GROUND
SAN(AR)	SANITARY DRAINAGE (ACID RESISTANT) - UNDERGROUND
STM	STORM DRAINAGE - ABOVE GROUND
STM	STORM DRAINAGE - UNDERGROUND
PD	PUMPED DISCHARGE
	DOMESTIC COLD WATER SUPPLY
	DOMESTIC HOT WATER SUPPLY
	DOMESTIC HOT WATER RECIRC.
TW	TEMPERED WATER
AWV	ACID RESISTANT VENT
V	VENT
G	GAS
RO	REVERSE OSMOSIS PIPING
ISO	RADIO ISOTOPE DRAIN
CA	COMPRESSED AIR
	HEAT TRACING
	RUNNING TRAP
	P-TRAP
BFP	BACKFLOW PREVENTER
	BACK WATER VALVE
"WC-1"	DENOTES FIXTURE TYPE PER SPECIFICATION
ES	EMERGENCY SHOWER
EW	EYE WASH
CO	CLEANOUT IN FLOOR
CO	CLEANOUT IN CEILING
HB	HOSE BIBB
NFHB	NON FREEZE HOSE BIBB
G	SINGLE GAS OUTLET
G	DOUBLE GAS OUTLET
RD	ROOF DRAIN
CFRD	CONTROL FLOW ROOF DRAIN
VTR	VENT THROUGH ROOF
RWL	RAIN WATER LEADER
TSP	DENOTES FIXTURE TYPE PER SPECIFICATION
	SCUPPER DRAIN
MH	MANHOLE
CB	CATCH BASIN
TD	TRENCH GRATE & FRAME
AD	AREA DRAIN
FFD	FUNNEL FLOOR DRAIN
FD	FLOOR DRAIN
HD	HUB DRAIN
FS	FLOOR SINK
TDD	TERRACE DECK DRAIN
FRD	FLOOR DRAIN - FLUSHING RIM
M	WATER METER ASSEMBLY
	GAS METER
CA	COMPRESSED AIR OUTLET

VENTILATION

SYMBOL	DESCRIPTION
FD	FUSIBLE LINK FIRE DAMPER (DOUBLE LINE)
FD	FUSIBLE LINK FIRE DAMPER (SINGLE LINE)
BDD	BACK DRAFT DAMPER (DOUBLE LINE)
BDD	BACK DRAFT DAMPER (SINGLE LINE)
SD	SMOKE DAMPER (DOUBLE LINE)
SD	SMOKE DAMPER (SINGLE LINE)
BD	BALANCING DAMPER (DOUBLE LINE)
BD	BALANCING DAMPER (SINGLE LINE)
600x300	RECTANGULAR DUCTWORK - DIMENSION AS SHOWN
600Ø	ROUND DUCTWORK - DIMENSION AS SHOWN
600x300	DUCTWORK (SINGLE LINE) - DIMENSION AS SHOWN
SFD	COMBINATION SMOKE/FIRE DAMPER (DOUBLE LINE)
SFD	COMBINATION SMOKE/FIRE DAMPER (SINGLE LINE)
	SUPPLY RISER UP
	EXHAUST/RETURN RISER UP
	SUPPLY RISER DOWN
	EXHAUST/RETURN RISER DOWN
	MITRED ELBOW WITH AIR TURNING VANES
	DUCT RISE (DOUBLE LINE)
	DUCT RISE (SINGLE LINE)
MD	MOTORIZED DAMPER
	SUPPLY GRILLE
	EXHAUST/RETURN GRILLE
	CEILING SUPPLY AIR DIFFUSER
	SUPPLY AIR LINEAR SLOT DIFFUSER
	CEILING EXHAUST/RETURN GRILLE
	BRANCH TAKE-OFF WITH ADJUSTABLE SPLITTER DAMPER IN SUPPLY DUCT (DOUBLE LINE) BRANCH TAKE-OFF WITH ADJUSTABLE SPLITTER DAMPER IN SUPPLY DUCT (SINGLE LINE)
O.E.D.	OPEN ENDED DUCT WITH BALANCING DAMPER AND BELLMOUTH. DIRECTION AS SHOWN (DOUBLE LINE)
O.E.D.	OPEN ENDED DUCT WITH BALANCING DAMPER AND BELLMOUTH. DIRECTION AS SHOWN (SINGLE LINE)
	FLEXIBLE DUCT CONNECTION
TYPE / NECK SIZE (mm) / A-2000-100 / AIRFLOW IN L/s	DIFFUSER TAG
TYPE / A-100 / AIRFLOW IN L/s	GRILLE TAG
	ACOUSTICALLY LINED DUCTWORK (DOUBLE LINE)
	ACOUSTICALLY LINED DUCTWORK (SINGLE LINE)
SL	SILENCER (ATTENUATOR)
	FLEXIBLE DUCT (DOUBLE LINE)
	FLEXIBLE DUCT (SINGLE LINE)
R.A.O.	RETURN AIR OPENING IN WALL ABOVE FINISHED CEILING
	FLEXIBLE DUCT CONNECTION WITH BALANCING DAMPER ON TAKE-OFF
	DUCT MOUNTED HEATING COIL (DOUBLE LINE)
	DUCT MOUNTED HEATING COIL (SINGLE LINE)
VAV 111	VARIABLE AIR VOLUME BOX C/W REHEAT COIL. 8 DENOTES SIZE, 111 DENOTES AIR QUANTITY IN LITRES/SEC.
	DUCT TRANSITION FROM RECTANGULAR TO ROUND
	RECTANGULAR DUCT BREAK
	ROUND DUCT BREAK
	SINGLE LINE DUCT BREAK

HEATING & COOLING

SYMBOL	DESCRIPTION
HWR	HEATING WATER RETURN
HWS	HEATING WATER SUPPLY
HGR	HEATING GLYCOL RETURN
HGS	HEATING GLYCOL SUPPLY
CWR	CONDENSER WATER RETURN
CWS	CONDENSER WATER SUPPLY
CHR	CHILLED WATER RETURN
CHS	CHILLED WATER SUPPLY
CHGR	CHILLED GLYCOL RETURN
CHGS	CHILLED GLYCOL SUPPLY
CNDR	CONDENSATE DRAIN
REFR	REFRIGERANT GAS
REFS	REFRIGERANT LIQUID
LPS	LOW PRESSURE STEAM
LPC	LOW PRESSURE CONDENSATE
HPS	HIGH PRESSURE STEAM
HPC	HIGH PRESSURE CONDENSATE
V	VENT
ST-V	STEAM VENT
FOS	FUEL OIL SUPPLY
FOR	FUEL OIL RETURN
FOV	FUEL OIL VENT
BB - XXX	ELECTRIC BASEBOARD HEATER OUTPUT AS SHOWN (KW)
ECH	ELECTRIC CABINET HEATER
CUH	CABINET HEATER
UH	UNIT HEATER
CV / 1200-5.6	CONVECTOR - LENGTH - HEAT OUTPUT (KW)
WF / 1200-5.6	WALL FIN - LENGTH - HEAT OUTPUT (KW)
	UNION
	MANUAL AIR VENT
	AUTOMATIC AIR VENT
	EXPANSION COMPENSATOR
	EXPANSION SWING
	PIPE ANCHOR
	PIPE GUIDE
	PIPE SLEEVE
	FLOAT & THERMOSTATIC TRAP
	INVERTED BUCKET TRAP
	ELECTRIC TRACING
8C-600-1100 = 2.1	RADIANT PANEL - 8 DENOTES DEPTH, 600mm DENOTES HEIGHT, 1100mm DENOTES LENGTH & 2.1 HEAT OUTPUT (KW)

GENERAL

SYMBOL	DESCRIPTION
	EXISTING TO REMAIN
	EXISTING TO BE DEMOLISHED
R	EXISTING TO BE REMOVED FOR RELOCATION
R	EXISTING RELOCATED IN NEW WORK
	NEW WORK
CTE	CONNECT TO EXISTING
DN	PIPE TURNING DOWN
	PIPE TURNING UP
	PRESSURE REDUCING VALVE
T	ROOM THERMOSTAT
H	ROOM HUMIDISTAT
	PUMP
	AUTOMATIC CONTROL VALVE - TWO WAY
	AUTOMATIC CONTROL VALVE - THREE WAY
	ISOLATION VALVE
	BALANCING VALVE
	CHECK VALVE
	STRAINER - OVER 50MM WITH VALVED FLUSHING DRAIN
	PIPE BRANCH OFF TOP
	PIPE BRANCH OFF BOTTOM
	RELIEF VALVE (PIPE TO DRAIN)
	PRESSURE GUAGE
	THERMOMETER
CAP	CAP

Drawing List

Sheet Number	Sheet Title
MA-100	MECHANICAL SYMBOLS AND DRAWING LIST
MA-101	MECHANICAL SCHEDULES
MP-101	PLUMBING - HABITAT 1 - NEW WORK PLAN
MP-102	PLUMBING - HABITAT 1 - ENLARGED NEW WORK PLAN
MP-103	PLUMBING - HABITAT 1 - ENLARGED NEW WORK PLAN
MV-101	HVAC - HABITAT 1 - ENLARGED NEW WORK PLAN
MX-100	MECHANICAL DETAILS

NO.	REV.	ISSUED FOR	DATE
1	0	ISSUED FOR PROGRESS REVIEW	2019-08-23
2	0	ISSUED FOR PROGRESS REVIEW	2019-10-18
3	0	ISSUED FOR 100% CD	2019-11-11
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PROJECT:
ORANGUTAN EXHIBIT

DRAWING NAME :

MECHANICAL SYMBOLS AND DRAWING LIST

PROJECT NO.:	DRAWN BY :	CHECKED BY:
CM-18-391	DB	DB

SCALE:
N.T.S.
08.2019

DRAWING NUMBER:
MA-100

SPLIT SYSTEM SCHEDULE

INDOOR UNIT TAG	OUTDOOR UNIT TAG	EQUIPMENT LOCATION	MANUFACTURER	MODEL	PERFORMANCE			POWER SUPPLY			WEIGHT (KG) INDOOR / OUTDOOR	REMARKS
					COOLING MIN-MAX (MBH)	HEATING MIN-MAX (MBH)	FAN (L/S)	V/PH/HZ	MCA	MOCP		
A/C-1	CU-1	RESEARCH STATION	MITSUBISHI	MSZ-GL09NA MUZ-GL09NAH-U1	3,600 - 12,200	6,700 - 8,000	68 - 188	208/230V 1ph 60Hz	10A	15A	10 / 37	C/W WIRELESS REMOTE CONTROLLER

NOTES:
1. PROVIDE WEATHER PROOF DISCONNECT SWITCH FOR EACH CONDENSING UNIT AND PROVIDE DISCONNECT SWITCH FOR EACH INDOOR UNIT.
2. PROVIDE CONTROL WIRING BETWEEN INDOOR AND OUTDOOR UNIT.
3. PROVIDE WITH ULTRA LOW AMBIENT HEATING KIT.

FANS

TAG	MAKE/MODEL	AIRFLOW (L/S)	TOTAL E.S.P. (IN. WG)	FAN SPEED (RPM)	POWER (HP)	ENCLOSURE	V/PH/Hz	WEIGHT (KG)	REMARKS
EF-1	GREENHECK G-143-B	781	0.5	1140	1/4	ODP	115 / 1 / 60	32	C/W 450mm PITCHED SOUND ROOF CURB (ATIP), MOTOR STARTER, DISCONNECT SWITCH, SPEED CONTROLLER, BIRDSCREEN, HINGED BASE.

FORCED FLOW HEATERS

TAG	MAKE/MODEL	AIRFLOW (L/S)	POWER (WATTS)	VOLTAGE	WEIGHT (KG)	REMARKS
FFH-1	OUELLET OAC WALL MOUNTED	75	2000	208	10.9	C/W INTEGRAL THERMOSTAT, COORDINATE COLOUR WITH ARCHITECT.
CFH-1	OUELLET OACP CEILING HUNG	75	3000	208	10.9	C/W WITH REMOTE THERMOSTAT, COORDINATE COLOR WITH ARCHITECT.
OAH-1	THERMO X AIR MINI FRESH AIR MAKE UP	21	1500	120 /240	-	MODULATING HEAT, REMOTE THERMOSTAT.

LOUVERS

TAG	MODEL	MANUFACTURER	AIRFLOW (L/S)	TYPE	DIMENSIONS (WxHxD)	REMARKS
L-1	DE439	EH PRICE	781	INTAKE	1200 x 450 x 100	COORINDATE FRAME, COLOR AND MOUNTING WITH ARCHITECT PRIOR TO ORDERING.
L-2	DE439	EH PRICE	25	INTAKE	300 x 300 x 100	COORINDATE FRAME, COLOR AND MOUNTING WITH ARCHITECT PRIOR TO ORDERING.

HYDRONIC PUMP SCHEDULE

TAG	DESCRIPTION	LOCATION	SERVICE	MAKE AND MODEL	PUMP HP	HEAD (m)	FLUID FLOW RATE (MIN/MAX)	RPM	STARTER TYPE	WORKING FLUID	VOLT/PHASE/Hz	FLA
P-1	SUBMERSIBLE GRINDER PUMP	OUTDOOR PIT	WATER FEATURE	SULZER PIRANHA PE28	3.75	19.8	1.3 / 3.5 L/S	3530	VFD	WATER	208/3/60	17.7

NOTES:
1. PUMP COMPLETE WITH WALL MOUNTED NEMA 4 WEATHER PROOF CONTROL PANEL, SUITABLE FOR OUTDOOR CONDITIONS.
2. PUMP TO OPERATE AT CONSTANT SPEED, COMPLETE WITH VFD FOR PROPER BALANCING AND WATER FLOW ADJUSTMENT.
3. PUMP TO COME COMPLETE WITH GUIDE RAIL BASE ASSEMBLY.

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PROJECT:
ORANGUTAN EXHIBIT

DRAWING NAME :
MECHANICAL SCHEDULES
HABITAT 1
NEW WORK PLAN

PROJECT NO.:	DRAWN BY :	CHECKED BY:
CM-18-391	DB	DB

DRAWING NUMBER:
MA-101

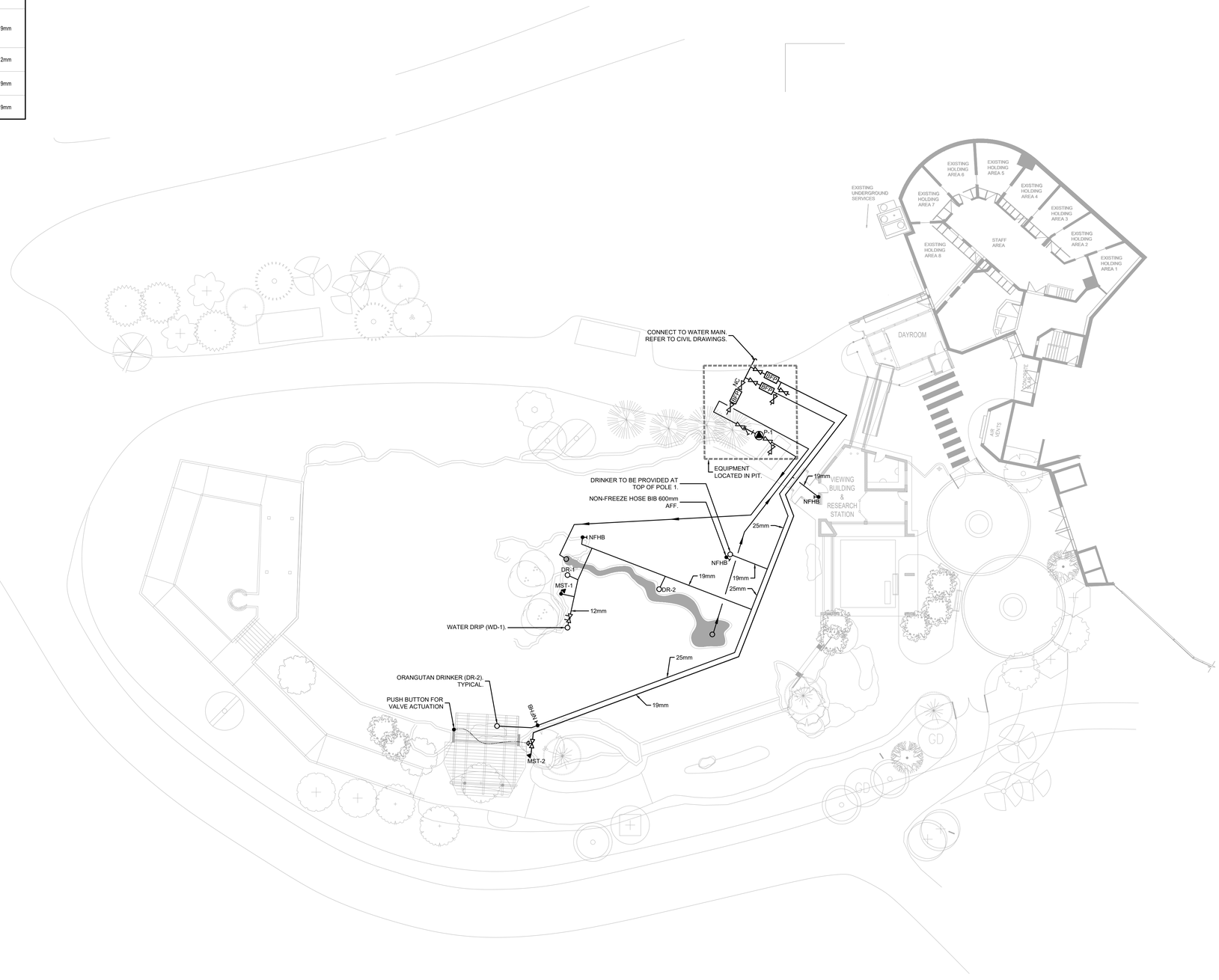
SCALE:
1:200
08.2019

PLUMBING FIXTURE TAGS

TAG	DESCRIPTION	SERVICE TYPE	SERVICE SIZE
DR-1	PROVIDE DRINKING SPOUT COMPLETE WITH PUSH BUTTON ACTUATION MOUNTED IN SHOTCRETE WALL. ACTUATION SHALL BE ENGAGED FOR AS LONG AS THE BUTTON IS PRESSED. ALL COMPONENTS TO BE WITHIN LOCKABLE, VANDAL PROOF COVER WITHIN SHOTCRETE.	NON-POTABLE WATER	19mm
DR-2	PROVIDE WATER CONNECTION FROM BELOW, PIPE INTO SHOTCRETE BOWL, COMPLETE WITH STRAINER AND PUSH BUTTON ACTUATION. ACTUATION SHALL BE ENGAGED FOR AS LONG AS THE BUTTON IS PRESSED. ALL COMPONENTS TO BE WITHIN LOCKABLE, VANDAL PROOF COVER WITHIN SHOTCRETE.	NON-POTABLE WATER	19mm
WD-1	WATER DRIP FEATURE IN SHOTCRETE. PROVIDE BALANCING VALVE WITHIN SHOTCRETE ROCK, LOCKABLE VANDAL PROOF COVER. PUSH BUTTON TIMED ACTUATION.	NON-POTABLE WATER	12mm
MST-1	WATER MISTER VIA PUSH BUTTON TIMED ACTUATION. ALL COMPONENTS INSTALLED WITHIN SHOTCRETE ROCK. LOCKABLE VANDAL PROOF COVER.	NON-POTABLE WATER	19mm
MST-2	WATER MISTER VIA PUSH BUTTON TIMED ACTUATION. ALL COMPONENTS INSTALLED WITHIN SHOTCRETE ROCK. LOCKABLE VANDAL PROOF COVER.	DOMESTIC COLD WATER	19mm

GENERAL NOTES

1.	ALL PIPING TO BE SLOPED BACK TO MAIN PIT FOR DRAINAGE DURING OFF SEASON.
2.	ALL NON-POTABLE WATER LINES SHOULD HAVE IDENTIFICATION TAGS IN PUBLIC AREAS. PROVIDE SIGN WHEN ENTERING EXHIBIT THROUGH VESTIBULE INDICATING ALL HOSE BIBS ARE NON-POTABLE.



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6	0	ISSUED FOR TENDER	2019-12-11

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CLIENT: TORONTO ZOO
toronto zoo
361A Old Finch Ave, Toronto ON M1B 5K7 · 416-392-5929

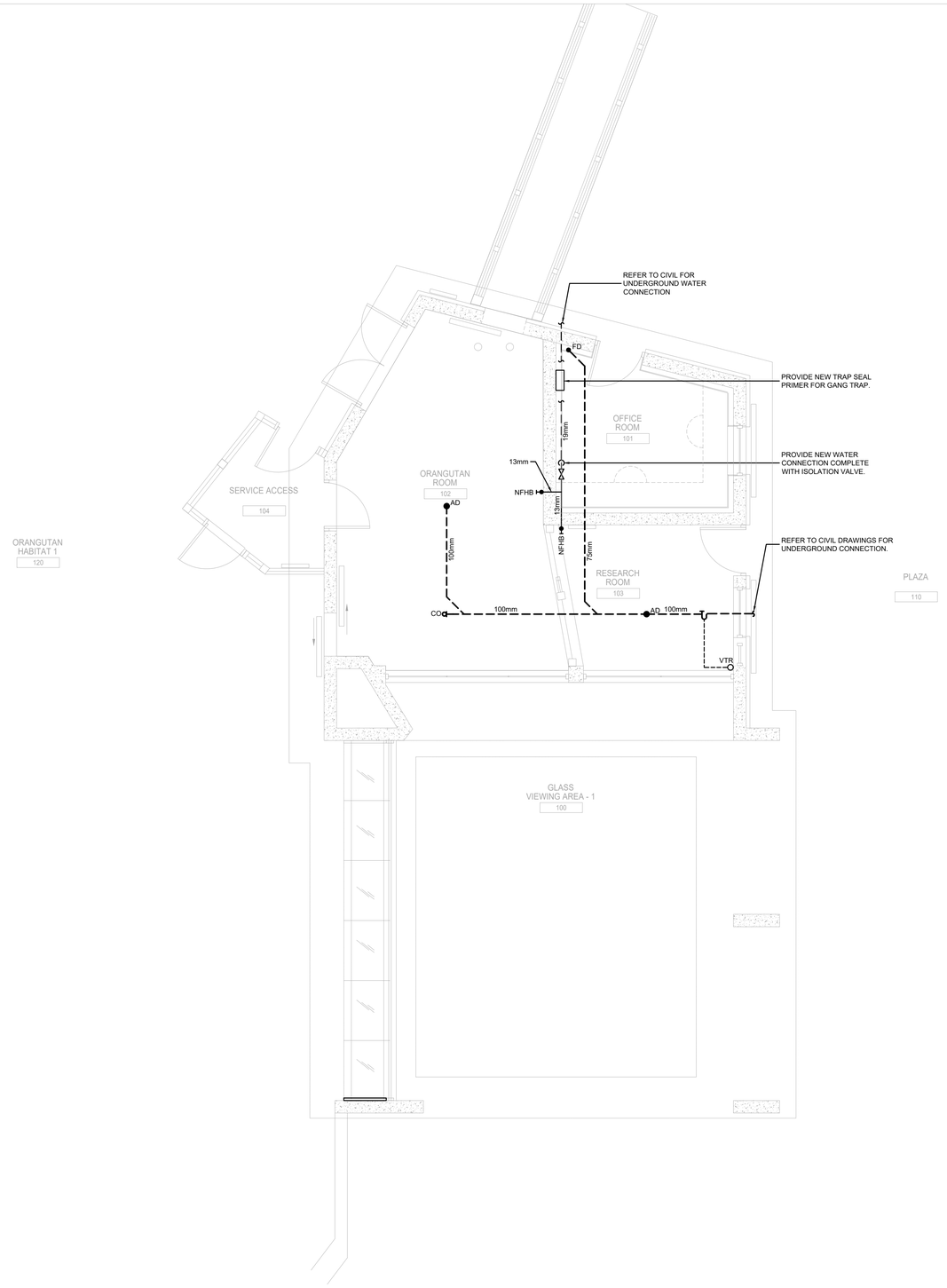
PROJECT:
ORANGUTAN EXHIBIT

DRAWING NAME :
PLUMBING
HABITAT 1
NEW WORK PLAN

PROJECT NO.:	DRAWN BY :	CHECKED BY:
CM-18-391	DB	DB

SCALE:
1:200
08.2019

DRAWING NUMBER:
MP-101



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CLIENT: **TORONTO ZOO**

toronto zoo
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PROJECT:
ORANGUTAN EXHIBIT

DRAWING NAME :

PLUMBING
HABITAT 1
ENLARGED NEW WORK PLAN

PROJECT NO.:	DRAWN BY :	CHECKED BY:
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MP-102

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toronto zoo
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PROJECT:
ORANGUTAN EXHIBIT

DRAWING NAME :

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HABITAT 1
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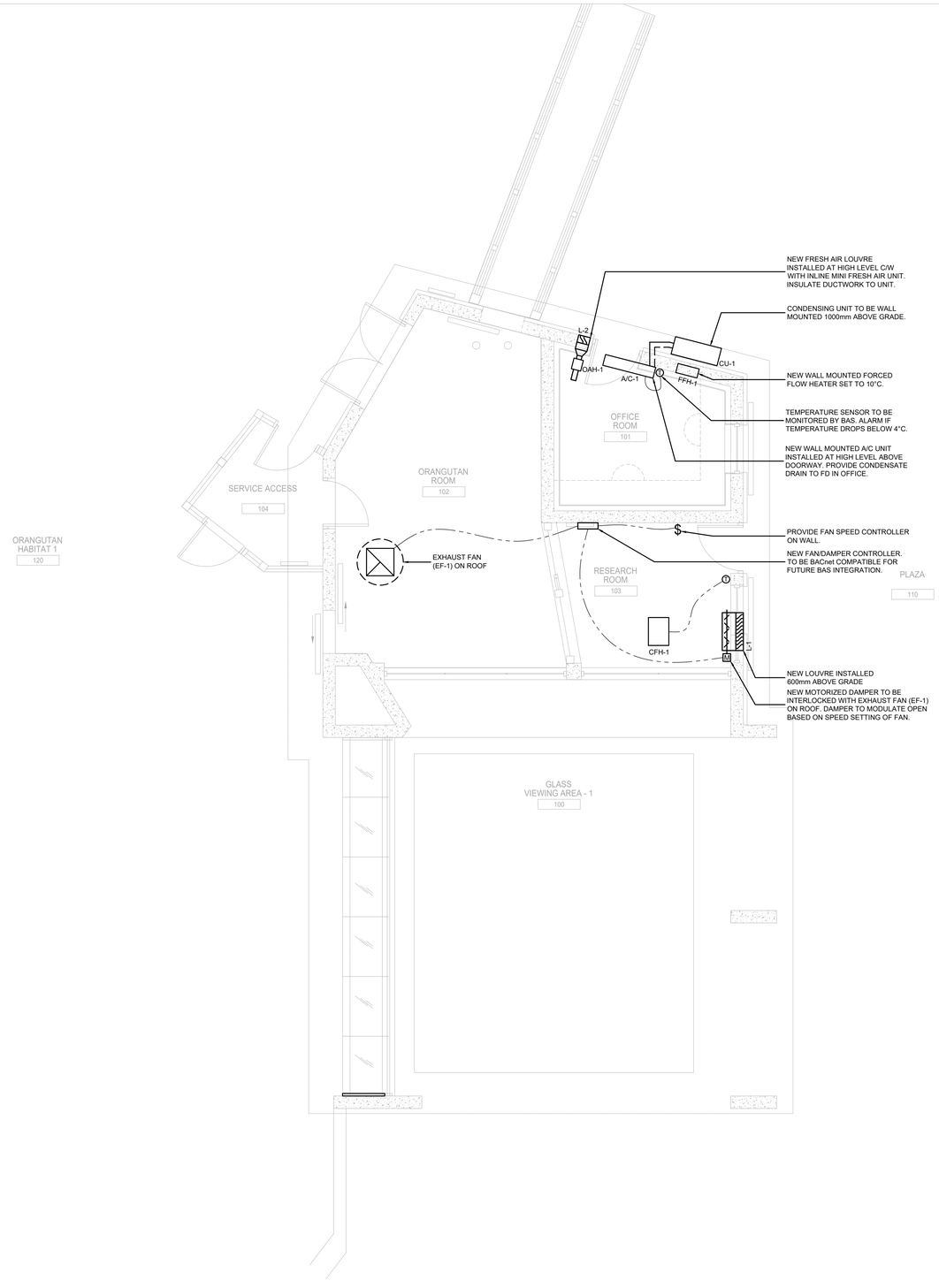
08.2019

MP-103



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CLIENT: TORONTO ZOO

toronto zoo
361A Old Finch Ave, Toronto ON M1B 5K7 · 416-392-5929

PROJECT:
ORANGUTAN EXHIBIT

DRAWING NAME :

HVAC
HABITAT 1
ENLARGED NEW WORK PLAN

PROJECT NO.:	DRAWN BY :	CHECKED BY:
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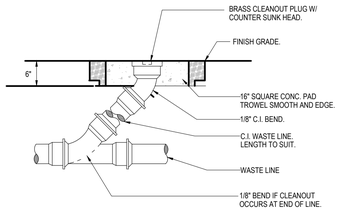
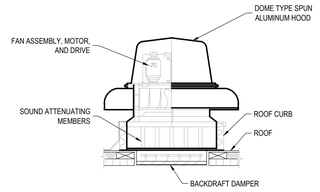
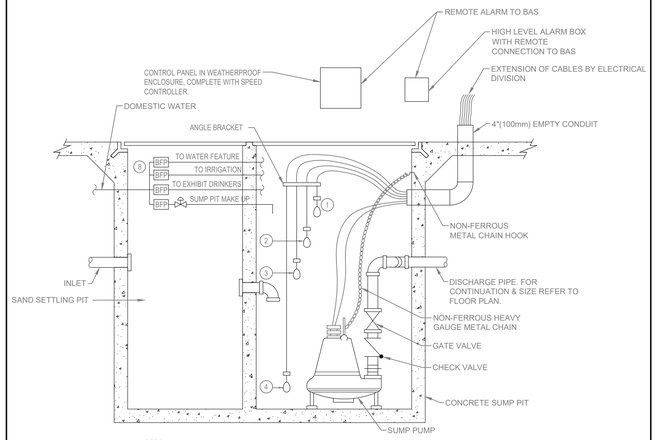
MV-101



3 FACILITY DRAINAGE PIPING FLOOR CLEANOUTS



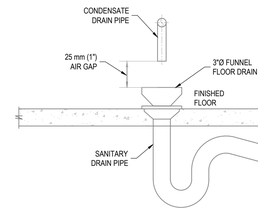
2 ROOF EXHAUST FAN



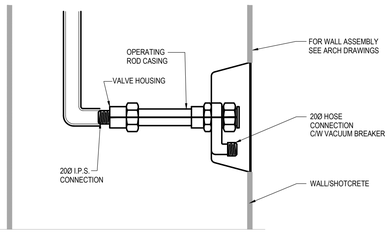
NOTES:

1. HIGH WATER LEVEL ALARM
2. MAKE UP WATER SHUT OFF
3. MAKE UP WATER OPERATING
4. LOW WATER LEVEL ALARM
5. NOT USED.
6. PROVIDE SUITABLE HEAVY GAUGE STEEL LADDER RUNGS 12" (300 mm) CENTRES FOR DEPTH OF PIT.
7. CAREFULLY CO-ORDINATE INSTALLATION OF COVER PLATE FRAME, PIPING, LADDER RUNGS & CHAIN HOOK WITH DIVISION RESPONSIBLE FOR SUMP PIT CONSTRUCTION.
8. PROVIDE NEW DOMESTIC WATER MAKE UP LINE AND SERVICE LINES FOR IRRIGATION, REMOTE DRINKERS AND HOSE BIBS, AND WATER MAKEUP FOR PUMP. EACH WATER SERVICE TO BE COMPLETE WITH BACKFLOW PREVENTER AND ISOLATION VALVES.

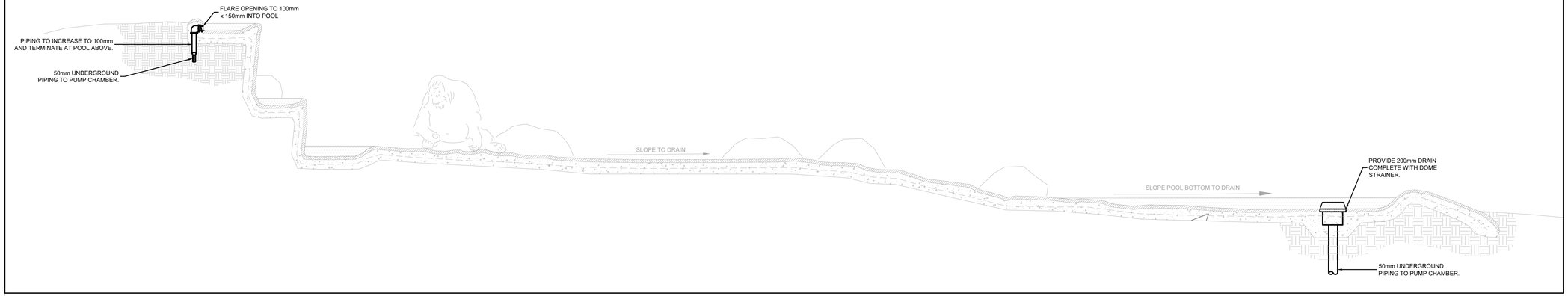
1 PUMP CHAMBER



5 CONDENSATE DRAIN TO FUNNEL FLOOR DRAIN



4 NON-FREEZE HOSE BIBB PIPING



6 STREAM PIPING CONNECTIONS
SCALE: 1:50

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PROJECT:
ORANGUTAN EXHIBIT

DRAWING NAME :
MECHANICAL
DETAILS

PROJECT NO.:	DRAWN BY :	CHECKED BY:
CM-18-391	DB	DB

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NTS
08.2019

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MX-100

GENERAL:

1. ALL DRAWINGS ARE FOR DIAGRAMMATIC PURPOSES ONLY AND SHALL BE READ IN CONJUNCTION WITH THE ARCHITECTURAL, LANDSCAPE, STRUCTURAL, AND MECHANICAL DRAWINGS.
2. MAINTAIN EXISTING FIRE ALARM, EXIT SIGNAGE AND EMERGENCY LIGHTING IN FULL OPERATION THROUGHOUT THE ENTIRE CONSTRUCTION STAGE. IF THE FIRE ALARM SYSTEM CANNOT BE MAINTAINED, PROVIDE FIRE WATCH FOR AREAS NOT MONITORED BY THE FIRE ALARM.
3. IN EVERY INSTANCE WHERE IT IS REQUIRED IN THE SPECIFICATION OR ON DRAWINGS THAT EQUIPMENT AND MATERIALS BE REMOVED FROM EXISTING LOCATIONS AND RE-INSTALLED, EITHER IN WHOLE OR IN PART IN NEW LOCATIONS, ALL SUCH EQUIPMENT AND MATERIALS SHALL BE THOROUGHLY CLEANED AND WHERE NECESSARY PUT INTO GOOD OPERATING CONDITION BEFORE BEING RE-INSTALLED IN THE NEW LOCATION. TEST ALL PARTS OF THE RE-USED OR RELOCATED ELECTRICAL EQUIPMENT AND CORRECT ALL FAULTS AND GROUNDS.
4. CONTRACTOR SHALL ENSURE THAT ELECTRICAL SERVICES (INCLUDING, BUT NOT LIMITED TO: AUXILIARY SERVICES, SECURITY, CRITICAL LOADS, FIRE ALARM SYSTEMS, ETC.) TO ANY AREAS OF THE BUILDING TO REMAIN IN OPERATION DURING CONSTRUCTION NOT BE AFFECTED UNDER ANY CONDITIONS. INCLUDE FOR ANY NECESSARY OVERTIME WORK AS REQUIRED.
5. ALL SLAB OPENINGS WILL BE X-RAYED AND REVIEWED WITH LANDLORD AND BASE BUILDING STRUCTURAL ENGINEER. COORDINATE ALL CORE DRILLING WITH LANDLORD'S SITE REPRESENTATIVE AND BASE BUILDING STRUCTURAL ENGINEER. ALL NOISY WORK SHALL BE PERFORMED AFTER HOURS.
6. ALL OPENINGS THROUGH RATED WALLS OR FLOORS (APPLIES TO ALL INSTANCES) SHALL BE SEALED WITH APPROVED FIRE STOPPING MATERIAL. ANY FIREPROOFING MATERIAL REMOVED WILL BE REPLACED WITH A SUITABLE AND APPROVED FIREPROOFING MATERIAL AND SHALL BE INSTALLED AS PER MANUFACTURER'S RECOMMENDATIONS TO APPLICABLE BUILDING AND FIRE CODES.
7. COORDINATE WITH THE CLIENT TO CONFIRM EQUIPMENT OR SYSTEMS/DEVICES TO REMAIN.
8. CONTRACTOR SHALL BE RESPONSIBLE FOR ALL REPAIR OF DAMAGED BUILDING AREAS AND FINISHES AFFECTED BY THE WORK AS OUTLINED UNDER SCOPE OF WORK OF THIS PROJECT.
9. THE CONTRACTOR IS RESPONSIBLE FOR THE INSTALLATION AND DISTRIBUTION OF TEMPORARY POWER AND LIGHTING WITHIN THE PREMISES DURING THE CONSTRUCTION PERIOD. EXPOSED ELECTRICAL CORDS OUTSIDE THE LEASED PREMISES SHALL NOT BE PERMITTED.
10. CONTRACTOR SHALL BE RESPONSIBLE FOR COORDINATION OF ALL THE WORK WITH ALL OTHER TRADES, CONSULTANTS, AND THE OWNER. ALL WORK SHALL BE SCHEDULED AND CARRIED OUT BY THE CONTRACTOR IN A MANNER TO ENSURE CONTINUED AND NON-INTERRUPTED OPERATION OF EXISTING FACILITY.
11. CONTRACTOR SHALL IDENTIFY AND LABEL CLEARLY ALL CIRCUITS, WIRING, SERVICES, JUNCTION BOXES, PULLBOXES, DEVICES AND EQUIPMENT INSTALLED AND CONNECTED UNDER SCOPE OF WORK OF THIS PROJECT. IDENTIFICATION SHALL BE AS PER OWNER'S REQUIREMENTS AND ALL MARKINGS SHALL BE OF NON-ERASEABLE LAMACOID TYPE. COORDINATE ALL LABELING WITH THE OWNER AND CONSULTANT.
12. ENSURE TO KEEP INSULATION OFF OF LIGHTS, FIRE ALARM DEVICES AND IN AREA OF DEVICES THAT REQUIRE REGULAR MAINTENANCE/ACCESS.
13. ALL NEW DEVICES INSTALLED WHERE NEW FINISHES OCCUR SHALL BE FLUSH MOUNTED, UNLESS OTHERWISE INDICATED.
14. ALL CONDUIT RUNS SHOWN ON PLANS ARE FOR INFORMATION AND DIAGRAMMATIC PURPOSES ONLY. CONTRACTOR SHALL VERIFY EXACT LOCATION AND ROUTING OF ALL RUNS ON SITE PRIOR TO BEGINNING WORK.
15. PROTECT ALL EXISTING STRUCTURES, SYSTEMS, FINISHES AND GENERAL CONSTRUCTION THAT ARE TO REMAIN THROUGHOUT THE COURSE OF THE WORK TO PREVENT DAMAGE OR LOSS.

DEMOLITION:

16. DEMOLITION DRAWINGS INDICATE VISIBLE DEVICES AND/OR SERVICES SEEN ONLY DURING CONSULTANT SITE VISIT. CONTRACTOR SHALL BE RESPONSIBLE FOR DETAILED SITE SURVEY OF ALL EXISTING AREAS (INCLUDING CEILING SPACE) DURING MANDATORY SITE WALKTHROUGH TO INVESTIGATE AND RECORD EXISTING BUILDING CONDITIONS PRIOR TO SUBMITTING THE BID. INCLUDE FOR ALL COSTS ASSOCIATED WITH DEMOLITION SCOPE OF WORK IN THE BID PRICE. CONTRACTOR SHALL BE RESPONSIBLE FOR FAMILIARIZING THEMSELVES FULLY WITH ALL EXISTING CONDITIONS BEARING UPON SCOPE OF WORK IDENTIFIED IN THE PROJECT DRAWINGS AND SPECIFICATIONS AND FOR INCLUSION OF ALL REQUIRED COSTS FOR THIS SCOPE OF WORK IN THE TENDER BID PRICE. NO ADDITIONAL COSTS ASSOCIATED WITH THE EXISTING CONDITIONS SHALL BE APPROVED BY THE OWNER DURING THE CONSTRUCTION OF THE PROJECT.
17. REMOVE ALL REDUNDANT POWER AND DATA CABLING IN CEILING SPACE AS PER ONTARIO FIRE CODE.
18. DEMOLISH ALL EQUIPMENT AS INDICATED BACK TO SOURCE AND MARK BREAKER AS SPARE. WHERE CIRCUIT SERVES OTHER EQUIPMENT TO REMAIN, DEMOLISH BACK TO NEXT DEVICE IN LINE. CONTRACTOR IS REQUIRED TO MAINTAIN OPERATION OF ALL EXISTING EQUIPMENT TO REMAIN.
19. CONTRACTOR SHALL REWORK EXISTING CIRCUITS THAT MAY BE AFFECTED BY ELECTRICAL WORK IN THE SCOPE OF THIS PROJECT.

POWER:

20. NEW ELECTRICAL WIRING AND CABLES EXPOSED WITHIN THE CEILING SPACES SHALL CONFORM TO THE PLENUM REQUIREMENTS OF THE LOCAL BUILDING CODE.
21. PROPERLY LABEL ALL ELECTRICAL PANELS, CLEARLY INDICATING ALL INFORMATION INCLUDING CIRCUIT NUMBERS. CIRCUITING SHOWN ON DRAWING IS DIAGRAMMATIC TO SHOW GENERAL CIRCUIT ARRANGEMENT AND PANEL DESIGNATION. RE-ARRANGE EXISTING BREAKERS IN EXISTING AND NEW PANELS AS REQUIRED TO SUIT NEW WORK REQUIREMENTS. SHOW FINAL ARRANGEMENT ON AS-BUILT DRAWINGS AND PROVIDE TYPED PANEL SCHEDULES WITHIN MODIFIED PANELBOARDS.
22. BE RESPONSIBLE FOR ALL EXISTING ELECTRICAL DEVICES TO REMAIN; CONNECT TO EXISTING CIRCUIT OR REWORK AND CONNECT TO NEW CIRCUIT AS SHOWN ON DRAWINGS.

ELECTRICAL LEGEND

SYMBOL	DESCRIPTION
	NEW WORK
	WORK TO BE DEMOLISHED, OR REMOVED
	EXISTING MATERIAL/EQUIPMENT/SERVICES TO REMAIN
	ABBREVIATIONS
E	EXISTING TO REMAIN
R	EXISTING TO BE DEMOLISHED/REMOVED
ER	EXISTING IN RELOCATED POSITION
RR	REMOVE AND RELOCATE
RL	REMOVE AND RELOCATE
C	CEILING MOUNTED CONNECTION
W	WALL MOUNTED CONNECTION
F	FLOOR MOUNTED CONNECTION
℄	CENTRE LINE
AFF	ABOVE FINISHED FLOOR
AFG	ABOVE FINISHED GRADE
O/C	OVER COUNTER
U/C	UNDER CABINET
U/F	UNDER RAISED FLOOR
CCT	CIRCUIT
CTE	CONNECT TO EXISTING
AFCI	ARC FAULT CIRCUIT INTERRUPTER
GFCI	GROUND FAULT CIRCUIT INTERRUPTER
GFI	GROUND FAULT INTERRUPTER
IG	ISOLATED GROUND
TL	TWIST LOCK
TR	TAMPER RESISTANT
WG	WIRE GUARD
WP	WEATHER PROOF
R/I	ROUGH-IN ONLY
NIC	NOT IN CONTRACT
SIM.	SIMILAR TO
TYP.	TYPICAL
	ABBREVIATIONS - CODES AND STANDARDS
OBC	ONTARIO BUILDING CODE
OESC	ONTARIO ELECTRICAL SAFETY CODE
	ANNOTATIONS
CL	CLOSET
WR	WASHROOM
	PLUMBING
PTP	ELECTRONIC TRAP PRIMER
PSC	PLUMBING SENSOR CONTROL (TOUCHLESS FAUCETS)
	HVAC
	THERMOSTAT OR TEMPERATURE SENSOR
T	
BBH	ELECTRIC BASEBOARD HEATER (BBH)
FFH	FORCED FLOW HEATER
ERV	ENERGY RECOVERY VENTILATOR
HRU	HEAT RECOVERY UNIT
MUA	MAKE-UP AIR UNIT
	CONDUIT AND BOXES
	CONDUIT WITH END BUSHING
	CONDUIT UP
	CONDUIT DOWN
	CONDUIT CONTINUES
JB	JUNCTION BOX
PB	PULL BOX
HH	HAND HOLE
	CONNECTIONS TO EQUIPMENT
DW	DISHWASHER
FR	FRIDGE
MW	MICROWAVE
HD	HAND DRYER. ALLOW UP TO 208V-1PH-20A
	1-PHASE DIRECT CONNECTION OUTLET AS NOTED.
	3-PHASE DIRECT CONNECTION OUTLET AS NOTED.
	SYSTEM FURNITURE WALL FEED FOR POWER AND TELECOMMUNICATIONS UNLESS NOTED OTHERWISE. 'C' ADJACENT TO SYMBOL DENOTES CEILING FEED, 'F' ADJACENT TO SYMBOL DENOTES FLOOR FEED.
W	ADJACENT TO 3-PHASE DIRECT CONNECTION, DENOTES WALL SYSTEM FURNITURE FEED FOR POWER AND COMMUNICATIONS.
	CONNECTION TO SINGLE PHASE MOTOR, HP (KW) AS NOTED. PROVIDE LOCAL DISCONNECT.
	THREE PHASE MOTOR, HP (KW) AS NOTED. PROVIDE LOCAL DISCONNECT.
	CLOCK.
	LIGHTING CONTROLS REFER TO SPECIFICATIONS AND RESPECTIVE SCHEDULES FOR EXACT REQUIREMENTS
S	SWITCH OR OTHER USER INTERFACE DEVICE AS DESCRIBED ON LIGHTING CONTROLS SCHEDULE.
S3	3-WAY SWITCH
DIM	ADJACENT TO SWITCH, DENOTES DIMMING SWITCH.
K	ADJACENT TO SWITCH, DENOTES KEY SWITCH.
PIR	PASSIVE INFRARED SENSOR
DT	DUAL TECHNOLOGY SENSOR
UT	ULTRASONIC SENSOR
OS	SENSOR (TYPE UNKNOWN)
M	ADJACENT TO SWITCH, DENOTES MASTER CONTROL FOR ALL LUMINAIRES IN A ROOM OR SPACE, OR AS NOTED.

THIS LEGEND IS GENERIC. ALL SYMBOLS LISTED MAY NOT BE APPLICABLE FOR THIS PROJECT. REFER TO FLOOR PLANS TO DETERMINE USED DEVICES AND EQUIPMENT.

ELECTRICAL LEGEND

SYMBOL	DESCRIPTION
PIR	WALL MOUNTED SWITCH/OCCUPANCY SENSOR. PIR DENOTES 'PASSIVE INFRARED', DT DENOTES 'DUAL PASSIVE INFRARED/ULTRASONIC'. LINE VOLTAGE TO SUIT CONTROLLED CIRCUIT, OR AS NOTED.
RP	RELAY PANEL
PP	POWER PACK
SC	SCENE CONTROLLER.
T	TIMER SWITCH.
P	PHOTOCELL SENSOR.
PC	PHOTOCELL SENSOR. 'PC' DENOTES CLOSED LOOP PHOTOCELL CONTROL, 'PO' DENOTES OPEN LOOP PHOTOCELL CONTROL
DT	CEILING MOUNTED OCCUPANCY SENSOR, PIR DENOTES 'PASSIVE INFRARED', UT DENOTES 'ULTRASONIC' (OR MICROPHONIC), DT DENOTES 'DUAL TECHNOLOGY', 'OS' DENOTES UNKNOWN TECHNOLOGY.
OT	WALL MOUNTED OCCUPANCY SENSOR.
	DISTRIBUTION EQUIPMENT
	TRANSFORMER, PLAN VIEW
	SURFACE MOUNTED LIGHTING AND RECEPTACLE PANELBOARD
	RECESSED RECEPTACLE AND LIGHTING PANELBOARD
	DISTRIBUTION PANELBOARD
	DISCONNECT SWITCH
	FUSED DISCONNECT SWITCH
C	CONTACTOR
	LOOSE STARTER. COORDINATE STARTING CHARACTERISTIC WITH EQUIPMENT REQUIREMENTS.
VFD	ADJACENT TO STARTER, DENOTES VARIABLE FREQUENCY DRIVE
	POWER RECEPTACLES AND BOXES
	120V U-GROUND DUPLEX RECEPTACLE.
	120V U-GROUND 20A DUPLEX RECEPTACLE.
	120V U-GROUND DUPLEX RECEPTACLE - AUTOMATICALLY CONTROLLED (ASHRAE 90.1-2013, 8.4.2).
	120V U-GROUND QUAD RECEPTACLE.
	SPECIAL RECEPTACLE. VERIFY OUTLET REQUIREMENTS PRIOR TO ROUGH-IN.
	120V U-GROUND DUPLEX RECEPTACLE MOUNTED ABOVE COUNTER TOP OR AS INSTRUCTED ON SITE.
	RECEPTACLE IN FLOOR BOX
USB	ADJACENT TO RECEPTACLE, INDICATES RECEPTACLE COMPLETE WITH ONE TYPE A AND ONE TYPE C USB CHARGING PORTS.
20A	ADJACENT TO RECEPTACLE DENOTES T-SLOT 20A, CSA TYPE 5-20R
	SERVICE POLE. PROVIDE POWER TO JUNCTION BOX IN CEILING SPACE ABOVE. DEVICES ON POLE AS NOTED ON PLANS.
FB1	FLOOR BOX [ADD SYMBOL]
	LIGHTING FIXTURES SYMBOLS IN ACCORDANCE WITH IES DG-3-00 WHERE NOT DETAILED OTHERWISE HERE. REFER TO LIGHTING FIXTURE SCHEDULE FOR FURTHER DETAILS AND EXACT FIXTURE REQUIREMENTS.
	SURFACE MOUNTED LINEAR LUMINAIRE
	LUMINAIRE RECESSED IN CEILING
	WALL MOUNTED LINEAR LUMINAIRE
	SUSPENDED LUMINAIRE: PENDANT, CHAIN, STEM, OR AIRCRAFT CABLE HUNG AS NOTED IN SCHEDULE.
	AS ABOVE, CONNECTED TO NIGHT LIGHT CIRCUIT
	AS ABOVE, CONNECTED TO EMERGENCY LIGHTING CIRCUIT
	RECESSED DOWNLIGHT
	RECESSED DOWNLIGHT
	RECESSED DOWNLIGHT, CONNECTED TO EMERGENCY OR NIGHT LIGHT CIRCUIT
	ROUND SUSPENDED LUMINAIRE
EM	CONNECTED TO EMERGENCY CIRCUIT
CE	CONNECTED TO EMERGENCY CIRCUIT. PROVIDE CUL 924 LISTED SHUNT TRIP RELAY TO PERMIT CONTROL OF LUMINAIRE BASED ON LOCAL LIGHTING CONTROLS.
NL	LUMINAIRE CONNECTED TO NIGHT LIGHT CIRCUIT (24 HOUR)
	TABLE LAMP
a, b, Z1, Z2, ETC.	DENOTES ZONING/CIRCUITING ASSIGNMENTS FOR LUMINAIRES AND CONTROLS IN THE SAME SPACE.
	EMERGENCY LIGHTING REFER TO EMERGENCY LIGHTING FIXTURE SCHEDULE FOR EXACT FIXTURE REQUIREMENTS.
	CEILING OR WALL MOUNTED ILLUMINATED EXIT SIGN. SHADED AREA INDICATES ILLUMINATED FACE. PROVIDE DIRECTIONAL ARROWS AS INDICATED ON PLANS.
	CEILING OR WALL MOUNTED ILLUMINATED EXIT SIGN. SHADED AREA INDICATES ILLUMINATED FACE. PROVIDE DIRECTIONAL ARROWS AS INDICATED ON PLANS.
RM	DENOTES 'RUNNING MAN' STYLE PICTOGRAM EXIT SIGNS
SL	DENOTES 'SELF-LUMINOUS' EXIT SIGN
PL	PHOTOLUMINOUS EXIT SIGN
	EMERGENCY LIGHTING BATTERY UNIT.
	ONE AND TWO HEAD WALL MOUNTED EMERGENCY LIGHTING REMOTE UNITS.

THIS LEGEND IS GENERIC. ALL SYMBOLS LISTED MAY NOT BE APPLICABLE FOR THIS PROJECT. REFER TO FLOOR PLANS TO DETERMINE USED DEVICES AND EQUIPMENT.

ELECTRICAL LEGEND

SYMBOL	DESCRIPTION
	RECESSED EMERGENCY REMOTE HEAD.
EM	DENOTES 'EMERGENCY'
	TELECOMMUNICATIONS
	SYSTEM FURNITURE FEED.
W	ADJACENT TO SYSTEM FURNITURE FEED, DENOTES WALL SYSTEM FURNITURE FEED FOR COMMUNICATIONS.
F	ADJACENT TO system furniture feed, DENOTES FLOOR SYSTEM FURNITURE FEED FOR COMMUNICATIONS
C	ADJACENT TO system furniture feed, DENOTES CEILING SYSTEM FURNITURE FEED FOR COMMUNICATIONS (SERVICE POLE OR DROP CORD AS NOTED).
	WALL MOUNTED DATA (D) OR VOICE (V) OUTLET. PROVIDE 1V AND 1D UNLESS NOTED OTHERWISE.
	WALL MOUNTED VOICE (TELEPHONE) OUTLET. PROVIDE 1V UNLESS NOTED OTHERWISE.
	WALL MOUNTED DATA OUTLET. PROVIDE 1D UNLESS NOTED OTHERWISE.
	WALL MOUNTED TELEVISION OUTLET.
B	ADJACENT TO COMMUNICATIONS OUTLET, INDICATES BLANK-OFF PLATE.
HDMI	HDMI OUTLET.
AV	AUDIO VIDEO GANG, AS NOTED.
WAP	WIRELESS ACCESS POINT (WIFI)
S	PUBLIC ADDRESS SPEAKER, CEILING AND WALL MOUNTED, RESPECTIVELY.
S	PUBLIC ADDRESS SPEAKER, WALL MOUNTED.
	PUBLIC ADDRESS SPEAKER, WALL MOUNTED HORN SPEAKER.
VOL S	PUBLIC ADDRESS SPEAKER VOLUME CONTROL SWITCH.
	INTERCOM
IDC	INSULATION DISPLACEMENT CONNECTION
	ACCESS CONTROL AND DOOR HARDWARE
CR	CARD READER
DA	DOOR ALARM SOUNDER
DC	DOOR CONTACT
EL	ELECTRIC LATCH
ES	ELECTRIC STRIKE
PTC	ELECTRIC POWER TRANSFER CABLE
PTH	POWER TRANSFER HINGE
KS	KEY SWITCH
ML	ELECTROMAGNETIC LOCK
REX	REQUEST TO EXIT SENSOR
	MUSHROOM HEAD PUSH BUTTON FOR MAGLOCK RELEASE, OR OTHER PUSH BUTTON AS INDICATED
	BARRIER FREE DOOR OPERATOR PUSH BUTTON
WS	TOUCHLESS "WAVE SWITCH" FOR DOOR OPERATOR CONTROL
R	DOOR BELL C/W SOUNDER AND STROBE
R	DOOR BELL (SOUNDER ONLY)
	INTRUSION DETECTION
	GLASS BREAK (GB)
MD	MOTION DETECTOR (MD)
KP	KEYPAD (KP)
	VIDEO SURVEILLANCE
	CCTV CAMERA
PTZ	PAN-TILT-ZOOM
	DURESS SYSTEM
DB	DURESS BUTTON (MOUNTED ON UNDERSIDE OF TABLETOP)
DB-W	WALL MOUNTED DURESS BUTTON WITH POLYCARBONATE ANTI-TAMPER COVER
	FIRE DETECTION AND ALARM
CACF	CENTRAL ALARM AND CONTROL FACILITY
FACP	FIRE ALARM CONTROL PANEL
FAAP	FIRE ALARM ANNUNICIATOR PANEL
FAAG	FIRE ALARM ACTIVE ANNUNCIATOR C/W GRAPHIC
FAPG	FIRE ALARM PASSIVE GRAPHIC
DGP	DATA GATHERING PANEL
FAZ	FIRE ALARM ZONE
FSZ	FIRE ALARM SUPERVISORY ZONE
FDSPCP	FIRE DETECTION, SUPPRESSION, AND PRE-ACTION CONTROL PANEL
FDSCP	FIRE DETECTION AND SUPPRESSION CONTROL PANEL
DNE	"DO NOT ENTER" SIGN
EOL	END OF LINE DEVICE
WG	WIRE GUARD
	MANUAL PULL STATION (MPS) C/W POLYCARBONATE (LEXAN) COVER
	MANUAL PULL STATION (MPS)
LX	WHERE NOTED ADJACENT TO MANUAL PULL STATIONS, DENOTES PULL STATION C/W POLYCARBONATE (LEXAN) COVER.
AUX	WHERE NOTED ADJACENT TO MANUAL PULL STATIONS, DENOTES MANUAL PULL STATION C/W AUXILIARY CONTACT.
FF	EMERGENCY TELEPHONE FOR FIREFIGHTER'S USE
	FIRE ALARM BELL, WALL MOUNTED.
C	ADJACENT TO BELL OR HORN, DENOTES CEILING MOUNTED.
	FIRE ALARM HORN
M	ADJACENT TO FIRE ALARM HORN, DENOTES 'MINI' HORN
	FIRE ALARM HORN/STROBE, WALL MOUNTED.
	FIRE ALARM EVACUATION SPEAKER, CEILING MOUNTED
	FIRE ALARM EVACUATION SPEAKER, COMPLETE WITH STROBE LIGHT, CEILING MOUNTED

THIS LEGEND IS GENERIC. ALL SYMBOLS LISTED MAY NOT BE APPLICABLE FOR THIS PROJECT. REFER TO FLOOR PLANS TO DETERMINE USED DEVICES AND EQUIPMENT.

ELECTRICAL LEGEND

SYMBOL	DESCRIPTION
	FIRE ALARM EVACUATION SPEAKER, WALL MOUNTED
	FIRE ALARM EVACUATION SPEAKER COMPLETE WITH STROBE LIGHT, WALL MOUNTED
	FIRE ALARM WALL MOUNTED STROBE LIGHT
	PHOTOELECTRIC SMOKE DETECTOR
A	ADJACENT TO SMOKE DETECTOR, INDICATES C/W AUXILIARY RELAY
	RESIDENTIAL SMOKE ALARM, 120 VOLT. FOR AREAS AS INDICATED ON PLANS, PROVIDE INTEGRAL CARBON MONOXIDE DETECTION. 'CO' ADJACENT TO DETECTOR DENOTES C/W CARBON MONOXIDE DETECTION.
	SAME AS ABOVE, WALL MOUNTED
DSD	DUCT MOUNTED SMOKE DETECTOR
	DUCT MOUNTED SMOKE DETECTOR
CO	CARBON MONOXIDE DETECTOR
VESDA	VERY EARLY SMOKE DETECTING APPARATUS
BSDT	BEAM SMOKE DETECTOR TRANSMITTER
BSDR	BEAM SMOKE DETECTOR RECEIVER (OR REFLECTOR)
ASD	ASPIRATING SMOKE DETECTOR
EOL	END OF LINE (EOL) DEVICE ON ZONE INITIATION OR SIGNAL CIRCUITS
KS	KEY SWITCH FOR FIREFIGHTER CONTROL OF ELEVATOR RECALL, OR AS NOTED
IM	ISOLATOR MODULE
	HEAT DETECTOR - FIXED TEMPERATURE
	SAME AS ABOVE, WALL MOUNTED
HT	ADJACENT TO HEAT DETECTOR, DENOTES "HIGH TEMPERATURE"
	HEAT DETECTOR - 94 DEGREES C (200 DEGREES F) FIXED TEMPERATURE
	HEAT DETECTOR - 58 DEGREES C (135 DEGREES F) FIXED TEMPERATURE AND RATE OF RISE
HO	MAGNETIC DOOR HOLDER AND RELEASING DEVICE ("HOLD OPEN")
FS	FLOW SWITCH
PS	PRESSURE SWITCH
SV	SUPERVISED VALVE
	SINGLE LINE DIAGRAM
	AIR CIRCUIT BREAKER
	MOLDED CASE CIRCUIT BREAKER
	DISCONNECT (UNFUSED)
	FUSE
M	METERING CABINET
	BUS DUCT
	TRANSFORMER
ATS	AUTOMATIC TRANSFER SWITCH
C	CONTACTOR
DP	DISTRIBUTION PANELBOARD
LP	LIGHTING PANELBOARD
MCB	MOBILE CONNECTION BOX
MCC	MOTOR CONTROL CENTRE
MTS	MANUAL TRANSFER SWITCH
RP	RECEPTACLE PANELBOARD
SPD	SURGE PROTECTIVE DEVICE
STS	STATIC TRANSFER SWITCH
SWBD	SWITCHBOARD
TX	TRANSFORMER
UPS	UNINTERRUPTIBLE POWER SUPPLY
	DETAIL REFERENCES
1	SHEET KEYNOTE
1	REVISION NUMBER

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DRAWING LIST

Sheet Number	Sheet Title
EA-100	ELECTRICAL SYMBOLS AND DRAWING LIST
EP-101	POWER AND SYSTEMS - HABITAT 1 - NEW WORK
EP-102	POWER AND SYSTEMS RESEARCH STATION ENLARGED NEW WORK PLAN
EP-103	ELECTRICAL POWER AND SYSTEMS - BOARDWALK NEW WORK
EP-104	ELECTRICAL POWER AND SYSTEMS - PATHWAY NEW WORK
EP-105	LIGHTING RESEARCH STATION ENLARGE NEW WORK PLAN
EP-107	POWER AND SYSTEMS - HABITAT 2 - NEW WORK
EX-101	ELECTRICAL SCHEDULE AND DETAILS
EX-102	ELECTRICAL DETAILS

NO.	REV.	ISSUED FOR	DATE
1	0	ISSUED FOR PROGRESS REVIEW	2019-08-23
2	0	ISSUED FOR PROGRESS REVIEW	2019-10-18
3	0	ISSUED FOR 100% CD	2019-11-11
4	0	ISSUED FOR PERMIT	2019-11-14
5	0	ISSUED FOR TENDER REVIEW	2019-12-06
6	0	ISSUED FOR TENDER	2019-12-11

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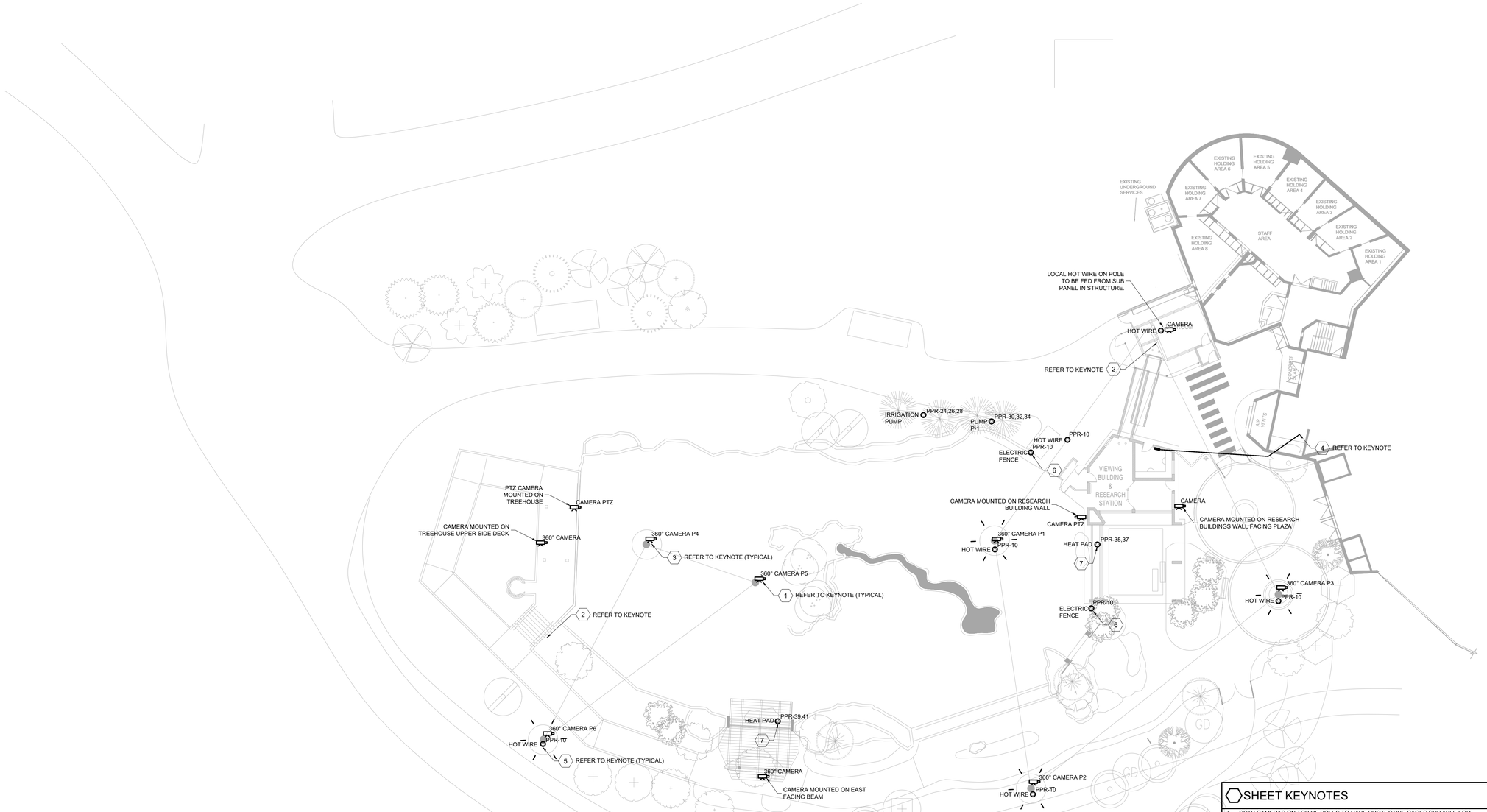
PROJECT:
ORANGUTAN EXHIBIT

DRAWING NAME :
ELECTRICAL SYMBOLS AND DRAWING LIST

PROJECT NO.:	DRAWN BY:	CHECKED BY:
CM-18-391	MI	MI

SCALE: N.T.S.
08.2019

DRAWING NUMBER:
EA-100



SHEET KEYNOTES

1. CCTV CAMERAS ON TOP OF POLES TO HAVE PROTECTIVE CAGES SUITABLE FOR DETENTION AREA. CAMERAS TO BE MOUNTED AS FLUSH AS POSSIBLE TO ELIMINATE GRABBING BY ANIMALS.
2. PROVIDE EMPTY CONDUIT FOR POWER AND DATA BACK TO RESEARCH STATION
3. POWER AND COMMUNICATION CONDUITS FEEDING CAMERAS SHALL BE TAMPERPROOF AND OUT OF REACH OF ANIMALS (2m REACH). CAMERA CABLING SHALL BE MINIMUM CAT6. WHERE CAMERA RUN LENGTH EXCEEDS 90m, PROVIDE A HYBRID FIBRE COMMUNICATIONS CABLE WITH INTEGRATED LOW VOLTAGE POWER CABLE TO CONVERT MEDIA TYPE. CCTV POWER AND COMMUNICATIONS CABLING TO BE RUN UNDERGROUND TO RESPECTIVE POLE WHERE WITHIN HABITAT PERIMETER.
4. NEW POWER CONNECTION FROM SWITCHBOARD DP-MA OR DP-MB IN BASEMENT TO FEED POWER PANEL PP-RESEARCH. CONTRACTOR TO VERIFY EXISTING ELECTRICAL LOAD ON PANELS PRIOR TO CONNECTION TO VERIFY ELECTRICAL CAPACITY FOR NEW LOAD.
5. REFER TO ARCHITECTURAL DRAWINGS FOR HOT WIRE INSTALLATION LOCATION.
6. REFER TO ARCHITECTURAL AND LANDSCAPE DRAWINGS FOR ELECTRIC FENCE INSTALLATION LOCATIONS.
7. HEAT PADS TO ALLOW FOR TEMPERATURE CONTROL UP TO 20 DEGREE CELCIUS. ALL ELECTRICAL BOXES SHALL BE LOCATED OUTSIDE OF THE HABITAT. ALL CONDUIT AND CABLING WITHIN THE HABITAT TO BE BURIED.

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CLIENT: TORONTO ZOO

toronto zoo
361A Old Finch Ave, Toronto ON M1B 5K7 · 416-392-5929

PROJECT:
ORANGUTAN EXHIBIT

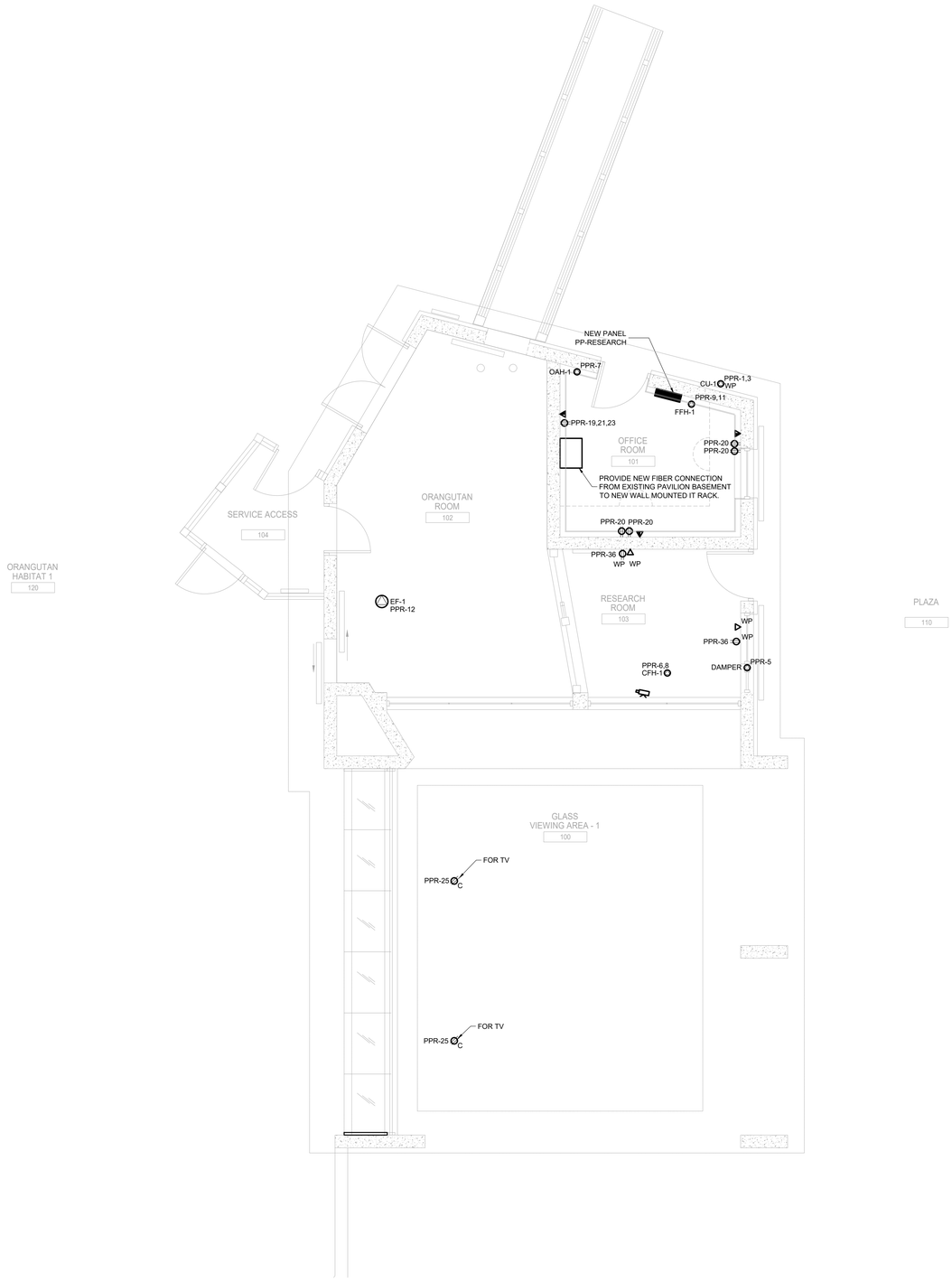
DRAWING NAME :

POWER AND SYSTEMS
HABITAT 1
NEW WORK

PROJECT NO.:	DRAWN BY :	CHECKED BY:
CM-18-391	MI	MI

SCALE:
1:200
08.2019

DRAWING NUMBER:
EP-101



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PROJECT:
ORANGUTAN EXHIBIT

DRAWING NAME :

POWER AND SYSTEMS RESEARCH STATION ENLARGED NEW WORK PLAN

PROJECT NO.: CM-18-391
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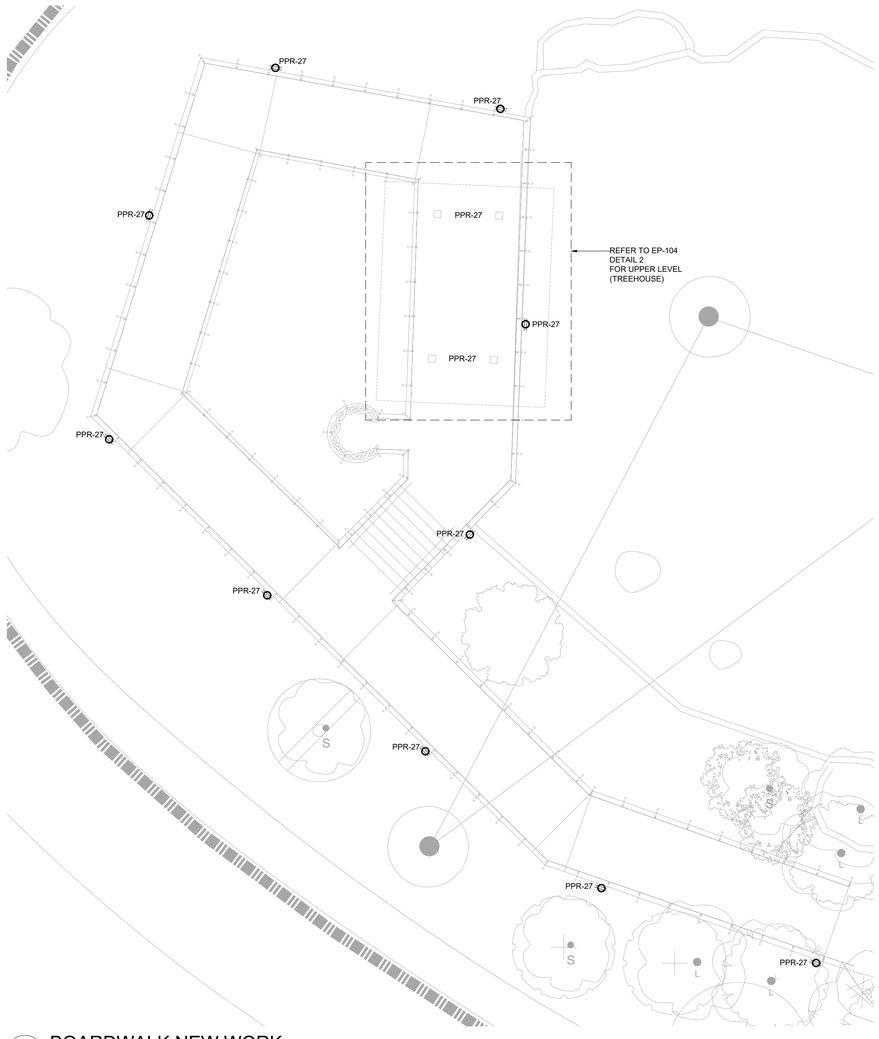
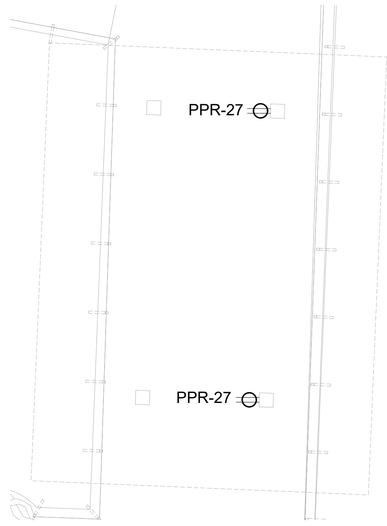
SCALE: 1:50
08.2019

DRAWING NUMBER: EP-102



1 BOARDWALK NEW WORK
SCALE: 1:100



2 TREEHOUSE NEW WORK
SCALE: 1:50

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PROJECT:
ORANGUTAN EXHIBIT

DRAWING NAME :
POWER AND SYSTEMS
BOARDWALK
NEW WORK

PROJECT NO.: CM-18-391
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08.2019
EP-103

NO.	REV.	ISSUED FOR	DATE
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PROJECT:
ORANGUTAN EXHIBIT

DRAWING NAME :

POWER AND SYSTEMS
PATHWAY
NEW WORK

PROJECT NO.: CM-18-391

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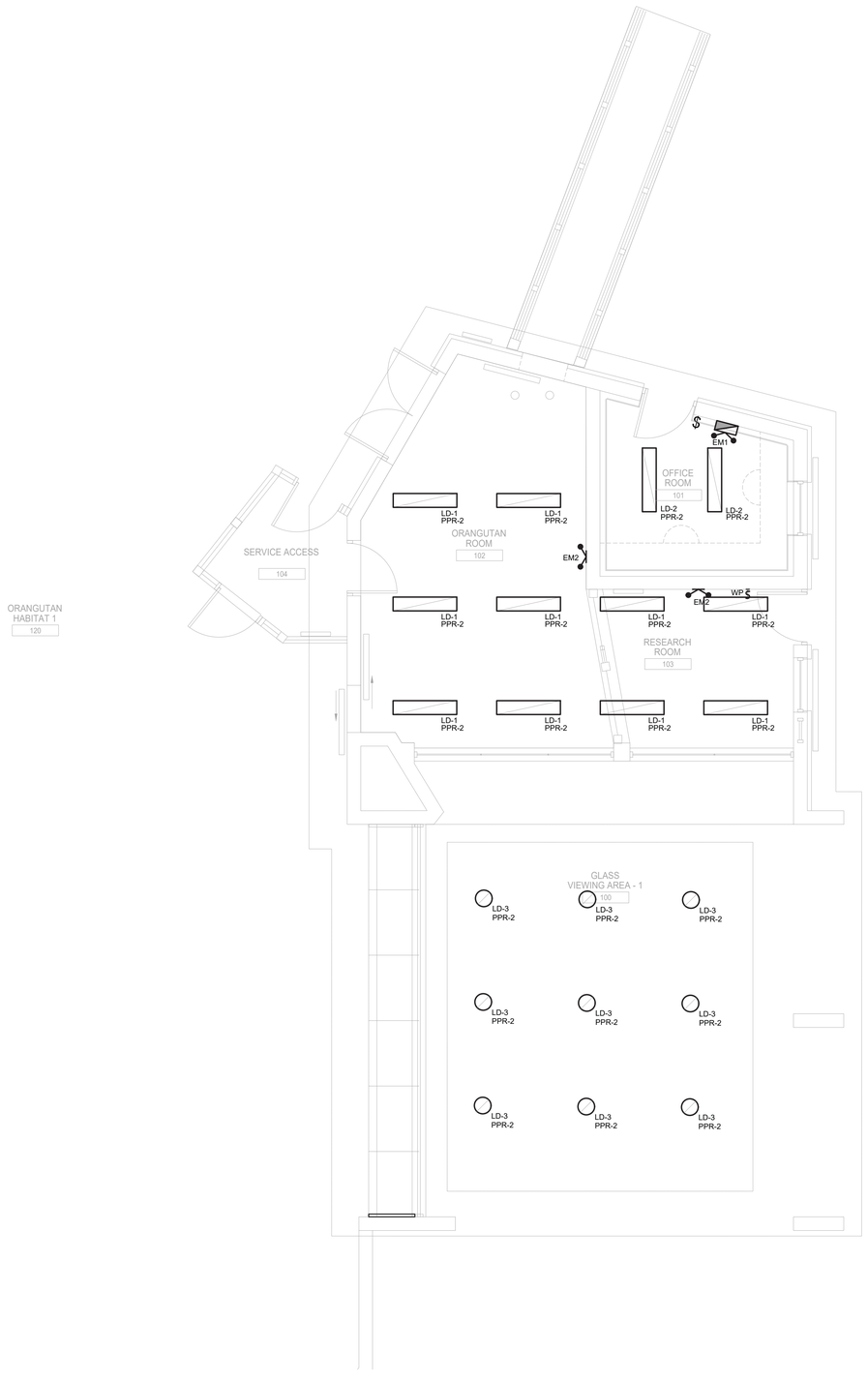
EP-104



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PROJECT:
ORANGUTAN EXHIBIT

DRAWING NAME :

LIGHTING
RESEARCH STATION
ENLARGED NEW WORK PLAN

PROJECT NO.: CM-18-391

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DRAWING NUMBER:
EP-105

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PROJECT:
ORANGUTAN EXHIBIT

DRAWING NAME :

POWER AND SYSTEMS
HABITAT 2
NEW WORK

PROJECT NO.:	DRAWN BY :	CHECKED BY:
CM-18-391	MI	MI

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1:200
08.2019

DRAWING NUMBER:
EP-107

ELECTRICAL PANELBOARD SCHEDULE

PANEL ID: PP-RESEARCH (PPR)	VOLTS: 120/208V	LOCATION: RESEARCH BUILDING
MAIN BUS: 225A	PHASE: 3	FED FROM: DP-MA/MB
MAIN BREAKER: 225A	WIRE: 4	FEEDER ENTRY AT: BOTTOM
TYPE:	MOUNTING: SURFACE	FEEDER:
INTERRUPTING CAPACITY 14kAIC	ENCLOSURE RATING:	REMARKS:

CIR NO.	DESCRIPTION	PHASE VA ØA	PHASE VA ØB	PHASE VA ØC	BRKR	Ø	BRKR	PHASE VA ØA	PHASE VA ØB	PHASE VA ØC	DESCRIPTION	CIR NO.
1	A/C-1	1300	-	-	20A	A	20A	889	-	-	LIGHTING	2
3		-	1300	-		B	15A	-	0	-	SPARE	4
5	DAMPER (ORANG ROOM)	-	-	200	15A	C	20A	-	-	1500	CFH-1	6
7	OAH-1	1500	-	-	20A	A		1500	-	-		8
9	FFH-1	-	1000	-	15A	B	15A	-	0	-	HOTWIRE	10
11		-	-	1000		C	15A	-	-	264	EF-1	12
13	PP-HABITAT1	0	-	-	100A	A	100A	0	-	-	PP-DAYROOM	14
15		-	0	-		B		-	0	-		16
17		-	-	0		C		-	-	0		18
19	COMMUNICATIONS RACK	207	-	-	30A	A	15A	1333	-	-	OFFICE RECEPTACLE 3X	20
21		-	207	-		B	15A	-	2	-	IRRIGATION CONTROLLER	22
23		-	-	207		C		-	-	2006	IRRIGATION PUMP	24
25	TV RECEPTACLES	889	-	-	15A	A	40A	2006	-	-		26
27	BOARDWALK RECEPTACLES	-	1200	-	15A	B		-	2006	-		28
29	BOARDWALK RECEPTACLES	-	-	1200	15A	C		-	-	2126		30
31	TREEHOUSE CAMERAS	222	-	-	15A	A	40A	2126	-	-	P-1 GRINDER PUMP	32
33	SPARE	-	0	-	15A	B		-	2126	-		34
35	HEATING PAD 1	-	-	1810	40A	C	15A	-	-	1200	RECEPTACLE (ORANG ROOM)	36
37		1810	-	-		A		0	-	-		38
39	HEATING PAD 2	-	1810	-	40A	B		-	0	-		40
41		-	-	1810		C		-	-	0		42
43		0	-	-		A		0	-	-		44
45		-	0	-		B		-	0	-		46
47		-	-	0		C		-	-	0		48
49		0	-	-		A		0	-	-		50
51		-	0	-		B		-	0	-		52
53		-	-	0		C		-	-	0		54
55		0	-	-		A		0	-	-		56
57		-	0	-		B		-	0	-		58
59		-	-	0		C		-	-	0		60

TOTAL ØA: 13,782 VA , TOTAL ØB: 13323VA , TOTAL ØC: 13,323VA

NOTES:

* - PROVIDE LOCKABLE BREAKER
** - PROVIDE GFI TYPE BREAKER
*** - COORDINATE EXACT BREAKER SIZE WITH EQUIPMENT SHOP DRAWINGS
R - RECEPTACLE
L - LIGHTING

CIRCUIT NUMBERS ARE GIVEN FOR GROUPING ONLY. SITE VERIFY AVAILABLE CIRCUIT BREAKER SPACES IN PANELS DURING TENDER WALKTHROUGH.

3. SUBMIT SHOP DRAWINGS FOR CONSULTANT'S REVIEW PRIOR TO PLACING ANY ORDER.

1 EXISTING SWITCHBOARD ELEVATION
SCALE: N.T.S.

LIGHTING FIXTURE SCHEDULE

SYMBOL	TYPE	DESCRIPTION	BASIS OF DESIGN MANUFACTURER AND CAT NO. SEE NOTE 1	VOLTAGE/ INPUT WATTS	LUMEN PACKAGE (3500 K CCT UNLESS NOTED OTHERWISE) MINIMUM 80 CRI	MOUNTING	REFERENCE	REMARKS
	LD1	VANDAL-PROOF 1'X4' LED LUMINAIRE. CRS BACKBOX, POLYCARBONATE LENS. TAMPERPROOF.	53L14-B-L2-40-1-2-A	120 V 50 WATTS	5750 LUMEN	SURFACE MOUNTED		
	LD2	1'X4' LED TROFFER, 4000K	LACH3-14G-30-40K-12	120V 25 WATTS	3041 LUMEN	T-BAR CEILING		
	LD3	6" ADJUSTABLE LED. 4000K, DAMP RATED	LFA6SL-6LFASL-15L-40K-8-WFL45	120V 15.7 WATTS	1214 LUMEN	RECESSED		
	EM1	EMERGENCY LED BATTERY PACK WITH BATTERY UNIT AND REMOTE HEADS	COOPER XR6C-LED	120V	300 LUMEN PER HEAD	WALL MOUNT		
	EM2	EMERGENCY REMOTE HEADS WITH WEATHERPROOF VANDAL RESISTANT POLYCARBONATE COVER	COOPER XR6C-LED COOPER VS2WP VANADL WEATHERPROOF COVER	120V	300 LUMEN PER HEAD	WALL MOUNT		

LIGHTING FIXTURE SCHEDULE NOTES:
1. ACCEPTED ALTERNATE MANUFACTURES AND SUPPLIERS: ACUITY BRANDS (LITHONIA), CREE CANADA, JUNO LIGHTING BY SCHNEIDER ELECTRIC, LSI INDUSTRIES, PHILIPS LIGHTING, VISCOR/VISIONEERING.
2. WHERE AN INCOMPLETE MODELCAT NO. IS LISTED, MANUFACTURERS/SUPPLIERS MUST CONFIRM THE PROPOSED FIXTURE WITH THE CONSULTANT A MINIMUM OF ONE WEEK PRIOR TO TENDER CLOSE.
3. SUBMIT SHOP DRAWINGS FOR CONSULTANT'S REVIEW PRIOR TO PLACING ANY ORDER.

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4	0	ISSUED FOR PERMIT	2019-11-14
5	0	ISSUED FOR TENDER REVIEW	2019-12-06
6	0	ISSUED FOR TENDER	2019-12-11

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STAMP

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CLIENT: TORONTO ZOO
toronto zoo
361A Old Finch Ave, Toronto ON M1B 5K7 · 416-392-5929

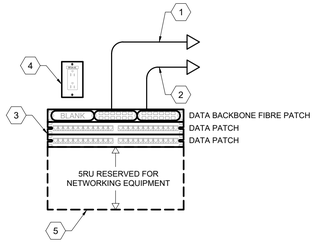
PROJECT:
ORANGUTAN EXHIBIT

DRAWING NAME :
ELECTRICAL
SCHEDULE AND DETAILS

PROJECT NO.: CM-18-391
DRAWN BY :
CHECKED BY:

SCALE: N.T.S.
08.2019

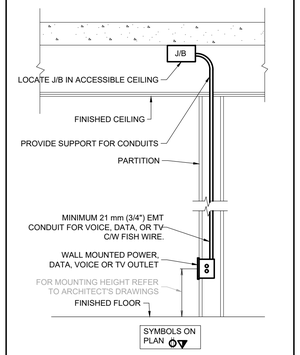
DRAWING NUMBER:
EX-101



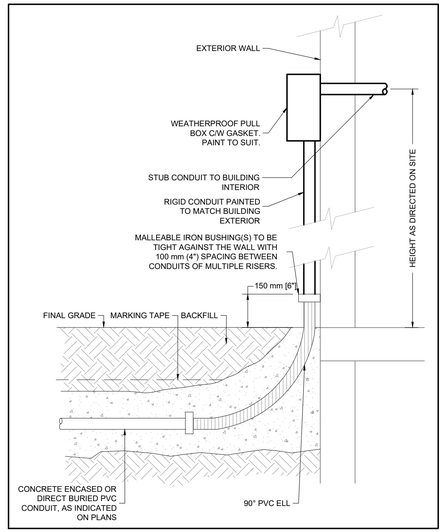
DETAIL KEYNOTES

1.	MULTIMODE BACKBONE: 6-STRAND OM1 (MMOF) C/W LC-DUPLEX AT EACH END TO IT ROOM ON P1 LEVEL.
2.	SINGLE MODE BACKBONE: 6-STRAND OS2 (SMOF) C/W LC-DUPLEX AT EACH END TO IT ROOM ON P1 LEVEL.
3.	24-PORT 1RU FLAT COPPER PATCH FOR DATA, TYPICAL OF TWO.
4.	120 VOLT, 15A CIRCUIT FOR NETWORK SWITCH POWER.
5.	WALL MOUNT CABINET.

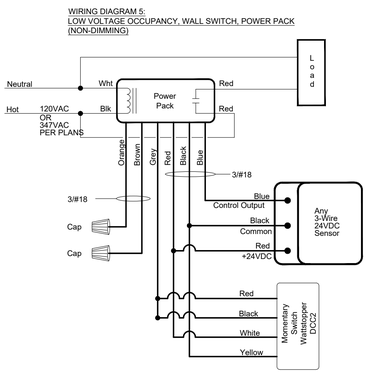
7 COMMUNICATIONS EQUIPMENT PATCH CABINET
SCALE: N.T.S.



6 WALL MOUNTED OUTLET BOX
SCALE: N.T.S.



5 UNDERGROUND CONDUIT BUILDING TRANSITION
SCALE: N.T.S.



TYPICAL APPLICABLE SPACES:
1. ELECTRICAL/MECHANICAL ROOMS.
2. SMALL RESTROOMS
3. SMALL STORAGE ROOMS
4. SPACES WITH ONLY ONE LUMINAIRE WITH RATED INPUT POWER LESS THAN 100 W.

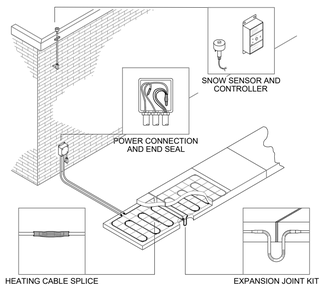
SEQUENCE OF OPERATION:
4. MANUAL ON (VACANCY MODE).
5. MANUAL OFF/AUTO OFF AFTER 15 MINUTES AFTER NO OCCUPANCY DETECTED.

INSTALLATION NOTES:
1. WIRING DIAGRAM BASIS OF DESIGN IS WATTSTOPPER. REFER TO LIGHTING CONTROL DEVICE SCHEDULE FOR OTHER MANUFACTURERS.
2. CONFIRM EXACT WIRING DIAGRAM WITH MANUFACTURER.

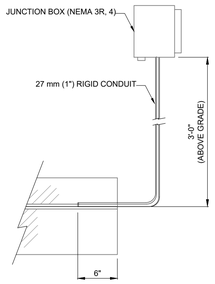
2.1. POWER PACKS:
2.1.1. PP1 - WATTSTOPPER BZ-50 (120 V).
2.1.2. PP3 - CONFIRM WITH MANUFACTURER.
2.2. MOMENTARY SWITCH: UI-SW-2 - WATTSTOPPER DCC2.
2.3. CEILING MOUNTED SENSORS: UT-C-2, DT-C-2 (REFER TO SCHEDULE).
3. PROVIDE LED SIGNAL WIRES FOR WATTSTOPPER DCC2 MOMENTARY SWITCHES AS PER TYPICAL WIRING DETAIL, TYPICAL OF 2.

CODE REFERENCE NOTES:
1. ASHRAE 90.1-2013, 9.4.1.2 - OCCUPANT SENSOR [...] TURNS LIGHTING OFF WITHIN 20 MINUTES OF ALL OCCUPANTS LEAVING A SPACE IN [LISTED SPACES].

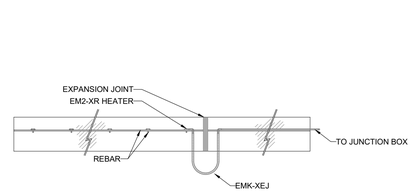
3 CEILING MOUNTED SENSOR WITH WALL SWITCH WIRING DIAGRAM
SCALE: N.T.S.



SYSTEM LAYOUT AND TYPICAL DETAILS

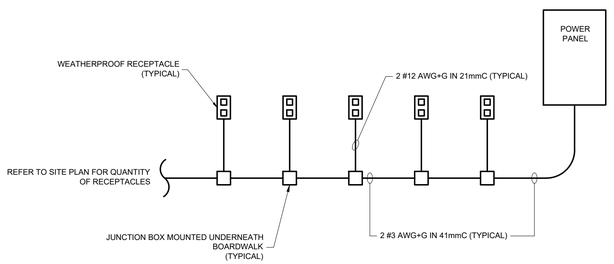


JUNCTION BOX DETAIL

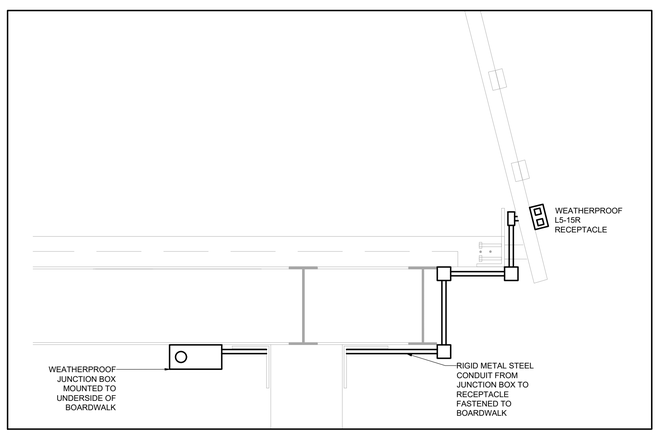


EXPANSION JOINT DETAIL

4 HEAT PAD DETAIL
SCALE: N.T.S.



2 BOARDWALK RAILING MOUNTED RECEPTACLE DETAIL
SCALE: N.T.S.



1 ELECTRICAL RECEPTACLE ON BOARDWALK SECTION
SCALE: N.T.S.

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CLIENT: TORONTO ZOO
toronto zoo
361A Old Finch Ave, Toronto ON M1B 5K7 · 416-392-5929

PROJECT:
ORANGUTAN EXHIBIT

DRAWING NAME :
ELECTRICAL DETAILS

PROJECT NO.: CM-18-391
DRAWN BY :
CHECKED BY:

SCALE: N.T.S.
08.2019

DRAWING NUMBER:
EX-102

NOTE:
1) REFER TO ARBORIST/LANDSCAPE ARCHITECT DRAWINGS AND REPORT FOR TREE REMOVAL INFORMATION.
2) REMOVALS SHOWN ARE FOR REFERENCE ONLY. REFER TO REMOVALS PLAN BY ARCHITECT.
3) TREE PROTECTION MAY BE ADJUSTED AS REQUIRED AND WITH THE APPROVAL OF THE ARBORIST AND/OR LANDSCAPE ARCHITECT TO ALLOW FOR CONSTRUCTION OF PROPOSED WORKS.

TREE PROTECTION FENCING (TYP.) REFER TO ARBORIST AND LANDSCAPE DRAWINGS FOR ADDITIONAL INFORMATION

TEMPORARY CATCH BASIN SEDIMENT PROTECTION DEVICE

INSTALL HEAVY-DUTY SILT FENCE BARRIER PER OPSD 219.130 ALONG EDGE OF EXISTING ASPHALT SERVICE ROAD

FRAME SHEDS TO BE DEMOLISHED

CONCRETE BLOCK BUILDING

CONCRETE SLAB

TIMBER PLANTER

"INDO-MALAYAN PAVILION"

DEAD TREE

POST

SIGN

DRAIN

GATE

WIRE FENCE

CHAIN LINK FENCE

BOARD FENCE

SWALE

BOTTOM OF SLOPE

TOP OF SLOPE

ASPHALT

GRAVEL

CONCRETE CURB

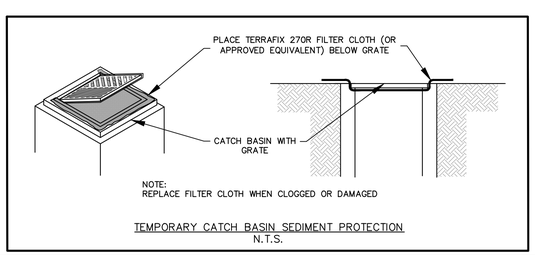
EDGE OF ASPHALT

GENERAL
EROSION AND SEDIMENT CONTROL NOTES

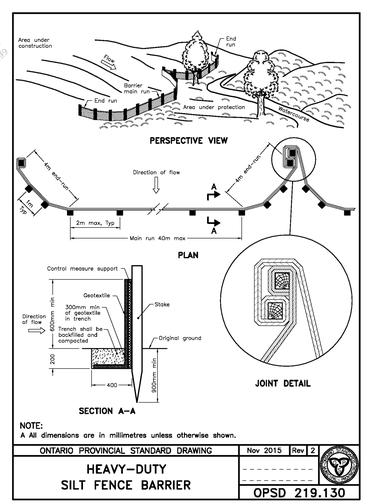
1. INSTALL TREE PRESERVATION FENCING AS PER THE APPROVED TREE PRESERVATION PLAN PRIOR TO COMMENCEMENT OF ANY SITEWORKS.
2. INSTALL EROSION AND SEDIMENT CONTROLS (ESC) PRIOR TO COMMENCEMENT OF ANY SITE WORKS. ESC MEASURES TO BE INSPECTED BY THE ENGINEER, CONSERVATION AUTHORITY AND MUNICIPALITY PRIOR TO COMMENCEMENT OF ANY SITEWORKS.
3. INSTALL CONSTRUCTION ACCESS MUD MAT PRIOR TO ANY SITE WORKS. CONSTRUCTION ACCESS SHALL CONFORM TO THE ONTARIO TRAFFIC MANUAL, BOOK 7 – TEMPORARY CONDITIONS. SITE MUST ONLY BE ACCESSED FROM THE APPROVED CONSTRUCTION ACCESS LOCATIONS.
4. INSPECT EROSION AND SEDIMENT CONTROL MEASURES REGULARLY AND AFTER WET WEATHER EVENTS. REPAIRS AND OR SEDIMENT REMOVAL MUST BE COMPLETED WITHIN 24 HOURS OF INSPECTION.
5. STRIPPED GROUND LEFT INACTIVE FOR OVER 30 DAYS SHALL BE VEGETATED BY HYDROSEEDING OR APPROVED EQUIVALENT.
6. IMPLEMENT DUST CONTROL MEASURES AT ALL TIMES.
7. CLEAN MUD TRACKING AND SWEEP ROADS ON A REGULAR BASIS.
8. INSTALL CATCHBASIN SEDIMENT CONTROL DEVICES IMMEDIATELY FOLLOWING INSTALLATION OF CATCHBASIN.

CITY OF TORONTO
EROSION AND SEDIMENT CONTROL

1. EROSION AND SEDIMENT CONTROL (ESC) MEASURES WILL BE IMPLEMENTED PRIOR TO, AND MAINTAINED DURING CONSTRUCTION PHASES, TO PREVENT ENTRY OF SEDIMENT INTO THE WATER. ALL DAMAGED EROSION AND SEDIMENT CONTROL MEASURES SHOULD BE REPAIRED OR REPLACED WITHIN 48hrs OF INSPECTION OR BOTH.
2. ALL DISTURBED AREAS WILL BE MINIMIZED TO THE EXTENT POSSIBLE AND TEMPORARILY OR PERMANENTLY STABILIZED OR RESTORED AS THE WORK PROGRESSES.
3. THE EROSION AND SEDIMENT CONTROL STRATEGIES OUTLINES ON THE PLANS ARE NOT STATIC AND MAY NEED TO BE UPGRADED/AMENDED AS SITE CONDITIONS CHANGE TO MINIMIZE THE SEDIMENT LADEN RUNOFF FROM LEAVING THE WORK AREA. IF THE PRESCRIBED MEASURES ON THE PLANS ARE NOT EFFECTIVE IN PREVENTING THE RELEASE OF DELETERIOUS SUBSTANCES, THEN ALTERNATIVE MEASURES MUST BE IMPLEMENTED IMMEDIATELY TO MINIMIZE POTENTIAL ECOLOGICAL IMPACTS AND A TORONTO REGION CONSERVATION AUTHORITY ENFORCEMENT OFFICE SHOULD BE IMMEDIATELY CONTACTED. ADDITIONAL ESC MEASURES TO BE KEPT ON SITE AND USED AS NECESSARY.
4. ALL ACTIVITIES, INCLUDING MAINTENANCE PROCEDURES, WILL BE CONTROLLED TO PREVENT THE ENTRR OF PETROLEUM PRODUCTS, DEBRIS, RUBBLE, CONCRETE OR OTHER DELETERIOUS SUBSTANCES INTO THE WATER. VEHICULAR REFUELING AND MAINTENANCE WILL BE CONDUCTED A MINIMUM 30M FROM THE WATER.
5. ALL GRADES WITHIN THE REGULATORY FLOOD PLAIN WILL BE MAINTAINED OR MATCHED.



TEMPORARY CATCH BASIN SEDIMENT PROTECTION
N.T.S.



ONTARIO PROVINCIAL STANDARD DRAWING	Nov 2015	Rev 2
HEAVY–DUTY SILT FENCE BARRIER		OPSD 219.130

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1.		ISSUED FOR PERMIT	2019.11.14
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3.		ISSUED FOR TENDER	2019.12.11

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ENGINEER'S STAMP

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toronto zoo
361A Old Finch Ave, Toronto ON M1B 5K7 · 416-392-5929

PROJECT:
ORANGUTAN EXHIBIT

DRAWING NAME :

EROSION AND SEDIMENT CONTROL PLAN

Habitat 1

PROJECT NO.:	DRAWN BY :	CHECKED BY:
2019 - 001	AP	MLS

SCALE: 1:150
DEC. 11, 2019

DRAWING NUMBER:
CV-001

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toronto zoo
361A Old Finch Ave, Toronto ON M1B 5K7 · 416-392-5929

PROJECT:
ORANGUTAN EXHIBIT

DRAWING NAME :

SERVICING PLAN

Habitat 1

PROJECT NO.:	DRAWN BY :	CHECKED BY:
2019 - 001	AP	MLS

SCALE:
1:150
DEC. 11, 2019

DRAWING NUMBER:
CV-002

LEGEND

- SITE AREA
- PROPOSED STORM SEWER
- PROPOSED SANITARY SEWER
- PROPOSED WATERMAIN
- PROPOSED SUBDRAIN
- PROPOSED MANHOLE
- PROPOSED WATERMAIN VALVE & BOX
- PROPOSED CATCH BASIN
- EXISTING WATERMAIN VALVE
- PROPOSED AREA DRAIN
- EXISTING CATCH BASIN
- EXISTING MANHOLE
- EXISTING TREE TO REMAIN
- PROPOSED TREE (BY OTHERS)
- PROPOSED WATER FEATURE (BY OTHERS)
- EXISTING GAS VALVE
- EXISTING FIRE HYDRANT
- EXISTING BOLLARD
- EXISTING GAS METER
- EXISTING STORM SEWER
- EXISTING SANITARY SEWER
- EXISTING WATERMAIN

NOTE:
LOCATION OF ALL EXISTING SERVICES AND UTILITIES SHOWN WERE OBTAINED FROM RECORD DRAWINGS. CONTRACTOR IS SOLELY RESPONSIBLE FOR CONFIRMING ALL SUBSURFACE INFORMATION PRIOR TO MATERIAL ORDERING AND CONSTRUCTION.

NOTE:
GRADING WITHIN EXHIBIT TO BE PER CONTOUR LINES SHOWN (BY JONES AND JONES) UNLESS NOTED OTHERWISE ON THIS GRADING PLAN. CONTRACTOR TO COORDINATE WITH JONES AND JONES, AND MGM CONSULTING INC. REGARDING GRADING DISCREPANCIES PRIOR TO CONSTRUCTION.

NOTE:
ALL GRADE ELEVATIONS BEYOND THE LIMIT OF WORK TO BE MAINTAINED

MAINTAIN EXISTING GRADE ELEVATIONS ALONG EXISTING ASPHALT SERVICE ROAD

BOARDWALK SHOWN IS LOCATED ABOVE GRADE, REFER TO ARCHITECTURAL DRAWINGS FOR BOARDWALK DETAIL

MAINTAIN GRADE ELEVATIONS AROUND EXISTING TREE THAT ARE TO REMAIN (TYP.)

RESEARCH STATION FF.140.00

PAD TO BE AT CONSISTENT ELEVATION OF 139.80

AREA DRAIN-1 T/G 138.00

REFER TO ARCHITECTURAL DRAWINGS FOR WALL HEIGHT AND DETAILS (TYP.)

AREA DRAIN-2 T/G 135.85

AREA DRAIN-3 T/G 139.36

4.6m WIDE FLUSH CURB

MAINTAIN TOP OF SLOPE GRADES

MATCH EXISTING GRADE ELEVATIONS ALONG EXISTING ASPHALT SERVICE ROAD

BOULDER RET. WALL

CONCRETE BUILDING BUILDING "INDO-MALAYAN PAVILION"

SITE BENCHMARK DOORSILL=139.53

ASPHALT

CONCRETE CURB

EDGE OF ASPHALT

WKEY

EX.STM.MH

EX.SAN.MH

CB4 T/G 139.90

CB5 T/G 139.47

DICB3 T/G 139.39

LEGEND

- SITE AREA
- PROPOSED GRADE ELEVATION
- PROPOSED GRADE SLOPE
- EXISTING GRADE ELEVATION
- PROPOSED EMERGENCY OVERLAND FLOW ROUTE
- EXISTING OVERLAND FLOW ROUTE
- PROPOSED WATERMAIN VALVE & BOX
- EXISTING WATERMAIN VALVE
- PROPOSED AREA DRAIN
- PROPOSED CATCH BASIN
- EXISTING CATCH BASIN
- PROPOSED MANHOLE
- EXISTING MANHOLE
- PROPOSED WATER FEATURE (BY OTHERS)
- EXISTING TREE TO REMAIN
- PROPOSED TREE (BY OTHERS)
- EXISTING BOLLARD
- EXISTING GAS METER
- EXISTING GAS VALVE
- EXISTING FIRE HYDRANT

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CLIENT: **TORONTO ZOO**

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PROJECT:
ORANGUTAN EXHIBIT

DRAWING NAME :

GRADING PLAN

Habitat 1

PROJECT NO.:	DRAWN BY :	CHECKED BY:
2019 - 001	AP	MLS

SCALE:
1:150
DEC. 11, 2019

DRAWING NUMBER:
CV-003

CITY OF TORONTO NOTES:

LEGISLATION, REGULATION AND CODES

1. ALL WORK WITHIN THE CITY RIGHT-OF-WAY SHALL BE CONSTRUCTED ACCORDING TO THE LATEST CITY OF TORONTO STANDARD DRAWINGS AND SPECIFICATION. ONTARIO PROVINCIAL STANDARD DRAWINGS AND SPECIFICATIONS MAY, SUBJECT TO THE APPROVAL OF THE CITY OF TORONTO, BE USED WHERE NO CITY STANDARD OR SPECIFICATION IS AVAILABLE.
2. ALL WORK SHALL BE COMPLETED ACCORDING TO THE CURRENT OCCUPATIONAL HEALTH AND SAFETY ACT AND REGULATIONS FOR CONSTRUCTION PROJECTS. THE GENERAL CONTRACTOR SHALL BE DEEMED TO BE THE CONSTRUCTOR AS DEFINED IN THE ACT.
3. ALL TEMPORARY TRAFFIC CONTROL AND SIGNAGE DURING CONSTRUCTION SHALL BE IN ACCORDANCE WITH CURRENT ONTARIO TRAFFIC MANUAL BOOK 7: TEMPORARY CONDITIONS FIELD EDITION.

CONSTRUCTION NOTES

1. ALL MATERIAL FOR SEWER, FORCEMAIN, WATERMAIN, HYDRANTS AND APPURTENANCES, SHALL BE ACCORDING TO CITY OF TORONTO MATERIAL/MANUFACTURER SPECIFICATIONS AS REQUIRED BY CHAPTER 6, MATERIAL SPECIFICATIONS FROM DESIGN CRITERIA FOR SEWERS AND WATERMAINS MANUAL.
2. UTILITY SEPARATION SHALL BE ACCORDING TO APPENDIX 'D' OF THE CITY OF TORONTO DESIGN CRITERIA FOR SEWERS AND WATERMAINS MANUAL.
3. ALL AREAS DISTURBED DURING CONSTRUCTION WITHIN SHALL BE RESTORED TO ORIGINAL OR BETTER CONDITION AND TO THE SATISFACTION OF THE CONTRACT ADMINISTRATOR. GRASS AREAS SHALL BE TREATED WITH 100mm OF TOPSOIL AND SHALL BE SODDED ACCORDING TO TS 5.00 AND TS 5.10, UNLESS OTHERWISE SPECIFIED BY THE LANDSCAPE ARCHITECT.
4. ALL EXISTING UTILITIES SHOWN ON DRAWINGS ARE FOR REFERENCE PURPOSES ONLY. THE CONTRACTOR SHALL SATISFY THEMSELVES AS TO THE ACTUAL LOCATION AND DEPTH OF ANY UTILITY AND SHALL BE LIABLE FOR ALL OR ANY DAMAGE.
5. ANY DISCREPANCIES BETWEEN SITE CONDITIONS AND CONSTRUCTION DRAWINGS MUST BE REPORTED TO MGM CONSULTING INC. PRIOR TO COMMENCEMENT OF CONSTRUCTION AND APPROPRIATE ACTION TAKEN TO THE SATISFACTION OF THE CONTRACT ADMINISTRATOR.
6. ALL SURVEY STAKE LAYOUT POINTS SHALL BE VERIFIED IN THE FIELD BY THE CONTRACTOR PRIOR TO CONSTRUCTION. ANY DISCREPANCIES BETWEEN THE DRAWINGS AND THE LAYOUT SHALL BE IMMEDIATELY REPORTED TO THE CITY.
7. ATTENTION IS DIRECTED TO THE POSSIBILITY OF EXISTING PRIVATE SPRINKLERS AND LIGHTING SYSTEMS WITHIN THE RIGHT-OF-WAY, WHICH ARE NOT SHOWN ON THE PLANS. LOCATING, WORKING AROUND AND PROTECTING THESE SYSTEMS SHALL BE COMPLETED AT NO EXTRA COST TO THE CITY.
8. AT ALL LOCATIONS WHERE THE PROPOSED WATERMAIN CROSSES UNDER OR ABOVE THE EXISTING SEWERS, OR UTILITIES, GRANULAR A BEDDING MATERIAL IS TO THE EXTEND FROM THE LOWER PIPE TO THE TOP OF THE UPPER PIPE. GRANULAR A TO BE COMPACTED TO MINIMUM 98% OF MAXIMUM DRY DENSITY.
9. CONTRACTOR TO PROVIDE ADEQUATE SUPPORT DURING CONSTRUCTION BETWEEN NEW WATERMAIN AND EXISTING GAS MAINS. MAINTAIN 300mm MINIMUM VERTICAL CLEARANCES BETWEEN THE NEW WATERMAIN AND EXISTING GAS MAINS LESS THAN 300mm IN DIAMETER. MAINTAIN 600mm MINIMUM VERTICAL CLEARANCE BETWEEN THE NEW WATERMAIN AND EXISTING GAS MAINS EQUAL TO OR GREATER THAN 300mm IN DIAMETER.
10. ALL EXISTING WATERMAINS AND SEWER PIPES LARGER THAN 300mm DIAMETER SHALL BE SUPPORTED ACCORDING TO DRAWING T-1007.01-4.
11. ALL DIMENSIONS ARE EXPRESSED IN METRES (m) AND PIPE SIZES ARE EXPRESSED IN MILLIMETRES (mm) UNLESS OTHERWISE NOTED.

ROAD RECONSTRUCTION

1. LIMITS OF SIDEWALK/CURB RECONSTRUCTION ARE APPROXIMATE, ACTUAL LIMITS ARE TO BE CONFIRMED IN THE FIELD BY THE CONTRACT ADMINISTRATOR.
2. ADJUST ALL STRUCTURES (MAINTENANCE HOLES, CATCH BASINS, ETC.) TO SUIT NEW DESIGN ELEVATIONS INCLUDING BREAKING DOWN AND REMOVAL OF PORTION OF TOP OF STRUCTURES TO ALLOW FOR MINIMUM 150mm ADJUSTMENT UNITS.
3. ALL CURBS SHALL BE CONSTRUCTED WITH A LEDGE AT THE BACK OF THE CURB TO FACILITATE FUTURE SIDEWALK CONSTRUCTION.
4. FULL DEPTH SAW-CUTS ARE REQUIRED AT CONSTRUCTION LIMITS OF EXISTING CURB, SIDEWALK AND PAVEMENT UNLESS OTHERWISE SHOWN.
5. SAW CUT EXISTING PAVEMENT, SIDEWALK, CURB, GUTTER, DRIVEWAYS, WALKWAYS, ETC. AT CONSTRUCTION LIMITS TO PROVIDE A CLEAN JOINT FOR THE PROPOSED WORK.
6. ADJUSTMENT OF APPROACHES, WALKWAYS AND STEPS MAY BE REQUIRED. LIMITS ARE TO BE DETERMINED IN THE FIELD BY THE CONTRACT ADMINISTRATOR.
7. EXISTING ASPHALT THICKNESS MAY VARY, TAPER TO MATCH EXISTING AT CONSTRUCTION LIMITS (MINIMUM 2.0m).
8. FILTER FABRIC TO BE PLACED UNDER GRATES ON ALL CATCH BASINS TO TRAP SEDIMENT. SILT TRAPS ARE TO BE CLEANED REGULARLY AND ARE NOT TO BE REMOVED UNTIL SUCH TIME AS THE CURBS ARE CONSTRUCTED AND THE BOULEVARDS ARE SODDED OR BACKYARDS GRADED AND SODDED. FILTER FABRIC FOR SILT CONTROL TO BE TERRA FIX 270R OR APPROVED EQUIVALENT.

WATERMAINS

1. PVC WATERMAINS SHALL BE MINIMUM DR 18 CLASS 235 (AWWA) C900-07.
2. EMBEDMENT MATERIAL FOR FLEXIBLE PIPE SHALL BE ACCORDING TO OPSD 802.010 AND USING GRANULAR A ACCORDING TO TS 1010 AND COMPACTED TO MINIMUM 98% OF MAXIMUM DRY DENSITY.
3. MINIMUM COVER ON WATERMAINS SHALL BE 1.8m.
4. ALL HYDRANTS SHALL BE CONSTRUCTED ACCORDING TO T-1105.01.
5. HYDRANT LEADS SHALL BE MINIMUM DR 18 CLASS 235 (AWWA) C900-07.
6. ALL SERVICES CONNECTIONS SHALL BE CONSTRUCTED ACCORDING TO T-1104.01, T-1104.02-1, T-1104.02-3, T-1105.02-1 AND T-1105.02-2.
7. SINGLE WATER SERVICE CONNECTIONS SHALL BE MINIMUM OF 19mm DIA. TYPE "K" SOFT COPPER ACCORDING TO T-1104.01. WHEN SERVICE LENGTH EXCEEDS 30m, THE DIAMETER SHALL BE 25mm DIA.
8. ALL CURB AND VALVE BOXES TO BE LOCATED AT STREET LINE.
9. MECHANICAL THRUST RESTRAINTS SHALL BE INSTALLED AT ALL FITTINGS, BENDS, TEES, CROSSES, REDUCERS AND VALVES FOR ALL WATERMAIN SIZES. MECHANICAL RESTRAINTS AT JOINTS SHALL BE INSTALLED AT EVERY PIPE JOINT 6.1m OF EITHER SIDE OF THE VALVE FOR WATERMAINS 100mm DIAMETER OR LARGER.
10. ALL TEES, PLUGS, HORIZONTAL, VERTICAL BENDS, REDUCERS AND HYDRANTS TO HAVE CONCRETE THRUST BLOCKS ACCORDING TO T-1103.01 AND T-1103.02.
11. WATERMAINS MUST FOLLOW THE ONTARIO MINISTRY OF THE ENVIRONMENT PROCEDURE F-6-1 THAT GOVERN THE SEPARATION OF SEWERS AND WATERMAINS. A MINIMUM VERTICAL CLEARANCE OF 0.30m WHEN CROSSING UNDER SEWERS AND ALL OTHER UTILITIES IS REQUIRED. MUST ALSO MAINTAIN 2.5m HORIZONTAL SEPARATION WITH SEWERS.
12. ALL VALVES LESS THAN 400mm WILL BE IN A VALVE AND BOX ACCORDING TO T-1101.02-2. ALL VALVES 400mm AND LARGER SHALL BE IN A CHAMBER.
13. SACRIFICIAL ANODES SHALL BE INSTALLED ON ALL METALLIC PIPES AND APPURTENANCES, WATER SERVICES AND FITTINGS ACCORDING TO T-1106.04, T-1106.05, T-1106.06 AND TS 7.22.
14. TRACER WIRE INSTALLATION SHALL BE ACCORDING TO TS 7.40.
15. HYDROSTATIC PRESSURE TEST AND LEAKAGE TESTING OF THE WATERMAIN SHALL BE ACCORDING TO TS 441.
16. THE NEW WATERMAIN SHALL BE ISOLATED ACCORDING TO T-1104.03-3 OR T-1104.03-4 UNTIL BACTERIOLOGICAL TESTS ARE SATISFACTORILY COMPLETED.
17. PROVISION FOR FLUSHING THE WATERMAIN PRIOR TO TESTING AND SO FORTH MUST BE PROVIDED WITH AT LEAST A 50mm OUTLET ON 100mm AND LARGER LINES ACCORDING TO T-1104.03-1. COPPER WATER SERVICES SHALL HAVE FLUSHING POINTS AT THE END, THE SAME SIZE AS THE LINE. ON FIRE LINES, FLUSHING OUTLET TO BE 50mm DIAMETER MINIMUM OR A HYDRANT.
18. DISINFECTION OF THE WATERMAIN SHALL BE ACCORDING TO TS 7.30 AND SHALL INCLUDE ALL NEW WATER SERVICES 100mm DIA. AND LARGER.
19. TORONTO WATER REQUIRES THAT THE NEW DISTRIBUTION SYSTEM REMAIN ISOLATED UNTIL SATISFACTORY BACTERIOLOGICAL SAMPLE RESULTS ARE RECEIVED. ECS CONTRACT ADMINISTRATOR SHALL NOTIFY TORONTO WATER WHEN SAMPLE RESULTS HAVE PASSED IN ORDER TO PROCEED WITH REMOVAL OF THE BLOW-OFF AND BACK FILLING OF THE ACCESS PIT.
20. AFTER SATISFACTORY DISINFECTION OF THE NEW WATERMAIN IS ACHIEVED, PERMANENT CONNECTIONS TO THE EXISTING WATERMAIN(S) WITH A FILLER PIECE SHALL BE MADE ACCORDING TO TS 7.70.
21. CITY IN-SERVICE WATER VALVES, CURB STOPS, FIRE HYDRANTS CAN ONLY BE OPERATED BY TORONTO WATER STAFF.
22. ALL NEW WATERMAINS SHALL BE INSULATED WHERE THE COVER IS LESS THAN 1.65m ACCORDING TO T-708.01-4.
23. THE CONTRACTOR SHALL CONNECT OR RECONNECT ALL STRAY CURRENT DRAINAGE CABLES CONNECTED TO THE TTC ELECTRIFIED RAIL SYSTEM ENCOUNTERED DURING WATERMAIN CONSTRUCTION.

SANITARY AND STORM SEWERS

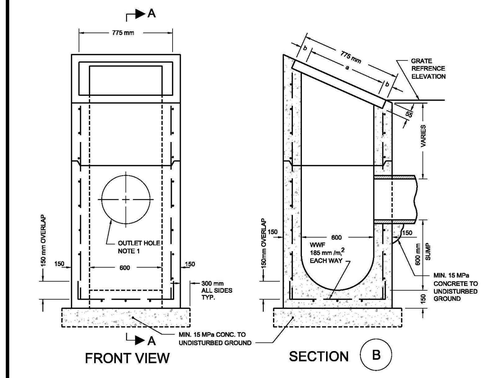
1. MAIN LINE PVC PIPE SHALL BE DR 35.
2. EMBEDMENT MATERIAL FOR FLEXIBLE PIPE SHALL BE ACCORDING TO OPSD 802.010 AND USING GRANULAR A ACCORDING TO TS 1010 AND COMPACTED TO MINIMUM 98% OF MAXIMUM DRY DENSITY.
3. BEDDING FOR RIGID PIPE SHALL BE CLASS B BEDDING MATERIAL ACCORDING TO OPSD 802.031 AND USING GRANULAR A BEDDING MATERIAL ACCORDING TO TS 1010 AND COMPACTED TO MINIMUM 98% OF MAXIMUM DRY DENSITY.
4. ULTRA-RIB PIPE IS NOT PERMITTED WITHIN THE MUNICIPAL RIGHT-OF-WAY.
5. MAINTENANCE HOLES SHALL BE ACCORDING TO T-701.010 (1200mm), T-701.011 (1500mm), T-701.012 (1800mm), OR T-701.013 (2400mm). FRAME AND COVER SHALL BE ACCORDING TO OPSD 401.010 TYPE A CLOSED (SANITARY AND STORM).
6. MAINTENANCE HOLE CHAMBER OPENINGS MUST BE LOCATED ON THE UPSTREAM SIDE OF THE MAINTENANCE HOLE.
7. BENCHING DETAILS SHALL BE ACCORDING TO T-701.021 OR AS SHOWN ON THE DRAWING.
8. DROP STRUCTURE SHALL BE ACCORDING TO T-1003.01 (EXTERNAL) AND T-1003.01-2 (INTERNAL).
9. SANITARY MAINTENANCE HOLES SHALL HAVE WATERTIGHT FRAMES AND COVERS IN PONDING AREAS ACCORDING TO OPSD 401.030.
10. REINFORCED CONCRETE PIPE SHALL BE MINIMUM 65-D. HEIGHT OF FILL TO BE VERIFIED USING OPSD TABLES 807.010 AND 807.030.
11. NON-REINFORCED CONCRETE PIPE 150mm TO 250mm SHALL BE CLASS 3. HEIGHT OF FILL TO BE VERIFIED USING OPSD TABLE 807.040.
12. SINGLE CATCH BASINS SHALL BE ACCORDING TO T-705.010 COMPLETE WITH GOSS TRAP, WHERE SPECIFIED. FRAME AND COVER SHALL BE ACCORDING TO OPSD 400.070.
13. DOUBLE CATCHBASINS SHALL BE ACCORDING TO T-705.020 COMPLETE WITH GOSS TRAP, WHERE SPECIFIED.
14. CATCHBASIN LEADS TO BE 250mm PVC DR 35 FOR SINGLE CATCHBASINS AND 300mm PVC DR35 FOR DOUBLE CATCHBASINS.
15. CONNECTION DETAIL FOR SEWER PIPE AT CATCHBASINS AND MAINTENANCE HOLES SHALL BE ACCORDING TO T-708.020.

GENERAL

1. PRIOR TO STARTING ANY WORKS, THE CONTRACTOR MUST ENSURE THAT ALL NECESSARY APPROVALS ARE IN PLACE FROM THE MUNICIPALITY, REGION, AND OTHER APPROVAL AGENCIES, AS REQUIRED.
2. WORK SHALL BE CARRIED OUT IN COMPLIANCE WITH THE APPLICABLE HEALTH AND SAFETY ACT AND REGULATIONS FOR CONSTRUCTION PROJECTS. THE GENERAL CONTRACTOR SHALL BE DEEMED TO BE THE CONSTRUCTORS AS DEFINED IN THE ACT.
3. WORKS AND MATERIALS SHALL CONFORM TO CURRENT MINISTRY OF THE ENVIRONMENT, CONSERVATION & PARKS, MUNICIPAL, REGIONAL AND ONTARIO PROVINCIAL STANDARDS AND SPECIFICATIONS. FOR WORK WITHIN PRIVATE PROPERTY, WORKS AND MATERIALS SHALL CONFORM TO THE ONTARIO BUILDING CODE OR THE ABOVE-NOTED STANDARDS, WHICHEVER IS MORE STRINGENT.
4. THE CONTRACTOR SHALL CONFIRM THE LOCATION OF ANY EXISTING UTILITIES AND SERVICES WITHIN THE SITE AND ADJACENT WORK AREAS. THE CONTRACTOR SHALL BE RESPONSIBLE FOR PROTECTING ALL EXISTING UTILITIES AND SERVICES TO THE SATISFACTION OF THE AUTHORITY HAVING JURISDICTION. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE RESTORATION AND/OR REPAIR, TO THE SATISFACTION OF THE AUTHORITY HAVING JURISDICTION, FOR ANY UTILITIES DISTURBED DURING CONSTRUCTION. DISCREPANCIES BETWEEN THE DRAWINGS AND FIELD CONDITIONS TO BE IMMEDIATELY REPORTED TO THE ENGINEER.
5. ALL TEMPORARY TRAFFIC CONTROL AND SIGNAGE DURING CONSTRUCTION SHALL BE IN ACCORDANCE WITH THE CURRENT ONTARIO TRAFFIC MANUAL BOOK 7: TEMPORARY CONDITIONS FIELD EDITION.
6. ANY AREAS BEYOND THE LIMIT OF THE SITE DISTURBED DURING CONSTRUCTION SHALL BE RESTORED BY THE CONTRACTOR, TO ORIGINAL CONDITION OR BETTER TO THE SATISFACTION OF PROJECT ENGINEER, ARCHITECT AND LANDOWNER. GRASSED AREAS SHALL BE RESTORED BY PLACING 150 mm TOPSOIL AND ACTIVELY GROWING NUMBER 1 NURSERY SOD.
7. REFER TO THE ARCHITECTURAL SITE PLAN FOR DIMENSIONS AND LAYOUT INFORMATION.

GRADING

1. PRIOR TO COMMENCEMENT OF EARTHWORKS, SITE ALTERATION PLANS MUST BE APPROVED AND ALL EROSION AND SEDIMENT CONTROL MEASURES SHALL BE INSTALLED AND OPERATIONAL. THE CONTRACTOR SHALL MAINTAIN ALL EROSION AND SEDIMENT CONTROL MEASURES UNTIL CONSTRUCTION IS COMPLETED TO THE SATISFACTION OF THE ENGINEER.
2. ENGINEERED FILL SHALL CONFORM TO THE SPECIFICATIONS PROVIDED IN THE GEOTECHNICAL REPORT, OR LATEST AMENDMENT THEREOF.
3. ENGINEERED FILL SHALL BE INSPECTED AND TESTED BY THE GEOTECHNICAL CONSULTANT. PROOF ROLLING OF SUBGRADE WILL BE REQUIRED PRIOR TO PLACEMENT OF GRANULAR MATERIALS. COORDINATE INSPECTIONS WITH GEOTECHNICAL CONSULTANT.
4. GRANULAR COMPACTION TO BE PER GEOTECHNICAL REPORT.
5. ASPHALT COMPACTION TO BE PER GEOTECHNICAL REPORT.
6. BARRIER CURB WITHIN THE SITE TO BE CONSTRUCTED AS PER OPSD 600.110. MOUNTABLE CURB SHALL BE AS PER OPSD 600.100. SEMI-MOUNTABLE CURB SHALL BE AS PER OPSD 600.090.
7. CONCRETE SIDEWALK: AS PER OPSD 310.020. WHERE SIDEWALK CROSSES RESIDENTIAL DRIVEEWAY: 150 mm DEEP. GRANULAR BASE UNDER SIDEWALK TO BE 75 mm GRANULAR 'A' AND SHALL BE INCREASED TO 150 mm UNDER DRIVEWAYS.
8. EXISTING BOUNDARY ELEVATIONS ALONG THE PERIMETER OF THE SITE SHALL REMAIN UNDISTURBED. DRAINAGE RECEIVED FROM ADJACENT PROPERTIES SHALL BE ACCOMMODATED AND DRAINAGE FROM THE SUBJECT LANDS SHALL BE SELF-CONTAINED UNLESS NOTED OTHERWISE.
9. PERFORATED SUB-DRAINS SHALL BE CONNECTED TO ALL CATCHBASINS AS PER DETAIL ON ARCHITECTURAL DRAWINGS.
10. INSTALL SIGNAGE AS PER THE ARCHITECTURAL SITE PLAN.
11. ALL EXCESS EXCAVATED MATERIAL SHALL BE REMOVED OFFSITE TO THE CONTRACTOR'S APPROVED DISPOSAL SITE.
12. EMBANKMENTS SHALL BE SLOPED AT A MAXIMUM OF 3H:1V, UNLESS OTHERWISE SPECIFIED.
13. DISTURBED AREAS SHALL BE RESTORED TO ORIGINAL CONDITION OR BETTER. THE RELOCATION OR REMOVAL OF TREES AND SHRUBS SHALL BE SUBJECT TO APPROVAL BY THE LANDSCAPE ARCHITECT OR ARBORIST.
14. REFER TO LANDSCAPE DRAWINGS FOR LOCATION AND TYPE OF ALL HARD LANDSCAPE SURFACES, INCLUDING CONCRETE SIDEWALKS, PAVING STONES, COULOURED CONCRETE, ETC.
15. CONTRACTOR TO ENSURE A 150mm ELEVATION DROP FROM FINISHED FLOOR TO PERIMETER GRADES AT BUILDING ENVELOPE. CONTRACTOR TO CONFIRM GRADING REQUIREMENTS AT LEVEL ACCESS LOCATIONS PRIOR TO CONSTRUCTION.



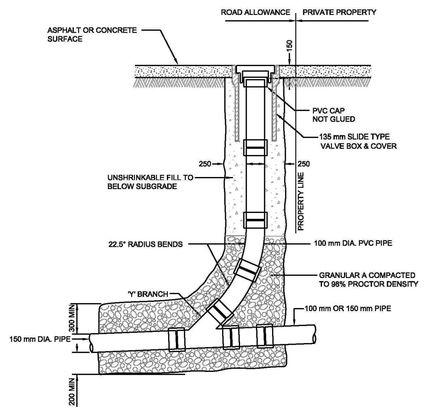
OPENING DIMENSIONS (mm)			
GRATE TYPE	SLOPE	a	b
A	2:1	670	52
	3:1	632	72
	4:1	618	79
	6:1	606	83
	8:1	605	85
	10:1	603	86
	HOR	600	87

NOTES:

1. OUTLET HOLE SIZE 625 mm MAXIMUM DIAMETER, LOCATION AS REQUIRED.
2. WHERE INLET IS PLACED ACROSS DITCH AND IS ACCESSIBLE TO VEHICULAR TRAFFIC, GRATING SLOPE IS TO BE 6:1 OR FLATTER.
3. ALL REINFORCING STEEL SHALL HAVE 25 mm MINIMUM COVER.
4. GRATING ACCORDING TO OPSD-403.010.
5. PIPE SUPPORT ACCORDING TO T-708.020.
6. ALL DIMENSIONS ARE NOMINAL.

All dimensions are in millimetres unless otherwise shown.

TORONTO	ENGINEERING AND CONSTRUCTION SERVICES STANDARD DRAWING	REV 1	APR 2013
	PRECAST CONCRETE CATCHBASIN DITCH INLET 600 mm x 600 mm x DEPTH 4.0 m MAX	T-705.040-1	
		NTS	SHEET 1



SURFACE CLEANOUT

NOTES:

1. INSTALL 135 mm SLIDE TYPE VALVE BOX AND COVER (MARKED SEWER) OVER PVC CAP, NOT GLUED.
2. USE EAST JORDAN IRON WORKS PRODUCT No. 85557126 WITH 06800006 SERIES DROP LID OR APPROVED EQUAL.
3. FOR USE IN PAVED AREAS.
4. THIS CONFIGURATION FOR HOUSE CONNECTIONS ONLY.

All dimensions are in millimetres unless otherwise shown.

TORONTO	ENGINEERING & CONSTRUCTION SERVICES STANDARD DRAWING	REV 1	NOV 2016
	SANITARY SEWER CLEANOUT OPTION "A" 100 mm SURFACE CLEANOUT	T-708.01-5	
		NTS	SHEET 1

NO.	REV.	ISSUED FOR	DATE
1.		ISSUED FOR PERMIT	2019.11.14
2.		ISSUED FOR TENDER REVIEW	2019.12.06
3.		ISSUED FOR TENDER	2019.12.11

N

ENGINEER'S STAMP

CONTRACTOR SHALL CHECK ALL DIMENSIONS ON THE WORK AND REPORT ANY DISCREPANCY TO THE CONSULTANT BEFORE PROCEEDING. THIS DRAWING IS NOT TO BE USED FOR CONSTRUCTION UNTIL AUTHORIZED IN WRITING BY CONSULTANT.

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toronto zoo
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PROJECT:
ORANGUTAN EXHIBIT

DRAWING NAME :

DETAIL AND NOTES PLAN

Habitat 1

PROJECT NO.:	DRAWN BY :	CHECKED BY:
2019 - 001	AP	MLS

SCALE:
AS NOTED
DEC. 11, 2019

DRAWING NUMBER:
CV-004

LEGEND

- LIMIT OF WORK
- KICK RAIL BY OTHERS
- VIEWING GUARDRAIL BY OTHERS
- BARRIER FENCE BY OTHERS
- HDT WIRE
- 3m TALL TREE SETBACK LINE

PLANTING

- EXISTING TREE TO BE REMAINED
- PLANTING AREA
- TREE PRESERVATION FENCING, REFER TO ARBORIST REPORT
- HORIZONTAL HOARDING, REFER TO ARBORIST REPORT

HARDSCAPE

- PERMEABLE UNIT PAVER THORNBURY PAVER BY UNILOCK PATTERN A
- STAMPED INTEGRAL CONCRETE BY INTERSTAR COLOUR: CHAPS (BN2520R)
- INTEGRAL CONCRETE BY INTERSTAR W/ WOOD PANEL TEXTURE COLOUR: PLUM (BN1616R) COLOUR: DESERT (J07961R)
- ASPHALT
- GRANULAR
- PINE WOOD CHIP

FURNISHING

- ARMOUR STONE SEATING
- POLE, BY OTHERS

NOTE:

1. ALL TREE PRESERVATION FENCING LOCATIONS AND REQUIREMENTS REFER TO ARBORIST REPORT AND TREE INVENTORY AND PRESERVATION PLAN BY KUNTZ FORESTRY CONSULTING;
2. EXISTING PAVEMENT THAT IS IMPACTED AND DAMAGED DUE TO CONSTRUCTION, NEEDS TO BE REPAIRED AS PER EXISTING CONDITION.

NO.	REV.	ISSUED FOR	DATE
1		ISSUED FOR TENDER	Dec. 11/19

N

ARCHITECT'S STAMP

ASSOCIATION OF LANDSCAPE ARCHITECTS ONTARIO
ROBERT NG
OALA
MEMBER

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CLIENT: **TORONTO ZOO**

toronto zoo

361A Old Finch Ave, Toronto ON M1B 5K7, 416-392-5929

PROJECT:
ORANGUTAN EXHIBIT

DRAWING NAME :

LAYOUTS & MATERIALS PLAN
Habitat 1

PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	RH	LC

DRAWING NUMBER:

SCALE:
1:200
AUGUST 13. 2019

LA1

ATV

ACCESS GATE

LAB

FIRE HYDRANT

1 LA4 WOODEN GATE

WOOD ACCESS GATE

3 LA4 WOODEN FENCE

WOOD FENCE

CONCRETE CURB

VIEWING BUILDING & RESEARCH STATION

LIMESTONE SCREENING SURFACE 6 LA3

INTEGRAL PIGMENTED STAMPED CONCRETE 10 LA3

ARMOURSTONE SEATING (3)

CONCRETE CURB

EXISTING PAVILION

CANOPY ABOVE

GLASS VIEWING

10 LA3 LANDSCAPE CURB @ CONCRETE PAVING

CONCRETE CURB

POLE BY OTHERS

11 LA3 ARMOURSTONE

ARMOURSTONE SEATING (3)

CONCRETE CURB

CONCRETE CURB

7 LA3 PERMEABLE PRECAST PAVER DETAIL

10 LA3 LANDSCAPE CURB @ ASPHALT PAVING

MESH GATE

EXCLUSION GATE 4 LA4

LEGEND

- LIMIT OF WORK
- KICK RAIL BY OTHERS
- VIEWING GUARDRAIL BY OTHERS
- BARRIER FENCE BY OTHERS
- HOT WIRE
- 3m TALL TREE SETBACK LINE

PLANTING

- PLANTING AREA

HARDSCAPE

- PERMEABLE UNIT PAVER THORNBURY PAVER BY UNILOCK PATTERN A
- STAMPED INTEGRAL CONCRETE BY INTERSTAR COLOUR: CHAPS (BN2520R)
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- ASPHALT
- GRANULAR

FURNISHING

- ARMOUR STONE SEATING
- POLE, BY OTHERS

NO.	REV.	ISSUED FOR	DATE
1		ISSUED FOR TENDER	Dec. 11/19

N

ARCHITECT'S STAMP

ASSOCIATION OF LANDSCAPE ARCHITECTS ONTARIO
ROBERT NG
OALA
MEMBER

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CLIENT: **TORONTO ZOO**

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PROJECT:
ORANGUTAN EXHIBIT

DRAWING NAME :

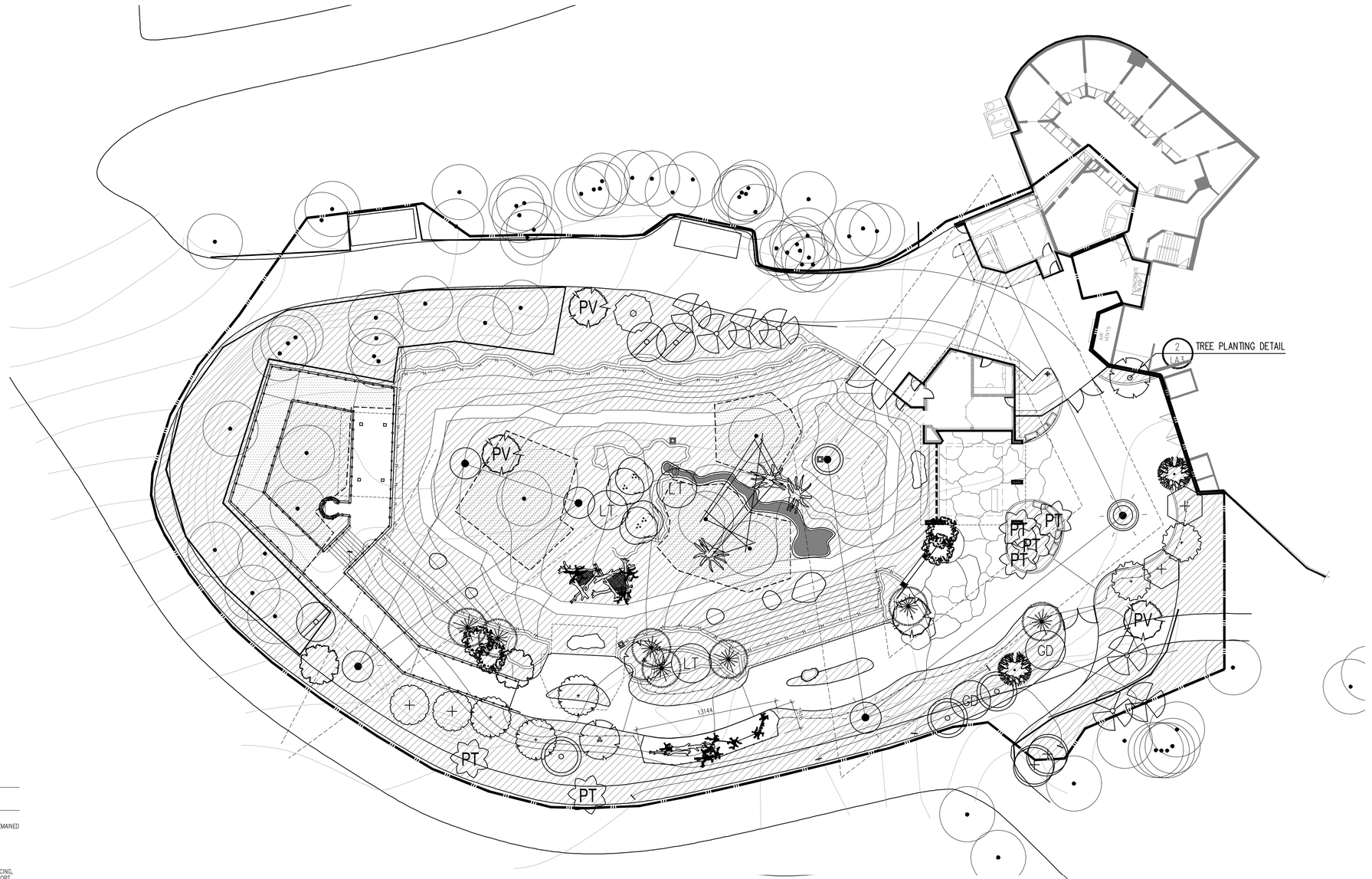
PLAZA
LAYOUTS & MATERIALS PLAN
Habitat 1

PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	RH	LC

DRAWING NUMBER:

SCALE:
1:50
AUGUST 13. 2019

LA1.1



LEGEND

LIMIT OF WORK

PLANTING

EXISTING TREE TO BE REMAINED

PLANTING AREA

TREE PRESERVATION FENCING, REFER TO ARBORIST REPORT

HORIZONTAL HOARDING, REFER TO ARBORIST REPORT

NOTE:
1. ALL TREE PRESERVATION FENCING LOCATIONS AND REQUIREMENTS REFER TO ARBORIST REPORT AND TREE INVENTORY AND PRESERVATION PLAN BY KUNTZ FORESTRY CONSULTING.
2. ENSURE TREES ARE 1m CLEAR OF EXISTING/PROPOSED UTILITIES;
3. REFER TO SHEET LA1.4 FOR PLANTING LIST.

Perennials, Grasses, Vines, Ferns, Bulbs, and Seeded areas

2438.46M²

Tree Symbol	Botanic Name
	Alnus incana
	Betula popuilfolia
	Carpinus caroliniana
	Carya ovata
	Catalpa speciosa
	Celtis occidentalis
	Cercis canadensis
	Cornus alternifolia
	Fagus grandifolia
GD	Gymnocladus dioicus

Tree Symbol	Botanic Name
	Juniperus virginiana
LT	Liriodendron tulipfera
	Ostrya virginiana
	Populus balsamifera
	Populus tremuloides
PV	Prunus virginiana
PT	Ptelea trifoliata

Tree Symbol	Botanic Name
	Quercus alba
	Quercus rubra
	Sassafras albidum
	Thuja occidentalis
	Zanthoxylum americanum

NO.	REV.	ISSUED FOR	DATE
1		ISSUED FOR TENDER	Dec. 11/19

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ASSOCIATION OF LANDSCAPE ARCHITECTS ONTARIO
ROBERT NG
OALA
MEMBER

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CLIENT: **TORONTO ZOO**

toronto zoo
361A Old Finch Ave, Toronto ON M1B 5K7, 416-392-5929

PROJECT:
ORANGUTAN EXHIBIT

DRAWING NAME :

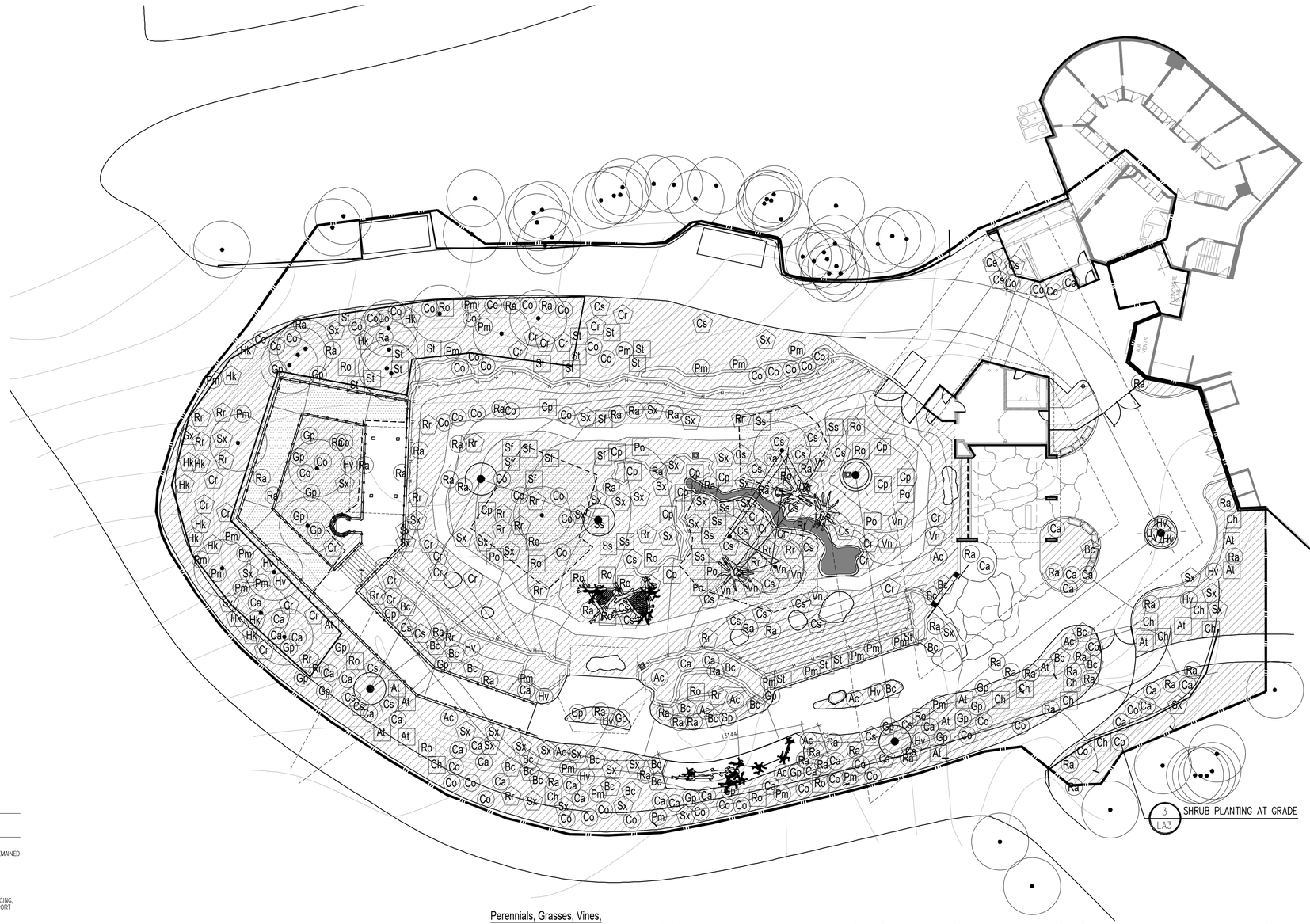
PLANTING PLAN
Habitat 1–Trees&Groundcovers

PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	RH	LC

DRAWING NUMBER:

SCALE:
1:200
AUGUST 13. 2019

LA1.2



LEGEND

LIMIT OF WORK

PLANTING

EXISTING TREE TO BE REMAINED

PLANTING AREA

TREE PRESERVATION FENCING, REFER TO ARBORIST REPORT

HORIZONTAL HOARDING, REFER TO ARBORIST REPORT

NOTE:
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2. REFER TO SHEET LA1.4 FOR PLANTING LIST.

Perennials, Grasses, Vines, Ferns, Bulbs, and Seeded areas

2438.46 m2

Shrub Symbol	Botanic Name
Ac	Amelanchier canadensis
Af	Amorpha fruticosa
Ae	Aralia elata
Am	Aronia melanocarpa
At	Asimina triloba
Bc	Berberis canadensis
Ca	Ceanothus americana
Ch	Ceanothus herbacea
Ce	Cephalanthus occidentalis
Cs	Cornus sericea
Co	Corylus americana
Cr	Cornus racemosa
Cp	Crataegus spp.
Gp	Gaultheria procumbens
Hv	Hamamelis virginiana
Hk	Hypericum kalmianum
Pm	Paxistima canbyu
Po	Physocarpus opuifolius
Ra	Rhus aromatica
Rr	Rosa rugosa
Rs	Rubus ideaus
Ro	Rubus ordoratus
Sx	Salix lucida
Sc	Sambucus canadensis
Sp	Sambucus pubens
Ss	Sobaria sorbifolia
Sr	Spirea alba
Sl	Spriea latifolia
Sf	Staphylea trifolia
St	Stepanandra incisa 'Crispa'
Va	Vaccinium vitis idaea 'Minus'
Vn	Viburnum acerifolium
Vo	Viburnum lantanoides
Vg	Viburnum lentago
Vt	Viburnum trilobum

NO.	REV.	ISSUED FOR	DATE
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CLIENT: **TORONTO ZOO**

toronto zoo

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PROJECT:
ORANGUTAN EXHIBIT

DRAWING NAME :

PLANTING PLAN
Habitat 1–Shrubs

PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	RH	LC

SCALE:
1:200
AUGUST 13. 2019

DRAWING NUMBER:
LA1.3

Plant Schedule

Trees

Symbol	Botanic name	Common Name	Toronto Native	Source	Size	Quantity	Notes	max height
	Alnus incana ssp. rugosa	Speckled Alder	Y	DM	70mm	3		6m
	Carpinus caroliniana	American Hornbeam	Y	DM	60mm	3	to be coppiced	7m
	Carya ovata	Shagbark Hickory	Y	GW		2	to be coppiced	15m
	Catalpa speciosa	Northern Catalpa		DM	100mm	7	listed as Zone 5A per NRC	15m
	Celtis occidentalis	Northern Hackberry	Y	DM	80mm	2	zones 2-7	15m
	Cercis canadensis	Redbud	Y	DM	70mm	1		8m
	Cornus alternifolia	Pagoda Dogwood	Y	DM	60mm	2	coppice	10m
	Fagus grandifolia	American Beech	Y	DM	50mm	2		18m
GB	Gymnocladus dioicus	Kentucky Coffee Tree	Y	DM	60mm	2		8m
	Juniperus virginiana	Eastern Red Cedar	Y	DM	300cm	1		10m
LT	Liriodendron tulipfera	Tulip Tree	Y	DM	70mm	3		8m
	Ostrya virginiana	Ironwood	Y	DM	70mm	1		10m
								12m
	Populus balsamifera	Balsam Poplar	Y	DM	70mm	2		30m
	Populus tremuloides	Quaking Aspen	Y	DM	50mm	4		30m
PV	Prunus virginiana 'Schubert'	Choke Cherry	Y	DM	80mm	3		8m
PT	Ptelea trifoliata	Hop Tree	Y	GW		6	verify with veterinarian	6m
	Quercus alba	White Oak	Y	DM	100mm	3	tannic acids in new buds causes diarrhea in giraffes	35m
	Quercus rubra	Red Oak	Y	DM	80mm	2		25m
	Sassafras albidum	Sassafras	Y			4	verify with veterinarian, used in public areas	20m
	Thuja occidentalis	Eastern White Cedar	Y	DM	245cm	7	field grown	15m
	Zanthoxylum americanum	Prickly Ash	Y	PN		2	verify with veterinarian	5m
						62	**TOTAL**	

Shrubs

Symbol	Botanic name	Common Name	Toronto Native	Source	Size	Quantity	Notes
Ac	Amelanchier canadensis	Serviceberry	Y	DM	200cm WB	10	
Af	Amorpha fruticosa	False Indigo	Y	PN	1 gal	4	
Ae	Aralia elata	Hercules' Club	Y			29	
Am	Aronia melanocarpa	Chokeberry	Y	DM	100cm	5	
At	Asimina triloba	Paw Paw				13	smallish tree
Bc	Berberis canadensis	American barberry				25	
Ca	Ceanothus americanus	New Jersey Tea	Y	DM - GW	60cm	33	
Ch	Ceanothus herbacea	Prairie Redroot	Y	GW	1 gal	12	
Ce	Cephalanthus occidentalis	Buttonbush	Y	DM	80cm	4	verify with veterinarian
Cs	Cornus racemosa	Gray Dogwood	Y	DM	80cm	39	
Co	Cornus sericea	Red-osier Dogwood	Y	DM	100cm	61	
Cr	Corylus americana	American Hazel	Y	DM	80cm	26	
Cp	Crataegus x mordenensis 'Snowbird'	Snowbird Hawthorn		DM	30cm	12	
Gp	Gaultheria procumbens	Wintergreen	Y	PARA	1 gal	25	
Hv	Hamamelis virginiana	Witchhazel	Y	DM	125cm WB	14	
Hk	Hypericum kalmianum	Kalm's t. John's Wort	Y	DM	30cm	13	
Pm	Paxistima canbyi	Canby Paxistima		DM	1 gal	27	
Po	Physocarpus opuifolius 'Golden'	Golden Ninebark	Y	DM	100cm	6	
Ra	Rhus aromatica	Fragrant Sumac	Y	NSH	1 gal	60	
Rr	Rosa rugosa	Rugosa Rose	Y	DM	80cm	26	
Rs	Rubus ideaus	Wild Raspberry	Y	DM	60cm	7	
Ro	Rubus ordoratus	Flowering Raspberry	Y	DM	60cm	19	
Sx	Salix lucida	Shining Willow	Y	DM	60cm	45	
Sc	Sambucus canadensis	American Elderberry	Y	DM	100cm	15	verify with veterinarian
Sp	Sambucus pubens	Red Elderberry	Y	DM	100cm	6	verify with veterinarian
Ss	Sobaria sorbifolia 'Sem'	Sem False Spirea		PARA	80cm	16	
Sr	Spirea alba	Hardhack		DM	80cm	21	
Sl	Spirea latifolia	Meadowsweet	Y			9	
Sf	Staphylea trifolia	Bladdernut	Y	NSH	1 gal	20	
St	Stephanandra incisa 'Crispa'	Cutleaf Stephanandra		DM	50cm	17	
Va	Vaccinium vitis idaea 'Minus'	Mountain Cranberry				6	
Vn	Viburnum acerifolium	Mapleleaf Viburnum	Y			9	
Vo	Viburnum lantanoides	Hobblebush	Y			4	
Vg	Viburnum lentago	Nannyberry	Y	PARA	1 gal	2	
Vt	Viburnum trilobum	Highbush Cranberry	Y	DM	100cm	9	
						649	**TOTAL**

Perennials, Grasses, Vines, Ferns, Bulbs, Seed

Symbol	Botanic name	Common Name		Toronto Native		size	quantity	notes
	Acanthus hungaricus	Bear's Breeches	perennial	No	LH	1 gal	100	
	Acanthus spinosus	Bear's Breeches	perennial	No	LH	1 gal	100	zone 5
	Achillea millefolia	Yarrow	perennial	Y	DM	1 gal	100	
	Allium canadense	Wild Garlic	bulb	Y	GW	bulb	100	
	Allium schoenoprasum v. sibiricum	Wild Chives	bulb	Y	GW	bulb	100	
	Anaphalis margaritacea	Pearly Everlasting	perennial	Y	GW	1 gal	100	
	Andropogon gerardii	Big Bluestem	grass	Y	DM	2 gal	500	
	Anemone canadensis	Canada Anemone	perennial	Y	DM	1 gal	100	
	Antennaria plataginfolia	Plaintain-leaved Pussytoes	perennial	Y	GW	1 gal	100	
	Aquilegia canadensis	Wild Columbine	perennial	Y	DM	1 gal	100	
	Aralia continentalis	Manchurian Spikenard	perennial	No	LH	1 gal	100	
	Aralia recemosa		perennial	No	LH	1 gal	100	
	Arisaema triphyllum	Jack-in-the-Pulpit	perennial	Y	GW	1 gal	100	verify with veterinarian
	Aruncus diocus	Giant Goat's Beard	perennial	No	DM	1 gal	100	
	Asarum canadense	Wild Ginger	perennial	Y	DM	1 gal	100	
	Aster cordifolius	Heart-leaved Aster	perennial	Y	GW	1 gal	100	
	Astilboides tabularis	Shieldleaf Rodgersia	perennial	No	PARA	1 gal	100	prefers moist soils
	Boehmeria platanifolia	Sycamore-leaf False Nettle	perennial	No			100	
	Brunnera macrophylla 'Jack Frost'	Brunnera	perennial	No	DM	1 gal	100	
	Carex muskingumensis	Palm Sedge	grass	Y	DM	1gal	500	
	Carex pennsylvanica	Oak Sedge	grass	Y	DM	1gal	500	
	Carex plantaginea	Plantain-leaved Sedge	grass	Y	GW	1 gal	500	
	Carex platyphylla	Broad-leaved Sedge	grass	Y	GW	1 gal	500	
	Carex tenera	Quill Sedge	grass	Y	GW	1 gal	500	
	Chamerion angustifolium	Fireweed	seed	Y	GW	seed	100	broadcast seed, treat an an annual
	Chasmanthium latifolium	Spangle Grass	grass	Y	DM	2 gal	500	
	Cimicifuga racemosa	Black Snakeroot	perennial	No	DM	1 gal	100	verify with veterinarian
	Clematis virginiana	Virgin's Bower	vine	Y	PARA	1 gal	100	
	Darmera peltata	Umbrella Plant / Indian Rhubarb	perennial	No	PARA	1 gal	100	verify with veterinarian, mulch for winter protection, needs bogg
	Desmodium canadense	Showy Tick-trefoil	perennial	Y	DM	1 gal	100	
	Elymus canadensis	Canada Wild Rye	seed	Y	DM	1 gal	seed	
	Elymus riparius	Riverbank Wild Ryegrass	grass	Y	GW	1 gal	500	
	Geranium maculatum	Wild Geranium	perennial	Y	DM	1 gal	100	
	Heliopsis helianthoides	Sweet Ox-eye	perennial	Y	DM	1 gal	100	
	Hosta 'Empress Wu'	Empress Wu Hosta	perennial	No	DM	1 gal	100	
	Kirengeshoma palmata 'Margarita'	Yellow Wax Bells	perennial	No	PARA	1 gal	100	mulch for winter protection
	Ligularia 'Little Rocket"	Little Rocket Ligularia	perennial	No	DM	1 gal	100	verify with veterinarian
	Matteuccia struthiopteris	Ostrich Fern	fern	Y	DM	1 gal	100	
	Monarda fistula	Wild Bee Balm	perennial	Y	DM	1 gal	100	
	Mukdenia rossii 'Karasuba'	Karasuba Mukdenia	perennial	No	LH	1 gal	100	
	Osmunda cinnamonea	Cinnamon Fern	fern	Y	DM	1 gal	100	
	Panicum virgatum	Switchgrass	grass	Y	DM	2 gal	500	
	Panicum virgatum 'Cloud Nine'	Cloud Nine Switchgrass	grass	No	DM	2 gal	500	
	Penstemon hirsutus	Hairy Beardtongue	perennial	Y	GW	1 gal	100	
	Petasites japonicus	Giant Butterbur	perennial	No	FN	1 gal	100	use on visitor side only
	Rheum palmatum	Chinese Rhubarb	perennial	No	PARA	1 gal	100	use on visitor side only
	Rodgersia aesculifolia	Fingerleaf Rodgersia	perennial	No	PARA	1 gal	100	mulch for winter protection
	Rodgersia pinnata	Rodgersia	perennial	No	DM	1 gal	100	mulch for winter protection
	Schizachyrium scoparium	Little Bluestem	grass	Y	DM	1 gal	500	
	Smilax hispida	Bristly Greenbriar	vine	Y	GW	1 gal	100	
	Solidago flexicaulis	Zig-zag Goldenrod	perennial	Y	GW	1 gal	100	limited to roots, verify with veterinarian
	Sorghastrum nutans 'Sioux Blue'	Indian Grass 'Sioux Blue'	grass	No	DM	1gal	500	
	Thalictrum pubescens	Tall Meadow Rue	perennial	Y	GW	1 gal	100	
	Verbena bonariensis	Tall Verbena	annual	No		seed	seed	broadcast seed, treat an an annual
	Verbena hastata	Blue Vervain	perennial	Y	GW	1 gal	100	
	Verbena strictus	Hoary Vervain	perennial	Y	GW	1 gal	100	
							10200	**TOTAL**

DM	Dutchmaster Nurseries, Brougham, Ontario
GW	Grow Wild Native Plant Nursery, Omemee, Ontario
PN	Puslinch Naturally Native Trees, Puslinch, Ontario
NSH	Not So Hollow Farm, Mulmur, Ontario
FN	Fiddlehead Nursery, Kimberley, Ontario
LH	Lost Horizons Nursery, Acton, Ontario
PARA	Paramount Nursery, Ottawa, Ontario

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toronto ZOO

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PROJECT:
ORANGUTAN EXHIBIT

DRAWING NAME :

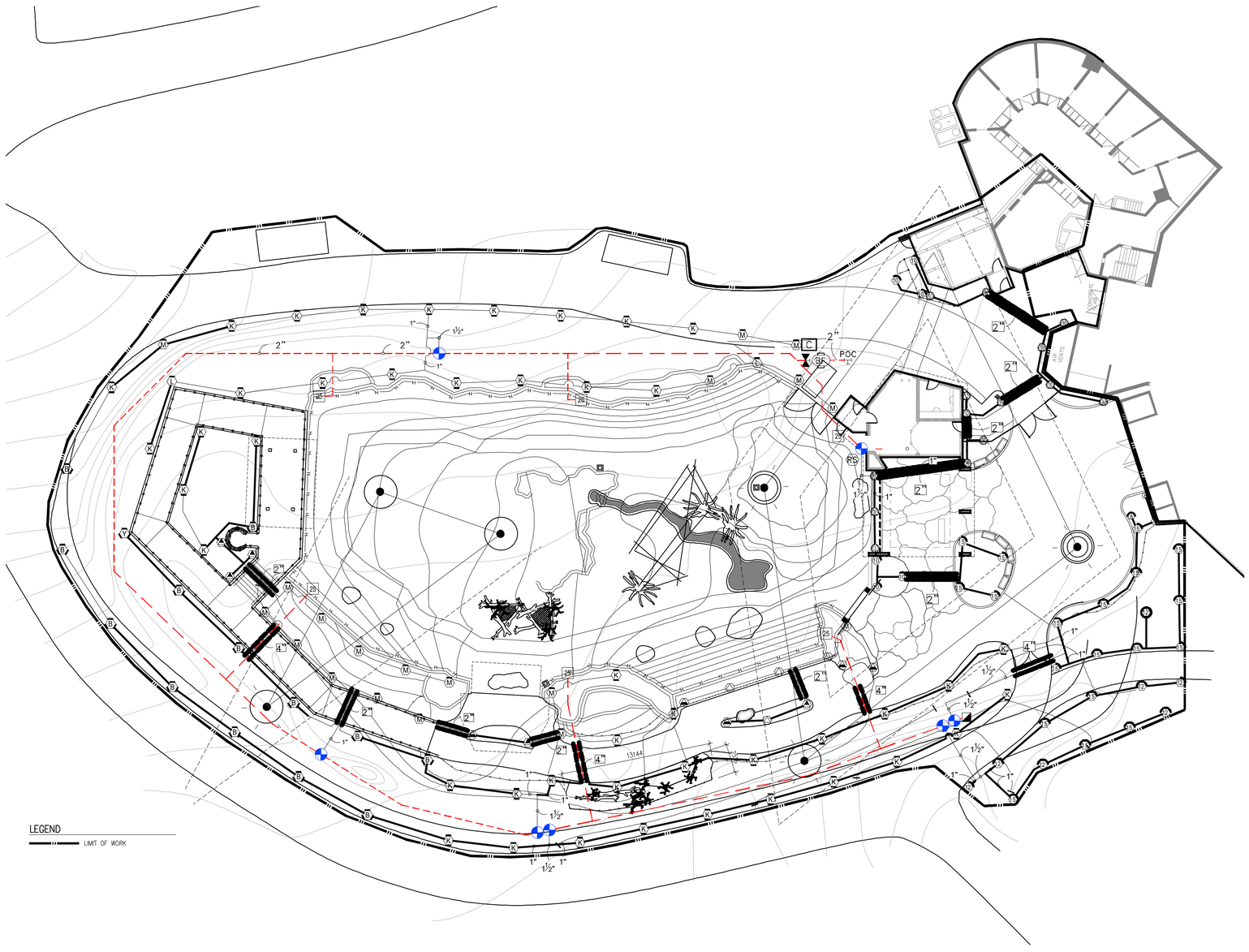
PLANTING LIST
Habitat 1

PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	RH	LC

DRAWING NUMBER:

SCALE:
1:200
AUGUST 13. 2019

LA1.4



IRRIGATION SCHEDULE

SYMBOL	MANUFACTURER/MODEL	QTY
ES LCS RCS CS SS	Hunter PROS-12-PRS40-CV 5' strip spray	14
Q T H F	Hunter PROS-12-PRS40-CV 8' radius	3
Q T H F	Hunter PROS-12-PRS40-CV 10' radius	6
Q T H TT TQ F	Hunter PROS-12-PRS40-CV 12' radius	7
Q T H TT TQ F	Hunter PROS-12-PRS40-CV 15' radius	19
LST RST SST	Hunter MP Strip PROS-12-PRS40-CV	14
	Hunter MP1000 PROS-12-PRS40-CV	22
	Hunter MP2000 PROS-12-PRS40-CV	44
	Hunter MP3000 PROS-12-PRS40-CV	14

SYMBOL	MANUFACTURER/MODEL	QTY
25	Hunter G995E w/ EZ-1 Decoder	6

SYMBOL	MANUFACTURER/MODEL	QTY
	Hunter PGV-1016 1" w/ EZ-1 Decoder	7
	Hunter HQ-44RC 1"	1
	Shut Off Valve - Sized to Mainline	1
BF	Zurn 975XL 2" 50mm	1
C	Hunter I2C-0800-M w/ EZ-DM Module	1
RS	Hunter RAIN-CLIK	1
POC	Point of Connection 2"	1
———	Irrigation Lateral Line: Polyethylene Pipe 100 PSI 1"	662.5 m
———	Irrigation Lateral Line: Polyethylene Pipe 100 PSI 1 1/2"	30.8 m
— — — —	Irrigation Mainline: PVC Class 160 SDR 26 1 1/2"	218.7 m
= = = = =	Pipe Sleeve: PVC Class 160 SDR 26 2"	37.1 m
= = = = =	Pipe Sleeve: PVC Class 160 SDR 26 4"	13.1 m

IRRIGATION NOTES

1. ALL WORK IS TO BE IN COMPLIANCE WITH ALL LOCAL, STATE AND FEDERAL CODES AND ORDINANCES.
2. ALL UNDERGROUND ELECTRICAL CONNECTIONS ARE TO BE MADE WITH 3-M WIRE CONNECTORS, DBY.
3. ALL REMOTE CONTROL VALVES ARE TO BE INSTALLED IN VALVE BOXES OF APPROPRIATE SIZE.
4. ALL CONTROL WIRING DOWNSTREAM OF THE CONTROLLER IS TO BE 14 AWG, UL APPROVED FOR DIRECT BURY.
5. ALL ROTORS AND SPRAY POP-UPS SHALL BE INSTALLED ON SWING PIPE.
6. ALL QCV SHALL BE INSTALLED ON 3-ELBOW PVC SWING JOINTS.
7. SYSTEM DESIGN BASED UPON 55 GPM @ 100 PSI.
8. ONLY ONE G995E ROTOR SHALL BE OPERATED AT A TIME.
9. ANY CHANGES IN AVAILABILITY OF SUPPLY SHOULD BE NOTED AND MODIFICATIONS TO THE DESIGN SHOULD BE MADE.
10. CONTRACTOR TO VERIFY WATER PRESSURE AND AVAILABILITY PRIOR TO INSTALLATION.
11. THE LOCATION OF ALL IRRIGATION IS DIAGRAMMATIC AND SUBJECT TO FIELD VERIFICATION.
12. ANY IRRIGATION PIPING SHOWN OUTSIDE OF CURBS FOR CLARITY ONLY.
13. 120V. TO CONTROLLER AND COPPER STUB, BY OTHER THAN IRRIGATION CONTRACTOR.
14. A BOOSTER PUMP IS REQUIRED IF SYSTEM DOES NOT MEET THE DESIGN PRESSURE.
15. THE CONTRACTOR IS RESPONSIBLE FOR THEIR OWN MATERIAL TAKE OFF.

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ORANGUTAN EXHIBIT

DRAWING NAME :

IRRIGATION PLAN
Habitat 1

PROJECT NO.:	DRAWN BY :	CHECKED BY:
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SCALE:
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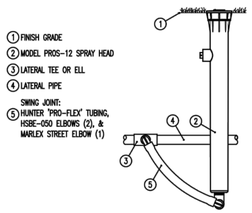
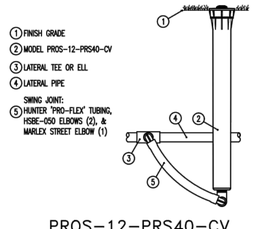


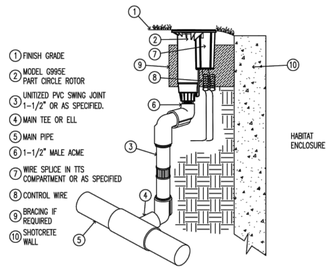
01 PROS-12 SPRAY HEAD

Hunter IRRIGATION DETAIL



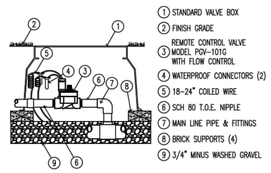
02 PROS-12-PRS40-CV MP ROTATOR SPRINKLER

Hunter IRRIGATION DETAIL



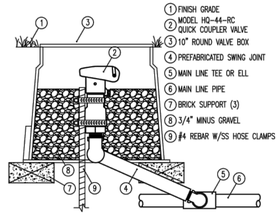
03 G995E GEARED ROTOR

IRRIGATION DETAIL



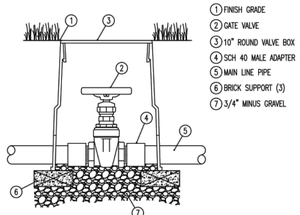
04 PGV GLOBE VALVE

Hunter IRRIGATION DETAIL



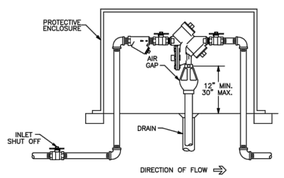
05 QUICK COUPLER VALVE

Hunter IRRIGATION DETAIL



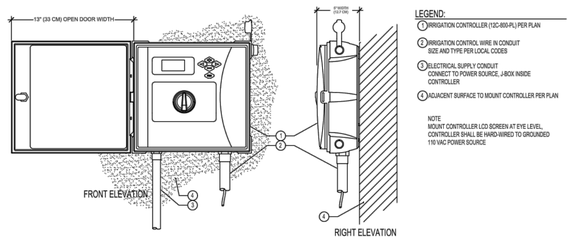
06 GATE VALVE

IRRIGATION DETAIL



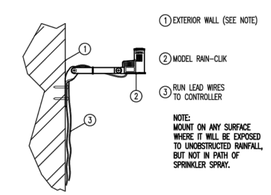
07 WILKINS 975XL

Hunter IRRIGATION DETAIL



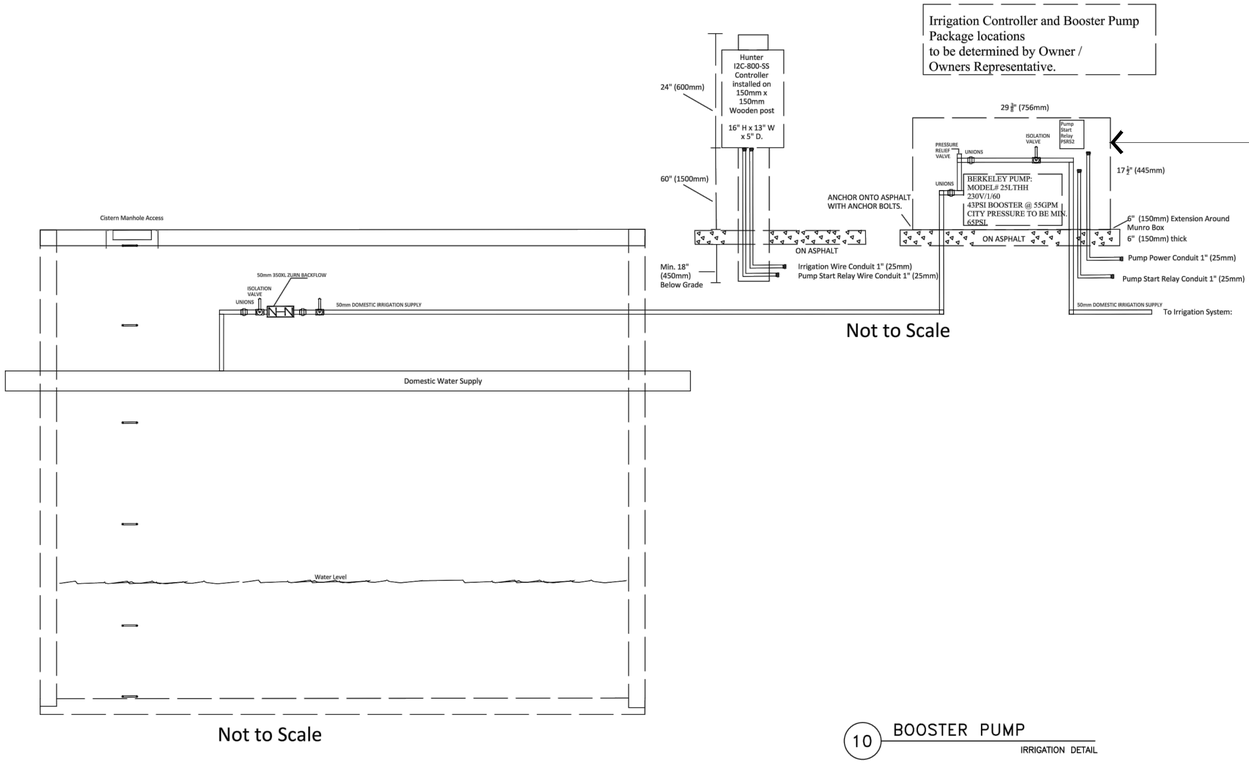
08 HUNTER I2C CONTROLLER

Hunter IRRIGATION DETAIL



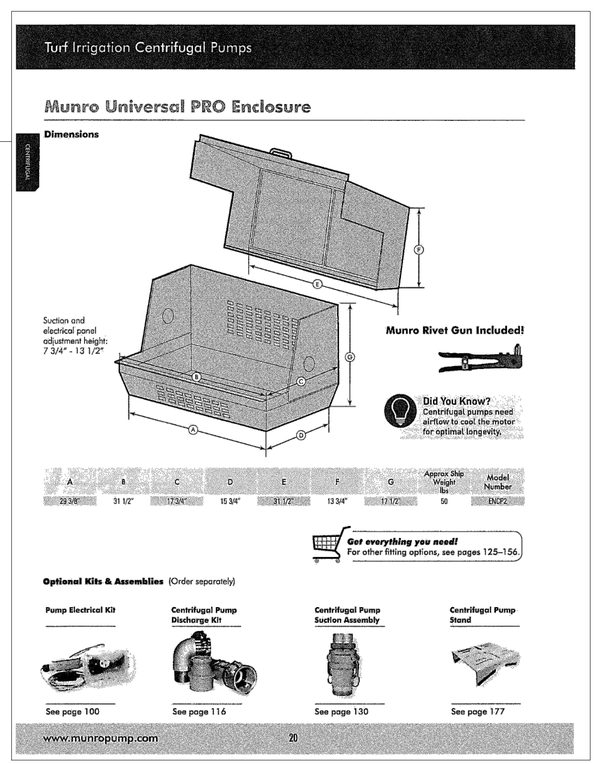
09 RAIN-CLIK

Hunter IRRIGATION DETAIL



10 BOOSTER PUMP

IRRIGATION DETAIL



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CLIENT: **TORONTO ZOO**

toronto zoo
361A Old Finch Ave, Toronto ON M1B 5K7, 416-392-5929

PROJECT:
ORANGUTAN EXHIBIT

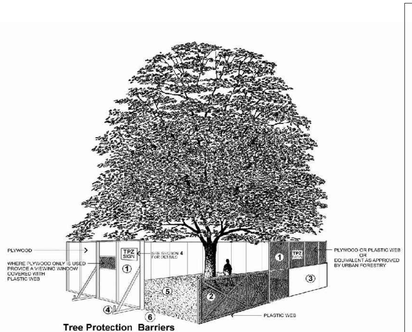
DRAWING NAME :

IRRIGATION DETAILS
Habitat 1

PROJECT NO.:	DRAWN BY :	CHECKED BY:
18-1-086	RH	LC

SCALE:
1:200
AUGUST 13. 2019

DRAWING NUMBER:
LA1.6

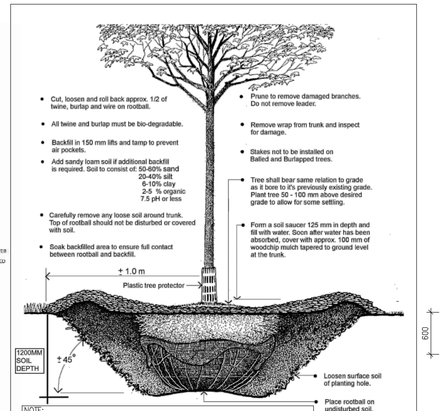


Tree Protection Barriers

1. **Tree protection barriers must be a plywood or plastic web hoarding or equivalent as approved by Urban Forestry.**
2. **Tree protection barriers for trees situated on the City road allowance where visibility must be maintained can be 1.2m (4ft.) high and consist of orange plastic web snow fencing on a wood frame made of 2"x 4"s .**
3. **Where some excavate or fill has to be temporarily located near a tree protection barrier, plywood must be used to ensure no material enters the Tree Protection Zone.**
4. **All supports and bracing should be outside the Tree Protection Zone. All such supports should minimize damaging roots outside the Tree Protection Barrier.**
5. **No construction activity, grade changes, surface treatment or excavations of any kind is permitted within the Tree Protection Zone.**
6. **Sediment control fencing shall be installed in locations indicated in an Urban Forestry approved Tree Protection Plan. The sediment control fencing must be installed to Ontario Providal Standards (OPSD-219.110) and to the satisfaction of Urban Forestry.**

TORONTO
Urban Forestry — Parks, Forestry and Recreation
Sept 2008 **Detail TP-1**

1 TREE PROTECTION BARRIERS
DETAIL TP-1

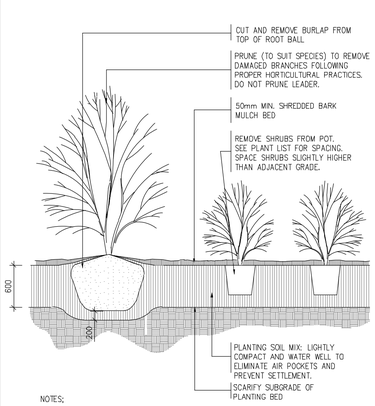


NOTE:
1. REMOVE ALL BURLAP, TWINE, WIRE BASKETS, AND PLASTIC TREE PROTECTORS FROM TREES PLANTED WITHIN THE ORANGUTAN HABITAT.
2. SOIL MIXTURE WILL BE FREE OF ALL STONES LARGER THAN 25mm dia.

Planting Detail for Balled and Burlapped Trees in Turf

TORONTO
Urban Forestry Services — Parks and Recreation Division
June 2002 **Detail PD -101**

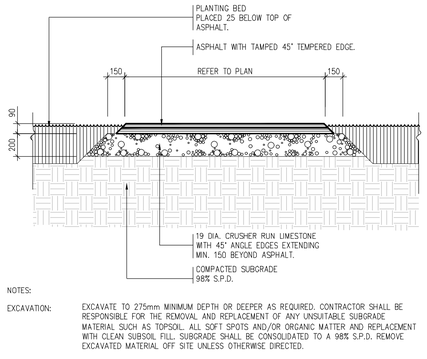
2 PLANTING DETAIL FOR BALLED AND BURLAPPED TREES IN TURF
DETAIL PD-101



NOTES;

1. PROVIDE 150 HIGH EARTH SAUCER AROUND SHRUB BED WITH 100 WIDE SMOOTH BED EDGE TO REMAIN MULCH
2. SOIL MIXTURE: PLANTING SOIL SHALL BE A SANDY LOAM SOIL COMPRISED OF 50-60% SAND, 20-40% SILT, 6-10% CLAY AND 2-5% ORGANIC WITH A PH OF 7.5 OR LESS. PLANTING SOIL SHALL BE FREE OF ALL STONES LARGER THAN 25mm dia.
3. REMOVE ALL BURLAP FROM SHRUBS PLANTED WITHIN THE ORANGUTAN HABITAT.

3 SHRUB PLANTING AT GRADE
1:30



NOTES:

EXCAVATION: EXCAVATE TO 275mm MINIMUM DEPTH OR DEEPER AS REQUIRED. CONTRACTOR SHALL BE RESPONSIBLE FOR THE REMOVAL AND REPLACEMENT OF ANY UNSUITABLE SUBGRADE MATERIAL SUCH AS TOPSOIL. ALL SOFT SPOTS AND/OR ORGANIC MATTER AND REPLACEMENT WITH CLEAN SUBSOIL FILL. SUBGRADE SHALL BE CONSOLIDATED TO A 98% S.P.D. REMOVE EXCAVATED MATERIAL OFF SITE UNLESS OTHERWISE DIRECTED.

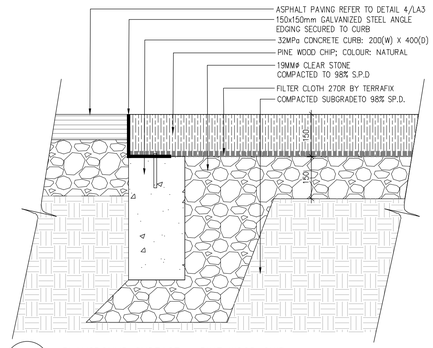
GRANULAR BASE: 200mm LAYER OF 19ø CRUSHER RUN COMPACTED TO 98% STANDARD PROCTOR DENSITY MIN.

ASPHALT: 40mm TOP LAYER (AFTER COMPACTION) OF HOT MIX HL3A, AND 50mm BOTTOM LAYER (AFTER COMPACTION) OF HOT MIX HL8 IN ACCORDANCE WITH O.P.S.S. STANDARDS.

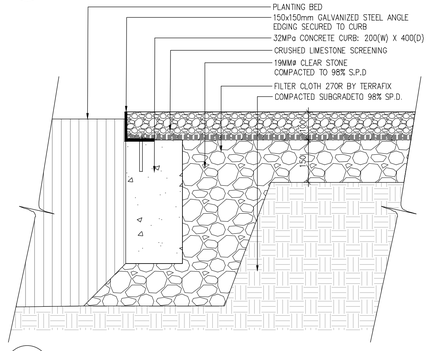
EDGE TREATMENT: ASPHALT EDGE TO BE 45° WELL TAMPED TO FORM UNIFORMLY, SMOOTH, CLEAN EDGES WITHOUT LATERIAL DEVIATIONS. SOD TO FEATHER IN WITH EXISTING SOD AND GRADES AT A MAXIMUM SLOPE OF 4:1 ALL SEEDED OR SODDED AREAS SHALL BE 25 BELOW THE ASPHALT SURFACE. REPLACE ALL TOPSOIL AND SOD AS DIRECTED IN CUT AND FILL SITUATIONS.

DRAINAGE: SLOPE TO BE A MINIMUM OF 2% ON CROWNED OR CROSS SLOPED PATHS AS DIRECTED ON SITE OR AS SHOWN IN DRAWINGS.

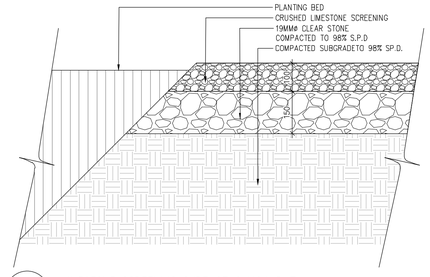
4 ASPHALT DETAIL
1:25



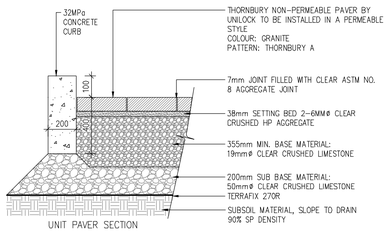
5 PLAYGROUND SURFACE - PINE WOOD CHIP
1:10



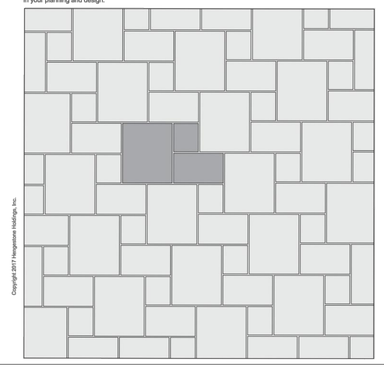
6 LIMESTONE SCREENING SURFACE
1:10



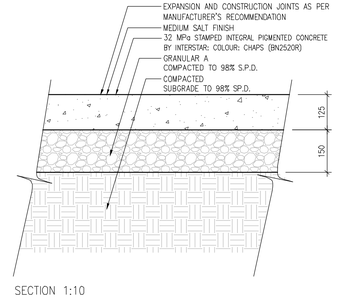
9 LIMESTONE SCREENING SURFACE @ MOW PATH
1:10



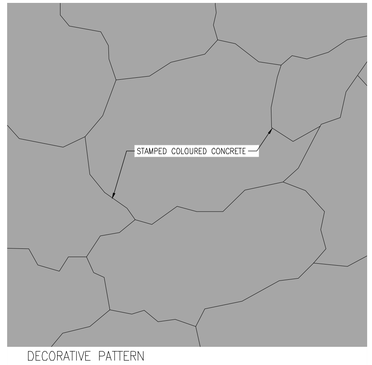
UNIT PAVER SECTION



7 PERMEABLE PRECAST PAVER DETAIL
1:20

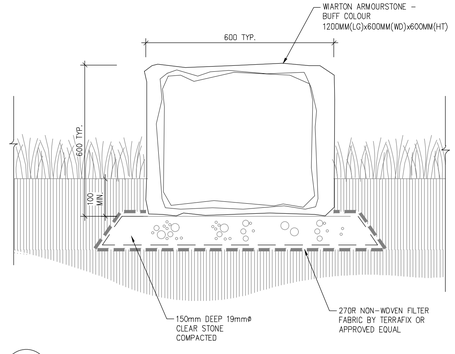


SECTION 1:10

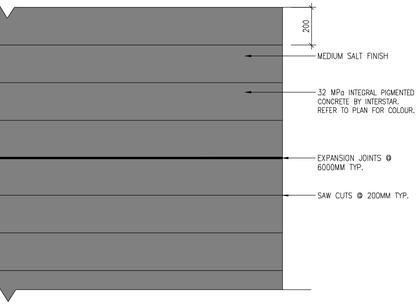


DECORATIVE PATTERN

10 INTEGRAL PIGMENTED STAMPED CONCRETE
AS SHOWN

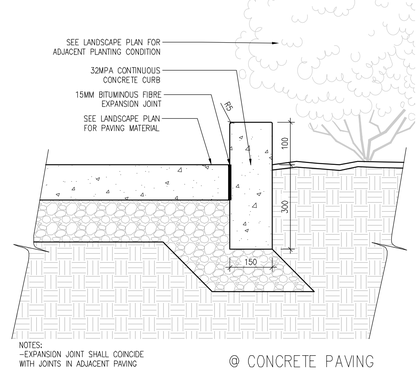


11 ARMOURSTONE
1:10



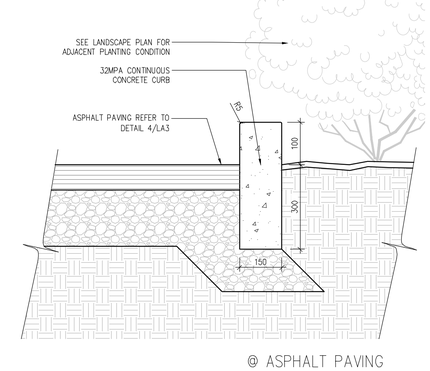
NOTE: REFER TO STRUCTURAL/ARCHITECTS FOR BOARDWALK DETAILING. LANDSCAPE DETAIL SHOWS JUST PAVING FINISH. REFER TO PLAN FOR COLOUR/LOCATION.

8 INTEGRAL PIGMENTED CONCRETE @ BOARDWALK
1:15



NOTES:
-EXPANSION JOINT SHALL COINCIDE WITH JOINTS IN ADJACENT PAVING

@ CONCRETE PAVING



@ ASPHALT PAVING

12 LANDSCAPE CURB @ CONCRETE PAVING / ASPHALT PAVING
1:10

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OALA
MEMBER

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toronto zoo
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PROJECT:
ORANGUTAN EXHIBIT

DRAWING NAME :

LANDSCAPE DETAILS

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18-1-086	RH	LC

DRAWING NUMBER:

SCALE:
AS SHOWN
AUGUST 13. 2019

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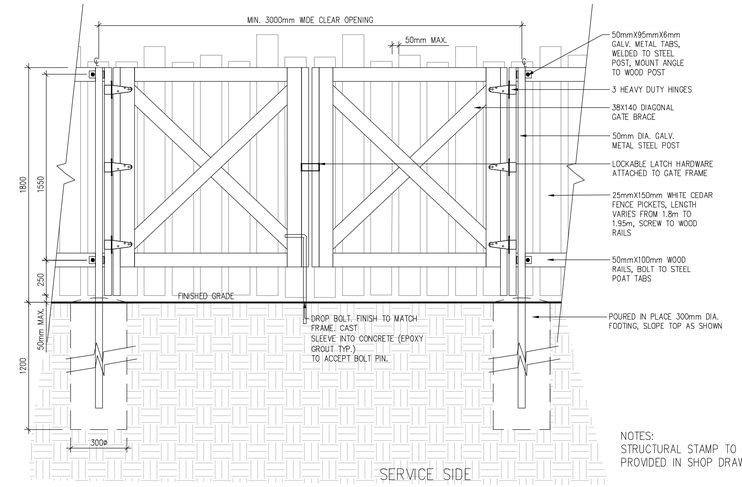
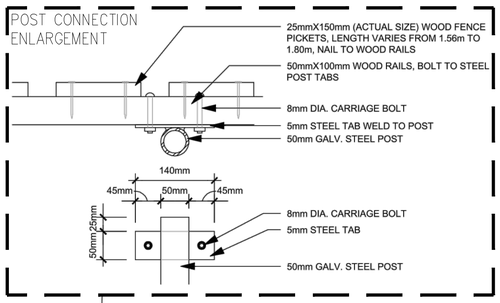
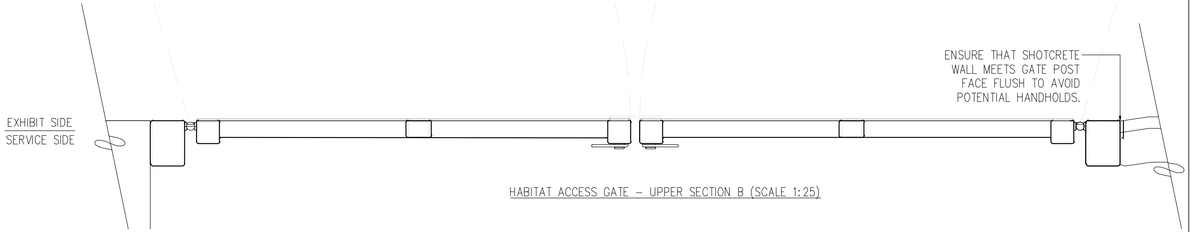


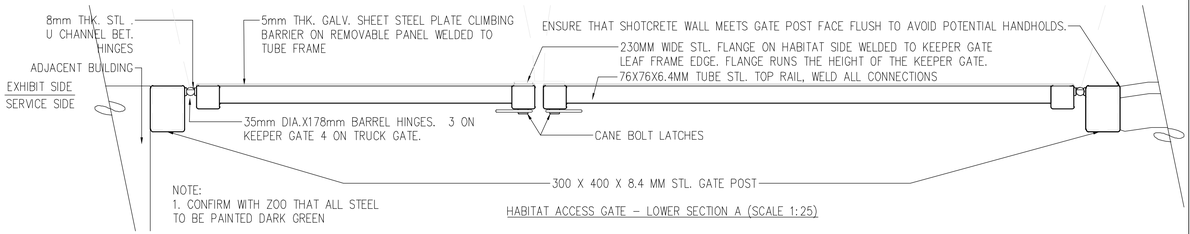
NOTES:
STRUCTURAL STAMP TO BE PROVIDED IN SHOP DRAWINGS

1 WOODEN GATE
1:20



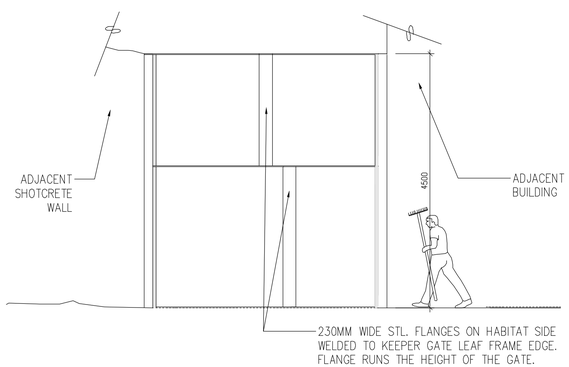


HABITAT ACCESS GATE – UPPER SECTION B (SCALE 1:25)

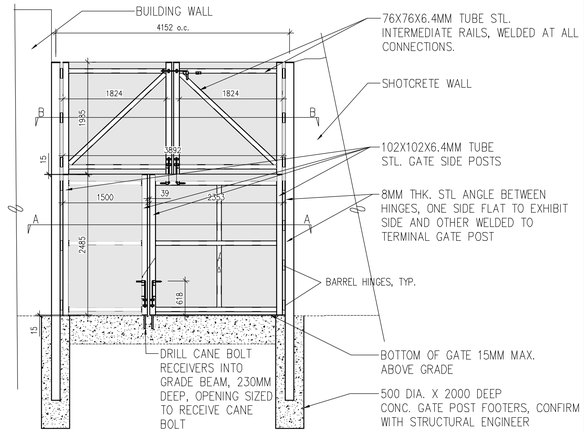


NOTE:
1. CONFIRM WITH ZOO THAT ALL STEEL TO BE PAINTED DARK GREEN

HABITAT ACCESS GATE – LOWER SECTION A (SCALE 1:25)

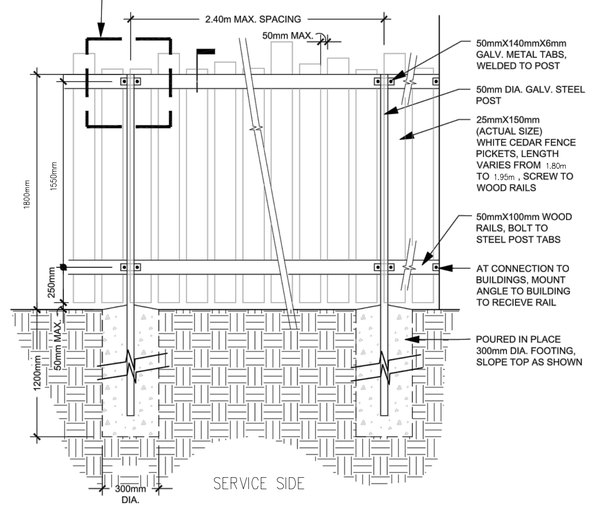


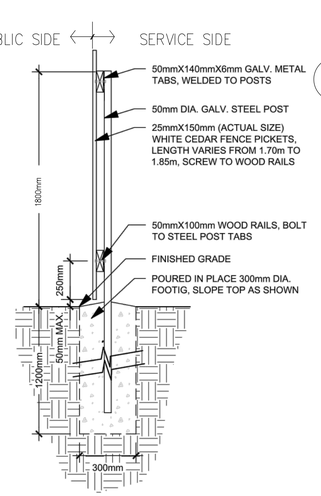
HABITAT FENCE/ACCESS GATE ELEVATION – HABITAT SIDE (SCALE 1:50)



HABITAT FENCE/ACCESS GATE ELEVATION – KEEPER SIDE (SCALE 1:50)

NOTES:
STRUCTURAL STAMP TO BE PROVIDED IN SHOP DRAWINGS

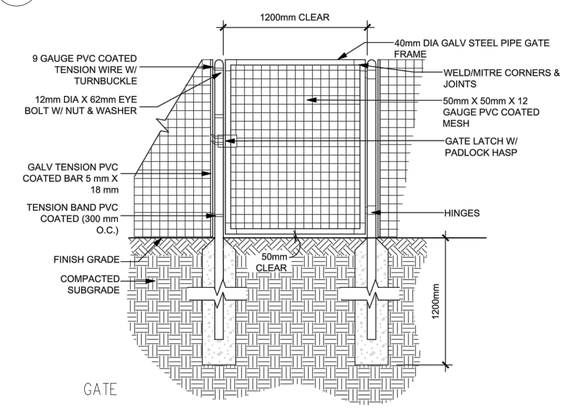




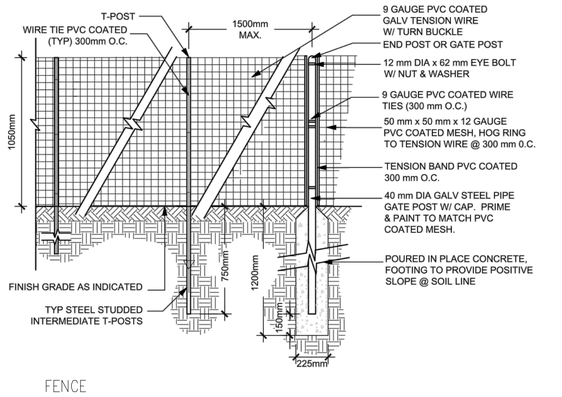
NOTES:
STRUCTURAL STAMP TO BE PROVIDED IN SHOP DRAWINGS

3 WOODEN FENCE
1:20

2 ACCESS GATE TO EXHIBIT
AS SHOWN



GATE



FENCE

NOTE:
DOUBLE GATE TO BE CONSTRUCTED IN SIMILAR DETAILS

STRUCTURAL STAMP TO BE PROVIDED IN SHOP DRAWINGS

4 EXCLUSION GATE AND FENCE
1:20

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ROBERT NG
OALA
MEMBER

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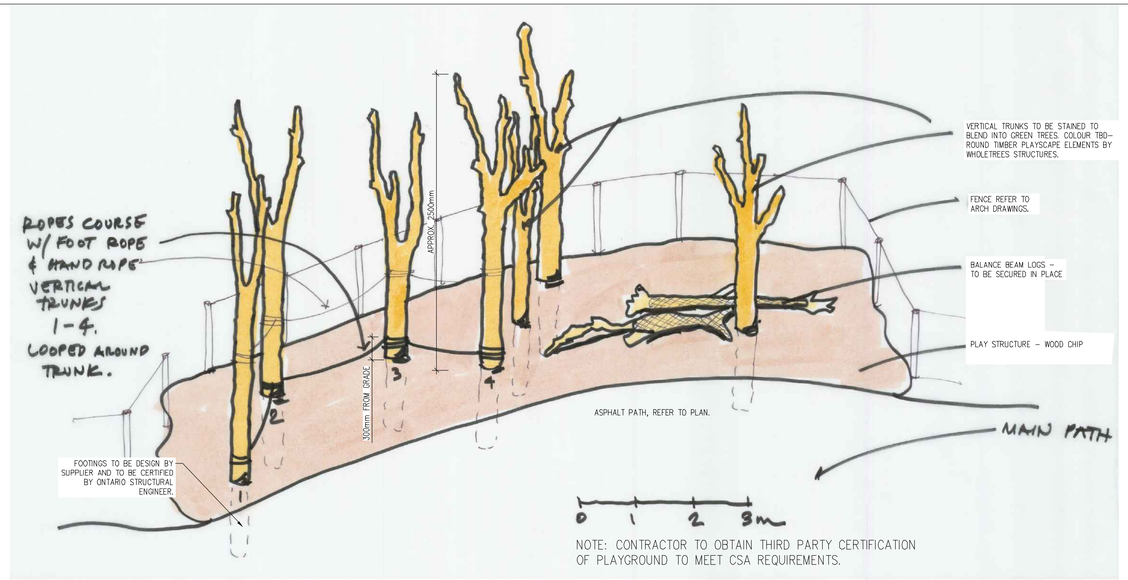
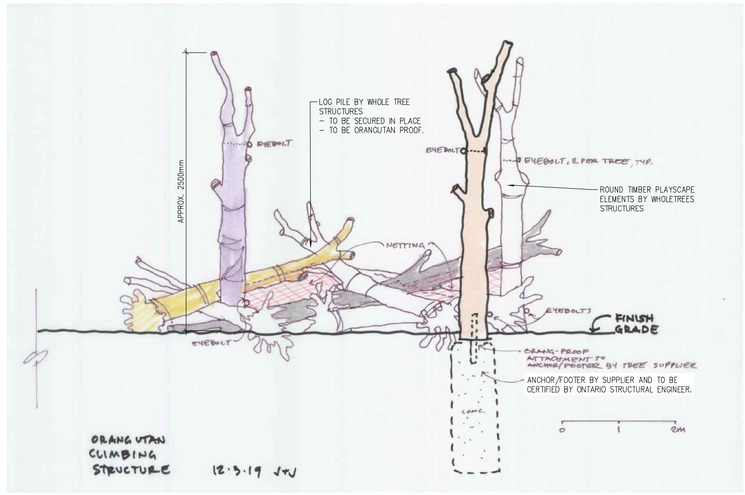
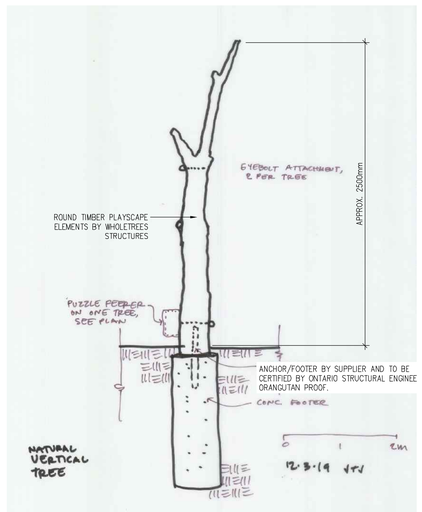


1 PLAY STRUCTURE
1:50



2 ORANGUTAN CLIMBING STRUCTURE
1:50



3 NATURAL VERTICAL TREES
1:50

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TORONTO ZOO

2000 MEADOWVALE ROAD
TORONTO, ONTARIO, M1B 5K7
INDO-MALAYA PAVILION GENERATOR REPLACEMENT

MAL PROJECT No. 2018282

ISSUED FOR TENDER

DECEMBER 19TH, 2019

toronto ZOO

McGREGOR ALLSOP
CONSULTING ENGINEERS
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LIST OF DRAWINGS

PREPARED BY:
McGREGOR ALLSOP LIMITED
1 CONCORDE GATE, SUITE 808, NORTH YORK, ON, M3C 3N6

ELECTRICAL DRAWING LIST

DWG No.	DESCRIPTION
E-1	LEGENDS AND SITE PLAN
E-2	SINGLE LINE DIAGRAM DEMOLITION AND NEW
E-3	ELECTRICAL ROOM LAYOUT
E-4	GENERATOR ENCLOSURE LAYOUT
E-5	DETAILS
E-6	PHOTOS
E-7	CUSTOM 2000A SPLITTER "SPL"

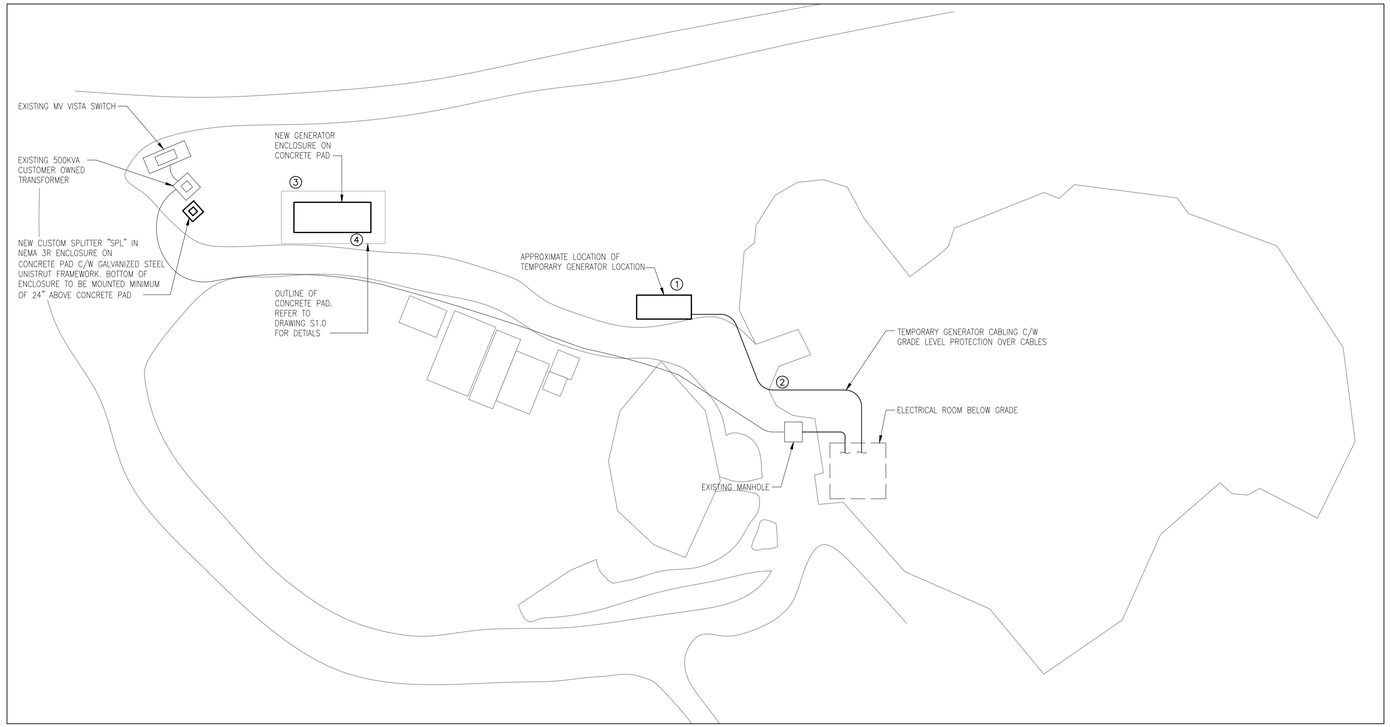
LIST OF DRAWINGS

PREPARED BY:
MTE CONSULTANTS INC.
520 BINGEMANS CENTRE DRIVE, KITCHENER, ON, 2B 3X9

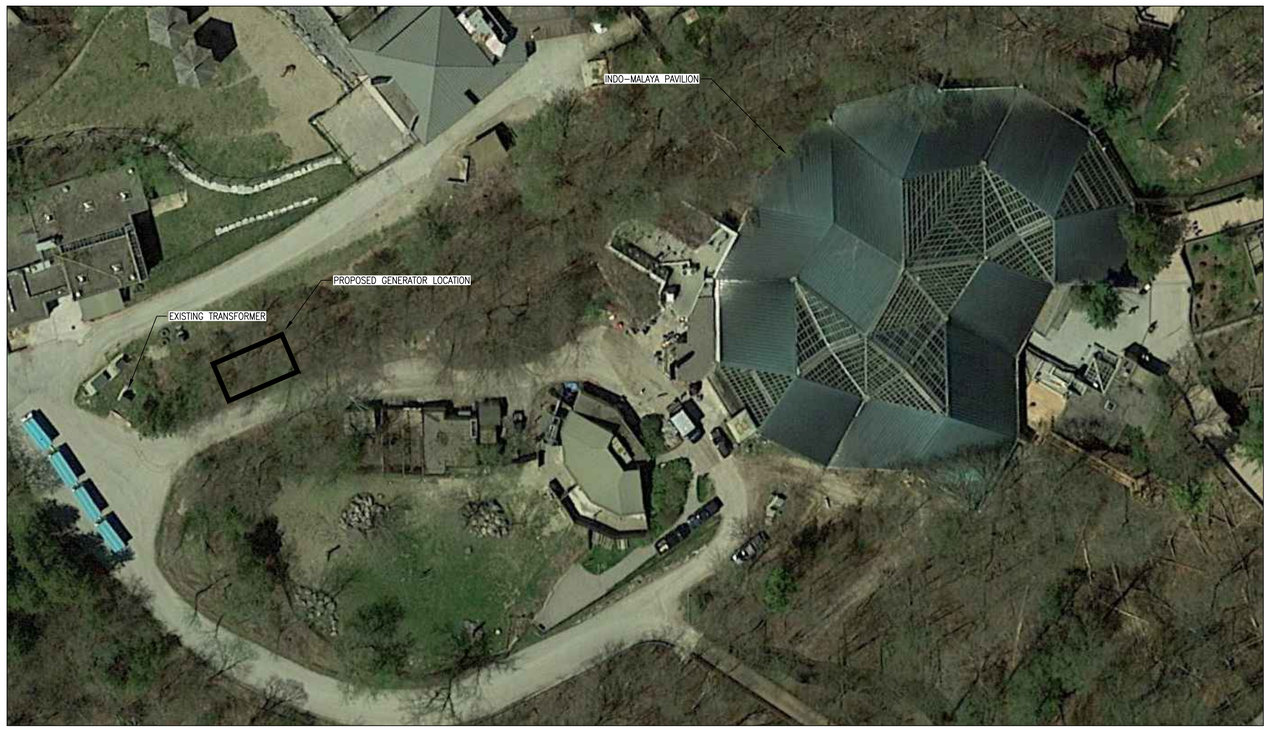
STRUCTURAL DRAWING LIST

DWG No.	DESCRIPTION
S1.0	GENERAL NOTES, GRADING PLAN, SLAB PLAN, SECTIONS AND DETAILS

914x1219mm



1 / E-1 **SITE PLAN WITH EXISTING EQUIPMENT**
SCALE: 1/32" : 1'-0"



2 / E-1 **SITE PLAN**
SCALE: N.T.S

NOTES:

①	PROVIDE 400kW TEMPORARY GENERATOR FOR THE BUILDING FEEDER RELOCATION SCOPE AT THE TRANSFORMER. COORDINATE EXACT LOCATION OF TEMPORARY GENERATOR WITH OWNER. PRIOR TO FEEDER RELOCATION (AS DETAILED ON E-4), TEMPORARY GENERATOR TO BE PLACED ONSITE C/W TEMPORARY CABLES CONNECTED TO EXISTING MAIN SWITCHBOARD BUS. INCLUDE FOR PROPER AND SUITABLE PROTECTION OF TEMPORARY CABLING ON GRADE FOR THE DURATION OF GENSET USE ON SITE. EXISTING MAIN BREAKER TO BE OPENED, LOCKED OUT, AND TAGGED BY THIS CONTRACTOR AND TORONTO ZOO MAINTENANCE STAFF. INCLUDE ALL COSTS FOR GENERATOR, GROUNDING, FUEL, ESA PERMIT, FIRE ALARM WIRING AND VERIFICATION REQUIRE TO OPERATE UNDER GENERATOR POWER FOR DURATION OF DUCTBANK RELOCATION. BE RESPONSIBLE TO DETERMINE LENGTH OF TIME REQUIRED TO COMPLETE DUCT BANK RELOCATION, CABLE RELOCATION, CABLE INSTALLATION, AND CONNECTIONS. INCLUDE ALL COSTS IN BID.
②	TEMPORARY CABLES TO BE INSTALLED THROUGH EXISTING VENTILATION LOUVERS. PROVIDE CABLE PROTECTION WHEN PASSING THROUGH LOUVERS AND IN MECHANICAL AND ELECTRICAL ROOMS AS REQUIRED. PROVIDE SLEEVES THROUGH WALLS AS REQUIRED. ALL PENETRATIONS THROUGH FIRE SEPARATIONS TO BE FIRESTOPPED. PROVIDE PROTECTION FOR ALL FLOOR MOUNTED CABLES. PROVIDE SUPPORTS AS NEEDED FOR ALL WALL MOUNTED CABLES.
③	THE TORONTO ZOO MAINTENANCE STAFF WILL PERFORM POWER SHUTDOWNS AT THE TRANSFORMER. COORDINATE ALL POWER SHUTDOWNS WITH TORONTO ZOO MAINTENANCE STAFF.
④	REFER TO DRAWING E-4 FOR RELOCATION OF EXISTING DUCTBANK AND INSTALLATION OF NEW DUCTBANK.

POWER SYMBOLS	
SYMBOL	DESCRIPTION
	DUPLEX U-GROUND RECEPTACLE, 2 POLE/3 WIRE, 15A, 125V
GFI	15/20A, NEMA 5-20R ALTERNATE, GROUND FAULT CIRCUIT INTERRUPTER DUPLEX RECEPTACLE, "WP" DENOTES DEVICE MOUNTED IN WEATHERPROOF BOX WITH COVER.
	SERVICE RECEPTACLE, 60A, 208V, 1PH.
	120V DIRECT CONNECTION.
	208/240V DIRECT CONNECTION.
	DISCONNECT SWITCH WHERE SHOWN ON DRAWINGS OR REQUIRED BY CODE.
EPO CG	"EMERGENCY POWER OFF" PUSH BUTTON MOUNTED 4'-0"(1.2m) ABOVE FINISHED FLOOR, "CG" DENOTES THAT DEVICE C/W STI CLEAR GUARD AND HORN. "WP" DENOTES WEATHERPROOF.
	FLOOR MOUNTED TRANSFORMER.
T	EMPTY SINGLE GANG BACK BOX FOR TEMPERATURE SENSOR OR THERMOSTAT. EXTEND ¾"(19mm) CONDUIT INTO CEILING SPACE C/W PULL CORD.
	DEMOLITION
	CONDUIT DOWN
	CONDUIT UP

LIGHTING SYMBOLS	
SYMBOL	DESCRIPTION
F 3-1	2'x4' LUMINAIRE. LETTER "F" DENOTES TYPE AS PER LUMINAIRE SCHEDULE. "3-1" DENOTES CONNECTED TO PANEL 3, CIRCUIT 1.
	WALL OR CEILING MOUNTED LED PICTOGRAM EXIT LIGHT. SHADED AREA DENOTES SINGLE ACTIVE FACE.
B	EMERGENCY LIGHTING BATTERY UNIT COMPLETE WITH RECEPTACLE FOR AC POWER AND EMERGENCY HEADS.
	DOUBLE HEAD EMERGENCY LIGHT. "B1" DENOTES CONNECTED TO EMERGENCY BATTERY UNIT B1.

SINGE LINE DIAGRAM SYMBOLS	
SYMBOL	DESCRIPTION
	LOW VOLTAGE MOLDED CASE CIRCUIT BREAKER.
	LOW VOLTAGE POWER CIRCUIT BREAKER, FIXED TYPE.
	LOW VOLTAGE UNFUSED DISCONNECT SWITCH.
	LOW VOLTAGE FUSE.
	LOW VOLTAGE FUSED DISCONNECT SWITCH.
	CONTACT.
	OVERLOAD RELAY.
	FLEXIBLE CONDUIT CONNECTION.
	CURRENT TRANSFORMER.
M	METER.
PB	PULL BOX.
JB	JUNCTION BOX.
SPD	SURGE PROTECTION DEVICE.

SINGE LINE DIAGRAM SYMBOLS	
SYMBOL	DESCRIPTION
	FIRE ALARM PULL STATION MOUNTED 4'-0"(1200mm) ABOVE FINISHED FLOOR LEVEL UNLESS OTHERWISE NOTED.
	AUTOMATIC HEAT DETECTOR WITH FIXED TEMPERATURE OF 200°F (93°C).
EOL	END OF LINE RESISTOR.

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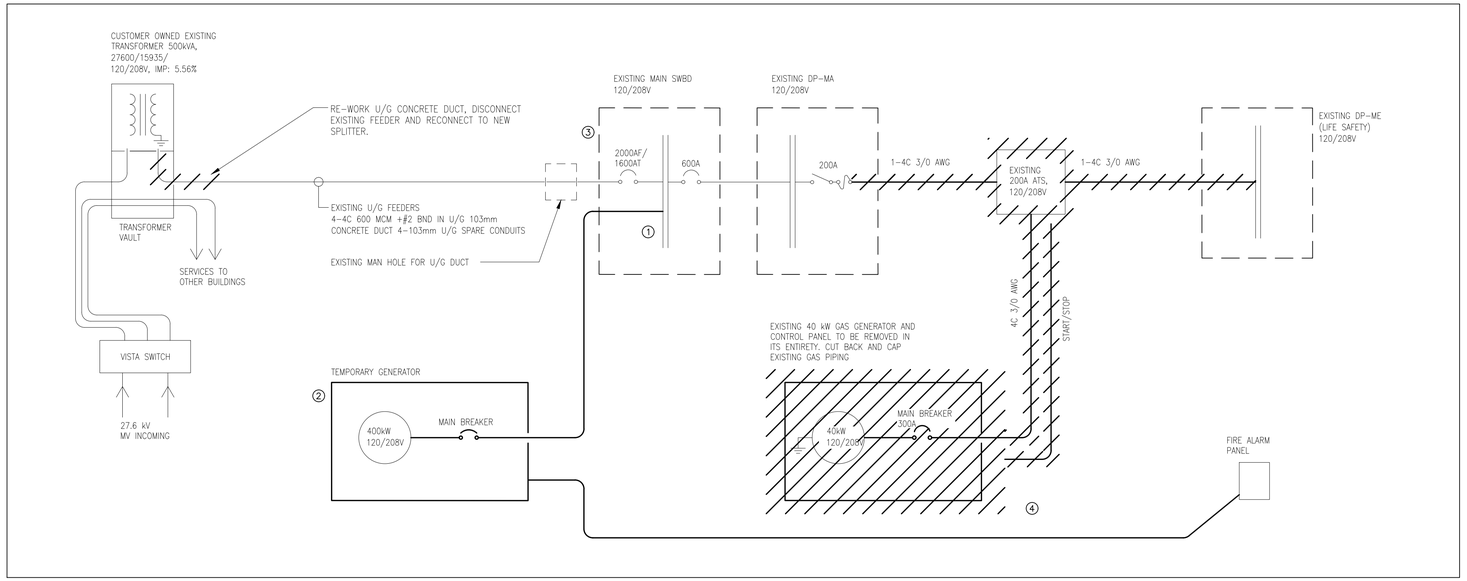
PROJECT NAME
TORONTO ZOO
INDO-MALAYA PAVILION
GENERATOR REPLACEMENT

DRAWING TITLE
LEGENDS
AND SITE PLAN

DRAWN BY: DC	SCALE: AS SHOWN
CHECKED BY: AL	DRAWING No.: E-1
PROJECT No.: 2018282	



1 / E-2 **SINGLE LINE DIAGRAM - DEMOLITION**
SCALE: N.T.S.

NOTES:

1	REMOVE NEUTRAL TO GROUND BOND IN MAIN SWITCHBOARD FOR THE NEW 3 POLE 1200A ATS.
2	PROVIDE TEMPORARY GENERATOR C/W TEMPORARY CONNECTIONS TO EXISTING SWITCHBOARD. SEE DRAWING E-1 FOR DETAILS.
3	PROVIDE PROTECTIVE DEVICE COORDINATION STUDY FOR THE NEW EQUIPMENT.
4	DEMOLISH EXISTING 40 kW GENERATOR C/W WIRING AT THE END OF THE PROJECT. REMOVE GENERATOR AND ALL ASSOCIATED DEVICES, EQUIPMENT, AND PIPING FROM SITE.

GENERATOR SEQUENCE OF OPERATION:

IN AN EVENT OF A NORMAL POWER FAILURE, THE AUTOMATIC TRANSFER SWITCHES ATS-1 AND ATS-2 WILL INITIATE THE GENERATOR START AFTER A 1-SECOND DELAY.

AFTER 5 SECONDS, THE GENERATOR WILL ENERGIZE THE EMERGENCY POWER FEEDERS TO EACH ATS. AT THE SAME TIME THE FIRE ALARM (FA) PANEL WILL INITIATE A TROUBLE "GENERATOR RUN".

IN 10 SECONDS THE ATS-1 WILL TRANSFER THE LOAD TO THE EMERGENCY POWER, IF THE NORMAL POWER WON'T RETURN.

IN 15 SECONDS ATS-2 WILL TRANSFER THE LOAD TO EMERGENCY POWER, IF NORMAL POWER IS AVAILABLE, ATS WILL NOT TRANSFER.

AFTER THE ATS-2 TRANSFERS TO THE EMERGENCY POWER SOURCE, THE ATS-1 WILL DETECT THAT THE NORMAL AND EMERGENCY POWER SOURCES ARE AVAILABLE AT THE SAME TIME.

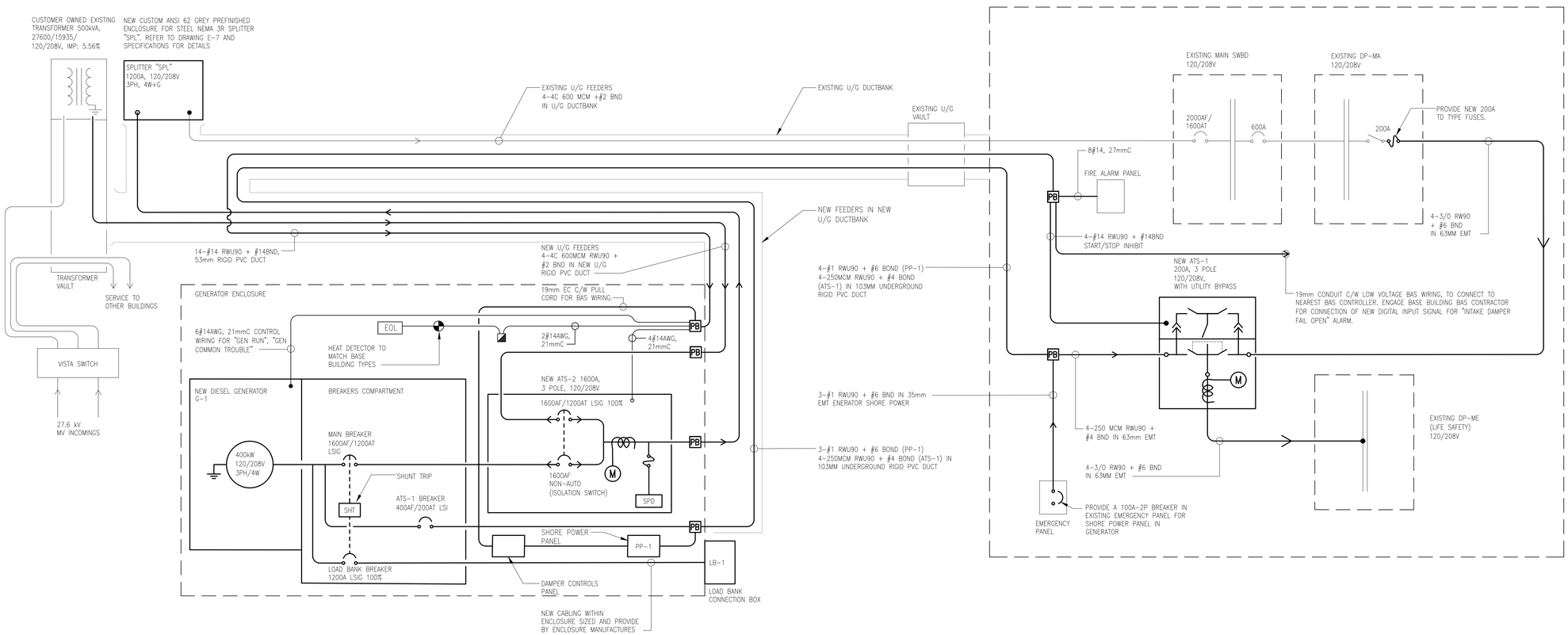
IF THE ATS-1 ALREADY TRANSFERRED, THE LOAD TO THE EMERGENCY POWER SOURCE, IT WILL STAY CONNECTED TO THE EMERGENCY SOURCE. A TRANSFER TO THE NORMAL POWER SOURCE WILL BE INHIBITED UNTIL THE EMERGENCY POWER IS AVAILABLE AND ATS-2 IS CONNECTED TO THE EMERGENCY SOURCE.

THE INHIBIT TO TRANSFER WILL BE HARDWIRED BETWEEN THE ATS-1 AND ATS-2 CONTROLS. IF THE ATS-2 WILL TRANSFER TO THE NORMAL POWER SOURCE, THE ATS-1 WILL TRANSFER TO THE NORMAL POWER AS WELL. IF THE ATS-2 REMAINS ON THE EMERGENCY POWER, BUT THE EMERGENCY POWER BECOMES NOT AVAILABLE FOR THE ATS-1, THE ATS-1 CONTROL WILL OVERRIDE THE INHIBIT AND WILL TRANSFER TO THE NORMAL POWER SOURCE IF AVAILABLE.

WHEN UTILITY POWER BECOMES AVAILABLE TO THE ATS-2, IT WILL TRANSFER TO UTILITY WITH A 30-SECOND DELAY. THE ATS-1 WILL TRANSFER TO UTILITY AFTER THE ATS-2 TRANSFER WITH A 120-SECOND DELAY.

EACH ATS SHALL BE TRANSFERRED TO THE NORMAL POWER SOURCE TO INITIATE THE GENERATOR 5-MIN COOL DOWN TIME BEFORE AND TO STOP THE GENERATOR.

THE STANDBY GENERATOR SYSTEM COMMON TROUBLES WILL BE CONSTANTLY MONITORED BY FA. IF COMMON TROUBLE SIGNALS ARE INITIATED, THE FA WILL NOTIFY THE OPERATORS AND MONITORING COMPANY.



2 / E-2 **SINGLE LINE DIAGRAM - NEW**
SCALE: N.T.S.

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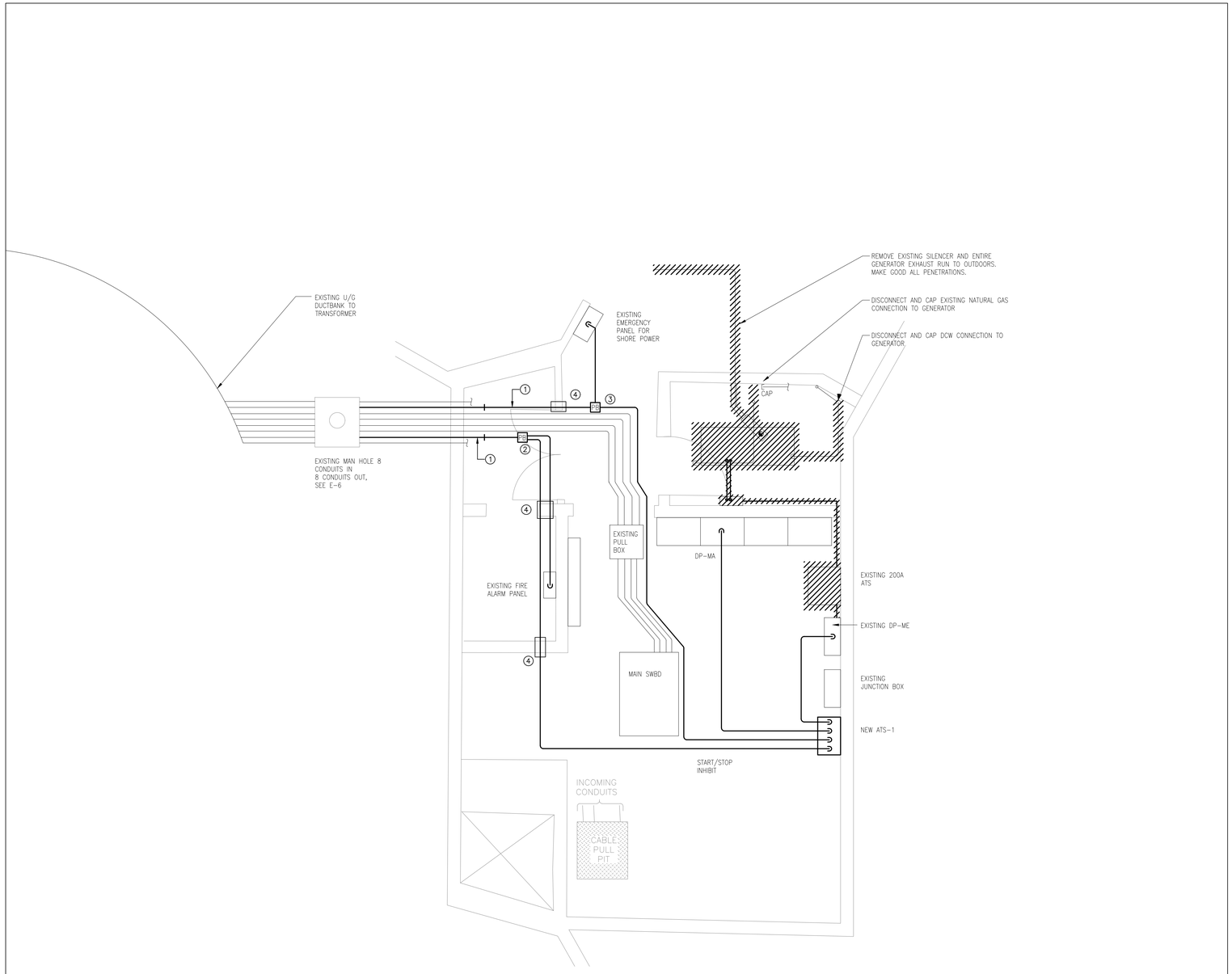

1 E-3 **ELECTRICAL ROOM LAYOUT**
SCALE: 1/4" : 1'-0"

NOTES:

①	EXISTING SPARE 103MM CONDUITS AT MAN HOLE AND INSIDE BUILDING. SEE 2/E-6 AND 10/E-6 FOR DETAILS OF EXISTING CONDUITS. CONTRACTOR TO SELECT TWO SPARES TO CUT AND RE-USE FOR NEW FEEDERS.
②	RE-ROUTE ONE SPARE 103MM CONDUIT TO NEW MINIMUM 18"x18"x6" PULL BOX. EXACT LOCATION OF PULL BOX TO BE DETERMINED ON SITE. FROM PULL BOX, PROVIDE 27mm EMT TO FIRE ALARM PANEL FOR NEW GENERATOR ZONES AND 27mm EMT TO ATS-1 FOR CONTROL. SEE DRAWING E-2 FOR TYPE AND QUANTITY OF CABLES.
③	RE-ROUTE ONE SPARE 103MM CONDUIT TO NEW MINIMUM 24x24x6 PULL BOX. EXACT LOCATION OF PULL BOX TO BE DETERMINED ON SITE. PROVIDE 1-35MM EMT FROM PULL BOX TO EXISTING EMERGENCY PANEL AND 1-63MM EMT TO NEW ATS-1 FOR GENERATOR POWER. SEE DRAWING E-2 FOR SIZE, TYPE & QUANTITY OF CONDUCTORS.
④	BE RESPONSIBLE TO CUT, PATCH, AND FIRE STOP EXISTING WALLS AS REQUIRED TO SUIT INSTALLATION OF NEW FEEDERS.

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CLIENT

toronto ZOO

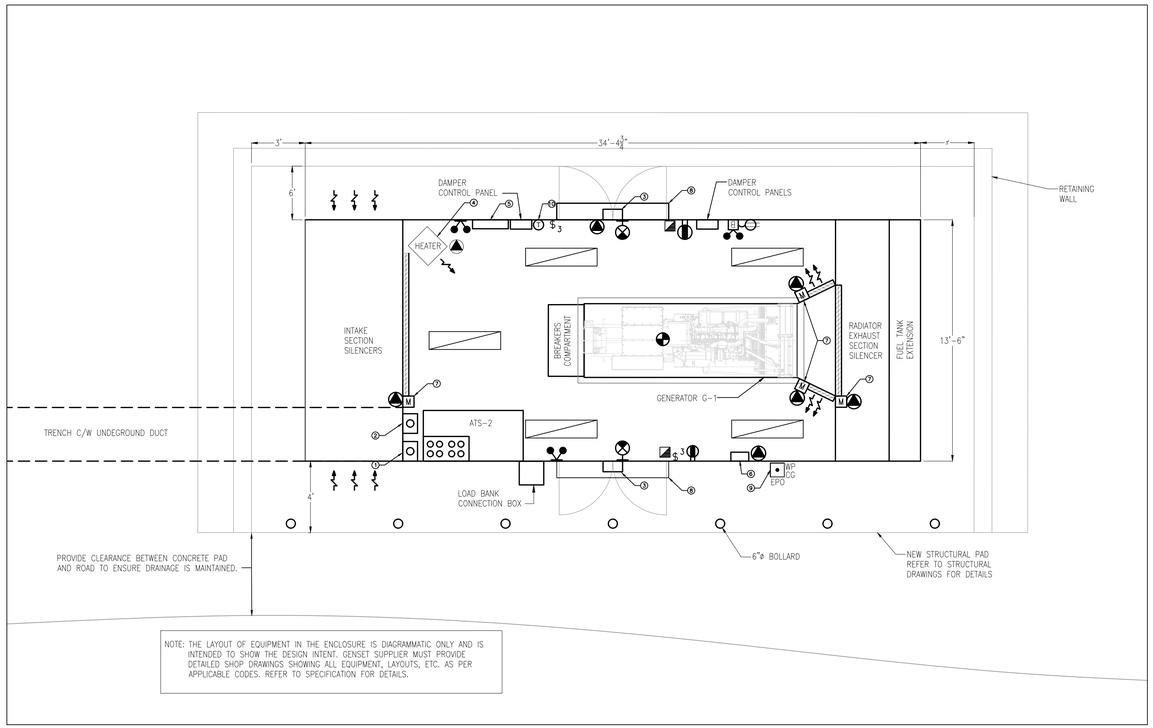
PROJECT NAME

TORONTO ZOO
INDO-MALAYA PAVILION
GENERATOR REPLACEMENT

DRAWING TITLE

ELECTRICAL ROOM LAYOUT

DRAWN BY: DC	SCALE: AS SHOWN
CHECKED BY: AL	DRAWING No.: E-3
PROJECT No.: 2018282	



1 / E-4 **GENERATOR ENCLOSURE LAYOUT**
SCALE: NTS

DRAWING NOTES 1/E-4:

1	STUB-UP AND PULL BOX FOR FIRE ALARM AND CONTROLS CONNECTIONS.
2	STUB-UP AND PULL BOX FOR SHORE POWER CONNECTIONS.
3	OUTDOOR LED LIGHT C/W PHOTO SENSOR.
4	HEATER AT HIGH LEVEL.
5	120/208V, 1PH 3W SHORE POWER PANEL FOR GENERATOR ENCLOSURE LOADS.
6	DAMPER ACTUATOR ALARM PANEL C/W CONTROLLER FOR DAMPER CONTROLS
7	MOTORIZED DAMPERS
8	METAL STEPS
9	EMERGENCY POWER OFF (EPO) SWITCH C/W WP STI ENCLOSURE
10	THERMOSTAT FOR RECIRCULATION DAMPER CONTROL

DRAWING NOTES 2/E-4:

1	1. APPROXIMATE AREA REQUIRED TO EXCAVATE EXISTING DUCT BANK AND EXPOSE. EXACT LOCATION AND SIZE OF EXCAVATION TO BE DETERMINED ONSITE. INITIAL EXCAVATION WILL DETERMINE IF DUCT BANK IS CONCRETE ENCASED. DRAWING CONSTRUCTION DETAILS ASSUME DUCT BANK IS CONCRETE ENCASED.

SHORE POWER PANEL

RATING	100 AMPS, 10kA, 1PH3W	VOLTAGE	120/208VAC
MAIN BREAKER	M.L.O	MOUNTING	SURFACE
FED FROM	EMERGENCY PANEL 3PH4W (INSTALLED OUTSIDE ELECTRICAL ROOM)	LOCATION	GENERATOR ENCLOSURE

DESCRIPTION	BREAKER SIZE	LOAD (VA) A	B	C	CCT. No.		LOAD (VA) A	B	C	BREAKER SIZE	DESCRIPTION
HEATER	20				1	2				15	RECEPTACLE
					3	4				15	RECEPTACLE
LIGHTING	15				5	6				15	INTAKE AND EXHAUST DAMPERS
EMERGENCY LIGHTING	15				7	8				15	RECIRCULATION DAMPERS
OUTDOOR LIGHTING	20				9	10				20	SPARE
SPARE	20				11	12				20	SPARE
SPARE	15				13	14				15	SPARE
SPACE					15	16					SPACE
SPACE					17	18					SPACE
SPACE					19	20					SPACE
SPACE					21	22					SPACE
SPACE					23	24					SPACE

NOTE: EXACT CIRCUITING & CONFIGURATION TO BE CONFIRMED BY GENERATOR MANUFACTURER

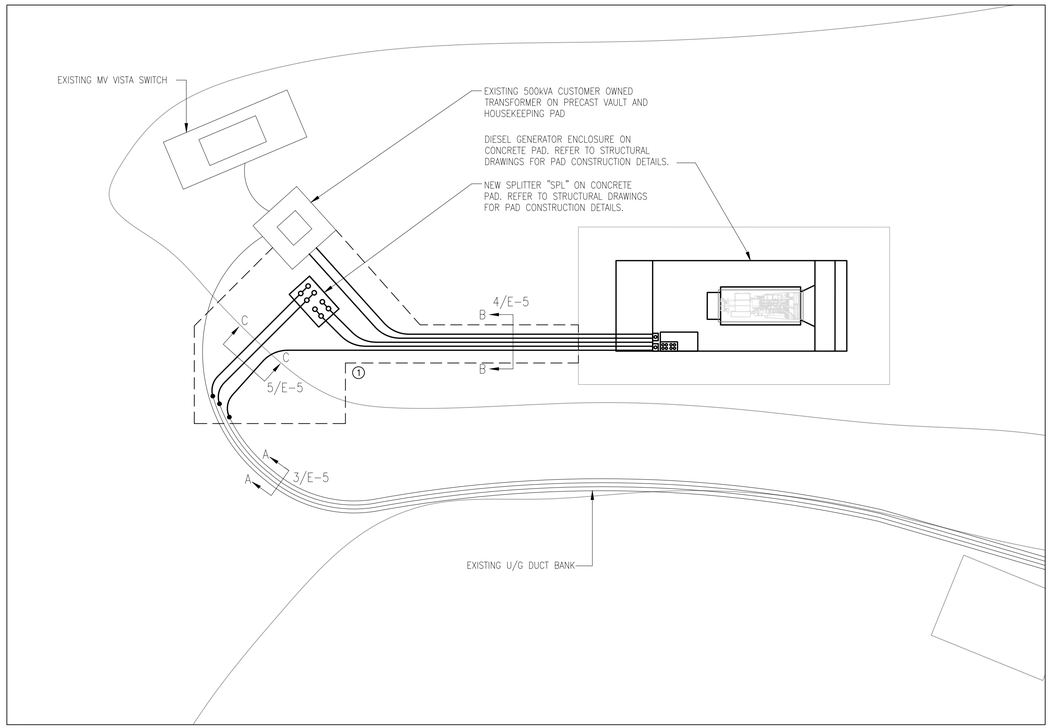
GENERAL NOTES

1. CONDUCT ALL WORK TO MINIMIZE POWER SHUTDOWNS TO OWNER'S FACILITIES. CONDUCT THE FOLLOWING PRIOR TO RELOCATION OF DUCT BANK:
   - PROVIDE AND COMMISSION NEW GENERATOR;
   - PROVIDE NEW SPLITTER AND SPLITTER FOUNDATION;
   - PROVIDE DUCT BANK FROM GENERATOR ENCLOSURE TO SPLITTER AND TRANSFORMER VAULT;
   - TERMINATE CONDUCTORS AT SPLITTER, TRANSFORMER, AND ATS-2;
2. PROVIDE TEMPORARY GENERATOR
3. TO FACILITATE RELOCATION OF DUCT BANK, REMOVAL OF CONDUCTORS FROM DUCT BANK IS RECOMMENDED. A VAULT C/W MANHOLE EXISTS AT THE INDO MALAYA PAVILION AND SHOWN ON SITE PLAN E-1. CABLES MAY BE PULLED OUT AT THIS LOCATION AND MADE SAFE DURING DUCT BANK RELOCATION. PROVIDE ALL REQUIRED PROTECTION OF CABLES WHILE EXPOSED. CONTRACTOR WILL BE RESPONSIBLE FOR INTEGRITY OF ALL CABLES DURING CONSTRUCTION PHASE.
4. EXPOSE AND SAWCUT DUCT BANK AT APPROPRIATE LOCATION. PROVIDE NEW DUCT BANK AND PULL CABLES TO NEW SPLITTER LOCATION AS SHOWN.

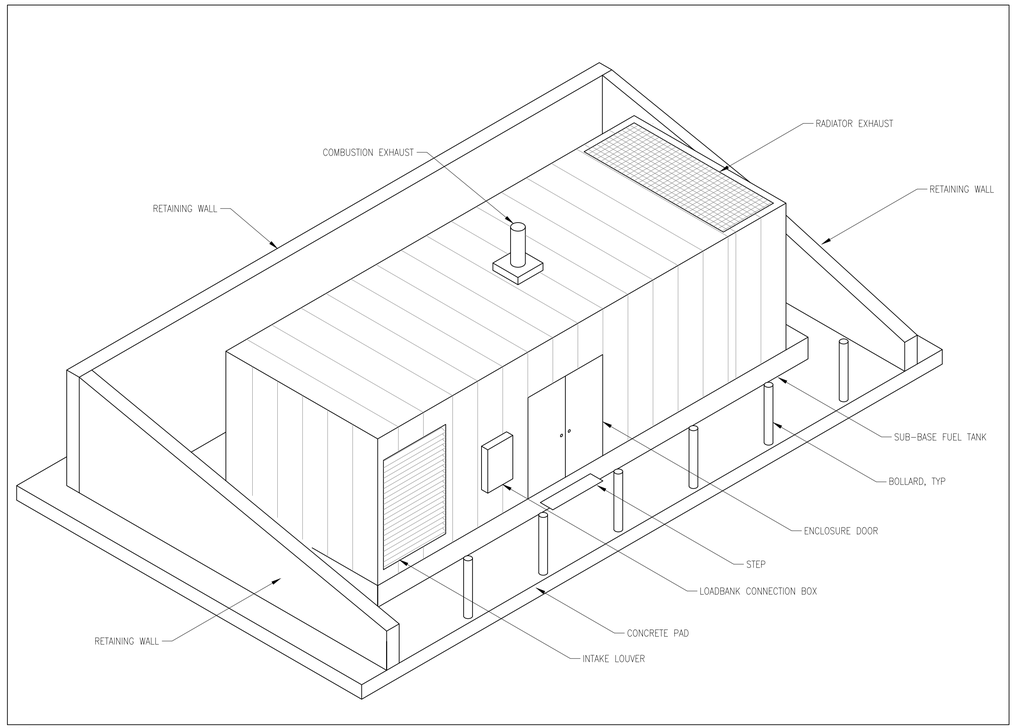
GENERATOR SCHEDULE

TAG	MANUFACTURER	MODEL	RATING	ENGINE TYPE	ENGINE RPM	FUEL 100% LOAD	FUEL TYPE	OUTPUT VOLTAGE	OUTPUT PHASE	OUTPUT CURRENT	OUTPUT FREQ	OPERATING WEIGHT
G-1	KOHLER*	400REOZJB*	400KW	6-CYL INLINE	1800	30.9 GPH	DIESEL	120/208V	3PH/4W	1388A	60Hz	8560 LBS

THE GENERATOR MANUFACTURER AND MODEL IS THE BASIS OF DESIGN FOR THIS PROJECT. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO MODIFY RELATED ASPECTS OF THE INSTALLATION TO ACCOMMODATE AN ALTERNATE GENERATOR INCLUDING, BUT NOT LIMITED TO ENCLOSURE DIMENSIONS, CONCRETE PAD STRUCTURAL BEARING CAPACITY AND FOOTPRINT, BREAKER SIZES, LOAD CENTRE POWER REQUIREMENTS, ETC.



2 / E-4 **SITE LAYOUT AFTER GENERATOR INSTALLATION**
SCALE: 1/16" : 1'-0"



3 / E-4 **GENERATOR AND STRUCTURAL PAD/RETAINING WALLS - ISOMETRIC VIEW**
SCALE: N.T.S.

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GENERATOR ENCLOSURE LAYOUT

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DC	AS SHOWN
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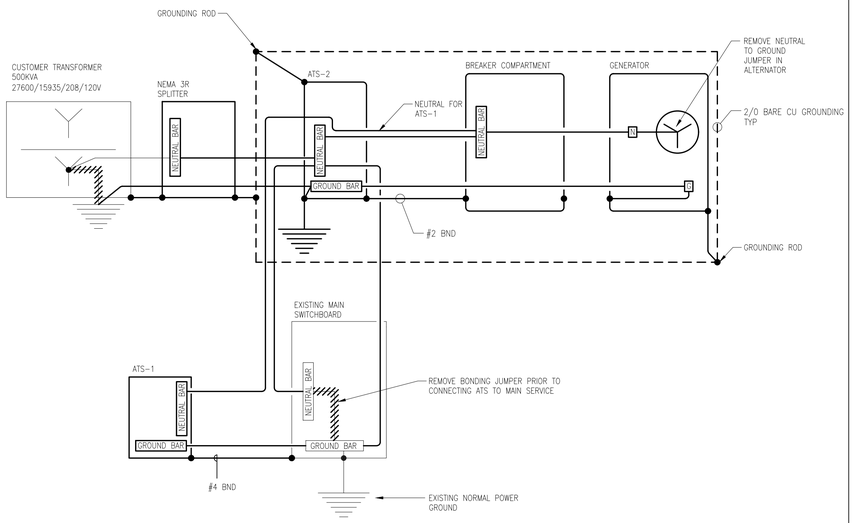
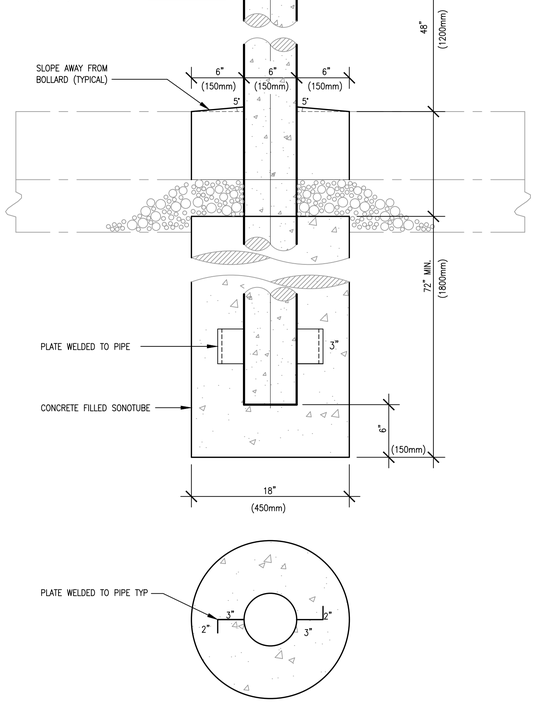
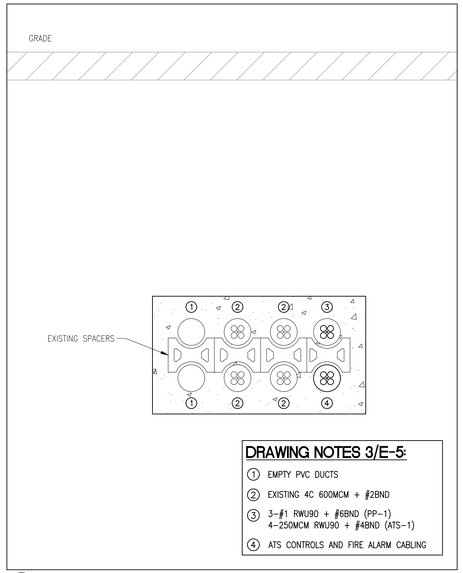
PROJECT No.: 2018282	



1 E-5 **GROUNDING AND BONDING DETAIL**
SCALE: N.T.S.



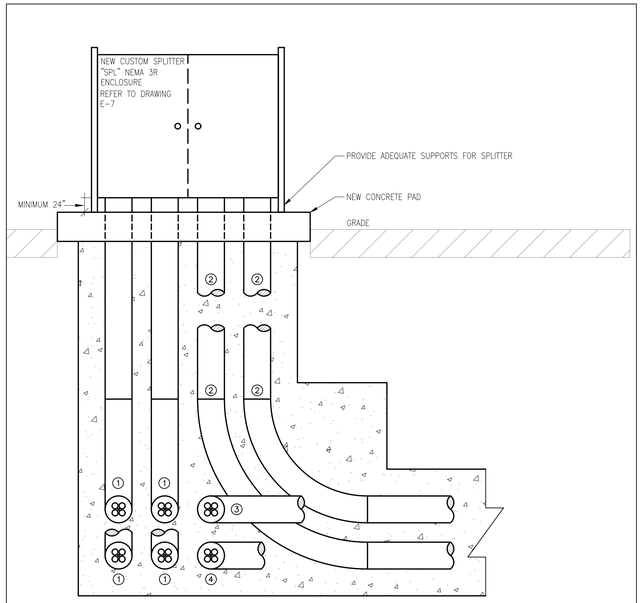
2 E-5 **BOLLARD DETAIL**
SCALE: N.T.S.



3 E-5 **SECTION A-A**
SCALE: N.T.S.

DRAWING NOTES 3/E-5:

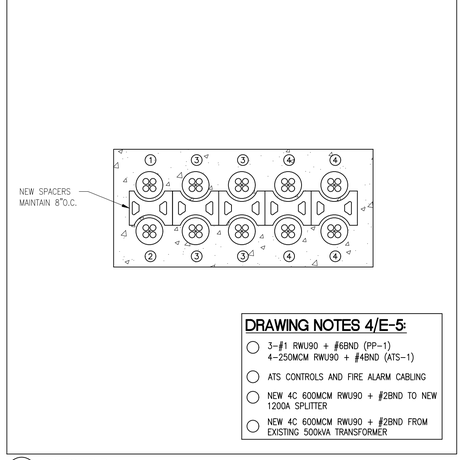
1. EMPTY PVC DUCTS
2. EXISTING 4C 600MCM + #2BND
3. 3–#1 RWU90 + #6BND (PP–1)
   4–250MCM RWU90 + #4BND (ATS–1)
4. ATS CONTROLS AND FIRE ALARM CABLING



5 E-5 **SECTION C-C**
SCALE: N.T.S.

DRAWING NOTES 4/E-5:

- RELOCATED 4C 600MCM RWU90 + #2BND FROM NEW 1200A SPLITTER TO BUILDING DISTRIBUTION
- NEW 4C 600MCM RWU90 + #2BND FROM ATS–2 TO 1200A SPLITTER
- 3–#1 RWU90 + #6BND (PP–1)
  3–250MCM RWU90 + #4BND (ATS–1)
- ATS CONTROLS AND FIRE ALARM CABLING



4 E-5 **SECTION B-B**
SCALE: N.T.S.

DRAWING NOTES 4/E-5:

- 3–#1 RWU90 + #6BND (PP–1)
  4–250MCM RWU90 + #4BND (ATS–1)
- ATS CONTROLS AND FIRE ALARM CABLING
- NEW 4C 600MCM RWU90 + #2BND TO NEW 1200A SPLITTER
- NEW 4C 600MCM RWU90 + #2BND FROM EXISTING 500KVA TRANSFORMER

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DETAILS

DRAWN BY	SCALE
DC	NTS
CHECKED BY	DRAWING No.
AL	E-5
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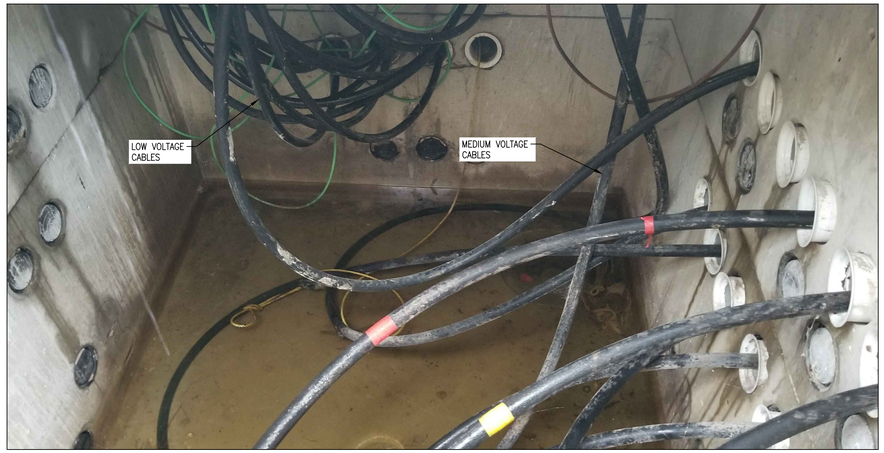
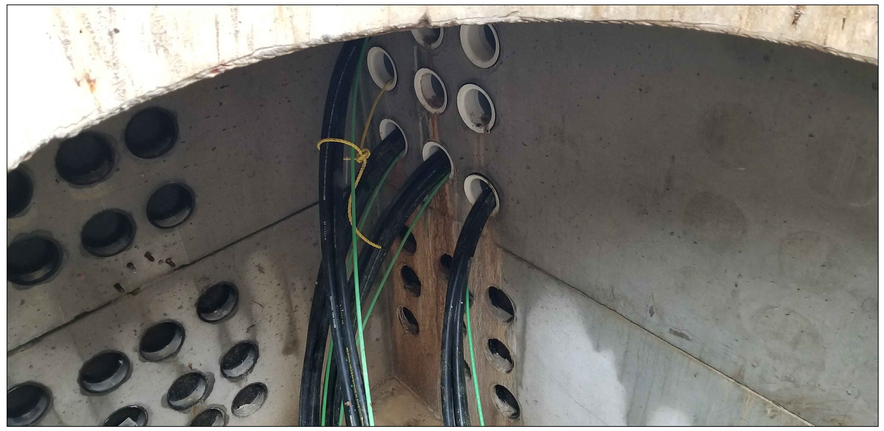


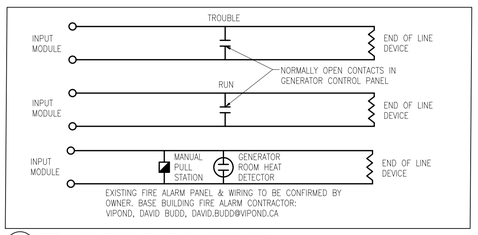
1 / E-6 **500 kVA TRANSFORMER VAULT**
SCALE: N.T.S.



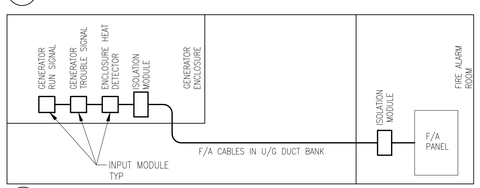
2 / E-6 **MAN HOLE**
SCALE: N.T.S.

NOTES:

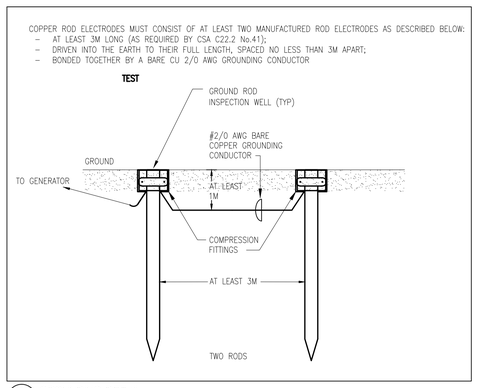
1. COORDINATE WITH CLIENT AND LOCAL AUTHORITIES FOR TREES REMOVAL. SEE 7/E-6.
2. SELECT AVAILABLE CONDUITS FROM SPARES. SEE 10/E-6.



3 / E-6 **FIRE ALARM TROUBLE AND RUN SCHEMATIC**
SCALE: N.T.S.

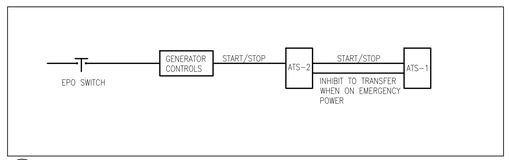


4 / E-6 **BASE BUILDING FIRE ALARM CONNECTIONS**
SCALE: N.T.S.

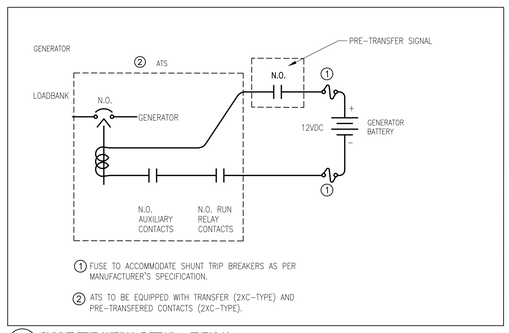


5 / E-6 **GROUNDING DETAIL**
SCALE: N.T.S.

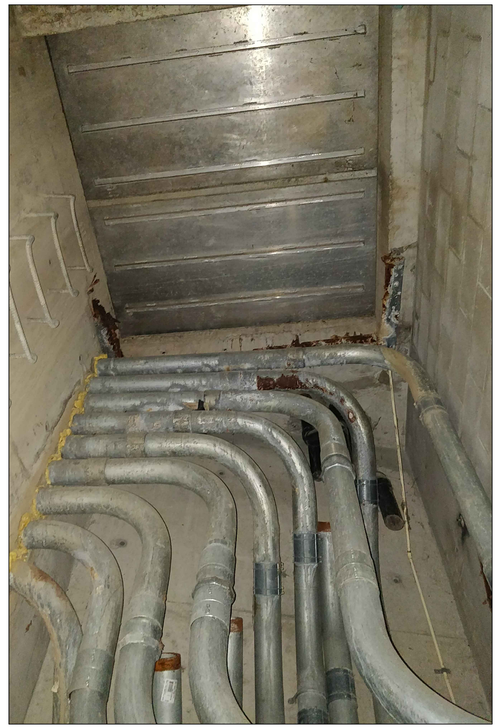
7 / E-6 **NEW 400kW GENSET LOCATION**
SCALE: N.T.S.



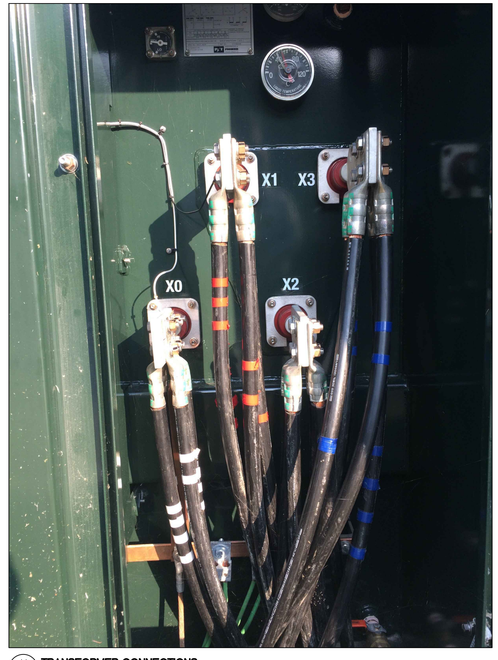
8 / E-6 **EMERGENCY POWER OFF (EPO) SWITCH CONNECTION DETAIL**
SCALE: N.T.S.



9 / E-6 **SHUNT TRIP WIRING DETAIL - TYPICAL**
SCALE: N.T.S.



10 / E-6 **SHAFT WITH CONDUITS**
SCALE: N.T.S.



11 / E-6 **TRANSFORMER CONNECTIONS**
SCALE: N.T.S.

No.	REVISION	DATE	BY

No.	ISSUE	DATE	BY
3	ISSUED FOR TENDER	2019/12/19	DC
2	ISSUED FOR 100% REVIEW	2019/01/11	LP
1	ISSUED FOR 66% REVIEW	2018/12/14	SR

LICENCED PROFESSIONAL ENGINEER
DEC.19, 2019
A. V. LEMON
PROVINCE OF ONTARIO

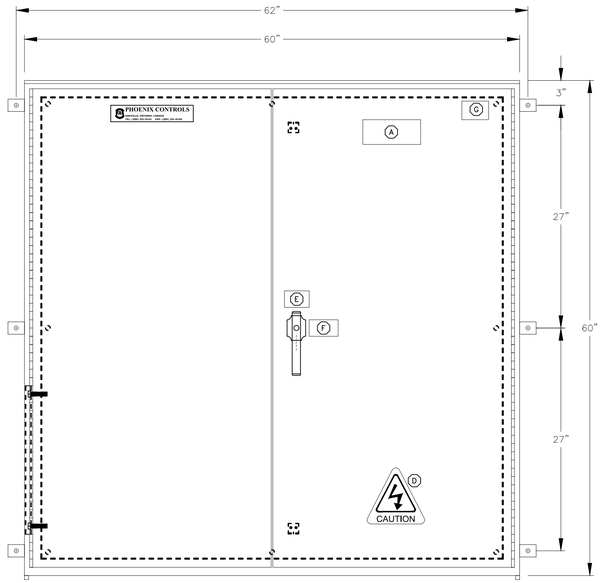
McGREGOR ALLSOP
CONSULTING ENGINEERS
www.mcgregor-allsop.com

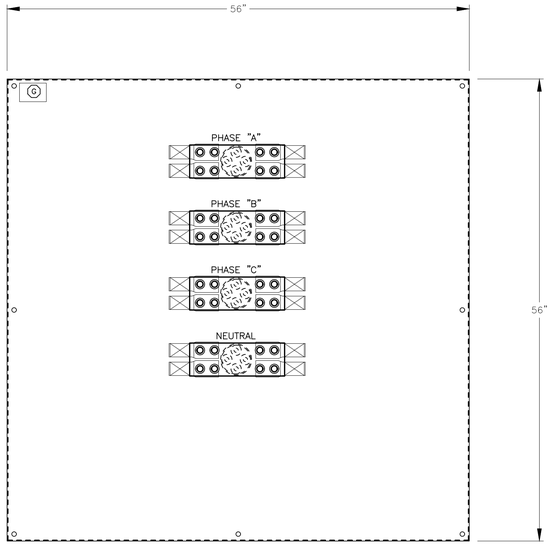
CLIENT
toronto ZOO

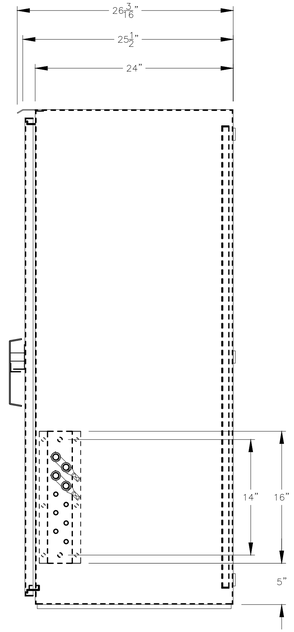
PROJECT NAME
TORONTO ZOO
INDO-MALAYA PAVILION
GENERATOR REPLACEMENT

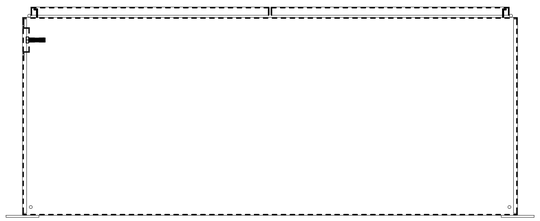
DRAWING TITLE
PHOTOS

DRAWN BY	SCALE
DC	NTS
CHECKED BY	
AL	
PROJECT No.	DRAWING No.
2018282	E-6







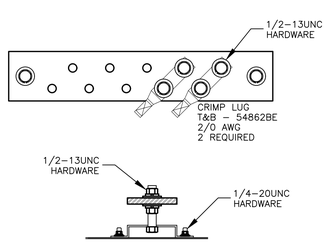


ENCLOSURE NOTES:

- NEMA 3R, WEATHERPROOF, RATED FOR OUTDOOR USE
- MATERIAL, 12GA MILD STEEL PAINTED ASA61 GREY
- BACK PAN MOUNTED ON Z-BARS
- DOOR STOPS 105° ON EACH DOOR
- GROUND STUDS ON EACH DOOR AND BODY

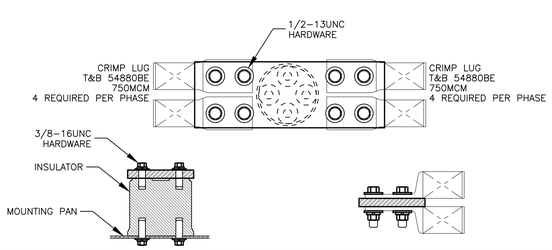
GROUND BUS DETAILS (NOT TO SCALE)

3" X 3/8" X 14"LG COPPER BUS BAR

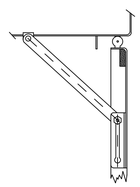


PHASE AND NEUTRAL BUS DETAILS (NOT TO SCALE)

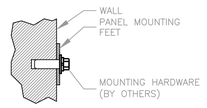
4" X 1/2" X 24"LG COPPER BUS BAR



DETAIL FOR DOOR STOP MECHANISM (NOT TO SCALE)



INSTALLATION DETAIL (NOT TO SCALE)



NAMEPLATE DETAIL (NOT TO SCALE)

LAMACOID SELF ADHEASIVE

WHITE TEXT ON RED LAMACOID (OUTDOOR RATED)

LOW VOLTAGE SPLITTER BOX 2000A, 120/208V, 3PH, 4W (A)
7"W X 3"H

CAUTION 208 VOLTS (E)

DANGER
HAZARDOUS VOLTAGE
ISOLATE BEFORE OPENING
TENSION DANDEREUSE
ISLOER AVANT D'OUVRIR (F)
4"W X 2"H

VINYL SELF ADHEASIVE

CSA/ESA LABEL (G)

FOR PRICING CONTACT:
CHRIS WIGHT
PHOENIX CONTROLS
29-212 WYECROFT ROAD
OAKVILLE, ON L6K 3T9

416-524-4410

No.	REVISION	DATE	BY

No.	ISSUE	DATE	BY
3	ISSUED FOR TENDER	2019/12/19	DC
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LICENCED PROFESSIONAL ENGINEER
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A. V. LEVESQUE
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www.mcgregor-allsop.com

CLIENT

toronto ZOO

PROJECT NAME

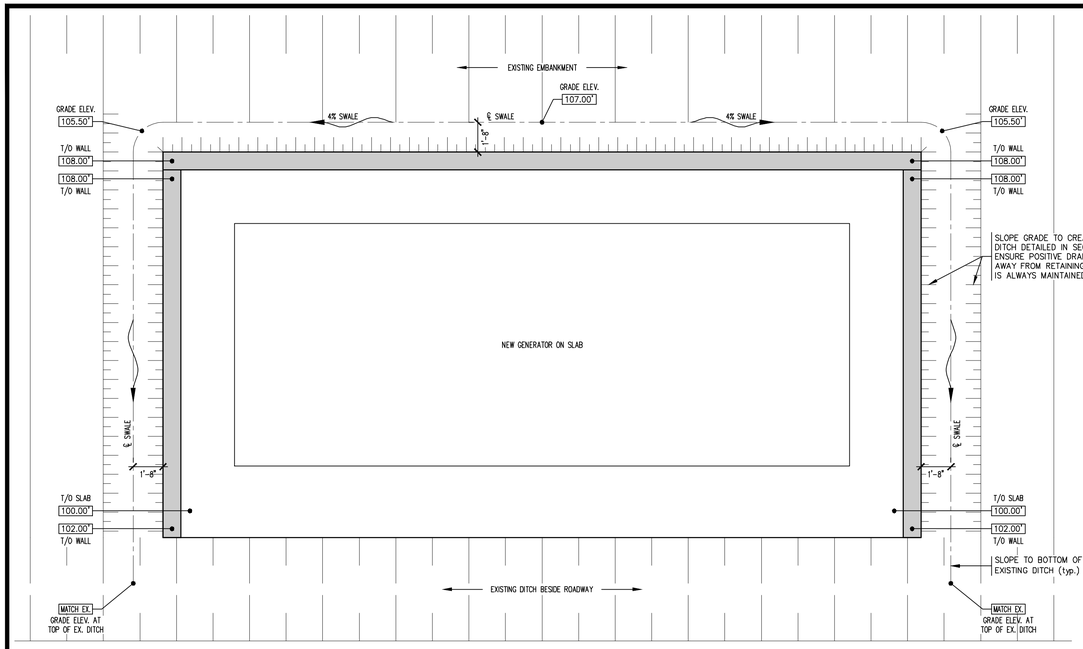
TORONTO ZOO
INDO-MALAYA PAVILION
GENERATOR REPLACEMENT

DRAWING TITLE

CUSTOM 2000A SPLITTER 'SPL'

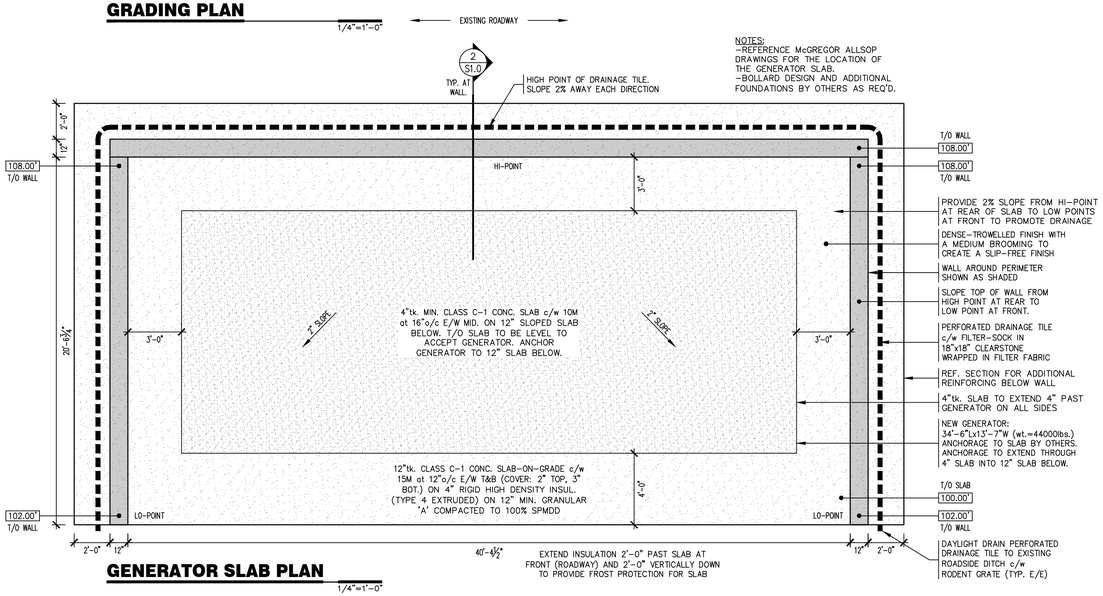
DRAWN BY	SCALE
DC	NTS
CHECKED BY: AL	DRAWING No. E-7
PROJECT No. 2018282	

MTE FILE No. 45238-100-S1.0
GENERAL NOTES, GRADING PLAN, SLAB PLAN, SECTIONS AND DETAILS ---
P:\P\45238\100\45238-100_STRU.dwg



GRADING PLAN

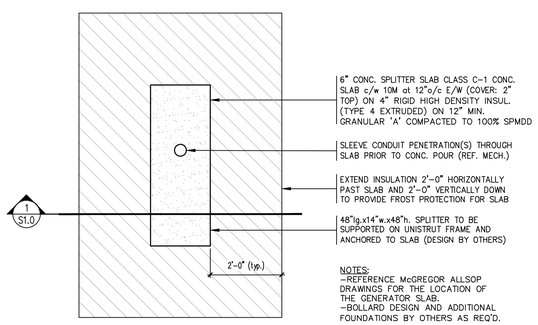
1/4"=1'-0"



NOTES:
-REFERENCE McGREGOR ALLSOP DRAWINGS FOR THE LOCATION OF THE GENERATOR SLAB.
-BOLLARD DESIGN AND ADDITIONAL FOUNDATIONS BY OTHERS AS REQ'D.

GENERATOR SLAB PLAN

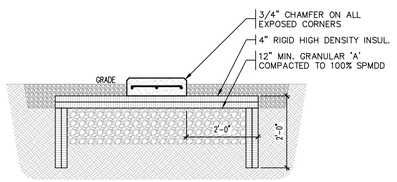
1/4"=1'-0"



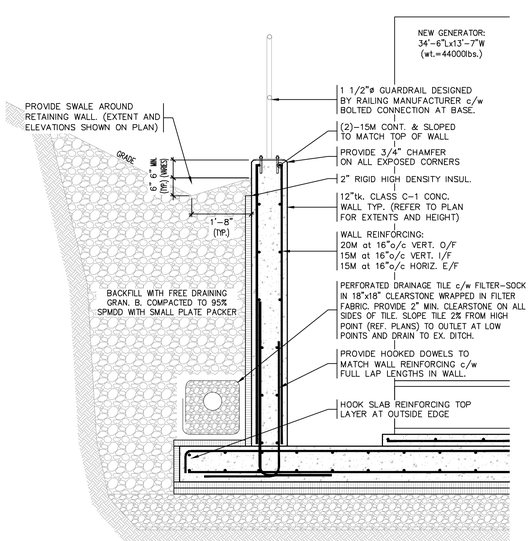
NOTES:
-REFERENCE McGREGOR ALLSOP DRAWINGS FOR THE LOCATION OF THE GENERATOR SLAB.
-BOLLARD DESIGN AND ADDITIONAL FOUNDATIONS BY OTHERS AS REQ'D.

SPLITTER SLAB PLAN

1/2"=1'-0"



1 S1.0 STRUCTURAL SECTION
1/2"=1'-0"



2 S1.0 STRUCTURAL SECTION
1/2"=1'-0"

GENERAL NOTES AND SPECIFICATIONS

GENERAL NOTES

1. CONFORM TO THE REQUIREMENTS OF THE LATEST ONTARIO BUILDING CODE (OBC) INCLUDING ALL THE LATEST STANDARDS REFERENCED THEREIN, AND ANY APPLICABLE ACTS OF AUTHORITY HAVING JURISDICTION. THE LATEST VERSION OF ALL STANDARDS AND CODES LISTED BELOW SHALL BE USED.

2. UNDER NO CIRCUMSTANCES ARE THESE DRAWINGS TO BE SCALED, INCLUDING FOR PREPARATION OF SHOP DRAWINGS, CONSTRUCTION LAYOUT, OR BIDDING PURPOSES. ERRORS MADE BY PERSONS SCALING THESE DRAWINGS SHALL NOT BE THE RESPONSIBILITY OF MTE CONSULTANTS.

3. ALL DEMOLITION DEBRIS, INCLUDING ASPHALT, SOILS, ETC. SHALL BE DISPOSED OF OFF-SITE, IN ACCORDANCE WITH ALL APPLICABLE REGULATIONS, UNLESS OTHERWISE DIRECTED BY THE OWNER'S REPRESENTATIVE.

4. PRIOR TO DEMOBILIZATION FROM SITE, THE CONTRACTOR SHALL MAKE GOOD ALL SURFACES DAMAGED/DISRUPTED DURING CONSTRUCTION INCLUDING, BUT NOT LIMITED TO: ASPHALT, GRASSED AREAS, CURBS, ETC.

5. SUBSTITUTIONS FROM SPECIFIED PRODUCTS AND MATERIALS MUST BE APPROVED IN WRITING BY THE ENGINEER PRIOR TO ORDERING OF MATERIALS. THE CONTRACTOR SHALL REIMBURSE ALL CONSULTANTS FOR ADDITIONAL COSTS INCURRED AS A RESULT OF REVIEWING ANY CHANGES MADE TO THE CONTRACT DOCUMENTS.

6. ALL WORK IS TO BE PERFORMED IN ACCORDANCE WITH THE OCCUPATIONAL HEALTH AND SAFETY ACT AND REGULATIONS FOR CONSTRUCTION PROJECTS – O.REG. 213/91.

7. IT IS THE RESPONSIBILITY OF BOTH THE OWNER AND THE CONTRACTOR TO NOTIFY THE ENGINEER OF CONSTRUCTION PROGRESS SO THE ENGINEER CAN COMPLETE GENERAL REVIEWS. THE CONTRACTOR SHALL PROVIDE THE ENGINEER WITH A CONSTRUCTION SCHEDULE PRIOR TO STARTING THE WORK.

8. GENERALLY PICTURES SHALL SUFFICE FOR A REVIEW OF THIS PROJECT. THESE PICTURES, TAKEN BY THE CONTRACTOR, SHALL BE SENT TO MTE AND APPROVED PRIOR TO ANY ADDITIONAL WORK AT THE TIMES LISTED BELOW:
   8.1. FOLLOWING EXCAVATION AND PROOF PACKING OF EXISTING NATIVE SUBGRADE.
   8.2. FOLLOWING THE INSTALLATION AND COMPACTION OF THE GRANULAR MATERIAL, AND INSTALLATION OF REINFORCING BARS ABOVE.
   8.3. FOLLOWING THE INSTALLATION OF THE CONCRETE PAD.
   8.4. FOLLOWING THE INSTALLATION OF RETAINING WALL REINFORCING BARS.

9. THE GENERATOR PAD SHALL NOT BE PLACED OVER AN EXISTING STRUCTURE WITHOUT THE THE WRITTEN CONSENT OF A LICENSED ENGINEER.

TESTING AND INSPECTION

THE FOLLOWING ITEMS REQUIRE TESTING OR INSPECTION BY A CERTIFIED INDEPENDENT TESTING OR INSPECTION AGENCY UNLESS NOTED OTHERWISE. THE AGENCY SHALL SEND COPIES OF ALL STRUCTURAL TESTING AND INSPECTION REPORTS TO THE ENGINEER FOR REVIEW.

ITEM	REQ'D?	COMMENTS
SOIL COMPACTION	YES	BY SOILS ENGINEER
REINFORCING STEEL PLACEMENT	YES	INSPECT FINAL PLACMENT
CONCRETE COMPRESSIVE TESTS	YES	MIN. 2 SETS PER 100 CUBIC METRES
CONCRETE SLUMP/AIR	YES	

CONCRETE AND REINFORCING

1. ALL CONCRETE WORK TO CONFORM TO THE LATEST REQUIREMENTS OF CSA STANDARDS A23.1, A23.2 & A23.3

2. COMPACT THE NATIVE SUBGRADE PRIOR TO PLACING SLAB-ON-GRADE. FILL ALL VOIDS AS REQUIRED WITH WELL-CONSOLIDATED CRUSHED STONE. ENSURE A SUITABLE BASE IS PROVIDED FOR THE SLAB

3. CONTRACTOR SHALL BE RESPONSIBLE FOR ARRANGING AND PAYING FOR THIRD-PARTY INSPECTION AND TESTING OF THE CONCRETE. TESTING SHALL INCLUDE SLUMP, AIR-CONTENT, 7 AND 28-DAY COMPRESSIVE STRENGTHS.

4. REINFORCING BARS SHALL CONFORM TO THE REQUIREMENTS OF CAN/CSA G30.18 GRADE 400R FOR REINFORCING STEEL AND BE DEFORMED HI-BOND HARD GRADE WITH Fy=400MPa

5. DETAILING/PLACING OF ALL REINFORCING STEEL SHALL BE IN ACCORDANCE WITH THE REINFORCING STEEL INSTITUTE OF CANADA "MANUAL OF STANDARD PRACTICE".

6. ALL REINFORCING STEEL SHALL BE SHOP FABRICATED TO INCLUDE HOOKS AND BENDS AS REQUIRED.

7. ALL REINFORCING LAP SPLICES SHALL CONFORM TO THE LATEST CSA STANDARD A23.3 AND ALL BAR SPLICES SHALL BE CLASS B TENSION SPLICES (U.N.O.).
   A.) NO BAR SPLICES SHALL BE LESS THAN IN THE TABLE BELOW.
   B.) INCREASE HORIZONTAL SPLICE LENGTHS IN THE TABLE BY 1.3 WHERE MORE THAN 300mm (12') OF FRESH CONCRETE IS CAST BELOW THE SPLICE.

BAR SIZE \ CONCRETE	TENSION SPLICE (mm) 25MPa	30MPa	35MPa	COMPRESSION SPLICE (mm)
10M	400 (16")	400 (16")	400 (16")	450 (18")
15M	600 (24")	600 (24")	600 (24")	450 (18")
20M	800 (32")	800 (32")	800 (32")	600 (24")
25M	1200 (48")	1100 (44")	1000 (40")	750 (30")
30M	1400 (56")	1300 (52")	1200 (48")	900 (36")

8. ALL DOWEL EMBEDMENT SHALL MATCH THE ABOVE TENSION SPLICE LENGTH, UNLESS NOTED.

9. ALL HORIZONTAL BARS SHALL BE HOOKED 300mm (12") AROUND CORNERS.

10. ALL REINFORCING STEEL FABRICATION AND PLACEMENT DRAWINGS SHALL BE SUBMITTED TO THE ENGINEER FOR REVIEW BEFORE FABRICATION.

11. CONFORM TO THE CONCRETE COVER REQUIREMENTS OF CSA A23.1 AND THE FOLLOWING, UNLESS NOTED:
   A.) CONCRETE CAST AGAINST EARTH: 75 mm (3')
   B.) PIERS AND WALL: 50 mm (2')

12. WELDING OF REINFORCING STEEL SHALL NOT BE PERMITTED UNLESS SPECIFICALLY NOTED ON THE DRAWINGS.

13. ALL OIL, GREASE, MUD AND DEBRIS SHALL BE REMOVED FROM THE REBAR PRIOR TO THE PLACEMENT OF CONCRETE. REBAR SHALL BE STORED ON SITE IN A MANNER TO BE KEPT CLEAN AND FREE FROM DELETERIOUS MATERIALS.

14. REINFORCING BARS SHALL BE SECURELY TIED IN PLACE SO AS TO MAINTAIN THEIR EXACT POSITION BEFORE AND DURING PLACEMENT OF CONCRETE. BAR SUPPORTS SHALL ONLY BE MADE OF PRECAST CONCRETE BLOCKS OR PLASTIC.

15. CONCRETE MIX DESIGN SHALL BE SUBMITTED TO THE ENGINEER FOR APPROVAL PRIOR TO USE AT JOB SITE. ALL CONCRETE TO BE 'C-1 EXPOSURE CLASS CONCRETE'

16. C-1 CLASS CONCRETE:
   28 DAY COMP. STRENGTH: 35MPa
   MAX. W/C RATIO: 0.4
   AIR CONTENT (%): 5% – 8%
   MAX. AGGREGATE SIZE (mm): 20mm
   SLUMP: 80mm ± 30mm

17. DO NOT ADD WATER TO CONCRETE UNLESS WRITTEN APPROVAL IS GIVEN BY THE ENGINEER. IF HIGHER SLUMP IS DESIRED, CONCRETE SUPPLIER SHALL DESIGN AND SUPPLY ACCORDINGLY.

18. HOT AND COLD WEATHER CONCRETING SHALL COMPLY WITH ALL REQUIREMENTS OF CSA STANDARD A23.1. CALCIUM CHLORIDE ADDITIVES WILL NOT BE PERMITTED.

19. ALL HORIZONTAL SURFACES SHALL HAVE A HARD, DENSE-TROWELLED FINISH WITH A MEDIUM BROOMING TO CREATE A SLIP-FREE FINISH.

REQUIRED SUBMITTALS

THE FOLLOWING ITEMS SHALL BE SUBMITTED TO THE ENGINEER FOR REVIEW PRIOR TO FABRICATION.

ITEM	REQ'D SUBMITTAL?	ENGINEER'S STAMP REQ'D?	NOTES
REBAR SHOP DRAWINGS	YES	NO	
CONCRETE MIX DESIGNS	YES	NO	

SHOP DRAWING REVIEW

1. ERECTION AND FABRICATION SHOP DRAWINGS FOR ALL BUILDING COMPONENTS AS LISTED IN THE REQUIRED SUBMITTALS TABLE AND ANY RELATED WORKS ARE TO BE SUBMITTED TO THE ENGINEER FOR APPROVAL BEFORE COMMENCING WITH FABRICATION.

2. AS PART OF THEIR FIELD SERVICES, MTE CONSULTANTS ("MTE") WILL REVIEW SHOP DRAWINGS PERTAINING TO WORK SHOWN ON MTE CONSULTANTS DRAWINGS BY MEANS OF APPROPRIATE RATIONAL SAMPLING PROCEDURES AND COMMENT ON THE ACCURACY WITH WHICH THE CONTRACTOR PREPARED THE DRAWINGS.

3. REVIEW OF THE SHOP DRAWINGS IS FOR THE SOLE PURPOSE OF ASCERTAINING CONFORMANCE WITH THE GENERAL DESIGN CONCEPT AND IS NOT AN APPROVAL OF THE DETAIL DESIGN INHERENT IN THE SHOP DRAWINGS, RESPONSIBILITY FOR WHICH SHALL REMAIN WITH THE CONTRACTOR SUBMITTING THEM. SUCH REVIEW SHALL NOT RELIEVE THE CONTRACTOR OF THEIR RESPONSIBILITY FOR ERRORS AND OMISSIONS IN THE SHOP DRAWINGS OR FOR MEETING ALL REQUIREMENTS OF THE CONTRACT DOCUMENTS. THE CONTRACTOR IS SOLELY RESPONSIBLE FOR INFORMATION PERTAINING TO THE FABRICATION PROCESS TECHNIQUES OF CONSTRUCTION AND INSTALLATION AND FOR COORDINATION OF THE WORK OF ALL SUB-TRADES.

4. THE APPROVAL OF SHOP DRAWINGS DOES NOT RELIEVE THE CONTRACTOR FROM THE RESPONSIBILITY OF THE FITTING OF BUILDING COMPONENTS, ANY DISCREPANCIES IN THE SHOP DRAWINGS ARE THE RESPONSIBILITY OF THE CONTRACTOR.

NOTE TO CONTRACTOR :

DO NOT SCALE DRAWINGS.

CONTRACTORS MUST CHECK AND VERIFY ALL DIMENSIONS AND REPORT ANY DISCREPANCIES TO THE ENGINEER BEFORE PROCEEDING WITH THE WORK.

ALL DRAWINGS REMAIN THE PROPERTY OF THE ENGINEER AND SHALL NOT BE REPRODUCED OR REUSED WITHOUT THE ENGINEER'S WRITTEN PERMISSION.

THE OWNER/ARCHITECT/CONTRACTOR IS ADVISED THAT M.T.E. CONSULTANTS INC. CANNOT CERTIFY ANY COMPONENT OF THE SITE WORKS NOT INSPECTED DURING CONSTRUCTION. IT IS THE RESPONSIBILITY OF THE GENERAL CONTRACTOR TO NOTIFY M.T.E. CONSULTANTS INC. PRIOR TO COMMENCEMENT OF CONSTRUCTION TO ARRANGE FOR INSPECTION.

ISSUED FOR TENDER	2	DEC. 19, 2019
ISSUED FOR PERMIT AND REVIEW	1	JAN. 14, 2018

MTE
Engineers |Scientists |Surveyors
(519) 743-6500 www.mte85.com

LICENSED PROFESSIONAL ENGINEER
G. A. DAHMER
100202027
2019-12-13
PROVINCE OF ONTARIO

OWNER
TORONTO ZOO
2000 MEADOWVALE RD. TORONTO, ONTARIO

PROJECT
INDO-MALAYA PAVILION GENERATOR REPLACEMENT
2000 MEADOWVALE RD. TORONTO, ONTARIO

DRAWING
GENERAL NOTES, GRADING PLAN, SLAB PLAN, SECTIONS AND DETAILS

Project Manager GAD	Date DEC. 11, 2018
Design By GAD	Project No. 45238-100
Drawn By GAD	Drawing No. S1.0
Scale AS NOTED	

December 13, 2019 - 1:44 PM - Printed By:Geoffrey Dahmer

SPECIFICATIONS

TORONTO ZOO
ORANGUTAN EXHIBITS

ISSUED FOR TENDER
December 11th, 2019

Zeidler Architecture Inc.

Design Discipline

Documents prepared by the respective Consultants are designated by the following discipline symbols:

- Owner (O)
- Architect (A)
- Civil Consultant (C)
- Electrical Consultant (E)
- Landscape Consultant (L)
- Mechanical Consultant (M)
- Structural Consultant (S)

DIVISION 00 - PROCUREMENT AND CONTRACTING REQUIREMENTS

Document	Title	Discipline		Pages
	Cover Page	A		1
00 01 10	Table of Contents	A		6
Refer to Owner's Document 0 Sections under separate cover.		O		
00 72 00	General Conditions: **"Agreement Between Owner and Contractor", "Definitions", and "General Conditions of the Stipulated Price Contract", Standard Contract Document CCDC2 - 2008.**	A	Not Included	

DIVISION 01 - GENERAL REQUIREMENTS

Section	Title	Discipline	Pages
01 11 00	Summary of Work	A	5
01 21 00	Allowances	A	2
01 31 00	Coordination	A	4
01 31 19	Project Meetings	A	2
01 32 13	Schedule	A	2
01 33 00	Submittal Procedures	A	8
01 40 00	Quality Requirements	A	6
01 41 00	Regulatory Requirements	A	5
01 50 00	Temporary Controls and Facilities	A	11
01 60 00	Product Requirements	A	11
01 70 00	Contract Closeout	A	2
01 71 23	Field Engineering	A	2
01 73 29	Cutting and Patching	A	3
01 74 00	Cleaning	A	2
01 78 23	Operation and Maintenance Manuals	A	4
01 78 39	Record Documents	A	2

DIVISION 02 - EXISTING CONDITIONS

Section	Title	Discipline	Pages
02 32 00	Geotechnical Information	A	1
	- Soil Investigation	O	32
	- Geotechnical Investigation Report	O	29
02 40 00	Demolition and Removals	A	8

DIVISION 03 - CONCRETE

Section	Title	Discipline	Pages
03 00 50	Testing of Concrete	S	5
03 10 00	Concrete Forming and Accessories - Landscape	L	3
03 20 00	Concrete Reinforcement - Landscape	L	3
03 21 00	Concrete Reinforcement	S	11
03 30 00	Structural Cast-in-Place Concrete	S	13
03 33 00	Architectural Concrete	A	8
03 33 01	Cast-in-Place Concrete - Landscape	L	9
03 35 00	Concrete Finishing	S	9
03 37 13	Shotcrete	S	12

DIVISION 04 - MASONRY

Section	Title	Discipline	Pages
04 20 00	Unit Masonry	A	9

DIVISION 05 - METALS

Section	Title	Discipline	Pages
05 00 50	Testing of Structural Steel, Steel Framing and Steel Decking	S	13
05 12 00	Structural Steel Framing	S	12
05 16 00	Steel Cabling	A	4
05 31 00	Steel Decking	S	7
05 50 00	Miscellaneous and Metal Fabrications	A	16
05 59 64	Wire Mesh Panels and Doors	A	9
	- Reference Photographs	A	4

DIVISION 06 - WOOD, PLASTICS, AND COMPOSITES

Section	Title	Discipline	Pages
Refer to Structural Drawings for Structural Specifications.		S	
06 10 00	Rough Carpentry	A	7
06 20 00	Finish Carpentry	A	9

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

Section	Title	Discipline	Pages
07 14 16	Cold Fluid Applied Waterproofing	A	16
07 16 16	Cementitious Waterproofing	A	7
07 19 00	Water Repellent Sealer	A	4
07 21 00	Thermal Insulation	A	3
07 26 00	Vapour Retarders	A	5
07 31 16	Metal Shingles	A	6
07 41 23	Cedar Wood Siding	A	4
07 61 00	Metal Roofing (Alternative Price)	A	7
07 62 00	Flashing and Sheet Metal	A	5
07 92 00	Sealants	A	5

DIVISION 08 - OPENINGS

Section	Title	Discipline	Pages
08 11 13	Metal Doors and Frames	A	7
08 45 13	Polycarbonate Panels	A	5
08 51 23	Steel Windows	A	9
08 52 00	Wood Windows	A	7
08 70 00	Finish Hardware	A	5
08 80 00	Miscellaneous Glass and Glazing	A	6
08 80 01	Exhibit Laminated Glazing	A	10

DIVISION 09 - FINISHES

Section	Title	Discipline	Pages
09 21 16	Gypsum Board	A	7
09 51 00	Acoustical Ceilings	A	5
09 65 16	Resilient Sheet Flooring	A	6
09 67 23	Epoxy Flooring	A	5
09 91 00	Painting	A	10
09 97 13	Exterior Steel Coatings	A	4

DIVISION 10 - SPECIALTIES

Section	Title	Discipline	Pages
10 80 00	Miscellaneous Specialties	A	4

DIVISION 11 - EQUIPMENT

Section	Title	Discipline	Pages
11 24 23	Fall Protection Systems	A	7

DIVISION 20 - MECHANICAL, GENERAL

Section	Title	Discipline	Pages
20 05 00	Common Work Results for Mechanical	M	28
20 05 10	Mechanical Work General Instructions	M	23
20 05 13.13	Variable Frequency Drives for Mechanical Equipment	M	12
20 05 17	Sleeves and Sleeve Seals for Mechanical Piping	M	2
20 05 48.13	Vibration Controls for Mechanical Systems	M	4
20 05 93	Testing, Adjusting, and Balancing for Mechanical Systems	M	5
20 07 00	Mechanical Systems Insulation	M	9

DIVISION 22 - PLUMBING

Section	Title	Discipline	Pages
22 06 69	Facility Plumbing Services	M	4
22 11 00	Facility Water Distribution	M	7
22 13 00	Facility Sanitary Sewerage	M	6
22 30 00	Plumbing Equipment	M	4
22 42 00	Commercial Plumbing Fixtures	M	3

DIVISION 23 - HEATING, VENTILATING AND AIR CONDITIONING

Section	Title	Discipline	Pages
23 23 00	Refrigerant Piping	M	4
23 34 00	HVAC Fans	M	3
23 81 26	Split-System Air-Conditioners	M	3
23 82 39.19	Wall and Ceiling Unit Heaters	M	2

DIVISION 25 - INTEGRATED AUTOMATION

Section	Title	Discipline	Pages
25 05 01	Automatic Control Systems	M	11
25 05 02	Building Automation System	M	18

DIVISION 26 - ELECTRICAL

Section	Title	Discipline	Pages
26 05 00	Common Work Results for Electrical	E	19
26 05 19	Low-Voltage Electrical Power Conductors and Cables	E	6
26 05 26	Grounding and Bonding for Electrical Systems	E	6
26 05 29	Hangers and Supports for Electrical Systems	E	5
26 05 33.13	Conduit for Electrical Systems	E	5
26 05 33.16	Boxes for Electrical Systems	E	5
26 05 43	Underground Ducts and Raceways for Electrical Systems	E	4
26 05 53	Identification for Electrical Systems	E	6
26 05 83	Wiring Connections	E	4
26 08 00	Commissioning of Electrical Systems	E	7
26 08 50	Commissioning of Lighting	E	3
26 09 23	Lighting Control Devices	E	10
26 24 16	Panelboards	E	11
26 27 26	Wiring Devices	E	7
26 27 26.10	Outdoor Ground Box	E	3
26 28 13	Fuses	E	3
26 28 16.02	Molded Case Circuit Breakers	E	3
26 28 16.16	Enclosed Switches	E	2
26 51 19	LED Interior Lighting	E	13
26 56 19	LED Exterior Lighting	E	5

DIVISION 27 - COMMUNICATIONS

Section	Title	Discipline	Pages
27 05 00	Common Work Results for Communications	E	7
27 05 26	Grounding and Bonding fo Communications Systems	E	5
27 05 28	Pathways for Communications Systems	E	2
27 05 28.63	Pathways for Video Surveillance	E	2
27 05 29	Hangers and Supports for Communications Systems	E	6
27 05 44	Sleeves and Sleeve Seals for Communications Pathways and Cabling	E	5
27 05 53	Identification for Communications Systems	E	2
27 08 11	Testing and Record Documentation for Communications	E	3
27 10 00	Structured Cabling	E	9

DIVISION 28 - ELECTRONIC SAFETY AND SECURITY

Section	Title	Discipline	Pages
28 20 00	Video Surveillance	E	11

DIVISION 31 - EARTHWORK

Section	Title	Discipline	Pages
31 00 00	Earthwork	A	10
31 05 17	Aggregates	C	4
31 23 10	Excavating, Trenching, Backfilling	C	6
31 23 13	Site Grading	C	5
31 25 00	Erosion and Sedimentation Control	C	2

DIVISION 32 - EXTERIOR IMPROVEMENTS

Section	Title	Discipline	Pages
Refer to Landscape Drawings for irrigation Specifications.		L	
32 11 19	Granular Sub-Base	C	4
32 11 23	Granular Base	C	4
32 12 16	Asphalt Paving - Landscape	L	5
32 14 13.19	Permeable Pavers	L	8
32 17 43	Paving Snow Melting Systems	E	5
32 91 21	Planting Soil	L	13
32 93 10	Trees, Shrubs, and Groundcover Planting	L	12

DIVISION 33 - UTILITIES

Section	Title	Discipline	Pages
33 05 14	Manholes and Catch Basin	C	4
33 11 17	Water Systems	C	5
33 31 13	Sanitary Sewers	C	4
33 44 00	Storm Sewers	C	5
33 44 01	Subdrains	C	3
36 46 23	Drainage Boards	A	4

END OF DOCUMENT

1 **GENERAL**

1.1 The requirements of the Articles of Agreement, Conditions of the Contract, Division 1 apply to and form all Sections of the Contract Documents and the Work.

1.2 Work in this Specification is divided into descriptive sections which are not intended to identify absolute contractual limits between Subcontractors, nor between the Contractor and their Subcontractors. The Contractor is responsible for organizing division of labour and supply of materials essential to complete the Contract. The Consultant assumes no liability to act as an arbiter to establish subcontract limits between Sections or Divisions of Work.

1.3 It is intended that Work supplied under these Contract Documents shall be complete and fully operational in every detail for the purpose required. Provide all items, articles, materials, services and incidentals, whether or not expressly specified or shown on Drawings, to make finished Work complete and fully operational, consistent with the intent of the Contract Documents.

1.4 Work designated as “N.I.C.” is not included in this Contract.

1.5 Specifications, Schedules and Drawings are complementary and items mentioned or indicated on one may not be mentioned or indicated on the others.

1.6 Contractors finding discrepancies or ambiguities in, or omissions from the Drawings, Specifications or other Contract Documents, or having doubt as to the meaning and intent of any part thereof shall contact the Consultant for clarification.

1.7 Mention in the specifications or indication on the drawings of materials, Products, operations, or methods, requires that the Contractor provide each item mentioned or indicated of the quality or subject to the qualifications noted; perform according to the conditions stated in each operation prescribed; and provide labour, materials, Products, equipment and services to complete the Work.

1.8 Where the singular or masculine is used in the Contract Documents, it shall be read and construed as if the plural, feminine or neuter had been used when the context or the statement so requires and as required to complete the Work, and the rest of the sentence, clause, paragraph, or Article shall be construed as if all changes in grammar, gender or terminology thereby rendered necessary had been made.

1.9 The terms “approved”, “review”, “reviewed”, “accepted”, “acceptance”, “acceptable”, “satisfactory”, “selected”, “directed”, “instructed”, “required”, “submit”, “permitted”, “approved alternative”, “approved equal”, or similar words or phases are used in standards or elsewhere in Contract Documents, it shall be understood, that words “by (to) the Consultant” follow, unless context provides otherwise.

1.10 The term ‘or approved alternative’ following a list of Products, systems, or manufacturers used in the Contract Documents shall be construed to mean approved by Consultant. Specified products to be Base Bid. Contractor to follow ‘Substitution’ procedures specified in Section 01 60 00 for submitting proposed Products, systems, and manufacturers and obtain Consultant’s approval of the same prior to proceeding with ordering proposed Products and systems or engaging manufacturers. Contractors who purchase Products and systems or engage manufacturers prior to Consultant’s review and acceptance do so at their own risk.

1.11 Where the words 'submit', 'acceptable' and 'satisfactory' are used in the Contract Documents, they shall be considered to be followed by the words 'to the Consultant' unless the context provides otherwise.

1.12 The terms “exposed” or “exposed to view” refers to surfaces that are within the line of vision of persons from any accessible viewpoint, both within and without the building. Where any part of a surface is exposed to view, all other portions of that surface shall also be considered as exposed to view.

2 **EXISTING SITE CONDITIONS**

2.1 Make a careful examination of the site, and investigate and be satisfied as to all matters relating to the nature of the Work to be undertaken, as to the means of access and egress thereto and therefrom, as to the obstacles to be met with, as to the extent of the Work to be performed, any limitations under which the work has to be executed, and any and all matters which are referred to in the Contract Documents. Claims for additional costs will not be entertained with respect to conditions which could reasonably have been ascertained by an inspection prior to Tender closing.

2.2 Report any inconsistencies, ambiguities, discrepancies, omissions, and errors between Site conditions and Contract Documents to the Consultant prior to the commencement of Work. If inconsistencies, ambiguities, discrepancies, omissions, and errors are not reported and clarified, the most stringent requirement shall govern, as determined by the Consultant. Ensure that each Subcontractor performing work related to the site conditions has examined it so that all are fully informed on all particulars which affect the Work thereon in order that construction proceeds competently and expeditiously.

2.3 Before commencing the Work of any Section or trade, carefully examine the Work of other Sections and trades upon which it may depend, examine substrate surfaces, and report in writing to the Consultant, defects which might affect new Work. Commencement of Work shall constitute acceptance of conditions and Work of other sections, trades, and Other Contractors upon which the new Work depends. If repair of surfaces is required after commencement of specific work it shall be included in the work of the trade providing the specific system or finish.

3 **USE OF SITE**

3.1 Accept full responsibility for assigned work and storage areas from the time of Contract award until Substantial Performance of the Work.

3.2 Check means of access and egress, rights and interests which may be interfered with. Do not block lanes, roadways, entrances of exits. Direct construction traffic and locate access to site as directed by municipality.

3.3 Where encroachment beyond property limits is necessary make arrangements with respective property owners.

3.4 Before vehicles or equipment enter the Site, obtain permission from the Owner/Consultant for storage and appropriate access route. Appropriately barricade, stake off, or snow fence access route and storage area and around construction area in order to minimize damage to buildings, grounds, planting, turf, and surrounding facilities at the Site, and to restrict unauthorized persons from entering the construction area. Be responsible for making good any/all damages caused by operations at the Site. Restoration of such damages shall be to original condition and to the satisfaction of the Owner.

3.5 Cost of providing temporary protection, roads and services, including removal of same at completion of the Work and restoration of the involved areas to original state, shall be included in the Bid Price.

3.6 Maintain the exterior of the affected existing building during performance of the work. provide proper housekeeping measures to maintain a neat and orderly site to eliminate any complaints from surrounding neighbours.

4 **ACCESS/PROPERTY CONSTRAINTS**

4.1 Provide and maintain access facilities as may be required for access to the Work.

4.2 Minimize disruption, noise and dust to the functions of existing operational areas of existing buildings affected by Work of this Project. Times of entry, routes of access and time required to complete the Work shall be arranged and scheduled in cooperation with the Owner.

4.3 Confine Work and operations of employees to limits indicated by the Contract Documents. Do not unreasonably encumber the premises with products.

4.4 Organize delivery of materials/equipment to and removal of debris and equipment from place of Work to permit continual progress of work and suitable for restricted site conditions.

4.5 Determine and make arrangement as required for loading and unloading of equipment and Products at times that will not affect public traffic flow and that will be permitted by the City of Toronto. Conform to City by-laws with regard to parking restrictions and other conditions.

4.6 Make provisions and arrangements and provide allowances if times for loading and unloading allowed by the City of Toronto are other than regular working hours.

4.7 All Products, materials and equipment required on Site shall be portable and/or size suitable for access and movement on Site and without causing damage to buildings.

4.8 The Work shall be confined to the area defined on the drawings and by the property lines except that services connections and certain portions of landscaping, hard paving and curb work shall be executed on Municipal property under regulation of authorities.

4.9 Provide locked doors in barriers, permit access by Owner and Consultant to Work areas and to areas Contractor is responsible for.

4.10 Workers shall not enter existing building requiring remedial work beyond construction areas except where required for connection or modification to existing services or other such work. Arrange such requirements with Owner prior to entering existing occupied areas.

4.11 Personnel access and material deliveries to the Site shall be only by routes designated by the Owner. Deliver Products between the hours as agreed upon by the Owner. Owner's equipment such as trucks, bins, dollies, and other such equipment/facilities shall not be used by Contractors. Arrangements for handling items weighty or bulky enough to require special treatment must be made and reviewed with the Owner.

4.12 Advise the Owner 48 hours in advance of large or cumbersome item deliveries. Give particulars of item size and weight, protection to existing surfaces to be provided and safety precautions during movement.

5 **SECURITY**

5.1 Be responsible for security of all areas affected by Work of this Contract until taken over by Owner. Take steps to prevent entry to the Work by unauthorized persons and guard against theft, fire and damage by any cause.

5.2 Provide suitable surveillance equipment and /or employ guard services, as required to adequately protect the work.

5.3 Make provisions to permit Owner's security personnel to view areas where all Work is being performed.

5.4 Use of facilities such as building entrances, washrooms, and access routes and paths through the Site as directed by Owner's security personnel and as specified.

5.5 Take acceptable precautions to guard Work site, premises, materials and the public during and after working hours due to the Work of this Contract.

5.6 A regular full time watchman is generally not required on Site, however, if in the opinion of the Consultant the Work is not adequately protected, the Owner may request that a watchman be employed by the Contractor at no extra cost to the Contract.

5.7 Any security service provided by the Owner is for the protection of the Owner's interest in the Work on the Site and shall not relieve the Contractor of the responsibility to protect the construction site and the Work of the Contract.

6 **WEATHER**

6.1 Incorporate into the Contract Schedule allowances for the number of working days lost due to inclement weather, which can be anticipated, on the basis of analysis of information available from Environment Canada, for weather conditions on and near the Site, over the last ten (10) years. The Contractor may be entitled to a schedule extension for those activities on the critical path which are delayed on account of inclement weather, assessed on a quarterly basis, by the number of days in excess of the anticipated number of working days for the quarter in question by more than 20%. No additional payment will be made on account of any such schedule extension.

6.2 For the purpose of this clause the quarters are defined as January 1 to March 31, April 1 to June 30, July 1 to September 30, and October 1 to December 31.

7 **WASTE AUDIT/PLANS FOR WASTE REDUCTION**

7.1 Comply with requirements of authorities having jurisdiction.

7.2 Prepare and submit waste audit and waste reduction plan in accordance with Ontario Regulation 102/94 Waste Audits and Waste Reduction Workplans.

7.3 Prepare and submit source separation plan in accordance with Ontario Regulation 103/94 Industrial, Commercial and Institutional Source Separation Programs.

7.4 Deliver to nearest appropriate depot all materials accepted for recycling by the region or municipality having jurisdiction over the Place of Work, including but not limited to cardboard, paper, plastic, aluminum, steel, and glass. Deliver to nearest appropriate depot all scrap and excess gypsum wallboard for recycling of this material. Pay all costs for this work.

END OF SECTION

1 GENERAL

1.1 Allowances included herein are for items of Work which could not be fully quantified prior to Bidding.

1.2 Expend each allowance as directed by the Consultant in writing. Work covered by allowances shall be performed for such amounts and by such persons as directed by Consultant.

1.3 Each allowance will be adjusted to actual cost as defined hereunder and the Contract Price will be amended accordingly by Contract Change Order.

1.4 Progress payments for Work and Products authorized under allowances will be made in accordance with the payment terms set out in Conditions of the Contract.

1.5 A schedule shall be prepared jointly by the Consultant and Contractor to show when items called for under allowances must be authorized by the Consultant for ordering purposes so that the progress of the Work will not be delayed.

1.6 Where a Cash Allowance is for work performed under a Subcontract, the Contractor shall Bid the work involved and submit the Bids received, with the Contractor's recommendations, for approval.

2 CASH ALLOWANCE(S)

2.1 Cash allowances, unless otherwise specified, cover the net cost to the Contractor of services, Products, construction machinery and equipment, freight, handling, unloading, storage, installation where indicated, and other authorized expenses incurred in performing the Work. Cash allowances shall not be included by a Subcontractor in the amount for their Subcontract work.

2.2 Supply only allowances shall include:
- .1 Net cost of Products.
- .2 Delivery to Site.
- .3 Applicable taxes and duties, excluding HST.

2.3 Supply and install allowances shall include:
- .1 Net cost of Products.
- .2 Delivery to Site.
- .3 Unloading, storing, handling or Products on Site.
- .4 Installation, finishing and commissioning of Products.
- .5 Applicable taxes and duties, excluding HST.

2.4 Inspection and testing allowances shall include:
- .1 Net cost of inspection and testing services.
- .2 Applicable taxes and duties, excluding HST.

2.5 Other costs related to work covered by cash allowances are not covered by the allowance but shall be included in the Contract Price.

2.6 Where costs under a cash allowance exceed the amount of the allowance, the Contractor will be compensated for any excess incurred and substantiated plus an allowance for overhead and profit as set out in the Contract Documents.

2.7 Progress payments on accounts of work authorized under cash allowances shall be included in the monthly certificate for payment.

2.8 Submit, before application for final payment, copies of all invoices and statements from suppliers and Subcontractors for work which has been paid from cash allowances.

2.9 Refer to Owner's Document 0 for cash allowances and associated amounts required for Work of this Project. Include in the Bid Price the amount of each cash allowance.

END OF SECTION

1 **GENERAL**

1.1 Coordination of the Work of all Sections of the specifications as required to complete the Project is the responsibility of the Contractor.

1.2 Cooperate and coordinate with Other Contractors including Other Contractor's employed by Owner.

1.3 Ensure that Subcontractors and trades cooperate with other subcontractors and trades whose work attaches to or is affected by their own work. Ensure that minor adjustments are made to make adjustable work fit fixed work.

1.4 Allow access of Owner's Other Contractors on site and to areas of Work. Cooperate and coordinate with such Other Contractors. Schedule work to complement work of such Other Contractors.

1.5 Entry by the Owner's own forces and by Other Contractors shall not mean acceptance of the Work and shall not relieve the Contractor of their responsibility to complete the Contract.

1.6 Placing, installation, application and connection of work by the Owner's own forces or by Other Contractors on and to the Contractor's Work shall not relieve the Contractor of his responsibility to provide and maintain the specified warranties.

1.7 Coordinate with removals/installations specified in other Divisions and Other Contracts.

1.8 Coordination of the installation of systems specified in Divisions 13, 21, 22, 23 and 26, including the interrelating operation and functioning between components of a system and between systems, is the responsibility of those performing the work of those Divisions, with final coordination the responsibility of the Contractor.

1.9 Coordinate relocation of existing mechanical and electrical items with work specified in Divisions 13, 21, 22, 23, and 26.

1.10 Existing equipment shall remain in present locations unless designated otherwise. Protect from damage. Remove, store and reinstall existing fixed equipment, fixtures and components which interfere with construction and which are scheduled for relocation.

1.11 Pay particular attention to types of ceiling construction and clearances throughout, especially where recessed fixtures are required. Coordinate work with Other Contractors and Subcontractors wherever ventilation ducts or piping installations occur to ensure that conflicts are avoided.

1.12 Install ceiling mounted components in accordance with final ceiling plans. Inform Consultant of conflicting installations.

1.13 Install and arrange ducts, piping, tubing, conduit, equipment, fixtures, materials and product to conserve headroom and space with minimum interference and in neat, orderly and tidy arrangement. Run pipes, ducts, tubing and conduit, vertical, horizontal and square with building grid unless otherwise indicated. Install piping, ducts, and conduit as close to underside of structure as possible unless shown otherwise.

1.14 Make provision, without interference or restriction by items located within the ceiling space, for unrestricted relocation of light fixtures to replace ceiling panels at grid spaces of the same size.

1.15 Where supports or openings are to be left for the installation of various parts of the Work furnish the necessary information to those concerned in ample time so that proper provision can be made for such items. Have cutting, drilling and other remedial work, and the subsequent patching or other work required for failing to comply with this requirement, performed at a later date at no additional Cost to Owner.

1.16 Properly coordinate the work of the various Sections and trades, taking into account the existing installations to assure the best arrangement of pipes, conduits, ducts and mechanical, electrical and other equipment, in the available space. Under no circumstances will any extra payment be allowed due to the failure by the Contractor to coordinate the work. If required, in critical locations, prepare interference and/or installation drawings showing the work of the various Sections as well as the existing installation, and submit these drawings to the Consultant for review before the commencement of work. Proceed with work in these areas only as, and when directed by the Consultant.

1.17 Coordinate with mechanical and electrical trades to ensure protecting supporting, disconnecting, cutting off, capping, diverting, relocating or removing of existing services in areas of Work before commencement of alteration work.

1.18 In case of damage to active services on utilities, notify Consultant and respective authorities immediately and make all required repairs under direction of Consultant and respective authorities. Carry out repairs to such damaged services and utilities continuously to completion, including working beyond regular working hours. Costs to be borne by the Contractor.

1.19 Existing areas shall remain in use except where alteration work is actually in progress. Confine effects of Work to areas indicated on Drawings unless otherwise approved by Owner.

2 METRIC DIMENSIONS

2.1 Measurements in this specification are expressed in metric (SI) units and depending on the progress made in the various sectors of the industry are either hard or soft converted units.

2.2 All metric units specified shall be taken to be the minimum acceptable unless otherwise noted.

2.3 It is the Contractor's responsibility to check and verify with manufacturers and suppliers on the availability of materials and products in either metric or imperial sizes. Be responsible for coordinating products supplied in metric (SI) and imperial units into the overall layout.

2.4 Where both metric and imperial sizes or dimensions are shown, the metric size or dimension shall govern.

3 BUILDING DIMENSIONS

3.1 Take necessary job dimensions for the proper execution of the work. Assume complete responsibility for the accuracy and completeness of such dimensions, and for coordination.

3.2 Verify that work, as it proceeds, is executed in accordance with dimensions and positions indicated which maintain levels and clearances to adjacent work, as set out by requirements of the Drawings, and ensure that work installed in error is rectified before construction resumes.

3.3 Check and verify dimensions referring to the work and the interfacing of services.

3.4 Do not scale directly from the Drawings. If there is ambiguity or lack of information, immediately inform the Consultant. Changes required through the disregarding of this clause shall be the responsibility of the Contractor.

3.5 All details and measurements of any work which is to fit or to conform with work installed shall be taken at the building.

3.6 Advise Consultant of discrepancies and if there are omissions on Drawings, particularly reflected ceiling plans and jointing patterns for surfaces finishes, which affect aesthetics, or which interfere with services, equipment or surfaces. Do not proceed with work affected by such items without direction from the Consultant.

3.7 Provide written requirements for site conditions and surfaces necessary for the execution of respective work, and provide setting drawings, templates and all other information necessary for the location and installation of material, holes, sleeves, inserts, anchors, accessories, fastenings, connections and access panels. Inform respective contractors whose work is affected by these requirements and preparatory work.

4 INTERFERENCE AND COORDINATION DRAWINGS

4.1 Coordinate placement of equipment to ensure that components will be properly accommodated within the spaces provided prior to commencement of work.

4.2 Prepare interference and equipment placing drawings to ensure that all components will be properly accommodated within the spaces provided. Provide copies of interference drawings to Consultant when requested by Consultant.

4.3 Prepare drawings to indicate coordination and methods of installation of a system with other systems where their relationship is critical. Ensure that all details of equipment apparatus, and connections are coordinated.

4.4 Take complete responsibility for any remedial work that results from failure to coordinate any aspect of the Work prior to its fabrication/installation.

4.5 Ensure that accesses and clearance required by jurisdictional authorities and/or for easy maintenance of equipment are provided in the layout of equipment and services.

5 **SLEEVING AND INSERT DRAWINGS AND TEMPLATES**

5.1 Prepare sleeving drawings for work of Divisions 13, 21, 22, 23, and 26, showing size and location of all penetrations through load bearing elements. Submit sleeving drawings in the form of one transparency and 4 prints to Consultant for review not less than 15 days prior to construction of affected elements.

5.2 Prepare insert setting drawings for work to be cast into concrete and/or mortared into masonry elements. Submit insert setting drawings in the form of a transparency and 4 prints to Consultant for review not less than 15 days prior to construction of affected elements.

5.3 Ensure that setting drawings, templates, and all other information necessary for the location and installation of materials, fixtures, equipment, holes, sleeves, inserts, anchors, accessories, fastenings, connections, and access panels are provided by each Section whose work requires cooperative location and installation by other Sections, and that such information is communicated to the applicable installer.

5.4 Provide cutting, fixing and making good to the work of Other Contractors, Subcontractors and trades as required for sleeving and inserts and make up time lost as a result of failure to comply with this requirement, at no additional cost to the Owner.

END OF DOCUMENT

1 PRE-CONSTRUCTION MEETING

1.1 Arrange and conduct pre-construction meeting(s).

1.2 Co-ordinate and organize attendance by representatives of major Subcontractors and parties in contract with the Contractor.

1.3 Consultant will arrange attendance of other interested parties not responsible to the Contractor.

1.4 Prepare and distribute copies of Agenda prior to meeting.

1.5 Agenda will include but not be limited to the following topics as are pertinent to the Contract.

.1 Review project communications procedures.

.2 Review contract administration requirements including submittals, payment, and change order procedures.

.3 Identify all critical points on construction schedule for positive action.

.4 Identify any product availability problems and substitution requests.

.5 Establish site arrangements and temporary facilities.

.6 Review Consultants inspection requirements.

.7 Review any points which, in Owner's, Consultants, and Contractor's opinion, require clarification.

1.6 Be prepared to provide specific information relative to agenda items as they are pertinent to the Contract.

1.7 Record minutes of meeting and distribute type written copies to all participants and other interested parties, within one week of meeting date.

2 PROGRESS MEETINGS

2.1 Attend regularly scheduled progress meetings to be held on Site at times and dates that are mutually agreed to by the Owner, Consultant, and Contractor.

2.2 Co-ordinate and organize attendance of individual Subcontractors and material suppliers when requested. Relationships and discussions between Subcontractor participants are not the responsibility of the Consultant and do not form part of the meetings content.

2.3 Ensure that Contractor representatives in attendance at meetings have required authority to commit Contractor to actions agreed upon. Assign same persons to attend such meetings throughout the contract period.

2.4 Inform the Consultant in advance of meetings regarding all items to be added to the agenda.

2.5 Prepare and distribute copies of Agenda prior to meeting.

2.6 Be prepared to provide specific information relative to agenda items at each meeting as they are pertinent to the Contract.

2.7 Agenda will include but not be limited to the following topics as are pertinent to the Contract.

.1 Review and agreement of previous minutes.

.2 Construction safety.

.3 Status of submittals.

.4 Quality control.

.5 Co-ordination.

.6 Contract Schedule

.7 Work plan up to next scheduled meeting.

.8 Requests for information/clarification.

.9 Contemplated changes.

2.8 Record minutes of meeting and distribute type written copies to all participants and other interested parties, within one week of meeting date.

END OF SECTION

1 **GENERAL**

1.1 Be responsible for planning and scheduling of the Work. As a minimum, prepare and update the following schedules:

.1 Contract Schedule.

.2 Detailed Construction Schedule.

1.2 Be responsible for ensuring that Subcontractors plan and schedule their respective portions of the Work. Subcontractor's schedules shall form part of the above mentioned schedules.

2 **CONTRACT SCHEDULE**

2.1 Prepare and submit the Contract Schedule within 7 days following award of Contract. This schedule, once it is reviewed by the Consultant and if it meets the Consultant's project requirements, will form part of the Contract.

2.2 The Contract Schedule shall be developed using a logic network technique for planning and scheduling. Provide both electronic format and hard copy of schedule.

2.3 The Contract Schedule shall be submitted for approval in its optimum levelled form. This presentation may be in either a time scaled network or a bar chart form. It shall be subdivided into either work areas or systems as applicable.

2.4 The Contract Schedule shall include the following information:

.1 Include and conform to the Key Work Milestones or any other milestones for the performance of the Work set out in the Agreement;

.2 Starting and ending dates of each activity including the float periods;

.3 Manpower requirements for each activity;

.4 Order and delivery dates for major or critical equipment.

.5 Interdependency with activities of other Contractors;

.6 Dates specified in the Contract Documents;

.7 Dates on which specific data will be required for submittal, i.e., Vendor data, shop drawings, samples, etc.

2.5 This schedule shall be reviewed and updated monthly by the Contractor so as to reflect any Contract changes as well as major changes to the schedule.

3 DETAILED CONSTRUCTION SCHEDULE

3.1 Prepare and submit a detailed construction schedule within 14 days of final review and acceptance of the Contract Schedule. This schedule, once reviewed and accepted by the Consultant, will be updated and submitted monthly with the Contract Schedule and weekly once the Contractor starts on Site.

3.2 This schedule shall cover the construction period. It will show, in detail, activities on a daily basis indicating durations, manpower and constraints. The activities shown on this schedule shall further clarify or detail the activities shown on the Contract Schedule.

3.3 The detailed construction schedule shall be presented in a bar chart form.

4 CASH FLOW CHART

4.1 Within 7 days after award of Contract, submit, in form approved by Consultant, cash flow chart broken down on a monthly basis in an approved manner. Cash flow chart shall indicate anticipated Contractor's monthly progress billings from commencement of work until completion.

4.2 Update cash flow chart whenever changes occur to scheduling and in manner and at times satisfactory to Consultant.

END OF SECTION

1 GENERAL

1.1 Provide labour, Products, equipment, services tools and supervision necessary for submittals. Make submittals specified in this Section to Consultant unless otherwise specified.

.1 Verify accuracy and completeness of submittals prior to submission.

.2 Verify field measurements, field construction criteria, catalogue numbers and similar data.

.3 Co-ordinate each submittal with requirements of the Work and the Contract Documents.

.4 Notify Consultant in writing at time of submission, of any deviation in submittals from requirements of the Contract Documents.

1.2 Submit in accordance with dates established under Section 01 32 13 for shop drawings, fabrication, manufacture, erection and installation to provide adequate time for reviews, securing necessary approvals, possible revisions and resubmittals, placing orders, securing delivery and to avoid construction delays.

1.3 Accompany each submittal with a letter of transmittal in duplicate containing all pertinent information required for identification and checking of submittals including but not limited to the following:

.1 Date of initial submission and date of each subsequent submission if required.

.2 Project title and Consultant’s project number.

.3 Names of:
- .1 Contractor.
- .2 Subcontractor.
- .3 Supplier/manufacturer/fabricator as applicable.

.4 Specification section numbers to which submission is related.

.5 Countersigned stamp of Contractor certifying that they have reviewed the submission.

1.4 Allow two weeks for the Consultant's review of each submission.

1.5 When submittals are resubmitted, transmit under a new letter of transmission.

1.6 Do not carry out Work until Consultants review of submittals has been completed.

1.7 Be responsible for payment of charges for delivery of submissions and resubmission to Consultant.

2 PRODUCT DATA

2.1 Before delivery of Products to the Site, submit Product data as specified in each section or as requested by the Consultant.

2.2 Submit manufacturer's Product data for systems, materials, and methods of installation proposed for use. Such literature shall identify systems, each component, and shall certify compliance of each component with applicable/specified standards.

3 SAMPLES

3.1 Before delivery of Products to the Site, submit samples of Products as specified or as requested by the Consultant. Label samples as to origin and intended use in the Work and in accordance with the requirements of the Specification Sections. Samples must represent physical examples to illustrate materials, equipment or work quality and to establish standards by which completed Work is judged.

3.2 Ensure samples are of sufficient size and quantity, if not already specified, to illustrate:

.1 The quality and functional characteristics of Products, including integrally related parts and attachment devices.

.2 The full range of colours available.

3.3 Notify the Consultant in writing, at time of submission, of any deviations in samples from requirements of the Contract Documents, and state the reasons for such deviations.

3.4 Identify samples with Project name, Contract number, date, Contractor's name, number and description.

3.5 If samples are not acceptable, both samples will be returned. If samples are acceptable, one sample will be so indicated and returned. Be responsible for the cost of samples that are not accepted and for resubmission of samples.

3.6 Acceptable samples shall serve as a model against which the products incorporated in the work shall be judged.

3.7 Each Product incorporated in the Work shall be precisely the same in all details as the acceptable sample.

3.8 Should there be any change to the accepted sample, submit in writing for approval of the revised characteristics and resubmit samples of the Product for approval if requested.

3.9 When samples are very large, require assembly, or require evaluation at the Site, they may only be delivered to the Site with approval and as directed.

4 SHOP DRAWINGS

4.1 Arrange for the preparation of Shop Drawings as called for in the Contract Documents or as may be reasonably requested by the Consultant. The Contractor and each Subcontractor shall operate as experts in their respective fields and all Shop Drawings and samples shall conform to the requirements of the Contract Documents.

4.2 The term "Shop Drawings" means drawings, diagrams, schematics, illustrations, schedules, performance charts, brochures and other data which are required to illustrate details of the Work.

4.3 In addition to Shop Drawings specified in the specification sections, submit Shop Drawings required by jurisdictional authorities in accordance with their requirements.

4.4 Shop Drawings for openings, sleeving and conduit:

.1 Prior to preparation of Shop Drawings, coordinate sizes of all structural openings and sleeves with respective fabricators for mechanical ducting. Adjustments to the opening sizes indicated on the Contract Drawings shall not be made without the approval of the Consultant.

.2 Prior to detailing structural reinforcement on Shop Drawings, arrange for the Structural Engineer to review formed holes, recesses and sleeving. Completely dimension openings, recesses and sleeves and relate to appropriate grid line(s) and elevation(s).

.3 Prior to forming of the structure, arrange for the preparation of Shop Drawings for review by the Consultant showing embedded conduit to be cast within the structure. Shop Drawings shall include conduit from all sources.

4.5 Shop Drawings shall indicate the following minimum criteria and any additional criteria indicated in the individual specification sections requiring Shop Drawings:

.1 Clear and obvious notes of any proposed changes from the Contract Documents.

.2 Fabrication and erection dimensions.

.3 Provisions for allowable construction tolerances and deflections provided for live loading.

.4 Details to indicate construction arrangements of the parts and their connections, and interconnections with other work.

.5 Location and type of anchors and exposed fastenings.

.6 Materials, physical dimensions including thicknesses, and finishes.

.7 Descriptive names of equipment.

.8 Mechanical and electrical characteristics when applicable.

.9 Information to verify that superimposed loads will not affect function, appearance, and safety of the work detailed as well as of interconnection work.

.10 Assumed design loadings, and dimensions and material specifications for load-bearing members.

4.6 Include in Shop Drawing submissions detailed information, templates, and installation instructions required for incorporation and connection of the Work.

4.7 Before submitting to the Consultant, review all Shop Drawings to verify that the Products illustrated therein conform to the Contract Documents. By this review, the Contractor agrees that it has determined and verified all field dimensions, field construction criteria, materials, catalogue numbers and similar data and that it has checked and coordinated each Shop Drawing with the requirements of the Work and of the Contract Documents. The Contractor's review of each Shop Drawing shall be indicated by stamp, date and signature of a qualified person possessing the appropriate authorization from the Contractor.

4.8 Be responsible for dimensions, confirmed at the Site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for coordination of the Work of all subtrades.

4.9 Submit Shop Drawings for the Consultant's review with reasonable promptness and in orderly sequence so as to cause no delay in the Work nor in the work of Other Contractors. At the time of submission, notify the Consultant in writing of any deviations in the Shop Drawings from the requirements of the Contract Documents. The Contractor will be held responsible for changes made from the Contract Documents which are not indicated or otherwise communicated in writing with the submission.

4.10 Drawings submitted by the Contractor as required herein are the property of the Owner who may use and duplicate such drawings where required in association with the Work.

4.11 Submit Shop Drawings signed and sealed by a licensed Professional Engineer registered in the place of the Work where indicated in individual Sections.

4.12 Shop Drawings shall have distinct, uniform letters, numerals and line thicknesses that will ensure the production of clear legible prints at original as well as reduced size.

4.13 Provide submissions in electronic Portable Document Format (PDF) format delivered via electronic means as directed by the Consultant.

4.14 Shop Drawings shall contain the following identification:

.1 Project name and Contract number.

.2 Applicable 6-digit Contract Specification number describing the item.

.3 Location (unit, level, room number, etc.).

.4 Name of equipment or Product.

.5 Name of Subcontractor or supplier/fabricator.

.6 Signature of Contractor certifying that Shop Drawing is in conformance with Contract Documents.

.7 On submissions subsequent to the first, the following additional identification:
.1 The revised submission number.
.2 Identification of the item(s) revised.

4.15 Dimensions and designations of elements shall be shown in the same system of measurement used on the applicable Contract Drawings.

4.16 The Consultant reserves the right to refuse acceptance of drawing submissions not meeting the above requirements.

4.17 The Consultant's review will be for conformity to the design concept and for general arrangement only and such review shall not relieve the Contractor of responsibility for errors or omissions in the Shop Drawings or of responsibility for meeting all requirements of the Contract Documents unless a deviation on the Shop Drawings has been approved in writing by the Consultant. Review does not mean that Consultant approves detail inherent in Shop Drawings, responsibility which shall remain with Contractor submitting same.

4.18 The Contractor shall make any changes in Shop Drawings which the Consultant may require consistent with the Contract Documents and re-submit unless otherwise directed by the Consultant. When re-submitting the Shop Drawings, the Contractor shall notify the Consultant in writing of any revisions other than those requested by the Consultant.

4.19 Only drawings noted for revision and resubmission need be resubmitted.

4.20 File one copy of each submitted Shop Drawing at the Site.

5 **CERTIFICATES**

5.1 Submit certificates that are required by authorities having jurisdiction or that are requested in the applicable specification sections.

5.2 Clearly show on each certification the name and location of the Work, name and address of Contractor, quantity and date of shipment and delivery and name of certifying company.

5.3 Certificates shall verify that Products and/or methods meet the specified requirements and shall include test reports of testing laboratories approved to validate certificates.

5.4 Submit certificates in duplicate and signed by an authorized representative of the certifying company.

6 CERTIFICATION OF TRADESMEN

6.1 Provide certificates, at the request of the Consultant, to establish qualifications of personnel employed on the Work where such certification is required by authorities having jurisdiction, by the Consultant or by the Contract Documents.

7 EXTENDED WARRANTIES

7.1 Submit extended warranties as requested in sections of the Specifications showing title and address of Contract, warranty commencement date and duration of warranty.

7.2 Extended warranties shall commence on termination of the standard warranty specified in the conditions of the contract and shall be an extension of these provisions. Clearly indicate what is being warranted and what remedial action is to be taken under the warranty. Ensure warranty bears the signature and seal of the Contractor.

7.3 Submit each extended warranty on a form that is acceptable to the Owner and Consultant.

8 INSPECTION AND TEST REPORTS

8.1 Submit inspection and test reports as specified in the Sections of the specifications for “Source Quality Control” and “Field Quality Control” within 3 working days of inspection or testing. If immediate action is required by the Contractor or Consultant inform the Consultant immediately and submit inspection and testing report within one working day.

8.2 Submit 3 copies of reports submitted with certificates of compliance indicating but not limited to the following:

.1 Project name and number.

.2 Date of inspection or test and date report is issued.

.3 Name and address of inspection and testing company.

.4 Name and signature of inspector or tester.

.5 Identification of Product and Specification Section covering inspected or tested work.

.6 Specified requirements for which the inspection or testing was performed and results of inspections or tests.

.7 Location of inspection or from which tested material was derived.

.8 Overview of inspection and testing methods and procedures.

.9 Remarks and observations on compliance with Contract Documents.

8.3 Inspection and test reports shall be signed by a responsible officer of the inspection and testing company.

9 **PROGRESS PHOTOGRAPHS**

9.1 Concurrently with monthly application for payment submit 2 CD's or DVD's of digital pictures illustrating the progress of the Work as follows:

.1 A minimum of 20 pictures that best illustrate the progress on the site.

.2 Pictures shall be in focus and properly illuminated; view shall be unobstructed.

.3 Pictures shall be taken with a minimum 5 megapixel camera or better such that quality and details can be discerned from photo.

.4 The Pictures shall either have an accurate date-stamp present in the photo, or be numbered and dated in the digital filename.

.5 The CD or DVD containing the photo's shall be labeled with the following information: The project name, the period the pictures are taken in, the monthly application number which the pictures are associated with.

10 **PROGRESS REPORTS**

10.1 Prepare a monthly progress report current to the last Friday of each month. The report shall indicate the period covered and include but not be limited to the following:

.1 Executive Summary.

.2 Areas of Concern/Action Required.

.3 Work Accomplished This Period.

.4 Work Planned Next Period.

.5 Schedule Status.

.6 Budget Status.

.7 Status of Submittals.

.8 Quality Control.

.9 Contract Changes.

.10 Outstanding Actions.

10.2 Submit the monthly progress report such that it is received by the Consultant no later than the Wednesday following the last Friday of the month, regardless of whether or not the Monday is a public holiday.

11 **OPERATION AND MAINTENANCE MANUALS**

11.1 Submit Operation and Maintenance Manuals in accordance with Section 01 78 23.

12 **RECORD DOCUMENTS**

12.1 Submit record documents in accordance with Section 01 78 39.

END OF SECTION

1 GENERAL

1.1 Be responsible for inspection and testing as required by the Contract Documents, statutes, regulations, by-laws, standards or codes or any other jurisdictional authority. Give the Consultant timely notice of the readiness for inspection, date and time for such inspection for attendance by the Consultant.

1.2 Verify by certification that specified products meet the requirements of reference standards specified in the applicable specification sections.

1.3 Conduct testing, balancing and adjusting of equipment and systems specified in applicable mechanical and electrical specifications sections by independent testing company.

2 INSPECTION AND TESTING BY THE OWNER

2.1 The Consultant, on behalf of the Owner may appoint an independent inspection and testing company to carry out inspection and testing of the Work for conformance to the Contract Documents. Such costs for inspection and testing will be paid by the Owner. However, any additional inspection and testing due to non-conformance to the Contract Documents shall be at the Contractor's expense.

2.2 Inspections and testing by the independent inspection an testing company will be promptly made. Uncover for examination any Work covered up prior to inspection or without approval of the Consultant. Make good such Work at no cost to the Owner.

2.3 The Owner may inspect and test Products during manufacture, fabrication, shop testing, installation, construction and testing phases of the Contract. The Consultant will ascertain the quantity and quality of testing to be performed. Inspection and testing may be performed at the place of manufacture/fabrication, storage, or at the Site as designated by the Consultant. Where inspection and testing is done either during manufacture, fabrication, or at Site, ensure that proper facilities and assistance are provided.

3 INSPECTION AND TESTING

3.1 Source and Field Quality Control specified in Other Sections:

.1 This Section includes requirements for performance of inspection and testing specified under Source Quality Control and Field Quality Control in other Sections of the specifications.

.2 Do not include in work of this Section responsibilities and procedures that relate solely to an inspection and testing company's functions that are specified in another Section which is paid for directly by the Owner. Such information is included in this Section for Contractor's information only.

3.2 Do not limit responsibility for ensuring that products and execution of the work meet Contract requirements, and inspection and testing required to this end, to specified inspection and testing.

4 QUALIFICATIONS OF INSPECTION AND TESTING COMPANIES

4.1 Inspection and testing companies to be certified by the Standards Council of Canada (SCC) or Canadian Council of Independent Laboratories (CCIL).

4.2 Companies engaged for inspection and testing shall provide equipment, methods of recoding and evaluation, and knowledgeable personnel to conduct tests precisely as specified in reference standards.

4.3 If requested, submit affidavits and copies of certificates of calibration made by an accredited calibrator to verify that testing equipment was calibrated and its accuracy ensured within the previous twelve months.

5 RESPONSIBILITIES OF THE CONTRACTOR

5.1 Be responsible for quality control methods and procedures to ensure performance of the work in accordance with the Contract Documents.

6 RESPONSIBILITIES OF INSPECTION AND TESTING COMPANIES

6.1 Determine from specifications and Drawings the extent of inspection and testing required for Work of the Contract. Subcontractors shall notify Consultant of any omissions or discrepancies in the work inspected and/or tested.

6.2 Perform applicable inspection and testing described in the Specifications and as may be additionally directed.

6.3 Provide competent inspection and testing personnel when notified by the Contractor that applicable work is proceeding. Inspection personnel shall cooperate with the Consultant and Contractor to expedite the Work.

6.4 Subcontractors shall notify the Consultant and Contractor of deficiencies and irregularities in the Work immediately when they are observed in the course of inspection and testing.

6.5 Inspection and testing companies shall not perform or supervise any of the Contractor's work, and shall not authorize:

.1 Performance of work that is not in strict accordance with the Contract Documents.

.2 Approval or acceptance of any part of the Work.

7 INSPECTION AND TESTING PROCEDURES

7.1 Perform specified inspection and testing only in accordance with specified reference standards, or as otherwise approved.

7.2 Observe and report on compliance of the Work to requirements of Contract Documents.

7.3 Ensure that inspectors are on site or at fabricator's operations for full duration of critical operations, and as otherwise required to determine that the Work is being performed in accordance with the contract Documents.

7.4 Identify samples and sources of materials.

7.5 Review and report on progress of the work. Report on count of units fabricated and inspected at fabricator's operations.

7.6 Observe and report on conditions of significance to work in progress at time of inspection or at fabricator's operations. Include where applicable and if critical to the work in progress:

.1 Time and date of inspection.

.2 Temperature of air, materials, and adjacent surfaces.

.3 Humidity of air, and moisture content of materials and adjacent materials.

.4 Presence of sunlight, wind, rain, snow and other weather conditions.

7.7 Include in reports all information critical to inspection and testing.

7.8 Ensure that only materials from the work and intended for use therein are tested.

7.9 Determine locations for work to be tested.

8 TOLERANCES FOR INSTALLATION OF WORK

8.1 Unless specifically indicated otherwise, work shall be installed plumb, level, square and straight.

8.2 Unless acceptable tolerances are otherwise specified in specification sections or are otherwise required for proper functioning of equipment, site services, and mechanical and electrical systems:

.1 "Plumb and level" shall mean plumb or level within 1 mm in 1 m.

.2 "Square" shall mean not in excess of 10 seconds lesser or greater than 90 degrees.

.3 "Straight" shall mean within 1 mm under a 1 m long straightedge.

.4 "Flush" shall mean within:
- .1 6 mm for exterior concrete, masonry, and paving materials.
- .2 1 mm for interior concrete, masonry, and similar surfaces.
- .3 0.05 mm for other interior surfaces.

8.3 Allowable tolerances shall not be cumulative.

9 REFERENCE STANDARDS

9.1 Perform inspection and testing in accordance with Standards quoted and as required by procedures described in specified reference standards that are applicable to the work being inspected and tested.

10 DEFECTS

10.1 Defective products, materials and workmanship found at any time prior to Contract Completion will be rejected regardless of previous inspections, testing, and reviews of the Work. Inspections, testing, and reviews shall not relieve the Contractor from their responsibility, but are a precaution against oversight or error. Remove and replace defective and rejected products, materials, systems, and workmanship. Be responsible for delays and expenses caused by rejection.

11 MOCK UPS

11.1 Where required by Contract Documents construct, unless indicated herein, mock-ups of work on Site, in size and at location directed by Consultant.

11.2 Construct mock-ups prior to start of affected work. Allow sufficient time for Consultant's review. Work affected by mock-ups may not commence prior to acceptance of mock-ups.

11.3 Construct mock-ups to include all related specified materials and workmanship. Make revisions as directed by Consultant, in accordance with the intent of the Contract Documents, until mock-ups are acceptable.

11.4 Mock-ups, reviewed and accepted by Consultant, shall become the standard of quality against which installed work will be measured.

11.5 Mock-ups, by prior arrangement, may be incorporated into finished work if approved by Consultant only.

12 DOCUMENTS ON SITE

12.1 Maintain at job site, one copy of each of the following:

- .1 Contract Documents including Drawings, Specifications, Addenda, and other modifications to the Contract.
- .2 'Reviewed' or 'Reviewed as Modified' Shop Drawings.

.3 Project Construction and Shop Drawing Schedules.

.4 Site Instructions and Change Orders.

.5 Field Test Reports.

.6 Reports by Authorities having Jurisdiction.

.7 Building and other applicable permits.

.8 Daily log including:
- .1 Weather conditions.
- .2 Excavation conditions
- .3 Start and finish date of each Trade Contractor.
- .4 Erection and removal dates of formwork.
- .5 Date, quantities and particulars of each concrete pour.
- .6 Dates and quantities and particulars of roofing and waterproofing work.
- .7 Visits to the Site by Owner, Consultants, Jurisdictional Authorities, Testing and Inspection companies, and material and equipment supplier representatives.

.9 Material Safety Data Sheet pursuant to WHMIS (Occupational Health & Safety Act).

.10 As-built drawings recording as-built conditions, instructions, changes for structure, equipment, wiring, plumbing, etc., as called for in Section 01 78 39 and Divisions 22 and 26, prior to being concealed.

.11 Copies of applicable codes.

12.2 The above material shall be made available to the Consultant at their request.

13 **BUILDING ENVELOPE**

13.1 Requirements specified herein apply to all elements of the exterior building envelope.

13.2 Continuity of air barrier/vapour retarder and insulation components is critical and must be maintained at all locations. Where different systems meet, ensure proper interface and continuity between adjacent components by implementing suitable construction sequences and by using compatible materials only.

13.3 Anchor exterior cladding components to structure in manner suitable to accommodate structural deflection and creep and to withstand loads from expected temperature gradients. Design anchorage to withstand expected wind loads, positive and negative, in accordance with applicable regulations.

13.4 Ensure that air spaces within exterior building components are firestopped in accordance with applicable regulations.

13.5 Ensure that air spaces on the outside of vertical air barrier/vapour retarder (walls) and window systems are constructed with adequate drainage provisions to the exterior.

13.6 Owner may complete a thermographic scan upon completion of the building envelope. Contractor will be responsible to correct identified thermal anomalies.

14 **DRAINAGE**

14.1 Layout and construct work to ensure that positive drainage is provided to floor drains, ditches, site drains and catch basins, as set in their final position, preventing undrained areas and ponding.

14.2 Ensure that allowable construction tolerances and structural deflection do not cause ponding of water.

14.3 Report to Consultant in writing prior to executing work affected, in case adequate drainage cannot be provided.

END OF SECTION

1 **GENERAL**

1.1 Provide Labour, Products, equipment, services, tools and Supervision to ensure that Work complies with minimum acceptable standards of materials and performance of Work in accordance with codes and standards referenced in the Specification.

1.2 Consider contract forms, codes, Specifications, standards, manuals, and installation and application instructions referred to in these specifications to be the latest published editions at the date of submission of the bid unless otherwise stated in the Specifications or otherwise required by the authorities having jurisdiction.

2 **BY-LAWS, PERMITS, AND FEES**

2.1 The Building Code - Ontario Regulation 332/12, including all amendments, shall govern the construction of the Work.

2.2 Comply with all By-Laws and regulations of authorities having jurisdiction. These codes and regulations constitute an integral part of the Contract Documents.

2.3 Owner shall apply and pay for Municipal Building Permit, and Contractor shall obtain and pay for all other permits, licenses, deposits, and certificates of inspection as part of the Contract Price as per Conditions of the Contract. Ensure that permits, licenses, deposits, and certificates included under specific Sections are provided as specified.

2.4 If required, pay for construction damage deposit required by authorities having jurisdiction.

2.5 Where permits, licences, and inspection fees are required by authorities having jurisdiction for specific trade functions, they shall be obtained by particular subtrade responsible for that work.

2.6 Arrange for inspection, testing of Work and acceptance required by the authorities having jurisdiction. Be responsible for necessary preparations, provisions and pay all associated costs.

2.7 Be responsible for ensuring that no work is undertaken which is conditional on permits, approvals, reviews, licences, fees, until all applicable conditions are met. No time extension will be allowed for delay in obtaining necessary permits.

2.8 Any additional work or changes to the materials due to Work not complying with the Ontario Building Code and Regulations as indicated by the Building Inspector shall be changed. All costs involved shall be borne by Contractor.

2.9 Obtain permit required to work on Municipal rights of way. Provide damage deposits for sidewalks, roads and services work, as applicable.

2.10 Give notice of completion of project prior to occupancy, as required by applicable legislation.

3 **EXISTING PUBLIC SERVICE LINES**

3.1 Where existing public services are indicated to be removed and/or relocated, perform Work in compliance with authorities having jurisdiction.

3.2 Make good public roads, walkways and curbs soiled or damaged due to construction to the requirements of local authorities.

4 **CODES**

4.1 Reference is made to standards in the specifications to establish minimum acceptable standards of materials, products and workmanship. Ensure that materials, products and workmanship meet or exceed requirements of the reference standards specified.

4.2 In the event of conflict between documents specified herein, execute the Work in accordance with the most stringent requirements.

5 **STANDARDS**

5.1 Where a material or product is specified in conjunction with a referenced standard, do not supply the material or product if it does not meet the requirements of the standard. Supply another specified material or product, or an acceptable material or product of other approved manufacture which does meet the requirements of the standard, at no additional cost to the Owner.

5.2 Where no standard is referred to, provide materials, products and workmanship which meet requirements of the applicable standards of the Canadian Standards Association, Canadian General Standards Board, Ontario Provincial standard specifications (OPSS), Ontario Provincial Standard Drawings (OPSD) and the applicable building code. References to "Measurement for Payment" and "Basis of Payment" in OPSS standard documents are not applicable to this Contract.

5.3 If there is question as to whether a material, product or system is in conformance with applicable standards, the Consultant reserves the right to have such materials, products or systems tested to prove or disprove conformance. The cost for such testing will be paid by the Owner in the event of conformance with contract Documents or by the Contractor in the event of non-conformance.

5.4 Where application, installation and workmanship standards are cited, it is intended that referenced standards form the basis for minimum requirements of the specified item and specifications supplement the standards unless specified otherwise.

5.5 Matters may be dealt with in part by these specifications which are also dealt with, under the same or similar headings in cited standard. It is not intended that these specifications take the place of the standards but supplement them, unless specified otherwise.

5.6 Where reference is made to manufacturer's directions, instructions or specifications they shall include full information on storing, handling, preparing, mixing, installing, erecting, applying, or other matters concerning the materials pertinent to their use and their relationship to materials with which they are incorporated.

5.7 Where standards, specifications, associations, and regulatory bodies are listed in the Specifications by their abbreviated designations. These are but not limited to the following:

AA	The Aluminum Association
AAMA	Architectural Aluminum Manufacturers Association
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AFBMA	Anti-Friction Bearing Manufacturer's Association
AIEE	American Institute of Electrical Engineers
AISI	American Iron and Steel Institute
AMCA	Air Movement and Control Association
AMEU	Association of Municipal Electric Utilities
ANSI	American National Standards Institute
ARI	Air-Conditioning and Refrigeration Institute
ASA	American Standards Association
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing and Materials
AWMAC	Architectural Woodwork Manufacturers Association of Canada
AWWA	American Water Works Association
CEMA	Canadian Electrical Manufacturer's Association
CGA	Canadian Gas Association
CGSB	Canadian General Standards Board
CISC	Canadian Institute of Steel Construction
CMHC	Canadian Mortgage and Housing Corporation
CMPA	Canadian Paint Manufacturers Association
COFI	Council of Forest Industries of British Columbia
CRCA	Canadian Roofing Contractors Association
CSA	Canadian Standards Association
CSSBI	Canadian Sheet Steel Building Institute
CWB	Canadian Welding Bureau
CWC	Canadian Wood Council
EEMAC	Electrical and Electronic Manufacturers Association Canada
FM	Factory Mutual
IEEE	Institute of Electrical and Electronic Engineers
MFMA	Maple Flooring Manufacturers Association
MIL	Military Standards
MSS	Manufacturer's Standardization Society
MTO	Ministry of Transportation Ontario
NAAMM	National Association of Architectural Metal Manufacturers
NFPA	National Fire Protection Association

NEMA	National Electrical Manufacturer's Association (U.S.A.)
NLGA	National Lumber Grades Authority
NRC	National Research Council of Canada
OCBA	Ontario Concrete Block Association
OHESC	Ontario Hydro Electrical Safety Code
OPSS	Ontario Provincial Standard Specification
PEI	Porcelain Enamel Institute
PDI	Plumbing Drainage Institute
PHA	Public Health Act
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SSPC	Steel Structures Painting Council
TEMA	Tubular Exchange Manufacturer's Association
TTMAC	Terrazzo, Tile and Marble Association of Canada
UL	Underwriters Laboratories Inc. (U.S.)
ULC	Underwriters Laboratories of Canada

6 FIRE RATINGS, ASSEMBLIES AND SEPARATIONS

6.1 Where a material, component, assembly, or separation is required to be fire rated, the fire rating shall be as determined or listed by one of the following testing authorities acceptable to the authorities having jurisdiction:

.1 Underwriters' Laboratories of Canada.

.2 Underwriters' Laboratories Inc.

.3 Factory Mutual Laboratories.

.4 The National Research Council of Canada.

.5 The National Board of Fire Underwriters.

.6 Intertek Testing Services.

6.2 Where reference is made to only one testing authority an equivalent fire rating as determined or listed by another of the aforementioned testing authorities is acceptable if approved by authorities having jurisdiction. Obtain and submit such approval of authorities, in writing when requesting acceptance of a proposed equivalent rating or test design.

6.3 Fire rated door assemblies shall include doors, frame, anchors, and hardware and shall bear label of fire rating authority showing opening classification and rating.

6.4 Material having a fire hazard classification shall be applied or installed in accordance with fire rating authorities printed instructions.

6.5 Fire rated assemblies shall be constructed in accordance with applicable fire test report information issued by fire rating authority. Deviation from fire test report will not be allowed.

6.6 Construct fire separations as continuous, uninterrupted elements except for permitted openings. Extend fire rated walls and partitions from floor to underside of structural deck above.

6.7 Fire separations may be pierced by openings for electrical and similar service outlets provided such boxes are non-combustible and are tightly fitted and sealed with a ULC approved sealant for the assembly being sealed.

6.8 Construction that abuts on or is supported by a non-combustible fire separation shall be constructed so that its collapse under fire conditions will not cause the collapse of the fire separation.

6.9 Do not use combustible members, fastenings, attachments and similar items to anchor electrical, mechanical or other fixtures to fire separations.

6.10 At penetration through fire rated walls, ceilings or floors, completely seal voids with ULC approved firestopping material; full thickness of the construction element. In locations that require a smoke seal, provide appropriate ULC approved system installed in accordance with the manufacturer's recommendations.

END OF SECTION

1 TEMPORARY CONTROLS

1.1 Hoarding, fencing and barriers:

.1 Before commencing operations, supply, erect and maintain hoarding around entire perimeter of construction area as required. Paint outside of hoarding in a colour selected by the Consultant and mark with "POST NO BILLS" signs.

.2 Before commencing operations, supply, erect and maintain chain link fence 1800 mm high around entire perimeter of Site to protect public and private property from injury or damage.

.3 Provide temporary enclosures as required to protect the existing building where remedial work is occurring in its entirety or in its parts, against the elements, to maintain environmental conditions required for work within the enclosure, and to prevent damage to materials stored within and to protect the overall construction site.

.4 Provide lockable gates through hoarding, fencing, and barriers for access to Site by workers and vehicles.

1.2 Prevent unauthorized entry to the Site. Barricade, guard or lock access points to the satisfaction of the Consultant and post "NO TRESPASSING" signs.

1.3 Provide hoarding, barriers and covered walkways required by governing authorities for public safety, public rights-of-way and for access to the existing building.

1.4 Provide temporary exterior and/or interior barrier free ramps/guardrails/handrails as required to permit public access to existing complex functions.

1.5 Install signs for movement of people around Work Site as required and directed by the Consultant.

1.6 Provide secure, rigid guide rails and barricades around deep excavations, open shafts, open stair wells, open edges of floors and roofs as required for protection of Work, workers, and the public.

1.7 Remove hoarding, fencing, barriers, existing building enclosures, guide rails and barricades upon Total Performance of the Work unless otherwise noted on the Contract Drawings or as directed by the Consultant.

2 SERVICE AND UTILITY SYSTEMS

2.1 Consult with utility companies and other authorities having jurisdiction to ascertain the locations of existing services on or adjacent to site.

2.2 Information as to the location of existing services, if shown on the Drawings, does not relieve the Contractor of his responsibility to determine the exact number and location of existing services.

2.3 Give proper notices for new services as may be required. Make arrangements with authorities and utilities for service connections required.

2.4 Pay any charges levied by utilities or authorities for work carried out by them in connection with this Contract, unless specified otherwise.

2.5 Operate and maintain all utility systems affected by work of this Contract, until the existing building or specific portions thereof have been accepted by the Owner.

2.6 Report existing unknown services encountered during excavation to Consultant for instructions; cut back and cap or plug unused services. Be responsible for the protection of all active services encountered and for repair of such services if damaged.

3 SCAFFOLDING, HOISTS AND CRANES

3.1 Select, operate, and maintain scaffolding, hoisting equipment and cranes as may be required.

3.2 Do not erect or operate equipment that will endanger existing structures, local municipalities hydro installations, or traffic signals.

3.3 Design and construct scaffolding in accordance with CAN/CSA S269.2-M.

4 TEMPORARY WORKS

4.1 Installation and Removal: Provide temporary utilities, facilities and controls in order to execute the Work expeditiously. Remove from Site all such Work after use.

4.2 Arrange for connections with Owner and pay all costs for installation, maintenance and removal.

4.3 Be responsible for the careful and reasonable use of Owner supplied water and power.

4.4 Temporary Power and Lighting Systems:

.1 Supply, install and maintain electrical power and necessary electrical equipment including overhead and underground feeders, transformers, motors, starters, panels, protective devices and equipment. Connections will be made available to any part of the Work within distance of a 30 m extension.

.2 Provide temporary lighting inside and outside structure of adequate intensity to illuminate construction activities. Provide temporary pedestrian lighting for sidewalk areas affected by the Work.

.3 Supply and install the type and quantity of minimum lighting equipment in each location to ensure adequate, continual illumination 24 hours per day, 7 days per week for the following:

.1 Emergency evacuation, safety and security throughout the Project at intensity levels required by jurisdictional authorities.

.2 General lighting for performance of the Work throughout the Project, evenly distributed, and at intensities to ensure that proper installations and applications are achieved.

.3 Performance of finishing trades in area as required evenly distributed, and of an intensity of at least 50 Lux.

.4 In locations approved by the Consultant. install and support the electrical plant, distribution and temporary lighting systems including service equipment and local hydro authority meter energized by the local hydro circuits. Installations shall be approved by the Consultant and shall be carried out in a neat manner to avoid interference with the application of finish material and to facilitate removal when the installed permanent lighting system is in operation.

.5 Make all necessary arrangements for and pay all costs for a temporary electrical service of sufficient capacity to supply temporary lighting, operation of power tools, cranes and equipment for all construction, implementation, and inspection and testing purposes. Supply and install necessary temporary cables and other electrical equipment and make all temporary connections as required.

.6 Temporary power distribution wiring shall comply with Ontario Hydro Electrical Safety Code. Obtain inspection certificates for temporary electrical work.

.7 Maintain the lighting systems in operation during the life of the Contract. Replace burned or missing lamps immediately.

.8 Upon Total Performance of the Work, remove electrical plant and temporary lighting from the Site.

4.5 Water supply:

.1 Provide and pay for a continuous supply of potable water for construction use. Provide as a minimum one water connection on each floor level.

.2 Provide and maintain all temporary lines, extensions and hoses as required. Remove all temporary connections and lines on completion of the Work and make good any damage.

4.6 Temporary Heating:

.1 Provide temporary heating required during construction period, including attendance, maintenance and fuel.

.2 Construction heaters used inside buildings must be vented to the outside or be flame less type. Solid fuel salamanders are not permitted.

.3 Maintain temperatures of minimum 10°C in areas where construction is in progress unless otherwise indicated in the Contract Documents. Protect exposed and adjacent services from freezing. Repair at no cost to the Owner any such services, buildings or other utilities disrupted by freezing.

.4 Ventilate heated areas and keep structures free from exhaust combustion gases.

.5 The permanent heating system of the building or portions thereof may be used when available only upon written permission by Consultant. If permission to use heating system is obtained:

.1 Before using air handling systems, ensure that dust/debris is removed from the premises and install temporary filters to prevent construction dust/debris from entering via return air or intake openings. keep unused ducts sealed to prevent entry of dust/debris. Replace filters frequently during construction.

.2 On competition of work remove temporary filters and install new filters in accordance with Division 23. After temporary use of air handling system is complete and before turning over system to Owner, vacuum internally to ensure all dust/debris is removed.

4.7 Temporary telephone and facsimile: Provide and pay for separate telephones and facsimile services, for local call only, as required for own use and use of the Consultant and Owner. Long distance call shall be paid by party making call.

4.8 Sanitary facilities: Provide sanitary facilities in accordance with occupational health and safety requirements in the place of the Work. Use of Owner's existing sanitary facilities on site is allowed.

5 PROTECTION

5.1 Protect surrounding property from damage during performance of the Work.

5.2 Take all necessary precautions to prevent damage to work affected by temperature, water, weather and other environmental conditions.

5.3 Protection of building finishes and equipment:

.1 Provide protection for existing structure, finished and partially finished building finishes, waterproofing systems, and equipment during performance of the Work.

.2 Cover Owner's equipment and plant within the Site with 6 mil PVC sheet, or equal, taped to make it dust-tight. Equipment and existing work moved or altered to facilitate construction, movement of Products or equipment shall be stored, protected with dust-tight covers and subsequently returned to its original location.

.3 Obtain approval from the Consultant prior to the installation of temporary supporting devices into existing roof, ceiling, or wall members for the erecting of equipment or machinery. Repair roof, ceiling, and wall members used for this purpose to the satisfaction of the Consultant.

.4 Provide necessary screens, covers and hoarding as required.

.5 Provide temporary weather tight, dust tight, and lockable partitions within the building where work is performed. Provide weather tight closures to unfinished door and window openings, and other openings in roofs.

.6 Any Products or equipment damaged while carrying out the Work shall be restored with new Products or equipment matching the original equipment. Damage shall include harm resulting from all construction work, such as falling objects, wheel and foot traffic, failure to remove debris, operation of machinery and equipment, and scaffolding and hoisting operations.

.7 Protect finished surfaces of new work from damage by restriction of access or by use of physical means suitable to the material and surface location. Where construction operations must be performed or traffic routed over finished floors, lay 6 mm plywood coverings tightly fitted and secured over surface in such areas.

5.4 Fire Protection:

.1 Take precautions to prevent fires. Provide and maintain temporary fire protection equipment of a type appropriate to the hazard anticipated in accordance with authorities having jurisdiction, governing codes, regulations, by-laws and to the satisfaction of the Consultant and insurance authorities.

.2 Excessive storage of flammable liquids and other hazardous materials is not allowed on Site. Flammable liquids must be handled in approved containers. Remove combustible wastes frequently.

.3 Inspect temporary wiring, drop cords, extension cables for defective insulation or connections frequently.

.4 Open burning of rubbish is not permitted on the Site.

.5 Handle, transport, store, use and dispose of gasoline, benzine or other flammable materials with good and safe practice as required by authorities having jurisdiction.

.6 Provide fire extinguishers of the non-freezing chemical type in each temporary building, enclosure and trailer. Use only fire-proofed tarpaulins.

.7 A fire watch shall be required for each of the following activities regardless of the number, duration or size of the activity in operation:
.1 any open flame activities(e.g., soldering and welding);
.2 shutdown of fire detection system;
.3 shutdown of sprinkler system.

5.5 Maintain adequate cover over services as required by Utility Authorities.

5.6 Report any discharge of a contaminant to the Authorities having jurisdiction.

6 **PEST CONTROL**

6.1 Be responsible to provide control measures, restraining procedures, and treatments to prevent infestation and spread of insects, rodents and other pests deemed to be present at Site and/or noticed during course of the Work. Carry out fumigation, pest control procedure, and posting of warning signs, notices including contents of such notices in accordance with requirements of Pesticides Act and any other authorities having jurisdictions. Pesticides used shall be in accordance with Canada Pest Control Products Act, and provincial and municipal regulations.

7 **FIRST-AID FACILITIES**

7.1 Provide site equipment and medical facilities necessary to supply first-aid service to injured personnel in accordance with regulations of the Workmen's Compensation Act. Maintain facilities for duration of Contract.

8 **USE OF NEW PERMANENT SERVICE & EQUIPMENT**

8.1 Do not use any new permanent service or equipment without Owner's written approval.

8.2 Where permission is granted to use permanent services and equipment provide competent persons to operate services and equipment; inspect frequently and maintain facilities in proper operating condition at all times.

8.3 Permanent services and equipment shall be turned over to Owner in "as new" and perfect operating condition.

8.4 Use of permanent systems and equipment as temporary facilities shall not affect the warranty conditions and warranty period for such systems and equipment. Make due allowance to ensure that Owner will receive full benefits of equipment manufacturers warranty after project takeover.

9 **PROJECT IDENTIFICATION**

9.1 If required, obtain approvals from jurisdictional authorities for temporary signs.

9.2 Do not display signs without the Consultant's and Owners written consent.

9.3 Maintain signs in good condition for the duration of Contract.

10 **SITE MAINTENANCE**

10.1 Maintain the Site and adjacent premises in a clean and orderly condition, free from debris and other objectionable matter. Immediately remove rubbish and surplus Products, equipment and structures from the Site. If the Site is not cleaned (within 48 hours after the Contractor has been instructed to do so), the Consultant may clean the Site and retain the cost from monies due, or to become due, to the Contractor.

10.2 When the Work is substantially performed, remove surplus Products, tools, construction machinery and equipment not required for the performance of the remaining Work.

11 SITE STORAGE AND OVER LOADING

11.1 Confine the Work and operations of employees to limits indicated by the Contract Documents. Do not unreasonably encumber the Site with Products.

11.2 Products shall be stored only in areas designated or approved by the Consultant, and shall not be left lying on streets, sidewalks, boulevards or elsewhere within public view. Products which the Consultant may permit to be stored elsewhere than in the Contractor's storage areas shall be neatly stacked or otherwise disposed and shall be so maintained.

11.3 Fabrication shops shall not be set up within the structure except as directed by or with the permission of the Consultant.

11.4 Do not load or permit to be loaded any part of the Work with a weight or force that it is not calculated to bear safely. Be solely responsible and liable for damages resulting from violation of this requirement. Provide temporary supports as strong as permanent support.

11.5 Do not cut, drill or sleeve load bearing members unless shown on drawings or otherwise approved by the Consultant in writing for each location.

11.6 Site storage and loading requirements to be in accordance with the Ontario Occupational Health and Safety Act and Regulations for Construction Projects.

12 PUBLIC CONVENIENCE AND SAFETY

12.1 Promptly remove ice and snow from walkways surround the construction area.

12.2 Keep haul routes free at all times from Products spilled on street surfaces and clean streets of deposits due to performance of the Work to the satisfaction of the Consultant and street authorities. Clean streets within 24 hours of Consultant's instruction.

12.3 The Consultant may inspect haul routes, the Site and adjacent premises daily and may halt operations, withhold payment or carry out such additional operations as necessary, deducting the cost from monies due, or to become due, to the Contractor.

13 ACCESS AND EGRESS TO SITE

13.1 Where construction requirements demand, construct access roads capable of withstanding construction equipment and haul traffic. Maintain access roads in good condition at all times. Remove access roads prior to completion of the Work unless otherwise noted and restore area as shown on the Contract Drawings.

14 **PUBLIC TRAFFIC FLOW**

14.1 Provide and maintain flag persons, Police Officers, traffic signals, barricades and illumination as required by Authorities having jurisdiction and/or as necessary to perform the Work and protect the public.

15 **PUBLIC UTILITIES AND SERVICES**

15.1 Verify limitations imposed on project work by presence of utilities and services, and ensure no damage occurs to them.

15.2 Notify service authorities concerned so that they protect, remove, relocate, or discontinue them, as they may require.

15.3 Make arrangements and pay for connection charges for services required for project work.

15.4 Locate poles, pipes, conduit, wires, fill pipes, vents, regulators, meters, and sanitary services work in inconspicuous locations. If not shown on Drawings, verify location of service work with Consultant before commencing installation.

16 **ROADS, CURBS, GUTTERS, AND WALKS**

16.1 Include all curb cuts and making good of existing curbs, walks and paving on Municipal property to provide fully paved and finished approaches to requirements of authorities having jurisdiction.

17 **CONSTRUCTION PARKING**

17.1 Parking will be permitted on Site in location as permitted by the Owner and provided it does not disrupt the performance of Work, Site safety or the movement of vehicular or pedestrian traffic and is acceptable to the Consultant.

18 **SITE VISITORS**

18.1 During the progress of the Work, afford access to visitors duly authorized by the Consultant and facilitate inspections or tests they may desire to make. Record site visitors in log book maintained on site.

18.2 Ensure construction site visitors wear appropriate safety apparel.

19 **EROSION AND SEDIMENTATION CONTROL**

19.1 Refer to Section 31 25 00 for erosion and sedimentation control requirements for Work of this Project.

19.2 Conform to sedimentation and erosion control requirements of the local Conservation Authority and authorities having jurisdiction.

19.3 Prevent tracking of mud and dirt from site onto paved roads. Provide stabilized vehicle access/egress points, constructed of coarse granular material. Place additional granular material as required to maintain access/egress points in proper working order. Clean mud and dirt from paved roads at end of each day by shoveling or sweeping and subsequent washing. Dispose of mud dirt in a controlled disposal area.

20 TEMPORARY DRAINAGE AND DEWATERING

20.1 Drainage lines and gutters shall be kept open at all times. No flow of water shall be directed across or over pavements except through pipes or properly constructed troughs. Keep all portions of Work properly and efficiently drained during construction and until completion. Be responsible for all disturbances, dirt and damage which may be caused by or result from water backing up or flowing over, through, from or along any part of Work, or due to operations which may cause water to flow elsewhere.

20.2 Keep trenches and other excavations free of water at all times. Employ adequate means to remove water in a manner that will prevent loss of soil, and maintain the stability of excavation.

20.3 Dispose of such water in a manner that will not be dangerous to public health, private property or to any portion of Work completed or under construction, nor which causes an impediment to the use of streets by the public.

20.4 Drainage of trenches or other excavation through newly laid storm drainage pipe will be allowed only with the express permission of the authority having jurisdiction.

20.5 When drainage is directed to existing catch basins, regularly inspect and clean such catch basins of debris and sediment.

21 SNOW REMOVAL

21.1 Allow no accumulation of ice and snow on Site, and on roof deck when roofing operations are scheduled to take place.

21.2 Remove snow from access road, Site circulation paths and elsewhere as required to permit access to Work, parking and uninterrupted construction progress.

22 POLLUTION (DUST, DEBRIS, AND NOISE) CONTROL

22.1 Cover or wet down dry materials and rubbish to prevent blowing dust and debris. Provide dust control for temporary roads.

22.2 Keep premises free of waste material.

22.3 Arrange and pay for removal of all waste generated by the work in manner acceptable to authorities having jurisdiction.

22.4 Limit noise levels in accordance with requirements of authorities having jurisdiction.

22.5 Maintain temporary erosion and pollution control features installed under this contract.

22.6 Control emissions from equipment and plant to local authorities emission requirements.

22.7 Prevent abrasive-blasting and other extraneous materials from contaminating air beyond application area, by providing temporary enclosures.

23 **TREE PROTECTION**

23.1 Within Contractor's assigned work and storage areas and adjacent to designated access routes, protect existing trees and other plants scheduled to remain. Provide minimum 1.8 m high chain link fencing outside of dripline of trees or groups of trees and other plants.

23.2 Leave fenced areas undisturbed; do not use areas for storage, stockpiling or any other purpose. Do not dump or flush any contaminants in areas of tree feeder roots.

23.3 Do not attach rigging cables to trees.

23.4 Where limbs or portions of plants are required to be removed to accommodate new work, they shall be removed in accordance with accepted arboricultural practice.

23.5 Where root systems of protected trees adjacent to construction are exposed or damaged, they shall be neatly trimmed and the area backfilled with suitable material to prevent desiccation.

23.6 Where necessary give plants an overall pruning to restore the balance between roots and top growth and/or to restore appearance.

23.7 Except at locations where specific procedures are included in Contract Documents do not alter grades around existing trees/plants without first obtaining Consultant's consent and directions.

END OF SECTION

1 SPECIFIED PRODUCTS

1.1 Work of this Contract is based on Products specified by:

.1 Manufacturer's catalogued trade names and/or;

.2 References to standards (i.e. CAN, CGSB, CSA, ASTM) or;

.3 Prescriptive Specifications or;

.4 Performance Specifications.

1.2 When one or more manufacturer's trade name is specified for a Product, any one of the specified Products will be acceptable. Products by other manufacturers are subject to the Consultant's acceptance as an equivalent substitution in accordance with the specified requirements of substitutions.

1.3 When more than one manufacturer's catalogued trade name Product is specified along with a referenced standard, any one of the specified Products will be acceptable on condition the Product complies with the referenced standard.

1.4 When a Product is specified by reference to a standard only, the Contractor may select any Product that meets or exceeds the specified standard for the intended purpose. The onus shall be on the Contractor to establish that such Products meet the reference standard requirements. Products exceeding minimum requirements established by reference standards will be accepted for the Work if such Products are compatible with the Work with which they are incorporated.

1.5 When a Product is specified by prescriptive or performance Specification, any Product meeting or exceeding the Specification will be accepted.

1.6 When a Product is specified by reference to a standard or by prescriptive or performance Specification, upon request of the Consultant, obtain from the manufacturer, an independent testing laboratory report showing that the Product meets or exceeds the specified requirements.

1.7 Unless otherwise indicated in the Specifications, maintain uniformity of manufacture for any particular or like item throughout the Work.

2 SUBSTITUTIONS

2.1 Requests for substitutions will not be accepted prior to the Notification of Award. Substitutions will be considered by the Consultant provided that:

.1 The proposed substitutions have been investigated and complete data are submitted which clearly includes highlighting all aspects that meet the specifications. Consultant will only review data submitted. Incomplete data will be grounds for non-acceptance.

.2 Data relating to changes in the Contract Schedule, if any, and relation to other Work have been submitted.

.3 Same warranty is given for the substitution as for the original Product specified.

.4 All claims are waived for additional costs related to the substitution which may subsequently arise.

.5 Installation of the accepted substitution is co-ordinated into the Work and that full responsibility is assumed when substitutions affect other work. Make any necessary changes required to complete the Work. Revisions to the drawings for incorporation of the substitutions shall be made by the Consultant and all costs associated with the revisions shall be borne by the Contractor.

2.2 Substitutions to methods or processes described in the Specifications or drawings, may be proposed for the consideration of the Consultant. Ensure that such substitutions are in accordance with the following requirements:

.1 Time spent by the Consultant in evaluating the substitution shall not be the basis for a claim by the Contractor for extensions to the Contract Time.

.2 Clearly indicate how the proposed substitutions would be advantageous to the Owner or in the opinion of the Contractor would improve the operation of the installation.

.3 Be responsible for substitutions to methods or processes concerning such Work and ensure that the warranty covering all parts of the Work will not be affected.

.4 The cost of all changes in the work of Other Contractors, necessitated by the substituted methods or processes, if accepted, is borne by the Contractor.

.5 The substituted methods or processes fit into space allotted for the specified methods or processes. Revisions to the drawings for incorporation of the substitutions shall be made by the Consultant and all costs associated with the revisions shall be borne by the Contractor.

2.3 Substitutions will not be considered if:

.1 They are indicated or implied on shop drawings or Product data without formal request.

.2 Acceptance will require substantial revision of the Specifications and Drawings.

2.4 Do not substitute Products or methods or processes into the Work unless such substitutions have been specifically approved for the Work by the Consultant.

2.5 Approved substituted Products shall be subject to the Consultant's inspection and testing procedures. Approved substituted Products shall only be installed after receipt of the Consultant's written approval.

2.6 The Contract Price will be adjusted accordingly to any and all credits arising from the substitutions mentioned above.

3 APPROVAL OF PRODUCTS AND INSTALLATION METHODS

3.1 Wherever in the Specifications it is specified that Products and installation methods shall meet approval of Authorities having Jurisdiction, underwriters, the Consultant, or others, such approval shall be in writing.

4 PRODUCT DELIVERY CONTROL

4.1 It is the responsibility of the Contractor to ensure that the supplier or distributor of materials specified or alternatives accepted, which he intends to use, has materials on the site when required. The Contractor shall obtain confirmed delivery dates from the supplier.

4.2 The Contractor shall contact the Consultant immediately upon receipt of information indicating that any material or item, will not be available on time, in accordance with the original schedule, and similarly it shall be the responsibility of all subcontractors and suppliers to so inform the Contractor.

4.3 The Consultant reserves the right to receive from the Contractor at any time, upon request, copies of actual purchase or work orders of any material or products to be supplied for the work.

4.4 If materials and products have not been placed on order, the Consultant may instruct such items to be placed on order, if direct communication in writing from the manufacturer or prime suppliers is not available indicating that delivery of said material will be made in sufficient time for the orderly completion of the Work.

4.5 The Consultant's review of purchase orders or other related documentation shall in no way release the Contractor, or his subcontractors and suppliers from their responsibility for ensuring the timely ordering of all materials and items required, including the necessary expediting, to complete the work as scheduled in accordance with the Contract Documents.

4.6 In the event of failure to notify the Consultant at commencement of Work and should it subsequently appear that Work may be delayed for such reason, the Consultant reserves the right to direct the Contractor to take the following measures at no increase in Contract Price:

.1 Substitute more readily available Products of similar or better quality and character, or

.2 Temporarily install another Product until such time as the specified Product becomes available, at which time the temporarily installed product shall be removed and the specified Product installed.

5 TRADEMARKS AND LABELS

5.1 Permanent labels, trademarks and nameplates on Products are not acceptable in the finished Work, except where required by authorities having jurisdiction, for operating instructions, or when located in service rooms.

5.2 Remove trademarks and labels by grinding, if necessary, painting out where the particular surface is being painted, or if on plated parts, replace with new plain plated or non-ferrous metal parts.

6 DELIVERY, STORAGE, HANDLING AND PROTECTION

6.1 Be responsible for handling and delivery of Products. Protect Products from damage during handling, storage and installation. Deliver store and handle items in accordance with manufacturer's instructions and as specified. Be responsible for all costs of delivery, loading and off-loading, and for transportation back to its origin for correction, if required, due to damage or defect. Reject materials and Products delivered to the Site which are damaged.

6.2 Manufacture, pack, ship, deliver, and handle Products so that no damage occurs to structural qualities and finish appearance, nor in any other way which is detrimental to their function and appearance.

6.3 Ensure that Products, while transported, are not exposed to an environment which would increase their moisture content beyond the maximum specified.

6.4 Organize delivery of materials, Products and equipment to, and removal of debris and equipment from, the site and surrounding property.

6.5 Schedule early delivery of Products to enable Work to be executed without delay. Before delivery, arrange for receiving at the Place of the Work.

6.6 Coordinate mechanical and electrical equipment and apparatus deliveries with the manufacturer's and suppliers such that equipment and apparatus is delivered to the site when it is required, or so that it can be stored within the building and protected from the elements.

6.7 Shop assemble work for delivery to site in size easily handled and to ensure passage through building openings.

6.8 Deliver packaged Products, in original unopened wrapping or containers, with manufacturer's seals and labels intact.

6.9 Label packaged products to describe contents, quantity, and other information as specified.

6.10 Labels attesting that materials conform to specified reference standards will be acceptable as verification that contents meet specified requirements. In the absence of labels, submit affidavits to validate conformance of Product to reference standards, as requested by the Consultant.

6.11 Label fire-rated Products to indicate Underwriters' Laboratories approval.

6.12 Handle and store materials and products in such a manner that no damage is caused to the materials and products, the Work, the site and surrounding property.

6.13 Do not obstruct or disrupt local traffic flow during construction period.

6.14 Allocate an area within the limits of the Work acceptable to the Owner for storage of Products brought to the site by all trades. Keep storage area tidy at all times and do not use other parts of he property for storage. Arrange and pay for off-site storage when required.

6.15 Locate products on site in a manner to cause minimal interference with the Work and building activities of the existing building where remedial work is occurring.

6.16 Store Products off the ground, in a manner to prevent damage, adulteration, deterioration and soiling to the Products, other building components, assemblies, other products, the structure, the site and surrounding property, and in accordance with manufacturer's instructions when applicable.

6.17 Store packaged or bundled Products in original and undamaged condition complete with written application instructions. Keep manufacturer's seals and labels intact. Do not remove from packaging or bundling until required in the Work.

6.18 Do not place or store materials and Products in corridors, public areas, streets, lanes, passageways or similar locations.

6.19 Store Products so as not to create any overloading conditions to any part of the building, structure, falsework, form work and scaffolding.

6.20 Store Products subject to damage from weather in weatherproof enclosures.

6.21 Store cementitious Products clear of earth or concrete floors, and away from walls.

6.22 Keep sand, when used for grout or mortar materials, clean and dry. Store sand on wooden platforms and cover with waterproof tarpaulins during inclement weather.

6.23 Store sheet materials and lumber on flat, solid supports and keep clear of ground. Slope to shed moisture.

6.24 Store and handle flammable liquids and other hazardous materials in approved safety containers and as otherwise prescribed by safety authorities. Store no flammable liquids or other hazardous material in bulk within the Work.

6.25 Store and mix paints in a heated and ventilated room or area assigned for this purpose. Keep this room or area locked when unattended. Remove oily rags and other combustible debris from the Place of the Work daily. Take every precaution necessary to prevent spontaneous combustion.

6.26 Protect prefinished metal surfaces by protective coatings or wrappings until time of final cleanup specified in Section 01 74 00. Protection shall be easily removable under work of Section 01 74 00 without damage to finishes. Do not permit strippable tape or coatings to become baked on surfaces which they protect.

6.27 Touch-up damaged factory finished surfaces to Consultant's satisfaction. Use primer and paint to match original.

6.28 Protect glass and other finishes against heat, slag and weld splatter by provision of adequate shielding. Do not apply Visible markings to surfaces exposed to view in finished state or that receive transparent finishes.

6.29 Protect surfaces of completed work exposed to view from staining, disfigurement and all other damage by restriction of access or by use of physical means suitable of the material and surface location.

6.30 Adequately protect trowelled concrete floors from damage. Take special measure when moving heavy loads or equipment on them.

6.31 Keep finished concrete floors free from oils, grease or other material likely to damage or discolour them or affect bond of applied finishes. Once new building is enclosed, keep floors as dry as possible after curing.

6.32 Protect finished flooring from pedestrian traffic with reinforced kraft paper as a minimum, secured in place and with joints sealed by reinforced pressure sensitive tape. Maintain protection in place until Total Performance of the Work.

6.33 Protect finished flooring from continuing construction work and delivery of products with plywood panels of minimum 6 mm thickness with joints between panels sealed with reinforced pressure sensitive tape. Maintain protection in place until work and deliveries are complete.

6.34 Make good or replace damaged materials to the satisfaction of the Consultant.

6.35 Hazardous Materials Information:

.1 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of hazardous materials; and regarding labelling and provision of material safety data sheets (MSDS) in accordance with jurisdictional authorities.

.2 Deliver copies of Material Safety Data Sheets (MSDS) to the Consultant on all Products intended for use in the Work and designated as a "controlled product."

7 MANUFACTURER'S INSTRUCTIONS

7.1 Unless otherwise indicated in the Specifications, fabricate, apply, connect, install, erect, use, clean, and condition Products in accordance with manufacturer's instructions except where more stringent requirements are specified. Do not rely on labels or enclosures provided with Products. Obtain written instructions directly from manufacturers.

7.2 Notify the Consultant in writing, of conflicts between the Specifications and manufacturer's instructions, so that the Consultant may establish the course of action. If requested, make a copy of those instructions available at the site.

7.3 In cases of improper installation or erection of Products, due to failure in complying with these requirements, the Consultant may direct removal and re-installation at no increase in Contract Price.

8 WORKMANSHIP

8.1 Workmanship shall be the best quality, executed by workers experienced and skilled in the respective duties for which they are employed. Immediately notify the Consultant if required Work is such as to make it impractical to produce required results.

8.2 Do not employ any unfit person or anyone unskilled in their required duties. The Consultant reserves the right to require the dismissal from the Place of the Work, workers deemed incompetent, careless, insubordinate or otherwise objectionable.

8.3 Decisions as to the quality or fitness of workmanship in cases of dispute rest solely with the Consultant, whose decision is final.

8.4 Give particular attention to finished dimensions and elevations of the Work. Make finished Work fit indicated spaces accurately. Make finished Work flush, plumb, true to lines and levels and accurate in all respects.

8.5 In finished areas, conceal pipes, ducts, conduit and wiring in floors, walls, ceilings, chases, or behind furring except where indicated otherwise.

8.6 Ensure that service poles, fill-pipes, vents, regulators, meters and similar service installations are located in inconspicuous locations. If not indicated on drawings, verify location of service installations with Consultant prior to commencing installation.

8.7 Ensure that integrity of fire separations is maintained where they are penetrated.

8.8 Finish access panels and doors to match adjacent wall and/or ceiling finish unless otherwise specified or indicated.

8.9 Keep surfaces, on which finished materials will be applied, free from grease, oil, and other contamination which would be detrimental in any way to the application of finish materials.

8.10 Enforce fire prevention methods at site. Do not permit fires, open flame heating devices or accumulation or debris. Use flammable materials only if all safety precautions are taken. Provide and maintain in working order ULC labelled fire extinguishers of types suitable for fire hazard in each case, and locate them in prominent location and to approval of jurisdictional authorities.

8.11 Where flammable materials are being applied, ensure that adequate ventilation is provided, spark-proof equipment is used, and smoking and open flames are prohibited.

9 **DIMENSIONS**

9.1 Check all dimensions at the site before fabrication and installation commences and report discrepancies to the Consultant.

9.2 Where dimensions are not available before fabrication commences, ensure that dimensions required are agreed upon between the parties concerned.

9.3 Prior to commencing work, ensure that clearances required by jurisdictional authorities can be maintained

9.4 Wall thicknesses and openings shown on the drawings may be nominal only; ascertain actual sizes at the site.

9.5 Verify dimensions of shop fabricated portions of the Work at the site before shop drawings and fabrications are commenced. The Owner will not accept claims for extra expense by reason of non-compliance with this requirement.

9.6 Fabricate and erect manufactured items, shop fabricated items, and items fabricated on or off site, to suit site dimensions and site conditions.

9.7 In areas where equipment is to be installed, check dimensional data on equipment to ensure that area and equipment dimensions are compatible with necessary access and clearance provided. Ensure that equipment supplied is dimensionally suitable for space provided.

9.8 The mechanical and electrical drawings are intended to show approximate locations of mechanical apparatus, fixtures, equipment, piping and duct runs, electrical apparatus, fixtures, outlets, equipment, units, and conduit in diagrammatic form and wherein the mechanical and electrical items are not dimensioned, consider their locations to be approximate. Check the drawings and confer with the Consultant to determine the actual locations of these items as may be required to suit aesthetic and site conditions. Such relocation shall be done without change to the Contract Price.

9.9 Leave areas clear where space is indicated to be reserved for future equipment, including access to such future equipment.

9.10 Whether shown on the Drawings or not, leave adequate space and provision for servicing of equipment and removal and reinstallation of replaceable items such as motors, coils and tubes.

10 **RELOCATION OF MECHANICAL AND ELECTRICAL ITEMS**

10.1 The Owner and the Consultant reserve the right to relocate outlets at a later date, but prior to installation, without additional cost to Owner, assuming that the relocation per outlet does not exceed 3000 mm from the original location. No credits will be anticipated where relocation per outlet of up to and including 3000 mm reduces materials, products and labour.

10.2 Should relocations per outlet exceed 3000 mm from the original location the Contract Price will be adjusted in accordance with the provisions for changes in the Contract Documents.

10.3 Alter the location of pipes and other equipment, without additional cost to the Owner, if approved, provided the change is made before installation.

10.4 Make necessary changes, due to lack of coordination, as required and when approved, at no additional cost, to accommodate structural and building conditions.

11 **EXPANSION, CONTRACTION, AND DEFLECTION**

11.1 Conform to manufacturer's recommended installation temperatures. If items, components, assemblies, systems, and finishes are installed at temperatures different from operation or service temperatures, make provisions for expansion and contraction in service as acceptable to manufacturer and consultant. Repair all resulting damage should expansion and contraction provisions provide inadequate.

11.2 Make provisions for expansion and contraction due to temperature changes within components, Products and assemblies, and between adjacent components, Products and assemblies, and due to building movements including but not limited to creep, column shortening, deflection, sway and twist. Ensure provisions for expansion, contraction and building movements prevent damages from occurring to and within components, Products and assemblies.

11.3 Make adequate allowance at wall and partition heads for deflection of the structure above. Determine requirements from Consultant where additional information is required. Where partitions butt to underside of floor assembly, or structural framing, the clearance shall be based on the span of the members supporting the floor or structural framing. In making such allowance use methods which maintain the integrity of the wall or partition as a sound, and/or fire barrier.

11.4 Make provisions in pipes, plenums, ducts and vessels containing air and fluids as is necessary to prevent damage due to fluid and air induced pressure, surges and vibrations, to pipes, plenums, ducts and vessels and to adjacent components, assemblies and construction to which pipes, ducts, plenums and vessels are attached or pass through.

12 DIELECTRIC SEPARATION

12.1 Ensure that a dielectric separator is provided in a permanent manner over entire contact surfaces to prevent electrolytic action (galvanic corrosion) between dissimilar materials. Similarly, prevent corrosion to aluminum in contact with alkaline materials such as contained in cementitious materials.

13 FASTENINGS

13.1 Include in the work of each section necessary fastenings, anchors, inserts, attachment accessories, and adhesives. Where installation of devices is in work or other sections, deliver and locate devices in ample time for installation.

13.2 Do not install fibre, plastic or wood plugs or blocking for fastenings in masonry, concrete, or metal construction, unless specified or indicated on drawings.

13.3 Install work with fastenings or adhesives in sufficient quantity to ensure permanent secure anchorage of materials, construction, components and equipment under static conditions, and to resist building thermal movement, creep and vibration.

13.4 Provide metal fastenings and accessories in same material, texture, colour, sheen and finish as metal on which they occur, unless indicated otherwise.

13.5 Prevent electrolytic action between dissimilar metals and materials.

13.6 Use non-corrosive hot dip galvanized steel fasteners and anchors for securing exterior Work, and where attached to, or contained within, exterior walls and slabs, unless stainless steel or other material is specified. Leave steel anchors bare where cast in concrete.

13.7 Space anchors within their load limit or shear capacity and ensure they provide positive permanent anchorage. Wood, or any other organic material plugs are not acceptable.

13.8 Conceal fasteners where indicated. Keep exposed fastenings to a minimum, space evenly and in an organized symmetrical pattern.

13.9 Fastenings which cause spalling or cracking of material to which anchorage is made are not acceptable.

13.10 Powder Actuated Fastenings:

.1 Do not use powder actuated fasteners for the support of ceilings.

.2 Do not use powder actuated fastenings on any portion of the Work, unless written consent for a specific use is obtained from the Consultant.

.3 Only low velocity tools will be permitted under any condition. Operators to be qualified and to be in possession of a valid operator's certificate.

14 **ADJUSTING**

14.1 Ensure that all components of assemblies fit snugly, accurately and in true planes, and that moving parts operate positively and freely, without binding and scraping.

14.2 Verify that work functions properly and adjust it accordingly to ensure satisfactory operation. Lubricate Products as recommended by manufacturer.

END OF SECTION

1 DEMONSTRATION AND INSPECTION OF PRODUCTS AND SYSTEMS

1.1 Arrange for a demonstration of systems and operating Products upon the 100% completion of their installation and prior to certification for Substantial Performance.

1.2 Include in the arrangements for the attendance of the Consultant, Owner, jurisdictional authorities, and personnel assigned by the Owner for the operation of the systems and/or Products.

1.3 Demonstrations shall be conducted by the Subcontractor responsible for the installation of the systems and/or Product, assisted by representatives of the manufacturer or supplier. All personnel conducting the demonstration shall be completely knowledgeable of all conditions of the operating, functioning and maintenance of the systems and/or Products.

1.4 Owner's representative will acknowledge the successful completion of each demonstration on a form provided by the Contractor. The form shall be agreed to by the Owner, Consultant and Contractor prior to demonstration and testing.

1.5 Submit copies of letters from manufacturers of Systems and/or Products before making application for certificate of Substantial Performance to verify that the Products have been installed and connected correctly, and that they are operating in a satisfactory manner. The certification shall be based upon inspection and testing of the Products by competent technical personnel. Include in letter of certification the names of personnel conducting the testing and inspection, the methods of inspection utilized, and the location in the building of the Products certified.

1.6 Following submission of letters of certification and their acceptance by the Owner, the owner shall have the right to use the Products on a trial basis and for instructing their personnel in its use.

2 FINAL INSPECTIONS AND CLOSE OUT

2.1 Submit proposed closeout procedures and schedule of inspection to Consultant for approval before final demonstrations and inspections commence.

2.2 Submit layout and survey requirements required by Owner and Authorities having jurisdiction.

2.3 Arrange for, conduct and document final demonstrations, inspections, close-out and take-over at completion of the Work in accordance with procedures described in OAA/OGCA TAKE-OVER PROCEDURES, OAA/OGCA Document No. 100. Where "Architect" is referred to in Document No. 100 it shall mean Consultant.

3 CERTIFICATE OF COMPLIANCE

3.1 Submit Certificates of Compliance, prior to the application for Substantial Performance, for each of the following items.

.1 An affidavit relative to the use of lead-free solder for all domestic water lines, regardless of location.

.2 Products for which Material Safety Data Sheets have been submitted and accepted.

.3 Other Work/Products identified in the Contract Documents as requiring a Certificate of Compliance.

3.2 Each Certificate of Compliance shall indicated names and addresses of the project, the Owner, the date of issue, product description including name, number, manufacturer, with a statement verifying that the Work/Product installed meets specified requirements and, if applicable, complies with the submitted and accepted Material Safety Data Sheets.

3.3 Each Certificate of compliance shall be issued on the subcontractor's letterhead, properly executed, under whose work the prospective Work/Product has been provided.

3.4 Each Certificate of Compliance shall be endorsed by the Contractor with his authorized stamp/signature. Ensure that submissions are made to allow sufficient time for review without delaying progress of scheduled completion.

END OF SECTION

1 LAYOUT AND SURVEY

1.1 Existing grades, lines, and site conditions shown on drawings were taken from survey information established by persons engaged directly by the Owner. The accuracy of survey information is not the Consultant's responsibility. The Contractor will establish location of property lines.

1.2 Be responsible for setting out the Work. Prior to setting out the Work, verify dimensions and elevations shown on the Contract Documents and report to the Consultant any unsatisfactory conditions that may adversely affect the proper completion of the Work.

1.3 Set up and maintain permanent reference points and be responsible for the accuracy of such reference points. Establish lines and levels required for the performance of the Work.

1.4 Accurately set out the Work from levels and lines. Where Work of this Contract is dependent upon grades and elevations of existing structures or facilities, such grades or elevations shall take precedence over those determined by reference to established elevations. Advise the Consultant of any discrepancies.

1.5 During any activity of the Work, employ a Land surveyor licensed to practice in the place of Work to layout and check all features, including but not limited to the following:

.1 Lay out building on the Site.

.2 Establish a permanent bench mark, or markers as widely separated as possible

.3 Establish and maintain temporary bench marks set in suitable locations.

.4 Provide general dimensions, lines and elevations required by Subcontractors.

.5 Verify elevations of floor and roof levels as construction proceeds and relate to bench mark datum.

.6 Verify that present or known future restrictions are not violated by construction on the site or lines of traverse to all public utilities.

.7 Correlate geodetic elevation of bench mark datum with elevations in use by public utilities adjacent to Project.

.8 Verify accuracy of site dimensions shown on Drawings.

.9 Provide a survey to verify location of caisson walls and grade beams immediately adjacent to property lines, before construction of such work proceeds.

.10 Provide a survey to verify location of building related to property lines when caisson walls are completed to grade level.

.11 Provide a survey prior to placement of paving work to confirm that grades conform to grades indicated on drawings.

.12 Provide a survey to verify location of completed building on Site.

1.6 Examine, preserve and protect established bench marks. Re-establish a lost or displaced bench mark by a Land Surveyor licensed to practice in the place of Work at no cost to the Owner. Accept responsibility for setting out the Work.

1.7 In the event of a discrepancy between the Owner and the Contractor regarding horizontal and/or vertical alignment conditions, that are beyond allowable specified tolerance, the Owner may engage the services of an independent Land Surveyor. The surveyor shall investigate the disputed condition and the results of the independent investigation shall determine the bearer of costs for this service, being either the Owner or the Contractor.

1.8 If the Contractor is found to be in error, all costs incurred to correct the condition shall be assumed by the Contractor.

END OF SECTION

1 GENERAL

1.1 Provide labour, Products, equipment, services, tools, and supervision necessary for cutting and patching work in accordance with the Contract Documents.

1.2 Obtain Consultant's approval prior to cutting, boring or sleeving load-bearing members.

2 DEFINITION(S)

2.1 The terms “make good”, “making good”, “made good”, “restore to existing”, “patch”, “repair”, or similar words or phases are used in standards and these Contract Documents to mean the following, unless context provides otherwise:

.1 Make good materials and finishes which are damaged or disturbed during the process of additions and reconstruction under the Contract.

.2 Where existing work is to be made good, match new work exactly with the existing work in material, form, construction and finish unless otherwise noted or specified.

.3 Where existing work is to be made good, there shall be no visible difference in appearance, or aesthetics between the existing work and the new work by the naked eye at a distance of 3 metres from the surface being made good. There shall be no difference in performance between existing materials and new materials.

3 SUBMITTALS

3.1 Submit written request in advance of cutting or alteration which affects:

.1 Structural integrity of any element of the Structure or Contract.

.2 Integrity of weather-exposed or moisture-resistant elements.

.3 Efficiency, maintenance, or safety of any operational element.

.4 Visual qualities of sight-exposed elements.

.5 Work of Owner’s or Other Contractors.

3.2 Include in request:

.1 Identification of Contract.

.2 Location and description of affected Work.

.3 Statement of necessity for cutting or alteration.

.4 Description of proposed Work and products to be used.

.5 Alternatives to cutting and patching.

.6 Effect on work of Owner's or Other Contractors.

.7 Date and time Work will be executed.

3.3 Obtain Consultant's approval of proposed method of cutting prior to proceeding with the Work.

4 PRODUCTS

4.1 Same quality or better than Products incorporated in original installation.

5 PREPARATION

5.1 Inspect existing conditions, including elements subject to damage or movement during cutting and patching.

5.2 After uncovering, inspect conditions affecting performance of the Work.

5.3 Beginning of cutting or patching means acceptance of existing conditions.

5.4 Provide supports to assure structural integrity of surroundings; devices and methods to protect other portions of the project from damage.

5.5 Provide protection from elements for areas which may be exposed by uncovering Work; maintain excavations free of water.

6 EXECUTION

6.1 Execute Work to avoid damage to other Work.

6.2 Execute cutting, fitting and patching as required to complete the Work.

6.3 Employ appropriate trades with skilled labour to perform cutting Work.

6.4 Fit Work segments together, to integrate with penetrations through surfaces and with other Work.

6.5 Remove and replace defective and non-conforming Work.

6.6 Do any drilling, cutting, fitting, patching and finishing that may be required to make the various classes and kinds of other Work fit together in a professional and finished manner. Make watertight connections with adjoining structures.

6.7 Provide openings in non-structural elements of Work for penetrations of mechanical and electrical Work.

6.8 Execute Work by methods to avoid damage to other Work and which will provide proper surfaces to receive patching and finishing.

6.9 Cut Products using proper equipment and methods. On rigid materials, use a masonry saw or core drill. Pneumatic or impact tools are not allowed on masonry work without prior approval.

6.10 Where new Work connects with existing structures, cut, patch and make good existing work to match original condition.

6.11 Be responsible for correct formation and bridging of openings in masonry and structural walls as required.

6.12 Ensure compatibility between installed Products and security of installation.

6.13 Restore Work with new Products in accordance with requirements of the Contract Documents.

6.14 Fit Work airtight to pipes, sleeves, ducts, conduits and other penetrations through surfaces.

6.15 Properly prepare surfaces to receive patching and finishing.

6.16 Refinish surfaces to match adjacent finishes; for continuous surfaces refinish to nearest intersection; for an assembly, refinish entire unit.

END OF SECTION

1 PROGRESS CLEANING

1.1 Remove from finish work, spatters, droppings, soil, labels, and debris, before they set up.

1.2 Ensure that only cleaning materials are used which are recommended for the purpose by both the manufacturer of the surface to be cleaned and of the cleaning material.

1.3 Maintain building work areas "broom clean" at least on a daily basis, but shall also be done immediately before finishing work.

1.4 No waste material may be burned or buried at site. Remove as often as required to avoid accumulation, no less than, at the end of each working day.

1.5 Remove packaging materials and debris from the site immediately after product and equipment is unwrapped or uncrated.

1.6 Ensure that volatile fluid wastes are not disposed of in storm or sanitary sewers, in open drain courses, or anywhere on site.

1.7 Do not allow waste material and debris to accumulate in an unsightly or hazardous manner. Sprinkle dusty accumulations with water. Provide containers in which to collect waste material and debris. Dispose of hazardous products in accordance with requirements of jurisdictional authorities.

1.8 Ensure that cleaning operations are scheduled to avoid deposits, of dust or other foreign matter on surfaces during finishing work and until wet or tacky surfaces are cured.

1.9 Provide instructions for final cleaning of finishing work, and for inclusion in Maintenance and Operating Manuals.

2 FINAL CLEANING

2.1 Before final inspection, replace glass broken, damaged, and etched during construction, or which are otherwise defective.

2.2 In addition to requirements for progress cleaning, Work shall include final cleaning by skilled cleaning specialists on completion of construction.

2.3 Remove temporary protections and make good defects before commencement of final cleaning.

2.4 Final cleaning shall remove dust, stains, paint spots, soil, grease, fingerprints, and accumulations of construction materials, interior and exterior to the building for all new work throughout new and existing Building that is affected by Work of this Project. Work shall be done in accordance with manufacturer's instructions for each material. This work shall include:

.1 Washing of exterior paved surfaces, and of interior concrete floors.

.2 Cleaning and polishing of glass, porcelain, enamel and finish metals.

.3 Vacuum cleaning of ceilings, walls and floors.

.4 Washing clean of glazed wall surfaces.

.5 Cleaning of hardware, mechanical fixtures, plumbing fixtures, lighting fixtures, cover plates, and equipment, including polishing of their finish metal, porcelain, vitreous, and glass components.

.6 Cleaning of windows and entrances, both interior and exterior surfaces.

2.5 Maintain cleaning until Owner has taken possession of building or portions thereof.

END OF SECTION

1 GENERAL

1.1 Hand over to the Consultant three (3) copies including two (2) hard copies and one (1) digital copy, of a comprehensive operations and maintenance manual and material suitable for the Owner's maintenance employees. Manuals shall cover all Products supplied and installed under the Contract.

1.2 Submit draft of the operation and maintenance manuals for the Consultant's review at least 15 days before testing systems and equipment. Incorporate alterations and additions, as found to be necessary during testing, and prepare the final version of the manual from the corrected draft.

1.3 Submit final version of operation and maintenance manuals prior to Total Performance of the Work.

1.4 Testing of systems and equipment will not be deemed to be complete until the requisite number of copies of the final version of the manuals has been handed over to the Consultant.

1.5 If standard literature is incorporated into the operations and maintenance manual, any irrelevant information shall be deleted, or suitably noted.

1.6 The manuals shall have sufficient detail in order that the Owner can totally maintain the equipment without outside help.

1.7 Submit all material in English.

2 FORMAT

2.1 Organize data in the form of an instructional manual.

2.2 Binders: Commercial quality, 219 x 279 mm, maximum "D" ring size.

2.3 When multiple binders are used, correlate data into related consistent groupings.

2.4 Cover: Identify each binder with type or printed title "Contract Record Documents"; list title of Contract, identify subject matter of contents.

2.5 Arrange content by systems or process flow, under Section numbers and sequence of Table of Contents.

2.6 Provide tabbed fly leaf for each separate Product and system, with typed description of Product and major component parts of equipment.

2.7 Text: Manufacturer's printed data, or typewritten data on 20 pound paper.

2.8 Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

3 **CONTENTS**

3.1 Operation and maintenance manuals shall contain the following minimum information and data:

.1 Table of contents: Provide title of Contract; names, addresses, and telephone numbers of Consultants and Contractor with name of responsible parties; schedule of Products and systems, indexed to content of the volume.

.2 For each Product or system: List names, addresses and telephone numbers of Subcontractors, suppliers and service representatives, including local source of replacement supplies and parts including telephone numbers.

.3 Warranties: Warranties are between the Contractor and Owner. Warranties shall include, as a minimum:
- .1 Description of warranty coverage.
- .2 Date warranty starts (being date of Total Performance of the Work).
- .3 Date warranty expires.
- .4 Contact name, address and phone number (the Contractor shall also be responsible for advising the Owner of changes in contact information during the warranty period).
- .5 Equipment and components performance curves.
- .6 Hydro certificates.

.4 Reports: For each Product or system provide the following:
- .1 Manufacturer's certified reports
- .2 Factory test reports.
- .3 Field testing reports.

.5 Details of design, construction and/or fabrication features, component function and maintenance requirements, to permit effective start-up, operation, maintenance, repair, modification, extension and expansion of any portion or feature of the installation.

.6 Technical data, Product data, supplemented by bulletins, component illustrations, detailed views, technical descriptions of items and parts lists.

.7 Schematics, interconnection lists: Manuals shall be complete with schematic and wiring diagrams, wiring interconnection lists and diagrams fully cross referenced and coordinated, printed circuit board layouts including the component identification, component parts list with electronic substitution equivalent. Provide cross referenced components lists and sequence of operations.

.8 Trouble shooting and fault location guide: Instructions to facilitate quick return of malfunctioning equipment to operation.

.9 Routine servicing and preventative maintenance schedule for Products and/or estimated hours required for routine servicing and preventative maintenance tasks.

.10 List of recommended spare parts and recommended quantity of each item to be stocked based on spare part availability and re-order time.

.11 Complete set of reviewed shop drawings.

.12 Product data: Mark each sheet to clearly identify specific Products and component parts, and data applicable to installation; delete inapplicable information.

.13 Drawings: Supplement Product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams and as required in the Specifications.

.14 Typed text: As required to supplement Product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions and as required in the Specification.

4 DRAWINGS

4.1 Prepare all required drawings on CAD, using Autocad Version as agreed upon by the Consultant.

4.2 Prepare CAD drawings to meet the requirements of the Owners or Consultant's CAD Standards and Procedures.

4.3 Supply and hand over to the Consultant one CD of drawings for each final drawing prepared under this Contract, including but not limited to circuit drawings, equipment layout drawings, and shop drawings.

4.4 The final size of drawings shall be 560 mm x 860 mm. Half size reproductions (280 mm x 430 mm) shall also be provided.

4.5 Prior to Total Performance of the Work, supply and hand over to the Consultant, one complete set of CAD Drawing Files in Autocad format on storage media acceptable to Consultant for each final drawing prepared under this Contract, including but not limited to circuit drawings, equipment layout drawings, and shop drawings.

4.6 Text files shall be written in word processing program acceptable to Owner.

5 TRANSMITTAL

5.1 Forward storage media to the Owner through the Consultant with a transmittal form. Transmittal shall contain the list of file names contained on the storage media.

5.2 Data forwarded to the Owner shall contain the following files in addition to the design information:

.1 Library parts used in the design files.

.2 Level convention used for each design file.

.3 Plotting instructions used to prepare hard copies including colour tables, pen tables and plot scale.

.4 Working units of the design files.

.5 Font library, if the standard is not used.

END OF SECTION

1 PROGRESS RECORDS

1.1 Maintain on site, permanent written records of daily progress of the Work. Records shall be open to review by Consultant and Owner at all times and a copy shall be furnished to Consultant on a weekly basis.

1.2 Records shall show dates of commencement, progress and completion of various trades and items of work. Particulars pertaining to number of employees of various trades and type and quantity of equipment employed daily, temperature, protection methods and other such data shall be noted.

2 AS-BUILT DRAWINGS

2.1 Authorized deviations from drawings shall be marked in red accurately on one set of drawing prints in a neat, legibly printed manner and shall be dated.

2.2 Prior to final inspection, accurately revise the CAD disks to incorporate the 100% complete ‘as built’ recorded information.

2.3 Submit the following:

.1 Original marked up white prints;

.2 One (1) complete hard copy set of the final as-built drawings and

.3 One (1) complete digital AutoCAD set of the final as-built drawings. Digital set to be on USB key or CD and CAD version as agreed upon by the Consultant.

2.4 Maintain as-built drawings up to date as Work progresses. Status of maintained as-built drawings may be considered as a condition for validation of applications for payment.

2.5 Identify each as-built drawing as "As-Built Copy" and maintain the as-built drawings in good condition. Make as-built drawings available to the Consultant at all times.

2.6 As-built drawings shall include accurate dimensioned record of deviations and changes in Work from drawings.

2.7 As-built drawings shall be signed and dated by Contractor.

2.8 Submit as-built drawing to Consultant for review and make corrections as directed by Consultant.

2.9 Record accurately all deviations in the Work.

2.10 Accurately record locations of concealed structure, mechanical and electrical services and similar Work not clearly in view, the location of which is required for maintenance, alteration Work and future additions. Do not conceal such Work until the location has been recorded.

2.11 Accurately record locations of equipment bases, anchors, concrete pads and roof curbs, sleeves, piping, conduits, ducts, maintenance holes and valves, etc. located either below, outside or within structure.

2.12 Where piping, conduits and ducts are underground, underfloor, embedded in concrete or otherwise in inaccessible locations, accurately record with respect to structure column lines or walls and elevations with respect to finished floor levels or grades referenced to the centre line of components.

2.13 Accurately record any components which will be in inaccessible locations for Consultant's review before the component is covered, or buried, or made inaccessible.

2.14 CAD drawings of Contract Drawings can be obtained from Consultant at a cost of $50.00 plus HST per drawing.

2.15 Clearly and prominently mark each drawing “AS-BUILT DRAWING prepared by _____ _____ (name of Contractor)”

END OF SECTION

1 GEOTECHNICAL INFORMATION

1.1 A copy of the following detailed geotechnical information is appended to this Document:

.1 **Soil Investigation**
A Soil Investigation for Proposed
Orangutan Exhibit
Toronto, Ontario
Prepared by: Soil Engineers Ltd.
Report No.: 1610-S137
Dated: January 2017
32 pages

.2 **Geotechnical Investigation Report**
Proposed Structures and Shoring
Toronto Zoo
Toronto, Ontario
Prepared by: Soil Engineers Ltd.
Report No.: 1908-S132
Dated: November 13, 2019
29 pages

1.2 This geotechnical information records properties of subsurface conditions and recommendations for the design of foundations, pavements and soil remediation as outlined in the information provided.

1.3 The geotechnical information by its nature, cannot reveal all conditions that exist or can occur on the Site. Should subsurface conditions be found to vary substantially from the report, immediately notify Consultant in writing and await instructions.

1.4 Contractor shall not be entitled to extra payment or extension of Contract Time for work which is required and which is reasonably inferable in the geotechnical information as being necessary.

1.5 In case of discrepancies between recommendations contained in geotechnical information and requirements of Contract Documents, the latter shall govern. Advise Consultant in writing of any discrepancies discovered.

END OF DOCUMENT

Soil Investigation

Soil Engineers Ltd.
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A REPORT TO
TORONTO ZOO

A SOIL INVESTIGATION FOR PROPOSED ORANGUTAN EXHIBIT

361A OLD FINCH AVENUE

CITY OF TORONTO

REFERENCE NO. 1610-S137

JANUARY 2017

DISTRIBUTION

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1.0 INTRODUCTION

In accordance with Purchase Order No. 0064367 issued on October 27, 2016, by Mr. Ben Knoop of the Toronto Zoo, a soil investigation was carried out for a proposed Orangutan Exhibit at the Toronto Zoo, located at 361A Old Finch Avenue, in the City of Toronto.

The purpose of the investigation was to reveal the subsurface conditions and determine the engineering properties of the disclosed soils for the design and construction of the proposed project.

The geotechnical findings and resulting recommendations are presented in this Report.

2.0 SITE AND PROJECT DESCRIPTION

The City of Toronto is located on Markham till plain where glacial drift predominates the soil stratigraphy. In places, the drift has been modified by the depositing of lacustrine clay, silt, sand and water-laid till derived from water action of Peel Ponding (glacial lake).

The subject site of investigation is located within the Toronto Zoo, situated southwest of Old Finch Avenue and Meadowvale Road, in the City of Toronto (Scarborough). The site area is an open space with some trees. The ground surface is relatively flat and level.

The proposed project consists of the construction of an Orangutan Exhibit with slab-on-grade structures.

3.0 FIELD WORK

The field work, consisting of 4 boreholes to depths of 5.2 m and 6.2 m, was performed on November 18, 2016, at the locations shown on the Borehole Location Plan, Drawing No. 1. Refusal to augering was encountered at a depth of 5.2 m at Borehole 1.

The holes were advanced at intervals to the sampling depths by a track-mounted, continuous-flight power-auger machine equipped for soil sampling. Standard Penetration Tests, using the procedures described on the enclosed "List of Abbreviations and Terms", were performed at the sampling depths. The test results are recorded as the Standard Penetration Resistance (or 'N' values) of the subsoil. The relative density of the granular strata and the consistency of the cohesive strata are inferred from the 'N' values. Split-spoon samples were recovered for soil classification and laboratory testing.

The field work was supervised and the findings were recorded by a Geotechnical Technician.

The sampling depths and the depths of the soil strata changes were referred to the prevailing ground surface at each of the borehole locations.

4.0 SUBSURFACE CONDITIONS

Detailed descriptions of the encountered subsurface conditions are presented on the Borehole Logs, comprising Figures 1 to 4, inclusive. The revealed stratigraphy is plotted on the Subsurface Profile, Drawing No. 2, and the engineering properties of the disclosed soils are discussed herein.

This investigation has disclosed that beneath a veneer of topsoil at Borehole 3, and a layer of earth fill at Boreholes 1, 2 and 4, the site is underlain by strata of sandy silt till and silty sand till.

4.1 **Topsoil** (Borehole 3)

The revealed topsoil is 18 cm thick. It is dark brown in colour, indicating that it contains appreciable amounts of roots and humus. These materials are unstable and compressible under loads; therefore, the topsoil is considered to be void of engineering value. Due to its humus content, it may produce volatile gases and generate an offensive odour under anaerobic conditions. Therefore, the topsoil must not be buried below any structures or deeper than 1.2 m below the finished grade, so that it will not have an adverse impact on the environmental well-being of the developed areas.

Since the topsoil is considered void of engineering value, it can only be used for general landscaping and landscape contouring purposes. A fertility analysis can be carried out to determine the suitability of the topsoil as a planting material.

4.2 **Earth Fill** (Boreholes 1, 2 and 4)

The earth fill was found extending to depths of 0.3 to 0.7 m below the prevailing ground surface. The fill consists of silty clay and silty sand materials.

The obtained 'N' values are 2, 5 and 11 blows per 30 cm of penetration, indicating that the fill is loosely placed. Its relative density is non-uniform and loose, and, therefore, it is unsuitable to support structures sensitive to settlement.

The natural water content values are 12%, 14% and 25%, indicating that the fill is in a moist to wet condition, which corresponds with our sample examinations.

Due to its unknown history, and non-uniform and loose density, the earth fill is considered to be unsuitable for supporting structures. For structural use, the fill must be subexcavated, inspected, sorted free of any deleterious material, if detected, and properly compacted.

One must be aware that the samples retrieved from boreholes 10 cm in diameter may not be truly representative of the geotechnical and environmental quality of the fill, and do not indicate whether the topsoil beneath the earth fill was completely stripped. This should be further assessed by laboratory testing and/or test pits.

4.3 **Sandy Silt Till** (All Boreholes)

The sandy silt till was encountered immediately below the earth fill or topsoil at Boreholes 1, 2 and 3, and beneath a layer of silty sand till in Borehole 4; it extends to the maximum investigated depth at all boreholes. It consists of a

random mixture of soil particle sizes ranging from clay to gravel, with the silt being the predominant fraction. Its structure is heterogeneous, indicating it is a glacial deposit.

Hard resistance to augering was encountered in places, indicating the presence of cobbles and boulders. Occasional wet sand and silt seams and layers were also found in the till mantle.

The obtained 'N' values range from 7 blows per 30 cm to 50 blows per 5 cm, with a median of 50 blows per 15 cm, showing that the relative density of the till is loose to very dense, being generally very dense. The surficial layer of the till is generally weathered to a depth of 0.6± m below grade.

The natural water content was determined, and the results are plotted on the Borehole Logs; the values range from 5% to 11%, with a median of 7%, showing the sandy silt till is in a damp to moist condition.

Grain size analyses were performed on 2 representative samples and the results are plotted on Figure 5.

The deduced engineering properties pertaining to the project are given below:

- Moderately high frost susceptibility and moderately low water erodibility.
- Low permeability, with an estimated coefficient of permeability of 10^{-6} cm/sec, an estimated percolation rate of 65 min/cm, and runoff coefficients of:

Slope	
0% - 2%	0.15
2% - 6%	0.20
6% +	0.28

- A frictional-cohesive soil, its shear strength is density dependent and is augmented by cementation and cohesion.
- It will slough slowly if submerged in an unconfined state, or from an open-face cut under seepage conditions, particularly in the zone where wet sand and silt layers are prevalent.
- A fair pavement-supportive material, with an estimated California Bearing Ratio (CBR) value of 8% to 10%.
- Moderately low corrosivity to buried metal, with an estimated electrical resistivity of 5000 ohm·cm.

4.4 **Silty Sand Till** (Borehole 4)

The silty sand till consists of a random mixture of soil particle sizes ranging from clay to gravel, with the sand being the dominant fraction. It is heterogeneous in structure, showing that it is a glacial deposit.

Hard resistance to augering was encountered, showing that cobbles and boulders are embedded in the sand till.

The natural water content was determined, and the results are plotted on the Borehole Logs; the values, 4%, 5% and 8%, indicate the sand till is in a damp to moist condition.

The obtained 'N' values are 10, 36 and 46 blows per 30 cm of penetration, showing that the relative density of the silty sand till is compact to dense. The surficial layer of the till is generally weathered to a depth of 0.8 m below grade.

A grain size analysis was performed on 1 sample and the result is plotted on Figure 6.

The deduced engineering properties pertaining to the project are given below:

- High frost susceptibility and moderate water erodibility.
- Relatively pervious, depending on the clay content, with an estimated coefficient of permeability of 10^{-4} cm/sec, an estimated percolation rate of about 20 min/cm, and runoff coefficients of:

Slope	
0% - 2%	0.07
2% - 6%	0.12
6% +	0.18

- A frictional soil, its shear strength is primarily derived from internal friction and is augmented by cementation. Therefore, its strength is density dependent.
- It will be stable in steep cuts; however, under prolonged exposure, immediate sloughing and sheet collapse will likely occur, particularly where seepage occurs.
- A fair pavement-supportive material, with an estimated CBR value of 10%.
- Moderately low corrosivity to buried metal, with an estimated electrical resistivity of 5000 ohm·cm.

4.5 Interpretation of Refusal to Augering

Refusal to augering was encountered at Borehole 1 at a depth of 5.2 m below the prevailing ground surface. It is inferred that boulders were encountered at this level.

4.6 Compaction Characteristics of the Revealed Soils

The obtainable degree of compaction is primarily dependent on the soil moisture and, to a lesser extent, on the type of compactor used and the effort applied.

As a general guide, the typical water content values of the revealed soils for Standard Proctor compaction are presented in Table 1.

Table 1 - Estimated Water Content for Compaction

Soil Type	Determined Natural Water Content (%)	Water Content (%) for Standard Proctor Compaction	
		100% (optimum)	Range for 95% or +
Earth Fill	12, 14 and 25	10 to 16	6 to 21
Sandy Silt Till	5 to 11 (median 7)	11	7 to 16
Silty Sand Till	4, 5 and 8	10	6 to 15

Based on the above findings, the sandy silt till and portions of the earth fill and silty sand till are generally suitable for a 95% or + Standard Proctor compaction. A portion of the earth fill is too wet and will require aeration, whereas a portion of the silty sand till is too dry and will require the addition of water or mixing with wetter soils prior to structural compaction. The existing earth fill must be sorted free of any deleterious materials prior to use as structural fill.

The silty clay fill, sandy silt till and silty sand till should be compacted using a heavy-weight, kneading-type roller. The silty sand fill can be compacted by a smooth roller with or without vibration, depending on the water content of the soil being compacted. The lifts for compaction should be limited to 20 cm, or to a suitable thickness as assessed by test strips performed by the equipment which will be used at the time of construction.

When compacting the tills on the dry side of the optimum, the compactive energy will frequently bridge over the chunks in the soils and be transmitted laterally in the soil mantle. Therefore, the lifts of this soil must be limited to 20 cm or less (before compaction). It is difficult to monitor the lifts of backfill placed in deep trenches; therefore, it is preferable that the compaction of backfill at depths over 1.0 m below the pavement subgrade be carried out on the wet side of the optimum. This would allow a wider latitude of lift thickness.

If the compaction of the soils is carried out with the water content within the range for 95% Standard Proctor dry density but on the wet side of the optimum, the surface of the compacted soil mantle will roll under the dynamic compactive load. This is unsuitable for pavement construction since each component of the pavement structure is to be placed under dynamic conditions which will induce the rolling action of the subgrade surface and cause structural failure of the new pavement. The foundation or bedding of the sewer and slab-on-grade will be placed on a subgrade which will not be subjected to impact loads. Therefore, the structurally compacted soil mantle with the water content on the wet side or dry side of the optimum will provide an adequate subgrade for the construction.

The presence of boulders in the till will prevent transmission of the compactive energy into the underlying material to be compacted. If an appreciable amount of boulders over 15 cm in size is mixed with the material, it must either be sorted or must not be used for structural backfill.

5.0 GROUNDWATER CONDITIONS

Groundwater seepage encountered during augering was recorded on the field logs. The level of groundwater was measured upon completion of the boreholes; the data are plotted on the Borehole Logs and listed in Table 2.

Table 2 - Groundwater Levels

BH No.	Borehole Depth (m)	Soil Colour Changes Brown to Grey	Seepage Encountered During Augering		Measured Groundwater/ Cave-In* Level On Completion
		Depth (m)	Depth (m)	Amount	Depth (m)
1	5.2	2.3	-	-	Dry
2	6.2	2.3	-	-	3.0/3.0*
3	6.2	2.3	-	-	Dry
4	6.2	3.0	-	-	Dry

* Cave-in level (In wet sand and silt layers, the level generally represents the groundwater regime at the borehole location.)

As shown above, groundwater was detected at a depth of 3.0 m below the prevailing ground surface at Borehole 2, and the borehole caved at the same depth; all other boreholes remained dry upon completion of the field work. The groundwater level will fluctuate with the seasons.

The yield of groundwater from the sandy silt till and silty sand till, due to their relatively low permeability, is expected to be small and limited.

6.0 DISCUSSION AND RECOMMENDATIONS

The investigation has disclosed that beneath a veneer of topsoil at Borehole 3, and a layer of earth fill at Boreholes 1, 2 and 4, the site is underlain by strata of compact to very dense, generally very dense sandy silt till and compact to dense silty sand till. The surficial soil layer is generally weathered to depths of 0.3 to 0.8 m below the prevailing ground surface.

Groundwater was detected at a depth of 3.0 m below the prevailing ground surface at Borehole 2, and the borehole caved at the same depth; all other boreholes remained dry upon completion of the field work. The groundwater level will fluctuate with the seasons.

The yield of groundwater from the sandy silt till and silty sand till, due to their relatively low permeability, is expected to be small and limited.

The geotechnical findings which warrant special consideration are presented below:

1. The topsoil must be removed for the project construction. This material is unsuitable for engineering applications; therefore, it should be placed in the landscaped areas only and should not be buried within the building envelope, or deeper than 1.2 m below the exterior finished grade of the project.
2. The existing earth fill is loose and is unsuitable for supporting foundations. For structural use, it must be subexcavated, assessed, sorted free of any deleterious materials, aerated and properly compacted. If it is impractical to sort the fill, then it must be wasted.
3. The sound natural soils below the topsoil, earth fill and weathered zone are suitable for normal spread and strip footing construction. The footing subgrade must be inspected by either a geotechnical engineer, or a

geotechnical technician under the supervision of a geotechnical engineer, to ensure that its condition is compatible with the design of the foundation.

4. For slab-on-grade construction, any weathered, soft or loose soils should be subexcavated, aerated and properly compacted prior to the placement of the slab. Any new material for raising the grade should consist of organic-free soil compacted to at least 98% of its maximum Standard Proctor dry density.
5. A Modulus of Subgrade Reaction of 25 MPa/m is recommended for the design of the floor slab.
6. A Class 'B bedding, consisting of compacted 20-mm Crusher-Run Limestone, is recommended for the construction of the underground services. The sewer joints should be leak-proof, or wrapped with an appropriate waterproof membrane, to prevent subgrade migration. If subgrade stabilization is required, the stone immersion technique may be applied. In areas where more extensive dewatering is required for sewer construction, a Class 'A' bedding should be considered.
7. The tills contain cobbles and boulders. Boulders over 15 cm in size must not be used for structural backfill. Excavation into the tills containing boulders will require extra effort and the use of a heavy-duty backhoe.

The recommendations appropriate for the project described in Section 2.0 are presented herein. One must be aware that the subsurface conditions may vary between boreholes. Should this become apparent during construction, a geotechnical engineer must be consulted to determine whether the following recommendations require revision.

6.1 **Foundations**

Based on the findings, the footings should be placed below the topsoil, earth fill and weathered soil onto the sound natural soils. The recommended soil pressures for

use in the design of the normal spread and strip footings, together with the corresponding suitable founding levels, are presented in Table 3.

Table 3 - Founding Levels

	Maximum Allowable Soil Pressure (SLS)/ Factored Ultimate Soil Bearing Pressure (ULS) and Corresponding Founding Level	
	250 kPa (SLS) 400 kPa (ULS)	**300 kPa (SLS) 480 kPa (ULS)**
Borehole No.	**Depth (m)**	**Depth (m)**
1	1.0 or +	1.6 or +
2	1.0 or +	1.6 or +
3	1.0 or +	1.6 or +
4	-	1.0 or +

The recommended soil pressures (SLS) incorporate a safety factor of 3. The total settlement of the new footings is estimated to be 15 mm.

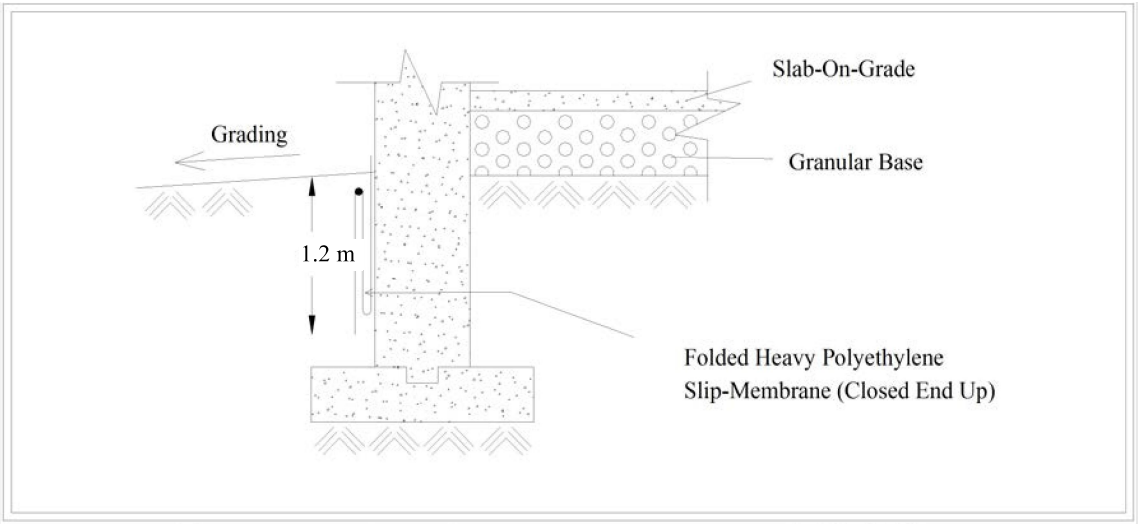
Due to the presence of topsoil, earth fill and weathered soils, the footing subgrade must be inspected by either a geotechnical engineer, or a geotechnical technician under the supervision of a geotechnical engineer, to ensure that the subgrade conditions are compatible with the foundation design requirements.

The footings exposed to weathering must have at least 1.2 m of earth cover for frost protection.

The footings should meet the requirements specified in the latest Ontario Building Code, and the building must be designed to resist a minimum earthquake force using Site Classification ‘C’ (very dense soil).

The in situ soils are highly frost susceptible; if these soils are to be used for the foundation backfill, the foundation walls should be shielded by a polyethylene slip-membrane for protection against soil adfreezing. The recommended measures are schematically illustrated in Diagram 1.

Diagram 1 - Frost Protection Measures (Foundations)



The necessity to implement the above measures should be further assessed by a geotechnical engineer at the time of construction.

The exterior grading must be such that runoff is directed away from the building to prevent ponding adjacent to the structure.

6.2 Slab-On-Grade

In preparation of the subgrade, the weathered and loose or soft soils must be completely removed. Properly compacted inorganic earth fill and sound natural soils are suitable for the slab-on-grade construction. The surface of the subgrade must be inspected, and proper proof-rolling must be carried out. Any loose soil

detected must be subexcavated and replaced with inorganic fill compacted to at least 98% of its maximum Standard Proctor dry density.

The slab should be constructed on a granular base, 20 cm thick, consisting of 20-mm Crusher-Run Limestone, or equivalent, compacted to its maximum Standard Proctor dry density.

A Modulus of Subgrade Reaction of 25 MPa/m is recommended for the design of the floor slab on sound natural soils.

The ground around the buildings must be graded to direct water away from the structure to minimize the frost heave phenomenon generally associated with the disclosed soils.

6.3 Underground Services

The subgrade for the underground services should consist of natural soils or compacted organic-free earth fill. Where weathered, loose or soft soils are encountered, these materials must be subexcavated and replaced with properly compacted bedding material.

A Class 'B' bedding, consisting of compacted 20-mm Crusher-Run Limestone, is recommended for the construction of the underground services. The sewer joints should be leak-proof, or wrapped with an appropriate waterproof membrane, to prevent subgrade migration. If subgrade stabilization is required, the stone immersion technique may be applied. In areas where more extensive dewatering is required for sewer construction, a Class 'A' bedding should be considered.

In order to prevent pipe floatation when the sewer trench is deluged with water, a soil cover with a thickness equal to the diameter of the pipe should be in place at all times after completion of the pipe installation.

The pipe joints should be leak-proof or they should be provided with a waterproof membrane. This is to prevent migration of fines due to leaks from faulty joints.

Openings to subdrains and catch basins should be shielded with a fabric filter to prevent blockage by silting.

6.4 Backfilling In Trenches and Excavated Areas

The backfill in trenches and excavated areas should be compacted to at least 95% of its maximum Standard Proctor dry density, and increased to 98% below any floor slabs. In the zone within 1.0 m below the subgrade, the material should be compacted with the water content 2% to 3% drier than the optimum, and the compaction should be increased to at least 98% of the respective maximum Standard Proctor dry density. In the lower zone, the compaction should be carried out on the wet side of the optimum; this allows a wider latitude of lift thickness. Wetting of the tills may be necessary to achieve this requirement.

In normal construction practice, the problem areas of ground settlement largely occur adjacent to footings, and strip, spread and narrow trench foundations, where access is difficult for a heavy compactor. Sand backfill should be used with thin lifts and should be compacted using a small, vibratory plate compactor.

The narrow trenches should be cut at 1 vertical:2 or + horizontal so that the backfill can be effectively compacted. Otherwise, soil arching will prevent the achievement

of proper compaction. The lift of each backfill layer should either be limited to a thickness of 20 cm, or the thickness should be determined by test strips.

6.5 Soil Parameters

The recommended soil parameters for the project design are given in Table 4.

Table 4 - Soil Parameters

Unit Weight and Bulk Factor	**Unit Weight (kN/m^3)**	**Estimated Bulk Factor**	
	Bulk	**Loose**	**Compacted**
Earth Fill and Weathered Soil	21.0	1.20	1.00
Sound Tills	22.0	1.33	1.05
Lateral Earth Pressure Coefficients			
	Active K_a	**At Rest K_o**	**Passive K_p**
Earth Fill and Weathered Soil	0.40	0.50	2.50
Sound Tills	0.30	0.40	3.33

6.6 Excavation

Excavation should be carried out in accordance with Ontario Regulation 213/91.

Excavations in excess of 1.2 m should be sloped at 1 vertical:1 horizontal for stability.

The tills contain occasional boulders. Extra effort and a properly equipped backhoe will be required for excavation. Boulders larger than 15 cm in size are not suitable for structural backfill.

For excavation purposes, the types of soils are classified in Table 5.

Table 5 - Classification of Soils for Excavation

Material	Type
Sound Tills	2
Earth Fill and weathered Soil	3

The groundwater yield from the sandy silt till and silty sand till, due to their relatively low permeability, will be small and can be controlled by pumping from sumps.

Prospective contractors must assess the in situ subsurface conditions prior to excavation by performing test cuts to at least 0.5 m below the intended bottom of excavation. These test pits should be allowed to remain open for a period of at least 4 hours to assess the trenching and groundwater conditions.

7.0 LIMITATIONS OF REPORT

This report was prepared by Soil Engineers Ltd. for the account of Toronto Zoo, and for review by its designated agents, financial institutions, and government agencies Use of the report is subject to the conditions and limitations of the contractual agreement. The material in the report reflects the judgment of Frank Lee, P.Eng., and Bernard Lee, P.Eng., in light of the information available to it at the time of preparation. Any use which a Third Party makes of this report, and/or any reliance on decisions to be made based on it are the responsibility of such Third Parties. Soil Engineers Ltd. Accepts no responsibility for damages, if any, suffered by any Third Party as a result of decisions made or actions based on this report.

SOIL ENGINEERS LTD.

Frank Lee, P.Eng.

Bernard Lee, P.Eng.
FL/BL:dd

LIST OF ABBREVIATIONS AND DESCRIPTION OF TERMS

The abbreviations and terms commonly employed on the borehole logs and figures, and in the text of the report, are as follows:

SAMPLE TYPES

AS Auger sample
CS Chunk sample
DO Drive open (split spoon)
DS Denison type sample
FS Foil sample
RC Rock core (with size and percentage recovery)
ST Slotted tube
TO Thin-walled, open
TP Thin-walled, piston
WS Wash sample

PENETRATION RESISTANCE

Dynamic Cone Penetration Resistance:

A continuous profile showing the number of blows for each foot of penetration of a 2-inch diameter, 90° point cone driven by a 140-pound hammer falling 30 inches.

Plotted as '—●—'

Standard Penetration Resistance or 'N' Value:

The number of blows of a 140-pound hammer falling 30 inches required to advance a 2-inch O.D. drive open sampler one foot into undisturbed soil.

Plotted as '○'

WH Sampler advanced by static weight
PH Sampler advanced by hydraulic pressure
PM Sampler advanced by manual pressure
NP No penetration

SOIL DESCRIPTION

Cohesionless Soils:

'N' (blows/ft)	Relative Density
0 to 4	very loose
4 to 10	loose
10 to 30	compact
30 to 50	dense
over 50	very dense

Cohesive Soils:

Undrained Shear Strength (ksf)	'N' (blows/ft)	Consistency
less than 0.25	0 to 2	very soft
0.25 to 0.50	2 to 4	soft
0.50 to 1.0	4 to 8	firm
1.0 to 2.0	8 to 16	stiff
2.0 to 4.0	16 to 32	very stiff
over 4.0	over 32	hard

Method of Determination of Undrained Shear Strength of Cohesive Soils:

x 0.0 Field vane test in borehole; the number denotes the sensitivity to remoulding

△ Laboratory vane test

□ Compression test in laboratory

For a saturated cohesive soil, the undrained shear strength is taken as one half of the undrained compressive strength

METRIC CONVERSION FACTORS

1 ft = 0.3048 metres
1lb = 0.454 kg
1 inch = 25.4 mm
1ksf = 47.88 kPa

Job Number: 1610-S137

LOG OF BOREHOLE NO.: 1

Figure No.: 1

Project Description: Proposed Orangutan Exhibit

Job Location: 361A Old Finch Avenue, City of Toronto (Scarborough)

Method of Boring: Flight-Auger

Drilling Date: November 18, 2016

Elevation (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0	Ground Surface			
0.0	Brown **SILTY CLAY and SILTY SAND, Fill**	1	DO	11
-0.7				
0.7	Compact to very dense	2	DO	28
		3	DO	48
	brown grey **SANDY SILT, Till** occ. wet sand and silt seams and layers, cobbles and boulders	4	DO	50/15
		5	DO	50/13
		6	DO	50/10
-5.2				
5.2	END OF BOREHOLE Refusal to augering Inferred boulders			

Depth Scale (m): 0 1 2 3 4 5 6 7 8 9 10

Dynamic Cone (blows/30cm): 20 40 60 80

Shear Strength (kN/m^2): 50 100 150 200

Penetration Resistance (blows/30cm): 10 30 50 70 90

Atterberg Limits: PL ▷ LL ◁

Moisture Content (%): 10 30 50 70 90

Moisture content values: 14, 9, 8, 5, 6, 6

Water Level: Dry on completion

SOIL ENGINEERS LTD.

Job Number: 1610-S137

LOG OF BOREHOLE NO.: 2

Figure No.: 2

Project Description: Proposed Orangutan Exhibit

Job Location: 361A Old Finch Avenue, City of Toronto (Scarborough)

Method of Boring: Flight-Auger

Drilling Date: November 18, 2016

Elevation (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0	Ground Surface			
0.0	Brown	1A	DO	
-0.3	**SILTY CLAY and SILTY SAND, Fill**	1B	DO	7
0.3	Loose to very dense			
	weathered silty sand layer	2	DO	24
		3	DO	48
	brown grey	4A	DO	
	SANDY SILT, Till	4B	DO	82
	fine sand layer			
	occ. wet sand and silt seams and layers, cobbles and boulders	5	DO	50/15
		6	DO	50/15
-6.2		7	DO	50/8
6.2	END OF BOREHOLE			

Depth Scale (m): 0 1 2 3 4 5 6 7 8 9 10

Dynamic Cone (blows/30cm): 20 40 60 80

Shear Strength (kN/m^2): 50 100 150 200

Penetration Resistance (blows/30cm): 10 30 50 70 90

Atterberg Limits: PL ▷ LL ◁

Moisture Content (%): 10 30 50 70 90

Moisture Content values: 25, 10, 9, 8, 6, 11, 8, 7, 8

Water Level: W.L. and Cave-in @ 3.0 m on completion

SOIL ENGINEERS LTD.

Job Number: 1610-S137

LOG OF BOREHOLE NO.: 3

Figure No.: 3

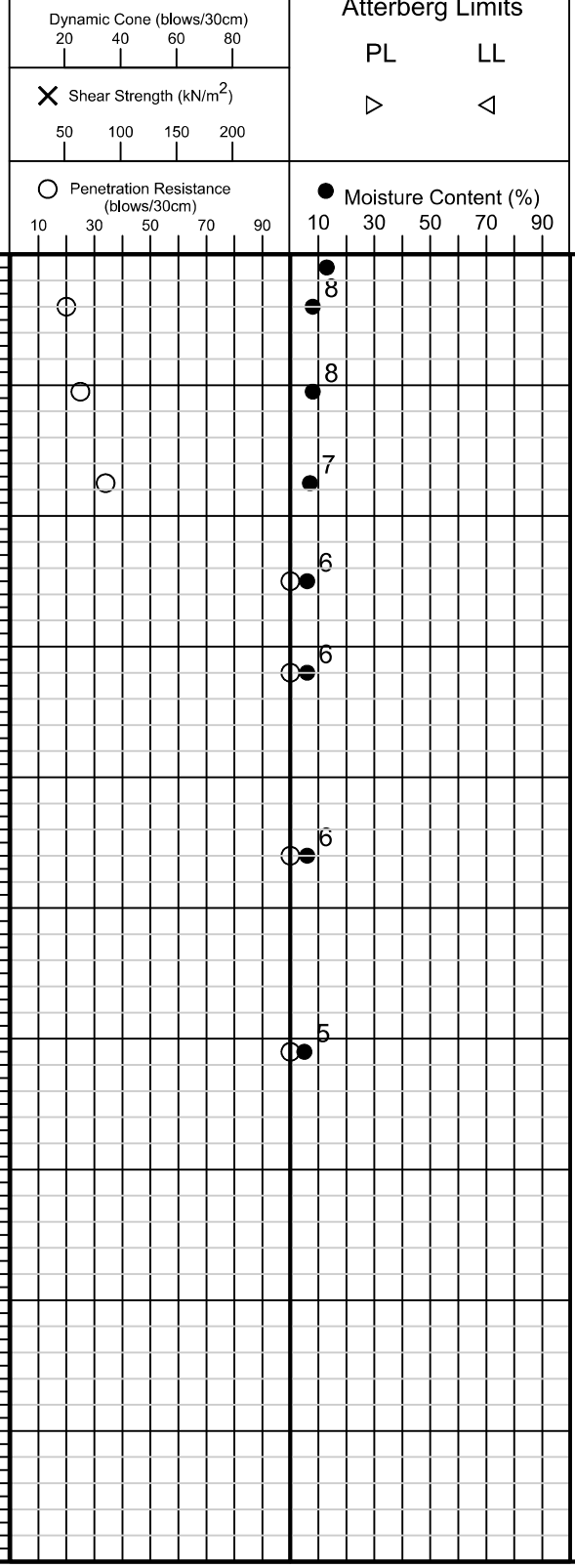
Project Description: Proposed Orangutan Exhibit

Job Location: 361A Old Finch Avenue, City of Toronto (Scarborough)

Method of Boring: Flight-Auger

Drilling Date: November 18, 2016

Elevation (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)
0.0	Ground Surface				
0.0	**18 cm TOPSOIL** Compact to very dense	1A	DO		0
		1B	DO	20	
		2	DO	25	1
	SANDY SILT, Till occ. wet sand and silt seams and layers, cobbles and boulders — brown grey	3	DO	34	2
		4	DO	50/15	
		5	DO	50/15	3
		6	DO	50/13	4
					5
-6.2		7	DO	50/8	6
6.2	END OF BOREHOLE				7
					8
					9
					10



Water Level: Dry on completion

SOIL ENGINEERS LTD.

Job Number: 1610-S137

LOG OF BOREHOLE NO.: 4

Figure No.: 4

Project Description: Proposed Orangutan Exhibit

Job Location: 361A Old Finch Avenue, City of Toronto (Scarborough)

Method of Boring: Flight-Auger

Drilling Date: November 18, 2016

Elevation (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0	Ground Surface			
0.0	Brown	1A	DO	
-0.4	**SILTY SAND, Fill**	1B	DO	10
0.4	Brown, compact to dense weathered			
	SILTY SAND, Till occ. wet sand and silt seams and layers, cobbles and boulders	2	DO	36
		3	DO	46
-2.1				
2.1	Very dense	4	DO	50/15
	brown grey **SANDY SILT, Till** occ. wet sand and silt seams and layers, cobbles and boulders	5	DO	50/10
		6	DO	50/13
-6.2		7	DO	50/5
6.2	END OF BOREHOLE			

Depth Scale (m): 0 1 2 3 4 5 6 7 8 9 10

Dynamic Cone (blows/30cm): 20 40 60 80

Shear Strength (kN/m^2): 50 100 150 200

Penetration Resistance (blows/30cm): 10 30 50 70 90

Atterberg Limits: PL LL

Moisture Content (%): 10 30 50 70 90

Water Level: Dry on completion

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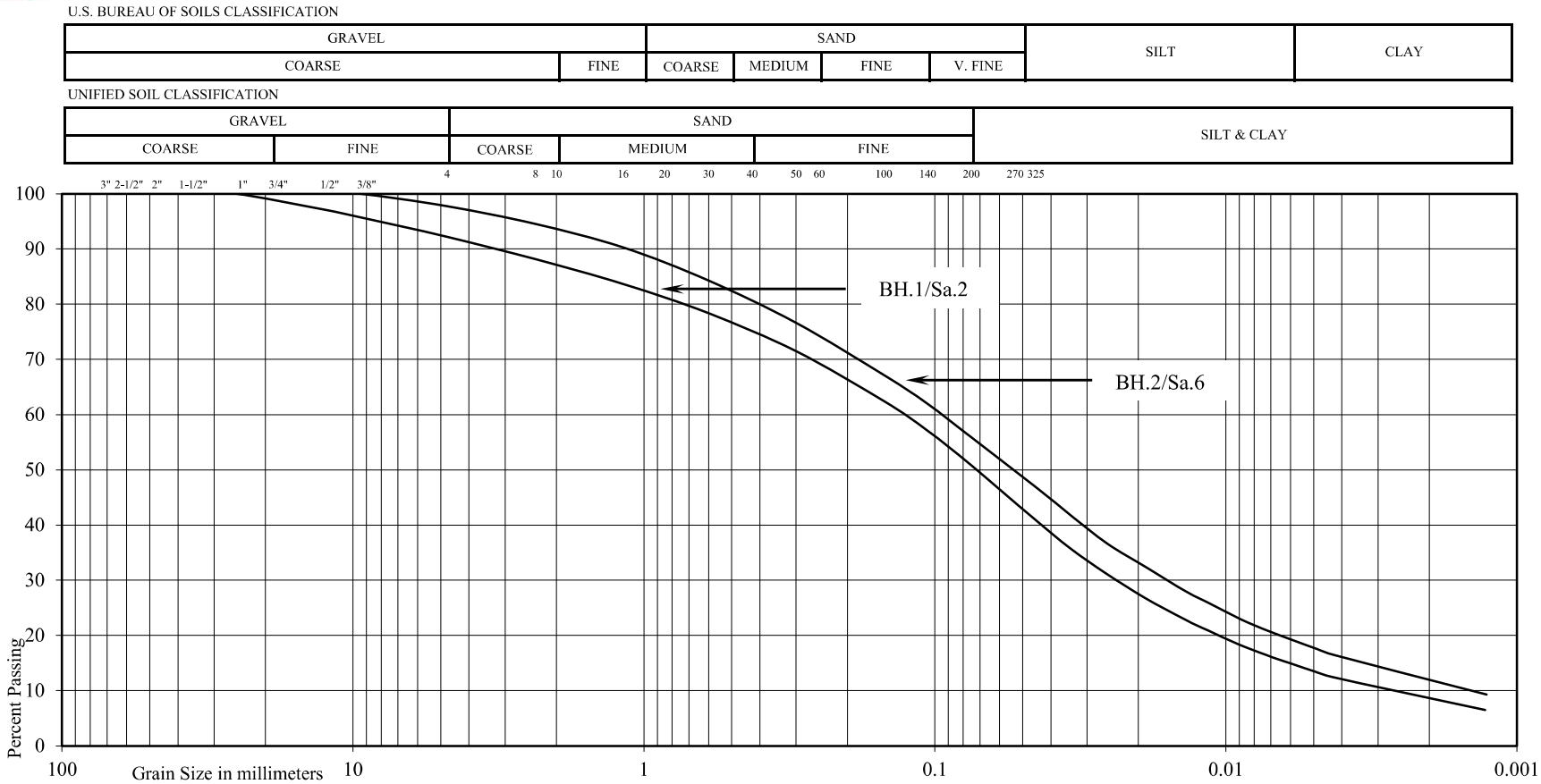
GRAIN SIZE DISTRIBUTION

Reference No: 1610-S137



Project:	Proposed Orangutan Exhibit	
Location:	361A Old Finch Avenue, City of Toronto	
Borehole No:	1	2
Sample No:	2	6
Depth (m):	1.1	4.6
Elevation (m):	-	-

BH./Sa.	1/2	2/6
Liquid Limit (%) =	-	-
Plastic Limit (%) =	-	-
Plasticity Index (%) =	-	-
Moisture Content (%) =	9	7
Estimated Permeability (cm./sec.) =	10^{-6}	10^{-6}

Classification of Sample [& Group Symbol]: SANDY SILT, Till
a tr. to some clay, a tr. of gravel

Figure: 5

Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

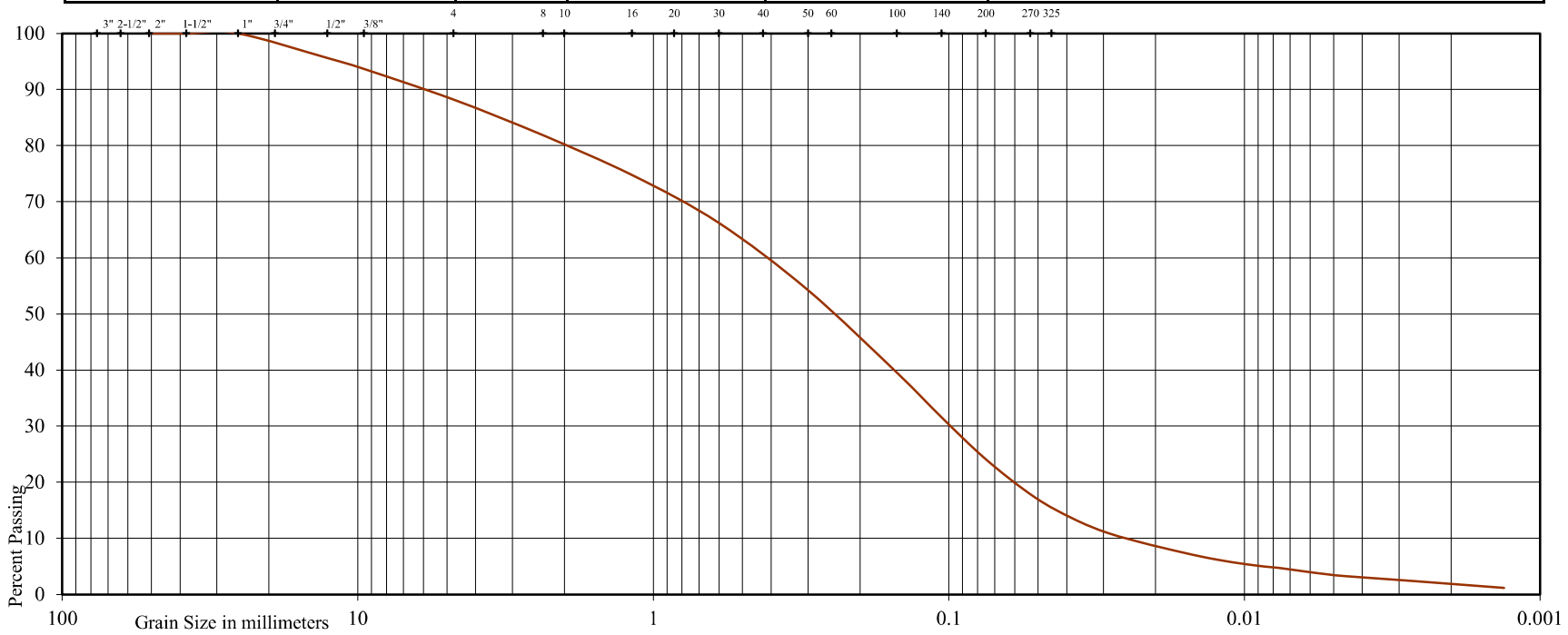
Reference No: 1610-S137

U.S. BUREAU OF SOILS CLASSIFICATION

GRAVEL		SAND				SILT	CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	V. FINE		

UNIFIED SOIL CLASSIFICATION

GRAVEL		SAND			SILT & CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



Project: Proposed Orangutan Exhibit

Location: 361A Old Finch Avenue, City of Toronto

Borehole No: 4

Sample No: 2

Depth (m): 1.1

Elevation (m): -

Liquid Limit (%) = -

Plastic Limit (%) = -

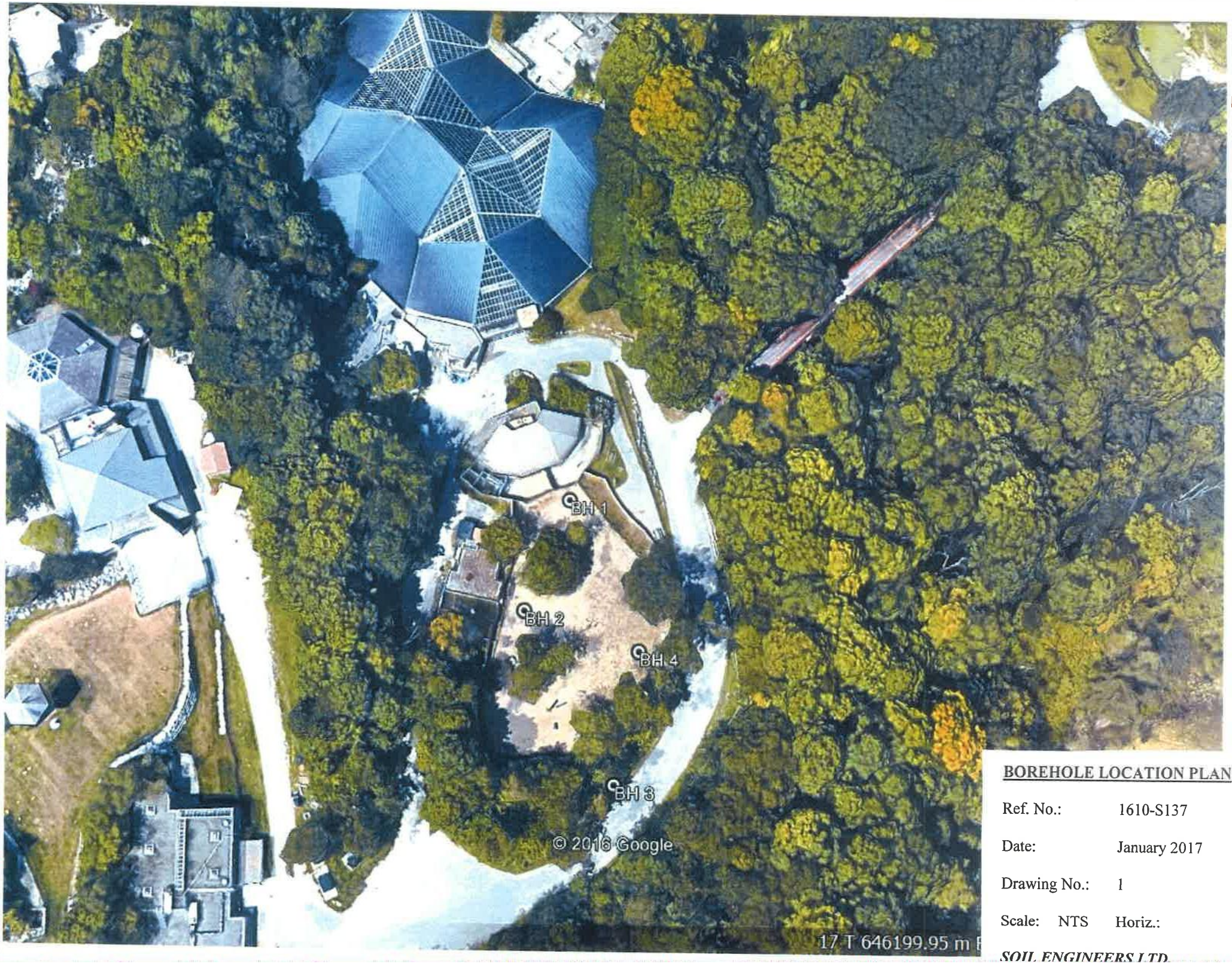
Plasticity Index (%) = -

Moisture Content (%) = 4

Estimated Permeability (cm./sec.) = 10^{-4}

Classification of Sample [& Group Symbol]: SILTY SAND, Till
some gravel, a tr. of clay

Figure: 6



BOREHOLE LOCATION PLAN

Ref. No.: 1610-S137

Date: January 2017

Drawing No.: 1

Scale: NTS Horiz.:

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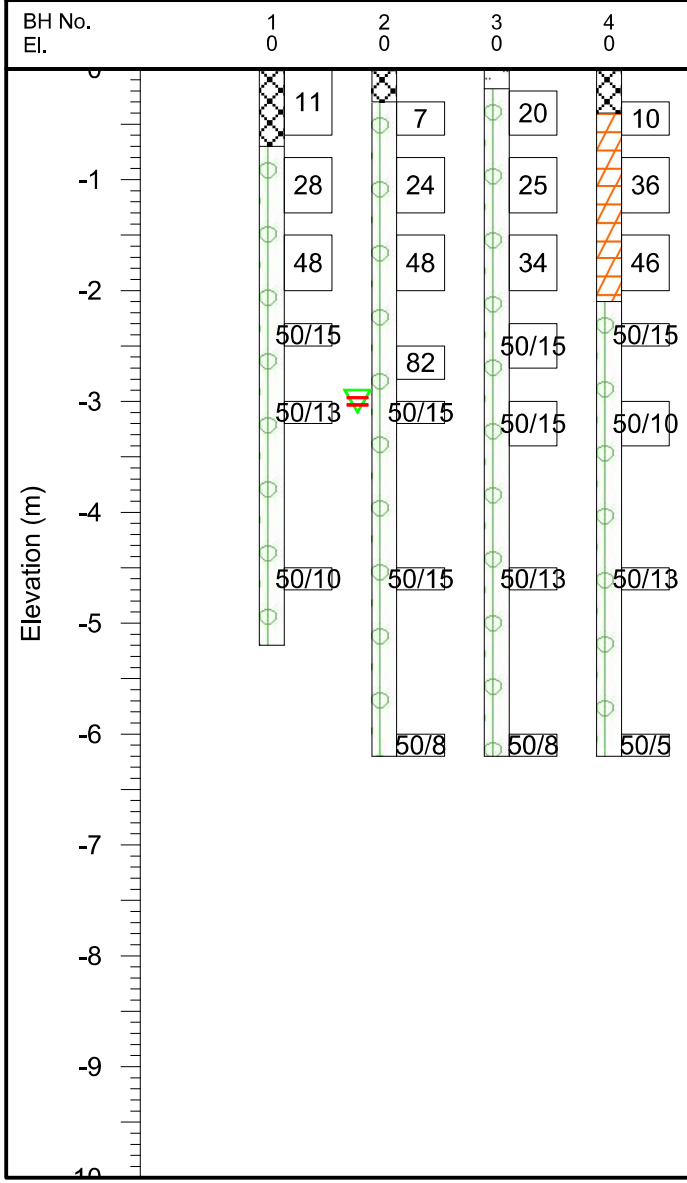
Subsurface Profile
Drawing No. 2
Scale: As Shown

Job Number: 1610-S137
Report Date: January 2017
Job Location: 361A Old Finch Avenue, City of Toronto (Scarborough)

Project Description: Proposed Orangutan Exhibit

Legend

CAVE IN
WL (END OF DRILLING)
WL (STABILIZED)
TOPSOIL
CONCRETE
PAVEMENT
GRANULAR
FILL
SAND
SILTY SAND
SILTY SAND TILL
SANDY SILT
SANDY SILT TILL
SILT
SILTY CLAY
SILTY CLAY TILL
SHALE
PEAT
ALLUVIUM



Geotechnical Investigation Report

Soil Engineers Ltd.
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BARRIE	MISSISSAUGA	OSHAWA	NEWMARKET	GRAVENHURST	HAMILTON
TEL: (705) 721-7863	TEL: (905) 542-7605	TEL: (905) 440-2040	TEL: (905) 853-0647	TEL: (705) 684-4242	TEL: (905) 777-7956
FAX: (705) 721-7864	FAX: (905) 542-2769	FAX: (905) 725-1315	FAX: (905) 881-8335	FAX: (705) 684-8522	FAX: (905) 542-2769

November 13, 2019 Reference No. 1908-S132

Zeidler Architecture Inc.
315 Queen Street West
Toronto. Ontario
M5V 2X2

Attention: Ms. Lena Chow

Re: Geotechnical Investigation Report
Proposed Structures and Shoring
Toronto Zoo
361A Old Finch Avenue
City of Toronto

Dear Madam:

As per your instructions, we have completed the borehole investigation for the captioned project and herein present our findings and recommendations.

The purpose of the investigation was to reveal the subsurface conditions and to provide recommendations for the design and construction of the proposed project.

The subject site of investigation is located within the Toronto Zoo, situated at the southwest of Old Finch Avenue and Meadowvale Road, in the City of Toronto. The investigated areas are within the Indo-Malaya Pavilion and Orangutan Habitat exhibit, where the ground surface is either covered with topsoil, concrete pad, interlocking brick or a layer of granular fill.

The proposed project consists of the construction of column-supported structures, such as boardwalk, tree house, glass viewing stand, wire rope swings and shoring structures at the perimeter.

FIELD WORK

The field work, consisting of 12 boreholes to depths ranging from 1.2 to 5.0 m, was performed on October 8, 9 and 10, 2019, at the locations shown on the Borehole Location

Plan, Drawing Nos. 1 and 2. Refusal to augering was encountered at 6 of the boreholes (Boreholes 3, 4, 5, 6, 8 and 12), at depths ranging from 1.2 to 3.5 m, it is inferred that boulder was encountered at these levels. Borehole 2 was cancelled by the client.

The holes were advanced at intervals to the sampling depths by a track-mounted continuous-flight power-auger machine or manual drop hammer equipped for soil sampling. Standard Penetration Tests, using the procedures described on the enclosed "List of Abbreviations and Terms", were performed at the sampling depths. The test results are recorded as the Standard Penetration Resistance (or 'N' values) of the subsoil. The relative density of the granular strata and the consistency of the cohesive strata are inferred from the 'N' values. Split-spoon samples were recovered for soil classification and laboratory testing.

The field work was supervised and the findings were recorded by a Geotechnical Technician.

The sampling depths and the depths of the soil strata changes were referred to the prevailing ground/pavement surface at each of the borehole locations.

SUBSURFACE CONDITIONS

Detailed descriptions of the encountered subsurface conditions are presented on the Borehole Logs, comprising Figures 1 to 12, inclusive. The revealed stratigraphy is plotted on the Subsurface Profile, Drawing Nos. 3 and 4, and the engineering properties of the disclosed soils are discussed herein.

The borehole investigation has revealed that beneath either a pavement structure, a layer of granular fill, a veneer of topsoil and a layer of earth fill, the site is generally underlain by strata of sandy silt till, silty sand till and silty sand.

Pavement Structure (Boreholes 3 and 5)

The revealed pavement structure consists of interlocking brick, 80 mm thick (Borehole 3) or a concrete pad, 80 mm thick and granular fill, 50 mm thick (Borehole 5). The granular fill consists of silty sand with some gravel to being gravelly.

Granular Fill (Borehole 12)

A layer of granular fill, 80 mm thick, was found at the ground surface. It consists of a mixture of crushed gravel and silty sand.

Topsoil (Boreholes 6, 7, 8, 9, 10 and 11)

The revealed topsoil is 20 to 41 cm thick. It is dark brown in colour, indicating that it contains appreciable amounts of roots and humus. These materials are unstable and compressible under loads; therefore, the topsoil is considered to be void of engineering value. Due to its humus content, it may produce volatile gases and generate an offensive odour under anaerobic conditions. Therefore, the topsoil must not be buried below any structures or deeper than 1.2 m below the finished grade, so that it will not have an adverse impact on the environmental well-being of the developed areas.

Since the topsoil is considered void of engineering value, it can only be used for general landscaping and landscape contouring purposes. A fertility analysis can be carried out to determine the suitability of the topsoil as a planting material.

Earth Fill (All Boreholes)

The earth fill was found extending to depths from 0.7 to 2.3 m below the prevailing pavement/ground surface. The earth fill consists of silty clay, sandy silt and silty sand material, with a trace of gravel.

The obtained 'N' values range from 4 to 20, with a median of 8 blows per 30 cm of penetration, indicating that the fill was loosely placed with nominal compaction. Its relative density is non-uniform and loose and, therefore, it is unsuitable to support structures sensitive to settlement.

The natural water content values range from 5% to 22%, with a median of 16%, indicating that the fill is in a moist to very moist condition, which corresponds with our sample examinations.

A grain size analysis was performed on 1 representative sample and the result is plotted on Figure 13.

Due to its unknown history and non-uniform, generally loose density, the earth fill is considered to be unsuitable for supporting structures. For structural use, the fill must be subexcavated, inspected and sorted free of any deleterious material, if detected, and properly compacted.

One must be aware that the samples retrieved from boreholes 10 cm in diameter may not be truly representative of the geotechnical and environmental quality of the fill, and do not

indicate whether the topsoil beneath the earth fill was completely stripped. This should be further assessed by laboratory testing and/or test pits.

Sandy Silt Till and **Silty Sand Till** (All Boreholes)

The sandy silt till and silty sand till consist of a random mixture of soil particle sizes ranging from clay to gravel, with the silt or sand being the predominant fraction. Their structure is heterogeneous, indicating a glacial deposit.

Hard resistance to augering was encountered in places, indicating the presence of cobbles and boulders. Occasional wet sand and silt seams and layers were also found in the till mantle.

The obtained 'N' values range from 17 blows per 30 cm to 50 blows per 10 cm, with a median of 62 blows per 30 cm of penetration, showing that the relative density of the till is compact to very dense, being generally very dense.

The natural water content was determined, and the results are plotted on the Borehole Logs; the values range from 5% to 19%, with a median of 8%, showing the till is in a moist to wet, generally moist condition.

Grain size analyses were performed on 2 representative samples of the tills and the results are plotted on Figures 14 and 15.

The deduced engineering properties pertaining to the project are given below:

- Moderately high frost susceptibility and moderately low water erodibility.
- Relatively low to low permeability, with an estimated coefficient of permeability of 10^{-5} to 10^{-6} cm/sec, depending on the clay and silt content, an estimated percolation rate of 30 to 60 min/cm, and runoff coefficients of:

Slope	
0% - 2%	0.11 to 0.15
2% - 6%	0.16 to 0.20
6% +	0.23 to 0.28

- Frictional-cohesive soils, their shear strength is density dependent and is augmented by cementation and cohesion.
- They will slough slowly if submerged in an unconfined state, or from an open-face cut under seepage conditions, particularly in the zone where wet sand and silt layers are prevalent.

- Fair pavement-supportive materials, with an estimated California Bearing Ratio (CBR) value of 8% to 10%.
- Moderately low corrosivity to buried metal, an estimated electrical resistivity of 5000 ohm·cm.

Silty Sand (Borehole 1)

The silty sand deposit was encountered below a stratum of sandy silt till and extends to the maximum investigated depth. Sample examination shows that it is non-cohesive. The laminated structure shows the deposit was derived from a lacustrine environment.

The obtained 'N' value is 54 blows per 30 cm of penetration; therefore, the relative density of the silty sand is very dense.

The natural water content was determined and the result is plotted on the Borehole Log. The value is 15%, showing that the silty sand deposit is in a wet condition.

Accordingly, the following engineering properties are deduced:

- Highly frost susceptible with high soil-adfreezing potential.
- Highly water erodible.
- Relatively pervious, with an estimated coefficient of permeability of 10^{-4} cm/sec, an estimated percolation rate of 15 min/cm, and runoff coefficients of:

Slope	
0% - 2%	0.07
2% - 6%	0.12
6% +	0.18

- A frictional soil, its shear strength is derived from internal friction and is density dependent. Due to its dilatancy, the shear strength of the wet sand is susceptible to impact disturbance; i.e., the disturbance will induce a build-up of pore pressure within the soil mantle, resulting in soil dilation and a reduction of shear strength.
- In relatively steep cuts, the sand will be stable in a damp to moist condition, but will slough if it is wet and run with water seepage. The bottom will boil under a piezometric head of 0.3 m.
- A fair material to support pavement, with an estimated CBR value of at least 8%.
- Moderately low corrosivity to buried metal, with an estimated electrical resistivity of 5000 ohm·cm.

GROUNDWATER CONDITIONS

Groundwater was detected at depths of 3.7 m and 4.3 m below the prevailing ground surface at Boreholes 7 and 9, respectively; all other boreholes remained dry upon completion of field work.

The yield of groundwater from the sandy silt till and silty sand till, due to their relatively low permeability, is expected to be small and limited. The yield from the silty sand will be appreciable and likely persistent.

ASSESSMENT AND RECOMMENDATIONS

Based on the findings, the geotechnical considerations pertaining to the general construction of the project are presented herein:

The topsoil must be stripped for the project construction. This material will generate volatile gases under anaerobic conditions and is unsuitable for engineering application. Therefore, the topsoil should be placed in the landscaped areas only and should not be buried within the building envelope or deeper than 1.2 m below the exterior finished grade of the project. A fertility test must be carried out to assess its suitability as landscaping material.

The earth fill has not been uniformly compacted and its history is unknown. Therefore, it is not suitable for foundation construction.

The sound natural soils are suitable for normal or caisson foundation construction. Due to the presence of topsoil and earth fill, the footing subgrade must be inspected by a geotechnical engineer, or a geotechnical technician under the supervision of a geotechnical engineer, to ensure that the revealed conditions are compatible with the foundation design requirements.

FOUNDATIONS

The recommended soil pressures together with the corresponding suitable founding levels are presented in the following table.

Borehole No.	Maximum Allowable Soil Pressure (SLS)/ Factored Ultimate Soil Bearing Pressure (ULS) and Corresponding Founding Level		
	150 kPa (SLS) 250 kPa (ULS)	250 kPa (SLS) 400 kPa (ULS)	300 kPa (SLS) 480 kPa (ULS)
	Depth (m)	Depth (m)	Depth (m)
1	1.6 or +	2.4 or +	4.6 or +
3	-	-	2.4 or +
4	-	-	1.0 or +
5	1.0 or +	-	1.6 or +
6	-	-	1.0 or +
7	-	-	1.0 or +
8	-	-	1.0 or +
9	-	-	1.0 or +
10	-	1.0 or +	1.6 or +
11	-	1.0 or +	1.6 or +
12	1.2 or +	-	1.6 or +

The caisson foundations for the proposed structures and shoring system must extend to a sufficient depth below the prevailing ground surface to provide adequate resistance to movement induced by lateral loads. It should be noted that the soils within the frost depth will be weakened by the effects of yearly freezing and thawing. Therefore, the lateral resistance within the frost depth, i.e., about 1.2 m, should be ignored.

The soil parameters given in the table below can be used for the design of the caisson foundations for both the structures and shoring system.

Foundations and grade beams exposed to weathering and in unheated areas should have at least 1.2 m of earth cover for protection against frost action.

The foundations must be inspected by a geotechnical consultant to ensure that the subgrade conditions are compatible with the foundation design requirements.

The footings must meet the requirements specified in the latest Ontario Building Code. As a guide, the structure should be designed to resist an earthquake force using Site Classification 'D' (stiff soil).

Soil Parameters

The recommended soil parameters are given in the following table.

Unit Weight and Bulk Factor	**Unit Weight (kN/m^3)**	**Estimated Bulk Factor**	
	Bulk	**Loose**	**Compacted**
Earth Fill	21.0	1.20	1.00
Sound Till	22.0	1.33	1.05
Silty Sand	20.5	1.25	0.98
Lateral Earth Pressure Coefficients			
	Active K_a	**At Rest K_o**	**Passive K_p**
Earth Fill	0.40	0.50	2.50
Sound Till	0.32	0.48	3.02
Silty Sand	0.30	0.46	3.33

Excavation

Excavations should be carried out in accordance with Ontario Regulation 213/91.

Excavations in excess of 1.2 m should be sloped at 1 vertical:1 horizontal for stability. The till contains occasional boulders. Extra effort and a properly equipped backhoe will be required for excavation.

For excavation purposes, the types of soils are classified in the following table.

Material	Type
Sound Till	2
Earth Fill and Silty Sand above groundwater	3
Silty Sand below groundwater	4

The groundwater yield from the sandy silt till and silty sand till, due to their relatively low permeability, will be small and can be controlled by pumping from sumps. The yield of groundwater in the silty sand, if encountered, is expected to be appreciable and likely persistent and may be controllable by pumping from closely spaced sumps and/or by the use of a well-point dewatering system.

LIMITATIONS OF REPORT

This report was prepared by Soil Engineers Ltd. for the account of Zeidler Architecture Inc., and for review by its designated consultants and government agencies. The material in it reflects the judgement of Frank Lee, P.Eng. and Bernard Lee, P.Eng., in light of the information available to it at the time of preparation. Any use which a Third Party makes of this report, or any reliance on decisions to be made based on it, are the responsibility of such Third Parties. Soil Engineers Ltd. accepts no responsibility for damages, if any, suffered by any Third Party as a result of decisions made or actions based on this report.

Yours very truly,
SOIL ENGINEERS LTD.

Frank Lee, P.Eng.

Bernard Lee, P.Eng.
FL/BL:dd

ENCLOSURES

Borehole Logs ..... Figures 1 to 12
Grain Size Distribution Graphs ..... Figures 13 to 15
Borehole Location Plan ..... Drawing Nos. 1 and 2
Subsurface Profile ..... Drawing Nos. 3 and 4

LIST OF ABBREVIATIONS AND DESCRIPTION OF TERMS

The abbreviations and terms commonly employed on the borehole logs and figures, and in the text of the report, are as follows:

SAMPLE TYPES

AS Auger sample
CS Chunk sample
DO Drive open (split spoon)
DS Denison type sample
FS Foil sample
RC Rock core (with size and percentage recovery)
ST Slotted tube
TO Thin-walled, open
TP Thin-walled, piston
WS Wash sample

PENETRATION RESISTANCE

Dynamic Cone Penetration Resistance:

A continuous profile showing the number of blows for each foot of penetration of a 2-inch diameter, 90° point cone driven by a 140-pound hammer falling 30 inches.

Plotted as '—●—'

Standard Penetration Resistance or 'N' Value:

The number of blows of a 140-pound hammer falling 30 inches required to advance a 2-inch O.D. drive open sampler one foot into undisturbed soil.

Plotted as '○'

WH Sampler advanced by static weight
PH Sampler advanced by hydraulic pressure
PM Sampler advanced by manual pressure
NP No penetration

SOIL DESCRIPTION

Cohesionless Soils:

'N' (blows/ft)	Relative Density
0 to 4	very loose
4 to 10	loose
10 to 30	compact
30 to 50	dense
over 50	very dense

Cohesive Soils:

Undrained Shear Strength (ksf)	'N' (blows/ft)	Consistency
less than 0.25	0 to 2	very soft
0.25 to 0.50	2 to 4	soft
0.50 to 1.0	4 to 8	firm
1.0 to 2.0	8 to 16	stiff
2.0 to 4.0	16 to 32	very stiff
over 4.0	over 32	hard

Method of Determination of Undrained Shear Strength of Cohesive Soils:

x 0.0 Field vane test in borehole; the number denotes the sensitivity to remoulding

△ Laboratory vane test

□ Compression test in laboratory

For a saturated cohesive soil, the undrained shear strength is taken as one half of the undrained compressive strength

METRIC CONVERSION FACTORS

1 ft = 0.3048 metres
1lb = 0.454 kg
1 inch = 25.4 mm
1ksf = 47.88 kPa

JOB NO.: 1908-S132

LOG OF BOREHOLE NO.: 1

FIGURE NO.: 1

PROJECT DESCRIPTION: Proposed Structures and Shoring

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: Toronto Zoo
361A Old Finch Avenue
City of Toronto

DRILLING DATE: October 8, 2019

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
0.0	Ground Surface							
0.0	Brown **EARTH FILL** sandy silt and sand a trace of gravel	1	DO	5	0		8	Dry on completion
		2	DO	4	1		18	
1.5	Brown, compact to dense **SANDY SILT TILL** occ. wet sand and silt seams and layers cobbles and boulders __ silt layer	3	DO	17	2		15	
		4	DO	32			19	
		5	DO	24	3		14	
		6	DO	24	4		17	
4.5	Brown, very dense **SILTY SAND**	7	DO	54			15	
5.0	**END OF BOREHOLE**				5			
					6			

Soil Engineers Ltd.

JOB NO.: 1908-S132

LOG OF BOREHOLE NO.: 2

FIGURE NO.: 2

PROJECT DESCRIPTION: Proposed Structures and Shoring

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: Toronto Zoo
361A Old Finch Avenue
City of Toronto

DRILLING DATE: October 8, 2019

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES: Number	SAMPLES: Type	SAMPLES: N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
0.0	Ground Surface							
0.0	**Note**: Borehole cancelled by client				0 1 2 3 4 5			
	brown				6			

JOB NO.: 1908-S132

LOG OF BOREHOLE NO.: 3

FIGURE NO.: 3

PROJECT DESCRIPTION: Proposed Structures and Shoring

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: Toronto Zoo
361A Old Finch Avenue
City of Toronto

DRILLING DATE: October 8, 2019

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
0.0	Pavement Surface							
0.0	**80 mm Interlocking Brick** Brown	1	DO	6	0		5	Dry on completion
	EARTH FILL silty sand and sand a trace of gravel	2	DO	8	1		17	
		3	DO	9	2		15	
2.3	Brown, dense to very dense	4	DO	40			8	
	SANDY SILT TILL	5	DO	50/15	3		7	
3.5	**END OF BOREHOLE** **Refusal to augering** **Inferred boulders or bedrock**				4			
	brown				5			
					6			

Soil Engineers Ltd.

JOB NO.: 1908-S132

LOG OF BOREHOLE NO.: 4

FIGURE NO.: 4

PROJECT DESCRIPTION: Proposed Structures and Shoring

METHOD OF BORING: Hand Hammer

PROJECT LOCATION: Toronto Zoo
361A Old Finch Avenue
City of Toronto

DRILLING DATE: October 8, 2019

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
0.0	Ground Surface							
0.0	Brown **EARTH FILL** silty sand a trace of gravel	1	DO	8	0	○	6 ●	Dry on completion
0.8	Brown, dense **SANDY SILT TILL**	2	DO	50	1	○	5 ●	
1.2	**END OF BOREHOLE** **Refusal to augering** **Inferred boulders or bedrock**				2			
	brown				3			
					4			
					5			
					6			

Soil Engineers Ltd.

JOB NO.: 1908-S132

LOG OF BOREHOLE NO.: 5

FIGURE NO.: 5

PROJECT DESCRIPTION: Proposed Structures and Shoring

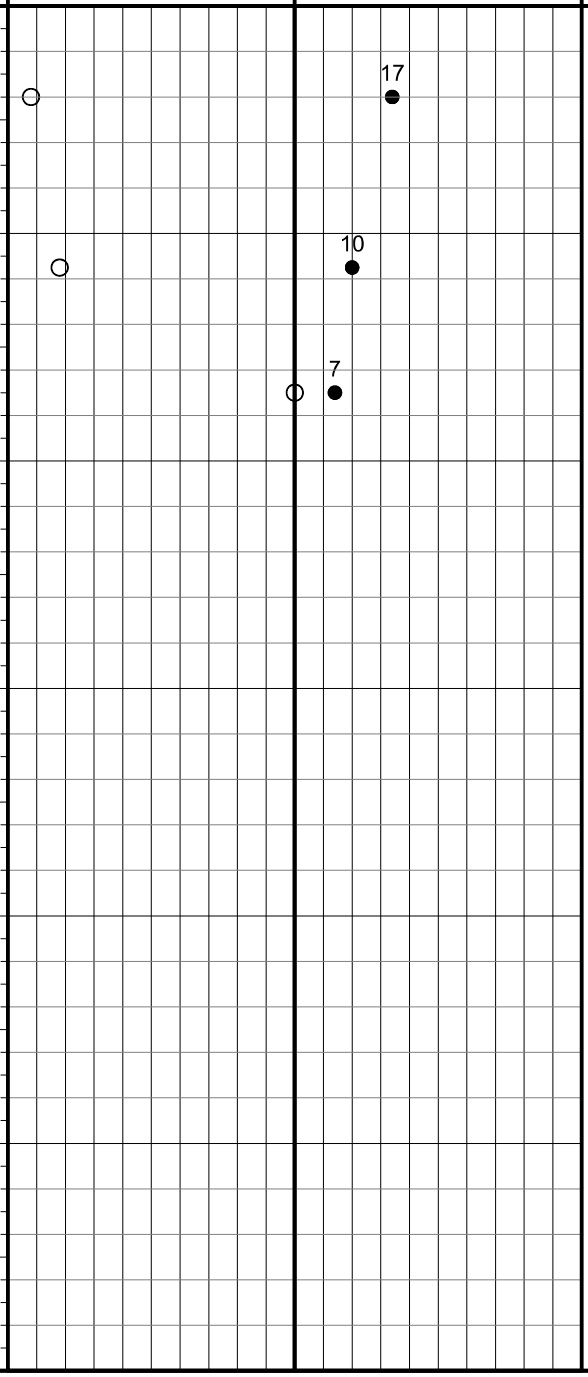
METHOD OF BORING: Flight-Auger

PROJECT LOCATION: Toronto Zoo
361A Old Finch Avenue
City of Toronto

DRILLING DATE: October 10, 2019

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) / Shear Strength (kN/m²) / Penetration Resistance (blows/30 cm)	Atterberg Limits PL LL / Moisture Content (%)	WATER LEVEL
0.0	Concrete Surface							
0.0	**80 mm Concrete Pad** **50 mm Granular Fill** Brown **EARTH FILL** silty clay and silty sand a trace of gravel	1	DO	8	0			Dry on completion
0.8	Brown, compact to very dense **SILTY SAND TILL**	2	DO	18	1			
		3	DO	50/13				
1.9	**END OF BOREHOLE** **Refusal to augering** **Inferred boulders or bedrock**				2			
	brown				3			
					4			
					5			
					6			

Dynamic Cone (blows/30 cm): 10 30 50 70 90
Shear Strength (kN/m²): 50 100 150 200
Penetration Resistance (blows/30 cm): 10 30 50 70 90
Atterberg Limits: PL LL
Moisture Content (%): 10 20 30 40



Soil Engineers Ltd.

JOB NO.: 1908-S132

LOG OF BOREHOLE NO.: 6

FIGURE NO.: 6

PROJECT DESCRIPTION: Proposed Structures and Shoring

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: Toronto Zoo
361A Old Finch Avenue
City of Toronto

DRILLING DATE: October 10, 2019

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
0.0	Ground Surface							
0.0	**25 cm TOPSOIL** Brown **EARTH FILL** silty clay and silty sand a trace of gravel	1	DO	5	0	○	22	Dry on completion
0.8	Brown, dense to very dense **SILTY SAND TILL** occ. wet sand and silt seams and layers cobbles and boulders	2	DO	36	1	○	9	
		3	DO	62	2	○	8	
2.3	**END OF BOREHOLE** **Refusal to augering** **Inferred boulders or bedrock** brown / grey				3 4 5 6			

Soil Engineers Ltd.

JOB NO.: 1908-S132

LOG OF BOREHOLE NO.: 7

FIGURE NO.: 7

PROJECT DESCRIPTION: Proposed Structures and Shoring

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: Toronto Zoo
361A Old Finch Avenue
City of Toronto

DRILLING DATE: October 9, 2019

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
0.0	Ground Surface							
0.0	**36 cm TOPSOIL**	1	DO	20	0		10	
	Brown **EARTH FILL** silty clay and silty sand a trace of gravel							
0.7	Dense to very dense	2	DO	50/10	1		7	
		3	DO	36	2		7	
	SILTY SAND TILL							
	occ. wet sand and silt seams and layers cobbles and boulders — brown / grey	4	DO	74			8	
		5	DO	50/13	3		5	
					4			
		6	DO	50/13			7	
4.7	**END OF BOREHOLE**				5			
					6			
					7			
					8			
					9			
					10			

W.L. @ depth of 3.7 m on completion

Soil Engineers Ltd.

JOB NO.: 1908-S132

LOG OF BOREHOLE NO.: 8

FIGURE NO.: 8

PROJECT DESCRIPTION: Proposed Structures and Shoring

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: Toronto Zoo
361A Old Finch Avenue
City of Toronto

DRILLING DATE: October 10, 2019

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
0.0	Ground Surface							
0.0	**20 cm TOPSOIL** Brown **EARTH FILL** silty clay and silty sand a trace of gravel	1	DO	15	0		6	Dry on completion
0.8	Brown, dense to very dense **SILTY SAND TILL** occ. wet sand and silt seams and layers cobbles and boulders	2	DO	32	1		7	
		3	DO	50/10			7	
2.0	**END OF BOREHOLE** **Refusal to augering** **Inferred boulders or bedrock**				2			
					3			
					4			
					5			
					6			
					7			
					8			
					9			
					10			

JOB NO.: 1908-S132

LOG OF BOREHOLE NO.: 9

FIGURE NO.: 9

PROJECT DESCRIPTION: Proposed Structures and Shoring

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: Toronto Zoo
361A Old Finch Avenue
City of Toronto

DRILLING DATE: October 9, 2019

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
0.0	Ground Surface							
0.0	**30 cm TOPSOIL**	1	DO	9	0		18	
	Brown **EARTH FILL** silty clay and silty sand a trace of gravel							
0.7	Dense to very dense	2	DO	35	1		9	
		3	DO	32	2		8	
	SILTY SAND TILL occ. wet sand and silt seams and layers cobbles and boulders — brown / grey	4	DO	71			7	
		5	DO	50/15	3		6	
		6	DO	50/10	4		6	
4.9	**END OF BOREHOLE**				5			
					6			
					7			
					8			
					9			
					10			

W.L. @ depth of 4.3 m on completion

Soil Engineers Ltd.

JOB NO.: 1908-S132

LOG OF BOREHOLE NO.: 10

FIGURE NO.: 10

PROJECT DESCRIPTION: Proposed Structures and Shoring

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: Toronto Zoo
361A Old Finch Avenue
City of Toronto

DRILLING DATE: October 9, 2019

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
0.0	Ground Surface							
0.0	**41 cm TOPSOIL**	1	DO	8	0		19	Dry on completion
	Brown **EARTH FILL** silty clay and silty sand a trace of gravel Compact to very dense							
0.7		2	DO	26	1		9	
		3	DO	33	2		7	
	brown / grey							
	SILTY SAND TILL	4	DO	50/13			7	
	occ. wet sand and silt seams and layers cobbles and boulders	5	DO	50/13	3		7	
		6	DO	50/10	4		8	
4.9	**END OF BOREHOLE**				5			
					6			
					7			
					8			
					9			
					10			

Soil Engineers Ltd.

JOB NO.: 1908-S132

LOG OF BOREHOLE NO.: 11

FIGURE NO.: 11

PROJECT DESCRIPTION: Proposed Structures and Shoring

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: Toronto Zoo
361A Old Finch Avenue
City of Toronto

DRILLING DATE: October 9, 2019

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
0.0	Ground Surface							
0.0	**30 cm TOPSOIL**	1	DO	10	0		9	Dry on completion
	Brown **EARTH FILL** silty sand a trace of gravel with topsoil layer							
0.7	Compact to very dense	2	DO	28	1		8	
		3	DO	38	2		8	
	SILTY SAND TILL occ. wet sand and silt seams and layers cobbles and boulders	4	DO	50/13			12	
	brown / grey	5	DO	50/13	3		6	
		6	DO	50/13	4		6	
4.7	**END OF BOREHOLE**				5			
					6			
					7			
					8			
					9			
					10			

Soil Engineers Ltd.

JOB NO.: 1908-S132

LOG OF BOREHOLE NO.: 12

FIGURE NO.: 12

PROJECT DESCRIPTION: Proposed Structures and Shoring

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: Toronto Zoo
361A Old Finch Avenue
City of Toronto

DRILLING DATE: October 10, 2019

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
0.0	Ground Surface							
0.0	**80 mm Granular Fill**				0			
	Brown **EARTH FILL** silty sand a trace of gravel	1	DO	13		○	19 ●	
0.8	Brown, compact to very dense	2	DO	20	1	○	8 ●	
	SILTY SAND TILL	3	DO	64	2	○	9 ●	Dry on completion
2.3	**END OF BOREHOLE** **Refusal to augering** **Inferred boulders or bedrock**				3 4 5 6 7 8 9 10			

Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

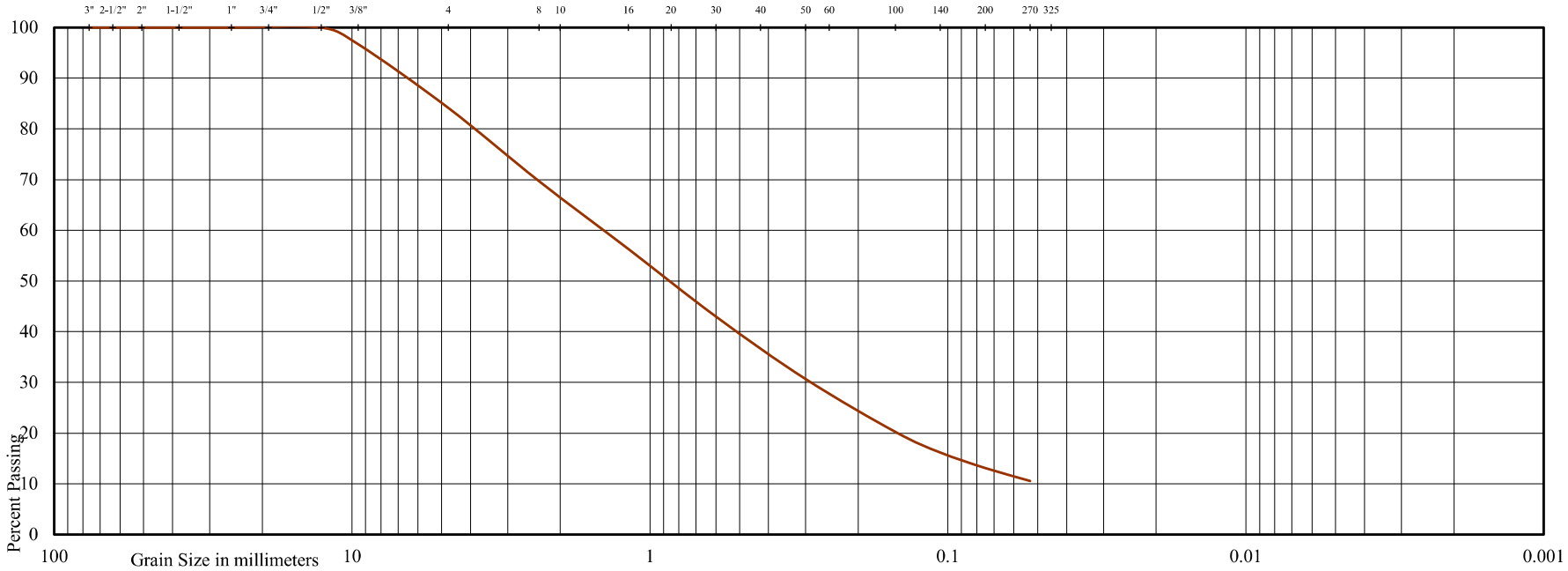
Reference No: 1908-S132

U.S. BUREAU OF SOILS CLASSIFICATION

GRAVEL		SAND				SILT	CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	V. FINE		

UNIFIED SOIL CLASSIFICATION

GRAVEL		SAND			SILT & CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



Project: Proposed Structures and Shoring

Location: Toronto Zoo
361A Old Finch Avenue, City of Toronto

Borehole No: 1

Sample No: 1

Depth (m): 0.4

Elevation (m): -

Liquid Limit (%) = -

Plastic Limit (%) = -

Plasticity Index (%) = -

Moisture Content (%) = 8

Estimated Permeability (cm./sec.) = 10^{-3}

Classification of Sample [& Group Symbol]: FINE TO COARSE SAND FILL, some silt and gravel

Figure: 13

Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

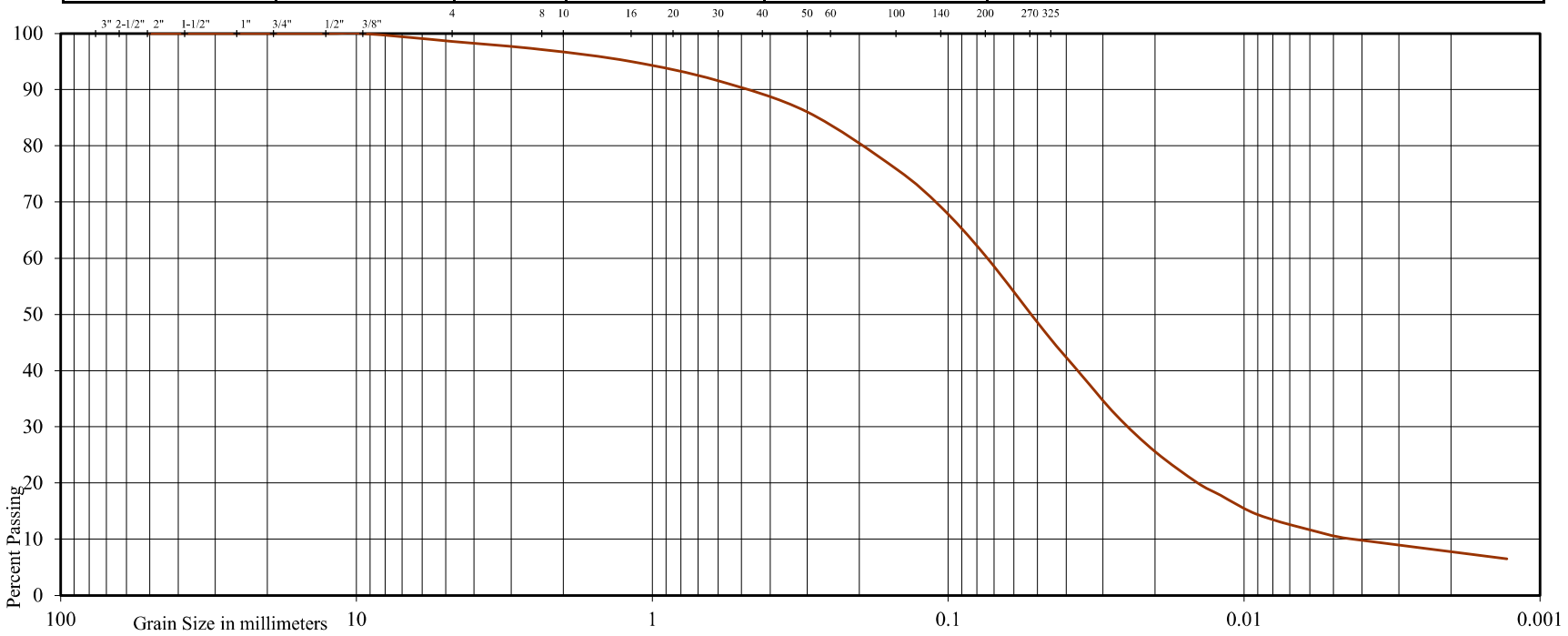
Reference No: 1908-S132

U.S. BUREAU OF SOILS CLASSIFICATION

GRAVEL		SAND				SILT	CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	V. FINE		

UNIFIED SOIL CLASSIFICATION

GRAVEL		SAND			SILT & CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



Project: Proposed Structures and Shoring

Location: Toronto Zoo

361A Old Finch Avenue, City of Toronto

Borehole No: 1

Sample No: 5

Depth (m): 3.4

Elevation (m): -

Liquid Limit (%) = -

Plastic Limit (%) = -

Plasticity Index (%) = -

Moisture Content (%) = 14

Estimated Permeability (cm./sec.) = 10^{-5}

Classification of Sample [& Group Symbol]: SANDY SILT TILL, traces of clay and gravel

Figure: 14

Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

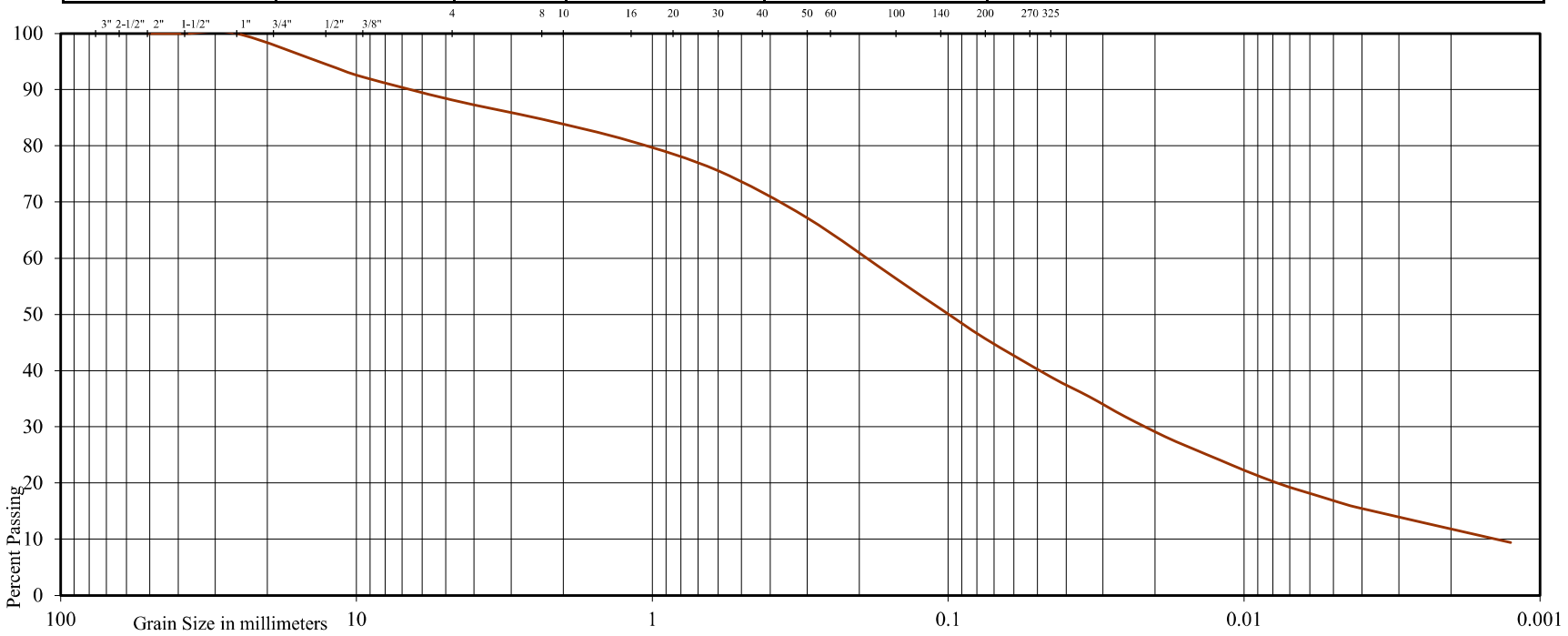
Reference No: 1908-S132

U.S. BUREAU OF SOILS CLASSIFICATION

GRAVEL		SAND				SILT	CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	V. FINE		

UNIFIED SOIL CLASSIFICATION

GRAVEL		SAND			SILT & CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



Project: Proposed Structures and Shoring

Location: Toronto Zoo

361A Old Finch Avenue, City of Toronto

Borehole No: 11

Sample No: 3

Depth (m): 1.8

Elevation (m): -

Liquid Limit (%) = -

Plastic Limit (%) = -

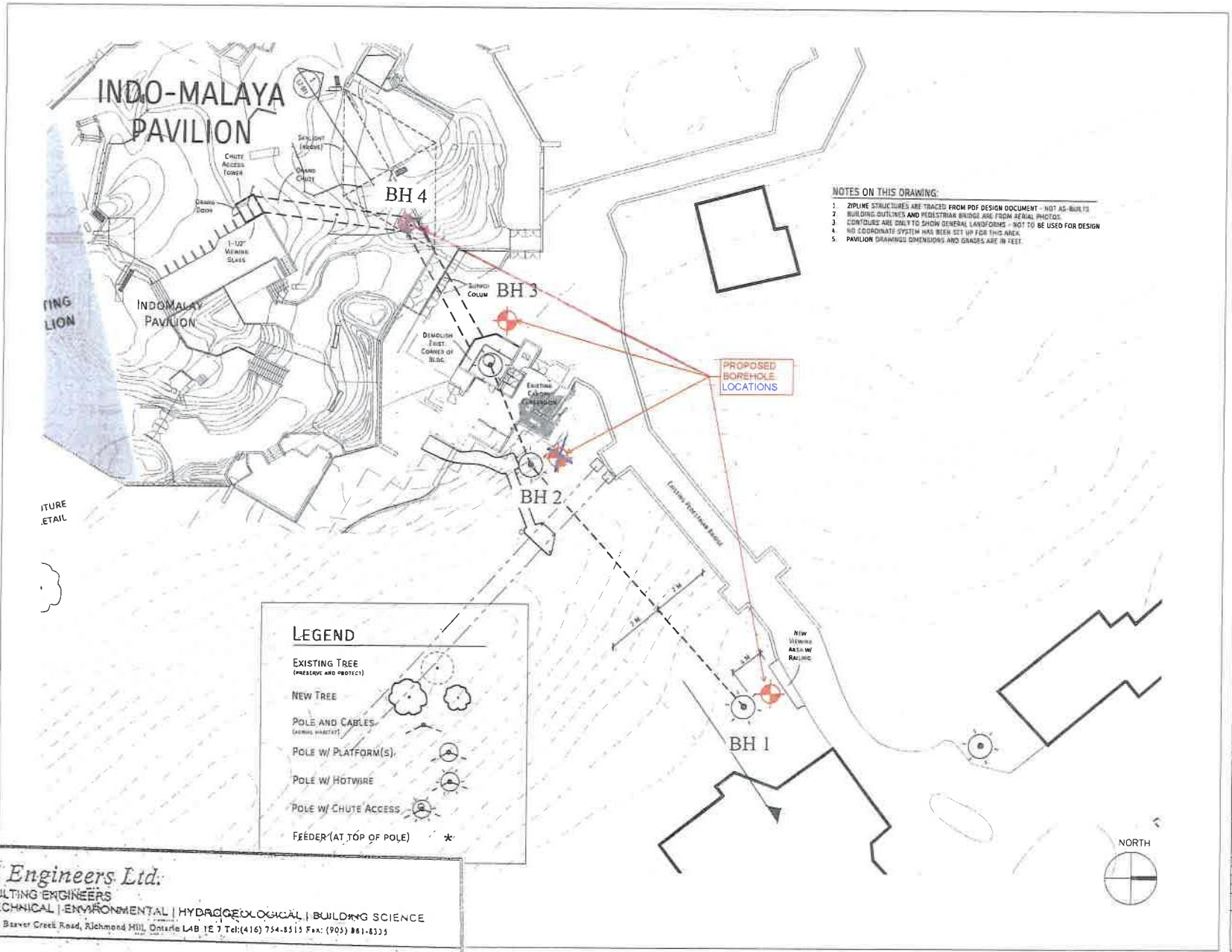
Plasticity Index (%) = -

Moisture Content (%) = 8

Estimated Permeability (cm./sec.) = 10^{-6}

Classification of Sample [& Group Symbol]: SILTY SAND TILL, some clay and gravel

Figure: 15



TORONTO ZOO ORANGUTAN EXHIBITS

toronto ZOO

DESIGN DEVELOPMENT

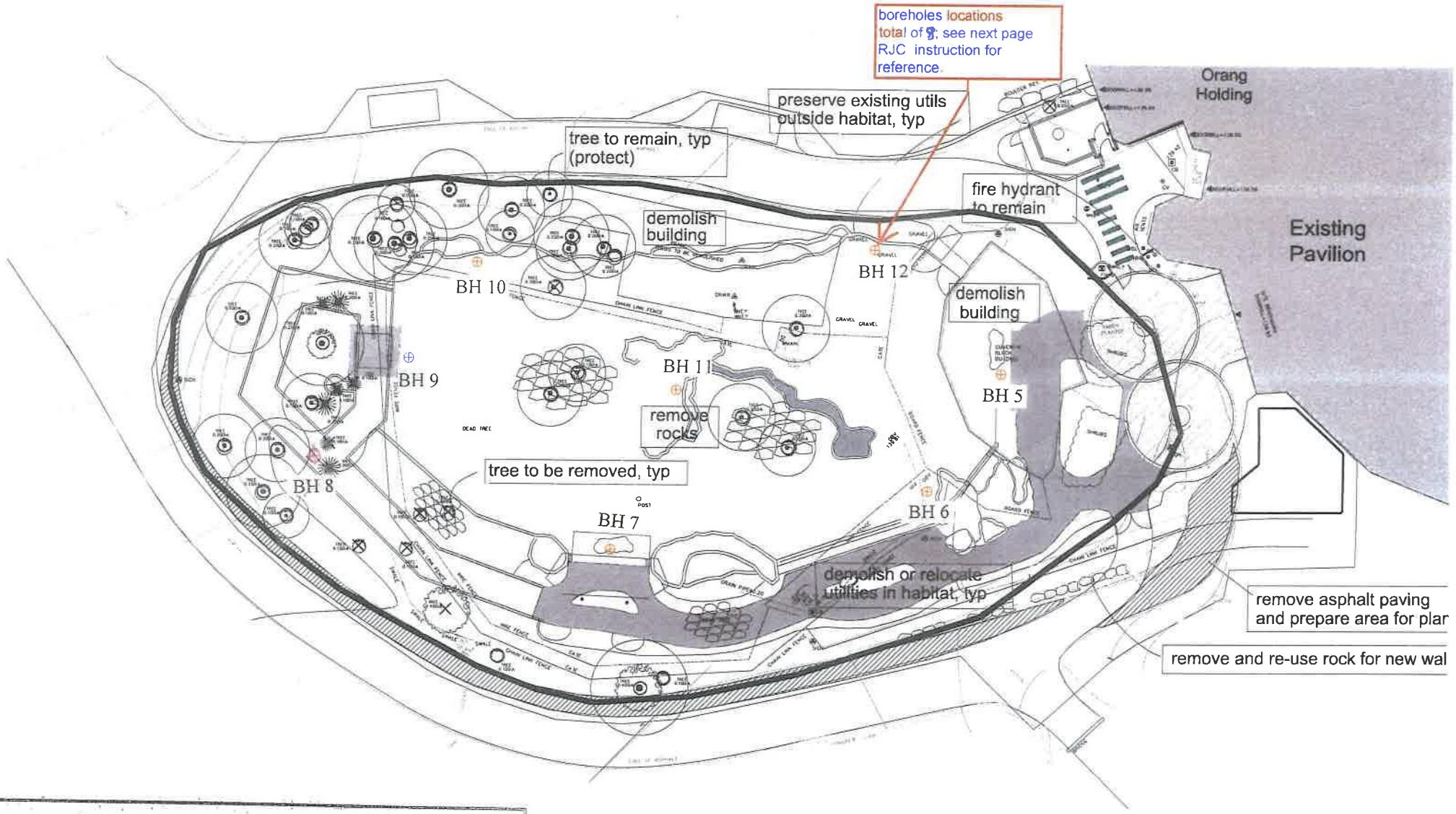
HABITAT 2 LAYOUT & MATERIALS PLAN

L2-101

Soil Engineers Ltd.
CONSULTING ENGINEERS
GEOTECHNICAL | ENVIRONMENTAL | HYDROGEOLOGICAL | BUILDING SCIENCE
90 West Beaver Creek Road, Richmond Hill, Ontario L4B 1E7 Tel:(416) 754-8515 Fax: (905) 881-8335

BOREHOLE LOCATION PLAN

DESIGNED	CHECKED	DWG NO. 1	REV
SCALE As shown	REF. NO. 1908-S132	DATE November 2019	



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90 West Beaver Creek Road, Richmond Hill, Ontario L4B 1E7 Tel:(416) 754-8515 Fax: (905) 881-8335

BOREHOLE LOCATION PLAN

DESIGNED	CHECKED	DWG NO. 2	REV
SCALE NTS	REF. NO. 1908-S132	DATE November 2019	

Soil Engineers Ltd.
CONSULTING ENGINEERS
GEOTECHNICAL | ENVIRONMENTAL | HYDROGEOLOGICAL | BUILDING SCIENCE

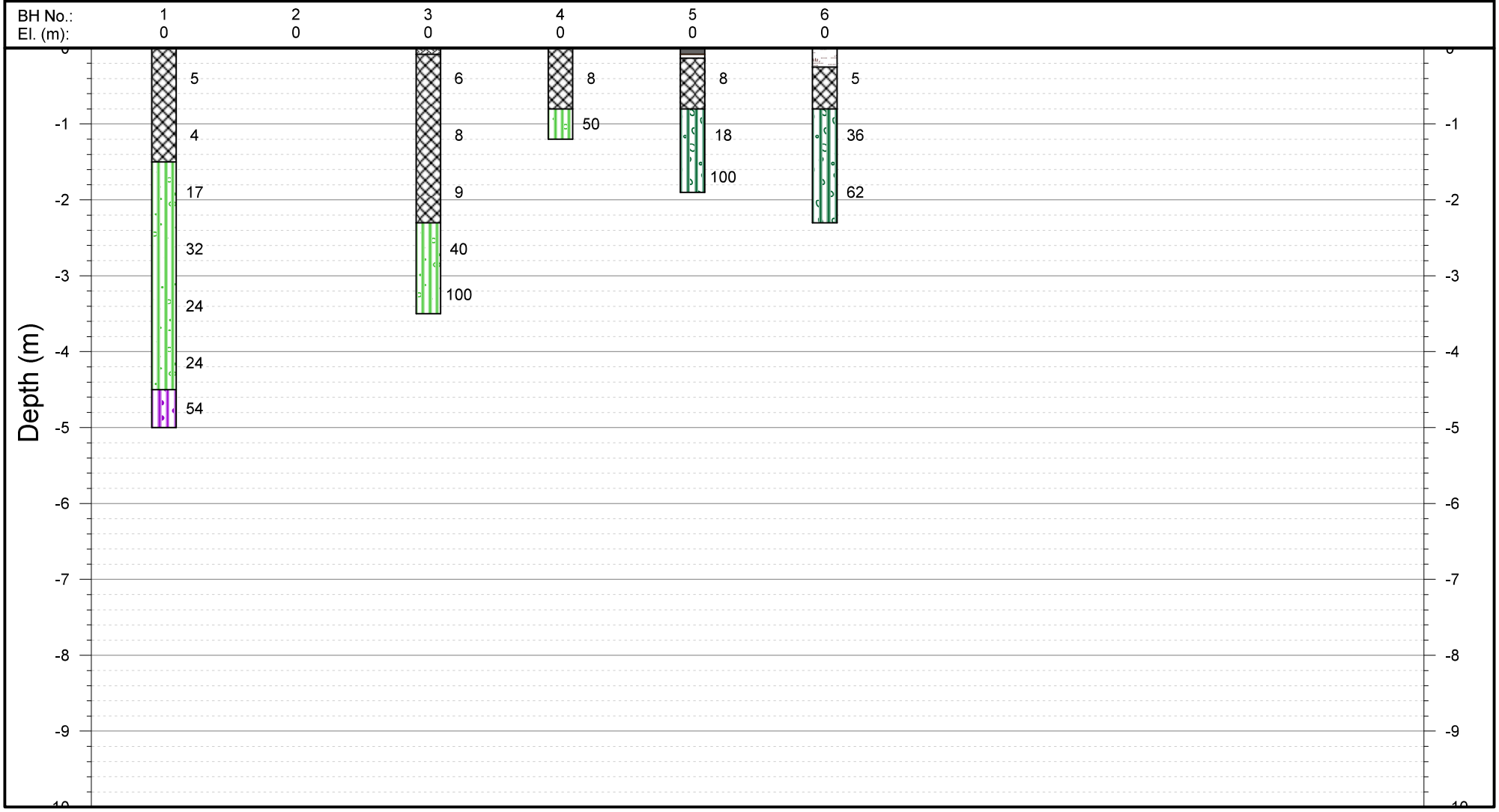
SUBSURFACE PROFILE
DRAWING NO. 3
SCALE: AS SHOWN

JOB NO.: 1908-S132
REPORT DATE: November 2019
PROJECT DESCRIPTION: Proposed Structures and Shoring

PROJECT LOCATION: Toronto Zoo
361A Old Finch Avenue
City of Toronto

LEGEND

TOPSOIL | GRANULAR | FILL | SILTY SAND TILL
BRICK | CONCRETE | SILTY SAND | SANDY SILT TILL



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CONSULTING ENGINEERS
GEOTECHNICAL | ENVIRONMENTAL | HYDROGEOLOGICAL | BUILDING SCIENCE

SUBSURFACE PROFILE
DRAWING NO. 4
SCALE: AS SHOWN

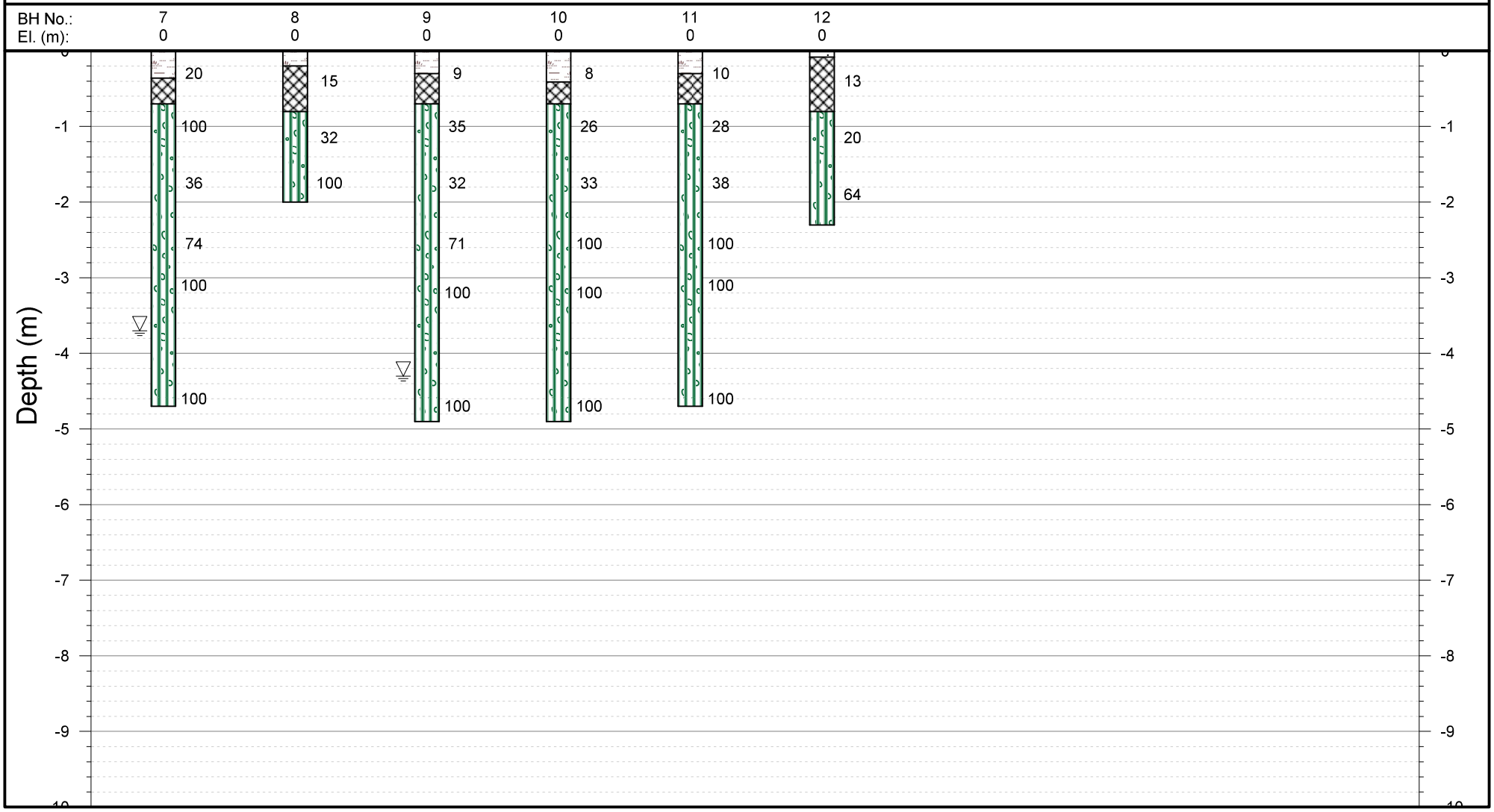
JOB NO.: 1908-S132
REPORT DATE: November 2019
PROJECT DESCRIPTION: Proposed Structures and Shoring

PROJECT LOCATION: Toronto Zoo
361A Old Finch Avenue
City of Toronto

LEGEND

TOPSOIL | GRANULAR | FILL | SILTY SAND TILL

WATER LEVEL (END OF DRILLING)



1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for demolition and removals work in accordance with the Contract Documents.

.2 Work included: Requirements for demolishing, salvaging and removing wholly or in part the various items designated on the drawings or required to be removed or partially removed for the receipt of the Work of this Contract, including not necessarily limited to:

.1 Demolition of existing buildings as shown.
.2 Alteration and renovations to existing building.
.3 Cutting and removing of doors and frames, in the existing building as indicated on Drawings.
.4 Patching, making good openings and chases in walls, floors, ceilings, including the supply and installation of lintels, channels and finishes.
.5 Removal of rubbish, debris, demolished fixtures, fitments and items not scheduled to remain the Owner's property, resulting from the demolition and preparatory work.
.6 Remove abandoned services such as conduits, pipes, wiring, ducts, fixtures, equipment, etc. where required for the work or indicated on the drawings.
.7 Removal of asphalt pavements, curbs and other site amenities as indicated on drawings.
.8 Removal of all mechanical items including plumbing fixtures, services etc. where required for the work or indicated on drawings and or where not required to be relocated.
.9 Removal of existing electrical items including fixtures, etc. where required for the work or indicated on the drawings and not required to be relocated.
.10 Dust control during the operations of the work of this Section.
.11 Removal shall mean removal from site and safe disposal in a legal manner.

1.2 **REFERENCES**

.1 CSA S350-M, Code of Practice for Safety in Demolition of Structures.

1.3 **SUBMITTALS**

.1 Where required by Authorities having jurisdiction, submit a Fire Plan to local fire department for review and approval.

.2 Submit shop drawings, diagrams and details in accordance with Section 01 33 00.

.3 30 calendar days prior to start of demolition and removals work, submit for review, drawings, diagrams or details showing sequence of disassembly work and shoring of supporting structures in accordance with authorities having jurisdiction.

.4 Submit for approval, a plan showing impacts, interruptions and delays to Owners operations.

.5 Have submissions signed and sealed by Professional Engineer licensed in Province of Ontario.

.6 Submit to Consultant, details of where rubble, debris and other materials are to be disposed or reused. Include each disposal/reuse site location, operator's name and business address, type of license under which site operates, and criteria used by site to assess suitability of rubble, debris and other materials for disposal.

.7 Give notice to Utility Authorities controlling services and appurtenances which will be affected by demolition work.

1.4 **QUALITY ASSURANCE**

.1 Prepare waste audits, waste reduction workplans, source separation programs and recycling programs as required by jurisdictional authorities and update programs and implement such programs as required.

.2 Perform the work of this section in accordance with the 'Environmental Protection Act' including Ontario Regulation 102 and the 'Environmental Assessment Act' including Ontario Regulation 103.

.3 Conform to Fire Code, Regulation under the Fire Marshals Act.

.4 The demolition contractor must engage a registered professional engineer who holds a certificate of authorization and an appropriate level of liability insurance to prepare demolition procedures.

.5 As part of the contract requirements, the engineer for the demolition contractor should be required to sign the general review commitment required by city building departments.

1.5 **SITE CONDITIONS**

.1 Interruptions to Owners operations will not be permitted.

.2 Perform operations, machine and equipment movements, deliveries and removals at time or times that will permit uninterrupted operations in and around structures, including parking, deliveries, and Site access and egress.

.3 Take over structures to be demolished based on condition on date that Tenders close.

2 Products

2.1 **MATERIALS**

.1 All materials requiring removal shall become the Contractor's property and shall be removed and disposed of from the site, as the work progresses, unless indicated otherwise.

.2 Salvaged material:
- .1 Salvage and stockpile Products, materials, and equipment as specified herein, indicated on Site or indicated on drawings.
- .2 Coordinate items to be salvaged with Consultant.
- .3 Salvaged materials shall not be chipped, cracked, split, stained or damaged.
- .4 Store items off of moist surfaces.

3 Execution

3.1 **GENERAL**

.1 Clean up rubble and debris, resulting from work promptly and dispose at end of day or place in waste disposal bins. Empty bins on regular basis.

.2 Stockpiling of rubble, debris, and surplus Products on Site will not be permitted.

.3 Remove, handle and transport Products indicated to be salvaged and stored for future use. Transport Products to storage area(s) designated by Consultant. Perform work to prevent any damage to Products during removal and in storage. Products damaged during removal, will be inspected by Consultant. Consultant will determine extent of damage and accept or refuse Products.

.4 List and description of items to be removed and stored or reused:
- .1 Rocks to be turned over to Owner.
- .2 Gaur chute/squeeze to be turned over to Owner.
- .3 Additional items as indicated on the drawings or by the Consultant.

.5 Tag and log all items to be salvaged to the satisfaction of the Consultant. Ensure identification tags do not damage items to be salvaged and are non-permanent, removable and durable.

.6 Take precautions to guard against movement, settlement or collapse of adjacent services, sidewalks, driveways or trees. Be liable for such movement, settlement or collapse caused by failure to take necessary precautions. Repair promptly such damage when ordered.

3.2 **EXAMINATION**

.1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

.2 Examine adjacent structures and other installations prior to commencement of demolition and removals work in accordance with Section 31 00 00.

3.3 **PRESERVATION OF REFERENCES**

.1 Record location and designation of survey markers and monuments located within demolition area, prior to removal. Store and restore markers and monuments upon completion of Work or relocate as directed by Consultant.

3.4 **PROTECTION**

.1 Provide flagmen where necessary or appropriate to provide effective and safe access to Site to vehicular traffic and protection to pedestrian traffic.

.2 Prevent movement or damage of adjacent structures, services, walks, paving, trees, landscaping, adjacent grades and parts of existing structures to remain. Supply and install bracing, and shoring as required. Make good damage caused by demolition to acceptance of Consultant.

.3 Protect adjacent structures and property against damage which might occur from falling debris or other causes. Repair or replace damage caused from work of this Section to acceptance of Consultant.

.4 Do not interfere with use of adjacent structures and Work areas. Maintain free, safe passage to and from adjacent structures and Work areas.

.5 Take precautions to support affected structures. If safety of structure being demolished, adjacent structures or services are endangered, cease demolition operations and take necessary action to support endangered item. Immediately inform Consultant. Do not resume demolition until reasons for endangering have been determined and corrected and action taken to prevent further endangering.

.6 If movement or settlement occurs, install additional bracing and shoring as necessary and make good damage to acceptance of Consultant.

.7 Hang tarpaulins where debris and other materials are lowered. Build in around openings with wood and plywood at locations used for removal of debris and materials.

.8 Prevent debris from blocking surface drainage system, mechanical, and electrical systems which are required to remain in operation.

.9 Pay particular attention to prevention of fire and elimination of fire hazards which would endanger Work or adjacent structures and premises.

.10 Supply and install adequate protection for materials to be re-used, set on ground and prevent moisture pick-up. Cover stockpiles of materials with tarpaulins.

.11 Close off access to areas where demolition is proceeding by barricades and post warning signs.

.12 Supply, install and maintain legal and necessary barricades, guards, railings, lights, warning signs, security personnel and other safety measures, and fully protect persons and property.

.13 Dust partitions:
- .1 Prior to demolition work proceeding in existing building, temporarily enclose Work area, access and supply and install dustproof and weatherproof partitions. Design partitions to prevent dust and dirt infiltration into adjoining areas, prevent ingress of water, and to resist loads due to wind.
- .2 Prevent dust, dirt and water from demolition operations entering operational areas.
- .3 Adjust and relocate partitions as required for various operations of work.
- .4 Upon completion of work, remove and dispose of partitions from Site.

.14 Dust protection:
- .1 Clean water to be applied to hard and soft surfaces and on open excavation faces on Site daily to eliminate dust.
- .2 Roadways and sidewalks to be cleaned daily or as required.
- .3 A designated truck loading area on granular material or existing asphalt to be used to mitigate tracking of potentially contaminated soil and demolition debris off Site. Contaminated loading points to be cleaned or re-established.
- .4 Loaded vehicles leaving Site to be cleaned of loose soil and debris with power washing or alternative method.
- .5 Trucks loaded with indigenous soil or demolition debris to be covered by tarps or attached screens.

.15 Blasting is not permitted.

3.5 PREPARATION

.1 Disconnect and/or re-route electrical data, communication and telephone service lines entering structures to be demolished. Remove abandoned lines as indicated on Contract Drawings. Post warning signs on electrical lines and equipment which is required to remain energized.

.2 Disconnect and cap designated mechanical services:
- .1 Natural gas supply lines: As indicated on drawings, to be removed by qualified workers in accordance with gas company instructions.
- .2 Sewer and water lines: Remove and dispose of as indicated on Contract Drawings.

.3 Other underground services: Remove and dispose of as indicated on Contract Drawings.

.3 Disassemble and remove mechanical equipment and piping complete with supports and associated components.

.4 Do not disrupt active or energized utilities designated to remain undisturbed.

.5 Perform rodent and vermin control to comply with health regulations.

3.6 **DEMOLITION**

.1 Perform demolition with extreme care. Confine effects of demolition to those parts which are to be demolished.

.2 Perform work and prevent inconvenience to persons outside those parts which are to be demolished.

.3 Carry out demolition in accordance with the requirements of CSA S350-M.

.4 Completely demolish buildings and structures as indicated.

.5 Permit remedial work as indicated in existing remaining building.

.6 Demolish foundation walls and footings, and concrete floors below or on grade within areas of new construction and as shown on Contract Drawings.

.7 Demolition shall proceed safely in systematic manner from roof to grade and as necessary to accommodate remedial work indicated. Parts of building which would otherwise collapse prematurely shall be securely shored. Walls and piers shall not be undermined.

.8 Do not overload floor or wall with accumulations of material or debris or by other loads.

.9 Perform work to minimize dusting. Keep work area wetted down with fog sprays to prevent dust and dirt rising. Supply and install temporary water lines and connections that may be required. Upon completion, remove installed temporary water lines. Use covered chutes, water down.

.10 Do not sell or burn materials on Site.

.11 Remove existing equipment, services, and obstacles where required for refinishing or making good of existing surfaces, and replace as Work progresses.

.12 At end of day's work, leave Work in safe condition with no part in danger of toppling or falling. Protect interiors of parts not to be demolished from exterior elements.

.13 Drainage and sewer system protection:
- .1 Ensure that no dust, debris or slurry enters drainage and sewer system on Site.
- .2 Remove and dispose of debris and slurry promptly from Site.
- .3 Comply with City of Toronto Sewer Use By-Law.

.14 Asphalt pavement:
- .1 Break out and remove existing asphalt pavement, curbs and sidewalks within confines of Work as shown on Contract Drawings.
- .2 Square up adjacent surfaces to remain in place by saw cutting or other methods acceptable to Consultant to avoid damage to remaining pavement.
- .3 Protect adjacent joints and load transfer devices.
- .4 Protect underlying granular materials.

.15 Concrete:
- .1 Demolish concrete by methods which avoid impact loads on items which are not to be demolished.
- .2 Where only part or parts of a concrete floor, wall, or other items are to be demolished, use saw cuts to isolate areas which are to be demolished except where existing reinforcing steel is to be left in place. Prior to such isolating, install suitable support to prevent premature movement of area(s) being isolated and undesirable transfer of loads as cutting progresses. If necessary remove area(s) to be demolished by successively isolating small sections.
- .3 Where reinforcing steel is to be left in place, use saw cuts from surface of concrete around perimeter(s) of area(s) to be demolished, chip concrete without damaging reinforcing steel. Retouch damaged epoxy coating of existing reinforcing steel.

.16 Masonry:
- .1 Demolish block walls in small sections of not more than 2 m^2. Do not permit masonry to fall in mass from one level to another.
- .2 Where only part(s) of a wall is to be demolished, install adequate support for adjacent part(s).
- .3 After removal of masonry walls, grind smooth floors ready for new floor finish.

.17 Steel: Where only part or parts of structure is to be demolished, dismantle and maintain structure stable. Do not place excessive loads on components. Install adequate temporary guys and supports to ensure stability and to prevent excessive loading. Support each component being disconnected from structure, and lower, do not drop, component after it is disconnected.

.18 Cut openings through existing walls, partitions, and floors. Establish exact location of steel reinforcing in existing concrete slabs or walls before cutting. Be responsible for damage to existing steel reinforcing and be liable for structural failure. Make good surfaces disturbed with materials to match existing.

19. Where doors are scheduled to be removed, include removal of door frames and door hardware.

20. Demolish all other items indicated or required.

3.7 **RECYCLING**

.1 Whenever possible, all materials shall be recycled. Pay all costs for this work.

.2 Deliver to nearest appropriate recycling depot all materials accepted for recycling by Authorities having jurisdiction over the Place of Work, including but not limited to cardboard, paper, plastic, aluminum, steel, and glass.

.3 Deliver to nearest appropriate depot all scrap and possible recycling materials.

3.8 **DISPOSAL OF MATERIALS**

.1 Remove from Site, rubble, debris, and other materials that can not be recycled resulting from demolition and removals work in accordance with Section 31 00 00 and Authorities having Jurisdiction, except where specified or indicated on Contract Drawings to be reused.

.2 Conform to requirements of municipality's Works Department regarding disposal of waste materials.

.3 Materials prohibited from municipality waste management facilities shall be removed from Site and dispose of at recycling companies specializing in recyclable materials.

3.9 **RESTORATION**

.1 Where demolition removed a structure or installation, rough grade and restore area in accordance with Section 31 00 00 and Authorities having Jurisdiction.

END OF SECTION

1. General

1.1 DOCUMENTS

.1 This section, along with the drawings, forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 DESCRIPTION OF WORK INCLUDED

.1 Provide all labour, materials, equipment, access, cooperation, coordination and services to allow the testing of concrete and concrete reinforcement to be carried out by a Testing Agency responsible to the Owner.

.2 The scope of the required quality assurance testing is described in this section to inform the Contractor of the type and scope of testing on the project and to allow the Contractor to make appropriate allowances. The costs for the testing described in this section is not the responsibility of the Contractor. It will be paid for by the Owner. It is the responsibility of the Contractor to schedule the testing described, to coordinate construction schedules with the Testing Agency, and to cooperate with the Testing Agency in the execution of this work.

.3 The scope of the required quality assurance testing is described in this section to inform the Contractor of the type and scope of testing on the project and allow the Contractor to make appropriate allowances.

.4 Testing required by the Contractor for his own quality control will be paid for by the Contractor.

1.3 RELATED WORK SPECIFIED ELSEWHERE

.1 Section 032100 - Concrete Reinforcement

.2 Section 033000 - Structural Cast-in-Place Concrete

1.4 REFERENCE STANDARDS

.1 Testing of concrete and reinforcement shall conform to the requirements of the following Building Code:

.1 Ontario Building Code – 2012

.2 Testing of concrete and reinforcement shall conform to the requirements of the following Standards unless otherwise required by this specification:

.1 CSA-A23.1 - Concrete Materials and Methods of Concrete Construction.

.2 CSA-A23.2 - Methods of Test and Standard Practices for Concrete.

.3 The revision date of all referenced codes, standards, and guidelines shall be as indicated in the above referenced Building Code. Where no reference is made within the Building Code, the latest published edition shall be used.

.4 Where the Standard is referenced in this specification it shall mean the documents specified in this clause, and their referenced Standards.

.5 A copy of A23.1 and A23.2 shall be kept on site by the Contractor for the duration of the work and be made available for reference.

.6 Where there are differences between the specifications and drawings and the codes, standards or acts, the most stringent shall govern.

1.5 DEFINITIONS - FOR THIS SECTION

.1 "Owner", "Contractor", "Consultant", as per the General Conditions and Definitions.

.2 "Specialty Engineer" is a Professional Engineer registered in Ontario responsible for components designed by the Contractor and who seals and signs shop drawings.

.3 "Testing Agency" shall mean the testing agency responsible to the Owner.

.4 "Standard" and "Standards" shall mean the reference standards listed under "Reference Standards" in this section.

1.6 APPOINTMENT OF TESTING AGENCY

.1 The Owner shall hire a CSA-approved Testing Agency who shall test concrete, reinforcement and grout as per this specification.

.2 Testing paid for by the Owner.

.1 Review of initial mix designs.

.2 Testing as outlined in Section 3.0, except for testing required by the Contractor for stripping of formwork.

.3 Testing paid for by the Contractor.

.1 Review of Contractor-requested mix design changes.

.2 Any waiting time incurred by the Testing Agency in excess of 1/2 an hour.

.3 Any additional costs due to overtime, shift work, holiday or weekend work, except that the Owner will pay for holiday or weekend pickup when the concrete was placed on a regular workday.

.4 Costs for testing required by the Contractor for stripping of formwork, such as field cure cylinders etc.

.5 Cost for retesting or additional testing of concrete or reinforcement where tests have failed to meet the specified requirements.

2. Duties

2.1 RESPONSIBILITY OF THE CONTRACTOR

.1 The Contractor shall cooperate fully with the Testing Agency.

.2 The Contractor shall give the Testing Agency at least twenty-four (24) hours prior notice of concrete placement.

.3 It is the Contractor's responsibility to provide a finished product that meets the

specification. If initial tests indicate that the concrete failed to meet the specification, the Consultant shall decide if any additional testing is necessary. This testing shall be done by a CSA-approved Testing Agency, but need not be the Owner's agency. The proposed additional testing shall have prior approval of the Consultants.

.4 Strengths of cored samples must equal the specified strength if tested dry or 85% of specified if tested wet, with wet or dry tests as per the Standard.

2.2 RESPONSIBILITY AND DUTIES OF THE TESTING AGENCY

.1 The Testing Agency is responsible to the Owner and has the authority to, and is expected to, reject any concrete not meeting the specifications.

.2 If the Testing Agency becomes aware that concrete is being placed without their notification, or if insufficient notice is received, then the Testing Agency shall notify the Consultant immediately.

.3 Low 7-day, 28-day, and 56-day strength tests shall be brought immediately to the attention of the Consultant and the Contractor.

.4 At the completion of the project, the Testing Agency to provide a signed letter to the Owner, with a copy to the Consultant. The letter shall confirm that testing has been carried out as per the specifications and that the Contractor and Consultant have been notified of any deficiencies in material properties.

3. Testing - Concrete And Reinforcement

3.1 GENERAL

.1 All strength tests shall be numbered consecutively and the cylinders marked as follows:

.1 7-Day Test: Marked "A".

.2 28-Day Test: Two (2) cylinders marked "B" and "C".

.2 All tests reports shall record:

.1 Name of Project

.2 Date and time of sampling

.3 Name of supplier

.4 Delivery truck number

.5 Batch time and discharge time

.6 Identification of sampling and testing technicians

.7 Exact location in the structure of the concrete sampled

.8 Design strength of concrete sampled

.9 Admixtures, cement type, maximum aggregate size

.10 Air and concrete temperature

.11 Slump, and air content

.3 All field cured cylinders shall be marked “F”.

.4 Slump tests shall be performed prior to the addition of superplasticizers.

.5 Tests for slump and air content shall be taken with each strength test and as required by the specifications and drawings.

3.2 REGULAR TESTING - CONCRETE

.1 To conform to the Standard, except each test shall consist of three (3) cylinders - one (1) for 7-day strength and two (2) for 28-day strength.

.2 Regular testing applied to all elements not listed in Clause 3.3 - Full Time Testing.

3.3 FULL-TIME TESTING - CONCRETE

.1 Full time testing shall apply to:

.1 Concrete above 40 MPa specified strength.

.2 Shall conform to the Standard and regular testing except:

.1 The Testing Agency shall have a representative on the job site at all times that the concrete requiring full time testing is being placed.

.2 Test the slump and air content from every truck and reject any concrete not within specification.

3.4 FIELD CURED CYLINDERS

.1 Field cure cylinders shall be protected against wind and be stored on the floor immediately below the slab they represent unless the floor below is heated. In that case they shall be stored on top of the slab but covered with a plywood box. The cylinders are to be undisturbed at this location until picked up by the Testing Agency. Field core cylinders are not to be stored in temperature controlled containers.

3.5 REINFORCEMENT AND ACCESSORIES

.1 The Testing Agency shall, over the duration of the project, perform at least one (1) tensile and bend test for each bar size and mill stamp used on the project. Such testing shall comply with the applicable CSA documents. Further testing may be requested at the Consultant’s discretion.

.2 The Testing Agency will select the bars to be tested from the reinforcing supplied to the construction site, not from the suppliers’ yard. The Contractor shall cut the bars to the required length and replace the shortened bars without cost to the Owner.

.3 The Contractor shall supply mill certificates of chemical analysis in accordance with CAN/CSA G30.18R and G30.18W for all bar supplied to site.

.4 Cut samples of mechanical splices and welded reinforcement as directed by the

Consultant. Replace mechanical splices and welded reinforcement cut out for testing.

.5 When requested, provide samples of support accessories (chairs, bolsters, spacers) which are intended to be used.

END OF SECTION 030050

SECTION 031000
CONCRETE FORMING AND ACCESSORIES-LANDSCAPE

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. General Conditions shall govern work of this Section.

B. Contractor shall obtain a copy of CSA Standard CAN3-A23.1 and maintain at site office.

C. Construction to adhere to the City of Vaughan standards.

1.2 DESCRIPTION

A. Cooperation with work of other Sections:

1. Check project drawings and specifications for requirements of other Sections which affect construction of formwork.
2. Inform those performing work of other Sections, in writing or by schedules, of requirements for services, materials and built-in items prepared or supplied by other Sections which affect work of this Section.

B. Related work specified in other Sections:

1. Section 03 30 01 – Cast-In-Place Concrete

1.3 QUALITY ASSURANCE

A. Reference Standards: The following reference standards shall govern work of this Section, except where they are in conflict with requirements imposed by this Specification, in which case the latter shall govern. Standards referenced in CAN3-A23.1 apply but are not repeated in following list.

1. CSA Standard CAN3-A23.1-M77, Concrete Materials and Methods of Concrete Construction.

B. Design of Formwork: Assume full responsibility for complete structural design and construction of formwork in accordance with CSA Standard S269.1.

C. Requirements of Regulatory Agencies: Conform to local and provincial regulations, including construction safety regulations.

D. Tolerances: Conform to CAN3-A23.1 and as specified herein.

1. Formed Surfaces:
   a. Construct formwork so that hardened concrete surfaces will conform to following tolerances:

: Variation from plumb:

A. In lines and surfaces of columns, piers, walls and in arrises:
   . In any 3m (10ft.) of length — 3mm (1/8in.)
   . Maximum for entire length — 12mm (1/2in.)

B. For exposed corner columns and other conspicuous lines:
   . Less than 6m (20ft.) — 5mm (3/16in.)
   . Maximum for entire length — 12mm (1/2in.)

: Variation from level or from grades specified in Contract Documents:

A. In exposed parapets, horizontal grooves and other conspicuous lines:
   . Less than 6m (20ft.) length 5mm (3/16in.)
   . Maximum for entire length 12mm (1/2in.)

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Protect formwork to prevent functional damage and damage to faces affecting appearance of concrete surfaces exposed to view.

PART 2 PRODUCTS

2.1 MATERIALS

A. Formwork materials brought on site shall be new.

B. Plywood:

1. Generally: minimum thickness of 17.0mm (11/16"), to CSA 0121, finished one side, fabricated specially for use as concrete form panels, with sealed edges.
2. For concrete surfaces exposed to view, provide panels smooth and free of defects which would be reproduced as concrete blemishes.

C. Form Ties: At surfaces: snap ties, with spreader washer and 25mm (1") break back.

PART 3 EXECUTION

3.1 FORMWORK CONSTRUCTION

A. Build formwork with joints sufficiently tight to prevent leakage of grout or cement paste.

B. Forms for concrete surfaces which will be exposed or painted:

1. Construct panels with continuous and level horizontal joints.
2. Back all edges of plywood to prevent separation of plywood panels at joints.
3. Construct corners so that concrete is not placed against panel edges.
4. Where tie marks will show, place ties in regular pattern as approved by Consultant or as indicated on drawings.
5. Reuse forms only if their surfaces are not marred in any manner and where established pattern of holes can be maintained with no alteration to panels.

C. Advise Structural Site Representative when an area of formwork will be ready for review. Allow sufficient time for review before starting concrete placing.

3.2 BUILT-IN WORK

A. Do not imbed wood in concrete.

3.3 CONSTRUCTION AND EXPANSION JOINTS

A. Review with Consultant and Structural Site Representative proposed location and details of concreted joints in foundations, walls and columns.

B. Construction Joints:

1. Construction joints shall present appearance of normal form panel joint.
2. Install continuous shear key in construction joints in foundations.

C. Expansion Joints: Install expansion joints in locations and as detailed and noted on drawings.

3.4 TREATMENT OF FORMWORK SURFACES

A. Form Release Agent:

1. Coat formwork with form release agent before reinforcement, anchors, accessories and other built-in items are installed.
2. Do not coat plywood forms pre-treated with release agent.

3.5 STRIPPING OF FORMWORK

A. Be responsible for safety of structure, both before and after removal of forms, until concrete has reached its specified 28 day strength.

B. Strip formwork for columns and piers not supporting weight of concrete only when no damage will result from stripping operations.

C. Remove formwork at architectural surfaces after other formwork has been removed, to prevent damage to surfaces.

D. Do not remove plywood formwork by jerking loose or by metal pinch bars. Use wood wedges and gradually force panels loose. Leave plywood forms in place as long as possible to permit maximum shrinkage away from concrete.

E. Take particular care not to damage external corners when stripping formwork.

F. When forms are stripped during curing period, cure and protect exposed concrete in accordance with Section 03 30 00.

3.6 REPLACEMENT OF DEFECTIVE WORK

A. Movement and displacement of formwork during construction, variations in excess of specified tolerances and marked and disfigured surfaces that cannot be repaired by approved methods will be considered defective work performed by this section.

B. Reconstruct defective formwork and replace concrete and reinforcement placed in defective formwork at no additional cost to Owner.

END OF SECTION

SECTION 032000
CONCRETE REINFORCEMENT-LANDSCAPE

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Supplementary Conditions, General Conditions, General Requirements, shall govern work of this section.

B. Contractor shall obtain a copy of CSA Standard CAN3-A23.1 and maintain at site office.

1.2 DESCRIPTION

A. Sections which specify reinforcement installed in compliance with this section:

1. Section 03 30 01 – Cast-In-Place Concrete
2. Section 03 10 00 – Concrete Forming and Accessories

B. Co-operation with consultant's Site Representative:

1. Before commencing work, review with Structural Site Representative, sampling program for work performed under this section.
2. Schedule work to allow sufficient time and access for consultant's Site Representative to carry out sampling program during regular working hours.

1.3 QUALITY ASSURANCE

A. Reference Standards: The following reference standards shall govern work of this section, except where they are in conflict with requirements imposed by this specification, in which case the latter shall govern. Standards referenced in CAN3-A23.1 apply but are not repeated in following list.

1. CSA Standard A23.1-M77, Concrete Materials and Methods of Concrete Construction.
2. CSA Standard A23.3-M84, Design of Concrete Structures for Buildings.
3. CSA Standard G30.5-M1983, Welded Steel Wire Fabric for Concrete Reinforcement.
4. CSA Standard G30.12-M1977, Billet-Steel Bars for Concrete Reinforcement.

1.4 SUBMITTALS

A. Shop Drawings:

1. Submit shop drawings stamped by a professional Engineer.
2. Submit placing drawings and bar lists sufficiently detailed and dimensioned, with complete information necessary for fabrication of reinforcement and placing of bars and accessories.
3. Show height of supporting chairs. For vertical reinforcement, show dimension from bar to concrete surface.
4. Show location of splice joints, all reinforcement to be continuous.
5. Prior to submission to the consultant, the Contractor shall review all shop drawings. By this review, the Contractor represents to have determined and verified all field measurements, site conditions, materials, catalogue number and similar data and to have checked and coordinated each shop drawing with the requirements of work and of contract documents. The Contractor's review of each shop drawing shall be indicated by stamp, date and signature of a responsible person.
6. At time of submission, the Contractor shall notify the consultant in writing of any deviations in shop drawings from requirements of contract documents.
7. The consultant will review and return shop drawings in accordance with an agreed schedule. The consultant's review will be for conformity to design concept and for general arrangement only and shall not relieve the Contractor of responsibility for errors or omissions in shop drawings or of responsibility for meeting all requirements of contract documents.
8. The Contractor shall make any changes in shop drawings which the consultant may require consistent with contract documents and resubmit unless otherwise directed by the consultant. When resubmitting, the Contactor shall notify the consultant in writing of any revisions other than those requested by the consultant.
9. Do not commence fabrication of reinforcement before drawings have been reviewed and the consultant's comments incorporated on drawings issued to fabricating shop.

PART 2 PRODUCTS

2.1 MATERIALS

A. General steel reinforcement for concrete shall conform with OPSS 1440.

B. Bar Reinforcing Steel: All bars: to CSA G30.12, with 400MPa minimum yield strength.

C. Epoxy Coated Steel Reinforcement: shall conform with OPSS 1442.

D. Welded Wire Fabric: 152 x 152, 6/6, to CSA G30.5 and in flat sheets, not rolls.

2.2 FABRICATION

A. Fabricate reinforcing steel only in a permanent fabricating shop unless otherwise approved by the consultant.

B. Fabricate reinforcing steel in accordance with shop drawings.

C. Tag reinforcing bars to indicate placement as designated on shop drawings.

D. Splices: Provide splices only where specifically indicated on drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine formwork to ensure that it has been completed and adequately braced in place before commencing to place reinforcement.

3.2 PLACING REINFORCEMENT

A. Place reinforcement in accordance with requirements of CAN3-A23.3, typical details and as indicated on the drawings.

B. Do not cut reinforcement to incorporate other work.

C. Relocate or rebend bars only on written instructions of Structural Site Representative.

D. Tie, do not weld, reinforcement in place.

E. Prevent damage to the epoxy coating bars during placement and placement of concrete. Restore coating to bars where removed as per ASTM D3963 / D3963M.

3.3 ADJUSTING AND CLEANING

A. Adjust and secure reinforcement in correct position immediately before concrete is placed.

B. Remove contaminants which lessen bond between concrete and reinforcement.

END OF SECTION

1. General

1.1 DOCUMENTS

.1 This section, along with the drawings, forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 DESCRIPTION OF WORK INCLUDED

.1 Provide all labour, materials, equipment and services necessary to supply and install reinforcing steel work shown or indicated in all the contract drawings and specifications including accessories such as hanger bars, spirals, wire ties, support bars, chairs, spacers supports or other devices required to position reinforcing properly.

1.3 RELATED WORK SPECIFIED ELSEWHERE

.1 Section 030050 - Testing of Concrete and Reinforcement

.2 Section 031100 - Concrete Forming and Accessories

.3 Section 033000 - Structural Cast-in-Place Concrete

.4 Section 033125 – Architectural Concrete

1.4 REFERENCE STANDARDS

.1 Concrete reinforcing shall conform to the requirements of the following Building Code:

.1 Ontario Building Code - 2012.

.2 Concrete reinforcing shall conform to the requirements of the following Standards unless otherwise required by this specification:

.1 CSA-A23.1 - Concrete Materials and Methods of Concrete Construction.

.2 CSA-A23.2 – Test Methods and Standard Practices for Concrete.

.3 CSA-A23.3 - Design of Concrete Structures.

.4 ASTM A1064M-13 - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.

.5 CSA G30.18 - Billet Steel Bars for Concrete Reinforcement

.6 CSA-W47.1 - Certification of Companies for Fusion Welding of Steel

.7 RSIC Reinforcing Steel Institute of Canada (RSIC), Manual of Standard Practice.

.8 ASTM A 820 Standard Specification for Steel Fibers for Fiber-Reinforced Concrete

.9 ASTM C 1116 Standard Specification for Fiber-Reinforced Concrete Shotcrete

.3 The revision date of all referenced codes, standards, and guidelines shall be as indicated in the above referenced Building Code. Where no reference is made within the Building Code, the latest published edition shall be used.

.4 Where the Standard is referenced in this specification it shall mean the documents specified in this clause and their referenced documents.

.5 A copy of A23.1 and A23.2 shall be kept by the Contractor on site for the duration of the work and be made available for reference.

.6 Where there are differences between the specifications and drawings and the codes, standards or acts, the most stringent shall govern.

1.5 DEFINITIONS FOR THIS SECTION

.1 "Owner", "Contractor", "Consultant" as per the General Conditions and Definitions.

.2 "Specialty Engineer" is a Professional Engineer registered in Ontario responsible for components designed by the Contractor and who seals and signs shop drawings.

.3 "Standard" and "Standards" shall mean the reference standards listed under "Reference Standards" in this section.

1.6 TESTING

.1 As per Section 030050 - Testing of Concrete and Reinforcement.

2. Products

2.1 GENERAL

.1 Products shall satisfy the requirements of the Standard unless otherwise specified herein or on the drawings.

2.2 MATERIALS

.1 Reinforcing bars shall conform to the Standard unless otherwise specified herein or on the drawings.

.2 Reinforcing bars to be welded shall conform to the Standard, G30, 18W.

.3 Welded wire fabric shall conform to the Standard, size and gauges as shown on the drawings.

.4 Welded wire fabric for slabs shall be delivered in flat sheets.

.5 In suspended parking slabs, bar support chairs shall be plastic or plastic coated.

.1 Storage: Galvanized bars that will be stored in the field in excess of 30 days shall be stored off the ground on dunnage to allow air circulation to prevent the formation of wet storage stain. Material galvanized in accordance with ASTM specifications shall be free from wet storage stain. These corrosion deposits, if present, shall be

removed in a manner satisfactory to the Consultant prior to incorporation of the material into the work. After removal of the wet storage stain, the coating shall have a uniform appearance free of uncoated spots, acid, flux or black spots.

.6 Chairs, bolsters, bar supports, spacers: to CSA A23.1. In the case of concrete exposed to view or weather the accessories shall be such that no metal is permitted to come closer than 40 mm ($1^5/_8$") from a formed face and 50 mm (2") from a troweled surface. Use precast concrete supports for exposed concrete beams and soffits and concrete cast against soil/rock. Precast concrete supports shall be made of concrete of quality and strength at least equal to that specified for the member in which they are used.

.7 Support accessories for [suspended parking garage slabs or future cathodic protection]: An approved plastic or non-corroding type of chair, bolster or spacer of sufficient strengths to rigidly support the weight of reinforcement and construction loads. Do not use plastic coated or plastic tipped steel chairs.

.8 Mechanical Tension Splices: LENTON COUPLERS, LENTON TRANSITION COUPLERS, LENTON FORMSAVER or LENTON POSITIONAL COUPLERS where appropriate, complete with bar end protectors and coupler end protectors, as supplied by Erico Canada Inc or approved alternative.

.9 Mechanical Compression Splices: [End-Bearing Compression Splice SPEEDSLEEVE as supplied by Erico Canada Inc] or approved alternative.

.10 Mechanical Butt Splice for Future Extension: [Lenton positive connecting taper threaded with internal coupler protector, all as supplied by Erico Canada Inc] or approved alternative.

.11 Steel fibers shall meet the requirements of ASTM A820 Type 1, deformed fibers. Minimum ultimate tensile strength shall be 1036MPa. Minimum aspect ratio shall be 80. Minimum fiber length shall be 60mm. Maximum fiber diameter shall be 0.03 inches. Steel fibers shall be Dramix RC 80/60 BN manufactured by Bekaert Corporation.

.12 Steel fiber concrete shall be proportioned as required in ASTM C 1116, alternative 3, in consultation with fiber manufacturer based on the required concrete properties indicated on drawings and specifications.

.13 Bar terminators: Anchorage which is at least five (5) times the area of the bar. Provide LENTON TERMINATOR D6 as manufactured by Erico, Inc. or approved alternate.

.14 Headed reinforcement: Reinforcement with anchorage which is at least ten (10) times the area of the bar. Provide LENTON TERMINATOR D14, or Dayton Superior, or approved alternate.

.15 Rebar end welded to structural steel: LENTON WELDABLE COUPLER as manufactured by Erico, Inc. or approved alternate.

3. Execution

3.1 GENERAL

.1 All phases of concrete reinforcement work shall be in accordance with the Standards unless otherwise specified herein or on the drawings. The Contractor shall ensure that the work is executed only by workers skilled and experienced in their trade.

.2 The Contractor shall notify the Consultant at least 24 hours before any concrete is placed in order that the Consultant may review the work.

.3 Identify with a tag each bundle of bars with a code mark corresponding to that appearing on the bar list.

.4 Bend reinforcement once only and at room temperature of 18°C. Do not straighten or rebend reinforcement. Do not use bars with kinks or bends not shown on the drawings.

.5 Replace bars which develop cracks or splits.

.6 Williams All –Thread – Bar must not be welded or subjected to the heat of a torch or used as a ground.

3.2 FIELD BENDING

.1 Do not field bend reinforcement except where indicated or authorized in writing by the Consultant.

.2 When field bending is authorized, bend without heat, applying a slow and steady pressure.

.3 Replace bars which develop cracks or splits.

3.3 CONSTRUCTION JOINTS IN CAST-IN-PLACE CONCRETE

.1 Obtain acceptance from the Consultant for details of construction joints not shown.

.2 Continue reinforcement through the joint in its normal position. Add additional reinforcement across the joint as shown or directed. Where a mechanical splice is required at a construction joint, use of the LENTON FORMSAVER type coupler or approved equivalent is appropriate.

3.4 MECHANICAL SPLICING OF REINFORCEMENT

.1 Tension Splices

.1 Provide mechanical tension splices at locations indicated. Where mechanical splice/coupler is indicated correct type of coupler should be used. Typically standard coupler is appropriate. Transitional couplers to be provided whenever the bar diameter changes. Positional couplers to be provided when both sides of the bar can't be rotated (hooks, bends, coupled both ends, etc.)

.2 Unless noted otherwise, mechanical tension splices shall develop the specified tensile strength of the reinforcement being spliced or of the smaller bar if the bars spliced are of different sizes.

.3 In each concrete member, unless otherwise indicated, mechanical tension splices in adjacent bars shall be staggered not less than the greater of 800 mm or 40 bar diameters.

.4 Install mechanical splices in strict accordance with the manufacturer's requirements.

.2 Compression Splices

.1 Provide compression splices at locations indicated.

.2 Non End-Bearing Mechanical splices

.1 Unless noted otherwise, mechanical compression splices shall develop 120% of the specified tensile yield strength, but not less than 110% of the actual tensile yield strength of the reinforcement being spliced or of the smaller bar, if the bars spliced are of different sizes.

.2 In each concrete member, stagger splices of adjacent bars by at least 800 mm.

.3 End-bearing splices

.1 End bearing splices shall develop the ultimate compressive strength of the reinforcing bars spliced.

.2 Accurately saw cut the end bearing surfaces of all bars to be spliced 90 degrees to the axis of the bar with a tolerance of 1-1/2 degrees.

.3 In setting the bars, rotate until the angle between bearing surfaces is at a minimum, but not more than 3 degrees of full bearing.

.4 In each concrete member, stagger splices in adjacent bars by 800 mm but not less than 20 bar diameters

.4 Rebar End Welded to Plates

.1 Provide weld details for weldable couples where bars are specified to be end welded to plates, steel sections etc. for the amount as specified in above sections.

3.5 SHOP DRAWINGS

.1 Refer to Section 01 33 00 for submittals.

.2 Allow at least two (2) weeks for shop drawing review by the Structural Engineer of concrete reinforcement, bar support and accessories. Allow sufficient time for review, correction, fabrication, shipping to site and placement.

.3 Clearly indicate bar sizes, grades, spacing, location and quantities of reinforcing mesh, bar supports and accessories, mechanical splices, and identifying code marks to permit correct placement without reference to structural drawings. Include total weight of materials being installed.

.4 Placing drawings and bar lists will be reviewed for number and size of bars only and this review shall in no way relieve the Contractor of his responsibility for carrying for carrying out the Work in accordance with the drawings.

.5 Substitution of imperial reinforcing sizes and grades will only be accepted if placing drawings showing imperial sizes are submitted to the Consultant for review. Approval must be obtained before any work is commenced.

.6 Clearly indicate placing order of reinforcement.

.7 Prepare sections of congested joints to avoid site issues.

.8 Prepare reinforcement shop drawings and bar lists taking into account all openings and recesses shown on the architectural, structural, mechanical and electrical drawings, and on the sleeving shop drawings. Reinforcement shop drawings may only be reviewed if sleeving and conduit shop drawing are submitted in parallel.

.9 Completely dimension openings, recesses and sleeves, and relate to suitable grid lines and elevation datum.

.10 Structural drawings are not prepared to be used as erection or shop drawings. However, electronic files or sepias may be used by the Contractor under the following conditions:

.1 Read Jones Christoffersen Ltd. is paid $150.00 per structural drawing used.

.2 Copyright remains with Read Jones Christoffersen Ltd.

.3 The drawings will only be used for shop drawings for this project and not be put to any other use.

.4 Read Jones Christoffersen Ltd. assumes no liability for errors or omissions in the drawings. The Contractor assumes all risk and expenses associated with the use of structural drawings in the production of his work.

.5 References to Read Jones Christoffersen Ltd. must be deleted from the title block.

.6 The Contractor signs a release available from Read Jones Christoffersen Ltd. that addresses the above items in more detail.

.11 Detail reinforcement in accordance with the contract documents, CSA A23.1, [CSA S304.1] and detailing standards in CRSI Manual of Standard Practice.

.12 Where 10M top bars and welded wire fabric are shown, provide adequate chairs, bolsters or supports to ensure that these bars are not bent or displaced prior to or during the concreting operation.

.13 Detail sections to fully illustrate placement of concrete reinforcement at areas such as openings, change of levels, spandrel, stairs and wherever else required.

.14 Provide large scale detail concrete sections at areas of steel concentrations such as at intersections of beams and columns, column splices or wherever else required.

.15 Placing sequence for reinforcement such as intersections of beams and beams, slabs and beams, and within slabs.

.16 Indicate minimum clearances between reinforcement and minimum concrete cover to reinforcement.

.17 Location and embedment of dowels.

.18 Location, number and type of support accessories, including support bars suitably sized and spaced to rigidly support the weight of reinforcement and construction load.

.19 Submit code marks or symbols used on reinforcement of each manufacturer so that RJC may identify grades and sizes of reinforcement.

.20 Shop Drawings for Mechanical Splices

.1 Submit drawings showing, as a minimum, the following: location, elevations and size of splices, materials and procedures.

.21 Certificates

.1 [Reinforcing Steel from Canadian Manufactures]: When requested, provide the Consultant with certified copy of reports of reinforcing steel showing physical and chemical analysis a minimum 4 weeks prior to commencing fabrication.

.2 [Reinforcing Steel from Other than Canadian Manufactures]: When requested, provide test data from a Canadian Testing Laboratory proving that each size and grade of reinforcement proposed meets specification requirements. Reinforcement reviewed for use by the Consultant shall be identified in a manner suitable to the Consultant. Only steel that has been reviewed and accepted may be used in the project.

.3 Provide Steel Fibers: Certification and test reports for each shipment of fibers.

.22 Substitutions

.1 Substitution of different size bars permitted only upon written acceptance of the Consultant.

.23 As-Built Drawings

.1 Mark on a complete set of final reproducible drawings any changes, additions or deletions that occur during construction as a result of the Contractor's work, change orders, or for any other reasons.

3.6 FABRICATION

.1 Fabricate all reinforcing to the Standard and contract documents.

.2 Reinforcing bars shall be cold bent. Bars shall not be straightened or re-bent.

.3 Splices in reinforcing bars at locations not shown on the drawings must be submitted for review by the Consultant. Such splices shall conform to the Standards.

.4 Colour code each bar to correspond with code mark appearing on bar list.

.5 Steel Stud Assemblies for Shear Reinforcement shall be fabricated in accordance with ASTM A1044/A1044M

3.7 PRODUCT DELIVERY, STORAGE AND HANDLING

.1 Store reinforcement in a manner to prevent excessive rusting and fouling with dirt, grease, form-oil and other bond-breaking coatings

.2 Reinforcement at the time concrete is placed shall be free from excessive rusting, mud, oil or other coatings that adversely affect its bonding capacity

3.8 PLACING

.1 Reinforcing of size and shapes shown on the structural drawings shall be accurately placed in accordance with the drawings and the requirements of the Standard.

.2 Reinforcement shall be adequately supported by chairs, spacers, support bars, hangers or other accessories, and secured against displacement within the tolerances permitted in the Standard. Support devices contacting surfaces exposed to the exterior shall be non-corroding.

.3 Bars that are not part of the structural design or drawings, and whose only function is supporting other reinforcing in lieu of other support accessories, shall be considered as accessories.

.4 In suspended parking slabs, uncoated metal ties shall not extend more than 5.0 mm (3/16") into the concrete cover.

.5 All rebar shall be adequately tied and chaired to maintain it in the specified location during pouring. Lifting of reinforcing or welded wire mesh into specified position during the concrete pour will not be allowed.

.6 Tolerances for bar placement shall be as per the Standard. Tolerances shall not be used to justify the use of chair, bolsters, or chair/support combinations which result in improper cover.

.7 Williams All-Thread-Bar must not be welded or subjected to the high heat of a torch or used as a ground.

.8 Field cutting is to be done with an abrasive wheel or band saw.

.9 Prior to concreting, accurately place reinforcement, support and secure against displacement, as indicated on reviewed placing drawings and in accordance with CSA A23.1. Tack welding of reinforcement to secure in place will not be permitted.

.10 Set column anchor bolts and wall dowels prior to concreting with wooden templates or other approved means.

.11 Do not ‘wet set’ reinforcement into fresh concrete.

.12 Secure reinforcement in columns and walls using sufficient spacers on each face to maintain the requisite distance between reinforcement and column or wall face and so that vertical bars are plumb.

.13 Where continuous drop panels or slab thickenings are noted on the drawings, place bottom slab reinforcement in the bottom of the continuous drop panel or slab thickening, unless noted otherwise on the drawings.

.14 Where toppings are placed on waterproof membranes, vapour barriers and the like, prevent reinforcement or tie wire from contacting these items.

.15 Ensure that longitudinal bars in beams have adequate vertical spacing between layers in accordance with the Standard.

.16 Pre-assemble column and beam cages as necessary. Do not "spring" or bend ties and stirrups in order to place longitudinal reinforcement.

.17 All splice locations are subject to review by the Consultant.

3.9 WELDING

.1 Any welding of reinforcing steel including Steel Stud Assemblies for Shear Reinforcement shall be in accordance with the Standard.

.2 Welding of concrete reinforcement shall be performed by workmen who are approved by the Canadian Welding Bureau in accordance with the Standard. Copies of the Canadian Welding Bureau approved welding procedure and certificate of current operator qualification shall be submitted to the Consultant prior to commencement of welding.

.3 Welding to reinforcement is only permitted as indicated in the Contract Documents or with prior written approval of the Consultant.

3.10 CONSTRUCTION REVIEW

.1 No concrete shall be placed until the Consultant has completed a review of reinforcing in place. The Contractor shall provide a minimum of 24 hours notice of the time when the reinforcement will be substantially in place and ready for the Consultants review. A minimum of 6 hours is to be provided for review and any required remedial work prior to concrete placement.

.2 The Consultant's general review during construction and inspection and testing by Independent Inspection and Testing Companies reporting to the Consultant are both undertaken to inform the Owner of the Contractor's performance and shall in no way augment the Contractor's quality control or relieve the Contractor of contractual responsibility.

3.11 TOLERANCES

.1 Perform fabrication and setting so that completed work will be within the tolerances set out in CSA A23.1.

.2 These tolerances are acceptable with regard to structural requirements. Interfacing tolerances may not be compatible with the above. Review and coordinate interfacing tolerances so that the various elements come together properly.

End of Section 03 21 00

1. General

1.1 DOCUMENTS

.1 This section, along with the drawings, forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 DESCRIPTION OF WORK INCLUDED

.1 Provide all labour, materials, equipment and services necessary to supply and install cast-in-place concrete work shown or indicated in all the contract drawings and specifications including concrete toppings, bases, sumps, curbs, posts, manholes, pits, paving, sidewalks, equipment bases or curbs, grouting of baseplates, etc.

.2 Coordinate concrete placement fully with other trades. Ensure other related work such as inserts, dowels, sleeves, reinforcement, etc. is complete before placing concrete.

1.3 RELATED WORK SPECIFIED ELSEWHERE

.1 Section 030050 - Testing of Concrete and Reinforcement

.2 Section 031100 - Concrete Forming and Accessories

.3 Section 032100 - Concrete Reinforcement

.4 Section 033125 – Architectural Concrete Section

.5 033500 - Concrete Finishing

.6 Section 051200 - Structural Steel Framing

.7 Section 053100 - Steel Decking

.8 Section 316323 - Bored Concrete Piles

1.4 REFERENCE STANDARDS

.1 Concrete work shall conform to the requirements of the following Building Code:

.1 Ontario Building Code - 2012.

.2 Concrete work shall conform to the requirements of the following Standards unless otherwise required by this specification:

.1 CSA-A23.1 - Concrete Materials and Methods of Concrete Construction.

.2 CSA-A23.2 - Methods of Test for Concrete.

.3 CSA-A23.3 - Design of Concrete Structures.

.4 CSA-S413 - Parking Structures.

.5 CSA A3001 - Cementitious Materials for use in Concrete.

.6 ACI 347 - Guide to Formwork for Concrete.

.2 The revision date of all referenced codes, standards, and guidelines shall be as indicated in the above referenced Building Code. Where no reference is made within the Building Code, the latest published edition shall be used.

.3 Where the Standard is referenced in this specification it shall mean the documents specified in this clause and their referenced documents.

.4 A copy of A23.1 and A23.2 shall be kept by the Contractor on site for the duration of the work and be made available for reference.

.5 Where there are differences between the specifications and drawings and the codes, standards or acts, the most stringent shall govern.

1.5 DEFINITIONS FOR THIS SECTION

.1 "Owner", "Contractor", "Consultant" as per the General Conditions and Definitions.

.2 "Specialty Engineer" is a Professional Engineer registered in Ontario responsible for components designed by the Contractor and who seals and signs shop drawings.

.3 "Standard" and "Standards" shall mean the reference standards listed under "Reference Standards" in this section.

1.6 SUBMITTALS

.1 Keep a record at the job site showing time and place of each pour of concrete, together with a transit-mix delivery slip certifying contents of pour. Make the record available to the Owner for his inspection upon request. Upon completion of this portion of work, submit placing records and delivery slips to the Owner.

.2 Submit details of proposed methods of concrete curing and provisions for weather protection to the Consultant for review

.3 Submit plan locations and details of construction joints for the Consultants review

.4 Certificates

.1 The concrete supplier shall have a current "Certificate of Ready Mixed (or Mobile Mix) Concrete Production Facilities," as issued by the National Ready Mixed Concrete Association (NRMCA). The certificate shall be submitted to the Consultant upon request.

.2 When requested, prior to beginning work and when any change in materials or source of supply is proposed, provide the following certificates prepared by an independent inspection company. The cost of this work shall be borne by the Contractor.

.1 Certification that all raw materials used in the production of concrete proposed for the work comply with the requirements of the specifications and

CSA A23.1. Specifically, the contractor must confirm that all aggregates used will not react with alkalis in the concrete to cause deleterious expansion.

.2 Certification that compressive strength, water-cement ratio, slump, entrained air content and other specified properties will be met, using the proposed mixes.

.3 Certification that classes of exposure C-1, A-1 and C-XL will meet the 56 day limits specified in CSA A23.1 for the rapid chloride permeability test, using the proposed mixes.

.4 The concrete supplier shall submit representative chloride permeability test data distributed over a period of 56 days for concrete exposure classes C-1, A-1 and C-XL with and without calcium nitrite corrosion inhibitor or any other admixture containing ionic salts.

.3 Concrete Quality Plan

.1 When requested, submit a complete "Concrete Quality Plan", in the format provided by the NRMCA.

.4 High Strength Concrete

.1 The concrete supplier shall demonstrate by appropriate tests and test results that the aggregates chosen have the potential to meet the design strength requirements specified herein.

.5 When requested and well in advance of construction, submit complete details of placing and consolidation procedures for sloping roofs, including details of construction and placing of top forms and top form panel.

.6 As-Built Drawings

.1 Mark on a complete set of final reproducible drawings any changes, additions or deletions that occur during construction as a result of the Contractor's work, change orders, or for any other reason.

2. Products

2.1 GENERAL

.1 Products shall satisfy the requirements of the Standard unless otherwise specified herein or on the drawings.

.2 Provide samples of materials upon request

2.2 MATERIALS

.1 Cement for S-1, S-2, and S-3 concrete shall be as per A23.1 Table "Additional requirements for concrete subject to sulphate attack" and conform to the Standard.

.2 Mixing water shall conform to the Standard.

.3 Air entraining admixtures to the Standard.

.4 Calcium chloride, either as a raw material or as a constituent in other admixtures, shall not be used unless approved in writing by the Consultant.

.5 Curing compounds shall conform to the specification and shall also be compatible with specified floor hardeners, covering adhesives and waterproofing compounds.

.6 Grout shall be preapproved, premixed, non-shrink conforming to the Standard. Exposed grout shall be non-staining cement grey in colour.

.7 Modulus of Elasticity (E): For each concrete mix design, the actual Modulus of Elasticity, at all times during construction, is to be not less than 4,500 MPa.

.8 Concrete: Normal density concrete with an air dry density of 23 +/- 1 kN/m3. Conform to CSA A23.1.

.9 Cement Type: General Use Portland Cement (Type GU) or Low Heat of Hydration Portland Cement (Type LH) meeting the requirements of Standard CSA-A3001A-03.

.10 Admixture:

.1 Corrosion Inhibiting Admixture: Calcium nitrite based corrosion inhibitor, "DCI" or "DCI(S)" by W.R. Grace & Co. (or approved alternative), shall be added at the rate of 10.1 litres per cubic metre of concrete, to all concrete designated Exposure Class 'C1'. The corrosion inhibitor shall contain 30 ± 3 percent of calcium nitrite by weight. The selection of "DCI" or "DCI(S)" (or approved alternative) shall be as directed by the admixture supplier, based on anticipated placing and curing conditions and the specific concrete mix design selected.

.11 Shrinkage Control Fibres: "Dramix" steel fibres by Bekaert or approved alternative, 60/1.05.

.12 Bonding Agent: Use Sika Sikdur 32 epoxy bonding agent for all bonded topping installations.

.13 Curing Compound: Conform to CSA A23.1.

.14 Grout Beneath Base Plates: Non shrink, non-metallic, flowable grout In Pakt or approved alternative having a compressive strength at 28 days of at least 35 MPa (5ksi). Where grout is exposed to view or weather, use nonferrous grout.

.15 Supplementary Cementing Materials (SCMs)

.1 It is anticipated that one or more supplementary cementing materials will have to be used in the concrete to produce a mix with acceptable fresh and hardened concrete properties and acceptable thermal characteristics during hardening. The materials will be one or more of the following:

a) Granulated blast furnace slag,
b) Fly-ash,
c) Silica fume.

.2 Supplementary cementing materials fly ash, granulated blast furnace slab or silica fume, shall comply with the requirements of Standard CSA A23.1 and A3001.

.3 The supplier shall submit evidence satisfactory to the owner to demonstrate that the storage and dispensing facilities for supplementary cementing materials do not have any deleterious effects on the materials themselves. These facilities will not expose these materials to such effects as the agglomeration or balling of particles or any separation or change in effective particle size of solids in slurries or to freezing and thawing or to excessive heat.

3. Execution

3.1 GENERAL

.1 All phases of concrete work shall be in accordance with the Standard unless otherwise specified herein or on the drawings. The work shall be executed only by experienced and skilled workers.

.2 The Contractor shall notify the Consultant at least 24 hours before any concrete is placed to allow the Consultant to review the work.

.3 Prior to the initial supply of concrete to the project, the contractor must schedule a “Pre-Pour Meeting” as outlined in the Concrete Supplier’s Concrete Quality plan.

3.2 MIX DESIGNS

.1 Concrete mixes shall be proportioned by the supplier to meet the compressive strength, exposure class, and other performance specifications noted in the contract documents. In addition, concrete mix design shall satisfy the transport, placing, and finishing requirements of the Contractor. All concrete shall be normal weight unless noted otherwise. Concrete types are specified in accordance with CSA-A23.1 Table “Alternate methods for specifying concrete”, Alternate 1.

.2 Concrete mix design is the responsibility of the supplier, including the use of admixtures, alone or in combination. The supplier is also responsible for ensuring the plastic and hardened properties of the concrete meet the construction and specified requirements. This includes the long term performance of the hardened mix.

.3 Pump mix slumps shall also conform to the above.

.4 Water/Cement ratios and air contents for exposure class shall be as per the Standard.

.5 The proposed mixes shall be submitted to the Consultant and Testing Agency for review.

.6 The mix designs shall note the constituents by the properties required by the structural drawings, and the structural elements for which the mix is to be used.

3.3 TESTING

.1 As per Section 030050 - Testing of Concrete and Reinforcement

3.4 PLACING OF CONCRETE

.1 Conveying and placing of concrete is to conform to the Standard.

.2 All concrete shall be consolidated by means of vibrators of appropriate size operated by experienced workers.

.3 The use of vibrators to transport concrete shall not be permitted.

.4 Cement slurry used to prime concrete pumps shall be discarded and not placed in the project.

.5 Immediately before placing concrete, clean forms and reinforcement of foreign matter.

.6 A maximum time limit of 120min from the time of initial mixing to complete discharge shall be observed. Exemptions to the maximum time limit, if required, shall be agreed upon by the Engineer, Owner, and the concrete supplier prior to placement of the concrete. In some circumstances set retarders or hydration stabilizers may be used to extend the discharge time.

.7 During hot weather conditions, as defined by CSA A23.1, do not use concrete mixed more than 1 hour after introduction of mixing water.

.8 Allow 24 hours minimum to elapse after placing concrete in columns, piers or walls before placing concrete in beams or slabs supported thereon.

.9 Prior to pouring the concrete elements directly supported above, remove forms to such an extent to allow the Architect/Owner/Engineer to review the quality of any exposed column surface. Provide necessary protection to the exposed surfaces upon completion of review.

.10 Place concrete on steel joist and steel deck floors in a manner that avoids piling up of concrete. Do not drop concrete directly from buckets, but employ suitable means of distribution. Wet down deck during hot weather prior to concreting.

.11 Remove concrete spilled onto forms around hoisting equipment before depositing concrete in these areas.

.12 Pumping Concrete

.1 Pumping or pneumatic placing of concrete shall only be used if the velocity of discharge is reduced to a point where no separation or scattering of the concrete occurs, and the consistency of the mix has been designed to allow such a system with no adverse effects on the quality of concrete.

.2 Excess grout or mortar used to lubricate pipelines, or washout water, must not be discharged into the forms.

3.5 OPENINGS AND INSERTS

.1 The Contractor shall notify all trades sufficiently in advance to ensure that provision is made for openings, inserts and fasteners. The Contractor shall cooperate with all trades in the forming and setting of all slots, sleeves, bolts, dowels, hangers, inserts, conduits, clips, etc. Any embedded hardware may be subject to review by the Consultant.

.2 Openings and sleeves shown on the structural drawings must be confirmed with mechanical, electrical and architectural drawings.

.3 Openings and sleeves not shown on the structural drawings must be approved by the Consultant.

.4 Openings and sleeves not shown on the structural drawings must be approved by the Consultant.

.5 Do not pass sleeves, ducts, pipes, or other openings through joists, beams, columns, or wall zones without written approval of the Consultant.

.6 Do not eliminate, cut or displace reinforcement to accommodate hardware. If inserts cannot be located as specified, obtain approval of modifications by the Consultant before placing concrete.

3.6 CONSTRUCTION AND CONTROL JOINTS

.1 Construction joints shall conform to the Standard except that for horizontal joints in walls, other than retaining walls, it will be sufficient to place fresh concrete on a clean rough surface unless directed otherwise by the Consultant or otherwise noted on the structural drawings.

.2 Joints in slabs on grade shall be located as indicated on the structural and/or architectural drawings. Unless noted otherwise on the drawings a joint in the slab on grade may be a pour joint, trowelled joint, saw cut, or other pre-approved method. The depth of joints shall be a minimum of ¼ of the thickness of the slab. Saw cut joints are to be completed within 12 hr. of placing. Alternative joint details are to be submitted in writing to the Consultant.

.3 For vertical joints in walls below grade, see standard detail on structural drawings. For locations, see architectural and structural drawings.

.4 Construction joints in walls and columns shall occur at the top of slab and at the underside of slab/beam systems unless noted otherwise on the structural drawings.

.5 Construction joints not shown in the drawings or specifications shall be subject to the approval of the Consultant. The Consultant may require keys, or extra reinforcing to be provided at the Consultant's discretion with associated costs borne by the Contractor.

.6 The existing concrete surface at construction joints shall be brought to a saturated surface dry condition immediately prior to placement of concrete.

.7 Construction joints exposed to view may be subject to non-structural review by Consultant.

.8 Unless noted otherwise on the drawings, control joints in walls are to be located at a maximum spacing of 9m (30') on centre and detailed as indicated on the structural drawings.

.9 Supply and install pre-molded water-stops in construction joints where indicated on the drawings. Weld joints to make watertight. Install waterstops in accordance with manufacturer's specifications and recommendations. Water stop procedures require approval of Consultant.

.10 Obtain approval from RJC for location and details of construction joints not shown.

.11 The maximum length of a concrete slab pour shall be 40 m (120'-0).

.12 The maximum length of a concrete foundation wall pour shall be 15 m (50').

.13 The maximum height of a concrete pour shall be 5 m (15'-0).

.14 If the construction joint (including joints around temporary openings) will be exposed in its permanent condition, such as in a Parking Garage, the joint must be caulked as outlined under the Materials section.

3.7 CURING AND PROTECTION

.1 Curing procedures shall be in accordance with the Standard. Alternate methods with Consultants approval, may be used providing they produce concrete that meets the contract documents.

.2 Cold and hot weather protection shall comply with the Standard or the requirements on the structural drawings, whichever are more rigorous.

.3 Concrete place during extreme drying conditions shall satisfy A23.1.

.4 Protect all concrete in accordance with CSA A23.1, the concrete supplier's requirements and as specified herein; to prevent freshly deposited concrete from freezing, being exposed to abnormally high temperatures or temperature differentials, premature drying, and moisture loss for a period of time necessary to develop the

specified properties of the concrete.

.5 Protection of Completed Work

.1 At all times during the work, protect exposed concrete, exposed masonry and other exposed members from staining or becoming coated with concrete leakage due to continuing concreting operations. Members which become coated may be classed as defective by the Consultant.

.2 Protect exposed members from staining due to rusting of reinforcement projecting beyond construction joints.

.3 Take suitable measures to prevent spalling and cracking damage occurring to the structure due to water freezing in expansion joints, small holes, slots, depressions and take suitable measures to prevent damage occurring to foundations and the like due to frost action in the soil or backfill.

.4 The application of deicing salts on completed work is not permitted.

.9 The Contractor shall submit a plan for curing to the Owner, for review and approval. The curing plan shall be prepared in strict accordance with the Standard, including:

- The method for protecting the concrete from evaporation of surface moisture from the fresh concrete.
- The type of curing material to be used.
- How the surface will be kept moist and the quality control requirements for keeping the surface moist.
- The time of initiation and duration of curing.
- Provisions to address potential problems such as high winds and hot and cold weather.
- The limitations of access, if any, to the surfaces being cured.

.10 All concrete mixes proportioned for C-XL class of exposure shall have Extended Curing. Concrete mixes that meet the definition of HVSCM-1 and where classes of exposure C-1, A-1, F-1, S-1, and S-2 apply shall have Extended Curing. For other exposure classifications, concrete mixes that meet the definition of HVSCM-1 or 2 shall have Additional Curing.

- HVSCM-1 = FA/40 + S/45 > 1.00
- HVSCM-2 = FA/30 + S/35 > 1.00

Where FA = fly ash (Type F, CI1, or CH content of the concrete (% mass of total cementing materials) and S = slag content of the concrete (% mass of total cementing materials)

- Additional Curing = 7 days at $\geq$ 10ºC for a time necessary to attain 70% of the specified strength. When using silica fume concrete, additional curing procedures shall be used. See Standard.
- Extended Curing = a wet-curing period of 7 days. The curing types allowed are ponding, continuous sprinkling, absorptive mat, or fabric kept continuously wet.

.11 The Contractor shall obtain the approval of the Owner, for proposed means of monitoring concrete curing conditions. The Contractor shall be responsible for confirming completion of curing.

.12 Suspended parking slabs shall be wet cured for seven (7) days minimum, as per S413. Curing compounds are not allowed.

3.8 DELAY STRIPS

.1 Place concrete in the delay strips after concrete in adjacent areas has cured for the duration noted on the drawings.

.2 If the delay strip will be exposed in its permanent condition, such as in a Parking Garage, the joints must be caulked as outlined under the Materials section

3.9 SLABS ON GRADE

.1 General

.1 Do not place concrete slabs on grade until the specified sub-floor material has been placed, inspected and approved.

.2 Do not place concrete on a frozen sub-grade, or on one that contains frozen materials.

.3 Do not place concrete on a sub-grade that has been frozen and thawed until the sub-grade has been reviewed by the geotechnical engineer and approved. If, in the geotechnical engineer's opinion, the bearing capacity of the sub-grade has been compromised, remove the affected materials and replace with compacted granular fill at no additional cost to the Owner.

.4 Upon approval of the placement of the sub-floor material and setting of reinforcement, place and consolidate concrete and finish and cure as specified herein.

.5 Where slab on grade is exposed to de-icing chemicals, provide an approved sealant at the joint between the slab on grade and abutting surfaces.

.6 Saw-cut slabs on grade as shown with a maximum length between saw-cuts of 4.5m (15' 0"). Arrange panels as shown or to the Consultant's approval.

.7 Carry out cutting in accordance with recommendations contained in CSA A23.1, but in any event between 6 and 18 hours after placement of concrete.

.8 After a period of at least 28 days, fill saw-cuts with mortar containing cement, sand and latex bonding agent. Ensure that joints to be filled are clean, dry and free of foreign matter.

.9 Mask edges of saw-cuts as required, to prevent concrete floors from becoming stained.

.10 Construction joints may be provided in slabs on grade so that pours on any one day may be kept to reasonable sizes. Locate construction joints to the Consultant's approval.

3.10 MAKING GOOD

.1 Where directed by the Consultant make good temporary openings left in concrete construction around pipes, ducts and the like using a mortar of the same proportions as the surrounding work. Reinforce mortar with welded wire fabric where openings exceed 75 mm (3"). Roughen existing surfaces to receive mortar or apply suitable bonding agent such that mortar will be securely bonded to existing concrete.

3.11 SLOPING SLABS

.1 In the case of sloping slabs, employ suitable concrete placing and consolidation procedures to ensure the completed concrete has the specified design characteristics, and in particular, to prevent movement of plastic concrete resulting in thickness variation, cracking, tearing, loss of bond, etc. [and to achieve a surface equivalent to a fine wood float finish suitable to receive the roofing membrane].

.2 Upon approval of the placement of the sub-floor material, place and consolidate a uniform thickness of slab on grade concrete to within 40 mm of top. Note 50 mm (2") maximum slump. Coordinate with Section 032000 the immediate placement of reinforcement on top of the first layer of concrete. Place, consolidate, finish and cure the final 40 mm (1½) thickness of slab to the tolerances specified.

3.12 PATCHING

.1 Honeycombing, exposed reinforcement and other defects shall be repaired and patched

by the Contractor at the Contractor's cost to the satisfaction of the Consultant using a procedure preapproved by the Consultant. Exposed patching must also be accepted by the Consultant.

.2 Immediately after the removal of forms, all bolts, ties, nails or other metal not specifically required for construction purposes shall be removed or cut back to a depth of 25 mm (1") from the surface of the concrete.

3.13 TOLERANCES

.1 Tolerances shall conform to the Standard or the requirements on the structural or architectural contract documents, whichever are more rigorous.

.2 Variations in building lines which result in extension of the building over lot lines or restriction lines will not be permitted.

.3 These tolerances are acceptable with regard to structural requirements. Interfacing tolerances may not be compatible with the above. Review and coordinate interfacing tolerances so that the various elements come together properly.

3.14 FINISHING - FLOORS

.1 Finishing shall conform to CSA-A23.1 - Section 7.5 as a minimum. Care shall be taken during finishing to maintain the cambers specified on the structural drawings. See also the architectural drawings and specifications for additional finish requirements.

.2 Unless noted otherwise, floor finishes shall be Class A "institutional and commercial floors" and have gaps less than or equal to 8.0 mm (5/16") under a 3000 mm (10'-0") straight edge. Only a single curvature within this distance is allowed.

3.15 FINISHES - FORMED SURFACES

.1 All formed surfaces shall be treated in accordance with CSA A23.1, Section 7.7 as a minimum. See also architectural drawings and specifications for additional finish requirements.

3.16 OPENINGS THROUGH STRUCTURAL WORK

.1 If, after any part of the structural work has been completed, it is required that additional openings be made through the structure, the Consultant shall be so informed. No opening, including cored sleeves, shall be made through completed work without authorization in writing from the Consultant.

.2 Where the location of openings is approved, locate the reinforcement by x-ray or other positive means as required by the Consultant and adjust the location of the opening so that no reinforcement is cut unless specifically approved otherwise in writing by the Consultant.

.3 In the case of precast concrete slabs, holes shall be cut or drilled only by the precast concrete fabricator.

3.17 REJECTION OF DEFECTIVE WORK

.1 In the event that concrete tests do not conform to the requirements of this specification, or when conditions are such to cause doubt about the safety of the structure, testing of the structure will be undertaken at the direction of the Consultant. This may entail further concrete tests, coring or load testing as per the Standard, or any other test the Consultant deems suitable. Such test shall be made at the expense of the Contractor and to the satisfaction of the Consultant.

.2 Where, in the opinion of the Consultant, material or workmanship fails to meet the requirements of the specification, such work may be rejected. Work rejected shall be replaced or repaired to the approval of the Consultant and at no additional cost to the Owner.

End of Section 03 30 00

1 General

1.1 **SECTION INCLUDES**

.1 Design, Labour, Products, equipment and services necessary for architectural concrete work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM C494, Chemical Admixtures for Concrete.

.2 ASTM C979/C979M, Standard Specification for Pigments for Integrally Colored Concrete.

.3 CAN/CSA-A23.1/.2, Concrete Materials and Methods of Concrete Construction.

.4 CAN/CSA-A23.3, Design of Concrete Structures.

.5 CAN/CSA A23.4, Precast Concrete-Materials and Construction Code.

.6 CSA O121, Douglas Fir Plywood.

.7 CAN/CSA-S16.1, Limit States Design of Steel Structures.

.8 CAN/CSA-S269.3, Concrete Formwork.

1.3 **DESIGN REQUIREMENTS**

.1 Design architectural concrete in accordance with CAN/CSA-A23.1, .2, .3 and .4 and CAN/CSA-S16.1. Construct to 50% of allowable tolerances and 28 day compressive strength.

1.4 **SUBMITTALS**

.1 Shop drawings:
- .1 Submit shop drawings in accordance with the Conditions of the Contract indicating:
  - .1 Panel joints and cone tie locations, show distribution of panels to provide minimum ½ sheet size through-out exposed locations.
  - .2 Design mix calculations and details of release agent.

.2 Samples:
- .1 Submit following samples in accordance with the Conditions of the Contract.
  - .1 600 x 600 mm samples of each panels finish.
  - .2 Six duplicate 300 x 300 x 50 mm samples for preliminary selection of colours and aggregates.

1.5 **QUALITY ASSURANCE**

.1 Conform to the requirements of Section 03 30 00 except where exceeded by requirements of this Section.

.2 Mock-up:

.1 Construct one mock-up for the purpose of determining casting procedures and vibration techniques, to examine segregation of concrete and to make any final adjustments to mix design, joint design, concrete colour, and to evaluate surface appearance. Size of prototype members to be determined by the Consultant. Place mock-up in a temporary location acceptable to Consultant and remove when directed.

.2 Include two form panels in order to determine joints between panels and to demonstrate tight joints without grooved joints or the formation of projecting fins of concrete.

.3 Erect a wall and column sample as directed at a permanent location in building designated by Consultant for examination and acceptable of appearance of colour, surface finish, details, jointing, assembly and alignment.

.4 Adjust sample installation at no extra cost to Owner as required to obtain acceptance. Accepted samples may become part of permanent Work, and shall be minimum standard to which balance of Work shall match, subject to passing of tests.

2 Products

2.1 **MATERIALS**

.1 Cement, Aggregates, Admixtures and Mix designs: in accordance with requirements of Section 03 30 00. Cement used for Architectural Concrete shall be supplied from a single kiln run.

.2 Aggregates:

.1 In accordance with CAN/CSA-A23.1, and in general, maximum size no greater than one-quarter thickness of concrete section being poured. Maximum coarse aggregate dimension; 19 mm. Aggregate shall be supplied in one batch to avoid colour variations.

.2 Exposed aggregate for face mix shall have max. dimension of 13 mm and crushed material of colour necessary to produce exposed surfaces which will match sample panel as per Art. 1.4.3. Maintain single source of aggregate for duration of Contract.

.3 Pigments:
- .1 ASTM C979/C979M, non-staining, non-bleeding, non-fading, pure oxide iron pigments.
- .2 Integral pigment colour 'Chaps BN2520R' by Interstar or approved alternatives by Northern Pigments, Harcros Pigments Canada or L.M. Scofield to match specified colour.

.4 Admixtures: CAN/CSA-A23.1. Water reducing, cement dispersing agent is acceptable; use air entrainment for concrete exposed to exterior environment.

.5 Superplasticizer: ASTM C 494, Type F or G, free of chlorides and alkalies, and shall be of the synthesized sulfonated complex polymer type which shall be added to concrete mixer at central batch plant or on site. Acceptable types: 'Rheobuild' by Master Builders Co Ltd. and 'PSP by Construction Chemicals Ltd.

.6 Forms: in addition to requirements of Section 03 10 00, comply with the following:
- .1 Flat surfaces: surface of forms in contact with architectural concrete shall be plastic coated plywood of a type similar to 'Fin Form' as distributed by Thomas Canada Ltd. Minimum thickness: 18 mm.
- .2 Flat Surfaces Scheduled for Exposed view Smooth Finish: Minimum 18 mm thick high density overlaid plywood to CSA O121 free from surface defects, boats, grain pattern, and durable under effects of weather, construction traffic and concrete placement. Acceptable products; 'CZ44' by Fletcher Challenge Canada Ltd. or 'Sylvaform' by MacMillan Bloedel Ltd. or 'Pourform 107' by Ainsworth Products Company Ltd. or 'Weldform' by Canweld Ltd.
- .3 Reglet Forms: Clear pine, sticker run, to dimensions detailed.

2.2 MIX DESIGN

.1 Design the mix in accordance with requirements of CAN/CSA-A23.1, complying with clauses 14 and 15 as applicable.

.2 Design mix for a slump which is the minimum necessary to ensure good placement and finishing of concrete. Do not design concrete with a slump in excess of 75 mm before addition of superplasticizer.

.3 Provide evidence acceptable to the inspection and testing company appointed that proposed mix proportions will produce specified quality of concrete.

.4 Adjust concrete mix proportions as necessary to maintain quality of concrete, to satisfaction of Consultant, without increase to the Contract Price.

.5 Provide an acceptable cement dispersing, water-reducing admixture in all concrete.

.6 Ensure that entrained air content of concrete is within range specified in Tables 7 and 8 of CAN/CSA-A23.1 for conditions of exposure given. For non-air entrained concrete, ensure that entrained air does not exceed 3%.

.7 In addition to water-reducing admixture, provide an air entraining agent in all concrete surfaces exposed to freeze-thaw conditions and/or action of road salt.

.8 Provide architectural concrete of the following design:

Portland Cement	Type GU, grey or white as required to achieve colour range of approved sample.
Coarse Aggregate	19 mm crushed limestone
Fine Aggregate	Clean sand - consolidated sand and gravel
Pigment	Selected pigment colour, to a maximum 1.5% loading by weight
Air Content	5% minimum - 7% maximum
Water/cement ratio	0.48
Slump	50 mm maximum before the use of superplasticer; 150 mm after addition of superplasticer

.1 Take necessary precautions to maintain quality control of concrete used for architectural concrete and ensure continuity of cement and aggregates used from batch to batch. Keep operations uniform throughout.

.2 Stockpile cement for use on this project in manner to ensure absence of any deleterious substances or contaminants.

3 Execution

3.1 EXAMINATION

.1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.2 COORDINATION WITH FORMWORK TRADES

.1 Give directions to work of Section 03 10 00 to ensure all formwork is constructed to ensure that finished concrete surfaces will be free from any imperfections as a result of, but not limited to, misalignment or warping of forms, misalignment or warping of plywood or steel elements, inadequate tightness of forms, mortar leakage and any texture imparted by formwork. Give directions to trades in establishing pattern of form ties. Apply silicone beads to all formwork joints to avoid mortar leakage.

.2 Where drawings do not show formwork layout joints, provide symmetrical architectural layout which relates to pronounced architectural building lines, grids and features such as columns and window mullions. Use maximum size formwork liner sheets commercially available. Obtain Consultant's approval of final joint locations.

.3 Provide double layer formwork for all architectural concrete, back all edges of plywood forms and brace for assurance that mortar leakage is eliminated. Carefully inspect column forms prior to erecting to ensure debris has not intruded plane between liner and fibre outer covers, nor has entered formwork voids.

.4 Internal form ties are not permitted in formwork at beams and girders.

.5 Water-resistant gaskets are required to seal form joints tight over previous pour.

.6 Ensure correct form ties have been used in which no metal is closer than 38 mm to surface of concrete, and form tie layout is in conformance with reviewed shop drawings.

3.3 PLACING OF CONCRETE

.1 Before commencement of erection procedures, examine form surfaces, location and alignment of component placed under section 03 10 00 and 03 20 00. Report deficiencies to Consultant.

.2 At least 48 hours before concrete is placed notify Construction Manager or proposed date and time of commencement of concreting.

.3 Ensure curing and sealing materials are compatible with architectural finishes, and are non-staining, including adhesives that may be used.

.4 Conform to Section 03 30 00 and CAN/CSA -A23.1 fro placing and compaction of concrete and as hereinafter specified. Comply with details of clause 28 of CAN/CSA-A23.1, and further references to CSA A23.4 and CAN/CSA-S269.3 for formwork and casting.

.5 Between October 15th and April 15th of the following year and/or when the air temperature is below 5°C, place all concrete in accordance with requirements of CAN/CSA-A23.1 'Cold Weather Requirements'.

.6 Effect hot weather concreting in accordance with the requirements of CAN/CSA-A23.1 and ACI standard 305 'Recommended Practice for Hot Weather Concreting'.

.7 Throughly clean equipment used in conveying concrete after each run, discharge such cleaning water outside the forms.

.8 Throughly clean forms or steel deck. Before placing concrete, use wooden ploughs and compressed air free from lubricating oil and condensate, clean forms of all paper, plastic, metal and other debris with special form cleaning tools.

.9 Apply release agent to faces of formwork in one molecule thickness no greater than 12.5 µm.

.10 Prior to erecting column and wall formwork against cast concrete surfaces, clean such surfaces throughly; after erecting formwork, seal the form top opening to prevent accidental entry of foreign objects. Remove protection as casting starts.

.11 Approximately 12 hours before concrete is placed, re-tighten forms as is necessary, and saturate the surfaces of construction joints and form sides with water.

.12 Deposit concrete as close to it's final position as possible, and do not allow to flow laterally more than 600 mm. Maximum free drop of concrete; 1200 mm.

.13 For depositing concrete in beams, provide suitably sized , tapered pouring boxes to tunnel concrete into forms. Provide sufficient boxes for each pour such that they can be placed simultaneously at approximately 2000 mm OC for the entire length of the pour.

.14 Use pumping methods only for depositing of concrete into column forms.

.15 Arrange operations so that once a pour is started, concreting is carried on continuously, and the concrete at the surface of the pour is maintained plastic until completion of the section.

.16 Do not use calcium chloride or other chemicals to accelerate setting.

.17 To compact Architectural Concrete, use internal vibrators 25 to 50 mm diameter as required. Apply vibrators at sufficiently short intervals (approximately 500-1000 mm OC) that vibrated areas overlap without omission of any part. Ensure that the vibrators are inserted through the layer being compacted, but take care not to damage forms or form liners. Leave vibrator in place from 5 to 15 seconds, and withdraw slowly leaving the vibrator operating. Place architectural concrete in 300 mm layers; vibrate through two layers into the third layer.

.18 Shortly after concrete is placed and compacted to top of designated construction joints, rework concrete with wooden chisels at the exposed faces to a depth of at least 600 mm and then re-vibrate.

.19 Where excessive vibrating of concrete results in segregation of concrete elements, remove and replace with specified concrete as directed.

.20 Monitor concrete hydration temperatures closely with immersion thermometers set in water-filled holes in tops of beams and columns and keep accurate log for Consultant's periodic review.

.21 Place concrete n horizontal and vertical lifts as one continuous operation between construction joints. Make joints in walls at the top of reglet, unless otherwise shown. Do not allow pour edges to set prior to placing adjacent concrete. Sequence placing operations to prevent concrete drying shrinkage.

.22 Concrete for each column and each beam shall be deposited from the same, single truck load.

.23 Exposed edges of tops of walls and beam soffits, column corners are designed as square corners without any type of radius. Take precautions in vibrating and form removal acceptable to Consultant to ensure clean, sharp, 90° corners. After form removal, hand rub corners to 3 mm radius.

3.4 CONSTRUCTION JOINTS

.1 Conform to CAN/CSA-A23.1 and as hereinafter specified.

.2 Provide vertical construction joints in walls at not more than 22 000 mm OC.

.3 Bond fresh concrete to hardened concrete to CAN/CSA-A23.1, clause 19.5, and where job conditions cause 'cold-joint' conditions to develop, resume casting over concrete surfaces having received coat of bonding or bond mortar. Ensure bonding material does not contaminate form surface or show in finished Work.

.4 Provide a continuous shear key in construction joints in walls and spandrels 125 mm or more in thickness and ensure reinforcement continues uninterrupted through joint.

3.5 STRIPPING OF FORMWORK

.1 Further to requirements of CAN/CSA-A23.1 and Section 03 30 00, prior to formwork removal, ensure minimum concrete strength is 75% of specified strength and temperature differential between ambient and concrete mass is no greater than 30°C.

.2 Strip forms no later than 7 days after pouring. Once this duration has been established, strip all successive pours after the same amount of time.

3.6 CURING AND PROTECTION

.1 Cure and protect formed concrete surfaces a minimum of 3 days and to CAN/CSA-A23.1. Only burlap curing with constant water spray techniques is permitted for architectural concrete; see further requirements under Section 03 30 00.

.2 Prevent rapid drying at end of curing period.

.3 To protect Architectural Concrete, use polyethylene sheets or the like to prevent members from staining or becoming coated with leakage during concrete operations. Protect concrete surfaces from staining due to rusting of reinforcing steel and other metal hardware items.

.4 Job Site Protection of Cast and Finished Elements:

.1 Construct rigid wood and plywood boxing to be kept in place for the duration of on site construction of the entire project.

.2 Immediately after stripping, cover concrete with an air tight bonnet consisting of heavy polyethylene. Design protection to ensure finished work is free of any traces of staining, shipping or other defects.

.3 Protective devices shall allow free passage of air, and shall be tightly wrapped and sealed over a spacer system of plastic coated hot dip galvanized woven wire mesh using heavy gauge polyethylene films. Provide closed cell synthetic or 'dimpled' plastic spacer pads between concrete and plywood; organic and metallic materials will not be allowed to make contact with architectural concrete surfaces.

.4 Wooden protective devices are required for all exposed architectural concrete surfaces located within 2400 mm of finished floor surfaces and for other areas subjected to possible damage by construction activities.

.5 Upon acceptance of protective devices by Consultant, continued inspections, modifications and maintenance of such devices shall be provided by work of the Conditions of the Contract.

3.7 FINISHES

.1 Standard Concrete Finish: See Section 03 30 00.

.2 Smooth architectural concrete finishes:

.1 No defects in exposed smooth architectural concrete finish shall be visible from a distance of 6 m. In addition to the defects listed under the referenced Standard, they include: spalling, honeycombing, pitting and surface cutouts and cavities with face size of 3 mm or more.

.2 Tolerances in formwork for smooth concrete finish shall be maximum 2 mm in 9000 mm.

.3 Finish shall be a superb concrete finish of glass-like quality, finished to the highest standards, pigmented and utilizing formwork and workmanship capable of producing the smoothest finish available.

.4 Where exterior concrete surfaces receiving smooth concrete finishes are judged by Consultant to fall below the standard level of finish displayed in accepted mock-up panel, concrete will be rejected and re-cast.

.5 Rub with an abrasive block and water to remove wood from grain markings, projections and other imperfections until the entire surface is smooth and is uniform in colour. No cement grout shall be used other than that produced from concrete by rubbing process. Clean rubbed surface on completion.

3.8 SPECIAL CLEANING

.1 As late as possible prior to turning building over to Owner, clean exposed architectural concrete with fibre brushes, soap and water, then rinse with clean water, preferably from a hose. Streaks and stains on visible concrete are not permitted.

.2 Remove surplus materials and rubbish from Site at completion of Work.

3.9 INSPECTION AND TESTING

.1 Carry out in-shop testing of materials and maintain quality control in accordance with stated standards. Submit results of tests for review.

.2 Provide air entrainment checks on every 25 m^2 of concrete cast into formwork for exterior elements.

.3 Monitor concrete hydration temperature by casting or drilling holes in tops of concrete members as designated and placing water and immersion thermometers into such holes and covering with an adequate amount of insulation to keep water from freezing.

.4 Allow independent inspection and testing company access to fabrication shop in order to witness testing and fabrication operations in accordance with requirements of the Conditions of the Contract.

END OF SECTION

SECTION 033301
CAST-IN-PLACE CONCRETE-LANDSCAPE

PART 1 GENERAL

1.1 DESCRIPTION

A. Work Included:

1. Concrete Curbs
2. Concrete Seatwall
3. Concrete Walkways

1.2 RELATED SECTIONS

A. Section 01 33 00 – Submittal Procedures.

B. Section 03 10 00 – Concrete Forming and Accessories

C. Section 03 30 00 – Concrete Reinforcement

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM)

1. ASTM C109/C109M-95, Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2 in. or 50-mm Cube Specimens).
2. ASTM C260-94, Specification for Air-Entraining Admixtures for Concrete.
3. ASTM C309-94, Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
4. ASTM C332-87(1991), Specification for Lightweight Aggregates for Insulating Concrete.
5. ASTM C494-92, Specification for Chemical Admixtures for Concrete.
6. ASTM C979-05 Standard Specification for Pigments for Integrally Coloured Concrete
7. ASTM C827-95a, Test Method for Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures.
8. ASTM C939-94a, Test Method for Flow of Grout for Preplaced-Aggregate Concrete.
9. ASTM D412-92, Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers-Tension.
10. ASTM D624-91, Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomer.
11. ASTM D1751-83(1991), Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non extruding and Resilient Bituminous Types).
12. ASTM D1752-84(1992), Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.

B. Canadian General Standards Board (CGSB)

1. CAN/CGSB-37.2-M88, Emulsified Asphalt, Mineral Colloid-Type, Unfilled, for Dampproofing and Waterproofing and for Roof Coatings.

2. CAN/CGSB-51.34-M86, Vapour Barrier, Polyethylene Sheet for Use in Building Construction.

C. Canadian Standards Association (CSA)

1. CAN/CSA-A5-93, Portland Cement.
2. CAN/CSA-A23.1-94, Concrete Materials and Methods of Concrete Construction.
3. CAN/CSA-A23.2-94, Methods of Test for Concrete.
4. CAN/CSA-A23.5-M86(R1992), Supplementary Cementing Materials.
5. CAN/CSA A363-M88(R1996), Cementitious Hydraulic Slag.

D. Architectural Concrete

1. Architectural concrete is concrete, which will be permanently exposed to view. This includes paving, curbs, stairs and walls. Refer to landscape drawings.
2. Ensure that exposed surfaces are dense, even, uniform in colour, texture and distribution of exposed aggregate. Ensure that exposed surfaces are free from defects such as honeycombing, voids, loss of fines, visible flow lines, cold joints, excessive bug holes, inadequate cover to reinforcement and incorrect tie holes, spacers, reglets, formwork joints or construction joints. Ensure that concrete members have sharp accurate definitions of corners, reglets, etc. and are free from chips and spalls. Failure to meet any of these requirements shall be cause for rejection at the discretion of the Owner's Representative.
3. Final appearance of architectural concrete is as important a factor as the engineering properties of the concrete and failure of the as-cast concrete to meet the required standard of appearance shall be cause for rejection at the discretion of the Owner's Representative.
4. Protect exposed surfaces during the construction period from damage, marking, staining and becoming coated with concrete leakage. Unless rejected, repair damage and remove marks and stains to the approval of the Owner's Representative.

1.4 SAMPLES

A. Submit samples in accordance with Section 01 33 00 - Submittal Procedures.

B. At least 4 weeks prior to commencing work, inform Owner's Representative of proposed source of aggregates and provide access for sampling.

1.5 MOCK-UPS

A. Construct mock-up field samples for each type of architectural concrete surface including walkways, walls and planters, conform to CSA A23.1 - 27.3. Use the same materials and workmanship as will be employed for the actual Work. Include a repaired area for each sample. If a sample does not meet the standard of quality specified for the Work, construct additional samples until the required standard is achieved and accepted. The accepted samples shall be the minimum standard of quality for Work. Do not proceed until the Owner's Representative accepts the samples.

B. Mock-ups for each proposed Architectural concrete finish and colour shall demonstrate typical joints, surface finish, texture, colour, tolerances and standard of workmanship.

C. Approved mock-ups for formed surfaces may become part of the completed Work if undisturbed at time of Substantial Completion. Mock-ups for slab-on-grade applications SHALL NOT be part of the completed Work.

D. Items for Mock-up include:

1. Concrete Walkway, minimum 1.8m wide x 1.8m long.

1.6 CERTIFICATES

A. Submit certificates in accordance with Section 01 33 00 - Submittal Procedures.

B. Minimum 4 weeks prior to starting concrete work submit to Owner's Representative manufacturer's test data and certification by qualified independent inspection and testing laboratory that following materials will meet specified requirements:

1. Portland cement.
2. Blended hydraulic cement.
3. Supplementary cementing materials.
4. Grout.
5. Admixtures.
6. Aggregates.
7. Water.
8. Joint filler.

C. Provide certification that mix proportions selected will produce concrete of quality, yield and strength as specified in concrete mixes, and will comply with CAN/CSA-A23.1.

D. Provide certification that plant, equipment, and materials to be used in concrete comply with requirements of CAN/CSA-A23.1.

E. Submit each concrete mix design for review and approval by Owner's Representative.

F. Provide recycling certificates to the Owner's representative.

1.7 QUALITY ASSURANCE

A. Qualifications

1. Construction of specialty concrete items including but not limited to paving (City standard sidewalk, coloured, and stamped), curbs, stairs and planters by company or person with a minimum of 5 years experience, who has adequate equipment and skilled workers to perform it expeditiously and is know to have been responsible for satisfactory installation similar to that specified.
2. General Contractor to submit a list of five references and list of recent applicable projects completed by the concrete trade.
3. Pre-Installation Meetings: conduct pre-installation meeting to verify project requirements and installation instructions and coordinate scope amongst trades.

B. Minimum 4 weeks prior to starting concrete work, submit proposed quality control procedures in accordance with Section 01 45 00 - Quality Control for Owner's Representative's approval for the following items:

1. Falsework erection.
2. Hot weather concrete.
3. Cold weather concrete.
4. Curing.
5. Finishes.
6. Formwork removal.
7. Joints.

1.8 WASTE MANAGEMENT AND DISPOSAL

A. Separate and recycle waste materials.

B. Excess concrete to be removed from site.

C. Use trigger operated spray nozzles for water hoses.

D. Designate a cleaning area for tools to limit water use and runoff.

E. Contractor to provide a designated area for cleaning of trucks ensuring no wash water enters any drainage system.

F. Carefully coordinate the specified concrete work with weather conditions.

G. Ensure emptied containers are sealed and stored safely for disposal away from children.

H. Prevent plasticizers, water-reducing agents and air-entraining agents from entering drinking water supplies or streams. Using appropriate safety precautions collect liquid or solidify liquid with an inert, non-combustible material and remove for disposal. Dispose of all waste in accordance with applicable local, provincial and national regulations.

I. Choose least harmful, appropriate cleaning method which will perform adequately.

1.9 SHOP DRAWINGS

A. Shop Drawings

1. Submit Shop Drawings indicating the method of construction of specialty concrete items including, concrete walkways and seat wall. Shop drawings to illustrate elevations, structural reinforcing, pour break locations, joint types and locations, penetrations, cast ins, and tie hole locations, colour pigment, and finishes.
2. Material shall not be purchased or delivered to site, nor shall work commence, prior to approval of shop drawings by Owner's Representative.
3. Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

PART 2 PRODUCTS

2.1 MATERIALS

A. Portland cement: 20% reduction, except for exterior slab on grade.

B. Blended hydraulic cement: to ASTM C595.

C. Supplementary cementing materials: to CAN/CSA-A23.5.

D. Cementitious hydraulic slag: to CAN/CSA-A363.

E. Water: to CAN/CSA-A23.1.

H. Aggregates: to CAN/CSA-A23.1. Coarse aggregates to be normal density.

I. Low density aggregate for insulating concrete: to CAN/CSA-A23.1 and ASTM C332.

J. Air entraining admixture: to ASTM C260.

K. Chemical admixtures: to ASTM C494. Owner's Representative to approve accelerating or set retarding admixtures during cold and hot weather placing.

L. Concrete retarders: to ASTM C494 water based, low VOC, solvent free. Do not allow moisture of any kind to come in contact with the retarder film.

M. Shrinkage compensating grout: premixed compound consisting of non-metallic aggregate, Portland cement, water reducing and plasticizing agents.

1. Compressive strength: 32 MPa at 28 days.
2. Consistency:
   - .1 Fluid: to ASTM C827. Time of efflux through flow cone (ASTM C939), under 30s.
   - .2 Flowable: to ASTM C827. Flow table, 5 drops in 3s, (ASTM C109, applicable portion) 125 to 145%.
   - .3 Plastic: to ASTM C827. Flow table, 5 drops in 3 s, (ASTM C109, applicable portions) 100 to 125 %.
   - .4 Dry pack to manufacturer's requirements.

N. Curing compound: to CAN/CSA-A23.1.

O. Premoulded joint fillers:

1. Lightweight, flexible expansion joint filler with removable portion to ensure uniform joints, Deck-O-Foam, as manufactured by W.R. Meadows or approved equivalent.
2. Sponge rubber: to ASTM D1752, Type I, flexible firm grade.
3. Self-expanding standard cork: to ASTM D1752, Type II III.

P. Weep hole tubes: rigid PVC 150mm DIA., cut in half.

S. Polyethylene film: 0.15 mm thickness to CAN/CGSB-51.34.

T. See Section 031000 for concrete forming and accessories.

2.2 MIXES

A. For structurally reinforced concrete proportion normal density concrete in accordance with CAN/CSA-A23.1.

1. Cement:
   .1 Type 10 Portland cement.
2. Minimum compressive strength at 28 days: 32 MPa.
3. Class of exposure: C-1
4. Nominal size of coarse aggregate:19 mm.
5. Slump at time and point of discharge: 50 to 110 mm.
6. Air content: 5 to 8%.

B. Coloured Concrete walkways:

1. As per technical drawings
2. Type 1: By Interstar colour: Chaps BN2520R
3. Type 2: By Interstar colour: BN161R Plum

C. Concrete Seatwall:

1. Cement:
   .1 Type 10 Portland cement.
2. Minimum compressive strength at 28 days: 32 MPa.
3. Class of exposure: C-1
4. Nominal size of coarse aggregate: 19 mm.
5. Slump at time and point of discharge: 50 to 110 mm.
6. Air content: 5 to 8%.

PART 3 EXECUTION

3.1 PREPARATION

A. Obtain Owner's Representative's approval before placing concrete. Schedule inspection of formwork with Owners Representative prior to placing of concrete providing 48 hours notice for structures such as walls, stairs and structures.

B. Placing of concrete shall not commence prior to inspection of forms, unless authorized in writing by the Owner's Representative. For typical slab on grade and paving provide 48 hours notice prior to placing of concrete.

C. Pumping of concrete is permitted only after approval of equipment and mix.

D. Ensure reinforcement and inserts are not disturbed during concrete placement.

E. Prior to placing of concrete obtain Owner's Representative's approval of proposed method for protection of concrete during placing and curing in adverse weather.

F. Maintain accurate records of poured concrete items to indicate date, location of pour, quality, air temperature and test samples taken. Test data must be submitted to the Owner's Representative for each pour.

H. In locations where new concrete is dowelled to existing work, drill holes in existing concrete. Place steel dowels or deformed steel reinforcing bars with Hilti HY-200 epoxy adhesive and hold and hold dowels in positions as indicated.

I. Do not place load upon new concrete until authorized by Owner's Representative.

3.2 CONSTRUCTION

A. Do cast-in-place concrete work in accordance with CAN/CSA-A23.1.

B. Obtain Owner's Representative's approval prior to placing concrete. Provide a minimum of 48 hours notice, prior to placement of concrete.

C. Ensure reinforcement and inserts are not disturbed during concrete placement.

D. Prior to placing concrete, obtain Owner's Representative approval of proposed method for protection of concrete during placing and curing.

E. Concrete shall be deposited continuously, or in layers of such thickness that no concrete will be deposited on concrete which has hardened sufficiently to cause the formation of seams or plains of weakness. If a section cannot be placed continuously, construction joints shall be located as permitted by the Owner's Representative. All pour and construction joints shall be formed with a straight-edge fixed to formwork. Placing shall be carried out at such a rate that concrete which is being integrated with fresh concrete is still plastic.

F. Take every precaution to protect finished surfaces from stains and abrasions. Surfaces and edges likely to be damaged during the construction period shall be especially protected.

G. Boardform Form Work as per section 031000.

H. Sleeves and inserts.

1. No sleeves, ducts, pipes or other openings shall pass through joists, beams, column capitals or columns, except where indicated or approved by Owner's Representative.
2. Where approved by Owner's Representative, set sleeves, ties, pipe hangers and other inserts and openings as indicated or specified elsewhere. Sleeves and openings greater than 100 x 100 mm not indicated must be approved by Owner's Representative.
3. Do not eliminate or displace reinforcement to accommodate hardware. If inserts cannot be located as specified, obtain approval of modifications from Owner's Representative before placing of concrete.
4. Check locations and sizes of sleeves and openings shown on drawings.
5. Set special inserts for strength testing as indicated and as required by non-destructive method of testing concrete.

I. Anchor bolts.

1. Set anchor bolts to templates under supervision of appropriate trade prior to placing concrete.
2. With approval of Owner's Representative, grout anchor bolts in preformed holes or holes drilled after concrete has set. Formed holes to be minimum 100 mm diameter. Drilled holes to manufacturers' recommendations.
3. Protect anchor bolt holes from water accumulations, snow and ice build-ups.
4. Set bolts and fill holes with shrinkage compensating grout epoxy grout.

5. Locate anchor bolts used in connection with expansion shoes, rollers and rockers with due regard to ambient temperature at time of erection.

J. Finishing

1. SPEC NOTE: Provide schedule of exposed or architectural finish requirements to walls, etc.
2. Finish concrete in accordance with technical drawings
3. Curbs: Light Brush Texture
4. Exposed Concrete Seatwall in accordance with technical drawings
5. Use procedures acceptable to Owner's Representative or those noted in CAN/CSA-A23.1 to remove excess bleed water. Ensure surface is not damaged.
6. SPEC NOTE: Applies to conductive and static disseminating surface treatment and conductive and static disseminating monolithic or bonded topping.
7. All architectural exposed concrete as stripped but remove all projections and fins greater than 1.5mm.
8. Fill flush all voids larger than 6mm using the technique described in Patching.
9. Salt finish surfaces shall have uniform appearance similar in all respects to the salt finish of prototype sample panels.
10. An additional salt wash mock-up on completed work to be approved by Owner's Representative prior to proceeding with acid washing the remaining large areas of finished work
11. Salt wash operations shall conform to existing codes and regulations.
12. Salt wash shall be carried out in a continuous operation for a given area, using the same personnel to completion.
13. Completely clean up
14. All corner radii to be 12mm unless otherwise specified.

K. Curing

1. Refer to technical drawings applicable to type / application of concrete.

L. Joint fillers.

1. As per technical drawings

M. Protection

1. Ensure all completed sections of concrete work are properly protected from damage.

N. Repair

1. Remove and replace all concrete work that does not comply with the requirements of this section.
2. General Repairs
   .1 Areas to be repaired shall be determined by the Owner's Representative and shall not exceed 0.2 square metres for each 93 square metres of surface area, and shall be widely dispersed. Repairs shall match the surrounding area. Architectural concrete requiring repair in excess of above standard is subject to rejection by the Owner's Representative and shall be removed and replaced. Removal and replacement of work shall be at no additional cost to the Owner.
   .2 Before commencing any repair work, the Contractor shall confirm repair procedures with the Owner's Representative and establish by trial mix the formula required. The Contractor shall demonstrate his repair techniques on a prototype sample panel.

3. The following are key steps to making a repair to architectural concrete:
   .1 Prepare the area to be repaired. This should include achieving the desired finish in the surrounding area. Remove loose particles and chip out part of the sound concrete to avoid feather edge repairs.
   .2 Proportion the repair mix by weight according to the same proportions as used in the concrete mix but substituting a portion of white cement for grey cement. This should be based on tests to determine what is required to match the finished surface.
   .3 Apply a coat of bonding material to the root of the areas to be repaired, being careful to avoid dripping on any surface to be exposed.
   .4 Fill in the area to be repaired with mortar of the stiffest consistency that will permit placing. Consolidate in place and strike off so as to leave the repaired area slightly higher than the surrounding surface to permit initial shrinkage. The repair shall be left undisturbed for at least one hour before being textured.
   .5 Cure the repaired area by keeping continuously damp for 7days.
   .6 Clean the repaired area to remove laitance and match the surrounding area.
   .7 Repair of cracks in concrete slabs and slabs-on-grade shall be the sole responsibility of the Contractor at no expense to the Owner

3.3 SITE TOLERANCE

A. Concrete tolerance in accordance with CAN/CSA-A23.1, plus or minus 3mm tolerance over vertical and horizontal dimensions. Refer to drawings.

3.4 FIELD QUALITY CONTROL

A. Inspection and testing of concrete and concrete materials will be carried out by a Testing Laboratory designated by Owner's Representative in accordance with CAN/CSA-A23.1 and Section 01 45 00 - Quality Control.

B. Owner will pay for costs of tests as specified in Section 01 29 83 - Payment Procedures: Testing Laboratory Services.

D. Non-destructive Methods for Testing Concrete shall be in accordance with CAN/CSA-A23.2.

E. Inspection or testing by Owner's Representative will not augment or replace Contractor quality control nor relieve him of his contractual responsibility.

END OF SECTION 03 33 00

1.0 General

1.1 DOCUMENTS

.1 This section, along with the drawings, forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 GENERAL REQUIREMENTS

.1 Comply with requirements of Division 1.

1.3 DESCRIPTION OF WORK INCLUDED

.1 Finish concrete surfaces in accordance with the current CSA-A23.1 and CSA-A23.2 standards.

.2 Select floor finishing techniques in function of the architectural floor finishes specified.

.3 Include in contract application of leveling compounds to achieve the proper floor finishing requirements set out in this specification.

1.4 RELATED WORK SPECIFIED ELSEWHERE

.1 Finishing of exterior walls: Section 02525

.2 Supply, placement and rough levelling of concrete: Section 033000

.3 Cementitious waterproofing: Section 07145

1.5 REFERENCE STANDARDS, CODES AND ACTS

.1 Conform with the [Ontario Regulation 350/06 (The Building Code) as amended by O.Reg. 137/07] any applicable acts of any authority having jurisdiction and the following:

.2 CSA-A23.1-09 (R2014) -Concrete Materials and Methods of Concrete Construction.

.3 CSA-A23.2-09 (R2014) - Methods of Test and Standard Practices for Concrete.

.4 ACI 302.1 R-04 - Guide for Concrete Floor and Slab Construction.

.5 Where there are differences between the specifications and drawings and the codes, standards or acts, the most stringent shall govern.

1.6 SUBMITTALS

.1 Cambers

.1 Submit a proposal for review by RJC regarding how the specified camber in slabs and beams are to be achieved and measured.

1.7 QUALIFICATIONS

.1 The ‘foreperson’ or ‘lead-hand’ supervising the placement consolidation, finishing and curing of the concrete shall be certified under an industry recognized concrete finishing program, such as the ACI Concrete Flatwork Finisher/Technician Certification Program.

1.8 QUALITY ASSURANCE

.1 Floor Finisher's Qualifications: Member in good standing of the Concrete Floor Contractors' Association or approved by the Consultant prior to Tender closing.

.2 Workmanship Standards: Unless otherwise specified, meet requirements of CSA-A23.1 and recommendations of Concrete Floor Contractors' Association.

.3 Verify with Sections applying finishes to slabs to ensure that respective material manufacture's requirements are met. Notify Consultant prior to start of work should any finish specified herein be considered unsuitable.

1.9 JOB CONDITIONS

.1 Maintain minimum 10°C ambient temperature, when performing work of this Section.

.2 Protect floor from construction traffic during curing period.

2.0 Products

2.1 MATERIALS

.1 Floor hardener: One of the following:

.1 Liquid curing and hardening compound: Sealtight Cure-Hard by W.R. Meadows of Canada Ltd or approved equivalent.

.2 Liquid concrete surface hardener: Shealhard 400 by Sternson Ltd. or approved equivalent.

.2 Curing and Sealing Compounds

.1 Liquid, membrane forming compound, meeting moisture retention requirements of ASTM C309.

.2 Curing compound for floors covered with finish flooring: Use only compounds which are proven to be compatible with finishing materials.

.3 Curing/sealing compound for exposed floors: Florseal by Sternson Ltd., Masterseal by Master Buildings Co. Ltd., or Sealtight CR-26 by W.R. Meadows or approved equivalent.

.4 Control joint filler: Loadflex by Sternson or approved equivalent.

.5 Joint Sealant: 2 component chemically reactive polyurethane modified sealant, self- levelling, grey: @c/SL by Sika Canada or approved equivalent.

3.0 Execution

3.1 GENERAL

.1 Finish the top or final surface of concrete by screeding, floating and trowelling as defined in CSA A23.1 and in accordance with the architectural final finish requirements. Unless specified otherwise, steel trowel to CSA A23.1.

.2 Verify floor finish tolerances and cambers after each slab section has been cast and before any formwork has been removed. For beams measure along their centre lines. For slabs measure along grid and centre lines as well as at all column or wall locations. Measuring points to include the point of maximum camber and shall be no further than 3000 mm (10'-0") apart.

.3 Survey floors including beams between 7 and 14 days after all shoring has been removed. Measure along same points as in sub clause above.

.4 Use suitable techniques to finish abutting pours at joints to eliminate "humping". If humping occurs, grind the joint down level to the surrounding surface.

.5 Where the finish is not of the quality specified, remove ridges, undulations, projections at construction joints and areas of carbonation and scaling by methods approved by RJC.

.6 Cure concrete in accordance with CSA A23.1.

3.2 FINISHING

.1 Provide steel trowel, float and scratched slab finishes where required. Meet workmanship standards and tolerances specified in CSA-A23.1. Meet workmanship standards and tolerances specified in the CSA standards and in this specification.

.2 Provide hardened concrete, where required, in accordance with hardener manufacturer's directions and as follows:

.1 Liquid curing and hardening compound:

.1 Apply compound as soon as all surface water has disappeared and the concrete is surface dry to permit penetration of the compound.

.2 Apply compound evenly to substrate with a low pressure power sprayer, a hair broom or a paint roller. Apply compound at a rate as per manufacturer.

.2 Liquid surface hardener:

.1 Moist cure concrete. Concrete must be at least 14 days old, free of dust and other foreign substances which would inhibit proper application of liquid compound.

.2 Apply compound in two coats; mix compound with water as directed by manufacturer.

.3 Apply first coat (diluted) with hair broom, mop or rubber squeegee; spread evenly, avoiding puddles; permit to dry for 24 hours.

.4 Check after application of first coat for accumulation of surplus hardener in low spots, remove white deposits with stiff brush and hot water.

.5 Apply second coat (full strength) similar to first coat.

.3 Provide hardened concrete in the following locations as a minimum, unless noted otherwise:

.1 Loading docks,

.2 Storage areas.

3.3 CURING AND SEALING

.1 Curing shall begin immediately after finishing has been completed in accordance with the CSA standards.

.2 Unless otherwise specified, cure all surfaces by one of the following methods:

.1 Coat surfaces with clear liquid curing or curing and sealing compound in accordance with manufacturer's directions. Refer to Clause 3.2.3.

.2 Moist cure in accordance with CSA-A23.1.

.3 Cure exposed concrete slabs, except hardened surfaces by coating with clear liquid curing and sealing compound. Apply compound in 2 coats; the first coat immediately after finishing operations. Apply the second coat immediately after finishing operations. Apply the second coat just prior to Substantial Performance or when directed by the Consultant. Prior to application of the second coat, suitably clean the floor surfaces to remove all substances detrimental to the sealer.

.4 Do not use curing compound in locations where curing compound might adversely affect finish flooring installation. Moist cure instead, as specified above.

.5 Define and submit the methods of curing for various weather conditions and the applicable sealants, if any, to RJC for review and approval.

3.4 CONTROL JOINTS

.1 Except where control joint inserts are cast into slabs on grade, provide sawcuts as per pattern indicated on drawings and as follows:

.1 Commence sawing as soon as concrete has hardened sufficiently to prevent excessive ravelling. Ensure that saw does not touch or disturb reinforcing steel. Sawcuts shall not vary more than 200mm from true joint alignment.

.2 Sawcut 4mm wide x 38mm deep joints along centre line of construction joints and at maximum spacing as shown on drawing.

.3 Clean joints after cutting and fill with sealant.

3.5 TOLERANCES

.1 Perform finishing operations so that completed work will be in accordance with the requirements set out in CSA-A23.1 and as listed below:

.2 Floor Levelness and Flatness

.1 Conform with CSA criteria set out on 7.5.1.1 to 7.5.1.3.

.2 Methods of surface tolerance measurements are defined in Cl. 7.5.1.4 (“straightedge method”) and in Cl.7.5.1.5 (FF method; measuring flatness and levelness).

.3 Timing of the measurements shall be in accordance with Cl. 7.5.1.2.

.3 In case that the required floor surface tolerances are not appropriate to the level required for the applicable floor finishes, or the floor surface tolerances defined in the specifications are not met, the Contractor shall apply leveling compound in time for application of the floor finishes specified by the Architect. This work shall not delay the overall project schedule.

.4 Interfacing tolerances must also be compatible with architectural and structural requirements. Review and coordinate interfacing tolerances so that the various elements come together properly.

3.6 JOINTS AT ELECTRICAL DUCTS

.1 Where electrical trunks or junction boxes finish flush with the concrete base slab or topping, hand trowel the concrete surface a distance [150 mm (6")] each side of ducts so that the concrete finishes flush with the top of

the duct without bumps or depressions. Tool the concrete surface on either side of electrical ducts to provide a groove 10 mm ($^3/_8$") wide by 25 mm (1") deep to receive mastic.

3.7 CRACK REPAIR

.1 Prior to completion of the project and in any case not sooner than 28 days after concrete has been placed, examine concrete floor surfaces and repair all major cracks. Rout cracks out with mechanical router to 13 mm (½") square approximate cross section. Then clean and fill cracks in same manner as control joints. Refer to Clause 3.3.3.

3.8 SEALING

.1 Seal floor slabs which have no applied finishes with Florseal, by the Sternson Limited or approved equivalent. Apply in strict accordance with the manufacturer's directions. Apply one coat immediately after finishing operation and apply a final coat just prior to completion of the project.

3.9 CONSTRUCTION JOINTS IN SLABS ON GRADE WITH TERRAZZO TOPPINGS

.1 Construct slabs in panels not exceeding 6 m (20'-0") in length. Arrange construction joints to fall below a metal parting strip in the terrazzo.

3.10 CONTROL JOINTS IN CONCRETE ON METAL DECK

.1 Where shown, provide 40 mm (1½") deep saw-cuts in the concrete fill on metal deck.

3.11 HARDENED CONCRETE

.1 Provide a hardened concrete finish to all concrete floors exposed to view in the finished building.

.2 The concrete surface shall be steel trowel finished per Clause 3.1.1. Apply silica sand equal to type SB-1 silica sand marketed by Webster and Sons Limited, broadcast at a minimum rate of 3.0 kg/m² (0.6 lbs/ft²) /Broadcast in two applications at right angles to each other for uniform application. Comply with manufacturer's instructions.

.3 Finish interior floors specified as B. F. Concrete by applying 3.0kg/m² of "Emerycrete SH Premixed" by Sternson Limited or approved alternative. Broadcast grits in two applications at right angles to each other for uniform application. Compact and trowel surface per manufacturing

requirements. Provide a textured broom finish to RJC's approval. Submit samples of finish well in advance of the work. After curing, apply two coats of sealer uniformly over floors. Comply with manufacturer's instructions for application of hardener and sealer. Sealed surfaces shall be clean, uniform in colour, free of peeled sealer, bubbles or dirt particles.

.4 Supply at the correct time during finishing operations, Emerycrete SH Premixed as supplied by Sternsons Limited or approved alternative. Broadcast at a minimum rate of 5.0 kg/m² (1.0 lb/ft²). Comply with manufacturer's directions. Broadcast hardener in two applications at right angles to each other at the application rate specified. At the correct time, apply a steel trowel finish.

.5 Where a hardened concrete finish to receive heavy traffic is specified in the Room Finish Schedule, steel trowel finish as noted above. Supply and finish a 1.1.2 mix monolithic traprock topping of a minimum thickness of 25 mm (1"). Use a ready-mix concrete only, with a 10 mm ($^3/_8$") traprock aggregate and a 50 mm (2") maximum slump. Observe the best work practices during all operations.

.6 Screed base slab 25 mm (1") below the finished slab elevation.

.7 Remove bleed water from the top of the base slab, should it occur.

.8 Place topping when base slab has sufficient rigidity to support the traprock mix without its being submerged into the base slab, but when the base slab also has sufficient plasticity to provide satisfactory bond for the topping. At the correct time, apply a steel trowel finish.

3.12 EXPOSED AGGREGATE

.1 Coarse aggregate for concrete toppings shall be 10 mm ($^3/_8$") pea gravel as supplied by Consolidated Sand & Gravel Company Limited Concrete shall contain entrained air controlled at 5 to 8%. Slump shall not exceed 50 mm (2"). Generally a lean concrete mix with a high proportion of coarse aggregate. The testing company shall recommend a trial mix.

.2 Immediately after pouring and consolidating the slabs, sprinkle the surface uniformly with 10 mm ($^3/_8$") pea gravel as required to produce the desired density of exposed aggregate. Roll the pea gravel into the surface.

.3 Subsequent to applying the pea gravel, wood float finish the slab surfaces. After there are no signs of bleeding, but before initial set of the concrete

has *taken place, spray on Rugasol CS retarder as manufactured by Sika Chemical in* strict accordance with the manufacturer's instructions. Note that if the retarder is applied after initial set, it is not effective. After spraying on the retarder, immediately begin curing the exposed surfaces by applying wet burlap or other approved methods.

.4 At the correct time, after the initial set of the concrete has occurred, wire brush surfaces to expose the desired degree of aggregate. After completion of wire brushing, clean the surface by fibre brushing with a weak solution of muriatic acid.

.5 Application and use of the retarder shall be done under the field direction and advice of a representative of the Sika Chemical Company. All work in connection with exposed aggregate concrete shall be carried out or directed by men with proven successful previous experience in this type of work.

3.13 SCHEDULE

.1 Provide steel trowel finish, sealed where exposed, in all locations except where indicated or required otherwise.

.2 Provide float finish at surfaces scheduled to receive rigid board insulation, wood on sleepers.

.3 Provide scratches finish at surfaces scheduled to receive concrete toppings and tile on mortar bed.

.4 Provide hardened surfaces in shops and where indicated on Drawings and Schedules.

End of Section 03 35 00

1. GENERAL

1.1 DOCUMENTS

.1 This section, along with the drawings, forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 DESCRIPTION OF WORK INCLUDED

.1 Provide labour, materials, equipment, and services necessary to supply and install new shotcrete concrete work as shown or indicated in contract drawings and specifications.

.2 Install anchors, hangers, embedded metal, etc. supplied by applicable trades for placement into shotcrete and assume responsibility for correct positioning within agreed tolerance and in accordance with drawings supplied by trade.

.3 Install openings, sleeves, block-outs, etc. required by other trades and assume responsibility for correct positioning within agreed tolerance and in accordance with drawings supplied by trade.

.4 Coordinate shotcrete placement fully with other trades. Ensure other related work such as inserts, dowels, sleeves, reinforcement, etc. is complete before shotcrete.

.5 Shoot a preconstruction moch-up of the reinforced shotcrete foundation walls to demonstrate that the shotcrete materials, mixture(s), equipment, crew and construction sequence and methods used are capable of producing a product conforming to these specifications and acceptable to the Engineer.

.6 Provide quality control services as necessary to ensure compliance of the complete work with the requirements of this specification. Shoot test panels at the frequency specified for independent quality assurance testing by the Engineer.

.7 Verify that the reinforcing steel bars in the walls are installed in a manner that is conducive to the shotcrete construction process.

.8 Provide all hoarding, covers or other protection devices necessary to protect all fixtures and installations in the shotcrete construction area from contamination, or damage from the shotcrete construction process. In particular, protect such fixtures and installations from impact form the shotcrete nozzle stream, rebound, overspray and shotcrete mist or dust.

.9 Provide all scaffolding, platforms, lift equipment or other devices necessary to provide the shotcrete nozzlemen and other crew and inspectors with safe and proper access to the shotcrete work.

.10 Provide suitable ventilation, lights, fans, curtains, or other devices necessary to provide the shotcrete nozzlemen and crew good visibility and control of shotcrete mist, dust, overspray and rebound.

.11 Provide all forming, bracing guide-wires and finishing tools necessary to enable construction of the reinforced shotcrete elements to the specified profiles, tolerance and finish.

.12 Apply shotcrete to the foundation walls using pre-qualified nozzlemen and crew and approved shotcrete mixture(s).

.13 Finish shotcrete to specified finish, dimensions, tolerance and line and grade. Provide moist curing as specified.

.14 Provide assistance to Engineer for quality assurance testing including access for any coring required by the Engineer. Remove and replace at no cost to the Owner, any defective shotcrete work which is non-conforming to the project specifications.

.15 Leave completed shotcrete work in a clean condition, free of any deposits of shotcrete, overspray, rebound or other contaminants. Remove all such materials from the work area and dispose at an approved disposal site.

1.3 RELATED WORK SPECIFIED ELSEWHERE

.1 Section 03 00 50 – Testing of Concrete and Reinforcement

.2 Section 03 11 00 – Concrete Forming

.3 Section 03 21 00 – Concrete Reinforcing

.4 Section 03 31 00 – Structural Cast-in-Place Concrete

1.4 REFERENCES

.1 Concrete work shall conform to requirements of the following Standards unless otherwise required by this specification:

.1 Building Code

.1 Ontario Building Code - 2012.

.2 Reference Standards

.1 CSA-A23.1-04 - Concrete Materials and Methods of Concrete Construction.

.2 CSA-A23.2-04 - Methods of Test and Standard of Practice for Concrete.

.3 CSA-A23.3-04 - Code for the Design of Concrete Structures for Buildings.

.4 CSA-S413 - Parking Structures.

.5 ACI 506R - Guide to Shotcrete.

.6 ACI 506.2 - Specification for Materials, Proportioning, and Application of Shotcrete.

.7 ACI-CP-60 (02) - Guide to Certification of Shotcrete Nozzlemen.

.8 CAN/CSA-A3001 - Cementitious Materials for use in Concrete.

.9 CAN/CSA-A23.5 – Supplementary Cementing Materials.

.10 ASTM C1140 – Standard Practice for Preparing and Testing Specimens from Test Panels.

.11 ASTM C1141 - Standard Specification for Admixtures for Shotcrete.

.12 ASTM C1436 – Standard Specification for Materials for Shotcrete.

1.5 DEFINITIONS FOR THIS SECTION

.1 "Owner", "Contractor", and "Consultant" as per General Conditions and Definitions.

.2 "Testing Agency" shall mean Testing Agency responsible to "Owner".

.3 "Specialty Engineer" is Professional Engineer registered in responsible for components designed by Contractor and who seals and signs shop drawings.

.4 "Standard" and "Standards" shall mean reference standards listed under "Reference Standards" in this section.

.5 "Bench Gunning" is the practice of shooting thick members of full section by building from the bottom up.

.6 "Core Grading System" is visual grading of core samples taken in-situ and from test panels. Five core grades shall be defined as per ACI 506.2-95

.7 "Blowpipe" is the air jet operated by nozzleman's helper in shotcrete application to assist in keeping rebound and overspray out of the work.

.8 "Guide Wire" (also called screed wire or shooting wire) is a small gauge, high strength wire used to establish line and grade to guide work.

.9 "Nozzleman" is a worker on the shotcrete crew who manipulates the nozzle, controls air addition at the nozzle and controls final deposition of the material.

.10 "Overspray" is shotcrete material deposited away from the intended receiving surface.

.11 "Rebound" is shotcrete material leaner than the original mixture which ricochets off the receiving surface and falls to accumulate on the ground or other surfaces.

.12 "Shadow" is an area of porous, improperly consolidated shotcrete behind reinforcing steel or other embedment's.

.13 "Shotcrete" is concrete pneumatically projected at high velocity onto a receiving surface.

.14 "Sloughing" (also called sagging) is a subsidence of shotcrete due generally to excessive water in the mix or placing too great a thickness or height in a single pass.

.15 "Wet-Mix Shotcrete" is shotcrete in which all the shotcrete ingredients, including mix water, are mixed prior to introduction into the shotcrete delivery system, and compressed air is introduced to the material flow at the nozzle.

1.6 PERFORMANCE REQUIREMENTS

.1 Shotcrete shall not debond from existing concrete, crack excessively, spall, or scale.

.2 Shotcrete shall meet compressive strength, material properties, and bond strength requirements as outlined in contract drawings and specifications.

1.7 QUALIFICATIONS

.1 Shotcrete work shall be performed by company experienced in structural shotcrete construction and application of shotcrete materials. Shotcrete contractor must have completed minimum of three projects of similar type, size, and complexity in past five years.

.2 Operators shall be qualified to perform work to ACI 506R-95.

.3 Foremen shall have minimum five years of experience as foreman, have proficiency at all crew positions, and have completed at least 5 similar applications.

.4 Nozzlemen shall have certification to ACI 506.3R-91, have completed minimum two years of experience as nozzleman, and have completed at least three similar applications as nozzleman.

.5 Nozzlemen who will be shooting on project are required to prepare mock-up test. Only nozzlemen who have successfully completed a mock-up panel with satisfactory results will be permitted to apply shotcrete on the project.

1.8 SUBMITTALS

.1 Use of shotcrete in place of cast-in-place concrete to be pre-approved by Structural Consultant. Submit extent of areas where shotcrete is proposed to be used to place concrete.

.2 Submit proposed method of shotcrete application and proposed method of curing.

.3 Submit description of proposed equipment for mixing and applying shotcrete.

.4 Submit proposed mix designs to Consultant and Testing Agency for review two weeks prior to placement of shotcrete. Mix design information shall include proportions by mass, water to cementitious materials ratio, aggregate grading, and admixture data.

.5 Submit pre-construction test data for review by Consultant two weeks prior to start of production shotcrete.

.6 Submit production test data for review by Consultant within five working days of performing tests.

.7 Submit test panel detailed with reinforcing which meets worst case of congestion for areas where shotcrete is to be used, not limited to:

.1 Contact tension splice locations for wall reinforcing

.2 Column, zones, and pilaster reinforcing cast into walls

.3 Lap splice locations for walls, columns, and zones including ties

.8 Submit a summary of shotcrete production and application for each shift within one working day to be reviewed by the Consultant. Information shall include, but not be limited to, the following: quantity and location of shotcrete applied, observations during production and application, description of placement equipment, batch number(s), and name and signature of nozzleman.

2. PRODUCTS

2.1 GENERAL

.1 Products shall satisfy requirements of Standard unless otherwise specified herein or on drawings.

2.2 MATERIALS

.1 Cement for S-1, S-2, and S-3 concrete shall be as per Table 3 A23.1 and conform to Standard

.2 Aggregates shall be natural stone and conform to Standard. Aggregate shall meet requirements of ASTM C33.

.3 Mixing water shall conform to Standard.

.4 Air entraining admixtures to Standard.

.5 Pozzolanic admixtures may be used and shall conform to Standard.

.6 Calcium chloride, either as a raw material or as a constituent in other admixtures, shall not be used unless approved in writing by Consultant.

2.3 EQUIPMENT

.1 Shotcrete equipment must conform to ACI 506R and ACI 506.2.

.2 Batching equipment to proportion aggregate and cement mixtures on mass basis.

.3 Use air supply system that delivers air uncontaminated by oil and capable of maintaining constant air pressure recommended by shotcrete equipment manufacturer.

.4 Provide separate air hose and air/water blowpipe, capable of simultaneous operation with shotcreting operation, for removal of rebound and dust.

.5 Equipment will be subject to approval of Consultant. Maintain equipment in clean and proper working order.

2.4 MIX DESIGNS

.1 Concrete mixes shall be proportioned by supplier to meet compressive strength, exposure class, and other performance specifications noted in contract documents and Section 03 31 00 - Cast-In-Place Concrete. In addition, concrete mix design shall satisfy transport, placing, and finishing requirements of. Concrete shall be normal weight unless noted otherwise. Concrete types are specified in accordance with CSA-A23.1 Table 5, Alternate 1.

.2 Shotcrete shall meet following additional material specifications:

.1 Where shotcrete is placed against adjacent substrate, minimum bond strength to substrate to be 1.0 MPa (minimum) @ 7 days.

.2 Shotcrete Density to be normal weight concrete.

.3 Silica Fume Content to be a minimum of 8% of Total Cementitious Material by Mass

.4 Water/Cement Ratio as per contract drawings and specifications.

.3 Mix design is responsibility of Contractor.

.4 Mix design requirements to be verified by testing of pre-construction test specimens by an approved Testing Agency.

3. EXECUTION

3.1 FORMWORK

.1 In addition to conforming to Section 03 11 00, formwork for shotcrete elements shall:

.1 Be designed to provide for escape of compressed air and rebound during shotcreting.

.2 Be adequately braced to prevent excessive vibration or deflection during shotcrete placement.

3.2 BATCHING AND MIXING

.1 Batching and Mixing For wet mix process:

.1 Shotcrete shall be ready-mixed and conform to following material properties immediately prior to application (i.e., at the pump):

.1	Air Content	Specified Air + 4% **
.2	Slump	40 to 70 mm*

*Note: Although maximum slump is specified, endeavour to provide wet mix shotcrete at minimum slump which permits proper placement and handling.

** Note: To obtain as-shot air content as specified will require additional air content at point of discharge into shotcrete pump. 4% is recommended, but concrete supplier is responsibility for determining appropriate amount.

.2 Shotcrete shall be applied no later than 90 minutes after batching.

.3 Individual components of shotcrete mix shall conform to requirements of Section 2.2

3.3 PREPARATION OF SURFACES

.1 Prepare surfaces and reinforcing steel as outlined in Sections 03 11 00 and 03 20 00.

.2 Clean surface of excess sand and loose debris by vacuuming or blowing with compressed air.

.3 Prior to application of shotcrete, keep substrate surfaces continuously moist for minimum of 12 hours.

.4 Concrete substrate shall be saturated surface dry at time of shotcrete application. No free water shall be present on substrate.

.5 Reinforcing shall be adequately supported and tied to prevent movement or vibration during shotcrete application.

3.4 APPLICATION OF SHOTCRETE

.1 Apply shotcrete to prepared surfaces in accordance with ACI 506.2 and ACI 506R.

.2 Shotcrete shall be applied only by personnel with approved qualifications who have fabricated mock-up panels from which acceptable test results were obtained.

.3 Shotcrete delivery equipment shall be capable of delivering steady stream of uniformly mixed material to discharge nozzle at proper velocity and rate of discharge. Shotcrete equipment is to be cleaned daily and kept in good working order. Application of shotcrete is to be stopped if equipment is not properly functioning.

.4 Under no circumstances shall rebound or overspray material be incorporated into Work. Endeavour to remove rebound or overspray from Work during shotcrete placement. Hardened rebound or overspray shall be removed by percussive or abrasive blasting methods prior to placement of shotcrete.

.5 Protect adjacent surfaces, including new reinforcing steel, from shotcrete overspray and rebound during operations.

.6 Defects such as slugs, sand pockets, wet sloughing, etc. shall be removed and repaired at Contractor’s expense.

.7 Do not apply shotcrete to a surface on which there is running or free water.

.8 Apply shotcrete to build concrete surface to finished lines. Acceptable plus or minus tolerance of finished surfaces shall conform to tolerance limits specified in Concrete specifications.

.9 Construction joints or end-of-the-day joints shall be tapered at approximate 45-degree angle. Surfaces shall be rough gun finish. Before placing adjoining Work, previously placed shotcrete shall be thoroughly cleaned of laitance, rebound, and other loose material with compressed air.

.10 Steel trowel finish to the minimum finish specified in drawings and specifications.

.11 Unfinished work shall not be allowed to stand for more than 30 minutes unless construction joint is provided.

.12 Remove areas which exhibit sags or sloughs, segregation, honeycombing, sand pockets, or other obvious defects. Shotcrete above sags or sloughs shall be removed while still plastic.

3.5 CURING

.1 Immediately following finishing, prevent shotcrete from drying out by moist curing using fogging or wetting or maintenance of a minimum 95% relative humidity in area surrounding shotcrete.

.2 Upon hardening sufficiently after placement, exposed shotcrete surfaces shall be moist cured for 7 days minimum by continuously wetting or by using water-saturated burlap.

.3 Maintain concrete temperature above 5˚C while curing. See also hot and cold weather curing requirements.

.4 Finish appearance to match adjacent existing concrete elements.

3.6 HOT AND COLD WEATHER PROTECTION

.1 The general requirements for hot and cold weather concreting detailed in CSA A23.1-04 apply to the shotcrete work.

.2 If the prevailing ambient conditions (relative humidity, wind speed, air temperature) are such that the shotcrete develops plastic shrinkage and/or early drying shrinkage cracking, terminate shotcrete application. Adopt corrective measure such as installation of wind barriers or fogging devices to protect the work, before restarting shotcrete application. Do not proceed with shotcrete application if the rate of evaporation at the shotcrete surface exceeds 1.0 kg/m2/h as detailed in CSA A23.1-04 Appendix D.

.3 Terminate shotcrete application if the ambient temperature rises above 30°C, unless the Contractor adopts special hot-weather shotcreting procedures which are approved by the Engineer.

.4 During periods of cold weather, shotcreting may only proceed if the concrete substrate to which the shotcrete is applied is above 5°C and the air temperature in contact with the repair surfaces is above 5°C.

.5 Maintain the air temperature at the shotcrete surfaces at 10°C or greater for at least 4

days after application of shotcrete. The means of maintaining the air temperature shall be approved by the engineer. The use of unvented heaters which give rise to carbonation is prohibited.

3.7 SHOTCRETE ACCEPTANCE AND REPAIR

.1 Materials Testing Agency or Structural Consultant have authority to accept or reject shotcrete work. Shotcrete which does not conform to project specifications may be rejected either during the shotcrete application process, or on basis of tests on cores from test panels or completed work.

.2 Deficiencies observed during shotcrete application process, such as, but not limited to the following, constitute cause for shotcrete rejection:

.1 Failure to properly control and remove build-up of overspray and rebound

.2 Incomplete consolidation of shotcrete around reinforcing steel and embedments

.3 Incorporation of shadows, excessive voids, delaminations, sags, or sloughing

.4 Failure to apply shotcrete to the required tolerances

.3 Whenever possible perform remedial work to correct deficiencies while shotcrete is still plastic.

.4 If results of compliance tests from shotcrete test panels, or assessment of plastic or hardened shotcrete indicate non-conformance of shotcrete to project specifications, Materials Testing Agency or Structural Engineer will require further testing at expense of Contractor. Additional testing may include:

.1 Extraction of additional cores from in-place shotcrete at locations selected by Structural Consultant and testing of such cores for compliance to project specifications.

.2 Checking for delaminations using sounding or other appropriate non-destructive testing procedures.

.3 Diamond saw cutting or coring to check adequacy of encasement of reinforcing steel and embedments.

.5 Shotcrete which is proven to be non-conforming to project specifications shall be removed and replaced by Contractor at no cost to Owner.

3.8 PRECONSTRUCTION TESTING

.1 Prepare mock-up panel and test section for examination and testing prior to proceeding with production of Work to confirm performance and material properties of mix design.

.2 Have mock-up panel made by application crew using equipment, materials, and mix proportions proposed for Work. Mock-up panels shall have typical reinforcing configuration and be shot in each anticipated shooting direction.

.3 Nozzleman to be used for job must perform testing prior to being approved for project. Change in nozzleman requires additional testing and approval prior to working on project.

.4 For mock-up panels:

.1 Minimum mock-up panel dimensions shall be 3 m (10 ft) x 3 m (10 ft) . Mock-up panel to be representative of worst case congested region of areas subject to shotcrete as directed by Structural Engineer.

.2 Shotcrete mock-up panel is to be completed in single effort (no cold joints or surface parging is allowed after initial set.)

.3 Six core locations at congested rebar locations to be provided at direction of Structural Consultant after shotcrete is complete for review of core grading and five additional cores at unreinforced areas to determine representative compressive strength at 7 days and 28 days.

.4 Obtaining and testing of core samples is to be conducted by Testing Agency in accordance with CAN/CSA-A23.2-04 -3C and 14C.

.5 Six cores shall be reviewed by Structural Consultant and Testing Agency. Testing Agency to review cores as per Core Grading System outlined in ACI 506.2-95. Five additional cores to be tested for compressive strength at 7 days and 28 days in accordance with Standard. Nozzleman approval shall be based on review of cores and cut panel to satisfaction of Materials Testing Agency and Structural Engineer.

.6 Any single core having Core Grade exceeding three or where two or more cores of the six cores have a Core Grade 3 or cores not meeting the required specified strength will be considered non-conformance.

.7 Mock-up panel is to be cut in half at the mid-height for review by the Materials Testing Agency and Structural Consultant.

.8 If mock-up panel or cores are rejected for non-conformance, two or more similar mock-up panels shall be made and tested at no additional cost to the Owner. If either of the two new mock-up panels or cores taken from this panel are found to be unacceptable, the nozzleman responsible will not be permitted to work on the project.

.9 Construction safety aspects of the mock-up panel, including but not limited to stability of the panel, are the responsibility of the contractor.

3.9 PRODUCTION TESTING

.1 After seven day wet cure of completed individual members, Testing Agency to sound shotcrete surfaces over wall zones, headers and additional areas at the discretion of the Testing Agency with a hammer to detect hollow sections. Suspect areas shall be subject to further testing and possible removal and replacement at no cost to the Owner as directed by the Consultant.

.2 Production testing of test panels shall be completed at a rate of one every 100 m2 of shotcrete applied with a minimum of one test for each production day. Production testing shall include the following:

.1 Shoot one test panel 450 mm x 450 mm (18" by 18") minimum x 200 mm (8") thick minimum for every 100 m2 of shotcrete applied. Test panel shall be of sufficient size to obtain six 100 mm diameter core samples.

.2 Test panel shall be made from wood and sealed plywood edges and have 45^0 sloped edges to permit rebound to escape and facilitate demoulding.

.3 Test panels to be identified with the batch that they are produced and cured on site for two days prior to being transported in the form to the testing laboratory. Cure the test panel in the same form as the shotcrete batch it represents close to the location where shot.

.4 Contractor to assist testing agency in removal of test samples from site.

.5 Test panels to be further cured as per the Standard to suit 7-day and 28-day strength tests.

.6 Materials Testing Agency to test cores in the same manner as the preconstruction testing.

.7 Cores not meeting the required specified strength will be considered non-conformance.

.8 If core testing fails to show adequate strengths, four additional cores will be taken from the element in question for further testing. If any of the additional cores are found to be unsatisfactory, the surrounding shotcrete will be deemed unacceptable, and the contractor will remove and replace this work at no additional cost to the Owner.

.3 Final acceptance of the shotcrete will be at the discretion of the Testing Agency and Structural Engineer based on test results obtained from cores.

.4 If additional testing is required to demonstrate the adequacy of any shotcrete which does not meet the requirement for strength or which has been placed before reinforcement has been reviewed by the Consultant, the Contractor shall pay the cost of testing.

.5 Testing shall in no way relieve the Contractor of the responsibility for the quality of work and materials.

3.10 FULL-TIME TESTING

.1 Materials testing Consultant to provide full-time testing for continuous inspection of the placement of reinforcing and shotcreting and shall submit a statement indicating compliance with the plans and specifications. Full-time testing shall continue until such time that the Testing Consultant is satisfied that the work being performed on site is of satisfactory quality. Inspections at the beginning of each day, and at any point throughout the day while shotcrete is being placed, shall be carried out by the Testing Consultant at a frequency determined by them such that they are satisfied that the work on site continues to be of satisfactory quality. Additional inspections are to be provided at locations of particularly congested reinforcing or other non-typical locations. If shotcreting procedures, conditions, equipment or personnel change from the initial testing, subsequent test panels will be required.

END OF SECTION 03 37 13

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for masonry work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM A480/A480M, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.

.2 ASTM E514/E514M, Standard Test Method for Water Penetration and Leakage Through Masonry.

.3 ASTM C207, Specification for Hydrated Lime for Masonry Purposes.

.4 CSA A165 Series, CSA Standards on Concrete Masonry Units.

.5 CSA A179, Mortar and Grout for Unit Masonry.

.6 CSA A370, Connectors for Masonry.

.7 CSA A371, Masonry Construction for Buildings.

.8 CAN/CSA A3001, Cementitious Materials for Use in Concrete.

.9 CSA G30.18, Carbon Steel Bars for Concrete Reinforcement.

.10 CSA S304, Design of Masonry Structures.

1.3 **SUBMITTALS**

.1 Shop drawings:
- .1 Submit shop drawings in accordance with Section 01 33 00 indicating.
- .2 Wall sections and details, reinforcing and anchors, special detailing, patterning and locations of control joints.

.2 Samples:
- .1 Submit samples in accordance with Section 01 33 00:
- .2 Submit samples of masonry anchors, and ties.
- .3 Submit 250 x 200 mm samples of dampproof course and flashing.

.3 Quality control submittals: Submit manufacturer's certificates stating that materials supplied are in accordance with this Specification.

1.4 **QUALITY ASSURANCE**

.1 Provide plain and reinforced masonry in accordance with CSA A370, CSA A371, and CSA S304.

.2 Cold Weather Protection:
- .1 To CAN/CSA-A371 and as follows:
  - .1 Maintain temperature of mortar between 5°C and 50°C until batch is used or becomes stable.
  - .2 Maintain ambient temperature of masonry work and it's constituent materials between 5°C and 50°C and protect site from windchill.
  - .3 Maintain temperature of masonry above 0°C for minimum of 3 days, after mortar is installed.
  - .4 Preheat unheated wall sections in enclosure for minimum 72 hours above 10°C, before applying mortar.
  - .5 Do not use scorched aggregate. Do not use salts or anti-freezes. Only use approved smokeless heaters.

.3 Hot Weather Requirements:
- .1 To CAN/CSA-A371 and as follows:
  - .1 Plan in advance for hot weather construction. Protect freshly laid masonry from drying too rapidly, by means of waterproof, non-staining coverings.
  - .2 Avoid using dry masonry in hot weather conditions. Use predampened masonry unit nominally saturated, but surface dry at time of laying. Do not dip masonry unit in bucket of water.
  - .3 Spread only enough mortar to permit soft setting of masonry units; do not over mix mortar materials; do not retemper mortar after 2 hours of use; do not retemper pigment coloured mortar; do not spread more than 900 mm (3') of mortar for placement of masonry unit.

1.5 **DELIVERY, STORAGE, AND HANDLING**

.1 Deliver, store and handle Products in accordance with the Conditions of the Contract and as specified herein.

.2 Remove unacceptable materials from Site and replace to acceptance of Consultant. Store materials off ground protected from wetting by rain, snow or ground water, or inter-mixture with earth or other materials. Store metal ties and reinforcement to prevent corrosion.

.3 Do not concentrate storage of materials on any part of structure beyond design load, take particular care not to overload unsupported portions of structure which may have not attained their full design strength.

.4 Comply with CSA A371. Do not use salt or calcium-chloride to remove ice from masonry surfaces.

.5 Deliver mortar materials in original unbroken and undamaged packages with the maker's name and brand distinctly marked thereon. Prevent damage to units.

.6 Keep masonry materials free from ice and frost. Keep units protected from concrete, mortar and other materials which could cause staining.

2 Products

2.1 **MASONRY UNITS**

.1 Concrete block units: Normalweight units, CSA A165 Series, 250 mm thick unless otherwise indicated on Contract Drawing, classifications as follows:
- .1 H/15/A/M.
- .2 SS/15/A/M.
- .3 SF/15/A/M.

.2 Integral water repellent: Provide units made with integral water repellent for exposed units.
- .1 Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength.
- .2 Units made with integral water repellent, when tested according to ASTM E514 as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive, with test period extended to 24 hours, shall show no visible water or leaks on the back of test specimen.
- .3 Integral waterproofing, 'RainBloc Water Repellent System' by ACM Chemistries, Inc. or approved alternative.

.3 Special shapes: Unless indicated otherwise, supply and install corner returns, bull-nosed or double bull-nosed units for exposed and external corners, bond beams, sash blocks for control joints, solid block where noted, concrete block lintels over openings in concrete block walls and any additional special shapes as indicated.

.4 Obtain each masonry unit type from same manufacturer. Supply and install units of uniform texture and colour for each kind required.

.5 Supply masonry units with exposed surfaces free of cracks, chips, blemishes, and broken corners.

2.2 **ACCESSORIES**

.1 Reinforcement: CSA A370, CSA A371, and ASTM A480/A480M, all components to be stainless steel, Type 304 unless otherwise specified:
- .1 This specification is based on products manufactured by Blok-Lok Limited. Products by Hohmann & Barnard Inc. and Fero Corporation are approved alternatives.
- .2 Type 1 (single wythe): Truss type, stainless steel; 'Blok-Trus BL30'.
- .3 Connectors: CSA A370 and CSA S304.
- .4 Reinforcing steel: CSA G30.18, Grade 400, refer to Contract Drawings for number, size, and location.

.2 Loose steel lintels and lateral support angles: Supplied as part of work of Section 05 50 00.

.3 Dampproof course and flashing: Reinforced SBS rubberized asphalt compound laminated to cross-laminated polyethylene film, 40 mils thick; 'Blueskin TWF' by Henry or 'Airshield Thru Wall Flashing' by W.R. Meadows or approved alternative, complete with primer and adhesive recommended by flashing manufacturer.

.4 Compressible filler: 75 x 6 mm thick preformed, polyurethane foam; 25V by Emseal Joint Systems Ltd.

.5 Control joint filler: Prefabricated extruded rubber joint to suit wall thickness; RS Series Rubber Control Joint by Blok-Lok or approved alternative.

2.3 **MORTAR MATERIALS**

.1 Loadbearing masonry: CSA A179, Type S, proportion method.

.2 Interior non-loadbearing masonry: CSA A179, Type N, proportion method.

.3 Cement: CAN/CSA A3001, normal Portland, Type GU. Provide white cement where required for white or light coloured mortars.

.4 Masonry aggregate: CSA A179. Provide white aggregate where required for white or light coloured mortars.

.5 Hydrated lime: ASTM C207, Type S.

.6 Water: Clean potable, free from deleterious elements and free from salts that can cause efflorescence.

.7 Concrete fill and grout: Minimum 12.5 Mpa concrete in accordance with CSA A179.

3 Execution

3.1 **EXAMINATION**

.1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.2 **PROTECTION**

.1 Supply and install temporary waterproof, non-staining coverings, secured against displacement, to extend over walls and down sides to protect masonry Work from snow and wind driven rain, and from drying too quickly, until masonry work is completed and protected by flashings or other permanent construction.

.2 Supply and install non-staining, protective coverings on horizontal and vertical surfaces to protect work of this Section from damage, staining, marking, and mortar droppings.

3.3 **WORKMANSHIP**

.1 Perform masonry work in accordance with CSA A371 and as indicated .

.2 Supply and install masonry work plumb, level and true to line, with vertical joints in alignment and horizontal courses level, uniform, and straight.

3.4 **MASONRY - GENERAL INSTALLATION**

.1 Construct masonry work as required by jurisdictional authorities.

.2 Before commencing masonry work, verify required limitations for wall heights, wall thicknesses, openings, bond, anchorage, lateral support, and compressive strengths of masonry units and mortars.

.3 Construct masonry fire protection and fire separations of the thickness indicated on Drawings for the fire resistant ratings as noted on Drawings, and conforming to the Fire-Performance Ratings, Appendix ‘D’ to the National Building Code of Canada.

.4 Do not butter corner units, throw mortar droppings into joints, or excessively furrow bed joints. Do not shift or tap units after mortar has taken initial set. If adjustment is necessary after mortar has started to set, remove and replace with fresh mortar.

.5 Do not use admixtures without Consultant's written acceptance.

.6 Tool mortar joints slightly concave with non-staining tools unless indicated otherwise. Strike joints flush in non exposed areas or where shown on Contract Drawings. Use sufficient force to press mortar tight against masonry units on both sides of joints. Remove excess, remaining mortar material and burrs.

.7 Install masonry walls 25 mm clear of underside of steel building frames, roof or floor deck. Install masonry with a 19 mm space beneath shelf angles and install compressible filler.

.8 Cut masonry units with a wet saw to obtain straight, clean, even, unchipped edges. Cut units as required to fit adjoining work neatly or for flush mounted electrical outlets, grilles, pipes, conduit, leaving 3 mm maximum clearance. Use full-size units without cutting wherever possible.

.9 Reinforce block walls with continuous wire reinforcement in every second block course. Supply and install prefabricated L and T sections. Cut, bend and lap reinforcing units as per manufacturer's printed directions for continuity at returns, offsets, pipe enclosures, and other special conditions. Bending of masonry reinforcement is not permitted.

.10 Reinforce masonry walls with reinforcing steel as indicated on Drawings. Vertical reinforcing shall be fully grouted in masonry cores with grout.

.11 At openings in block walls install extra reinforcement, so that first and second courses above and below openings are reinforced. Extend extra reinforcement 600 mm beyond opening in each direction.

.12 Reinforce joint corners and intersections with strap anchors 400 mm o.c.

.13 Do not place reinforcement across masonry wythes at control joints.

.14 Install masonry with 10 mm thick joints unless indicated otherwise. Make vertical and horizontal joints equal and of uniform thickness.

.15 Build control joints in masonry walls at intervals and in locations shown. Form joints for block walls using sash block units in accordance with details shown. Form joints for veneer walls by leaving head joints between stacked units void of mortar. Fill chase and joint with joint filler full height of control joints. Leave a depth of 13 mm for sealing unless otherwise shown.

.16 Install control joints in masonry walls where indicated on drawings and at projections and changes in direction. Where control joints have not been indicated provide joints at 6100 mm o.c. for exterior walls and 9150 mm o.c. for interior walls.

.17 If required, provide movement joints, similar to building control joints, installed between areas with different support conditions.

.18 Supply and install solid block or metal lath under block, and fill block cells solid for lintel bearing and as required to secure built-in anchor bolts and/or anchors shown.

.19 Do not tooth intersections of walls except as otherwise indicated.

3.5 DAMPPROOF COURSES AND FLASHING

.1 Install dampproof courses beneath first masonry bearing course on slabs-on-grade. Trim dampproofing to conceal it.

.2 Install flashings in masonry in accordance with CSA A371.

.3 Lap dampproofing and flashing 150 mm and seal in accordance with manufacturer's instructions.

.4 Before masonry work begins, place specified dampproofing under first course of masonry. Install continuous dampproofing with ends lapped and cut flush with exterior face of wall. Place similar dampproofing over top course.

3.6 MORTAR MIXING

.1 Thoroughly mix mortar ingredients in proper quantities needed for immediate use to requirements of CSA A179.

.2 Measure and batch mortar materials either by volume or weight, to accurately control and maintain proportions. Do not measure materials by shovel.

.3 Mix mortar with maximum amount of water consistent with workability for maximum tensile bond strength within capacity of mortar.

.4 Do not use mortar which has begun to set. Use mortar within 2 hours after initial mixing. Re-temper mortar during 2 hour period only as required to restore workability.

.5 Provide uniformity of mix.

3.7 BLOCK

.1 Lay blocks in running bond except as indicated otherwise. Align block webs vertically and install thicker ends of face shells up.

.2 Install a full bed of mortar for first courses of masonry, for masonry units 100 mm thick and less, and between solid units. For remaining courses bed face shells, including vertical end joints, fully in mortar.

.3 Install special shaped and sized concrete block units as indicated and as required for a complete and coordinated assembly and to minimize cut units.

.4 Supply and install two courses of solid block beneath lintel bearing.

.5 Stagger end joints in every course. Align joints plumb over each other in every other course.

.6 Bond intersecting block walls in alternate courses. Where block work abuts concrete, anchor each block course to concrete.

3.8 **LINTELS**

.1 Install concrete block lintels over openings in masonry except where steel lintels are indicated.

.2 Set lintels with minimum of 200 mm uniformly distributed bearing at each end. Provide bond breaker under bearing ends.

.3 Install reinforcing steel and concrete fill in block lintels.

.4 Install loose steel lintels, as indicated in Contract Drawings. Centre over opening width.

3.9 **LATERAL SUPPORT ANGLES**

.1 Where non load bearing unit masonry partitions meet structural elements at top of partitions, install supplied lateral supports as required by the Ontario Building Code and in accordance with Structural details. In areas where ceilings are scheduled, use 150 mm lengths of steel angle located each side of partition at 1200 mm and staggered.

3.10 **BUILT-IN ITEMS**

.1 Coordinate and locate build-in items required to be built into masonry or supplied under work of other Sections including hollow metal doors, windows, lintels, sleeves, inserts, etc. Build-in items to present a neat, rigid, true and plumb installation.

.2 Build wall openings, slots, and recesses required for ducts, grilles, pipes and other items.

.3 Coordinate installation of conduit, outlet boxes and other mechanical and electrical built-ins with work of Divisions 21, 22, 23 and 26.

.4 Prevent displacement of built-in items during construction. Check plumb, location and alignment frequently, as Work progresses.

.5 Brace door jambs to maintain plumbness. Set anchors between metal frames and masonry and fill voids between hollow metal frames and masonry walls with mortar.

3.11 **INSTALLATION TOLERANCES**

.1 Install masonry work to a plane flatness and exposed end tolerance of 3 mm in 3000 mm.

.2 Variation in Alignment from Unit to Adjacent Unit: 1.5 mm maximum.

.3 Plumb within 6 mm in 3 m, or in 6 mm in 6 m at external corners, expansion joints, or other conspicuous lines.

.4 Level within 6 mm in any bay or 6 m maximum distance, and 12 mm in 12 m or more.

.5 Located from position shown, and from related position of columns, walls, and partitions within 12 mm in any bay or 6 m maximum distance, and 19 mm in 12 m or more.

.6 Opening sizes within 6 mm of designated dimension.

.7 Column and wall cross-section dimensions within minus 6 mm and plus 12 mm.

.8 Joint widths to dimensions indicated or specified herein, but in no case greater than 12 mm. Variation of Mortar Joint Thickness: 1 mm every metre.

3.12 **REPAIR AND POINTING**

.1 Remove and replace masonry units which are loose, chipped, broken, cracked, marked, stained, discoloured, or otherwise damaged. Supply and install new units to match adjoining units and install in fresh mortar, and point to eliminate evidence of replacement.

.2 During tooling of joints, enlarge any cracks, holes, or other defects, point and completely fill with mortar.

.3 Point-up joints including corners, openings and adjacent Work for a neat, uniform appearance, properly prepared for application of sealant compounds.

3.13 **CLEANING**

.1 Obtain and follow unit masonry manufacturer's written instructions for cleaning of masonry.

.2 Clean exposed, masonry surfaces, removing excess mortar as work progresses. Allow mortar droppings to partially dry then dry brush with a stiff fibre brush.

END OF SECTION

1. General

1.1 DOCUMENTS

.1 This section, along with the drawings, forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

.2 Drawings include architectural, mechanical, and electrical drawings.

1.2 DESCRIPTION OF WORK INCLUDED

.1 Provide all labour, materials, equipment, access, cooperation, coordination and services to allow the testing of structural steel, open web steel joists, structural steel deck and welds to be carried out by a Testing Agency responsible to the Owner.

.2 The scope of the required quality assurance testing is described in this section to inform the Contractor of the type and scope of testing on the project and allow the Contractor to make appropriate allowances. The testing describe in this section is not the responsibility of the Contractor. It will be paid for by the Owner.

.3 Testing required by the Contractor for their own quality control will be paid for by the Contractor.

1.3 RELATED WORK SPECIFIED ELSEWHERE

.1 Section 05 12 00 - Structural Steel Framing.

.2 Section 05 31 00 - Steel Decking.

.3 Section 05 50 00 – Metal Fabrications

.4 Section 05 51 00 – Metal Stairs

1.4 REFERENCE STANDARDS

.1 Testing of Structural Steel shall conform to the requirements of the following Building Code and Reference Standards unless otherwise required by the specification:

.1 Building Code

.1 **Ontario Building Code - 2012**

.2 Reference Standards

.1 General

.1 CSA S16-14 - Limit States Design of Steel Structures.

.2 CSA G40.21-04 - Structural Quality Steel.

.3 CSA G40.20-04 - General Requirements for Rolled or Welded Structural Quality Steel.

.4 CSA S136-12 - North American Specification for the Design of Cold-Formed Steel Structural Members

.5 ASTM A6/A6M-17a – Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling

.6 CSA W47.1-09 - Certification of Companies for Fusion Welding of Steel Structures.

.7 CSSBI 10M-06 - Standard for Steel Roof Deck.

.8 CSSBI 12M-06 - Standard for Composite Steel Deck.

.9 RCSC Specification for Structural Joints Using ASTM A325 or A490 Bolts.

.10 SDI Manual of Steel Construction with Steel Deck.

.11 CSA W59-13 - Welded Steel Construction (Metal Arc Welding).

.12 CSA W178.1-08 - Certification of Welding Inspection Organizations.

.13 ASTM A653-09 - Sheet Steel, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

.14 ASTM A435/A435M-17 – Standard Specification for Straight-Beam Ultrasonic Examination of Steel Plates

.15 ASTM A673/A673M-17 - Standard Specification for Sampling Procedure for Impact Testing of Structural Steel

.2 Galvanizing

.1 ASTM A123/A123M-09 - Zinc (Hot-Dip Galvanizing) Coatings on Iron and Steel Products.

.2 ASTM A143/A143M-07 - Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.

.3 ASTM A153-09 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

.4 ASTM A384/A384M-07 - Safeguarding Against Warpage and Distortion During Hot Dip Galvanizing of Steel Assemblies.

.5 ASTM A385 – Practice for Providing High-Quality Zinc Coatings (Hot-Dip)

.6 ASMT E376-17 – Practice for Measuring Coating Thickness by Magnetic-Field or Eddy-Current Examination Methods.

.7 ASTM A780-09 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot Dip Galvanized Coatings.

.2 Where the Standard is referenced in this specification it shall mean the documents specified in clause 1.4.1.2, as specified in the Building Code noted in clause 1.4.1.1, and their referenced documents.

1.5 DEFINITIONS FOR THIS SECTION

.1 "Owner", "Contractor" and "Consultant" as per the General Conditions and Definitions.

.2 "Structural Engineer" shall mean a representative of Read Jones Christoffersen Ltd.

.3 "Testing Agency" shall mean the testing agency responsible to the Owner.

.4 "Non-destructive Testing" shall mean liquid penetrant (LP), magnetic particle (MP), ultrasonic (UT), or radiographic testing (RT) as determined appropriate by the Testing Agency.

.5 "Standard" and "Standards" shall mean the reference standards listed under "Reference Standards" in this section.

.6 The terms "Heavy Sections", "Heavy Rolled Section" or "Heavy Plate" in these specifications and drawings is defined to include hot rolled steel shapes with flanges exceeding 38 mm (1-1/2") in thickness and built up cross sections with plates exceeding 50 mm (2") in total thickness.

.7 The term "High Restraint Weld" describes welds in which there is essentially no freedom of movement from weld shrinkage for members joined due to geometry or material thickness.

.8 Extra Smooth: Surface noted herein as "Extra Smooth" requires a finish with surface variation of 12.7 um or less (AWS C4.1, Sample #4).

.9 "Composite" refers to steel reinforced concrete (SRC), structural steel elements cast or embedded into concrete and similar.

1.6 APPOINTMENT OF TESTING AGENCY

.1 The Owner will appoint a Testing Agency approved under W178.1 (Building Category).

.2 Testing paid for by the Owner is outlined in Section 3.0.

.3 Testing paid for by the Contractor:

.1 Testing of pre-approved connections not on the structural drawings and required by the Contractor for ease of fabrication, transportation or erection.

.2 Any additional costs due to overtime, shift work, holiday or weekend work required to meet the schedule.

.3 Costs for retesting or additional testing due to work having failed to meet the specified requirements.

.4 For the purpose of bidding, assume all welds will be examined by a nondestructive testing method. Non-destructive testing will be performed on samples of the work at the discretion of the Structural Engineer as well as outlined in this specification. Any repair and retesting costs shall be borne by the Contractor.

.5 Deficiencies in work will trigger required additional testing. Refer to the tiered testing description for costs related to this testing.

2. Duties

2.1 RESPONSIBILITY OF THE CONTRACTOR

.1 The Contractor shall cooperate fully with the Testing Agency. Allow free access to all parts of the work for the purpose of testing and review at all times.

.2 Notify the Testing Agency and Structural Engineer when work is ready for review.

.3 Prior to commencement of work, provide a schedule of shop fabrication and erection to the Testing Agency and Structural Engineer. Changes in this schedule shall be communicated to these parties in a timely fashion.

.4 Provide a quantity takeoff of all the members in the project for use in determining the number of members required for testing. This takeoff should also indicate the divisions in which the members are to be fabricated to aid in shop inspection planning.

.5 Provide mill certificates in accordance with the Standard, properly correlated to the elements being fabricated.

.6 The contractor shall make available any non-destructive testing reports performed in the shop during fabrication.

.7 The contractor shall prep all areas requiring NDT to an acceptable level. Preparation shall include, but not be limited to:

.1 Ultrasonic Testing (UT) to 300mm away from the weld by grinding off weld splatter and buffing the area with a wire wheel.

.2 Provision of all necessary access platforms or scaffolding to allow for inspections to be carried out.

.8 The Contractor is solely responsible to provide a finished product that meets the specifications and contract documents. Testing is not carried out for the Contractor's benefit, nor does it make the Structural Engineer or Testing Agency guarantors of the Contractor's work.

2.2 RESPONSIBILITY AND DUTIES OF THE TESTING AGENCY

.1 The Testing Agency is responsible to the Owner and has the authority to, and is expected to, reject any work not meeting the specifications.

.2 Identify the number, type and locations of members, connections, studs, etc. to be tested and coordinate required shop and site visits.

.3 Review the structural drawings and specifications prior to carrying out the work.

.4 Provide testing as per the Standards and as per this specification.

.5 Provide timely test reports to the Structural Engineer, Consultant and Contractor.

3. TESTING AND INSPECTION

3.1 GENERAL

.1 The Structural Engineer may reject at any time during the progress of the work a piece of material or any member which the Structural Engineer may find defective or not in accordance with the detailed drawings. This material may be rejected notwithstanding any previous acceptance and components so rejected shall be replaced at no expense to the Owner. In case of dispute, the decision of the Structural Engineer shall be final

.2 Testing in general shall conform to CSA S16 and W59. Acceptance criteria for welding to be for statically loaded structures as per W59.

.3 If initial tests indicate that the work failed to meet specification, the Structural Engineer shall decide if any additional testing is necessary. This testing shall be done by the Owner's agency. The proposed additional testing shall have prior approval of the Structural Engineer.

.4 Non-destructive testing operators shall have a Level II qualification as a minimum.

3.2 DOCUMENTS & MATERIALS

.1 Confirm that the fabricator and erector are certified to CSA-W47.1 and that all welders are properly qualified.

.2 Review mill certificates for all types of material used in the project ensure they meet the requirements of 05 12 00 and forward to the Structural Engineer.

.3 Review approved shop welding procedures.

.4 Confirm welding consumables provided will meet the levels of strength, notch toughness and quality of the base member and that they are properly stored in shop and field.

.5 Review bolt storage, handling and installation procedures including pre-installation verification testing as required depending on the types of bolts or washers to be used.

.1 Tension Control (TC) Bolts

.1 Pre-installation verification must be carried out in accordance with CSA S16 to ensure that the bolts will function as intended.

.2 Direct Tension Indicator (DCI) Washers

.1 Review fabricator installation procedures.

.2 General review for damage to washers prior to installation.

.6 Review all available non-destructive testing reports performed by the contractor.

.7 Where more than one type of paint is specified, ensure that the colour of each coat of paint differs so that they can be visually identified after applications.

.8 Obtain invoices and product data from the steel supplier, for the purchase of the specified primers and paints required for the project. Circulate these documents to both the Structural and Architectural consultants.

3.3 VISUAL TESTING (VT) OF MEMBERS AND CONNECTIONS (WELDED OR BOLTED)

.1 Perform visual testing of the structural components, framing and connections through a combination of shop and field visits to meet the requirements below.

Structural Framing	Comments (Weights, Forces, Descriptions, Etc.)	Individual Item Sample Size	Total Project Minimum Sampling
Columns & Base Plates	W ≤ 30 kg/m	5%	15%
	30 ≤ W ≤ 100 kg/m	15%	
	W ≥ 100 kg/m	25%	
Bracing	W ≤ 20 kg/m	5%	15%
	20 ≤ W ≤ 40 kg/m	15%	
	W ≥ 40 kg/m	25%	
Beams & Joists	W ≤ 40 kg/m	5%	10%
	40 ≤ W ≤ 70 kg/m	10%	
	W ≥ 70 kg/m	15%	
Girders	W ≤ 60 kg/m	10%	30%
	60 ≤ W ≤ 100 kg/m	20%	
	W ≥ 100 kg/m	30%	
	60 ≤ W ≤ 100 kg/m	30%	
	W ≥ 100 kg/m	50%	
Moment Connections	W ≤ 30 kg/m	10%	50%
	30 ≤ W ≤ 60 kg/m	25%	
	W ≥ 60 kg/m	50%	
	Beams	80%	
	Trusses	80%	
Splices	Columns	100%	100%
	Beams / Girders	100%	100%
	Trusses / Joist Girders	100%	100%
Section Reinforcement & Stiffeners	Base Plate Stiffeners	30%	30%
	Beam Stiffeners	30%	
	Beam Web Openings	30%	
	Doubler Plates	30%	
	Existing Steel Reinf.	100%	100%
	Integrity Blocks	100%	

.2 The Visual Testing (VT) requirements above shall include but not be limited to verifying:

.1 Grade markings on structural steel in fabricator's plant prior to fabrication.

.2 Dimensions, including cross-section, in relation to the specified members (in-house plant QC may be relied upon to perform this task assuming the testing agency is satisfied with the level of QC being carried out).

.3 Locations of all holes, cuts, fittings and milling of member ends

.4 Tolerances of joint preparation and fit up (bevel angle, etc.) to be in accordance with CSA S16.1, clause 28.5 Joints in Contact Bearing.

.5 Preheat and interpass temperatures based on the approved welding procedures.

.6 Snug tight bolted connections are properly compacted and brought to the snug tight condition progressing outward from the most rigid part.

.7 For all bolted connections that are indicated as pre-tensioned or slip critical, pre-installation verification testing is performed by the inspector in cooperation with the Contractor.

.8 For bolted connections indicated as pre-tensioned or slip critical, determine that the pre-tensioning methods of RCSC 8.2.1, 8.2.3, or 8.2.4, as appropriate, are performed.

.9 Specified beam and or truss camber and that the cambering procedure does not reduce the member capacity.

.10 Erection tolerances meet the tolerances of CSA S16.

.11 Joist and truss erection tolerances meet CSA S16 requirements, and report twisting, sweeping and local damage.

.12 Adequate joist bearing on supporting structure as detailed in the drawings.

.13 All truss permanent top and bottom chord bridging and end connections are complete.

.14 The number of headed studs per beam and that stud placement is properly offset towards the closest beam support within composite deck flutes as per the typical details.

.15 All steel surface preparation prior to priming and or painting is in conformance with the requirements of the Structural and Architectural specifications.

.16 All steel which is exposed or in unconditioned spaces such as canopies, parapet walls, steel lintels, shelf angles, etc. are galvanized and or painted in accordance with the contract documents.

.3 Any defects noted during the Visual Testing (VT) work shall be reviewed using appropriate comprehensive Non-Destructive Testing (NDT) which shall be in addition to the requirements in clause 3.5.

3.4 TIERED TESTING REQUIREMENTS

.1 Testing of connections, studs, etc. shall be carried out in a tiered approach as follows:

.1 The highest tier (4 or 3 respectively) in the table is the most stringent in the testing hierarchy and progressively becomes less stringent moving down.

.2 Each tier has a sample size which indicates the number of members (columns, beams, girders, etc.) which are to be selected for testing.

.3 The tiers testing value indicates the percentage of the connections, studs, etc. which must be tested for each member of that sample size.

.4 Should the testing find all workmanship to be satisfactory the Testing Agency may step down to the next tier's requirements (starting from 4 to 3 and so on).

.5 At any time of defects are found in the workmanship the testing must step back up to the previous tier's testing percentage for a confirmation sample size of two (2) and upon satisfactory workmanship may revert back and re-satisfy the full requirements of the tier where the original defective work was found.

.6 Should defects be found in the confirmation sample size of two (2) then the testing shall re-satisfy the full requirements of the more stringent tier prior to stepping back to the the tier where the original defective work was found.

.7 Written notice shall be provided to the structural consultant of any additional sampling requirements due to defective work.

.8 Testing shall also ensure that the minimum total connection sampling is achieved irrespective of the tiered testing requirements however the testing shall not be discontinued if the minimum is reached prior to the completion of the project.

.9 The fee proposal should be based on the minimum total connection sampling requirements provided.

.10 The cost of up to two instances where confirmation samples are required within each component type should be covered as part of the base fee.

.11 Any addition testing beyond the two instances of confirmation sampling shall be paid for by the contractor.

3.5 COMPREHENSIVE NDT TESTING OF CONNECTIONS (WELDED OR BOLTED)

.1 Perform testing of the connections through a combination of shop and field visits to meet the sampling required in Tables 1 and 2.

.2 The requirements of Table 1 and 2 shall include but not be limited to verifying:

.1 At least one type of unique connection shall be tested irrespective of the sampling requirements.

.2 Bolt types conform to the drawings and specifications prior to start of bolting operations and that any pre-installation verification has been completed.

.3 All bolted connections shall be tested in accordance with CSA S16 with a minimum of two (2) bolts tested for each pre-tensioned connection.

.4 Splices not shown on the structural drawings shall be 100% ultrasonically tested (UT) at the Contractor's expense.

.5 All full penetration welds shall be 100% ultrasonically tested (UT).

.3 Post-installation review of bolts using the following techniques:

.1 Conventional bolts

.1 Turn of the nut method marked on the washer and bolt head or calibrated torque wrench.

.2 Tension Control (TC) Bolts

.1 Post-installation should be carried out to ensure that the bolt tip is sheared off at the tension control point

.3 Direct Tension Indicator (DTI) Washers

.1 A post-installation review shall be carried out to ensure even bearing of the connection and no obstructions are present that would cause uneven pressure to be applied to the DTI.

.4 Welded connections for heavy sections for the following additional requirements:

.1 Testing of welds at heavy sections and high restraint welds shall be performed not less than 48 hours after the weld has been completed.

.2 Inspection and Testing by the Testing Agency of high restraint welds and where Heavy Sections are to be joined by partial or complete joint penetration welds in tension.

.3 Fit up and joint preparation (bevel angle, etc) for conformance to the submitted welding procedure including preheat and interpass temperature shall be monitored. Base me

.4 Metal temperature shall be monitored during welding operations.

.5 Review ultrasonic testing reports of Heavy Sections for de-laminations performed in accordance with ASTM A435.

3.6 TESTING OF STEEL DECK

.1 Provide visual review of the steel deck gauge and connections to meet the requirements below.

Deck Type (Composite / Non-Composite)	Comments (Gauge, Diaphragm Forces, Connection Pattern, Etc.)	Individual Item Sample Size			
		Deck Gauge	Support Connection	Seam Connection	Deck Edge Connection
Non-Composite	22 Gauge	10%	30%	30%	30%
Non-Composite	20 Gauge	10%	40%	40%	40%
Non-Composite	t > 20 Gauge	10%	50%	50%	50%
Composite	t ≤ 20 Gauge	10%	30%	30%	30%
Composite	t > 20 Gauge	10%	40%	40%	40%

.2 The Visual Testing (VT) requirements above shall include but not be limited to verifying:

.1 The types of connections (welds) or fasteners (mechanical) and verify they meet what has been specified in the engineering drawings.

.2 That the welds align with the supporting structure below and proper fusion has been achieved.

.3 Verify that all localized deck supports have been provided at discontinuous deck ends which do not bear on structure due to framing interruptions.

.4 Verify the deck galvanizing as per the specifications by taking random zinc thickness measurements of 10% of supplied galvanized deck. Ensure that the areas where testing has taken place are touched up with zinc rich paint.

.5 If the Testing Agency determines that the quality of the welds appear deficient they shall request a weld quality control test in accordance with the SDI Manual of Steel Construction with Steel Deck. The Structural Engineer shall be immediately notified of this requirement and may request to be present at the time of the test.

Table 1: Single Piece Members

Structural Framing	Comments (Weights, Forces, Descriptions, Etc.)	Tier 4		Tier 3		Tier 2		Tier 1		Minimum Total % Connection Testing
		Sample Size	Testing	Sample Size	Testing	Sample Size	Testing	Sample Size	Testing	
Columns & Base Plates	W ≤ 30 kg/m	-	-	5.0%	75%	5%	50%	5.0%	35%	10%
	30 ≤ W ≤ 100 kg/m	5.0%	80%	5%	60%	5%	45%	5.0%	35%	
	W ≥ 100 kg/m	10.0%	100%	10.0%	80%	10%	65%	10%	55%	
Bracing	W ≤ 20 kg/m	-	-	5%	75%	5%	50%	5.0%	35%	10%
	20 ≤ W ≤ 40 kg/m	5.0%	80%	5%	60%	5%	45%	5.0%	35%	
	W ≥ 40 kg/m	10.0%	100%	10.0%	80%	10%	65%	10%	55%	
Beams & Joists	W ≤ 40 kg/m	-	-	5.0%	75%	5%	50%	5.0%	35%	7.5%
	40 ≤ W ≤ 70 kg/m	5.0%	80%	5%	60%	5%	45%	5.0%	35%	
	W ≥ 70 kg/m	10.0%	100%	5%	80%	5%	65%	5%	55%	
Girders	W ≤ 40 kg/m	-	-	5.0%	75%	5%	50%	5.0%	35%	10%
	40 ≤ W ≤ 70 kg/m	5.0%	80%	5%	60%	5%	45%	5.0%	35%	
	W ≥ 70 kg/m	10.0%	100%	10.0%	80%	10%	65%	10%	55%	
Moment Connections	W ≤ 30 kg/m	-	-	10%	75%	10%	50%	15%	35%	20%
	30 ≤ W ≤ 60 kg/m	20%	100%	20%	75%	10%	60%	10%	45%	
	W ≥ 60 kg/m	40%	100%	20%	80%	10%	65%	10%	55%	
Splices	Any Members	100%	100%	-	-	-	-	-	-	100%
Section Reinforcement & Stiffeners	Base Plate Stiffeners	10%	100%	7.5%	75%	7.5%	55%	10%	35%	25%
	Beam Stiffeners	10%	100%	7.5%	75%	7.5%	55%	10%	35%	25%
	Beam Web Openings	10%	100%	7.5%	75%	7.5%	55%	10%	35%	25%
	Doubler Plates	10%	100%	7.5%	75%	7.5%	55%	10%	35%	25%
Castings	Nodes	100%	100%	-	-	-	-	-	-	100%
	Integrity Blocks	100%	100%	-	-	-	-	-	-	100%
Seismic Systems	Specialty Restraint Systems	100%	100%	-	-	-	-	-	-	100%

Table 2: Multi-Piece Members

Structural Framing	Comments (Weights, Forces, Descriptions, Etc.)	Components	Tier 4		Tier 3		Tier 2		Tier 1		Minimum Total % Connection Sampling
			Sample Size	Testing	Sample Size	Testing	Sample Size	Testing	Sample Size	Testing	
Trusses & Joist Girders	W ≤ 50 kg/m	First Panel	10%	100%	10.0%	80%	5%	65%	5%	55%	15%
		Second Panel	5.0%	100%	5.0%	75%	5.0%	60%	5.0%	45%	
		Remaining	-	-	5.0%	75%	5.0%	50%	5.0%	35%	
	50 ≤ W ≤ 100 kg/m	First Panel	10.0%	100%	10.0%	80%	10%	65%	10%	55%	
		Second Panel	10%	100%	5.0%	75%	5.0%	60%	5.0%	45%	
		Remaining	-	-	5.0%	75%	5.0%	50%	5.0%	35%	
	W ≥ 100 kg/m	First Panel	15%	100%	10%	80%	10%	65%	10%	55%	
		Second Panel	10%	100%	10.0%	75%	5.0%	60%	5.0%	45%	
		Remaining	-	-	5.0%	75%	5.0%	50%	5.0%	35%	
Built-Up Tension / Compression Members	W ≤ 50 kg/m	Ea. End 10%	12.5%	75%	10%	45%	10%	25%	5.0%	10%	30%
		Remaining		40%		20%		10%		5%	
	W ≥ 50 kg/m	Ea. End 10%	20%	100%	12.5%	75%	10%	50%	5.0%	25%	
		Remaining		50%		35%		20%		10%	
Built-Up Beams / Girders	W ≤ 50 kg/m	Ea. End 10%	12.5%	75%	10%	45%	10%	25%	5.0%	10%	
		Remaining		40%		20%		10%		5%	
	W ≥ 50 kg/m	Ea. End 10%	20%	100%	12.5%	75%	10%	50%	5.0%	25%	
		Remaining		50%		30%		20%		10%	
Field Reinforcing Work	Tension / Compression Members	Ea. End 10%	20%	100%	15%	75%	10%	50%	5.0%	25%	30%
		Remaining		50%		30%		20%		10%	
	Beams / Girders	Ea. End 10%	20%	100%	15%	75%	10%	50%	5.0%	25%	
		Remaining		50%		30%		20%		10%	

End of Section 050050

1. General

1.1 DOCUMENTS

.1 This section, along with the drawings, forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

.2 Drawings include architectural, mechanical, and electrical drawings.

1.2 DESCRIPTION OF WORK INCLUDED

.1 Provide all labour, materials, equipment and services to supply, design, and erect structural steel required and/or indicated on the drawings or specified herein, including the supply of plates and/or angles for support of masonry, embedded steel parts, headed stud and deformed bar anchors, wedge anchors, and epoxy anchors which will form the connection between the structural steel, open web steel joists and masonry or concrete; and reinforcement of steel deck openings larger than 400 mm (16"). Report any discrepancies between structural, mechanical, electrical and architectural drawings to the Consultant and Structural Engineer immediately.

.2 Co-ordinate with Section 05200 (Open Web Steel Joists) for the design, fabrication, supply, installation and erection of open web steel joists.

.3 Co-ordinate with Section 05300 (Steel Deck) for the design, supply, and installation of headed stud shear connectors for composite beams and girders, and where required on other beams, girders, and drag struts.

1.3 RELATED WORK SPECIFIED ELSEWHERE

.1 Section 033100 – Structural Cast-in-Place Concrete

.2 Section 050050 - Testing of Structural Steel, Open Web Steel Joists and Deck

.3 Section 052100 – Steel Joist Framing

.4 Section 053100 - Steel Decking

.5 Section 055000 - Metal Fabrications

.6 Section 078100 – Applied Fireproofing

.7 Section 099100 - Painting

1.4 REFERENCE STANDARDS

.1 Structural steel shall conform to the requirements of the following Standards unless otherwise required by the specification:

.1 Building Code

.1 Ontario Building Code– 2012

.2 Reference Standards

.1 CSA S16 - Limits States Design of Steel Structures.

.2 CSA S136 - North American Specification for the Design of Cold-Formed Steel Structural Members

.3 CSA W47.1 - Certification of Companies for Fusion Welding of Steel Structures.

.4 CSA W59 - Welded Steel Construction (Metal Arc Welding) (Metric version).

.5 CSA G40.20 - General Requirements for Rolled or Welded Structural Quality Steel.

.6 CSA G40.21 - Structural Quality Steel.

.7 CSA G30.18 - Billet Steel Bars for Concrete Reinforcement.

.8 CSA W186 - Welding of Reinforcing Bars in Reinforced Concrete Construction.

.9 ASTM F1554 Standard Specification for 36, 55 and 105 ksi yield strength Steel Anchor Bolts.

.10 ASTM A193 – Standard Specification for Alloy-Steel Bolting Materials for Special Purpose Applications.

.11 ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated 120 / 105 ksi Minimum Tensile Strength.

.12 ASTM A490 - Standard Specification for Structural Bolts, Alloy Steel, Heat Treated 150 ksi Minimum Tensile Strength.

.13 ASTM A496 - Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.

.14 CISC / CPMA Standard 1-73a - A Quick-Drying One-Coat Paint for Use on Structural Steel.

.15 SSPC SP-6 - Commercial Blast Cleaning

.16 ASTM A123 - Zinc (Hot-Dip Galvanizing) Coatings on Iron and Steel Products.

.17 ASTM A143 - Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.

.18 ASTM A153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

.19 ASTM A384 - Safeguarding Against Warpage and Distortion During Hot Dip Galvanizing of Steel Assemblies.

.20 ASTM A780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot Dip Galvanized Coatings.

.2 Where the Standard is referenced in this specification it shall mean the documents specified in clause 1.4.1.2, as specified in the Building Code noted in clause 1.4.1.1, and their referenced documents.

1.5 DEFINITIONS FOR THIS SECTION

.1 "Owner", "Contractor" and "Consultant" as per the General Conditions and Definitions.

.2 "Structural Engineer" shall mean a representative of Read Jones Christoffersen Ltd.

.3 "Specialty Structural Engineer" is a Professional Engineer registered in Ontario responsible for components designed by the Contractor and who seals and signs shop drawings.

.4 "Testing Agency" shall mean the testing agency responsible to the Owner.

.5 "Standard" and "Standards" shall mean the reference standards listed under "Reference Standards" in this section.

1.6 QUALIFICATIONS

.1 Structural steel fabricator shall have not less than five (5) years experience in the fabrication of structural steel.

.2 Erector shall not have less than five (5) years experience in the erection of structural steel.

.3 Steel fabricators and erectors must be certified under requirements of CSA W47.1 as required by CSA S16.

.4 Welding procedures, welders and welding operations shall be qualified in accordance with Canadian Welding Bureau Standards.

1.7 EXAMINATIONS

.1 All dimensions shall be taken from the drawings and verified by field measurement. Be responsible for the correctness of such measurements and report to the Consultant and Structural Engineer in writing all discrepancies between measurements in the field and those shown on drawings prior to commencing work. Verify location of anchor bolts and embedded steel and ensure that work prepared by other trades is at a proper elevation, on line, level and true.

1.8 SUBMITTALS

.1 The Contractor shall submit, with tender, written evidence of qualification of the steel fabricators and erectors for welding under Canadian Welding Bureau requirements.

.2 The Contractor shall submit, with the tender, written evidence of ability to weld reinforcing steel to structural steel in accordance with CSA W186.

.3 When requested, submit copies of mill test reports properly correlated to the materials used on the project.

.4 Provide a schedule of fabrication to the Consultant, Structural Engineer and Testing Agency prior to the commencement of the fabrication.

1.9 SHOP DRAWINGS

.1 The Contractor shall notify the Consultant and Structural Engineer, in writing and before the submission of shop drawings, of the name of the Specialty Structural Engineer who will be designing and providing field review for the connections and components designed by the Contractor.

.2 Submit "design" drawings for review summarizing the proposed connection details to be used on the project. These drawings to be prepared by, or under supervision of, the Specialty Structural Engineer and submitted for review before start of shop drawing production. These design drawings shall show the complete connection and:

.1 How the connection assembly fits with the connected members.

.2 Sizes of plates, bolts, welds, etc.

.3 Capacities of the connection.

.4 Assumed eccentricities, lines of action of forces, etc.

.3 Submit shop drawings prepared under direction of the Specialty Structural Engineer. Drawings of components and connections designed by the Contractor shall be sealed and signed by this Specialty Structural Engineer or a letter shall be submitted at the end of the project signed and sealed by this Specialty Structural Engineer. The letter shall identify what was designed by the Specialty Structural Engineer and list the final shop drawings by number with dates and revision numbers.

.4 Shop drawings shall show complete shop and erection details necessary for fabrication and erection of the component parts of the structure, including cuts, copes, connections, holes, threaded fasteners, splices and location, type, size and extent of all welds. Splices not shown on the shop drawings will be rejected. All welds, both shop and field, shall be indicated by AWS Welding Symbols as specified in the CSA W59 Appendix D and E.

.5 Provide a shop drawing clearly locating all anchor bolts, embedded plates, baseplates, etc.

.6 Provide setting drawings, templates and directions for the installation of anchor bolts, plates and other devices.

.7 Prior to starting erection work, submit a description of the methods, sequence of erection and type of equipment proposed for use in erecting structural steel for review of the effects of construction loads on the remainder of the structure.

.8 Review of the shop drawings by the Structural Engineer is intended as an assistance to the Contractor and does not relieve the Contractor of his responsibility for the completeness or accuracy of his work and its conformance with the contract documents.

.9 Fabrication that commences prior to shop drawing review by the Structural Engineer is at the risk of the Contractor.

.10 Clearly identify on the shop drawing all revisions, changes, or modifications.

.11 Resubmit reviewed shop drawings where noted in the Read Jones Christoffersen Ltd.'s review stamp, or when the Contractor makes revisions for his own purposes.

.12 Allow at least two (2) weeks for shop drawing review by the Structural Engineer.

.13 Structural drawings are not prepared to be used as erection or shop drawings. However, electronic files or sepias may be used by the Contractor under the following conditions:

.1 Read Jones Christoffersen Ltd. is paid $150.00 per structural drawing used.

.2 Copyright remains with Read Jones Christoffersen Ltd.

.3 The drawings will only be used for shop drawings for this project and not be put to any other use.

.4 Read Jones Christoffersen Ltd. assumes no liability for errors or omissions in the drawings. The Contractor assumes all risk and expenses associated with the use of structural drawings in the production of his work.

.5 References to Read Jones Christoffersen Ltd. must be deleted from the title block.

.6 The Contractor signs a release available from Read Jones Christoffersen Ltd. that addresses the above items in more detail.

1.10 SUPPLY OF ALTERNATE PRODUCTS

.1 Should the rolled sections shown on the drawings not be procurable, or should substitution for those sections be desired, sections of equivalent strength, may be substituted if approved by the Consultant. In such cases full particulars, thereof must be submitted prior to the closing of Bid. Material substitutions after the closing of Bid, if accepted, will be at the Contractor's cost.

1.11 TESTING AND FIELD REVIEW

.1 See Section 050050 - Testing of Structural Steel, Steel Joists Framing and Steel Decking.

.2 The Specialty Structural Engineer responsible for shop drawings, or the Specialty Structural Engineer's representative, shall visit the site to review in place the connections and components designed by that Specialty Structural Engineer. The Specialty Structural Engineer shall be satisfied or take steps to ensure that these connections and components substantially comply with the Specialty Structural Engineer's design. The Specialty Structural Engineer shall then provide a sealed and signed letter to the Consultant and Structural Engineer to this effect.

.3 Prior to the commencement of work provide a schedule of shop fabrication to the Testing Agency.

.4 If requested, submit certified mill tests in accordance with the Standards.

.5 The Contractor shall advise the Testing Agency of the scheduling of all shop and field work pertaining to this Project. The Contractor shall permit the testing agency full access to the fabrication shop and the site, for the purpose of carrying out his work and he shall provide assistance required to aid in the performance of the inspection and testing.

1.12 STORAGE AND HANDLING

.1 The Contractor shall be responsible for the protection of all steelwork during fabrication, shipping, storage and construction. All small bends and damage shall be reported to the Structural Engineer for instructions. Steel work which is bent, broken or otherwise damaged, shall be repaired or replaced by the Contractor prior to erection to the satisfaction of the Structural Engineer at no cost to the Owner.

.2 The Contractor shall be responsible for proper scheduling of delivery and erection for the structural steel in accordance with the construction schedule.

.3 Store structural steel members at the site above ground on platforms, skids or other devices so that ground dampness will not affect the bottom members of the stacks.

.4 Steel, which is stored outdoors after fabrication, shall be protected from accumulations of standing water.

.5 Other materials shall be stored in a weather tight and dry place until ready for use in the Work.

.6 Packaged materials shall be stored in their original unbroken packages or containers.

1.13 COORDINATION WITH OTHER TRADES

.1 Supply all necessary instructions and drawings to other trades for setting bearing plates, anchor bolts, and other members that are built in with the work of other trades. Provide punched holes for the convenience of other trades in attaching wood blocking or other materials. Coordinate with drawings of other disciplines for locations and details. Supply the necessary material in accordance to the construction schedule.

2. Products

2.1 MATERIALS

.1 All steel shall be new unless otherwise indicated and be of sizes and shapes listed in the current CISC Handbook or AISC Handbook and as indicated on the drawings.

.2 Provide only new material (including bolts) manufactured in Canada, United States, United Kingdom or EU country mills. New materials are to be in accordance with the Referenced Standards. New materials are to be traceable and records of mill test certificates are to be provided to the Consultant by the Contractor.

.3 Where sections identified are not available from Canada, United States, United Kingdom or EU country mills or where the Contractor chooses to use sections produced by other mills, provide new materials of minimum strength and minimum quality noted in the Reference Standard. For Steel that is not produced by Canada, United States, United Kingdom or EU country mills, the Contractor shall make written requests for approval of the alternate mill to the Consultant before proceeding with material procurement. The Consultant reserves the right to require physical test data, in addition to the mill test reports, proving that the steel from the proposed mill meets the specification requirements prior to approving. Steel must conform to the following:

.1 A total maximum boron content of 0.0008%.

.2 Each steel batch is to be tested to confirm the steel meets or exceeds the Reference Standards, and does not exceed the maximum boron specified in 2.1.3.1 above.

.3 Testing of the steel is to be performed in Canada by an ISO 17025 accredited testing laboratory.

.4 Rolled shapes, except wide flanges, and rolled plate shall be to CSA G40.21 - grade 300W or equal.

.5 Wide flange rolled shapes and welded wide flange sections shall be to CSA G40.21 - grade 350W or equal.

.6 Hollow structural sections shall be to CSA G40.21 - grade 350W, Class H or C.

.7 High strength bolts shall be to ASTM A325 or A490, as required by the drawings.

.8 Standard anchor rods shall be to ASTM F1554, 36ksi. High strength anchor rods shall be to ASTM A193, grade B7, see drawings for locations, if required.

.9 Bolts and nuts shall be to ASTM A307.

.10 Primer for interior exposure not to receive a shop or field paint finish shall be to CISC / CPMA Standard 1-73a or other pre-approved, unless noted otherwise.

.11 Primer used in a multi-coat system where a final shop or field paint finish is to be applied shall conform to Section 09900 - Painting and shall be selected and preapproved by the Architect based on surface preparation, exposure conditions and compatibility with subsequent coatings, unless noted otherwise.

.12 Brick support angles and related framing materials exposed to weather, shall be galvanized to CSA G164.

.13 Headed shear stud connectors shall be Nelson anchors with fluxed ends or other pre-approved equal conforming to ASTM A108. Studs to be automatically end welded with suitable stud welding equipment or shop fillet welded to develop full strength of the stud. Field fillet welded studs will be rejected.

.14 Bar anchors shall be Nelson deformed bar anchors or pre-approved equal conforming to ASTM A496.

.15 Welding consumables for all processes shall be fully approved by the Canadian Welding Bureau and certified by the manufacturers as complying with the requirements of this specification. Such certificates shall be not more than two (2) years old.

.16 Electrode strengths to be equal to E49XX (E70XX) or better.

.17 Grout for column bases shall be non-metallic, non-expanding and non-shrink type with a minimum strength of 35 MPa at 28 days, unless noted otherwise. Grout may be place in a dry pack or flowable consistency.

2.2 DESIGN

.1 Unless otherwise noted connections and trusses shall be designed by the Contractor to the reference Standards by the Specialty Structural Engineer.

.2 Where connections are detailed, use connection of the type and detail shown on the drawings. Modifications to the specified connection types and details will not be permitted without prior approval from the Structural Engineer.

.3 The following connections, and any connections so noted on the structural drawings, shall be designed as slip critical and shall be pre-tensioned:

.1 Trusses.

.2 Elements resisting crane loads.

.3 Connections for supports of running machines or other live loads that produce impact or cyclic loads.

.4 Connections where bolts are subject to repeated tensile loads.

.5 Connections using slotted holes in the direction of the load or oversize holes unless specifically designed to accommodate movement.

.4 Connections for wind or seismic lateral load-resisting elements, such as bracing and drag struts, and others so noted on the structural drawings may be designed as bearing connections but shall be pre-tensioned.

.5 Other bolted connections may be snug tight.

.6 Use standard connection types where connections are not detailed on the structural drawings.

.7 Design shall be for the forces and loads shown on the drawings and shall allow for the effects of beam deflections. Provide a minimum of two (2) 19 mm (3/4") A325 bolts or an equivalent weld for all beam to girder and beam to column connections. If forces or loads are not given, the connection shall be designed for the maximum uniform distributed load that the member can carry for the span shown.

.8 Structural steel members spliced for ease of fabrication or transportation shall have splices designed to develop the full strength and stiffness of the member. Splices shall be subject to non-destructive testing as directed by the Structural Engineer. The cost for such testing shall be borne by the Contractor.

.9 Provide stiffeners in beam webs at all locations where beams pass over supports. Unless noted otherwise in the structural drawings, web stiffeners shall be 10 mm minimum.

.10 Provide separators for all double members in accordance with CSA S16.

3. Execution

3.1 FABRICATION

.1 Fabrication shall be to CSA S16 and reviewed shop drawings.

.2 Welding shall be to CSA W59.

.3 Structural steel work shall be executed by skilled and experienced workmen.

.4 Fabricated units shall be straight and true and without sharp kinks or bends, accurate to sizes shown.

.5 Fabricate rolled steel sections so that any camber and/or sweep resulting from manufacturing is positioned to create a hump up between the ends, not a sag down.

.6 Flame cut steel columns shall have their ends milled. Steel base plates supporting columns shall be flat.

.7 Unless noted otherwise, all hollow structural sections shall be dry inside and closed airtight with end plates sealed with welds.

.8 Visually inspect all plates and shapes for laminations. Replace plates or shapes that contain laminations.

.9 Headed shear stud connectors and deformed bar anchors shall be applied in strict accordance with the manufacturer's instructions and the Standards or shop fillet welded as per the Standards. Procedural control to be in accordance with W59 as a minimum. Field fillet welds will be rejected.

.10 Obtain Structural Engineer's approval for holes required through structural steel that are not shown on the drawings.

.11 Refer to Architectural drawings for extent and location of Architecturally exposed steel elements.

.12 Remove and replace any work which is not acceptable to the Consultant, when and as directed. Such operation shall not become an extra charge to the Owner.

.13 Steel members spliced for ease of fabrication shall develop the full strength and stiffness of the member.

.14 Where roof slopes exceed 5% and do not permit flush bearing of the steel deck on the beams, provide continuous 3mm bent plates to the pitch and necessary to ensure full bearing of the steel deck. Co-ordinate with the deck supplier the locations that will require these bent plates.

3.2 CLEANING AND PRIMING

.1 All steel shall be thoroughly cleaned of all loose mill scale, loose rust, oil or dirt.

.2 Architecturally exposed steel members, related framing and exterior steel shall be primed.

.3 Steel, which will be encased in concrete, fireproofed, zinc coated or galvanized, welded, receive shear studs, faying surfaces of slip resistant connections and the underside of base plates and bearing plates steel shall not be primed.

.4 Steel girder, beams, trusses, columns, bracing and connections plates on the perimeter of the building shall be primed.

.5 Structural steel which will not receive a finish paint coat and is required to be primed for interior exposure shall be cleaned in accordance with CISC / CPMA Standard 1-73 (minimum). Structural steel to be primed for exterior exposure shall be cleaned in accordance with SSPC SP6 “Commercial Blast Cleaning” as a minimum.

.6 Structural steel to receive a shop or field paint finish shall be cleaned in accordance with Section 099100 - Painting or SSPC SP6 “Commercial Blast Cleaning”, whichever produces a surface which has less rust and mill scale.

.7 Apply primers in accordance with the manufacturer’s instructions.

.8 Use paint prepared by manufacturer without thinning or adding admixtures. Execute painting on dry surfaces, free from rust, scale, or grease. Do not paint in temperatures lower than 8°C.

.9 Where finish painting to parts inaccessible for finish painting after final assembly is required, apply two coats of paint during fabrication. Apply paint of 2 different colours so that missed areas can be detected.

.10 Provide the following touchup for steel in an exterior exposure or which has a finish paint coat. After erection and after connections are completed, provide a field touchup coat of primer to all surfaces that had no paint shop coat and have been chipped or scraped. Touch up with primer and paint all shop coat painted areas that have been chipped or scraped.

.11 Provide the following touchup for galvanized steel. After erection and after connections are completed, provide a field touchup coat of zinc rich paint to all surfaces that have been chipped or scraped.

3.3 ERECTION

.1 The erector is fully responsible for erection methods, equipment, workmanship and safety precautions.

.2 Confirm the setting of anchor bolts and bearing plates and make an instrument survey to verify the setting prior to erection of steel members.

.3 Cutting or burning of baseplates to accommodate anchor bolts shall be cause for rejection of baseplates.

.4 Install all temporary bracing that is required to stabilize the work against wind, earthquake and construction loads. Keep structure true and plumb until completion of the building. Assume complete responsibility for the extent and timing of the removal of such bracing. The bracing members indicated on the drawings are required for the finished structure and shall not be considered as adequate for temporary bracing. Any failure to make proper and adequate provision for stresses occurring during the erection from any causes whatsoever shall be entirely the responsibility of the Contractor.

.5 As erection progresses, the work shall be securely bolted up to take care of all loads including wind and seismic during erection. Any failure to make proper and adequate provisions for loads during erection shall be solely the responsibility of the Contractor.

.6 The Contractor shall be responsible for the design of all hooks, erection connections and handling gear.

.7 Whenever piles of materials, erection equipment, or other loads are carried during erection, proper provision shall be made to take care of stresses resulting from same. All construction loads shall be adequately distributed so as not to exceed the capacity of any member.

.8 Structural steel shall be assembled and erected in accordance with the approved erection drawings and specified reference Standards.

.9 Structural steel work on concrete shall be carefully located at the proper grade and rigidly secured in place, using steel shims. Spaces under the steel shall then be filled with nonshrink premix grout as soon as possible, and before placing any concrete toppings or precast concrete units.

.10 Plumb, level and align individual members of steel work as specified in CSA S16.

.11 The various members forming parts of complete frame or structure after being assembled shall be aligned and adjusted accurately before being fastened.

.12 Bearing surfaces and surfaces which will be in permanent contact shall be cleaned before the members are assembled.

.13 Temporary bolts, clips and angles etc. used to facilitate erection shall be removed unless noted otherwise on the drawings.

3.4 TEMPORARY FLOORING

.1 Provide all temporary flooring, planking and scaffolding necessary in connection with erection of structural steel, or support of erection machinery in accordance with governing regulations and by-laws.

3.5 WELDING

.1 Welding shall be done by the shielded metal-arc method in accordance with the requirements CSA W59. The welding operators shall be currently certified under CSA W47.1 for the work they are performing.

.2 Submit, when requested, welding procedures prepared and sealed by a Specialty Structural Engineer for review.

.3 Surfaces to be welded shall be free from loose scale, rust, paint, or other foreign matter. Where weld material is deposited in two (2) or more layers, each layer shall be cleaned before the next layer is deposited. Care shall be taken to minimize stresses due to heat expansion, contraction and distortion by using proper sequence in welding and by approved methods.

.4 Appearance, quality of welds made, methods of correcting defective work shall be in accordance with CSA W59.

.5 Welding of reinforcing bars to structural steel as per CSA W186.

3.6 COMPLETION

.1 The Specialty Structural Engineer responsible for the sealed shop drawings, or his representative shall visit the site to review in place connections and components designed by that Specialty Structural Engineer to ensure substantial compliance with his sealed shop drawings. He shall then submit a sealed and signed letter of substantial compliance to the Consultant and Structural Engineer.

.2 On completion of the work of this section, all protection erected in conjunction with the structural steel work shall be removed, all damage to this work and adjoining work shall be made good and all surplus materials and debris and all tools, plant and equipment shall be removed from the site.

End of Section 051200

1 General

1.1 **SECTION INCLUDES**

.1 Design, labour, Products, equipment and services necessary for the steel cabling system work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 CAN/CSA S16.1-M, Limit States Design of Steel Structures.

.2 CSA S136.1-M, Commentary on CAN/CSA S136-M, Cold Formed Steel Structural Members.

.3 NAAMM, The National Association of Architectural Metal Manufacturers.

1.3 **DESIGN REQUIREMENTS**

.1 Design cabling system, anchors and connections in accordance with CSA S16.1, S136.1, and to withstand live, dead, lateral, wind, seismic, handling, transportation, erection loads and Project loading requirements for usage by orangutans.

1.4 **SUBMITTALS**

.1 Shop drawings:
.1 Submit shop drawings for fabrication and erection of cabling in accordance with Section 01 33 00 indicating:
.1 Materials, core thicknesses, class of finish (AMP 555), connections, method of anchorage, number of anchors, supports, reinforcement, details, and accessories.

.2 Samples:
.1 Submit samples in accordance with Section 01 33 00 of the following:
.1 Two 300 mm sample of steel cabling demonstrating material, size and finish.

1.5 **QUALITY ASSURANCE**

.1 Retain a Professional Engineer, licensed in the Province of Ontario, with experience in work of comparable complexity and scope, to perform the following services as part of the work of this Section:
.1 Design steel cabling system and associated components.
.2 Review, stamp, date and sign shop drawings.

.2 Workmanship: Fabricate work of this Section to meet the required class of workmanship indicated below in accordance with NAAMM's AMP 555, Section 8.
- .1 Class 1: for use on direct exposed to view fabricated items:
  - .1 Exposed surfaces are finished smooth with pitts, mill marks, nicks, burrs, sharp edges, and scratches filled or ground off.
  - .2 Distortions should not be visible to the eye.

.3 Mock-up:
- .1 Construct one full size mock-up of orangutan cabling system in location acceptable to Consultant, demonstrating workmanship and installation procedures and connections.
- .2 Arrange for Consultant's review and acceptance, allow 48 hours after acceptance before proceeding with work.
- .3 Mock-up may remain as part of Work if accepted by Consultant. Remove and dispose of mock-ups which do not form part of Work.
- .4 Upon acceptance, mock-up shall serve as a minimum standard of quality for the balance of the work of this Section.

.4 Pre-installation meetings: Arrange meeting on Site to be attended by Consultant, Contractor, and cabling Subcontractor to inspect substrates, and to review installation procedures 48 hours in advance of installation.

2 Products

2.1 ACCEPTABLE MANUFACTURERS

.1 Tway Lifting Products.

.2 Or approved alternative.

2.2 MATERIALS

.1 General:
- .1 All materials under work of this Section, including but not limited to, primers and paints are to have low VOC content limits.
- .2 Unless detailed or specified herein, standard products will be acceptable if construction details and installation meet intent of Drawings and Specifications.
- .3 Include all materials, products, accessories, and supplementary parts necessary to complete assembly and installation of work of this Section.

.2 Steel cables and accessories:
- .1 Vinyl coated structural steel cables complete with anti-tamper connectors, cable 'O' lines, size and diameter as required to suit Project requirements.
- .2 UV stabilized vinyl material in colour as selected by the Consultant.
- .3 Fasteners: Corrosion resistant stainless steel fasteners as recommended by cabling manufacturer for securement of cabling.

.4 Drilled inserts and anchoring system: Heavy-duty anchors, complete with all components required for a complete installation and to suit Project.

2.3 **FABRICATION**

.1 Fabricate steel cabling and associated components in accordance with reviewed shop drawings and manufacturer's written instructions.

.2 Verify dimensions of existing Work before commencing fabrications and report any discrepancies to the Consultant.

.3 Carefully make and fit details. Take special care with exposed finished work to produce a neat and correct appearance to the Consultant's acceptance.

3 Execution

3.1 **EXAMINATION**

.1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.2 **INSTALLATION**

.1 Install steel cabling system in accordance with reviewed shop drawings, manufacturer's written instructions and to meet Owner's Project requirements.

.2 Make work in true planes with adequate fastenings.

.3 Install steel cabling system plumb, true, square, straight, level and accurate to sizes detailed, free from distortion or defects detrimental to appearance or performance.

.4 Securely attach cabling and adjust for proper appearance.

.5 Ensure cabling system is installed taut and secure and meets the satisfaction of the Consultant.

3.3 **CLEANING**

.1 Cleaning cabling system and associated components in accordance with manufacturer's written instructions.

3.4 **PROTECTION**

.1 Do not permit subsequent construction activities to cause damage to appearance or operation of installed cabling system and accessories.

END OF SECTION

1. General

1.1 DOCUMENTS

.1 This section, along with the drawings, forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

.2 Drawings include architectural, mechanical, and electrical drawings.

1.2 DESCRIPTION OF WORK INCLUDED

.1 Provide all labour, materials, closures, equipment and services necessary to design, supply, fabricate, erect and install the steel deck and field welded shear connectors to structural steel as indicated on the drawings and as hereinafter specified. Provide gauge metal formwork at all deck edges for composite deck or concrete-filled deck and reinforcement for deck openings as required herein.

.2 Coordinate with Section 051000 - Structural Steel for the design, supply and installation of headed stud shear connections for composite beams and girders and where required on other beams, girders and drag struts.

1.3 RELATED WORK SPECIFIED ELSEWHERE

.1 Section 031000 - Concrete Forming

.2 Section 032100 - Concrete Reinforcing

.3 Section 033000 – Structural Cast-in-Place Concrete

.4 Section 050050 - Testing of Structural Steel, Steel Joist Framing and Steel Decking

.5 Section 051200 - Structural Steel Framing

.6 Section 052100 - Steel Joist Framing

.7 Section 055000 - Metal Fabrications

.8 Section 055100 – Metal Stairs

1.4 REFERENCE STANDARDS

.1 Structural steel shall conform to the requirements of the following Standards unless otherwise required by the specification:

.1 Building Code

.1 Ontario Building Code –2012

.2 Reference Standards

.1 CSA S136-12 - North American Specification for the Design of Cold-Formed Steel Structural Members

.2 CSA W47.1-09 - Certification of Companies for Fusion Welding of Steel Structures.

.3 CSA W59-13 - Welded Steel Construction (Metal Arc Welding).

.4 ASTM A653M-09a - Sheet Steel, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

.5 CSSBI 10M-06 - Standard for Steel Roof Deck.

.6 CSSBI 12M-06 - Standard for Composite Steel Deck.

.2 Where the Standard is referred to in this specification it shall mean the documents specified in this clause and their referenced documents.

1.5 DEFINITIONS FOR THIS SECTION

.1 "Owner", "Contractor" and "Consultant" as per the General Conditions and Definitions.

.2 "Structural Engineer" shall mean a representative of Read Jones Christoffersen Ltd.

.3 "Specialty Structural Engineer" is a Professional Engineer registered in Ontario responsible for components designed by the Contractor and who seals and signs shop drawings.

.4 "Testing Agency" shall mean the testing agency responsible to the Owner.

.5 "Standard" and "Standards" shall mean the reference standards listed under "Reference Standards" in this section.

1.6 QUALIFICATIONS

.1 Steel deck fabricator shall have not less than five (5) years experience in the fabrication of steel deck.

.2 Erector shall not have less than five (5) years experience in the erection of steel deck.

.3 Steel deck welders must possess current Canadian Welding Bureau Certificates of Qualification for light gauge structural welding.

.4 The deck erectors must be certified under the requirements of CSA W47.1

1.7 EXAMINATION

.1 Examine and verify all necessary measurements and dimensions of previously executed work which may affect the work of this contract.

.2 Examine surfaces which work is to be placed on or against to ensure that they are square, true, level, plumb, of correct slope or shape and of proper surface to receive such work.

.3 Report any discrepancies to the Consultant and Structural Engineer immediately so that instructions may be given for the necessary remedial work.

.4 Commencement of work shall be construed as acceptance of all conditions and surfaces.

1.8 SHOP DRAWINGS

.1 Submit shop drawings prepared under the supervision of a Specialty Structural Engineer. Drawings of components designed by the Contractor shall be sealed and signed by this Specialty Structural Engineer.

.2 Shop drawings shall show the position, extent, type and arrangement of the units, their relationship to other materials, depth, core thickness, coating thickness, connections, openings, accessories, closures, light gauge formwork and reinforcement for openings, and complete stud shear connector details for composite beams.

.3 Calculations and/or test data may be requested with the shop drawings to justify deck design and shear connector design.

.4 Show deck load capacities, including point load capacities, and for composite deck confirm that these load capacities are compatible with the zinc coating.

1.9 TESTING AND FIELD REVIEW

.1 As per Section 050050 - Testing of Structural Steel and Deck.

1.10 STORAGE AND HANDLING

.1 Bundles of decking shall be stacked on wood blocking clear of the ground and tilted to ensure that no water lies on the material.

2. Products

2.1 GENERAL

.1 Products shall satisfy the requirements of the Standard unless otherwise specified herein or on the drawings.

2.2 MATERIALS

.1 Steel deck units shall be formed of zinc-coated sheet steel minimum CSSBI 10M Grade A with a base steel nominal thickness of 0.76 mm or greater. Unless noted otherwise, zinc coatings shall be:

.1 Interior Exposure Floors ZF75 Galvanneal; Roofs - ZF75 - Galvanneal

.2 Exterior Exposure Z275.

.2 Touchup paint for welds shall conform to CGSB –1.181 Ready-Mixed Organic Zinc Rich Coating.

.3 Cover plates, cell closures, etc. shall be of the same material as the deck with a minimum nominal thickness of 0.76 mm.

.4 Deck shall conform to the depths shown on the drawings. Deck receiving composite shear studs shall have an average bottom flute width equal to twice the deck depth.

.5 Shear stud connectors shall be Nelson headed anchors or other preapproved. Studs to be automatically end welded with suitable stud welding equipment in the field. Fillet welded studs will be rejected.

.6 Steel deck to receive concrete topping shall be composite deck unless noted otherwise.

.7 Steel deck that is indicated to be painted on the underside shall have factory applied, baked-on series 5000 paint finish. Painted steel deck shall be connected with alternate fasteners that do not damage the paint finish. Painted steel deck shall not be connected with welds.

.8 Alternate Fasteners – Note that any alternates must be reviewed by RJC:

.1 The following alternate fasteners are acceptable in lieu of welding to structural supports:

.1 Hilti X-HSN-24 or X-ENP-19 as recommended by the manufacturer for the application.

.2 6mm x 25mm HHA weather-guard screws at 300mm maximum centers at all bearing points (min. of 4 screws per sheet) for use on wood trusses.

.2 In lieu of button-punching, clinching or welding sidelaps, Hilti-SLC01 M HWH, as recommended by the manufacturer for the application, are acceptable.

2.3 FABRICATION

.1 Composite steel deck shall be formed with integral locking lugs to provide mechanical lock between concrete and steel.

.2 Steel deck shall span over three (3) or more supports unless prevented by the structural steel layout.

.3 Steel deck shall have interlocking male and female side laps.

.4 Provide cell closures where required by architectural drawings and specifications at open ends of all cell runs at columns, openings, walls, etc., and where cells change direction.

.5 For deck with concrete topping provide necessary metal gauge formwork at the deck edges for full deck and concrete depth to prevent leaking of concrete topping. This includes, but is not limited to, edges formed by building edges, openings framed by structural steel, elevator shafts, stairwells, and around webs and flanges of columns.

2.4 DESIGN

.1 Steel deck shall be designed by the Contractor to the reference Standards and the loads on the drawings unless otherwise noted.

.2 Deck thickness, spacing of puddle welds or mechanical fasteners and type and extent of side connections shall be proportioned to resist forces and loads shown on drawings, or as designated on drawings.

.3 Deck material thickness may be greater than the minimum thickness shown on the drawings.

.4 Design floor deck to support loads without temporary shoring and with deflection not exceeding 1/180th of the span under construction loading.

.5 Unless noted otherwise, the deflection under live load alone shall be limited to span/360 for floors, and for roof deck the deflection shall be limited to span/360.

.6 Where the diaphragm loads are not shown on the drawings or where shear requirements are not shown on the drawings, the design of the decking and its fastenings shall meet a minimum diaphragm shear requirement of 3.5 kN/m.

.7 Decking to be used as formwork shall conform to WCB formwork requirements.

.8 Shear stud connectors shall be designed for the forces indicated on the drawings. If the capacities of the individual studs are reduced because of the geometry of the particular deck profile used, provide additional studs so that the total shear transfer capacity provided is at least that indicated on the drawings.

.9 At splice locations, steel decking shall be installed with laps sufficient to ensure that both pieces of deck are properly fastened to the supporting member. As a minimum, over supporting members with uninterrupted top surfaces, such as W-beams and channels, the lap shall be 100mm and the welds or deck fasteners shall be at or near the centerline of the supporting members. Over supporting members with interrupted top surfaces, such as OWSJ's with double angle or hat-shaped top chords, each sheet shall extend a minimum of 25mm past the opposite edge of the joist chord, and the sheets shall not lap less than 100mm total. In this case the welds or deck fasteners shall be centered on the supporting surface nearer the end of the top deck sheet. See General Notes and Typical Details for clarification.

3. Execution

3.1 ERECTION

.1 The erection of the steel deck shall be carried out by personnel experienced in the installation of steel deck.

.2 Obtain and verify all dimensions at project site or from approved shop drawings.

.3 The Contractor shall be solely responsible for the accuracy of such measurements and precise fitting and assembly of the finished product.

.4 Use special care in unloading, handling and erecting the deck to avoid bending, twisting or otherwise distorting the panels.

.5 The steel deck units shall be laid in accordance with the approved shop drawings.

.6 At splice locations, steel decking shall be installed with laps sufficient to ensure that both pieces of deck are properly fastened to the supporting member. As a minimum, over supporting members with uninterrupted top surfaces, such a W-beams and channels, the lap shall be 100mm and the welds or deck fasteners shall be at or near the centerline of the supporting members. Over supporting members with interrupted top surfaces, such as OWSJ's with double angle or hat-shaped top chords, each sheet shall extend a minimum of 25mm past the opposite edge of the joist chord, and the sheets shall not lap less than 100mm total. In this case the welds or deck fasteners shall be centered on the supporting surface nearer the end of the top deck sheet. See General Notes and Typical Details for clarification.

.7 Metal closures and flashing shall be fastened in place by welding, sheet metal screws, or structural adhesive as recommended by the decking manufacturer.

.8 Unless noted otherwise the decking shall be welded to the supporting steel by means of 19mm diameter fusion welds in every second flute and 300mm maximum centers at all bearing points (minimum of 4 welds per sheet).

.9 Side laps shall be mechanically fastened (clinched) or welded together at not more than 600mm on center.

.10 At perimeter parallel to flutes deck edges shall be fastener to supporting steel at 300mm on center unless noted otherwise on the drawings.

.11 Alternate Fasteners – Note that any alternatives must be reviewed by RJC:

.1 The following alternative fasteners are acceptable in lieu of welding to structural supports:

.1 Hilti X-HSN-24 or X-ENP-19 as recommended by the manufacturer for the application.

.2 6mm x 25mm HHA weather-guard screws at 300mm maximum centers at all bearing points (min. of 4 screws per sheet) for use on wood trusses.

.2 In lieu of button-punching, clinching or welding sidlaps, Hilti S-SLC01 M HWH or S-SLC02 M HWH, as recommended by the manufacturer for the application, are acceptable.

.12 Steel deck shall be placed on the supporting steel framework and adjusted to final position before being permanently fastened. Each section shall be brought to proper bearing. If the supporting framework is not in proper alignment or at the proper level, the Contractor shall so advise the Consultant and Structural Engineer of such irregularities and shall not make final placement until corrections are made.

.13 For steel deck that will not receive a concrete topping, immediately after the steel deck is welded in place, the steel deck surface shall be inspected, and all areas where zinc coating has been burned by welding shall be covered by a suitable zinc enriched paint, applied to the paint manufacturer's instructions.

.14 Cut openings in metal decking at locations shown on the project drawings. These openings shall be located and dimensioned in cooperation with the various trades at the time of erecting the steel deck. Unless noted otherwise, openings up to 150 mm (6") need not be reinforced. Openings between 150 mm (6") to 400 mm (16") in size shall be reinforced by this trade, using 75 mm x 75 mm x 5.0 mm x 1200 mm (48") steel angles welded to the flutes on either side of those cut.

.15 The Contractor shall accommodate the erection and welding sequence of the structural steel as required.

.16 Shear stud connectors to be applied in strict accordance with manufacturer's instructions and Standards. Procedural control to be in accordance with W59 as a minimum.

.17 Studs shall be placed in bottom flutes of steel deck on the side closest to the nearest end of the beam.

.18 After welding studs, the ceramic ferrule shall be removed and the stud fillet visually inspected by the operator. If the fillet is less than 360° around the base of the stud, then the stud is to be hammer tested by the operator by bending the stud 30° from the vertical away from the side of no fillet. If the weld fails, the stud is to be replaced. Bent studs may be left bent.

.19 If studs are welded to steel plates or members with temperature below 0°C, one (1) stud in each 100 is to be tested by the operator by bending 30° from the vertical.

.20 No stud welding is to be done when the base metal temperature is below -15°C or when the deck surface is wet or the structural steel surface below the deck is wet.

3.2 COVER PLATES AND CLOSURES

.1 Furnish, install and weld in position, sheet metal cover plates to close openings between deck sections and columns and to cover gaps where deck sections abut or change direction.

.2 For deck with concrete topping install all light gauge metal closures and edge strips necessary as formwork for the concrete.

.3 Install all closures as required by the architectural drawings and specifications.

3.3 CLEAN-UP

.1 Steel deck cuttings, strappings, packaging material and other debris pertaining to steel deck units shall be cleaned up.

.2 Remove all debris and excess material at completion of erection of steel deck and leave work ready for other trades.

.3 Touchup welds and other areas of damaged galvanizing with zinc rich paint.

.4 Repair any defects. Leave steel deck free of all oil, grease, paint and dirt.

End of Section 053100

1 General

1.1 **SECTION INCLUDES**

.1 Design, labour, Products, equipment and services necessary for the miscellaneous and metal fabrication work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 AAMA 2605, Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.

.2 ANSI, H35.1M Alloy and Temper Designation Systems for Aluminum (Metric).

.3 ASTM A53, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.

.4 ASTM A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished

.5 ASTM A123, Specification for Zinc (Hot Dip Galvanized) Coatings on Iron & Steel Products.

.6 ASTM A153, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

.7 ASTM A276, Specification for Stainless and Heat-Resisting Steel Bars and Shapes.

.8 ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

.9 ASTM A480/A480M, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.

.10 ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.

.11 ASTM B209, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

.12 ASTM B211, Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire.

.13 ASTM B633,Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.

.14 ASTM C1107/C1107M, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).

.15 ASTM E488/E488M, Standard Test Methods for Strength of Anchors in Concrete Elements.

.16 ASTM F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

.17 ASTM F1941/F1941M, Standard Specification for Electrodeposited Coatings on Mechanical Fasteners, Inch and Metric.

.18 CAN/CGSB 138.1-M, Fence, Chain Link, Fabric.

.19 CAN/CGSB 138.2-M, Fence, Chain Link, Framework, Zinc-Coated, Steel.

.20 CISC/CPMA 1.73a, A Quick-Drying One-Coat Paint for Use on Structural Steel.

.21 CAN/CSA-G40.20/G40.21-M, General Requirements for Rolled or Welded Structural Quality Steel/ Structural Quality Steels.

.22 CAN/CSA S16.1-M, Limit States Design of Steel Structures.

.23 CSA S136.1-M, Commentary on CAN/CSA S136-M, Cold Formed Steel Structural Members.

.24 CSA W47.1, Certification of Companies for Fusion Welding of Steel Structures.

.25 CSA W48, Filler Metal and Allied Materials for Metal Arc Welding.

.26 CSA W59-M, Welded Steel Construction (Metal Arc Welding).

.27 CAN/CSA W117.2-M, Safety in Welding, Cutting and Allied Processes.

.28 NAAMM, The National Association of Architectural Metal Manufacturers.

.29 Steel Structures Painting Council (SSPC), Steel Structures Painting Manual, Vol. 2.

1.3 DESIGN REQUIREMENTS

.1 Design details and connections, where not shown on Drawings, in accordance with CAN/CSA-S16.1 and CSA S136.1.

.2 Ensure no sharp edges occur in metal fabrications that will be exposed to orangutans.

1.4 SUBMITTALS

.1 Shop drawings:

.1 Submit shop drawings for fabrication and erection of miscellaneous and metal items in accordance with Section 01 33 00 indicating:

.1 Materials, core thicknesses, class of finish (AMP 555), connections, joints, method of anchorage, number of anchors, supports, reinforcement, details, and accessories.

.2 Ensure shop drawings are of one uniform size and based on field measurements.
.3 Adjacent construction, elevations and details, dimensions, gauges, finishes and relationship to adjacent construction.
.4 Show methods of fastenings, accessory items required, and design computations, and other pertinent data and information.

.2 Samples:
.1 Submit samples in accordance with Section 01 33 00 of the following:
.1 Two 300 x 300 mm samples of guard cable mesh infill panel demonstrating material, pattern, powder coat finish and colour for the Consultant's approval.
.2 One 500 mm sample of grating tread with checker plate nosing at ship ladder.
.3 Two 300 x 300 mm samples of black coloured stainless steel rope mesh for use at chute assemblies, demonstrating material, mesh pattern, finish and colour for the Consultant's approval.
.4 Two 300 mm square wire fabric mesh with vinyl coating.
.5 Each hardware item for pole feeder as specified. Tag samples identifying applicable Specification article number, brand name and number, finish, building location, date and catalogue number.

.3 Certification: Submit compliance certificate from Engineer of record certifying that guards, stairs and ladders meet design criteria and performance requirements of this Section.

1.5 **QUALITY ASSURANCE**

.1 Retain a Professional Engineer, licensed in the Province of Ontario, with experience in work of comparable complexity and scope, to perform the following services as part of the work of this Section:
.1 Design exhibit viewing window metal components, climbing pole metal components, steel stairs, handrails and railings, ladders and metal fabrication items that are required to resist live, dead, lateral, wind, or seismic loads.
.2 Review, stamp, date and sign shop drawings.

.2 Workmanship: Fabricate work of this Section to meet the required class of workmanship indicated below in accordance with NAAMM's AMP 555, Section 8.
.1 Class 1: for use on direct exposed to view fabricated items:
.1 Exposed surfaces are finished smooth with pitts, mill marks, nicks, burrs, sharp edges, and scratches filled or ground off. Defects should not show when painted, polished, or finished.
.2 Welds should be concealed where possible. Exposed welds are ground to small radius with uniform sized cove unless otherwise noted.
.3 Distortions should not be visible to the eye.
.4 Exposed joints are fitted to a hairline finish.

.3 Execute welding by firms certified in accordance with CSA W47.1 Division 1 or 2.1. Ensure welding operators are licensed per CSA W47.1 for types of welding required by Work.

.4 Perform stainless steel work in accordance with NAAMM, Code of Standard Practice for the Metal Industry, Workmanship, Class 1.

2 Products

2.1 **MATERIALS**

.1 General:
- .1 All materials under work of this Section, including but not limited to, primers and paints are to have low VOC content limits.
- .2 Unless detailed or specified herein, standard products will be acceptable if construction details and installation meet intent of Drawings and Specifications.
- .3 Include all materials, products, accessories, and supplementary parts necessary to complete assembly and installation of work of this Section.
- .4 Incorporate only metals that are free from defects which impair strength or durability, or which are visible. Install only new metals of best quality, and free from rust or waves and buckles, and that are clean, straight, and with sharp defined profiles.

.2 Structural shapes, plates, and similar items: CAN/CSA-G40.20/G40.21-M, Grade 350W. Hollow structural sections: CAN/CSA-G40.20/G40.21-M, Grade 350W, Class H.

.3 Galvanized sheet steel: ASTM A653/A653M Grade A, Z275 Commercial Quality zinc coating, size and shape as shown.

.4 Stainless steel materials:
- .1 Stainless steel tubing: ASTM A269, Type 316, finish to X-L Blend S. Size as shown.
- .2 Stainless steel sheet and plate: ASTM A480/A480M, Type 316, finish to X-L Blend S. Size as shown.
- .3 Stainless steel shapes: ASTM A276, Type 316, finish to X-L Blend S. Sizes and shapes as shown.

.5 Aluminum materials:
- .1 Aluminum extrusions and channels: ASTM B211 and ANSI H35.1 AA6063 alloy, T6 temper.
- .2 Aluminum sheet: ASTM B209 and ANSI H35.1 AA1100 aluminum alloy, H14 temper.
- .3 Powder coat finish (retractable/lockable ladder): Manufacturer's standard powder coat finish in colour as selected by the Consultant.

.6 Pipe: ASTM A53/A53-M, Schedule 40 standard weight steel pipe, for ship ladder and bollard applications. Sizes as shown.

.7 Black stainless steel rope mesh:
- .1 2.4 mm wire rope diameter with mesh size of x 60 x 60 mm, Type 316 stainless steel rope mesh with black oxide finish, manufactured by Huamei Metal Mesh Factory or approved alternative.
- .2 Provide all components and accessories as required for complete and secure installation of mesh material at chute assemblies.

.8 Cable wire mesh infill panel (guards):
- .1 4.1 mm diameter, drawn galvanized steel wire, electrically welded nominal 50 x 50 mm mesh, galvanized with powder coat finish as specified herein.
- .2 Mesh, together with frame, shall be electrostatically finished in fabricator's shop with specified powder coat finish in colour as selected by the Consultant.

.9 Wire rope cabling and associated components (kick rails):
- .1 Cabling: 5 mm diameter Type 316 stainless steel stranded wire rope to suit intended kick rail application. Manufactured by Unirope Ltd., Wire Rope Industries Ltd., or approved alternative.
- .2 Accessories: Provide all components and accessories as required for complete and secure installation including but not limited to turnbuckles, fittings, hooks, clips, clamps, and eye bolts as required. Accessories shall be manufactured by Spae-Naur or approved alternative.

.10 Metal grating stair treads: Galvanized grating treads with checkered plate nosing. 'Welded Steel Treads' by Fisher & Ludlow Ltd.; Safety Steps' by IKG Borden; or 'Stair Treads' by Amico-ISG.

.11 Fence materials (barrier fence)
- .1 Powder coated fence fabric: CAN/CGSB 138.1, powder coated No. 9 gauge steel wire woven in a 50 mm mesh, with knuckled finish top and bottom selvage edges.
- .2 Posts, braces and rails: CAN/CGSB 138.2; Schedule 40 pipe, size, thickness, diameter and length to meet standard. Minimum galvanizing weight: 610 g/m^2 of uncoated base metal surface with powder coating.
- .3 Bottom tension wire and tie wire fasteners: CAN/CGSB 138.1; Zinc-coated steel wire and zinc coating, same diameter as specified for chain link fence fabric.
- .4 Tension bar: 19 x 4.88 mm galvanized steel.
- .5 Tension bar bands: 33 x 19 mm minimum galvanized steel.
- .6 Fittings and hardware: Galvanized steel with minimum galvanizing weight of 610g/m^2 of uncoated base metal.
  - .1 Post caps: Waterproof fit, to fasten securely over posts and, to carry top rail.
  - .2 Turnbuckles: Drop forged.
- .7 Finish coating: Powder coating as specified herein in colour as selected by the Consultant.

.12 Welding materials: CSA W48 and CSA W59-M.

.13 Fasteners:
- .1 Unless otherwise indicated, provide Type 316 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
- .2 Steel bolts and nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A653/A653M; and, where indicated, flat washers.
- .3 Anchor bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A653/A653M; and, where indicated, flat washers. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
- .4 Supply bolts of lengths required to suit thickness of material being joined, but not projecting more than 6 mm beyond nut, without the use of washers.

.14 Powder coat finish:
- .1 Epoxy polyester coating conforming to AAMA 2605 with finish and colours as selected by the Consultant. 'Interpon D3000' by Interpon Powder Coatings (Akzo Nobel) or approved alternative. Provide manufacturers recommended primer.
- .2 For use at cable mesh infill panels at guardrails and barrier fence fabric.

.15 Primer paint:
- .1 Interior metal fabrications: CPMA 1.73a and in accordance with Section 09 91 00.
- .2 Exterior metal fabrications: In accordance with Section 09 97 13 for exterior steel coating system.

.16 Galvanized primer paint: Inorganic zinc rich primer. For use on galvanized fabrications where touch up is to remain unpainted in finished work; Carbozinc 11WB by Carboline Company, Catha-Coat 305 by Devoe Coatings or Zinc Clad XI by Sherwin Williams.

.17 End sleeves: Galvanized steel sleeves for installation within concrete.

.18 Cast-in safety treads (metal pan stairs): Nosing base to be type 6063-T5 extruded aluminum; epoxy/abrasive filler to have minimum 60% aluminum oxide content; 'Spectra Type WP3SP' by Wooster Products Inc. or approved alternative. Colour to be selected by the Consultant.

.19 Anchors:

.1 Anchors, general: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E488/E488M.

.2 Drilled inserts: “HSL-3" by Hilti Inc. or “Dynabolt Sleeve Anchors” by ITW Construction Products, heavy-duty anchors, sizes as shown.

.3 Adhesive anchor system: ‘HIT HY 200 Injectable Mortar with Hilti HAS Stainless Steel Anchor Rod System’ by Hilti Ltd. or approved alternative by ITW Construction Products, complete with all components required for a complete installation.

.20 Non-shrink, nonmetallic grout: Factory-packaged, non-staining, non-corrosive, non-gaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

.21 Pole feeder hardware:

.1 Heavy duty winch driven cable assembly complete with all hardware as required for complete and secure installation.

.2 Hardware to be corrosion resistant and suitable for pole feeder unit.

.22 Concrete: In accordance with Division 3 - Concrete.

2.2 FABRICATION

.1 Verify dimensions of existing Work before commencing fabrications and report any discrepancies to the Consultant.

.2 Fit and assemble work in shop where possible. Execute work in accordance with details and reviewed shop drawings.

.3 Use self-tapping shake-proof screws on items requiring assembly by screws or as indicated. Use screws for interior metal work. Use welded connections for exterior metal work unless otherwise found acceptable by the Consultant.

.4 Ensure exposed welds are continuous for length of each joint. File or grind exposed welds smooth and flush. Seal exterior steel fabrications against corrosion in accordance with CAN/CSA S16.1-M.

.5 Execute shop welding to requirements specified.

.6 Carefully make and fit details. Take special care with exposed finished work to produce a neat and correct appearance to the Consultant's acceptance.

.7 Assemble members without twists or open joints.

.8 Correctly size holes for connecting work of other trades where such can be determined prior to fabrication. Where possible, show holes on shop drawings. Place holes not to cause appreciable reduction in strength of member.

.9 Draw mechanical joints to hairline tightness and seal countersunk screw and access holes for locking screws with metal filler where these occur on exposed surfaces.

2.3 **FABRICATED ITEMS**

.1 Refer to Drawings for details of metal fabrication work and related items not specifically listed in this Section.

.2 Where work is required to be built into work of other Sections supply such members to respective Sections.

.3 Provide miscellaneous and metal fabrications indicated on the drawings, listed below, and not indicated to be supplied under other Sections. Provide miscellaneous and metal fabrications including but not limited to the following:

.4 Metal components for exhibit viewing windows:

.1 Provide galvanized steel bent plates and for fastening of viewing glass to structural steel members, and galvanized steel plates and angles as required for casting into concrete at sills, jambs and headers as shown on Contract Drawings.

.2 Coordinate with Section 08 80 01 as required for sizing and installation of laminated glass at intended viewing areas and Division 3 - Concrete for casting steel angles as required.

.3 Install exhibit viewing window members in accordance with reviewed shop drawings, plumb, true, and level.

.4 Finish and colour: Exterior steel coating for metal components in accordance with Section 09 97 13, in colour as selected by the Consultant.

.5 Metal pan stairs:

.1 Fabricate exterior galvanized bent steel pan stairs in accordance with reviewed shop drawings.

.2 Fabricate galvanized steel channel stringer of size, construction and attachment to structure as shown.

.3 Furnish treads, risers and landing permanent metal forms of steel sheet formed as shown; treads to be concrete filled in accordance with Division 3. Fabricate landings for concrete fill of same material as stair treads, unless ribbed metal deck form is shown.

.4 Support treads, risers and landings as detailed on reviewed shop drawings.

.5 Finish and colour: Exterior steel coating for galvanized steel components in accordance with Section 09 97 13, in colour as selected by the Consultant.

.6 Metal components for guardrails:
- .1 Provide galvanized steel components for guardrail consisting of a wood handrail, cable mesh infill panels, metal posts, stainless steel pipe handrail as end sleeves and additional components as indicated on Contract Drawings.
- .2 Coordinate with Section 06 20 00 as required for sizing and installation of wood handrail and wood slats at guardrails.
- .3 Design guard system to withstand minimum horizontal and vertical loads as required to meet requirements of authorities having jurisdiction. In no instance shall load design of railings be less than 3.0 kN/m horizontally and 1.5 kN/m vertically.
- .4 Ensure cable mesh infill panels are installed straight, smooth, plumb and free of wrinkles, buckles and defects in appearance.
- .5 Finishes and colours:
  - .1 Metal components, typical: Exterior steel coating for galvanized steel components in accordance with Section 09 97 13, in colour as selected by the Consultant.
  - .2 Cable mesh infill panels: Powder coat finish as specified, in colour as selected by the Consultant.

.7 Metal components for climbing poles:
- .1 Provide galvanized steel components for climbing poles such as but not limited to shade leaf, platforms and pipe vines. Sizes as shown.
- .2 Coordinate with Sections 05 12 00 and 06 20 00 as required for sizing and installation for structural steel posts and base plate connections and wood components.
- .3 Shade leaf:
  - .1 Shade leaf to consist of galvanized steel HSS pipe steel frame and beams and steel band as shown on Contract Drawings.
  - .2 Shade structure to be complete with wood planks provided under Section 06 20 00.
- .4 Platforms:
  - .1 Aerial platforms:
    - .1 Aerial platforms to consist of galvanized steel HSS pipe steel frame and beams, steel band, feeder tube and inserts as shown on Contract Drawings.
    - .2 Platforms to be complete with black locust decking provided under Section 06 20 00.
  - .2 Nesting platforms:
    - .1 Nesting platforms to consist of galvanized steel plate gussets as shown on Contract Drawings.
    - .2 Platforms to be complete with wood planks, posts and boards provided under Section 06 20 00.
- .5 Pipe vines: Provide galvanized steel pipe vines, pine vine attachments and plate gussets to sizes and shapes as shown on Contract Drawings.
- .6 Ensure metal components are installed plumb, true, rigid, secure, level and free from distortion or defects detrimental to appearance or performance.
- .7 Finish and colour: Exterior steel coating for metal components in accordance with Section 09 97 13, in colour as selected by the Consultant.

8. Ships ladder and railings:
   .1 Design ladders to support a minimum live load of 6 kPa, in addition to dead load. Ladders shall be securely anchored to building structure.
   .2 Design railings to withstand minimum horizontal and vertical loads as required to meet requirements of authorities having jurisdiction with a minimum of 3.8 kPa horizontally and 4.8 kPa vertically.
   .3 Fabricate treads of 6 mm thick galvanized steel checkered plate with leading edge turned down to form nosing. Reinforce back edge of treads using a continuous steel angle on underside.
   .4 Ladder shall be complete with 38 mm diameter, Schedule 40 pipe balustrades at maximum 1200 mm on centre. Cap exposed ends of all rails.
   .5 Finish and colour: Exterior steel coating in accordance with Section 09 97 13, in colour as selected by the Consultant.

.9 Vertical lockable ladder:
   .1 Fabricate ladder as shown on Contract Drawings complete with lockable panel and safety cage and in compliance with authorities having jurisdiction.
   .2 Fabricate aluminum ladders complete with stiffeners, rungs, angle rails, bent plate straps or angle brackets, lockable panel and safety cage.
   .3 Provide safety cage around ladder to meet Ministry of Labour requirements.
   .4 Lockable panel on ladder to prevent accessibility to unauthorized parties. Panel lock to be keyed to meet Owner's requirements.
   .5 Ensure panel is installed straight, smooth, plumb and free of wrinkles, buckles and defects in appearance.
   .6 Adjust ladder panel to provide smooth and efficient operation.
   .7 Finish and colour: Manufacturer's standard powder coat system, in colour as selected by the Consultant.
   .8 Retractable and lockable ladder as manufactured by Acklands Grainger or approved alternative.

10. Ladder rungs:
   .1 Provide galvanized steel ladder rungs in at concrete wall application as shown on Contract Drawings.
   .2 Fabricate ladder rungs from 19 mm diameter, intermediate grade, plain Hi-bond bars.
   .3 Rungs shall be 400 mm wide, spaced at 300 mm centres, projecting 150 mm clear from face of wall.
   .4 Finish and colour: Exterior steel coating in accordance with Section 09 97 13, in colour as selected by the Consultant.

11. Kick rail:
   .1 Provide galvanized steel components for kick rail consisting of steel square tubing, end caps and stainless steel cabling as indicated on Contract Drawings.
   .2 Ensure cabling is installed taut, rigid and secure.
   .3 Finish and colour: Exterior steel coating for galvanized steel components in accordance with Section 09 97 13, in colour as selected by the Consultant.

12. Barrier fence:
    .1 Lay out lines and establish elevations required for correct location and setting of fence posts, framing and fabric to suit Site contours.
    .2 Erect fence along lines as indicated on Contract Drawings and in accordance with CAN/CGSB-138.3 and reviewed shop drawings.
    .3 Auger post holes to depths and dimensions in accordance with CAN/CGSB-138.3. Form top 250 mm with concrete forms.
    .4 Space line posts maximum 3000 mm apart, measured parallel to ground surface.
    .5 Space straining posts at equal intervals 50 m maximum between end or corner posts on straight continuous lengths of fence and over smooth grade.
    .6 Install additional straining posts at changes in grade.
    .7 Install corner post where change in alignment exceeds 10^0.
    .8 Install end posts at end of fence and at structures and walls.
    .9 Embed posts into concrete and extend concrete 50 mm above ground level and slope to drain away from posts.
    .10 Brace posts in plumb position and true to alignment and elevation until concrete has set.
    .11 Do not install fence fabric until concrete has cured a minimum of 7 days.
    .12 Install brace between end posts and nearest line post, at inclination as indicated on Contract Drawings. Install braces on both sides of corner and straining post in similar manner.
    .13 Install post caps.
    .14 Install top rail between posts and fasten securely to posts and secure waterproof caps.
    .15 Install bottom tension wire, stretch tightly and fasten securely to end, corner, gate and straining posts with turnbuckles and tension bar bands. Place 150 mm from bottom of fabric.
    .16 Lay out fence fabric. Stretch tightly to tension recommended by manufacturer and fasten to end, corner, gate and straining posts with tension bar secured to post with tension bar bands spaced at 300 mm intervals. Knuckled selvage at bottom. Twisted selvage at top. Make closures by splicing fabric to form a continuous mesh.
    .17 Secure fabric to top rails, line posts and bottom tension wire with tie wires at 450 mm intervals. Give tie wires minimum two twists.
    .18 Powder coat finish and colour: Powder coat finish as specified, in colour as selected by the Consultant.

.13 Lintels: Fabricated from CAN/CSA-G40.20/G40.21-M, Grade 350W, size and location as shown, width to be not less than 25 mm less than width of wall and extend 200 mm beyond opening at each end. Unless otherwise shown, fabricate lintels in block walls of steel sections.

14. Masonry lateral support angles:
    .1 Supply only, to Section 04 20 00 for installation, all horizontal lateral support anchors at top of non-load-bearing masonry walls.
    .2 Refer to Structural Drawings for size and spacing of required support anchors. Provide drilled holes as required for anchorage.
    .3 Galvanized finish.

.15 Tubular steel door frames:
- .1 Structural tubular steel door frame sections as shown on Contract Drawings, with joints welded and ground smooth. Supply anchors for anchorage to wall as required.
- .2 Coordinate with Section 08 11 13 as required for sizing and installation with extra heavy duty hollow metal door.
- .3 Finish and colour: Exterior steel coating in accordance with Section 09 97 13, in colour as selected by the Consultant.

.16 Steel plate cladding, channels and supports:
- .1 Provide minimum 6 mm thick galvanized steel plate cladding for Habitat 2 access tower location as shown on Contract Drawings, complete with HSS channels and supports as required.
- .2 Fabricate and install plate cladding and supports in accordance with reviewed shop drawings.
- .3 Fabricate plate cladding flat, true, free of marks, without visible distortion and with edges straight and true. Make all planes true, and corners square and bend of minimum radius.
- .4 Install plates plumb, true, square, straight, level and accurate to sizes detailed, free from distortion or defects detrimental to appearance or performance.
- .5 Finish and colour: Exterior steel coating in accordance with Section 09 97 13, in colour as selected by the Consultant.

.17 Vertical and horizontal chutes (Habitat 2):
- .1 Provide chute assemblies as shown on Contract Drawings, complete with black coloured stainless steel rope mesh, cabling, steel pipes, tubing, bars, channels, pipe rails, tabs and additional components as indicated. Coordinate with Section 05 12 00 as required for sizing and installation with structural steel columns, tube trusses and additional components.
- .2 Install chute assemblies in accordance with reviewed shop drawings. Chute assemblies are to be installed plumb, true, square, straight, level and accurate to sizes detailed, free from distortion or defects detrimental to appearance or performance.
- .3 Ensure rope mesh is installed taut, rigid and secure.
- .4 Finish and colour: Exterior steel coating for galvanized steel components in accordance with Section 09 97 13, in colour as selected by the Consultant.

.18 Bollards (protection posts):
- .1 Provide galvanized steel bollards as indicated on drawings. Posts to be 250 mm diameter with a wall thickness of 8 mm. Place posts into a 1500 mm foundation, fill with 20 Mpa concrete and round top. Project pipes 1500 mm above finished grade.
- .2 Finish and colour: Exterior steel coating in accordance with Section 09 97 13, in colour as selected by the Consultant.

.19 Orangutan pole feeders:
- .1 Provide heavy duty winch driven cable and pulley galvanized steel pipe feeders, casings and shafts as shown on Contract Drawings and to meet Project requirements.
- .2 Provide all galvanized metal components and corrosion resistant hardware as required for pole feeder assembly. Sizes as shown.
- .3 Fabricate and install pole feeders in accordance with reviewed shop drawings and to the satisfaction of the Owner.
- .4 Adjust hardware for smooth and efficient operation of pole feeder unit.
- .5 Finish and colour: Exterior steel coating in accordance with Section 09 97 13, in colour as selected by the Consultant.

.20 Miscellaneous steel brackets, supports and angles
- .1 Supply and install or supply for installation by trades responsible, all loose steel brackets, supports and angles where indicated, except where such brackets, supports and angles are specified under work of other Sections. Drill for countersunk screws, expansion anchors and anchor bolts.
- .2 Unless otherwise specified, galvanized finish.

2.4 STAINLESS STEEL WORK

.1 Take all necessary precautions to safeguard against latent surface discolouration due to disturbance of the natural protective oxide coating of the material or to contamination from other sources.

.2 Workmanship shall be the best standard practice for this type of work. Execute stainless steel work in accordance with the applicable instructions set forth in Atlas Stainless Steels' "Technical Data" handbook on stainless steel.

.3 Do all stainless steel fabrication in clean shops, located away from areas where carbon steel is burnt, ground, or cut with abrasive wheels to ensure that carbon steel dust will not be embedded into the stainless steel, and as follows:
- .1 In fabrication of stainless steel do not use tools and dies which have been used on carbon steels.
- .2 Ensure tools and dies use for forming and cutting stainless steel are free of nicks and other damage.
- .3 Do not use carbon grits and grinding wheels which will imbed foreign particles into stainless steel surfaces. Use only stainless steel wool when wool polishing is required.
- .4 Stainless steel items, on which rust stains appear, shall be replaced with new fabricated material.

2.5 ANCHORS AND FASTENING

.1 Use weld studs of size not larger than 10 mm for attaching miscellaneous materials and equipment to building steel. If weight of item requires larger fasteners use clips or brackets and secure by welding or through bolting.

.2 Use self drilling expansion type concrete anchors for attaching to masonry and concrete

.3 Do not secure items to decks.

.4 Use steel beam clamps of two bolt design to transmit load to beam web. Do not use C and I clamps.

2.6 **WELDING**

.1 Perform welding by electric arc process.

.2 Execute welding to avoid damage or distortion to Work. Execute welding in accordance with following standards:
- .1 CSA W48 - for Electrodes. If rods are used, only coated rods are allowed.
- .2 CSA W59-M and CSA W59S1-M for design of connections and workmanship.
- .3 CAN/CSA W117.2-M - for safety.

.3 Thoroughly clean welded joints and expose steel for a sufficient distance to perform welding operations. Finish welds smooth. Supply continuous and ground welds which will be exposed to view and finish paint.

.4 Test welds for conformance and remove work not meeting specified standards and replace to Consultant's acceptance.

2.7 **SHOP PAINTING**

.1 Clean steel to SSPC SP6 and remove loose mill scale, weld flux and splatter.

.2 Shop prime steel with one coat of primer paint to dry film thickness of 0.07 mm. Paint on dry surfaces, free from rust, scale, grease. Do not paint when temperature is lower than 7 deg C. Paint items under cover and leave under cover until primer is dry. Follow paint manufacturer's recommendations regarding application methods, equipment, temperature, and humidity conditions.

.3 Clean but do not paint surfaces being welded in field.

.4 Do not paint surfaces embedded in concrete, but clean as if they were to be primed.

.5 Do not prime steel to be fireproofed or to receive intumescent paint coating.

.6 Do not prime machine finished surfaces, but apply an effective anti-rust compound.

.7 Take precautions to avoid damage to adjacent surfaces.

2.8 **POWDER COAT FINISH**

.1 Shop apply electrostatic coating in strict accordance with manufacturer's written instructions.

.2 Provide primer where required and one finish coat.

.3 Ensure application of each coat into all corners, pinholes and other difficult areas and ensure full coverage to all surfaces.

.4 Ensure a smooth finish, free of laps, sags, runs, pin holes, crawls and skips. Back lap all edges to achieve full coverage.

2.9 **HOT DIP GALVANIZING**

.1 After fabrication, hot dip galvanize specific miscellaneous steel items as indicated. After galvanizing, plug relief vents air tight with appropriate aluminum plugs as suitable and required for intended metal fabricated item. Straighten shapes and assemblies true to line and plane after galvanizing. Repair damaged galvanized surfaces with zinc rich primer in accordance with manufacturer's printed directions.

.2 Hot-dip galvanize members in accordance with requirements of the following ASTM, with minimum coating weights or thicknesses as follows:

.1 Rolled, pressed and forged steel shapes, plates, bars and strips: ASTM A123; average weight of zinc coating per square/metre of actual surface, for 4.8 mm and less thickness members 600 g/m^2 for 6 mm and heavier members 640 g/m^2.

.2 Iron and steel hardware: ASTM A153; minimum weight of zinc coating, in ounces per square foot of surface, in accordance with ASTM A153,Table 1 for the various classes of materials used in the Work.

3 Execution

3.1 **EXAMINATION**

.1 Examine previously installed Work, upon which this Section depends, verify dimensions and condition of existing Work, and coordinate repairs, alterations, and rectification if necessary. Commencement of work of this Section is deemed to signify acceptance of existing, prior conditions.

.2 Obtain Consultant's written approval prior to field cutting or altering of structural members.

3.2 **ERECTION**

.1 Install metal fabrications in accordance with reviewed shop drawings and manufacturer's written instructions.

.2 Fit joints and intersecting members accurately. Make work in true planes with adequate fastenings. Build and erect work plumb, true, square, straight, level and accurate to sizes detailed, free from distortion or defects detrimental to appearance or performance.

.3 Perform drilling of concrete and steel as required to fasten work of this Section.

.4 Erect rails in true vertical and horizontal planes, rigid, and free from whip.

.5 Continuously weld connections for railings, and anchor directly to steel stringers.

3.3 **TOUCH UPS**

.1 Paint bolt heads, washers, nuts, field welds and previously unpainted items. Touch up shop primer damaged during transit and installation, with primer to match shop primer.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Design, labour, Products, equipment and services necessary for the wire mesh panel and door work in accordance with the Contract Documents.

.2 Work of this Section shall include the following:
.1 Mesh enclosures including ceiling, wall and vestibule enclosure panels.
.2 Mesh swing, sliding and guillotine doors.
.3 Associated framing and supports for panels and doors.
.4 Orangutan puzzle feeders.

1.2 **REFERENCES**

.1 ASTM A123, Specification for Zinc (Hot Dip Galvanized) Coatings on Iron & Steel Products.

.2 ASTM A153, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

.3 ASTM A392, Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.

.4 ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.

.5 ASTM F3125/F3125M, Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength.

.6 CAN/CSA-G40.20/G40.21-M, General Requirements for Rolled or Welded Structural Quality Steel/ Structural Quality Steels.

.7 CAN/CSA S16.1-M, Limit States Design of Steel Structures.

.8 CSA S136.1-M, Commentary on CAN/CSA S136-M, Cold Formed Steel Structural Members.

.9 CSA W47.1, Certification of Companies for Fusion Welding of Steel Structures.

.10 CSA W48, Filler Metal and Allied Materials for Metal Arc Welding.

.11 CSA W59-M, Welded Steel Construction (Metal Arc Welding).

.12 CAN/CSA W117.2-M, Safety in Welding, Cutting and Allied Processes.

.13 NAAMM, The National Association of Architectural Metal Manufacturers.

1.3 DESIGN REQUIREMENTS

.1 Design details and connections, where not shown on Drawings, in accordance with CAN/CSA-S16.1 and CSA S136.1.

1.4 SUBMITTALS

.1 Product data: Submit manufacturer's Product data in accordance with Section 01 33 00 indicating compliance with reference standards, transportation, storage, handling and installation requirements.

.2 Shop drawings:
- .1 Submit shop drawings for fabrication and erection of wire mesh panels and doors in accordance with Section 01 33 00 indicating:
  - .1 Materials, core thicknesses, class of finish (AMP 555), connections, joints, method of anchorage, number of anchors, supports, reinforcement, details, and accessories.
  - .2 Ensure shop drawings are of one uniform size and based on field measurements.
  - .3 Detailed drawings for sliding and guillotine doors, hardware and locking mechanisms.
  - .4 Door locations, sizes, hardware quantities required, and mounting heights of each type of hardware.

.3 Samples:
- .1 Submit samples in accordance with Section 01 33 00 of the following:
  - .1 One 600 x 600 mm of each wire mesh type demonstrating material, opening, finish, showing typical termination conditions, typical welded connections, and other pertinent construction components.
  - .2 Each hardware item for each type of door. Tag samples identifying applicable Specification article number, brand name and number, finish, building location, date and catalogue number.
  - .3 Do not order hardware until samples have been accepted. Submit new samples to replace rejected samples. Supply hardware and finishes identical to each accepted sample.

.4 Certificates: Submit fabricator and installer qualification data for the Consultant’s review.

.5 Closeout submittals:
- .1 Submit the following in accordance with Section 01 78 23 for each Product for incorporation into Operation and Maintenance Manual:
  - .1 Maintenance data.
  - .2 Operating instructions and safety precautions.
  - .3 Parts list with name and address of supplier.
  - .4 Lubrication schedule and type of lubricant recommended.
  - .5 Keys, tools and special devices.
  - .6 Inspection procedures related to preventive maintenance.

1.5 QUALITY ASSURANCE

.1 Reference photographs: Sliding and guillotine mesh door hardware to be similar to types and layout as shown in reference photographs appended to this Section.

.2 Fabricator's and installer's qualifications: Qualifications for companies not listed in this Section are as follows:
- .1 Perform work of this Section by a company having a minimum of ten years experience in metal work of this type, plus a minimum of three similar projects involving containment of animals.
- .2 Companies requesting consideration shall submit written and photographic proof of previously performed projects.

.3 Retain a Professional Engineer, licensed in the Province of Ontario, with experience in work of comparable complexity and scope, to perform the following services as part of the work of this Section:
- .1 Design wire mesh panel enclosures and door assemblies.
- .2 Review, stamp, date and sign shop drawings.

.4 Workmanship: Fabricate work of this Section to meet the required class of workmanship indicated below in accordance with NAAMM's AMP 555, Section 8.
- .1 Class 1: for use on direct exposed to view fabricated items:
  - .1 Exposed surfaces are finished smooth with pitts, mill marks, nicks, burrs, sharp edges, and scratches filled or ground off. Defects should not show when painted, polished, or finished.
  - .2 Welds should be concealed where possible. Exposed welds are ground to small radius with uniform sized cove unless otherwise noted.
  - .3 Distortions should not be visible to the eye.
  - .4 Exposed joints are fitted to a hairline finish.

.5 Execute welding by firms certified in accordance with CSA W47.1 Division 1 or 2.1. Ensure welding operators are licensed per CSA W47.1 for types of welding required by Work.

1.6 DELIVERY, STORAGE, AND HANDLING

.1 Deliver hardware to Site packaged, labelled and its scheduled installation location.

.2 Accept Products of this Section on Site and ensure that each item is undamaged.

.3 Catalogue and store hardware in secure area.

1.7 SITE CONDITIONS

.1 Prior to submission of shop drawings, the mesh work Subcontractor shall verify that all field measurements are as indicated on Drawings, and notify the Consultant in writing of any major discrepancies. No fabrication shall proceed until all inconsistencies are corrected.

.2 Established dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating metal fabrications without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions. Caging not fitting the conditions as detailed and specified shall be rejected and replaced at no cost to the Owner.

1.8 **COORDINATION**

.1 Contractor shall coordinate with the finish hardware requirements to provide for smooth operation with minimal efforts as approved by the Owner and Consultant. Any conditions detrimental to door operation as specified shall be brought to the attention of the Consultant prior to fabrication.

.2 Coordinate with concrete and masonry trades for installation details required.

.3 Secondary containment areas: Contractor shall be responsible to maintain the joints, attachments, and clearances to equal the detailed dimensions and connections required for the primary enclosure unless otherwise noted.

2 Products

2.1 **ACCEPTABLE FABRICATORS**

.1 Mesh work:
- .1 A Thru Z Consulting and Distributing, Inc.
- .2 Thermeq Company.
- .3 LGL Animal Care Products, Inc.

2.2 **MATERIALS**

.1 General:
- .1 All materials under work of this Section, including but not limited to, primers and paints are to have low VOC content limits.
- .2 Unless detailed or specified herein, standard products will be acceptable if construction details and installation meet intent of Drawings and Specifications.
- .3 Include all materials, products, accessories, and supplementary parts necessary to complete assembly and installation of work of this Section.
- .4 Incorporate only metals that are free from defects which impair strength or durability, or which are visible. Install only new metals of best quality, and free from rust or waves and buckles, and that are clean, straight, and with sharp defined profiles.

.2 Galvanized structural shapes, plates, and similar items: CAN/CSA-G40.20/G40.21-M, Grade 350W. Hollow structural sections: CAN/CSA-G40.20/G40.21-M, Grade 350W, Class H.

.3 Galvanized sheet steel: ASTM A653/A653M Grade A, Z275 Commercial Quality zinc coating, size and shape as shown.

.4 Galvanized wire mesh panel and door assemblies:
- .1 Woven wire crimped mesh with galvanized after weld finish.
- .2 Size of wire mesh to be 50 x 50 mm, unless otherwise indicated.
- .3 Mesh to be complete with framing, supports and fasteners as specified herein.
- .4 Mesh gauges as follows:
  - .1 Vertical wall panels: 5 mm (6 ga.).
  - .2 Doors: 5 mm (6 ga.).
  - .3 Ceilings (accessible to orangutans): 5 mm (6 ga.).
  - .4 Ceilings (inaccessible to orangutans): 3.4 mm (10 ga.).
  - .5 Vestibule enclosure (inaccessible to orangutans): 3.4 mm (10 ga.).
- .5 Joints are to be continuously welded on animal side and ground smooth and with no ends typical.
- .6 Galvanized finish: Weight of metallic (zinc) Coating conforming to ASTM A 392, Type II, Class 2, 610 g/sq. m. with zinc coating applied before weaving.

.5 Steel cover plate: 3.4 mm (10 ga.) thick galvanized steel sheet. Pre-drill for fasteners.

.6 Cords and wires: Heavy duty, galvanized steel, sized to suit intended application.

.7 Welding materials: CSA W48 and CSA W59-M.

.8 Exposed mechanical fastenings:
- .1 Typical: Flush countersunk torx or hex socket machine screws and bolts; stainless steel finish; unobtrusively located; consistent with design of component, except where specifically noted otherwise. Fasteners, bolts, nuts, and washers: ASTM F3125/F3125M; all bolts, machine screws and fasteners shall be Type 316 stainless steel.
- .2 Ceilings: Ceiling mesh to be secured with recessed allen screws to rafter above; unobtrusively located; consistent with design of component, stainless steel finish and conforming to ASTM F3125/F3125M.

.9 Galvanized primer paint: Inorganic zinc rich primer. For use on galvanized fabrications where touch up is to remain unpainted in finished work; Carbozinc 11WB by Carboline Company, Catha-Coat 305 by Devoe Coatings or Zinc Clad XI by Sherwin Williams.

.10 Door hardware and locking mechanisms for swing, sliding and guillotine mesh doors:
- .1 Metal finishes: Free from defects, clean, unstained and of a uniform colour for each type of finish required.
- .2 Sliding and guillotine door hardware and locking mechanisms to be heavy duty type, cable drive operator with spring loaded pin and to match reference photographs appended to this Section.
- .3 Hardware to include tracks, pulleys and cables in animal spaces with steel casing covers.

.4 Hardware to include exterior tracks and operators with steel covers for weather and snow protection.

.5 Hardware to be complete with all components and accessories as required for complete, secure and safe installation and to meet Owner's Project requirements.

.6 Ensure that hardware selected will function correctly, meets Contract requirements and Ontario Building Code and authorities having jurisdiction.

.7 Mortise lock/latch and strike boxes: 3 mm thick galvanized steel sheet, galvanized with door/gate frame, pre-drilled for latch/strike installation. Box shall fully enclose mortise lock mechanisms with removable mortise face by mortise manufacturer.

.8 Keying: Coordinate all keying with the Owner's Representative and the requirements of Section 08 70 00.

.11 Polycarbonate panels: In accordance with Section 08 45 13.

.12 Medical port: Fabricate 450 x 450 mm lockable painted and galvanized steel medical port for blood sleeve to match Owner's standard, complete with cover and padlock. Colour of painted port as selected by the Consultant.

.13 Anchor bolt system: Countersunk flathead hex socket, stainless steel finish, for installation in monolithic concrete, sizes as shown, complete with all components required for a complete installation; 'Kwik-Bolts' by Hilti Ltd. or approved alternative by ITW Construction Products.

.14 Puzzle feeders: Fabricate two (2) 300 x 600 mm galvanized steel mesh and steel plate puzzle feeders as shown on Contract Drawings and to match Owner standards.

2.3 FABRICATION

.1 Fabricate wire mesh panels and doors in accordance with reviewed shop drawings, manufacturer's written instructions and to meet Owner's Project requriements.

.2 Verify dimensions of existing Work before commencing fabrications and report any discrepancies to the Consultant.

.3 Fabricate work free from defects impairing function, appearance, strength and durability.

.4 Carefully make and fit details. Take special care with exposed finished work to produce a neat and correct appearance to the Consultant's acceptance.

.5 Fabricate items with joints tightly fitted and secured. Make exposed joints butt tight, flush, and hairline.

.6 All oversized holes required for fabrication shall be welded and plugged. No holes, cavities or other voids, will be acceptable, unless specifically designed into the caging system.

.7 Continuously seal joined members by continuous welds.

.8 Fit and shop assemble in largest practical sections, for delivery to site.

.9 Grind exposed welds flush and smooth with adjacent finished surface. Ease exposed edges to small uniform radius of 3 mm. Radius all comers to 6 mm.

.10 Provide weep holes in closed HSS sections, 10 mm diameter.

.11 Galvanized wire mesh panel and door assemblies: Refer to drawings for panel assembly and door components fabricated as follows:

.1 Wall and ceiling panels:

.1 Woven wire crimped mesh with galvanized after weld finish.

.2 Wall panel mesh to be secured with continuous 5 mm x 25 mm compression bar and 6 mm diameter Tek Hex headed screws at 150 mm o.c. to each frame member on the animal side of frames.

.3 Ceiling panel mesh to be secured with recessed allen screws to rafters as specified herein.

.4 Frame walls and ceiling panels are composed of HSS steel as indicated on the drawings, with joints welded continuously on animal side and ground smooth, and with no open ends typical.

.5 Anchor HSS frame to slab with shim space and with minimum of two (2) anchor bolts adjacent to each HSS post connected to slab through the frame base angle detailed.

.6 At angle frames, connect the sill member to slab with shim space and anchor bolts spaced at 600 mm on center minimum.

.7 Provide continuous mesh with joints only if unavoidable and if supported continuously by metal frame members.

.8 Provide 10 mm weeps in lower horizontal member HSS at 600 mm on center in the bottom of enclosed HSS sections.

.2 Steel mesh doors:

.1 Provide all mesh door types required for Work of this Project including swing, guillotine and sliding doors as scheduled.

.2 Frame: 38 x 38 x 3 mm HSS steel, mitred and welded continuously.

.3 Wire mesh panels continuously welded to frame, G90 galvanized after fabrication.

.4 Provide mechanically attached polypropylene door guides in guide tracks to prevent metal to metal contact. Door tracks shall be as detailed.

.3 Coordinate with Section 08 45 13 as required for sizing and installation of polycarbonate glazing panels used in conjunction with mesh work.

.12 Medical port: Fabricate medical port in wire mesh training wall as shown on Contract Drawings, complete with galvanized steel framing.

.13 Feeders: Fabricate puzzle feeders as specified herein, as shown and to match Owner's standards.

2.4 **WELDING**

.1 Perform welding by electric arc process.

.2 Execute welding to avoid damage or distortion to Work. Execute welding in accordance with following standards:
- .1 CSA W48 - for Electrodes. If rods are used, only coated rods are allowed.
- .2 CSA W59-M and CSA W59S1-M for design of connections and workmanship.
- .3 CAN/CSA W117.2-M - for safety.

.3 Thoroughly clean welded joints and expose steel for a sufficient distance to perform welding operations. Finish welds smooth. Supply continuous and ground welds which will be exposed to view.

.4 Test welds for conformance and remove work not meeting specified standards and replace to Consultant's acceptance.

2.5 **HOT DIP GALVANIZING**

.1 After fabrication, hot dip galvanize specific miscellaneous steel items as indicated. After galvanizing, plug relief vents air tight with appropriate aluminum plugs as suitable and required for intended metal fabricated item. Straighten shapes and assemblies true to line and plane after galvanizing. Repair damaged galvanized surfaces with zinc rich primer in accordance with manufacturer's printed directions.

.2 Hot-dip galvanize members in accordance with requirements of the following ASTM, with minimum coating weights or thicknesses as follows:
- .1 Rolled, pressed and forged steel shapes, plates, bars and strips: ASTM A123; average weight of zinc coating per square/metre of actual surface, for 4.8 mm and less thickness members 600 g/m^2 for 6 mm and heavier members 640 g/m^2.
- .2 Iron and steel hardware: ASTM A153; minimum weight of zinc coating, in ounces per square foot of surface, in accordance with ASTM A153,Table 1 for the various classes of materials used in the Work.

3 Execution

3.1 **EXAMINATION**

.1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.2 INSTALLATION

.1 Install wire mesh panels, doors and hardware in accordance with reviewed shop drawings, manufacturer's written instructions and to meet Owner's Project requirements.

.2 Perform field welding in accordance with CSA A59.

.3 Fit joints and intersecting members accurately.

.4 Make work in true planes with adequate fastenings.

.5 Perform drilling of concrete and steel as required to fasten work of this Section.

.6 Install mesh work plumb, true, square, straight, level and accurate to sizes detailed, at correct elevation and free of wrinkles, buckles, distortion or defects detrimental to appearance or performance.

.7 Erect mesh enclosures plumb, level, straight, rigidly supported, and securely fastened to abutting surfaces, free from superimposed loads.

.8 Mesh doors and door hardware:
- .1 Install doors and hardware and adjust as required for proper closing, locking, smooth and balanced operation.
- .2 Lubricate hardware if required by manufacturer's instructions.

.9 Ports and feeders: Install ports and feeders in accordance with reviewed shop drawings and to the satisfaction of the Owner.

.10 Remove all sharp edges, burrs, corners and slivers which, in the opinion of the Consultant or Owner, could injure animals or caregivers.

3.3 CLEANING

.1 Remove wrappings at completion of the Project and clean hardware in accordance with manufacturer's instructions.

.2 Clean mesh panels and doors.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for rough carpentry work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM A153, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

.2 ASTM A325, Specification for Bolts Quenched/Tempered Steel Nominal Thread Diameter M16 - M36 For Structural Steel Joints.

.3 ASTM A653, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

.4 ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

.5 ASTM F1667, Driven Fasteners: Nails, Spikes and Staples.

.6 AWPA Standards, American Wood Protection Association.

.7 CAN/CSA O80 Series M, Wood Preservation.

.8 CSA O121-M, Douglas Fir Plywood.

.9 CAN/CSA O141, Softwood Lumber.

.10 CSA O151-M, Canadian Softwood Plywood.

.11 NLGA, Standard Grading Rules for Canadian Lumber, National Lumber Grades Authority

1.3 **SUBMITTALS**

.1 Product data:
.1 Submit copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
.1 Manufacturer's instructions for use, including requirements for storage, cutting, and finishing.

.2 Certificates: Preservative treatment certification; treating plant's certification of compliance with specified standards, process employed, and preservative retention values.

1.4 **QUALITY ASSURANCE**

.1 Source quality: Obtain treated wood products from a single approved source.

.2 Independent third party inspection: Provide plant inspections.

.3 Preservative treatment:
- .1 Exposed wood components: Each piece of pressure treated lumber shall be shop marked with the pressure treatment brand in accordance with AWPA requirements.
- .2 Concealed wood components: Each piece of pressure treated lumber shall be shop marked with the pressure treatment brand in accordance with CAN/CSA O80-M.

.4 Kiln Dry After Treatment (KDAT):
- .1 Provide kiln dry material as indicated or required for the Project.
- .2 Kiln dry after treatment to 19 percent maximum moisture content for lumber and 18 percent for plywood in accordance with AWPA T1.

.5 Lumber identification: Grade stamp of an agency certified by the Canadian Lumber Standards Accreditation Board.

.6 Plywood identification: Grade mark in accordance with applicable CSA standards.

.7 Lumber quality: Carefully select individual pieces so that knots and obvious defects will not interfere with placing bolts, proper nailing or making proper connections.

.8 Moisture content of wood at time of construction shall be 19% maximum.

.9 Each piece of fire retardant treated lumber shall be shop marked with the ULC monogram in accordance with CAN/CSA O80-M.

10. Dimensions of lumber shall conform to dressed sizes specified in CAN/CSA-0141 unless actual dimensions are otherwise indicated or specified.

11. Dimensional references to lumber on Drawings and in Specifications are to nominal sizes unless actual dimensions are indicated. Such actual dimensions shall be dry size.

.12 Lumber defects: Discard wood with defects which will render a piece unable to serve its intended function. Lumber will be rejected by Consultant for excessive warp, twist, bow, crook, mildew, fungus, or mould, as well as for improper cutting and fitting, whether or not it has been installed.

1.5 **ENVIRONMENTAL REQUIREMENTS**

1. When it is required that wood maintain dimensional stability and tolerances to ensure accurate installation of later work, store and install it only in dry areas, and where no further installation of moist materials is contemplated.

1.6 **DELIVERY, STORAGE AND HANDLING**

.1 Store materials in a dry area. Cover materials with tarpaulins or polyethylene sheets to prevent moisture absorption and impairment of structural and aesthetic properties. Vent to allow air movement. Tie covering to keep in place.

.2 Protect wood products against moisture and dimensional changes in accordance with instructions from preservative treating plant.

1.7 **EXTENDED WARRANTY**

.1 Manufacturer's warranty: Provide manufacturer's standard lifetime limited warranty for pressure treated wood.

2 Products

2.1 **MATERIALS**

.1 General:
- .1 All materials under work of this Section, including but not limited to, adhesives are to have low VOC content limits.
- .2 Adhesives - Urea-formaldehyde-free glues.
- .3 All dimensional lumber, plywood and sheathing to be FSC certified.

.2 Lumber: Softwood, G4S, moisture content 19% or less at time of installation, in accordance with the following:
- .1 Lumber shall be of same species and grade, equally seasoned and shall be processed and stamped at same mill.
- .2 CSA O141 and NLGA Standard Grading Rules for Canadian Lumber.
- .3 Board quality: Construction or better.
- .4 Dimension quality:
  - .1 Structural joists, planks, and framing: No. 1 Select Structural.
  - .2 Light framing: Construction.

.3 Plywood: CSA O121-M, G1S, T & G, standard construction, laminated with waterproof adhesive, exterior grade, Thickness as indicated on drawings.

4. Sheathing: Douglas Fir, CSA 0121-M or CSA O151-M; Select-Tight Face, exterior grade, T & G.

.5 Roof lumber: NLGA, Construction grade light framing, Jack Pine, S4S, pressure treated to CAN/CSA-O80 series using copper based waterborne preservative treatment, impregnated to a net retention of 4 kg/ m^3 of preservative unless otherwise specified by preservative manufacturer.

.6 Fire retardant treatment of lumber and plywood (interior and protected locations): 'Dricon FRT' fire retardant treatment by Biewer Lumber or approved alternative, conforming to ASTM E84, to provide a flame spread rating of 25 or less.

.7 Rough hardware: Conforming to ASTM F1667; Nails, bolts, screws, anchors, expansion shields, and other fastenings required to frame and fix rough carpentry as follows:
- .1 Nails, spikes and staples: Spiral type.
- .2 Bolts: ASTM A325; 12.7 mm diameter minimum with nuts and washers unless noted otherwise.
- .3 Screws: Countersunk head, full thread type.
- .4 Proprietary fasteners: Toggle bolts, expansion shields, lag bolts, screws, inorganic fibre plugs, recommended for purpose by manufacturer.
- .5 Galvanize rough hardware used in fire treated wood and hardware exposed to the atmosphere.

.8 Fasteners for use in pressure treated wood:
- .1 For treated wood and where wood is in ground contact, subject to high relative humidity, or exposed to weather, provide the below specified fasteners.
- .2 Provide hot dipped galvanized fasteners complying to ASTM A153 and connectors in accordance with ASTM A653, Class G185 for non-structural members.
- .3 Provide Type 316 stainless steel fasteners and connectors for use in Structural, pressure treated wood.

2.2 PRESERVATIVE TREATMENTS

.1 Preservative treatment - for above ground use:
- .1 For use on wood components that are exposed to view such as but not limited to decking, fencing, and handrails.
- .2 Treatment: Water-based wood preservative, 'Preserve Alkaline Copper Quaternary (ACQ)' in accordance with AWPA U1, AWPA P5 and P26-29 as required, using 2.4 kg/m^3 of said preservative treatment as required.
- .3 Treat wood in the following locations:
  - .1 In contact with masonry or concrete.
  - .2 Within 450 mm of grade.
  - .3 Exposed to weather.
  - .4 Other locations indicated.

.2 Preservative treatment - ground contact:
- .1 For use on wood components that are exposed to view such as but not limited to fence posts.
- .2 Treatment: Water-based wood preservative, 'Preserve Alkaline Copper Quaternary (ACQ)' in accordance with AWPA U1, using 6.4 kg/m^3 of specified preservative treatment as required and same value for retention.
- .3 If required, kiln dry after treatment to 19 percent maximum moisture content for lumber and 18 percent for plywood.
- .4 Treat wood in the following locations:
  - .1 In contact with ground.
  - .2 Used as posts.

.3 Surface applied wood preservative (concealed/protected applications): Green coloured copper napthenate or 5% pentachlorophenol solution, water repellant preservative or same copper based preservative as used for shop impregnation, in accordance with CAN/CSA O80.

3 Execution

3.1 **EXAMINATION**

.1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.2 **GENERAL**

.1 Lay out work carefully and to accommodate work of others. Cut and fit accurately: erect in position indicated by Drawings.

.2 Install rough carpentry to allow for expansion and contraction of the materials.

.3 Cut work into lengths as long as practicable and with square ends. Align, level, square, plumb, and secure work permanently in place. Brace work temporarily as required. Join work only over solid backing.

.4 Bore holes true to line and to same size as bolts. Drive bolts into place for snug fit, and use plates or washers for bolthead and nut bearings. Turn up bolts and lag screws tightly when installed, and again just before concealed by other work or at completion of Work.

.5 Provide anchors, bolts, and inserts required for attachment of the work of this Section, to those performing the work of other Sections and who are responsible for their installation.

.6 Do not attach work by wood plugs or blocking in concrete or masonry. Use lead shields, expansion shields, or similar methods only as approved by Consultant.

3.3 **MISCELLANEOUS WOODWORK**

.1 Fit and install wood furring, strapping, grounds and blocking. Adequately size, correctly place and conceal members for finishes, fitments and for work under other Sections. Do not assume that Drawings show required work exactly or completely. Anchor wood members securely in place.

.2 Install rough bucks, nailing strips and linings to rough openings as required for backing for frames and other work.

.3 Bolt wood blocking or nailing strips to steel framing.

.4 Align and plumb faces of furring and blocking to tolerance of 1:600.

.5 Use fire retardant lumber for blocking/framing in ceiling\spaces, partitions and bulkheads as required by authorities having jurisdiction.

3.4 **ROOF WOODWORK**

.1 Provide roof woodwork as required for trellis structure and metal roof application as required for the Work.

.2 Install continuous wood nailers around roof perimeters, curbs and roof openings larger than 150 x 150 mm, and at edges of insulation as detailed. Install cut cant strips and continuous nailers on copings and curbs as detailed.

.3 Install wood backing, dressed, tapered and recessed slightly below top surface of roof insulation and roof hopper.

.4 Fasten roof woodwork at maximum 400 mm o.c. in staggered pattern unless noted otherwise.

3.5 **ROOF SHEATHING**

.1 Install plywood roof sheathing with the surface grain at right angles to the roof framing.

.2 Install with a 1.6 mm gap between sheets. Nail to strapping with common spiral galvanized nails.

.3 Where panel-type sheathing requires edge support, the support shall be not less than 50 mm x 50 mm blocking securely nailed between framing members or metal H clips. The supports are not required when tongued-and-grooved edged plywood is used.

3.6 **FASTENERS**

.1 Frame, anchor, fasten, tie and brace members for required strength and rigidity.

.2 Unless otherwise indicated, use hot dipped galvanized fasteners for exterior work and work below grade.

.3 Countersink bolts and bolt heads as required for clearance of other work.

.4 Size fasteners to penetrate base member by half of fastener length minimum. Minimize splitting of wood members by staggering nails in direction of grain.

.5 For plywood use spiral, annular or resin coated nails and staples.

3.7 SURFACE-APPLIED WOOD PRESERVATIVE

.1 Surface treatment of field cuts:

- .1 Provide surface applied preservative treatment in accordance with manufacturer's written instructions and as specified herein.
- .2 All field cuts on members that provide structural support to a permanent structure shall be field treated in accordance with AWPA M4.
- .3 Treat raw surfaces, drilled holes and cut ends of pressure treated wood with 2 coats of wood preservative immediately after cutting.
- .4 Apply preservative by dipping, by brush or by pouring into plugged holes to completely saturate surface.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products equipment and services necessary for the exterior and interior finish carpentry work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 AAMA 2605, Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels - Series: Components, Coatings and Finishes.

.2 APA - The Engineered Wood Association.

.3 ASTM F1667, Driven Fasteners: Nails, Spikes and Staples.

.4 Architectural Woodwork Manufacturers Association of Canada (AWMAC).

.5 Architectural Woodwork Standards (AWS) - Quality Standards for Architectural Woodwork.

.6 National Hardwood Lumber Association (NHLA) Rules for the Measurement and Inspection of Hardwood and Cypress.

.7 National Lumber Grades Authority (NLGA) Standard Grading Rules for Canadian Lumber.

1.3 **DESIGN REQUIREMENTS**

.1 Exterior soffit system:
- .1 Design exterior wood soffit system to accommodate expansion and contraction of soffit elements without causing buckling, failure of joints, undue stress on fasteners or other effects detrimental to appearance or performance.
- .2 Design subframing as necessary for complete exterior soffit system installation.
- .3 Soffit system to be complete with all fascia, coves, vents and trims as required for complete installation.

.2 Open grid wood ceiling system:
- .1 Design open grid wood ceiling system in accordance to withstand live, dead, lateral, wind, seismic, handling, transportation, and erection loads.
- .2 Provide a complete suspension system for wood ceiling grid and to support ceiling loads.
- .3 Design for a safety factor of at least twice the anticipated load.
- .4 Design wood ceiling system to have a maximum deflection of l/360.
- .5 Design subframing as necessary for complete and secure installation.

.6 Suspension system indicated on Drawings are diagrammatic only and serves to indicate only the intended appearance and performance criteria.

.3 Ensure no sharp edges or similar features occur in finish carpentry items that will be exposed to orangutans and that would otherwise cause harm to said animals.

1.4 **SUBMITTALS**

.1 Shop drawings: Submit shop drawings of finish carpentry work in accordance with Section 01 33 00 indicating:
- .1 Materials, thicknesses, sizes, finishes, wood species, grades, profiles, connection attachments, shop jointing, field jointing, reinforcing, anchorage, fastener types and sizes, location of exposed fastenings, service outlets, cutout locations, and sizes.
- .2 Include erection drawings, plans, elevations, sections, and details as applicable.
- .3 Soffit system: Details, sections, dimensions, tolerances, connections, terminations, control joints, system components, installation sequence, accessories and other pertinent information required for proper and complete installation.
- .4 Open grid wood ceiling system: Suspension system including cable rods, inserts, framing, and supports for open grid wood ceiling system, including materials, layout and sizes, thicknesses, methodology of anchorage and connection attachments.
- .5 Complete design data to confirm that soffit and ceiling systems meet design requirements specified.
- .6 Wood handrails (orangutan artwork): Include 1:1 scale of orangutan artwork for wood handrails demonstrating size, shapes, details, sections and anchorage for Consultant's review.

.2 Samples: Submit samples of the following in accordance with the requirements of Section 01 33 00:
- .1 Two representative pieces of each type of wood to receive a stained or painted finish.
- .2 Two representative pieces of each type of wood finished as specified.
- .3 Two 600 long samples demonstrating animal shape engraving and carving of wood handrail, demonstrating workmanship, sizing, shapes, material and finish.
- .4 Two 300 mm long samples of soffit vent with insect mesh demonstrating material, colour and finish.

.3 Certificates: Provide millworker's qualification data for proof of compliance with this Section and for the Consultant's review.

1.5 **QUALITY ASSURANCE**

.1 Retain a Professional Engineer, licensed in Province of Ontario, with experience in work of comparable complexity and scope, to perform following services as part of work of this Section:
- .1 Design of open grid wood ceiling and associated suspension system.
- .2 Review, stamp, and sign Shop Drawings and design calculations.
- .3 Conduct shop and on-site inspections, prepare and submit written inspection reports verifying that this part of Work is in accordance with Contract Documents and reviewed Shop Drawings.

.2 Millworker's qualifications:
- .1 Execute work of this Section by member of AWMAC, with 5 years experience in finish carpentry work of comparable complexity and scope. Submit proof of experience upon Consultant's request.
- .2 Wood handrails (orangutan artwork): Execute handrail orangutan artwork of this Section by member of AWMAC, with 10 years experience in animal depiction/carving work of comparable complexity and scope and provide a list of five (5) reference sample projects where such carving work has been employed.
- .3 Submit proof of experience upon Consultant's request.

.3 Fabricate finish carpentry work in accordance with AWS Quality Standards, Premium Quality materials and installation unless otherwise indicated. Perform work in accordance with the definition of Good Workmanship as defined in the AWS Quality Standards.

.4 Remove and replace finish carpentry work which does not conform to the AWS Quality standards or as amended by these Specifications.

1.6 **DELIVERY, STORAGE, AND HANDLING**

.1 Deliver, store, and handle finish carpentry in accordance with the AWS Quality Standards. Control the temperature and humidity in accordance with the AWS recommendations, before, during, and after finish carpentry delivery, and also during storage and installation.

2 Products

2.1 **MATERIALS**

.1 General:
- .1 All materials under work of this Section, including but not limited to, adhesives and mastics, are to have low VOC content limits.
- .2 Adhesives - Urea-formaldehyde-free glues.
- .3 All exposed and concealed dimensional lumber, plywood and panels to be FSC certified.

.2 Concealed framing lumber and plywood:
- .1 Eastern Spruce, Balsam Fir, or Jack Pine, to CAN/CSA O141, NLGA, and AWS Custom Grade, S4S, average moisture content 7% +/- 2% at installation.
- .2 Softwood plywood: CSA O151-M; 19 mm unless indicated otherwise, (G2S).

.3 Hardwood lumber:
- .1 Conforming to NHLA and AWS Premium Grade, S4S, average moisture content 7% +/- 2% at installation.
- .2 Wood species:
  - .1 Provide Ironwood or IPE for woodwork accessible to orangutans as specified herein.
  - .2 Wood used for Work on this Project that is accessible to orangutans is to be weather and decay resistant and provided without harmful treatments or finishes.
- .3 Hardwood (Ironwood): Australian hardwood with Janka hardness of approximately 5,000 lbf. Wood shall be allowed to acclimatize prior to installation.
- .4 Hardwood (IPE): Brazilian hardwood with Janka hardness of approximately 3,700 lbf, naturally resistant to fire (Class A), 12% moisture content. Wood shall be allowed to acclimatize prior to installation.

.4 Softwood lumber:
- .1 FSC certified Cedar to NLGA Standard Grading Rules for Canadian Lumber, western red cedar, tongue and groove, sizes as shown.
- .2 Kiln dry planks to 15% maximum moisture content.

.5 Paint grade wood (interior): FSC paint grade wood, to NHLA and AWS Premium Grade, S4S, average moisture content 7% +/- 2% at installation. For use at window sill.

.6 Soffit vents:
- .1 Approximately 100 mm wide continuous, prefinished aluminum soffit vent with continuous insect screen.
- .2 Aluminum finish: 'Duranar (XL)' by PPG in accordance with AAMA 2605.
- .3 Colour: Vent and mesh colour to be selected by the Consultant.

.7 Nails: Conforming to ASTM F1667; Size and type to suit application, corrosion resistant stainless steel for exterior applications, galvanized for interior applications.

.8 Bolts, nuts, washers, blind fasteners, lags and screws: Size and type to suit application, corrosion resistant stainless steel for exterior applications and galvanized steel for interior applications.

.9 Fasteners for use in Ironwood and IPE wood: Provide Type 316 stainless steel fasteners.

.10 Adhesive and bituminous mastic: Selected by the millwork fabricator with low VOC content.

.11 Metal suspension system components:
- .1 Hanger wires and tie wire or suitable aircraft cable: Heavy duty, Type 316 stainless steel in length and diameter as required, complete with fittings as required for complete installation.
- .2 Anchors: Tie wire sleeve anchors, to suit application and meet intended design criteria.

.12 Miscellaneous metals: In accordance with Section 05 50 00.

.13 Preservative treatments: In accordance with Section 06 10 00.

.14 Finishing: In accordance with Section 09 91 00.

2.2 FABRICATION

.1 Finish carpentry work required by this Section is to include but not be limited to the following items:
- .1 Wood handrails at guardrails with orangutan artwork.
- .2 Wood slats at guardrails, sunshade structure and tree house roof.
- .3 Open grid wood ceiling.
- .4 Ironwood or IPE floor planks and wood components at orangutan climbing poles and platforms.
- .5 Cedar floor planks at visitor tree house.
- .6 Wood screens at windows and trellis.
- .7 Solid wood panels.
- .8 Cedar wood soffit complete with wood fascias, coves and built-in soffit vent with insect screen.
- .9 Interior wood sills.

.2 Be responsible for methods of construction and for ensuring that materials are rigidly and securely attached and will not be loosened by the work of other sections.

.3 Coordinate locations of concealed supports and blocking with other parts of work. Provide cutouts for fixtures.

.4 Fabricate work in a manner which will permit expansion and contraction of the materials without visible open joints. Conceal joints and connections in wherever possible.

.5 Set nails and countersink screws, apply wood filler to indentations, sand smooth and leave ready to receive finish.

.6 Finish millwork in accordance with Section 09 91 00. Finished millwork shall be free from bruises, blemishes, mineral marks, knots, shakes and other defects and shall be selected for uniformity of colour, grain and texture.

.7 Wood handrail:
- .1 Construct wood handrail to depict orangutan shapes and imagery as approved by the Owner.
- .2 Said style shall also serve as a means of preventing visitors from sitting on rails.
- .3 Orangutan artwork for rail to meet satisfaction of the Owner and shall be fabricated in accordance with reviewed shop drawings.
- .4 Ensure all edges of wood handrails are ground smooth and that would otherwise cause harm to visitors.

3 Execution

3.1 **EXAMINATION**

.1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.2 **INSTALLATION**

.1 Install finish carpentry work in accordance with AWS Quality Standards and tolerances for Architectural Woodwork and reviewed shop drawings.

.2 Set and secure finish carpentry in place, rigid, plumb, square, and level.

.3 Scribe and cut as required, fit to abutting walls, and surfaces, fit properly into recesses and to accommodate columns, fixtures, outlets, or other projecting, intersecting or penetrating objects leaving a 0.8 mm gap maximum.

.4 Coordinate cutouts for plumbing fixtures, inserts, outlet boxes, and other fixtures, in finish carpentry. Round internal corners of cut-outs and seal exposed cores.

.5 Form joints to conceal shrinkage.

.6 Apply bituminous coating over wood framing members in contact with masonry or cementitious construction.

.7 Wood handrail and slats:
- .1 Construct wood handrail and slats for guardrails as shown on Contract Drawings.
- .2 Round all corners, edges and ends of wood handrail.
- .3 Install handrail supports supplied under work of Section 05 50 00.

.8 Wood slats (orangutan tree house):
- .1 Construct Ironwood or IPE wood slats at orangutan tree house application for sunshade and tree house roof as shown on Contract Drawings.
- .2 Round all corners, edges and ends of wood slats to avoid harm to animals.
- .3 Fasten wood slats using corrosion resistant screws and ensure that fasteners installed do not pose harm to animals in the exhibit.

.9 Exterior wood soffit system and associated components:
- .1 Install exterior wood soffit and associated components in accordance with reviewed Shop Drawings and to meet requirements of authorities having jurisdiction and the satisfaction of the Consultant.
- .2 Exterior soffits and fascias: Use greatest length of material practicable. Locate joints as directed. Use Cedar wood. Appearance and finish of exterior wood soffit and components to meet Cedar wood siding provided under Section 07 41 23.
- .3 Install soffit system and components to prevent warping, buckling, and deformation induced by restriction of thermal induced movement.
- .4 Damaged wood panels, waviness, warp or distortion of finished work will not be accepted.
- .5 Completed installation shall be free from rattles, wind whistles, noise due to thermal movement and other noises.
- .6 Install continuous soffit vents in soffits as indicated on drawings to provide ventilation of concealed soffit spaces in accordance with OBC requirements.

.10 Open grid wood ceiling system:
- .1 Install wood ceiling components, ceiling suspension system and associated components in accordance with reviewed Shop Drawings, manufacturer's written instructions and to meet requirements of authorities having jurisdiction and the satisfaction of the Consultant.
- .2 Ensure wood ceiling grid is installed straight, level and plumb, securely fastened in true vertical and horizontal manner.
- .3 Remove and replace damaged, marked or stained planks as required or as requested by the Consultant.

.11 Wood floor planks (visitor tree house):
- .1 Provide Cedar wood for floor planks used at visitor tree house.
- .2 Machine nail fastening. Maintain tight joints and board ends.
- .3 Remove tool marks, bruises, and scratches.

.12 Wood floor planks/decking (orangutan tree house platforms at research station building):
- .1 Unless otherwise indicated, provide Ironwood or IPE wood for floor planks used at orangutan tree house platform. Planks to be sized at 75 x 100 mm (3" x 4") with maximum 15 mm spacing between planks.
- .2 Fasten floor planks using corrosion resistant screws. Maintain tight joints and board ends. Ensure no fasteners are protruding or that would harm animals in the exhibit.
- .3 Remove tool marks, bruises, and scratches.

.13 Wood components at climbing poles:
- .1 Provide Ironwood or IPE wood components for the climbing poles such as wood planks, posts, boards and frames as indicated on Contract Drawings.
- .2 Shade leaf: Provide Ironwood or IPE wood for planks used in shade leaf sized at 75 x 100 mm (3" x 4") with maximum 6 mm spacing between planks.
- .3 Aerial platforms: Provide Ironwood or IPE decking sized at 75 x 100 mm (3" x 4") with maximum 15 mm spacing between planks.
- .4 Nesting platforms:
  - .1 Provide Ironwood or IPE decking sized at 75 x 100 mm (3" x 4") with maximum 15 mm spacing between planks.
  - .2 Provide wood planks and boards to sizes and placed at intervals as indicated on Contract Drawings.
- .5 Fasten floor planks using corrosion resistant screws. Maintain tight joints and board ends. Ensure no fasteners are protruding or that would harm animals in the exhibit.
- .6 Remove tool marks, bruises, and scratches.

.14 Wood screens and solid panels:
- .1 Provide wood screens and solid panels as shown on Contract Drawings. Screen/solid panel configuration to be provided at window applications as shown.
- .2 Ensure that wood screens and solid panels are installed in straight lines, true, level, and plumb.
- .3 Finished work shall be securely anchored, free of distortion, free of surface imperfections and uniform in colour.

.15 Window sills:
- .1 Provide all painted wood window sills as indicated.
- .2 Conceal all fixings.
- .3 Provide all solid continuous blocking and shims required for installation.
- .4 Install window sills level, plumb and even in locations as indicated and ensure that sills are securely fastened.

.16 Fastening:
- .1 Position items of finished carpentry work accurately, level, plumb, true and fasten or anchor securely.
- .2 Design and select fasteners to suit size and nature of components being joined. Use proprietary devices as recommended by manufacturer.
- .3 Set finishing nails to receive filler. Where screws are used to secure members, countersink screw in round cleanly cut hole and plug with wood plug to match material being secured.

.17 Remove and replace damaged, marked, or stained finish carpentry.

3.3 **PROTECTION**

.1 Provide suitable, continuous covering protection for installed millwork and maintain until final cleaning.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for cold fluid applied waterproofing work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ACI-308, Guide to External Curing of Concrete.

.2 ASTM C920, Standard Specification for Elastomeric Joint Sealants.

.3 ASTM D4259, Standard Practice for Abrading Concrete.

.4 ASTM F2170, Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.

1.3 **SUBMITTALS**

.1 Product data:
- .1 Submit manufacturer's Product data in accordance with Section 01 33 00 indicating:
  - .1 Materials list of items to be provided under this Section.
  - .2 Manufacturer's specifications and other data needed to ensure compliance with the specified requirements including but not limited to installation details and physical properties.
  - .3 Manufacturer's current recommended installation procedures.

.2 Shop drawings:
- .1 Submit shop drawings in accordance with Section 01 33 00 indicating:
  - .1 Adjacent construction and typical details, dimensions, thickness, crack and joint treatment, method of attachment, protection and penetration details.
  - .2 Location of each membrane penetration.

.3 Certificates/reports:
- .1 Submit certifications for items required at least 4 weeks prior to installation of work of this Section.
- .2 Submit manufacturer's certification that waterproofing system materials and accessories supplied are compatible, meet Specification requirements and that installer is licensed/approved by membrane manufacturer.
- .3 Submit manufacturer's certification that waterproofing system components are approved for use as complete waterproofing system.
- .4 Submit Contractor's certification that waterproofing installers and quality control supervisors meet Specification requirements. Submit names of successful membrane installations in which certified personnel have performed tasks of comparable complexity and scope within preceding 5 years.

.5 Submit inspection reports and certification by manufacturer confirming that installations are in accordance with manufacturer's requirements.

1.4 **QUALITY ASSURANCE**

.1 Applicator qualifications:
- .1 Perform work of this Section by company, approved by Product manufacturer and having 5 years recent experience in Work of comparable complexity and scope.
- .2 Applicator shall have at written approval from the manufacturer as recommended for the installation of the waterproofing system.
- .3 Applicator shall designate a single individual as project foreman who shall be on site at all times during installation.

.2 Evaluate moisture content of cementitious substrate materials. Contractor shall determine substrate moisture content throughout the work and record with daily inspection reports or other form of reporting acceptable to the Owner, Consultant and membrane manufacturer.

.3 Evaluate surface moisture content by means of a Tramex Concrete Moisture Encounter Meter. A surface moisture content of under 5% is required to allow for proper primer penetration into the substrate.

.4 Frothing, bubbling, or pinholes within the primer indicates excessive moisture content within the substrate. Blistering of membrane may result from excessive substrate moisture. Primer application during late afternoon/early evening will reduce vapour pressure within the substrate and may alleviate these conditions.

.5 Continued frothing, bubbling, or pinholes indicates excessive moisture content that requires more substantial measures. Evaluate substrate moisture content by means of relative humidity (RH) probes in accordance with ASTM F2170. A relative moisture content of 75% or greater indicates the need for more extensive substrate priming and sealing.

.6 Random tests to determine tensile bond strength of membrane to substrate shall be conducted by the Contractor at the job site using an Elcometer Adhesion Tester Model 106 or similar device, or by the performance of a manual pull test. Contractor shall perform tests at the beginning of the Work, and at intervals as required to ensure specified adhesion with a minimum of three (3) tests per 5000 square feet. Smaller areas shall receive a minimum of three (3) tests. Test results shall be submitted to the Owner, Consultant and the membrane manufacturer. Contractor shall immediately notify the Owner, Consultant and membrane manufacturer in the event bond test results are below specified values.
- .1 Adequate surface preparation will be indicated by tensile bond strength of membrane to substrate greater than or equal to 220 psi (1.5 N/mm^2), as determined by use of an adhesion tester.
- .2 Adequate surface preparation will be indicated by 135 degree peel bond strength of membrane to substrate such that cohesive failure of substrate or membrane occurs before adhesive failure of membrane/substrate interface.

.3 In the event the bond strengths are less than the minimum specified, additional substrate preparation is required. Repeat testing to verify suitability of substrate preparation.

.7 Monitor quantities of installed materials. Monitor application of resin mixture, reinforcing fleece and flashing. Perform Work in accordance with manufacturer's instructions.

.8 Field inspection services: Manufacturer's technical representative shall provide the following inspections of the membrane application:
- .1 Job start inspection at the beginning of each phase of the project, to review special detailing conditions and substrate preparation.
- .2 Periodic in-progress inspections throughout duration of the project to evaluate membrane and flashing application.
- .3 Final punch-list inspection at the completion of each phase of the project prior to installation of any surfacing or overburden materials.
- .4 Warranty inspection to confirm completion of all punch list items, surfacing, and overburden application.

.9 Mock-up:
- .1 Construct one 2 m^2 mock-up of waterproofing system in a location acceptable to the Consultant. Show stages of application and crack and joint preparation and treatment.
- .2 Obtain Consultant's acceptance. Accepted mock-up may become part of the Work. Mark mock-up to Consultant's acceptance and match remainder of work to accepted mock-up. Remove unacceptable mock-up.

.10 Pre-installation meeting: Arrange with Consultant and manufacturer's representative to inspect substrates and review drawings and specifications affecting work of this Section, verify all conditions, review installation procedures, and coordinate scheduling with interfacing portions of the Work minimum one (1) week in advance of installation.

1.5 REGULATORY REQUIREMENTS

.1 Conform to applicable building and jurisdictional codes for waterproofing assembly and fire resistance requirements.

.2 Comply with requirements of local governing authority for work place safety.

.3 Comply with authority or agency "Confined Space Policy" during and throughout all work to be performed.

1.6 **DELIVERY, STORAGE, AND HANDLING**

.1 The Contractor together with the Owner or Consultant shall define a storage area for all components. The area shall be cool, dry, out of direct sunlight, and in accordance with manufacturer's recommendations and relevant regulatory agencies. Materials shall not be stored in quantities that will exceed design loads, damage substrate materials, hinder installation or drainage.

.2 Store solvent-bearing solutions, resins, additives, inhibitors or adhesives in accordance with the MSDS and/or local fire authority. After partial use of materials replace lids promptly and tightly to prevent contamination.

.3 Roll goods shall be stored horizontally on platforms sufficiently elevated to prevent contact with water and other contaminants. Do not use rolls that are wet, dirty or have damaged ends.

.4 Waterproofing materials must be kept dry at all times. If stored outside, raise materials above ground level on pallets and cover with a tarpaulin or other waterproof material. Plastic wrapping installed at the factory should not be used as outside storage covers.

.5 Follow manufacturer's directions for protection of materials prior to and during installation. Do not use materials that have been damaged to the point that they will not perform as specified. Fleece reinforcing materials must be clean, dry and free of all contaminants.

.6 Copies of all current MSDS for all components shall be kept on site. Provide any and all crew members with appropriate safety data information and training as it relates to the specific chemical compound they may be expected to deal with. Each crew member shall be fully aware of first-aid measures to be undertaken in case of incidents. Comply with requirements of local governing authority for work place safety.

1.7 **SITE CONDITIONS**

.1 Do not install the work of this Section outside of environmental range without Consultant's and Product manufacturer's written acceptance.

.2 Supply and install temporary protection and facilities to maintain Product manufacturer's, and above specification, environmental requirements before, during, and after installation.

.3 Do not apply waterproofing membrane during or with the threat of inclement weather.

.4 Application of cold fluid-applied reinforced polyurethane waterproofing membrane may proceed while air temperature is between 5°C and 30°C providing the substrate is a minimum of -15°C above the dew point.

.5 When ambient temperatures are at or expected to fall below 10°C, or reach 30°C or higher, follow membrane system manufacturer's recommendations for weather related additives and application procedures.

.6 Ensure that substrate materials are dry and free of contaminants. Do not commence with the application unless substrate conditions are suitable. Contractor shall demonstrate that substrate conditions are suitable for the application of the materials.

.7 Odour control and elimination measures are not typically necessary, but if required by the Owner or Consultant, Contractor shall implement odour control and elimination measures prior to and during the application of the waterproofing materials. Control/elimination measures shall be field tested at off-hours and typically consists of one (1) or a multiple of the following measures:

.1 Erection and use of moveable enclosure(s) sized to accommodate work area(s) and stationary enclosure for resin mixing station. Enclosure shall be field constructed or pre-manufactured of fire retardant materials in compliance with local code requirements in accordance with requirements of the Owner or Consultant. Equipment enclosure(s) with mechanical air intake/exhaust openings and odour control air cleaners, as required to clean enclosed air volume and to prevent odour migration outside the enclosure. Exhaust opening shall be sealed with activated carbon filter.

.2 Protection of Contractor personnel and occupants of the Site as necessary to comply with requirements of governing local authority.

.8 When disposing of all refuse or unused materials, observe all local disposal requirements.

1.8 **COORDINATION AND PROTECTION**

.1 Coordinate the work with the installation of associated metal flashings, accessories, appurtenances, and similar as the work of this Section proceeds.

.2 Site components shall be protected adequately (with tarp or other suitable material) from soil, stains, or spills at all hoisting points and areas of application. Contractor shall be responsible for preventing damage from any operation under its Contract. Any such damage shall be repaired at Contractor's expense to Owner's satisfaction or be restored to original condition.

.3 Provide barricades, retaining ropes, safety elements (active/passive) and any appropriate signage required by the Owner or Consultant.

.4 Protect finished waterproofing membrane from damage by other trades by the use of a cushioning layer such as 25 mm thick expanded polystyrene insulation and an impact layer such as 13 mm thick exterior-grade plywood.

.5 Do not allow waste products containing petroleum, grease, acid, solvents, vegetable or mineral oil, animal oil, animal fat, and similar items or direct steam venting to come into direct contact with the membrane unless approved by manufacturer's chemical resistance chart.

1.9 **EXTENDED WARRANTY**

.1 Manufacturer's premier warranty:
- .1 Submit a written copy of manufacturer's premier warranty for fluid applied waterproofing system in accordance with the General Conditions and provisions of this Section, except that warranty period is extended to twenty (20) years from date of Substantial Performance of the Work.
- .2 This warranty provides for cost of labour and materials for loss of watertightness, limited to amounts necessary to effect repairs necessitated by either defective material or defects in related installation workmanship, with no dollar limitation ("NDL").

.2 Applicator's warranty: Submit an extended written warranty for fluid applied waterproofing system in accordance with the General Conditions, except that warranty period is extended to five (5) years from date of Substantial Performance of the Work.
- .1 Warrant Work covering workmanship for all work of this Section including installation of membrane, flashings, and waterproofing accessories.
- .2 Coverage: Complete replacement including effected adjacent Work.

2 Products

2.1 **ACCEPTABLE MANUFACTURERS**

.1 Kemper System Canada Inc.

.2 Or approved alternative.

2.2 **MATERIALS**

.1 General:
- .1 All components of the waterproofing system shall be supplied by one manufacturer.
- .2 Provide all components and accessories as required for complete and water tight installation at waterproofing system.

.2 Fluid applied waterproofing system:
- .1 Fully reinforced cold fluid-applied polyurethane liquid resin waterproofing membrane and flashing system, 'Kemperol 2K-PUR Waterproofing System' by Kemper System Canada, Inc. or approved alternative.
- .2 Membrane:
  - .1 Two-component, cold fluid-applied reinforced polyurethane waterproofing membrane with a 360 degree needle punched non-woven 165 g/m^2 polyester reinforcing fleece, for a finished dry film membrane thickness of 2 mm (0.080") nominal per ply.
  - .2 Colour (water feature): To be selected by the Consultant from manufacturer's full colour range.
- .3 Membrane flashings: A composite of the same resin material as field membrane with 165 g/m^2 fleece reinforcement.
- .4 Primer: Type as recommended by membrane manufacturer to suit intended condition.
- .5 For use at interactive water feature and foundation wall application.

.3 Accessories:
- .1 Application tools, accessories, and cleaners: Types as recommended by membrane manufacturer.
- .2 Solvent-based cleaner for tools and membrane tie-ins: Methyl Ethyl Ketone (MEK) or acetone.
- .3 Water-based cleaner for membrane: Simple Green HD.
- .4 Topcoat surfacing aggregate: Silica sand, ceramic-coated quartz, or specialty aggregate shall be washed, kiln-dried, and dust-free with the following size specification:
  - .1 Utility/fire rating: 0.5 - 1.2 mm.
  - .2 Alkalinity/adhesion key: 0.5 - 1.2 mm.
- .5 Leveling and patching aggregate: Silica sand shall be washed, kiln-dried, and dust-free, suitable for troweling or pourable self-leveling, round grain or angular with the following size specification:
  - .1 For voids less than 1" in depth: #00 (0.3 - 0.6 mm)
  - .2 For voids 1" to 2" in depth: #0 (0.5 - 1.2 mm)
  - .3 Mixing proportions shall be a ratio of resin to sand at 1:2 by volume for leveling, 1:4 by volume for patching, or as approved by membrane manufacturer.
- .6 Backer rod: Expanded, closed-cell polyethylene foam designed for use with cold-applied joint sealant.
- .7 Caulking: Single component, non-sag elastomeric polyurethane sealant meeting ASTM C920, Type S, Grade NS, Class 35 for use in sealing cracks and joints, and making watertight seals where required. Type as recommended by membrane manufacturer.

.4 Drainage board: In accordance with Section 33 46 23.

3 Execution

3.1 **EXAMINATION**

.1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of Work means acceptance of existing conditions.

.2 Verify that existing substrates to receive waterproofing are clean, dry, sound, smooth, and continuous.

.3 Verify substrate is structurally supported, secure and sound.

3.2 **SUBSTRATE PREPARATION AND PROTECTION**

.1 Verify substrate surfaces are solid, free from surface water, dust, oil, grease, scaling or laitance, projections and foreign matter detrimental to the adhesion of the waterproofing system.

.2 The contractor shall determine the condition of the existing structural substrate. All defects in the substrate shall be corrected before new waterproofing work commences. Areas of deteriorated substrate, porous or other affected materials must be removed and replaced with new to match existing.

.3 Prepare flashing substrates as required for application of new waterproofing membrane flashings.

.4 Inspect substrates, and correct defects before application of new waterproofing. Fill all surface voids greater than 3 mm wide with an acceptable fill material.

.5 Remove all ponded water from the work substrate prior to installing new waterproofing materials.

.6 The final substrate for waterproofing shall be clean, dry, free of loose, spalled or weak material including coatings, mineral aggregate, and flood coat/gravel surfacing, oil, grease, contaminants, abrupt changes in level, waterproofing agents, curing compounds, and free of projections which could damage membrane materials.

.7 Structural concrete:

.1 New concrete shall have cured a minimum of 28 days in accordance with ACI-308, or as approved by waterproofing manufacturer's technical department.

.2 New or existing concrete shall be free of oil, grease, curing compounds, loose particles, moss, algae growth, laitance, friable matter, dirt, bituminous products and previous waterproofing materials.

.3 New or existing concrete shall be dry with a maximum moisture content of five (5) percent. Determinations of moisture content shall be performed by the Contractor. Contractor shall be responsible to perform periodic evaluations of moisture content during the work. Moisture evaluation results shall be submitted in writing to the Owner or Consultant and waterproofing manufacturer for acceptance.

.4 Where required, concrete shall be abrasively cleaned in accordance with ASTM D4259 to provide a sound substrate free from laitance. Achieve an open concrete surface in accordance with ICRI surface profiles CSP 3-5. When using mechanical methods to remove existing waterproofing products or surface deterioration, the surface profile is not to exceed 6 mm (peak to valley).

.5 The substrate shall be sound and all spalls, voids and blow holes on vertical or horizontal surfaces must be repaired prior to placement of the primer coat. Spalls and other deterioration shall be repaired in accordance with the requirements of the Owner or Consultant and membrane manufacturer.

.6 Areas of minor surface deterioration of 6 mm or greater in depth shall be repaired to prevent possible pooling of the liquid applied materials, leading to excessive usage of primer and resin.

.7 For concrete materials with a compressive strength of less than 3,000 psi contact waterproofing manufacturer's technical department for substrate preparation requirements.

.8 Finish leveling, patching and crack preparation:

.1 General: Primer/sand mix is the preferred material for all concrete substrate finish leveling, crack and wall/deck preparation and patching. Primer/sand patching mix provides a set time of approximately twelve (12) hours and does not require surface grinding. Primer/sand mix is typically applied in conjunction with general surface priming.

.2 Concrete substrate leveling and patching: Substrate conditions are to be evaluated by the Contractor, the Owner, or Consultant, and membrane manufacturer. Perform leveling and patching operations as follows:

.1 Level uneven surfaces with a leveling mixture of primer and approved kiln-dried silica sand in a 1:2 primer to sand ratio by volume. Spread and plane this compound with a squeegee and trowel to achieve a flat surface.

.2 Fill cavities with a patching mixture of primer and approved kiln-dried sand in a 1:4 primer to sand ratio by volume.

.3 Silica sand must be kept absolutely dry during storage and handling.

.4 Any surface to be leveled or filled must first be primed with an appropriate primer.

.3 Joint and crack preparation: Joints, cracks and fractures in the structural substrate shall be prepared as defined below prior to installation of the waterproofing membrane. Note: Joints, cracks, and fractures may telegraph through the waterproofing/coating membrane.

.1 Non-moving cracks, joints, and voids: Determine that crack/joint is non-moving. Clean out crack/joint by brushing and oil-free compressed air. Fill crack/joint with polyurethane sealant. Voids require the installation of backer rod or other backing material prior to application of the polyurethane sealant. Allow for a minimum of twelve (12) hours cure or as required by sealant manufacturer.

.2 Moving cracks: Determine that crack is moving. Clean out crack by brushing and oil-free compressed air. Fill crack with polyurethane sealant. Allow for a minimum of twelve (12) hours cure or as required by sealant manufacturer. Following full curing of primer, apply waterproofing resin and 100 mm wide strip of membrane (resin and fleece) in strict accordance with membrane manufacturer's written instructions.

.9 Primer application:

.1 General:

.1 Mix and apply primer in strict accordance with written instructions of Membrane manufacturer. Use only proprietary materials, as supplied by the membrane manufacturer.

.2 The substrate surface must be dry, with any remaining dust or loose particles removed using clean, dry, oil-free compressed air, industrial vacuum, cloth wipe or a combination of methods.

.3 Do not install primer on any substrate containing newly applied and/or active asphalt, coal-tar pitch, creosote or penta-based materials unless approved in writing by membrane manufacturer. Some substrates may require additional preparation before applying primer.

.2 Mixing of primer:

.1 Premix primer Component A thoroughly with a spiral agitator or stir stick. Pour primer Component B into Component A and mix the components for approximately 2 minutes with a clean spiral agitator on slow speed or stir stick without creating any bubbles or streaks. Do not aerate. The primer solution should be a uniform colour, with no light or dark streaks present.

.2 Do not thin primer. Determine required primer coverage for each substrate material/condition and apply in strict accordance with written instructions of membrane manufacturer.

.3 Mix only that amount of primer components A & B that can be used in 20 minutes.

.3 Application of primer:

.1 Roll or brush the primer evenly onto the surface to fully saturate the substrate in one application. Do not allow primer to pond or collect in low areas. Follow manufacturer's recommended application rates to ensure that a thin layer of cured primer remains on the substrate surface.

.2 Apply primer only up to the edge of the membrane flashing terminations. Primer application past the membrane terminations requires surfacing with an approved material.

.3 For primer applications over cementitious substrates where protection from substrate wetness is required, apply primer coat at a heavier application rate until pore saturation is achieved.

.4 For all primer applications, apply kiln-dried sand into the final coat of primer while still wet at the rate of 50 lbs. per 100 square feet.

.5 Allow standard primers to cure for a minimum of twelve (12) hours before membrane application. Allow quick-dry primers to cure for a minimum of four (4) hours before membrane application. Membrane must be applied to primer only when completely dry and without tack.

.6 Exposure of the primer in excess of eight (8) days or premature exposure to moisture may require removal and application of new primer. Do not apply new primer over exposed primer older than eight (8) days, primer prematurely exposed to moisture, or primer used as temporary waterproofing, unless approved in writing by the membrane manufacturer.

.4 Disposal of primer:

.1 Cured primer may be disposed of in standard landfills. This is accomplished by thoroughly mixing all components.

.2 Uncured primer is considered a hazardous material and must be handled as such, in accordance with local regulation. Do not through uncured resin away.

.10 Supply and install temporary protection to adjacent surfaces to prevent damage resulting from work of this Section.

3.3 WATERPROOFING MEMBRANE APPLICATION

.1 General:

.1 It is recommended to apply the waterproofing membrane immediately following full curing of the primer in order to obtain the best bond between primer and membrane.

.2 Mix and apply cold fluid-applied reinforced polyurethane waterproofing membrane in strict accordance with written instructions of membrane manufacturer. Use only proprietary membrane resins and materials, as supplied by the membrane manufacturer.

.3 The primed substrate surface shall be dry, with any remaining dust or loose particles removed using clean, dry, oil-free compressed air, industrial vacuum, cloth-wipe or a combination.

.4 Protect all areas where membrane has been installed. Do not work off installed membrane during application of remaining work before forty-eight (48) hours of curing. Movement of materials and equipment across installed membrane is not acceptable. If movement is necessary, provide complete protection of affected areas.

.5 Closely follow the membrane manufacturer's recommendation for hot and cold weather application. Monitor surface and ambient temperatures, including the effects of wind chill.

.2 Mixing of membrane resin:

.1 Mix resin Component A (cream formulation) with a spiral agitator until the liquid is a uniform cream colour. If the ambient temperature is below 10°C, then a weather related additive should be combined and mixed into the Component A.

.1 Accelerator should be added to resin Component A when the ambient temperature is 10°C and below. The accelerator should be mixed with the spiral agitator for 2 minutes or until both liquids are thoroughly blended.

.2 Pour resin Component B into Component A at a 4:1 ratio (by weight) and thoroughly mix the components with a clean spiral agitator. The Resin solution should be a uniform color, with no light or dark streaks present.

.3 Mix only that amount of resin components A & B that can be used in 30 minutes.

.3 Application of resin/fleece:

.1 Apply mixed resin to the prepared surface at the manufacturer's recommended application rate. The resin should be rolled or brushed liberally and evenly onto the surface using a broad, even stroke. Cover one working area at a time, between 1.4 - 1.9 m^2.

.2 Roll out dry polyester fleece onto the liquid resin mix, making sure the smooth side is facing up (natural unrolling procedure), avoiding any folds and wrinkles. The fleece will begin to rapidly saturate with the liquid resin mix. Use a medium nap roller or brush to work the resin into the fleece, saturating from the bottom up, and eliminating air bubbles, wrinkles, etc. The appearance of the saturated fleece should be light opaque amber with no white spots. White spots are indications of unsaturated fleece or lack of adhesion. It is important to correct these faults before the resin cures.

.3 Apply additional liquid resin mix on top of fleece at the manufacturer's recommended application rate to finish the saturation of the fleece. Roll this final coating into the fleece, which will result in a glossy appearance. The fleece can only hold so much resin and all excess should be rolled forward to the unsaturated fleece, eliminating ponding or excessive build-up of the resin. The correct amount of resin will leave no whiteness in fleece and there will be a slightly fibrous surface texture. The final resin coating should be smooth and uniform.

.4 Approximately 2/3 of the total resin should be applied to the substrate below the fleece reinforcement, and 1/3 of the total resin should be applied over the fleece reinforcement.

.5 Prevent contact between mixed/unmixed resin and new/existing membrane. If any unmixed resin contacts membrane surface remove immediately and clean thoroughly with a cloth rag.

.6 At all fleece seams, allow a 50 mm overlap for all side joints and a 100 mm overlap for all end joints.

.7 At membrane tie-offs, clean in-place membrane with MEK (methyl ethyl ketone) solvent or acetone once resin has cured. Allow solvents to fully evaporate before application of new resin.

.4 Disposal of resin:
- .1 Cured resin may be disposed of in standard landfills. This is accomplished by thoroughly mixing all components.
- .2 Uncured resin is considered a hazardous material and must be handled as such, in accordance with local, state and federal regulation. Do not throw uncured resin away.

3.4 FLASHING APPLICATION

.1 General:
- .1 Install flashing system in accordance with the requirements/recommendations of the membrane manufacturer and as depicted on standard drawings and details. Provide system with base flashing, edge flashing, penetration flashing, counter flashing, and all other flashings required for a complete watertight system.
- .2 Wherever possible, install the flashings before installing the field membrane to minimize foot traffic over newly installed field membrane.
- .3 All membrane flashings shall be installed concurrently with the waterproofing membrane as the job progresses. Temporary flashings are not allowed without prior written approval from the membrane manufacturer. Should any water penetrate the new waterproofing membrane because of incomplete flashings, the affected area shall be removed and replaced at the contractor's expense.
- .4 Provide a minimum vertical height of 200 mm for all flashing terminations. Flashing height shall be at least as high as the potential water level that could be reached as a result of a deluging rain and/or poor slope.
- .5 All flashings shall be terminated as required by the membrane manufacturer.
- .6 Alkalinity surface protection consisting of one application of primer and one application of approved broadcast mineral aggregate surfacing shall be applied wherever stone, concrete, or masonry elements will be placed directly over the flashing.

.2 Membrane flashing, general:
- .1 Membrane flashings shall be fabricated with primer appropriate for the substrate surface, resin of the same base chemical type as the field membrane, and fleece of the same weight as the field membrane unless specified otherwise.
- .2 Primer, resin, and fleece mixing and application methods as specified for field membranes are also suitable for membrane flashing.
- .3 Fleece shall overlap 50 mm minimum for all joints. Fleece shall be cut neatly to fit all flashing conditions without a buildup of multiple fleece layers. Work wet membrane with a brush or roller to eliminate blisters, openings, or lifting at corners, junctions, and transitions.

.3 Pipes, conduits, and unusually shaped penetrations: Flashing is typically constructed as a two part assembly consisting of a vertical wrap and a horizontal target patch. There must be a minimum of a 50 mm overlap between vertical and horizontal flashing components.

.4 Drains:
- .1 Acceptable drain materials are cast iron, cast aluminum, and copper.
- .2 Connect new drains to existing plumbing system.
- .3 Alternatively, replace all broken or damaged parts of existing drains.
- .4 Flashing material shall extend 100 mm minimum onto drain flange and into drain body.
- .5 Install clamping ring if provided as part of the drain design. Install a strainer basket to prevent debris from clogging the drainage line.

.5 Flexible penetrations:
- .1 Provide a weathertight gooseneck of round cross-section for each penetration or group of penetrations. Set in water cut-off mastic and secure to the structural substrate.
- .2 Acceptable gooseneck material is copper, of a sheet weight appropriate for the application.
- .3 Flashing is typically constructed as a two part assembly consisting of a vertical wrap and a horizontal target patch. There must be a minimum of a 50 mm overlap between vertical and horizontal flashing components.

.6 Walls, curbs and base flashings:
- .1 Wall, curb and base flashings shall be installed to solid substrate surfaces only. Adhering to gypsum-based panels, cementitious stucco, synthetic stucco, wood or metal siding, and other similar materials is not acceptable.
- .2 Reinforce all transition locations and other potential wear areas with a 100 mm wide membrane strip evenly positioned over the transition prior to installing the exposed flashing layer.
- .3 Reinforce all inside and outside corners with a 100 mm diameter conical piece of membrane prior to installing the exposed flashing layer.
- .4 All pins, dowels and other fixation elements shall be flashed separately with a vertical flashing component prior to installing the exposed flashing layer.
- .5 Extend flashing a minimum of 100 mm onto the field substrate surface.

.7 Drip edges:
- .1 Metal drip edges shall be installed to solid substrate surfaces or wood nailers only. Securement to gypsum-based panels, cementitious stucco, synthetic stucco, wood or metal siding or coping, and other similar materials is not acceptable.
- .2 Flash all drip edges by extending the field membrane all the way to the edge of the exposed face prior to installing the metal edging. Strip in the metal flange with a separate 200 mm wide strip of membrane adhered to both the securement flange and to the field membrane.
- .3 For conditions where water infiltration behind the exposed drip edge face is possible, install a separate membrane layer positioned behind the face area and extending a minimum of 100 mm past the securement flange onto the field substrate prior to installing the drip edge.

.8 Field fabricated control or expansion joint flashing:

.1 Control or expansion joints in excess of 50 mm in width require the use of a separate engineered joint system.

.2 Grind or otherwise bevel the inside edges of the joint opening to provide a smooth transition edge for the fleece.

.3 Flashing typically consists of a fully saturated membrane bottom layer looped into the joint as a cradle, a compressible foam or rubber insert at 25% compression fitted into the joint, and a membrane top layer applied over the joint. Extend both fleece layers 100 mm minimum onto the field substrate on both sides of the joint.

.4 Apply the field membrane over the entire joint area.

3.5 DRAINAGE BOARD

.1 Supply and install drainage board in accordance with detailed system, and manufacturer's instructions.

3.6 TEMPORARY CLOSURES AND WATERSTOPS

.1 Contractor shall be responsible to ensure that moisture does not damage any completed section of the new waterproofing system. Completion of flashings, terminations, and temporary closures shall be completed as required to provide a watertight condition. All temporary closures shall be made as recommended or required by the membrane manufacturer.

3.7 FIELD QUALITY CONTROL

.1 Arrange for inspection of waterproofing system installation by manufacturer's representative.

3.8 FLOOD TEST

.1 A flood test of the completed membrane and flashing system shall be conducted prior to the installation of any overburden/surfacing. The flood test shall be of a 24 hr. minimum duration, and shall apply a water head of 50 mm over the entire application area. Any incidents of water entry shall be evaluated and all necessary repairs conducted, followed by an additional flood test.

.2 Work that does not conform to specified requirements including tolerances, slopes, and finishes shall be corrected and/or replaced. Any deficiencies of membrane application, termination and/or protection as noted during the membrane manufacturer's inspections shall be corrected and/or replaced at Contractor's expense.

3.9 **PROTECTION**

.1 Upon completion of waterproofing and flashings (including all associated work), institute appropriate procedures for surveillance and protection of waterproofing during remainder of construction period. Protect all areas where membrane has been installed.

3.10 **CLEANING**

.1 Clean metal, masonry, and similar items of dirt, cuttings, stains and foreign matter upon completion of the Work.

.2 Dispose of waterproofing materials, trash, debris, and equipment from the Site. Any trash and debris removal shall comply with codes and requirements and shall be disposed of in a legal manner.

.3 Repair or replace damaged Site components or surrounding areas to the satisfaction of the Consultant.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for the application of cementitious waterproofing work at shotcrete application in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM C39/C39M, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.

.2 ASTM C109/C109M, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).

.3 ASTM C267, Standard Test Methods for Chemical Resistance of Mortars, Grouts, and Monolithic Surfacings and Polymer Concretes.

.4 ASTM C321, Standard Test Method for Bond Strength of Chemical-Resistant Mortars.

.5 ASTM C348, Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars.

.6 ASTM C596, Standard Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement.

.7 CE CRD-C 48, Standard Test Method for Water Permeability of Concrete.

.8 NSF/ANSI/CAN 61, Drinking Water System Components.

1.3 **SUBMITTALS**

.1 Product data:
- .1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
  - .1 Performance criteria, installation details, physical properties, detailed application and installation instructions, and limitations.
  - .2 Product transportation, storage, and handling requirements.

.2 Shop drawings: Submit shop drawings in accordance with Section 01 33 00 indicating materials, details, dimensions, thickness, treatment of joints and cracks, protection, penetration details, and relationship to adjacent construction.

.3 Certificates:
- .1 Submit certifications for items required at least 4 weeks prior to installation of work of this Section.
- .2 Submit manufacturer's certification that waterproofing system materials and accessories supplied are compatible, meet Specification requirements and that installer is approved by membrane manufacturer.
- .3 Submit inspection reports, within 3 working days after each inspection, and certification by manufacturer confirming that installations are in accordance with manufacturer's requirements.

.4 Extended warranty: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.

1.4 QUALITY ASSURANCE

.1 Installers qualifications: Perform work of this Section by a company that has a minimum of five years proven experience in the installation of cementitious waterproofing of a similar size and nature and that is approved by manufacturer. Submit to Consultant, applicator's current certificate of approval by the material manufacturer as proof of compliance.

.2 Cementitious waterproofing system shall be tested in accordance with the following standards and conditions, and the testing results shall meet or exceed the performance requirements as specified herein:
- .1 Independent Laboratory: Testing shall be performed by an independent laboratory meeting the requirements of the Standards Council of Canada. Testing laboratory shall obtain all concrete samples and water proofing product samples.
- .2 Crystalline Penetration: Crystallizing capability of waterproofing material shall be evidenced by independent SEM (Scanning Electron Microscope) photographs documenting penetration of crystal-forming waterproofing material to a depth of 50 mm.
- .3 Permeability:
  - .1 Independent testing shall be performed according to U.S. Army Corps of Engineers CRD-C48.
  - .2 Concrete samples (treated and untreated) to have design strength of 13.8 MPa and thickness of 50 mm. No admixtures permitted.
  - .3 Coatings to have maximum thickness of 1 mm per coat with up to two coats permitted.
  - .4 Samples to be pressure tested to 1.2 MPa (121.5 m head of water).
  - .5 Treated samples, after crystalline growth has occurred, shall exhibit no measurable leakage.
- .4 Chemical Resistance:
  - .1 Independent testing shall be performed according to ASTM C267 and ASTM C39/C39M.
  - .2 Concrete samples (treated and untreated) to have design strength of 27.6 MPa. No admixtures permitted.

.3 Coatings to have maximum thickness of 1 mm per coat with up to two coats permitted.

.4 Untreated and treated specimens to be immersed for a minimum of 84 days in following chemical solutions: hydrochloric acid (3.5pH), brake fluid, transformer oil, ethylene glycol, toluene, caustic soda.

.5 Treated specimens shall exhibit no detrimental effects after exposure, and shall have a minimum of 14% increase in compressive strength versus untreated control specimens.

.6 Potable water approval: Independent testing shall be performed according to NSF Standard 61 and approval for use of waterproofing material on structures holding potable water shall be evidenced by NSF certification.

.3 Mock-up:

.1 Construct one 2 m^2 mock-up of cementitious waterproofing over shotcrete work, in location acceptable to Consultant.

.2 Demonstrate typical installation conditions and workmanship.

.3 Arrange for Consultant's review and acceptance, allow 48 hours after acceptance before proceeding with work.

.4 Mock-up may remain as part of Work if accepted by Consultant. Remove and dispose of mock-ups which do not form part of Work.

.5 Upon acceptance, mock-up shall serve as a minimum standard of quality for the balance of the work of this Section.

.4 Pre-installation meetings: Arrange with manufacturer's representative and Consultant to inspect substrates, and to review installation procedures 48 hours in advance of installation.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Store packaged materials in original undamaged containers with manufacturers labels and seals intact, in dry enclosed area, off the ground. Prevent damage of materials during handling and storage.

.2 Handle and store materials in accordance with manufacturers written instructions.

1.6 SITE CONDITIONS

.1 Do not install work of this Section outside of following environmental ranges without Consultant's and Product manufacturer's written acceptance:

.1 Ambient air and surface temperature are below: 5°C.

.2 Precipitation: None.

.2 Ensure that temperature of substrate and its moisture content conforms to manufacturer's minimum requirements, before proceeding with work.

.3 Supply and install temporary protection and facilities to maintain Product manufacturer's, and above specified environmental requirements for 24 hours before, during, and 24 hours after installation.

1.7 **EXTENDED WARRANTY**

.1 Submit an extended warranty for cementitious waterproofing work in accordance with the General Conditions of the Contract, except that warranty period is extended to five years from date of Substantial Performance of the Work. .
  .1 Warrant work against leakage.
  .2 Warranty includes removing and reinstalling finish shotcrete under the specifications for Division 3 Shotcrete.
  .3 Coverage: Complete replacement including affected adjacent Work.

2 Products

2.1 **ACCEPTABLE SYSTEMS AND MANUFACTURERS**

.1 'Aquafin-2K/M' by Aquafin Inc.

.2 'Cem-Kote CW Plus' W.R. Meadows.

.3 'Vandex Super' by Vandex International Ltd.

.4 'Xypex Crystalline Waterproofing' by Xypex Chemical Corporation.

2.2 **MATERIALS**

.1 Cementitious waterproofing system:
  .1 Furnish a cementitious waterproofing system comprising a prepackaged, gray-coloured proprietary blend of portland cement, specially treated sand, and active chemicals that, when mixed with water and applied, penetrates by capillary action into concrete surfaces and reacts chemically with free lime in the presence of water to produce a crystalline growth throughout the capillary voids in the concrete and an impervious, dense, waterproof concrete substrate.
  .2 Cementitious waterproofing to meet the following minimum criteria and additional quality control requirements as specified herein:
    .1 Permeability: 0 for water at 33 feet when tested according to CE CRD-C 48.
    .2 Compressive strength: 3000 psi when tested according to ASTM C109/C109M.

.2 Patching compound:
  .1 Type as recommended by cementitious waterproofing manufacturer.
  .2 Cementitious waterproofing and repair mortar for filling and patching tie holes, honeycombs, reveals, and other imperfections; with properties meeting or exceeding the following criteria:
    .1 Compressive strength: 7600 psi at 28 days when tested according to ASTM C109/C109M.

.2 Flexural strength: 710 psi at 28 days when tested according to ASTM C348.

.3 Shrinkage: Minus 0.093 percent at 28 days and plus 0.073 percent at 90 days when tested according to ASTM C596.

.3 Plugging compound:

.1 Type as recommended by cementitious waterproofing manufacturer.

.2 Cementitious compound with hydrophobic properties; resistant to water and moisture but vapour permeable for all standard applications (vertical, overhead and horizontal surfaces not exposed to vehicular traffic); with properties meeting or exceeding the following criteria:

.1 Permeability: 30 feet when tested according to CE CRD-C 48.

.2 Compressive strength: 6000 psi at 28 days when tested according to ASTM C109/C109M.

.3 Flexural strength: 1000 psi at 28 days when tested according to ASTM C348.

.4 Bond Strength: 300 psi at 14 days when tested according to ASTM C321.

.4 Water: Potable.

2.3 **MIXES**

.1 Mix cementitious waterproofing materials in accordance with manufacturer's written instructions.

.2 Mix waterproofing material, by volume with clean water free from salt and deleterious materials, to the required proportions and consistency in accordance with manufacturer's written recommendations to achieve.

.3 Protective topping: Measure, batch, and mix portland cement and sand in the proportion of 1:3 and water. Blend together with mechanical mixer to required consistency.

.4 Mix waterproofing material in quantities that can be applied within 20 to 30 minutes from time of mixing.

.5 As mixture thickens, stir frequently, but do not add additional water. Do not mix bonding agents or admixtures with cementitious waterproofing materials.

3 Execution

3.1 **EXAMINATION**

.1 Verify condition and dimensions of previously installed work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

.2 Verify that concrete surfaces are sound and clean, and that form release agents and materials used to cure the concrete are compatible with waterproofing treatment.

.3 Examine surfaces to be waterproofed for form tie holes and structural defects such as honeycombing, rock pockets, faulty construction joints and cracks. Such defects to be repaired in accordance with manufacturer's written instructions.

.4 Proceed with waterproofing work only after projections through the substrate to be waterproofed have been completed.

.5 Proceed only after shotcrete surface defects, including honeycombs, voids, and cracks, have been repaired to provide a sound substrate free of forming materials.

3.2 PREPARATION

.1 Verify substrate surfaces are solid, free from surface water, frozen matter, dust, oil, grease, scaling or laitance, projections and any other foreign matter detrimental to performance. Obtain manufacturer's approval of substrate in writing, submit copy to Consultant.

.2 Prepare intended shotcrete substrates in accordance with manufacturer’s written instructions.

.3 Concrete surfaces to receive waterproofing shall have an open capillary system to provide tooth and suction, and shall be free from scale, excess form oil, laitance, curing compounds and foreign matter.

.4 Smooth surfaces or surfaces covered with excess form oil or other contaminants shall be washed, lightly sand-blasted, water-blasted, or acid etched with muriatic acid as necessary to provide a clean absorbent surface. Surfaces to be acid-etched shall be saturated with water prior to application of acid.

.5 Surface defects shall be repaired in accordance with manufacturer's written instructions.

3.3 INSTALLATION

.1 Install cementitious waterproofing in accordance with reviewed shop drawings and manufacturer's written instructions and as follows:
- .1 Dampen surface for several hours prior to application with water and maintain damp condition until applying waterproofing.
- .2 Apply waterproofing to negative side surfaces.
- .3 Number of coats:
  - .1 One for brush or spray application.
  - .2 Dampen surface between coats.
  - .3 Final coat finish: Spray textured.

.4 Application methods:
- .1 Use semi-stiff bristle brush or broom or suitable spray equipment for coats as specified herein.
- .2 When brushing, work slurry well into surface of the concrete, filling surface pores and hairline cracks.
- .3 When spraying, hold nozzle close enough to ensure that slurry is forced into pores and hairline cracks.

.2 Curing:
- .1 Moist-cure waterproofing for three days immediately after application has set, followed by two days of air drying as recommended in writing by manufacturer.
- .2 Moist cure with a mist fog spray of clean water three times a day for the prescribed period or cover treated surfaces with damp burlap for the prescribed period.
- .3 During the curing period, protect treated surfaces from rapid drying, damage by severe weather exposure, wind, sun, rain and temperatures below 2°C and water accumulation. If plastic sheeting is used for protection, it must be raised off of waterproofing coating to allow sufficient air circulation.

.3 Maintain moisture as required for bonding of finish layer of shotcrete by shotcrete applicator under Division 3.

3.4 FIELD QUALITY CONTROL

.1 Inspection: Manufacturer's representative to inspect completed application and to provide a written report that application complies with manufacturer's written instructions.

3.5 CLEANING

.1 Clean to Consultant's approval, soiled surfaces, spatters, and damage caused by work of this Section.

.2 Remove debris, equipment and excess material from site.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for water repellent sealer work in accordance with the Contract Documents.

1.2 **SUBMITTALS**

.1 Product data:
- .1 Submit copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
  - .1 Performance criteria, compliance with appropriate reference standard(s), characteristics, limitations, preparation and installation requirements.
  - .2 Product transportation, storage, and handling requirements.

.2 Reports/certificates:
- .1 Submit manufacturer's written acceptance of substrate prior to installation.
- .2 Submit applicator's current certificate of approval, for installation of sealer, by the material manufacturer as proof of compliance.
- .3 Submit letter certifying that materials proposed for use on this project meet criteria specified, are compatible with each other, and that the manufacturer had recommended the product for it's intended end use.
- .4 Submit inspection report after application of sealer.
- .5 Submit certification from sealer manufacturer that installation meets specified and manufacturer's requirements.
- .6 Submit a letter from the sealer manufacturer stating that the manufacturer will inspect the surface to which sealer has been applied, at the end of the first, third, and fifth years after application, and will submit a written report after each inspection to the Owner. The report shall state conditions that may adversely affect the sealer performance or cause water penetration, such as structural movement or defects, faulty construction or materials, and joint areas requiring resealing or repointing, and recommendations for corrective measures under the terms of the Warranty. This maintenance inspection shall be performed at no cost to the Owner.

.3 Closeout submittals: Submit maintenance data for incorporation into Operations and Maintenance Manuals in accordance with Section 01 78 23.

.4 Extended warranty: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.

1.3 **QUALITY ASSURANCE**

.1 Applicators qualifications: Perform work of this Section by a company that has a minimum of five years proven experience in work of similar size and nature and that is approved by manufacturer. Submit to Consultant, applicator's current certificate of approval by the material manufacturer as proof of compliance.

.2 Pre-installation meetings: Arrange with manufacturer's representative and Consultant to inspect substrates, and to review installation procedures 48 hours in advance of installation.

1.4 **DELIVERY, STORAGE, AND HANDLING**

.1 Deliver products in original factory packaging bearing identification of product, manufacturer, and batch number. Provide Material Safety Data Sheets for each product.

.2 Store product in location protected from freezing, damage, construction activity, precipitation, and direct sunlight, in strict accordance with manufacturer's recommendations.

.3 Prior to application, condition products in accordance with manufacturer's recommendations.

.4 Handle all products with appropriate precautions and care as stated on Material Safety Data Sheet.

1.5 **SITE CONDITIONS**

.1 Do not install work of this Section outside of following environmental ranges without Consultant's and Product manufacturer's written acceptance:
.1 Ambient air and surface temperature: 5°C to 38°C
.2 Precipitation: None.

.2 Supply and install temporary protection and facilities to maintain Product manufacturer's, and above specified environmental requirements for 24 hours before, during, and 24 hours after installation.

1.6 **EXTENDED WARRANTY**

.1 Submit an extended warranty for the work of this Section in accordance with General Conditions, except that warranty period is extended to ten years from date of Substantial Performance of the Work.
.1 Warrant against loss of water repellency when tested as follows:
.1 Modified ASTM C642 procedure: Treated concrete shall not absorb more than 0.75% water for a period of 24 hours.
.2 AASHTO T259: Concrete shall not absorb more than 250 ppm of chlorides at the 11/2 inch level over baseline conditions.

.2 Coverage: Complete repair of defective areas and reapplication of sealer.

2 Products

2.1 **MATERIALS**

.1 Water repellent sealer: Clear, penetrating, breathable, for use on horizontal and vertical concrete applications, 100% active silane based sealer:
- .1 'Protectosil BHN' by DRE Industries Inc.
- .2 'MasterProtect H 1000' by BASF.
- .3 'Pentreat 244-100' by W. R. Meadows.

.2 Cleaning agents: As recommended by material manufacturer, harmless to substrates and adjacent finished surfaces.

3 Execution

3.1 **EXAMINATION**

.1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

.2 Verify substrate surfaces are solid, free from surface water, frozen matter, dust, oil, grease, scaling or laitance, and any other foreign matter detrimental to performance. Obtain manufacturer's approval of substrate in writing, submit copy to Consultant.

3.2 **PREPARATION**

.1 Supply and install temporary protection to adjacent surfaces to prevent damage resulting from work of this Section.

.2 Thoroughly clean all surfaces to receive sealer by steel shotblasting or other method approved by the manufacturer.

3.3 **SEALER APPLICATION**

.1 Apply sealer in accordance with manufacturer's written instructions.

.2 Apply sealer without dilution or alteration in any way.

.3 Horizontal applications:
- .1 Apply sealer with low pressure airless spray equipment (15 Psi) capable of flooding the surface to obtain uniform coverage and extending sealer 100 mm up walls.
- .2 Apply sealer at a minimum application rate of 4.3 m^2/L.

.3 Apply sealer by method other than spray application only at locations where overspray would affect adjacent materials.

.4 Vertical applications:
.1 Apply sealer in a flooding application from bottom up, so sealer runs down 150 to 200 mm below the spray pattern.
.2 Apply sealer at manufacturer recommended coverage rates for intended substrates.

3.4 FIELD QUALITY CONTROL

.1 Immediately after sealing has been completed, have the sealer manufacturer's representative visit the site to inspect, test, and approve the application. Submit written inspection report to Consultant.

.2 Deficiencies in the application shall be repaired at no cost to Owner.

3.5 PROTECTION

.1 Prevent traffic over sealed areas, and protect work of this Section from precipitation, freezing, and debris after installation.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for the thermal insulation work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 CAN/ULC-S702, Mineral Fibre Thermal Insulation for Buildings.

.2 CAN/ULC-S710.1, Standard for Thermal Insulation – Bead-Applied One Component Polyurethane Air Sealant Foam, Part 1: Material Specification.

.3 CAN/ULC-S710.2, Standard for Thermal Insulation – Bead-Applied One Component Polyurethane Air Sealant Foam, Part 2: Installation.

1.3 **SUBMITTALS**

.1 Product data: Submit manufacturer's Product data in accordance with Section 01 33 00 indicating characteristics, performance criteria, and limitations. Indicate installation requirements and techniques, storage, and handling criteria and installation procedure acceptable to manufacturer.

.2 Certification: Submit installer's certification verifying compliance with specification requirements.

1.4 **QUALITY ASSURANCE**

.1 Qualifications: Execute work of this Section by company specializing in thermal insulation work with minimum of three years, recent, documented experience, on work of comparable complexity and scope.

2 Products

2.1 **MATERIALS**

.1 All materials under work of this Section, including but not limited to, adhesives are to have low VOC content limits.

2. Batt insulation: CAN/ULC-S702, Type 1, friction fit; ‘Unfaced Thermal and Sound Control Batts’ by Johns Manville, ‘EcoTouch Pink Fiberglas Insulation’ by Owens Corning Canada or ‘ComfortBatt’ by Rockwool.

.3 Rigid insulation (below grade): CAN/ULC-S701, Type 4; Minimum RSI of 0.87, Extruded polystyrene, ship-lapped edges. Thickness: As indicated on Drawings.
.1 ‘Stryofoam SM’ by Dupont de Nemours Inc.
.2 ‘Foamular C-300' by Owens Corning Canada Inc.

4. Rigid insulation (cavity wall): CAN/ULC -S701, Type 3, Extruded polystyrene, ship-lapped edges. Thickness: As indicated on Drawings.
   .1 Cavitymate by Dupont de Nemours Inc.
   .2 Foamular C-200 by Owens Corning Canada Inc.

5. Foam insulation (kit): CAN/ULC-S710.1, closed cell, polyurethane foam-in-place moisture cured sealant insulation, CFC free, 16 kg per m^3 to 32 kg per m^3 density; injected from prepackaged pressurized containers.

.6 Adhesive for polystyrene insulation: Type as recommended by insulation manufacturer.

3 Execution

3.1 EXAMINATION

.1 Verify condition of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

.2 Ensure substrate surfaces are dry, clean, suitable to receive adhesive and free from other deleterious substances.

3.2 INSTALLATION

.1 Install thermal insulation in longest panel sizes possible in accordance with manufacturer's instructions.

.2 Butt insulation with moderate contact and, cut and fit them tightly around other construction elements. Offset single layer vertical joints and both vertical and horizontal joints in multiple layer applications.

.3 Make thermal insulation continuous, maintain thermal protection continuity and secure to prevent displacement. Ensure that insulation is tight to substrate without air gaps.

.4 Cut and fit thermal insulation tightly around electrical boxes, plumbing and heating pipes and ducts, exterior doors and windows, and other protrusions.

.5 Leave 75 mm separation between thermal insulation and heat emitting devices such as recessed light fixtures.

.6 Cut and trim thermal insulation neatly to fit spaces; do not compress insulation to fit. Install only thermal insulation boards which are free from chipped or broken edges.

.7 Fill miscellaneous cavities with insulation to maintain continuity of thermal barrier. Do not compress insulation to fit.

.8 Arrange for Consultant to review thermal insulation before it is enclosed.

3.3 **SECUREMENT**

.1 Batt insulation:
- .1 Install batt insulation in partitions, between studs, and as indicated on Contract Drawings and in accordance with the manufacturer's instructions.
- .2 Fill stud cavities to full height of partitions and carefully cut and fit required batt insulation type around services and protrusions.

.2 Rigid insulation (cavity wall - adhesive attachment):
- .1 Apply adhesive to thermal insulation foam boards in accordance with manufacturer's recommendations.
- .2 Omit adhesive bonding of foam board insulation over expansion and control joints.

.3 Rigid insulation (under slab insulation): Install insulation boards in locations shown in accordance with manufacturer’s written instructions, with joints butted tight.

.4 Foamed-in-place (kit): Except where otherwise specified in other Sections, install foamed-in-place insulation fully in crevices and frame voids between exterior concrete or masonry and door frames, and about lintels, around louvers and around other items built into exterior concrete and masonry walls to prevent air infiltration. Install in accordance with CAN/ULC-S710.2.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for vapour retarders work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM E1643, Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.

.2 ASTM E1745, Standard Specification for Water Vapour Retarders used in contact with Soil or Granular Fill under Concrete Slabs.

.3 CAN/CGSB 19.21-M, Sealing and Bedding Compound, Acoustical.

.4 CAN/CGSB-51.34-M, Vapour Barrier, Polyethylene Sheet, for Use in Building Construction.

1.3 **SUBMITTALS**

.1 Product data:
- .1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
  - .1 Performance criteria, compliance with appropriate reference standard, characteristics, and limitations.
  - .2 Product transportation, storage, handling and installation requirements.

.2 Samples: Submit following samples in accordance with Section 01 33 00:
- .1 Two 300 x 300 mm samples of vapour retarders.
- .2 Two samples, 300 mm long, of fastening bar.
- .3 Duplicate samples of pipe and conduit boot.

1.4 **QUALITY ASSURANCE**

.1 Pre-Installation Meeting: Arrange meeting on Site to be attended by Consultant, Contractor, and vapour retarder manufacturer’s representative to review installation procedures, interfaces with adjacent work, conditions under which work will be performed, inspect the surfaces to receive the vapour retarder, and installation procedures 48 hours in advance of installation.

1.5 **SITE CONDITIONS**

.1 Do not install the work of this Section outside of environmental ranges as recommended by manufacturer without Consultant's and Product manufacturer's written acceptance.

.2 Supply and install temporary protection and facilities to maintain Product manufacturer's, and above specification, environmental requirements before, during, and after installation.

2 Products

2.1 **MATERIALS**

.1 All materials under work of this Section, including but not limited to, primers and sealants are to have low VOC content limits.

.2 Sheet vapour retarder 'Super Six' Polyethylene film to CAN/CGSB-51.34, 0.15 mm (6 mil) thick.
- .1 Joint sealing tape: Air and vapour resistant pressure sensitive adhesive tape, type recommended by sheet vapour retarder manufacturer, 50 mm wide for lap joints and perimeter seals, 25 mm wide elsewhere.
- .2 Sealant: CAN/CGSB 19.21; One-part, non-sag, non-bleeding, non-drying, non-hardening, sealant shall remain tacky for permanent bonding to all surfaces; 'Tremco Acoustical Sealant' by Tremco Ltd. or approved alternative.

.3 Membrane vapour retarder:
- .1 Membrane vapour retarder: 1.0 mm thick, single-ply, self adhering, self sealing, rubberised asphalt, bonded to a cross-laminated high density polyethylene film.
  - .1 'CCW 705' by Carlisle Coatings & Waterproofing.
  - .2 'Blueskin SA' by Henry Company Canada Inc.
  - .3 'Sopraseal Stick 1100 T' by Soprema.
  - .4 'Exo-Air 110' by Tremco.
  - .5 'Air-Shield" by W. R. Meadows.
- .2 Primer: Unless otherwise recommended by membrane manufacturer:
  - .1 'CCW-AWP Primer' by Carlisle Coatings & Waterproofing.
  - .2 'Aquatac' by Henry Company Canada Inc.
  - .3 'Elastocol Stick H20' by Soprema.
  - .4 'ExoAir WB Primer' by Tremco
  - .5 'Mel-Prime Water Base' by W.R. Meadows.
- .3 Mastic: Unless otherwise recommended by membrane manufacturer:, one-part, low VOC building envelope sealant approved for use with membrane vapour retarder:
  - .1 'CCW 201' by Carlisle Coatings & Waterproofing.
  - .2 '925 BES Sealant' by Henry Company Canada Inc.
  - .3 'Sopramastic SP2' by Soprema.
  - .4 'Dymonic 100' by Tremco.
  - .5 'BEM' by W.R. Meadows.
- .4 Fastening bar: Continuous 25 mm wide x 3 mm thick aluminum bar, predrilled for mechanical attachment.
- .5 Fasteners: As specified herein or manufacturer's recommended fastener for attaching to Substrate.

.4 Vapour retarder (under slab): ASTM E1745, Class A, 0.38 mm (15 mil) thick; 'Stego Wrap Vapor Barrier' by Stego Industries or 'Perminator' by W.R. Meadows.
- .1 Joint sealing tape: High density polyethylene tape with pressure sensitive adhesive with minimum width 100 mm. Type recommended by sheet vapour retarder manufacturer.
- .2 Pipe and conduit boots: Construct pipe and conduit boots from vapour retarder material and pressure sensitive tape as recommended by manufacturer.

3 Execution

3.1 **EXAMINATION AND COORDINATION**

.1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

.2 Verify that existing substrates to receive vapour retarder are clean, dry, sound, smooth, and continuous.

.3 Coordinate installation of vapour retarders with work of other Sections to achieve a vapour tight building envelope.

3.2 **SHEET VAPOUR RETARDER INSTALLATION**

.1 Ensure services are installed and inspected prior to installation of retarder.

.2 Install sheet vapour retarder on the warm side of exterior wall assemblies, prior to installation of insulation or interior finishes to form a continuous vapour retarder.

.3 Use sheets of largest practical size to minimize joints.

.4 Inspect for continuity. Repair punctures and tears with sealing tape before work is concealed.

.5 At exterior surface openings, cut vapour retarder to form openings and ensure material is lapped and sealed to frame.

.6 Ensure continuity of vapour retarder is maintained at junctures with other materials.

.7 At perimeter seals, seal perimeter of sheet vapour retarder as follows:
- .1 Apply continuous bead of sealant to substrate at perimeter of sheets.
- .2 Lap sheet over sealant and press into sealant bead.
- .3 Ensure that no gaps exist in sealant bead. Smooth out folds and ripples occurring in sheet over sealant.

.8 Seal lap joints of sheet vapour retarder as follows:
- .1 Attach first sheet to substrate.
- .2 Apply continuous bead of sealant over solid backing at joint.
- .3 Lap adjoining sheet minimum 150 mm and press into sealant bead.
- .4 Ensure that no gaps exist in sealant bead. Smooth out folds and ripples occurring in sheet over sealant.

.9 Seal electrical switch and outlet device boxes that penetrate vapour retarder as follows:
- .1 Wrap boxes with film sheet providing minimum 300 mm perimeter lap flange.
- .2 Apply sealant to seal edges of flange to main vapour retarder and seal wiring penetrations through box cover.

3.3 MEMBRANE VAPOUR RETARDER INSTALLATION

.1 Install vapour retarder and associated components in accordance with manufacturer's instructions in locations indicated.

.2 Primer and mastic:
- .1 Primer:
  - .1 Prime substrate surfaces to receive vapour retarder, at recommended application rate, allow to dry. Vary coverage to suit surface porosity.
  - .2 Prime surfaces. Re-prime surfaces if not covered with vapour retarder within 4 hours.
- .2 Mastic:
  - .1 Install mastic where required to ensure integrity of vapour retarder installation at protrusions and other complex details.
  - .2 Fill substrate voids, gaps, depressions, cracks, and joints with mastic until continuous, smooth, substrate for vapour retarder is achieved.

.3 Lap vapour retarder ends and edges 50 mm minimum. Roll vapour retarder and laps for continuous adhesion over entire substrate area; use manufacturer's recommended roller.

.4 Extend vapour retarder as required to connect to roof parapets, windows, doors frames, aluminum work and other components of Work comprising vapour retarder system.

.5 Provide end-dams and terminations fabricated from same material as membrane vapour retarder or material recommended by membrane manufacturer at sills, lintels, openings, and where horizontal surfaces intersect with vertical surfaces to ensure moisture is shed to exterior.

.6 Cut and fit vapour retarder as required for passage of protrusions, ensuring continuous adherence to substrate.

.7 At end of days' work, trowel mastic water cut-off along uppermost edge of incomplete vapour retarder assembly, to prevent loss of adhesion and damage vapour retarder.

.8 Supply and install continuous mechanical fastening bar to clamp vapour retarder both sides of unfilled gaps, cracks, and joints.

3.4 **UNDER SLAB VAPOUR RETARDER INSTALLATION**

.1 Install sheet vapour retarder under the floor slab prior to installation of floor slab, to form a continuous vapour retarder in accordance with ASTM E1643 and manufacturer's written instructions.

.2 Lap vapour barrier over grade beams and seal to caisson walls.

.3 Overlap joints 150 mm and seal with manufacturer approved sealing tape.

.4 Seal all penetrations (including conduits and pipes) with manufacturer's pipe boot.

.5 Use sheets of largest practical size to minimize joints.

.6 Inspect for continuity. Repair punctures and tears with sealing tape before work is concealed.

.7 Ensure continuity of vapour retarder is maintained at junctures with other materials.

3.5 **FIELD QUALITY CONTROL**

.1 Inspect vapour retarder continuity immediately prior to installation of subsequent construction. Repair punctures, rips and tears to ensure continuity of vapour retarder.

.2 Where punctures and tears are extensive, replace entire damaged section.

.3 Do not cover or permit to be covered any portion of vapour retarder until it has been inspected by Consultant.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for metal shingle work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM B209, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

.2 ASTM C920, Specification for Elastomeric Joint Sealants.

.3 ASTM D2244, Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates.

.4 ASTM D4214, Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films.

.5 CRCA, Canadian Roofing Contractor's Association.

.6 OIRCA, Ontario Industrial Roofing Contractors Association.

1.3 **DESIGN REQUIREMENTS**

.1 Design metal shingles to withstand live, dead, lateral, wind, seismic, handling, transportation and erection loads.

.2 Design metal shingles to prevent restriction of thermal induced movement which would induce deformation such as warping, buckling, and failure of joint seals and fasteners.

.3 Design metal shingle roofing system to prevent the infiltration of water into the roof system and to prevent roofing system components from vibrating due to design wind loads.

1.4 **SUBMITTALS**

.1 Product data:
- .1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
  - .1 Performance criteria, compliance with appropriate reference standard(s), characteristics, and limitations.
  - .2 Product transportation, storage, handling and installation requirements.

.2 Samples:
.1 Submit two of the following samples in accordance with Section 01 33 00 indicating:
.1 Two full size samples of metal shingles.
.2 300 x 300 mm samples of waterproofing membrane.
.3 Any additional accessories required in a complete installation.

.3 Shop drawings:
.1 Submit shop drawings in accordance with Section 01 33 00 indicating:
.1 Arrangements of shingles and joints, materials, thicknesses, dimensions, layouts, types and locations of supports and fasteners and special shapes.
.2 Relationship of shingles to roof deck.
.3 Details of waterproofing membrane, connections, and all other components in the system.

.4 Certificates: Qualification data for qualified manufacturer and installer.

.5 Reports: Submit written field inspection and test report results within 3 days after each inspection.

.6 Extended warranty: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.

.7 Close-out submittals:
.1 Submit close-out submittals in accordance with Section 01 33 00.
.2 Submit manufacturer's certificate that membrane has been installed in accordance with Contract Documents.

1.5 QUALITY ASSURANCE

.1 Manufacturer’s qualification: Perform work of this Section by a company that has a minimum of fifteen years proven experience in the manufacture of metal shingles of a similar size and nature.

.2 Installer’s qualification: Perform work of this Section by a company that is a member in good standing of Ontario Industrial Roofing Contractors Association (OIRCA) and has a minimum of ten years proven, acceptable roofing experience on installations of similar complexity and scope and that is approved by the manufacturer.

.3 Perform roofing work in accordance with CRCA Roofing Specifications Manual.

.4 Mock-up:
.1 Construct one full scale 3 m^2 mock-up of metal shingle construction, in location acceptable to Consultant.
.2 Demonstrate installation of underlay board, underlayment, metal shingles, finish, and quality of workmanship.
.3 Mock-up may form part of final Work, if acceptable to Consultant. Remove and dispose of mock-ups which do not form part of Work.

.5 Pre-installation meetings: Arrange meeting on Site to be attended by Consultant, Contractor, and shingle roof manufacturer's representative to inspect substrates, and to review installation procedures 48 hours in advance of installation.

1.6 **SITE CONDITIONS**

.1 Install roofing on dry deck, free of snow and ice, use only dry Products and apply only during weather that will not introduce moisture into roofing system.

.2 Apply roofing only when air and surface temperatures are in accordance with manufacturer's written instructions.

1.7 **EXTENDED WARRANTY**

.1 At completion of this work, provide a signed OIRCA warranty to the Owner covering defects of workmanship and materials for a period of 2 years commencing from Substantial Performance of the Work. Agree to make good promptly any defects which occur or become apparent within the warranty period in conjunction with the shingle manufacture's warranty. Defects shall include but not be limited to leakage, failure to stay in place, lifting, and deformation.

.2 Manufacturer's shingle warranty: At completion of this work, provide a signed non-prorated warranty from the roof shingle manufacturer to the Owner covering defects in materials for a period of 35 years commencing from Substantial Performance of the Work.

.1 Warranty against shingle warping, twisting, failure, jointing, water penetration below waterproofing membrane and failure to drain water from rainscreen cavity.

.2 Coverage: Complete replacement including affected adjacent parts.

.3 Manufacturer's finish warranty: Provide manufacturer's written warranty naming Owner as beneficiary and covering finish failure of shingles beyond normal weathering for a period of 40 years commencing from Substantial Performance of the Work.

.1 Warrant finish against chipping, cracking, checking or peeling.

.2 Warrant against chalk in excess of a numerical rating of 8 when measured in accordance with ASTM D4214.

.3 Warrant against fade or changing of colour in excess of five (5) E units in accordance with ASTM D2244. Colour change to be measured on exposed painted surface cleaned of excess soils and oxidation.

2 Products

2.1 **ACCEPTABLE SYSTEMS AND MANUFACTURERS**

.1 'CastleTop' by Atas International, Inc.

.2 'Aluminum Diamond Shingles' by Fine Metal Roof Tech.

2.2 **MATERIALS**

.1 Provide all primary roofing products, including but not limited to shingles, waterproofing, ventilation, etc. by a single manufacturer.

.2 Metal shingles:
- .1 ASTM B209, minimum 0.8 mm thick, interlocking diamond shaped aluminum shingle panels with hidden/concealed fastening system.
- .2 Finish and colour: Manufacturer's standard PVDF fluorocarbon coating system in colour as selected by the Consultant from full colour range.
- .3 Size: Manufacturer's standard sizing of 394 x 394 mm (15-¾" x 15-¾") by Atas International, Inc. or 400 x 400 mm (16" x 16" - Size 16 in 90 degree version) by Fine Metal Roof Tech.

.3 Accessories: Starters, clips, flashings, ridge and hip caps, snow hooks, etc: Material, finish, colour, fasteners and thickness to match metal shingle material.

.4 Roof sheathing board: In accordance with Section 06 10 00.

.5 Waterproof membrane: 1.0 mm thick composite sheet comprised of SBS modified bitumen with woven polyethylene reinforcement; 'CCW 300 HT' by Carlisle Coatings and Waterproofing, 'Lastobond Shield HT' by Soprema or approved alternative by Henry Company Canada Inc. Primer recommended by membrane manufacturer.

.6 Cement: Plastic and lap cement, trowel grade asphalt mastic.

.7 Fasteners: Corrosion resistant stainless steel clips per shingle.

.8 Sealant: ASTM C920, primer and sealant as recommended by roof shingle manufacturer.

2.3 **FABRICATION**

.1 Fabricate metal shingles in accordance with reviewed shop drawings and manufacturer's written instructions.

.2 Fabricate metal shingles to intended diamond shape, true and accurate to size, free from distortion and other defects detrimental to appearance or performance.

3 Execution

3.1 **EXAMINATION**

.1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.2 **PREPARATION**

.1 Prepare intended roof substrate in accordance with manufacturer's written instructions.

.2 Verify substrate surfaces are solid, free from surface water, frozen matter, dust, projections and any other foreign matter detrimental to performance.

.3 Supply and install temporary protection to adjacent surfaces to prevent damage resulting from work of this Section.

3.3 **INSTALLATION**

.1 Install metal shingles and associated components in accordance with reviewed shop drawings, manufacturer's written instructions, CRCA requirements and as required for a complete and water tight installation.

.2 Roof sheathing: Install plywood roof sheathing in accordance with Section 06 10 00.

.3 Waterproofing membrane:
- .1 Install primer and waterproof membrane continuously over plywood roof sheathing, in accordance with manufacturer's instructions.
- .2 Overlap waterproof membrane 50 mm along sidelaps and 75 mm on end laps and lap in direction of waterflow.
- .3 Coordinate airseal transition to adjacent parts of work.

.4 Metal shingles and accessories:
- .1 Interlock metal shingles and accessories in accordance with manufacturer's written instructions and reviewed shop drawings.
- .2 Install each shingle complete with a minimum of 2 or 4 clips as recommended by shingle manufacturer and depending on size of shingle.
- .3 Form and profile accessories including inside and outside corners, flashing, edgings, cap strips, drips, fillers, closure strips, and starter strips in accordance with the drawings.
- .4 Ridge vents: Install ridge vents in accordance with manufacturer's written instructions.
- .5 Damaged metal shingles, waviness, warp or distortion of finished work will not be accepted.
- .6 Completed installation shall be free from rattles, wind whistles, noise due to thermal movement and other noises.

.5 Sealant: Seal where necessary to form weathertight seal between flashing and adjoining surfaces and between flashing and other work. Sealing work consists of bedding between members where possible. Tool sealant to concave profile where exposed.

3.4 CLEANING AND TOUCH-UP

.1 Clean exposed finished surfaces of complete installation free of dirt, grease and smudges.

.2 Touch-up scratches with air dry formulation of coating system to match original factory finish.

3.5 PROTECTION

.1 Any roof areas that are not completed by the end of the workday are to be protected from moisture and contaminants.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for cedar wood siding system work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM F1667, Driven Fasteners: Nails, Spikes and Staples.

.2 CAN/CGSB-51.32-M, Sheathing, Membrane, Breather Type.

.3 NLGA Standard Grading Rules for Canadian Lumber.

1.3 **DESIGN REQUIREMENTS**

.1 Design wood siding system to withstand live, dead, lateral, wind, seismic, handling, transportation, and erection loads.

.2 Design wood siding system in accordance with following Climatic Design Data for Toronto contained in Ontario Building Code.
.1 Design Temperature: January 1%, July 2 ½%.
.2 Wind (Hourly Wind Pressures): 1 in 50 year occurrence.
.3 Earthquake: Seismic Data as listed.

.3 Prevent rain penetration through siding system. Incorporate means of draining to the exterior.

.4 Design siding system to prevent restriction of thermal induced movement which would induce deformation such as warping, buckling, and failure of joint seals and fasteners. Design siding system to prevent vibration when subject to the effects of wind.

1.4 **SUBMITTALS**

.1 Product data:
.1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
.1 Performance criteria, compliance with appropriate reference standard(s), characteristics, and limitations.
.2 Product transportation, storage, handling and installation requirements.

.2 Shop drawings: Submit shop drawings in accordance with Section 01 33 00 indicating elevations, details, sections, profiles, dimensions, thickness of materials, finishes, methods of joining, arrangement of sheets, joints, and seams, special shapes, methods of anchoring, anchor and clip details, types of sealants and gaskets, waterproof connections to adjoining work, details of other pertinent components of the work (i.e. windows, penetrations, membranes, etc), and compliance with design criteria and requirements of related work.

.3 Samples: Submit two 300 mm long samples of siding in accordance with Section 01 33 00.

1.5 **QUALITY ASSURANCE**

.1 Mock-up:
- .1 Construct one 1 m^2 mock-up of siding in location acceptable to Consultant indicating as a minimum one exterior corner, one inside corner, and one window or door interface.
- .2 Arrange for Consultant's review and acceptance, allow 48 hours after acceptance before proceeding with work.
- .3 Mock-up may remain as part of Work if accepted by Consultant. Remove and dispose of mock-ups which do not form part of Work.
- .4 Upon acceptance, mock-up shall serve as a minimum standard of quality for the balance of the work of this Section.

1.6 **DELIVERY, STORAGE, AND HANDLING**

.1 Do not store siding in heated building. Keep siding on manufacturer's supplied pallets.

2 Products

2.1 **MATERIALS**

.1 All materials under work of this Section, including but not limited to, sealants are to have low VOC content limits.

.2 Cedar siding: FSC certified Cedar, to NLGA Standard Grading Rules for Canadian Lumber. Bevel siding, western red cedar Clear V. G. Heart grade, vertical pattern as indicated on drawings, nominal 175 mm width.

.3 Accessories: Starter strips, mouldings, exposed trim, closures, cap and corner pieces of manufacturer's standard.

.4 Building paper: CAN/CGSB-51.32-M, 15 lbs. unperforated asphalt building paper.

.5 Wood strapping: In accordance with Section 06 10 00.

.6 Fasteners: Nails to ASTM F1667, hot galvanized steel, sized as required, spiral thread type with flat head.

.7 Siding sealant: ASTM C920, Type S, Grade NS, Class 25; One-part, non-sag type, silicone sealant, in colour as selected by the Consultant.
- .1 'Dowsil CWS' by Dow Consumer Solutions.
- .2 'Sikasil 305CN' by Sika.
- .3 'Tremsil 400' by Tremco.

.8 Joint backing: Type as recommended by siding sealant manufacturer.

3 Execution

3.1 **EXAMINATION**

.1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.2 **INSTALLATION**

.1 Install wood siding in accordance with reviewed shop drawings and manufacturer's written instructions.

.2 Building paper: Apply a layer of building paper over cast-in-place concrete back-up structure, so that the paper is lapped not less than 100 mm at the joints and returned around openings, and when applied horizontally, the upper sheets overlap the lower sheets.

.3 Install furring strips, vertically or horizontally depending on direction of siding, and nail into wall studs at 400 o.c., over the full height of the wall. Furring strips must not be less than 6 mm thick.

.4 Level and install sill flashings, starter strips, inside corner flashings, edgings and flashings over openings.

.5 Fasten wood siding in straight, aligned lengths to strapping at 400 mm o.c. maximum using two nails at each fixing location. Stagger butt joints not less than 800 mm and distribute evenly over wall faces. Cut butt joints at 45° and for vertical siding slope to outside. Seal cut surfaces.

.6 Align joints between adjacent siding pieces over the strapping. Fasten on each side at the top nailing line.

.7 Space nails 200 mm o.c. along edge of siding over and under doors and windows: shim where necessary. Do not force or spring siding into place. Always leave a 3 mm space wherever siding butts against trim or other materials and seal.

.8 Butt siding to inside and outside corners leaving a 3 mm gap. Apply inside and outside corners before siding.

.9 Ensure final installation of wood siding is straight, true, level and plumb.

3.3 **SEALANT**

.1 Joint backing and sealant: Install joint backing and sealant at penetrations, joints and perimeter in accordance with manufacturer's written instructions and for weathertight installation. Tool sealant to concave profile.

3.4 **REPAIRS**

.1 Touch up siding with colour matched paint provided by manufacturer.

3.5 **CLEANING**

.1 Clean surfaces of work exposed to view. Remove deposits of foreign material, dirt, soil, and stains.

.2 Protect adjoining work from damage during cleaning.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Design, labour, Products, equipment and services necessary for metal roofing work in accordance with the Contract Documents.

.2 **Special pricing:** Refer to Document 0 for special pricing requirements for work of this Section.

1.2 **REFERENCES**

.1 ANSI B18.6.4, Screws, Tapping and Metallic Drive, Inch Series, Thread Forming and Cutting.

.2 ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.

.3 ASTM C612, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.

.4 CAN/CGSB-19.13-M, Sealing Compound, One Component, Elastomeric, Chemical Curing.

.5 CAN/CSA S136-M, Cold Formed Steel Structural Members.

.6 CAN/CSA S136.1-M, Commentary on CAN/CSA S136-M, Cold Formed Steel Structural Members.

.7 CRCA, Canadian Roofing Contractor's Association.

1.3 **DESIGN REQUIREMENTS**

.1 Design metal roofing elements in accordance with CAN/CSA S136-M, S136.1-M and to withstand live, dead, lateral, wind, seismic, handling, transportation and erection loads.

.2 Design metal roofing elements in accordance with following Climatic Design Data for Toronto contained in Ontario Building Code:
.1 Design temperature: January 1%, July 2 1/2%.
.2 Wind (Hourly wind pressures): 1 in 50 year occurrence.
.3 Earthquake: Seismic Data as listed.

.3 Design metal roofing system to limit deflection under design loads to 240.

.4 Design metal roofing system to prevent restriction of thermal induced movement which would induce deformation such as warping, buckling, and failure of joint seals and fasteners.

.5 Design metal roofing system to prevent the infiltration of water into the roof system and to prevent roofing system components from vibrating due to design wind loads.

.6 Incorporate design of snow fencing into roof design to meet design criteria specified herein. Snow fencing to be of same material and colour as roof system.

1.4 **SUBMITTALS**

.1 Product data:
- .1 Submit copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
  - .1 Performance criteria, compliance with appropriate reference standard, characteristics, limitations.
  - .2 Product transportation, storage, handling and installation requirements.

.2 Shop drawings:
- .1 Submit shop drawings in accordance with Section 01 33 00 indicating:
  - .1 Arrangements of sheets and joints, materials, thicknesses, dimensions, layouts, types and locations of supports and fasteners and special shapes.
  - .2 Relationship of panels to structural frame.
  - .3 Details of waterproofing membrane, insulation, connections, snow fencing and all other components in the system.

.3 Samples:
- .1 Submit following samples in accordance with Section 01 33 00.
  - .1 Submit 300 x 300 mm samples of each sheet metal material and finish.
  - .2 Waterproofing membrane.

.4 Reports: Submit written field inspection and test report results within 3 days after each inspection.

.5 Extended warranty: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.

1.5 **QUALITY ASSURANCE**

.1 Perform roofing work in accordance with CRCA Roofing Specifications Manual.

.2 Manufacturer’s qualification: Perform work of this Section by a company that has a minimum of ten years proven experience in the manufacture of metal roofing of a similar size and nature.

.3 Installers qualifications: Perform work of this Section by a company that has a minimum of five years proven experience in the installation of metal roofing of a similar size and nature and that is approved by manufacturer. Submit to Consultant, installer's current certificate of approval by the material manufacturer as proof of compliance.

.4 Retain a Professional Engineer, licensed in Province of Ontario, with experience in metal roofing work of comparable complexity and scope to perform following services as part of work of this Section:
- .1 Design of metal roofing and snow fencing and framing for snow fencing and attachment.
- .2 Review, stamp, and sign shop drawings.
- .3 Conduct shop and on-Site inspections and prepare and submit inspection reports.

.5 Mock-up:
- .1 Construct one full scale 1200 mm wide x 1800 mm long mock-up panel of metal roofing construction, in location acceptable to Consultant.
- .2 Demonstrate installation of underlay board, insulation, metal roofing, finish, and quality of workmanship.
- .3 Mock-up may form part of final Work, if acceptable to Consultant. Remove and dispose of mock-ups which do not form part of Work.

.6 Pre-installation meeting: Arrange with manufacturer's representative, Contractor, and Consultant to inspect substrates, and to review installation procedures 48 hours in advance of installation.

1.6 DELIVERY, STORAGE, AND HANDLING

.1 Stockpile panels tilted to provide water run-off, free from ground contact on firm, level, non-staining supports extending full width of sheet and spaced not more than 450 mm apart. Cover components with opaque polyethylene sheet. Vent to allow air movement.

1.7 EXTENDED WARRANTY

.1 Submit an extended warranty for metal roofing work In accordance with the General Conditions, except that the warranty is extended to 2 years from date of Substantial Performance of the Work.
- .1 Warrant against panel warping, twisting, failure, jointing, finish failure, water penetration below waterproofing membrane and failure to drain water from rainscreen cavity.
- .2 Coverage: Complete replacement including affected adjacent parts.

2 Products

2.1 **MATERIALS**

.1 All materials under work of this Section, including but not limited to, sealants and coatings are to have low VOC content limits.

.2 Standing seam metal: ASTM A653M; 0.61 mm (24 Ga.) minimum base metal, Z275, galvanized steel. 'Tradition 150' by VicWest Steel or approved alternative by Agway Metals Inc., or Roll From Group.

.3 Metal roofing finish: Perspectra Series coating system by ArcelorMittal Dofasco, or WeatherXL by Vicwest Steel. Colour: Colour as selected by Consultant.

.4 Roof sheathing board: In accordance with Section 06 10 00.

.5 Waterproof membrane: 1.0 mm thick composite sheet comprised of SBS modified bitumen with woven polyethylene reinforcement; 'CCW 300 HT' by Carlisle Coatings and Waterproofing, 'Lastobond Shield HT' by Soprema or approved alternative by Henry Company Canada Inc. Primer recommended by membrane manufacturer.

.6 Z girts and C channels: CAN/CSA S136-M; Minimum 1.2 mm, Z275 galvanized Z girts and C channels. Depth: As indicated on Contract Drawings.

.7 Seam clips: ASTM A653M; Z275 galvanized steel, thermal clip system.

.8 Fascia, trim, closure, and flashings: Material, finish, colour, fasteners and thickness to match metal roofing material.

.9 Snap on batten: Provide 13 mm x 33 mm snap on batten full length of roof panel complete with concealed clip system. Do not fasten concealed clips to metal roof panels. Finish and colour to match roof system.

.10 Snow fencing: Fabricated from galvanized steel and prefinished to match metal roof; 'Snow Fence' by TRA Snow Fences Inc., 'Snow Guard' by Vicwest, or approved alternative.

.11 Screw fasteners: ANSI B18.6.4, stainless steel Type 304. Exposed fasteners to be complete with coloured heads to match metal roofing.

.12 Sealant: CAN/CGSB-19.13-M. Primer as recommended by sealant manufacturer.

2.2 **FABRICATION**

.1 Fabricate metal roofing in accordance with reviewed shop drawings and manufacturer's written instructions.

.2 Fabricate roof components in accordance with reviewed shop drawings factory-ready for field installation.

.3 Fabricate individual metal roofing panels in maximum lengths.

.4 Fabricate metal roofing panels square, true and accurate to size, free from distortion and other defects detrimental to appearance or performance.

.5 Notch Z girts and C channels as required to allow for drainage of rainscreen cavity.

3 Execution

3.1 **EXAMINATION**

.1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.2 **ROOF SHEATHING**

.1 Roof sheathing: Install plywood roof sheathing in accordance with Section 06 10 00.

3.3 **WATERPROOF/AIRSEAL MEMBRANE**

.1 Install primer and waterproof membrane continuously over sheathing board, in accordance with manufacturer's instructions.

.2 Overlap waterproof membrane 50 mm along sidelaps and 75 mm on end laps and lap in direction of waterflow.

.3 Coordinate airseal transition to adjacent parts of work.

3.4 **GIRTS AND CHANNELS**

.1 Install Z girts, fastened through waterproof membrane and into structural framing beneath. Orient Z girts to drain water from rainscreen cavity.

.2 Frame roofing system edges, with C channels and orient channel webs to face outwards.

3.5 **FASCIA, TRIM, CLOSURES, AND FLASHINGS**

.1 Form and profile fascia and trim including inside and outside corners, flashing, edgings, cap strips, drips, fillers, closure strips, and starter strips in accordance with the drawings.

.2 Flashings to utilize a “S” locking joint for concealed fastening.

.3 Cut neat holes in metal roofing to accommodate roof penetrations and install flashing for a watertight installation.

3.6 **METAL ROOFING (STANDING SEAM)**

.1 Install metal roofing in accordance with reviewed shop drawings and manufacturer's written instructions. Used concealed fasteners unless otherwise approved by the Consultant.

.2 Install seam clips spaced as indicated on reviewed shop drawings to comply with design criteria. Secure cleats with two fasteners each minimum, into Z girts or metal deck.

.3 Apply sheet metal roofing beginning at eaves. Loose lock pans to valley flashing and edge strips at eaves and gable rakes.

.4 Fold lower ends of seams at eaves over at 45° angle. Terminate standing seams at ridge and hips by turning down in tapered fold.

.5 Install metal roofing panels and snap on battens in one piece, for entire slope, except as indicated otherwise. In locations that roof panels cannot be installed in one piece, provide 100 mm starter strip to join the panels together. Provide a continuous sealant bead under starter strip.

.6 Metal roof panels terminating at eaves or valleys shall not have a raw metal edge or exposed fasteners. Fold panel ends and install in accordance with reviewed shop drawings.

.7 Insert metal roof panels terminating at hips or ridges into concealed metal closures. Metal closures shall allow for expansion of the metal roof panel and also act as a starter strip for hip or ridge flashings.

.8 Install valley sheets not exceeding 3 m in length. Shingle lap joints 150 mm in direction of flow. Extend valley sheet minimum 150 mm under roofing sheets. Double fold valley and roofing sheets and secure at 450 mm oc.

.9 Install snow fencing in accordance with manufacturer's instructions and reviewed shop drawings.

.10 Tapered roof panels to be one piece.

.11 Apply isolation coating to metal surfaces in contact with concrete or mortar.

.12 Remove and replace damaged metal roofing. Do not touch-up damaged panels.

3.7 **SEALANT**

.1 Seal where necessary to form weathertight seal between flashing and adjoining surfaces and between flashing and other work. Sealing work consists of bedding between members where possible. Tool sealant to concave profile where exposed.

3.8 **CLEANING AND TOUCH-UP**

.1 Clean exposed finished surfaces of complete installation free of dirt, grease and smudges.

.2 Touch-up scratches with air dry formulation of coating system to match original factory finish.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for flashing and sheet metal work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 AAMA 2605, Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels - Series: Components, Coatings and Finishes.

.2 ASTM B209, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

.3 ASTM C1193, Standard Guide for Use of Joint Sealants.

.4 ASTM C920, Specification for Elastomeric Joint Sealants.

.5 ASTM D2244, Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates.

.6 ASTM D4214, Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films.

.7 CSA A123.21, Standard Test Method for the Dynamic Wind Uplift Resistance of Membrane-Roofing Systems.

.8 CRCA Roofing Manual, Canadian Roofing Contractors Association.

1.3 **DESIGN REQUIREMENTS**

.1 Design flashing elements and fastenings to withstand wind loading and perimeter and corner uplift pressures for roof system in accordance with CSA A123.21.

.2 Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction.

.3 Completed sheet metal flashing and trim shall not rattle or loosen.

1.4 SUBMITTALS

.1 Shop drawings:
- .1 Submit shop drawings in accordance with Section 01 33 00 indicating:
  - .1 Proposed method of shaping, forming, jointing.
  - .2 Application of flashing and sheet metal work.
  - .3 Flashing fastening method, fasteners, and fastener spacing to meet wind loading and uplift pressures.

.2 Samples:
- .1 Submit following samples in accordance with Section 01 33 00:
  - .1 50 x 50 mm samples of sheet metal material, colour and finish.
  - .2 Representative sample section of each metal flashing material, illustrating S locking jointing method, minimum 600 mm long.

1.5 QUALITY ASSURANCE

.1 Perform flashing and sheet metal work in accordance with the CRCA Roofing Specifications Manual.

2. Fabricator's qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting or other surface damage.

.2 Store sheet metal flashing and trim materials away from uncured concrete and masonry.

.3 Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

1.7 EXTENDED WARRANTY

1. Manufacturer's finish warranty:
- .1 Provide manufacturer's written warranty naming Owner as beneficiary and covering finish degradation or failure of factory-applied exterior fluoropolymer finish on sheet metal flashing and trim within the warranty period.
- .2 Exposed sheet and trim finish: Deterioration includes, but is not limited to, the following:
  - .1 Colour fading more than 5 Hunter units when tested according to ASTM D2244.
  - .2 Chalking in excess of a No. 8 rating when tested according to ASTM D4214.

.3 Cracking, checking, peeling, or failure of paint to adhere to bare metal.

.3 Warranty period for finish: 20 years from date Work is certified as substantially performed.

2 Products

2.1 **MATERIALS**

.1 All materials under work of this Section, including but not limited to, sealants and paints are to have low VOC content limits.

.2 Aluminum sheet:

.1 ASTM B209 and ANSI H35.1, alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required, with smooth, flat surface, minimum 1.0 mm thick. For use as typical flashing, gutters, downpipes, fascia caps and additional areas as indicated.

.2 Finish: 'Duranar (XL)' by PPG in accordance with AAMA 2605. Colour: To be selected by Consultant.

.3 Isolation coating: Alkali resistant bituminous coating; '810-07' by Henry Company Canada Inc.

.4 Plastic cement: Trowel grade asphalt mastic.

.5 Sealant: ASTM C920, Type S, Grade NS, Class 25; High-performance, medium-modulus, one-part, neutral-cure silicone sealant. 'Dowsil CWS' by Dow Consumer Solutions, 'Sikasil 305CN' by Sika or 'Tremsil 400' by Tremco.

.6 Starter strips: Starter strips to be continuous, of same material as flashing used, 1.2 mm thick.

.7 Gutter membrane: 1.5 mm thick, non-reinforced, cured, synthetic single-ply EPDM. Adhesive as recommended by EPDM manufacturer.

.8 Fasteners: Flat head roofing nails of length, type and thickness suitable for metal flashing application.

.9 Washers: of same material as sheet metal, 1 mm thick with rubber packings.

.10 Touch-up paint: Same colour and material as prepainted sheet, as recommended by prefinished coating manufacturer.

2.2 **FABRICATION**

.1 Fabricate miscellaneous flashings, fascia caps, starter strips, gutters and downpipes in accordance with CRCA and to details shown.

.2 Form pieces in 2400 mm maximum practical lengths. Make allowance for expansion at joints.

.3 Hem exposed edges 13 mm minimum on underside for appearance and stiffness. Mitre and seal corners with sealant.

.4 Reglets and cap flashing: Form flashings of as detailed and in accordance with CRCA. Provide slotted fixing holes and steel/plastic washer fasteners.

.5 Gutters and downpipes:

.1 Form gutters and downpipes from prefinished aluminum sheet metal to cross section required, complete with end pieces, outlet tubes, and other accessories as required

.2 Provide goosenecks, outlets, strainer baskets and necessary fastenings.

.3 Furnish flat-stock gutter brackets and flat-stock gutter spacers and straps fabricated from same metal as gutters, of size as required and with thickness not less than twice the gutter thickness.

.4 Fabricate expansion joints, expansion-joint covers and gutter accessories from same metal as gutters.

.5 Accessories: Continuous, removable leaf screen with sheet metal frame and hardware cloth screen.

.6 Downpipes: Fabricate round downpipes to dimensions indicated, complete with mitred elbows. Furnish with metal hangers from same material as downpipes and anchors.

3 Execution

3.1 EXAMINATION

.1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.2 INSTALLATION

.1 Install miscellaneous flashings, starter strips, gutters, downpipes, fascia caps and fasteners to details indicated and in accordance with reviewed shop drawings and CRCA requirements.

.2 Use concealed fasteners. Exposed fasteners such as pop rivets are not allowed.

.3 Apply isolation coating to metal surfaces in contact with concrete or mortar.

.4 Install continuous starter strips to present a true, non-waving, leading edge. Anchor to back-up for a rigid, secure installation.

.5 Counterflash bituminous flashings at intersections of roof with vertical surfaces and curbs. Flash joints using S-lock forming tight fit over hook strips.

.6 Make end joints using an S lock joint. Execute by inserting end coping length in 25 mm deep S lock formed in end of adjacent length. Extend concealed portion of S lock 25 mm outwards and nail to substrate. Face nailing of joints will not be permitted.

.7 Seal where necessary to form weathertight seal between flashing and adjoining surfaces and between flashing and other work. Sealing work consists of bedding between members where possible. Tool sealant to concave profile where exposed. Install sealant in accordance with ASTM C1193.

.8 Insert metal flashing under cap flashing to form weathertight junction.

.9 Caulk flashing at cap flashing with sealant.

.10 Gutters and downpipes:

- .1 Fabricate and install gutters and downpipes in accordance with reviewed shop drawing and manufacturer's written instructions. Seal joints watertight.
- .2 Longitudinal joints not acceptable.
- .3 Install downpipes and provide goosenecks back to trellis columns. Secure downpipes to trellis columns with straps at 1800 mm oc; minimum two straps per downpipe.
- .4 Line gutter with fully adhered EPDM. Ensure gutters are water tight.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for sealant work in accordance with the Contract Documents.

.2 Work of this Section does not include sealant work identified in individual specification sections.

1.2 **REFERENCES**

.1 ASTM C920, Specification for Elastomeric Joint Sealants.

.2 ASTM C1330, Specification for Cylindrical Sealant Backing for Use with Cold Liquid Applied Sealants.

1.3 **SUBMITTALS**

.1 Product data: Submit copies of Product data in accordance with Section 01 33 00 describing type, composition and recommendations or directions for surface preparation, material preparation and material installation.

.2 Samples:
.1 Submit following samples in accordance with Section 01 33 00:
.1 Two samples of sealant/caulking, for colour selection.
.2 Two samples of back-up material and primer for physical characteristics.

.3 Extended warranty: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.

1.4 **QUALITY ASSURANCE**

.1 Qualifications: Work of this Section shall be executed by trained applicators approved by sealant manufacturer and having a minimum of 5 years proven experience.

1.5 **SITE CONDITIONS**

.1 Do not install materials when ambient air temperature is less than 5°C, when recesses are wet or damp, or to manufacturer's recommendations.

1.6 **DELIVERY, STORAGE AND HANDLING**

.1 Arrange delivery of materials in original, unopened packages with labels intact, including batch number, and ensure that on-site storage is kept to a minimum. Do not store materials on site where there exists any danger of damage from moisture, direct sunlight, freezing and other contaminants.

1.7 **EXTENDED WARRANTY**

.1 Submit an extended warranty for Sealant work in accordance with General Conditions, except that warranty period is extended to 2 years from date of Substantial Performance of the Work.
- .1 Warrant against leakage, cracking, crumbling, melting, shrinkage, running, loss of adhesion and staining adjacent surfaces.
- .2 Coverage: Complete replacement including affected adjacent work.

2 Products

2.1 **MATERIALS**

.1 General:
- .1 All materials under work of this Section, including but not limited to, primers and sealants are to have low VOC content limits.
- .2 Use materials as received from manufacturers, without additives or adulterations. Use one manufacturer's Product for each kind of Product specified.
- .3 Compatibility: Provide joint sealants, backings and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint sealant manufacturer, based on testing and field experience.

.2 Sealant **Type A**: ASTM C920, Type S, Grade NS, Class 100/50; one-part, low-modulus, moisture-curing, silicone. Colour as selected by Consultant.
- .1 'Dowsil 790' by Dow Consumer Solutions.
- .2 ''Spectrem 1' by Tremco.

.3 Sealant **Type B**: ASTM C920, Type S, Grade NS; One-part mildew-resistant silicone, in standard colours selected.
- .1 'Dowsil 786 Mildew Resistant Silicone Sealant' by Dow Consumer Solutions.
- .2 'Sikasil GP Mildew Resistant' by Sika.
- .3 'Tremsil 200 Silicone Sealant' by Tremco Ltd.

.4 Sealant **Type C**: ASTM C920, Type M, Grade P, Class 25; Two-part, semi self-levelling type, in standard colours selected.
- .1 'Silicone Parking Structure SL' by Dow Consumer Solutions.
- .2 'THC-900/901' by Tremco Ltd.

.5 Sealant **Type D**: ASTM C834; Pure acrylic siliconized sealant; in standard white colour (paintable).
.1 '950A Siliconized Acrylic Latex Caulk' by Sherwin Williams.
.2 'Tremflex 834 Silconized Sealant' by Tremco Ltd.

.6 Sealant **Type E**: ASTM C920, Type S, Grade NS, Class 35, one-component, non-sag, polyurethane shotcrete joint sealant; in standard colours selected.
.1 'Pourthane NS' by W. R. Meadows, Inc.
.2 Or approved alternative.

2.2 **ACCESSORIES**

.1 Primers: Type recommended by material manufacturers for various substrates, primers to prevent staining of adjacent surfaces encountered on project.

.2 Joint backing: ASTM C1330; Round, solid section, closed cell, skinned surface, soft polyethylene foam gasket stock, compatible with primer and sealant materials, 30 to 50% oversized, Shore A hardness of 20, tensile strength 140 to 200 kPa. Bond breaker type surface.

.3 Bond breaker: Type recommended by material manufacturers.

.4 Void filler around the window frames to be one part expanding polyurethane foam.

.5 Cleaning agents: As recommended by material manufacturer, non-staining, harmless to substrates and adjacent finished surfaces.

2.3 **MIXING**

.1 Follow manufacturers instructions on mixing, shelf and pot life.

3 Execution

3.1 **EXAMINATION**

.1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.2 **PREPARATION**

.1 Protect adjacent exposed surfaces to prevent smearing, staining or other damage, by masking or other means, prior to performing work. Make good any damage caused by sealant application. Remove protection upon completion and clean adjacent, exposed surfaces of any compound deposited upon such surfaces.

.2 Prepare joints to receive sealants to manufacturer's instructions. Ensure that joints are clean and dry and ferrous surfaces are free from rust and oil.

.3 Clean recesses to receive sealant, to be free of dirt, dust, loose material, oil, grease, form release agents and other substances detrimental to sealant's performance.

.1 Remove lacquer or other protective coatings from metal surfaces, without damaging metal finish, using oil-free solvents. Remove rust, mill scale and coatings from ferrous metals by wire brush, grinding or sand blasting.

.2 Ensure recess is dry.

.3 Do not apply sealants to joint surfaces treated with sealer, curing compound, water repellent, or other coatings. Remove incompatible coatings as required.

.4 Ensure that all materials in contact with sealant are compatible. Test substrate for adhesion.

.5 Depth of recess: Maintain depth to ½ joint width up to a maximum of 13 mm and not less than 6 mm at centre of joint. For greater depth, use joint backing under. Where recess is less than specified depth, cut back surface of recess to specified recess depth.

.6 Install polyethylene backing rod in joints 6 mm or more in width. Roll backing rod into joint. Do not stretch or bend backing rod. Install bond breaker to back of recess.

.7 Prime sides of recess, in accordance with sealant manufacturer's instructions.

.8 Condition products for use in accordance with manufacturer’s recommendations.

3.3 INSTALLATION

.1 Apply sealant immediately after adjoining work is in condition to receive such work. Apply sealant in continuous bead using gun with correctly sized nozzle. Use sufficient pressure to evenly fill joint.

.2 Ensure sealant has full uniform contact with, and adhesion to, side surfaces of recess. Superficial painting with skin bead is not acceptable. Tool sealant to smooth surface, free from ridges, wrinkles, sags, air pockets, embedded impurities, dirt, stains or other defects.

.1 At recesses in angular surfaces, finish sealant with flat profile, flush with face of material at each side.

.2 At recesses in flush surfaces, finish compound with concave face, flush with face of material at each side.

.3 Make sealant bead uniform in colour.

.4 Cure sealants in accordance with sealant manufacturer's instructions. Do not cover up sealants until proper curing has taken place.

.5 Immediately remove excess compound or droppings which would set up or become difficult to remove from adjacent finished surfaces, using recommended cleaners, as work progresses. Do not use scrapers, chemicals or other tools which could damage finished surfaces. Remove defective sealant.

.6 Clean recesses and re-apply sealant.

.7 Remove masking tape immediately after joints have been sealed and tooled.

3.4 **CLEANING**

.1 Clean surfaces adjacent to joints, remove sealant smears or other soiling resulting from application of sealants. At metal surfaces, remove residue. Do not mar or damage finishes on materials adjacent to joints. Repair or replace marred or damaged materials.

3.5 **SCHEDULE OF LOCATIONS**

.1 Following sealant location schedule is included for convenience and may not be complete. Examine Contract Drawings and other specification sections and determine entire extent of work of this Section. Generally seal following locations:
- .1 Concrete, masonry, wood and stone to metal.
- .2 Wood to masonry, concrete and stone.
- .3 Metal to metal.
- .4 All dissimilar materials.
- .5 Where ‘sealant’ or ‘caulking’ in indicated on drawings.

.2 Sealant **Type A**:
- .1 Exterior joints between masonry and steel or aluminum.
- .2 Exterior joints between masonry and shelf angle.
- .3 Exterior joints between steel or aluminum and concrete or masonry.
- .4 Interior and exterior control joints, except in floors.
- .5 Door frames, louvre frames, interior and exterior side.
- .6 Protrusions through interior and exterior walls and floors, interior and exterior side.
- .7 Seal thresholds.

.3 Sealant **Type B:**
- .1 Around mechanical fixtures/fittings.

.4 Sealant **Type C:**
- .1 Sidewalk and exterior floor joints.

.5 Sealant **Type D:**
- .1 Junction between drywall with a differing/adjacent material.

.6 Sealant **Type E:**
- .1 For use where shotcrete adjoins with a differing/adjacent material.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for the metal doors and frames work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.

.2 ASTM A568/A568M, Specification for General Requirements for Steel, Carbon and High-Strength Low-Alloy, Hot-Rolled Sheet and Cold-Rolled Sheet.

.3 CAN/CGSB-1.198, Cementitious Primer, (for Galvanized Surfaces).

.4 CGSB 41-GP-19Ma, Rigid Vinyl Extrusions for Windows and Doors.

.5 CAN/ULC-S702, Thermal Insulation, Mineral Fibre for Buildings.

.6 CSA W47.1, Certification of Companies for Fusion Welding of Steel Structures.

.7 CSA W59-M, Welded Steel Construction (Metal Arc Welding).

.8 CSDMA, Canadian Steel Door Manufacturer's Association.

1.3 **DESIGN REQUIREMENTS**

.1 Design exterior frame assemblies to accommodate expansion and contraction when subjected to minimum and maximum surface temperature of -35°C to 35°C.

1.4 **SUBMITTALS**

.1 Product data: Submit manufacturer's Product data in accordance with Section 01 33 00 indicating door and frame construction.

.2 Shop drawings:
  .1 Submit shop drawings in accordance with Section 01 33 00 for each type of door and frame indicating:
    .1 Thickness and type of steel.
    .2 Thickness and type of core.
    .3 Thickness and type of steel stiffeners and location of them within the door.
    .4 Thickness and type of metal facing on edges of door and method of fastening.
    .5 Location of mortises, reinforcement, anchorages, joining, welding, sleeving, exposed fasteners, openings and arrangement for hardware.
    .6 Details of each different wall opening condition.

.7 Details of moldings, stops and glazing.
.8 Details of conduit and preparations for power, signal, and control systems.

.2 Include schedule identifying each unit with door marks and numbers relating to numbering on Contract Drawings and in door schedule.

.3 Schedule: Provide a schedule of hollow metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final Door Hardware Schedule.

1.5 **QUALITY ASSURANCE**

.1 Perform work in accordance with requirements by a member of the Canadian Steel Door Manufacturer's Association (CSDMA).

1.6 **DELIVERY, STORAGE, AND HANDLING**

.1 Deliver hollow metal work palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use non-vented plastic.

.2 Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

.3 Store hollow metal work vertically under cover at Project site with head up. Place on minimum 100 mm high wood blocking. Provide minimum 6 mm space between each stacked door to permit air circulation.

2 Products

2.1 **ACCEPTABLE MANUFACTURERS**

.1 Hollow metal doors:
.1 16 ga. hollow metal doors with continuous welded seams, 'Fleming H-Series Door' by Fleming Doors Products.
.2 Or approved alternative as approved by the Owner.

.2 Hollow metal frame:
.1 16 ga. hollow metal door frames complete with pre-drilled and countersunk attachment holes, manufactured by Fleming Doors Products.
.2 Or approved alternative as approved by the Owner.

2.2 **MATERIALS**

.1 General: All materials under work of this Section, including but not limited to, primers are to have low VOC content limits.

.2 Steel: ASTM A568/A568M, Class 1; Commercial grade steel, hot dip galvanized to ASTM A653/A653M, G90 (ZF275) heavy galvanized coating.

.3 Minimum base steel thickness:

.1	Frames	1.6 mm
.2	Typical doors	1.6 mm
.3	Extra heavy duty doors	1.9 mm
.4	Lock/strike reinforcements	1.6 mm
.5	Hinge reinforcements	2.7 mm
.6	All other reinforcement	1.6 mm
.7	Top and bottom channels	1.2 mm
.8	Glazing stops	0.9 mm
.9	Guard boxes	0.9 mm
.10	Jamb spreaders	0.9 mm

.4 Top caps and thermal breaks: CGSB 41-GP-19Ma; Rigid PVC extrusions.

.5 Primer: CAN/CGSB 1.198.

.6 Core material: Exterior doors; rigid poly/isocyanurate, closed cell insulation, 32 kg/m^3, thermal value: RSI 1.9.

.7 Screws: Stainless steel screws with countersunk flat head.

.8 Door silencers: Type 6-180, black neoprene.

.9 Frame anchors: Frames in masonry; 1.2 mm minimum, adjustable T-strap jamb anchors to suit frame size.

.10 Floor anchors: 1.6 mm minimum adjustable floor clip angles with 2 holes for anchorage to floor.

.11 Grout: In accordance with Section 04 20 00, for full grouting of frames.

.12 Bituminous coating: Cold-applied asphalt mastic, compounded for 0.4 mm dry film thickness per coat. Provide inert-type non-corrosive compound free of asbestos fibres, sulfur components, and other deleterious impurities.

.13 Glass and glazing materials:
- .1 Hollow metal doors inaccessible to orangutans: As specified in Section 08 80 00, for door lite kit, consisting of tempered glass panes.
- .2 Hollow metal doors accessible to orangutans: As specified in Section 08 80 01, for laminated glass in viewing ports.

.14 Tubular steel frames: In accordance with Section 05 50 00.

2.3 FABRICATION

.1 General

.1 Fabricate doors and frames in accordance with reviewed shop drawings.

.2 Welding: CSA W59-M to produce a finished unit with no visible seams or joints, rigid, square, true and free of distortion, defects, warp or buckle.

.3 Welding: Continuous unless specified otherwise. Execute welding by a firm fully acceptable to the Canadian Welding Bureau to requirements of CSA W47.1.

.4 Form profiles accurately to details shown on Contract Drawings.

.5 Ream and remove burrs from drilled and punched holes.

.6 Grind welded corners and joints to a flat plane and fill with metallic filler and sand to a uniform smooth finish. Apply one coat of primer.

.7 Provide weather strip for exterior doors in accordance with Section 08 70 00 and door manufacturer.

.8 Unless otherwise indicated, overall door thickness to be 45 mm.

.2 Frames:

.1 Fabricate frames of welded construction. Cut mitres and joints accurately and weld continuously on inside of frame profile. Exterior frames to be thermally broken.

.2 Construct large frame sections with provision for on Site assembly to suit Site conditions.

.3 Blank, reinforce, drill and tap frames for mortised, templated hardware. Protect mortised cut-outs with guard boxes.

.4 Reinforce frames where required for surface mounted hardware.

.5 Reinforce frames over 1200 mm wide with roll formed steel channels or hollow structural sections specified in Section 05 50 00 and as indicated on drawings.

.6 Grout guards: Weld guards to frame at back of hardware mortises in frames to be grouted.

.7 Furnish exterior door frames with a continuously welded integral steel weather drip at head of frame.

.8 Prepare each door opening for single stud rubber door silencers, 3 for single door openings located in strike jamb, and 2 for double door openings located in head.

.9 Install 2 channel or angle spreaders per frame, to ensure correct frame alignment. Install stiffener plates or spreaders between frame trim where required, to prevent bending of trim and to maintain alignment when setting in place.

.10 Form channel glazing stops minimum 16 mm height, accurately cut, mitred, fitted and fastened to frame sections with stainless steel counter-sunk, flat head screws spaced at maximum 450 mm throughout and 50 mm from each end.

.3 Anchorage:

.1 Anchor units to floor and wall construction. Locate each wall anchor immediately above or below each hinge reinforcement on hinge jamb and directly opposite on strike jamb, minimum number of anchors for each jamb:

.1	Frames up to 2285 mm	3 anchors.
.2	Frames from 2285 mm to 3000 mm	4 anchors.
.3	Frames above 3000 mm high	4 anchors plus one additional anchor per jamb for each 600 mm above the stated height

.2 Where frames are to be set in masonry or concrete, supply adjustable anchors to trade installing frame.

.4 General Door Requirements:

.1 Hollow steel construction, flush swing type, of sizes to conform to details, schedules and reviewed shop drawings with provisions for cut-outs for glass and grilles and reinforced to receive hardware fastenings.

.2 Blank, reinforce, drill and tap doors for mortised, templated hardware. Where required, reinforce doors for surface mounted hardware and door closers.

.3 Reinforce oversized doors with steel channels and plates specified in Section 05 50 00 and as indicated on drawings.

.4 Where openings are required, form integral cut-outs with framing, glass stop moldings and division bars.

.5 Bevel both stiles of single doors 1 in 16.

.5 Exterior Doors:

.1 Supply and install inverted, recessed, fully welded channels at top and bottom of doors. Supply and install PVC top caps.

.2 Fabricate doors with joints between front and back panels meeting on stile edges. Make joints continuously welded for entire height of door. After welding has been completed, grind joints smooth to match metal. Ensure that no filler is used in joints.

.3 Fill hollow space within door from top to bottom with rigid polyisocyanurate insulation.

3 Execution

3.1 EXAMINATION

.1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

.2 Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

.3 Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.

3.2 HOLLOW METAL DOOR AND FRAME INSTALLATION

.1 Install hollow metal doors and frames in accordance with reviewed shop drawings, manufacturer's written instructions and to meet CSDMA requirements.

.2 Install hollow metal doors and frames plumb, square, level, secure, and at correct elevation.

.3 Install doors clear of floor finishes, and with the correct rebate opening for the door installation. Install door silencers in frames before grouting.

.4 Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.

.1 Secure anchorages and connections to adjacent construction. Brace frames rigidly in position while building-in. Remove temporary steel shipping jamb spreaders.

.2 Install wood spreaders at third points of frame rebate height to maintain frame width. Supply and install vertical supports as indicated on drawings for openings over 1200 mm in width.

.3 Remove wood spreaders after frames have been built-in.

.4 Check plumb, square, and twist of frames as walls are constructed. Shim as necessary to comply with CSDMA installation tolerances.

.5 Field apply bituminous coating to backs of frames that will be filled with grout containing anti-freezing agents.

.5 Masonry walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.

.6 Allow for structural deflection and prevent structural loads from being transmitted to hollow metal frames.

.7 Touch-up areas where galvanized coating has been removed or damaged with primer and as required to make repaired area smooth, flush, and invisible on exposed faces.

3.3 ADJUSTING AND CLEANING

.1 Adjust doors for smooth and balanced door movement. Leave work in complete and proper operating condition.

.2 Clean doors and frames.

.3 Remove grout and other bonding material from hollow metal work immediately after installation.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Design, labour, Products, equipment, tools, and services necessary for polycarbonate panel work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM D635, Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.

.2 ASTM D1003, Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics.

.3 ASTM D1435, Standard Practice for Outdoor Weathering of Plastics.

.4 ASTM D1929, Standard Test Method for Determining Ignition Temperature of Plastics.

.5 ASTM D2244, Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates.

.6 ASTM D2843, Standard Test Method for Density of Smoke from the Burning or Decomposition of Plastics.

.7 ASTM E84, Test Method for Surface Burning Characteristics of Building Materials.

1.3 **DESIGN REQUIREMENTS**

.1 Design polycarbonate panels to accommodate live, dead, lateral, wind, seismic, handling, transportation, and erection loads.

.2 Polycarbonate panels shall withstand the effects of the following forces without failure due to defective manufacture, fabrication, installation, or other defects in construction:
- .1 Structural loads.
- .2 Thermal movements.
- .3 Failure includes, but is not limited to, the following:
  - .1 Deflection exceeding specified limits.

.3 Deflection limits: Panel to be limited to 1.5 mm of clear span.

.4 Thermal movements: Allow for thermal movements from ambient- and surface-temperature changes for the Place of Work. Base calculations on surface temperatures of materials.

1.4 SUBMITTALS

.1 Shop drawings:
- .1 Submit shop drawings in accordance with Section 01 33 00 indicating as a minimum:
  - .1 Fabrication and erection of polycarbonate panel elements indicating materials, thicknesses, finishes, connections, joints, method of anchorage, number of anchors, supports, reinforcement, details, and accessories.

.2 Samples:
- .1 Submit following samples in accordance with Section 01 33 00.
- .2 Submit one sample of 150 x 150 mm of polycarbonate panel with selected finish.

.3 Extended warranty: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.

1.5 QUALITY ASSURANCE

.1 Installers qualifications: Perform work of this Section by a company that has a minimum of five years proven experience in the installation of polycarbonate panels of a similar size and nature.

.2 Product options: Information on Drawings and in Specifications establishes requirements for panel assemblies' aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including testing conducted by an independent testing agency and in-service performance.
- .1 Do not modify intended aesthetic effects, as judged solely by Consultant, except with Consultant's approval. If modifications are proposed, submit comprehensive explanatory data to Consultant’s for review.

1.6 EXTENDED WARRANTY

.1 Manufacturer’s warranty (failure or workmanship): Provide panel manufacturer’s warranty naming Owner as beneficiary for a period of 5 years from the date Work is certified as Substantially Performed and as specified herein.
- .1 Manufacturer agrees to repair or replace components of panel assemblies that fail in materials or workmanship within specified warranty period.
- .2 Failures include, but are not limited to, the following:
  - .1 Structural failures including, but not limited to, excessive deflection.
  - .2 Deterioration of metals, and other materials beyond normal weathering.
  - .3 Water leakage.

.3 Warranty to include the removal of failed Products, replacement with new Products conforming to the specifications, and restoration of work damaged by removal and replacement including labour and installation costs.

.2 Manufacturer's warranty (defects or workmanship): Provide panel manufacturer's warranty naming Owner as beneficiary for a period of 10 years from the date Work is certified as Substantially Performed and as specified herein.

.1 Manufacturer agrees to replace panels that exhibit defects in materials or workmanship within specified warranty period.

.2 Defects include, but are not limited to, the following:

.1 Delamination.

.2 Colour changes exceeding requirements.

.3 Losses in light transmission beyond 6 percent from original when measured per ASTM D1003.

.3 Warranty to include the removal of defective Products, replacement with new Products conforming to the specifications, and restoration of work damaged by removal and replacement including labour and installation costs.

2 Products

2.1 **MATERIALS**

.1 General:

.1 All materials under work of this Section, including but not limited to, primers, sealants, and cleaners are to have low VOC content limits.

.2 Edges of polycarbonate panels shall be free from spalls or chips which would be either visible or reduce the strength of panels when subjected to temperature differentials.

.2 Polycarbonate panels:

.1 Provide translucent, extruded-polycarbonate sheet for wire mesh panel enclosures and doors as required for the Work.

.2 Polycarbonate panels shall meet the following criteria:

.1 Plastic self-ignition temperature: 343 deg. C (650 deg. F) or more per ASTM D1929.

.2 Smoke developed index: 450 or less per ASTM E84 or 75 or less per ASTM D2843.

.3 Flame spread index: Not more than 25 per ASTM E84.

.4 Combustibility classification: Class CC1 per ASTM D635.

.5 Interior finish classification: Class A per ASTM E84.

.6 Colour change: Not more than 3.0 units Delta E when measured according to ASTM D2244 after outdoor weathering compliant with procedures in ASTM D1435.

.7 Impact resistance: No failure at impact of 200 ft. x lbf according to free falling-ball impact test using a 89 mm diameter, 6.3-lb ball.

.8 Panel thickness: 13 mm nominal.

.9 Panel colour: Translucent.

.3 Screws, bolts and fasteners: Corrosion resistant Type 316 stainless steel.

.4 Polycarbonate glazing and rebate primers, tapes, sealants, sealers, cleaners: Compatible with each other. Types as recommended by polycarbonate glazing panel manufacturer.

2.2 **FABRICATION**

.1 Verify polycarbonate panel dimensions on Site.

.2 Fabricate polycarbonate panels in accordance with reviewed shop drawings and manufacturer's written instructions.

.3 Fabricate panels to ensure profiles that are straight and free of defects or deformations.

.4 Accurately fitted joints with ends coped or mitred.

.5 Provide all cut-outs and holes in polycarbonate panels as required.

.6 Carefully make and fit details. Take special care with exposed finished work to produce a neat and correct appearance to the Consultant's acceptance.

3 Execution

3.1 **EXAMINATION**

.1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

.2 Verify that openings for polycarbonate panels are correctly sized and within tolerance.

3.2 **PREPARATION**

.1 Prepare framing to receive polycarbonate panels in accordance with manufacturer's written instructions.

.2 Verify that surfaces of polycarbonate panel framing or recesses are clean, free of obstructions, and ready to receive polycarbonate panels.

3.3 **INSTALLATION**

.1 Install polycarbonate panels in accordance with reviewed shop drawings and manufacturer's written instructions.

.2 Install polycarbonate panels to the work of Sections 05 59 64. Coordinate with noted Section as required for sizing and installation of polycarbonate panels with wire mesh panels.

.3 Provide neat, straight sight lines.

.4 Polycarbonate panels:
- .1 Install polycarbonate panels to extent, locations, sizes and details shown.
- .2 Install components plumb and true in alignment with established lines and elevations.
- .3 Mount panels rigidly in framing and ensure proper spacing, levelness, alignment and plumbness.
- .4 Secure panels in framing with stainless steel fasteners.
- .5 Seal joints watertight unless otherwise indicated.

.5 Erection tolerances: Install panel assemblies to comply with the following maximum tolerances:
- .1 Alignment: Limit offset from true alignment to 0.8 mm where surfaces abut in line, edge to edge, at corners, or where a reveal or protruding element separates aligned surfaces by less than 75 mm; otherwise, limit offset to 3 mm.
- .2 Location and plane: Limit variation from true location and plane to 3 mm in 1200 mm.

.6 Remove, dispose of, and replace broken, cut, abraded polycarbonate panels, and defective panels including but not limited to production dimples, marks, chips, cracks, etc.

3.4 FIELD QUALITY CONTROL

.1 Repair or remove work where test results and inspections indicate that it does not comply with specified requirements.

.2 Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

.3 Prepare test and inspection reports.

3.5 CLEANING

.1 Remove labels, protective material, and glass presence markers from prefinished surfaces.

.2 Clean polycarbonate panel surfaces with cleaning agents and methods in accordance with manufacturer’s written instructions.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Design, labour, Products, tool, equipment and services necessary for steel window work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 AAMA 502, Voluntary Specification for Field Testing of Newly Installed Fenestration Products.

.2 AAMA 2605, Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels - Series: Components, Coatings and Finishes.

.3 AAMA/WDMA/CSA 101/I.S.2/A440, Standard Specification for Windows, Doors, and Unit Skylights.

.4 ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

.5 ASTM C920, Specification for Elastomeric Joint Sealants.

.6 ASTM E331, Standard Test Method for Water Penetration of Exterior Windows, Curtain Walls and Doors by Uniform Static Air Pressure Difference.

.7 CAN/CGSB-1.108-M, Bituminous Solvent Type Paint.

.8 CAN/CSA-G40.20/G40.21-M, General Requirements for Rolled or Welded Structural Quality Steel/ Structural Quality Steels.

.9 CAN/ULC S705.1, Standard for Thermal Insulation - Spray Applied Rigid Polyurethane Foam, Medium Density - Material Third Edition.

.10 NFRC 100, Procedure for Determining Fenestration Product U-factors.

.11 NFRC 200, Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence.

1.3 **DESIGN REQUIREMENTS**

.1 Design windows to meet requirements of AAMA/WDMA/CSA 101/I.S.2/A440, NFRC 100, NFRC 200 and to meet performance and energy requirements specified herein and as required by authorities having jurisdiction.

.2 Design steel work in accordance with following Climatic Design Data for Toronto contained in the Ontario Building Code:
.1 Design temperature: January 1%, July 2 1/2%.

.2 Hourly wind pressures: 1 in 50 year occurrence.

.3 Design steel work to accommodate following without producing detrimental effect:
.1 Cyclic 40 degrees C daily thermal swing of components.
.2 Cyclic, dynamic loading and release of loads such as wind loads.
.3 13 mm vertical deflection in supporting structure and movement of supporting structure due to live, dead load, and creep or deflections, seismic load, sway displacement and similar items.

.4 Design to prevent accumulation of condensate on interior side of steel work framing under the following service conditions:
.1 Interior temperature: 25°C.
.2 Exterior temperature: -25°C.
.3 Interior RH: 35%.

.5 Design and detail controlled drainage path to actively discharge water, which enters into or forms within steel work, to exterior; prevent accumulation or storage of water within steel work. Prevent water from entering interior when tested in accordance with ASTM E331.

.6 Design windows in accordance to AAMA/WDMA/CSA -101/I.S.2/ A440, to the following performance levels:
.1 Performance class: CW.
.2 Minimum performance grade (PG): 30.
.3 Minimum positive design pressure: 1440 Pa.
.4 Minimum negative design pressure: - 1440 Pa.
.5 Minimum water penetration test pressure: 220 Pa.
.6 Minimum air infiltration/exfiltration: A2.
.7 Condensation resistance: I57.

.7 Design and detail air barrier, vapour retarder, and rainscreen products and assemblies into continuous and integrated steel work envelope. Optimize steel work design to align envelope layers and to minimize thermal bridges.

.8 Prevent deflection and permanent or progressive glazing displacement. Restrict horizontal and vertical mullion deflection to less than L/175 (under uniformly distributed positive design wind load), and 10 mm maximum regardless of span.

.9 Design anchorage inserts for installation as part of other Sections of Work. Design anchorage assemblies to accommodate construction and installation tolerances.

1.4 SUBMITTALS

.1 Shop drawings:
.1 Submit shop drawings in accordance with Section 01 33 00 indicating:
.1 Plans, sections, details, profiles, finishes, related flashings, closures, fillers, and end caps, and sealants.
.2 Products and glazing types.
.3 Anchorage inserts, system installation tolerances.

.4 Section and hardware reinforcement, anchorage, assembly fixings.
.5 Detailing, locations, and allowances for movement, expansion, contraction
.6 Path of cavity drainage and air pressure equalization.
.7 Calculations or modelling confirming windows conforms to intended performance and energy requirements.

.2 Samples:
.1 Submit two samples of following in accordance with Section 01 33 00.
.1 250 x 200 mm samples of glass unit.
.2 One complete corner detail of sash, frame, glazing, and finish for each type.
.3 Typical muntin section.

.3 Certificates: Qualification data for qualified installer.

.4 Reports: Submit documentation to substantiate ten years of experience in steel window manufacture and installation.

.5 Extended warranty: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.

.6 Close-out submittals: Submit window data for incorporated into the Operations and Maintenance Manual as part of Section 01 78 23.

1.5 QUALITY ASSURANCE

.1 Retain a Professional Engineer, licensed in Province of Ontario, with experience in steel work of comparable complexity and scope to perform the following services as part of the work of this Section:
.1 Design of steel window work.
.2 Review, stamp, and sign shop drawings.
.3 Conduct on-Site inspections and prepare and submit inspection reports.

.2 Source limitations: Obtain steel windows from single source from single manufacturer.

.3 Installers qualifications: Perform work of this Section by a company that has a minimum of five years proven experience in the installations of steel windows of a similar size and nature and that is approved by manufacturer. Submit to Consultant, installer's current certificate of approval by the material manufacturer as proof of compliance. Submit proof of experience upon Consultant's request.

.4 Mock-up:
.1 Fabricate, deliver, and erect one, full scale mock-up of a steel window, in location acceptable to Consultant.
.2 Demonstrate full range of Products, finishes, textures, quality of fabrication, and workmanship.
.3 Mock-up may form part of final Work, if acceptable to Consultant. Remove and dispose of mock-ups which do not form part of Work.

.5 Pre-installation meeting: Arrange with manufacturer's representative, Contractor, and Consultant to inspect substrates, and to review installation procedures 48 hours in advance of installation.

1.6 **DELIVERY, STORAGE, AND HANDLING**

.1 Handle primed steel work in accordance with manufacturer's written instructions.

.2 Protect steel surfaces with strippable coating. Do not use adhesive papers or sprayed coatings which bond when exposed to sunlight or weather. Do not remove before final cleaning of building.

1.7 **EXTENDED WARRANTY**

.1 Submit an extended warranty for steel work in accordance with General Conditions, except that warranty period is extended to 5 years.
.1 Warrant against failure to meet the design criteria and requirements such as interior leakage, glass unit failure, frame condensation.
.2 Coverage: Complete replacement including affected adjacent work.

2. Manufacturer's finish Warranty: Provide manufacturer's written warranty naming Owner as beneficiary and covering failure of factory-applied exterior finish on steel window work for a period of 10 years.

2 Products

2.1 **ACCEPTABLE MANUFACTURER(S) AND SYSTEM(S)**

.1 Hot-rolled steel windows:
.1 'RTS 430 Thermally Broken Steel Windows' by Optimum Window Manufacturing Corp.
.2 Or approved alternatives by Bliss Nor-Am Doors & Windows Ltd. or g. Torrance Steel Window Co., Inc.

2.2 **MATERIALS**

.1 All materials under work of this Section, including but not limited to, sealants are to have low VOC content limits.

.2 Billet steel: Solid, hot rolled steel conforming to CAN/CSA-G40.20/G40.21-M.

.3 Reinforcements, and anchors clips, and angles: To CAN/CSA-G40.20/G40.21-M, sizes and shapes shown or as required.

.4 Glass and glazing materials:
.1 Steel windows inaccessible to orangutans: As specified in Section 08 80 00.
.2 Steel windows accessible to orangutans: As specified in Section 08 80 01.

.5 Airseal sealant: ASTM C920; one part silicone, neutral cure, elastomeric sealant; 'Spectrem 2' by Tremco or 'Dowsil 795' by Dow Consumer Solutions. Colour as later selected by Consultant.

.6 Frame sealant: Type as recommended by the steel work manufacturer.

.7 Steel work sealant: ASTM C920; single-component, silicone sealant; 'Spectrem 1' by Tremco or 'Dowsil 790' by Dow Consumer Solutions. Colour as selected by Consultant.

.8 Joint backing: Closed cell foam polyethylene rod, outsized minimum 30-50% larger than joint width and compatible with joint sealant. Product as recommended by sealant manufacturer.

.9 Airseal transition membrane: 'Sopraseal Stick 1100' by Soprema Inc., 'Exoair 110' by Tremco or 'Air-Shield' by W.R. Meadows. Membrane to come complete with applicable primer.

.10 Shims and blocking for frame: Rigid plastic, wood is not permitted.

.11 Flashings, closures and trim: 1.0 mm minimum steel sheet, finish to match framing.

.12 Screws, bolts and other fasteners: Conforming to ASTM A307, Grade A, in areas not exposed to view, use unfinished bolts with hexagon heads and nuts. In areas exposed to view, use bolts, nuts, washers, rivets, lock washers, anchor bolts, machine screws and machine bolts Z275 zinc coated. Supply bolts of lengths required to suit thickness of material being joined, but not projecting more than 6 mm beyond nut, without the use of washers.

.13 Isolation coating: CAN/CGSB-1.108-M; Bitumastic coating, acid and alkali resistant material.

.14 Foam insulation: CAN/ULC S705.1, CFC free, polyurethane foam in place, closed cell, low expansion, one component air sealant, minimum density 15 kg/m^3.

2.3 FABRICATION

.1 Fabricate steel windows in accordance with reviewed shop drawings and manufacturer's written instructions.

.2 Fabricate sections true to detail, free from defects impairing appearance, strength and durability. Fabricate rolled shapes with sharp, well defined corners.

.3 Fabricate, fit, and secure framing joints and corners accurately, with flush surfaces, and hairline joints. Apply frame sealant at joints for weatherproof seams.

.4 Conceal anchors, reinforcement and attachments from view. Fabricate reinforcement in accordance with design requirements.

.5 Do not expose manufacturer's identification labels on steel assemblies.

.6 Fabricate continuous sill flashings with intermediate anchor clips, and joint reinforcing, form to profile shown.

.7 Fabricate filler and closure pieces as necessary for a complete and weather tight installation.

.8 Fabricate glazing recess with drainage to exterior.

.9 Fabricate steel work closures and trim from steel sheet. Form to profile shown. Make weathertight.

.10 Steel tee muntins shall be tenoned and welded to the perimeter frame. Intersection shall be slotted and cross-notched. All joints shall be face welded and exposed surfaces finished smooth flush with adjacent surfaces.

.11 Weatherstripping: Extruded flexible PVC.

2.4 **FINISH**

.1 Primer and finish: After fabrication steel windows, mullions, covers and trim shall receive one or both of the following finishes:
- .1 Hot-dipped galvanizing.
- .2 Fluoropolymer finish: Duranar (kynar), baked on enamel and conforming to AAMA 2605.
- .3 Brown colour as approved by the Consultant.

.2 Panel and sheet finish: As indicated on drawings to match adjacent steel finish.

3 Execution

3.1 **EXAMINATION**

.1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.2 INSTALLATION

.1 Install steel window work in accordance with reviewed shop drawings, manufacturer's written instructions, AAMA/WDMA/CSA 101/I.S.2/A440 and to meet requirements of authorities having jurisdiction.

.2 Install work of this Section securely, in correct location, level, square, plumb, at proper elevations, free of warp or twist.

.3 Apply isolation coating at 0.8 mm dry film thickness to prevent corrosive or electrolytic action between dissimilar materials such as steel to concrete, masonry, galvanized steel and similar conditions.

.4 Install flashings, closures, and trim pieces.

.5 Fill voids between steel framing and adjacent construction with foam insulation.

.6 Install sills in maximum lengths possible. For sills over 1200 mm in length, maintain 3 mm to 6 mm space at each end.

.7 Refer to Contract Drawings for glazing type locations. Install glazing in accordance with Sections 08 80 00.

.8 Remove damaged or unacceptable Products and assemblies from Site and replace to Consultant's acceptance.

.9 Install glass presence markers, in two cross stripes extending from diagonal corners. Maintain markers until final clean-up.

3.3 ERECTION TOLERANCES

.1 Tolerances: Non-cumulative.
- .1 Maximum variation from plumb: 1.5 mm/3 m non-cumulative or 12 mm/30 m, whichever is less.
- .2 Maximum misalignment of two adjoining members abutting in plane: 0.8 mm.
- .3 Vertical and horizontal positions: +/- 3 mm.
- .4 Racking of face: 6 mm, nil in elevation.
- .5 Maximum perimeter sealant joint between steel entrance and adjacent construction: 13 mm.

3.4 GLAZING PERIMETER AIRSEAL

.1 Install glazing perimeter airseal at entire perimeter of each glass unit to achieve an airseal from glass unit to frame. Do not obstruct path of cavity drainage and air pressure equalization.

3.5 AIRSEAL TRANSITION MEMBRANE

.1 Install primer and airseal transition membrane in accordance with manufacturer's instructions.

.2 Overlap airseal transition membrane 75 mm minimum and lap in direction of waterflow.

.3 Coordinate airseal transition to adjacent parts of Work.

.4 Provide end-dams and terminations fabricated from same material as airseal transition membrane or material recommended by membrane manufacturer at sills, lintels, openings, and where horizontal surfaces intersect with vertical surfaces to ensure moisture is shed to exterior.

3.6 JOINT BACKING AND STEEL WORK SEALANT

.1 Prepare substrate surface and mask as recommended by sealant manufacturer.

.2 Install joint backing and sealant at steel work and perimeter joints for weather tight installation in accordance with sealant manufacturer's instructions. Tool sealant. Remove excess sealant.

3.7 FIELD QUALITY CONTROL

.1 Testing agency: Owner will engage a qualified testing agency to perform tests and inspections.

.2 Tests and Inspections:

.1 Testing Methodology: Testing of windows for air-penetration resistance and water resistance will be performed according to AAMA 502, Test Method A or B, by applying same test pressures required for performance.

.2 Testing extent: One window as selected by the Consultant and a qualified independent testing and inspecting agency. Windows shall be tested immediately after installation.

.3 Window will be considered defective if it does not pass tests and inspections.

.4 Prepare test and inspection reports according to AAMA 502. Testing agency will interpret test results and state in each report whether tested work complies with or deviates from requirements.

3.8 CLEANING

.1 Maintain steel work, inside and outside, in clean condition throughout construction period.

.2 Remove labels, protective material, and glass presence markers from prefinished surfaces.

.3 Wash steel work with solution of mild detergent in warm water, with particular attention to recesses and corners. Wipe surfaces clean and dry.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Design, labour, Products, equipment and services necessary for wood window work in accordance with the Contract Documents.

1.2 **REFERENCE**

.1 AAMA/WDMA/CSA 101/I.S.2/A440, Standard Specification for Windows, Doors, and Unit Skylights.

.2 Architectural Woodwork Manufacturers Association of Canada (AWMAC) - Quality Standards for Architectural Woodwork.

.3 ASTM A167, Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.

.4 ASTM F738M, Specification for Stainless Steel Metric Bolts, Screws, and Studs.

.5 CAN/CGSB-19.13-M, Sealing Compound, One-Component, Elastomeric, Chemical Curing.

.6 CAN/CGSB 79.1-M, Insect Screens.

.7 CAN/CSA O141, Softwood Lumber.

.8 CAN/ULC S705.1, Standard for Thermal Insulation - Spray Applied Rigid Polyurethane Foam, Medium Density - Material Third Edition.

.9 NFRC 100, Procedure for Determining Fenestration Product U-factors.

.10 NFRC 200, Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence.

1.3 **DESIGN REQUIREMENTS**

.1 Design windows to meet requirements of AAMA/WDMA/CSA 101/I.S.2/A440, NFRC 100, NFRC 200 and to meet performance and energy requirements specified herein and as required by authorities having jurisdiction.

.2 Design windows in accordance with following Climatic Design Data for Toronto contained in Ontario Building Code:
.1 Design Temperature: January 1%, July 2 1/2% .
.2 Wind (Hourly Wind Pressures): 1 in 50 year occurrence.

.3 Design windows to accommodate following without detrimental effect:
- .1 Cyclic 40 degrees C daily, thermal swing of components.
- .2 Cyclic, dynamic loading and release of loads such as wind loads.
- .3 13 mm vertical deflection in the supporting structure and movement of supporting structure due to live, dead load, and creep or deflection, seismic load, sway displacement and similar items.

.4 Design windows in accordance to AAMA/WDMA/CSA -101/I.S.2/ A440, to the following performance levels:
- .1 Performance class: CW.
- .2 Minimum performance grade (PG): 30.
- .3 Minimum positive design pressure: 1440 Pa.
- .4 Minimum negative design pressure: - 1440 Pa.
- .5 Minimum water penetration test pressure: 220 Pa.
- .6 Minimum air infiltration/exfiltration: A2.
- .7 Condensation resistance: I57.

.5 Design and detail air barrier, vapour retarder, insulation and rainscreen Products and assemblies into continuous and integrated window envelopes. Optimize window design to align envelope layers and to minimize thermal bridges.

.6 Prevent deflection and permanent or progressive glazing displacement. Restrict horizontal and vertical mullion deflection to L/175 maximum under uniformly distributed positive load and 10 mm maximum regardless of span.

.7 Design anchorage inserts for installation as part of other Sections of the Work. Design anchorage assemblies to accommodate construction and installation tolerances.

1.4 SUBMITTALS

.1 Shop drawings:
- .1 Submit shop drawings in accordance with Section 01 33 00 indicating:
  - .1 Plans, elevations, sections, and details.
  - .2 Products, glazing types, hardware, and finishes.
  - .3 Section reinforcement, anchorage, assembly fixings.
  - .4 Anchorage inserts, system installation tolerances
  - .5 Detailing, locations, and allowances for movement, expansion, contraction of materials.
  - .6 Detailing of air/vapour retarder system to ensure continuity.
  - .7 Path of cavity drainage and air pressure equalization.
  - .8 Clearly indicate materials and assemblies in large scale details for head, jamb, sill, top and bottom rails, stiles, and muntin bar conditions.
  - .9 Calculations or modelling confirming windows conforms to intended performance and energy requirements.

.2 Samples: Submit following samples in accordance with Section 01 33 00.
- .1 Two 250 mm long samples of fixed frame and finish.
- .2 Two 250 x 200 mm samples of sill flashing.

.3 Reports:
- .1 Submit substantiating engineering data, and independent test results of pre-tested window designs to substantiate compliance with design criteria.
- .2 Submit documentation to substantiate ten years of experience in window manufacture and installation.

.4 Project close-out submittals: Submit data for windows incorporated into Operation and Maintenance Manual as part of Section 01 78 23.

.5 Extended warranty: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.

1.5 QUALITY ASSURANCE

.1 Installers qualifications: Perform work of this Section by a company that has a minimum of five years proven experience in the installations of a similar size and nature and that is approved by manufacturer. Submit to Consultant, applicator's current certificate of approval by the material manufacturer as proof of compliance. Submit proof of experience upon Consultant's request.

.2 Independent inspection:
- .1 Inspection and testing of windows may be performed by an inspection and testing firm designated and paid for by the Owner.
- .2 Inspection and testing by the independent inspection company may be performed on or off site. Inspection and testing will be performed to ensure that windows meet specified design criteria. Coordinate with inspection and testing company.
- .3 Windows not meeting design criteria will be replaced at no cost to Owner.

.3 Mock-up:
- .1 Fabricate, deliver, and erect one window mock-up, for each type of window, in location acceptable to Consultant.
- .2 Demonstrate full range of Products, finishes, quality of fabrication, workmanship and conformance with design criteria.
- .3 Mock-up may form part of final Work, if acceptable to Consultant. Remove and dispose of mock-ups which do not form part of Work.

.4 Pre-installation meeting: Arrange with manufacturer's representative, Contractor, and Consultant to inspect substrates, and to review installation procedures 48 hours in advance of installation.

1.6 DELIVERY, STORAGE, AND HANDLING

.1 Protect windows during delivery and store in a dry, well ventilated place indoors and protect from injury.

.2 Provide plywood covering to protect window openings and unit interiors from the weather and intrusion during the work.

1.7 **EXTENDED WARRANTY**

.1 Submit an extended warranty for window work in accordance with General Conditions, except that the warranty period is extended to 5 years.
  .1 Warrant against failure to meet the design criteria and requirements such as interior leakage, insulating glass unit failure, finish degradation, frame condensation.
  .2 Coverage: Complete replacement including affected adjacent work.

2 Products

2.1 **MATERIALS**

.1 All materials under work of this Section, including but not limited to, sealants are to have low VOC content limits.

.2 Wood windows:
  .1 Wood windows to be complete with hardware, prefinished with Consultant approved stain finish suitable for the environment and fabricated from cedar wood.
  .2 Wood windows as manufactured by Heritage Windows & Doors Inc., Loewen Windows or Pella Windows and Doors.

.3 Glass and glazing materials: As specified in Section 08 80 00.

.4 Airseal sealant: CAN/CGSB-19.13-M; One part silicone neutral cure low modulus sealant. Verify compatibility with insulating glass unit manufacturer's secondary sealant.

.5 Frame sealant: Type as recommended by the window manufacturer.

.6 Window sealant: CAN/CGSB-19.13-M; Single-Component, silicone sealant; 790 Silicone Building Sealant by Dow Consumer Solutions. Colour as selected by Consultant.

.7 Glass presence markers: As specified in Section 08 80 00.

.8 Joint backing: Closed cell foam polyethylene rod, outsized minimum 30-50% larger than joint width and compatible with joint sealant. Product as recommended by sealant manufacturer.

.9 Airseal tape: 19 mm wide butyl tape, thickness as required.

.10 Transition membrane: EPDM sheet, 1.1 mm thick complete with manufacturer's recommended adhesives for lap seal.

.11 Fastening bar: 25 x 3 mm, Type 304 stainless steel fastening bar, with pre-punched fastening holes at 100 mm o.c.

.12 Shims and blocking for frame: Rigid plastic, wood is not permitted.

.13 Screws, bolts and other fasteners: ASTM F738M; Stainless Steel Type 304.

.14 Foam insulation: CAN/ULC S705.1, CFC free, polyurethane foam in place, closed cell, low expansion, one component air sealant, minimum density 15 kg/m^3.

.15 Window hardware: Manufacturer's standard heavy duty hardware, stainless steel with AISI No. 4 finish.

.16 Insect screen: Wood frames containing 14 x 18 mesh fibreglass screen cloth conforming to CAN/CGSB 79.1-M. Screen to be retained in place with turn clip type fixings.

.17 Weatherstripping: Extruded flexible EPDM to ASTM D-2000.

2.2 **FABRICATION**

.1 Fabricate wood windows in accordance with reviewed shop drawings and manufacturer's written instructions.

.2 Take site measurements of all openings for new window, frame and sash.

.3 Fabricate sections true to detail, free from defects impairing appearance, strength and durability. Fabricate extrusions with sharp, well defined corners.

.4 Provide removable interior glass stops, and with glazing channels weeped to exterior.

.5 Fabricate, fit and secure framing joints and corners accurately, with flush surfaces, and hairline joints. Seal frame with sealant at joints for weatherproof seams.

.6 Conceal anchors, reinforcement and attachments from view. Fabricate reinforcement in accordance with design requirements.

.7 Fabricate continuous sill flashings with intermediate anchor clips, and joint reinforcing. Fabricate filler and closure pieces as necessary for a complete and weathertight installation.

.8 Do not expose manufacturer's identification labels on window assemblies.

.9 Certify windows as complying with the AAMA/WDMA/CSA 101/I.S.2/A440 design criteria and requirements using an easily removable label located on the inside face of glazing.

.10 Fabricate frames complete with internal reinforcements, cut-outs, and recesses to accommodate finish hardware. Reinforce cut-outs to assure adequate strength.

.11 Fabricate work in a manner which will permit expansion and contraction of the materials without visible open joints. Conceal joints and connections in wherever possible.

.12 Fabricate window flashings, closures and trim to profile shown. Make weathertight.

.13 Double weatherstrip windows. Install weatherstripping and secure to prevent shrinkage or movement.

3 Execution

3.1 **EXAMINATION**

.1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.2 **INSTALLATION**

.1 Install wood windows in accordance with AAMA/WDMA/CSA 101/I.S.2/A440, reviewed shop drawings and manufacturer's instructions.

.2 Install work of this Section securely, in correct location, level, square, plumb, at proper elevations, free of warp or twist.

.3 Install window flashings, closures, and trim pieces.

.4 Fill voids between framing and adjacent construction with foam insulation.

.5 Install sills in maximum lengths possible. For sills over 1200 mm in length, maintain 3 mm to 6 mm space at each end.

.6 Refer to drawings for glazing type locations. Install glass units in accordance with requirements of Section 08 80 00.

.7 Install glass presence markers, in two cross stripes extending from diagonal corners. Maintain markers until final clean-up.

3.3 **ERECTION TOLERANCES**

.1 Tolerances: Non-cumulative.

.2 Maximum variation from plumb: 1.5 mm/3 m non-cumulative .

.3 Maximum misalignment of two adjoining members abutting in plane: 0.8 mm.

.4 Vertical and horizontal positions: +/- 3 mm.

.5 Operable units: Consistent with smooth operation and weatherproof performance.

.6 Maximum perimeter sealant joint between window and adjacent construction: 13 mm.

3.4 GLAZING PERIMETER AIRSEAL

.1 Install glazing perimeter airseal at entire perimeter of each insulating glass unit to achieve an airseal from insulating glass unit to frame. Do not obstruct path of cavity drainage and air pressure equalization.

3.5 AIRSEAL TRANSITION MEMBRANE

.1 Install airseal transition membrane in accordance with manufacturer's instructions, pre-installed onto entire window frame perimeter in factory, sandwiching airseal tape and EPDM sheet with continuous fastening bar.

.2 Overlap and seal airseal transition membrane 75 mm minimum into continuous boot.

.3 Supply and install airseal transition boot extended minimum 150 mm beyond frame to accommodate Site seal. Supply and install airseal tape and fastening bar to building airseal, on Site.

.4 Provide end-dams and terminations fabricated from same material as airseal transition membrane or material recommended by membrane manufacturer at sills, lintels, openings, and where horizontal surfaces intersect with vertical surfaces to ensure moisture is shed to exterior.

3.6 JOINT BACKING AND SEALANT

.1 Prepare substrate surface, mask as recommended by sealant manufacturer.

.2 Install joint backing and frame sealant at window system joints and perimeter for weathertight installation in accordance with window sealant manufacturer's instructions. Remove excess sealant.

.3 Seal joints between window sills with sealant. Bed sill expansion joint cover plates and drip deflectors in sealant. Seal between sill upstand and door-frame. Seal butt joints in continuous sills.

3.7 CLEANING

.1 Maintain window, inside and outside, in clean condition throughout duration of work.

.2 Remove protective material, and glass presence markers from prefinished surfaces.

.3 Remove AAMA/WDMA/CSA 101/I.S.2/A440 certification labeling when directed by Consultant, in writing.

.4 Wash window with solution of mild detergent in warm water, with particular attention to recesses and corners. Wipe surfaces clean and dry.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for finish hardware work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 BHMA, Builders Hardware Manufacturing Association.

1.3 **SUBMITTALS**

.1 Product data: Submit manufacturer's Product data in accordance with Section 01 33 00 indicating compliance with reference standards, transportation, storage, handling and installation requirements.

.2 Shop Drawings:
- .1 Submit Shop Drawings in accordance with Section 01 33 00 indicating:
  - .1 Door locations, sizes, hardware manufacturer's catalogue numbers, finish symbols and quantities required.
  - .2 Locations and mounting heights of each type of hardware.
- .2 Supply templates and required information to door and frame manufacturer to enable accurate sizes, locations of cut-outs and reinforcement for hardware.
- .3 Submit templates to required trade to arrange for provisions for accurate setting and fitting of hardware.

.3 Hardware Schedule: Submit 3 complete hardware lists for Consultant’s review.

.4 Samples:
- .1 Submit 2 samples in accordance with Section 01 33 00 of each item that is different from hardware specified and include manufacturer's parts lists and installation instructions.
- .2 Submit hardware component samples illustrating style, colour and finish. Tag samples identifying applicable Specification article number, brand name and number, finish, building location, date and catalogue number.
- .3 Do not order hardware until samples have been accepted. Submit new samples to replace rejected samples. Supply hardware and finishes identical to each accepted sample.

.5 Closeout submittals:
- .1 Submit the following in accordance with Section 01 78 23 for each Product for incorporation into Operation and Maintenance Manual:
  - .1 Maintenance data.
  - .2 Operating instructions and safety precautions.
  - .3 Parts list with name and address of supplier.
  - .4 Lubrication schedule and type of lubricant recommended.
  - .5 Keys, tools and special devices.
  - .6 Inspection procedures related to preventive maintenance.

1.4 **QUALITY ASSURANCE**

.1 General:
- .1 Manufacturers: Companies specializing in manufacturing door hardware and registered with BHMA.
- .2 Hardware supplier: Company specializing in supplying commercial door hardware and acceptable to manufacturer.

.2 Certifications:
- .1 Employ an Architectural Hardware Consultant to inspect completed installation and certify that hardware has been installed in accordance with manufacturer's printed instructions, Authorities having Jurisdiction and as specified.
- .2 Submit manufacturer's certificate that finish hardware meets specified requirements.

1.5 **DELIVERY, STORAGE, AND HANDLING**

.1 Be responsible for packaging of hardware, on a set by set basis. As material is received from various manufacturers identify it to correspond to Hardware List symbols.

.2 Label packages legibly, indicating manufacturer's number, types, sizes, opening number and Hardware List reference number. Wrap hardware and include in package, screws, bolts and fastening necessary for correct installation. If hardware package is not complete, pay additional charges incurred by installer.

.3 Deliver hardware to Site packaged, labelled and cross-referenced to hardware list for each item and its scheduled installation location.

.4 Accept Products of this Section on Site and ensure that each item is undamaged.

.5 Catalogue and store hardware in secure area.

2 Products

2.1 **GENERAL**

.1 Provide hardware schedule to Consultant for approval indicating products, materials and finishes. Do not order products until schedule has been approved by Consultant.

.2 Provide all finish hardware components as required for complete and secure installation and to meet requirements of authorities having jurisdiction.

.3 Finish hardware to be keyed to meet Owner’s requirements.

.4 Standard hollow metal doors: Finish hardware for standard hollow metal doors shall include but not be limited to the following listed items. Alternatives will be considered by the Consultant provided they meet or exceed the requirements of the specified products and are approved in writing by the Consultant.

.1 Weatherstripping: 'K.N. Crowder # 13' by K.N. Crowder Inc.
.2 Threshold: 'CT-11' by K.N. Crowder Inc.
.3 Sweep: 'W-24S' by K.N. Crowder Inc.
.4 Vinyl caps: Top of door rain cap.
.5 2-¾" backset hole pre- drilled for Stanley Best Series Locks.
.6 Lever set: 2-1/8" hole for '93 K Series H.D. Stanley Best Lever Set' with housing for 'Best 7-Pin 1C- Core', # 15 lever with 'C' rose , in 626 finish.
.7 Tubular deadbolt: 2-1/8" hole '83 T Series H.D. Stanley Best' tubular deadbolt with housing for 'Best 7-Pin 1C- Core, STK', in 626 finish.
.1 DBL keyed tubular deadbolt: 'Best - 83T 7M-STK' in 626 finish.
.8 Universal mortise lock: Door prep for '45 H Series H.D. Stanley Best'; universal mortise lock with housing for 'Best 7- Pin 1C-Core' Unr (Multi-Function) #15 Lever, M-escutcheon.
.9 Hinges: Prep door and frame for 4-½" x 4-½ " Hager - NRP - stainless steel - heavy- duty butt hinges - 'BB 1199' - 3 per door or Stanley hinges 'FBB 199 - NRP (32 D)'.
.10 Door closer: 'LCN 4040 XP' universal door closer.
.11 Flush bolt: DON-JO '#1578', 8" stainless steel surface bolt.
.12 Kickplate: DON-JO '#J102', stainless steel.
.13 Push plate: DON-JO '#J301', stainless steel push plate.

.5 Carefully check and verify Hardware List against Contract Drawings to ensure that hardware listed can be used as specified. Inform Consultant of concerns regarding quality, quantity, operation or function of hardware selected:

.1 Verify hand of doors, examine details on Contract Drawings and at Site to ensure hardware supplied can be correctly installed and is correct for work as constructed.
.2 Select hardware in accordance with applicable codes and regulations.
.3 Replace and pay for defective hardware including hardware which was incorrectly selected, and remedial and installation costs.

.6 Ensure that hardware selected will function correctly, meets Contract requirements and Ontario Building Code and authorities having jurisdiction.

.7 Ensure that each hardware item is of same type, design and by same manufacturer.

.8 Manufacturer's names or trade marks are not permitted on exposed surfaces of hardware.

.9 Include in packing slip a list of parts, name of supplier and door number in which lock is to be installed.

2.2 **ACCESSORIES**

.1 Items to be attached to masonry or concrete with expandable shields, lag screws, bolts or other fastening devices as required. Exposed screws: Stainless steel, Phillips or Robertson heads.

2.3 **FINISHES**

.1 Metal finishes: Free from defects, clean, unstained and of a uniform colour for each type of finish required. Exposed surfaces and anchors: Specified finish symbol of item.

3 Execution

3.1 **EXAMINATION**

.1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.2 **INSTALLATION**

.1 Install hardware in accordance with reviewed Shop Drawings, manufacturer's installation instructions, and applicable Codes and regulations.

.2 Install hardware in accordance with hardware templates.

.3 Adjust fixed and operable hardware for correct clearances and function.

.4 Mount hardware measured from finished floor to centre of hardware, unless indicated otherwise or required by Code:
- .1 Top hinge: 250 mm from head of door to top.
- .2 Bottom hinge: 265 mm from finished floor to bottom of hinge.
- .3 Intermediate hinge: Equal distance between top and bottom hinge.
- .4 Locksets, latchsets: 1000 mm.
- .5 Panic device crossbar: 1000 mm.
- .6 Push plates: 1100 mm to bottom of plates.
- .7 Guard bars: 1100 mm.
- .8 Door pulls: 1100 mm to bottom of pulls.
- .9 Blank strike: 1450 mm.
- .10 Blank fronts: 1450 mm.

.5 Include for supply and installation of wiring for electric strikes from electrical junction box to electric strike hardware.

.6 Locate door stops to contact doors 75 mm from latch edge.

.7 Install hardware and trim square and plumb to doors.

.8 Replace wrappings for hardware provided by manufacturer after installation.

.9 Safeguard keys to keep them out of unauthorized hands, tag them with door number, and deliver them to person designated by Consultant at building completion.

3.3 **FIELD QUALITY CONTROL**

.1 Have hardware inspected after installation by hardware supplier's representative, obtain certification in writing that hardware has been supplied and installed in accordance with Specifications and hardware manufacturer's instructions and is functioning correctly.

.2 Test access control system and electrified hardware devices for proper operation. Verify electric door release hardware operates properly upon activation of fire alarm system.

3.4 **ADJUSTING**

.1 Verify under work of this Section, that installed hardware functions properly.

.2 Adjust hardware so that latches and locks operate smoothly and without binding, and closers act positively with the least possible resistance in use. Lubricate hardware if required by manufacturer's instructions.

3.5 **CLEANING**

.1 Remove wrappings at completion of the Project and clean hardware in accordance with manufacturer's instructions.

3.6 **HARDWARE GROUPS/SCHEDULE**

.1 Hardware groups/schedule: Provide hardware schedule for Consultant’s review and approval.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Design, labour, Products, equipment, tools, and services necessary for miscellaneous glass and glazing work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM D2240, Test Method for Rubber Property - Durometer Hardness.

.2 ASTM E2190, Standard Specification for Insulating Glass Unit Performance and Evaluation.

.3 CAN/CGSB-12.1-M, Tempered or Laminated Safety Glass.

.4 CAN/CGSB-12.8, Insulating Glass Units.

.5 Glass Association of North America (GANA) Glazing Manual.

1.3 **DESIGN REQUIREMENTS**

.1 Glass design:
- .1 Design glass using a probability of breakage of 8 lites per 1000 at the first application of design load.
- .2 Perform stress analysis. Design units to accommodate live, dead, lateral, wind, seismic, handling, transportation, and erection loads.
- .3 Perform a thermal stress analysis on each glass unit with Low-E coating and provide heat strengthening as necessary to prevent thermal breakage.
- .4 Perform a thermal stress analysis on each insulating thermal unit and provide heat strengthening as necessary to prevent thermal breakage.
- .5 Where required, design glazing units so as not to allow thermal stress fracture due to heat build-up behind insulating units.
- .6 Coordinate with applicable Sections as required to meet intended energy and performance requirements for insulating glass units.

.2 Limit glass deflection to flexural limit of glass with full recovery of glazing materials.

.3 Utilize inner light of multiple light sealed units for continuity of air and vapour seal.

1.4 **SUBMITTALS**

.1 Shop drawings:
- .1 Submit shop drawings in accordance with Section 01 33 00 indicating as a minimum:
  - .1 Fabrication and erection of glazing elements indicating materials, thicknesses, finishes, connections, joints, method of anchorage, number of anchors, supports, reinforcement, details, and accessories.

.2 Samples:
  .1 Submit following samples in accordance with Section 01 33 00.
  .2 Submit one sample of each type of glass.
    .1 300 x 300 mm of each type of insulating glass unit, complete with each different Low-E coating.

.3 Certificates: Submit manufacturer's certification that glass and glazing materials are compatible.

.4 IGMA Compliance Audit: Submit in accordance with Section 01 33 00, a written certification of successful completion of a Compliance Audit within the last six months.

.5 Extended warranty: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.

1.5 QUALITY ASSURANCE

.1 Insulating glass unit fabricators shall be a certified member of the Insulating Glass Manufacturer's Alliance (IGMA). IGMA members must participate in the certification program and shall have successfully passed a Compliance Audit within the last six months.

.2 Installers qualifications: Perform work of this Section by a company that has a minimum of five years proven experience in the installation of glazing units of a similar size and nature.

1.6 SITE CONDITIONS

.1 Glaze with compounds, sealants, or tapes only when glazing surfaces are at temperatures over 4°C, and when positive that no moisture is accumulating on them from rain, mist, or condensation.

.2 When temperature of glazing surfaces is below 4°C, obtain from Consultant and material manufacturer approval of glazing methods and protective measures which will be used during glazing operations.

1.7 EXTENDED WARRANTY

.1 In accordance with Section 08 51 23 and 08 52 00.

2 Products

2.1 **ACCEPTABLE MANUFACTURERS**

.1 Glass manufacturers:
- .1 AGC Flat Glass.
- .2 Cardinal Glass Industries.
- .3 Guardian Industries.
- .4 Viracon Inc.
- .5 Vitro Architectural Glass (formerly PPG Industries Ltd.)

2.2 **MATERIALS**

.1 General:
- .1 All materials under work of this Section, including but not limited to, primers, coatings, sealers, sealants, adhesives and cleaners are to have low VOC content limits.
- .2 All coatings of a similar type shall be applied in a single production run to ensure colour match.
- .3 Edges of glass shall be free from spalls, flake chips or rough chips which would be either visible or compromise the adhesion of the exterior weather seal or reduce the strength of glass when subjected to temperature differentials.

.2 Low iron tempered glass **(TGL)**: CAN/CGSB-12.1-M, clear, tempered, glazing quality, minimum 6 mm thick, low iron content, colourless; 'Ultra White Low Iron' by Guardian Industries, 'Starphire Ultra Clear Glass' by PPG or 'low-Iron Glass' by AGC.

.3 Door lite kit:
- .1 Manufactured by Hager Company or approved alternative, and to match Owner's standard.
- .2 Insulated double glass unit, consisting of clear tempered glass panes and manufacturer's standard gaskets.

.4 Insulating glass units:
- .1 To CAN/CGSB-12.8-M, ASTM E2190 and IGMA requirements utilizing approved stainless steel edge spacer. Dual seal with a PIB primary seal and silicone secondary seal.
- .2 To comply with IGMA labelling requirements to be considered certified. Materials, excluding the glass, shall be from the same manufacturer as those employed for the certification of the insulating glass units.

.5 Low-E coating: ASTM C1376, high performance sputtered low-E coating. Provide insulating glass units with low-E coating edge deletion and low-E coating. Apply low-E coating to second surface unless otherwise indicated. 'EnergySelect 36' by AGC Flat Glass, 'Cardinal LoE-272' by Cardinal Glass Industries or 'SN 68' by Guardian Industries.

.6 Glazing and rebate primers, sealants, sealers, and cleaners: Compatible with each other. Type as recommended by sealant, spline, and glass manufacturer.

.7 Glazing sealant: Silicone sealant as recommended by glazing manufacturer. Verify compatibility with insulating glass unit secondary sealant.

.8 Heel & toe bead: Silicone sealant as recommended by glazing manufacturer.

.9 Glazing gasket: 'Visionstrip' or Polyshim II' by Tremco Ltd., glazing seal, size as recommended by manufacturer.

.10 Glazing tape: 'Polyshim II' glazing tape EPDM shim.

.11 Glazing splines: EPDM, neoprene or silicone, extruded shape to suit glazing channel retaining slot, colour as selected.

.12 Setting blocks (regular): EPDM, 80 - 90 Shore A durometer hardness to ASTM D2240, sized to suit glazing method, glass unit weight and area.

.13 Edge blocks: EPDM, 60-70 Shore A Durometer hardness, self adhesive on face, sized with 3 mm clearance from glass edge and spanning glass thickness(es).

.14 Glass presence markers: Easily removable, non-residue depositing.

.15 Screws, bolts and fasteners: Type 304 stainless steel.

2.3 GLAZING SCHEDULE

.1 General: Glass types shall be as indicated below unless otherwise required due to thermal stress analysis.

.2 **Glazing Type 1**: TGL outside, air space, TGL inside. For use at steel and wood windows as scheduled. 25 mm overall thickness.

.3 **Glazing Type 2**: Door vision lite kit, consisting of TGL outside, air space, TGL inside. For use at exterior hollow metal door not accessible to orangutans (research building office). 25 mm overall thickness.

2.4 FABRICATION

.1 Verify glazing dimensions on Site.

.2 Clearly label each glass lite with maker's name and glass type. Ensure labels are easily removable, non-residue depositing type. Do not remove labels until after Work is accepted by Consultant.

.3 Fabricate glazing not less than 3 mm smaller than rebate size in either dimension; allow for edge spacers, shims, and setting blocks as necessary.

.4 Work shall have smooth finished surfaces free from distortion and defects detrimental to appearance and performance.

.5 Carefully make and fit details. Take special care with exposed finished work to produce a neat and correct appearance to the Consultant's acceptance.

3 Execution

3.1 **EXAMINATION**

.1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

.2 Verify that openings for glazing are correctly sized and within tolerance.

.3 Verify that surfaces of glazing channels or recesses are clean, free of obstructions, and ready to receive glazing.

3.2 **PREPARATION**

.1 Clean contact surfaces with solvent and wipe dry.

.2 Seal porous glazing channels or recesses with substrate compatible primer or sealer.

.3 Prime surfaces scheduled to receive sealant.

3.3 **INSTALLATION**

.1 Provide glazing in accordance with IGMA recommendations. Provide continuous contact between glazing tapes and gasket to the glazing.

.2 Install glazing to the work of Sections 08 11 13, 08 51 23 and 08 52 00.

.3 Provide neat, straight sight lines. Trim excess glazing tape flush with top of stops and fixed leg of frames.

.4 Remove protective coatings, glazing stops, clean rebate and glass contact surfaces with solvent, wipe dry.

.5 Apply primer/sealer to contact surfaces, prior to glazing.

.6 Apply glazing tape as per manufacturer’s instructions including recommended corner sealant.

.7 Use setting blocks at 1/4 points and spacers to centre glass unit in frame.

.8 Install glazing in accordance with reviewed shop drawings and manufacturer's written instructions. Install glazing with full contact and adhesion at perimeter. Maintain edge clearance recommended by glass manufacturer.

.9 Apply a continuous heel bead of sealant around perimeter of inboard lite of the sealed unit and the metal framing.

.10 Re-install glazing stops ensuring continuous contact and rattle-free installation. Do not distort glass. Trim tape protruding more than 2 mm above stop.

.11 Install glazing gasket in accordance with manufacturer's recommendations.

.12 Do not cut or abrade tempered, heat treated, or coated glass.

.13 Install glass presence markers in two cross stripes extending from diagonal corners. Maintain markers until final clean-up.

.14 Remove, dispose of, and replace broken, cut, abraded glass, and defective glass including but not limited to production dimples, roller wave or marks, tong marks, chips, cracks, etc.

.15 Exterior glass: Glaze units with gasket on exterior side and glazing tape on interior side. Seal gap between glazing and stop with sealant to depth equal to bite of frame. Apply cap head of sealant along void between stop and glazing, to uniform line, flush with sight line. Tool or wipe sealant surface smooth.

3.4 **CLEANING**

.1 Immediately remove sealant and compound droppings from finished surfaces.

.2 Remove labels, protective material, and glass presence markers from prefinished surfaces.

.3 Clean glass surfaces with cleaning agents and methods in accordance with Manufacturer's written instructions.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Design, labour, Products, equipment, tools, and services necessary for exhibit laminated glass work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM C719, Standard Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants Under Cyclic Movement (Hockman Cycle).

.2 ASTM C920, Specification for Elastomeric Joint Sealants.

.3 ASTM C1048, Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass.

.4 ASTM C1087, Standard Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems.

.5 ASTM C1184, Standard Specification for Structural Silicone Sealants.

.6 ASTM D2240, Test Method for Rubber Property - Durometer Hardness.

.7 ASTM E1300, Standard Practice for Determining Load Resistance of Glass in Buildings.

.8 CAN/CGSB-12.1-M, Tempered or Laminated Safety Glass.

.9 CAN/CGSB-12.3-M, Flat, Clear Float Glass.

.10 Glass Association of North America (GANA) Glazing Manual.

1.3 **DEFINITIONS**

.1 Deterioration of laminated glass: Defects are those developed from normal use that are attributed to the manufacturing process and not to causes such as glass breakage and practices for maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, fogging, and blemishes exceeding those allowed by referenced laminated-glass standard.

1.4 **DESIGN REQUIREMENTS**

.1 Provide glazing systems capable of withstanding normal thermal movement and wind and animal impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: Defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

.2 Glass design and thickness: Glass thickness designations indicated in the Contract Documents are minimums and are for detailing only. Confirm glass thicknesses by analyzing Project loads and in-service conditions. Provide glass lites in the thickness designations indicated for various size openings, but not less than thicknesses and in strengths (heat treated) required to meet or exceed the following criteria:

.1 Glass thicknesses: Select minimum glass thicknesses to comply with ASTM E1300, according to the following requirements:

.1 Probability of breakage for vertical glazing: 8 lites per 1000 for lites set vertically or not more than 15 degrees off vertical.

.1 Load duration: 60 seconds or less.

.2 Maximum lateral deflection: For laminated glass supported on all 4 edges, provide thickness required that limits center deflection at design pressure to 1/50 times the short side length or 25 mm, whichever is less.

.3 Thickness of animal exhibit glass: Thickness shall not be less than thickness shown on drawings or as required by the Bidder Designer to meet the specified requirements.

.3 Thermal movements:

.1 Provide glazing that allows for thermal movements resulting from the maximum change (range) in ambient and surface temperatures acting on glass framing members and glazing components required for the Place of Work. Base engineering calculation on surface temperatures of materials due to solar heat gain.

.2 Perform stress analysis. Design units to accommodate live, dead, lateral, wind, seismic, handling, transportation, and erection loads.

.3 Perform a thermal stress analysis on each glass unit and provide heat strengthening and/or tempered units as necessary to prevent thermal breakage.

.4 Structural glazing:

.1 Carry out design of structural silicone joints by rational analysis including all movements specified herein. Maximum stress shall not exceed 138 kPa (20 psi) in tension or shear for short term loading. Maximum stress in shear for long term loading due to the dead load of glass shall not exceed 7 kPa (1 psi) or the limit imposed by sealant manufacturer, whichever is less.

.2 The joint shall be essentially rectangular in shape and shall include no internal corners which could precipitate tearing or create high local stresses.

.3 Single Source Responsibility for Sealants, Gaskets and Other Glazing Accessories: In order to ensure consistent quality of performance, provide all glazing sealants and seals from a single manufacturer.

.4 Preconstruction Compatibility and Adhesion Testing:
.1 Submit to sealant manufacturer, samples of each glass, gasket, glazing accessory and glass-framing member that will contact or affect glazing sealants for compatibility and adhesion testing. Schedule submission of test samples to provide sufficient time for testing and analysis of results to prevent delay in the progress of work.
.2 Use ASTM C1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.

.5 Limit glass deflection to flexural limit of glass with full recovery of glazing materials.

1.5 **SUBMITTALS**

.1 Product data:
.1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
.1 Performance criteria, compliance with appropriate reference standard, characteristics, and limitations.
.2 Product transportation, storage, handling and installation requirements.
.3 For glazing sealant including printed statement of VOC content.

.2 Shop drawings:
.1 Submit shop drawings in accordance with Section 01 33 00 indicating as a minimum:
.1 Fabrication and erection of glazing elements indicating glass composition, materials, thicknesses, finishes, connections, joints, method of anchorage, number of anchors, supports, reinforcement, details, and accessories.
.2 To sealant manufacturer for their review and approval of tensile bead contact/bite dimension and thickness.
.3 Provide design calculations demonstrating exhibit glazing meets intended Project requirements.

.3 Glazing Schedule: Use same designations indicated on Drawings for glazed openings in preparing a schedule listing glass types and thicknesses for each size opening and location.

.4 Samples:
.1 Submit following samples in accordance with Section 01 33 00:
.2 Submit two samples of 300 x 300 mm laminated glass.
.3 For each colour (except black) of exposed glazing sealant indicated.
.4 Submit two samples of 300 mm long snack tube demonstrating material and colour for Consultant’s review.

.5 Certificates:
- .1 Submit manufacturer's certification that glass and glazing materials are compatible.
- .2 Qualification data: For installers.

.6 Reports:
- .1 Submit compatibility and adhesion test reports from sealant manufacturer indicating that glazing materials were tested for compatibility and adhesion with glazing sealants, setting blocks, edge blocks and any other material that contacts or can affect the edge seal.
- .2 Include sealant manufacturer's interpretation of test results relative to sealant performance and recommendations for primers and substrate preparation needed for adhesion.

.7 Detail coordination: Submit in accordance with 'Design Requirements' Article.
- .1 For structural steel materials and steel windows provided by others, the General Contractor shall submit these concurrent with the glazing submittal for coordination purposes. The glazing supplier shall confirm in writing that the details meet their engineering, installation, and warranty requirements.
- .2 Edge details shall confirm that the installed glazing is installed in accordance with manufacturer's recommendations for the conditions required for its intended use.

.8 Extended warranty: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.

1.6 **QUALITY ASSURANCE**

.1 Retain a Professional Engineer, licensed in the Province of Ontario, with experience in work of comparable complexity and scope, to perform the following services as part of the work of this Section:
- .1 Design exhibit laminated glazing work.
- .2 The perimeter glazing details shall be as indicated on the drawings and verified as acceptable by the Professional Engineer.
- .3 Glass composition for strength and impact by orangutans (frame and glass) and verified as acceptable by the Professional Engineer.
- .4 Specified structural silicone sealant for exhibit glazing for use at glass viewing windows and verified as acceptable by the Professional Engineer.
- .5 Review, stamp, date and sign shop drawings.

.2 Source limitations for glass: Obtain through one source from a single manufacturer for each glass type.

.3 Source limitations for glazing accessories: Obtain glazing accessories through one source from a single manufacturer for each product and installation method indicated.

.4 Installers qualifications: Perform work of this Section by a company that has a minimum of five years proven experience in the installation of glazing units of a similar size and nature.

.5 Pre-installation meetings: Arrange meeting on Site to be attended by Consultant, Contractor, and glazing manufacturer's representative to inspect substrates, and to review installation procedures 48 hours in advance of installation.

1.7 **SITE CONDITIONS**

.1 Do not proceed with glazing and sealing work when ambient and substrate temperature conditions are outside limits permitted by glazing material and sealant manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

1.8 **DELIVERY, STORAGE AND HANDLING**

.1 Protect glazing materials according to manufacturer's written instructions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

1.9 **EXTENDED WARRANTY**

.1 In accordance with Section 08 51 23.

.2 Manufacturer’s warranty (laminated glass):
- .1 Provide glass manufacturer’s warranty naming Owner as beneficiary for a period of 10 years from the date Work is certified as Substantially Performed and as specified herein.
- .2 Laminated glass manufacturer agrees to replace laminated glass units that deteriorate as defined in ‘Definitions’ Article within the specified warranty period.

2 Products

2.1 **ACCEPTABLE MANUFACTURERS**

.1 Glass manufacturers:
- .1 AGC Flat Glass.
- .2 Cardinal Glass Industries.
- .3 Guardian Industries.
- .4 Viracon Inc.
- .5 Vitro Architectural Glass (formerly PPG Industries Ltd.)

2.2 **MATERIALS**

.1 General:
- .1 All materials under work of this Section, including but not limited to, primers, coatings, sealers, sealants, adhesives and cleaners are to have low VOC content limits.
- .2 Edges of glass shall be free from spalls, flake chips or rough chips which would be either visible or compromise the adhesion of the exterior weather seal or reduce the strength of glass when subjected to temperature differentials.

.2 Low iron exhibit laminated glazing:
- .1 Polyvinyl butyral (PVB) interlayer:
  - .1 Minimum thicknesses of 1.5 and 2.2 mm as specified herein, clear PVB interlayer. PVB interlayer to be 'Butacite PVB' film by Dupont or approved alternative.
  - .2 For polyvinyl butyral interlayers, laminate lites in autoclave with heat plus pressure.
- .2 Glass pane - low iron heat strengthened glass **(HSGL)**:
  - .1 Provide low iron heat strengthened glass pane for laminated glass units as specified herein.
  - .2 Conforming to CAN/CGSB-12.3-M and heat strengthened in accordance with ASTM C1048.
  - .3 Clear, glazing quality, low iron content, colourless; 'Low-Iron Glass' by AGC Flat Glass, 'Ultra White Low Iron' by Guardian Industries or 'Starphire Ultra Clear Glass' by Vitro Architectural Glass (formerly PPG Industries Ltd.).
- .3 Glass pane - low iron tempered glass **(TGL)**:
  - .1 Provide low iron tempered glass pane for laminated units as specified herein.
  - .2 Conform to CAN/CGSB-12.1-M, clear, tempered, glazing quality, low iron content, colourless; 'Low-Iron Glass' by AGC Flat Glass, 'Ultra White Low Iron' by Guardian Industries, 'Starphire Ultra Clear Glass' by Vitro Architectural Glass (formerly PPG Industries Ltd.).
- .4 Glass pane - low iron tempered/laminated glass **(TLGL)**:
  - .1 Provide low iron tempered/laminated glass panes for laminated glass units as specified herein.
  - .2 Low iron tempered glass for tempered/laminated panes to conform to CAN/CGSB-12.1-M, clear, tempered, glazing quality, low iron content, colourless; 'Low-Iron Glass' by AGC Flat Glass, 'Ultra White Low Iron' by Guardian Industries, 'Starphire Ultra Clear Glass' by Vitro Architectural Glass (formerly PPG Industries Ltd.).
  - .3 Low iron tempered/laminated glass construction to consist of two panes of low iron tempered glass sandwiching a 1.5 mm thick clear PVB interlayer as specified.

.5 Exhibit laminated glass construction **(LGL1)** - viewing windows:
  .1 Conform to CAN/CGSB-12.1, Category II for a minimum overall thickness of 38 mm, consisting of:
  - Clear low iron heat strengthened glass pane (HSGL) on the viewing side
  - 2.2 mm thick clear PVB interlayer
  - Clear low iron tempered/laminated glass pane (TLGL)
  - 2.2 mm thick clear PVB interlayer
  - Clear low iron tempered/laminated glass pane (TLGL) on the orangutan side

.6 Exhibit laminated glass construction **(LGL2)** - orangutan doors:
  .1 Conform to CAN/CGSB-12.1, Category II for a minimum overall thickness of 25 mm, consisting of:
  - Clear low iron heat strengthened glass pane (HSGL) on the keeper side
  - 2.2 mm thick clear PVB interlayer
  - Clear low iron tempered glass pane (TGL)
  - 2.2 mm thick clear PVB interlayer
  - Clear low iron tempered/laminated glass pane (TLGL) on the orangutan side

.3 Glazing and rebate primers, sealants, gaskets, tapes, sealers, and cleaners: Compatible with each other. Type as recommended by sealant and glass manufacturer.

.4 Glazing sealant (structural glazing):
  .1 Conforming to ASTM C920, ASTM C1184 and ASTM C719.
  .2 Silicone, One Part in accordance with ASTM C920, Type S or M, Grade NS, Class 25.
  .3 Structural glazing tensile bead: ‘Proglaze SSG’ by Tremco or ‘Dowsil 795' by Dow Consumers Solution.
  .4 Structural glazing weather bead: ‘Spectrem 2 Sealant’ by Tremco or ‘Dowsil 795' by Dow Consumers Solution.
  .5 Structural glazing (factory glazed): Two-part, neutral cure silicone sealant, ‘Proglaze II’ by Tremco or ‘Dowsil 983' by Dow Consumers Solution.
  .6 Colour: Colour to be selected by the Consultant from full colour range.

.5 Setting Block (Structural Glazing): Silicone setting blocks with Shore, Type A durometer hardness of 85, plus or minus 5 to ASTM D2240, sized to suit glazing method, glass unit weight and area.

.6 Edge blocks: EPDM, 60-70 Shore A Durometer hardness, self adhesive on face, sized with 3 mm clearance from glass edge and spanning glass thickness(es).

.7 Glass presence markers: Easily removable, non-residue depositing.

.8 Screws, bolts and fasteners: Type 316 stainless steel.

.9 Snack tube: Snack tube material to match zoo standard, having a diameter of 65 mm, embedded into exhibit glass and secured with structural silicone glazing. Snack tube to be complete with a corrosion resistant cover and padlock.

2.3 **FABRICATION**

.1 Verify glazing dimensions on Site.

.2 Clearly label each glass lite with maker's name and glass type. Ensure labels are easily removable, non-residue depositing type. Do not remove labels until after Work is accepted by Consultant.

.3 Fabricate glazing not less than 3 mm smaller than rebate size in either dimension; allow for edge spacers, shims, and setting blocks as necessary.

.4 Work shall have smooth finished surfaces free from distortion and defects detrimental to appearance and performance.

.5 Carefully make and fit details. Take special care with exposed finished work to produce a neat and correct appearance to the Consultant's acceptance.

.6 Grind and polish a 1.5 mm arris to both edges of exposed glazing at locations where glazing is not encapsulated in framing and where edges are exposed to occupants.

3 Execution

3.1 **EXAMINATION**

.1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

.2 Verify that openings for glazing are correctly sized and within tolerance.

.3 Verify that surfaces of glazing channels or recesses are clean, free of obstructions, and ready to receive glazing.

.4 Laminated glass edges shall be completely covered by tape to protect against sealants and water if required by manufacturer.

3.2 **PREPARATION**

.1 Clean contact surfaces with solvent and wipe dry.

.2 Seal porous glazing channels or recesses with substrate compatible primer or sealer.

.3 Prime surfaces scheduled to receive sealant.

3.3 **INSTALLATION**

.1 Provide glazing in accordance with GANA's 'Laminated Glass Design Guide' and GANA's 'Glazing Manual'. Provide continuous contact between glazing tapes and gaskets to the glazing.

.2 Install exhibit glazing to the work of Section 05 50 00 where said glazing is secured within metal fabricated components and Section 08 11 13 for glazing in viewing ports of hollow metal doors accessible to orangutans.

.3 Provide neat, straight sight lines. Trim excess glazing tape flush with top of stops and fixed leg of frames.

.4 Remove protective coatings, glazing stops, clean rebate and glass contact surfaces with solvent, wipe dry.

.5 Apply primer/sealer to contact surfaces, prior to glazing.

.6 Apply glazing tape as per manufacturer's instructions including recommended corner sealant.

.7 Use setting blocks at 1/4 points and spacers to centre glass unit in frame.

.8 Install glazing in accordance with reviewed shop drawings and manufacturer's written instructions. Install glazing with full contact and adhesion at perimeter. Maintain edge clearance recommended by glass manufacturer.

.9 Do not cut or abrade tempered, heat treated, or coated glass.

.10 Install glass presence markers in two cross stripes extending from diagonal corners. Maintain markers until final clean-up.

.11 Remove, dispose of, and replace broken, cut, abraded glass, and defective glass including but not limited to production dimples, roller wave or marks, tong marks, chips, cracks, etc.

.12 Structural glazing:
- .1 Glaze exhibit laminated glass units in accordance with reviewed shop drawings and in accordance with manufacturer's written instructions, including all butt joints, with structural quality silicone sealant.
- .2 Provide all cut-outs and holes for fastenings required.
- .3 Mount glass rigidly in framing and ensure proper spacing, levelness, alignment and plumbness.

.13 Snack tube:
- .1 Install snack tube in accordance with reviewed shop drawings, manufacturer's written instructions and to be satisfaction of the Consultant, with structural silicone glazing.
- .2 Install snack tube at intended position in glass exhibit wall, secure and rigid.

3.4 **CLEANING**

.1 Immediately remove sealant and compound droppings from finished surfaces.

.2 Remove labels, protective material, and glass presence markers from prefinished surfaces.

.3 Clean glass surfaces with cleaning agents and methods in accordance with Manufacturer's written instructions.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Design, labour, Products, equipment and services necessary for gypsum board work.

1.2 **REFERENCES**

.1 ASTM A653/A653M, Specification for Steel Sheet, Zinc-coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.

.2 ASTM C475, Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.

.3 ASTM C645, Specification for Nonstructural Steel Framing Members.

.4 ASTM C754, Specification for Steel Framing Members to Receive Screw-Attached Gypsum Board.

.5 ASTM C840, Specification for Application and Finishing of Gypsum Board.

.6 ASTM C1002, Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.

1.3 **DESIGN REQUIREMENTS.**

.1 Design gypsum board wall systems with a maximum deflection of l/360.

.2 Design wall framing system and reinforce as necessary to accommodate and support items attached to and supported by wall framing system.

1.4 **SUBMITTALS**

.1 Product data:
.1 Submit copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
.1 Performance criteria, compliance with appropriate reference standard, characteristics, and limitations.
.2 Product transportation, storage, handling and installation requirements.

.2 Shop Drawings:
.1 Submit Shop Drawings in accordance with Section 01 33 00 indicating:
.1 Wall assemblies, adjacent construction, elevations, sections and details, dimensions, thickness, finishes and relationship to adjacent construction.
.2 Framing and blocking for items being supported of wall systems.

1.5 **QUALITY ASSURANCE**

.1 Qualifications: Execute the work of this Section by skilled, qualified, and experienced workers trained in the installation of the work of this Section.

1.6 **SITE CONDITIONS**

.1 Do not begin work of this Section until:
.1 Substrate and ambient temperature is above 15°C.
.2 Relative humidity is below 80 %.
.3 Ventilation is adequate to remove excess moisture.

.2 Install temporary protection and facilities to maintain Product manufacturer's, and above specification, environmental requirements 24 h before, during, and 24 h after installation.

2 Products

2.1 **MATERIALS**

.1 General: All materials under work of this Section, including but not limited to, sealants, adhesives, and primers are to have low VOC content limits.

.2 Steel framing: ASTM C754; ASTM A653/A653-M, Z275; cold rolled, galvanized steel sheet.
.1 Bailey Metal Products Limited.
.2 Corus Metal Profiles.

.3 Steel studs and track runners: ASTM C645; Galvanized steel studs and runners, 32 mm wide x depth as indicated on Contract Drawings. Formed from galvanized steel sheet, thicknesses as follows:
.1 Studs less than 3000 mm: Minimum 0.53 mm (25 ga.).
.2 Track runners and ancillary components to match stud thickness.

.4 Resilient channel: ASTM C645; 0.5 mm thick galvanized metal, 57 mm wide x 12 mm deep for walls to reduce sound transmission.

.5 Furring channels: ASTM C645; Formed from galvanized steel sheet, 22 mm winged flange type, cold rolled.

.6 Furring channels (hat type): ASTM C645; 0.5 mm base steel thickness, galvanized. 70 mm wide x 22 mm deep hat shaped channel.

.7 Corner bead, casing bead, and special shapes: Formed from 0.6 mm thick minimum, galvanized steel sheet, designed to be concealed by joint compound.

.8 Control joint strip: Roll formed from galvanized steel sheet, with a tape protected recess, 6 mm wide x 11 mm deep.

.9 Screw fasteners: ASTM C1002 Type S; Corrosion resistant.

.10 Batt insulation: In accordance with Section 07 21 00.

.11 Sealants: In accordance with Section 07 92 00.

.12 Polyethylene vapour retarder: In accordance with Section 07 26 00.

.13 Moisture, mould, and abuse resistant panels: 15.9 mm thick unless indicated otherwise on drawings; 'AirRenew Extreme Impact Resistant with M2Tech' by Certainteed Gypsum Canada, 'Sheetrock Mold Tough AR' by CGC Inc. or 'DensArmor Plus Abuse-Resistant Interior Panel' by Georgia-Pacific Canada LP.

.14 Joint reinforcing tape: ASTM C475; fibreglass mat joint tape as recommended by board manufacturer to suit location.

.15 Bonding adhesive: Type for purpose intended and as recommended and approved by manufacturer.

.16 Joint and patching compound: ASTM C475; Asbestos-free, supplied by manufacturer of gypsum board used.

.17 Fast setting patching compound: ASTM C475; Asbestos-free, Sheetrock or Durabond by CGC Inc., 'Moisture and Mold Resistant Setting Compound with M2Tech' by Certainteed Gypsum Canada or approved alternative.

.18 Access doors: Supplied by other Sections for installation as part of the work of this Section.

3 Execution

3.1 EXAMINATION

.1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.2 STEEL STUDS AND FURRING

.1 Install steel studs and furring in accordance with reviewed Shop Drawings and manufacturer's written instructions.

.2 Install steel stud partitions to underside of structure unless indicated otherwise.

.3 Install track runners at floors and underside of structure; align track runners accurately and secure to structure at 600 mm centres maximum.

.4 Install double top track runner assembly to prevent the transmission of structural loads to steel studs.

.5 Install steel studs vertically at 400 mm o.c., unless otherwise indicated, and not more than 50 mm from abutting walls, at openings, and at each side of corners. Install studs securely to track runners.

.6 Schedule and coordinate steel framing installation with mechanical and electrical services installation.

.7 Install full height, double studs at door and service openings, fastened together and stiffened back to the structure to prevent vibration when doors close.

.8 Provide double studs boxed together at all openings, sill, head and jambs and at door jambs, fastened together and stiffened back to the structure to prevent vibration. At each opening exceeding 900 mm in width, double studs shall be 20 ga. extending to structure above, and adequately anchored at each end. Provide steel studs above and below openings spaced at 400 mm oc maximum. All metal stud partitions above doors and screens over 1220 mm wide shall be secured to structure over and reinforced with sway bracing to stabilize walls to prevent lateral movement.

.9 Erect three studs at corner and intermediate intersections of partitions. Space 50 mm apart and brace together with wired 19 mm channels.

.10 Stiffen partitions over 2440 mm high or 3000 mm long, or both, with horizontal bracing extended for full length of partitions. Provide one line of bracing in partitions. Space lines to provide equal unbraced panels. Provide bracing for portions of partitions over door openings in partitions over 3000 mm high, and bracing both above and below openings in partitions located no greater than 150 mm from top and bottom of opening, and extending two stud spaces beyond each edge of opening for both doors and windows. Wire tie or weld bracing to studs.

.11 Frame control joints using back to back double studs at abutting structural elements, at dissimilar backup interface, at dissimilar walls, at structural expansion and control joints, at door and other openings, and at 9000 mm maximum spacing in continuous runs. Install control joint strips and secure in place.

.12 Install additional support framing at openings and cutouts for built-in equipment, upper cabinet support, access panels and similar items.

.13 Attach to framing adequate steel reinforcing members or an 1.2 mm (18 ga.) steel stud mounted horizontally and notched around furring members to support the load of, and to withstand the withdrawal and shear forces imposed by, items installed upon the work of this Section. Such items include, but are not restricted to, miscellaneous metals, wall-hung cabinets and fitments, shelving; Owner supplied equipment; and minor mechanical and electrical work. Heavy mechanical and electrical equipment shall be self-supporting in Divisions 21, 22, 23 and 26.

.14 Provide for support and incorporation of flush-mounted and recessed mechanical and electrical equipment and fixtures only after consultation and verification of methods with those performing the work of Divisions 21, 22, 23 and 26.

.15 Install cross bracing in accordance with the steel stud manufacturer's recommendations.

3.3 BATT INSULATION

.1 Install non-rated batt insulation as required for Work of this Project in accordance with Section 07 21 00.

3.4 SEALANT

.1 Sealant: Install joint backing and sealant in accordance with Section 07 92 00.

3.5 GYPSUM BOARD

.1 Comply with ASTM C840. Install gypsum board in accordance with reviewed Shop Drawings and manufacturer's written instructions.

.2 Install gypsum board vertically or horizontally, whichever results in fewer end joints. Locate end joints over supporting members.

.3 Install gypsum board in lightly butted contact at edges and ends and with 1.6 mm maximum open space between boards; do not force gypsum board into place. Do not install imperfect, damaged or damp boards.

.4 Install gypsum board butting paired tapered edge joints, and mill-cut or field-cut end joints; do not place tapered edges against cut edges or ends.

.5 Install vertical joints minimum 300 mm from the jamb lines of openings and stagger vertical joints over different studs on opposite sides of partitions.

.6 Do not locate joints within 200 mm of corners or openings, except where control joints occur at jamb lines or where openings occur adjacent to corners. Where necessary, place a single vertical joint over the centre of wide openings.

.7 Install gypsum board over concrete and concrete masonry units with adhesive as recommended by gypsum board manufacturer where indicated on Drawings.

.8 Cut, drill and patch gypsum board as may be necessary to accommodate the work of other trades.

3.6 CORNER, CASING BEADS AND TRIM

.1 Corner reinforcing bead: Install along all external angles, erect plumb, level and with a minimum of joints. Secure with screws at 225 mm o.c. apply filler over flanges flush with nose of the bead and extending at least 75 mm onto surface of board each side of corner. When filler dries, apply a thin coat of topping cement and blend onto adjoining surfaces.

.2 Casing bead: Install where wallboard butts against a surface having no trim concealing the juncture and where shown on drawings. Erect casing beads plumb or level, with minimum joints, and secure with screws at 300 mm o.c. apply filler over flange flush with bead and extending at least 75 mm onto surface of board. When dry, apply a thin coat of topping cement and blend onto adjoining surfaces.

.3 Recess channels and trim: Install recess channels and special metal trim where shown. Secure to substrate. Provide casing beads full height on wallboard edges at recess channels and metal trim.

3.7 JOINT TAPING AND FINISHING

.1 Install reinforcing tape and a minimum of 3 coats of joint compound over gypsum board joints, metal trim and accessories, and screw fasteners in accordance with the gypsum board manufacturer's instructions.

.2 Fill gaps between ,and any imperfections in, gypsum boards with joint compound, allow to dry, and sand smooth ready for painting.

.3 Install finished gypsum board work smooth, seamless, plumb, true, flush, and with square, plumb, and neat corners.

.4 Finish gypsum board in accordance with ASTM C840 to the following grades:

1. Level 0: No taping, finishing, or accessories required. Use above suspended ceilings and within other concealed spaces, unless the assembly is fire rated, sound rated, sound or smoke controlled, or unless the space serves as an air plenum.
2. Level 1: At joints and interior angles embed tape in joint compound. Leave surface free of excess joint compound. Tool marks and ridges are acceptable. Use above suspended ceilings and within other concealed spaces if the gypsum board assembly is fire rated, sound rated, sound or smoke controlled, or the space serves as an air plenum.
3. Level 2: At joints and interior angles embed tape in joint compound with one separate coat of joint compound applied over joints, angles, fastener heads, and accessories. Use for water resistant gypsum board indicated for use as a substrate for ceramic tile.
4. Level 3: At joints and interior angles embed tape in joint compound with two separate coats of joint compound applied over all joints, angles, fastener heads, and accessories. Apply joint compound smooth and free of tool marks and ridges. Use where heavy grade wall coverings are the final decoration.

5. Level 4: At joints and interior angles embed tape in joint compound with three separate coats of joint compound applied over all joints, angles, fastener heads, and accessories. Apply joint compound smooth and free of tool marks and ridges. Use for all locations except those indicated for other finish levels.
6. Level 5: At joints and interior angles embed tape in joint compound with three separate coats of joint compound applied over all joints, angles, fastener heads, and accessories. Apply a thin skim coat of joint compound, or a material manufactured especially for this purpose, to the entire surface. Leave surface smooth and free of tool marks and ridges. Use where semi-gloss or gloss finish coatings are the final decoration.

3.8 ACCESS DOORS

.1 Install access doors, supplied as part of other parts of the work, in accordance with manufacturer's written instructions.

3.9 SITE TOLERANCES

.1 Install metal support systems to ensure that, within a tolerance of +3 mm and -1.5 mm for plaster thickness, finish surfaces will be flat within 3 mm under a 3 m straightedge, and with no variation greater than 1.5 mm in any running 300 mm, and that surface planes shall be within 3 mm of dimensioned location.

3.10 REPAIR

1. Make good cut-outs for services and other work, fill in defective joints, holes and other depressions with joint compound.

2. Make good defective work, and ensure that surfaces are smooth, evenly textured and within specified tolerances to receive finish treatments.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Design, labour, Products, equipment and services necessary for acoustical ceilings work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

.2 ASTM C635, Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.

.3 ASTM C636, Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels.

.4 ASTM C645, Specification for Non-Load Bearing (Axial) Steel Studs, Runners (Tracks), and Rigid Furring Channels for Screw Application of Gypsum Board.

.5 ASTM E1264, Classification for Acoustical Ceiling Products.

1.3 **DESIGN REQUIREMENTS**

.1 Design ceiling suspension systems in accordance with ASTM C636 and manufacturer's printed directions.

.2 Design tile ceiling system for adequate support of electrical fixtures as required by the current bulletin of the Electrical Safety Authority. Acoustic panel system is not designed to carry the weight of electrical equipment.

.3 Design hanger anchor and entire suspension system static loading not to exceed 25% of their ultimate capacity including lighting fixture dead loads.

.4 Design tile suspension system to support weight of mechanical and electrical items such as air handling boots and lighting fixtures, and with adequate support to allow rotation/relocation of light fixtures. Acoustic panel system is not designed to carry the weight of mechanical and electrical equipment.

.5 Design subframing as necessary to accommodate, to avoid conflicts and interferences where ducts or equipment prevent regular spacing of hangers.

1.4 **SUBMITTALS**

.1 Shop drawings:
.1 Submit shop drawings in accordance with Section 01 33 00 indicating:
.1 Suspension system layout including hangers and supports for acoustic tile system.

.2 Acoustic panel system including suspension system, hangers, supports and panel sizes and locations.
.3 Conditions at abutting, intersecting, and penetrating construction.
.4 Dimensioned locations of lighting fixtures, diffusers, sprinkler heads and other items that pierce the ceiling plane.

.2 Samples:
.1 Submit following samples in accordance with Section 01 33 00:
.1 One full-size sample of each type of tile panels to be used.
.2 One of each type of suspension system members.

.3 Certificates: Submit written certification stating that suspended ceiling system is designed for adequate support of electrical fixtures as required by the current bulletin of the Electrical Safety Authority.

1.5 SITE CONDITIONS

.1 Do not install the work of this Section until:
.1 Mechanical and electrical work above the ceiling is complete.
.2 Relative humidity is below 80 %.
.3 Ventilation is adequate to remove excess moisture.
.4 Areas are closed and protected against weather, and maintained at no less than 10°C.

.2 Install temporary protection and facilities to maintain Product manufacturer's, and above specification, environmental requirements 24 h before, during, and after installation.

1.6 MAINTENANCE

.1 Submit extra acoustic ceilings amounting to 2% of gross ceiling area, allowing proportionately for each pattern and type specified to nearest full carton. Submit Products which are part of same production run as installed Products. Store maintenance Products as directed by Consultant.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Transport, handle and store material in manner to prevent warp, twist, damage to panel edges and surfaces in accordance with Manufacturer's recommendations.

.2 Any warped and/or damaged panels and trim shall be rejected and be replaced by new, straight, undamaged and acceptable material at no cost to Owner.

.3 Bent, twisted or otherwise damaged Tee grid suspension components shall not be used under any circumstances. Replace such damaged items with new undamaged material at no additional cost to Owner.

.4 Store material in warm, dry place away from water and the elements. Protect against undue loading stresses and shock.

.5 All packaged material shall be delivered in original manufacturers wrappers and containers with labels and seals intact. All cartons shall bear U.L. label.

2 Products

2.1 **MATERIALS**

.1 Galvanized steel sheet: ASTM A653/A653-M, Z275; cold rolled, galvanized steel sheet.

.2 Main carrying channels: ASTM C645; Channels formed from galvanized steel sheet, 38 x 19 mm cold rolled.

.3 Subframing: ASTM C645; Channels formed from galvanized steel sheet, dimensions and spans as required.

.4 Hangers: 2.6 mm minimum diameter, galvanized steel wire.

.5 Tie wire: 1.6 mm minimum diameter, soft annealed galvanized steel wire.

.6 Anchors: Tie wire sleeve anchors, to suit application and meet intended design criteria.

.7 Wall mouldings and accessories, including but not limited to, corner caps, edge mouldings, panel hold over clip, metal closures, and trim. Finish and colour: same as main tees.

.8 Exposed main, cross tees, and relocatable cross tees: ASTM C635, 38 mm high steel, bulb tee design double steel web, rectangular single spans without exceeding a deflection of 1/360 of the span. Splices to be integral and reversible; cross tee interlocking into main tee. Colour and finish: Manufacturer's standard white.

.1 15/16" suspension system:

.1 'Prelude XL' by Armstrong World Industries Inc.

.2 'Donn DX/DXL' by CGC Inc.

.3 'Classic Stab' by Certainteed Ceilings Canada.

.4 'Seismic 1200' by Rockfon/Chicago Metallic.

.9 Acoustic tile (ACT): ASTM E1264, type 20, Pattern CE. Ceramic and mineral fibre composite with scrubbable factory applied vinyl plastic paint. Size as indicated x 15 mm thick square edge, 'Fine Fissured Ceramaguard' as manufactured by Armstrong Ceiling Tiles, 'Certainteed Aquarock' by Certainteed Ceilings Canada, 'Radar Ceramic' by CGC Inc., or 'Koral' by Rockfon.

.10 Wall mouldings: To match acoustical ceiling suspension system.

3 Execution

3.1 **EXAMINATION**

.1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.2 **SUSPENSION SYSTEM**

.1 Coordinate locations and openings of mechanical and electrical services support, and penetration through the acoustical ceilings. Coordinate field conditions, clearances, measurements, and mechanical and electrical services testing and commissioning, above the acoustical ceilings.

.2 Install hanger wires plumb and securely anchored to the building structural framing, independent of walls, pipes, ducts, and metal deck; install additional framing and hangers to bridge interference items.

.3 Install acoustical ceiling systems in accordance with manufacturer's written instructions, reviewed shop drawings, and ASTM C636, listed in order of precedence.

.4 Install hanger wires at 1200 mm maximum centres along carrying channels, not less than 25 mm, and not more than 150 mm from channel ends.

.5 Install additional hangers at lighting fixture and air distribution ductwork locations. Do not attach hanger wires to mechanical or electrical equipment. Do not support mechanical and electrical fixtures and fitting on ceiling without the ceiling manufacturer's written acceptance.

.6 Install acoustical ceiling suspension system to a tolerance of 1:1200 of span and 0.4 mm maximum between adjacent metal members. Tolerances are not cumulative. Refer to Electrical Contract Drawings for fixture layout.

.7 Do not bend or twist hangers as a means of levelling. Form double loops tightly and lock to prevent vertical movement or rotation within the loop.

.8 Install edge moulding at intersection of ceiling and vertical surfaces.

.9 Centre acoustical ceiling suspension systems on room axis; install equal border pieces. Install hangers onto the ends of main tee runners at not more than 150 mm from ends of runners, adjacent and perpendicular to walls.

.10 Support the suspension system independently of walls, columns, ducts, pipes and conduits.

.11 Install main runners in maximum available lengths. Layout joints in suspension members to avoid the perimeters of recessed fixtures. Lock grid members to form a rigid assembly. Install additional tee, suspension system framing around recessed fixtures, diffusers, grilles and other items for a complete assembly.

3.3 ACOUSTIC LAY-IN TILES

.1 Install acoustic tile in grid system openings supported by bottom flanges of members. Provide special shapes and sizes to provide a complete installation by cutting tile to fit into openings. Fit tile moderately tight between upright legs of members.

.2 Carefully cut and trim acoustic tiles to accommodate items piercing the finished ceiling plane.

.3 Remove and replace acoustic tiles with broken edges, or damaged, marked, discoloured, soiled, or stained faces.

3.4 ADJUSTMENTS AND CLEANING

.1 Clean soiled or discoloured surfaces of exposed work on completion of work.

.2 Replace components which are visibly damaged, marred or uncleanable.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for resilient sheet flooring work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM D2047, Standard Test Method for Static Coefficient of Friction of Polish-Coated Floor Surfaces as Measured by the James Machine.

.2 ASTM F710, Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.

.3 ASTM F970, Standard Test Method for Static Load Limit.

.4 ASTM F1516, Standard Practice for Sealing Seams of Resilient Floor Products by the Heat Weld Method.

.5 ASTM F1861, Specification for Resilient Wall Base.

.6 ASTM F1869, Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Cloride.

.7 ASTM F 2170, Standard Test Method for Determining Relative Humidity in Concrete Slabs Using in-situ Probes.

.8 ASTM F2034, Standard Specification for Sheet Linoleum Floor Covering.

.9 CAN/ULC-S102.2-M, Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies.

.10 ISO 717-2, Acoustics - Rating of Sound Insulation in Buildings and of Building Elements - Part 2: Impact Sound Insulation.

1.3 **SUBMITTALS**

.1 Product data:
  .1 Submit copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
    .1 Performance criteria, compliance with appropriate reference standard, characteristics, and limitations.
    .2 Product transportation, storage, handling and installation requirements.

.2 Shop drawings: Submit shop drawings indicating seam layout and welding procedures in accordance with Section 01 33 00.

.3 Samples:
.1 Submit samples in accordance with Section 01 33 00:
.1 Two 250 x 200 mm samples of each type of sheet material and colour.
.2 Two 250 mm long samples of each base, accessory and colour.

.4 Extended warranties: Submit extended warranties signed and registered by the manufacturer providing the warranties in the name of the Owner for the timeframe and coverage specified in this Section.

.5 Closeout submittals: Submit maintenance and cleaning data for incorporating into Operations and Maintenance Manuals in accordance with Section 01 78 23.

1.4 **SITE CONDITIONS**

.1 Maintain air temperature and structural base temperature at flooring installation area above 20°C for 48 hr before, during and 48 hr after installation.

.2 Store materials for 2 days prior to installation in area of Work to achieve temperature stability.

.3 Do not lay flooring in conditions of high humidity or where exposed to cold drafts. In hot weather, protect from direct sunlight.

.4 Provide adequate ventilation during installation.

1.5 **EXTENDED WARRANTY**

.1 Manufacturer's warranty: Provide flooring manufacturer's warranty naming Owner as beneficiary, covering excessive wear for a period of 5 years from the date Work is certified as Substantially Performed.

1.6 **MAINTENANCE**

.1 Submit extra 5% or to nearest full roll of each colour, pattern and type of flooring material required for maintenance use. Identify each roll. Store where directed. Submit maintenance material in one piece and of same production run as installed materials.

2 Products

2.1 **MATERIALS**

.1 All materials under work of this Section, including but not limited to, primers and adhesives are to have low VOC content limits.

.2 Linoleum sheet flooring (LINO):
- .1 Conforming to ASTM F2034, Type 1, 2.5 mm thick, homogeneous resilient flooring, made from natural ingredients, mixed and calendared onto a natural jute backing.
- .2 Flame spread: 150 to CAN/ULC-S102.2-M.
- .3 Smoke developed: 160 to CAN/ULC-S102.2-M.
- .4 Impact sound reduction: when tested to ISO 717/2, 6 dB.
- .5 Slip resistance: Static coefficient of slip resistance meets or exceeds 0.6 when tested in accordance with ASTM D2047.
- .6 Static load limit: 450 pounds per square inch when tested in accordance with ASTM F970.
- .7 Colour: To be selected by the Consultant from manufacturer's full colour range.
- .8 Acceptable products and manufacturers: 'Marmoleum' by Forbo Flooring or approved alternative.

.3 Rubber base: ASTM F1861, Type TP, Group 1, rubber wall base, approximately 100 mm high x 3 mm thick, toeless profile, in lengths as long as possible including premoulded end stops and inner and outer corners. Colour: As selected by Consultant. 'Traditional Wall Base' by Johnsonite or approved alternative.

.4 Welding rod: type recommended by flooring manufacturer to complement flooring.

.5 Primers and adhesives: Low VOC, waterproof, of types recommended by flooring and base manufacturer for specific material on applicable substrate, above, on or below grade.

.6 Reducing edge strips, thresholds: Nitrile rubber plasticized vinyl, 80-95 Shore A Durometer, adhesive as recommended by manufacturer.

.7 Concrete skim coat compound: High-performance, rapid-setting cement based skim coating compound. 'Ultra SkimCoat' by Mapei or approved alternative for filling minor voids and leveling existing substrate.

.8 Stain sealer and polish: If applicable, type recommended by flooring manufacturer.

3 Execution

3.1 EXAMINATION

.1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

.2 Ensure concrete floors meet the following minimum requirements and requirements of the flooring manufacturer. If there is a conflict between these requirements and those of the flooring manufacturer, the more stringent shall apply.

.1 Internal Relative Humidity Test: Perform internal relative humidity testing in accordance with ASTM F2170. Results shall not exceed 80% RH.

.2 Moisture Test: Moisture emissions from concrete subfloors (cured for a minimum of 28 days) must not exceed 3 lbs per 1000sf per 24 hours (1.4 kg H2O/24 hr/93 m2) for acrylic adhesive and 5lbs for polyurethane adhesive via the Calcium Chloride Test Method (ASTM F1869).

.3 The pH level of the subfloor surface shall not be higher than 9.9. If higher, subfloor must be neutralized.

.3 Ensure that sub-floors have been provided as specified without holes, protrusions, cracks, depressions or other major defects.

.4 Ensure that control joints have been filled and levelled.

.5 Defective work resulting from application to unsatisfactory surfaces will be considered the responsibility of those performing the work of this Section.

3.2 SUBFLOOR TREATMENT

.1 Flooring shall be installed over subfloors conforming to ASTM F710 for concrete.

.2 Remove sub-floor ridges and bumps. Fill low spots, cracks, joints, holes and other defects with sub-floor filler.

.3 Apply sub-floor filler to low spots and cracks to achieve floor level to a tolerance of 1:1000, allow to cure.

.4 Meet ASTM F710 Standard for Concrete or other monolithic floors.

.5 Clean and remove all deleterious materials from surfaces to receive this work in accordance with the adhesive manufacturer's recommendations.

.6 Prime concrete to flooring manufacturer's printed instructions.

3.3 RESILIENT SHEET FLOORING APPLICATION

.1 Install resilient sheet flooring in accordance with manufacturer’s written instructions.

.2 Apply adhesive uniformly using recommended trowel in accordance with flooring manufacturers instructions. Do not spread more adhesive that can be covered by flooring before initial set takes place.

.3 Run sheets in direction of traffic. Double cut sheet joints and continuously seal according to manufacturer's printed instructions. Remove adhesive seepage of seams or surface while adhesive is still wet.

.4 Heat weld seams in accordance with ASTM F1516 and manufacturer's printed instructions.

.5 As installation progresses and after installation, roll flooring with minimum 45 kg roller to ensure full adhesion.

.6 Cut flooring neatly around fixed objects.

.7 Terminate flooring at centreline of door in openings where adjacent floor finish or colour is dissimilar.

.8 Install reducing edge strips at unprotected or exposed edges where flooring terminates or where there are two finishes of different thicknesses.

3.4 RESILIENT BASE APPLICATION

.1 Install resilient base in accordance with manufacturer’s written instructions.

.2 Lay out base to keep number of joints at minimum.

.3 Prior to installing base, fill cracks and irregularities with a filler recommended by base manufacturer.

.4 Set base in adhesive using a 3 kg hand roller, against wall and floor surfaces.

.5 Install straight and level to variation of 1:1000.

.6 Scribe and fit to door frames and other obstructions.

.7 Cope internal corners.

3.5 CLEANING AND SEALING

.1 Forty-eight hours after installation, clean sheet flooring surfaces with a mild soap solution approved by finish manufacturer. Rinse clean and allow to dry.

.2 If applicable to flooring material, apply stain sealer and allow to dry. Apply number of coats of sealer as recommended by flooring manufacturer and polish thoroughly.

3.6 PROTECTION OF FINISHED WORK

.1 Protect floors and bases from time of final set of adhesive until accepted by Consultant.

.2 Protect bases from scratches, gouges, scuff marks and other damage from time initial surface protection application until final inspection.

.3 Prohibit traffic on floor for 48 hours after installation.

.4 Cover cleaned surfaces with fibre reinforced, clean, non-staining clean, kraft paper. Secure in position with gummed tape to prevent drifting. Remove covering when directed by Consultant.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for epoxy flooring work in accordance with the Contract Drawings.

1.2 **REFERENCES**

.1 ASTM D4263, Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.

.2 ASTM F1869, Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.

.3 ASTM F2170, Standard Test Method for Determining Relative Humidity in Concrete Slabs Using In-situ Probes.

1.3 **SUBMITTALS**

.1 Product data: Submit manufacturer's Product data in accordance with Section 01 33 00 indicating:
- .1 Two copies of manufacturer's Product data on characteristics, performance criteria, and limitations.
- .2 Preparation, installation requirements and techniques, Product storage, and handling criteria.

.2 Samples: Submit duplicate samples of each type and colour of epoxy flooring mounted on 250 x 200 mm hardboard in accordance with Section 01 33 00.

.3 Certificates: Signed by manufacturer certifying that applicator’s comply with specified requirements.

.4 Reports: Submit manufacturer's acceptance of substrate prior to installation in writing. Submit verification of moisture content of floor prior to installation.

.5 Close-out submittals: Submit maintenance data for incorporation into Operations and Maintenance manuals in accordance with Section 01 78 23.

1.4 **QUALITY ASSURANCE**

.1 Applicator’s qualifications: Perform work of this Section by a company that has a minimum of five years proven experience in installations of a similar size and nature and that is approved by manufacturer. Submit to Consultant, applicator’s current certificate of approval by the material manufacturer as proof of compliance.

.2 Pre-installation meetings: Arrange with manufacturer's representative and Consultant to inspect substrates, and to review installation procedures 48 hours in advance of installation.

1.5 **SITE CONDITIONS**

.1 Do not install the work of this Section outside of the following environmental ranges without Product manufacturer's written acceptance:
- .1 Ambient air and surface temperature: 15^0C to 30^0C.
- .2 Relative humidity: In accordance with manufacturers' requirements.
- .3 When no dust is being raised.
- .4 In well-ventilated and broom clean areas.

.2 Do not apply epoxy flooring over materials that contain over 4% moisture.

.3 Install temporary protection and facilities to maintain the Product manufacturer's, and the above specification, environmental requirements for 24 hours before, during, and 24 h after installation.

.4 Post do not enter and appropriate warning signs at conspicuous locations.

1.6 **DELIVERY, STORAGE, AND HANDLING**

.1 Package, seal and label each epoxy flooring material to show manufacturer's and product name, and colour.

.2 Store materials at site in an area specifically set aside for purpose that is locked, ventilated, and maintained at a minimum temperature of 16°C.

.3 Ensure that health and fire regulations are complied with in storage area, and during handling and application.

2 Products

2.1 **ACCEPTABLE MANUFACTURERS**

.1 Stonhard, Inc.

.2 Or approved alternative by BASF Canada Inc. or Sika Canada Inc.

2.2 **MATERIALS**

.1 General:
- .1 All materials under work of this Section, including but not limited to, primers and epoxy flooring are to have low VOC content limits.
- .2 Each material used in the application of each flooring system shall be as recommended or manufactured by the supplier of the flooring system.

.2 Patching and fill material: Resinous product of or approved by epoxy flooring manufacturer and recommended by manufacturer for application indicated.

.3 Primer: As recommended by manufacturer.

.4 Industrial epoxy flooring and base:
.1 Overall system thickness of 6 mm, abrasion, impact and chemical resistant, industrial aggregate filled, resin-based, monolithic floor surfacing designed to produce a seamless floor and integral cove base.
.2 Epoxy flooring system to consist of the following:
.1 Mortar base:
.1 Trowel applied, four-component, epoxy mortar base, consisting of 25% recycled glass blended with an epoxy resin, amine curing agent and soy based additives, 'Stonclad GR' by Stonhard, Inc.
.2 Thickness: Two coats at 3 mm each.
.2 Top coats: 100% solids epoxy coating, 'Stonkote GS4' or 'Stonkote HT4' by Stonhard, Inc.
.3 Colours and finishes to later selection by Consultant from manufacturer's full colour range.

2.3 **MIXES**

.1 Mix epoxy flooring materials in accordance with manufacturer's written instructions.

3 Execution

3.1 **EXAMINATION**

.1 Verify condition of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

.2 Verify that concrete floor has cured 28 days minimum and that substrate is acceptable to epoxy manufacturer.

.3 Moisture content testing:
.1 Test surfaces for moisture content to ensure that they are suitable for application and are within acceptable levels according to manufacturer's written instructions.
.2 Perform anhydrous calcium chloride test, ASTM F1869. Proceed with application of epoxy flooring only after substrates have maximum moisture-vapour-emission rate of 3 lb of water/1000 sq. ft. of slab area in 24 hours.
.3 Perform plastic sheet test, ASTM D4263. Proceed with application only after testing indicates absence of moisture in substrates.
.4 Perform relative humidity test using in situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.

.4 Alkalinity and adhesion testing: Verify that concrete substrates have pH within acceptable range. Perform tests recommended by manufacturer. Proceed with application only after substrates pass testing.

3.2 PREPARATION

.1 Prepare intended substrate in accordance with manufacturer's written instructions.

.2 Prepare substrate using steel aggregate blast method and vacuum substrate free of debris and dust.

.3 Fill minor cracks, voids and depressions with patching and fill material in accordance with manufacturer's written instructions.

.4 Project adjacent surfaces from damage resulting from this work. Mask and/or cover adjacent surfaces, fixtures, and equipment as necessary.

.5 Fill open control joints, and other cracks and voids with material compatible with epoxy materials and in accordance with manufacturer's written instructions.

.6 Clean prime and seal surfaces as recommended by epoxy manufacturer.

3.3 APPLICATION

.1 Apply and cure epoxy flooring in accordance with manufacturer's printed instructions. Epoxy manufacturer shall supervise application.

.2 Coordinate application of components to provide optimum adhesion of epoxy flooring system to substrate, and optimum intercoat adhesion.

.3 Stop epoxy in a straight line on each side of control joints; fill space over expansion joint with a self-levelling, non-sag polyurethane sealant.

.4 Apply epoxy with care to ensure that no laps, voids, or other marks or irregularities are visible, and with an appearance of uniform colour, sheen and texture, all within limitations of materials and areas concerned.

.5 Match colours and textures of approved samples.

.6 Make clean true junctions with no visible overlap between adjoining applications of epoxy.

.7 Chase edge of adjacent floor systems so that epoxy finishes flush with adjacent floor systems.

.8 Apply self-levelling slurry body coats in thickness indicated for flooring system.

.1 Broadcast aggregates at rate recommended by manufacturer and, after resin is cured, remove excess aggregates to provide surface texture indicated.

.9 Apply trowelled or screeded body coats in thickness indicated for flooring system. Hand or power trowel and grout to fill voids. When cured, remove trowel marks and roughness using method recommended by manufacturer.

.10 Apply grout coat, of type recommended by resinous flooring manufacturer, to fill voids in surface of final body coat and to produce wearing surface indicated.

.11 Apply topcoats in number indicated for flooring system and at coverage rates recommended in writing by flooring manufacturer.

.12 Integral cove base:
- .1 Apply 100 mm high cove base mix to wall surfaces at room perimeter and at built-in fitment locations, before applying flooring.
- .2 Apply according to manufacturer's written instructions and details including those for taping, mixing, priming, troweling, sanding, and topcoating of cove base. Round internal and external corners. Form cove with 25 mm radius.

3.4 SITE TOLERANCES

.1 Finish surfaces shall be level, or straight where sloped to drains, within a tolerance of 1.5 mm in 3 m, and shall not vary more than 0.8 mm in any running 300 mm.

3.5 REPAIR

.1 Touch-up and refinish minor defective work. Refinish entire coated surface areas where finish is damaged or otherwise unacceptable.

3.6 CLEANING

.1 Remove promptly as work progresses spilled or spattered materials from surfaces of work performed under other Sections. Clean floors on completion of work. Do not mar surfaces while removing.

.2 Leave storage and mixing areas in same condition as equivalent spaces in project.

3.7 PROTECTION

.1 Erect barriers to prevent the entry and presence of personnel not performing work of this Section during application of epoxy flooring, and for 48 hours following completion of application.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for painting work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 Master Painters Institute (MPI), Painting Specification Manual.

.2 SSPC Steel Structures Painting Council, Standards.

1.3 **SUBMITTALS**

.1 Product data:
- .1 Submit copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
  - .1 Performance criteria, compliance with appropriate reference standard, characteristics, limitations.
  - .2 Product transportation, storage, handling and installation requirements.
- .2 Submit listing of manufacturer's Product types, Product codes, and Product names, number of coats, and dry film thicknesses, corresponding to each Painting Schedule code; submit listing minimum of 8 weeks before materials are required.

.2 Samples:
- .1 Submit following samples in accordance with Section 01 33 00.
  - .1 Three 300 x 150 mm draw downs of each colour minimum 4 weeks before paints are required.
  - .2 Identify each sample with Contract number and title, colour reference, sheen, date, and name of applicator.

.3 Certificates:
- .1 Submit certification from paint manufacturer, on company letterhead, indicating each product proposed for use is Manufacture's premium grade, first line Product.
- .2 Submit certified documentation to confirm each airless spray painter has minimum of 5 years experience on applications of similar complexity and scope.
- .3 Submit certified documentation to confirm each worker has Provincial Tradesman Qualification certificate of proficiency.

.4 Reports:
- .1 Submit written field inspection and test report results after each inspection.
- .2 Submit Field Quality Control test result reports for alkali content, substrate moisture, and dry film thickness.
- .3 Submit electronic moisture meter manufacturer's specifications including tolerances. Submit record of latest meter calibration to meet manufacturer's recommendations.

1.4 QUALITY ASSURANCE

.1 Finishing work: Perform work to MPI requirements for premium grade.

.2 Supervision: Have work supervised by a full-time qualified foreperson who has 10 years minimum experience on Contracts of similar complexity and scope.

.3 Mock-up:
- .1 Construct three 2 m^2 mock-ups of different Paint Schedule code systems, selected by Consultant, in locations acceptable to Consultant to demonstrate installation workmanship, colour, and hiding power of Products.
- .2 Obtain Consultant's acceptance in writing before proceeding with the work of this Section.
- .3 Mock-ups may remain as part of the Work if acceptable to Consultant and will serve as a standard for similar code systems.
- .4 Repaint over mock-ups which do not form part of the Work.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Install correct, safe temporary storage for paint, thinner, solvents, and other volatile, corrosive, hazardous, and explosive materials in accordance with requirements of authorities having jurisdiction.

.2 Post hazard warning signage in areas of storage and mixing. Install and maintain sufficient CO_2 fire extinguishers of minimum 9 kg capacity, accessible in each storage mixing and storage areas.

.3 Maintain storage enclosures at minimum 10°C ambient temperature and to manufacturer's instructions.

1.6 SITE CONDITIONS

.1 Apply coatings under the following conditions:
- .1 Exterior coatings (except Latex): 5° C minimum.
- .2 Exterior latex coatings: 10°C minimum.
- .3 24 hours minimum after rain, frost, condensation, or dew.
- .4 When no condensation is possible (unless specifically formulated against condensation).
- .5 Interior coatings: 7°C minimum.
- .6 Relative humidity: 85% maximum.
- .7 Not in direct exposure to sun light.

.2 Maintain temperature conditions indicated above for 24 hours before, during and 24 hours after painting.

.3 Install clean plywood sheets to protect floors and walls in storage and mixing areas, from paint drips, spatters, and spills.

.4 Apply sufficient masking, clean drop cloths, and protective coverings for full protection of work not being painted including, but not limited to, the following:
.1 Light fixtures, fire and smoke detectors.
.2 Sprinkler heads.
.3 Prepainted diffusers and registers.
.4 Prepainted equipment.
.5 Fire rating labels and equipment specification plates.
.6 Finished surfaces.

1.7 **ENVIRONMENTAL PERFORMANCE REQUIREMENTS**

1. Provide paint products meeting MPI "Green Performance Standard GPS-1-12.

1.8 **MAINTENANCE**

1. Deliver to Owner's place of storage on completion of work, sealed containers of each finish painting material applied, and in each colour. Label each container as for original, including mixing formula. Provide the following:
.1 1 L of extra materials when less than 50 L are used for Project;
.2 3.78 L of extra stock when 50 to 200 L are used;
.3 7.57 L of extra stock when over 200 L are used.

2 Products

2.1 **MATERIALS**

.1 Paint:
.1 All materials under work of this Section, including but not limited to, primers, stains, and paints are to have low VOC content limits.
.2 Products in accordance with the MPI Painting Specification Manual, Exterior and Interior Systems;
.1 For each MPI paint code, manufacture's premium grade, first line Products is to be use.
.2 Uniform dispersion of pigment in a homogeneous mixture.
.3 Ready-mixed and tinted whenever possible.
.3 Products within each MPI paint system code: From single manufacturer.
.4 Acceptable manufacturers: Sherwin Williams or approved alternatives by:
.1 Benjamin Moore.
.2 PPG Industries Inc.

.2 Wood stain system (WD-STAIN): Three coat wood sealer system as manufactured by Sikkens Wood Coatings or approved alternative.
.1 Wood primer: One coat of acrylic/alkyd translucent primer with blue stain fungi protection, ‘Cetol WP 567’ by Sikkens Wood Coatings.
.2 Wood topcoat: Two coats of ‘Duraflex Cetol WF 957’ by Sikkens Wood Coatings translucent waterborne acrylic topcoat with UV protection, in colour as selected by the Consultant.

.3 Aliphatic polyurethane coating system:
- .1 Primer: Type as recommended by coating manufacturer to suit intended masonry substrate.
- .2 Top coat: Minimum two (2) coats of 'Amercoat 450H Acrylic Aliphatic Polyurethane/ SigmaDur 550' by PPG Protective & Marine Coatings or approved alternative by PPG Industries Inc.; minimum 3 mils (0.076 mm) dry film thickness per coat.
- .3 Finish and colour: High gloss finish and in colour as selected by the Consultant.
- .4 For use on masonry and concrete substrates in research building, day room and additional areas as indicated or required.

.4 Water repellent sealer: In accordance with Section 07 19 00.

.5 Exterior steel coatings: In accordance with Section 09 97 13.

2.2 COLOUR SCHEDULE

.1 Paint types (PT):
- .1 Refer to Materials and Finishes Legend for paint types, colour selections and gloss levels.
- .2 Where colours have not yet been selected, allow for colour selection by the Consultant beyond paint manufacturer's standard colour range.

.2 Conform to gloss reflectance definitions listed in MPI Specification Manual.

2.3 PAINTING AND FINISHING SCHEDULE

.1 Refer to Table 1, MPI Painting and Finishing Schedule coded systems, comply with MPI Painting Specification Manual.

Table 1: Painting and Finishing Schedule

EXTERIOR SUBSTRATES	Typical substrates (Including but not limited to)	MPI Manual Ref.	MPI Finish System Code	Topcoat
Concrete	Exterior concrete surfaces requiring water repellent sealer.	N/A	N/A	In accordance with Section 07 18 00.
Concrete block masonry	Aliphatic polyurethane coating system	N/A	N/A	See Note 1.
Galvanized steel	HM doors & frames	EXT 5.3	EXT 5.3L	Pigmented polyurethane

Galvanized steel (structural steel)	Structural steel components with galvanized finish	N/A	N/A	In accordance with Section 09 97 13.
Galvanized steel (metal fabrications)	Metal fabrications components with galvanized finish, such as ship's ladder, metal stairs, kick rail, etc.	N/A	N/A	In accordance with Section 09 97 13.
Dimension lumber	Wood screens, open grid wood ceiling, slats	N/A	N/A	See Note 2.
Wood paneling	Cedar wood siding, soffit panels, fascias, coves, etc. for continuity of appearance	EXT 6.4	EXT 6.4A	Solid colour stain, W.B.
Wood deck	Cedar decking at visitor tree house	EXT 6.5	EXT 6.5D	Deck stain
Dressed lumber	Handrail and wood slats	N/A	N/A	See Note 2.
INTERIOR SUBSTRATES	Typical substrates (Including but not limited to)	MPI Manual Ref.	MPI Finish System Code	Topcoat
Concrete walls	Aliphatic polyurethane coating system	N/A	N/A	See Note 1.
Concrete floors	Interior concrete floors requiring a water repellent sealer.	N/A	N/A	In accordance with Section 07 18 00.
Concrete block masonry	Aliphatic polyurethane coating system	N/A	N/A	See Note 1.
Structural steel (Factory primed)		INT 5.1	INT 5.1F	Pigmented polyurethane

Metal Fabrications (Factory primed)		INT 5.1	INT 5.1F	Pigmented polyurethane
Galvanized steel	Ducts, pipes, metal deck	INT 5.3	INT 5.3M	High performance architectural latex
Dressed lumber	Wood window sills	INT 6.3	INT 6.3A	High performance latex
Gypsum board,	Gypsum board walls	INT 9.2	INT 9.2F	Epoxy-modified latex

.2 Notes:
- .1 Provide three coat aliphatic polyurethane system consisting of one primer coat and two coats of topcoat specified herein in accordance with this specification and the manufacturers directions.
- .2 Provide three coat wood sealer system consisting of one coat of the basecoat and two coats of topcoat specified herein in accordance with this specification and the manufacturers directions.

3 Execution

3.1 **EXAMINATION**

.1 Verify condition of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.2 **PREPARATION**

.1 General:
- .1 Clean substrate surfaces free from, dust, grease, soiling, or extraneous matter, which are detrimental to finish.
- .2 Patch, repair, and smoothen minor substrate defects and deficiencies e.g. machine, tool and sand paper marks, shallow gouges, marks, and nibs.
- .3 Clean, sweep, and vacuum floors and surfaces to be painted, debris and dust-free prior to painting.
- .4 Refer to MPI Painting Specification Manual for surface preparation requirements of substrates not listed here.

.2 Where finish hardware has been installed remove, store, re-install finish hardware, to accommodate painting. Do not clean hardware with solvent that will remove permanent lacquer finishes.

.3 Alkali content tests and neutralization:
- .1 Test for ph level using litmus paper on dampened substrate.
- .2 Neutralize surfaces over 8.5 ph with 4% solution of Zinc Sulphate for solvent based systems and tetrapotassium pyrophosphate for latex based systems, to below 8.0 ph, and allow to dry.
- .3 Brush-off any residual Zinc Sulphate crystals.
- .4 Coordinate paint system primer / sealer to be alkali-resistant.

.4 Substrate moisture tests:
- .1 Test for moisture content over entire surface to be painted, minimum one test/ 2 m^2 in field areas and one test/600 mm along inside corners including at ceiling to wall juncture.
- .2 If any test registers above 10% allow entire substrate surfaces, within the plane, to dry further before paint system application. Install temporary drying fans if necessary.
- .3 Re-test employing same criteria.

.5 Galvanized steel sheet:
- .1 Z275 (Satin & Spangled Sheet): SSPC SP7 brush blast.
- .2 ZF075 (Wiped Coat): Remove contamination, wash with Xylene solvent.
- .3 Touch-up damaged galvanized areas with organic zinc rich primer.

.6 Galvanized iron and steel: Prepare galvanized and ungalvanized metal surfaces as follows:
- .1 Unpassivated, unweathered and weathered: Remove contamination, wash with Xylene or Toluol solvent, allow to dry thoroughly. Make paint system primer/sealer an etching type primer.
- .2 Manufacturer pre-treated (including passivated): SSPC SP7.
- .3 Touch-up damaged galvanized areas with organic zinc rich primer.

.7 Structural steel and miscellaneous metal fabrications:
- .1 Coordinate the following with the responsible trades:
  - .1 Rust, mars, mill scale, and weld-burn touch-ups.
  - .2 Oil, grease, weld flux and other residue removal.
- .2 Prime paint items, not otherwise indicated to be primed as part of another Section.
- .3 Touch-up damaged galvanized areas with organic zinc rich primer.

.8 Wood and millwork:
- .1 Wood surfaces to be clean and dry with a moisture content of less than 15%.
- .2 Remove foreign matter prior to prime coat; spot coat knots, pitch streaks and sappy sections with sealer.
- .3 Fill nail holes and fine cracks after primer has dried.
- .4 Backprime interior and exterior woodwork.

.9 Wood decking (visitors):
- .1 Apply primer/sealer paint to seal areas that will be unreachable after construction is complete.
- .2 Moisture content must not be above 12%.

.3 When stain finish is specified remove all discolourations such as water stains, pencil and scuff marks etc. and sand all rough areas.

.10 Factory primed surfaces:
- .1 Touch up damaged areas.
- .2 Clean as required for top coat.

.11 Gypsum board:
- .1 Apply primer/sealer paint to reveal defects and deficiencies and to equalize absorption areas.
- .2 Coordinate repairs and touch-ups with the responsible trade.
- .3 Re-prime repairs.

.12 Coordinate with other trades to prevent:
- .1 Damage, and inadvertent activation of fire and smoke detectors.
- .2 Odour and dust distribution by permanent HVAC systems including fouling of ducts and filters.

.13 Field-mix Products in accordance with manufacturer's written instructions.

3.3 APPLICATION

.1 Apply painting systems in accordance with the MPI Painting Specification Manual. Apply each Product to manufacturer's recommended dry film thickness.

.2 Painting systems listed are required minima, apply additional coats if necessary to obtain substrate hiding acceptable to the Consultant.

.3 Tint intermediate coats lighter than final top coats for identification of each succeeding coat and to facilitate inspections. Include only manufacturer's recommended reducing and tinting accessories. Do not add adulterants.

.4 Primer to be specialized primer coating system as required by manufacturer for selected colour. Standard primer being tinted shall be tinted to a maximum of 1.5% by volume.

.5 Sand lightly between coats to achieve a tooth or anchor for subsequent coats.

.6 Apply paint uniformly in thickness, colour, texture, and gloss, as determined by the Consultant under adequate illumination and viewed at a distance of 1500 mm. Apply finishes free of defects in materials and application which, in the opinion of the Consultant, affect appearance and performance. Defects include, but are not limited to:
- .1 Improper cleaning and preparation of surfaces.
- .2 Entrapped dust, dirt, rust.
- .3 Alligatoring, blisters, peeling.
- .4 Scratches, blemishes.
- .5 Uneven coverage, misses, drips, runs, and poor cutting in.

.7 Do not apply coatings on substrates which are not sufficiently dry. Unless indicated otherwise, allow each painting system coat to cure dry and hard before following coats are applied.

.8 Repaint entire areas of damaged or incompletely covered surfaces, to the nearest inside or outside corner; patching will not be permitted.

.9 Miscellaneous painting requirements:
- .1 Paint projecting ledges, and tops, bottoms and sides of doors both above and below sight lines to match adjacent surfaces.
- .2 Paint door frames, access doors and frames, door grilles, prime coated butts, and prime coated door closers to match surface in which they occur.

.10 Mechanical, electrical and other painting coordination:
- .1 Paint mechanical services in accordance with Mechanical Identification Division 21, 22 and 23.
- .2 Coordinate painting of pipes, ducts, and coverings with the work of Division 21, 22 and 23 to precede pipe colour banding, flow arrows, and other pipe identification labeling installation.
- .3 Paint exposed conduit, pipes, hangers, ductwork, grilles, gratings, louvres, access panels, fire hose cabinets, registers, convector, covers, enclosures, and other mechanical and electrical equipment; apply colour and sheen to match adjacent surfaces, except as noted otherwise.
- .4 Paint portions of surfaces such as duct interiors, piping, ductwork, hangers, insulation, walls, and similar items, visible through grilles, louvres, convector covers etc., matte black in colour.
- .5 Remove the following to accommodate painting, carefully store, clean, then re-install on completion of each area and when dry:
  - .1 Switch and receptacle plates, fittings and fastenings, grilles, gratings, louvres, access panels, convector covers, and enclosures.

3.4 FIELD QUALITY CONTROL

.1 Dry film thickness tests:
- .1 Test for film thickness over entire surface to be painted, minimum one test/2 m^2 in field areas and one test/600 mm along inside corners including at ceiling to wall juncture.
- .2 If any test registers below specified thickness, re-apply paint to entire surface to nearest inside and outside corners.
- .3 If test registers more than 50% above specified thickness, consult with paint manufacturer, determine if problem exists, offer solutions to Consultant, and repair as directed.
- .4 Re-test employing same criteria after repair.

3.5 **CLEANING**

.1 Remove spilled, splashed, and spattered paint promptly as work proceeds and on completion of work. Clean surfaces soiled by paint spillage and paint spatters. Repair or replace damaged work, as directed by Consultant.

3.6 **PROTECTION**

.1 Post Wet Paint signs during drying and restrict or prevent traffic where necessary.

.2 Post sign, after Consultant's inspection and acceptance of each room, reading: PAINTING COMPLETE - NO ADMITTANCE WITHOUT CONTRACTOR'S PERMISSION.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for exterior steel coating work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 CAN/CGSB 85.10, Protective Coatings for Metals.

.2 SSPC Steel Structures Painting Council, Standards.

.3 SSPC-SP1, Solvent Cleaning.

.4 SSPC-SP7, Brush-Off Blast Cleaning.

1.3 **SUBMITTALS**

.1 Product data:
- .1 Submit copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
  - .1 Performance criteria, compliance with appropriate reference standard, characteristics, limitations.
  - .2 Product transportation, storage, handling and installation requirements.
- .2 Submit listing of manufacturer's Product types, Product codes, and Product names, number of coats, and dry film thicknesses, corresponding to each Painting Schedule code; submit listing minimum of 8 weeks before materials are required.

.2 Samples:
- .1 Submit following samples in accordance with Section 01 33 00.
  - .1 Three 300 x 150 mm draw downs of each colour minimum 4 weeks before paints are required.
  - .2 Identify each sample with Contract number and title, colour reference, sheen, date, and name of applicator.

.3 Certificates:
- .1 Submit certified documentation to confirm each airless spray painter has minimum of 5 years experience on applications of similar complexity and scope.
- .2 Submit certified documentation to confirm each worker has Provincial Tradesman Qualification certificate of proficiency.

.4 Reports:
- .1 Submit written field inspection and test report results after each inspection.
- .2 Submit Field Quality Control test result reports for alkali content, substrate moisture, and dry film thickness.
- .3 Submit electronic moisture meter manufacturer's specifications including tolerances. Submit record of latest meter calibration to meet manufacturer's recommendations.

.5 Closeout submittals: Submit maintenance instructions in accordance with Section 01 78 23 for incorporation into Operation and Maintenance Manual.

1.4 QUALITY ASSURANCE

.1 Applicators qualifications: Perform work of this Section by a company that has a minimum of five years proven experience in the application of coatings of a similar nature and that is approved by manufacturer. Submit to Consultant, applicator's current certificate of approval by the material manufacturer as proof of compliance.

.2 Shop mock-up:
- .1 Construct one 1 m^2 mock-up of a steel item as selected by Consultant with exterior steel coating system, in locations acceptable to Consultant to demonstrate installation workmanship, colour, and hiding power of Products.
- .2 Obtain Consultant's acceptance in writing before proceeding with the work of this Section.
- .3 Mock-ups may remain as part of the Work if acceptable to Consultant and will serve as a standard for similar code systems.
- .4 Repaint over mock-ups which do not form part of the Work.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Install correct, safe temporary storage for paint, thinner, solvents, and other volatile, corrosive, hazardous, and explosive materials in accordance with requirements of authorities having jurisdiction.

.2 Post hazard warning signage in areas of storage and mixing. Install and maintain sufficient CO^2 fire extinguishers of minimum 9 kg capacity, accessible in each storage mixing and storage areas.

.3 Maintain storage enclosures at minimum 10°C ambient temperature and to manufacturer's instructions.

1.6 SITE CONDITIONS

.1 Apply coatings under following conditions:
- .1 Exterior coatings: 5°C minimum.
- .2 24 hours minimum after rain, frost, condensation, or dew.
- .3 When no condensation is possible (unless specifically formulated against condensation).
- .4 Not in direct exposure to sun light.

.2 Maintain temperature conditions indicated above for 24 hours before, during and 24 hours after painting.

.3 Install clean plywood sheets to protect floors and walls in storage and mixing areas, from paint drips, spatters, and spills.

.4 Apply sufficient masking, clean drop cloths, and protective coverings for full protection of work not being painted such as:
- .1 Prepainted equipment.
- .2 Fire rating labels and equipment specification plates.

2 Products

2.1 **ACCEPTABLE MANUFACTURERS**

.1 Acceptable manufacturers - exterior steel coatings:
- .1 PPG Protective & Marine Coatings.
- .2 Or approved alternative by Devoe High Performance Coatings (AkzoNobel) that has been used in similar animal habitats.

.2 All materials under work of this Section, including but not limited to, coatings are to have low VOC content limits.

.3 Each material used in the application of each coating system shall be as recommended or manufactured by the supplier of the coating and be in accordance to CAN/CGSB 85.10.

.4 Coating formula (shop applied on galvanized steel):
- .1 Primer: Unless otherwise recommended by coating manufacturer, one coat epoxy primer, minimum 4 mils (0.102 mm) to 8 mils (0.204 mm) dry film thickness. 'Amercoat Amerlock 2 High Solids Epoxy Coating' by PPG Protective & Marine Coatings.
- .2 Top coats: Minimum two (2) coats of 'Amercoat 450H Acrylic Aliphatic Polyurethane' by PPG Protective & Marine Coatings, minimum 2 mils (0.051 mm) to 5 mils (0.128 mm) dry film thickness per coat.
- .3 Colour: As selected by the Consultant.

2.2 **SHOP PAINTING**

.1 Preparation:
- .1 Prepare surfaces in accordance with manufacturer's written instructions and specifications.
- .2 Clean steel prior to application of coating in accordance with Steel Structures Painting Council Standards published in Steel Structures Painting Manual, Vol. 2, Systems and Specifications.
- .3 Prior to abrasive blast cleaning, remove oil and grease in accordance with SSPC-SP1.

.4 Prepare steel surfaces in a manner as specified as SSPC-SP7 to create a surface profile as recommended by coating manufacturer.

.5 Cover or mask surfaces adjacent to those receiving coating to protect work of others and property from damage and soiling.

.2 Shop application:

.1 Shop apply coating in accordance with coating manufacturer's written application instructions and specifications.

.2 Apply coatings with no runs, laps, voids, or other marks or irregularities, and with uniform colour, sheen and texture.

.3 Apply each successive coat only after the previous coat has dried.

.3 Refinish entire coated surface where finish is damaged or otherwise unacceptable. Surfaces exhibiting pin holes or other defects shall be recoated.

.4 Dry film thickness tests:

.1 Test for film thickness over entire surface to be painted, minimum one test/2 m2 in field areas and one test/600 mm along inside corners including at ceiling to wall juncture.

.2 If any test registers below specified thickness, re-apply paint to entire surface to nearest inside and outside corners.

.3 If test registers more than 50% above specified thickness, consult with paint manufacturer, determine if problem exists, offer solutions to Consultant, and repair as directed.

.4 Re-test employing same criteria after repair.

3 Execution

3.1 EXAMINATION

.1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.2 TOUCH-UP AND CLEANING

.1 Touch-up coating with top coats as required or where requested by the Consultant.

.2 Remove spilled, splashed, and spattered paint promptly as work proceeds and on completion of work. Clean surfaces soiled by paint spillage and paint spatters.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for miscellaneous specialties work in accordance with the Contract Documents.

1.2 **DESIGN REQUIREMENTS**

.1 Appearance of finished work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved samples and are assembled or installed to minimize contrast.

1.3 **SUBMITTALS**

.1 Product data:
.1 Submit duplicate copies of manufacturer's Product data for each Product specified in accordance with Section 01 33 00 indicating:
.1 Performance criteria, compliance with appropriate reference standard(s), characteristics, and limitations.
.2 Product transportation, storage, handling and installation requirements.

.2 Shop drawings:
.1 Submit shop drawings in accordance with Section 01 33 00 indicating:
.1 Elevations, sections, details, dimensions, materials, gauges, and finishes.
.2 Details shall indicate fasteners, anchorage assemblies and components and erection details and interfacing with other Work.
.3 Structural engineering stamp to be provided on shop drawings for play structures and anchorage of dead trees.

.3 Samples:
.1 Submit sample in accordance with Section 01 33 00 of the following:
.1 For each exposed product and for each colour and texture specified.

.4 Certificates/certification: Provide certificates demonstrating compliance of play structures with performance requirements of the Section.

.5 Closeout submittals: Submit cleaning and maintenance instructions for miscellaneous specialties for incorporation into Operations and Maintenance Manuals in accordance with Section 01 78 23.

1.4 **QUALITY ASSURANCE**

.1 Obtain third party certification of playground equipment to meet CSA certification.

.2 Installers qualifications: Perform work of this Section by a company that has a minimum of five years proven experience in the installation of play structures and trees of a similar size and nature and that is approved by manufacturer. Submit to Consultant, installer's current certificate of approval by the material manufacturer as proof of compliance.

.3 Retain a Professional Engineer, licensed in Province of Ontario, with experience in Work of comparable complexity and scope, to perform following services as part of Work of this Section:
- .1 Design of play structures.
- .2 Design of anchorage components to concrete foundations as required for dead trees.
- .3 Review, stamp, and sign shop drawings and design calculations.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Package or crate, and brace products to prevent distortion in shipment and handling. Label packages and crates, and protect finish surfaces by sturdy wrappings.

2 Products

2.1 MANUFACTURED UNITS

.1 Orangutan play structure:
- .1 Conforming to CSA requirements for playground equipment.
- .2 Modified log pile with netting for orangutans. Manufactured by Whole Trees Structures or approved alternative.
- .3 Provision of anchors as required for complete installation and anchorage details to concrete foundations to be by the Contractor. Coordinate with Section 03 30 00 as required for concrete work.

.2 Play structure 1:
- .1 Conforming to CSA requirements for playground equipment.
- .2 Maze structure with non-structural black locust. Manufactured by Whole Trees Structures or approved alternative. Provide four (4) vertical tree trunks and balance beam logs.

.3 Play structure 2:
- .1 Conforming to CSA requirements for playground equipment.
- .2 Rope course non-structural black locust with Anaconda foot rope and elevated hand rope. Manufactured by Whole Trees Structures or approved alternative.

.4 Standing dead trees:
- .1 Provide six (6) black locust natural vertical trees by manufactured by Whole Trees Structures or approved alternative.
- .2 7000 mm (7 m) is the anticipated tree height but the final tree height will be selected by Consultant from standard available trees.
- .3 Provide four (4) eye-bolt attachments per tree, consisting of two (2) on top and two (2) on bottom as directed by the Consultant.

.4 Provision of anchors as required for complete installation and anchorage details to concrete foundations to be by the Contractor. Coordinate with Section 03 30 00 as required for concrete work.

2.2 **FABRICATION**

.1 Factory assembly: Assemble components in the factory to greatest extent possible to minimize field assembly. Clearly mark units for assembly in the field.

3 Execution

3.1 **EXAMINATION**

.1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.2 **PREPARATION**

.1 Verify substrate surfaces are solid, free from surface water, dust, oil, grease, projections and other foreign matter detrimental to performance.

.2 Provide information and templates required for installation of work of this Section, and assist or supervise, or both, the setting of anchorage devices, and construction of other work incorporated with products specified in this Section in order that they function as intended.

3.3 **INSTALLATION**

.1 Install miscellaneous specialties level and securely and rigidly anchored to substrate in accordance with authorities having jurisdiction, reviewed shop drawings, and manufacturer's written instructions.

.2 Coordinate with other Sections in advance and build-in or make provisions for installation of work other Sections.

.3 Post setting: Set cast-in support posts in concrete footing with smooth top, shaped to shed water. Protect portion of posts above footing from concrete splatter. Verify that posts are set plumb or at correct angle and are aligned and at correct height and spacing. Hold posts in position during placement and finishing operations until concrete is sufficiently cured.

.4 Posts set into voids in concrete: Form or core-drill holes for installing posts in concrete to depth recommended in writing by manufacturer of site furnishings and 19 mm larger than O.D. of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with non-shrink, non-metallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.

.5 Pipe sleeves: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with non-shrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.

.6 Ensure final installation is rigid, secure, level and free from defects detrimental to appearance or performance.

.7 After installation, adjust miscellaneous specialties in accordance with manufacturer's written instructions.

3.4 **CLEANING**

.1 Clean exposed surfaces prior to acceptance by Consultant.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Design, labour, Products, equipment and services necessary for fall protection systems work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ANSI, H35.1M Alloy and Temper Designation Systems for Aluminum (Metric).

.2 ASTM A123, Specification for Zinc (Hot Dip Galvanized) Coatings on Iron & Steel Products.

.3 ASTM A153, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

.4 ASTM A276, Specification for Stainless and Heat-Resisting Steel Bars and Shapes.

.5 ASTM B221M, Specification for Aluminum-Alloy Extruded Bars, Rods, Wires, Shapes and Tubes.

.6 CAN/CSA-G40.20/G40.21-M, General Requirements for Rolled or Welded Structural Quality Steel/ Structural Quality Steels.

.7 CAN/CSA S16.1-M, Limit States Design of Steel Structures.

.8 CSA S136.1-M, Commentary on CAN/CSA S136-M, Cold Formed Steel Structural Members.

.9 CSA S157-M, Strength Design in Aluminum.

.10 CSA W47.1, Certification of Companies for Fusion Welding of Steel Structures.

.11 CSA W47.2-M, Certification of Companies for Fusion Welding of Aluminum.

.12 CSA W48.1-M, Carbon Steel Covered Electrodes for Shielded Metal Arc Welding.

.13 CSA W59-M, Welded Steel Construction (Metal Arc Welding).

.14 CAN/CSA W117.2-M, Safety in Welding, Cutting and Allied Processes.

.15 CAN/CSA-Z91, Health and Safety Code for Suspended Equipment Operations.

.14 CAN/CSA-Z271, Safety Code for Suspended Platforms

1.3 DESIGN REQUIREMENTS

.1 Design fall protection systems for maintenance of exhibit landscaping as required by the Project and in accordance with the Occupational Health & Safety Act and Regulations, CAN/CSA-Z91, and CAN/CSA-Z271. Comply with applicable guidelines issued by the Ontario Ministry of Labour.

.2 Design fall protection system in accordance with Occupational Health & Safety Act, CAN/CSA-Z91, CAN/CSA-Z271, and to withstand live, dead, seismic, imposed and other loads, and which meets proper and current maintenance practices.

.3 Design structural members with 4:1 safety factor based on ultimate strength and normal operating conditions or with limit states design as specified in referenced standards.

.4 Design fall protection system to ensure building surfaces and finishes will not be marred or otherwise damaged during normal operation of equipment.

.5 Design all anchor components to provide an adequate attachment means suited to current maintenance practices and compatible with industry standard equipment.

.6 As a minimum, design shall comply with CSA S16.1, CSA S136, and CAN3 S157-M.

1.4 SUBMITTALS

.1 Product data:
- .1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
  - .1 Performance criteria, compliance with appropriate reference standard(s), characteristics, and limitations, and trouble-shooting protocol.
  - .2 Product transportation, storage, handling and installation requirements.

.2 Shop drawings:
- .1 Submit shop drawings in accordance with Section 01 33 00 indicating:
  - .1 Elevations, sections, details, materials, operating components, dimensions, gauges, finishes and relationship to adjacent construction.
  - .2 Complete layout and configuration of complete fall protection system, including locations and all other components and accessories.
  - .3 Clearly indicate design and fabrication details, hardware and installation details.
  - .4 Include all necessary Restrictive and Non Restrictive Working Usage Notes and General Safety Notes.
  - .5 Complete engineering design data confirming that Products meet design criteria specified.
  - .6 Name and proof of CWB Certification or welding fabricator.

.3 Reports/Certificates/letters:
- .1 Provide all necessary and required test reports and certificates to comply with the relevant codes and regulations of jurisdictional authorities.
- .2 Submit test data from an independent testing laboratory to show that all anchors which are to be used in this project meet the loading requirements of CAN/CSA-Z91-M. Anchors are to be tested after installation to loads specified in design standard in Design Requirements.
- .3 Submit inspection reports within 5 days of inspection.
- .4 Submit certified proof of product liability insurance.
- .5 Submit a letter from the Engineer certifying that fall protection system meets the performance requirements of the Ministry of Labour and standards specified in Design Requirements.

.4 Closeout submittals:
- .1 Provide reduced as-built shop drawing showing anchor locations and details, in accordance with requirements of jurisdictional authorities. Drawings shall be metal framed with clear polycarbonate scratch resistant cover. Locate drawings in location approved by the Owner, securely fastened to intended substrate.
- .2 Complete inspection log book, to certify fall protection system is ready for use in accordance with requirements of jurisdictional authority and for yearly inspections.
- .3 Submit following for each Product incorporation into Operations and Maintenance Manuals in accordance with Section 01 78 23:
  - .1 Identification: Manufacturing name, type, year, serial number, number of units, capacity, and identification of related systems.
  - .2 Functional description detailing operation and control of components.
  - .3 Performance criteria and maintenance data.
  - .4 Operating instructions and precautions.
  - .5 Safety precautions.

1.5 QUALITY ASSURANCE

.1 Manufacturer's qualifications:
- .1 Execute work of this Section only by a Subcontractor specializing in the design, fabrication and installation of fall protection systems and who is also known to have been responsible for satisfactory installations similar to that specified during a period of at least the immediate past five years.
- .2 Manufacturers shall carry specific liability insurance (products and completed operations insurance in the amount of $ 5,000,000.00). This insurance must cover the failure of equipment and anchors.

.2 Installers qualifications: Perform work of this Section by a company that is employed by, and under direct supervision of component manufacturer and has a minimum of five years proven experience in the installation of fall protection systems of a similar size and nature.

.3 Retain a Professional Engineer, licensed in Province of Ontario, with experience in fall protection systems work of comparable complexity and scope, to perform following services as part of work of this Section:
.1 Design of fall protection system.
.2 Review, stamp, and sign fabrication, shop drawings, and design calculations.
.3 Conduct shop and on-site inspections, prepare and submit written inspection reports verifying that this part of work is in accordance with Contract Documents and reviewed shop drawings.

.4 Execute welding by firms certified in accordance with CSA W47.1 Division 1 or 2.1 and CSA W47.2-M. Ensure welding operators are licensed per CSA W47.1 and CSA W47.2-M for types of welding required by work.

2 Products

2.1 **ACCEPTABLE MANUFACTURERS**

.1 Specified manufacturer's products of Ankor Engineering Systems Inc., Pro-Bel Enterprises Limited and Thaler Industries Ltd. establish minimum acceptable standards for work of this Section.

.2 Equipment of other manufacturers shall meet or exceed specified manufacturer's standard. Conform to the requirements for equivalent products specified in Division 1.

2.2 **MATERIALS**

.1 Structural shapes, plates, and similar items: CAN/CSA-G40.20/G40.21-M, Grade 350W.

.2 Aluminum: ASTM B221 and ANSI H35.1 AA6063 alloy, T6 temper.

.3 Stainless steel: ASTM A276, Type 316.

.4 Welding materials: CSA W48.1-M and CSA W59-M.

2.3 **FABRICATION**

.1 Verify dimensions of existing work before commencing fabrications and report discrepancies to Consultant.

.2 Fabricate work in accordance with reviewed shop drawings and manufacturer’s written instructions.

.3 Fabricate work free from defects impairing function, strength and durability.

.4 Accurately cut, machine and fit joints, corners, copes and mitres so that junctions between components fit together tightly and in true planes. Cap open ends of sections exposed to view.

.5 Fabricate work with materials and component sizes, metal gauges, reinforcing, anchors, and fastenings of adequate strength to ensure that it will remain free of warping, buckling, opening of joints and seams, and distortion within limits of intended and specified use and with allowable design factors imposed by jurisdictional authorities.

.6 Weld all connections, unless otherwise indicated. Cleanly and smoothly finish exposed edges of materials including holes.

2.4 WELDING

.1 Perform welding by electric arc process.

.2 Execute welding to avoid damage or distortion to work. Execute welding in accordance with following standards:

.1 CSA W48.1-M - for Electrodes. If rods are used, only coated rods are allowed.

.2 CSA W59-M and CSA W59S1-M for design of connections and workmanship.

.3 CAN/CSA W117.2-M - for safety.

.3 Thoroughly clean welded joints and expose steel for a sufficient distance to perform welding operations. Finish welds smooth. Supply continuous and ground welds which will be exposed to view and finish painted.

.4 Test welds for conformance and remove work not meeting specified standards and replace to Consultant's acceptance.

2.5 HOT DIP GALVANIZING

.1 After fabrication, hot dip galvanize steel items that will be exposed to the elements and as indicated. After galvanizing, plug relief vents air tight with appropriate aluminum plugs as suitable and required for intended metal fabricated item. Straighten shapes and assemblies true to line and plane after galvanizing. Repair damaged galvanized surfaces with zinc rich primer in accordance with manufacturer's printed directions.

.2 Hot-dip galvanize members in accordance with requirements of the following ASTM, with minimum coating weights or thicknesses as follows:

.1 Rolled, pressed and forged steel shapes, plates, bars and strips: ASTM A123; average weight of zinc coating per square/metre of actual surface, for 4.8 mm and less thickness members 600 g/m^2 for 6 mm and heavier members 640 g/m^2.

.2 Iron and steel hardware: ASTM A153; minimum weight of zinc coating, in ounces per square foot of surface, in accordance with ASTM A153,Table 1 for the various classes of materials used in the Work.

3 Execution

3.1 **EXAMINATION**

.1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

.2 Take site measurements of construction to which work of this Section must conform, and through which access must be made, before work is delivered to site, to ensure that adaptation is not required which would result in construction delay.

3.2 **INSTALLATION**

.1 Install work in accordance with reviewed shop drawings and manufacturer's recommended specifications, true, tightly fitted, and level or flush to adjacent surfaces, as suitable for installation.

.2 Provide anchorage information, roughing-in dimensions, templates, and service requirements for installation of work of this Section, and assist or supervise, or both, the setting of anchorage devices, and construction of other work incorporated with work specified in this Section in order that they function as intended.

.3 Assemble components delivered in sections. Use only fastenings suitable for materials.

.4 Work shall include rough hardware, fastenings, and other items necessary for secure installation.

.5 Install work straight, plumb, level, and secured to prevent distortion or displacement, or both.

.6 Secure components to construction as required to maintain it permanently in place, and so that it functions properly with no damaging vibration to the building or itself.

.7 Insulate between dissimilar metals, to prevent electrolysis.

3.3 **REPAIR**

.1 Refinish damaged or defective work so that no variation in surface appearance is discernible.

3.4 ADJUSTING AND FINAL INSPECTION

.1 Verify under work of this Section that installed products function properly, and adjust them accordingly to ensure satisfactory operation. Fall arrest anchors shall be inspected and tested by an independent inspection and testing body approved by jurisdictional authorities, before being used for the first time, independent and inspection and testing body shall fill out the log book in accordance with jurisdictional authority requirements.

.2 Complete the inspection log book to certify system for use.

END OF SECTION

1 General

1.1 **REFERENCES**

.1 Division 00 and Division 01 apply to and are a part of each Mechanical Division:
  .1 Division 22 – Plumbing;
  .2 Division 23 – Heating, Ventilating, and Air Conditioning;
  .3 Division 25 - Integrated Automation.

1.2 **APPLICATION**

.1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Mechanical Divisions. It is intended as a supplement to each Section and is to be read accordingly.

1.3 **SUBMITTALS**

.1 Submit shop drawings/product data sheets for:
  .1 electric motors (submit with equipment they are associated with).

.2 Submit weight loads for selected equipment (upon request).

.3 Submit copy of architectural reflected ceiling plan drawings and elevation drawings to indicate proposed access door locations.

.4 Submit a list of equipment identification nameplates indicating proposed wording and sizes.

.5 Submit a list of pipe and duct identification colour coding and wording.

.6 Submit a proposed valve tag chart and a list of proposed valve tag numbering and identification wording.

.7 Submit drawings indicating size and location of required sleeves, recesses and formed openings in poured or precast concrete work.

2 Products

2.1 **PIPE SLEEVES**

.1 Galvanized Sheet Steel – Minimum #16 gauge galvanized steel with an integral flange at one end to secure sleeve to formwork construction.

.2 Polyethylene – Factory fabricated, flanged, high density polyethylene sleeves with reinforced nail bosses.

.3 Waterproof Galvanized Steel Pipe – Schedule 40 mild galvanized steel pipe with a welded-on square steel anchor and water stop plate at sleeve midpoint.

.4 Galvanized Steel or Cast Iron Pipe – Schedule 40 mild galvanized steel, or Class 4000 cast iron.

2.2 FIRESTOPPING AND SMOKE SEAL MATERIALS

.1 Firestopping and smoke seal system materials for mechanical penetrations through fire rated construction are specified in “20 05 17.00 - Sleeves and Sleeve Seals for Mechanical Piping” and work is to be done as part of mechanical work unless otherwise specified in Division 07.

2.3 WATERPROOFING SEAL MATERIALS

.1 Modular, mechanical seal assemblies consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and pipe sleeve or wall opening, assembled with stainless steel bolts and pressure plates and designed so when bolts are tightened the links expand to seal the opening watertight. Select seal assemblies to suit pipe size and sleeve size or wall opening size.

.2 Acceptable products are:
- .1 Thunderline Corp. (Power Plant Supply Co.) "LINK SEAL" Model S-316;
- .2 The Metraflex Co. "MetraSeal" type ES.

2.4 PIPE ESCUTCHEON PLATES

.1 One-piece chrome plated brass or #4 finish type 302 stainless steel plates with matching screws for attachment to building surface, each plate sized to completely cover pipe sleeve or building surface opening, and to fit tightly around pipe or pipe insulation.

2.5 PIPING HANGERS AND SUPPORTS

.1 Pipe hanger and support materials, including accessories, are to be, unless otherwise specified, in accordance with Manufacturers Standardization Society (MSS) Standard Practice Manual SP-58, Pipe hangers and Supports-Materials, Design and Manufacture, and where possible, MSS designations are indicated with each product specified below. Conform to following requirements:
- .1 unless otherwise specified, ferrous hanger and support products are to be electro-galvanized;
- .2 hangers and supports for insulated piping are to be sized to fit around insulation and insulation jacket.

.2 Hangers and supports for horizontal suspended piping as follows:
- .1 adjustable steel clevis hanger – MSS Type 1;
- .2 adjustable swivel ring band hanger – MSS Type 10;

.3 Supports for horizontal pipe on vertical surfaces as follows:
- .1 steel offset pipe clamp – Anvil Fig. 103 or Myatt Fig. 170;
- .2 heavy-duty steel pipe clip – MSS Type 26;
- .3 single steel pipe hook – Myatt Fig. 156;
- .4 epoxy coated steel pipe stays are not permitted.

.4 Floor supports for vertical risers as follows:
- .1 copper tubing riser clamp – MSS Type 8;
- .2 heavy-duty steel riser clamp – MSS Type 8.

.5 Supports for vertical piping on vertical surfaces as follows:
- .1 steel offset pipe clamp – Anvil Fig. 103 or Myatt Fig. 170;
- .2 heavy-duty steel pipe bracket or soil pipe bracket – MSS Type 26;
- .3 extension split pipe clamp – MSS Type 12;
- .4 epoxy coated steel pipe stays are not permitted.

.6 For horizontal pipe on racks, Unistrut or equal galvanized steel pipe racks with pipe securing hardware as follows:
- .1 standard galvanized steel U-bolts/clamps supplied by rack manufacturer;

.7 Special hangers and supports for various applications as follows:
- .1 vibration isolated riser supports – black steel riser clamps as specified above, complete with neoprene–steel–neoprene sandwich type vibration isolation pads between clamp and floor;
- .2 for groups of pipes having same slope – MSS Type 32 welded steel brackets, Anvil Fig. 46 universal trapeze assemblies, or Unistrut or equal support assemblies, all with U-bolts, clamps, etc., to secure pipes in place;
- .3 for sections of piping connected to vibration isolated equipment – hangers and supports as specified above but complete with MSS Type 48 spring cushions;
- .4 for plastic piping – generally as specified above but in accordance with pipe manufacturer's recommendations;
- .5 for bare horizontal copper piping – generally as above but factory vinyl coated to prevent direct copper/steel contact;
- .6 for bare copper vertical piping – corrosion resistant ferrous clamps with flexible rubber gasket type material (not tape) to isolate pipe from clamp;
- .7 insulation protection shields to and including 40 mm (1-½") dia. – MSS Type 40 galvanized steel shields with ribs to keep shield centred on hanger.

.8 Hanger rods are to be electro-galvanized carbon steel (unless otherwise specified), round, threaded, to ASTM A36, complete with captive machine nuts with washers at hangers, sized to suit loading in accordance with Table 3 in MSS SP-58, but in any case minimum 9.5 mm (3/8") diameter.

.9 Acceptable manufacturers are:
- .1 E. Myatt & Co. Inc.;
- .2 Anvil International Inc.;
- .3 Empire Industries Inc.;
- .4 Hunt Manufacturing Ltd.;
- .5 Unistrut Canada Ltd.;
- .6 Nibco Inc. "Tolco";
- .7 Taylor Pipe Supports.

2.6 ACCESS DOORS

.1 Provide all access doors required for Mechanical work unless otherwise specified in Division 08. Coordinate consistency of look and finish of access doors on project with each Division of Work. Coordinate exact requirements with General Trades Contractor.

.2 Access doors to be rust resistant steel door panels, with concealed hinges and positive locking and self-opening screwdriver operated lock. Wall type frame to be

suitable for wall installation and have integral keys for plaster walls. Doors in tile wall to be stainless steel and in ceilings to be suitable for plaster covering with only frame joint showing. Other doors to be prime painted steel.

.3 Size access doors to suit the concealed work for which they are supplied, and wherever possible they are to be of standard size for all applications, but in any case they are to be minimum 300 mm x 300 mm (12" x 12") for hand entry and 600 mm x 600 mm (24" x 24") for body entry.

.4 Lay-in type tiles, properly marked, may serve as access panels. Coordinate marking of ceiling tiles with Consultant. Panels in glazed tile walls to be 12 gauge, 304 alloy stainless steel, No. 4 finish, with recessed frame secured with stainless steel counter-sunk flush head screws.

.5 Panels in plaster surfaces to have dish-shaped door and welded metal lath, ready to take plaster. Provide a plastic grommet for door key access.

.6 Other access doors to be welded 12 gauge steel, flush type with concealed hinges, lock and anchor straps, complete with factory prime coat. Submit to Consultant for review, details of non-standard door construction details.

.7 Access doors in fire rated ceilings, walls, partitions, structures, etc., to be ULC listed and labelled and of a rating to maintain fire separation integrity.

.8 Where access doors are located in surfaces where special finishes are required, they are to be of a recessed door type capable of accepting finish in which they are to be installed so as to maintain final building surface appearance throughout.

.9 Acceptable manufacturers include Le Hage, SMS, Pedlar and Acudor.

2.7 PRESSURE GAUGES AND THERMOMETERS

.1 Pressure gauges as follows:
- .1 adjustable, glycerine filled, 100 mm or 115 mm (4" or 4-½") diameter and each accurate to within 1% of scale range;
- .2 type 304 stainless steel case with relief valve and polished stainless steel bayonet;
- .3 stainless steel rotary movement with stainless steel bushings and socket;
- .4 clear acrylic window;
- .5 dual scale white dial with a scale range such that working pressure of system is at approximate mid-point of scale;
- .6 black pointer.

.2 Pressure gauge accessories and additional requirements as follows:
- .1 a bronze ball type shut-off valve is to be provided in the piping to each pressure gauge;
- .2 each pressure gauge for piping and equipment with normal everyday flow is to be equipped with a brass pressure snubber;
- .3 each pressure gauge for steam piping or steam equipment is to be equipped with a steel coil syphon;
- .4 pressure gauges in fire protection piping must be ULC listed and labelled;

.3 Thermometers as follows:
- .1 round, 125 mm (5") diameter, adjustable (90°) angle bimetal dial type thermometers, each accurate to within 1% of full scale;
- .2 hermetically sealed stainless steel case with stainless steel ring;
- .3 dampened bimetal coil;
- .4 calibration adjustment screw;
- .5 white aluminum dual scale dial with black and blue markings and a range such that working temperature of system is approximate mid-point of the scale;
- .6 black aluminum pointer;
- .7 double strength glass window;
- .8 12 mm (½") NPT connection with 6.4 mm (¼") diameter stainless steel stem;
- .9 suitable thermowell.

.4 Acceptable manufacturers are:
- .1 H.O. Trerice Co.;
- .2 Weiss Instruments;
- .3 Ashcroft.

2.8 EQUIPMENT BELT DRIVES

.1 ANSI/RMA Standard V-belt type rated at minimum 1.5 times motor nameplate rating, and in accordance with following requirements:
- .1 belts are to be reinforced cord and rubber, and multiple belts are to be matched sets;
- .2 sheaves are to be cast iron or steel, secured to shafts with removable keys unless otherwise specified, standard adjustable pitch (± 10% range) for motors under 10 HP, fixed pitch type with split tapered bushing and keyway for motors 10 HP and larger, and, if required, replaced as part of mechanical work to suit system air/water quantity testing and balancing work;
- .3 motor slide rail adjustment plates are to allow for centre line adjustment.

.2 Supply a spare belt set (tagged and identified) for each belt drive and hand to Owner upon Substantial Performance of the Work.

2.9 EQUIPMENT DRIVE GUARDS AND ACCESSORIES

.1 For V-belt drives – removable, 4-sided, fully enclosed, galvanized sheet steel guards to OHSA standards, cleaned, factory primed and painted with yellow equipment enamel, complete with a 2-piece full length hinged front panel to permit belt maintenance or replacement without removing guard, and 40 mm (1-½") diameter tachometer openings at each shaft location.

.2 For flexible couplings – removable "U" shaped galvanized steel guards to OHSA Standards with a 2.3 mm (3/32") thick frame and expanded mesh face.

.3 For unprotected fan inlets and outlets – unless otherwise specified, removable 20 mm (¾") galvanized steel wire mesh with galvanized steel frames, all to OHSA Standards.

2.10 ELECTRIC MOTORS

.1 Unless otherwise specified, motors are to conform to NEMA Standard MG1, applicable IEEE Standards, and applicable CSA C22.2 Standards, and are to meet NEMA standards for maximum sound level ratings under full load. Confirm motor voltages prior to ordering.

.2 Vertically mounted and submersible motors are to be purposely designed for mounting in this attitude.

.3 Efficiency of 1-phase motors to 1 HP is to be in accordance with CAN/CSA C747. Efficiency of 3-phase motors 1 HP and larger is to be in accordance with CAN/CSA C390 or IEEE 112B.

.4 Unless otherwise specified, 1-phase motors smaller than ½ HP are to be 115 volt, continuous duty capacitor start type with an NEMA 48 or 56 frame size, solid base, heavy-gauge steel shell with solid die-cast end shields, dynamically balanced die-cast rotor, integral automatic reset thermal overload protection, Class "B" insulation, and a 1.15 service factor at 40°C (105°F) ambient temperature.

.5 Explosion-proof 1-phase motors are to be totally enclosed, fan cooled, 115 volt continuous duty capacitor start type in accordance with CSA C22.2 No. 145, as specified for standard 1-phase motors but suitable for use in Class 1 Group D hazardous locations and complete with a rolled steel shell and a 1.0 service factor at 40°C (105°F) ambient temperature.

.6 Unless otherwise specified, motors ½ HP and larger are to be totally enclosed, fan cooled, 3-phase, T-frame, squirrel cage continuous duty induction motors suitable for voltages indicated on Drawings, NEMA Design "B" for normal starting torque or Design "C" for high starting torque as required by the application, each complete with Class "B" insulation, a 1.15 service factor at 40°C ambient temperature, grease lubricated open ball bearings with grease fittings to permit re-lubrication without dismantling motor, a cast iron frame with cast iron feet where required, cast iron end bracket and precision machined bearing fit, and balanced carbon steel shaft assembly with die-cast aluminum rotor windings.

.7 Explosion-proof 3-phase motors are to be totally enclosed fan cooled motors in accordance with CSA C22.2 No. 145, generally as specified above for standard 3-phase motors but suitable for use in Class 1 Group D hazardous locations and with a 1.0 service factor at 40°C (105°F) ambient temperature.

.8 Motors for equipment with variable frequency drives are to be generally as specified above but inverter duty type to NEMA Standard MG-1 Part 31, quantified by CSA for operation from a variable frequency drive of type specified, and complete with Class "H" insulation. Motors are to be equipped with AEGIS, or approved equal, shaft grounding ring system to protect bearings from damage by diverting harmful shaft voltages and bearing currents to ground.

.9 Motors for equipment which is scheduled or specified with a corrosion resistant coating or constructed from corrosion resistant materials are to be factory coated with a primer and epoxy paint finish.

.10 Acceptable manufacturers are:
- .1 TECO-Westinghouse Motors (Canada) Inc.;
- .2 Canadian General Electric;
- .3 Baldor Electric Co.;
- .4 U.S. Electrical Motors;
- .5 Weg Electric Corp.;
- .6 Marathon Electric;
- .7 Toshiba Corp.;
- .8 Leeson Canada.

2.11 MOTOR STARTERS AND ACCESSORIES

.1 Motor starters must be capable of starting associated motors under the imposed loads. Confirm starter voltage matches motor prior to ordering.

.2 Unless otherwise specified, starters for 1-phase motors are to be 115 volt, thermal overload protected manual starting switches with a neon pilot light, a surface or recessed enclosure to suit the application, and, where automatic operation is required, a separate H-O-A switch in an enclosure to match starter enclosure.

.3 Unless otherwise specified, starters for 3-phase motors less than 50 HP are to be combination "quick-make" and "quick-break" fused disconnects and full voltage non-reversing across-the-line starters, each complete with and overload relay per phase, an enclosure to suit the application, and, a H-O-A switch, pilot lights, control transformer, auxiliary contacts, and other accessories as per motor starter schedule.

.4 Unless otherwise specified, starters for 3-phase motors 50 HP to 150 HP are to be reduced voltage, non-reversing, auto-transformer type starters complete with one overload relay per phase, an enclosure to suit the application, and, a H-O-A switch, pilot lights, control transformer, auxiliary contacts, and other accessories as per motor starter schedule.

.5 Unless otherwise specified, starters for 3-phase motors 150 HP and larger are to be reduced voltage, non-reversing, closed transition "wye-delta" starters complete with one overload relay per phase, an enclosure to suit the application, and, a H-O-A switch, pilot lights, control transformer, auxiliary contacts, and other accessories as per motor starter schedule.

.6 Starters for 2-speed double winding motors are to be generally as specified above but suitable for motor and equipped with a 45 second time delay to permit equipment to coast down to low speed before it is operated at low speed.

.7 Starters for 2-speed single winding motors are to be generally as specified above but suitable for motor and equipped with a 45 second time delay to permit equipment to coast down to low speed before it is operated at low speed.

.8 Starters for reversible motors for cooling towers are to be generally as specified above but suitable for motor and equipped with a 45 second time delay to allow fan(s) to coast down to a stop before being operated in reverse rotation.

.9 Unless otherwise specified, motor starter enclosures are to be in accordance with following NEMA ratings:
- .1 enclosures located in sprinklered areas – Type 2;
- .2 enclosures exposed to the elements – Type 3R, constructed of stainless steel;
- .3 enclosures inside the building in wet areas – Type 3R, constructed of stainless steel;
- .4 enclosures in explosion rated area – Type 7 with exact requirements to suit the area and application;
- .5 enclosures except as noted above – Type 1;
- .6 enclosures located in finished areas – as above but recess type with brushed stainless steel faceplate.

.10 Motor control centres are to be multi-unit, 2.28 m (9') high, NEMA Class 1, type "B", factory assembled, dead front, floor mounted, free-standing motor control centre with tin plated copper bus and an NEMA Type 1 or Type 2 enclosure as for loose starters specified above. Each motor control centre is to be complete with starters as specified above, load and control wiring terminal boards, and required facilities for line and load side power wiring connections.

.11 Disconnect switches for motor control centres are to be heavy-duty, CSA certified, front operated switches as per motor starter schedule, each complete with a handle suitable for padlocking in "off" position and arranged so that door cannot be opened with handle in "on" position and an NEMA enclosure as specified for loose starters. Fusible units are to be complete with fuse clips to suit fuse types specified below.

.12 Fuses are to be, unless otherwise scheduled or specified, English Electric Ltd. HRC fuses, Form I Class "J" for constant running equipment and Form II Class "C" for equipment that cycles on and off.

.13 Acceptable manufacturers are:
- .1 Rockwell Automation Inc. - Allen-Bradley;
- .2 Eaton Corp. – Cutler-Hammer;
- .3 Eaton Corp. – Moeller Electric;
- .4 Siemens Canada;
- .5 Schneider Electric.

2.12 MECHANICAL WORK IDENTIFICATION MATERIALS

.1 Confirm with the Owner if an existing mechanical work identification system is in place and, if so, match accordingly.

.2 If an existing mechanical work identification system is not in place, the following is to be used:
- .1 Equipment nameplates are to be minimum 1.6 mm (1/16") thick 2-ply laminated coloured plastic plates, minimum 12 mm x 50 mm (½" x 2") for smaller items such as damper motors and control valves, minimum 25 mm x 65 mm (1" x 2-½") for equipment, and minimum 50 mm x 100 mm (2" x 4") for control panels and similar items. Additional requirements are as follows:

.1 unless otherwise specified or required, each nameplate is to be white, complete with bevelled edges and black engraved wording to completely identify equipment and its use with no abbreviations;
.2 wording is generally to be as per drawings, i.e. Fan EF-1, and is to include equipment service and building area/zone served, but must be reviewed prior to engraving;
.3 supply stainless steel screws for securing nameplates in place;
.4 nameplates for equipment suspended above floor level or generally not within easy viewing from floor level are to be increased in size so as to be easily readable from floor level.

.2 Valve tags are to be coloured, 40 mm (1-½") square, 2-ply laminated plastic with bevelled edges, red-white, green-white, yellow-black, etc., to match piping identification colour, each complete with a 3.2 mm (1/8") diameter by 100 mm (4") long brass plated steel bead chain, and four lines of engraved maximum size identification wording, i.e.:

VALVE V12
200 mm (8")
CHILL. WATER
NORMALLY
OPEN

.3 Standard pipe identification is to be equal to Smillie McAdams Summerlin Ltd., Brady or Primark Manufacturing Inc. vinyl plastic with indoor/outdoor type vinyl ink lettering and directional arrows, as follows:
.1 for pipe less than or equal to 150 mm (6") diameter, coiled type snap-on markers of a length to wrap completely around pipe or pipe insulation;
.2 for pipe larger than 150 mm (6") diameter, saddle type strap-on markers with 2 opposite identification locations and complete with nylon cable ties.

.4 Identification wording and colours for pipe identification materials are to be as follows:

PIPE SERVICE	IDENTIFICATION COLOUR	LEGEND
domestic cold water	green	DOM. COLD WATER
sanitary drainage	green	SAN.
plumbing vent	green	SAN. VENT

.5 Colours for pipe identification legends and directional arrows are to be as follows:

IDENTIFICATION COLOUR	LEGEND & ARROW COLOUR
yellow	black
green	white
red	white

.6 Duct identification is to be custom made Mylar stencils with 50 mm (2") high lettering to accurately describe duct service, i.e. "AHU-1 SUPPLY", complete with a directional arrow, and coloured ink with ink pads and roller

applicators. Ink colour is generally to be black but must contrast with lettering background.

2.13 **FLEXIBLE CONNECTORS**

.1 Double wall stainless steel flexible connectors for piping connections to vibration isolated equipment, each selected by manufacturer to suit the application. Shop drawings or product data sheets must indicate construction and performance requirements that suit the application. Acceptable manufacturers are:
- .1 Hyspan Precision Products Inc.;
- .2 Senior Flexonics Ltd.;
- .3 The Metraflex Co.

3 Execution

3.1 **GENERAL PIPING AND DUCTWORK INSTALLATION REQUIREMENTS**

.1 Unless otherwise specified, locate and arrange horizontal pipes and ducts above or at ceiling on floors, arranged so that under consideration of all other work in area, maximum ceiling height and/or usable space is maintained. If required to maintain ceiling heights, reroute and/or resize ductwork, with Consultant's approval.

.2 Unless otherwise specified, install work concealed in finished spaces, and concealed to degree possible in partially finished and unfinished spaces. Refer to and examine Architectural drawings and room finish schedules to determine finished, partially finished, and unfinished areas. Walls which are painted are considered finished.

.3 Install pipes and ducts parallel to building lines and to each other.

.4 Neatly group and arrange exposed work.

.5 Locate work to permit easy access for service or maintenance as required and/or applicable. Locate valves, dampers and any other equipment which will or may need maintenance or repairs and which are to be installed in accessible construction so as to be easily accessible from access doors. Where valves, dampers and similar piping or ductwork accessories occur in vertical services in shafts, pipe spaces or partitions, locate accessories at floor level.

.6 Make connections between pipes of different materials using adapters suitable for application. Provide cast brass dielectric type adapters/unions at connections between ferrous and copper pipe.

.7 Comply with equipment and material manufacturer's installation instructions unless otherwise specified herein or on drawings, and unless such instructions contradict governing codes and regulations.

.8 Carefully clean ducts, pipe and fittings prior to installation. Temporarily cap or plug ends of pipe, ducts and equipment which are open and exposed during construction.

.9 Install piping and ductwork which are to be insulated so that they have sufficient clearance to permit insulation and finish to be applied continuously and unbroken around pipe or duct, except for ductwork at fire barriers, in which case insulation will be terminated at each side of the duct fire damper.

.10 Inspect surfaces and structure prepared by other trades before performing work. Verify surfaces or structure to receive work has no defects or discrepancies which could result in poor application or cause latent defects in installation and workmanship. Report defects in writing. Installation of work will constitute acceptance of such surfaces as being satisfactory.

.11 Any ferrous piping that exhibits in excess of 5% surface rust, either inside or outside or both, is to be wire brush cleaned to bare metal and coated with suitable primer. Steel pipe, fittings and accessories are to be free of corrosion and dirt when work is complete or prior to being concealed from view. Where dirt is evident, clean piping prior to being concealed.

.12 For factory applied finishes, repaint or refinish surfaces damaged during shipment and installation. Quality of repair work is to match original finish. This requirement also applies to galvanized finishes.

.13 Where mechanical work is located in high humidity areas where ferrous metal products will be subject to corrosion and protection for such products is not specified, provide finishes on products to protect against corrosion or provide products which will not corrode in the environment, i.e. aluminium ductwork, copper or stainless steel pipe, etc.

.14 Provide screwed unions or flanges in piping connections to equipment and in regular intervals in long (in excess of 12 m [40']) piping runs to permit removal of sections of piping.

.15 Unless otherwise specified and except where space limitations do not permit, piping elbows are to be long radius. Eccentric reducers are to be installed with straight side at top of piping.

3.2 PIPE JOINT REQUIREMENTS

.1 Do not make pipe joints in walls or slabs.

.2 Ream piping ends prior to making joints.

.3 Properly cut threads in screwed steel piping and coat male threads only with Teflon tape or paste, or an equivalent thread lubricant. After pipe has been screwed into fitting, valve, union, or piping accessory, not more than 2 pipe threads are to remain exposed.

.4 Site bevel steel pipe to be welded or supply mill bevelled pipe. Remove scale and oxide from bevels and leave smooth and clean. Use factory made welding tees or welding outlet fittings for piping branches off mains. Do not use shop or site fabricated fittings unless written approval has been obtained.

.5 Welded joints are to be made by CWB certified licensed journeyman welders qualified in accordance with CSA B51, Boiler Pressure Vessel and Pressure Piping Code, and who are in possession of a proper certificate of qualification for each procedure to be performed. Each weld is to be identified with the welder's identification symbol, and welds are not to be concealed until they have been inspected and approved. Electrodes are to be in accordance with CSA W48 Series, Electrodes, and requirements of CAN/CSA W117.2, Safety in Welding, Cutting and Allied Processes are to be followed.

.6 Unless otherwise specified, make flanged joints with Garlock 5500 or equivalent gasket materials to suit the application, and bolts and nuts. Bolts are not to be longer than length necessary to screw nut up flush to the end of bolt. Bolts used for flanged connections in piping with a working pressure of 690 kPa (100 psi) and greater are to be ASTM A-193 Grade B-7, with heavy hexagon nuts to ASTM A-194 CL-2H. Provide suitable washers between each bolt head and flange and between each nut and flange.

.7 A random check of bolted flanged connections will be made to verify flanged connections are properly mated with no shear force acting on bolts. Supply labour to disconnect and reconnect selected flanged joints. If improperly mated joints are found, remove and reinstall affected piping so flanges mate properly. If improperly mated joints are found, additional joints will be checked, and you will be responsible for the repair of any other improper joints discovered.

.8 Unless otherwise specified make soldered joints in copper piping using flux suitable for and compatible with type of solder being used. Clean the outside of pipe end and inside of fitting, valve, or similar accessory prior to soldering.

.9 Install mechanical joint fittings and couplings in accordance with manufacturer's instructions.

.10 Grooves are to be rolled. Make arrangements with coupling and fitting manufacturer for shop and/or site instructions and demonstrations as required, and adhere to manufacturer's instructions with respect to pipe grooving, support, type of gasket required, anchoring and guiding the grooved piping system.

.11 If pressure crimped couplings and fittings are used, ensure gaskets are fully compatible with piping fluid, and valves and piping accessories are suitable. Use only fitting manufacturer supplied crimping equipment. Comply with manufacturer's latest published specification, instructions, and recommendations with respect to pipe, coupling, and fitting preparation and installation, and support, anchoring and guiding of the piping system.

.12 Solvent weld PVC piping in 2 parts, primer stage and cementing stage, in accordance with manufacturer's recommendations, ASTM D2855, and CSA requirements.

.13 Install PVC piping with gasketed joints in accordance with manufacturer's current published specifications, instructions and recommendations, and CSA requirements.

3.3 INSTALLATION OF PIPE SLEEVES

.1 Where pipes pass through concrete and/or masonry surfaces provide pipe sleeves as follows:
- .1 in poured concrete slabs – unless otherwise specified, minimum 16 gauge flanged galvanized steel or, where permitted by governing authorities, factory fabricated plastic sleeves;
- .2 in concrete or masonry walls – Schedule 40 galvanized steel pipe or Class 4000 cast iron pipe.

.2 Sleeves in waterproofed slabs or walls are to be lengths of Schedule 40 mild galvanized steel pipe with a waterstop plate in accordance with drawing detail. Provide waterproof sleeves in following locations:
- .1 in mechanical room floor slabs, except where on grade;
- .2 in slabs over mechanical, fan, electrical and telephone equipment rooms or closets;
- .3 in floors equipped with waterproof membranes;
- .4 in roof slab;
- .5 in waterproof walls.

.3 Size sleeves, unless otherwise specified, to leave 12 mm (½") clearance around pipes, or where pipe is insulated, a 12 mm (½") clearance around pipe insulation.

.4 Pack and seal void between pipe sleeves and pipe or pipe insulation in non-fire rated construction for the length of sleeves as follows:
- .1 pack sleeves in interior construction with mineral wool and seal both ends of sleeves with non-hardening silicone base caulking compound;
- .2 pack sleeves in exterior walls above grade with mineral wool and seal both ends of sleeves water-tight with approved non-hardening silicone base caulking compound unless mechanical type seals have been specified;
- .3 seal sleeves in exterior walls below grade (and any other wall where water leakage may be a problem) with link type mechanical seals as specified.

.5 Where sleeves are required in masonry work, accurately locate and mark sleeve location, and hand sleeves to mason for installation.

.6 Terminate piping for sleeves that will be exposed so sleeve is flush at both ends with building surface concerned so sleeve may be completely covered by an escutcheon plate, except for sleeves in waterproof floors which are to terminate 100 mm (4") above finished floor.

.7 "Gang" type sleeving will not be permitted.

.8 Where sleeves are provided in non-fire rated construction for future piping, or where piping has been removed from existing sleeves, cap and seal both ends of sleeved opening.

3.4 INSTALLATION OF WATERPROOF MECHANICAL SEALS

.1 Provide watertight link type mechanical seals in exterior wall openings.

.2 Assemble and install each mechanical seal in accordance with manufacturer's instructions.

.3 After installation, periodically check each mechanical seal installation for leakage and, if necessary, tighten link seal bolts until seal is completely watertight.

3.5 DUCT OPENINGS

.1 Duct openings, air inlet and outlet openings, fire damper and similar openings will be provided in new poured concrete work, masonry, drywall and other building surfaces by trade responsible for particular construction in which opening is required.

.2 Size openings for fire dampers to 600 mm (24") high to suit damper arrangement with folding blade out of air stream.

.3 For duct openings except where fire dampers are required, pack and seal space between duct or duct insulation and duct opening as specified above for pipe openings in non-fire rated construction.

3.6 SLEEVE AND FORMED OPENING LOCATION DRAWINGS

.1 Prepare and submit for review, drawings indicating size and location of required sleeves, recesses and formed openings in poured or precast concrete work.

.2 Such drawings are to be completely and accurately dimensioned and relate sleeve, recesses, and formed openings to suitable grid lines and elevation datum, and are to take into account structural items such as grade beams, column caps, and column drop slabs.

.3 Begin to prepare such drawings immediately upon notification of acceptance of bid and award of Contract.

3.7 INSTALLATION OF PIPE ESCUTCHEON PLATES

.1 Provide escutcheon plates suitably secured over exposed piping passing through finished building surfaces. A finished building surface is any surface with a factory finish or that receives a site applied finish.

.2 Install plates so they are tight against building surface concerned, completely covering pipe sleeves and/or openings, except where waterproof sleeves extend above floors, in which case fit plate tightly around sleeve.

3.8 INSTALLATION OF FASTENING AND SECURING HARDWARE

.1 Provide fastening and securing hardware required for mechanical work to maintain installations attached to structure or to finished floors, walls and ceilings in a secure and rigid manner capable of withstanding dead loads, live loads, superimposed dead loads, and any vibration of installed products.

.2 Use fasteners compatible with structural requirements, finishes and types of products to be connected. Do not use materials subject to electrolytic action or corrosion where conditions are liable to cause such action.

.3 Where floor, wall or ceiling construction is not suitable to support loads, provide additional framing or special fasteners to ensure proper securement to structure that is to support the products. Provide reinforcing or connecting supports where required to distribute loading to structural components.

.4 Obtain written consent before using explosive actuated fastening devices. If consent is obtained, comply with requirements of CAN/CSA Z166.1 and CAN/CSA Z166.2.

.5 Do not attach fasteners to steel deck without written consent from Consultant.

3.9 INSTALLATION OF PIPE HANGERS AND SUPPORTS

.1 Provide required pipe hangers and supports.

.2 Provide any additional structural steel channels, angles, inserts, beam champs and similar accessories required for hanging or supporting pipe. Unless otherwise shown or specified, hang or support pipes from structure only.

.3 For insulated pipe, size hanger or support to suit diameter of insulated pipe and install hanger or support on outside of insulation and insulation finish.

.4 Support requirements for underground piping are as follows:
- .1 support underground pipe, unless otherwise specified, on a well compacted bed of dry, natural, undisturbed earth free from rocks or protrusions of any kind, or on compacted material as specified;
- .2 support underground service piping penetrating building exterior walls or foundations to prevent pipe damage if minor building settlement occurs;
- .3 ensure bedding and supports for underground pipes are flat and true and allowances are made for pipe hubs, couplings, or other protrusions so no voids are left between pipe and bedding.

.5 Unless otherwise shown or specified, hang and/or support horizontal pipe above ground by means of hangers and/or supports specified in Part 2 of this Section. Unless otherwise shown or specified, hangers for suspended pipe less than or equal to 25 mm (1") dia. are to be clevis type or adjustable ring type, and hangers for suspended pipe greater than or equal to 40 mm (1-½") dia. are to be adjustable clevis type.

.6 Space hangers and supports in accordance with following:
- .1 cast iron pipe – hang or support at every joint with maximum 2.4 m (8') spacing;
- .2 plastic pipe – conform to pipe manufacturer's recommended support spacing;
- .3 glass pipe – conform to pipe manufacturer's recommended support spacing and support requirements;
- .4 copper and steel pipe – hang or support at spacing in accordance with following schedule:

PIPE DIA.	MAX. SPACING STEEL (meters)	MAX. SPACING COPPER (meters)
to 25 mm (1")	2.4 m (8')	1.8 m (6')
40 mm (1-½")	2.7 m (9')	2.4 m (8')
50 mm (2")	3.0 m (10')	2.7 m (9')
65 mm (2-½")	3.6 m (12')	3.0 m (10')
75 mm (3")	3.6 m (12')	3.0 m (10')
90 mm (3-½")	3.6 m (12')	3.6 m (12')
100 mm (4")	4.2 m (14')	3.6 m (12')
250 mm (10")	6.0 m (20')	
300 mm (12")	6.7 m (22')	

.5 flexible grooved pipe/coupling joint piping – as above but with not less than one hanger or support between joints;

.7 Where pipes change direction, either horizontally or vertically, provide a hanger or support on horizontal pipe not more than 300 mm (12") from elbow, and where pipes drop from tee branches, support tees in both directions not more than 50 mm (2") on each side of tee.

.8 When pipes with same slope are grouped and a common hanger or support is used, space hanger or support to suit spacing requirement of smallest pipe in group and secure pipes in place on common hanger or support.

.9 Provide roller hangers or supports for heat transfer piping greater than or equal to 150 mm (6") diameter and conveying a material 75°C (170°F) or greater to facilitate pipe movement due to expansion and contraction, and at each hanger or support tack weld a steel protection saddle to pipe to protect piping insulation.

.10 Unless otherwise shown or specified, support vertical piping by means of supports specified in Part 2 of this Section, spaced in accordance with following:

.1 support vertical pipes at maximum 3 m (10') intervals or at every floor, whichever is lesser;

.2 for sections of vertical piping with a length less than 3 m (10'), support pipe at least once;

.3 for vertical cast iron plain end pipe (mechanical joint type), secure riser or pipe clamp around pipe under a flange integral with pipe for vertical support purposes, or provide a length of hub and spigot pipe to facilitate proper support;

.4 for vertical steel pipe risers in excess of 3 m (10'), weld shear lugs to pipe to carry load;

.5 for vibration isolated piping risers, provide rubber-steel-rubber vibration isolation pads between riser clamps and floor.

.11 Each hanger, support or securement for horizontal bare copper tubing is to be plastic coated to prevent direct contact between pipe and ferrous hanger. Each wall or floor clamp for vertical bare copper piping is to be isolated from pipe by

means of strips of flexible rubber inserts. Use of painted ferrous hangers and supports, including those painted with copper coloured paint, is not acceptable. Site application of tape or other types of isolation is not acceptable.

.12 For insulated horizontal piping less than or equal to 40 mm (1-½") diameter, provide galvanized steel insulation protection shields between insulation and hanger or support. Install shields immediately after pipe is insulated.

.13 Do not support piping from steel deck without written consent from Consultant.

3.10 SUPPLY OF ACCESS DOORS

.1 Supply access doors to give access to mechanical work which may need maintenance or repair but which is concealed in inaccessible construction, except as otherwise specified herein or on drawings.

.2 Before commencing installation of mechanical work, coordinate with other trades and prepare on a set of reflected ceiling plans and wall elevations, complete layouts of access doors. Submit these layouts for Consultant's review and show exact sizes and locations of such access doors. Locate and arrange mechanical work to suit.

.3 Access doors will be installed by trade responsible for particular type of construction in which doors are required. Supply access doors to trade installing same at proper time.

.4 Wherever possible, access doors to be of a standard size for each application. Confirm exact dimensions and minimum size restrictions with Consultant prior to ordering.

.5 Group piping and ductwork to ensure minimum number of access doors is required.

.6 Coordinate with Electrical Contractor and General Trades Contractor to ensure access doors on project are provided by a single manufacturer, installed as part of work of General Trades Contractor and work involving both mechanical and electrical services should, where possible, be accessible from common access door. Coordinate work to ensure common location access doors are not supplied by both Mechanical Divisions and Electrical Divisions.

3.11 INSTALLATION OF VALVES

.1 Generally, valve locations are indicated or specified on drawings or specified in Sections of the Specification where valves are specified, however, regardless of locations shown or specified, following requirements apply:
  .1 provide shut-off valves to isolate systems, at base of vertical risers, in branch take-offs at mains and risers on floors, to isolate equipment, to permit work phasing as required, and wherever else required for proper system operation and maintenance;
  .2 install shut-off valves with handles upright or horizontal, not inverted, and located for easy access;

.3 unless otherwise specified, provide a check valve in discharge piping of each pump;
.4 valve sizes are to be same as connecting pipe size;
.5 valves are to be permanently identified with size, manufacturer's name, valve model or figure number and pressure rating, and wherever possible, valves are to be product of same manufacturer;
.6 for valves in insulated piping, design of valve stem, handle and operating mechanism is to be such that insulation does not have to be cut or altered in any manner to permit valve operation.

3.12 INSTALLATION OF PRESSURE GAUGES AND THERMOMETERS

.1 Provide pressure gauges in following locations where applicable:
.1 in valved tubing across suction, suction strainer (if applicable), and discharge piping of each circulating pump;
.2 in supply and return piping connections to main mechanical plant equipment such as boilers, chillers, heat exchangers, main coils, etc.;
.3 in expansion tank(s);
.4 in separate domestic hot water storage tank(s);
.5 at top most outlet in each standpipe fire protection system riser;
.6 in piping at each side of a pressure reducing valve;
.7 in potable water service piping downstream of meter;
.8 wherever else shown and/or specified.

.2 Provide thermometers in following locations where applicable:
.1 in supply and return piping connections to main mechanical plant equipment such as boilers, chillers, cooling towers, heat exchangers, main coils, etc., unless temperature indication is supplied with equipment;
.2 wherever else shown and/or specified.

.3 Conform to following installation requirements where applicable:
.1 for installation of thermometers in piping wells, provide a coat of metallic base heat transfer paste or grease in piping well;
.2 for pressure gauges in piping at equipment locations, install pressure gauge between equipment and first pipe fitting;
.3 locate, mount and adjust instruments so they are easily readable;
.4 where pressure gauges and/or thermometers are located at high level or in an area where they cannot be easily seen, provide remote reading instruments.

3.13 INSTALLATION OF EQUIPMENT DRIVE GUARDS AND ACCESSORIES

.1 Provide OHSA guards for exposed accessible rotating parts such as belt drives, couplings, fan wheels, and shaft ends on mechanical equipment.

.2 Install belt guards to allow movement of motors for adjusting belt tension.

.3 Provide a means to permit lubrication and use of test instruments with guards in place.

.4 Secure guards to equipment or equipment base but do not bridge sound or vibration isolation.

.5 Where equipment oil level gauges, oil reservoirs, grease cups, or grease gun fittings are integral with equipment but are not easily accessible for service, extend to an accessible location using aluminium or copper tubing.

3.14 MECHANICAL WORK IDENTIFICATION

.1 Identify new exposed piping and ductwork as per Part 2 of this Section in locations as follows:
- .1 at every end of every piping or duct run;
- .2 adjacent to each valve, strainer, damper and similar accessory;
- .3 at each piece of connecting equipment;
- .4 on both sides of every pipe and duct passing through a floor, wall or partition, unless otherwise specified;
- .5 at 6 m (20') intervals on pipe and duct runs exceeding 6 m (20') in length;
- .6 at least once in each room, and at least once on pipe and duct runs less than 6 m (20') in length.

.2 Unless otherwise specified identify new concealed piping and ductwork as per Part 2 of this Section in locations as follows:
- .1 at points where pipes or ducts enter and leave rooms, shafts, pipe chases, furred spaces, and similar areas;
- .2 at maximum 6 m (20') intervals on piping and ductwork above suspended accessible ceilings, and at least once in each room;
- .3 at each access door location;
- .4 at each piece of connected equipment, automatic valve, etc.

.3 Provide an identification nameplate for equipment provided as part of this project, including items such as control valves, motorized dampers, instruments, and similar products. Secure nameplates in place, approximately at eye level if possible, with stainless steel screws unless such a practice is prohibitive, in which case use epoxy cement applied to cleaned surfaces. Locate nameplates in the most conspicuous and readable location.

.4 Paint new natural and/or propane gas piping with primer and 2 coats of yellow paint in accordance with Code requirements. Identify piping at intervals as specified above.

.5 Provide an identification nameplate for each motor starter or disconnect switch located in a motor control centre or on a motor starter panel, and on each individually mounted starter provided as part of mechanical work, and on each disconnect switch provided as part of the electrical work for motorized equipment provided as part of mechanical work.

.6 For electrically traced mechanical work, identification wording is to include "ELECTRICALLY TRACED".

.7 Tag valves and prepare a valve tag chart in accordance with following requirements:
- .1 attach a valve tag to each new valve, except for valves located immediately at equipment they control;

.2 prepare a digital valve tag chart to list tagged valves, with, for each valve, the tag number, location, valve size, piping service, and valve attitude (normally open or normally closed);

.3 if an existing valve tag chart is available at site, valve tag numbering is to be an extension of existing numbering and new valve tag chart is to incorporate existing chart;

.4 include a copy of valve tag chart in each copy of operating and maintenance instruction manuals.

.8 Where shut-off valves, control dampers, sensors, and similar items which will or may need maintenance and/or repair are located above accessible suspended ceilings, provide round coloured ceiling tacks in ceiling panel material, or stickers equal to Brady "Quick Dot" on ceiling grid material to indicate locations of items. Unless otherwise specified, ceiling tack or sticker colours are to be as follows:

.1	HVAC piping valves and equipment:	yellow
.2	fire protection valves and equipment:	red
.3	plumbing valves and equipment:	green
.4	HVAC ductwork dampers and equipment:	blue
.5	control system hardware and equipment:	orange

3.15 FINISH PAINTING OF MECHANICAL WORK

.1 Finish paint exposed mechanical work as specified and/or scheduled in accordance with requirements of Division 09.

.2 Touch-up paint damaged factory applied finishes on mechanical work products.

3.16 PIPE LEAKAGE TESTING

.1 Before piping has been insulated or concealed, and before equipment, fixtures and fittings have been connected, test piping for leakage.

.2 Tests are to be witnessed by Consultant and/or Owner's representative, and, where required, representatives of governing authorities. Give ample notice of tests in writing and verify attendance. Have completed test report sheets dated and signed by those present to confirm proper test results.

.3 When circumstances prevent scheduled tests from taking place, give immediate and adequate notice of cancellation to all who were scheduled to attend.

.4 Gravity Drainage and Vent Piping

.1 Test piping in accordance with local governing building code.

.2 After fixtures and fittings are set and pipes are connected to building drain or drains, turn on water into pipe, fixtures, fittings and traps in order to detect any imperfect material or workmanship. Perform a smoke test if required by local governing authorities.

.5 Pumped Piping

.1 Test piping with cold water at a pressure of 1-½ times normal working pressure and maintain pressure for a minimum of 2 hours.

.6 Domestic Water Piping
.1 Test piping with cold water at a pressure of 1-½ times normal working pressure and maintain pressure for a minimum of 2 hours.

.7 Refrigerant Piping
.1 Test refrigerant piping for leakage and dehydrate in accordance with requirements of Chapter 18 of ASHRAE Handbook - Fundamentals.

.8 Following requirements apply to all testing:
.1 ensure piping has been properly flushed, cleaned and is clear of foreign matter prior to pressure testing;
.2 temporarily remove or valve off piping system specialties or equipment which may be damaged by test pressures prior to pressure testing systems, and flush piping to remove foreign matter;
.3 when testing is carried out below highest level of the particular system, increase test pressure by the hygrostatic head of 7 kPa (1 psi) for every 600 mm (24") below the high point;
.4 include for temporary piping connections required to properly complete tests;
.5 piping under test pressure is to have zero pressure drop for length of test period;
.6 make tight leaks found during tests while piping is under pressure, and if this is impossible, remove and refit piping and reapply test until satisfactory results are obtained;
.7 where leaks occur in threaded joints in steel piping, no caulking of these joints will be allowed under any conditions;
.8 tests are be done in reasonably sized sections so as to minimize number of tests required;
.9 in addition to leakage tests specified above, demonstrate proper flow throughout systems including mains, connections and equipment, as well as proper venting and drainage, and include for any necessary system adjustments to achieve proper conditions.

3.17 SUPPLY OF MOTOR STARTERS AND ACCESSORIES

.1 Unless otherwise shown or specified, supply a starter for each item of motorized equipment. Refer to Motor Starter Schedule.

.2 Where 3-phase starters are indicated in motor control centres, supply motor control centres with starters and bolt to a concrete housekeeping pad.

.3 Where package type equipment with integral starters, or equipment with starters integral in loose power and control panels supplied with equipment is fed from a motor control centre, provide a disconnect switch in motor control centre in lieu of a motor starter.

.4 Where 3-phase starters are indicated and/or scheduled to be mounted on a motor starter panel, starters will be mounted and connected, complete with panels and splitter trough, as part of electrical work. Hand starters to electrical trade at site when they are required.

.5 Where package type equipment with integral starters, or equipment with starters integral in loose power and control panels supplied with equipment is fed from a motor starter panel, a disconnect switch will be provided on motor starter panel as part of electrical work.

.6 Unless otherwise specified or shown on drawings, 1-phase motor starters will be mounted adjacent to equipment they serve and connected complete as part of electrical work. Hand starters to electrical trade at site at the proper time.

3.18 ELECTRICAL WIRING WORK FOR MECHANICAL WORK

.1 Unless otherwise specified or indicated, following electrical wiring work for mechanical equipment will be done as part of the electrical work:

- .1 "line" side power wiring to motor starters or disconnect switches in motor control centres and starters or disconnects on motor starter panels, and "load" side wiring from starters or disconnects to equipment;
- .2 "line" side power wiring to individual wall mounted starters, and "load" side wiring from starters to equipment;
- .3 "line" side power wiring to pre-wired power and control panels and variable frequency drives (VFD), and "load" side power wiring from the panels and VFD's to equipment;
- .4 provision of receptacles for plug-in equipment;
- .5 provision of disconnect switches for motors in excess of 10 m (30') from starter location, or cannot be seen from starter location, and associated power wiring;
- .6 motor starter interlocking in excess of 24 volts;
- .7 wiring from motor winding thermistors in motors 30 HP and larger to motor starter contacts;
- .8 120 volt power connections to electrical receptacles integral with small ceiling exhaust fans, including wiring through light switches or speed controllers;
- .9 120 volt wiring connections to lighting fixture/switch combinations integral with air handling units;
- .10 120 volt wiring connections to duplex receptacles integral with air handling unit control panels.

.2 Mechanical wiring work not listed above or specified herein or on drawings to be done as part of electrical work is to be installed in conduit and is to be done as part of mechanical work in accordance with wiring requirements specified for electrical work.

3.19 INTERRUPTION TO AND SHUT-DOWN OF MECHANICAL SERVICES AND SYSTEMS

.1 Coordinate shut-down and interruption to existing mechanical systems with Owner. Generally, shut-downs may be performed only between the hours of 12:00 midnight Friday until 6:00 a.m. Monday morning, unless otherwise specified in Division 01. Include for costs of premium time to perform work during nights, weekends or other times outside of normal working hours, which may be necessary to comply with stipulations specified herein this Article. Services for operation of existing non-renovated areas of building are to be maintained.

.2 Upon award of a Contract, submit a list of anticipated shut-down times and their maximum duration.

.3 Prior to each shut-down or interruption, inform Owner and Consultant in writing 5 working days in advance of proposed shut-down or interruption and obtain written consent to proceed. Do not shut-down or interrupt any system or service without such written consent. Shutdowns of some essential services may require additional advance notification time.

.4 Perform work associated with shut-downs and interruptions as continuous operations to minimize shut-down time and to reinstate systems as soon as possible, and, prior to any shut-down, ensure materials and labour required to complete the work for which shut-down is required are available at site.

.5 Where existing isolation valves do not hold, pipe freezing shall be used to connect new piping to existing piping.

3.20 EQUIPMENT BASES AND SUPPORTS

.1 Unless otherwise specified or required, set floor mounted equipment on minimum 100 mm (4") high reinforced concrete housekeeping pads 200 mm (8") clear of equipment on each side and end, or a minimum of 200 mm (8") from centreline of equipment anchor bolts to edge of the base, whichever is larger. Conform to following requirements:
- .1 supply dimensioned drawings and equipment base templates, and provide anchor bolts for proper setting and securing of equipment on pads;
- .2 place anchor bolts during concrete pour and be responsible for required levelling, alignment, and grouting of equipment;
- .3 as a minimum, use wire mesh reinforcement, however, for pads for large heavy equipment, use reinforcement as per structural drawing details.

.2 For equipment not designed for base mounting, where required, provide welded, cleaned and prime coat painted structural steel stands or supports conforming to following requirements:
- .1 provide stands and supports, except those for small equipment, designed by a structural engineer registered in jurisdiction of the work, and submit stamped and signed design drawings with calculations as shop drawings for review;
- .2 flange bolt steel stands to concrete housekeeping pads;
- .3 seismically restrained stands and supports in accordance with applicable requirements.

3.21 CONCRETE WORK FOR MECHANICAL EQUIPMENT BASES/PADS

.1 Exactly locate bases/pads at site and be present during concrete pour to ensure anchor bolts, inserts, plates and similar hardware are not damaged or dislodged.

.2 Coordinate base/pad installations with concrete trade and ensure bases and pads are keyed into structure to meet seismic restraint requirements where applicable.

.3 Unless otherwise specified in Division 03, provide poured concrete work, including reinforcing and formwork, required for mechanical equipment bases/pads. Perform concrete work in accordance with requirements specified in Division 03.

.4 Unless otherwise specified in Division 03, concrete is to be minimum 20,700 kPa ready-mix concrete in accordance with CAN/CSA-A23.1 and the Building Code.

.5 Ensure that bases and pads are keyed into the structure to meet seismic restraint requirements where applicable.

3.22 EXCAVATION AND BACKFILL WORK

.1 Unless otherwise specified in Division 31, provide all excavation and backfill associated with the mechanical scope of work.

.2 Before commencement of excavation for work, determine in consultation with Consultant, Owner, Municipality and utilities, presence, if any, of existing underground services at site. Engage local utilities to locate and mark out such services. Ensure trades concerned are aware of their presence.

.3 Be responsible for any damage done to underground services caused by neglect to determine and mark out location of such services prior to excavation work commences.

.4 Where Work falls under jurisdiction of local governing utility, confirm requirements and comply with utility requirements.

.5 Unless otherwise specified in Division 31, provide excavation, backfill and related work required for mechanical work. Obtain a copy of soil test report if available from Consultant. Depth of excavations must accommodate local governing requirements and local standard practices to compensate for local frost levels of Place of the Work.

.6 Inverts and locations of existing site services may have been site surveyed and approximate location may be shown on drawings. Confirm inverts and locations are correct, prior to commencing excavation and contact Utilities to accurately locate their services. Where discrepancies are found, immediately inform Consultant, and await a direction. Grade bottom of trench excavations as required.

.7 In firm, undisturbed soil, lay pipes directly on soil, unless otherwise directed.

.8 Before backfilling, arrange for inspection of work by Consultant. Do not backfill work unless reviewed with Consultant. Failure to do so prior to backfilling will require re-excavating work and re-backfill at no additional cost to Owner.

.9 Unless otherwise specified, backfill trenches within building with clean sharp sand in individual layers of maximum 150 mm (6”) thickness compacted to a density of 100% Standard Proctor. Hand compact first layers up to a compacted level of minimum 300 mm (12") above top of pipe. Hand or machine compact the balance up to grade.

.10 Unless otherwise specified, backfill trenches outside the building (not under roads, parking lots or traffic areas), up to a compacted level of 450 mm (18") thick above the pipe, hand compacted to a density of 95% Standard Proctor, using granular "A" gravel. Backfill the balance in 150 mm (6") layers with approved excavated material, compacted to 95% Standard Proctor density.

.11 Unless otherwise specified, backfill trenches outside building under roads, parking lots or traffic areas with crushed stone or granular "A" gravel in layers not exceeding 150 mm (6") thickness, compacted to 100% Standard Proctor density up to grade level.

.12 Provide minimum 1.37 m (4.5') of cover for underground piping subject to freezing and located outside building.

.13 Provide minimum 450 mm (18") of cover for underground piping subject to freezing and located inside building.

.14 After first lift of backfill has been compacted, mark entire path of pipe using continuous 75 mm (3") wide detectable identified marking tape equal to SMS Ltd. D-UGMT.

.15 Unless otherwise directed in Division 02 and/or 31, store and dispose of excavated materials as follows:

.1 during progress of contract, place material as directed in such a manner to minimize damage or disfigurement of ground and which in no way impedes progress of work;

.2 separately place surplus topsoil and subsoil as directed; leave site clean and unencumbered.

.16 Perform pumping as required to keep excavations free of water.

.17 Engage services of independent soils testing agency to test final backfill compaction density of each backfilled location. Compact backfill to satisfaction of testing agency and in accordance with Specification. Submit a copy of testing agency's report to Consultant for review.

.18 Fill depressions to correct grade level with appropriate material, after an adequate period has passed to reveal any settlement. Use maximum possible compaction. Pay costs required to make good damages caused by settlement.

.19 Coordinate requirements for final surface toppings (concrete, asphalt, pavers, grass sod, etc.) with General Contractor.

3.23 CUTTING, PATCHING AND CORE DRILLING

.1 Unless otherwise provided by General Trades, perform cutting, patching, and core drilling of existing building required for installation of mechanical work. Perform cutting in a neat and true fashion, with proper tools and equipment to Consultant's approval. Patching is to exactly match existing finishes and be performed by tradesmen skilled in particular trade or application. Work is subject to review and acceptance by Consultant.

.2 Criteria for cutting holes for additional services:
- .1 cut holes through slabs only; no holes to be cut through beams;
- .2 cut holes 150 mm (6") diameter or smaller only; obtain approval from Structural Consultant for larger holes;
- .3 keep at least 100 mm (4") clear from beam faces;
- .4 space at least 3 hole diameters on centre;
- .5 for holes that are required closer than 25% of slab span from supporting beam face, use cover meter above slab to clear slab top bars;
- .6 for holes that are required within 50% of slab span, use cover meter underside of slab to clear slab bottom bars;
- .7 submit sleeving drawings indicating holes and their locations for Structural Consultant's review.

.3 Do not cut or drill any existing work without approval from Owner and Consultant. Be responsible for damage done to building and services caused by cutting or drilling.

.4 Where pipes pass through existing construction, core drill an opening. Size openings to leave 12 mm (½") clearance around pipes or pipe insulation.

.5 Prior to drilling or cutting an opening, determine, in consultation with Consultant and Owner, and by use of non-destructive radar scan (magnetic scan) of slab or wall, presence of any existing services and reinforcement bars concealed behind building surface to be cut and locate openings to suit. Coring is not permitted through concrete beams or girders.

.6 Where drilling is required in waterproof slabs, size opening to permit snug and tight installation of a pipe sleeve sized to leave 12 mm (½") clearance around pipe or pipe insulation. Provide a pipe sleeve, constructed of Schedule 40 galvanized steel pipe with a flange at one end and of a length to extend 100 mm (4") above slab, in opening. Secure flange to the underside of slab and caulk void between sleeve and slab opening with proper non-hardening silicone base caulking compound to produce a water-tight installation.

.7 Firestop and seal openings in fire rated construction. Do not leave openings open overnight unless approved by Owner and Consultant.

3.24 PACKING AND SEALING CORE DRILLED PIPE OPENINGS

.1 Pack and seal void between pipe opening and pipe or pipe insulation for length of opening as follows:
- .1 non-fire rated interior construction – pack with mineral wool and seal both ends of opening with non-hardening silicone base caulking compound to produce a water-tight seal;
- .2 exterior walls above grade – pack with mineral wool and seal both ends of sleeves water-tight with non-hardening silicone base caulking compound unless mechanical type seals have been specified;
- .3 exterior walls below grade (and any other wall where water leakage may be a problem) – seal with link type mechanical seals as specified.

3.25 FLASHING FOR MECHANICAL WORK PENETRATING ROOF

.1 Unless otherwise specified in Division 07, perform required flashing work, including counter-flashing, for mechanical work penetrating and/or set in roof.

.2 Perform flashing work in accordance with requirements of drawing details and/or requirements specified in Division 07.

3.26 CLEANING MECHANICAL WORK

.1 Refer to cleaning requirements specified in Division 01.

.2 Clean mechanical work prior to application for Substantial Performance of the Work.

.3 Include for vacuum cleaning interior of air handling units and ductwork systems.

3.27 CONNECTIONS TO OTHER EQUIPMENT

.1 Carefully examine Contract Documents during bidding period and include for mechanical work piping and/or ductwork connections to equipment requiring such connections.

3.28 INSTALLATION OF FLEXIBLE CONNECTORS

.1 Provide flexible connectors in piping connections to seismically restrained equipment, where applicable, and wherever else shown.

.2 Provide flexible connectors in piping connections to vibration isolated equipment.

3.29 FAN NOISE LEVELS

.1 Submit sound power levels with fan shop drawings/product data, with levels measured to AMCA 300 and calculated to AMCA 301.

3.30 EQUIPMENT AND SYSTEM MANUFACTURER'S CERTIFICATION

.1 When equipment/system installation is complete, but prior to start-up procedures, arrange and pay for equipment/system manufacturer's authorized representative to visit site to examine installation, and after any required corrective measures have been made, to certify in writing to Consultant that equipment/system installation is complete and in accordance with equipment/system manufacturer's instructions.

3.31 EQUIPMENT AND SYSTEM START-UP

.1 When installation of equipment/systems is complete but prior to commissioning, perform start-up for equipment/systems as specified in mechanical work Sections in accordance with following requirements:

.1 submit a copy of each equipment/system manufacturer's start-up report sheet to Consultant for review, and incorporate any comments made by Consultant;

.2 under direct on-site supervision and involvement of equipment/system manufacturer's representative, start-up equipment/systems, make any required adjustments, document procedures, leave equipment/systems in proper operating condition, and submit to Consultant complete set of start-up documentation sheets signed by manufacturer/supplier and Contractor.

END OF SECTION

1 General

1.1 **REFERENCES**

.1 Division 00 and Division 01 apply to and are a part of this Section.

1.2 **APPLICATION**

.1 This Section specifies requirements that are common to Mechanical Divisions work Sections and it is a supplement to each Section and is to be read accordingly. Where requirements of this Section contradict requirements of Divisions 00 or 01, conditions of Division 00 or Division 01 to take precedence.

.2 Be responsible for advising product vendors of requirements of this Section.

1.3 **DEFINITIONS**

.1 "concealed" – means hidden from normal sight in furred spaces, shafts, ceiling spaces, walls and partitions.

.2 "exposed" – means work normally visible, including work in equipment rooms, service tunnels, and similar spaces.

.3 "finished" - means when in description of any area or part of an area or a product which receives a finish such as paint, or in case of a product may be factory finished.

.4 “provision” or "provide" (and tenses of "provide") – means supply and install complete.

.5 "install" (and tenses of "install") – means secure in position, connect complete, test, adjust, verify and certify.

.6 "supply" – means to procure, arrange for delivery to site, inspect, accept delivery and administer supply of products; distribute to areas; and include manufacturer’s supply of any special materials, standard on site testing, initial start-up, programming, basic commissioning, warranties and manufacturers’ assistance to Contractor.

.7 "delete" or "remove" (and tenses of "delete" or “remove”) – means to disconnect, make safe, and remove obsolete materials; patch and repair/finish surfaces to match adjoining similar construction; include for associated re-programming of systems and/or change of documentation identifications to suit deletions, and properly dispose of deleted products off site unless otherwise instructed by Owner and reviewed with Consultant.

.8 "BAS" – means building automation system; "BMS" – means building management system; "FMS" – means facility management system; and “DDC” means direct digital controls; references to "BAS", "BMS", "FMS" and “DDC” generally mean same.

.9 "governing authority" and/or "authority having jurisdiction" and/or "regulatory authority" and/or "Municipal authority" – means government departments, agencies, standards, rules and regulations that apply to and govern work and to which work must adhere.

.10 "OSHA" and "OHSA" – stands for Occupational Safety and Health Administration and Occupational Health and Safety Act, and wherever either one is used, they are to be read to mean local governing occupational health and safety regulations that apply to and govern work and to which work must adhere, regardless if Project falls within either authority's jurisdiction.

.11 "Mechanical Divisions" – refers to Divisions 20, 21, 22, 23, 25 and other Divisions as specifically noted, and which work as defined in Specifications and/or on drawings is responsibility of Mechanical Contractor, unless otherwise noted.

.12 "Electrical Divisions" – refers to Divisions 26, 27, 28 and other Divisions as specifically noted, and which work as defined in Specifications and/or on drawings is responsibility of Electrical Contractor, unless otherwise noted.

.13 "Consultant" – means person, firm or corporation identified as such in Agreement or Documents, and is licensed to practice in Place of the Work, and has been appointed by Owner to act for Owner in a professional capacity in relation to the Work.

.14 Wherever words "indicated", "shown", "noted", "listed", or similar words or phrases are used in Contract Documents they are understood, unless otherwise defined, to mean product referred to is "indicated", "shown", "listed", or "noted" on Contract Documents.

.15 Wherever words "reviewed", "satisfactory", "as directed", "submit", or similar words or phrases are used in Contract Documents they are understood, unless otherwise defined, to mean that work or product referred to is "reviewed by", "to the satisfaction of", "submitted to", etc., Consultant.

1.4 DOCUMENTS

.1 Documents for bidding include but are not limited to issued Drawings, Specifications and Addenda.

.2 Specification is arranged in accordance with CSI/CSC 49 Divisions of MasterFormat.

.3 Drawings and Specifications are portions of Contract Documents and identify labour, products and services necessary for performance of work and form a basis for determining pricing. They are intended to be cooperative. Perform work that is shown, specified, or reasonably implied on the drawings but not mentioned in Specification, or vice-versa, as though fully covered by both.

.4 Review Drawings and Specifications in conjunction with documents of other Divisions and, where applicable, Code Consultant’s report.

.5 Unless otherwise specifically noted in Specifications and/or on Drawings, Sections of Mechanical Divisions are not intended to delegate functions nor to delegate work and supply of materials to any specific trade, but rather to generally designate a basic unit of work, and Sections are to be read as a whole.

.6 Drawings are performance drawings, diagrammatic, and show approximate locations of equipment and connecting services. Any information regarding accurate measurement of building is to be taken on site. Do not scale Drawings, and do not use Drawings for prefabrication work.

.7 Drawings are intended to convey the scope of work and do not show architectural and structural details. Provide, at your cost, offsets, fittings, transformations and similar products required as a result of obstructions and other architectural and/or structural details but not shown on Drawings.

.8 Locations of equipment and materials shown may be altered, when reviewed by Consultant, to meet requirements of equipment and/or materials, other equipment or systems being installed, and of building, all at no additional cost to Contract.

.9 Specification does not generally indicate specific number of items or amounts of material required. Specification is intended to provide product data and installation requirements. Refer to schedules, Drawings (layouts, riser diagrams, schematics, details) and Specification to provide correct quantities. Singular may be read as plural and vice versa.

.10 Starter/motor control centre (MCC)/variable frequency drive (VFD) schedule drawings are both mechanical and electrical, and apply to work of Mechanical Divisions and Electrical Divisions. Be responsible for reviewing starter, MCC, VFD, and motor specification requirements prior to Bid submission. Confirm and coordinate exact scope of work and responsibility of work between Mechanical Divisions and Electrical Divisions.

.11 Drawings and Specifications have been prepared solely for use by party with whom Consultant has entered into a contract and there are no representations of any kind made by Consultant to any other party.

.12 In the case of discrepancies between the drawings and specifications, documents will govern in order specified in “General Conditions”, however, when scale and date of drawings are same, or where discrepancy exists within specification, most costly arrangement will take precedence.

1.5 METRIC AND IMPERIAL MEASUREMENTS

.1 Generally, both metric and imperial units of measurement are given in Sections of Specification governed by this section. Measurement conversions may be generally "soft" and rounded off. Confirm exact measurements based on application. Where measurements are related to installation and onsite applications, confirm issued document measurements with applicable local code requirements, and/or as applicable, make accurate measurements onsite. Where significant discrepancies are found, immediately notify Consultant for direction.

1.6 EXAMINATION OF DOCUMENTS AND SITE

.1 Carefully examine Documents and visit site to determine and review existing site conditions that will or may affect work, and include for such conditions in Bid Price.

.2 Report to Consultant, prior to Bid Submittal, any existing site condition that will or may affect performance of work as per Documents. Failure to do so will not be grounds for additional costs.

.3 Upon finding discrepancies in, or omissions from Documents, or having doubt as to their meaning or intent, immediately notify Consultant, in writing.

1.7 WORK STANDARDS

.1 Where any code, regulation, bylaw, standard, contract form, manual, printed instruction, and installation and application instruction is quoted it means, unless otherwise specifically noted, latest published edition at time of submission of Bids adopted by and enforced by local governing authorities having jurisdiction. Include for compliance with revisions, bulletins, supplementary standards or amendments issued by local governing authorities.

.2 Where regulatory codes, standards and regulations are at variance with Drawings and Specification, more stringent requirement will apply unless otherwise directed by Owner and reviewed with Consultant.

.3 Supplementary mandatory specification and requirements to be used in conjunction with project include but are not limited to following:

- .1 Air-Conditioning, Heating and Refrigeration Institute (AHRI);
- .2 Air Movement and Control Association (AMCA);
- .3 American Iron and Steel Institute (AISI);
- .4 American National Standards Institute (ANSI);
- .5 American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., (ASHRAE);
- .6 American Society of Mechanical Engineers (ASME);
- .7 American Society of Testing and Materials (ASTM);
- .8 American Water Works Association (AWWA);
- .9 Associated Air Balance Council (AABC);
- .10 Building Industry Consulting Services, International (BICSI);
- .11 Canadian Gas Association (CGA);
- .12 Canadian General Standards Board (CGSB);
- .13 Canadian Standards Association (CSA);
- .14 Electrical and Electronic Manufacturers Association of Canada (EEMAC);
- .15 Electrical Safety Authority (ESA);
- .16 Electronic Industries Association (EIA);
- .17 Factory Mutual Systems (FM);
- .18 Illuminating Engineering Society (IES);
- .19 Institute of Electrical and Electronic Engineers (IEEE);
- .20 International Standards Organization (ISO);
- .21 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS);
- .22 National Building Code of Canada (NBC);

.23 National Electrical Manufacturers Association (NEMA);
.24 National Environmental Balancing Bureau (NEBB);
.25 National Fire Protection Association (NFPA);
.26 National Standards of Canada;
.27 NSF International;
.28 Occupational Health and Safety Act (OHSA);
.29 Ontario Building Code (OBC);
.30 Ontario Electrical Safety Code (OESC);
.31 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA);
.32 Technical Standards and Safety Authority (TSSA);
.33 Thermal Insulation Association of Canada (TIAC);
.34 Underwriters' Laboratories of Canada (ULC);
.35 Workplace Hazardous Materials Information System (WHMIS);
.36 Material Safety Data Sheets by product manufacturers;
.37 local utility inspection permits;
.38 Codes, standards, and regulations of local governing authorities having jurisdiction;
.39 additional codes and standards listed in Trade Sections;
.40 Owner's standards.

.4 Provide applicable requirements for barrier free access in accordance with latest edition of local governing building code.

.5 Where any governing Code, Regulation, or Standard requires preparation and submission of special details or drawings for review they are to be prepared and submitted to appropriate authorities. Be responsible for costs associated with these submittals.

.6 Unless otherwise specified, install equipment in accordance with equipment manufacturer's recommendations and instructions, and requirements of governing Codes, Standards, and Regulations. Governing Codes, Standards, and Regulations take precedence over manufacturer's instructions.

.7 Work is to be performed by journeyperson tradesmen who perform only work that their certificates permit, or by apprentice tradesmen under direct on site supervision of experienced journeyperson tradesman. Journeyperson to apprentice ratio is not to exceed ratio determined by the Board as stated in Ontario College of Trades and Apprenticeship Act or local equivalent governing body in Place of the Work.

.8 Journeyperson tradesmen are to have a copy of valid trade certificates available at site for review with Consultant at any time.

.9 Experienced and qualified superintendent is to be on-site at times when work is being performed.

.10 Coordinate work inspection reviews and approvals with governing inspection department to ensure that construction schedule is not delayed. Be responsible for prompt notification of deficiencies to Consultant and submission of reports and certificates to Consultant.

.11 Properly protect equipment and materials on site from damage due to elements and work of trades, to satisfaction of Owner and reviewed with Consultant. Equipment and materials are to be in new condition upon Substantial Performance of the Work.

.12 Mechanical piping system work, including equipment, must comply in all respects with requirements of local technical standards authorities and CSA B51, Boiler, Pressure Vessels and Pressure Piping Code. Where required, mechanical work products must bear a CRN number.

.13 Electrical items associated with mechanical equipment are to be certified and bear stamp or seal of a recognized testing agency such as CSA, UL, ULC, ETL, etc., or bear a stamp to indicate special electrical utility approval.

1.8 PERMITS, CERTIFICATES, APPROVALS, AND FEES

.1 Contact and confirm with local authorities having jurisdiction including utility providers, requirements for approvals from such authorities. Obtain and pay for permits, certificates, and approvals required to complete Work.

.2 Be responsible for ensuring that authorities having jurisdiction which require on-site inspection of work, have ample notification to perform inspection, with sufficient lead time to correct deficiencies in a manner that will not impede schedule of completion of Work. If any defect, deficiency or non-compliant is found in work by inspection, be responsible for costs of such inspection, including any related expenses, making good and return to site, until work is passed by governing authorities.

.3 Obtain and submit to Consultant, approval/inspection certificates issued by governing authorities to confirm that Work as installed is in accordance with rules and regulations of local governing authorities and are acceptable.

.4 Include in each copy of operating and maintenance instruction manuals, copies of approvals and inspection certificates issued by regulatory authorities.

1.9 REQUIREMENTS FOR CONTRACTOR RETAINED ENGINEERS

.1 Professional engineers retained to perform consulting services with regard to Project work, i.e. seismic engineer, fire protection engineer or structural engineer, are to be members in good standing with local Association of Professional Engineers, and are to carry and pay for errors and omissions professional liability insurance in compliance with requirements of governing authorities in Place of the Work.

.2 Retained engineer’s professional liability insurance is to protect Contractor's consultants and their respective servants, agents, and employees against any loss or damage resulting from professional services rendered by aforementioned consultants and their respective servants, agents, and employees in regards to the Work of this Contract.

.3 Unless otherwise specified in Division 00 or 01, liability insurance requirements are as follows:

.1 coverage is to be a minimum of $1,000,000.00 CDN inclusive of any one occurrence;
.2 insurance policy is not to be cancelled or changed in any way without insurer giving Owner minimum thirty days written notice;
.3 liability insurance is to be obtained from an insurer registered and licensed to underwrite such insurance in the Place of the Work;
.4 retained consultants are to ascertain that sub-consultants employed by them carry insurance in the form and limits specified above;
.5 evidence of the required liability insurance in such form as may be required is to be issued to Owner, Owner's Consultant, and Municipal Authorities as required prior to commencement of aforementioned consultant's services.

1.10 WORKPLACE SAFETY

.1 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage and disposal of hazardous materials. Submit WHMIS MSDS (Material Safety Data Sheets) for products where required, and maintain one copy at site in a visible and accessible location available to personnel.

.2 Comply with requirements of Occupational Health and Safety Act and other regulations pertaining to health and safety, including worker's compensation/insurance board and fall protection regulations. When working in confined spaces, comply with requirements of Occupational Health and Safety Act - Ontario Regulation 632, "Confined Spaces" and any other applicable Ministry of Labour requirements.

.3 If at any time during course of existing building work, hazardous materials other than those identified in Documents and pertaining to Project Scope of Work, are encountered or suspected that were not identified as being present and which specific instructions in handling of such materials were not given, cease work in area in question and immediately notify Consultant. Comply with local governing regulations with regards to working in areas suspected of containing hazardous materials. Do not resume work in affected area without approval from Owner and reviewed with Consultant.

1.11 PLANNING AND LAYOUT OF WORK

.1 Base installation layout, design, terminations, and supply of accessories, on Contract Documents with specific coordination with reviewed shop drawings.

.2 Plan, coordinate, and establish exact locations and routing of services with affected trades prior to installation such that services clear each other as well as other obstructions. Generally, order of right of way for services to be as follows:
.1 piping requiring uniform pitch;
.2 piping 100 mm (4") dia. and larger;
.3 large ducts (main runs);
.4 cable tray and bus duct;
.5 conduit 100 mm (4") dia. and larger;
.6 piping less than 100 mm (4") dia.;
.7 smaller branch ductwork;
.8 conduit less than 100 mm (4") dia..

.3 Unless otherwise shown or specified, conceal work in finished areas, and conceal work in partially finished and/or unfinished areas to extent made possible by the area construction. Install services as high as possible to conserve headroom and/or ceiling space. Notify Consultant where headroom or ceiling space appears to be inadequate prior to installation of work.

.4 Do not use Contract Drawing measurements for prefabrication and layout of piping, sheet metal work and such other work. Locations and routing are to generally be in accordance with Contract Drawings, however, prepare layout drawings for such work. Use established bench marks for both horizontal and vertical measurements. Confirm inverts, coordinate with and make allowances for work of other trades. Accurately layout work, and be entirely responsible for work installed in accordance with layout drawings. Where any invert, grade, or size is at variance with Contract Drawings, notify Consultant prior to proceeding with work.

.5 Prepare plan and interference drawings (at a minimum drawing scale of 1:50 or ¼"=1' 0") of work for coordination with each trade Contractor. Arrange for preparation of detailed section drawings of ceiling spaces of corridors and any other congested areas. Sections are to be cross referenced with plan drawings so that trades may make use of section drawings. Section drawings to indicate lateral and elevation dimensions of major services within ceiling space. Lateral dimensions are to be from grid lines and elevations from top of floor slab. Obtain from Consultant, engineering drawings for this use. Contractors' interference drawings are to be distributed among other Trade Contractors. Submit drawings to Consultant for review. Failure of General Contractor to prepare and coordinate overall interface drawings of trades does not relieve respective Division Contractor of responsibility to ensure that work is properly planned and coordinated.

.6 Carry out alterations in arrangement of work that has been installed without proper coordination, study, and review, even if in accordance with Contract Documents, in order to conceal work behind finishes, or to allow installation of other work, without additional cost. In addition, make necessary alterations in other work required by such alterations, without additional cost.

.7 Shut-off valves, balancing devices, air vents, equipment and similar products, particularly such products located above suspended ceilings must be located for easy access for servicing and/or removal. Products which do not meet this location requirement are to be relocated to an accessible location at no additional cost.

.8 Be responsible for making necessary changes, at no additional cost, to accommodate structural and building conditions that were missed due to lack of coordination.

1.12 **PHASING**

.1 Include for scheduling, coordination, and construction phasing to suit project as specified in Division 01 and on drawings. Review exact phasing requirements with Consultant prior to start of Work.

.2 Phasing and scheduling of Work is required in order to maintain existing building operations. Include costs (including costs for "off hours" work) for scheduling, co-

ordination, and construction phasing to suit this project as specified in Division 01 and on drawings. Review phasing requirements with Consultant prior to start of Work.

.3 Protect existing areas above, below and adjacent areas of Work from any debris, noise, or interruptions to existing services to satisfaction of Owner and reviewed with Consultant. Maintain in operation existing services to these areas to allow Owner to continue use of these areas. If services that are required to be maintained run through areas of renovations, provide necessary protection to services or reroute, in coordination with Owner and Consultant. Include for required premium time work to meet these requirements.

.4 Work being performed within occupied spaces and work affecting surfaces adjacent to occupied spaces may need to be performed after regular business hours. For areas where spaces are used by Owner on a 24 hours basis or over various hours, coordinate hours of work with Owner on a regular basis to suit Owner's schedule. Execute work at times confirmed with and agreed to by Owner and reviewed with Consultant, so as not to inconvenience Owner's occupation or in any way hinder Owner's use of building. Include for required premium timework to meet these requirements.

.5 Project partial occupancy permits to be required throughout project. Provide for each partial permit, required local governing authority certificate and any other testing/verification certificates for systems.

1.13 **COORDINATION OF WORK**

.1 Review Contract Documents and coordinate work with work of each trade. Coordination requirements are to include but not be limited to following:
- .1 requirements for openings, sleeves, inserts and other hardware necessary for installation of work;
- .2 concrete work such as housekeeping pads, sumps, bases, etc., required for work, and including required dimensions, operating weight of equipment, location, etc.;
- .3 depth and routing of excavation required for work, and requirements for bedding and backfill;
- .4 wiring work required for equipment and systems but not specified to be done as part of mechanical work, including termination points, wiring type and size, and any other requirements.

.2 Ensure materials and equipment are delivered to site at proper time and in such assemblies and sizes so as to enter into building and be moved into spaces where they are to be located without difficulty.

.3 Wherever possible, coordinate equipment deliveries with manufacturers and/or suppliers so equipment is delivered to site when it is required, or so it can be stored within building, subject to available space as confirmed with Owner and reviewed with Owner, and protected from elements.

.4 Ensure proper access and service clearances are maintained around equipment, and, where applicable, access space for future equipment removal or replacement is not impeded. Comply with code requirements with regards to access space

provision around equipment. Remove and replace any equipment which does not meet this requirement.

.5 Where work is to be integrated, or is to be installed in close proximity with work of other trades, coordinate work prior to and during installation.

1.14 **PRODUCTS**

.1 Be responsible for ordering of products (equipment and materials) in a timely manner in order to meet project-scheduling timelines. Failure to order products to allow manufacturers sufficient production/delivery time to meet project-scheduling timelines is an unacceptable reason to request for other suppliers or substitutions.

.2 Provide Canadian manufactured products wherever possible or required and when quality and performance is obtainable at a competitive price. Products are to be supplied from manufacturer's authorized Canadian representative, unless otherwise noted. Unless otherwise specified, products are to be new and are to comply with applicable respective Canadian standards. References to UL listings of products to include requirements that products are to be also Underwriters Laboratories of Canada (ULC) listed for use in Canada. Products are to meet or exceed latest ANSI/ASHRAE/IES 90.1 standards, as applicable. Do not supply any products containing asbestos materials or PCB materials.

.3 Systems and equipment of this Project are to be "State of the Art" and be most recent and up to date series/version of product that is available at time of shop drawing review process. Products that have been stored or "on shelf" for an extended period of time will not be accepted. Software is to be of latest version available and be provided with updates available at time of shop drawing review process. Systems are to be designed such that its software is backwards compatible. Future upgrades are not to require any hardware replacements or additions to utilize latest software.

.4 Products scheduled and/or specified have been selected to establish a performance and quality standard, and, in some instances, a dimensional standard. In most cases, base specified manufacturers are stated for any product specified by manufacturer's name and model number. Where acceptable manufacturers are listed, first name listed is base specified company. Bid Price may be based on products supplied by any of manufacturers' base specified or named as acceptable for particular product. If acceptable manufacturers are not stated for a particular product, base Bid Price on product supplied by base specified manufacturer.

.5 Documents have been prepared based on product available at time of Bidding. If, after award of Contract, and if successful manufacturer can no longer supply a product that meets base specifications, notify Consultant immediately. Be responsible for obtaining other manufacturers product that complies with base specified performance and criteria and meets project timelines. Proposed products are subject to review and consideration by Consultant and are considered as substitutions subject to a credit to Contract. In addition, if such products require modifications to room spaces, mechanical systems, electrical systems, etc., include required changes. Such changes are to be submitted in detail to Consultant for review and consideration for acceptance. There will be no

increase in Contract Price for revisions. Above conditions supplement and are not to supersede any specification conditions with regards to substitutions or failure to supply product as per issued documents.

.6 Listing of a product as "acceptable" does not imply automatic acceptance by Consultant and/or Owner. It is responsibility of Contractor to ensure that any price quotations received and submittals made are for products that meet or exceed specifications included herein.

.7 If products supplied by a manufacturer named as acceptable are used in lieu of base specified manufacturer, be responsible for ensuring that they are equivalent in performance and operating characteristics (including energy consumption if applicable) to base specified products. It is understood that any additional costs (i.e. for larger starters, larger feeders, additional spaces, etc.), and changes to associated or adjacent work resulting from provision of product supplied by a manufacturer other than base specified manufacturer, is included in Bid Price. In addition, in equipment spaces where equipment named as acceptable is used in lieu of base specified equipment and dimensions of such equipment differs from base specified equipment, prepare and submit for review accurately dimensioned layouts of rooms affected, identifying architectural and structural elements, systems and equipment to prove that equipment in room will fit properly meeting design intent. There will be no increase in Contract Price for revisions.

.8 In addition to manufacturer's products base specified or named as acceptable, other manufacturers of products may be proposed as substitutions to Consultant for review and consideration for acceptance, listing in each case a corresponding credit for each substitution proposed. However, base Bid Price on products base specified or named as acceptable. Certify in writing to Consultant that proposed substitution meets space, power, design, energy consumption, and other requirements of base specified or acceptable product. It is understood that there will be no increase in Contract Price by reason of any changes to associated equipment, mechanically, electrically, structurally or architecturally, required by acceptance of proposed substitution. Consultant has sole discretion in accepting any such proposed substitution of product. Indicate any proposed substitutions in areas provided on Bid Form. Do not order such products until they are accepted in writing by Consultant.

.9 Where products are listed as "or approved equal", certify in writing that product to be used in lieu of base specified product, at least meets space, power, design, energy consumption, and other requirements of base specified product and is equivalent or better than base specified product. When requested by Consultant, provide full design detail drawings and specifications of proposed products. Acceptance of these "or approved equal" products is at sole discretion of Consultant. It is understood that there will be no increase in Contract Price by reason of any changes to associated equipment, mechanically, electrically, structurally or architecturally, required by acceptance of approved equal product. There must be no increase in Contract price due to Consultant's rejection of proposed equivalent product.

.10 Whenever use of product other than base specified product is being supplied, ensure corresponding certifications and product information (detailed catalogue and engineering data, fabrication information and performance characteristics) are

submitted to Consultant for review. Failure of submission of these documents to Consultant in a timely manner to allow for review will result in base specified product to be supplied at Consultant's discretion, at no additional cost to Contract.

.11 Products supplied by a manufacturer/supplier other than a manufacturer listed as acceptable may be considered for acceptance by Consultant if requested in writing with full product documentation submitted, a minimum of 10 working days prior to Bid closing date.

.12 Any proposed changes initiated by Contractor after award of Contract may be considered by Consultant at Consultant's discretion, with any additional costs for such changes if accepted by Owner and reviewed with Consultant, and costs for review, to be borne by Contractor.

.13 Whenever use of product other than based specified products or named as acceptable is being supplied, time for process of submission of other products and Consultant's review of products will not alter contract time or delay work schedule.

1.15 **SHOP DRAWINGS**

.1 At start-up meeting, review with Consultant products to be included in shop drawing submission. Prepare and submit list of products to Consultant for review.

.2 Submit electronic copies of shop drawings unless otherwise directed by Consultant. Coordinate exact requirements with Consultant.

.3 Submit for review, drawings showing detail design, construction, and performance of equipment and materials as requested in Specification. Submit shop drawings to Consultant for review prior to ordering and delivery of product to site. Include minimally for preparation and submission of following, as applicable:
- .1 product literature cuts;
- .2 equipment data sheets;
- .3 equipment dimension drawings;
- .4 system block diagrams;
- .5 sequence of operation;
- .6 connection wiring schematic diagrams;
- .7 functionality with integrated systems.

.4 Each shop drawing or product data sheet is to be properly identified with project name and product drawing or specification reference. Shop drawing or product data sheet dimensions are to match dimension type on drawings.

.5 Where any item of equipment is required by Code or Standard or By-Law to meet a specific energy efficiency level, or any other specific requirement, ensure this requirement is clearly indicated on submission.

.6 Ensure proposed products meet each requirement of Project. Endorse each shop drawing copy "CERTIFIED TO BE IN ACCORDANCE WITH ALL REQUIREMENTS". Include company name, submittal date, and sign each copy. Shop drawings that are received and are not endorsed, dated and signed will be returned to be resubmitted.

.7 Consultant to review shop drawings and indicate review status by stamping shop drawing copies as follows:

.1 "REVIEWED" or "REVIEWED AS NOTED" (appropriately marked) – If Consultant's review of shop drawing is final, Consultant to stamp shop drawing;

.2 "RETURNED FOR CORRECTION" – If Consultant's review of shop drawing is not final, Consultant to stamp shop drawing as stated above, mark submission with comments, and return submission. Revise shop drawing in accordance with Consultant's notations and resubmit.

.8 Following is to be read in conjunction with wording on Consultant's shop drawing review stamp applied to each and every shop drawing or product data sheet submitted:

.9 "THIS REVIEW BY CONSULTANT IS FOR SOLE PURPOSE OF ASCERTAINING CONFORMANCE WITH GENERAL DESIGN CONCEPT. THIS REVIEW DOES NOT MEAN THAT CONSULTANT APPROVES DETAILED DESIGN INHERENT IN SHOP DRAWINGS, RESPONSIBILITY FOR WHICH REMAINS WITH CONTRACTOR. CONSULTANT'S REVIEW DOES NOT RELIEVE CONTRACTOR OF RESPONSIBILITY FOR ERRORS OR OMISSIONS IN SHOP DRAWINGS OR OF CONTRACTOR'S RESPONSIBILITY FOR MEETING REQUIREMENTS OF CONTRACT DOCUMENTS. BE RESPONSIBLE FOR DIMENSIONS TO BE CONFIRMED AND CORRELATED AT JOB SITE, FOR INFORMATION THAT PERTAINS SOLELY TO FABRICATION PROCESSES OR TO TECHNIQUES OF CONSTRUCTION AND INSTALLATION, AND FOR COORDINATION OF WORK OF SUB-TRADES."

.10 Submit each system and each major component as separate shop drawing submissions. Submit together, shop drawings for common devices such as devices of each system are to be submitted together.

.11 Obtain shop drawings for submission from product manufacturer's authorized representatives and supplemented with additional items specified herein.

.12 Do not order product until respective shop drawing review process has been properly reviewed with Consultant.

.13 Where extended warranties are specified for equipment items, submit specified extended warranty with shop drawing submittal.

1.16 **EQUIPMENT LOADS**

.1 Supply equipment loads (self-weight, operating weight, housekeeping pad, inertia pads, etc.) to Consultant, via shop drawing submissions, prior to construction.

.2 Where given choice of specific equipment, actual weight, location and method of support of equipment may differ from those assumed by Consultant for base design. Back-check equipment loads, location, and supports, and include necessary accommodations.

.3 Where supporting structure consists of structural steel framing, it is imperative that equipment loads, location, and method of support be confirmed prior to fabrication

of structural steel. Review locations of equipment with Consultant prior to construction.

1.17 **OPENINGS**

.1 Supply opening sizes and locations to Consultant to allow verification of their effect on design, and for inclusion on structural drawings where appropriate.

.2 No openings are permitted through completed structure without written approval from Owner and reviewed with Consultant. Show required openings on a copy of structural drawings. Identify exact locations, elevations, and size of proposed openings and submit to Consultant for review, well in advance of doing work.

.3 Prior to leaving site at end of each day, walk through areas of work and check for any openings, penetrations, holes, and/or voids created under scope of work of project, and ensure that any openings created under scope of work have been closed off, fire-stopped and smoke-sealed. Unless directed by Owner and reviewed with Consultant, do not leave any openings unprotected and unfinished overnight.

1.18 **SCAFFOLDING, HOISTING AND RIGGING**

.1 Unless otherwise specified or directed, supply, erect and operate scaffolding, rigging, hoisting equipment and associated hardware required for work, and subject to approval from Owner and reviewed with Consultant.

.2 Immediately remove from site scaffolding, rigging and hoisting equipment when no longer required.

.3 Do not place major scaffolding/hoisting equipment loads on any portion of structure without approval from Owner and reviewed with Consultant.

1.19 **CHANGES IN THE WORK**

.1 Whenever Consultant proposes in writing to make a change or revision to design, arrangement, quantity or type of work from that required by Contract Documents, prepare and submit to Consultant for review, a quotation being proposed cost for executing change or revision.

.2 Quotation is to be a detailed and itemized estimate of product, labour, and equipment costs associated with change or revision, plus overhead and profit percentages and applicable taxes and duties.

.3 If overhead and profit percentages are not specified in Division 00 or 01, but allowable under Contract as reviewed with Consultant prior to contract signing, then allowable maximum percentages for overhead and profit are to be 5% and 5% respectively.

.4 Unless otherwise specified in Divisions 00 or 01, following additional requirements apply to all quotations submitted:

.1 when change or revision involves deleted work as well as additional work, cost of deleted work (less overhead and profit percentages but including

taxes and duties) is to be subtracted from cost of additional work before overhead and profit percentages are applied to additional work;

.2 material costs are not to exceed those published in local estimating price guides;

.3 mechanical material labour unit costs are to be in accordance with Mechanical Contractors Association of America Labor Estimating Manual, less 25%;

.4 electrical material labour unit costs are to be in accordance with National Electrical Contractors Association Manual of Labor Units at difficult level, less 25%;

.5 costs for journeyperson and apprentice labour must not exceed prevailing rates at time of execution of Contract and must reflect actual personnel performing work;

.6 cost for site superintendent must not exceed 10% of total hours of labour estimated for change or revision, and change or revision must be such that site superintendent's involvement is necessary;

.7 costs for rental tools and/or equipment are not to exceed local rental costs;

.8 overhead percentage will be deemed to cover quotation costs other than actual site labour and materials, and rentals;

.9 quotations, including those for deleted work, to include a figure for any required change to Contract time.

.5 Quotations submitted that are not in accordance with requirements specified above will be rejected and returned for re-submittal. Failure to submit a proper quotation to enable Consultant to expeditiously process quotation and issue a Change Order will not be grounds for any additional change to Contract time.

.6 Make requests for changes or revisions to work to Consultant in writing and, if Consultant agrees, will issue Notice of Change.

.7 Do not execute any change or revision until written authorization for the change or revision has been obtained from Consultant.

1.20 PROGRESS PAYMENT BREAKDOWN

.1 Prior to submittal of first progress payment draw, submit a detailed breakdown of work cost to assist Consultant in reviewing and approving progress payment claims.

.2 Payment breakdown is subject to Owner's approval and Consultant's review. Progress payments will not be processed until an approved breakdown is in place. Breakdown is to include one-time claim items such as mobilization and demobilization, insurance, bonds (if applicable), shop drawings and product data sheets, commissioning including testing, adjusting and balancing, system testing and verification, and project closeout submittals.

.3 Indicate equipment, material and labour costs for site services (if applicable) and indicate work of each trade in same manner as indicated on progress draw.

1.21 NOTICE FOR REQUIRED FIELD REVIEWS

.1 Whenever there is a requirement for Consultant to perform a field review prior to concealment of any work, to inspect/re-inspect work for deficiencies prior to Substantial Performance of the Work, for commissioning demonstrations, and any other such field review, give minimum 5 working days' notice in writing to Consultant.

.2 If Consultant is unable to attend a field review when requested, arrange an alternative date and time.

.3 Do not conceal work until Consultant advises that it may be concealed.

.4 When Consultant is requested to perform a field review and work is not ready to be reviewed, reimburse Consultant for time and travel expenses.

1.22 PRELIMINARY TESTING

.1 When directed by Consultant, promptly arrange, pay for, and perform site tests on any piece of equipment or any system for such reasonable lengths of time and at such times as may be required to prove compliance with Specification and governing Codes and Regulations, prior to Substantial Performance of the Work.

.2 When, in Consultant’s opinion, tests are required to be performed by a certified testing laboratory, arrange and pay for such tests.

.3 These tests are not to be construed as evidence of acceptance of work, and it is agreed and understood that no claim for delays or damage will be made for injury or breakage to any part or parts of equipment or system due to test where such injuries or breakage were caused by faulty parts and/or workmanship of any kind.

.4 When, in Consultant’s opinion, tests indicate that equipment, products, etc., are defective or deficient, immediately remove such equipment and/or products from site and replace them with acceptable equipment and/or products, at no additional cost.

1.23 TEMPORARY SERVICES

.1 Coordinate with Prime Contractor, requirements for temporary services including but not limited to temporary heating, cooling and water. Unless otherwise noted, provide required services in compliance with requirements of local governing building code and local governing inspection authorities.

.2 Maintain fire protection of areas which may include fire watch during temporary shutdowns of existing systems, in accordance with requirements of local governing code and local governing authorities.

1.24 MAINTAINING EQUIPMENT PRIOR TO ACCEPTANCE

.1 Maintain equipment in accordance with the manufacturer's printed instructions prior to start-up, testing and commissioning.

.2 Employ a qualified millwright to check and align shafts, drives, and couplings on all base mounted split coupled motor driven equipment.

.3 Where equipment lubrication fittings are not easily accessible, extend the fittings to accessible locations using copper or aluminium tubing.

.4 All filters are to be new upon Substantial Performance of the Work. This is in addition to any spare filters specified.

1.25 **CLEANING**

.1 During construction, keep site reasonably clear of rubbish and waste material resulting from work on a daily basis to the satisfaction of Owner and Consultant. Before applying for a Certificate of Substantial Performance of the Work, remove rubbish and debris, and be responsible for repair of any damage caused as a result of work.

.2 Clean equipment and devices installed as part of this project.

1.26 **RECORD AS-BUILT DRAWINGS**

.1 Drawings for this project have been prepared on a CAD system using AutoCAD software of release version reviewed with Consultant. For purpose of producing record "as built" drawings, copies of Contract Drawings can be obtained from Consultant, at expense of $25.00 CDN plus HST, per drawing, up to first 10 drawings, and $5.00 CDN plus HST, per any additional drawings thereafter. Drawings may also to be used for preparation of layouts and interference drawings.

.2 Drawings for this project have been prepared on a CAD system using AutoCAD software of release version reviewed with Consultant. For purpose of producing record "as built" drawings, copies of Contract Drawings can be obtained from Consultant.

.3 As work progresses at site, clearly mark in red in a neat and legible manner on a set of bound white prints of Contract Drawings, changes and deviations from routing of services and locations of equipment shown on Contract Drawings, on a daily basis. Changes and deviations include those made by addenda, change orders, and site instructions. Use notes marked in red as required. Maintain white print red line as-built set at site for exclusive use of recording as-built conditions, keep set up-to-date at all times, and ensure set is always available for periodic review. As-built set is also to include the following:
   .1 dimensioned location of inaccessible concealed work;
   .2 locations of control devices with identification for each;
   .3 for underground piping and ducts, record dimensions, invert elevations, offsets, fittings, cathodic protection and accessories if applicable, and locate dimensions from benchmarks to be preserved after construction is complete;
   .4 for fire protection systems, record actual locations of equipment, sprinkler heads, and valves, drains, and test locations, and deviations of pipe routing and sizing from that shown on the drawings;
   .5 location of piping system air vents;

.6 location of concealed services terminated for future extension and work concealed within building in inaccessible locations.

.4 Before applying for a Certificate of Substantial Performance of the Work, update a clean copy of Contract Drawing set in accordance with marked up set of "as-built" white prints including deviations from original Contract Drawings, thus forming an "as-built" drawing set. Submit "as-built" site drawing prints to Consultant for review. Make necessary revisions to drawings as per Consultant's comments, to satisfaction of Consultant.

.5 Use final reviewed "as-built" drawing set to provide CAD files of drawings thus forming true "as-built" set of Contract Drawings. Identify set as "Project Record Copy". Load digital copies of final reviewed by Consultant as-built drawings onto USB type flash drive. Provide 2 complete sets of "as-built" drawings on separate USBs. Submit "as-built" sets of white prints and USBs to Consultant.

.6 Submitted drawings are to be of same quality as original Contract Drawings. CAD drawing files are to be compatible with AutoCAD software release version confirmed with Consultant.

.7 Unless otherwise noted in Divisions 00 or 01, failure to maintain accurate record drawings will incur additional 5% holdback on progress claims until drawings are brought up to date to satisfaction of Owner and reviewed with Consultant.

.8 For projects with phased turnover of project (refer to Division 01), review with Consultant completeness of as-built drawings prior to turn over of an area. Copies of hand drawn interim as-built drawings to be made available to Owner's maintenance personnel.

.9 Retain and pay for services of a land surveyor registered in Place of the Work to measure, verify, and record size, location, invert elevation and pitch of buried piping services, and, when complete, to produce a signed and sealed AutoCAD disc (of release version reviewed with Consultant) of survey work which is to be submitted to Consultant. Transfer survey work to as-built drawings.

.10 Requirements regarding medical gas piping system as-built record drawings are as follows:

.1 prepare a separate set of site record red line white print drawings on a day-to-day basis, and provide a separate record CAD disc and a set of record white prints in accordance with requirements of CAN/CSA Z7396.1.

.2 obtain from Owner, existing medical gas piping record drawings and, on a day-to-day basis, record alteration work and new work, including location of concealed piping, and, if a drawing disc is available, update disc using compatible CAD software, in accordance with requirements of CAN/CSA Z7396.1.

.3 obtain from Owner, existing medical gas system record drawings (and CAD disc if applicable), and, on a day-to-day basis, record medical gas system work, incorporating existing work which is to remain, and provide a separate record CAD disc and white prints in accordance with requirements of CAN/CSA Z7396.1.

1.27 OPERATING AND MAINTENANCE MANUALS

.1 For each item of equipment for which a shop drawing is required (except for simple equipment), supply minimum 3, project specific, indexed copies of equipment manufacturers' operating and maintenance (O&M) instruction data manuals. Review exact quantity of manuals with Consultant. Consolidate each copy of data in an identified hard cover three "D" ring binder. Each binder to include:

- .1 front cover: project name; wording – "Mechanical Systems Operating and Maintenance Manual"; and date;
- .2 introduction sheet listing Consultant, Contractor, and Subcontractor names, street addresses, telephone and fax numbers, and e-mail addresses;
- .3 equipment manufacturer's authorized contact person name, telephone number and company website;
- .4 Table of Contents sheet, and corresponding index tab sheets;
- .5 copy of each "REVIEWED" or clean, updated "REVIEWED AS NOTED" shop drawing or product data sheet, with manufacturer's/supplier's name, telephone and fax numbers, email address, company website address, and email address for local source of parts and service; when shop drawings are returned marked "Reviewed As Noted" with revisions marked on shop drawing copies, they are to be revised by equipment supplier to incorporate comments marked on "Reviewed" shop drawings and a clean updated copy is to be included in operating and maintenance manuals;
- .6 Operating data is to include:
  - .1 pressure test reports, and certificates issued by governing authorities;
  - .2 description of each system and its controls;
  - .3 control schematics for equipment/systems including building environmental controls;
  - .4 wiring and connection diagrams;
  - .5 if applicable, BAS architecture and all required operating data;
  - .6 description of operation of each system at various loads together with reset schedules and seasonal variances;
  - .7 operation instruction for each system and each component;
  - .8 description of actions to be taken in event of emergencies and/or equipment failure;
  - .9 valve tag schedule, and flow diagrams to indicate valve locations.
- .7 Maintenance data is to include:
  - .1 operation and trouble-shooting instructions for each item of equipment and each system;
  - .2 schedules of tasks, frequency, tools required, and estimated task time;
  - .3 recommended maintenance practices and precautions;
  - .4 complete parts lists with numbers.
- .8 Performance data is to include:
  - .1 equipment and system start-up data sheets;
  - .2 equipment performance verification test results, and final commissioning report;
  - .3 final testing, adjusting and balancing reports.
- .9 copies of warranties;
- .10 items requested specifically in Section Articles.

.2 Generally, binders are not to exceed 75 mm (3") thick and not to be more than 2/3 full.

.3 Operating and maintenance instructions are to relate to job specific equipment supplied under this project and related to Owner's building. Language used in manuals is to contain simple practical operating terms and language easy for in-house maintenance staff to understand how to operate and maintain each system.

.4 Before applying for a Certificate of Substantial Performance of the Work, assemble one copy of O & M Manual and submit to Consultant for review prior to assembling remaining copies. Incorporate Consultant's comments into final submission.

.5 Provide 2 digital copies of contents of operating and maintenance manuals and load onto separate USB type flash drives and submit to Consultant. Prepare digital copies using version of Adobe Acrobat Portable Document Format or equal as reviewed with Consultant and enhanced with bookmarks and internal document links.

1.28 **COMMISSIONING**

.1 After successful start-up and prior to Substantial Performance of the Work, commission the mechanical work. Commissioning work is the process of Contractor demonstrating to Owner and Consultant, for purpose of final acceptance, by means of successful and documented functional performance testing, that systems and/or subsystems are capable of being operated and maintained to perform in accordance with requirements of Contract Documents, as further described below.

.1 Retain services of a testing, adjusting, and balancing agency to perform testing and balancing of mechanical system air/fluid flows and capacities, prior to operational performance testing. Refer to Section 20 05 93 – Testing, Adjusting, and Balancing of Mechanical Systems.

.2 Test, adjust and operate equipment and systems after start-up but before functional performance testing, to confirm operations are in accordance with requirements of Contract Documents. Verify modes and sequences of control and monitoring, interlocks, and responses to emergency conditions. Complete commissioning data sheets to document successful operational performance testing.

.3 Repeat successful operational performance testing with completed commissioning data sheet documentation in the presence of Consultant and Owner to validate and verify equipment and systems are complete in all respects, function correctly, and are ready for acceptance.

.4 Submit final commissioning data sheets, TAB reports as specified in Section 20 05 93 – Testing, Adjusting, and Balancing of Mechanical Systems, project closeout documents, and other required submittals.

.2 Where commissioning specifications are included as part of Division 01, requirements of Section 20 08 00 – Commissioning of Mechanical Systems are to supplement commissioning requirements of Division 01. Where variances or contradictions exist, more stringent requirement will apply unless otherwise directed by Consultant.

1.29 PROJECT CLOSEOUT SUBMITTALS

.1 Prior to application for Substantial Performance of the Work, submit required items and documentation specified, including following:
- .1 Operating and Maintenance Manuals;
- .2 as-built record drawings and associated data;
- .3 extended warranties for equipment as specified;
- .4 operating test certificates, i.e. Sprinkler Test Certificate;
- .5 final commissioning report and TAB report;
- .6 identified keys for equipment and/or panels for which keys are required, and other items required to be submitted;
- .7 other data or products specified.

1.30 INSTRUCTIONS TO OWNER

.1 Refer to equipment and system operational and maintenance training requirements specified in Division 01.

.2 Train Owner's designated personnel in aspects of operation and maintenance of equipment and systems as specified. Demonstrations and training are to be performed by qualified technicians employed by equipment/system manufacturer/supplier. Supply hard copies of training materials to each attendee.

.3 Unless where specified otherwise in trade Sections, minimum requirements are for manufacturer/suppliers of each system and major equipment, to provide minimum two separate sessions each consisting of minimum 4 hours on site or in factory training (at Owner's choice), of Owner's designated personnel (for up to 6 people each session), on operation and maintenance procedures of system.

.4 For each item of equipment and for each system for which training is specified, prepare training modules as specified below. Use Operating and Maintenance Manuals during training sessions. Training modules include but are not limited to:
- .1 Operational Requirements and Criteria – equipment function, stopping and starting, safeties, operating standards, operating characteristics, performance curves, and limitations;
- .2 Troubleshooting – diagnostic instructions, test and inspection procedures;
- .3 Documentation – equipment/system warranties, and manufacturer's/supplier's parts and service facilities, telephone numbers, email addresses, and the like;
- .4 Maintenance – inspection instructions, types of cleaning agents to be used as well as cleaning methods, preventive maintenance procedures, and use of any special tools;
- .5 Repairs – diagnostic instructions, disassembly, component removal and repair instructions, instructions for identifying parts and components, and review of any spare parts inventory.

.5 Before instructing Owner's designated personnel, submit to Consultant for review preliminary copy of training manual and proposed schedule of demonstration and training dates and times. Incorporate Consultant's comments in final copy.

.6 Obtain in writing from Consultant list of Owner's representatives to receive instructions. Submit to Consultant prior to application for Certificate of Substantial

Performance of the Work, complete list of systems for which instructions were given, stating for each system:
.1 date instructions were given to Owner's staff;
.2 duration of instruction;
.3 names of persons instructed;
.4 other parties present (manufacturer's representative, consultants, etc.).

.7 Obtain signatures of Owner's staff to verify they properly understood system installation, operation and maintenance requirements, and have received operating and maintenance instruction manuals and "as-built" record drawings.

.8 Submit to Consultant, copy of electronic version of training materials loaded on USB flash drive. Include in operating and maintenance manuals submission.

.9 Provide digital video disc (DVD) recording of operating and instructions training for following systems:
.1 building automation system.

.10 Provide a custom video in DVD format that details on site systems and equipment operations and includes following:
.1 professional videographer on site to capture training session; use wireless lavalier microphone to capture crystal clear audio of trainer in association with video footage; edit video to remove unnecessary footage;
.2 DVD to include custom site specific system/equipment screens that outline key information about system/equipment and devices used on site only;
.3 DVD to also include custom site specific video that details programming procedures in conjunction with a voiceover from on-site technician;
.4 DVD created with a main menu screen and authored with chapters to allow operator to access specific areas of training instantly.

.11 Supply minimum quantity of 3 copies of DVDs for each system/equipment.

1.31 **FINAL INSPECTION**

.1 Submit to Consultant, written request for final inspection of systems. Include written certification that:
.1 deficiencies noted during job inspections have been completed;
.2 field quality control procedures have been completed;
.3 systems have been tested and verified, balanced and adjusted, and are ready for operation;
.4 maintenance and operating data have been completed and submitted to, reviewed with Consultant and accepted by Owner;
.5 tags and nameplates are in place and equipment identifications have been completed;
.6 clean-up is complete;
.7 spare parts and replacement parts specified have been provided and acknowledged by Consultant;
.8 as-built and record drawings have been completed and submitted to and reviewed with Consultant and accepted by Owner;
.9 Owner's staff has been instructed in operation and maintenance of systems;
.10 commissioning procedures have been completed.

2 Products – Not Used

3 Execution – Not Used

END OF SECTION

1 General

1.1 **SUBMITTALS**

.1 Shop Drawings/Product Data: Submit shop drawings with product data sheets for variable frequency drives (VFDs). Include:
- .1 construction and performance details;
- .2 wiring and control schematics;
- .3 dimensions of units;
- .4 calculations specific to installation showing total harmonic voltage distortion is less than 5%;
- .5 certified production test results with serial numbers for harmonic mitigation performance and energy efficiency under actual variable frequency drive loading.

.2 Certification Letter: Submit a start-up and installation certification letter from supplier of VFDs as specified in Part 3 of this Section;

.3 Parameters: Prepare list of parameters for uploading for Owner's future use as specified in Part 3 of this Section. Load on USB type flash drive and submit to Consultant.

.4 Extended Warranty: Where extended warranty is specified to be included, include a copy of VFD extended warranty in each Operating and Maintenance Manual. Prior to Substantial Performance of Work, submit a copy of warranty to Owner.

.5 Additionally, coordinate with Prime Contractor and Electrical Contractor to ensure that shop drawings clearly identify that proposed VFDs and connected motors are 100% compatible and Mechanical Contractor to sign off on selected VFDs.

1.2 **COORDINATION WITH ELECTRICAL DIVISIONS**

.1 This Section specifies VFD requirements for motors. Ensure that VFDs packaged with various system equipment, complies with specifications of this Section.

.2 VFDs are each to be approved by respective manufacturers of VFDs and connected motors, as suitable for installation on scheduled motors. VFD output current rating to match or exceed connected motor nameplate full load current rating.

.3 Coordinate and review with Electrical Divisions, responsibility requirements for supply of VFDs, harmonic filters and requirements for control and power conductors and connections.

.4 Check that motors are equipped with AEGIS or approved equal, shaft grounding ring system to protect bearings from damage in motors by diverting harmful shaft voltages and bearing currents to ground.

.5 Additionally, review and confirm responsibilities with Consultant and Prime Contractor.

2 Products

2.1 **VFD BASIC REQUIREMENTS**

.1 VFDs supplied on project to be products of same manufacturer and be CSA approved, ULC listed and labelled. Base specified product is ABB ACH series units that include compliance with following standards:
- .1 CSA C22.2 No.14 Industrial Control Equipment;
- .2 UL 508 - Industrial Control Equipment;
- .3 UL 508C – Power Conversion Equipment;
- .4 NEMA ICS 7 - Adjustable-Speed Drives.

.2 Basis for limiting harmonics is to be provided generally to IEEE Standard 519 - Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems, except intended for user's electrical distribution system with point of common coupling (where harmonic limits are assessed) to be set at input terminals of harmonic mitigating equipment.

.3 Refer to Schedule of VFDs on drawings for features to include with respective VFDs.

.4 VFDs to include following basic requirements:
- .1 regardless of HP rating are to be of same VFD model; I/O and control circuit boards as well as keypads are to be identical and interchangeable regardless of HP rating;
- .2 to be capable of starting into a coasting load (forward or reverse) up to full speed and accelerate or decelerate to set point without safety tripping or component damage (flying start);
- .3 6-pulse width modulated (PWM) AC to AC converter utilizing latest isolated gate bipolar transistor (IGBT) technology; PWM switching pattern to include a motor flux optimization circuit that automatically reduces applied motor voltage to the motor to optimize energy consumption and audible motor noise;
- .4 carrier frequency control circuit that reduces the carrier frequency based on actual VFD temperature that allows higher carrier frequency without derating VFD or operating at high carrier frequency only at low speeds;
- .5 provisions that determines motor torque and flux every 25 microseconds (40,000 times per second);
- .6 completely assembled and tested by manufacturer in their facility;
- .7 designed to provide at least 250,000 hours mean time before failure (MTBF) when specified preventative maintenance is performed.
- .8 bypass system completely factory wired and tested;
- .9 door interlocked padlockable disconnect switch that disconnects all input power from drive and all internally mounted options;
- .10 control panel keyboard and display with password protection against parameter changes.

2.2 **VFD RATINGS**

.1 VFDs to be rated to operate from 3 phase input voltage of 208 or 600 volts ± 10%, as scheduled, and frequency range from 48 to 63 Hz. In addition, a tolerated voltage window to allow system to operate from a line of +30% to -35% nominal

voltage. System to incorporate circuitry that allows drive or bypass contactor to remain "sealed in" over this voltage tolerance at a minimum.

.2 VFDs to employ a full wave rectifier to prevent input line notching and operate at a minimum fundamental input power factor of 0.97 at all speeds and loads.

.3 VFDs efficiency to be 97% or better at full speed and load.

.4 Output voltage and current ratings to match adjustable frequency operating requirements of standard 3ph, 60Hz, NEMA design B inverter-duty motors in compliance with NEMA-MG1, Part 31 Standard. Overload current capacity for variable torque overload capacity to be 110% of rated current for 1 minute out of 10 minutes and 130% for 2 seconds. Output frequency to be adjustable between 0 and 500 Hz.

.5 Open loop static speed regulation to be 0.1% to 0.3% (10% of motor slip). Dynamic speed accuracy to be 4%-sec. or better open loop.

.6 When a suitable motor is used, drive provides breakaway torque equal to 200% of rated motor torque. Torque response time to be 5 ms or less.

.7 Enclosures:
- .1 in climate controlled areas – minimum NEMA 12 with drip shield;
- .2 in non-climate controlled areas – NEMA 3R.

2.3 HARMONIC FILTERS AND REACTORS

.1 VFDs to include internal 5% impedance AC line reactor (or equivalent 5% impedance dual positive and negative DC bus reactors) provided as a standard to reduce input current harmonic content and provide isolation from power line transients and to reduce RFI emissions.

.2 VFDs serving motors sized 11 kw (15 HP) or more to be provided with harmonic filters to limit harmonics distortion produced by each drive to following maximum levels as measured on input side of drive:
- .1 Total harmonic distortion (voltage) – 5%;
- .2 Total harmonic distortion (current) – 10%.

.3 Harmonic filter to be based on MIRUS International Inc. "LINEATOR AUHF" series, with features as follows:
- .1 manufactured and tested in accordance with latest applicable standards of ULC, CSA and NEMA;
- .2 treat characteristic low frequency harmonics generated by a 3-phase, diode bridge rectifier load (5th, 7th, 11th, 13th, etc.);
- .3 passive inductor/capacitor network;
- .4 low capacitive reactance (KVAR) of less than 20% of kVA rating, to ensure compatibility with engine generator sets;
- .5 full load efficiency of harmonic mitigation equipment / VFD combination to be greater than 96%;
- .6 copper wiring;
- .7 220°C system insulation class and temperature rise of 130°C;
- .8 anti-vibration pads between reactor or transformer core and enclosure;

.9 manufacturer's standard ventilated, NEMA-3R enclosure.

2.4 CONTROLS AND ADJUSTMENT FUNCTIONS

.1 Include for following:

.1 programmable critical frequency lockout ranges to prevent VFD from operating load continuously at an unstable speed;

.2 proportional integral derivative (PID) speed loop regulators with an auto tune function as well as manual adjustments; PID set point controllers to allow pressure or flow signals to be connected to VFD, using microprocessor in VFD for closed loop control; includes 250 ma of 24 VDC auxiliary power and capability of loop powering a transmitter supplied by others; two parameter sets for first PID that allow sets to be switched via a digital input, serial communications or from keypad for night setback, summer/winter set points, etc; independent, second PID loop that can utilize second analogue input and modulate analogue outputs to maintain set point of an independent process (ie. valves, dampers, etc.); set points, process variables, etc. to be accessible from serial communication network;

.3 programmable analogue inputs that accept current or voltage signals.

.4 programmable analogue outputs (0-20ma or 4-20 ma), that may be programmed to output proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, Active Reference, and other data;

.5 programmable digital inputs;

.6 programmable digital Form-C relay contact outputs for programmable on and off delay times and adjustable hysteresis; rated for maximum switching current 8 amps at 24 VDC and 0.4 A at 250 VAC; maximum voltage 300 VDC and 250 VAC; continuous current rating 2 amps RMS;

.7 run permissive circuit - for damper or valve control; dry contact closure that will signal damper to open (VFD motor does not operate); when damper is fully open, a normally open dry contact (end-switch) closes; closed end-switch is wired to a VFD digital input and allows motor operation; two separate safety interlock inputs, when either is opened, motor to coast to stop, and damper to close;

.8 two independently adjustable accel and decel ramps with 1 – 1800 seconds adjustable time ramps;

.9 fireman's override input - upon receipt of a contact closure from fireman's control station, VFD operates in one of two modes: operate at a programmed predetermined fixed speed or operate in a specific fireman's override PID algorithm that automatically adjusts motor speed based on override set point and feedback; mode overrides all other inputs (analogue/digital, serial communication and keypad commands), except customer defined safety run interlock, and forces motor to run in one of the two modes; "Override Mode" to be displayed on control panel; upon removal of override signal, VFD resumes normal operation.

.2 Operator Control Panel:

.1 front mounted plug-in operator control panel consisting of keypad, multi-line backlit LCD display for programming and fault diagnostics;

.2 keys (switches) for HAND, OFF, AUTO, and manual speed control INCREASE/DECREASE;

.3 menu navigation and parameter selection keys for custom programming;

.4 HELP key for assistance with programming and troubleshooting;
.5 date and time clock - clock to have a battery backup with 10 years minimum life span; clock to be used to date and time stamp faults and record operating parameters at time of fault; if battery fails VFD I automatically reverts to hours of operation since initial power up; clock also to be programmable to control start/stop functions, constant speeds, PID parameter sets and output relays; VFD to have a digital input that allows an override to time clock (when in off mode) for a programmable time frame; four (4) separate, independent timer functions that have both weekday and weekend settings;
.6 parameter names, fault messages, warnings and other information to be displayed in complete words or standard abbreviations to allow user to understand what is being displayed without use of a manual or cross reference table, as follows:
  .1 “HAND” position to start drive and modify reference frequency by use of INCREASE/DECREASE keys;
  .2 “OFF” position stops drive;
  .3 "AUTO" position allows drive to be started or stopped using whichever remote start/stop command configured; drive speed controlled by external speed reference input or by PID controller.
  .4 applicable operating values to be capable of being displayed in engineering (user) units; operating displayed include:
    .1 Output Frequency;
    .2 Motor Speed (RPM, %, or Engineering units);
    .3 Motor Current;
    .4 Drive Temperature;
    .5 DC Bus Voltage;
    .6 Output Voltage.

2.5 PROTECTIVE FUNCTIONS

.1 For each programmed warning and fault protection function, keypad displays a message in complete words or standard abbreviations. Three most recent fault messages and times are stored in drive’s fault history.

.2 VFDs include metal oxide varistors (MOV’s) for phase to phase and phase to ground line voltage transient protection.

.3 Short circuit current rating of 100,000 amps to be provided per UL 508C without relying on line fuses.

.4 Ground fault protection, motor phase loss protection and phase unbalance protection to be provided. Single phase protection to be provided on input and output.

.5 VFDs to provide electronic motor overload protection qualified per UL 508C.

.6 Protection to be provided for AC line or DC bus overvoltage at 130% of maximum rated or undervoltage at 65% of minimum rated.

.7 Stall protection to be programmable to provide a warning or stop VFD after motor has operated above a programmable torque level for a programmed time limit.

.8 Underload protection to be programmable to provide a warning or stop VFD after motor has operated below a selected underload curve for a programmed time limit.

.9 Overtemperature protection to provide a warning if power module temperature is less than 5C° (9F°) below overtemperature trip level.

.10 Input terminal to be provided for connecting a motor thermistor (PTC type) to drive's protective monitoring circuitry. An input to also be programmable to monitor an external relay or switch contact.

.11 VFDs through 56 kW (75HP) to be protected from damage from input and output power miss-wiring. VFD to sense this condition and display an alarm on control panel.

.12 EMI / RFI filters to be provided as per standard EN 61800-3.

.13 dv/dt long lead filter (LRC) to protect power system network.

.14 Automatic reset feature to automatically reset selected faults and attempt to restart drive based on control parameters such as adjustable time delays, number of restart attempts and duration of restart attempts. Faults include following:
- .1 Overcurrent;
- .2 Overvoltage;
- .3 Undervoltage;
- .4 Analogue input signal reference loss;
- .5 External fault.

.15 Additional built-in protection circuits include:
- .1 Overcurrent trip limit;
- .2 Undervoltage trip limit;
- .3 Microprocessor fault;
- .4 Keypad control panel loss;
- .5 Serial communication loss;
- .6 External fault interlock inputs;
- .7 Adjustable output frequency and motor speed limits;
- .8 Pass code parameter change protection;
- .9 Keypad operator control lockout.

2.6 ELECTRONIC BYPASS

.1 Electronic bypass system to be a fully operational horsepower rated manual and automatic system for full speed operation without VFD, with following components and features:
- .1 factory wired and tested microprocessor controlled bypass system consisting of an output contactor and bypass contactor, service (isolation) switch and VFD input fuses; (bypass designs, which have no VFD only fuses, or that incorporate fuses common to both VFD and bypass will not be accepted);
- .2 bypass enclosure door and VFD enclosure to be interlocked such that input power is turned off before either enclosure can be opened;

.3 door interlocked padlockable disconnect switch that disconnects all input power from drive and all internally mounted devices;
.4 following operators:
  .1 bypass Hand-Off-Auto;
  .2 drive mode selector and light;
  .3 bypass mode selector and light;
  .4 bypass fault reset;
  .5 bypass LCD display, 2 lines for programming and status / fault / warning indications.
.5 motor protection from single phase power conditions; bypass system to detect a single phase input power condition while running in bypass, disengage motor in a controlled fashion, and give a single phase input power indication;
.6 bypass system does not depend on VFD for bypass operation; bypass to be completely functional in both Hand and Automatic modes even if VFD is removed from enclosure for repair / replacement;
.7 run permissive circuit - for damper or valve control; dry contact closure that will signal damper to open (VFD motor does not operate); when damper is fully open, a normally open dry contact (end-switch) closes; closed end-switch is wired to a VFD digital input and allows motor operation; two separate safety interlock inputs, when either is opened, motor to coast to stop, and damper to close;
.8 bypass control to monitor status of VFD and bypass contactors and indicate when there is a welded contactor contact or open contactor coil; this failed contactor operation to be indicated on Bypass LCD display as well as over serial communications protocol;
.9 bypass control to include a programmable time delay for bypass start and control panel indication that this time delay is in process; this allows VAV boxes to be driven open before motor operates at full speed in bypass mode; time delay to be field programmable from 0 - 120 seconds;
.10 bypass control to be programmable for manual or automatic transfer to bypass; user to be able to select via control panel programming which drive faults will generate an automatic transfer to bypass and which faults require a manual transfer to bypass;
.11 adjustable motor current sensing circuit for bypass and VFD mode to provide proof of flow indication; condition is indicated on control panel display, transmitted over building automation protocol and on a relay output contact closure;
.12 programmable digital inputs, and programmable Form-C relay outputs;
.13 relay outputs from bypass to be programmable for any of following indications:
  .1 system started;
  .2 system running;
  .3 bypass override enabled;
  .4 drive fault;
  .5 bypass fault;
  .6 bypass H-O-A position;
  .7 motor proof of flow (broken belt);
  .8 overload;
  .9 bypass selected;
  .10 bypass run;

.11 system started (damper opening);
.12 bypass alarm;
.13 over temperature.

.14 digital inputs for system accept 24VAC or 24VDC; bypass incorporates internally sourced power supply and does not require an external control power source; bypass power board to supply 250 ma of 24 VDC for use by others to power external devices;

.15 interlock terminal strip: provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command; external safety interlocks to remain fully functional whether system is in VFD or bypass mode; remote start/stop contact to operate in VFD and bypass modes; terminal strip allows for independent connection of up to four (4) unique safety inputs;

.16 User is able to select text to be displayed on keypad when safety opens; example text display indications include "Firestat", "Freezestat", "Over pressure" and "Low pressure"; user is able to determine which of four (4) safety contacts is open over serial communications connection;

.17 Class 10, 20, or 30 (selectable) electronic motor overload protection is included as required for specific applications.

2.7 COMMUNICATIONS

.1 VFD to be complete with communications connections of integrated RS-485 port suitable to allow for VFD to be controlled, supervised, monitored and programmed from one remote control panel or PC with VFD system Windows based application software.

.2 Communications protocol to be industry standard compatible to BAS of building. Coordinate exact requirements with Mechanical Divisions controls contractor and BAS vendor to ensure that appropriate interface module is supplied for drive system to communicate with BAS being used in building with interface capability to include serial communication standard protocols as follows:
.1 BACnet.

.3 Serial communication to be used for drive setup, diagnostic analysis, monitoring and control with capabilities to include, but not be limited to:
.1 run-stop control;
.2 speed set adjustment;
.3 proportional/integral/derivative PID control adjustments;
.4 current limit;
.5 accel/decel time adjustments;
.6 ability to lock and unlock control panel keypad;
.7 capability of allowing BAS to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature;
.8 monitoring relays output status, and digital input status and analogue output values;
.9 transmitting diagnostic warning and fault information over communications bus to BAS or other monitoring system;
.10 remote fault reset.

.4 Serial communication and Windows based software to be used for drive setup, diagnostic analysis, monitoring and control. Software to provide real time graphical displays of drive performance. VFD software communication capabilities include, but not be limited to:
- .1 system ON/OFF;
- .2 system status;
- .3 Suitable input for speed control;
- .4 run-stop control;
- .5 ability to force unit to bypass;
- .6 ability to lock and unlock control panel keypad;
- .7 allowing BAS to monitor feedback such as, current (in amps), kilowatt hours (resettable), operating hours (resettable), and logic board temperature;
- .8 monitoring relays output status, and all digital input status;
- .9 transmitting diagnostic warning and fault information over communications bus to BAS or other monitoring system;
- .10 remote fault reset;
- .11 keypad "Hand" or "Auto" selected, and status indications and settings transmitted over serial communications bus;
- .12 monitor if motor is running under load in both VFD and bypass (proof of flow) in VFD mode over serial communications or Form-C relay output;
- .13 minimum of 40 field parameters to be capable of being monitored in bypass mode.

2.8 WARRANTY

.1 VFDs to be warranted free from defective labour and materials for period of 36 months from date of Substantial Performance of the Work. Include for initial one year Contract warranty and an additional 2 year extended warranty direct to Owner. Extended warranty terms and conditions are to be identical to one year Contract warranty, and extended warranty period is to commence day Contract warranty expires.

2.9 SITE SERVICES, TRAINING, AND MAINTENANCE MANUALS

.1 Provide onsite inspection, testing, start up and verification work of VFDs and filters by manufacturer's authorized technician. Allow a minimum of 1/2 day per system. Also include for a second visit to site of one (1) day duration to train operating personnel in operation and maintenance of drives. Provide verification reports and supply soft copy of system programming parameters.

.2 Upon completion of installation, supplier of VFDs to supply minimum one hard copy of complete sets of service and maintenance manuals including wiring and connection diagrams. Include for digital copy loaded onto a USB type flash drive.

.3 Provide system training and instructions on operating and maintenance procedures. Refer to additional requirements in General Instructions section and Division 01.

2.10 ACCEPTABLE MANUFACTURERS

.1 Acceptable VFD manufacturers are:
- .1 ABB;

.2 Schneider Electric (Square D);
.3 Rockwell Automation;
.4 Eaton Cutler Hammer;
.5 Siemens Electric.

3 Execution

3.1 **INSTALLATION OF VARIABLE FREQUENCY DRIVES**

.1 Provide variable frequency drives for motorized equipment in accordance with drawing requirements. Coordinate requirements for conductors and connections with Electrical Divisions Contractor.

.2 Ensure that variable speed drives supplied are products of same manufacturer.

.3 Unless otherwise noted on drawings or in Part 2 of this Section, include minimally, a manual bypass with each VFD. Supply electronic bypass with VFDs specifically noted and/or scheduled on drawings.

.4 Ensure wire length between VFD and motor is less than 15 m (50') with properly sized conductors.

.5 Install VFDs in accordance with manufacturer's instructions. Ensure that VFDs installation include upstream protection, either fuses or circuit breakers in accordance with VFD manufacturer's recommendations and local electrical code requirements. Advise Electrical Divisions Contractor of these requirements in addition to required conductors and connections. Provide required control wiring and connections.

.6 Review VFD and related connected motor installation. Provide local disconnect to VFD in accordance with local governing code requirements.

.7 Mount VFDs operating controls/display at approximately 1.5 m (5') above finished floor level, unless otherwise directed by Consultant. Provide dual back to back C-channel support system from floor to ceiling, complete with cross bracing to form a solid backing for VFD mounting at required locations.

.8 Properly support VFDs. Coordinate exact locations on site with Consultant.

.9 Where VFDs are required for custom made air handling units VFDs to be supplied, factory mounted on fan cabinets, and "load" side connected to fan motors by air handling unit manufacturer. "Line" side power wiring to these VFDs to be provided as part of Electrical Divisions work.

.10 Where VFDs are required for commercial fans, mount each VFD generally where shown but with exact location to ensure that VFD is accessible in accordance with local governing electrical code requirements. "Line" and "load" side power wiring to these VFD's to be provided as part of Electrical Divisions work.

.11 Where VFDs are required for pumps, mount each VFD generally where shown but with exact location to ensure that VFD is accessible in accordance with local

governing electrical code requirements. "Line" and "load" side power wiring to these VFDs to be provided as part of Electrical Divisions work.

.12 Install harmonic mitigation filter equipment as follows:
- .1 in accordance with manufacturer's recommended installation practices and to comply with applicable local governing codes;
- .2 provide each VFD as specified in per Part 2, with a harmonic filter sized as per manufacturer's rating table to match rating of connected VFD;
- .3 mount harmonic filters sized up to 110 kW (150 HP) typically to wall/ceiling construction using suitable brackets, metal C-channel framework and vibration isolators assemblies, ensuring full support of units acceptable to local governing authorities;
- .4 mount harmonic filters sized greater than 110 kW (150 HP) typically to floor mounted concrete pads with suitable vibration isolators and seismic restraints in accordance with local governing building codes;
- .5 ensure that adequate ventilation and space for access is provided;
- .6 review exact locations with Consultant prior to installation;
- .7 coordinate with Electrical Division Contractor to ensure units are connected complete to line side supply feed and to VFD in accordance with VFD manufacturer's instructions for standalone VFDs and VFD system with bypass; include required control wiring and connections.

.13 Ground and bond equipment as per local governing electrical code requirements and manufacturer's instructions.

.14 Provide engraved lamacoid nameplate identifying each piece of equipment. Review exact nomenclature with Consultant.

.15 Be responsible for ensuring that VFDs, harmonic filters and connected motors are properly installed, connected, tested in proper working order and operation verified.

3.2 TESTING, START-UP, AND VERIFICATION

.1 When installation of VFDs are complete, arrange for VFD manufacturer/supplier to:
- .1 supply factory authorized technician at site for minimum of 4 hours per system to examine installation and connection of each VFD, and to perform start-up and set-up procedures in conjunction with equipment start-up and testing procedures;
- .2 supply factory authorized technician at site for minimum of one 8 hour day to train Owner's personnel on VFD operating and maintenance procedures;
- .3 prepare and submit letter to certify that VFDs have been properly installed, tested and adjusted, and are in proper operating condition;
- .4 submit list of start-up and testing parameters for uploading for future use by Owner.

.2 Start-up data entries to include motor nameplate power, speed, voltage, frequency and current.

.3 Inspect VFDs and accessories for verification of proper operation and installation.

.4 Inspect interface wiring to BAS for verification of proper operation and installation.

.5 Verification of wire terminations to VFDs and bypass and to operational circuitry.

.6 Installation verification of VFD, bypass and motor being driven for proper operation and reliability.

.7 Verification that connections and communications to BAS or other monitoring/remote control system are of proper operation and installation and of full communications compatibility.

.8 Measurement for verification of proper operation on each of following items:
- .1 Motor voltage and frequency;
- .2 Verification of proper motor operation;
- .3 Control input for proper building automation system interface and control calibration.

.9 Calibration check for following set points (and adjustment as necessary):
- .1 minimum speed;
- .2 maximum speed;
- .3 acceleration and deceleration rates.

.10 Verify harmonic compliance with onsite field measurements of both voltage and current harmonic distortion at point of common coupling-input terminals of harmonic mitigating equipment with and without equipment operating. Utilize recording type Fluke 41 or equivalent harmonics analyser displaying individual and total harmonic currents and voltages.

.11 Document testing and results in a report signed by a Professional Engineer licensed in the Place of Work and authorized by system manufacturer. Include for minimum 3 hard copies and electronic copy of report to be submitted to Consultant for review.

.12 Additionally, refer to applicable installation, testing, coordination and verification requirements in Electrical Divisions Sections.

END OF SECTION

1 General

1.1 **APPLICATION**

.1 This Section specifies firestopping and smoke seal requirements that are common to mechanical work Sections of the Specification and it is a supplement to each Section and is to be read accordingly.

1.2 **SUBMITTALS**

.1 Submit a product data sheet and a WHIMIS sheet for each firestopping and smoke seal product.

.2 Submit for review, full company name and experience of proposed firestopping and smoke seal system applicator.

.3 Submit a letter of proper firestopping and smoke seal certification as specified in Part 3 of this Section.

1.3 **QUALITY ASSURANCE**

.1 Applicator is to have a minimum of 3 years of successful experience on projects of similar size and complexity, and applicator's qualifications are to be reviewed by Consultant.

.2 Comply with firestopping and smoke seal product manufacturer’s recommendations regarding suitable environment conditions for product installation.

2 Products

2.1 **FIRESTOPPING AND SMOKE SEAL SYSTEM MATERIALS**

.1 Asbestos-free elastomeric materials tested, listed and labelled by ULC in accordance with ULC S115 and ULC S101 for installation in ULC designated firestopping and smoke seal systems to provide a positive fire, water and smoke seal, and a fire-resistance rating (flame, hose stream and temperature) not less than fire resistance rating of surrounding fire rated construction.

.2 Materials are to be compatible with abutting dissimilar materials and finishes and complete with primers, damming and back-up materials, supports, and anchoring devices in accordance with firestopping manufacturer’s recommendations and ULC tested assembly.

.3 Pipe insulation forming part of a fire and smoke seal assembly is specified in Section entitled Mechanical Insulation.

.4 Acceptable manufacturers are:
.1 A/D Fire Protection Systems "FIREBARRIER";
.2 Tremco Inc. Fire Protection Systems Group "TREMSTOP";
.3 3M Canada;
.4 Hilti (Canada) Ltd. Firestop Systems;

.5 Specified Technologies Inc.

3 Execution

3.1 **INSTALLATION OF FIRESTOPPING AND SMOKE SEAL MATERIALS**

.1 Where mechanical work penetrates fire rated construction, provide ULC listed and labelled firestopping and smoke seal materials installed in accordance with requirements of ULC S115, ULC S101, and other governing authorities to seal penetrations.

.2 Abide by following requirements:
- .1 Examine substrates, openings, voids, adjoining construction and conditions under which firestop and smoke seal system is to be installed. Confirm compatibility of surfaces.
- .2 Verify penetrating items are securely fixed and properly located with proper space allowance between penetrations and surfaces of openings.
- .3 Report any unsuitable or unsatisfactory conditions to Contractor and Consultant in writing, prior to commencement of work. Commencement of work will mean acceptance of conditions and surfaces.
- .4 Mask where necessary to avoid spillage and over coating onto adjoining surfaces. Remove stains on adjacent surfaces.

.3 Conform to following application requirements:
- .1 Prime substrates in accordance with product manufacturer's written instructions.
- .2 Provide temporary forming as required and remove only after materials have gained sufficient strength and after initial curing.
- .3 Tool or trowel exposed surfaces to a neat, smooth, and consistent finish.
- .4 Remove excess compound promptly as work progresses and upon completion.
- .5 At fusible link damper locations, seal perimeter of angle iron framing on both sides of wall or slab with ULC listed and labelled sealant materials to provide a positive smoke seal.

.4 Notify Consultant when work is complete and ready for inspection, and prior to concealing or enclosing firestopping and smoke seal materials and service penetration assemblies. Arrange for final inspection of work by Municipal Building Inspector prior to concealing or enclosing work. Make any corrections required.

.5 On completion of firestopping and smoke sealing installation, submit a Letter of Assurance to Consultant certifying the firestopping and smoke sealing installation has been carried out throughout the building to mechanical service penetrations and that installation has been done in strict accordance with requirements of Provincial Building Code, any applicable local Municipal Codes, ULC requirements, and manufacturer's instructions.

END OF SECTION

1 General

1.1 **APPLICATION**

.1 This Section specifies vibration isolation product requirements that are common to mechanical work Sections of the Specification and it is a supplement to each Section and is to be read accordingly.

1.2 **SUBMITTALS**

.1 Submit copies of manufacturer's product data sheets for products specified in this Section. Product data sheets are to include product characteristics, limitations, dimensions, finishes, and installation recommendations.

.2 Submit a letter from vibration isolation manufacturer to certify correct installation of products, as specified in Part 3 of this Section.

2 Products

2.1 **GENERAL**

.1 Vibration isolation products are to be in accordance with the most recent edition of the ASHRAE Handbook and/or as indicated on drawings, schedules, details, and as specified below.

.2 Springs are to be stable, colour coded, selected to operate at no greater than ⅔ solid load, designed in accordance with Society of Automotive Engineers Handbook Supplement 9 entitled Manual on Design and Application of Helical and Spiral Springs, and with spring diameters in accordance with manufacturer's recommendations to suit static deflection and maximum equipment load.

.3 Steel components of isolation products not exposed to the weather or moisture are to be zinc plated. Steel components of isolation products exposed to the weather or in a damp, moist environment are to be factory painted with rust inhibiting primer and 2 coats of neoprene.

.4 Where weight of isolated equipment may change significantly due to draining or filling with a liquid, vibration isolators are to be equipped with limit stops to limit spring extensions.

.5 Seismic rated isolators and snubbers are to be listed, rated, and approved by State of California Office of Statewide Health and Planning Department (O.S.H.P.D.) and carry an O.S.H.P.D. pre-approved number. Seismic restraints supplied with vibration isolation are to meet requirements specified in Section entitled Seismic Control and Restraint.

.6 Flexible piping connections to vibration isolated equipment are specified in the appropriate piping sections of the Specification.

2.2 ISOLATION PADS

.1 Sandwich type pads, 20 mm (¾") nominal thickness, selected for 3.2 mm (1/8") static deflection unless otherwise specified, consisting of 2 waffle type or ribbed 50 durometer neoprene pads permanently bonded to a minimum #10 gauge steel plate, and complete with rubber bushed bolt holes and equipment anchor bolts with neoprene isolation grommets.

.2 Acceptable products are:
- .1 Vibro-Acoustics Ltd. Type NSN;
- .2 The VMC Group Vibration Mounting & Controls Inc. (Korfund-Dynamics) "SHEAR-FLEX PLATES";
- .3 Kinetics Noise Control Vibron Products Group Type NGS/NGD;
- .4 Mason Industries Inc. Type SW/S/SW with HG Bolt Insertion Washers;
- .5 J. P. America Inc. Type JSJ.

2.3 RUBBER FLOOR ISOLATORS

.1 Captive, bridge bearing quality neoprene mount selected for a minimum 4 mm (0.15") static deflection unless otherwise specified, with an integral ductile iron housing and integral equipment anchor bolt.

.2 Acceptable products are:
- .1 Vibro-Acoustics Ltd. Type R;
- .2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) Type RSM;
- .3 Kinetics Noise Control Vibron Products Group Type RQ;
- .4 Mason Industries Inc. Type BR;
- .5 J. P. America Inc. Type TRM.

3 Execution

3.1 INSTALLATION OF VIBRATION ISOLATION MATERIALS

.1 Unless otherwise stated in the drawings, schedules and/or typical details, vibration isolation is to be provided for all mechanical equipment as per the recommendations contained within in the most recent edition of the ASHRAE Handbook.

.2 Supply to vibration isolation product manufacturer or supplier a copy of a "reviewed" shop drawing or product data sheet for each piece of equipment to be isolated and dimensioned pipe layouts of associated piping to be isolated.

.3 Unless otherwise specified, vibration isolation products are to be product of one manufacturer.

.4 Ensure vibration isolation manufacturer coordinates material selections with equipment provided in order to ensure adherence to performance criteria. Allow for expansion and contraction when material is selected and installed.

.5 Unless otherwise indicated, install isolation materials for base mounted equipment on concrete housekeeping pad bases which extend at least over the full base and isolated area of the isolated equipment. Additional requirements are as follows:
- .1 block and shim bases level so ductwork and piping connections can be made to a rigid system at proper operating level, before isolated adjustment is made, and ensure there is no physical contact between isolated equipment and building structure;
- .2 steel bases are to clear the sub-base by 25 mm (1");
- .3 concrete bases are to clear the sub-base by 50 mm (2").

.6 Isolate piping larger than 25 mm (1") dia. directly connected to motorized and/or vibration isolated equipment with 25 mm (1") static deflection spring hangers at spacing intervals in accordance with following:
- .1 for pipe less than or equal to 100 mm (4") dia. – first 3 points of support;
- .2 for pipe 125 mm (5") to 200 mm (8") dia. – first 4 points of support;
- .3 for pipe equal to or greater than 250 mm (10") dia. – first 6 points of support;

.7 First point of isolated piping support is to have a static deflection of twice the deflection of the isolated equipment but maximum 50 mm (2").

.8 Secure top of spring hanger frame rigidly to structure, and do not install spring hangers in concealed locations.

.9 Where it is impossible to use at least 2 spring hangers, provide Senior Flexonics Ltd. Style 102 (or 102-U as required) or equal, twin sphere, moulded rubber flexible connection assemblies, selected by manufacturer and suitable in all respects for intended application, and complete with required nipples and connections to provide proper vibration isolation.

.10 Erect roof curb vibration isolation in accordance with instructions shipped with assembly. Match vibration isolation with associated roof top unit and orient isolation as identified by manufacturer to ensure proper loading and optimum performance. Caulk top of roof curb with 2 beads of caulking provided and centre isolation assembly onto roof curb and, unless otherwise noted, screw in place with 50 mm (2") lag screws at 900 mm (36") O.C. Position gasket on top rail or alternatively, caulk with 2 beads of caulking provided and orient and lower roof top unit onto isolation rails and, unless otherwise noted, screw unit into top rail with 25 mm (1") lag screws at 900 mm (36") O.C. After roof top unit is secured in place, but before damageable work is installed, spray each isolated equipment assembly with water and correct any water leaks.

.11 For control wiring connections to vibration isolated equipment ensure flexible metallic conduit with 90° bend is used for conduit 25 mm (1") dia. and smaller, and for conduit larger than 25 mm (1") dia., use Crouse Hinds EC couplings. Connections are to be long enough so that conduit will remain intact if equipment moves 300 mm (12") laterally from its installed position, and flexible enough to transmit less vibration to structure than is transmitted through vibration isolation. Coordinate these requirements with mechanical trades involved. If electrical power connections are not made in a similar manner as part of the electrical work, report this fact to Consultant.

.12 Arrange and pay for vibration isolation product manufacturer to visit site to inspect installation of his equipment. Perform revision work required as a result of improper installation. When vibration isolation equipment manufacturer is satisfied with the installation, obtain and submit a letter stating manufacturer has inspected the installation and equipment is properly installed.

.13 Refer to Section entitled Seismic Control and Restraint for requirements pertaining to seismically restrained vibration isolation.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 This Section specifies mechanical system testing, adjusting, and balancing requirements that are common to mechanical work Sections of the Specification and it is a supplement to each Section and is to be read accordingly.

1.2 **DEFINITIONS**

.1 "Agency" – means agency to perform testing, adjusting and balancing work.

.2 "TAB" – means testing, adjusting and balancing to determine and confirm quantitative performance of equipment and systems and to regulate specified fluid flow rate and air patterns at terminal equipment, e.g., reduce fan speed, throttling, etc.

.3 "hydronic systems" – includes heating water, chilled water, glycol-water solution, condenser water, and any similar system.

.4 "air systems" – includes outside air, supply air, return air, exhaust air, and relief air systems.

.5 "flow rate tolerance" – means allowable percentage variation, minus to plus, of actual flow rate values in Contract Documents.

.6 "report forms" – means test data sheets arranged for collecting test data in logical order for submission and review, and these forms, when reviewed and accepted, should also form permanent record to be used as basis for required future testing, adjusting and balancing.

.7 "terminal" – means point where controlled fluid enters or leaves the distribution system, and these are supply inlets on water terminals, supply outlets on air terminals, return outlets on water terminals, and exhaust or return inlets on air terminals such as registers, grilles, diffusers, louvers, and hoods.

.8 "main" – means duct or pipe containing system's major or entire fluid flow.

.9 "submain" – means duct or pipe containing part of the systems' capacity and serving 2 or more branch mains.

.10 "branch main" – means duct or pipe servicing 2 or more terminals.

.11 "branch" – means duct or pipe serving a single terminal.

1.3 **SUBMITTALS**

.1 Within 30 days of work commencing at site, submit name and qualifications of proposed testing and balancing agency in accordance with requirements of article entitled Quality Assurance below.

.2 Submit sample test forms, if other than those standard forms prepared by Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB), are proposed for use.

.3 Submit a report by Agency to indicate Agency's evaluation of mechanical drawings with respect to service routing and location or lack of balancing devices. Include set of drawings used and marked-up by Agency to prepare report.

.4 Submit a report by Agency after each site visit made by Agency during construction phase of this Project.

.5 Submit a draft report, as specified in Part 3 of this Section.

.6 Submit a final report, as specified in Part 3 of this Section.

.7 Submit a testing and balancing warranty as specified in Part 3 of this Section.

.8 Submit reports listing observations and results of post construction site visits as specified in Part 3 of this Section.

1.4 **QUALITY ASSURANCE**

.1 Employ services of an independent testing, adjusting, and balancing agency meeting qualifications specified below, to be single source of responsibility to test, adjust, and balance building mechanical systems to produce design objectives. Agency is to have successfully completed testing, adjusting and balancing of mechanical systems for a minimum of 5 projects similar to this Project within past 3 years, and is to be certified as an independent agency in required categories by one of following:
   .1 AABC - Associated Air Balance Council;
   .2 NEBB - National Environmental Balancing Bureau.

.2 Testing, adjusting and balancing of complete mechanical systems is to be performed over entire operating range of each system in accordance with 1 of following publications:
   .1 National Standards for a Total System Balance published by Associated Air Balance Council;
   .2 Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems published by National Environmental Balancing Bureau;
   .3 Chapter 37, Testing, Adjusting, and Balancing of ASHRAE Handbook HVAC Applications.

2 Products – Not Used

3 Execution

3.1 **SCOPE OF WORK**

.1 Perform total mechanical systems testing, adjusting, and balancing. Requirements include measurement and establishment of fluid quantities of mechanical systems

as required to meet design specifications and comfort conditions, and recording and reporting results.

.2 Mechanical systems to be tested, adjusted and balanced include:
- .1 TAB of air handling systems is to include equipment and ductwork air temperatures, capacities and flows.
- .2 TAB of water systems supplying water features.

3.2 TESTING, ADJUSTING, AND BALANCING

.1 Conform to following:
- .1 as soon as possible after award of Contract, Agency is to carefully examine a set of mechanical drawings with respect to routing of services and location of balancing devices, and is to issue a report listing results of the evaluation;
- .2 set of drawings examined by Agency is to be returned with evaluation report, with red line mark-ups to indicate locations for duct system test plugs, and required revision work such as relocation of balancing devices and locations for additional devices;
- .3 after review of mechanical work drawings and specification, Agency is to visit site at frequent, regular intervals during construction of mechanical systems, to observe routing of services, locations of testing and balancing devices, workmanship, and anything else that will affect testing, adjusting and balancing;
- .4 after each site visit, Agency is to report results of site visit indicating date and time of visit, and detailed recommendations for any corrective work required to ensure proper adjusting and balancing;
- .5 testing, adjusting and balancing is not to begin until:
  - .1 building construction work is substantially complete and doors have been installed;
  - .2 mechanical systems are complete in all respects, and have been checked, started, adjusted, and then successfully performance tested.
- .6 mechanical systems to be tested, adjusted and balanced are to be maintained in full, normal operation during each day of testing, adjusting and balancing;
- .7 obtain copies of reviewed shop drawings of applicable mechanical plant equipment and terminals, and temperature control diagrams and sequences;
- .8 Agency is to walk each system from system "head end" equipment to terminal units to determine variations of installation from design, and system installation trades will accompany Agency;
- .9 Agency is to check valves and dampers for correct and locked position, and temperature control systems for completeness of installation before starting equipment;
- .10 wherever possible, Agency is to lock balancing devices in place at proper setting, and permanently mark settings on devices;
- .11 Agency is to leak test ductwork as specified in Section entitled HVAC Air Distribution in accordance with requirements of SMACNA "HVAC Air Duct Leak Test Manual", coordinate work with work of aforementioned Sections, provide detailed sketch(es) to Sheet Metal Contractor and Consultant identifying ductwork not in accordance with acceptable leakage values specified in aforementioned Sections, and retest corrected ductwork;

.12 Agency is to balance systems with due regard to objectionable noise which is to be a factor when adjusting fan speeds and performing terminal work such as adjusting air quantities, and should objectionable noise occur at design conditions, Agency is to immediately report problem and submit data, including sound readings, to permit an accurate assessment of noise problem to be made;

.13 Agency is to check supply air handling system mixing plenums for stratification, and where variation of mixed air temperature across coils is found to be in excess of ±5% of design requirements, Agency is to report problem and issue a detail sketch of plenum baffle(s) required to eliminate stratification;

.14 Agency is to perform testing, adjusting and balancing to within ±5% of design values, and make and record measurements which are within ±2% of actual values;

.15 for air handling systems equipped with air filters, test and balance systems with simulated 50% loaded (dirty) filters by providing a false pressure drop;

.16 test, adjust and balance air conditioning systems during summer season and heating systems during winter season, including at least a period of operation at outside conditions within 2.8°C (5°F) wet bulb temperature of maximum summer design condition, and within 5.5°C (10°C) dry bulb temperature of minimum winter design condition, and take final temperature readings during seasonal operation.

.2 Prepare reports as indicated below.

.1 Upon completion of testing, adjusting, and balancing procedures, prepare draft reports on AABC or NEBB forms. Draft reports may be hand written, but must be complete, factual, accurate, and legible. Organize and format draft reports in same manner specified for final reports and submit for review.

.2 Upon verification and approval of draft reports, prepare final reports organized and formatted as specified below. Use units of measurement (SI or Imperial) as used on Project Documents.

.3 Report forms are to be those standard forms prepared by the referenced standard for each respective item and system to be tested, adjusted, and balanced. Report forms complete with schematic systems diagrams and other data are to be consolidated in electronic format as a PDF. PDF file to be indexed and organized into sections, as it applies to the project, as follows:

.1 General Information and Summary;
.2 Air Systems;
.3 Hydronic Systems;
.4 Temperature Control Systems;
.5 Special Systems.

.4 Agency is to provide following minimum information, forms and data in report:

.1 inside cover sheet to identify Agency, Contractor, and Project, including addresses, and contact names and telephone numbers and a listing of instrumentation used for procedures along with proof of calibration;

.2 remainder of report is to contain appropriate forms containing as a minimum, information indicated on standard AABC or NEBB report forms prepared for each respective item and system;

.3 Agency is to include for each system to be tested, adjusted and balanced, a neatly drawn, identified (system designation, plant equipment location, and area served) schematic "as-built" diagram indicating and identifying equipment, terminals, and accessories;

.4 Agency is to include report sheets indicating building comfort test readings for all rooms.

.3 After final testing and balancing report has been submitted, Agency is to visit site with Contractor and Consultant to spot check results indicated on balancing report. Agency is to supply labour, ladders, and instruments to complete spot checks. If results of spot checks do not, on a consistent basis, agree with final report, spot check procedures will stop and Agency is to then rebalance systems involved, resubmit final report, and again perform spot checks with Contractor and Consultant.

.4 When final report has been accepted, Contractor is to submit to Owner, in name of Owner, a certificate equal to AABC National Guaranty Certification or a NEBB Quality Assurance Program Bond, and in addition, Contractor is to submit a written extended warranty from Agency covering one full heating season and one full cooling season, during which time any balancing problems which occur, with exception of minor revision work done during scheduled site visits, will, at no cost, be investigated by Agency and reported on to Owner, and if it is determined that problems are a result of improper testing, adjusting and balancing, they are to be immediately corrected without additional cost to Owner.

END OF SECTION

1 General

1.1 **APPLICATION**

.1 This Section specifies insulation requirements common to Mechanical Divisions work Sections and it is a supplement to each Section and is to be read accordingly.

1.2 **DEFINITIONS**

.1 "concealed" – means mechanical services and equipment above suspended ceilings, in non-accessible chases, in accessible pipe spaces, and furred-in spaces.

.2 "exposed" – means exposed to normal view during normal conditions and operations.

.3 "mineral fibre" – includes glass fibre, rock wool, and slag wool.

.4 "domestic water" or "potable water" – means piping extended from building Municipal supply main.

1.3 **SUBMITTALS**

.1 Submit a product data sheet for each insulation system product.

1.4 **QUALITY ASSURANCE**

.1 Mechanical insulation is to be applied by a licensed journeyman insulation mechanic, or by an apprentice under direct, daily, on-site supervision of a journeyman mechanic.

.2 Do not apply insulation unless leakage tests have been satisfactorily completed.

.3 Ensure surfaces to be insulated are clean and dry.

.4 Ensure ambient temperature is minimum 13°C (55°F) for at least 1 day prior to application of insulation, and for duration of insulation work, and relative humidity is and will be at a level such that mildew will not form on insulation materials.

.5 Company with sub-contract for mechanical insulation work is to be a member in good standing of Thermal Insulation Association of Canada.

.6 Insulation materials must be stored on site in a proper and dry storage area. Any wet insulation material is to be removed from site.

2 Products

2.1 **FIRE HAZARD RATINGS**

.1 Unless otherwise specified, insulation system materials inside building must have a fire hazard rating of not more than 25 for flame spread and 50 for smoke

developed when tested in accordance with ULC S102, Surface Burning Characteristics of Building Materials and Assemblies.

2.2 THERMAL PERFORMANCE

.1 Unless otherwise specified, thermal performance of insulation is to meet or exceed values given in Tables entitled Minimum Piping Insulation Thickness Heating and Hot Water Systems and Minimum Piping Insulation Thickness Cooling Systems, as stated in ANSI/ASHRAE/IES Standard 90.1 version referenced in Ontario Building Code.

2.3 PIPE INSULATION MATERIALS

.1 Flexible foam elastomeric is to be closed cell, sleeve type, longitudinally split self-seal, foamed plastic pipe insulation with a water vapour transmission rating of 0.10 in accordance with ASTM E96, Procedure B, and required installation accessories. Acceptable products are:
- .1 Armacell AP/Armaflex SS;
- .2 IK Insulation Group K-Flex "LS" Self-Seal Pipe Insulation.

.2 Fire rated pre-moulded mineral wool is to be non-combustible, fire-rated, rigid, sectional, longitudinally split mineral wool or basalt pipe insulation with a reinforced vapour barrier jacket and compatible with ULC S115 and ULC-S101 firestopping. Acceptable products are:
- .1 Roxul "Techton 1200";
- .2 IIG (Johns Manville Inc.) MinWool-1200;
- .3 Paroc 1200.

.3 Pre-moulded mineral fibre is to be rigid, sectional, sleeve type insulation to ASTM C547, with a factory applied vapour barrier jacket. Acceptable products are:
- .1 Johns Manville Inc. "Micro-Lok AP-T Plus";
- .2 Knauf Fiber Glass "Pipe Insulation" with "ASJ-SSL" jacket;
- .3 Manson Insulation Inc. "ALLEY K APT";
- .4 Owens Corning “Fiberglas” Pipe Insulation.

2.4 DUCTWORK SYSTEM INSULATION MATERIALS

.1 Rigid mineral fibre board is to be pre-formed board type insulation to ASTM C612, 48 kg/m3 (3 lb/ft³) density, with a factory applied reinforced aluminum foil and kraft paper facing. Acceptable products are:
- .1 Knauf Fiber Glass Insulation Board with FSK facing;
- .2 Manson Insulation Inc. "AK BOARD FSK";
- .3 Johns Manville Inc. Type 814 "Spin-Glas";
- .4 Owens Corning 703.

.2 Semi-rigid mineral fibre board is to be roll form insulation to ASTM C1393, consisting of cut strips of rigid mineral board insulation glued to an aluminium foil and kraft paper facing. Acceptable products are:
- .1 Multi-Glass Insulation Ltd. "Multi-Flex MKF";
- .2 Glass-Cell Fabricators Ltd. "R-FLEX";
- .3 Owens Corning Pipe and Tank Insulation;
- .4 Johns Manville Inc. Pipe and Tank Insulation.

.3 Blanket mineral fibre is to be blanket type roll form insulation to ASTM C553, 24 kg/m3 (1½ lb/ft3) density, 40 mm (1-½") thick, with a factory applied vapour barrier facing. Acceptable products are:
- .1 Johns Manville Inc. Microlite FSK Duct Wrap Type 150;
- .2 Knauf Fiber Glass Blanket Insulation FSK Duct Wrap Type III;
- .3 Manson Insulation Inc. ALLEY WRAP FSK Duct Wrap Type III;
- .4 Certainteed Corporation Softtouch FSK Duct Wrap Type 150.

2.5 INSULATION FASTENINGS

.1 Wire – minimum #15 gauge galvanized annealed wire.

.2 Wire with Mesh – minimum #15 gauge galvanized annealed wire factory woven into 25 mm (1") hexagonal mesh.

.3 Aluminium Banding – equal to ITW Insulation Systems Canada "FABSTRAPS" minimum 12 mm (½") wide, 0.6 mm (1/16") thick aluminium strapping.

.4 Stainless Steel Banding – equal to ITW Insulation Systems Canada "FABSTAPS" 0.6 mm (1/16") thick, minimum 12 mm (½") wide type 304 stainless steel strapping.

.5 Duct Insulation Fasteners – weld-on 2 mm (3/32") diameter zinc coated steel spindles of suitable length, complete with minimum 40 mm (1-½") square plastic or zinc plated steel self-locking washers.

.6 Tape Sealant – equal to MACtac Canada Ltd. self-adhesive insulation tapes, types PAF, FSK, ASJ, or SWV as required to match surface being sealed.

.7 Mineral Fibre Insulation Adhesive – clear, pressure sensitive, brush consistency adhesive, suitable for a temperature range of -20°C to 82°C (-4°F to 180°F), compatible with type of material to be secured, and WHMIS classified as non-hazardous.

.8 Flexible Elastomeric Insulation Adhesive – Armacell "Armaflex" #520 air-drying contact adhesive.

.9 Closed Cell Foamed Glass Insulation Adhesive – Pittsburgh Corning PC88 multi-purpose 2-component adhesive.

.10 Lagging Adhesive – white, brush consistency, ULC listed and labelled, 25/50 fire/smoke rated lagging adhesive for canvas jacket fabric, suitable for colour tinting, complete with fungicide and washable when dry.

.11 Screws – No. 10 stainless steel sheet metal screws.

2.6 INSULATION JACKETS AND FINISHES

.1 Canvas Jacket Material – ULC listed and labelled, 25/50 fire/smoke rated, roll form, minimum 170 g (6 oz.).

.2 Roll Form Sheet and Fitting Covers – minimum 15 mm (1/2") thick white PVC, 25/50 fire/smoke rated tested in accordance with ULC S102, complete with installation and sealing accessories. Acceptable products are:
- .1 Proto Corp. "LoSMOKE";
- .2 The Sure-Fit System "SMOKE-LESS 25/50";
- .3 Johns Manville Inc. "Zeston" 300.

.3 Rigid Aluminium Jacket – equal to ITW Insulation Systems Canada "Lock-on" 0.406 mm (0.016") thick embossed aluminum jacket material to ASTM B209, factory cut to size and complete with polysurlyn moisture barrier and continuous modified Pittsburgh Z-Lock, butt straps with "Fabstraps" to weatherproof the end to end joints, and 2-piece epoxy coated pressed aluminum fittings with weather locking edges.

.4 Stainless Steel Jacket – equal to ITW Insulation Systems Canada "Lock-on" 0.254 mm (0.010") thick type 304 embossed stainless steel jacket material to ASTM A240, factory cut to size and complete with moisture barrier and continuous modified Pittsburgh Z-Lock, butt straps with "Fabstraps" to cover end to end joints, and 2-piece pressed stainless steel fittings with weather locking edges.

.5 Adhesive backed flexible aluminium is to be MFM Building Products Corp. "Flex-Clad 400" roll form sheet material with an aggressive rubberized asphalt adhesive backing, high density polyethylene reinforcement, and an embossed aluminum facing.

.6 Heat resistant, trowel consistency thermal insulating and finishing cement to CAN/CGSB 51.12, and suitable for the application.

.7 Foamed glass insulation protective coating is to be Pittsburgh Corning "PITTCOTE 404" flexible acrylic latex weather barrier coating, white unless otherwise specified.

.8 Flexible foam elastomeric insulation protective coating equal to Armacell "WB Armaflex" weatherproof, water-based latex enamel finish.

3 Execution

3.1 GENERAL INSULATION APPLICATION REQUIREMENTS

.1 Unless otherwise specified, do not insulate following:
- .1 factory insulated equipment and piping;
- .2 heating piping within radiation unit enclosures, including blank filler sections of enclosures;
- .3 heating piping in soffits and/or overhang spaces and connected to bare element radiation in spaces;
- .4 branch potable water piping located under counters to serve counter mounted plumbing fixtures and fittings, except barrier-free lavatories;
- .5 exposed chrome plated potable water angle supplies from concealed piping to plumbing fixtures and fittings, except barrier-free lavatories;
- .6 heated liquid system pump casings, valves, strainers and similar accessories;
- .7 heating system expansion tanks;

.8 fire protection pump casings;
.9 manufactured expansion joints and flexible connections;
.10 acoustically lined ductwork and/or equipment;
.11 factory insulated flexible branch ductwork;
.12 fire protection system water storage tanks;
.13 piping unions, except for unions in "cold" category piping.

.2 Install insulation directly over pipes and ducts, not over hangers and supports.

.3 Install piping insulation and jacket continuous through pipe openings and sleeves.

.4 Install duct insulation continuous through walls, partitions, and similar surfaces except at fire dampers.

.5 When insulating "cold" piping and equipment, extend insulation up valve bodies and other such projections as far as possible, and protect insulation jacketing from the action of condensation at its junction with metal.

.6 Insulate, vapour seal, and finish seismic restraints, braces, anchors, hanger rods, and similar hardware directly connected to "cold" piping and/or equipment, for a distance of 300 mm (12") clear of adjacent pipe or equipment finish, to match piping and/or equipment insulation.

.7 When insulating vertical piping risers 75 mm (3") diameter and larger, use insulation support rings welded directly above lowest pipe fitting, and thereafter at 4.5 m (14.7') centres and at each valve and flange. Insulate as per Thermal Insulation Association of Canada National Insulation Standards, Figure No. 9.

.8 Where piping and/or equipment is traced with electric heating cable, ensure cable has been tested and accepted prior to application of insulation, and ensure cable is not damaged or displaced during the application of insulation.

.9 Where existing insulation work is damaged as a result of mechanical work, repair damaged insulation work to Project work standards.

.10 Where mineral fibre rigid sleeve type insulation is terminated at valves, equipment, unions, etc., neatly cover exposed end of insulation with a purpose made PVC cover on "cold" piping, and with canvas jacket material on "hot" piping.

.11 Carefully and neatly gouge out insulation for proper fit where there is interference between weld bead, mechanical joints, etc., and insulation. Bevel away from studs and nuts to permit their removal without damage to insulation, and closely and neatly trim around extending parts of pipe saddles.

.12 Where thermometers, gauges, and similar instruments occur in insulated piping, and where access to heat transfer piping balancing valve ports and similar items are required, create a neat, properly sized hole in insulation and provide a suitable grommet in the opening.

3.2 INSULATION FOR HORIZONTAL PIPE AT HANGERS AND SUPPORTS

.1 At each hanger and support location for piping 50 mm (2") diameter and larger and scheduled to be insulated, except where roller hangers and/or supports are required, and unless otherwise specified, supply a factory fabricated section of phenolic foam pipe insulation with integral vapour barrier jacket and captive galvanized steel shield. Supply insulation sections to piping installers for installation as pipe is erected.

.2 For 100 mm (4") diameter and larger heating system piping where roller type hangers and supports are provided, a steel saddle will be tack welded to pipe at each roller hanger or support location. Pack saddle voids with loose mineral wool insulation.

3.3 PIPE INSULATION REQUIREMENTS – MINERAL FIBRE

.1 Insulate following pipe inside building and above ground with mineral fibre insulation of thickness indicated:

- .1 domestic cold water piping, less than 100 mm (4") dia. – 25 mm (1") thick;
- .2 domestic cold water piping, greater than or equal to 100 mm (4") dia. – 40 mm (1-½") thick;
- .3 condensate drainage piping from fan coil unit or any other air conditioning system/unit drain pans to main vertical drain risers or to indirect drainage point – 25 mm (1") thick;
- .4 refrigerant suction piping (between compressor and evaporator coil) inside building – 25 mm (1") thick;
- .5 refrigerant hot gas piping (between compressor and condenser) inside building – 25 mm (1") thick;
- .6 refrigerant hot gas by-pass piping (between compressor discharge and evaporator coil) inside building – 25 mm (1") thick;

.2 Secure overlap flap of the sectional insulation jacket tightly in place. Cover section to section butt joints with tape sealant.

.3 Insulate fittings with sectional pipe insulation mitred to fit tightly, and cover butt joints with tape sealant, or, alternatively, wrap fittings with blanket mineral fibre insulation to a thickness and insulating value equal to the sectional insulation, secure in place with adhesive and/or wire, and cover with PVC fitting covers.

.4 Unless otherwise specified, insulate unions, valves, strainers, and similar piping system accessories in "cold" piping with cut and tightly fitted segments of sectional pipe insulation with joints covered with tape sealant, or, alternatively, wrap piping union, valve, strainer, etc., with blanket mineral fibre and cover with PVC covers as for paragraph above.

.5 Terminate sectional insulation approximately 50 mm (2") from flange or coupling on each side of flange or coupling. Cover flange or coupling with a minimum 50 mm (2") thickness of blanket mineral fibre insulation wide enough to butt tightly to ends of adjacent sectional insulation. Secure blanket insulation in place and cover with a purpose made PVC coupling cover.

.6 Take special care at concealed water rough-in piping at plumbing fixtures to ensure piping is properly insulated. If necessary due to space limitations, use 12 mm (½") thick sectional pipe insulation in lieu of 25 mm (1") thick insulation.

3.4 PIPE INSULATION REQUIREMENTS – FLEXIBLE FOAM ELASTOMERIC

.1 Install flexible elastomeric pipe insulation in strict accordance with manufacturer's published instructions to suit the application, and using adhesive, joint sealants and finish to produce a water-tight installation. Insulate following pipe with flexible elastomeric pipe insulation of thickness indicated:

.1 refrigerant suction and hot gas piping outside building – 25 mm (1") thick.

3.5 PIPE INSULATION REQUIREMENTS – FIRE RATED INSULATION

.1 Where pipe (inside building and above ground) which is to be insulated as specified above penetrates fire rated construction, provide fire-rated, non-combustible sectional insulation on portion of pipe in fire barrier and for a distance of 50 mm (2") on either side of fire barrier. Insulation thickness is to be as specified, but in any case minimum 25 mm (1").

3.6 DUCTWORK INSULATION REQUIREMENTS – MINERAL FIBRE

.1 Insulate following ductwork systems inside building and above ground with mineral fibre insulation of thickness indicated:

.1 outside air intake ductwork, casings and plenums from fresh air intakes to and including mixing plenums or sections, or, if mixing plenums or sections are not provided, to first heating coil, or if both mixing plenums or sections and heating coil sections are not provided, and fresh air is not tempered, then the fresh air ductwork system complete – minimum 40 mm (1-½") thick as required;

.2 exhaust discharge ductwork for a distance of 3 m (10') downstream (back) from exhaust openings to atmosphere, including any exhaust plenums within the 3 m (10') distance – minimum 25 mm (1") thick rigid board or minimum 40 mm (1-½") thick flexible blanket as required;

.3 any other ductwork, casings, plenums or sections specified or detailed on drawings to be insulated – thickness as specified.

.2 Provide rigid board type insulation for casings, plenums, and exposed rectangular ductwork. Provide blanket type insulation for round ductwork and concealed rectangular ductwork.

.3 Liberally apply adhesive to surfaces of exposed rectangular ducts and/or casings. Accurately and neatly press insulation into adhesive with tightly fitted butt joints. Provide pin and washer insulation fasteners at 300 mm (12") centres on bottom and side surfaces. Secure and seal joints with 75 mm (3") wide tape sealant. Additional installation requirements as follows:

.1 at trapeze hanger locations, install insulation between duct and hanger;

.2 provide drywall type metal corner beads on edges of ductwork, casings and plenums in equipment rooms, service corridors, and any other area where insulation is subject to accidental damage, and secure in place with tape sealant.

.4 Liberally apply adhesive to surfaces of concealed rectangular or oval ductwork, and wrap insulation around duct with a top butt joint and tight section to section butt joints. Provide pin and washer insulation fasteners at 300 mm (12") centres on bottom surfaces. Secure and seal joints with 75 mm (3") tape sealant. At each trapeze type duct hanger, provide a 100 mm (4") wide full length piece of rigid mineral fibre board insulation between duct and hanger.

.5 Accurately cut sections of insulation to fit tightly and completely around exposed and concealed round or oval ductwork. Liberally apply adhesive to surfaces of duct, and wrap insulation around duct with a top butt joint and tight section to section butt joints. Seal joints with tape sealant. At duct hanger locations install insulation between duct and hanger. At each hanger location for concealed ductwork where flexible blanket insulation is used, provide a 100 mm (4") wide full circumference strip of semi-rigid board type duct insulation between duct and hanger.

.6 Insulation application requirements common to all types of rigid ductwork are as follows:

- .1 at duct connection flanges, insulate flanges with neatly cut strips of rigid insulation material secured with adhesive to side surfaces of flange with a top strip to cover exposed edges of the side strips, then butt the flat surface duct insulation up tight to flange insulation, or, alternatively, increase insulation thickness to depth of flange and cover top of flanges with tape sealant;
- .2 installation of fastener pins and washers is to be concurrent with duct insulation application;
- .3 cut insulation fastener pins almost flush to washer and cover with neatly cut pieces of tape sealant;
- .4 accurately and neatly cut and fit insulation at duct accessories such as damper operators (with standoff mounting) and pitot tube access covers;
- .5 prior to concealment of insulation by either construction finishes or canvas jacket material, patch vapour barrier damage by means of tape sealant.

3.7 INSULATION FINISH REQUIREMENTS

.1 Unless otherwise shown and/or specified, jacket exposed mineral fibre insulation, and calcium silicate duct insulation work inside building with canvas secured in place with a full covering coat of lagging adhesive. Accurately cut canvas with scissors or a knife. Do not rip or tear canvas to size. Remove lagging adhesive splatter from adjacent uninsulated surfaces.

.2 Jacket exposed pipe insulation work inside building with white sheet PVC and fitting covers. Install sheet PVC and fitting covers tightly in place with overlapped circumferential and longitudinal joints arranged to shed water. Seal joints to produce a neat water-tight installation. Provide slip-type expansion joints where required by manufacturer’s instructions.

.3 Apply 2 heavy coats of "PITTCOTE 404" coating with 24 hr. between coats to foamed glass insulation exposed above grade.

.4 Apply 2 coats (with 24 hr. between coats) of specified coating to flexible elastomeric insulation outside building.

END OF SECTION

1 General

1.1 **SUBMITTALS**

.1 Submit shop drawings/product data sheets for all products specified in Part 2 of this section except pipe and fittings.

.2 Submit a copy of the plumbing inspection certificate prior to application for Substantial Performance of the Work.

.3 Submit laboratory water purity test results indicating chlorine residual prior to application for Substantial Performance of the Work.

2 Products

2.1 **PIPE, FITTINGS AND JOINTS**

.1 PVC Sewer
.1 DR35 rigid, green PVC hub and spigot pattern sewer pipe and fittings to CAN/CSA B182.2, with gasket joints assembled with pipe lubricant.

.2 PVC Water Service
.1 ULC listed, rigid, Class 150, DR18, 1035 kPa (150 psi) pressure rated bell and spigot pattern PVC pipe to CAN/CSA B137.3, and CSA certified fittings to CAN/CSA B137.2, and AWWA C900, complete with gasket joints, and Ford "Uni-Flange" or equal restraint collars in accordance with Part 3 of this section.

.3 Soft Copper Water Service
.1 Type "K" soft copper to ASTM B88, supplied in a continuous coil with no joints if possible, and complete with, if joints are required, compression type flared joint couplings.

.4 Flexible Polyethylene
.1 Flexible polyethylene pipe to CAN/CSA B137.1, 690 kPa (100 psi) rated, complete with insertion type fittings secured with Series 300 stainless steel gear type clamps.

3 Execution

3.1 **EXCAVATION AND BACKFILL**

.1 Refer to requirements specified in Civil Specifications.

.2 Locate general reference points and take necessary precautions to prevent damage or destruction to these points. Be responsible for site services work lines, elevations and measurements.

.3 Ensure locations of existing underground services, mechanical and electrical, are properly and accurately located and marked. Be responsible for any damage to existing services caused as a result of site services work.

.4 Excavate to a minimum of 150 mm (6") below bottom of pipe. Support pipe, unless otherwise specified, on a well compacted bed of dry, natural, undisturbed earth free from rocks or protrusions of any kind, or on compacted sand or granular B material as specified.

.5 Where unstable soil is present at bottom of trench, provide concrete saddles, pies, or other approved and suitable foundations.

3.2 CONCRETE WORK

.1 Provide poured concrete work, including reinforcing and formwork, required for site services work.

.2 Concrete is to be minimum 20 700 kPa (3 000 psi) ready-mix concrete in accordance with CAN/CSA A23.1 and the Building Code.

3.3 DRAINAGE SERVICE PIPING INSTALLATION REQUIREMENTS

.1 Provide required underground drainage service piping as shown on mechanical drawings, piping shall be rigid PVC sewer pipe.

.2 Install and slope underground drainage piping to inverts or slopes indicated on drawings to facilitate straight and true gradients between points shown. Verify available slopes before installing pipes.

.3 At the end of each working day temporarily plug and/or cap open piping ends to prevent entry of debris or dirt.

3.4 WATER SERVICE PIPING INSTALLATION REQUIREMENTS

.1 Provide required underground water service piping to within 1.5 m (5') of building.

.2 Piping, unless otherwise specified, is as follows:
- .1 for service piping greater than or equal to 100 mm (4") dia. - rigid PVC;
- .2 for service piping less than 100 mm (4") dia. - Type "K" soft copper;
- .3 for distribution piping to exterior fixtures/outlets at grade level – flexible polyethylene, snaked in trench and in a continuous length wherever possible.

.3 Brace and secure underground water service pipe at bends, tees and similar fittings with restraint devices, and provide concrete thrust blocks in accordance with Municipal or Provincial standards and details. Regardless of what is specified elsewhere in this Specification regarding provisions of concrete, provide thrust block concrete. Paint restraint devices with 2 coats of corrosion resistant black asphalt base coating and allow time to dry prior to backfilling.

.4 Lay pipes true to line and grade with bells upgrade. Fit sections together so, when complete, pipe has a smooth and uniform invert. Keep pipe thoroughly clean so jointed compound will adhere. Inspect pipe for defects before being lowered into trench.

.5 Slope piping so it can be completely drained.

.6 At the end of each working day, temporarily plug and/or cap all open piping ends to prevent entry of debris or dirt.

3.5 TESTING AND INSPECTION OF SERVICES

.1 Prior to backfilling, test new service piping for leakage and flow in the presence of Consultant and Plumbing Inspector. Give a minimum of 72 hours' notice for scheduled tests.

.2 Drainage Piping Leakage
- .1 Perform infiltration or exfiltration tests on drainage piping as directed by Consultant with leakage not to exceed values issued by Consultant. Where leakage exceeds values issued, refit piping, and re-apply tests until acceptable results are obtained.

.3 Drainage Piping Flow
- .1 When directed by Consultant and/or Plumbing Inspector, perform ball flow tests on all drainage piping.

.4 Drainage Piping Interior Inspection
- .1 Provide video inspection and documentation of drainage service piping after piping has been flushed and leakage tested. Give Consultant a minimum of 72 hours' notice of inspections. Perform video inspections using an experienced specialist company in accordance with following requirements:
  - .1 video equipment specially designed for the purpose and videos are to be high-resolution colour videos recorded on DVD’s with audio documentation;
  - .2 each DVD is to be identified according to a piping segment marked on a site services drawing print by personnel performing the video work;
  - .3 report documenting all conditions discovered during video procedures is to be prepared by specialist company and submitted to Consultant along with original video DVD’s.

.5 Water Mains Leakage
- .1 Leakage test new water mains using clean water at 1400 kPa (200 psi) for a minimum period of 8 hours with no pressure drop.

3.6 FLUSHING AND DISINFECTING WATER SERVICE PIPING

.1 Thoroughly flush domestic water service piping after leakage and flow testing is complete.

.2 Flush piping with clean water at a minimum velocity of 1.2 m/s (240 ft./min.) at 205 kPa (30 psi) minimum pressure until all foreign materials have been removed and flushed water is clear. Provide connections and pumps as required.

.3 When flushing is complete, disinfect piping with a solution of chlorine in accordance with AWWA C601.

.4 When disinfecting is complete, submit water samples to a certified laboratory for purity testing and, when testing indicates pure water in accordance with governing standards, submit a copy of test results and fill systems.

END OF SECTION

1 General

1.1 **SUBMITTALS**

.1 Submit shop drawings/product data sheets for all products specified in Part 2 of this Section except for pipe, fittings, and chlorine. Df

1.2 **CLOSEOUT SUBMITTALS**

.1 Prior Substantial Performance of the Work, submit a minimum of 3 identified keys for key operated hydrants/hose bibs.

.2 Submit signed test results and inspection and test log cards for each backflow preventer as specified in Part 3 of this Section.

1.3 **QUALITY ASSURANCE**

.1 Domestic water piping and valves are to comply with following codes, regulations and standards (as applicable):
- .1 applicable local codes and regulations;
- .2 CAN/CSA B125.1, Plumbing Supply Fittings;
- .3 CAN/CSA B125.3, Plumbing Fittings;
- .4 CAN/CSA B137 Series, Thermoplastic Pressure Piping Compendium;
- .5 NSF/ANSI 14, Plastics Piping System Components and Related Materials;
- .6 NSF/ANSI 61, Drinking Water System Components – Health Effects;
- .7 NSF/ANSI 372, Drinking Water System Components – Lead Content.

2 Products

2.1 **PIPE, FITTINGS, AND JOINTS**

.1 PVC
- .1 ULC listed, rigid, Class 150, DR18, 1035 kPa (150 psi) pressure rated bell and spigot pattern PVC pipe to CAN/CSA B137.3, and CSA certified fittings to CAN/CSA B137.2, and AWWA C900, complete with gasket joints, and Ford "Uni-Flange" or equal restraint collars as per Part 3 of this Section.

.2 Soft Copper
- .1 Type "K" soft copper to ASTM B88, supplied in a continuous coil with no joints if possible, and complete with, if joints are required, compression type flared joint couplings.

.3 Copper - Solder Joint
- .1 Type "L" hard drawn seamless copper to ASTM B88, complete with copper solder type fittings to ASME/ANSI B16.18 and soldered joints using The Canada Metal Co. Ltd. "SILVABRITE 100" or equal lead-free solder for cold water pipe, and 95% tin / 5% Antimony or "SILVABRITE 100" solder for other services.

.4 Semi-Rigid Polyethylene Tubing
- .1 Versa Fittings and Mfg. Inc. 12 mm (½") dia., high density, semi-rigid polyethylene tubing, 1380 kPa (200 psi) rated.

.5 Flexible Polyethylene
.1 Flexible polyethylene pipe to CAN/CSA B137.1, 690 kPa (100 psi) rated, complete with insertion type fittings secured with Series 300 stainless steel gear type clamps.

2.2 SHUT-OFF VALVES

.1 Ball Valves
.1 Class 600, 4140 kPa (600 psi) WOG rated, lead-free, full port ball type valves, each complete with a forged brass body with solder ends, forged brass cap, blowout-proof stem, solid forged brass chrome plated ball, "Teflon" or "PTFE" seat, and a removable lever handle. Valves in insulated piping are to be complete with stem extensions.
.2 Acceptable products are:
.1 Toyo Valve Co. Fig. 5049A-LF;
.2 Milwaukee Valve Co. #UPBA485B;
.3 Kitz Corporation Code 859;
.4 Apollo Valves #77LF-200;
.5 Watts Industries (Canada) Inc. #LFFBVS-3C.

2.3 CHECK VALVES

.1 Horizontal
.1 Lead-free, Class 125, bronze, 1380 kPa (200 psi) WOG rated horizontal swing type check valves with solder ends.
.2 Acceptable products are:
.1 Toyo Valve Co. Fig. 237A-LF;
.2 Milwaukee Valve Co. #UP1509;
.3 Kitz Corporation Code 823;
.4 Apollo Valves #61LF Series.

.2 Vertical
.1 Equal to Kitz Corp. Code 826, lead-free, 1725 kPa (250 psi) WOG rated vertical lift check valve with soldering ends.

2.4 DRAIN VALVES

.1 Minimum 2070 kPa (300 psi) water rated, 20 mm (¾") dia., straight pattern full port bronze ball valves, each complete with a threaded outlet suitable for coupling connection of 20 mm (¾") dia. garden hose, and a cap and chain.

.2 Acceptable products are:
.1 Toyo Valve Co. Fig. 5046;
.2 Dahl Brothers Canada Ltd. Fig. No. 50. 430;
.3 Kitz Corporation Code 58CC;
.4 Apollo Valves #78-104-01;
.5 Watts Industries (Canada) Inc. #B6000.

2.5 NON-FREEZE WALL HYDRANTS

.1 Flush-Concealed

.1 Recessed, encased, self-draining hydrants, each complete with a copper casing, operating rod assembly to suit wall thickness, polished nickel bronze box with hinged locking cover, 20 mm (¾") dia. threaded hose connection outlet, vacuum breaker, and a loose tee handle operating key.
.2 Acceptable products are:
.1 Watts Industries (Canada) Inc. #HY-725.
.2 Jay R. Smith #5519-98;
.3 Zurn #Z1320;
.4 Mifab #MHY-26;

2.6 FLOOR DRAIN TRAP SEAL PRIMERS

.1 Primer Valve Type with Manifold
.1 Precision Plumbing Products Inc. Model P1-500 trap primer valve constructed as specified above for the Model P2-500 primer valve, complete with a Model DU-3 or DU-4, 3 or 4 outlet distribution unit for priming 3 or 4 traps, and at Model "YS-8" supply tube with combinations of Model DU-3 and DU-4 distribution units for priming from 5 to 6 traps.

2.7 SHOCK ABSORBERS

.1 Type 304 stainless steel piping shock absorbers, each complete with a nesting type bellows and a casing of sufficient displacement volume to dissipate kinetic energy generated in piping system, and each sized to suit connecting potable water pipe and equipment it is provided for.

.2 Acceptable products are:
.1 Watts Industries (Canada) Inc. "SG" Series.
.2 Jay R. Smith 5000 Series "HYDROTROL";
.3 Zurn #Z1700 "SHOKTROL";
.4 Mifab "HAMMERGUARD" WHB Series;

2.8 BACKFLOW PREVENTERS

.1 Double Check Valve Assembly
.1 Minimum 1205 kPa (175 psi) rated lead-free dual check valve assembly backflow preventer to CAN/CSA B64 (including supplements), complete with tight-closing resilient seated shut-off valves, test cocks and strainer.
.2 Acceptable manufacturers are:
.1 Watts Industries Canada;
.2 Zurn/Wilkins;
.3 Apollo Valves (Conbraco Industries).

.2 Reduced Pressure Zone Assembly
.1 Lead-free reduced pressure zone assembly backflow preventer in accordance with CAN/CSA B64 (including supplements), each of bronze or epoxy coated cast iron bronze fitted construction depending on size, and complete with inlet strainer, inlet and outlet shut-off valves, an intermediate relief valve, ball valve type test cocks, and a proper air gap fitting.
.2 Acceptable products are:

.1 Watts Industries #LF009QT-S for 12 mm (½") size, #LF909QT-S for 20 mm to 50 mm (¾" to 2") size, and #LF909-NRS-S for 65 mm (2-½") and larger size;
.2 Zurn/Wilkins 975XL2 and 375 Series;
.3 "Apollo" Valves manufactured by Conbraco Industries Inc. Series 4ALF;
.4 Danfoss Flomatic Corp. Series RPZ.

3 Execution

3.1 PIPING INSTALLATION REQUIREMENTS

.1 Provide required domestic water piping.

.2 Piping, unless otherwise specified, is as follows:
.1 for underground piping 100 mm (4") dia. and larger outside and/or inside the building – rigid PVC;
.2 for underground piping less than 100 mm (4") dia. inside building – Type "K" soft copper;
.3 for pipe 100 mm (4") dia. and larger inside building and above ground – Schedule 10 stainless steel;
.4 for 12 mm (½") dia. trap seal primer tubing located underground or in concrete or masonry construction – semi-rigid polyethylene;
.5 for pipe inside building and aboveground in sizes to 100 mm (4") dia., except in vertical shafts and through fire barriers – rigid CPVC;
.6 for branch hot and cold piping aboveground from mains and risers to fixtures, fittings, and equipment where fire rated construction is not penetrated – at your option, PEX tubing installed and joined in strict accordance with manufacturer's instructions;
.7 for underground piping outside building to fixtures/outlets at grade level – flexible polyethylene, snaked in the trench and in a continuous length wherever possible;
.8 for pipe inside building and aboveground in sizes to 100 mm (4") dia. – Type "L" hard copper with solder joints.
.1 Option: Type "L" hard copper with pressure coupled mechanical joints.
.2 Option: Type "L" hard copper with grooved end mechanical joints.
.1 Grooved pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing. All couplings will meet Victaulic standards for visual inspection sizes 2" to 8". The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Install in accordance with manufacturer's latest recommendations. A Victaulic factory trained representative shall periodically visit the job site and review the installation for best practices. The installing Contractor shall correct any identified deficiencies. Victaulic product that has been examined and has not met the visual inspection criteria for proper installation must be corrected and re-examined by Victaulic prior to the completion of the project.

.3 Brace and secure underground water service pipe at bends, tees and similar fittings with restraint devices, and provide concrete thrust blocks in accordance

with Municipal standards and details. Regardless of what is specified elsewhere in this Specification regarding provisions of concrete, provide thrust block concrete. Paint restraint devices with 2 coats of corrosion resistant black asphalt base coating prior to backfilling.

.4 Lay pipes true to line and grade with bells upgrade. Fit sections together so that, when complete, pipe has a smooth and uniform invert. Keep pipe thoroughly clean so jointed compound will adhere. Inspect pipe for defects before being lowered into trench.

.5 Slope piping so it can be completely drained.

.6 Provide cast brass dielectric type adapters/unions at connections between ferrous and copper pipe or equipment.

3.2 INSTALLATION OF SHUT-OFF AND CHECK VALVES

.1 Refer to Part 3 of Section 20 05 00 – Common Work Results for Mechanical.

.2 For shut off valves installed on solder joint copper piping up to and including 75 mm (3") diameter, provide ball type valves, and for flanged joints copper or stainless steel piping larger than 75 mm (3") diameter provide butterfly type valves.

3.3 INSTALLATION OF DRAIN VALVES

.1 Provide a drain valve at the bottom of domestic water piping risers, at other piping low points, and wherever else shown.

.2 Locate drain valves so they are easily accessible.

.3 Locate each valve so it is easily accessible.

3.4 INSTALLATION OF PRESSURE REDUCING VALVES

.1 Provide domestic water pressure reducing valves. Install so each valve is readily accessible. Whenever possible, provide pressure reducing valves factory pre-set to required pressures.

.2 Check and test operation, and adjust as required.

3.5 INSTALLATION OF EXTERIOR NON-FREEZE WALL HYDRANTS

.1 Provide non-freeze wall hydrants.

.2 Install hydrants level and plumb such that hose outlets are approximately 600 mm (2') above grade level. Confirm exact locations prior to roughing-in.

.3 Provide a shut-off valve inside building to each exterior non-freeze wall hydrant.

3.6 INSTALLATION OF EXTERIOR NON-FREEZE GROUND HYDRANTS

.1 Provide non-freeze ground hydrants. Confirm exact locations prior to roughing-in.

.2 Ensure length of piping to outlet box suits depth of underground piping, and underground piping elbow and valve housing is set in an envelope of clean sharp, 100% Proctor density compacted sand. Provide a length of small bore copper tubing from valve drain port into sand envelope.

.3 Provide a shut-off valve inside building to each ground hydrant.

3.7 INSTALLATION OF TRAP SEAL PRIMERS

.1 Provide trap primer valves to prime single or multiple (1 to 6) traps. Install trap primer valves in domestic cold water piping to frequently used plumbing fixtures. Where from 2 to 6 traps are to be primed from same primer valve, provide appropriate supply and distribution tube assemblies. Ensure primer valves are accessible.

3.8 INSTALLATION OF SHOCK ABSORBERS

.1 Provide accessible shock absorbers in domestic water piping.

.2 Ensure size of each shock absorber is properly selected to suit size of domestic water pipe and equipment pipe is connected to.

3.9 INSTALLATION OF BACKFLOW PREVENTERS

.1 Provide a double check valve assembly backflow preventer on incoming DCW service. Provide a reduced pressure zone assembly backflow preventer in each direct domestic water connection to equipment other than plumbing fixtures and fittings.

.2 Locate each backflow preventer on floor or wall between 765 mm and maximum 1.5 m (30" and 60") above floor such that it is easily accessible for maintenance and testing. Equip each backflow preventer with an air gap fitting and pipe the reduced pressure zone water outlet to drain.

.3 Test operation of each backflow preventer in accordance with requirements of CAN/CSA B64 by personnel certified for such testing by governing authorities, and submit signed test results and a properly and clearly identified and marked inspection and test record card for each backflow preventer.

3.10 INSTALLATION OF EXPANSION COMPENSATORS, GUIDES AND ANCHORS

.1 Provide expansion compensators in domestic water piping.

.2 Ensure pipe ends are properly aligned. Provide alignment guides on each side of expansion compensators, properly secured to building structure.

.3 Provide anchors to secure domestic water piping to structure. Locate anchors generally where shown but with exact locations to suit piping as installed and requirements of reviewed anchor shop drawings.

.4 When installation of anchors is complete, arrange, and pay for anchor design engineer to visit site to review anchor installation. Submit a letter from design engineer confirming each anchor is properly installed.

3.11 FLUSHING AND DISINFECTING PIPING

.1 Flush and disinfect all new and/or reworked domestic water piping after leakage testing is complete.

.2 Flush piping until all foreign materials have been removed and flushed water is clear. Provide connections and pumps as required. Open and close valves, faucets, hose outlets, and service connections to ensure thorough flushing.

.3 When flushing is complete, disinfect the piping with a solution of chlorine in accordance with AWWA C601.

.4 When disinfecting is complete, submit water samples to a certified laboratory for purity testing and, when testing indicates pure water in accordance with governing standards, submit a copy of test results and fill the systems.

END OF SECTION

1 General

1.1 **SUBMITTALS**

.1 Submit shop drawings/product data sheets for all products specified in this Section except pipe and fittings.

1.2 **CLOSEOUT SUBMITTALS**

.1 Submit a copy of plumbing inspection certificate prior to application for Substantial Performance of the Work.

.2 Submit letters from product manufacturers/suppliers to certify correct installation of products as specified in Part 3 of this section.

2 Products

2.1 **PIPE, FITTINGS, AND JOINTS**

.1 PVC Sewer
- .1 DR35 rigid, green PVC hub and spigot pattern sewer pipe and fittings to CAN/CSA B182.2, with gasket joints assembled with pipe lubricant.
- .2 DR35 rigid, PVC sewer pipe and fittings, with solvent weld joints, all certified to CSA B182.1 and colour-coded as per local governing codes, regulations and standards.

.2 PVC - DWV
- .1 Equal to Ipex System XFR 15-50 rigid PVC drain, waste and vent pipe and fittings to CAN/CSA B181.2, complete with a flame spread rating less than 25 and a smoke developed rating less than 50 when tested to CAN/ULC S102.2, solvent weld joints, and, for fire barrier penetration, approved firestop conforming to CAN/ULC S115.

.3 Copper - Solder Joint
- .1 Type DWV hard temper to ASTM B306, with forged copper solder type drainage fittings and 50% lead - 50% tin solder joints.

.4 Cast Iron
- .1 Class 4000 cast iron pipe, fittings, and mechanical coupling joints to CAN/CSA B70.

.5 Copper-Victaulic Coupling Joint
- .1 Type DWV hard temper to ASTM B306, with factory or site rolled grooved ends (with grooving rolls designed for copper) and Victaulic "Copper Connection" wrought copper or cast bronze fittings and Style 606 gasket type couplings.

.6 Galvanized Steel - Victaulic Coupling Joint
- .1 Schedule 40 mild steel, galvanized, ASTM A53, factory or site rolled grooved, complete with Victaulic galvanized ductile iron grooved end fittings and, unless otherwise specified, Victaulic Style 77 hot dip galvanized mechanical joint couplings with Grade M gaskets.

2.2 SHUT-OFF AND CHECK VALVES

.1 Shut-off Valves
- .1 Class 600, 4140 kPa (600 psi) WOG rated full port ball valves, each complete with a forged brass body, blowout-proof stem, chrome plated solid brass ball, solder or screwed ends as required, and removable lever handle.
- .2 Acceptable products are:
  - .1 Toyo Valve Co. Fig. 5049A or Fig. 5044A;
  - .2 Milwaukee Valve Co. #BA-155 or #BA -125;
  - .3 Kitz Corporation Code 58 or Code 59;
  - .4 Victaulic Co. of Canada Ltd. Series 722;
  - .5 Apollo Valves # 77-100 or # 77-200;
  - .6 Watts Industries (Canada) Inc. #FBVS-3C.

.2 Check Valves
- .1 Class 125, bronze, 1725 kPa (250 psi) WOG rated vertical lift check valve with solder or screwed ends as required, and, for horizontal piping, Class 125, bronze 1380 kPa (200 psi) WOG rated swing check valves with solder or screwed ends.
- .2 Acceptable products are:
  - .1 Toyo Valve Co. Fig. 231 or Fig. 236 or Fig. 237;
  - .2 Milwaukee Valve Co. #1510 or #510;
  - .3 Kitz Corporation Code 36 or Code 22 or Code 23.

2.3 VENT STACK COVERS

.1 Equal to Lexcor Model "Flash-Tite" seamless, spun aluminum, insulated vent stack covers with caps and a factory applied asphalt primer coating on top and bottom of flange.

.2 Each vent stack cover is to be complete with a vandal-proof cap.

2.4 CLEANOUTS

.1 Horizontal Piping
- .1 TY pipe fitting with an extra heavy brass plug screwed into the fitting.

.2 Vertical Piping
- .1 Bronze or copper cleanout tees in copper piping, each complete with a bronze ferrule, and, for cast iron piping, "BARRETT" type cast iron cleanout tees, each gas and water-tight and complete with a bolted cover.

2.5 FLOOR CLEANOUT TERMINATIONS

.1 Factory finished cast iron terminations, each adjustable and complete with a cast iron body with neoprene sleeve, solid, gasketed, polished nickel-bronze scoriated top access cover to suit floor finish, a seal plug, and captive, vandal-proof, stainless steel securing hardware.

.2 Acceptable products are:
- .1 Watts Industries (Canada) Ltd. # CO-200-R-1.
- .2 Jay R. Smith #4020-F-C Series;

.3 Zurn # ZN-1602-SP Series;
.4 Mifab # C1100-XR-1 or #C1000-R-3;

.3 Cleanout terminations in areas with a tile or sheet vinyl floor finish are to be as above but with a square top in lieu of a round top.

2.6 **FLOOR DRAINS, FUNNEL FLOOR DRAINS, AND HUB DRAINS**

.1 Unless otherwise specified or indicated, floor drains are to be vandal-proof drains in accordance with drawing symbol list, each complete with a cast iron body and a trap seal primer connection. Cast iron components are to be factory finished with latex based paint coating.

.2 Floor drains in areas with a tile or sheet vinyl floor finish are to be as above but with a square grate in lieu of a round grate.

.3 Acceptable manufacturers are:
.1 Watts Industries (Canada) Ltd.;
.2 Jay R. Smith Manufacturing Co.;
.3 Zurn Industries Ltd.;
.4 Mifab Inc.

2.7 **INTERIOR CATCH BASIN FRAMES AND COVERS**

.1 Heavy-duty, 508 mm (13") square, baked epoxy coated cast iron, non-removable, hinged slotted grate with coated steel frame with concrete anchors.

.2 Acceptable products are:
.1 Watts Industries (Canada) Ltd. #FD-410;
.2 Jay R. Smith #8915FC;
.3 Zurn #Z-799-1;
.4 Mifab #F1570.

2.8 **BACKWATER VALVES**

.1 Heat bonded powder epoxy coated cast iron in-line type, each complete with a bolted and gasketed cover, bronze flapper, stainless steel extension, and stainless steel hardware.

.2 Acceptable products are:
.1 Watts Industries (Canada) Inc. BV-230-R Series;
.2 Jay R. Smith #7022-CAN.
.3 Zurn #Z-1095-15-MJ;

3 Execution

3.1 **DEMOLITION**

.1 Refer to demolition requirements specified in Section 20 05 05 – Selective Demolition for Mechanical.

3.2 UNDERGROUND MUNICIPAL SERVICE CONNECTION

.1 Make required arrangements with Municipality for installation of drain service piping mains from Municipal main to property line.

.2 Pay charges levied by Municipality for service connection work.

.3 Municipal charges for underground street service connection work will be paid out of a prime cost allowance. Submit original copies of invoices issued by Municipality for street service connection work.

3.3 DRAIN AND VENT PIPING INSTALLATION REQUIREMENTS

.1 Provide required drainage and vent piping. Pipe, unless otherwise specified, as follows:

- .1 for underground pipe inside building and to points 1.5 m (5') outside building lines – rigid PVC sewer pipe, minimum 75 mm (3") dia.;
- .2 for pipe inside building and aboveground in sizes less than or equal to 65 mm (2-½") dia. – type DWV copper;
- .3 for pipe inside building and aboveground in sizes greater than or equal to 75 mm (3") dia. – Class 4000 cast iron;
- .4 for pipe inside building and aboveground in lieu of type DWV copper and cast iron, at your option and where permitted by governing Codes and Regulations – rigid PVC DWV;
- .5 for drainage pump discharge pipe connections from pump to and including shut-off and check valve connections – Type "DWV" copper with Victaulic "Copper Connection" fittings and couplings, or Schedule 40 galvanized steel with Victaulic fittings and couplings.

.2 Unless otherwise specified, slope horizontal drainage piping aboveground in sizes to and including 75 mm (3") dia. 25 mm (1") in 1.2 m (4'), and pipe 100 mm (4") dia. and larger 25 mm (1") in 2.4 m (8').

.3 Install and slope underground drainage piping to inverts or slopes indicated on drawings to facilitate straight and true gradients between points shown. Verify available slopes before installing pipes.

.4 Unless otherwise specified, slope horizontal branches of vent piping down to fixture or pipe to which they connect with a minimum pitch of 25 mm (1") in 1.2 m (4').

.5 Extend vent stacks up through roof generally where shown but with exact locations to suit site conditions and in any case a minimum of 3 m (10') from fresh air intakes. Terminate vent stacks a minimum of 330 mm (13") above roof (including roof parapets) in vent stack covers. Where not shown on drawings, route vent piping from source to building exterior as required in order to satisfy local governing codes and authority. Coordinate vent routing with other building services and ensure there is no architectural impact.

.6 Provide cast brass dielectric unions at connections between copper pipe and ferrous pipe or equipment.

3.4 INSTALLATION OF SHUT-OFF AND CHECK VALVES

.1 Provide a shut-off valve and a check valve in discharge piping of each drainage pump.

.2 Locate valves so they are easily accessible without the use of ladders or other such devices.

3.5 SUPPLY OF VENT STACK COVERS

.1 Supply a properly sized vent stack cover for each vent stack penetrating roof.

.2 Hand vent stack covers to roofing trade at site for installation and flashing into roof construction as part of roofing work. Coordinate installation to ensure proper locations. Provide waterproofing caps over vent stacks.

3.6 INSTALLATION OF CLEANOUTS

.1 Provide cleanouts in drainage piping in locations as follows:
- .1 in building drain or drains as close as possible to inner face of outside wall, and, if a building trap is installed, locate cleanout on downstream side of building trap;
- .2 at or as close as practicable to the foot of each drainage stack;
- .3 at maximum 15 m (50') intervals in horizontal pipe 100 mm (4") dia. and smaller;
- .4 at maximum 30 m (100') intervals in horizontal pipe larger than 100 mm (4") dia.;
- .5 in the wall at each new urinal or bank of urinals in a washroom;
- .6 wherever else shown on drawings.

.2 Cleanouts are to be same diameter as pipe in piping to 100 mm (4") dia., and not less than 100 mm (4") dia. in piping larger than 100 mm (4") dia.

.3 Where cleanouts in vertical piping are concealed behind walls or partitions, install cleanouts near floor and so cover is within 25 mm (1") of the finished face of the wall or partition.

3.7 INSTALLATION OF FLOOR CLEANOUT TERMINATIONS

.1 Where cleanouts occur in horizontal inaccessible underground piping, extend cleanout TY fitting up to floor, and provide a cleanout termination set flush with finished floor.

.2 In waterproof floors, ensure each cleanout termination is equipped with a flashing clamp device. Cleanout terminations are to suit floor finish.

.3 Where cleanout terminations occur in finished areas, confirm locations prior to rough-in and arrange piping to suit.

.4 Ensure cleanout termination covers in tiled floor are square in lieu of round.

3.8 INSTALLATION OF FLOOR DRAINS, FUNNEL FLOOR DRAINS AND HUB DRAINS

.1 Provide floor drains, funnel floor drains and hub drains.

.2 Coordinate location of floor drains, funnel floor drains and hub drains with equipment provided by Mechanical Division and Owner's supplied equipment. Install in accordance with manufacturer's instructions.

.3 Equip each drain with a trap.

.4 In equipment rooms and similar areas, exactly locate floor drains to suit location of mechanical equipment and equipment indirect drainage piping. In washrooms, exactly locate floor drains to avoid interference with toilet partitions.

.5 Confirm exact location of drains prior to roughing in. Where floor drains occur in washrooms coordinate locations with toilet partition installations.

.6 Temporarily plug and cover floor drains during construction procedures. Remove plugs and covers during final clean-up work and when requested, demonstrate free and clear operation of each drain. Replace any damaged grates, and refinish any areas of the drain where cast iron finish has been damaged or removed, including rusted areas.

3.9 INSTALLATION OF INTERIOR CATCH BASIN FRAMES AND COVERS

.1 Supply frames and hinged grates for interior catch basins and provide sump inlet and outlet piping and accessories.

.2 Hand frames to concrete trade pouring concrete sump, and coordinate installation of sump piping with the formwork installation.

.3 Install grates and secure in place. Clean sumps when work is complete.

3.10 INSTALLATION OF BACKWATER VALVES

.1 Provide backwater valves in drainage piping and connect with piping.

.2 Set backwater valve assembly such that cover is flush with finished floor. Provide an extension piece if required due to depth of piping.

END OF SECTION

1 General

1.1 **SUBMITTALS**

.1 Submit shop drawings/product data sheets for all equipment and associated hardware specified in this Section.

.2 Submit manufacturer/supplier installation certification letters as specified in Part 3 of this Section.

.3 After installation is complete, submit a written report verifying that the installation provides softening based on influent water analysis, signed by manufacturer's technical representative.

.4 Submit sufficient granular salt for 12 complete regenerations

.5 Submit, prior to Substantial Performance of the Work, start-up or test data specified in Part 3 of this Section.

2 Products

2.1 **SUBMERSIBLE SUMP PUMP**

.1 Major pump components shall be of gray cast iron, EN-GJL-250 (ASTM A-48, Class 35B) with smooth surfaces devoid of porosity or other irregularities.

.2 All exposed fasteners shall be stainless steel, 1.4401 (AISI type 316) construction.

.3 All metal surfaces coming into contact with the pumped media (other than the stainless steel components) shall be protected by a factory applied spray coating of zinc phosphate primer followed by a high solids two part epoxy paint finish on the exterior of the pump. The pump shall be equipped with an open lifting hoop suitable for attachment of standard chain fittings, or for hooking from the wet well surface.

.4 The hoop shall be stainless steel, 1.4401 (AISI 316), and shall be rated to lift a minimum of four times the pump weight.

.5 Sealing design for the pump/motor assembly shall incorporate machined surfaces fitted with Nitrile (Buna-N) rubber O-rings.

.6 Sealing will be the result of controlled compression of rubber O-rings in two planes of the sealing interface.

.7 Housing interfaces shall meet with metal to metal contact between machined surfaces, and sealing shall be accomplished without requiring a specific torque on the securing fasteners. Rectangular cross sectioned gaskets requiring specific torque limits to achieve compression shall not be considered equal. No secondary sealing compounds shall be required or used.

.8 The grinder mechanism shall consist of two circular, hardened cutter elements, one rotating and one stationary. The cutter material shall be similar to an AISI

440C stainless steel with the addition of cobalt, vanadium, and molybdenum for superior abrasion resistance and a hardness of Rockwell C 58-62.

.9 All wastewater being pumped by the impeller shall be drawn through the grinder mechanism by the natural suction of the pump impeller and reduced to a particle size approximately 1/8 inch. The grinder mechanism shall not require routine adjustments throughout the life of the grinder assembly.

.10 The impeller shall be a semi open multi vane design with a solids passage size sufficient to prevent clogging on the wastewater material that has passed through the integrated grinder assembly. The impeller material shall be gray cast iron, EN-GJL-250 (ASTM A-48, Class 35B). The impeller shall be dynamically balanced to the ISO 10816 standard to provide smooth vibration free operation.

.11 The ABS style wear plate shall be constructed from gray cast iron, EN-GJL-250 (ASTM A-48, Class 35B). The wear plate shall be designed to hold and secure the stationary cutter firmly in place, concentric to the rotating cutter. The wear plate shall be mounted to the volute with stainless steel securing screws and stainless-steel adjusting screws to permit adjustment between the wear plate and impeller for maximum pump efficiency. Adjustment to allow for wear and to restore peak pumping performance shall be easily accomplished in the field utilizing standard tools, and without requiring disassembly of the pump. The use of fixed or non-adjustable wear plates or rings, or systems that require disassembly of the pump or shimming of the impeller to facilitate adjustment shall not be considered equal.

.12 The pump volute shall be single piece gray cast iron, EN-GJL-250 (ASTM A-48, Class 35B) non-concentric design with centerline discharge. Passages shall be smooth and large enough to pass any solids which may enter the impeller. The discharge flange design shall permit attachment to the ABS guide rail system, and shall also accept a 1 1/4" NPT male fitting when the pump is supplied with an available NPT adapter kit. The minimum working pressure of the volute and pump assembly shall be 10 bar (145 psi).

.13 The pump shaft and motor shaft shall be an integral, one piece unit adequately designed to meet the maximum torque required at any normal start-up condition or operating point in the system. The shaft shall have a full shutoff head design safety factor of 1.7, and the maximum shaft deflection shall not exceed .05 mm (.002 inch) at the lower seal during normal pump operation. Each shaft shall be stainless steel 1.4021 (AISI 420) material, and shall have a polished finish with accurately machined shoulders to accommodate bearings, seals and impeller. Carbon steel, chrome plated, or multi piece welded shafts shall not be considered adequate or equal.

.14 The power cables shall be sized according to NEC and CSA standards and shall be of sufficient length to reach the junction box without requiring splices. The outer jacket of the cable shall be oil and water resistant, and shall be capable of continuous submerged operation underwater to a depth of 65 feet.

.15 Guide Rail Base Assembly shall be included in the pump package. There shall be no need for personnel to enter the wet well to remove or reinstall the pump(s). In a wet pit installation, the discharge base & elbow assembly shall be permanently

installed in the wet well and connected to the discharge piping. In order to prevent binding or separation of the pump from the guide rail system, the pump(s) shall connect to the guide rail base automatically and firmly, guided by one 1 ¼ inch guide pipe extending from the base elbow to the top of the station. Systems using guide cable in lieu of rigid guide bars or pipes shall not be considered acceptable.

.16 The sliding guide bracket shall be a separate part of the pumping unit.

.17 Submersible sump pump as per drawing schedule, complete with:
- .1 Pump to be continuously running;
- .2 oil-filled, overload protected, submersible, ball bearing type, 3-phase motor with a minimum of 3 m (20') of PVC jacketed power cord pre-wired to motor;
- .3 open, 2-vane type, non-clog cast iron impeller secured to a stainless steel pump and motor shaft;
- .4 4 switches, each sealed in a polyurethane float and complete with a minimum of 3 m (20') of power cord, 2 float switches for make up water "ON-OFF" control, other float switches for high and low water level alarm;
- .5 Low level alarm to trigger pump to turn OFF;
- .6 bracket to support float switch cables in sump pit;
- .7 simplex factory pre-wired and tested power and control panel complete with a NEMA 4 enclosure with hinged and gasketed padlockable door, galvanized steel back panel with power and control wiring terminal blocks, bundled and identified wiring, and following:
  - .1 circuit breaker, a H-O-A switch, an overload protected magnetic motor starter with test and reset pushbuttons, and an identified "RUN" pilot light;
  - .2 fused control transformer;
  - .3 solid state pump controller with LED indicator lights;
  - .4 high level alarm horn with push to silence switch and automatic reset flashing red light;
  - .5 dry contacts for high water level alarm condition connection to a building automation system.

.18 Power cord and control and high water level float switch cords are to be of sufficient length to extend unbroken from sump pit through conduit to wall on which power and control panel is to be mounted.

.19 Acceptable manufacturers are:
- .1 Sulzer Pumps;
- .2 Hydromatic Pumps;
- .3 Liberty Pumps;
- .4 F.E. Myers (Canada) Ltd.;
- .5 ITT Flygt Canada;
- .6 Barnes Pumps (GSW Pump Company).

3 Execution

3.1 DRAINAGE COORDINATION

.1 Coordinate drain requirements of plumbing equipment provided by Mechanical Division and or Owner with location of drains specified in Section 22 13 00.

3.2 INSTALLATION OF SUBMERSIBLE DRAINAGE PUMP(S)

.1 Provide submersible drainage pump(s) in sump. Refer to drawing detail.

.2 Provide required sump piping, including a shut-off valve and a check valve for each pump. Ensure valves are readily accessible from floor level and piping is easily removable for removal of pump(s) from sump.

.3 Install pump removal guide rail system with accessories in accordance with manufacturer's instructions.

.4 Install float switch(es) at proper height in sump and secure cable to a sump wall mounted bracket such that cables cannot twist around each other.

.5 Leave pump power and control cables outside sump, neatly coiled, taped and identified for extension and connection to starting and control equipment.

.6 Hand pump starter and control panel(s) and high water level alarm panel(s) to electrical trade at site for installation.

.7 Provide sump and pump accessories.

.8 Clean sump(s) prior to Substantial Performance of the Work.

.9 Refer to Section 20 05 00 – Common Work Results for Mechanical for equipment/system start-up requirements.

.10 Refer to Section 20 05 00 – Common Work Results for Mechanical for equipment/system manufacturer certification requirements. Submit a copy of the letter prior to Substantial Performance of the Work.

.11 Include for 4 hours of on-site training for 2 groups of 6 people. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.

END OF SECTION

1 General

1.1 **SUBMITTALS**

.1 Submit product data sheets (fixture cuts) for all plumbing fixtures and fittings.

.2 Submit fixture manufacturer's standard colour charts for all fixtures where colours are available but a particular colour is not specified.

2 Products

2.1 **GENERAL RE: PLUMBING FIXTURES AND FITTINGS**

.1 Fixtures and fittings, where applicable, are to be in accordance with requirements of CAN/CSA B45 Series, General Requirements for Plumbing Fixtures, including supplements, ASME A112.1.18.1/CSA B125.1, Plumbing Supply Fittings, and CSA B125.3, Plumbing Fittings.

.2 Unless otherwise specified, fittings and piping exposed to view are to be chrome plated and polished.

.3 Fittings located in areas other than private washrooms are to be vandal-proof.

.4 Exposed traps for fixtures not equipped with integral traps, such as lavatories, are to be adjustable chrome plated cast brass "P" traps with cleanouts, minimum #17 gauge chrome plated tubular extensions, and chrome plated escutcheons, all to suit fixture type and drain connection.

.5 Concealed traps for fixtures not equipped with integral traps, such as counter sinks, are to be adjustable cast brass with cleanout plugs, all to suit fixture type and drain connection.

.6 Exposed supplies for fixtures which do not have supply trim/fittings with integral stops, i.e. lavatories, are to be solid chrome plated brass angle vales with screwdriver stops for public areas, wheel handle stops for private areas, flexible stainless steel risers, and stainless steel or chrome plated steel escutcheons, all arranged and sized to suit fixture.

.7 Water piping as specified, complete with ball type shut-off valves as specified with water piping, or Dahl Bros. Canada Ltd. ¼ turn Mini Ball Valves.

2.2 **PLUMBING FIXTURES AND FITTINGS**

2.3 **ACCEPTABLE MANUFACTURERS**

.1 Non-Freeze Hose Bib: Equal to Jay R. Smith 5519 hydrant. Bronze quarter turn non-freeze automatic draining hydrant with stainless steel face, hose connection, integral vacuum breaker and dual check valve, "T" handle key, wheel handle and stainless steel box with full 180° cover opening.

.2 Floor Drain: Watts #FD-436-4-6 Floor Drain - epoxy coated fabricated steel catch basin, membrane flashing flange with clamping cast iron frame, 12-3/4" x 12-3/4"

(324 mm x 324 mm), hinged, square grate, vandal proof, integral trap with cleanout plug, 6"Ø (152 mm) no hub side outlet Watts -4 12-3/4" x 12-3/4" (324 mm x 324 mm) epoxy coated ductile iron, hinged, square grate.

.3 Subject to compliance with requirements, manufacturers that may be incorporated into the Work include, but are not limited to, following:

.1 Plumbing Brass:

.1 Sloan;
.2 Acorn Engineering;
.3 American Standard;
.4 Delta Commercial;
.5 Chicago Faucet;
.6 Moen Commercial.

.2 Floor Drains:

.1 Watts;
.2 Zurn.

.3 Drain Fittings, Angle Supplies, and Traps:

.1 McGuire;
.2 American Standard;
.3 Delta Commercial;
.4 Zurn Industries.

.4 Hose Bibbs:

.1 Murdok Hydrants;
.2 Jay R. Smith;
.3 Zurn Industries.

2.4 CAULKING

.1 General Electric Series SCS-1200 Silicone Construction Sealant or Dow Corning 780 silicone rubber sealant with primers as recommended by sealant manufacturer. Caulking colour(s) for coloured fixtures other than white, if any, will be selected by Consultant from sealant manufacturer's standard colour range.

3 Execution

3.1 INSTALLATION OF PLUMBING FIXTURES AND FITTINGS

.1 Provide required plumbing fixtures and fittings.

.2 Where new fixtures and fittings are to be connected to existing piping, include for required piping revisions.

.3 Confirm exact location of plumbing fixtures and trim prior to roughing-in. Refer to architectural plan and elevation drawings.

.4 When installation is complete, check, and test operation of each fixture and fitting. Adjust or repair as required.

3.2 CAULKING AT PLUMBING FIXTURES AND FITTINGS

.1 Caulk around plumbing fixtures and fittings where they contact walls, floors, and any other building surface.

.2 Clean areas/surfaces to be caulked and prime in accordance with sealant manufacturer's instructions. Where damage to a building surface may occur, mask surface to prevent damage and ensure a clean exact edge to the caulking bead.

.3 Apply caulking using a gun with proper size and shape of nozzle and force sealant into joints to ensure good surface contact and a smooth and even finished bead of sealant.

.4 If joints have been masked sealant may be tooled in a continuous stroke to obtain complete void filling. Remove masking tape immediately after tooling and before sealant begins to skin.

END OF SECTION

1 General

1.1 **SUBMITTALS**

.1 Submit shop drawings/product data sheets for all products specified in Part 2 of this section except for pipe and fittings.

.2 Submit, in shop drawing form, a schematic piping diagram for each refrigerant piping system indicating pipe sizes, slopes, valves, traps, and piping specialties. Piping schematics must be reviewed, approved, and signed by refrigeration equipment manufacturers prior to being submitted to Consultant for review.

.3 Submit letters from equipment suppliers certifying proper installation and start-up of piping systems and equipment as specified in Part 3 of this section.

1.2 **QUALITY ASSURANCE**

.1 Refrigerant piping systems are to be in accordance with CSA B52, Mechanical Refrigeration Code, and any applicable local Codes and Regulations.

.2 Refrigerant piping installing contractor is to be certified by Technical Standards and Safety Authority (TSSA). Installing contractor is to install refrigerant piping in accordance with manufacturer's installation instructions and in accordance with local codes. Contractor is responsible for all regulatory approvals, if required. Upon completion of installation, documentation of refrigerant amount, test certificates and verification documentation, etc., is to be provided in a binder, in accordance with requirements of local authorities having jurisdiction.

.3 Refrigerant piping and direct expansion refrigeration equipment must be installed by or under direct on site supervision of a licensed journeyman refrigeration mechanic.

2 Products

2.1 **PIPE, FITTINGS AND JOINTS**

.1 Type ACR hard drawn seamless copper refrigerant tubing to ASTM B280, factory degreased, dehydrated and capped or nitrogen filled and capped, complete with factory washed and bagged wrought copper soldering fittings to ASME B16.22, and brazed joints made with high melting point silver brazing alloy conforming to AWS Classification BcuP-5.

2.2 **PIPING LINE SETS**

.1 Equal to Great Lakes Copper Inc. "EZ-Roll" soft annealed copper to ASTM B280, suitable for use with refrigerant involved, factory cleaned and capped, and with sizes and lengths as required.

2.3 **GENERAL RE: VALVES AND PIPING SPECIALTIES**

.1 Refrigerant valves and piping specialties specified below are to factory cleaned, degreased, and supplied to site with capped ends.

2.4 SHUT-OFF VALVES

.1 Ball Valves
- .1 ¼ turn, CSA certified forged brass ball valves, each suitable for a maximum working pressure of 3445 kPa (500 psi) and complete with carbon filled Teflon ball seals, 2 O-ring stem seals, a gasketed seal cap, a flow direction arrow cast into body, a ball position indicator on stem, and extended copper tube connections to permit brazing the valve into line without disassembling valve.
- .2 Acceptable manufacturers are:
  - .1 Mueller Industries Inc.;
  - .2 Sporlan Valve Co.;
  - .3 Superior Refrigeration Products/Sherwood.

.2 Diaphragm Valves
- .1 Forged brass, frost-proof, Type 1 Series, CSA certified packless diaphragm valves, each suitable for a 3445 kPa (500 psi) working pressure and complete with an O-ring to prevent moisture from entering diaphragm chamber, one phosphor bronze and 2 stainless steel diaphragms, and extended copper tube brazing connections.
- .2 Acceptable manufacturers are:
  - .1 Mueller Industries Inc.;
  - .2 Sporlan Valve Co.;
  - .3 Superior Refrigeration Products/Sherwood.

2.5 CHECK VALVES

.1 Straight through type for valves 6.4 mm to 16 mm (¼" to 5/8") diameter, globe type for valves 22 mm (7/8") diameter and larger, each complete with extended tubing for brazing connections, and as follows:
- .1 straight through type check valves complete with a machined brass gasketed body, phosphor bronze spring, and neoprene seat;
- .2 globe type check valves complete with a cast bronze body, forged brass cap, phosphor bronze spring, Teflon seat disc, and neoprene O-ring seal.

.2 Acceptable manufacturers are:
- .1 Mueller Industries Inc.;
- .2 Sporlan Valve Co.;
- .3 Superior Refrigeration Products/Sherwood.

2.6 PIPING TRAPS

.1 Mueller Industries Inc. Style No. WE-554P brazing end copper "P" traps.

.2 Acceptable manufacturers are:
- .1 Mueller Industries Inc.;
- .2 Sporlan Valve Co.;
- .3 Superior Refrigeration Products/Sherwood.

2.7 PRESSURE VESSEL RELIEF VALVES

.1 Factory set pressure relief valves, straight through or angle type as required, each constructed in accordance with requirements of ANSI B9.1 and the ASME Code for Unfired Pressure Vessels, and each complete with a brass body, neoprene seat disc, and lead seal and locking wire.

.2 Acceptable manufacturers are:
- .1 Mueller Industries Inc.;
- .2 Sporlan Valve Co.;
- .3 Superior Refrigeration Products/Sherwood.

2.8 REFRIGERANT LIQUID MOISTURE INDICATORS

.1 Forged brass, triple sealed, CSA certified liquid moisture indicators, each suitable for a maximum working pressure of 3445 kPa (500 psi) and complete with a liquid indicator which shows "FULL" when system is fully charged with refrigerant and remains blank when there is a restriction or shortage of refrigerant in liquid line, a moisture indicator which changes colour from blue to pink when moisture is present in system, a plastic dust cover, and extended copper tube brazing connections.

.2 Acceptable manufacturers are:
- .1 Mueller Industries Inc.;
- .2 Sporlan Valve Co.;
- .3 Superior Refrigeration Products/Sherwood.

2.9 LIQUID LINE FILTER-DRIER

.1 Mueller Industries Inc. "Drymaster" CSA certified filter-driers, each suitable for a maximum 3445 kPa (500 psi) working pressure and complete with a combination of desiccants in a fluted briquette for drying, and a fluted briquette type filter.

.2 Acceptable manufacturers are:
- .1 Mueller Industries Inc.;
- .2 Sporlan Valve Co.;
- .3 Superior Refrigeration Products/Sherwood.

2.10 FLEXIBLE PIPING CONNECTIONS

.1 Senior Flexonics Canada "VIBRA-SORBERS" phosphor bronze construction, factory cleaned, dried, and sealed flexible piping connections with copper tube brazing ends.

.2 Acceptable manufacturers are:
- .1 Senior Flexonics Canada;
- .2 The Metraflex Co.

2.11 THERMOSTATIC EXPANSION VALVES

.1 Factory tested, balanced port design thermostatic expansion valves, with exact selection to suit the application and refrigerant used, each complete within a

replaceable stainless steel diaphragm and welded element construction thermostatic element charged with hydraulic fluid, and removable inlet strainer.

.2 Acceptable manufacturers are:
- .1 Mueller Industries Inc.;
- .2 Sporlan Valve Co.;
- .3 Superior Refrigeration Products/Sherwood.

3 Execution

3.1 INSTALLATION OF REFRIGERANT PIPING, VALVES AND SPECIALTIES

.1 Provide required refrigerant piping. Piping is to be type ACR copper with wrought copper fittings. Install piping in accordance with requirements of reviewed refrigerant piping schematics referred to in Part 1 of this section.

.2 Make refrigerant piping joints using a light coat of approved brazing flux applied to both pipe and fitting. Do not use acid flux. During brazing process, ensure pipe and fittings are kept full of nitrogen or carbon dioxide to prevent scale formation inside pipe and fitting.

.3 Where shown or specified, use soft copper refrigerant piping line sets.

.4 Provide shut-off valves to isolate each piece of equipment if shut-off valves are not supplied integral with equipment. Provide ball or diaphragm type shut-off valves inside building. Provide diaphragm shut-off valves outside building.

.5 Provide a refrigerant charging valve for each system if such a valve is not supplied integral with equipment.

.6 Provide refrigerant piping accessories shown and/or required and install in accordance with manufacturer's recommendations.

.7 Provide required refrigerant.

.8 Provide flexible connections at piping connections to roof mounted condensing units. Install in accordance with manufacturer's instructions.

.9 Provide expansion valves where shown and/or required, each matched to coil and installed in accordance with manufacturer's instructions.

END OF SECTION

1 General

1.1 **SUBMITTALS**

.1 Submit shop drawings/product data sheets for fans and accessories. Include following:
- .1 certified fan performance curves at specified operating point with flow, static pressure and HP clearly plotted;
- .2 certified sound power data that conforms to specified levels;
- .3 product data sheets for all accessories;
- .4 product data sheets for fan motors.

.2 Submit with delivery of each unit a copy of the factory inspection report, and include a copy of each report with O&M Manual project close-out data.

.3 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this section.

.4 Supply reviewed copies of fan/curb assembly shop drawings or product data to trade who will cut roof openings for fans, and ensure openings are properly located.

1.2 **QUALITY ASSURANCE**

.1 Fan manufacturers, as applicable, are to be current members of the Air Movement and Control Association International Inc. (AMCA), and fans are to be rated (capacity and sound performance) and certified in accordance with requirements of following standards:
- .1 ANSI/AMCA Standard 210, Laboratory Method of Testing Fans for Certified Aerodynamic Performance Rating;
- .2 AMCA Standard 211, Product Rating Manual for Fan Air Performance;
- .3 ANSI/AMCA Standard 300, Reverberant Room Method for Sound Testing of Fans;
- .4 AMCA Standard 311, Product Rating Manual for Fan Sound Performance;
- .5 AMCA Standard 99-2408, Operating Limits for Centrifugal Fans.

2 Products

2.1 **ROOF MOUNTED EXHAUST FANS**

.1 Centrifugal, ULC listed, factory run tested roof mounted exhaust fans in accordance with drawing schedule.

.2 Spun aluminium housing with deep venturi inlet, aluminium curb cap with continuously welded corners, pre-punched mounting holes, galvanized steel or aluminium birdscreen, and EMT conduit chase to the motor compartment.

.3 Centrifugal, non-overloading aluminum wheel with backward inclined blades matched to inlet venturi, statically and dynamically balanced as an assembly.

.4 For belt-drive fans only, hot rolled steel shaft, accurately turned, ground, and polished, and sized for a first critical speed of at least 1.25 times maximum rated

speed for fan, and one-piece grease lubricated pillow block type bearings selected for an AFBMA L-50 minimum average life in excess of 500,000 hours at maximum catalogue operating speed and equipped with a lubrication fitting, and a heavy-gauge galvanized steel adjustable V-belt drive with guard conforming to requirements of Section 20 05 00 – Common Work Results for Mechanical.

.5 Motors are to conform to requirements specified in Section 20 05 00 – Common Work Results for Mechanical, mounted on vibration isolation in a compartment outside of the airstream, and factory pre-wired to a NEMA 4 disconnect switch.

.6 Prefabricated, minimum 300 mm (12") high heavy-duty aluminum roof mounting curb with factory installed wood nailer, 40 mm (1-½") thick insulation, continuously welded seams, and damper tray.

.7 For fans as scheduled, factory supplied accessories as follows:
- .1 gravity backdraft damper with #20 gauge galvanized steel frame and #26 gauge aluminum blades with felt edge blade seals;
- .2 non-corrosive motorized damper with linkage, end switch, and motor with voltage to match fan motor;
- .3 continuous non-corrosive piano type curb hinge to permit access to fan, damper and connecting duct, complete with retaining chain and a security hasp to prevent removal of unit from curb cap and prevent building entry through connecting ductwork;
- .4 2-speed switch and 2-speed double winding 1-phase motor in accordance with Section 20 05 00 – Common Work Results for Mechanical;

.8 Acceptable manufacturers are:
- .1 Twin City Fan and Blower;
- .2 Loren Cook Co.;
- .3 Greenheck Fan Corp.;
- .4 JencoFan;
- .5 Carnes Company Inc.

3 Execution

3.1 **INSTALLATION OF ROOF MOUNTED EXHAUST FANS**

.1 Provide roof mounted exhaust fans.

.2 Supply a roof mounting curb with each fan and hand curbs to roofing trade on roof for mounting and flashing into roof construction as part of roofing work. Secure fans in place on curbs.

.3 Install dampers in curb damper tray and secure in place.

.4 Refer to Section 20 05 00 – Common Work Results for Mechanical for equipment/system manufacturer certification requirements.

.5 Refer to Section 20 05 00 – Common Work Results for Mechanical for equipment/system start-up requirements.

.6 Include for a 4 hour on-site operation demonstration and training session. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.

END OF SECTION

1 General

1.01 Related Requirements

.1 Section 23 23 00 – Refrigerant Piping.

1.02 Submittals

.1 Submit shop drawings/product data sheets, complete with control components, and piping and wiring schematics.

.2 Submit a start-up and certification letter from equipment supplier as specified in Part 3 of this section.

.3 Prepare and submit a schematic layout of refrigerant piping showing all piping components required for satisfactory operation and maintenance of the system(s), including but not limited to pipe sizes, charging valve, isolating valves, sight glasses, strainers, driers, traps, etc. Schematic diagram must be reviewed with and approved by air conditioning equipment supplier prior to submittal to Consultant.

1.03 Quality Assurance

.1 Split system air conditioning equipment and installation of equipment are to be in accordance with requirements of following:

.1 all applicable Provincial Codes and Standards;

.2 ANSI/AHRI Standard 210/240, Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment.

.2 Split system air conditioning system installation tradesmen are to be journeyman refrigeration mechanics.

2 Products

2.01 Split System Air Conditioning Equipment

.1 Factory assembled and tested, package type equipment consisting of an indoor evaporator unit and an exterior condensing unit in accordance with drawing schedule, CSA or ETL listed and labelled, AHRI rated and certified and with a minimum system efficiency of 13 SEER.

.2 Wall mounting evaporator assembly consisting of a white moulded high-strength plastic cabinet with front access panel, a motorized horizontal vane to automatically direct air flow in a horizontal and downward direction and which closes when fan operation is stopped, motorized vertical vanes controlled remotely, and a mounting plate supplied loose. Evaporator complete with:

.1 double inlet, forward curve fan(s) direct driven by a single 4-speed motor;

.2 removable and washable return air filter;

.3 factory pressure tested multi-angled coil of non-ferrous construction with aluminium fins, copper tubes with silver alloy solder joints, and an insulated condensate drain pan sloped to a drain connection for positive drainage.

.3 Factory run tested, weatherproof condensing unit equipped with a control board to interface with indoor unit and perform all necessary operation functions. Pre-charge unit with R-410a refrigerant for a minimum of 21 m (70') of refrigerant tubing. Unit is to be capable of operation at -18°C (0°F) without additional low ambient controls, and capable of a height difference between condensing unit and evaporator of 30 m (100'). Each condensing unit complete with:

.1 galvanized steel plate cabinet with an electrostatically applied thermally fused polyester powder finish, and an ABS plastic fan grille;

.2 draw-through direct driven balanced fan with horizontal air discharge, mounted in front of coil, arranged to pull air across coil, and equipped with a raised fan guard;

.3 "L" shaped coil with copper tubes and aluminium fins, factory pressure tested, complete with an integral metal guard and refrigerant flow controlled by a linear expansion valve metering orifice controlled by a microprocessor controlled step motor;

.4 vibration isolated DC rotary compressor driven by an inverter circuit to dynamically control compressor speed to match room load, complete with an accumulator, high pressure safety switch, and circuitry to permit a minimal amount of current to be applied to motor to maintain enough heat during off cycle to prevent liquid from accumulating.

.4 System controls consisting of a microprocessor in each indoor and outdoor unit, and an indoor wall mounted controller site connected to indoor evaporator unit. System is to be capable of automatic restart after power interruption, and have self-diagnostics ability and indication of total compressor run time, and following:

.1 Indoor unit microprocessor is capable of monitoring return air temperature and evaporator coil temperature, receiving and processing commands from wall mounted controller, providing emergency operation, and controlling outdoor unit through its microprocessor and interface board;

.2 controller is complete with an integral temperature sensor, able to perform input and output functions necessary to operate system, and equipped with following:

.1 large DOT liquid crystal display to indicate diagnostic codes for both indoor and outdoor units, compressor run time, a weekly timer with up to 8 pattern settings per day, set temperature, room temperature, refrigerant piping temperatures, compressor operating conditions, and linear expansion valve opening pulses, sub-cooling and discharge super heat;

.2 On/Off button, Increase/Decrease Set Temperature buttons, a Cool/Dry/Fan mode selector, a Timer Menu button, a Timer On/Off button, Set Time buttons, a Fan Speed selector, a Vane Position selector, a Louvre Swing button, a Ventilation button, a Test Run button, and a Check Mode button.

.5 Acceptable manufacturers are:

.1 Mitsubishi Electric Sales Canada Inc.;

.2 LG Electronics Canada Inc.;

.3 Daikin;

.4 Fujitsu General America Inc.

3 Execution

3.01 Installation of Split System Air Conditioning Equipment

.1 Provide split system air conditioning equipment consisting of an exterior condensing unit and an indoor evaporator.

.2 Secure condensing unit in place, level and plumb, on vibration isolation pads on a concrete housekeeping pad.

.3 Mount indoor evaporator unit. Confirm exact location prior to roughing-in.

.4 Connect condensing unit and indoor evaporator with refrigerant piping in accordance with piping shop drawing schematic. Refer to Section 23 23 00 - Refrigerant Piping. Provide any required additional refrigerant.

.5 Install loose control components and perform required control wiring (except building automation system connections) between condensing unit and evaporator in conduit in accordance with manufacturer's control wiring schematic and wiring standards of electrical work.

.6 Refer to Section 20 05 00 – Common Work Results for Mechanical for equipment/system manufacturer certification requirements.

.7 Refer to Section 20 05 00 – Common Work Results for Mechanical for equipment/system start-up requirements.

.8 Include for 4 hours of on-site operation demonstration and training session. Training is to be a full review of all components including, but not limited to, a full operation and maintenance demonstration, with control set-up and abnormal events.

End of Section

1 General

1.1 **SUBMITTALS**

.1 Submit shop drawings/product data sheets for electric heaters, including accessories.

.2 Submit a site start-up report from manufacturer's representative as specified in Part 3 of this Section.

.3 Submit manufacturer's standard colour chart.

2 Products

2.1 **GENERAL RE: ELECTRIC HEATERS**

.1 Electric heaters are to be certified and labelled in accordance with CSA C22.2 No. 46, Electric Air-Heaters, and are to be complete with automatic reset high limit temperature control, baked epoxy/polyester powder coat white or almond finish as selected, and in accordance with drawing schedule.

.2 Acceptable manufacturers are:
.1 Ouellet Canada Inc.;
.2 Chromalox Inc.;
.3 Stelpro Design Inc.

2.2 **MOTORIZED CABINET HEATERS**

.1 Surface mounted or recessed cabinet heaters as shown, each complete with:
.1 #18 gauge steel cabinet and removable front panel with integral louvers and grille with rounded corners;
.2 tubular steel heating element with aluminium fins;
.3 steel fan wheel, direct driven by means of a motor conforming to requirements of Section 20 05 00 – Common Work Results for Mechanical, and complete with a fan delay to purge heater of residual heat;
.4 remote, tamperproof, adjustable thermostat;
.5 factory supplied enclosure accessories as indicated on drawings and/or heater schedule;
.6 factory supplied control components in accordance with drawing schedule, with low voltage/line voltage barrier as required.

3 Execution

3.1 **INSTALLATION OF ELECTRIC HEATERS**

.1 Supply electric heaters, complete with all required accessories. Hand heaters, in original packaging, to electrical trade at site in room/area where they are to be installed.

.2 Locate electric heaters for electrical trade so accurate electrical rough-in can be made. Confirm exact locations prior to electrical rough-in.

.3 Ensure heaters are properly installed.

.4 Where remote thermostats are indicated, provide thermostats and required control wiring and accessories. Unless otherwise indicated, locate thermostats 1.4 m (5') above floor, and confirm exact thermostat locations prior to roughing-in.

.5 Refer to Section 20 05 00 – Common Work Results for Mechanical for equipment/system start-up requirements.

3.2 DEMONSTRATION AND TRAINING

.1 Include for a 4 hour on-site heater operation demonstration and training session. Training is to be a full review of all components including but not limited to construction details, operation, and maintenance.

END OF SECTION

1 General

1.1 **SUBMITTALS**

.1 Submit shop drawings/product data sheets for following:
- .1 all control system components;
- .2 identified schematic control diagrams with component identification, catalogue numbers, and sequence of operation for all systems;
- .3 certified wiring diagrams for all systems.

.2 Submit following samples for review:
- .1 control damper section with linkage, operator, and certified flow and leakage data;
- .2 wall mounting control system flow diagram as specified in Part 2 of this Section;
- .3 each type of thermostat to be used, each identified as to intended use.

.3 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this Section.

.4 Submit written confirmation from control component manufacturer that site installation personnel are qualified and experienced in installation of components, and have parts and service availability on a 24/7 basis.

1.2 **QUALITY ASSURANCE**

.1 Control systems are to be installed by control component manufacturer or by licensed personnel authorized by control component manufacturer. Submit written confirmation from control component manufacturer.

.2 Control wiring work is to be performed by licensed journeyman electricians, or under direct daily supervision of journeyman electricians.

2 Products

2.1 **AUTOMATIC CONTROL VALVES AND OPERATORS**

.1 Each control valve must be suitable in all respects for the application, including system pressure.

.2 Unless otherwise indicated, control valves for proportional operation are to have equal percentage characteristics, and control valves for open/shut 2-position operation are to have straight line flow characteristics. All valves are to have position indicators. Valves for outdoor applications must be suitable in all respects for the application.

.3 Heating valves are to be normally open unless otherwise specified.

.4 Cooling valves are to be normally closed unless otherwise specified.

.5 Unless otherwise specified, control valves in hydronic piping systems are to conform to requirements specified in Section 23 21 00 – HVAC Piping and Pumps.

.6 Unless otherwise specified, valves in steam/condensate piping are to generally conform to requirements specified in Section 23 22 00 – Steam and Condensate Piping and Pumps, but must be equipped with stainless steel plugs and stems, removable screwed stainless steel seat rings, and spring loaded Teflon V-ring packing.

.7 All control valve operators are to be spring return type for fail safe operation, sized to tightly shut the control valves against differentials imposed by system, equipped with position indicators, and suitable in all respects for environment in which they are located.

.8 Electric valve operators are to be equal to Belimo "EF Series" enclosed reversible gear type operators that can accept modulating control signals as required. Each is to be 1-phase AC, 120 or 24 volt as required or indicated, overload protected, and complete with an enclosure to suit the mounting location.

2.2 CONTROL DAMPERS AND OPERATORS

.1 T. A. Morrison & Co. Inc. "TAMCO" 100 mm (4') deep, flanged, AMCA low leakage certified aluminium dampers. Dampers for modulating and mixing applications are to be parallel blade type. Dampers for open-shut service are to be opposed blade type. Maximum blade length is to be 1 m (4'). Dampers greater than 2 sections wide are to be complete with a jackshaft. Each damper is to be complete with:

- .1 extruded 6063T5 aluminum frame and airfoil blades, each with an integral slot to receive a gasket;
- .2 extruded TPE frame gaskets and extruded EPDM blade gaskets;
- .3 slip-proof aluminium and corrosion resistant plated steel linkage of a metal thickness to prevent warping or bending during damper operation, concealed in frame, equipped with seal-sealing and self-lubricating bearings consisting of a Celcon inner bearing fixed on hexagonal blade pin and rotating in a polycarbonate outer bearing inserted in frame.

.2 For standard damper(s), Series 1000 as above.

.3 For insulated damper(s), Series 9000 as above but with all 4 sides of frame insulated with polystyrene, and blades thermally broken and insulated with expanded polyurethane foam.

.4 For stainless steel dampers, as above but constructed of type 316 stainless steel and equipped with Teflon blade bearings.

.5 Each damper motor is to be shaft mounted, spring return, fail safe in the normally open or normally closed position, sized to control damper against maximum pressure or dynamic closing pressure, whichever is greater, to suit sizes of dampers involved, and to provide sufficient force to maintain damper rated leakage characteristics. Each operator is to be complete with a damper position indicator, and external adjustable stops to limit length of stroke in either direction,

and is to be mounted on a corrosion resistant adjustable bracket. Operating arms are to have double yoke linkages and double set screws for fastening to damper shaft. Operators for dampers to be connected to building fire alarm system or to freeze protection devices are to be equipped with additional relays to permit dampers to respond and go to required position in less than 15 seconds upon receipt of a signal. Operator enclosures are to be suitable in all respects for environment in which they are located.

.6 Electric damper operators are to be equal to Belimo EF Series 24 volt or 120 volt AC spring return, direct coupled electric motor operators for either modulating or 2-position control as required. Each operator is to be overload protected and complete with an enclosure to suit the mounting location.

.7 Pneumatic damper operators are to be replaceable elastomer diaphragm piston type, suitable in all respects for damper sequence.

2.3 LOCAL CONTROL PANELS

.1 NEMA 2 wall mounting, enamelled steel barriered enclosures sized to suit the application with 20% spare capacity, a perforated sub-panel, numbered terminal strips for all low and line voltage wiring, hinged door, and slotted flush latch.

2.4 CONTROL SYSTEM COMPONENTS

.1 Components specified below are required for control of equipment and systems in accordance with drawing control diagrams and sequences of operation. Not all required components may be specified.

.2 Sensor/transmitter input devices must be suitable in all respects for the application and mounting location. Devices are as follows:

- .1 room temperature sensors constructed for surface or recessed wall box mounting, complete with an adjustable set-point reset slide switch with a ± 1.66°C (±3°F) range, individual heating/cooling set-point slide switches as required, a momentary override request pushbutton for activation of after-hours operation, an analogue thermometer;
- .2 outside air sensors designed and constructed for ambient temperatures and to withstand environmental conditions to which they are exposed, complete with a NEMA 3R enclosure, solar shield, and a perforated plate surrounding sensor element where exposed to wind velocity pressure;
- .3 insertion duct mounting sensors type with lock nut and mounting plate, designed to mount in an electrical box (weather-proof with gasket and cover where outside) through a hole in duct;
- .4 for ducts greater than 1.2 m (4') or for ducts where air temperature stratification occurs, averaging type sensors with multiple sensing points, and for plenums for applications such as mixed air temperature measurement to account for air turbulence and/or stratification, an averaging string of sensors with capillary supports on the sides of duct/plenum;
- .5 factory solid-state relative humidity sensors with an element that resists contamination, weather-proof with a NEMA 3R enclosure for outside air applications, supplied with a type 304 stainless steel probe with mounting bracket and hardware for duct mounting, each complete with a factory calibrated humidity transmitter which is accurate (including lead loss and

analog to digital conversion) to 3% between 20% to 80% RH at 25°C (77°F) and equipped with non-interactive span and zero adjustments, and a 2-wire isolated loop powered, 4-20 mA, 0 to 100% linear proportional output;

.6 carbon dioxide sensors for air quality control purposes having a maximum 20 second response time, suitable for operating conditions from 0°C to 50°C (32°F to 122°F) and 0 to 100% RH non-condensing, complete with a calibration kit (to be handed to Owner) and characteristics as follows:
- .1 measurement range: 0 to 2000 ppm;
- .2 accuracy: ±100 ppm;
- .3 repeatability: ±20 ppm;
- .4 drift: ±100 ppm per year;
- .5 output signal: 0 to 10 VDC proportional over the 0 to 2000 ppm range.

.3 Pressure transmitters are to be constructed to withstand 100% pressure over-range without damage and to hold calibrated accuracy when subject to a momentary 40% over-range input. Pressure transmitters are to transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal. Differential pressure transmitters used for flow measurement are to be sized to the flow sensing device and supplied with a tee fitting and shut-off valves in the high and low sensing pick-up lines to allow permanent ease of use connection for balancing, etc. Transmitter housing is to suit mounting location. Standalone pressure transmitters are to be mounted in a minimum NEMA 1 (NEMA 2 in sprinklered area) by-pass valve assembly panel with high and low connections piped and valved, air bleed units, by-pass valves, and compression fittings. Transmitters are to be as follows:

- .1 low differential water pressure, 0 to 5 kPa (0 to 20" wc): equal to Setra or Mamac industrial quality transmitter capable of transmitting a linear 4 to 20 mA output in response to variation of flow meter differential pressure or water pressure sensing points, each complete with non-interactive zero and span adjustments adjustable from outside the cover, and performance as follows:
  - .1 maintain accuracy up to 20 to 1 ratio turndown;
  - .2 reference accuracy: +0.2% of full scale.
- .2 medium to high differential water pressure, over 5 kPa (20" wc): equal to Setra or Mamac transmitters as specified above for low pressure transmitters but with a pressure range of from 2.5 kPa (10" wc) to 2070 kPa (300 psi), a reference accuracy of ±1% of full span (includes non-linearity, hysteresis, and repeatability);
- .3 building differential air pressure: equal to Setra or Johnson Controls Inc. industrial quality transmitter with a range suitable for the application, capable of transmitting a linear 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points, each complete with non-interactive zero and span adjustments adjustable from outside the cover, and performance as follows:
  - .1 maintain accuracy up to 20 to 1 ratio turndown;
  - .2 reference accuracy: +0.2% of full span.
- .4 low differential air pressure, 0 to 1.25 kPa (0" to 5" wc): equal to Setra or Johnson Controls Inc. industrial quality transmitter with a range suitable for the application, capable of transmitting a linear 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points, each complete with non-interactive zero and span adjustments adjustable from outside the cover, and performance as follows:

.1 maintain accuracy up to 20 to 1 ratio turndown;
.2 reference accuracy: +0.2% of full span.

.5 medium differential air pressure, over 1.5 kPa (5" wc): equal to Setra or Johnson Controls Inc. transmitters as specified above for low pressure air transmitters but performance requirements as follows:
.1 zero and span: (c/o F.S./Deg. F); .04% including linearity, hysteresis, and repeatability;
.2 accuracy: 1% F.S. (best straight line); static pressure effect: 0.5% F. S.;
.3 thermal effects: <+0.33 F.S./°F over 40°F to 100°F (calibrated at 70°F).

.4 Air and water flow monitoring stations and probes are to be Air Monitor Corp., Tek-Air Systems Inc., Ebtron, or Dietrich Standard products as follows:
.1 Fan Inlet Air Flow Measuring Station: At fan inlet and near exit of inlet sound trap, air flow traverse probes are to continuously monitor fan air volume and system velocity pressure, and traverse probes are to be as follows:
.1 each probe is to be of a dual manifold, cylindrical, anodized type 3003 extruded aluminium construction probe with sensors located along the stagnation plane of approaching air flow, and the static pressure manifold is to incorporate dual offset static tops on opposing sides of averaging manifold so as to be insensitive to flow angle variations for as much as ±20° in approaching air stream;
.2 each probe is not to introduce a measurable pressure drop, nor is sound level within duct to be amplified by its singular or multiple presence in air stream, and each probe is to contain multiple static and total pressure sensors places at equal distances along its length in accordance with ASHRAE Standards for duct traversing.
.2 Single Probe Air Flow Measuring Sensor: Duct mounting hot wire anemometer type which utilizes 2 temperature sensors, one is a heater element temperature sensor and the other is to measure downstream temperature, with temperature differential related directly to air flow velocity. Sensor insertion length is to be adjustable up to 200 mm (8"), and transmitter is to produce a 4 to 20 mA or 0 to 10 VDC signal linear to air velocity.
.3 Duct Flow Measuring Stations: #14 gauge galvanized steel casing with duct connection flanges of a size to mate with connecting ductwork, and complete with an air directionalizer and a 98% free area parallel cell 20 mm (¾") honeycomb profile suppressor across entering air stream to equalize velocity profile and eliminate turbulent and rotational flow from the air stream prior to measuring point, mechanically fastened to casing so as to withstand velocities of up to 1828 m (6000') per minute. Additional requirements as follows:
.1 total pressure measurement side (high side) is to be designed and spaced to requirements of Industrial Ventilation Manual, 16th Edition, page 9-5, and self-averaging manifolding is to be constructed of brass and copper components;
.2 static pressure sensing probes (low side) is to be bullet-nose shaped, per detailed radius, as illustrated in Industrial Ventilation Manual referred to above, page 9-5;

.3 main take-off point from both total pressure and static pressure manifolds is to be symmetrical, and manifolds are to terminate with external ports for connection to control tubing;
.4 each station is to be equipped with a label on casing indicating unit model number, size, area, and specified air flow capacity;
.5 each station is to have a self-generated sound rating of less than NC 40, and sound level within duct is not to be amplified nor is additional sound to be generated.

.4 Static Pressure Traverse Probe: Duct mounting, complete with multiple static pressure sensors located along exterior surface of cylindrical probe.

.5 Shielded Static Air Probe: Indoor type or outdoor type as required, each with multiple sensing ports, an impulse suppression chamber, and air flow shielding.

.6 Water Flow Monitoring: Equal to Onicon microprocessor-based electromagnetic water flow meters with an accuracy of 0.25%.

.5 Power (amps) monitoring is to be performed by a combination of a current transformer and a current transducer with transformer sized to reduce full amperage of monitored circuit to a maximum 5 ampere signal which will be converted to a 4 to 20 mA DDC compatible circuit for use by building automation system. Current transformer and current transducer are as follows:
.1 equal to Veris Industries split core current transformer with an operating frequency of from 50 to 400 Hz, 0.6 Kv class, 10 Kv BIL insulation, and 5 ampere secondary;
.2 equal to Veris Industries current to voltage or current to mA transducer with an accuracy of ±5%, a minimum load resistance of 30 kOhm, an input of 0 to 20 amperes and an output of 4 to 20 mA, and a 24 VDC regulated power supply.

.6 Duct mounting smoke detectors supplied as part of electrical work for mounting as part of control system work.

.7 Honeywell Analytics microprocessor-based gas detection system, programmable monitoring and alarm equipment as indicated on drawings, CSA certified, in accordance with ANSI/UL 2017, General-Purpose Signaling Devices and Systems, ANSI/UL 2034, Single and Multiple Station Carbon Monoxide Alarms, and CAN/CSA C22.2 No. 61010, Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use-Part 1: General Requirements, and as follows:
.1 Digital to Analog Output Convertor: Model 4201 24 volt AC, 500 mA convertor to communicate digitally with up to 8 sensor/transmitter units and control panel within a daisy-chain network to convert digital signal from transmitters to analog outputs to permit each transmitter to produce up to 8 dedicated 4-20 mA signals to a building automation system or variable frequency drive from one central location which can be a maximum of 600 m (2000') from control panel.
.2 Acceptable manufacturers are:
.1 Honeywell Analytics/Vulcain Inc.;
.2 Mine Safety Appliance Co. (MSA);
.3 Armstrong Monitoring Co.;
.4 Quatrosense Environmental Ltd. (QEL).

.8 Double contact switches to monitor equipment status and safety conditions, and generate alarms when a failure or abnormal condition occurs. Status and safety switches are to be as follows:

.1 current sensing switches: equal to Veris Industries self-powered dry contact output switches for sensing run status of motor loads, each calibrated to indicate a positive run status only when motor is operating under load, and each consisting of a current transformer, a solid-state current sensing circuit, adjustable trip point, solid-state switch, SPDT relay, and a LED to indicate on or off status;

.2 air filter status switches: equal to Johnson Controls Inc. or Cleveland Controls automatic reset type differential pressure switches, each complete with SPDT contacts rated for 2 amperes at 120 VAC, a scale range and differential pressure adjustment appropriate for the service, and an installation kit which includes static pressure taps, tubing, fittings, and air filters;

.3 air flow switches: equal to Johnson Controls Inc. or Cleveland Controls pressure flow switches, bellows actuated mercury switch or snap-acting micro-switch type with an appropriate scale range and pressure adjustment;

.4 air pressure safety switches: equal to Johnson Controls Inc. or Cleveland Controls manual reset switches, each complete with SPDT contacts rated for 2 amperes at 120 VAC and an appropriate scale range and pressure adjustment;

.5 water flow switches: equal to Johnson Controls Inc. Model P74;

.6 low temperature limit switches: manual reset type equal to Johnson Controls Inc. Model A70, each complete with DPST snap acting contacts rated for 16 amperes at 120 VAC, a minimum 4.5 m (15') sensing element for mounting horizontally across duct/plenum with sensing reaction from coldest 450 mm (18") section of element, and where sensing element does not provide full coverage of air stream, additional switches are to be supplied as required.

.9 Control relays as follows:

.1 control pilot relays: equal to Johnson Controls Inc. or Lectro modular plug-in design with snap-mount mounting bases, retaining springs or clips, DPDT, 3 PDT or 4 PDT as required for the application, with contacts rated for 10 amperes at 120 VAC;

.2 lighting control relays: latching type with integral status contacts rated for 20 amperes at 120 VAC, each complete with a split low voltage coil that moves the voltage contact armature to On or Off latched position, each controlled by a pulsed tri-state output (preferred) or pulsed paired binary outputs, and each designed so power outages will not result in a change-of-state and so multiple same state commands will simply maintain commanded state.

.10 Electronic signal isolation transducers equal to Advanced Control Technologies for installation whenever an anolog output signal from building automation system is to be connected to an external control system as an input (i.e. equipment control panel), or is to receive as an input signal from a remote system, and to provide ground plane isolation between systems.

.11 Each manual override station is to be complete with contacts rated minimum 1 ampere at 24 VAC and is to provide following:

.1 integral H-O-A switch to override controlled device pilot relay;

.2 status input to building automation system to indicate whenever switch is not in the Auto position;
.3 status LED to illuminate whenever output is On;
.4 override LED to illuminate whenever H-O-A switch is in either the Hand or Off position.

.12 Electronic/pneumatic transducers equal to Johnson Controls Inc. transducers with an output of from 3 to 15 psig, an input of from 4 to 20 mA or 10 VDC, manual output adjustment, a pressure gauge, and an external replaceable supply air filter.

.13 Thermostats:
.1 Wall mounting adjustable set-point thermostats, each suitable in all respects for equipment (and operating sequence) they are provided for, equipped with a thermometer, a cover and any required mounting and connection accessories.
.2 Pneumatic thermostats are to be of bimetal element construction, double valve type, operating without constant waste of air.
.3 Line voltage thermostats are to be 115 volt.
.4 Low voltage thermostats are to be 24 volt electronic type.
.5 Set-point adjustment for thermostats in public spaces is to be concealed behind cover. Set-point adjustment for other thermostats is to be accessible through cover.
.6 Covers are to be removable, tamper-proof covers with temperature set-point and thermometer displays.
.7 Guards for thermostats are to be clear, ventilated acrylic covers with allen key locking hardware.

.14 Humidistats:
.1 Direct or reverse acting (to suit system), proportional type, adjustable humidity controllers, each corrosion resistant, suitable in all respects for the application and complete with a nylon element, replaceable cartridge type air filter, internally adjustable limit stops for maximum and minimum settings, a cover, and required mounting and connection accessories.
.2 Pneumatic humidistats are to be 2 pipe type and complete with plug-in air connections.
.3 Electric humidistats are to be line voltage (115 volt), or 24 volt electronic type.
.4 Wall mounting humidistats are to be complete with a tamper-proof display type cover.
.5 Duct mounting humidistats are to be complete with a display type cover, duct sampling chamber with 300 mm (12") long extruded pick-up tube for duct mounting, a moulded mounting base, and a ventilated cover.

.15 Hardware to permit building automation system control and monitoring of input/output points in accordance with Section 25 05 02 - Building Automation System, points schedule, and drawing control diagrams and operation sequences. All such hardware is to be suitable in all respects for interface with the building automation system.

2.5 **SYSTEM WIRING MATERIALS**

.1 System wiring, conduit, boxes, and similar materials are to be in accordance with requirements specified in appropriate Section(s) of Electrical Work specification.

3 Execution

3.1 **DEMOLITION**

.1 Perform required control system demolition work.

.2 Refer to demolition requirements specified in Section 20 05 05 – Selective Demolition for Mechanical.

3.2 **GENERAL RE: INSTALLATION OF CONTROLS**

.1 Provide complete systems of control and instrumentation to control and supervise building equipment and systems in accordance with this Section and drawings.

.2 Control systems are to generally be as indicated on drawing control diagrams and are to have all the elements therein indicated or implied.

.3 Control diagrams show only the principal components controlling the equipment and systems. Supplement each control system with all relays, transformers, sensors, etc., required to enable each system to perform as specified and to permit proper operation and supervision.

.4 Brace and secure control system equipment in accordance with requirements specified in Section 20 05 48.16 - Seismic Controls for Mechanical.

3.3 **SUPPLY OF CONTROL AIR DAMPERS AND OPERATORS**

.1 Unless otherwise specified, supply required control dampers. Hand dampers to sheet metal trade at site in location where they are required for installation as part of sheet metal work. Ensure each damper is correctly located and mounted.

.2 Provide linkage and operators for dampers. Wherever possible locate damper operators so they are accessible from outside duct, plenum, and equipment casings. Bracket mount operators on ducts or plenums clear of insulation where applicable.

.3 Where sequence operation is indicated, or where multiple operators drive a series of dampers, provide pilot positioners to couple their action.

.4 Ensure dampers located in ductwork other than galvanized steel are constructed of type 316 stainless steel.

3.4 **SUPPLY OF AUTOMATIC CONTROL VALVES AND OPERATORS**

.1 Unless otherwise specified, supply required automatic control valves. Hand valves to appropriate piping trades at site in locations they are required for installation as part of piping work. Ensure each valve is properly located and installed.

.2 Provide an operator for each valve.

3.5 INSTALLATION OF THERMOSTATS

.1 Unless otherwise noted, provide required thermostats.

.2 Provide a ventilated clear acrylic cover for each thermostat located in finished areas, and a wire type guard for each thermostat located in unfinished areas and in areas such as mechanical rooms where thermostat is subject to damage.

.3 Unless otherwise indicated, mount room thermostats 1.5 m (5 ft.) above finished floor level. Confirm exact location of thermostats prior to roughing-in.

.4 Provide stand-off mounting and an insulated sub-base for thermostats on outside walls.

.5 Perform control wiring associated with installation of electric or electric-electronic thermostats.

3.6 INSTALLATION OF CONTROL SYSTEM COMPONENTS

.1 Provide required control system components and related hardware. Refer to drawing control diagrams and sequences.

.2 Where components are pipe, duct, or equipment mounted supply components at proper time, coordinate installation with appropriate trade, and ensure components are properly located and mounted.

.3 Perform required control wiring work for control systems except:
- .1 power wiring connections to equipment and panels, except as noted below;
- .2 control wiring associated with mechanical plant equipment and systems whose control is not part of work specified in this Section;
- .3 starter interlock wiring.

.4 Except as specified below, install wiring in conduit. Unless otherwise specified, final 600 mm (2') connections to sensors and transmitters, and wherever conduit extends across flexible duct connections is to be liquid-tight flexible conduit.

.5 Control wiring in ceiling spaces and wall cavities may be plenum rated cable installed without conduit but neatly harnessed, secured, and identified.

.6 Wiring work is to be in accordance with certified wiring schematics and instructions, and wiring standards specified in appropriate Sections of Electrical Work Specification.

3.7 IDENTIFICATION AND LABELLING OF EQUIPMENT AND CIRCUITS

.1 Refer to identification requirements specified in Section 20 05 00 – Common Work Results for Mechanical.

.2 Identify equipment as follows:

.1 enclosures and components: engraved laminated nameplates with wording listed and approved prior to manufacture of nameplates;
.2 wiring: numbered sleeves or plastic rings at both ends of conductor, with numbering corresponding to conductor identification on shop drawings and "as-built" record drawings.

3.8 TESTING, ADJUSTING, CERTIFICATION, START-UP, AND TRAINING

.1 When control work is complete, check installation of components and wiring connections, make any required adjustments, and coordinate adjustments with personnel doing HVAC testing, adjusting and balancing work.

.2 Refer to Section 20 05 00 – Common Work Results for Mechanical for equipment/system manufacturer certification requirements.

.3 Refer to Section 20 05 00 – Common Work Results for Mechanical for equipment/system start-up requirements.

.4 Include for 2 full, 8 hour days on-site operation demonstration and training sessions. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.

.5 Include for 2 follow-up site training and troubleshooting visits, one 6 months after Substantial Completion and other at end of warranty period, both when arranged by Owner and for a full, 8 hour day to provide additional system training as required, and to demonstrate troubleshooting procedures.

END OF SECTION

1 General

1.1 ABBREVIATIONS AND DEFINITIONS

.1 Abbreviations used in this Specification are as follows:
- .1 BAS building automation system;
- .2 DDC direct digital controls;
- .3 LAN local area network;
- .4 PC personal computer.

1.2 SUBMITTALS

.1 Submit shop drawings/product data sheets for BAS components. As a minimum, submit the following:
- .1 BAS network architecture, including modes and interconnections;
- .2 systems schematics, sequences, and flow diagrams;
- .3 points schedule for each point in BAS, including point type, object name, expanded ID, display units, controller type, and address;
- .4 samples of graphic display screen types and associated menus;
- .5 detailed Bill of Materials for each system or application, identifying quantities, part numbers, descriptions, and optional features;
- .6 control damper schedule including a separate line for each damper and a column for each of damper attributes including code number, fail position, damper type, damper operator, duct size, damper size, mounting and actuator type;
- .7 control valve schedules including a separate line for each valve and a column for valves as for control dampers;
- .8 room schedule including a separate line for each HVAC terminal unit indicating type, location and address;
- .9 details of BAS interfaces and connections to other systems;
- .10 product data sheets or marked catalogue pages including part number, photograph and description for BAS hardware and software.

.2 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this Section.

1.3 DESCRIPTION OF THE BUILDING AUTOMATION SYSTEM

.1 Building automation system is to consist of a modular, BACnet protocol, open architecture system incorporating direct digital control and monitoring of equipment and systems and consisting of all hardware and software required for complete, functional DDC control system. BAS is to be accessible through standard personal computers within building through a wireless application protocol device, or remotely through Internet by means of a standard web browser.

.2 BAS is to be field expandable, with a distributed architectural design to eliminate dependence upon any single device for alarm reporting and control execution. Failure of any single component or network connection is not to interrupt execution of control strategies at other operational devices. BAS is to maintain all settings and overrides through a system re-boot, and is to incorporate, as a minimum, following integrated features, functions and services:

.1 graphic user interface for accessing and viewing BAS information, commanding points, changing setpoints, responding to alarms, programming time-of-day schedules;
.2 operator information, alarm management, and control features;
.3 enterprise-level information and control access;
.4 information management including monitoring, transmission, archiving, retrieval, and reporting functions;
.5 diagnostic monitoring and reporting of BAS functions;
.6 off-site monitoring and management access;
.7 energy management;
.8 standard applications for terminal HVAC systems.

.3 BAS is to include, but not be limited to, following:
.1 personal computer based server for networking and integrating all hardware components into a single BAS;
.2 personal computer based operator work station with colour monitor for colour graphic displays, and a colour printer;
.3 portable operator's terminal;
.4 network of standalone network automation engine(s);
.5 network of field equipment controllers;
.6 input/output modules;
.7 local display devices;
.8 distributed user interfaces;
.9 network processing, data storage and communication equipment;
.10 all other components required for a complete and operating BAS.

1.4 QUALITY ASSURANCE

.1 BAS hardware and software is to be installed by experienced personnel employed and trained by manufacturer/supplier of field equipment controllers. System wiring is to be installed by journeyman electricians or under direct on-site supervision of journeyman electricians.

2 Products

2.1 GENERAL RE: BUILDING AUTOMATION SYSTEM

.1 Control system components (field devices) other than those specified in this Section are generally specified in Section 25 05 01 - Automatic Control Systems. Components factory installed with equipment or supplied with equipment are specified in mechanical work Sections with equipment.

.2 BAS specified in this Section is an expandable DDC building automation system in accordance with drawing control diagrams and sequences, and points lists. Acceptable manufacturers are:
.1 Johnson Controls Inc.;
.2 Siemens Building Technologies Inc.;
.3 Honeywell International Inc.;
.4 Train Controls;
.5 Distech Controls;
.6 Delta;
.7 Alerton.

2.2 BAS ARCHITECTURE

.1 BAS is to be based industry standard Ethernet TCP/IP communications protocol. Where used, LAN controller cards are to be standard "off-the-shelf" products available through normal PC vendor channels. BAS is to be capable of operating at a communication speed of 100 Mbps, with full peer-to-peer network communication. BAS is to be compatible with other enterprise-wide networks, and where indicated, BAS is to be connected to the enterprise network and share resources with it by way of standard networking devices and practices.

.2 Network automation engines are to provide supervisory control over control network and are to support BACnet Standard MS/TP bus communication protocol (ASHRAE SSPC-135, Clause 9). Control networks are to provide either a "peer-to-peer", master-slave, or supervised token passing communications and are to operate at a minimum communication speed of 9600 baud. DDC controllers are to reside on control network.

.3 BAS is to include appropriate hardware and software to allow BACnet bi-directional data communications between BAS and building equipment/system control panels. BAS is to receive, react to, and return information from connected equipment and systems. Data required by application is to be mapped into automation engine's data base and is to be transparent to operator. Point inputs and outputs from building equipment/system control panels is to have real-time interoperability with BAS software features such as control software, energy management, custom process programming, alarm management, historical data and trend analysis, totalization, and local area network communications.

2.3 DEDICATED WEB BASED USER INTERFACE

.1 User interface is to be web based and is to operate on a personal computer for command entry, information management, network alarm management, and database management functions. Real-time control functions including scheduling, history collection, and alarming are to be resident in appropriate components of BAS network to facilitate greater fault tolerance, availability and reliability.

.2 Architecture of personal computer is to be implemented to conform to industry standards such that it can accommodate applications provided with BAS and mechanical systems and equipment, including but not limited to Microsoft Office Applications. Specifically, it must conform to following interface standards:

- .1 Microsoft Internet Explorer (or other standard browser) for user interface functions;
- .2 Microsoft Office Professional for creations, modification and maintenance of reports, and sequencing other necessary building management functions;
- .3 Microsoft Outlook or other email program for supplemental alarm functionality and communication of system events, and reports;
- .4 required network operating system for exchange of data and network functions such as printing of reports, trends, and specific system summaries.

.3 Personal computer server or operator workstation is to be configured at minimum as follows:

- .1 memory: 8 GB;

.2 processor: Intel;
.3 hard drive: 500 GB free hard drive;
.4 graphics card: 1 GB DDR3;
.5 ports: 1 HMDI, 2 serial, one parallel, and 2 USB-C ports;
.6 keyboard: 101 keyboard and 2-button mouse;
.7 monitors: 23" LCD monitor with 1920 x 1080 resolution;
.8 LAN communications: 10/100/1000 network card.

.4 Operating System Software: Windows 7 Professional 64-bit Microsoft SQL 2008 Server and SQL 2008 Server Express are automatically installed by EBI. Where user interface is not provided via browser, PC is to be equipped with a complete workstation software package including any software or hardware keys, and package is to include original installation discs and licenses for all software, device drivers, peripherals, and software registration cards which are to be handed to Owner.

.5 Printer is to be at minimum equal to Hewlet Packard "DeskJet" colour printer with a speed of 600 DPI black and 300 DPI colour, and 64 K input print buffer.

2.4 DISTRIBUTED WEB BASED USER INTERFACE

.1 Features and functions of dedicated web based user interface described above are to be available on any computer connected directly or via a wide area or virtual private network to BAS network, which conforms to the following specifications:
.1 software is to run on Microsoft Internet Explorer (8.0 or higher) browser;
.2 minimum hardware requirements are:
.1 2 GB RAM;
.2 2.0 GHz clock speed Pentium 4 microprocessor;
.3 120.0 GB hard drive;
.4 keyboard with 83 keys minimum;
.5 SVGA 1024 x 768 resolution display with 64K colours and 16 bit colour depth;
.6 mouse or other pointing feature.

2.5 USER INTERFACE APPLICATION COMPONENTS

.1 Integrated browser based client application is to be used as user operator interface program. System is to employ an event-driven rather than a device polling methodology to dynamically capture and present new data to user. Additional features are as follows:
.1 inputs, outputs, set-points, and other parameters as defined in Part 3 of this Section, shown on drawings, or required as part of system software are to be displayed for operator viewing and modification from operator interface software;
.2 user interface software is to provide help menus and instructions for each operation and/or application;
.3 system is to support customization of user interface configuration and a home page for each operator;
.4 system is to support user preferences in alarm, trend, display, and applications screen presentations;

.5 controller software operating parameters are to be displayed for operator to view/modify from user interface, and these parameters are to include set-points, alarm limits, time delays, PID tuning constants, run times, point statistics, schedules, etc.;

.6 operator interface is to incorporate comprehensive support for functions including but not limited to following:

.1 user access for selective information retrieval and control command execution;

.2 monitoring and reporting;

.3 alarm, non-normal, and return to normal condition annunciation;

.4 selective operator override and other control actions;

.5 information archiving, manipulation, formatting, display and reporting;

.6 BAS internal performance supervision and diagnostics;

.7 on-line access to help menus;

.8 on-line access to current BAS as-built records and documentation;

.9 means for controlling, re-programming, and re-configuration of the BAS operation and for the manipulation of the BAS database information in compliance with applicable Codes and Regulations for individual BAS applications.

.7 system is to support a list of application programs configured by users that are called up by the Tools Menu, hyperlinks within graphic displays, and key sequences;

.8 operation of control system is to be independent of user interface, which is to be used for operator communication only.

.2 System is to have a minimum of 5 levels of nesting, and the capability of displaying multiple navigation trees to aid operator in navigating throughout all systems and points connected, adding custom trees, defining any logical grouping of points and arranging them on a tree in any order, and nesting groups within other groups. Navigation trees are to be "dockable" to other displays such as graphics, meaning trees will appear as part of display but can be detached and then minimized to Windows task bar or closed altogether, however, a simple keystroke will reattach navigation to primary display of user interface.

.3 Alarms are to be routed directly from network automation engines to PC's and servers, and it is to be possible for specific alarms from specific points to be routed to specific PC's and servers. BAS is to annunciate diagnostic alarms indicating system failures and non-normal operating conditions, annunciate application alarms as required by points lists and sequences, and as a minimum, permit 4 categories of alarm sounds customizable through user defined wav files. Alarm management segment of user interface is to provide, as a minimum, following alarm functions:

.1 log, date, and time of alarm occurrence;

.2 generate a "pop-up" window or populate a dedicate section of screen with audible alarm to inform a user that an alarm has been received;

.3 permit a user with the appropriate security level to acknowledge, temporarily silence, or discard an alarm;

.4 provide an audit trail on PC hard drive for alarms by recording user acknowledgement, deletion or disabling of an alarm, name of the user, alarm, action taken, and time/date of alarm;

.5 facilitate ability to direct alarms to an email address or alphanumeric pager, in addition to pop-up window described above;
.6 any attribute of any object in system may be designated to report an alarm.

.4 Reports and summaries are to be generated and directed to user interface displays with subsequent assignment to printers or discs. Summaries and reports are to be accessible via standard user interface functions, and selection of a single menu item, tool bar item, or tool bar button is to print any displayed report or summary. System is to permit creation of custom reports and queries via a standard web services XML (Extensible Mark-up Language) interface and commercial of-the-shelf software such as Microsoft Access, Microsoft Excel, or Crystal Reports. As a minimum, BAS is to provide following reports and summaries:
.1 all points in BAS;
.2 all points in each BAS application;
.3 all points in a specific controller;
.4 all points in a user-defined group of points;
.5 all points currently in alarm;
.6 all points locked out;
.7 all BAS schedules;
.8 all user defined and adjustable variables, schedules, interlocks, etc.

.5 Graphical display for time-of-day scheduling and override scheduling of building operations is to be provided, with weekly schedules for each group of equipment with a specific time use schedule, and it is to be possible to define one or more exception schedules for each schedule including reference to calendars, with monthly calendars provided to permit simplified scheduling of holidays and special days for a minimum of 5 years in advance, user selected with the pointing device or keyboard. Changes to schedules made from user interface are to directly modify network automation engine schedule database. Selection of a single menu item or tool bar button is to print any displayed schedule. As a minimum, following functions are to be provided:
.1 weekly schedules;
.2 exception schedules;
.3 monthly calendars;
.4 global schedules.

.6 BAS Is to be complete with multiple-level password access protection to permit user/manager to user interface control and display, database manipulation capabilities deemed appropriate for each user, based on an assigned password. Password access protection features are to include:
.1 each user is to have a user name (24 characters minimum), a password (12 characters minimum), and access levels;
.2 each user may change his or her password at any time;
.3 when editing or entering passwords, system is not to echo actual characters for display on monitor;
.4 minimum of 500 unique password is to be supported;
.5 operators are to be able to perform only those commands available for their respective passwords, and display of menu selections is to be limited to only those items defined for access level assigned to password of each user;
.6 BAS is to automatically generate a report of log-on/log-off and system activity for each user, and any action that results in a change in operation or

configuration of control system is to be recorded, including acknowledgement and deletion of alarms;

.7 minimum of 5 levels of access is to be supported individually or in any combination of following:
- .1 Level 1 – view data;
- .2 Level 2 – command;
- .3 Level 3 – operator overrides;
- .4 Level 4 – database modification;
- .5 Level 5 – database configuration;
- .6 Level 6 – all privileges including password add/modify.

.7 User interface is to be equipped with screen management capabilities that allows user to activate, close, and simultaneously manipulate a minimum of 4 active display windows plus a network of user defined navigation trees.

.8 Graphics application program is to be an integral part of user interface and is to include a create/edit function and a runtime function, and system architecture is to support a number of graphic documents (graphic definition files) limited only by memory and computing resources to be generated and executed. Graphics are to be capable of displaying and providing animation based on real-time data that is acquired, derived, or entered. Additional features include following:
- .1 maximum of 16 graphic applications are to be able to be executed at any one time on a user interface or workstation with 4 visible to user, and each graphic application is to capable of following functions:
  - .1 all graphics are to be fully scalable;
  - .2 graphics are to support a maintained aspect ratio;
  - .3 multiple fonts are to be supported;
  - .4 unique background is to be assigned on a per graphic basis;
  - .5 colour of animations and values on displays is to indicate status of object attribute.
- .2 it is to be possible to change values (set-points) and states in system controlled equipment by using drop-down windows accessible via pointing device;
- .3 graphic editing tool is to be provided to permit creation and editing of graphic files, and graphic editor is to be capable of performing/defining animations, defining runtime binding, and:
  - .1 in general, facilitate creation and positioning of point objects by dragging from tool bars or drop-downs and positioning where required;
  - .2 be capable of adding additional content to any graphic by importing backgrounds in the SVG, BMP, or JPG file formats.
- .4 many graphic displays representing part of building and various building components are exact duplicates, with exception that various variables are bound to different field values, consequently, it is to be possible to bind value of a graphic display to aliases, as opposed to physical field tags.

.9 Trend and change of value data is to be stored within the automation engines or server and uploaded to a dedicated trend database or exported in a selectable data format via a data export utility. Uploads to a dedicated database are to occur based on one of user-defined interval, manual command, or when trend buffers are full. Exports are to be as requested by user or on a time scheduled basis. System is to be equipped with a configurable data storage sub-system for collection of historical data which can be stored in either Microsoft Access or SQL

database format. Each automation engine is to store, trend, and point history data for analog and digital inputs and outputs as follows:

.1 any point, physical or calculated, may be designated for trending, and methods of collection are to be defined time interval or a change of value;

.2 each automation engine or server is to capable of storing multiple samples for each physical point and software variable based on available memory, including an individual sample time/date stamp, and points may be assigned to multiple history trends with different collection parameters.

.10 Trend viewing utility with access to data points and capability of defining trend study displays to include multiple trends is to be provided, and is to include:

.1 capability of retrieving any historical database point for use in displays and reports by specifying point name and associated trend name;

.2 displays which are able to be single or stacked graphs with on-line selectable display characteristics such as ranging, colour, and plot style;

.3 display magnitude (zoom capability) and units selectable by operator at any time without reconfiguration of processing or collection of data;

.4 display magnitude is to be automatically scaled to show full graphic resolution of data being displayed;

.5 trend studies are to be capable of calculating and displaying calculated variables including highest value, lowest value, and time based;

.6 display is to support user's ability to change colours, sample sizes, and types of markers.

.11 BAS is to be equipped with a database manager that separates database monitoring and management functions by supporting 2 separate windows. Database secure access is to be accomplished using standard SQL authentication including ability to access data for use outside of BAS application. Additional features are as follows:

.1 database management function is to include summarized information on trend, alarm, event, and audit for backup, purge, and restore database management functions;

.2 database manager is to support 4 tabs as follows:

.1 statistics, which is to display database server information and trend, alarm (event), and audit information on BAS database;

.2 maintenance, which is to be an easy method of purging records from BAS server trend, alarm (event), and audit databases by supporting separate screens for creating a backup prior to purging, selecting database, and allowing for retention of a selected number of day's data;

.3 backup, which is to provide means to create a database backup file and select a storage location;

.4 restore, which is to provide a restricted means of restoring a database by requiring user to log into an Expert Mode in order to view Restore screen.

.3 status bar is to appear at bottom of BAS database manager tabs and is to indicate information on current display activity with icons as follows:

.1 Ready;

.2 Purging Record From Database;

.3 Action Failed;

.4 Refreshing Statistics;

.5 Restoring Database;
.6 Shrinking A Database;
.7 Backing-Up A Database;
.8 Resetting Internet Information Services;
.9 Shutting Down BAS Deice Manager;
.10 Action Successful.

.4 database manager monitoring functions are to be accessed through Monitoring Settings window and are to continuously read database information once user has logged in;

.5 system is to advise user via task bar icons and email messages when a database value has exceeded a warning or alarm limit;

.6 Monitoring Settings window is to have following sections:
.1 General: allow user to set and review scan intervals and start times;
.2 Email: allow user to create and review email and telephone text messages to be delivered when a warning or alarm is generated;
.3 Warning: allow user to define warning limit parameters, set reminder frequency, and link email message;
.4 Alarm: allow user to define alarm limit parameters, set reminder frequency, and link email message;
.5 Database Login: protect system from unauthorized database manipulation by creating a read access and write access for each trend, alarm (event), and audit databases as well as an Expert Mode required to restore a database.

.7 Monitoring Settings taskbars to display following informational icons:
.1 Normal: indicates by colour and size that databases are within their limits;
.2 Warning: indicates by colour and size that one or more databases have exceeded their warning limit;
.3 Alarm: which indicates by colour and size that one or more databases have exceeded their alarm limit.

.8 BAS is to indicate via taskbar icons and email messages when a database value has exceeded a warning or alarm limit;

.12 BAS is to be equipped with a demand limiting and load rolling program for purpose of limiting peak energy usage and reducing overall energy consumption. Program is to support both Sliding Window and Fixed Window methods of predicting demand. Additional features are as follows:
.1 system is to support 3 levels of sensitivity in Sliding Window demand calculations for fine tuning the system, as follows:
.1 Low Setting: sheds loads later and over shortest period of time and maximizes period of time equipment is on;
.2 Medium Setting: sheds loads earlier over a period of time greater than Low Setting, and increases time equipment is on and decreases probability of exceeding "Tariff Target";
.3 High Setting: sheds loads earlier and over a longer period of time than Medium Setting to minimize probability of exceeding "Tariff Target".

.2 system is to have both a Shed Mode and a Monitor Only Mode of operation, as follows:
.1 when Shed Mode is engaged, system is to actively control demand;
.2 when Monitor Mode is engaged, system is to simulate shedding action but will not take any action.

.3 Demand Limiting Program is to monitor energy consumption rate and compare it to a user defined "Tariff Target", and maintain consumption below target by selectively shedding loads based on a user defined strategy;

.4 Demand Limiting Program is to be capable of supporting a minimum of 10 separate load priorities, with each load user assigned, and a minimum of 12 separate "Tariff Targets" defining maximum allowed average power usage during current interval;

.5 system is to support a maximum shed time for each load as determined by user, and system is to restore load before maximum shed time has expired;

.6 system is to support a minimum shed time for each load as determined by user, and system is not to restore load before minimum shed time has expired;

.7 system is to support a minimum release time for each load as determined by user, and system is not to shed load until it has been off for minimum release time;

.8 system is to support three user defined options if meter does not function properly, as follows:

- .1 shedding – currently shed loads will be released as their maximum shed time expires;
- .2 maintain current shed rate – system will use demand limiting shed rate that was present when meter began to function improperly;
- .3 use unreliable meter shed rate – system is to control to a user defined unreliable shed rate target.

.9 Load Rolling Program is to sum the loads currently shed and compare sum to a user defined load rolling target, and system is to maintain consumption below target by selectively shedding loads based on a user defined load priority;

.10 Load Rolling Program is to be capable of supporting a minimum of 10 separate load priorities with each load user defined to a load priority;

.11 Load Rolling Program is to be capable of supporting a minimum of 12 separate "Tariff Targets" defining amount of energy by which demand must be reduced;

.12 system is to equip user with a Load Tab that displays all demand limiting and load rolling parameters for any selected load;

.13 system is to be complete with a Load Summary that displays all loads associated with demand limiting and load rolling program, and status icons for each load are to indicate:

- .1 Load Is Offline;
- .2 Load Is Disabled;
- .3 Load Is Shed;
- .4 Load Is Locked;
- .5 Load Is In Comfort Override.

.14 Load Summary is to include a load summary runtime view listing following load conditions:

- .1 Load Priority;
- .2 Shed Strategy;
- .3 Load Rating;
- .4 Present Value;
- .5 Ineligible Status;
- .6 Active Timer;
- .7 Time Remaining;

.8 Last Shed time.

2.6 NETWORK AUTOMATION ENGINES

.1 Network automation engines are to be ULC listed and labelled, BACnet Testing Labs (BTL) certified and labelled, fully user programmable supervisory controllers to monitor a network of a minimum of 100 distributed application-specific controllers for a global strategy and direction and to communicate on a peer-to-peer basis with other network automation engines.

.2 Each network automation engine is to have ability to deliver a web based user interface as specified above, and computers connected physically or virtually to automation network are to have access to web-based user interface. Additional characteristics/requirements are as follows:

- .1 web-based user interface software is to be imbedded in each network automation engine;
- .2 each network automation engine is to support a minimum of 4 concurrent users;
- .3 user is to be capable of accessing all system data through one network automation engine;
- .4 remote users connected to network through an internet service provider or by telephone dial-up are also to have total system access through one network automation engine;
- .5 each network automation engine is to be capable of generating web-based user interface graphics, and this capability is to be imbedded in network automation engine;
- .6 user interface is to support following functions using a standard version of Microsoft Internet Explorer:
  - .1 configuration;
  - .2 commissioning;
  - .3 data archiving;
  - .4 monitoring;
  - .5 commanding;
  - .6 system diagnostics.
- .7 each network automation engine is to permit temporary use of portable devices without interrupting normal operation of permanently connected modems.

.3 Each network automation engine is to be a multi-tasking, multi-user, microprocessor-based real time digital control processor sized to meet requirements of system with a minimum word size of 32 bits, and standard operating systems.

.4 Each network automation engine is to have sufficient memory to support its own operating system, databases, and control programs to provide supervisory control for control level devices.

.5 Each network automation engine is to include an integrated, hardware based real time clock.

.6 Each network automation engine is to be equipped with LED indicators to identify following conditions:

.1 Power, On/Off;
.2 Ethernet Traffic, Ethernet Traffic/No Ethernet Traffic;
.3 Ethernet Connection Speed, 10 Mbps/100 Mbps;
.4 FC Bus A, Normal Communications/No Field Communications;
.5 FC Bus B, Normal Communications/No Field Communications;
.6 Peer Communication, Data Traffic Between Network Automation Engines;
.7 Run, NAE Running/NAE in Start-up/NAE Shutting Down/Software Not Running;
.8 Battery Fault, Battery Defective/Data Protection Battery Not Installed;
.9 24 VAC, 24 VAC Present/Loss of 24 VAC;
.10 Fault, General Fault;
.11 Modem RX, NAE Modem Receiving Data;
.12 Modem TX, NAE Modem Transmitting Data.

.7 Each network automation engine is to be equipped with ports for operation of operator input/output devices such as industry standard computers, modems, and portable operator's terminals. Ports are to be as follows:
.1 2 USB ports;
.2 2 URS-232 serial data communication ports;
.3 2 RS-485 ports;
.4 one Ethernet port.

.8 Each network automation engine is to continually perform self-diagnostics, communications diagnostics, and diagnostics of all pane components, and transmit both local and remote annunciation of any detected component failure, low battery condition, and repeated failures to establish communication.

.9 In event of loss of normal power each network automation engine is to continue to operate for a user adjustable period of up to 10 minutes after which there is to be an orderly shut-down of all programs to prevent loss of database or operating system software, and:
.1 during a loss of normal power, control sequences are to go to normal system shutdown conditions, and critical configuration data is to be saved into Flash memory;
.2 upon restoration of normal power and after a minimum off-time delay, controller is to automatically resume full operation through a normal soft-start sequence without manual intervention.

2.7 FIELD EQUIPMENT CONTROLLERS

.1 Each field equipment controller is to be a fully user programmable BACnet Testing Labs (BTL) certified and labelled digital controller that communicates via BACnet MS/TP protocol. Each controller is to be housed in a plenum rated plastic housing with removable base to permit pre-wiring of analog and binary input/output field points without controller in place.

.2 Each controller is to employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences, and is to be factory programmed with a continuous adaptive tuning algorithm that sense changes in physical environment and continually adjusts loop tuning parameters appropriately.

.3 Each field equipment controller is to:
- .1 include troubleshooting LED's to identify following conditions:
  - .1 Power On;
  - .2 Power Off;
  - .3 Download or Start-Up In Progress-Not Ready For Normal Operation;
  - .4 No Faults;
  - .5 Device Fault;
  - .6 Field Controller Bus-Normal Data Transmission;
  - .7 Field Controller Bus-No Data Transmission;
  - .8 Field Controller Bus-No Communication;
  - .9 Sensor Actuator Bus-Normal Data Transmission;
  - .10 Sensor Actuator Bus-No Data Transmission;
  - .11 Sensor Actuator Bus-No Communication.
- .2 support universal inputs, configured to monitor any of following:
  - .1 analog input, voltage mode;
  - .2 analog output, current mode;
  - .3 analog input, resistive mode;
  - .4 binary input, dry contact maintained mode;
  - .5 binary input, pulse counter mode.
- .3 support binary inputs configured to monitor either of following:
  - .1 dry contact maintained mode;
  - .2 pulse counter mode.
- .4 support analog outputs configured to output either of following:
  - .1 analog output, voltage mode;
  - .2 analog output, current mode.
- .5 support binary outputs, 24 VAC Triac;
- .6 support configurable outputs capable of following:
  - .1 analog output, voltage mode;
  - .2 binary output mode.
- .7 have ability to reside on a master-slave/token-passing field controller bus supporting BACnet standard protocol as follows:
  - .1 support communications, including input/output communications between field controllers and network automation engines;
  - .2 support a minimum of one hundred input/output modules and field equipment controllers in any combination;
  - .3 operate at a maximum distance of 4560 m (15,000') between field controller and furthest connected device.
- .8 have ability to monitor and control a network of sensors and actuators over a master-slave/token-passing sensor-actuator bus supporting BACnet standard protocol as follows:
  - .1 bus is to support a minimum of ten devices per trunk;
  - .2 bus is to operate at a maximum distance of 365 m (1200') between field controller and furthest connected device.
- .9 capability of executing complex control sequences involving direct wired input/output points as well as input and output devices communicating over field controller bus or sensor-actuator bus;
- .10 support, but not limited to, following:
  - .1 hot water, chilled water/central plant applications;
  - .2 custom air handling units for special applications;
  - .3 terminal units;
  - .4 special programs as required for systems control.

.11 support a password protected local controller LCD back-lit display with 6 key keypad as an integral part of field controller or as a remote device communicating over sensor-actuator bus to permit user to view monitored points without logging into system, and to view and change set-points, modes of operation, and parameters.

2.8 INPUT/OUTPUT MODULES

.1 Input/output modules to facilitate additional inputs and outputs for use in field equipment controllers are to be similar to field equipment controllers but less display and with a minimum of 4 and a maximum of 17 points.

2.9 SYSTEM CONFIGURATION TOOLS

.1 System configuration tool is a software package supplied with BAS to enable a computer platform to be used as a stand-alone engineering configuration tool for a network automation engine and to permit programming of field equipment controllers. Configuration tool is to provide an archive database for configuration and application data and is to have same look and feel at user interface regardless of whether configuration is being done online or offline. Additional features and characteristics are as follows:

- .1 tool is to include:
  - .1 basic system navigation tree for connected networks;
  - .2 integration of system enabled devices;
  - .3 customized user navigation tress;
  - .4 point naming operator parameter setting;
  - .5 graphic diagram configuration;
  - .6 alarm and event message routing;
  - .7 graphical logic connector tool for custom programming;
  - .8 downloading, uploading, and archiving databases.
- .2 tool is to have capability to automatically discover field devices on connected buses and networks;
- .3 tool is to be capable of configuring from a library of standard applications, simulating to verify applications, and commissioning field equipment controllers and field devices;
- .4 tool is to be complete with a Bluetooth Wireless Technology wireless access point to enable a wireless enabled portable computer to make a temporary Ethernet connection to automation network.

.2 Bluetooth Wireless Technology converter is to provide temporary wireless connection between sensor-actuator bus or field-controller bus and a wireless enabled portable computer. Converter is to be powered through a connection to either sensor-actuator bus or the field-controller bus and is to support downloading and troubleshooting field equipment controllers and field devices from portable computer over wireless connection. Converter is to be complete with LED indicators for following conditions:

- .1 Power: On/Off;
- .2 Fault: Fault/No Fault;
- .3 SA/FC Bus: Bus Activity/No Bus Activity;
- .4 Bluetooth: Bluetooth Communication Established/Bluetooth Communication Not Established.

2.10 **WIRING MATERIALS**

.1 System wiring, conduit, boxes, and similar materials are to be in accordance with requirements specified in Division 26 - Electrical.

3 Execution

3.1 **GENERAL RE: INSTALLATION OF THE BAS**

.1 Provide a complete building automation system in accordance with requirements of this Section of the Specification, Section 25 05 01 - Automatic Control Systems, drawings, and the input/output points list(s).

.2 Unless otherwise specified, perform BAS work in accordance with system manufacturer's instructions.

3.2 **INSTALLATION OF DIRECT DIGITAL CONTROL SYSTEM COMPONENTS**

.1 Provide required direct digital control hardware, software, accessories, and wiring for a complete BAS. Refer to drawing control diagrams and sequences, points list(s), and Section 25 05 01 - Automatic Control Systems.

.2 Provide operator workstation in a location as directed by the Owner.

.3 DDC work is to be performed by skilled technicians, properly trained and are qualified for this work.

.4 Materials and equipment used are to be standard components, regularly manufactured for this and/or other systems, and not custom designed especially for this project. Systems and components are to have been thoroughly tested and proven in actual use.

.5 System is to be modular, permitting expansion by adding hardware and software without changes in communication or processing equipment.

.6 Provide new communications bus as required complete with required ancillaries. Connect and extend existing communications bus.

.7 Provide 1 supervisory controller (SC) per cabinet fan (air handler). Provide necessary field equipment controllers (FEC).

.8 Provide necessary quantity of SC to accomplish requirements of this specification, and to minimize number of mechanical systems that would be inoperative in event of a FEC failure. A maximum of 2 major mechanical systems are to be controlled by 1 FEC.

.9 Surface wall mount SC and FEC control units in Mechanical Rooms ensuring they are not mounted on vibrating surfaces, and connect to 15A-1P circuit breakers dedicated for control system applications, in branch panel circuit boards in adjacent spaces. Power wiring from control units to circuit breakers is to be the responsibility of the controls contractor. Wiring is to be in conduit and conduit and wiring are to be in accordance with standards and requirements of Division 26 -

Electrical. Refer to electrical drawings for locations of branch circuit panelboards with dedicated circuits for controls system applications.

.10 Indicate via number, and systems controlled by SC and FEC. Indicate via a lamacoid label mounted inside panel the identification number of electrical panel supplying power to SC and FEC.

.11 Submit schedule(s) of input/output points to Consultant for review. Directly connect each SC and FEC to point devices in accordance with control diagrams and schedule of miscellaneous control points as shown on drawings. Sensor wires for each analogue input are to be No. 18 AWG twisted-shielded cable. Other types of wire required are to be as recommended by system supplier.

.12 Provide required sensors, remote devices, etc., and required interface accessories. Mount duct and/or plenum sensors half-way across duct or plenum.

.13 Differential pressure sensor used to provide space pressurization control through regulation of return air quantities must be mounted with snubbers on indoor pressure leg to prevent sudden fluctuations caused by door openings, etc. Mount outdoor air ports in locations that minimize effects of abnormal surface flow conditions and wind gusts.

.14 Supply and turn over to Consultant prior to application for a Certificate of Substantial Performance of the Work, reports to be used in assisting Owner in defining and debugging DDC programs. These reports are to consist, as a minimum, of following:
- .1 process control language (PCL) logs;
- .2 control loop logs;
- .3 PCL master point.

.15 Submit Point Data Input forms to Consultant that Owner will fill out with DDC system supplier's assistance. Input this point data into the system.

.16 Contacts will be supplied as part of mechanical work or electrical work for alarm and status points for systems and equipment other than building environmental systems and equipment. Connect to DDC system in accordance with point schedule.

3.3 CONTROL WIRING

.1 Perform required control wiring work for control systems except:
- .1 power wiring connections to equipment and panels, except as noted below;
- .2 control wiring associated with mechanical plant equipment and systems whose control is not part of work specified in this Section;
- .3 starter interlock wiring.

.2 Except as specified below, install wiring in conduit. Unless otherwise specified, final 600 mm (2') connections to sensors and transmitters, and wherever conduit extends across flexible duct connections is to be liquid-tight flexible conduit.

.3 Control wiring in ceiling spaces and wall cavities may be plenum rated cable installed without conduit but neatly harnessed, secured, and identified.

.4 Wiring work is to be in accordance with BAS manufacturer's certified wiring schematics and instructions, and wiring standards specified in electrical work Division of this Specification.

3.4 IDENTIFICATION AND LABELLING OF EQUIPMENT AND CIRCUITS

.1 Refer to Section 20 05 00 – Common Work Results for Electrical.

.2 Identify BAS equipment as follows:
- .1 enclosures: engraved laminated nameplates with lettering such as BAS Panel CP2, or BAS Relays, or BAS E/P Transformers, with all wording listed and approved prior to manufacture of nameplates;
- .2 panel points: a weather-proof input/output layout sheet for each controller with the name of each point connected to controller, and associated wire labelling information;
- .3 wiring: numbered sleeves or plastic rings at both ends of conductor, with numbering corresponding to conductor identification on shop drawings and "as-built" record drawings;
- .4 interface components: a weather-proof layout sheet clearly illustrating/identifying purpose of each component within enclosure such that an operator or service technician can quickly identify exact use of each relay, transducer, contactor, etc., with each sheet fastened securely to back of enclosure door.

3.5 TESTING, ADJUSTING, CERTIFICATION, START-UP, AND TRAINING

.1 Refer to Section 20 05 00 – Common Work Results for Electrical for equipment/system manufacturer certification requirements.

.2 Refer to Section 20 05 00 – Common Work Results for Electrical for equipment/system start-up requirements.

.3 Include for demonstration and training sessions for each of 2 groups of Owner's operating and maintenance personnel as follows:
- .1 3 full, 8 hour day orientation sessions at system manufacturer's office to educate personnel on BAS architecture, hardware, and software, with an overview of BAS operation and capabilities including but not limited to operational programmes, equipment functions (both individually and as part of a total integrated system), BAS commands, advisories, alarms, and appropriate operator intervention required in responding to BAS operation;
- .2 2 full, 8 hour day sessions at site using BAS for a "hands-on" demonstration of BAS functions and features with instruction regarding chronological flow of information from field devices, contacts and sensors to operator's workstation, an overview of communications network describing interplay between initiating devices, field hardware panels, systems communications, and their importance within operating BAS, and alarm indications and appropriate responses;
- .3 2 full, 8 hour day seasonal (summer-winter) site sessions to perform additional instruction regarding seasonal changes and how they affect BAS.

.4 Include for 2 follow-up site training and troubleshooting visits, one 6 months after Substantial Completion and other at end of warranty period, both when arranged by Owner and for a full day to provide additional system training as required.

3.6 PROJECT CLOSEOUT WORK

.1 Record "as-built" drawings are to include:
- .1 schematic outline of BAS for quick reference of overall system scope;
- .2 adequate record of work as installed, including locations and routing of system wiring.

.2 O&M Manual is to include:
- .1 hardware specification manual which gives a functional description of hardware components;
- .2 operator's manual which outlines concise instructions for operation of system and an explanation and recovery route for system alarms;
- .3 engineering manual which outlines and defines system set-up, definition and application;
- .4 data manual which indicates applications data programmed into system;
- .5 system software documentation.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Common requirements for electrical work.

.2 Mounting heights for electrical equipment and devices.

1.2 **RELATED REQUIREMENTS**

.1 Provisions of this section apply to all sections of Division 26, and Division 27.

.2 Document 00 64 01 – Request Form for Electronic Files.

.3 Division 07

.4 Division 08

.5 Division 09

.6 This section is to be read in conjunction with Division 00 documents, and Division 01 specification sections, which take precedence as described in CCDC 2-2008.
- .1 General Conditions.
- .2 Supplementary General Conditions.
- .3 General Requirements.

1.3 **INTENT**

.1 Include all material, labour, equipment, and plant construction as necessary to make a complete installation as shown and specified hereinafter.

.2 Leave complete systems ready for continuous and efficient satisfactory operation.

.3 Discipline and Trade Jurisdiction
- .1 In accordance with CCDC 2-2008 GC 1.1.7: Neither the organization of the Specifications nor the arrangement of Drawings shall control the Contractor in dividing the work among Subcontractors and Suppliers.
- .2 MasterFormat's organizational structure used in a project manual does not imply how the work is assigned to various design disciplines, trades, or subcontractors. MasterFormat is not intended to determine which particular elements of the project manual are prepared by a particular discipline. Similarly, it is not intended to determine what particular work required by the project manual is the responsibility of a particular trade. A particular discipline or trade is likely to be responsible for subjects from multiple Divisions, as well as from multiple Subgroups.

1.4 **DRAWINGS AND SPECIFICATIONS**

.1 The drawings and specifications are complementary each to the other and what is called for by one to be binding as if called for by both. Should any discrepancy appear between the drawings and specifications, which leaves the Contractor in doubt as to the true intent and meaning of plans and specifications, a ruling is to be obtained from the Consultant in writing before submitting Bid. If this is not

done, the maximum, the most expensive alternate or option will be provided in base tender bid.

.2 All drawings and all Divisions of these specifications shall be considered as a whole, and work of this Division shown anywhere therein shall be furnished under this Division.

.3 Drawings are diagrammatic and indicate the general arrangement of equipment and pathways. Most direct routing of conductors and wiring is not assured. Exact requirements are governed by architectural, structural, and mechanical conditions of the job. Consult all other drawings in preparation of the bid. Extra lengths of wiring or addition of pull and junction boxes, etc. necessitated by such conditions are to be included in the bid. Check all information and report and apparent discrepancies before submitting the bid.

.4 Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pathways so as to best fit the layout of the job.

.5 Scaling off the drawings will not be sufficient or accurate for determining these locations. Where job conditions require reasonable changes in indicated arrangement and locations, such changes shall be made at no additional cost to the Owner.

.6 Because of the scale of the drawings, certain basic items, such as junction boxes, pull boxes, conduit fittings, etc. may not be shown, but where such items are required by other sections of the specifications of where there are required for proper installation of the work, such items are to be furnished and installed.

.7 Before ordering any conduit, cable tray, conductors, wireways, raceway bus duct, fittings, etc., verify all pertinent dimensions at the job site and be responsible for their accuracy.

.8 If obvious ambiguities or omissions are noticed when tendering refer same to the Consultant for a ruling and obtain the ruling in writing in the form of an Addendum. Claims for extras for ambiguities or omission of items brought to the attention of the Consultant after the award of a contract which, due to the nature of the ambiguity or omission, should have been brought to the attention of the Consultant during the tendering period, will not be allowed.

.9 The drawings are performance drawings, diagrammatic, and show locations for apparatus and materials. The drawings are intended to convey the scope of work and do not intend to show Architectural and Structural details. The locations shown are approximate, and may be altered, when approved by the Consultant, to meet requirements of the material and/or apparatus, other equipment and systems being installed, and of the building. Do not scale drawings.

.10 Provide any fitting, offset, transformation, etc., required to suit architectural and structural details but not shown.

1.5 WORK RESTRICTIONS

.1 Refer to Division 01.

.2 Existing buildings:

.1 Examine the existing building, the site and surrounding areas and by fully informed as to the conditions and limitations under which the work has to be executed. Claims for additional costs will not be entertained with respect to conditions which could reasonably been ascertained by an inspection prior to Tender closing.
.2 All work in the existing building, other than minor works required to permit construction of the new addition, is to be performed in such a manner as to not disrupt the building operations.
.3 All systems are to be kept in full operation during normal building hours.
.4 Note that any noise generating works that disrupt the building operation shall be coordinated accordingly and carried out after/before normal operating hours.
.5 Cut, modify, or extend as necessary or as directed by the Consultant, the existing material or equipment to be reused or relocated to suit work under this contract.
.6 Existing materials and equipment which are to be used in new work shall be repaired and refinished as necessary. Provide additional new materials and components as required to facilitate reinstallation of such existing materials and equipment.
.7 Co-ordinate with the Owner, and refer to General Conditions.
.8 Do work in existing areas to best suit available space and not interfere with or obstruct use of existing facilities.
.9 Where disruptions of existing services are required, coordinate shut down with the Owner's operating staff and do the work at a time and in a manner mutually acceptable. Carefully schedule disruptions to keep "down time" to a minimum.

.3 Do all cutting, patching and making good to leave in a finished condition and to make the several parts of the Work come together properly. Co-ordinate work to keep cutting and patching to a minimum.

.4 Quality of workmanship and materials used in patching, making good and refinishing of existing construction and/or compartments shall be of a standard equal to that specified for new construction and if not specified, equal to or exceeding that of original existing work.

.5 Prior to cutting openings, examine wall, floor and ceiling construction for buried electrical cables and pipes; and take adequate protection. Conduct cable locating tests to locate buried cables in existing work.

1.6 **SUBSTITUTION PROCEDURES**

.1 Refer to Division 01 and General Provisions of the Contract.

.2 Additionally, "Approved Equal" shall be defined as an alternate approved by the Consultant.

.3 If during the tender bid process, the bidding contractor wishes to substitute the specified equipment for an "Approved Equal", the bidding contractor must submit shop drawings to the Consultant before the tender close for approval. If no substitution request is made, the as-specified equipment is that to be provided.

.4 Where several manufacturers' names are given, the first named manufacturer constitutes the basis for job design and establishes the equipment quality required to be used in this contract.

.5 This contractor, at his option, may use equipment as manufactured by the other manufacturers if listed. This contractor is responsible to ensure that all items submitted by these other manufacturers meets are requirements of the drawings and specification and fits in the allocated space. The final determination of a product being equivalent is to be determined by the Consultant when a catalog number is not listed, or listed in part.

.6 Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Consultant as described in the General Provisions of the Contract for Submittals. The Contractor bears full responsibility for the unnamed manufacturers' equipment adequately meeting the intent of the design. The Owner or the Consultant may reject manufacture at time of shop drawing submittal.

1.7 CONTRACT MODIFICATION PROCEDURES

.1 When submitting quotations in response to changes in the contract, quotations for electrical work are to include a breakdown of all material, including material unit rates, and labour units as indicated in the NECA Manual of Labor Units (MLU).

1.8 COORDINATION

.1 Refer to Division 01.

.2 Coordinate work with other trades to avoid conflict and to provide correct rough-in and connection for equipment furnished under other trades that require electrical connection. Inform Contractors of other trades of the required access to and clearances around electrical equipment to maintain serviceability and code compliance.

.3 Verify equipment dimensions and requirements with provision specified under this Section. Check actual job conditions before fabricating work. Report necessary changes in time to prevent needless work. Changes or additions subject to additional compensation, which are made without written authorization and an agreed price, shall be at Contractor's risk and expense.

.4 Read specifications and drawings of other trades and conform with their requirements before proceeding with any work specified in this Division related to other trades. Co-operate with all other trades on the job, so that all equipment can be satisfactorily installed, and so that no delay is caused to any other trades.

.5 Coordinate utility service outages with the owner. Obtain permission from Owner at least 24 hours before partially or completely disabling system. Minimize outage duration.

.6 Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.

.7 Co-ordinate work with all trades to ensure a proper and complete installation. Notify all trades concerned of the requirement for openings, sleeves, insets and other hardware necessary for the installation and, where work is to be integrated with the work of other trades or is to be installed in close proximity with the work of other trades, carefully co-ordinate the work prior to installation.

.8 Working Detail Drawings

.1 The contractor is to prepare working detail drawings supplementary to the contract drawings, when deemed necessary by the Consultant, for all areas where a multiplicity of materials and or apparatus occur, or where the work due to architectural and structural considerations involves special study and treatment. Such drawings may be prepared jointly by all trades affected, or by the one trade most affected with due regard for and approval of the other trades, all as the Consultant will direct in each instance. Such drawings must be reviewed by the Consultant before the affected work is installed.

.2 Carry out all alterations in the arrangement of work which has been installed without proper study and approval, even if in accordance with the contract documents, in order to make such work come within the finished lines of walls, floors and ceilings, or to allow the installation of other work, without additional cost. In addition, make any alterations necessary in other work required by such alterations, without additional cost.

1.9 **SUBMITTAL PROCEDURES**

.1 Refer to Division 01.

.2 Before delivery to site of any item of equipment, submit shop drawings complete with all data, pre-checked and stamped accordingly, for review by the Consultant. Indicate project name on each brochure or sheet, make reference to the number and title of the appropriate specification section, type identifier such panelboard ID or luminaire type as indicated on appropriate schedule, and provide adequate space to accommodate the Consultant’s review stamp(s).

.3 Verify field measurements and affected adjacent Work are coordinated, including passageway clearances for movement of equipment into location.

.4 Submit shop drawings to the Consultant in electronic (PDF) format, as coordinated after award of contract. Where submittals are derived from digital originals, do not print and rescan documents; submittals made as such will be immediately rejected.

.5 Submit a schedule of shop drawings within one week after award of contract. Group submittals by specification division as appropriate.

.6 Shop Drawings

.1 Submit for review, properly identified shop drawings showing in detail the design and construction of all equipment and materials as requested in sections of the specification governed by this Section.

.2 Obtain and comply with the manufacturer's installation instructions.

.3 Endorse each shop drawing copy "CERTIFIED TO BE IN ACCORDANCE WITH ALL REQUIREMENTS", stamp each copy with your company name, date each copy with the submittal date, and sign each copy. Shop drawings which are received and are not endorsed, dated and signed will be returned for re-submittal.

.4 The Consultant will stamp shop drawings as follows:

.1 Reviewed ( )
.2 Reviewed as Modified ( )
.3 Revise and Re-Submit( )
.4 Not Reviewed ( )

.5 If "REVIEWED" is checked-off, the shop drawing is satisfactory. If "REVIEWED AS MODIFIED" is checked-off, the shop drawing is satisfactory subject to requirements of remarks put on shop drawing copies. If "REVISE AND RE-SUBMIT" is checked-off, the shop drawing is entirely unsatisfactory and must be revised in accordance with comments written on shop drawing copies and resubmitted. If "NOT REVIEWED" is checked-off, the shop drawing is in error of submission, not applicable for this project.

.6 This review by the Consultant is for the sole purpose of ascertaining conformance with the general design concept. This review shall not mean that the Consultant approved the detail design inherent in the shop drawings, responsibility for which shall remain with the Contractor, and such review shall not relieve the Contractor of responsibility for errors or omissions in the shop drawings or of responsibility for meeting all requirements of the contract documents. Be responsible for dimensions to be confirmed and correlated at the job site, for information that pertains solely to fabrication processes or to techniques of construction and installation, and for co-ordination of the work as well as compliance with codes and inspection authorities such as CSA, etc.

1.10 SAFETY REQUIREMENTS

.1 Refer to Division 01.

.2 Be responsible for the safety of workers and the equipment on the project in accordance with all applicable safety legislation passed by Federal, Provincial, and local authorities governing construction safety. The more stringent regulations prevail.

1.11 REGULATORY REQUIREMENTS

.1 Refer to Division 01.

.2 Codes and Standards

.1 Ontario Electrical Safety Code c/w Bulletins and Amendments.
.2 Ontario Building Code and its referenced standards.
.3 Applicable CSA and ULC Standards.

.3 Permits and Fees

.1 Obtain and pay for all permits and fees required for the execution and inspection of the electrical work and pay all charges incidental to such permits. Submit to Electrical Inspection Department and Supply authority necessary number of drawings and specifications for examination and

approval prior to commencement of work. Arrange and pay for any special inspection of equipment specified if and when required.

.2 Apply, pay and obtain all permits as required for the electrical work.

.3 Upon substantial completion of your work, supply and turn over to the Consultant all required inspection certificates from governing authorities to certify that the work as installed conforms to the rules and regulations of the governing authorities.

.4 Patents

.1 Pay all royalties and licence fees, and defend all suits or claims for infringement of any patent rights, and save the Owner, Architect, Project Manager and Consultants harmless of loss or annoyance on account of suit, or claims of any kind for violation or infringement of any letters patent or patent rights, by this Subcontractor or anyone directly or indirectly employed by him or by reason of the use by him or them of any part, machine, manufacture or composition of matter on the work, in violation or infringement or such letters patent or rights.

1.12 REFERENCES

.1 Canadian Standards Association

.1 CSA-C22.1-12, Canadian Electrical Code, Part 1 (22nd Edition), Safety Standard for Electrical Installations.

.2 CAN3-C235-83(R2006), Preferred Voltage Levels for AC Systems, 0 to 50 000 V.

.3 Do underground systems in accordance with CSA C22.3 No.7-06, Underground Systems, except where specified otherwise.

.4 Ontario Electrical Safety Code, 25th Edition / 2012.

.2 Electrical and Electronic Manufacturer's Association of Canada (EEMAC)

.1 EEMAC 2Y-1-1958, Light Gray Colour for Indoor Switch Gear.

.3 Health Canada / Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

.4 Ontario Electrical Safety Code, 25th Edition / 2012, and all bulletins.

.5 Hydro requirements and local applicable codes and regulations.

.6 Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC)

.1 IEEE SP1122-2000, The Authoritative Dictionary of IEEE Standards Terms, 7th Edition.

1.13 DEFINITIONS

.1 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE SP1122.

1.14 QUALITY ASSURANCE

.1 Refer to Division 01.

.2 The specifications contained herein are set forth as the minimum acceptable requirements. This does not relieve the Contractor from executing other quality assurance measures to obtain a complete operating system within the scope of this project.

.3 Ensure that all workmanship, all materials employed, all required equipment and the manner and method of installation conforms to accepted construction and engineering practices, and that each piece of equipment is in satisfactory working condition to satisfactorily perform its functional operation.

.4 Provide quality assurance tests and operational check on all components of the electrical distribution system, all lighting fixtures, and communication systems.

.5 Only first class workmanship will be accepted, not only in regards to durability, efficiency and safety, but also in regards to neatness of detail. Present a neat and clean appearance on completion to the satisfaction of the Consultant. Any unsatisfactory workmanship will be replaced at no extra cost.

.6 Conform to the best practices applicable to this type of work. Install all equipment and systems in accordance with the manufacturer's recommendations, but consistent with the General Requirements of this specification. Electrical Contractor will be held responsible for all damage to the work of his own or any other trade, resulting from the execution of his work. Store all electrical equipment and materials in dry locations.

.7 Provide foreman in charge of this work at all times.

.8 The contractor shall be fully liable to provide and maintain in force during the life of this Contract, such insurance, including Public Liability Insurance, Product Liability Insurance, Auto Liability Insurance, Worker’s Compensation, and Employer’s Liability Insurance.

.9 Governing Federal, Provincial and Municipal codes and regulations will be considered minimum standards for the work and where these are at variance with the drawings and specification, the more stringent ruling will apply.

.10 Where any code, regulation, bylaw, or standard is quoted it shall mean the current edition including all revisions or amendments at the time of the tender.

.11 In case of conflict, the codes and regulations take precedence over the Contract Documents. In no instance reduce the standard or scope of work or intent established by the drawings and specifications by applying any of the codes referred to herein.

1.15 **QUALITY CONTROL**

.1 Refer to Division 01.

.2 Provide a full time Superintendent to oversee and coordinate all sub-trades in these divisions.

1.16 **TEMPORARY UTILITIES**

.1 Refer to Division 01.

.2 Do not use any of the permanent facility systems during construction except as may be specified, or unless written approval is obtained from the Consultant.

.3 The use of permanent facilities for temporary construction service will not affect in any way the commencement day of the warranty period.

.4 Temporary heating during the construction period will be provided as described in Division 01.

1.17 TEMPORARY FACILITIES AND CONTROLS

.1 Refer to Division 01.

.2 Prior to start of each work period in occupied area, install temporary protection to prevent damage to any personal property or furnishing. Coordinate with Owner's representative if any furniture must be relocated to facilitate work.

.3 Take necessary steps to ensure that required firefighting apparatus is accessible at all times. Flammable materials shall be kept in suitable places outside the building.

1.18 PRODUCT REQUIREMENTS

.1 Refer to Division 01.

.2 The design, manufacture and testing of electrical equipment and materials shall conform to or exceed the latest applicable CSA, IEEE, and ANSI standards.

.3 All materials must be new and be ULC or CSA listed. Any materials not covered by the aforementioned listing standards shall be tested and approved by an independent testing laboratory, Technical inspection Services, or other government agency.

.4 Materials and equipment are specifically described and named in this Specification in order to establish a standard of material and workmanship.

.5 Materials required for performance of work shall be new and the best of their respective kinds and of uniform pattern throughout work.

.6 Materials shall be of Canadian manufacture where obtainable. Materials of foreign manufacture, unless specified, shall be approved before being used.

.7 Equipment items shall be standard products of approved manufacture. Identical units of equipment shall be of same manufacture. In any unit of equipment, identical component parts shall be of same manufacture, but the various component parts comprising the unit need not be of one manufacture.

.8 Chemical and physical properties of materials and design performance characteristics and methods of construction and installation of items of equipment, specified herein, shall be in accordance with latest issue of applicable Standards or Authorities when such are either mentioned herein, or have jurisdiction over such materials or items of equipment.

.9 Materials shall bear approval labels as required by Code and/or Inspection Authorities.

.10 Install materials in strict accordance with manufacturer's recommendations.

.11 Include items of material and equipment not specifically noted on Drawings or mentioned in Specification but which are necessary to make a complete and operating installation.

.12 Remove materials, condemned as not approved for use, from job site and deliver and install suitable approved materials in their place.

.13 Unless otherwise noted, equipment and material specifications in Sections of the Specification governed by this Section are based on products of a manufacturer selected by the Consultant for the purpose of setting a standard of quality, size, performance, capacity, appearance and serviceability.

.14 In most instances the names of acceptable manufacturers are also stated for materials and equipment, and you may base your tender price on equipment and materials produced by either the specified manufacturer or a manufacturer listed as acceptable.

.15 For any items of equipment, material, or for any system where acceptable manufacturers are not stated, you must provide only the equipment, material or system specified.

.16 If materials or equipment manufactured and/or supplied by a manufacturer named as acceptable are used in lieu of products of the manufacturer specified, be responsible for ensuring that the substituted material or equipment is equivalent in size, performance and operating characteristics to the specified materials or equipment, and it shall be understood that all costs for larger starters, additional space, larger power feeders, and changes to associated or adjacent work required as a result of providing materials and equipment named as acceptable in lieu of the specified product will be borne by Contractor.

.17 In addition to the manufacturers specified or named as acceptable, the Contractor may propose alternative manufacturers of equipment and/or apparatus to the Consultant for acceptance, listing in each case a corresponding credit for each alternative proposed, however, the tender price must be based on apparatus or materials specified or named as acceptable. Certify in writing to the Consultant that the alternative meets all space, power, design, and all other required of the specified or equivalent material or apparatus. In addition, it shall be understood that all costs for larger starters, space, power feeders, and changes to associated equipment, mechanical and/or electrical, required by acceptance of proposed alternatives, will be borne by the party making the proposal. Alternative equipment requiring greater than specified energy requirements or unduly limiting service space requirements will not be accepted.

.18 Where a manufacturer is not listed for a particular product, it will be deemed to mean that the contractor will provide the specified manufacturer's product.

1.19 EXAMINATION AND PREPARATION

.1 Refer to Division 01.

.2 Examine the existing equipment, the site and surrounding areas and be fully informed as to the conditions and limitations under which the work has to be executed. Claims for additional costs will not be entertained with respect to conditions which could reasonably have been ascertained by an inspection prior to Tender closing.

.3 Examine work upon which your work depends. Report in writing defects in such work. Application of your work shall be deemed acceptance of work upon which your work depends.

.4 Drawings are, in part, diagrammatic and are intended to convey scope of work and indicate general and approximate location, arrangement and sizes of equipment, piping, and similar items. Obtain more accurate information about locations, arrangement and sizes from study and coordination of drawings, including shop drawings and manufacturers' literature and become familiar with conditions and spaces affecting these matters before proceeding with work.

.5 Where job conditions require reasonable changes in indicated locations and arrangements, make such changes with approval of the Consultant at no additional cost to the Owner. Similarly, where existing conditions interfere with new installation and require relocation, such relocation is included in work.

1.20 CUTTING AND PATCHING

.1 Refer to Division 01.

.2 The Electrical Contractor will be responsible for all cutting and patching required for the electrical installation. Structural members are not to be cut without the consent of the Consultant.

.3 All cutting and patching required under Division 26, Division 27, and Division 28 shall be in accordance with Division 01. Layout such work for approval before undertaking same.

.4 Cutting shall be kept to an absolute minimum and performed in a neat and workmanlike manner using the proper tools and equipment. Caution shall be exercised in all cutting and procedures to ensure that concealed services are not affected. Do not cut if in doubt. Request Consultant's presence to determine if concealed services exist.

.5 Assume responsibility for prompt installation of Work in advance of concrete pouring or similar Work. Should any cutting or repairing of finished/unfinished Work be required because such installation was not done, employ the particular trade, whose Work is involved, to do such cutting and patching. Pay for any resulting costs. Layout such Work for approval before undertaking same.

1.21 CLEANING AND WASTE MANAGEMENT

.1 Refer to Division 01.

.2 The Contractor and associated sub trades, at all times during construction, to keep the site free of all debris, boxes, packing, etc., resulting from work of this trade. At the completion of this work, the electrical installation is to be left in a clean and finished condition to the satisfaction of the Consultant.

.3 Clean and repair existing materials and equipment which remain or are to be reused.

.4 Luminaires to be reinstalled: Remove existing luminaires for cleaning. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts and broken electrical parts.

.5 Assume responsibility for removing tools and waste materials on completion of Work, and leave Work in clean and perfect condition.

1.22 **STARTING AND ADJUSTING**

.1 Refer to Division 01.

.2 Conduct acceptance tests to demonstrate that the equipment and systems actually meet the specified requirements. Tests may be conducted as soon as conditions permit, and consequently make all changes, adjustments, or replacements required as the preliminary tests may indicate prior to the final tests. Tests shall be as specified in various sections of this Division. Carry out tests in the presence of the Consultant. Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project. The Electrical Contractor shall be in charge of the plant during tests. He shall assume responsibility for damages in the event of injury to the personnel, building, equipment, and shall bear all costs for liability, repairs, and restoration in this connection. Submit test results.

.3 Make tests of equipment and wiring at times requested.

.4 Tests shall include meggered insulation values, voltage and current readings to determine balance of panels and feeders under full load, and operation of each piece of equipment for correct operation.

.5 Supply meters, materials and personnel as required to carry out these tests.

.6 Test electrical work to standards and function of Specification and applicable codes in an approved manner. Replace defective equipment and wiring with new material and leave entire system in complete first class operating condition.

.7 Connect single phase loads so that there is the least possible unbalance of the supply phases.

.8 Submit all test results in report format.

.9 Trial Usage

.1 The Consultant reserves the right to use any system, piece of equipment, device, or material for such reasonable lengths of time and at such times as may be required to make a complete and thorough test of the same, or for the purpose of learning operational procedures, before the final completion and acceptance of the work. Such tests shall not be construed as evidence

of acceptance of the work, and it is agreed and understood that no claim for damage will be made for injury or breakage to any part or parts of the above due to the aforementioned tests, where such injuries or breakage are caused by a weakness or inaccuracy of parts, or by defective materials or workmanship of any kind. Supply all labour and equipment required for such tests.

.2 Perform and pay for all costs associated with any testing required on the system components where, in the opinion of the Consultant the equipment manufacturer's ratings or specified performance is not being achieved.

1.23 **CLOSEOUT PROCEDURES**

.1 Refer to Division 01.

.2 The Consultant will carry out inspections and prepare deficiency list for action by the Contractor, during and on completion of project.

.3 Furnish a Certificate of Acceptance from Inspection Department on completion of work.

1.24 **CLOSEOUT SUBMITTALS**

.1 Refer to Division 01.

.2 Project Record Documents

.1 Extra sets of white prints will be provided on which to make, as the job progresses, all approved changes and deviations from the original drawings. Complete Record Drawings accurately marked up in red ink must be submitted for approval before the contract is considered to be completed.

.2 Changes and deviations include those made by addenda, change orders, and supplemental instructions, and changes and deviations to be marked on the white print record drawings indicated on supplemental drawings issued with addenda, change orders, and supplemental instructions. Maintain the "as-built" white prints at the site for periodic inspection by the Consultant throughout the duration of the work.

.3 Upon substantial completion of the work, obtain a set of reproducible white prints of the drawings and neatly amend the print in accordance with the marked-up white prints to produce a true "as-built" set of drawings.

.4 As-built drawings are to indicate all circuiting as installed and all distribution junction box locations as well as conduit routes.

.5 Trace routing of existing panelboard feeders for all panelboards and indicate on as-built drawings.

.6 As-Built AutoCAD Drawings

.1 Submit completed Document 00 64 01 to the Consultant, and remit payment as indicated for release of Consultant’s AutoCAD files.

.2 Transfer the information from the “as-built” white prints to the files, and submit to the Consultant for review.

.3 Employ a competent computer draftsperson to indicate changes on the electronic set of record drawings. Provide drawings in Adobe Acrobat 6.0, and AutoCAD release 2010.

.4 Submit three (3) CD’s of as-built drawings in AutoCAD format, one with each O&M manual.

.5 Provide three (3) sets of full size as-built drawings in hard copy format, one with each O&M manual.

.7 As-built Single Line Diagram:

.1 Provide in Main Electrical Room one wall mounted copy of as-built Single Line Diagram on 1/4 inch foam board.

.2 As-built Single Line Diagram to indicate manufacturer name and catalogue numbers of as-installed products.

.3 Operations and Maintenance (O&M) Data

.1 Submit two complete sets of Operation and Maintenance instruction manuals in hard copy, and one in electronic format. Include in each copy of the manual:

.1 Verification certificates for installation of life safety systems by the manufacturer's representative.

.2 A copy of "reviewed" shop drawings.

.3 Complete explanation of operating principles and sequences.

.4 Recommended maintenance practices and precautions.

.5 Complete wiring and connection diagrams.

.6 Certificates of guarantees.

.2 Ensure that operating and maintenance instructions are specific and apply to the model and types of equipment provided.

.4 Warranties

.1 Submit a written guarantee to the Owner for one year from the date of acceptance. This guarantee shall bind the contractor to correct, replace or repair promptly any defective equipment workmanship without cost to the Owner.

.2 All equipment, materials and workmanship shall be unconditionally guaranteed for a minimum period of one year from the date of acceptance.

.3 Provide warranty certificates, wherever given or required, in excess of the normal warranty period showing the name of the firm giving the warranty, dated and acknowledged, on specific equipment and systems.

.4 Warranties for temperature controls and building automation systems will start on the date of verification of acceptance by the Consultant.

.5 Include these certificates with the maintenance and operating manuals in the appropriate sections.

1.25 DEMONSTRATION AND TRAINING

.1 Refer to Division 01.

.2 In the presence of the Owner, demonstrate the proper operation of all systems.

.3 Instruct the Owner's designated representatives in all aspects of the operation and maintenance of systems and equipment listed in the trade sections governed by this Section. Obtain in writing from the Consultant a list of the Owner's representatives qualified to receive instructions.

.4 Arrange for and pay for the services of qualified service technicians and other manufacturer's representatives required for instruction of specialized portions of the installation.

2 Products – Not Used

3 Execution

3.1 **DEMOLITION**

.1 Refer to Division 02 and Section 26 05 05.

.2 Remove all electrical equipment and devices on redundant structures. Make safe all circuits, and provide continuity of remaining circuits.

.3 To make safe: Withdraw redundant wiring and remove unwanted conduit/wiring and accessories. Position breakers to OFF position and update panel schedules.

.4 Make safe any redundant mechanical devices as shown on mechanical drawings.

.5 Maintain continuity of existing services for other circuits/devices serving areas outside the Work area. Provide additional wiring/conduits/boxes etc. to suit existing services to be maintained and also implement new Work as detailed.

.6 Allow for this work in Tender Price.

.7 Turn over designated equipment to the Owner. Dispose of unwanted materials and equipment.

3.2 **CONCRETE WORK**

.1 Refer to Division 03 – Concrete.

.2 Provide all concrete work required for the electrical work. Reinstall surfacing as per architectural requirements.

.3 Provide a 100 mm (4 inch) high concrete housekeeping pad for floor mounted electrical distribution equipment, such as the following:
.1 Transformers.
.2 Distribution panelboards.

3.3 **LINTELS**

.1 Refer to Division 04 – Masonry.

.2 Lintels for openings in masonry shall conform with requirements of by-laws, and as approved by the Structural Engineer.

.3 Pay all costs for lintels over openings, required solely by the electrical trades, not shown on architectural or structural drawings.

3.4 **METALS**

.1 Refer to Division 05 – Metals.

.2 Steel construction required solely for the work of this trade, and not shown on architectural or structural drawings shall be provided by this Division to the requirements of Division 05.

3.5 FLASHING AND SHEET METAL

.1 Refer to Division 07.

.2 Flash all conduits and systems passing through roof or built into an outside wall, or a waterproof floor.

.3 Provide copper flashing for sleeves passing through exterior walls or waterproof floors.

3.6 FIRESTOPPING

.1 Provide firestopping in accordance with Division 07.

.2 Ensure that fire ratings of floors and walls are maintained.

.3 Provide ULC classified firestopping products by 3M or Hilti which have been tested in accordance with CAN4-S115.

.4 Pack clearance spaces, fill all spaces between openings, pipes and ducts passing through fire separations and install firestopping systems in accordance with the appropriate ULC system number for the products and type of penetration.

.5 Install firestopping systems using personnel trained or instructed by the product manufacturer.

3.7 ACCESS DOORS

.1 Provide access doors in accordance with Division 08.

.2 Group conduit work to ensure the minimum number of access doors is required.

.3 Access doors are to be installed by the trade responsible for the particular type of construction in which the doors are required.

3.8 PAINTING AND FINISHES

.1 Refer to Division 09.

.2 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.

.3 Repair and finish factory finished equipment, damaged or scratched during installation, in an approved manner.

.4 All structural steel including hangers, brackets, supports and other ferrous metals shall be shop or factory prime painted wherever practicable. Wherever structural steel including hangers, brackets, supports, and other ferrous metals cannot be shop or factory prime painted, wire brush to remove all traces of rust, clean of all traces of dirt, oil, and grease, and apply one coat of an approved rust inhibiting primer in accordance with CGSB-GB-40d, and leave ready to receive finish paint.

.5 Primary and final painting for Work, other than items specified as factory primed or finished, will be performed as described in Division 09 – Finishes.

.6 All electrical fittings, supports, hanger rods, pull boxes, channel frames, conduit racks, outlet boxes, brackets, clamps etc., to have galvanized finish or paint finish over corrosion-resistant primer.

.7 All panelboards, motor starters etc., to be factory finished with baked on enamel. All enamel to be baked on gloss over corrosion resistant primer.

.8 Touch up minor damage to finish on factory finished equipment. Items suffering major damage to finish shall be replaced at the direction of the Consultant.

.9 Protect work so that finishes will not be damaged or marred during construction. Maintain the necessary protection until completion of the work.

.10 Provide all exposed ferrous metal work on equipment with at least one factory prime coat, or paint one prime coat on job. Clean up or wire brush all equipment, etc., before painting.

.11 For factory applied finishes, repaint or refinish surfaces damaged during shipment, erection or construction work.

3.9 LOCATION OF OUTLETS

.1 Refer to Architectural drawings for dimensions denoting exact locations.

.2 The Consultant reserves the right to change the location of outlets to within 3 m from the point indicated on the plans without extra charge providing the Contractor is advised before installation is made.

.3 Location of lighting, convenience, telephone, power and communication outlets shall be subject to change, without extra cost to Owners, provided information is given prior to installation. No extra amount will be paid for extra labour and materials for relocating outlets up to 3000 mm from their original location nor will credits be anticipated where relocation up to 3000 mm reduces materials and labour. Other cases will be considered on their individual merits.

.4 Coordinate location of boxes with latest architectural drawings and instructions to suit door swings, millwork etc. prior to rough-in.

3.10 MOUNTING HEIGHTS AND DEVICE LOCATIONS

.1 Refer to architectural drawings for exact location of electrical equipment and devices.

.2 Architectural elevations take precedence over electrical elevations. If there are conflicts between architectural and electrical, adjust locations of electrical equipment at no additional cost to the owner.

.3 Prior to roughing-in, the contractor is to mark locations of electrical equipment and devices for conflicts with architectural, studs, etc. If conflicts are noted, inform the consultant for a decision prior to commencing the rough-in.

.4 Mounting heights of equipment and devices listed below is from finished floor to centreline of equipment, unless specified or indicated otherwise.

.5 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.

.6 Install electrical equipment at following heights above finished floor (AFF). Dimensions are to centre of device unless indicated otherwise.
- .1 Power door operator push buttons: 1000 mm.
- .2 HVAC thermostats and manual HVAC controls: 1200 mm.
- .3 Local switches, and manual lighting control devices:
  - .1 1100 mm.
  - .2 Locate on lock side of door.
- .4 System furniture service fittings: to suit furniture layout.
- .5 Wall receptacles:
  - .1 General: min. 400 mm AFF.
  - .2 Above top of counters: 175 mm.
  - .3 Above top of continuous baseboard heater, or mechanical heating/radiation units: 75 mm to bottom of device.
  - .4 In fan rooms, mechanical rooms, and electrical rooms: 1100 mm.
- .6 Outlets in raceways or millwork to be located as per Architectural details.
- .7 Panelboards: as indicated in Section 26 24 16.
- .8 Emergency lighting remote heads: 300 mm below finished ceiling, or 2400 mm AFF for exposed areas or areas with ceiling height above 2750 mm (9 feet).
- .9 Communications:
  - .1 Typical communication outlets (voice and data): 400 mm.
  - .2 Communications outlets for wall mounted telephones, intercom, or similar: 1100 mm.
  - .3 Television outlets: 200 mm below finished ceiling.
  - .4 Wall mounted public address speakers: 2100 mm.
  - .5 Clocks: 2100 mm.
- .10 Access control card readers and keypads: 900 mm.
- .11 Fire alarm manual pull stations: 1200 mm.
- .12 Wall mounted fire alarm audible devices, including bells or horns:
  - .1 2300 mm to the top of the device in areas of ceiling height 2450 mm or greater.
  - .2 150 mm below the finished ceiling for ceiling heights less than 2450 mm, measured to the top of the device.
- .13 Wall mounted fire alarm visible signal devices, including strobes: 2300 mm.

3.11 MANUFACTURER'S INSTRUCTIONS

.1 Where the specifications call for an installation to be made in accordance with Manufacturer's recommendations, a copy of such recommendations shall be at all times be kept on the job site and be available to the Owner's Representative.

.2 Follow manufacturer's instructions where they cover points now specifically indicated on the drawings and specifications. If they are in conflict with the drawings and specifications obtain clarification from the Consultant before starting work.

3.12 TESTS AND ACCEPTANCE

.1 The operation of the equipment and electrical system does not constitute an acceptance of the work by the Owner. The final acceptance is to be made after

the Contractor has adjusted his equipment and demonstrated that it fulfills the requirements of the drawings and the specifications.

.2 Testing of all systems shall be performed in the presence of the Owner's designated representative. The contractor shall give 72 hours advance notice to the Owner before beginning the tests.

.3 Upon completion of the installation, the Contractor shall furnish certificates of approval from all authorities having jurisdiction, as applicable. Contractor shall demonstrate that work is complete and in perfect operating condition, with raceway and conduit systems properly grounded, wiring free from grounds, shorts, and that the entire installation is free for any physical defects.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Building wire and cable.
- .1 Armoured cable.
- .2 Metal clad cable.
- .3 Wiring connectors and connections.

.2 Permitted voltage drop for feeder and branch circuits.

1.2 **REFERENCES**

.1 CSA C22.1 - Canadian Electrical Code, Part I, Safety Standard for Electrical Installations

.2 Ontario Electrical Safety Code

.3 CSA C22.2 No. 0.3 - Test Methods for Electrical Wires and Cables.

.4 CSA C22.2 No. 48-M90 (R2000) - Non-metallic Sheathed Cable.

.5 CSA C22.2 No. 51 Armoured Cables.

.6 CSA C22.2 No. 52-96 (R2000) - Underground Service-Entrance Cables.

.7 CAN/CSA C22.2 No. 65-03 (CSA/UL/ANCE) – Wire Connectors.

.8 CSA C22.2 No. 75-03 (CSA/UL/ANCE) - Thermoplastic-Insulated Wires and Cables.

.9 CSA C22.2 No. 123 Aluminum Sheathed Cables.

.10 CSA C22.2 No. 131 Type TECK 90 Cable.

.11 NECA (National Electrical Contractors Association) - Standard of Installation.

.12 NETA (International Electrical Testing Association) - ATS-2003 - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

.13 CAN/ULC-S139-12 – Standard Method of Fire Test for Evaluation of Integrity of Electrical Power, Data and Optical Fibre Cables.

1.3 **COORDINATION**

.1 Where wire and cable destination is indicated and routing is not shown, determine exact routing and lengths required.

1.4 **QUALIFICATIONS**

.1 Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

1.5 **REGULATORY REQUIREMENTS**

.1 Conform to CSA C22.1.

.2 Provide products listed and classified by CSA (Canadian Standards Association) as suitable for the purpose specified and indicated.

1.6 **SITE CONDITIONS**

.1 Verify that field measurements are as indicated.

.2 Conductor sizes are based on copper unless indicated as aluminum or "AL".

.3 Wire and cable routing indicated is approximate unless dimensioned.

2 Products

2.1 **MANUFACTURERS**

.1 BICC Phillips.

.2 General Cable.

.3 Nexans.

.4 Prysmian.

.5 Southwire.

2.2 **BUILDING WIRE**

.1 RW90:
- .1 Single copper conductor.
- .2 Minimum #12 AWG for branch circuit wiring.
- .3 Minimum #14 AWG for 120V control wiring.
- .4 Chemically cross-linked polyethylene insulation.
- .5 Rated for 90 degrees C, 600V
- .6 Suitable for handling to minus 40 degrees C.
- .7 For interior installations in conduit.

.2 RWU90:
- .1 Single copper conductor.
- .2 Minimum 12 AWG for branch circuit wiring.
- .3 Minimum 14 AWG for 120 V control wiring.
- .4 Chemically cross-linked polyethylene insulation.
- .5 Rated for 90 degrees C, 600 V
- .6 Suitable for handling to minus 4 degrees C.
- .7 For exterior installations in conduit.

.3 T90 Nylon:
- .1 Single copper conductor.
- .2 Thin wall PVC insulation with nylon covering.

.3 Rated for 90 degrees C, 600V.
.4 May be used up to size 10 AWG for interior installations.
.5 Base conduit fill on RW90 cable diameters.

2.3 ARMOURED CABLE

.1 Description: Type AC.

.2 Two, three or four copper conductors rated RW90, 1000 V.

.3 Bare copper ground wire.

.4 Insulation Voltage Rating: 600 volts.

.5 Insulation Temperature Rating: 90 degrees C (194 degrees F).

.6 Insulation Material: Thermoplastic.

.7 Runs to be limited to fixture drops and in walls, maximum exposed run 1.5 m.

.8 Do not daisy chain (leap frog) luminaires with armoured cable.

2.4 MINERAL INSULATED (MI) CABLES

.1 Pentair Pyrotenax 1850 series with 2 hour fire rating to ULC S139 and to meet Ontario Building Code Rule 3.2.7.10.

.2 Alternates such as “Lifeline” installed in conduit may only be considered if listed by ULC under ULC Category Code ‘FHJRC’ after October 2014.

.1 Acceptable alternate: VITALink MC Brand Type MC, manufactured by Marmon Wire & Cable Inc. (listed by ULC under ULC category code ‘FHJRC’, dated 19 May 2015).

2.5 TECK90 CABLE

.1 Single, three, or four conductors as indicated on drawings.

.2 Cable to CAN/CSA-C22.2 No. 131.

.3 Conductors:
.1 Grounding conductor: copper.
.2 Circuit conductors: copper, size as indicated.

.4 Insulation: Cross-linked polyethylene (XLPE), type RW90, rating: 600 V.

.5 Inner jacket: polyvinyl chloride.

.6 Armour: interlocking aluminum.

.7 Overall covering: thermoplastic.

.8 Fastenings:
- .1 One-hole steel straps to secure surface cables 50 mm diameter and smaller. Two-hole steel straps for cables larger than 50 mm diameter.
- .2 Channel type supports for two or more cables at 1500 mm centres.
- .3 Threaded rods: 6 mm diameter to support suspended channels.

.9 Connectors: Watertight, approved for TECK cable.

2.6 WIRING TERMINATION

.1 Lugs, terminals, or screws used for termination of wiring to be suitable for copper conductors. Identify wiring with permanent indelible identifying markings, either numbered or coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring. Maintain phase sequence and colour coding throughout.

.2 Splice wire, up to and including No. 6 gauge, with nylon insulated expandable spring type connectors.
- .1 Thomas & Betts – Marr Max Series

.3 Splice large conductors using compression type connections insulated with heat shrink sleeves.
- .1 Thomas & Betts – 5400 Series lugs & heat shrink type #s series

2.7 CONDUCTORS, WIRES, AND CABLES

.1 Indoor wiring installed in conduit, unless otherwise noted: 600 volt "RW90 XLPE".

.2 Wiring in channel back of fluorescent lighting fixtures: 600 volt type GTF or TEW.

.3 Lighting and power branch circuit wiring:
- .1 Copper, minimum No. 12 gauge.
- .2 Home runs to lighting and receptacle panels, which exceed 22 m (75 feet) in length: minimum No. 10 gauge.

.4 Size wires for 2 per cent maximum voltage drop to farthest outlet on a maximum 80 per cent loaded circuit.

.5 Outdoor wiring: “RWU90 XLPE”.

.6 Conductors shall be colour coded. Conductors No. 10 gauge and smaller shall have colour impregnated into insulation at time of manufacture. Conductors size No. 8 gauge and larger may be colour coded with adhesive colour coding tape but only black insulated conductors shall be employed in this case, except for neutrals which shall be white wherever possible.

.7 Colour coding as follows:
- .1 Phase "A" - Red
- .2 Phase "B" - Black
- .3 Phase "C" - Blue
- .4 Control - Orange
- .5 Ground - Green
- .6 Neutral - White

.8 Neatly train circuit wiring in cabinets, panels, pull boxes and junction boxes and hold with nylon cable ties.

3 Execution

3.1 EXAMINATION

.1 Voltage Drop
- .1 Ensure voltage drop in power and control conductors is in accordance with the requirements of the Electrical Code.
- .2 Size conductors accordingly when sizes are not identified.
  - .1 Feeder conductors: maximum voltage drop of 2 per cent.
  - .2 Branch circuit conductors: maximum voltage drop of 3 per cent.

.2 Verify that mechanical work likely to damage wire and cable has been completed.

.3 Verify that raceway installation is complete and supported.

3.2 PREPARATION

.1 Completely and thoroughly swab raceway before installing wire.

3.3 INSTALLATION

.1 Route wire and cable as required to meet project conditions.

.2 Install cable to CSA C22.1.

.3 Conduit and cable supports
- .1 All wiring to be installed in EMT at all exposed areas and in partitions unless otherwise specified.
- .2 All mechanical equipment to be connected with liquid tight flexible conduit.
- .3 Support cables above accessible ceiling, using spring metal clips to support cables from structure. Do not rest cable on ceiling panels.

.4 Conductors
- .1 Provide separate neutral for each circuit. Common neutrals not permitted.
- .2 Use solid conductor for feeders and branch circuits 10 AWG and smaller.
- .3 Use stranded conductors for control circuits.
- .4 Use conductor not smaller than 12 AWG for power and lighting circuits.
- .5 Use conductor not smaller than 16 AWG for control circuits.
- .6 Armoured cable (commonly referred to as BX) is only to be used for light fixture connections and limited to maximum 1830 mm in length.
- .7 Use 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 25 m.

.5 Pulling conductors
- .1 Pull all conductors into raceway at same time.
- .2 Use suitable wire pulling lubricant for building wire 4 AWG and larger.
- .3 Neatly train and lace wiring inside boxes, equipment, and panelboards.
- .4 Protect exposed cable from damage.

.6 Connectors
- .1 Use suitable cable fittings and connectors.
- .2 Clean conductor surfaces before installing lugs and connectors.
- .3 Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
- .4 Use split bolt connectors for copper conductor splices and taps 6 AWG and larger. Tape uninsulated conductors and connector with electrical tape to 150 per cent of insulation rating of conductor.
- .5 Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.
- .6 Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

3.4 IDENTIFICATION

.1 Identify and colour code wire and cable to Section 26 05 53. Identify each conductor with its circuit number or other designation indicated.

.2 Where colour-coded tape is utilized, apply a minimum of 50 mm (2 inches) at terminations, junction and pull boxes and conduit fittings. Do not paint conductors under any condition.

.3 Utilize colour coding on bussing in panels and, switchgear, disconnects, and metering cabinets to match conductor colour coding.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Grounding electrodes and conductors.

.2 Equipment grounding conductors.

.3 Bonding.

.4 The terms “connect” and “bond” are used interchangeably in this Specification and have the same meaning.

1.2 **RELATED REQUIREMENTS**

.1 Section 27 05 26 – Grounding and Bonding for Communications Systems.

1.3 **REFERENCES**

.1 Canadian Standards Association
- .1 CSA C22.1 - Canadian Electrical Code, Part I, Safety Standard for Electrical Installations.
- .2 CSA C22.2 No.0.4 - Bonding of Electrical Equipment.
- .3 CSA C22.2 No. 41 - Grounding and Bonding Equipment.

.2 Ontario Electrical Safety Code.

.3 ANSI/TIA/EIA J-STD-607-A - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.

.4 Institute of Electrical and Electronics Engineers, Inc.: IEEE 81-1983 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.

1.4 **PERFORMANCE REQUIREMENTS**

.1 Grounding System Resistance: 5 ohms.

.2 Provide all equipment grounding as required regardless of whether it has been shown on drawings or called for in this specification. Arrange grounds so that under normal operating conditions no injurious amount of current will flow in any grounding conductor.

1.5 **ACTION SUBMITTALS**

.1 Product Data: Provide for grounding electrodes and connections.

1.6 **INFORMATIONAL SUBMITTALS**

.1 Test Reports: Indicate overall resistance to ground and resistance of each electrode.

.2 Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.7 **CLOSEOUT SUBMITTALS**

.1 Project Record Documents: Record actual locations of components and grounding electrodes.

.2 Certificate of Compliance: Indicate approval of installation by authority having jurisdiction.

1.8 **QUALIFICATIONS**

.1 Manufacturer: Company specializing in manufacturing the products specified in this section with minimum three years' experience.

1.9 **REGULATORY REQUIREMENTS**

.1 Products: Listed and classified testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

2 Products

2.1 **MANUFACTURERS**

.1 B-Line by Eaton.

.2 Hubbell (Burndy).

.3 Panduit.

.4 Thomas & Betts.

2.2 **GROUNDING AND BONDING CONDUCTORS**

.1 Electrical grounding conductors shall be UL 83 insulated stranded copper, except that sizes #10 AWG and smaller shall be solid copper. Insulation colour shall be continuous green for all equipment grounding conductors.

.2 Bonding conductors shall be ASTM B8 bare stranded copper, except that sizes #10 AWG and smaller shall be ASTM B1 solid bare copper wire.

2.3 **ROD ELECTRODES**

.1 Material: Copper-clad steel.

.2 Diameter: 19 mm.

.3 Length: 3000 mm.

2.4 **GROUND RODS**

.1 Copper clad steel, 19 mm (3/4 inch) diameter by 3000 mm (10 feet) long, conforming to UL 467.

.2 Quantity of rods shall be as required to obtain the specified ground resistance.

2.5 **SPLICES AND TERMINATION COMPONENTS**

.1 Components shall meet or exceed CSA C22.2 No 41, and be clearly marked with the manufacturer, catalog number, and permitted conductor size(s).

2.6 **GROUND CONNECTIONS**

.1 Below Grade: Exothermic-welded type connectors.

.2 Above Grade:
.1 Bonding Jumpers: compression type connectors, using zinc-plated fasteners and external tooth lockwashers.
.2 Ground Busbars: Two-hole compression type lugs using tin-plated copper or copper alloy bolts and nuts.

2.7 **GROUND TERMINAL BLOCKS**

.1 At any equipment mounting location (e.g. backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted, provide screw lug-type terminal blocks.

2.8 **SPLICE CASE GROUND ACCESSORIES**

.1 Splice case grounding and bonding accessories shall be supplied by the splice case manufacturer when available. Otherwise, use 6 AWG insulated ground wire with shield bonding connectors.

2.9 **MECHANICAL CONNECTORS**

.1 Material: Bronze.

2.10 **WIRE**

.1 Material: Stranded copper.

.2 Foundation Electrodes: 2/0 AWG.

.3 Grounding Electrode Conductor: Size to meet Ontario Electrical Safety Code requirements.

2.11 **GROUNDING WELL COMPONENTS**

.1 Well Pipe: 200 mm by 600 mm long concrete pipe with belled end.

.2 Well Cover: Cast iron with legend "GROUND" embossed on cover.

3 Execution

3.1 **EXAMINATION**

.1 Verify that final backfill and compaction has been completed before driving rod electrodes.

3.2 **INSTALLATION**

.1 General
- .1 Ground in accordance with the Ontario Electrical Safety Code, as shown on drawings, and as hereinafter specified.
- .2 System Grounding:
  - .1 Secondary service neutrals: Ground at the supply side of the secondary disconnecting means and at the related transformers.
  - .2 Separately derived systems (transformers downstream from the service entrance): Ground the secondary neutral.
- .3 Equipment Grounding: Metallic structures (including ductwork and building steel), enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits shall be bonded and grounded.
- .4 Ground electrical equipment and wiring in accordance with Ontario Electrical Safety Code and Local Inspection Authority's Rules and Regulations.
- .5 Install grounding conductors, outside Electric Rooms and Electrical Closets in conduit and conceal where possible. Make connections to water mains, all metallic piping systems, neutral and equipment with brass, copper or bronze bolts and connectors or weld using Cadweld or Thermoweld processes.
- .6 Provide grounding conductors, sized as per Code, and connect to grounding bus or water main wherever non-raceways are installed.

.2 Provide grounding electrode conductor and connect to reinforcing steel in foundation footing. Bond steel together.

.3 Provide bonding to meet Regulatory Requirements.

.4 Bond together metal siding not attached to grounded structure; bond to ground.

.5 Install ground grid under access floors indicated.

.6 Bond together each metallic raceway, pipe, duct and other metal object entering space under access floors. Bond to underfloor ground grid. Use #6 AWG bare copper conductor.

.7 Equipment Grounding Conductor: Provide separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

.8 Ground Resistance
- .1 Grounding system resistance to ground not to exceed 5 ohms. Make necessary modifications or additions to the grounding electrode system for compliance without additional cost to the Owner. Final tests shall assure that this requirement is met.

.2 Resistance of the grounding electrode system shall be measured using a four-terminal fall-of-potential method as defined in IEEE 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

.3 Services at power company interface points shall comply with the power company ground resistance requirements.

.9 Ground Rod Installation

.1 Drive each rod vertically in the earth, not less than 3000 mm (10 feet) in depth.

.2 Where permanently concealed ground connections are required, make the connections by the exothermic process to form solid metal joints. Make accessible ground connections with mechanical pressure type ground connectors.

.3 Where rock prevents the driving of vertical ground rods, install angled ground rods or grounding electrodes in horizontal trenches to achieve the specified resistance.

.10 Inaccessible Grounding Connections

.1 Make grounding connections, which are buried or otherwise normally inaccessible (except connections for which periodic testing access is required) by exothermic weld.

.11 Secondary Equipment and Circuits

.1 Main Bonding Jumper: Bond the secondary service neutral to the ground bus in the service equipment.

.2 Metallic Piping, Building Steel, and Supplemental Electrode(s):

.1 Provide a grounding electrode conductor sized per code between the service equipment ground bus and all metallic water and gas pipe systems, building steel, and supplemental or made electrodes. Jumper insulating joints in the metallic piping. All connections to electrodes shall be made with fittings that conform to CSA C22.2 No 41.

.2 Provide a supplemental ground electrode and bond to the grounding electrode system.

.3 Conduit Systems:

.1 Ground all metallic conduit systems. All metallic conduit systems shall contain an equipment grounding conductor.

.2 Non-metallic conduit systems shall contain an equipment grounding conductor, except that non-metallic feeder conduits which carry a grounded conductor from exterior transformers to interior or building-mounted service entrance equipment need not contain an equipment grounding conductor.

.3 Conduit containing only a grounding conductor, and which is provided for mechanical protection of the conductor, shall be bonded to that conductor at the entrance and exit from the conduit.

.4 Feeders and Branch Circuits: Install equipment grounding conductors with all feeders and power and lighting branch circuits.

.5 Boxes, Cabinets, Enclosures, and Panelboards:
- .1 Bond the equipment grounding conductor to each pull box, junction box, outlet box, device box, cabinets, and other enclosures through which the conductor passes (except for special grounding systems for intensive care units and other critical units shown).
- .2 Provide lugs in each box and enclosure for equipment grounding conductor termination.
- .3 Provide ground bars in panelboards, bolted to the housing, with sufficient lugs to terminate the equipment grounding conductors.

.6 Receptacles shall not be grounded through their mounting screws. Ground with a jumper from the receptacle green ground terminal to the device box ground screw and the branch circuit equipment grounding conductor.

.7 Raised Floors: Provide bonding of all raised floor components.

.12 Corrosion Inhibitors
- .1 When making ground and ground bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.

.13 Conductive Piping
- .1 Bond all conductive piping systems, interior and exterior, to the building to the grounding electrode system. Bonding connections shall be made as close as practical to the equipment ground bus.

3.3 FIELD QUALITY CONTROL

.1 Perform inspections and tests listed in NETA ATS, Section 7.13.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Conduit and equipment supports.

.2 Anchors and fasteners.

1.2 **REFERENCES**

.1 CSA C22.1 - Canadian Electrical Code, Part I, Safety Standard for Electrical Installations.

.2 Ontario Electrical Safety Code.

.3 CECA - Canadian Electrical Contractors Association.

1.3 **CLOSEOUT SUBMITTALS**

.1 Submit the following in the Operation and Maintenance Manual for products used over the course of the project:
.1 Product Data: Provide manufacturer's catalogue data for fastening systems.
.2 Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

1.4 **REGULATORY REQUIREMENTS**

.1 Provide products listed and classified by Canadian Standards as suitable for purpose specified and shown.

2 Products

2.1 **MANUFACTURERS**

.1 B-line by Eaton.

.2 Burndy Canada Ltd. (Hubbell).

.3 Erico Caddy.

.4 E. Myatt & Co. Inc.

.5 Hilti Canada.

.6 Thomas & Betts.

.7 Unistrut.

.8 Alternates as considered by the Consultant.

2.2 GENERAL

.1 All supporting devices, strut channel, threaded rod, anchors, etc. to be used shall be of the “hot dipped” galvanized type. Electrogalvanized components will not be accepted.

.2 Materials and Finishes: Provide adequate corrosion resistance.

.3 Provide materials, sizes, and types of anchors, fasteners and supports to carry the loads of equipment and conduit. Consider weight of wire in conduit when selecting products.

.4 Anchors and Fasteners:
- .1 Concrete Structural Elements: Use expansion anchor sand preset inserts.
- .2 Steel Structural Elements: Use beam clamps and welded fasteners.
- .3 Concrete Surfaces: Use self-drilling anchors and expansion anchors.
- .4 Hollow Masonry, Plaster, and Gypsum Board Partitions: Use toggle bolts and hollow wall fasteners.
- .5 Solid Masonry Walls: Use expansion anchors and preset inserts.
- .6 Sheet Metal: Use sheet metal screws.
- .7 Wood Elements: Use wood screws.

2.3 ANCHORS AND HANGERS

.1 Hangers for electrical conduit shall be galvanized after fabrication.

.2 Perforated strapping: not permitted.

2.4 INSERTS

.1 Use only factory-made threaded or toggle type.

.2 Where inserts cannot be placed, use factory-made expansion shields for light weights, where approved by the Consultant.

.3 Do not use powder-activated tools except with the written permission of the Consultant.

2.5 SLEEVES

.1 Through interior walls, use standard weight steel pipes, conduit, or 18 gauge galvanized steel. Cut flush with finished surfaces. Check room finish schedules.

.2 Through exterior walls above grade, floors, and roof use standard weight steel pipes, machine cut, flush with finished surface inside and to suit flashing outside.

.3 Through exterior walls below grade, water-proofed floors, and other water-proof walls, use heavy weight cast iron pipes, machine cut. Extend sleeves 100 mm (4 inches) above finished floors, and cut flush with underside of floor.

2.6 **STEEL CHANNEL**

.1 Description: Painted steel.

2.7 **SUPPORTS**

.1 Steel supports in wet or dry locations to be galvanized after fabrication.

.2 Where galvanized members are bolted together use cadmium plated bolts.

.3 For hanger rods use minimum 10 mm (3/8 inch) diameter steel threaded rod. Use clevis type attachment.

.4 Provide minimum 100 mm (4 inch) high concrete bases for all floor mounted equipment.

2.8 **SUPPORTS AND BASES**

.1 Submit proposed method of attachment of hangers and beam clamps, to cellular steel deck for approval before proceeding with Work.

.2 Supply and erect special structural Work required for the installation of electrical equipment. Provide anchor bolts and other fastenings unless noted otherwise. Mount equipment required to be suspended above floor level, where details are not shown, on a frame or platform bracketed from the wall or suspended from the ceiling. Carry supports to either the ceiling or the floor, or both as required, at locations where, because wall thickness is inadequate, it is not permitted to use such brackets.

.3 Electrical panels, switches or other electrical equipment shall be complete with suitable bases or mounting brackets.

.4 Provide channel or other metal supports where necessary, to adequately support lighting fixtures. Do not use wood unless wood forms part of the building structure.

.5 Support hangers, in general, from inserts in concrete construction or from building structural steel beams, using beam clamps. Provide additional angle or channel steel members, required between beams for supporting conduits and cables.

.6 Provide any additional supports required from existing concrete construction for any piping or equipment, by drilling same and installing expansion bolt cinch anchors.

.7 Do not use explosive drive pins in any section of Work without obtaining prior approval.

2.9 **THREADED ROD COVERS**

.1 Protect cable from abrasion caused by contact with threaded rod.

.2 To meet UL 94V-0 specifications.

.3 Colour: Black.

.4 Example product: Panduit TRC18FR-X20Y.

3 Execution

3.1 **INSTALLATION**

.1 Obtain permission from Consultant before drilling or cutting structural members.

.2 Fabricate supports from structural steel or steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.

.3 Install surface-mounted cabinets and panelboards with minimum of four anchors.

.4 In wet and damp locations use steel channel supports to stand cabinets and panelboards 25 mm (1 inch) off wall.

.5 Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.

.6 Where threaded rod is exposed in data centre, provide threaded rod cover.

.7 Provide inserts, sleeves, equipment supports and hangers, sealing of sleeves and openings, as required for all electrical work. Ensure that the load onto structures does not exceed the maximum loading per square metre as shown on Structural Drawings or as directed by the Consultant.

.8 Provide insets, holes, anchor bolts and sleeves in time when walls, floors, and roof are erected.

.9 Provide sleeves at each place where electrical devices pass through a wall, floor or roof.

.10 Size sleeves to provide 13 mm (1/2 inches) clearance all round.

.11 Sleeves are not required in interior walls and dry area floors where conduit is installed ahead of floor construction.

.12 Seal all openings and sleeves after installation of equipment:
- .1 With an approved material to maintain fire rating where sleeves and openings pass through fire separations and floors.
- .2 With an approved material to maintain fire rating for sleeves and openings provided for future equipment.

.13 Provide all flashing and waterproofing for sleeves through roof and exterior walls to the requirements of Division 07.

.14 Place insets only in structural members and not in the finishing material.

.15 Secure all supports and hangers to the structure unless noted otherwise.

.16 Suspend hanger rods from approved concrete inserts and from beam clamps. Obtain Consultant's approval before welding to steel structural members.

.17 Secure supports to precast concrete members to inserts originally cast into the members or by rods passing between the members and connected to a steel plate bearing.

.18 Sealing of Sleeves and Openings to Maintain Fire Rating
- .1 Use Dow-Corning #3-6548 'Silicone RTV' foam, Thomas & Betts "Flamesafe' firestopsystem, Electrovert 'Flameseal" firestop putty, or approved equal materials installed in accordance with the manufacturer's specifications and recommendations.
- .2 Submit data sheets for review prior to installation.

.19 Supports
- .1 All conduits, panels, etc. to be securely and adequately supported.
- .2 Where more than three conduits run together, conduit racks to be used.
- .3 Single runs of conduit to be supported by galvanized conduit straps or ring bolt type hangers. Tie wire or perforated metal strap hangers will NOT be accepted.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Metal conduit.

.2 Flexible metal conduit.

.3 Liquid tight flexible metal conduit.

.4 Electrical metallic tubing.

.5 Fittings and conduit bodies.

1.2 **REFERENCES**

.1 Canadian Standards Association
- .1 CSA C22.1 – Canadian Electrical Code, Part I, Safety Standard for Electrical Installations.
- .2 Ontario Electrical Safety Code.
- .3 CAN/CSA-C22.2 No. 18 – Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.
- .4 CSA C22.2 No. 45 – Rigid Metal Conduit.
- .5 CSA C22.2 No. 45.1 – Rigid Metal Conduit - Steel.
- .6 CSA C22.2 No. 56 – Flexible Metal Conduit and Liquid - Tight Flexible Metal Conduit.
- .7 CSA C22.2 No. 83.1 – Electrical Metallic Tubing - Steel.
- .8 CSA C22.2 No. 211.1 – Rigid Types EB1 and DB2/ES2 PVC Conduit.
- .9 CSA C22.2 No.211.2 – Rigid PVC (Unplasticized) Conduit.
- .10 CSA C22.2 No. 211.3 – Reinforced Thermosetting Resin Conduit (RTRC) on Fittings.
- .11 CSA C22.2 No. 227.1 – Electrical Nonmetallic Tubing.
- .12 CSA C22.2 No. 227.2.1 – Liquid-Tight Flexible Nonmetallic Conduit.

1.3 **PROJECT RECORD DOCUMENTS**

.1 Accurately record actual routing of conduits larger than 51 mm.

.2 Accurately record actual routing of all conduits installed below grade, regardless of size, including whether direct buried or installed in concrete duct bank.

1.4 **REGULATORY REQUIREMENTS**

.1 Provide products listed and classified by CSA (Canadian Standards Association) as suitable for purpose specified and shown.

1.5 **DELIVERY, STORAGE, AND HANDLING**

.1 Accept conduit on site. Inspect for damage.

.2 Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

1.6 **PROJECT CONDITIONS**

.1 Verify that field measurements are as shown on drawings.

.2 Verify routing and termination locations of conduit prior to rough-in.

.3 Conduit routing is shown on drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

2 Products

2.1 **MANUFACTURERS**

.1 Where products are listed in this section based on a single manufacturer, the equivalent product from the following manufacturers is acceptable:
- .1 Appleton.
- .2 Columbia-MBF.
- .3 Crouse-Hinds by Eaton.
- .4 Hubbell.
- .5 Thomas & Betts Ltd.

2.2 **CONDUIT REQUIREMENTS**

.1 Minimum size: 21 mm (3/4 inch) unless otherwise specified.

.2 Outdoor locations, above grade: use rigid steel.

.3 Wet and damp locations: use rigid and non-metallic tubing.

.4 Dry locations:
- .1 Concealed: Use electrical metallic tubing
- .2 Exposed: Use electrical metallic tubing.

2.3 **METAL CONDUIT**

.1 Rigid Steel Conduit: C22.2 No. 45.1.

.2 Rigid Aluminum Conduit: C22.2 No. 45.

.3 Intermediate Metal Conduit (IMC): Rigid steel.

.4 Fittings and Conduit Bodies: Material to match conduit.

2.4 **FLEXIBLE METAL CONDUIT**

.1 Description: Interlocked steel construction.

.2 Fittings: CSA C22.2 No. 56.

2.5 **LIQUID TIGHT FLEXIBLE METAL CONDUIT**

.1 Description: Interlocked steel aluminum construction with PVC jacket.

.2 Fittings: CSA C22.2 No. 56.

2.6 **ELECTRICAL METALLIC TUBING (EMT)**

.1 Description: CSA C22.2 No. 83.1; galvanized tubing.

.2 Fittings and Conduit Bodies: CSA C22.2 No. 83.1; steel type.

2.7 **ELECTRICAL NONMETALLIC TUBING (ENT)**

.1 Not permitted.

2.8 **CONDUIT, FITTINGS, AND ACCESSORIES**

.1 Conduit accessories, conduits and fittings conforming to CSA Standard C22.2 No. 18-1972.

.2 Rigid conduit bushings:
.1 Thomas & Betts Ltd. - Series 5031.

.3 EMT Connectors:
.1 Thomas & Betts Ltd. - Steel City TC 121E Series.

.4 Ground Bushings:
.1 Thomas & Betts – Blackjack or 1220 Series.

.5 Flexible conduit connectors:
.1 Thomas & Betts Ltd. - Series 3110.
.2 EMT couplings: steel concrete tight to match connectors.

.6 Terminate rigid conduit entering boxes or enclosures with nylon insulated steel threaded bushings.
.1 Thomas & Betts – 8125 Series.

.7 Terminate EMT entering boxes or enclosures with nylon insulated steel concrete tight connectors.

.8 Terminate flexible conduit entering boxes or enclosures with nylon insulated steel connectors.
.1 Thomas & Betts – 5332 Series.

3 Execution

3.1 **INSTALLATION**

.1 Install conduit to CSA C22.1.

.2 Arrangement and supports
.1 Arrange supports to prevent misalignment during wiring installation.
.2 Arrange conduit to maintain headroom and present neat appearance.
.3 Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.

.4 Group related conduits; support using conduit rack.
.5 Construct rack using steel channel; provide space on each for 25 per cent additional conduits.
.6 Fasten conduit supports to building structure and surfaces to Section 26 05 29.
.7 Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports
.8 Do not attach conduit to ceiling support wires.
.9 Route exposed conduit parallel and perpendicular to walls.
.10 Route conduit installed above accessible ceilings parallel and perpendicular to walls.
.11 Route conduit in and under slab from point-to-point.
.12 Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.
.13 Provide suitable fittings to accommodate expansion and deflection where conduit crosses expansion joints.

.3 Clearances
.1 Maintain adequate clearance between conduit and piping.
.2 Maintain 300 mm (12 inch) clearance between conduit and surfaces with temperatures exceeding 40 degrees C.

.4 Conduit bends
.1 Install no more than equivalent of three 90 degree bends between boxes.
.1 Use conduit bodies to make sharp changes in direction, as around beams.
.2 Use hydraulic one-shot bender to fabricate bends in metal conduit larger than 50 mm size.

.5 Install wall entrance seals where conduits pass through exterior walls below grade.

.6 Provide expansion coupling in conduit runs at building expansion joints and in long runs subject to thermal expansion, all in accordance with manufacturer recommendations.

.7 Cut conduit square using saw or pipe cutter; de-burr cut ends.

.8 Bring conduit to shoulder of fittings; fasten securely.

.9 Use suitable caps to protect installed conduit against entrance of dirt and moisture.

.10 Use conduit hubs or sealing locknuts to fasten conduit and to cast boxes.

.11 Provide suitable pull string in each empty conduit except sleeves and nipples.

.12 Ground and bond conduit to Section 26 05 26.

.13 Identify conduit to Section 26 05 53.

.14 Wiring Methods

.1 Install wiring in conduit unless otherwise specified.

.2 Install wiring and conduit work in a concealed manner. Surface conduit work is not permitted unless specifically noted.

.3 Use thin wall conduit, up to and including 53 mm (2 inch) conduit size, for branch circuit and feeder wiring in ceilings, furred spaces, and in hollow walls and partitions. Use rigid galvanized steel conduit for wiring in poured concrete, where exposed, and for conduit 65 mm or larger. Use rigid PVC conduit for wiring in slabs on grade and wiring below grade.

.4 Aluminium conduit may be used, in lieu of rigid steel conduit, in clean and dry locations, but shall not be used in poured concrete, or for signal and intercommunication systems wiring.

.5 Flexible conduit and armoured cable will be accepted for a maximum length of 1500 mm for final connection to lighting fixtures. Do not connect from fixture to fixture.

.6 Conduit manufacturer's touch-up enamel shall be used to repair all scratches and gouges on epoxy-coated conduit.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Wall and ceiling outlet boxes.

.2 Pull and junction boxes.

1.2 **RELATED REQUIREMENTS**

.1 Section 26 09 23 – Lighting Control Devices.

.2 Section 26 27 16 – Electrical Cabinets and Enclosures.

.3 Section 26 27 26 – Wiring Devices: Wall plates in finished areas, floor box service fittings, fire-rated poke-through fittings, and access floor boxes.

1.3 **REFERENCES**

.1 CSA C22.1 - Canadian Electrical Code, Part I, Safety Standard for Electrical Installations

.2 Ontario Electrical Safety Code.

.3 CAN/CSA-C22.2 No. 18 - Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.

.4 CSA C22.2 No. 18.1 (CSA/UL/ANCE) - Metallic Outlet Boxes.

.5 CSA C22.2 No. 40 - Cutout, Junction and Pull Boxes.

.6 CAN/CSA-C22.2 No. 85 - Rigid PVC Boxes and Fittings.

1.4 **CLOSEOUT SUBMITTALS**

.1 Record actual locations and mounting heights of outlet, pull, and junction boxes on project record documents.

1.5 **REGULATORY REQUIREMENTS**

.1 Provide products listed and classified by CSA (Canadian Standards Association) as suitable for the purpose specified and indicated.

2 Products

2.1 **OUTLET BOXES**

.1 Sheet Metal Outlet Boxes: CSA C22.2 No. 18, galvanized steel.
  .1 Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 13 mm male fixture studs where required.
  .2 Concrete Ceiling Boxes: Concrete type.

.2 Non-metallic Outlet Boxes: CSA C22.2 No. 18.

.3 Cast Boxes: CSA C22.2 No. 18, Type FD, aluminum. Provide gasketed cover by box manufacturer. Provide threaded hubs.

.4 Wall Plates for Finished Areas: As specified in Section 26 27 26.

2.2 PULL BOXES AND JUNCTION BOXES

.1 Sheet Metal Boxes: CSA C22.2 No. 18, galvanized steel.

.2 Hinged Enclosures: As specified in Section 26 27 16.

.3 Surface Mounted Cast Metal Box: CSA C22.2 No. 18, Type 4; flat-flanged, surface mounted junction box:
- .1 Material: Cast aluminum.
- .2 Cover: Provide with ground flange, neoprene gasket, and stainless steel cover screws.

2.3 OUTLET BOXES

.1 Conform to CSA C22.2 No. 18.

.2 Where 103 mm (4 inch) square outlet boxes are installed in exposed concrete or cinder block finished areas, blocks will be cut as described in Division 04 as instructed under this Section. Cut openings to provide a close fit to boxes and covers so that edges of openings are not visible after installation of plates. Use of mortar to patch up openings that are cut too large or to patch ragged edges is not permitted.

.3 Ceiling boxes: 103 mm (4 inch) octagon or square, complete with fittings, where required to support fixtures.

.4 Switch and receptacle boxes:
- .1 103 mm (4 inch) square with plaster ring, where flush mounted in plaster walls.
- .2 Iberville 1104 series box, or equal, where flush mounted in wood or drywall, with stud fasteners as required.
- .3 Masonry boxes in masonry walls.

.5 Where boxes are surface mounted in unfinished areas they shall be FS conduits.

.6 Standard outlet boxes manufactured from code gauge galvanized steel.

.7 Provide a suitable outlet box for each light, switch, receptacle or other outlet, approved for the particular area it is to be installed.

.8 Support outlet boxes independently of conduit and cable.

.9 Locate outlet boxes, mounted in hung ceiling space, so they do not obstruct or interfere with the removal of lay-in ceiling tiles.

.10 Offset outlet boxes, shown back to back in partitions, horizontally a minimum 150 mm (6 inch) to minimize noise transmission between adjacent rooms.

.11 Use gang boxes at locations where more than one device, of the same system only, is to be mounted. Utilize separate boxes for each system.

.12 Use tile wall covers where 103 mm (4 inch) square outlet boxes are installed in exposed concrete or cinder block in finished areas.

.13 Provide flush mount boxes, panels, cabinets and electrical devices, which are installed in finished areas, with suitable flush trims and doors or covers, unless specifically noted otherwise.

.14 Provide pre-formed polyethylene vapour barriers for all boxes located in walls with internal vapour barriers.

3 Execution

3.1 **EXAMINATION**

.1 Verify locations of floor boxes prior to rough-in.

3.2 **INSTALLATION**

.1 Install boxes to CSA C22.1.

.2 Install in locations as shown on drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.

.3 Set wall mounted boxes at elevations to accommodate mounting heights indicated.

.4 Electrical boxes are shown on drawings in approximate locations unless dimensioned. Adjust box location up to 3 m (10 feet) if required to accommodate intended purpose.

.5 Orient boxes to accommodate wiring devices oriented as specified in Section 26 27 26.

.6 Maintain headroom and present neat mechanical appearance.

.7 Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.

.8 Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 150 mm (6 inch) from ceiling access panel or from removable recessed luminaire.

.9 Install boxes to preserve fire resistance rating of partitions and other elements, using materials and methods.

.10 Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.

.11 Locate outlet boxes to allow luminaires positioned as shown on reflected ceiling plan.

.12 Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

.13 Use flush mounting outlet box in finished areas.

.14 Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.

.15 Do not install flush mounting box back-to-back in walls; provide minimum 150 mm separation. Provide minimum 600 mm separation in acoustic rated walls.

.16 Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

.17 Use stamped steel bridges to fasten flush mounting outlet box between studs.

.18 Install flush mounting box without damaging wall insulation or reducing its effectiveness.

.19 Use adjustable steel channel fasteners for hung ceiling outlet box.

.20 Do not fasten boxes to ceiling support wires.

.21 Support boxes independently of conduit.

.22 Use gang box where more than one device is mounted together. Do not use sectional box.

.23 Use gang box with plaster ring for single device outlets.

.24 Use cast outlet box in exterior locations exposed to the weather.

.25 Use cast outlet box in wet locations.

.26 Set floor boxes level.

.27 Large pull boxes: Use hinged enclosure in interior dry locations, surface-mounted cast metal box in other locations.

3.3 ADJUSTING

.1 Adjust floor box flush with finish flooring material.

.2 Adjust flush-mounting outlets to make front flush with finished wall material.

.3 Install knockout closures in unused box openings.

3.4 **CLEANING**

.1 Clean interior of boxes to remove dust, debris, and other material.

.2 Clean exposed surfaces and restore finish.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Cables installed in ducts.

.2 Direct buried cables.

1.2 **RELATED REQUIREMENTS**

.1 Division 31 – Excavation and Fill.

1.3 **REFERENCES**

.1 Canadian Standards Association, (CSA International).

.2 Insulated Cable Engineers Association, Inc. (ICEA).

2 Products

2.1 **FILL MATERIALS**

.1 Sand fill: clean, natural sand and gravel material, free from silt, clay, loam, friable or soluble materials and vegetable matter.

.2 Backfill material: Selected material from excavation or other sources, reviewed by Consultant, unfrozen and free from rocks larger than 75 mm (3 inch), rock with sharp angular surfaces, cinders, ashes, sods, refuse, or other deleterious materials.

3 Execution

3.1 **EXCAVATION AND FILL**

.1 In accordance with Section 31 23 00.

.2 Trenching:
- .1 Excavate to dimensions indicated. Ensure trench width is sufficient to accommodate mechanical vibratory compactor.
- .2 Do not leave open trench at end of day's operation.

.3 Backfilling
- .1 Do not proceed with backfilling operations until Electrical Inspection Authority has inspected and approved installation.

.4 Restoration
- .1 Restore surface of work area to conditions exiting prior to execution of work.
- .2 After backfilling trench, provide new topsoil as required to follow minimum depths after settlement of 100 mm (4 inches) for grass seeded areas.
- .3 Restore surface of paved areas to match existing.

3.2 CABLE INSTALLATION IN DUCTS

.1 Install cables as indicated in ducts.

.2 Do not pull spliced cables inside ducts.

.3 Install multiple cables in duct simultaneously.

.4 Use CSA approved lubricants of type compatible with cable jacket to reduce pulling tension.

.5 To facilitate matching of colour coded multiconductor control cables reel off in same direction during installation.

.6 Before pulling cable into ducts and until cables are properly terminated, seal ends of lead covered cables with wiping solder; seal ends of non-leaded cables with moisture seal tape.

.7 After installation of cables, seal duct ends with duct sealing compound.

3.3 DIRECT BURIAL OF CABLE

.1 Provide sand bed as indicated.

.2 Lay cables maintaining 75 mm (3 inch) clearance from each side of trench to nearest cable. Do not pull cable into trench.

.3 Provide offsets for thermal action and minor earth movements. Offset cable 150 mm for each 60 m run, maintaining minimum cable separation and bending radius requirements.

.4 Install treated planks on cables for mechanical protection. Install above cables and below markers.

.5 Cable separation:

- .1 Maintain 75 mm (3 inch) minimum separation between cables of different circuits.
- .2 Maintain 300 mm (12 inch) horizontal separation between low and high voltage cables.
- .3 When low voltage cables cross high voltage cables maintain 300 mm (12 inch) vertical separation with low voltage cables in upper position.
- .4 At crossover, maintain 75 mm (3 inch) minimum vertical separation between low voltage cables and 150 mm between high voltage cables.

3.4 MARKERS

.1 Mark cable every 150 m along duct runs and changes in direction.

.2 Mark underground splices.

.3 Where markers are removed to permit installation of additional cables, reinstall existing markers.

.4 Install cedar post type markers.

.5 Lay concrete markers flat and centred over cable with top flush with finish grade.

.1 Where warning tape is used to comply with OESC Rule 12-012(11), bury the tape approximately halfway between the installation and grade level, covering the width of the raceways or cables installed, in accordance with OESC Bulletin 12-2-(latest version).

3.5 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 00.

.2 Perform tests using qualified personnel. Provide necessary instruments and equipment.

.3 Check phase rotation and identify each phase conductor of each feeder.

.4 Check each feeder for continuity, short circuits and grounds. Ensure resistance to ground of circuits is not less than 50 megohms.

.5 Pre-acceptance tests.
- .1 After installing cable but before splicing and terminating, perform insulation resistance test with 1000 V megger on each phase conductor.
- .2 Check insulation resistance after each splice and/or termination to ensure that cable system is ready for acceptance testing.

.6 Acceptance Tests
- .1 Ensure that terminations and accessory equipment are disconnected.
- .2 Ground shields, ground wires, metallic armour and conductors not under test.
- .3 High Potential (Hipot) Testing.
  - .1 Conduct hipot testing in accordance with manufacturer's recommendations.

.7 Provide Owner with list of test results showing location at which each test was made, circuit tested and result of each test.

.8 Non-Conforming Work: Remove and replace entire length of cable if cable fails to meet any of test criteria.

3.6 WASTE MANAGEMENT

.1 Remove from site and dispose of all packaging materials at appropriate recycling facilities.

.2 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.3 Do not dispose of unused sealant material into sewer system, into streams, lakes, onto ground or in other location where it will pose health or environmental hazard.

.4 Divert unused metal and wiring materials from landfill to metal recycling facility as approved by Departmental Representative.

.5 Do not dispose of preservative treated wood through incineration.

.6 Do not dispose of preservative treated wood with other materials destined for recycling or reuse.

.7 Dispose of treated wood, end pieces, wood scraps and sawdust at sanitary landfill approved by Departmental Representative.

.8 Fold up metal banding, flatten and place in designated area for recycling.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Nameplates and labels.

.2 Wire and cable markers.

.3 Conduit markers.

.4 Receptacle labels.

.5 Signage.

1.2 **RELATED REQUIREMENTS**

.1 Section 27 05 53 – Identification for Communications Systems.

1.3 **SUBMITTALS**

.1 Product Data: Provide catalogue data for nameplates, labels, and markers.

.2 Provide shop drawings of nameplates for Consultant's review prior to fabrication (scale 1:1)

.3 Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under regulatory requirements. Include instructions for storage, handling, protection, examination, preparation and installation of Product.

1.4 **REGULATORY REQUIREMENTS**

.1 Provide products listed and classified by CSA (Canadian Standards Association) as suitable for the purpose specified and indicated.

2 Products

2.1 **NAMEPLATES AND LABELS**

.1 Nameplates:
  .1 Engraved three-layer laminated plastic, letters on contrasting background.
  .2 Colours to match existing building system, where applicable. If no building system exists, use the following:
    .1 347/600 Volt System: White text on Blue Background.
    .2 230/400 Volt System: White text on Blue Background.
    .3 120/208 Volt System: Black text on White Background.
    .4 Fire Detection System: White text on Red Background.
    .5 Emergency Lighting System: Red text on White Background.
    .6 LV Systems: White text on Green Background.
    .7 120/208 Volt Uninterruptable Power Supply (UPS): White text on Orange Background.
  .3 Confirm colours with Engineer prior to ordering nameplates.

.2 Equipment Nameplates to indicate:
- .1 Equipment/Panelboard ID
- .2 Ampacity.
- .3 Voltage
- .4 Number of Phases
- .5 Number of wires in system
- .6 Interrupting Capacity
- .7 Size, number of poles, Panelboard ID, and circuit number of upstream overcurrent protection device.
  - .1 Location of upstream device if not in the same room.

.3 Coordination Study Labels to Section 26 05 73.16.

.4 Arc Flash Study Labels to Section 26 05 73.19.

.5 Locations:
- .1 Distribution panelboards, and individual distribution panelboard branch breakers.
- .2 Receptacle panelboards.
- .3 Each electrical distribution and control equipment enclosure.
- .4 Uninterruptible Power Supply.
- .5 Mechanical Equipment.
- .6 UPS Receptacles.
- .7 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
- .8 Terminal cabinets, junction boxes, and pull boxes: indicate system and voltage.
- .9 Transformers: indicate capacity, primary and secondary voltages.

.6 Letter Size:
- .1 Use 3 mm letters for identifying individual equipment and loads.
- .2 Use 6 mm letters for identifying grouped equipment and loads.

.7 Labels:
- .1 Mechanically fastened with sheet metal screws, with 5 mm white letters on black background.
- .2 White letters on red background for UPS and equipment, and devices downstream of UPS.
- .3 Labels: embossed plastic labels with 6 mm high letters unless specified otherwise.
- .4 Wording on nameplates and labels to be approved by the Engineer prior to manufacture.
- .5 Allow for minimum of twenty-five (25) letters per nameplate and label.
- .6 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .7 Terminal cabinets and pull boxes: indicate system and voltage.

2.2 WIRING IDENTIFICATION

.1 Identify wiring with permanent indelible identifying markings, numbered, on both ends of phase conductors of feeders and branch circuit wiring.

.2 Maintain phase sequence and colour coding throughout.

.3 Colour coding: to CSA C22.1.

.4 Use colour coded wires in communication cables, matched throughout system.

2.3 WIRE MARKERS

.1 Description: tape, split sleeve, or tubing type wire markers.

.2 Locations: Each conductor at panelboard gutters, pull boxes, outlet and junction boxes and each load connection.

.3 Legend:
- .1 Power and Lighting Circuits: Branch circuit or feeder number indicated on drawings.
- .2 Control Circuits: Control wire number indicated on shop drawings.

2.4 CONDUIT MARKERS

.1 Colour code conduits, boxes and metallic sheathed cables.

.2 Location: Provide markers for each conduit longer than 2 m.

.3 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15 m intervals.

.4 Colours to match equipment nameplate background colour:
- .1 347/600 Volt System: Blue.
- .2 230/400 Volt System: Blue.
- .3 120/208 Volt System: Black.
- .4 Fire Alarm System: Red.
- .5 Emergency Lighting System: Red/White.
- .6 LV Systems (EPO, Remote Monitoring, Generator Control, Communications): Green.
- .7 120/208 Volt Uninterruptable Power Supply (UPS): Orange

.5 Confirm colours with Engineer prior to commencing rough-in.

2.5 BRANCH BREAKER LABELS

.1 General:
- .1 Legibly identify every circuit and circuit modification as to its clear, evident, and specific purpose or use. Include sufficient detail to allow each circuit to be distinguished from all others.
- .2 Label spare positions that contain unused overcurrent devices or switches.
- .3 Do not describe any circuit in a manner that depends on transient conditions of occupancy.

.2 Switchboards, distribution panelboards, enclosed breakers, and disconnect switches:
- .1 Locate identification at each switch.

.2 Branch breaker nameplates on switchboards, distribution panelboards and switchboards, and generator load breakers to indicate:
- .1 Locate identification at each switch on a switchboard.
- .2 Identification of downstream equipment fed from the breaker.
  - .1 Location of downstream device if not in the same room.
- .3 Breaker size and number of poles.
- .4 Interrupting Capacity.
- .5 Circuit number (where applicable).
- .6 Do not describe any circuit in a manner that depends on transient conditions of occupancy.

.3 Lighting and Receptacle Panelboards:
- .1 Provide a circuit directory that is located on the face or inside of the panel door.
- .2 Do not describe any circuit in a manner that depends on transient conditions of occupancy.

2.6 **RECEPTACLE LABELS**

.1 Label all receptacles with the panelboard ID and circuit number.

.2 Use receptacle labels by electronic labeller Brother P-Touch, model PT-20/25, Dymo-Tape or approved equal.

.3 Location: On receptacle wall plate.

3 Execution

3.1 **EQUIPMENT NAMEPLATES FROM MANUFACTURERS**

.1 Ensure manufacturer's nameplates, CSA labels and identification nameplates are visible and legible after equipment is installed.

.2 Manufacturers' nameplates and CSA labels are to be visible and legible after equipment is installed. Provide warning signs, as specified, or to meet requirements of Inspection Department, Health and Safety, and the Consultant.

.3 Label power outlets with circuit identification on visible portion of faceplate or surface mounted outlet box.

3.2 **CONDUIT IDENTIFICATION**

.1 Locate labels as follows:
- .1 At every end of every conduit, duct or cable run, adjacent to item of equipment serviced.
- .2 On each exposed conduit, duct or cable passing through a wall, partition or floor (one on each side of such wall partition or floor).
- .3 At intervals of 50'-0" along every exposed conduit, duct or cable run exceeding 50'-0" in length.
- .4 At every access point on concealed conduit duct or cable.

.2 Place labels so as to be visible from 5'-0" above adjacent floor platform.

3.3 PREPARATION

.1 Degrease and clean surfaces to receive nameplates and labels.

3.4 APPLICATION

.1 Confirm colours prior to start of work.

.2 Install nameplate and label parallel to equipment lines.

.3 Secure nameplate to equipment front using adhesive.

.4 Secure nameplate to inside surface of door on panelboard that is recessed in finished locations.

.5 Identify conduit using field painting.

.6 Paint coloured band on each conduit longer than 2 m.

.7 Paint bands 6 m on centre.

3.5 LABELLING

.1 Colour code wiring consistently throughout the installation and generally match colour coding of internal wiring of pre-wired components.

.2 Label wiring with point name using Thomas & Betts 12 character polestar metalized labels with 3 rows of characters per label, or equal by Brady. Label to occur as a minimum at both ends and at pull boxes of the wiring run.

.3 Identify all pull boxes, junction boxes, etc. (installed as part of this project or used by this project) with the exact use of the box. Indelible felt pen marker is acceptable.

.4 Label light control items with point name using Thomas & Betts 12 character label, or equal by Brady. Label to be black lettering on clear backing.

.5 Label relays and controllers inside panels using Thomas & Betts 12 character label, or equal by Brady.

.6 Provide red, 13 mm (1/2 inch) diameter, sticker on emergency light fixture frame. Include circuit number on sticker with thin permanent black mark pen.

3.6 LABELS AND SIGNS

.1 Manufacturers' nameplates and CSA labels are to be visible and legible after equipment is installed. Provide warning signs, as specified, or to meet requirements of Inspection Department, Health and Safety, and the Consultant.

.2 Label power outlets with circuit identification on visible portion of faceplate or surface mounted outlet box.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Electrical connections to equipment specified in other sections.

1.2 **RELATED REQUIREMENTS**

.1 Division 08 – Openings.

.2 Division 11 – Equipment.

.3 Division 21 – Fire Suppression.

.4 Division 22 – Plumbing.

.5 Division 23 – Heating, Ventilating, and Air Conditioning.

1.3 **REFERENCES**

.1 NEMA WD 1 - General Colour Requirements for Wiring Devices.

.2 NEMA WD 6 - Wiring Devices - Dimensional Requirements.

1.4 **COORDINATION**

.1 Coordinate work to Division 01.

.2 Obtain and review shop drawings, product data, and manufacturer's instructions for equipment provided under other sections.

.3 Determine connection locations and requirements.

.4 Sequence rough-in of electrical connections to coordinate with installation schedule for equipment.

.5 Sequence electrical connections to coordinate with start-up schedule for equipment.

1.5 **SUBMITTALS**

.1 Submit to Division 01.

.2 Product Data: Provide wiring device manufacturer's catalogue information showing dimensions, configurations, and construction.

.3 Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.6 **REGULATORY REQUIREMENTS**

.1 Provide products listed and classified by testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

2 Products

2.1 **COMMON MOTOR REQUIREMENTS**

.1 Motors up to and including 1/3 HP, shall be 1 phase, 60 Hz, 120 volts.

.2 Motors 1/2 HP and above shall be 3 phase, 60 Hz, 575 volts or 208 volts.

2.2 **CORDS AND CAPS**

.1 Attachment Plug Construction: Conform to NEMA WD 1.

.2 Configuration: NEMA WD 6; match receptacle configuration at outlet provided for equipment.

.3 Cord Construction: NFPA 70, Type SJO multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.

.4 Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

3 Execution

3.1 **WIRING OF EQUIPMENT PROVIDED UNDER OTHER DIVISIONS**

.1 Use the following procedure with regard to wiring of motors and equipment provided under other Divisions.

.2 The following equipment shall be responsibility of the trade supplying the equipment unless otherwise noted, in accordance with the requirements laid out in the individual section, or this division:
- .1 Motors.
- .2 Starters.
- .3 Variable Frequency Drives.
- .4 Motor Control Centres.
- .5 Control wiring.

.3 In every instance, install starter, motor control centre, variable frequency drivers (VFD), etc. and wire to line side of the starter, the Motor Control Centre, or VFD. Extend wiring from starter, motor control centre or VFD to motor as indicated.

.4 Provide all wiring for starters and VFD's from supply to starter to VFD and to motor. Coordinate requirements with the appropriate trade.

.5 Provide 500 mm of liquid tight flexible metal conduit for final connection to motor. Provide disconnect switches where required by code, and as indicated on the drawings.

.6 Where individual starters and controls are grouped together provide a panel for mounting this equipment. Provide a feeder, main fused disconnect and a splitter of adequate size and capacity and wire to line side of the starters on this panel and from starters to motors.

.7 Equipment, General
- .1 Ascertain exact locations of starters, motor control centres, motors, etc. from drawings and coordinate exact locations with the supplying trade.
- .2 Control wiring shall be the responsibility of the supplying trade.
  - .1 Control wiring shall be in accordance with Section 26 05 19, and Section 26 05 23.
  - .2 Control wiring shall be installed in conduit in accordance with Section 26 05 33.13.

.8 Plumbing Equipment
- .1 Ascertain exact locations of starters, motor control centres, motors, infra-red plumbing fixture controls from Mechanical Drawings and coordinate exact locations with plumbing trade.
- .2 Provide branch circuit wiring and an outlet for each infra-red plumbing fixture control.
- .3 Control wiring shall be the responsibility of the plumbing trade, as described above.

.9 HVAC Equipment
- .1 Ascertain exact locations of starters, motor control centres, motors, motorized dampers, VAV boxes, and heating control valves from HVAC drawings and coordinate exact locations with HVAC Division.
- .2 In the case of unit heaters, reheat coils and cabinet unit heaters, terminate wiring on terminals provided. Control wiring, thermostats, or other control devices shall be the responsibility of the HVAC trade, as described above.
- .3 Provide branch circuit wiring and an outlet for each motorized damper, variable air volume (VAV) box, or heating control valve. Control wiring shall be the responsibility of the HVAC trade, as described above.

3.2 EXAMINATION

.1 Verify that equipment is ready for electrical connection, wiring, and energization.

3.3 ELECTRICAL CONNECTIONS

.1 Make electrical connections to equipment manufacturer's instructions.

.2 Make conduit connections to equipment using flexible conduit. Use liquid-tight flexible conduit with watertight connectors in damp or wet locations.

.3 Make wiring connections using wire and cable with insulation suitable for temperatures encountered in heat producing equipment.

.4 Provide receptacle outlet where connection with attachment plug is indicated. Provide cord and cap where field-supplied attachment plug is indicated.

.5 Provide suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

.6 Install disconnect switches, controllers, control stations, and control devices as indicated.

.7 Modify equipment control wiring with terminal block jumpers as indicated.

.8 Provide interconnecting conduit and wiring between devices and equipment where indicated.

.9 Coolers and Freezers: Cut and seal conduit openings in freezer and cooler walls, floor, and ceilings.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Commissioning of all building electrical systems and component including:
- .1 Testing and adjustment.
- .2 Demonstration and training.
- .3 Instructions of all procedures for Owner's personnel.
- .4 Updating as-built data.
- .5 Co-ordination of Operation and Maintenance material.

.2 Provide labour and material to conduct the commissioning process as outlined in this specification section, including the hiring of an Independent Testing Contractor (ITC) as detailed below.

.3 Provisions of this section shall apply to all sections of Division 26, and Division 27.

1.2 **RELATED REQUIREMENTS**

.1 Testing and commissioning are called for throughout the individual specifications. This does not relieve this trade from providing all testing and commissioning necessary to ensure that systems and equipment operate as required and that they interface with other systems and equipment as required.

.2 Section 26 08 50 – Commissioning of Lighting: additional commissioning requirements for commissioning of lighting and lighting controls.

1.3 **COMMISSIONING PROCESS ALLOCATION**

.1 The commissioning process shall be allocated a value equal to 5 per cent of the contract. The Electrical Contractor may draw from this allocation as the commissioning process is completed.

.2 The Electrical Contractor shall submit all test and verification forms. The Consultant will use these forms to calculate percentage complete.

.3 The Electrical Contractor may claim up to 3 per cent of the contract from this allocation leading up to performance testing. The remaining 2 per cent shall not be paid out until the performance testing, O&M manuals, and training have been completed satisfactorily.

1.4 **DEFINITIONS**

.1 Cx – Commissioning.

.2 Commissioning Authority
- .1 The Commissioning Authority (CxA), also referred to as the Commissioning Consultant, shall be hired by The Owner.
- .2 The CxA responsibilities shall include:
  - .1 preparing the commissioning plan
  - .2 co-ordinating with the contractor to schedule tests
  - .3 preparing a test form manual

.4 witnessing selected tests
.5 receiving all test forms
.6 co-ordinating the contractors training
.7 chair the commissioning meetings

.3 The Electrical Contractor shall co-operate with the CxA.

.4 The Electrical Contractor shall provide assistance to the CxA and have personnel available during the performance testing procedure. Each electrical system shall be tested in the operational mode.

1.5 **SUBMITTALS**

.1 Conform to Division 01 for requirements for shop drawings and record drawings.

.2 A commissioning document shall be prepared by the CxA prior to conducting these activities for use by the Commissioning Team.

.3 The electrical sub-contractor shall be responsible for ensuring all activities are properly documented in this manual and co-ordinated through the General Contractor.

.4 As-built drawings and data books must be available two weeks prior to commissioning for review and use by the consultant and Commissioning Team prior to the start of the commissioning activities.

1.6 **QUALITY ASSURANCE**

.1 Provide qualified trades persons, certified testing agencies, factory trained and approved by the Commissioning Team Leader.

.2 Submit the names of all personnel to be used during the Commissioning activities.

1.7 **WARRANTY**

.1 Equipment and system warranties shall not begin until the system demonstration and turnover has been conducted successfully and accepted by the Owner.

.2 The Electrical Contractor shall fill out the warranty form listing the equipment and systems and the start and finishing dates for warranty.

.3 Refer to Division 01 and Section 26 05 00 for the requirements during the warranty period.

2 Products

2.1 **EQUIPMENT**

.1 The Contractor and manufacturers shall provide all instrumentation and equipment necessary to conduct the tests specified. The Contractor shall advise the Consultant of instrumentation to be used and the dates the instruments were calibrated.

3 Execution

3.1 THE COMMISSIONING PROCESS

.1 The purpose of the commissioning process is to fully test all building systems including architectural, mechanical and electrical components and operating procedures by challenging these systems to realistic operation conditions.

.2 The commissioning process consists of:
- .1 Shop Drawings and Record Drawings
- .2 Installation inspection and equipment verification
- .3 Independent testing contractor
- .4 Testing of equipment and systems
- .5 Commissioning meetings
- .6 Operating and maintenance manuals
- .7 Operating training
- .8 Commissioning Agent testing
- .9 Systems Demonstration and turnover
- .10 Testing forms
- .11 Warranties

3.2 PREPARATION

.1 Provide test instruments required for all activities as defined in the commissioning documents.

.2 Verify all systems are in compliance with the requirements of the commissioning documents prior to the pre-commissioning check out operation.

.3 Confirm all scheduled activities have identified personnel available.

.4 Where systems or equipment do not operate as required, make the necessary corrections or modifications, re-test and re-commission.

3.3 SYSTEM DESCRIPTION

.1 Perform all start-up operations, control adjustment, trouble shooting, servicing and maintenance of each item of equipment as defined in the commissioning documentation.

.2 Owner will provide list of personnel to receive instructions and will co-ordinate their attendance at agreed upon times.

.3 Prepare and insert additional data in the operations and maintenance manuals and update as-built drawings when need for additional data becomes apparent during the commissioning exercise.

.4 Where instruction is specified in the commissioning manual, instruct personnel in all phases of operation and maintenance using operation and maintenance manuals as the basis of instruction.

.5 Conduct presentation on Owner’s premises. Owner will provide space.

3.4 COMMISSIONING

.1 Commission the components of the electrical system using the NETA Acceptance Testing Specifications.

.2 Refer to the project commissioning plan prepared by the CxA.

.3 Commissioning activities for the electrical systems must have available up to date as-built drawing information and accurate Operations and Maintenance Manuals. These documents shall be a major part of this activity.

.4 Contractor shall be responsible to update all documentation with information and any changes duly noted during the Commissioning exercise.

.5 Contractor shall arrange for all outside suppliers, equipment manufacturers, test agencies and others as identified in the commissioning sections of this specification. The cost associated with this requirement shall be included as part of the tender price.

3.5 FINAL REPORT

.1 This trade shall assemble all testing data and commissioning reports and submit them to the General Contractor for submission to the Owner.

.2 Each form shall bear signature of recorder, and that of supervisor of reporting organizer.

3.6 SCHEDULE OF ACTIVITIES

.1 Commissioning activities shall be conducted based on pre-established schedule with all members of the commissioning team.

.2 In addition, there will be two meetings held through the contract duration to introduce the parties of the commissioning team, establish the schedules and deadlines for the various activities and review the Commissioning Manual.

.3 Adhering to the established schedule is very important as the co-ordination and scheduling of the participants will be difficult to alter once this is established. Close co-ordination of this schedule is important.

.4 In the event project cannot be commissioned in the allotted time slot, the contractor shall pay for all costs associated with assembling the Commissioning Team at a later date. If the contractor has not performed his duties to reach commissioning stage as outlined earlier, he will incur all expenses of other trades and the Commissioning Team due to his non-compliance.

3.7 INSTALLATION INSPECTION AND EQUIPMENT VERIFICATION

.1 The Electrical Contractor shall co-ordinate with the Electrical Consultant who will inspect the electrical installation.

.2 The Electrical Contractor shall complete the equipment verification forms for each piece of equipment. The forms shall be included in the operating and maintenance manual. The equipment data shall include:
- .1 Manufacturers name, address and telephone number
- .2 Distributors name, address and telephone number
- .3 Make, model number and serial number
- .4 Voltage and current ratings

3.8 INDEPENDENT TESTING CONTRACTOR

.1 The Independent Testing Contractor (ITC) shall be hired by the contractor and shall issue reports to the Electrical Consultant.

.2 The ITC shall conduct load balancing measurements to verify load balancing performed in accordance with Section 26 05 00.

3.9 TESTING OF EQUIPMENT AND SYSTEMS

.1 The Electrical Contractor shall be responsible for all tests detailed in this Section, and those tests required by a manufacturer as part of their installation requirements.

.2 The Electrical Contractor shall schedule all tests which shall be witnessed by the Electrical Consultant or the Commissioning Consultant. The contractor shall complete and sign the testing forms.

.3 The Electrical Contractor shall conduct tests on the following equipment as a minimum. Refer to the individual specification sections for test procedures.
- .1 Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables.
- .2 Section 26 05 73.16 – Coordination Studies.
- .3 Section 26 24 16 – Panelboards.
- .4 Section 27 51 16 – Public Address Systems.

.4 When all testing has been completed and all mechanical and electrical systems are operational the contractor shall conduct system load balance measurements, infra-red test and harmonics tests.

3.10 COMMISSIONING MEETINGS AND REPORTING

.1 The Electrical Contractor shall include the schedule for all tests in the construction schedule.

.2 The Commissioning meetings shall occur during the regular construction meetings. The testing schedules and the results of all tests shall be reviewed.

.3 All testing forms and reports associated with the electrical systems shall be directed to the Electrical Consultant, with copies to the Architect, Commissioning Consultant, and the Owner.

.4 The forms and reports to be issued shall include:
- .1 Shop drawings, issued and accepted
- .2 Equipment verification forms

.3 Testing forms
.4 Reports resulting from tests
.5 Testing schedule
.6 Minutes of commissioning meetings
.7 Manufacturers' Certificates

3.11 OPERATING AND MAINTENANCE MANUAL

.1 Conform to the specification section for the requirements of the O&M manuals.

3.12 DEMONSTRATION AND TRAINING

.1 Conform to section for requirements for instructions to the Building Owner for each system and equipment.

.2 The training shall be provided by qualified technicians or electricians and shall be conducted in a classroom and at the equipment or system.

.3 The training sessions shall be scheduled, co-ordinated and video taped by the Commissioning Consultant.

.4 Each training session shall be structured to cover:
.1 The operating and maintenance manual.
.2 Operating procedures.
.3 Maintenance procedures.
.4 Troubleshooting procedures.
.5 Spare parts.

.5 Submit a course outline to the Electrical Consultant before training commences. Provide course documentation for up to eight people.

.6 The training session shall be scheduled and co-ordinated by the Commissioning Consultant. The Commissioning Consultant shall video tape the sessions.

.7 Training shall be provided for the following systems:
.1 Electrical Systems including distribution and lighting: 8 hour minimum
.2 Section 27 51 16 – Public Address Systems: 1 hour minimum

.8 The Electrical Contractor shall conduct a walkthrough of the installation. During the walkthrough the Electrical Contractor shall:
.1 Identify equipment
.2 Identify electrical panels
.3 Identify starters and disconnects
.4 Review the electrical power distribution
.5 Review the light power distribution
.6 Review the switchgear
.7 Review the general maintenance procedures

3.13 THE ELECTRICAL SYSTEM DEMONSTRATION AND TURNOVER

.1 The system demonstration and turnover to The Owner shall occur when:
.1 The installation is complete.

.2 The acceptance test conducted by the Electrical Consultant has been completed successfully.
.3 Training has been completed.
.4 Equipment Operating and Maintenance Manuals have been accepted.
.5 System operating manuals have been accepted.
.6 Shop-drawings have been updated.
.7 As-built drawings have been completed.
.8 The commissioning process has been completed successfully and system operation accepted by the Electrical Consultant and Commissioning Consultant.

.2 The systems demonstration shall be conducted by the Electrical Contractor and manufacturers. The demonstration shall cover a physical demonstration of equipment installation and operation.

3.14 TESTING FORMS

.1 The Electrical Contractor and manufacturers shall fill out the forms listed in this section or provide other forms. The forms must be approved by the Electrical Consultant and the Owner before they are used.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Common requirements for commissioning of all electric lighting, including interior, exterior, and emergency lighting.

.2 The party responsible for the functional testing shall not be directly involved in either the design or construction of the project.

1.2 **RELATED REQUIREMENTS**

.1 Section 26 09 23 – Lighting Control Devices.

.2 Section 26 51 00 – Interior Lighting.

.3 Section 26 52 13.13 – Emergency Lighting.

.4 Section 26 56 19 – LED Exterior Lighting.

1.3 **REFERENCES**

.1 ASHRAE
  .1 ASHRAE Guideline 0-2005 – The Commissioning Process.
  .2 ASHRAE 90.1-2010 – Energy Standard for Building Except Low-Rise Residential Buildings.

.2 Illumination Engineering Society (IES)
  .1 IES DG-29-11 – Design Guide for the Commissioning Process Applied to Lighting and Control Systems.

.3 Ontario Building Code
  .1 Supplementary Standard SB-10: Energy Efficiency Requirements.

1.4 **ACTION SUBMITTALS**

.1 Refer to Division 01.

.2 Submit sample commissioning forms.

1.5 **CLOSEOUT SUBMITTALS**

.1 Division 01: Submittals for project closeout.

.2 Submit commissioning reports.
  .1 Submit a floor plan or spreadsheet table checklist that indicates each local lighting control device, occupancy sensors, daylighting controls, system component.
  .2 Submit the system sequence of operation fully describing the equipment components and functionality, including set points and alarm functions.

.3 The detailed sequence of operation shall be provided regardless of the completeness and clarity of the sequences in the controls specification and/or drawings.

.3 The functional testing party shall provide documentation certifying that the installed lighting controls meet or exceed all documented performance criteria.

2 Products – Not Used

3 Execution

3.1 **COMMISSIONING**

.1 Sensor placement and orientation for all sensor types.

.2 Occupancy sensor function, sensitivity, and time delays.

.3 Daylight harvesting sensor calibration.

.4 Automated shade operation.

.5 Manual control placement and operation.

.6 Automated control operation, including scheduled on/off functions and dimming trims and presets.

.7 Override operation, access, and functionality.

.8 Centralized control interfaces and operation.

.9 Client education of operations.

.10 Documentation archived to client.

3.2 **FUNCTIONAL TESTING**

.1 Lighting control devices and control systems shall be tested to ensure that control hardware and software are calibrated, adjusted, programmed, and in proper working condition in accordance with the construction documents and manufacturer's installation instructions.

.2 When occupant sensors, time switches, programmable schedule controls, or photosensors are installed, at a minimum, the following procedures shall be performed:

.1 Confirm that the placement, sensitivity and time-out adjustments for occupant sensors yield acceptable performance, lights turn off only after space is vacated and do not turn on unless space is occupied.

.2 Confirm that time switches and programmable schedule controls are programmed to turn the lights off.

.3 Confirm that photosensor controls reduce electric lights levels based on the amount of usable daylight in the space as specified.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Occupancy and Vacancy sensors.

.2 Power packs, and auxiliary relays, momentary switches.

.3 Manual controls devices, including dimming switches and low voltage momentary switches.

.4 Timer switches.

.5 Daylight harvesting photo sensors.

.6 Emergency lighting control units.

1.2 **PRODUCTS INSTALLED BUT NOT SUPPLIED UNDER THIS SECTION**

.1 Line voltage manual control devices, as described in Section 26 27 26 – Wiring Devices.

1.3 **RELATED REQUIREMENTS**

.1 Section 26 08 50 – Commissioning of Lighting.

.2 Section 26 27 26 – Wiring Devices.

.3 Section 26 50 00 – Lighting.

1.4 **REFERENCES**

.1 Canadian Standards Association (CSA) (www.csa.ca).
- .1 CSA C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.
- .2 Ontario Electrical Safety Code.
- .3 CSA C22.2 No. 14 Industrial Control Equipment
- .4 CSA C22.2 No. 184 - Solid-State Lighting Controls
- .5 CSA C22.2 No. 184.1 - Solid State Dimming Controls.
- .6 CSA C22.2 No. 156 - Solid-State Speed Controls
- .7 CSA C22.2 No. 42.1 - Cover Plates for Flush Mounted Wiring Devices
- .8 CSA C22.2 No. 42 - General Use Receptacles

.2 National Electrical Manufacturers Association (NEMA)
- .1 WD1 (R2005) — General Color Requirements for Wiring Devices.
- .2 WD6 – Dimensional Specifications

.3 Ontario Building Code.

.4 UL 924 - Standard for Safety of Emergency Lighting and Power Equipment.

1.5 **SUBMITTALS**

.1 In accordance with Division 01.

.2 Product Data:
- .1 Submit manufacturer's descriptive literature and product specifications for each product.
- .2 Manufacturer's product drawings.
- .3 Manufacturer's installation instructions

1.6 **QUALITY ASSURANCE**

.1 Manufacturer Qualifications: Products free of defects in material and workmanship.

1.7 **WARRANTY**

.1 Product is warranted free of defects in material and workmanship.

.2 Product is warranted to perform the intended function within design limits.

2 Products

2.1 **MANUFACTURERS**

.1 Wattstopper (Basis of Design).

.2 Eaton's Cooper Lighting Business.

.3 Hubbell.

.4 Lutron.

.5 Sensorswitch.

2.2 **GENERAL REQUIREMENTS OF ALL SENSORS AND POWER PACKS**

.1 Manufactured by an ISO 9002 certified manufacturing facility and shall have a defect rate of less than 1/3 of 1 per cent.

.2 Five year warranty and CUL listed.

.3 In the event of failure, provide a bypass manual "override on" feature on each sensor.

.4 When bypass utilized, lighting to remain on constantly, or control is to be diverted to a wall switch until sensor is replaced. The override feature is to be designed for use by building maintenance personnel and not be readily achieved by building occupants.

2.3 OCCUPANCY AND VACANCY SENSORS

.1 General:
- .1 Sensors using passive infrared, ultrasonic, microphonic, and multi-technology adaptive technology.
- .2 Sensor timeouts configurable by system software.
- .3 Electrical: Rating: 24 VDC input voltage, up to 40 mA current draw.
- .4 Mechanical: Mounting: Sensors for mounting on ceilings and walls, including corners, must be available.
- .5 Environmental:
  - .1 Operating Temperature Range: 0 degrees C to 40 degrees C
  - .2 Relative Humidity: 0 per cent to 95 per cent non-condensing.

.2 Dual Technology Wall Switch Sensor, 24V
- .1 Wattstopper DW-100-24-W series (Basis of Design).
- .2 Sensor capable of detecting presence in the control area by detecting Doppler shifts in transmitted ultrasound and passive infrared heat changes.
- .3 Utilize a dual sensing verification principle for coordination between ultrasonic and Passive Infrared (PIR) Technologies to reduce likelihood of false triggering.
- .4 For best results, sensor shall feature a trigger mode where the end-user can choose which technology will activate the sensor from Off mode (initial), the type of detection that will reset the time delay (maintain), and the type of detection that will cause the sensor to be turned back on immediately after the lights are turned off due to lack of motion (re-trigger). Selection of technologies for initial, maintain, and re-trigger shall be done with DIP switches.
- .5 Sensor shall have its trigger mode factory preset to allow for quick installation in most applications. In this default setting, both technologies must occur in order to initially activate lighting systems. Detection by either technology shall maintain the lighting on, and detection by either technology shall turn lights back on after lights were turned off for 5 seconds or less in automatic mode, and 30 seconds or less in manual mode.
- .6 Robotic test method, as referred in the NEMA WD 7 Guide, shall be utilized for minor motion coverage verification.
- .7 Ultrasonic sensing shall be volumetric in coverage with a frequency of 40 kHz. It shall utilize Advanced Signal Processing which automatically adjusts the detection threshold dynamically to compensate for constantly changing levels of activity and air flow throughout controlled space.
- .8 The PIR technology shall utilize a temperature compensated, dual element sensor and a multi-element Fresnel lens. The lens shall filter short wavelength IR, such as those emitted by the sun and other visible light sources. Face lens grooves in to avoid dust and residue build up which affects IR reception.
- .9 Utilize zero crossing circuitry to reduce stress on relay, and therefore increase sensor life.
- .10 Operate at 24 VDC and halfwave rectified and utilize a power pack or lighting control system input module to supply power.
- .11 To blend in aesthetically, sensor protrusion not more than 3/8” from the wall and utilize colour-matched lens.

.12 To assure detection at desktop level uniformly across the space, sensor shall have a 28 segment, 2 level, Fresnel injection molded lens.
.13 Sensor shall feature a walk-through mode, where lights turn off 3 minutes after the area is initially occupied if no motion is detected after the first 30 seconds, set by DIP switch.
.14 To avoid false ON activations and to provide immunity to RFI and EMI, Detection Signature Analysis shall be used to examine the frequency, duration, and amplitude of a signal, to respond only to those signals caused by human motion.
.15 Coverage up to 1,000 sq. ft. for walking motion, with a field view of 180 degrees.
.16 Automatic-ON or manual-ON operation, adjustable with a DIP switch.
.17 Sensor shall have an adjustable time delay.
.18 Each sensing technology shall have an LED indicator that remains active at all times, in order to verify detection within the area to be controlled.
.19 Sensor shall have a service switch to allow end-users to operate the sensor in the unlikely event of a failure; set by a trim pot.
.20 Sensor shall have a built-in light level that features simple, one-step daylighting setup that works from 8 fc to 180 fc.
.21 The Dual Technology wall switch sensor shall be a completely self-contained control system that replaces a standard toggle switch

.3 Dual Technology Ceiling Mounted Sensor, 24V
.1 Wattstopper DT-300 series (Basis of Design).
.2 The Dual Technology sensor shall be capable of detecting presence in the control area by detecting doppler shifts in transmitted ultrasound and passive infrared heat changes.
.3 Sensor shall utilize Dual Sensing Verification Principle for coordination between ultrasonic or microphonic and Passive Infrared (PIR) Technologies. Detection verification of both technologies must occur in order to activate lighting systems. Upon verification, detection by either technology shall keep the lighting on.
.4 Sensor shall have a retrigger feature in which detection by either technology shall retrigger the lighting system on within 5 seconds of being switched off.
.5 Sensors shall be ceiling mounted with a flat, unobtrusive appearance, and provide 360 degree coverage.
.6 Ultrasonic sensing shall be volumetric in coverage, with a frequency of 40 kHz. It shall utilize Advanced Signal Processing that automatically adjusts the detection threshold dynamically to compensate for changing levels of activity and airflow throughout a controlled space.
.7 To avoid false ON activations, and to provide immunity to RFI and EMI, Detection Signature Analysis shall be used to examine the frequency, duration, and amplitude of a signal, in order to respond only to those signals caused by human motion.
.8 The PIR technology shall utilize a temperature compensated, dual element sensor and a multi-element Fresnel lens. The lens shall be Poly IR4 material to offer superior performance in the infrared wavelengths and filter short wavelength IR, such as those emitted by the sun and other visible light sources. The lens shall have grooves facing in to avoid dust and residue build up which affects IR reception.

.9 Sensors shall operate at 24 VDC, and halfwave rectified, and utilize a 24 V power pack.
.10 Sensors shall feature a walk-through mode, where lights turn off 3 minutes after the area is initially occupied if no motion is detected after the first 30 seconds.
.11 The sensor shall have a built-in light level sensor that works from 10 fc to 300 fc.
.12 The sensors shall feature terminal style wiring.
.13 Each sensing technology shall have an LED indicator that remains active at all times in order to verify detection within the area to be controlled. The LED can be disabled for applications that require less sensor visibility.

2.4 SPECIAL PURPOSE OCCUPANCY SENSORS

.1 Occupancy Sensors for High bay applications:
.1 For use in warehouses, distribution centers, and gymnasiums.
.2 Maximum 14 m (45 feet) mounting height.
.3 Surface-mount or end-mount model to suit application.
.4 180 degree and 360 degree coverage lenses available.
.5 Low-voltage, passive infrared (PIR) sensor.
.6 End-mount model to attach directly to industrial T5HO and T8 fixtures through an extended 13 mm (0.5 inch) chase nipple or junction box.
.7 Adjustable timeout for maximum energy savings.
.8 Basis of design: Lutron LUT-WSPSM24V-360-CPN6111 and similar.

2.5 POWER PACKS

.1 General:
.1 Self-contained transformer and relay module.
.2 Internal relay controlling up to 20A for 120, 230, 277VAC or 347VAC ballast loads and 120VAC incandescent loads.
.3 Provide a 24 VDC, 150 mA output.
.4 Capable of parallel wiring without regard to AC phases on primary.
.5 Power pack can be used as a standalone, low voltage switch, or can be wired to sensor for auto control.
.6 Construction: high impact, UL rated plastic case
.7 Power pack shall be UL/CUL Listed, FCC Certified, UL 2043 plenum rated and meets ASHRAE 90.1 requirements
.8 Shall at minimum meet the following environmental specifications:
.1 Operating Temperature Range: 0 degrees C to 40 degrees C
.2 Relative Humidity: 0 per cent to 95 per cent non-condensing

.2 Power Pack and Auxiliary Relay, 347 V
.1 Power Pack: Wattstopper B347D-P Series (Basis of Design)
.2 Auxiliary Relay: Wattstopper S347-E-P Series (Basis of Design)
.3 Power pack shall be a self-contained transformer and relay module measuring 45 mm by 70 mm by 38 mm (1.75 inch by 2.75 inch by 1.5 inch).
.4 For ease and speed of installation, power pack shall have 12 mm (1/2") snap-in nipple for 12 mm (1/2") knockouts and mounting on outside of enclosure.
.5 Power pack shall have dry contacts capable of switching 15 amp ballast @ 347 VAC, 60Hz.

.6 Power pack shall have primary voltage input of 347 VAC.
.7 Power pack shall provide a 24 VDC, 114 mA output, with the relay connected.
.8 Power pack shall be capable of parallel wiring without regard to AC phases on primary.
.9 Power pack can be used as a standalone, low voltage switch, or can be wired to sensor for auto control.
.10 Power pack shall have hold-ON and hold-OFF inputs for integration with lighting control panels, BMS and other building systems.
.11 Power pack shall have overcurrent protection if the low voltage current drawn exceeds 150 mA. In the event of an overcurrent, the low voltage output current shuts down and the LED will blink to indicate a fault condition.
.12 Power pack shall have an LED to indicate status of relay.
.13 Power pack shall utilize Zero Crossing Circuitry to protect from the effects of inrush current and increase product longevity.

2.6 DECORATOR LOW VOLTAGE MOMENTARY SWITCHES

.1 Wattstopper DCC2 series (Basis of Design).

.2 Switch intended for use with power packs and sensors requiring a momentary contact switch that provides on/off signals.

.3 12 VAC/VDC, 24 V Rectified, 24 VAC/VDC

.4 50 mA Max. Internal Contact rating

.5 500 mΩ resistance when closed

.6 Single pole, double throw with center position rest.

2.7 DIMMING SWITCHES

.1 Direct control of dimming luminaires up to the luminaire manufacturer's specified rating.

.2 Coordinate dimming signal configuration (2-wire phase cut, 3-wire, 4-wire 0-10V, or 4-wire DALI) with the fixture ballast or driver per Section 26 50 00, lighting fixture schedule, and related sections.

.3 Compatible with related lighting control devices i.e. occupancy sensors.

.4 Submit luminaire manufacturer's dimmer compatibility documentation to demonstrate compatibility and limits of dimming level.

.5 Acceptable Manufacturers:
.1 Lutron NovaT* style dimmers.
.2 Equal by Cooper.
.3 Equal by Philips.
.4 Approved Equal.

2.8 TIMER SWITCHES

.1 Digital time switch programmable to turn loads off after a preset time.

.2 Capable of operating as an ON/OFF switch.

.3 Five terminal, completely self-contained control system that replaces a standard toggle switch. Switching mechanism 30 V @ 1 A air gap relay.

.4 24 VAC when used in conjunction with power packs. For small rooms, or small localized loads, line voltage is permitted.

.5 No minimum load requirement.

.6 Time scroll feature permitting manual overriding of the preset time-out period. Selecting time scroll UP shall allow time-out period to scroll up throughout the timer possibilities to the maximum. Time scroll DN (down) shall allow time-out period to scroll down to minimum.

.7 Options available for user to enable:
- .1 One second light flash warning at five minutes before the timer runs out and twice when the countdown reaches one minute (when used to control lighting loads).
- .2 Beep warning sounding every five seconds once the time switch countdown reaches one minute.

.8 Manual timer reset where pressing the ON/OFF switch for more than 2 seconds resets the timer to the programmed time-out period.

.9 Liquid crystal display (LCD) that shows the timer's countdown.

.10 Incorporates two pulsed, open collector NPN transistor outputs for external latching relay coil drives or lighting control panel inputs.

.11 Fit behind a decorator style faceplate. Concealed calibration switch for setting time-out, time scroll, one second light flash, and beep warning to prevent tampering of adjustments and hardware.

.12 Time-out period adjustable in increments of 5 minutes from 5 minutes to 1 hour, and in increments of 15 minutes from 1 hour to 12 hours.

.13 Operate with power packs in order to control additional loads.

.14 Utilize terminal style wiring.

.15 For safety, in the event there is an open circuit in the low voltage line, automatically switch to OFF mode.

.16 Warranty: 5 year warranty.

.17 CUL listed.

.18 Wattstopper TS-400 and TS-400-24 series (Basis of Design).

2.9 EMERGENCY LIGHTING CONTROL UNIT FOR 120 VOLT CIRCUITS

.1 Description:
- .1 Sequence of Operation: activate emergency lighting in the event of loss of normal utility power, regardless of control status of the luminaire.
- .2 Provide all required functionality to allow any standard lighting control device to control emergency lighting in conjunction with normal lighting in any area within a building.

.2 Device shall be listed to UL 924 to meet the intent of Ontario Building Code for “fail-safe operation”, and be approved for use in Canada.

.3 Example Manufacturers
- .1 Functional Devices Inc. ESR01P series.
- .2 Douglas Lighting Controls WR-RIB2401B-EL.
- .3 Philips Bodine BLCD-20B.
- .4 Schneider Electric SLSERC1277.
- .5 Wattstopper ELCU-200 series.
- .6 Approved Equal.

.4 Mounting: Able to fit in a standard junction box knockout.

.5 Features:
- .1 Senses local single circuit power failure.
- .2 LED indication for emergency and normal power.
- .3 Provides absolute fail-to-on emergency lighting.
- .4 Emergency lights are controlled with normal lighting.
- .5 Sequence of Operation: automatically switch emergency lighting on and off as normal lighting is switched. When normal power is not available, force and hold emergency lighting on regardless of the state of any external control device until normal power is restored.

.6 Specifications:
- .1 120 VAC; 60 Hz.
- .2 Maximum Ballast Load: 10A @ 120 VAC.
- .3 Housing: Fire rated V-0, 80 degrees C.
- .4 Zero crossing circuitry to protect relay contacts from damaging effects of inrush current generated by switching electronic ballast loads.
- .5 UL94 V-O plenum rated with compression wire terminals.
- .6 UL, cUL listed Emergency Lighting and Equipment; five year warranty.

2.10 DAYLIGHT HARVESTING PHOTO SENSORS

.1 General:
- .1 Class 2, low voltage.
- .2 Ambient light sensor designed to interface directly with the analog input of the Lighting Control System.
- .3 Supply an analog signal to the Lighting Control System proportional to the light measured.
- .4 Sensor output shall provide for zero or offset based signal.

.5 Capable of a fully adjustable response in the range between 0 and 10,000 foot candles with a +/- 1 per cent accuracy at 21 degrees C.
.6 Input: 10 VDC.
.7 Output: 0 VDC to 10 VDC.
.8 Flame retardant housing and meet UL 94 HB standards.
.9 Operating temperature: -10 degrees C to 60 degrees C.

.2 Interior sensors: Fresnel lens, with a 60 degree cone of response. Range between 0 fc and 750 fc.

.3 Exterior sensors: Complete with hood over the aperture to shield the sensor from direct sunlight. Outdoor sensor circuitry completely encased in an optically clear epoxy resin. Sensor range between 0 fc and 750 fc.

.4 Atrium sensors: Translucent dome with a 180 degree field of view. Range from 2 fc to 2,500 fc.

.5 Skylight sensors: Translucent dome with a 180 degree field of view. Range between 10 fc and 7,500 fc.

3 Execution

3.1 **INSTALLATION**

.1 In accordance with manufacturer’s instructions.

.2 Minimum 14 AWG from the circuit control hardware relays.

.3 It shall be the contractor's responsibility to locate and aim sensors in the correct location required for complete and proper volumetric coverage within the range of coverage(s) of controlled areas per the manufacturer's recommendations. Rooms shall have 90 per cent to 100 per cent coverage to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants at any location within the room(s). The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only the rooms which are to be provided with sensors. The contractor shall provide additional sensors if required to properly and completely cover the respective room.

.4 It is the contractor’s responsibility to arrange a pre-installation meeting with manufacturer's factory authorized representative, at Owner's facility, to verify placement of sensors and installation criteria.

.5 Proper judgement must be exercised in executing the installation so as to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structural components.

.6 Install manual control devices and sensors in accordance with manufacturer’s instructions for Vacancy Operation.

3.2 **TRAINING**

.1 Provide training in accordance with Division 01.

3.3 **COMMISSIONING**

.1 In accordance with Section 26 08 50.

.2 Upon completion of the installation, the system shall be completely commissioned to verify all adjustments and sensor placement to ensure a trouble-free lighting control system.

.3 Submit commissioning report to the Consultant and the commissioning authority for review.

.4 Provide the Consultant and Commissioning Authority with ten working days written notice of the scheduled commissioning date.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Power distribution panelboards – Circuit breaker type.

.2 Lighting and Appliance Branch Circuit Panelboards.

1.2 **RELATED REQUIREMENTS**

.1 Section 26 28 16.02 – Molded Case Circuit Breakers.

.2 Section 26 43 13 – Surge Protective Devices for Low-Voltage Electrical Power Circuits.

1.3 **REFERENCES**

.1 CSA C22.1-12 - Canadian Electrical Code, Part I (22nd Edition), Safety Standard for Electrical Installations

.2 Ontario Electrical Safety Code (25th Edition / 2012)

.3 CSA C22.2 No.29 - Panelboards and Enclosed Panelboards.

.4 NEMA AB1 - Molded Case Circuit Breakers, Molded Case Switches, and Circuit - Breaker Enclosures.

.5 NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts.

.6 NEMA KS1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

.7 NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment (published by the International Electrical Testing Association).

.8 The panelboards and circuit breakers referenced herein are designed and manufactured according to the latest revision of the following specifications.
- .1 NEMA PB 1 - Panelboards
- .2 NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
- .3 NEMA AB 1 - Molded Case Circuit Breakers
- .4 CSA C22.2 No. 29-M1989 - Panelboards and Enclosed Panelboards
- .5 CSA C22.2 No. 5-M91 - Molded Case Circuit Breakers

1.4 **ACTION SUBMITTALS**

.1 Submit in accordance with Section 01 33 00.

.2 Shop drawings shall contain overall panelboard dimensions, interior mounting dimensions, and wiring gutter dimensions. The location of the main, branches,

and solid neutral shall be clearly shown. In addition, the drawing shall illustrate one line diagrams with applicable voltage systems.

.3 Shop drawings
- .1 Indicate the following:
  - .1 Outline and support point dimensions
  - .2 Voltage
  - .3 Main bus ampacity
  - .4 Integrated short circuit ampere rating
  - .5 Circuit breaker arrangement, types and sizes.
- .2 The following information shall be submitted to the Engineer:
  - .1 Breaker layout drawing with dimensions indicated and nameplate designation
  - .2 Component list
  - .3 Conduit entry/exit locations
  - .4 Assembly ratings including:
    - .1 Short-circuit rating
    - .2 Voltage
    - .3 Continuous current
  - .5 Cable terminal sizes
  - .6 Product data sheets
- .3 Where applicable, the following additional information shall be submitted to the Engineer:
  - .1 Key interlock scheme drawing and sequence of operations

.4 Submittals for Construction
- .1 The following information shall be submitted for record purposes:
  - .1 Installation information

1.5 CLOSEOUT SUBMITTALS

.1 Refer to Section 01 78 00.

.2 Record actual locations of panelboards and record actual circuiting arrangements in project record documents.

.3 Maintenance Data: Include spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

.4 Final as-built drawings and information shall incorporate all changes made during the manufacturing and installation process.

1.6 MAINTENANCE MATERIAL SUBMITTALS

.1 Manufacturer shall provide installation instructions and NEMA Standards Publication PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

.2 Equipment operation and maintenance manuals shall be provided with each assembly shipped and shall include instruction leaflets, instruction bulletins and

renewal parts lists where applicable, for the complete assembly and each major component.

.3 Provide two of each panelboard key.

.4 Provide final panelboard schedules indicating panelboard data, phasing, breaker sizes, and loads served.

1.7 **QUALITY ASSURANCE**

.1 Regulatory Requirements
.1 Products: Listed and classified by CSA (Canadian Standards Association).

.2 Qualifications
.1 Company specializing in manufacturing of panelboard products with a minimum of 20 years' experience.
.2 The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.
.3 For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.
.4 The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.8 **DELIVERY, STORAGE, AND HANDLING**

.1 Inspect and report concealed damage to carrier within their required time period.

.2 Handle carefully to avoid damage to panelboard internal components, enclosure, and finish.

.3 Store in a clean, dry environment. Maintain factory packaging and, if required, provide an additional heavy canvas or heavy plastic cover to protect enclosure(s) from dirt, water, construction debris, and traffic.

.4 Equipment shall be handled and stored in accordance with manufacturer's instructions. One copy of these instructions shall be included with the equipment at time of shipment.

1.9 **MANUFACTURER WARRANTY**

.1 Warrant specified equipment to be free from defects in materials and workmanship for eighteen (18) months from the date of purchase.

2 Products

2.1 **GENERAL**

.1 Description: CSA C22.2 No.29, circuit breaker type.

2.2 DISTRIBUTION PANELBOARDS – CIRCUIT BREAKER TYPE

.1 Manufacturers:
- .1 Square D by Schneider Electric, I-LINE Series.
- .2 Eaton Cutler-Hammer, PRL 3 and PRL4 Series.
- .3 Equal by Siemens.

.2 The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the Engineer ten days prior to bid date.

.3 Panelboard Bus:
- .1 Copper, ratings as indicated.
- .2 Provide copper neutral bus for panelboards indicated for 4-wire systems.
- .3 Provide copper ground bus in each panelboard.

.4 Short Circuit Ratings:
- .1 Panelboards rated 600 V shall have minimum integrated short-circuit ratings as shown on the drawings or as herein scheduled, but not less than 65 000 amperes RMS symmetrical.
- .2 Distribution panelboards with bolt-on devices contained therein shall have interrupting ratings as specified herein or indicated on the drawings.
- .3 Panelboards shall be fully rated.
- .4 Where indicated, provide circuit breakers ULC listed for application at 100 per cent of their continuous ampere rating in their intended enclosure.

.5 Minimum integrated short circuit rating: Panelboards rated 240 V shall have minimum integrated short-circuit ratings as shown on the drawings or as herein scheduled, but not less than 10 000 amperes RMS symmetrical.

.6 Molded Case Circuit Breakers: To Section 26 28 16.02.

.7 Circuit Breaker Accessories: Trip units and auxiliary switches as indicated.

.8 Cabinet Front: Surface type, fastened hinge and latch, metal directory frame, finished in manufacturer's standard gray enamel.

.9 Enclosures: CSA type 2 sprinklerproof complete with drip hood, or as noted.

.10 Trims shall be equipped with a flush lock

.11 Breaker positions labeled as “Spare” or “Space” shall constitute no less than 20 per cent of available breaker positions, whether indicated or not in panelboard schedules.

.12 Each panel shall be complete with a directory which shall be mounted inside door in a metal frame with clear plastic cover and copy in each Data Book. Use final Room Numbers for directories.

2.3 BRANCH CIRCUIT PANELBOARDS

.1 Manufacturers:
- .1 Square D by Schneider Electric, NQ or NQOD Series.
- .2 Eaton Cutler-Hammer, POW-R-LINE 1, POW-R-LINE 2, POW-R-LINE 3 Series.
- .3 Equal by Siemens.

.2 Description: CSA C22.2 No.29, circuit breaker type, lighting and appliance branch circuit panelboard.

.3 Panelboard Bus:
- .1 Copper, ratings as indicated.
- .2 Provide copper neutral bus in each panelboard.
- .3 Provide copper ground bus in each panelboard.
- .4 Provide insulated ground bus where scheduled.

.4 Minimum Integrated Short Circuit Rating: 10 000 amperes RMS symmetrical for 240 volt panelboards, or as indicated.

.5 Molded Case Circuit Breakers: NEMA AB 1, plug-on type thermal magnetic trip circuit breakers, with common trip handle for all poles, listed as Type SWD for lighting circuits, Type HACR for air conditioning equipment circuits, Class A ground fault interrupter circuit breakers where scheduled. Do not use tandem circuit breakers.

.6 Current Limiting Molded Case Circuit Breakers where indicated: NEMA AB 1, circuit breakers with integral thermal and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole. Interrupting rating 100,000 symmetrical amperes, let-through current and energy level less than permitted for same size Class RK-5 fuse.

.7 Cabinet Front: Surface cabinet front with concealed trim clamps, concealed hinge, metal directory frame, and flush lock all keyed alike. Finish in manufacturer's standard gray enamel.

.8 Enclosure shall be CSA type 2 sprinklerproof complete with drip hood, or as noted.

.9 Trims shall be equipped with a flush lock

.10 Breaker positions labeled as “Spare” or “Space” shall constitute no less than 20 per cent of available breaker positions, whether indicated or not in panelboard schedules.

.11 Panelboards: to CSA C22.2 No.29 and product of one manufacturer.
- .1 Install circuit breakers in panelboards before shipment.
- .2 In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.

.12 Panelboards rated 240 Vac or less shall have short-circuit ratings as shown on the drawings or as herein scheduled, but not less than 10,000 amperes RMS symmetrical.

.13 Bus and breakers rated for symmetrical interrupting capacity, as indicated.

.14 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.

.15 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.

.16 Two keys for each panelboard and key panelboards alike.

.17 Copper bus with neutral of same ampere rating as mains.

.18 Mains: suitable for bolt-on breakers.

.19 Trim with concealed front bolts and hinges.

.20 Trim and door finish: baked grey enamel.

.21 The minimum short-circuit rating for branch circuit panelboards shall be as specified herein or as indicated on the drawings. Panelboards shall be fully rated.

.22 Bolt-on type, heavy-duty, quick-make, quick-break, single- and multi-pole circuit breakers of the types specified herein, shall be provided for each circuit with toggle handles that indicate when unit has tripped.

.23 Circuit breakers shall be thermal-magnetic type with common type handle for all multiple pole circuit breakers. Circuit breakers shall be minimum 100-ampere frame and through 100-ampere trip sizes shall take up the same pole spacing. Circuit breakers shall be ULC listed as type SWD for lighting circuits.

.1 Circuit breaker handle locks shall be provided for all circuits that supply exit signs, emergency lights, energy management, and control system (EMCS) panels and fire alarm panels.

.24 Circuit breakers shall have a minimum interrupting rating of 10 000 amperes symmetrical at 240 volts, and 14 000 amperes symmetrical at 480 volts, unless otherwise noted on the drawings.

.25 Each panel shall be complete with a directory which shall be mounted inside door in a metal frame with clear plastic cover and copy in each Data Book. Use final Room Numbers for directories.

.26 Lighting and receptacle panels shall be surface or flush-mounting type, as shown.

.27 Panels shall be dead front type in code gauge steel enclosures. All panels shall be sprinkler proof c/w drip hoods as required.

.28 Panels shall have mains of voltage and capacity, and main and branch breakers, as shown on the drawings. Spaces shall include necessary bus work such that Owners, at a later date, need buy only the breakers.

.29 Where panels exceed 42 circuits, use multi-section panel with main cross-over solid bus bars. Main bus capacity of each section shall be full size to match cross-over bus.

.30 Breakers shall have bolted type connections. Multi-pole breakers shall be common trip type with a single handle, suitable for voltage applied and of same manufacture as single pole breakers.

.31 Panels for 120/208 volt, 3-phase, 4-wire systems shall be complete with full size breakers.

.32 Where shown on drawings or required by code, certain breakers shall include ground fault interrupter.

.33 Provide lighting and receptacle panels, surface or flush-mounting type, as shown.

.34 Provide locking bars on non-switched circuits where panels are used for switching lighting circuits.

.35 Panels for non-linear loads shall be complete with lugs for double neutrals.

.36 Panels shall be given a rust-resistant treatment to both tub and trim.

.37 Flush panels shall have concealed hinges and flush type combination lock latch. Locks shall be chrome plated. Doors shall open minimum 135 degrees. Trims shall have fasteners concealed and shall be prime coated to receive room finish paint.

.38 Surface mounted panels shall have manufacturer's standard surface door trim complete with lock and latch. Finish shall be grey.

.39 Recessed panels shall have standard flush trims.

.40 Co-ordinate panel finish with Room Finish Schedule.

2.4 MOLDED CASE CIRCUIT BREAKERS

.1 Breakers: to Section 26 28 16.02.

.2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.

.3 Main breaker: separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.

.4 Lock-on devices for 10 per cent of 15 A to 30 A breakers installed as indicated. Turn over unused lock-on devices to Owner.

.5 Lock-on devices for fire alarm, security, and sprinkler circuits.

.6 Provide shunt trips, bell alarms, and auxiliary switches as shown on the contract drawings.

.7 Provide breakers for externally mounted Surge Protective Devices in accordance with Section 26 43 13.

2.5 CONSTRUCTION

.1 General:
- .1 Interiors shall be completely factory assembled. They shall be designed such that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors.
- .2 Surface trims shall be same height and width as box. Flush trims shall overlap the box by 3/4 of an inch on all sides.
- .3 A temporary directory card with a clear plastic cover shall be supplied and mounted on the inside of each door.
- .4 All locks shall be keyed alike. Key same as existing.

.2 Branch Circuit Panelboards:
- .1 Trims for branch circuit panelboards shall be supplied with a hinged door over all circuit breaker handles. Doors in panelboard trims shall not uncover any live parts. Doors shall have a semi flush cylinder lock and catch assembly. Door-in-door trim shall be provided. Both hinged trim and trim door shall utilize three point latching. No tools shall be required to install or remove trim. Trim shall be equipped with a door-actuated trim locking tab. Equip locking tab with provision for a screw such that removal of trim requires a tool, at the owner's option. Installation shall be tamper resistant with no exposed hardware on the panelboard trim.

.3 Distribution Panelboards:
- .1 Distribution panelboard trims shall cover all live parts. Switching device handles shall be accessible.

2.6 BUS

.1 Main bus bars shall be copper sized in accordance with CSA standards to limit temperature rise on any current carrying part to a maximum of 65 degrees C above an ambient of 40 degrees C maximum.

.2 A copper system ground bus shall be included in all panelboards.

.3 Full-size (100 per cent rated) insulated copper neutral bars shall be included for panelboards shown with neutral. Bus bar taps for panels with single-pole branches shall be arranged for sequence phasing of the branch circuit devices. Neutral busing shall have a suitable lug for each outgoing feeder requiring a neutral connection. 200 per cent rated neutrals shall be supplied for panels designated on drawings with oversized neutral conductors.

2.7 **EQUIPMENT IDENTIFICATION**

.1 Provide equipment identification in accordance with Section 26 05 53.

.2 Nameplate for each panelboard size 4 engraved.

.3 Nameplate for each branch circuit in distribution panelboards size 2 engraved.

.4 Complete circuit directory with typewritten legend showing location and load of each circuit.

.5 Provide an engraved nameplate for each panelboard section.

.6 Provide copies of all circuit directories in Manuals.

3 Execution

3.1 **INSTALLATION**

.1 Install panelboards to CSA C22.1.

.2 Install panelboards plumb.

.3 Height: 1800 mm to top of panelboard; install panelboards taller than 1800 mm with bottom no more than 100 mm above floor.

.4 Provide filler plates for unused spaces in panelboards.

.5 Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes required to balance phase loads.

.6 Provide engraved plastic nameplates under the provisions of Section 26 05 53.

.7 Ground and bond panelboard enclosure according to Section 26 05 26.

.8 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.

.9 Install surface mounted panelboards on fire rated plywood backboards in accordance with Division 06. Where practical, group panelboards on common backboard.

.10 Connect loads to circuits.

.11 Connect neutral conductors to common neutral bus with respective neutral identified.

.12 Deliver five (5) duplicate keys for each panel lock to Owner.

.13 Mount electrical panels, where possible, with top of trim at uniform height of 2000 mm.

.14 Cap ends of conduits in accessible locations in ceiling spaces above panels, to allow for future wiring.

.15 The Contractors shall install all equipment per the manufacturer's recommendations and the contract drawings.

.16 Install panelboards in accordance with manufacturer's written instructions, NEMA PB 1.1 and Electrical Code requirements.

.17 After completion of wiring, type directory showing a clear description of each circuit being controlled from panel and place in metal frame inside door.

.18 Provide revised directories for existing panels if revised.

.19 Provide circuit breaker handle locks for all circuits that supply exit signs, emergency lights, energy management, and control system (EMCS) panels and fire alarm panels.

3.2 FIELD QUALITY CONTROL

.1 Perform inspections and tests listed in NETA ATS, Section 7.4 for switches, Section 7.5 for circuit breakers.

.2 Inspect complete installation for physical damage, proper alignment, anchorage, and grounding.

.3 Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads within 20 per cent of each other. Maintain proper phasing for multi-wire branch circuits.

.4 Check tightness of bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written specifications.

3.3 ADJUSTING

.1 Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads to within 20 percent of each other.

.2 Maintain proper phasing for multi-wire branch circuits.

3.4 FACTORY TESTING

.1 The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of NEMA and UL standards.

3.5 CLOSEOUTS

.1 Provide three 27 mm empty conduits from top of lighting, receptacle, telephone, signal and communication panels recessed in walls, to ceiling space.

.2 Include a copy of each panelboard schedule in the Operation and Maintenance manual.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Switches, receptacles, wiring devices, cover plates and their installation.

1.2 **RELATED REQUIREMENTS**

.1 Section 26 09 23 – Lighting Control Devices.

1.3 **REFERENCES**

.1 Canadian Standards Association
- .1 CSA C22.1 - Canadian Electrical Code, Part I, Safety Standard for Electrical Installations.
- .2 Ontario Electrical Safety Code.
- .3 CSA-C22.2 No.42-99(R2004), General Use Receptacles, Attachment Plugs and Similar Devices.
- .4 CAN/CSA-C22.2 No.42.1-00(R2004), Cover Plates for Flush-Mounted Wiring Devices (Bi-National standard, with UL 514D).
- .5 CSA-C22.2 No.55-M1986 (R2003), Special Use Switches.
- .6 CSA-C22.2 No.111-00(R2005), General-Use Snap Switches (Bi-national standard, with UL 20, twelfth edition).

.2 International Electrotechnical Commission (IEC)
- .1 IEC 60309 – Plugs, socket-outlets and couplers for industrial purposes.

1.4 **ACTION SUBMITTALS**

.1 Submit shop drawings and product data in accordance with Division 01.

.2 Product Data: Provide manufacturer's catalogue information showing dimensions, colours, and configurations.

1.5 **INFORMATIONAL SUBMITTALS**

.1 Submit manufacturer's installation instructions.

1.6 **REGULATORY REQUIREMENTS**

.1 Provide products listed and classified by CSA (Canadian Standards Association).

2 Products

2.1 **MANUFACTURERS**

.1 Cooper Wiring Devices by Eaton.

.2 Hubbell Bryant.

.3 Pass & Seymour (Legrand).

2.2 WALL SWITCHES

.1 Single pole, double pole, three-way, four-way switches to: CSA-C22.2 No.55 and CSA-C22.2 No.111.

.2 Description: CSA-C22.2 No.111, Commercial Spec Grade, AC only general-use snap switch.

.3 Local switches shall be 20 ampere, silent, brown coloured, AC type and CSA certified, specification grade. Provide switches rated to suit system voltage 120 V or 347 V.

.4 Manually-operated general purpose AC switches with following features:
- .1 Terminal holes approved for 10 AWG wire.
- .2 Silver alloy contacts.
- .3 Urea or melamine moulding for parts subject to carbon tracking.
- .4 Suitable for back and side wiring.

.5 Voltage: 120 volt or 347 volt, AC as indicated.

.6 Current: 20 amperes.

.7 Body and Handle: white plastic with toggle handle. Confirm finish colour prior to ordering.

.8 Toggle operated fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads.

.9 Example Products (Decorator style):
- .1 120 volt:
  - .1 Hubbell HBL2121 series.
- .2 347 volt:
  - .1 Pass & Seymour 2601-347 series.

.10 Example Products (Toggle style):
- .1 120 volt:
  - .1 Hubbell HBL1221 (single pole).
  - .2 Hubbell HBL1222 (double pole).
  - .3 Hubbell HBL1223 (three-way).
  - .4 Hubbell HBL1224 (four-way).
- .2 347 volt:
  - .1 Hubbell HBL18221 (single pole).
  - .2 Hubbell HBL18223 (three-way).
  - .3 Pass & Seymour PS372030l

.11 Local switches and receptacles shall be of the same manufacturer throughout except where a specified item is not made by that manufacturer.

2.3 RECEPTACLES

.1 General

.1 Description: CSA C22.2 No.42, Commercial Spec Grade general use receptacles.
.2 Device Body: white plastic.
.3 Configuration: Type as specified and indicated.
.4 Convenience Receptacle: Type 5-15, 5-20 where indicated.
.5 GFCI Receptacle: Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements.
.6 Data Room Receptacle Types: As indicated on drawings.
.7 Receptacles of one manufacturer throughout project.

.2 Receptacles shall be white coloured, specification grade, unless noted otherwise.

.3 Receptacles shall be as listed below:
.1 15 ampere, 120 volt, single phase grounded duplex receptacle shall be NEMA-U- ground type CSA Configuration 5-15R.
.2 20 ampere, 120 volt, single phase grounded duplex receptacle shall be NEMA-U-ground type CSA Configuration 5-20RA
.3 15 ampere, 120 volt, weatherproof receptacles shall be equal to those above but complete with gasketted cast plate and hinged covers.

.4 Other types of receptacles shall be provided as shown on Drawings.

.5 Duplex receptacles, CSA type 5-15 R, 125 V, 15 A, U ground, to: CSA-C22.2 No.42 with following features:
.1 White urea moulded housing.
.2 Suitable for No. 10 AWG for back and side wiring.
.3 Break-off links for use as split receptacles.
.4 Eight back wired entrances, four side wiring screws.
.5 Triple wipe contacts and riveted grounding contacts.

.6 Single receptacles CSA type 5-15 R, 125 V, 15 A, U ground with following features:
.1 White urea moulded housing.
.2 Suitable for No. 10 AWG for back and side wiring.
.3 Four back wired entrances, 2 side wiring screws.

.7 Other receptacles with ampacity and voltage as indicated.

.8 Example Products (Decorator style duplex 5-15R):
.1 Pass & Seymour 26252 Series.
.2 Hubbell HBL2152 Series.

.9 Ground Fault Circuit Interrupter (GFCI or GFI) Receptacles
.1 Protected by a ground fault circuit interrupter of the Class A type.
.2 Any receptacle within 1.5 m of a sink must be GFCI protected.
.3 Any receptacle located outdoor must be GFCI protected.

.10 Isolated Ground (IG) Receptacles:
.1 Marked as such (green triangle).
.2 Example Products:
.1 Hubbell IG2152 (15A duplex decorator style, orange faceplate).

.11 Tamper Proof receptacles.
- .1 Marked as such (for example “TR”)
- .2 To be used in the following spaces:
  - .1 Child care facilities and kindergarten classrooms.
  - .2 Dwelling unit receptacles.
- .3 Example Products:
  - .1 Hubbell BR15WHITR (15A duplex decorator style).
  - .2 Hubbell BR20WHITR (20A duplex decorator style).

.12 Wet Location and weatherproof devices:
- .1 Receptacles and cover plates suitable for wet locations, cover plates to provide shielding with and without a plug inserted into the receptacle in accordance with OESC rule 26-702. Cover plates to be marked “Extra Duty”.
- .2 Receptacles shall be 20A rated, GFI.

2.4 COVER PLATES

.1 Cover plates for wiring devices to: CAN/CSA-C22.2 No.42.1.

.2 Cover plates from one manufacturer throughout project.

.3 Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.

.4 Stainless steel, vertically brushed, cover plates, thickness 2.5 mm for wiring devices mounted in flush-mounted outlet box.

.5 Cast cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.

.6 Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for duplex receptacles as indicated.

.7 Weatherproof spring-loaded cast aluminum cover plates complete with gaskets for single receptacles or switches.

.8 Decorative Cover Plate: Polycarbonate.
- .1 Pass & Seymour TP26W Series

.9 Switch, receptacle, telephone and other plates shall be stainless steel 18-8 chrome metal alloy, Type 302, non-metallic in finished areas and pressed steel in unfinished areas. Finish brush marks shall be run in a vertical direction.

.10 Wet Location and weatherproof devices: receptacles and cover plates shall be suitable for wet locations, and provide shielding with and without a plug inserted into the receptacle in accordance with OESC rule 26-702.

2.5 SPECIAL WIRING DEVICES

.1 Pilot lights as indicated, with neon type 0.04 W, 125 V lamp and red plastic jewel flush type.

2.6 **IEC 60309 ("PIN AND SLEEVE") DEVICES**

.1 Manufacturers:
- .1 Crouse-Hinds by Eaton.
- .2 Hubbell.
- .3 Meltric.
- .4 Mennekes.
- .5 Russellstoll (Thomas & Betts).
- .6 Walther Electric.

.2 Refer to equipment schedule and plans for locations and specific requirements.

3 Execution

3.1 **MOUNTING HEIGHTS**

.1 In accordance with Section 26 05 00.

3.2 **EXAMINATION**

.1 Verify that outlet boxes are installed at proper height.

.2 Verify that wall openings are neatly cut and will be completely covered by wall plates.

.3 Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.3 **PREPARATION**

.1 Provide extension rings to bring outlet boxes flush with finished surface.

.2 Clean debris from outlet boxes.

3.4 **INSTALLATION**

.1 Install to CSA C22.1.

.2 Install devices plumb and level.

.3 Install switches with OFF position down.

.4 Install wall dimmers to achieve full rating specified and indicated after de-rating for ganging as instructed by manufacturer.

.5 Do not share neutral conductor on load side of dimmers.

.6 Install receptacles with grounding pole on bottom.

.7 Connect wiring device grounding terminal to outlet box with bonding jumper.

.8 Install decorative plates on switch, receptacle, and blank outlets in finished areas.

.9 Connect wiring devices by wrapping conductor around screw terminal.

.10 Use jumbo size plates for outlets installed in masonry walls.

.11 Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.

.12 Switches:
- .1 Install single throw switches with handle in "UP" position when switch closed.
- .2 Install switches in gang type outlet box when more than one switch is required in one location.

.13 Receptacles:
- .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
- .2 Where split receptacle has one portion switched, mount vertically and switch upper portion.
- .3 Connect receptacle grounding terminal to the outlet box with an insulated green ground strap.
- .4 Receptacles for maintenance of HVAC and similar equipment located on rooftops
  - .1 Provide weatherproof GFI 5-20R receptacles on roof, installed at 750 mm (30 inches) above finished roof level, complete with wet location cover plate.
  - .2 Locate within 7500 mm (25 feet) of new HVAC equipment, and at least 1800 mm (6 feet) away from roof line.
  - .3 Refer to OESC 2012 rules 2-314, 26-702, and 26-704, and OESC bulletin 26-27-0.

.14 Cover plates:
- .1 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.
- .2 Install suitable common cover plates where wiring devices are grouped.
- .3 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.
- .4 Do not install plates until final painting of room or area is completed. Remove protective covering.

.15 Circuit identification: in accordance with Section 26 05 53.

3.5 FIELD QUALITY CONTROL

.1 Inspect each wiring device for defects.

.2 Operate each wall switch with circuit energized and verify proper operation.

.3 Verify that each receptacle device is energized.

.4 Test each receptacle device for proper polarity.

.5 Test each GFCI receptacle device for proper operation.

3.6 **ADJUSTING**

.1 Adjust devices and wall plates to be flush and level.

3.7 **CLEANING**

.1 Clean exposed surfaces to remove splatters and restore finish.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Outdoor ground boxes.

1.2 **RELATED REQUIREMENTS**

.1 Division 26 - Electrical: Electrical systems and components.

1.3 **ACTION SUBMITTALS**

.1 Submit shop drawings and product data in accordance with Division 01.

.2 Product Data: Provide manufacturer's catalogue information showing dimensions, colours, and configurations.

1.4 **INFORMATIONAL SUBMITTALS**

.1 Submit under provisions of Div 01

.2 Product Data: Submit for outdoor ground boxes.

1.5 **REGULATORY REQUIREMENTS**

.1 Provide products listed and classified by CSA (Canadian Standards Association).

1.6 **QUALITY ASSURANCE**

.1 Outdoor Ground Boxes: Comply with requirements of applicable local codes, NEC, UL, CSA, and NEMA Standards pertaining to outdoor floor boxes. Tested and listed by Underwriters Laboratories, Inc. to meet NEMA 6P and IP68 requirements for use in outdoor locations. Outdoor ground boxes comply with ADA guidelines including unobstructed reach requirements.

1.7 **DELIVERY, STORAGE AND HANDLING**

.1 Deliver outdoor ground boxes in factory labeled packages.

.2 Store and handle in strict compliance with manufacturer’s written instructions and recommendations.

.3 Protect from damage due to weather, excessive temperature, and construction operations.

2 Products

2.1 **MANUFACTURERS**

.1 Legrand

2.2 OUTDOOR GROUND BOX

.1 Classification and Use: Outdoor ground boxes shall have been examined and tested by Underwriters Laboratories Inc. to meet NEMA 6P and IP68 requirements to be safe to use even during inclement weather and bear the cULus Listing Mark.

.2 Outdoor Ground Boxes, General:

.1 Outdoor ground boxes shall be designed to trap and maintain an air pocket to protect the devices, plugs and connections from water, snow, and ice. Boxes shall be constructed from UV rated chemical resistant materials. Boxes designed to ANSI/SCTE 77 with a Tier 5 rating to hold up to 5000 lbs of load. Boxes install flush to finished ground reducing tripping hazards. Box shall have a diving bell concept to maintain an air pocket and keep water away from connections. Box shall have an egress door that will auto-adjust to cable diameter and auto-lock in the closed position when no cables are exiting the box.

.2 Model XB814 Exterior Ground Boxes: Single service 2-gang ground box manufactured from UV rated nonmetallic material. Box accepts up to two 1-1/4" trade size PVC conduit feeds. Boxes designed to be installed separately or ganged together for greater capacity and flexibility. Accepts optional XB814 cover assembly. Boxes shall be 16-1/8” L x 8-1/8” W x 10-3/4” H [410mm x 206mm x 273mm]. Box assemblies include main box body, installation cap, and installation plate.

2.3 ACCESSORIES

.1 Model XB814CPBK Exterior Box Cover Plate Kit: Replacement cover plate including new handle and required mounting hardware.

.2 Model XB814ED Replacement Egress Door Kit: Replacement door can be changed out if the door is ever wears out or becomes damaged.

.3 Model XB814SP Replacement Egress Door Spring Pin Set: Locks egress door in the closed position when cover is closed.

.4 Model XBLNT Exterior Box Locknut Tool: Exterior box locknut wrench; used to tighten locknut on the junction box.

3 Execution

3.1 EXAMINATION

.1 Examine conditions under which outdoor ground boxes are to be installed. Notify the [Architect/Engineer] [Construction Manager] in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

.1 Strictly comply with manufacturer's installation instructions and recommendations. Coordinate installation with adjacent work to ensure proper clearances and to prevent electrical hazards.

3.3 CLEANING AND PROTECTION

.1 Clean exposed surfaces using non-abrasive materials and methods recommended by manufacturer.

.2 Protect boxes until acceptance.

END OF SECTION

1 General

1.1 **SUBMITTALS**

.1 Provide submittals in accordance with Division 01.

.2 Product Data:
.1 Provide fuse performance data characteristics for each fuse type and size above 200 amps. Performance data to include: average melting time-current characteristics.

.3 Shop Drawings:
.1 Provide shop drawings in accordance with Division 01.

1.2 **DELIVERY, STORAGE, AND HANDLING**

.1 Ship fuses in original containers.

.2 Do not ship fuses installed in switchboard.

.3 Store fuses in original containers in storage cabinet.

.4 Waste Management and Disposal:
.1 Separate waste materials for reuse and recycling in accordance with Division 01.

1.3 **MAINTENANCE MATERIALS**

.1 Provide maintenance materials in accordance with Division 01.

.2 3 spare fuses of each type and size installed above 600 A.

.3 6 spare fuses of each type and size installed up to and including 600 A.

2 Products

2.1 **MANUFACTURERS**

.1 Bussman by Eaton.

.2 GEC.

.3 Littelfuse.

.4 Mersen.

.5 Substitutions are not permitted.

2.2 **FUSES - GENERAL**

.1 Fuse type references L1, L2, J1, R1, etc. have been adopted for use in this specification.

.2 Fuses: product of one manufacturer.

.3 Fuses shall be sized as shown, time delay type, and of the same type throughout.

.4 Fuses shall be CSA certified Class-J for 1-600A or Class-L for 650 Amps and above.

2.3 FUSE TYPES

.1 Class J fuses.
- .1 Type J1, time delay, capable of carrying 500 per cent of its rated current for 10 seconds minimum.
- .2 Type J2, fast acting.

.2 Class L fuses.
- .1 Type L1, time delay, capable of carrying 500 per cent of its rated current for 10 seconds minimum.
- .2 Type L2, fast acting.

.3 Class R fuses.
- .1 Type R1, (UL Class RK1), time delay, capable of carrying 500 per cent of its rated current for 10 seconds minimum, to meet UL Class RK1 maximum let-through limits.
- .2 Type R2, time delay, capable of carrying 500 per cent of its rated current for 10 seconds minimum.
- .3 Type R3, (UL Class RK1), fast acting Class R, to meet UL Class RK1 maximum let-through limits.

2.4 FUSE REQUIREMENTS

.1 Dimensions and Performance: CSA C22.2 No. 248 Series, Class as specified or indicated.

.2 Voltage: Provide fuses with voltage rating suitable for circuit phase-to-phase voltage.

.3 Power Load Feeder Switches: HRC-1 Class J time delay type.

.4 Other Feeder Switches: HRC-1 Class J time delay type.

2.5 SPARE FUSE CABINET

.1 Description: Wall-mounted sheet metal cabinet, suitably sized to store spare fuses and fuse pullers specified.

.2 Doors: Hinged, with hasp for Owner's padlock.

.3 Finish: Prime finish for field painting.

.4 Dimensions: Minimum 3 foot by 3 foot by 1 foot.

3 Execution

3.1 **INSTALLATION**

.1 Install fuses to manufacturer's instructions.

.2 Install fuse with label oriented such that manufacturer, type, and size are easily read.

.3 Install spare fuse cabinet in electrical room.

.4 Provide a complete set of fuses in each fusible device supplied under this Division and provide 3 spare fuses for each size used in spare fuse cabinet.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Materials for Molded-Case Circuit Breakers (MCCB).

.2 Accessories

1.2 **RELATED REQUIREMENTS**

.1 Section 26 24 16 – Panelboards.

1.3 **REFERENCES**

.1 CSA C22.1-12 - Canadian Electrical Code, Part I (22nd Edition), Safety Standard for Electrical Installations

.2 Ontario Electrical Safety Code 25th Edition / 2012.

.3 CSA-C22.2 No. 5-02, Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, tenth edition, and the second edition of NMX-J-266-ANCE).

.4 NEMA AB1 - Molded Case Circuit Breakers, Molded Case Switches, and Circuit - Breaker Enclosures.

.5 NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment (published by the International Electrical Testing Association).

1.4 **SUBMITTALS**

.1 Submit product data in accordance with Division 01.

.2 Include time-current characteristic curves for breakers with ampacity of 400 A and above, or with interrupting capacity of 22,000 A symmetrical (rms) and over at system voltage.

.3 Include termination temperature rating in degrees C.

.4 Certificate of Origin
- .1 Prior to any installation of circuit breakers in either a new or existing installation, Contractor must submit three (3) copies of a certificate of origin, from the manufacturer, duly signed by the factory and the local manufacturer's representative, certifying that all circuit breakers come from this manufacturer, they are new and they meet standards and regulations. These certificates must be submitted to the Engineer for approval.
- .2 A delay in the production of the certificate of origin won't justify any extension of the contract and additional compensation.
- .3 Any work of manufacturing, assembly or installation should begin only after acceptance of the certificate of origin by Engineer. Unless complying with this requirement, Engineer reserves the right to mandate the manufacturer

listed on circuit breakers to authenticate all new circuit breakers under the contract, and that, to Contractor's expense.

.4 In general, the certificate of origin must contain:

.1 The name and address of the manufacturer, and the person responsible for authentication. The responsible person must sign and date the certificate;

.2 The name and address of the licensed dealer, and the person of the distributor responsible for the Contractor's account.

.3 The name and address of the Contractor, and the person responsible for the project.

.4 The name and address of the local manufacturer's representative. The local representative must sign and date the certificate.

.5 The name and address of the building where circuit breakers will be installed:

.1 Project title

.2 End user's reference number

.3 The list of circuit breakers

2 Products

2.1 GENERAL

.1 Molded-case circuit breakers, Circuit breakers, and Ground-fault circuit-interrupters, Fused circuit breakers, and Accessory high-fault protectors: to CSA C22.2 No. 5

.2 Bolt-on Molded case circuit breaker: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.

.3 Plug-in Molded case circuit breakers: quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.

.4 Common-trip breakers: with single handle for multi-pole applications.

.5 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting.

.1 Trip settings on breakers with adjustable trips to range from 3-8 times current rating.

.6 Circuit breakers with interchangeable trips.

2.2 INTERRUPTING CAPACITY

.1 Protective devices shall be fully rated, for required available fault current. Series rated shall not be used on this installation.

.2 Refer to panelboard and switchboard Specification Sections.

2.3 **MOLDED CASE CIRCUIT BREAKERS – GENERAL**

.1 Molded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.

.2 NEMA AB 1, circuit breakers with integral thermal and instantaneous magnetic trip in each pole.

.3 Provide circuit breakers UL listed as Type HACR for air conditioning equipment branch circuits.

.4 1-, 2-, or 3-pole bold on, single-handle common trip voltage as indicated on drawings.

.5 Overcentre toggle-type mechanism, quick-make, quick-break action. Trip indication is by handle position.

.6 Calibrate for operation in 40 degree C ambient temperature.

2.4 **MOLDED CASE CIRCUIT BREAKERS – UP TO 150 AMPERE**

.1 Permanent trip unit containing individual thermal and magnetic trip elements in each pole, unless noted otherwise on drawings.

2.5 **MOLDED CASE CIRCUIT BREAKERS – 151 TO 399 AMPERE**

.1 Variable magnetic trip elements. Provide push-to-trip button on cover of breaker for mechanical tripping.

2.6 **ADDITIONAL FEATURES**

.1 Provide as indicated on drawings:
- .1 Shunt trip
- .2 Auxiliary switch
- .3 Motor-operated mechanism.
- .4 Under-voltage release
- .5 On-off locking device
- .6 Handle mechanism

3 Execution

3.1 **INSTALLATION**

.1 Install circuit breakers as per related sections.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Fusible and non-fusible enclosed low-voltage disconnect switches from 30 to 800 amps.

1.2 **RELATED REQUIREMENTS**

.1 Section 26 28 13 – Fuses.

1.3 **REFERENCES**

.1 Canadian Standards Association
- .1 CSA C22.1 - Canadian Electrical Code, Part I (22nd Edition), Safety Standard for Electrical Installations.
- .2 Ontario Electrical Safety Code (25th Edition / 2012).
- .3 CAN/CSA-C22.2 No. 4 - Enclosed and Dead-Front Switches.
- .4 CSA C22.2 No. 248 Series – Low-Voltage Fuses.

.2 NETA (International Electrical Testing Association) ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.4 **SUBMITTALS FOR REVIEW**

.1 Product Data: Provide switch ratings, and enclosure dimensions.

1.5 **SUBMITTALS FOR CLOSEOUT**

.1 Record actual locations of enclosed switches in project record documents.

1.6 **REGULATORY REQUIREMENTS**

.1 Products: Listed and classified by CSA or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

2 Products

2.1 **MANUFACTURERS**

.1 Eaton Cutler-Hammer

.2 Siemens.

.3 Square D by Schneider Electric.

2.2 **DISCONNECT SWITCHES**

.1 Provide dedicated disconnect switches at electrical equipment.

.2 Fused or un-fused disconnect or safety switches: Type "A", quick-make, quick-break construction with provision for padlocking switches in either "ON" or "OFF" position.
- .1 Quick-make, quick-break.
- .2 Heavy duty industrial type.
- .3 Lockable with up to 3 padlocks.
- .4 Cover interlocked with switch mechanism.
- .5 Viewing window for viewing blades.

.3 Fused switches equipped with fuse clips designed for Class "J" fuses and designed to reject standard NEC fuses.

.4 Enclosure: CSA Type 1 sprinkler-proof, or as noted.

.5 Switches throughout project of same manufacturer.

3 Execution

3.1 **INSTALLATION**

.1 Provide fused or un-fused safety or disconnect switches as shown and as required by Code.

.2 Install disconnect switches complete with fuses, if applicable, to CSA C22.1.

.3 Apply neatly typed adhesive tag on inside door of each fusible switch indicating NEMA fuse class and size installed.

.4 Coordinate fuse ampere rating with installed equipment. Fuse ampere rating variance between original design information and installed equipment, size in accordance with Bussmann Fusetron 40 degree C recommendations. Do not provide fuses of lower ampere rating than motor starter thermal units.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Solid state, light emitting diode (LED) source interior luminaires.

.2 New, fully integrated luminaires for indoor applications.

1.2 **RELATED REQUIREMENTS**

.1 Section 26 09 23 – Lighting Control Devices.

.2 Section 26 50 00 – Lighting.

.3 Section 26 52 13.13 – Emergency Lighting.

1.3 **REFERENCES**

.1 Canadian Standards Association (CSA)
- .1 CSA C22.1-12, Canadian Electrical Code, Part 1 (22nd edition), Safety Standard for Electrical Installations.
- .2 Ontario Electrical Safety Code, 25th Edition / 2012.
- .3 CSA C22.2 No. 9.0 - General Requirements for Luminaires.
- .4 CSA C22.2 No. 250.0 - Luminaires (Bi-National Standard, with UL 1598).

.2 DesignLights Consortium (DLC).
- .1 Technical Requirements Table v2.1, or latest edition.
- .2 While the specifications do not explicitly call for DLC qualified LED luminaires, the technical criteria provided in the DLC Technical Requirements provide the basis of the requirements for this section of the Specification.

.3 Energy Star
- .1 Program Requirements for Luminaires - Eligibility Criteria, Version 1.2, or latest edition.

.4 Illuminating Engineering Society (IES)
- .1 IES HB-10-11 – The Lighting Handbook, 10th Edition.
- .2 IES LM-79-08 – Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products.
- .3 IES LM-80-08 – IES Approved Method for Measuring Lumen Maintenance of LED Light Sources.
- .4 TM-21-11- IES Technical Memorandum on Projecting Long Term Lumen Maintenance of LED Light Sources.

.5 National Electrical Manufacturer's Association (NEMA)
- .1 SSL-1-10 – Electronic Drivers for LED Devices, Arrays, or Systems.
- .2 WD 6 - Wiring Devices - Dimensional Requirements.

1.4 **DEFINITIONS**

.1 CCT: Correlated colour temperature.

.2 CRI: Colour-rendering index.

.3 LED: Light Emitting Diode.

.4 Lumen: Measured output of lamp and luminaire, or both.

.5 Luminaire: Complete lighting fixture, including ballast housing if provided.

1.5 ACTION SUBMITTALS

.1 Refer to Division 01 and Section 26 50 00.

.2 Product submittals shall be accompanied by product specification sheets or other documentation that includes the designed parameters as detailed in this specification. These parameters include (but not limited to):

- .1 Maximum power in Watts.
  - .1 If a transformer is used in conjunction with a driver (for example on some 347 volt lighting circuits), the maximum power shall include the transformer losses.
- .2 L70 in hours, when extrapolated for the worse case operating temperature. TM-21 report shall be submitted to demonstrate this.
- .3 Product submittals shall be accompanied by performance data that is derived in accordance with appropriate IESNA testing standards and tested in a laboratory that is NVLAP accredited for Energy Efficient Lighting Products.

1.6 INFORMATIONAL SUBMITTALS

.1 Installation instructions.

1.7 CLOSEOUT SUBMITTALS

.1 Division 01.

.2 Submit manufacturer's operation and maintenance instructions for each product.

1.8 QUALIFICATIONS

.1 Manufacturer: Company specializing in manufacturing the products specified in this section with minimum five years documented experience.

1.9 REGULATORY REQUIREMENTS

.1 Products shall be listed and classified by CSA (Canadian Standards Association), ULC (Underwriter’s Laboratories of Canada), or certified by recognized independent testing organizations that test to CSA standards.

.2 Products shall be certified by a recognized testing agency accredited by the Standards Council of Canada and bear a certification mark from that agency.

.3 All luminaires shall be listed and labeled for installation in fireproof or non-fireproof construction, dry, damp, or wet locations as required.

.4 Recessed fixtures mounted in an insulated ceiling shall be listed for use in insulated ceilings.

1.10 **DELIVERY, STORAGE, AND HANDLING**

.1 Deliver, store and handle materials in accordance with Division 01.

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

1.11 **EXTRA STOCK MATERIALS**

.1 Refer to Division 01.

.2 Provide the following additional equipment as listed herein.
- .1 Provide an additional 2 per cent spare luminaires of each new type to be provided.
- .2 Provide 1 per cent of each plastic lens type.
- .3 Provide three of each type of any special tools required for system use and maintenance.

1.12 **WARRANTY**

.1 Refer to Division 01 and Section 26 05 00.

.2 The manufacturer shall provide a warranty against loss of performance and defects in materials and workmanship for the luminaires for a period of 5 years after acceptance of the luminaires. Warranty shall cover all components comprising the luminaire.

.3 All warranty documentation shall be provided to customer prior to the first shipment.

.4 LED Luminaires shall have a manufacturer’s warranty for a period of not less than five years.

.5 LED boards, drivers and associated components shall have a warranty of 5 years on the LEDs, 5 years on the driver, 10 years on the paint finish.

2 Products

2.1 **INDOOR LED LUMINAIRES, GENERAL**

.1 Initial delivered lumens – thermal losses should be less than 10 per cent when operated at a steady state at an average ambient operating temperature of 25 degrees C, and optical losses should be less than 15 per cent.

.2 Average Delivered Lumens – Average delivered lumens over 50 000 hours should be minimum of 85 per cent of initial delivered lumens.

.3 All luminaires shall be tested per LM79/80 and published L70 data.

.4 Available in 3500 K correlated colour temperature, CRI greater than or equal to 80, or as indicated.

.5 Accessibility and Maintenance:
- .1 All LED luminaires shall be field serviceable, with LED arrays, LED modules, drivers, etc. fully serviceable and easily accessible. In the case of recessed ceiling mounted, and in the case of surface mounted ceiling fixtures, these components must be accessible from below. Luminaires in which any of these components are accessible only from above are not acceptable.
- .2 Ballasts, drivers, LED arrays, LED modules, and lamps shall be serviceable while the fixture is in its normally installed position. Ballasts or drivers shall not be mounted to removable reflectors or wireway covers unless so specified. In the case of ceiling mounted luminaires, the serviceable components must be accessible from below.

.6 Housings:
- .1 Formed to prevent warping and sagging. Housing, trim and lens frame shall be true, straight (unless intentionally curved), and parallel to each other as designed.
- .2 Sheet steel housings to be minimum 20 gauge.
- .3 Wireways and fittings: free of burrs and sharp edges, and shall accommodate internal and branch circuit wiring without damage to the wiring.
- .4 When installed, any exposed fixture housing surface, trim frame, door frame, and lens frame shall be free of light leaks.
- .5 Hinged door frames shall operate smoothly without binding. Latches shall function easily by finger action without the use of tools.
- .6 Drivers shall not be mounted to removable reflectors or wireway covers unless so specified.

.7 Mechanical Safety: Lighting fixture closures (lens doors, trim frame, hinged housings, etc.) shall be retained in a secure manner by captive screws, chains, aircraft cable, captive hinges, or fasteners such that they cannot be accidentally dislodged during normal operation or routine maintenance.

.8 Metal Finishes:
- .1 Fixture finish and construction to meet ULC listings and CSA certifications related to intended installation.
- .2 All metal components of fixtures shall be painted after fabrication to mitigate raw metal edges, and thus prevent premature corrosion.
- .3 The manufacturer shall apply standard finish (unless otherwise specified) over a corrosion-resistant primer, after cleaning to free the metal surfaces of rust, grease, dirt and other deposits. Edges of pre-finished sheet metal exposed during forming, stamping or shearing processes shall be finished in a similar corrosion resistant manner to match the adjacent surface(s). Fixture finish shall be free of stains or evidence of rusting, blistering, or flaking, and shall be applied after fabrication.
- .4 Interior light reflecting finishes shall be white with not less than 85 per cent reflectance, except where otherwise shown on the drawing.

.9 Wiring:

.1 Lighting fixtures shall have a specific means for grounding metallic wireways and housings to an equipment grounding conductor.
.2 Supplied complete with a luminaire disconnect plug.

2.2 DRIVERS, GENERAL

.1 Electronic LED drivers shall be integral to the luminaire, and be designed to be accessible in the field for replacement and servicing.

.2 Input Voltage:
.1 Driver with a voltage range of (120-277) +/- 10% or (347-480) +/- 10%.
.2 Refer to lighting fixture schedule.
.3 For luminaires connected to a 347 volt circuit and utilizing a natively 120-277 volt driver, provide an appropriately sized step down transformer.

.3 Input frequency 60 Hz.

.4 Load regulation: +/- 1 per cent from no load to full load.

.5 Output ripple less than 10 per cent.

.6 Output should be isolated.

.7 Case temperature: rated for -40 degrees C through +80 degrees C.

.8 Overheat protection, self-limited short circuit protection and overload protected.

.9 Primary fused.

.10 Driver life rating not less than 50 000 hours

.11 Power Factor and Total Harmonic Distortion
.1 Power factor of greater than or equal to 0.9 at full load.
.2 THD of less than or equal to 20 per cent at full load.

.12 Dimming Control:
.1 Coordinate with Section 26 09 23.
.2 0-10 V dimming control typical for all fixtures unless otherwise noted.
.3 Control range: 10 per cent to 100 per cent typical, unless noted otherwise.
.4 Provide a mock-up to demonstrate the luminaire is free of flicker throughout the dimming range when used with the dimming controllers described in related sections.

2.3 INTERIOR WALL-WASH LED LUMINAIRES

.1 Minimum Light Output: 575 lm.

.2 Zonal lumen density:
.1 Minimum 60 per cent between 0 degrees and 90 degrees from nadir.
.2 Minimum 60 per cent of the lumens must be produced in the “forward” hemisphere, towards the wall.

.3 Minimum luminaire efficacy: 45 lumens per watt.

.4 Correlated Colour Temperature (CCT): 3500 K

.5 Colour Rendition Index (CRI): 80 CRI minimum.

.6 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

2.4 TRACK OR MONO-POINT DIRECTIONAL LED LUMINAIRES

.1 Minimum Light Output: 250 lm.

.2 Zonal lumen density:
.1 Minimum 85 per cent between 0 degrees and 90 degrees from nadir.

.3 Minimum luminaire efficacy: 45 lumens per watt.

.4 Correlated Colour Temperature (CCT): 3500 K

.5 Colour Rendition Index (CRI): 80 CRI minimum.

.6 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

2.5 DOWNLIGHT LUMINAIRES

.1 Minimum Light Output: 500 lm.

.2 Zonal lumen density: Minimum 75 per cent between 0 degrees and 60 degrees from nadir.

.3 Minimum luminaire efficacy: 45 lumens per watt.

.4 Correlated Colour Temperature (CCT): 3500 K

.5 Colour Rendition Index (CRI): 80 CRI minimum.

.6 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

2.6 NOMINAL 610 MM BY 610 MM (2 FOOT BY 2 FOOT) LUMINAIRES FOR AMBIENT LIGHTING OF INTERIOR SPACES

.1 Minimum Light Output: 2 000 lm.

.2 Zonal lumen density:
.1 Minimum 75 per cent between 0 degrees and 60 degrees from nadir.

.3 Spacing Criteria:
.1 0 degrees to 180 degrees: 1.0 to 2.0
.2 90 degrees to 270 degrees: 1.0 to 2.0

.4 Minimum luminaire efficacy: 85 lumens per watt.

.5 Correlated Colour Temperature (CCT): 3500 K

.6 Colour Rendition Index (CRI): 80 CRI minimum.

.7 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

2.7 **NOMINAL 305 MM BY 1220 MM (1 FOOT BY 4 FOOT) LUMINAIRES FOR AMBIENT LIGHTING OF INTERIOR SPACES**

.1 Minimum Light Output: 1 500 lm.

.2 Zonal lumen density:
.1 Minimum 75 per cent between 0 degrees and 60 degrees from nadir.

.3 Spacing Criteria:
.1 0 degrees to 180 degrees: 1.0 – 2.0
.2 90 degrees to 270 degrees: 1.0 – 2.0

.4 Minimum luminaire efficacy: 85 lumens per watt.

.5 Correlated Colour Temperature (CCT): 3500 K

.6 Colour Rendition Index (CRI): 80 CRI minimum.

.7 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

2.8 **NOMINAL 610 MM BY 1220 MM (2 FOOT BY 4 FOOT) LUMINAIRES FOR AMBIENT LIGHTING OF INTERIOR SPACES**

.1 Minimum Light Output: 3 000 lm.

.2 Zonal lumen density:
.1 Minimum 75 per cent between 0 degrees and 60 degrees from nadir.

.3 Spacing Criteria:
.1 0 degrees to 180 degrees: 1.0 – 2.0
.2 90 degrees to 270 degrees: 1.0 – 2.0

.4 Minimum luminaire efficacy: 85 lumens per watt.

.5 Correlated Colour Temperature (CCT): 3500 K

.6 Colour Rendition Index (CRI): 80 CRI minimum.

.7 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

2.9 **LINEAR AMBIENT LUMINAIRES: INDIRECT**

.1 Minimum Light Output: 500 lm per foot.

.2 Zonal lumen density:
.1 Minimum 50 per cent between 90 degrees and 150 degrees from nadir.

.3 Minimum luminaire efficacy: 85 lumens per watt.

.4 Correlated Colour Temperature (CCT): 3500 K

.5 Colour Rendition Index (CRI): 80 CRI minimum.

.6 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

2.10 **LINEAR AMBIENT LUMINAIRES: INDIRECT/DIRECT**

.1 Minimum Light Output: 500 lm per foot.

.2 Zonal lumen density:
.1 Minimum 25 per cent between 0 degrees and 60 degrees from nadir.
.2 Minimum 50 per cent between 90 degrees and 150 degrees from nadir.

.3 Minimum luminaire efficacy: 85 lumens per watt.

.4 Correlated Colour Temperature (CCT): 3500 K

.5 Colour Rendition Index (CRI): 80 CRI minimum.

.6 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

2.11 **LINEAR AMBIENT LUMINAIRES: DIRECT/INDIRECT**

.1 Minimum Light Output: 500 lm per foot.

.2 Zonal lumen density:
.1 Minimum 40 per cent between 0 degrees and 60 degrees from nadir.
.2 Minimum 35 per cent between 90 degrees and 150 degrees from nadir.

.3 Minimum luminaire efficacy: 85 lumens per watt.

.4 Correlated Colour Temperature (CCT): 3500 K

.5 Colour Rendition Index (CRI): 80 CRI minimum.

.6 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

2.12 **LINEAR AMBIENT LUMINAIRES: DIRECT**

.1 Minimum Light Output: 375 lm per foot.

.2 Zonal lumen density:
.1 Minimum 40 per cent between 0 degrees and 60 degrees from nadir.

.3 Minimum luminaire efficacy: 85 lumens per watt.

.4 Correlated Colour Temperature (CCT): 3500 K

.5 Colour Rendition Index (CRI): 80 CRI minimum.

.6 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

2.13 **HIGH-BAY LUMINAIRES FOR COMMERCIAL AND INDUSTRIAL BUILDINGS**

.1 Minimum Light Output: 10 000 lm.

.2 Zonal lumen density:
.1 Minimum 30 per cent between 20 degrees and 50 degrees from nadir.

.3 Minimum luminaire efficacy: 80 lumens per watt.

.4 Correlated Colour Temperature (CCT): 4000 K

.5 Colour Rendition Index (CRI): 70 CRI minimum.

.6 Minimum L70 lumen maintenance to occur at 35 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

2.14 **LOW-BAY LUMINAIRES FOR COMMERCIAL AND INDUSTRIAL BUILDINGS**

.1 Minimum Light Output: 5 000 lm.

.2 Zonal lumen density:
.1 Minimum 30 per cent between 20 degrees and 50 degrees from nadir.

.3 Minimum luminaire efficacy: 80 lumens per watt.

.4 Correlated Colour Temperature (CCT): 4000 K

.5 Colour Rendition Index (CRI): 70 CRI minimum.

.6 Minimum L70 lumen maintenance to occur at 35 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

2.15 **HIGH-BAY AISLE LUMINAIRES**

.1 Minimum Light Output: 10 000 lm.

.2 Zonal lumen density:

.1 Minimum 30 per cent between 0 degrees and 20 degrees from nadir.
.2 Minimum 50 per cent between 20 degrees and 50 degrees from nadir.

.3 Minimum luminaire efficacy: 80 lumens per watt.

.4 Correlated Colour Temperature (CCT): 4000 K

.5 Colour Rendition Index (CRI): 70 CRI minimum.

.6 Minimum L70 lumen maintenance to occur at 35 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

3 Execution

3.1 VERIFICATION OF CONDITIONS

.1 Coordinate the lighting system installation with the relevant trades so as to eliminate interferences with hangers, mechanical ducts, sprinklers, piping, steel, etc.

3.2 INSTALLATION

.1 Install lighting equipment, including but not limited to luminaires, controls, auxiliary devices and the integration of same in strict conformance with all manufacturers' recommendations and instructions the securing of which shall be the responsibility of the Contractor.

.2 Integrate luminaires with controls in accordance with respective luminaire manufacturers' and controls manufacturers' recommendations and instructions and to provide a complete, trouble-free operation without compromising safety, code and CSA requirements.

.3 Seal all luminaires for wet locations (i.e. all knock-outs, all pipe and wire entrances, etc.) as is standard industry practice to prevent water from entering luminaires.

.4 Luminaire Alignment
.1 Locate recessed ceiling luminaires as indicated on reflected ceiling plan. Install recessed luminaires to permit removal from below. Include accessories and materials to meet applicable codes and regulatory requirements.
.2 Align luminaires mounted in continuous rows to form straight uninterrupted line.
.3 Align luminaires mounted individually parallel or perpendicular to building grid lines.
.4 Install surface mounted luminaires plumb and adjust to align with building lines and with each other. Secure to prevent movement.
.5 Locate and install luminaires as indicated. Mounting heights and configuration of the luminaires shall be as specified in the Luminaire Schedule portion of the Specification or indicated on the drawings, and where conflicts exist, as approved by the Consultant.

.6 Installed all luminaires plumb and true and level as viewed from all directions unless specifically identified otherwise in the Lighting Fixture Schedule. Luminaires shall remain plumb and true without continual adjustment or visibly obvious means beyond what is shown on luminaire submittal drawings.

.7 For installation in suspended ceilings, ensure that the luminaires are supported such that there is no resultant bowing or deflection of the ceiling system greater than 1/360 of the length of the total span of the ceiling member.

.5 Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.

.6 Whenever a luminaire or its hanger canopy is installed directly to a surface mounted junction box, use a finishing ring painted to match the ceiling to conceal the junction box.

.7 Suspended Luminaires:

.1 Install suspended luminaires and exit signs using pendants supported from swivel hangers. Provide pendant length required to suspend luminaire at indicated height.

.2 Suspended luminaires shall be installed plumb and true and level unless specifically identified otherwise in the Luminaire Schedule portion of this Specification and at a height from finished floor as specified on the drawings, details and Luminaire Schedule. In cases where this is impractical, refer to the Consultant for a decision. All appurtenances shall be consistently organized for a neat, uniform appearance.

.8 Install wall mounted luminaires at height as indicated.

.9 Accessories:

.1 Reflector cones, louvers, baffles, lenses, trims and other decorative elements shall be installed after completion of ceiling tile installation, plastering, painting and general cleanup.

.2 Install accessories provided with each luminaire.

.3 All accessories shall be properly installed and adjusted by Contractor in accordance with specification and installation instructions. Any spare items shall be clearly labeled (indicate type of accessory and associated luminaire types).

3.3 TESTING AND ADJUSTMENT

.1 As required, all adjustable luminaires shall be aimed, focused, locked, etc., by the Contractor under the observation of the Consultant. As aiming and adjusting is completed, locking setscrews and bolts and nuts shall be tightened securely by the Contractor.

.2 All ladders, scaffolds, lifts, etc. required for aiming and adjusting luminaires shall be furnished by the Contractor.

.3 Where possible, units shall be focused during the normal working day. However, where daylight interferes with seeing lighting effects, aiming shall be accomplished at night.

3.4 LUMINAIRE SUPPORTS

.1 Provide adequate support to suit ceiling system.

.2 Support luminaires independently of ceiling framing, unless ceiling is certified by the manufacturer to support weight of installed devices. Confirm if T-bar ceilings are metric or imperial and provide luminaires to suit ceiling dimensions.

.3 Provide chain hangers for new and existing luminaires.

.4 Install clips to secure recessed grid-supported luminaires in place.

.5 Fixtures supported by suspended ceiling systems shall be securely fastened to the ceiling framing member by mechanical means, such as bolts, screws, or rivets. Ceiling framing members must be securely attached to each other and to the building structure as required by all applicable codes and standards. Use of integral clips is not acceptable.

3.5 WIRING

.1 Install luminaire disconnect plugs on all new luminaires not provided as such from the manufacturer.

.2 Connect luminaires to branch circuit outlets provided under Section 26 05 33.13 using flexible conduit.

.3 Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.

.4 Bond products and metal accessories to branch circuit equipment grounding conductor.

3.6 FIELD QUALITY CONTROL

.1 Operate each luminaire after installation and connection. Inspect for proper connection and operation.

.2 Make wiring connections to the branch circuit using building wire with insulation suitable for temperature conditions within luminaire.

.3 Occupancy Sensors.

.1 Locate and aim sensors in the correct location required for complete and proper volumetric coverage within the range of coverage(s) of controlled areas.

.2 Rooms shall have 90 per cent to 100 per cent coverage to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants at any location within the room.

.3 Exercise proper judgment in executing the work to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structural components.

3.7 CLEANING

.1 Thoroughly clean all luminaires and accessories after installation. All fingerprints, dirt, tar, smudges, drywall mud, dust, etc. shall be removed by the Contractor from the luminaire bodies, reflectors, trims, and lens or louvers prior to final acceptance. All reflectors shall be free of paint other than factory-applied, if any. All reflectors, cones and lenses shall be cleaned only according to manufacturers' instructions.

.2 Clean electrical parts to remove conductive and deleterious materials.

.3 Remove dirt and debris from enclosures.

.4 Clean photometric control surfaces as recommended by manufacturer.

.5 Clean finishes and touch up damage.

.6 Luminaire finishes which are disturbed in any way during construction shall be touched up or refinished in a manner satisfactory to the Consultant.

3.8 COMMISSIONING

.1 In accordance with Section 26 08 50.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Pole mounted, wall mounted, and canopy mounted solid state, light emitting diode (LED) source exterior luminaires.

1.2 **RELATED REQUIREMENTS**

.1 Section 26 09 23 – Lighting Control Devices.

.2 Section 26 50 00 – Lighting.

1.3 **REFERENCES**

.1 Canadian Standards Association (CSA):
- .1 CSA C22.1, Canadian Electrical Code, Part I, Safety Standard for Electrical Installations.
- .2 Ontario Electrical Safety Code.
- .3 CSA C22.2 No. 9.0 – General Requirements for Luminaires.
- .4 CSA C22.2 No. 250.0 – Luminaires (Bi-National Standard, with UL 1598).
- .5 CAN/CSA-C22.2 No. 250.13 – Light Emitting Diode (LED) equipment for lighting applications.

.2 DesignLights Consortium (DLC):
- .1 Technical Requirements table v2.1, or latest edition.
- .2 While the specifications do not explicitly call for DLC qualified LED luminaires, the technical criteria provided in the DLC Technical Requirements provide the basis of the requirements for this section of the Specification.

.3 Illuminating Engineering Society (IES)
- .1 IES HB-10-11 – The Lighting Handbook, 10th Edition.
- .2 IES LM-79-08 – Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products.
- .3 IES LM-80-08 – IES Approved Method for Measuring Lumen Maintenance of LED Light Sources.
- .4 IES TM-21-11- IES Technical Memorandum on Projecting Long Term Lumen Maintenance of LED Light Sources.

.4 National Electrical Manufacturer's Association (NEMA)
- .1 SSL-1-10 – Electronic Drivers for LED Devices, Arrays, or Systems.
- .2 WD 6 - Wiring Devices - Dimensional Requirements.

.5 Underwriters Laboratories Inc. (UL):
- .1 ANSI/UL 1449, (3rd Edition), Standard for Safety, Surge Protective Devices.

1.4 **ACTION SUBMITTALS**

.1 Submit product data in accordance with Division 01.

.2 Manufacturer Reports: Provide a point-by-point photometric analysis of the site, in accordance with the procedures laid out in IES RP-20-14, for review by the Consultant. Include point-by-point calculation zones along the property line.

.3 Product specification sheets or other documentation that includes the designed parameters as detailed in this specification. These parameters include (but not limited to):
- .1 Cut sheets:
  - .1 Luminaire cut sheets.
  - .2 Cut sheets for LED driver(s).
  - .3 Cut sheets for surge protective device, if applicable.
- .2 Highlight lumen package, IES distribution type (if applicable), and input watts of the luminaire.
- .3 Instructions for installation and maintenance.
- .4 Performance data:
  - .1 Maximum power, in Watts.
  - .2 L70 lumen maintenance data, in hours, when extrapolated for the worse case operating temperature. Submit IES TM-21 report to demonstrate this.
- .5 Performance data that is derived in accordance with appropriate IES testing standards and tested in a laboratory that is NVLAP accredited for Energy Efficient Lighting Products. Include:
  - .1 Name of test laboratory.
  - .2 Report number.
  - .3 Data.
  - .4 Complete luminaire catalogue number.
  - .5 Provide explanation if catalogue number in test report does not match catalogue number of luminaire submitted. Clarify whether discrepancy does not affect performance, e.g. in the case of differing luminaire housing colour.

1.5 QUALITY ASSURANCE

.1 Luminaire tested to IESNA LM 79-08.

.2 Design Qualification Testing performed by a National Voluntary Laboratory Accreditation Program (NVLAP) testing facility. Such testing may be performed by the manufacturer, or an independent testing lab hired by the manufacturer on new luminaire designs, and when a major design change has been implemented on an existing design. A major design change is defined as a design change (electrical or physical) which changes any of the performance characteristics of the luminaire, results in a different circuit configuration for the power supply, or changes the layout of the individual LED's in the module.

.3 Products certified by a recognized testing agency accredited by the Standards Council of Canada, and bearing a certification mark from that agency. Certification shall include wet location rating.

1.6 **WARRANTY**

.1 Manufacturer Warranty against loss of performance and defects in materials and workmanship for the luminaires for a period of 5 years after acceptance of the luminaires. Warranty to cover all components comprising the luminaire.

.2 All warranty documentation shall be provided to customer prior to the first shipment.

2 Products

2.1 **OUTDOOR LED LUMINAIRES, GENERAL**

.1 Maximum nominal luminaire input wattage as specified for each luminaire type as indicated on the Lighting Fixture Schedule. Nominal input wattage accounting for nominal applied voltage and any reduction in driver efficiency due to sub-optimal driver loading.

.2 Luminaires designed for ease of component replacement and end-of-life disassembly.

.3 Input Voltage:
.1 As indicated on Lighting Fixture Schedule.
.2 Driver to be compatible with system voltage without use of a step-down transformer. If the manufacturer's standard product offering cannot achieve this, clearly indicate on the shop drawings and clearly indicate location of transformer.

.4 Surge Protection
.1 UL 1449 recognized surge protective device that is wired in front of the driver(s) and protects the luminaire to a minimum Category C Low (per ANSI/IEEE C62.41.2).

.5 Power Factor and Total Harmonic Distortion
.1 Power factor of greater than or equal to 0.9.
.2 THD of less than or equal to 20 per cent.

.6 Gasket: neoprene seal between refractor and housing.

.7 Light Distributions:
.1 Fixtures available with IES distribution types I, II, III, IV, V, and other distributions, as noted, and distribution shall be adjustable or replaceable in the field.
.2 Pole mounted luminaire shall have an available option for low-profile house-side shield.

.8 Self-locking latches of stainless steel and aluminum.

.9 Factory wired including integral driver, terminated at terminal block.

.10 Luminaires with cast aluminum weatherproof housing.

.11 Ingress protection: sealed against moisture and environmental contaminants to IP65 rating or better for both light engines/optics and overall luminaire.

.12 Finishes
- .1 Housing and heat sink finished in polyester powder coat paint, minimum 2.5 mil nominal thickness.
- .2 Standard finish colours to include black, bronze, grey, white, dark platinum and graphite metallic.
- .3 RAL and custom color matches to be available as indicated on the lighting fixture schedule.

2.2 OUTDOOR POLE/ARM MOUNTED AREA AND ROADWAY LED LUMINAIRES

.1 Pole mounted luminaires suitable for the EPA rating of the pole.

.2 Pole finish colour to match that of luminaire.

.3 Lamp type: Light Emitting Diode (LED) source.
- .1 Minimum Light Output: 1 000 lm.
- .2 Zonal Lumen Density:
  - .1 100 per cent between 0 degrees and 90 degrees from nadir.
  - .2 Less than or equal to 10 per cent between 80 degrees and 90 degrees from nadir.
- .3 Minimum luminaire efficacy: 70 lumens per watt.
- .4 Correlated Colour Temperature (CCT): 4000 K
- .5 Colour Rendition Index (CRI): 70 CRI minimum.
- .6 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation. LM-80 testing is to utilize 10 000 hour testing data.

2.3 OUTDOOR WALL MOUNTED AREA LED LUMINAIRES

.1 Lamp type: Light Emitting Diode (LED) source.
- .1 Minimum Light Output: 300 lm.
- .2 Zonal Lumen Density:
  - .1 100 per cent between 0 degrees and 90 degrees from nadir.
  - .2 Less than or equal to 10 per cent between 80 degrees and 90 degrees from nadir.
- .3 Minimum luminaire efficacy: 70 lumens per watt.
- .4 Correlated Colour Temperature (CCT): 4000 K
- .5 Colour Rendition Index (CRI): 70 CRI minimum.
- .1 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation. LM-80 testing is to utilize 10 000 hour testing data.

3 Execution

3.1 INSTALLATION

.1 Install luminaires on poles in accordance with Section 26 56 13.

.2 Check luminaire orientation, level, and tilt.

.3 Connect luminaire to lighting circuit.

.4 Perform tests in accordance with Section 26 50 00.

3.2 **SITE TESTS AND INSPECTIONS**

.1 Perform lighting system commissioning in accordance with Section 26 08 50.

.2 Perform light meter testing at night and report values to the Consultant.

END OF SECTION

1 General

1.1 CONDITIONS AND REQUIREMENTS

.1 Refer to the General Conditions, Supplementary General Conditions, and General Requirements.

.2 Provisions of this Section shall apply to all Sections of Division 27.

.3 Refer to Consultant's drawings for exact location of electrical equipment and devices. Refer to Designer drawings for additional notes which complement these specifications.

.4 The Division 26 specification documents shall be followed in conjunction with the specification in this section.

1.2 RELATED DIVISIONS

.1 Division 25 – Integrated Automation.

.2 Division 26 – Electrical.

1.3 INTENT

.1 Include all material, labour, equipment, and plant construction as necessary to make a complete installation as shown and specified hereinafter. Sections of this specification are not intended to delegate functions nor to delegate work and supply to any specific Trade. It shall be your responsibility to ensure that the systems specified hereafter are complete and operative.

1.4 CODES AND STANDARDS

.1 The equipment, material and installation shall conform to the latest version of the applicable Codes, Standards (including technical service bulletins and addenda) and regulations of authorities having jurisdiction.

.2 BICSI
- .1 Telecommunications Distribution Methods Manual
- .2 Cabling Installation Manual
- .3 Outside Plant Manual

.3 Canadian Standards Association (CSA)
- .1 CSA C22.1 – Canadian Electrical Code, Part 1
- .2 CSA T529 – Commercial Building Telecommunications Cabling Standard (ANSI/EIA/TIA-568-B).
- .3 CSA T530 – Commercial Building Standard For Telecommunications Pathways And Spaces (TIA/EIA 569-A).
- .4 CSA T528 – Administration Standard For The Telecommunications Infrastructure Of Commercial Buildings (ANSI/EIA/TIA-606).
- .5 CSA T527 – Commercial Building Grounding And Bonding Requirements For Telecommunications (ANSI/EIA/TIA-607).
- .6 CSA C22.2 No. 214 – Communications Cables.

.7 CSA C22.2 No. 232-M – Fibre Optic Cables.
.8 CSA C22.2 No. 182.4-M90 – Plugs, Receptacles, and Connectors for Communication Systems.

.4 TIA
.1 TIA/EIA-568-B.1 – Commercial Building Telecommunications Cabling Standard
.2 TIA/EIA-568-B.2 – Balanced Twisted Pair Cabling Components
.3 TIA/EIA-568-B.3 – Optical Fibre Cabling Components Standard

.5 ISO
.1 ISO/IEC IS 11801A – Generic Cabling for Customer Premises.

.6 CENELEC EN 50173 – Performance Requirements for Generic Cabling Schemes.

.7 IEC
.1 IEC 603-7, PART 7 – Detailed Specification For Connectors, 8-Way, Including Fixed And Free Connectors With Common Mating Features.
.2 IEC 807-8 – Rectangular Connectors For Frequencies Below 3 MHz, Part 8: Detailed Specification For Connectors, Four-Signal Contacts And Earthing Contacts For Cable Screens, First Edition.

.8 FIPS PUB 174 – Commercial Building Telecommunications Wiring Standard. Federal Information Standard Publication.

.9 UL 444 and 13 – Adopted Test and Follow-Up Service Requirements For the Optional Qualification of 100Ω Twisted-Pair (Cables).

.10 NEMA WC 63 – Performance Standard For Field Testing Of Unshielded Twisted-Pair Cabling System.

.11 ANSI/EIA/TIA
.1 ANSI/EIA/TIA-492AAAA – Detailed Specification For 62.5µm Core Diameter / 125µm Cladding Diameter Class 1a Multimode, Graded-Index Optical Waveguide fibres.
.2 ANSI/EIA/TIA-492BAAA – Detailed Specifications For Class Iva Dispersion-Unshifted Singlemode Optical Waveguide Fibres Used In Communication Systems.
.3 ANSI/EIA/TIA-472CAAA – Detailed Specifications For All Dielectric (Construction 1) Fibre optic Communications Cable For Indoor Plenum Use, Containing Class 1a, 62.5µm Core Diameter / 125µm Cladding Diameter Fibre optic(s).
.4 ANSI/EIA/TIA-472DAAA – Detailed Specifications For All Dielectric Fibre optic Communications Cable For Outdoor Plant Use, Containing Class 1, 62.5µm Core Diameter / 250µm Cladding Diameter Fibre optic(s).
.5 ANSI/EIA/TIA-455 – Test Procedures For Fibre optics, Cables And Transistors.
.6 ANSI/EIA/TIA-598 – Colour Coding of Fibre Optic Cables.
.7 ANSI/EIA/TIA-604-3 – FOCIS 3 Fibre Optic Connector Intermateability Standard.
.8 ANSI/EIA/TIA-606 – Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.

.9 ANSI/EIA/TIA-607 – Commercial Building Grounding and Bonding Requirements for Telecommunications.

.12 ANSI Z136.2 – American Standards For The Safe Operation of Fibre optic Communication Systems Utilizing Laser Diode And LED Sources.

.13 ANSI/CEA
- .1 ANSI/ICEA S-83-640 – Fibre Optic Outside Plant Communications Cable.
- .2 ANSI/ICEA S-83-596 – Fibre Optic Premises Distribution Cable.

1.5 WORK SEQUENCE

.1 Prior to start of each work period in occupied area, temporary protection shall be installed to prevent damage to any personal property or furnishing. Coordinate with Owner's representative if any furniture must be relocated to facilitate work.

.2 Owner's representative shall approve temporary protection plan prior to use.

.3 Necessary steps shall be taken by contractor to ensure that required fire fighting apparatus is accessible at all times. Flammable materials shall be kept in suitable places outside the building.

1.6 INSPECTIONS

.1 The Engineer and/or the Project Manager will carry out inspections and prepare deficiency list for action by the Contractor, during and on completion of project.

1.7 DRAWINGS AND SPECIFICATIONS

.1 The drawings and specifications are complementary each to the other and what is called for by one to be binding as if called for by both. Should any discrepancy appear between the drawings and specifications which leaves the Contractor in doubt as to the true intent and meaning of plans and specifications, a ruling is to be obtained from the Engineer in writing before submitting Tender. If this is not done, the maximum, the most expensive alternate or option will be provided in base tender bid.

.2 All drawings and all Divisions of these specifications shall be considered as a whole and work of this Division shown anywhere therein shall be furnished under this Division.

.3 Drawings are diagrammatic and indicate the general arrangement of equipment and pathways. Most direct routing of cabling is not assured. Exact requirements shall be governed by architectural, structural, and mechanical conditions of the job. Consult all other drawings in preparation of the bid. Extra lengths of wiring or addition of pull and junction boxes, etc. necessitated by such conditions shall be included in the bid. Check all information and report and apparent discrepancies before submitting the bid.

.4 Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pathways so as to best fit the layout of the job.

.5 Scaling off the drawings will not be sufficient or accurate for determining these locations. Where job conditions require reasonable changes in indicated arrangement and locations, such changes shall be made by the Contractor at no additional cost to the Owner.

.6 Before ordering any conduit, cable tray, cables, fittings, etc., this Contractor shall verify all pertinent dimensions at the job site and be responsible for their accuracy.

1.8 **MATERIAL**

.1 This contractor is responsible to ensure that all items submitted meet all requirements of the drawings and specification, and fits in the allocated space. The final determination of a product being acceptable shall be determined by the Engineer.

1.9 **TESTING DATA**

.1 The contractor shall provide a complete testing report utilizing a testing device as specified in the applicable TIA/EIA standard with the correct adapter and test. All copper tests shall be compliant to the current TIA/EIA standards: Perm Link or Channel.

.2 The Summary report shall provide be provided to the end user in a universal format so that there is no need to purchase any software to read and print the report.
.1 Utilizing Adobe Acrobat is an acceptable manner.

1.10 **PAINTING AND FINISHES**

.1 Minor damages to finish on factory finished equipment shall be touched up to the Engineer's satisfaction. Items suffering major damage to finish shall be replaced at the direction of the Engineer. Protect work so that finishes will not be damaged or marred during construction. Maintain the necessary protection until completion of the work.

1.11 **SAFETY**

.1 The Contractor shall be responsible for the safety of his workmen and the equipment on the project in accordance with all applicable safety legislation passed by Federal, Provincial, and local authorities governing construction safety. The more stringent regulations shall prevail.

1.12 **WARRANTY**

.1 Submit a written performance warranty to the Owner for one year for the complete installation for a period of no less than five years from the date of testing and acceptance. The system warranty shall be based on industry standards.

.2 The contractor shall also provide a one year labour warranty on the installation.

2 Products

2.1 **MATERIAL APPROVAL**

.1 The design, manufacture and testing of electrical equipment and materials shall conform to or exceed the latest applicable CSA, IEEE, and ANSI standards.

.2 All materials must be new and be ULC or CSA listed. Any materials not covered by the aforementioned listing standards shall be tested and approved by an independent testing laboratory, Technical inspection Services, or other government agency.

2.2 **SHOP DRAWINGS**

.1 Before delivery to site of any item of equipment, submit 6 copies of shop drawings c/w all data, pre-checked and stamped accordingly, for approval to the Engineer. Indicate project name on each brochure or sheet. Submit shop drawings within 1 week after award of contract, for the following:
- .1 Copper Cabling
- .2 Fibre Optic Cabling
- .3 Fabric Innerduct
- .4 Racks, managers
- .5 Patch Panels
- .6 Telecommunications Outlets, Faceplates
- .7 Fibre Optic Routing System
- .8 Rack Power Distribution Units

2.3 **AS-BUILT DRAWINGS**

.1 To Division 01.

.2 Red lines, mark-ups by this contractor.

2.4 **OPERATION AND MAINTENANCE MANUALS**

.1 Refer to Division 01.

3 Execution

3.1 **WORKMANSHIP AND CONTRACTOR'S QUALIFICATIONS**

.1 Only first class workmanship will be accepted, not only in regards to durability, efficiency and safety, but also in regards to neatness of detail. Present a neat and clean appearance on completion to the satisfaction of the Engineer. Any unsatisfactory workmanship will be replaced at no extra cost.

.2 Conform to the best practices applicable to this type of work. Install all equipment and systems in accordance with the manufacturer's recommendations, but consistent with the General Requirements of this Specification. This Contractor will be held responsible for all damage to the work of his own or any other trade, resulting from the execution of his work. Store all equipment and materials in dry locations.

.3 Provide foreman in charge of this work at all times.

.4 The contractor shall be fully liable to provide and maintain in force during the life of this Contract, such insurance, including Public Liability Insurance, Product Liability Insurance, Auto Liability Insurance, Worker's Compensation, and Employer's Liability Insurance.

3.2 COORDINATION

.1 Coordinate work with other trades.

.2 Verify equipment dimensions and requirements with provision specified under this Section. Check actual job conditions before fabricating work. Report all necessary changes in time to prevent needless work. Changes or additions subject to additional compensation, which are made without written authorization and an agreed price, shall be at Contractor's risk and expense.

.3 Read specifications and drawings of other trades and conform with their requirements before proceeding with any work specified in this Division related to other trades. Cooperate with all other trades on the job, so that all equipment can be satisfactorily installed, and so that no delay is caused to any other Trades.

3.3 MANUFACTURERS' INSTRUCTIONS

.1 Where the specifications call for an installation to be made in accordance with Manufacturer's recommendations, a copy of such recommendations shall be at all times be kept on the job site and be available to the Owner's Representative.

.2 Follow manufacturer's instructions where they cover points now specifically indicated on the drawings and specifications. If they are in conflict with the drawings and specifications obtain clarification from the Consultant before starting work.

3.4 QUALITY ASSURANCE

.1 See General Provisions of the Contract.

.2 The specifications contained herein are set forth as the minimum acceptable requirements. This does not relieve the Contractor from executing other quality assurance measures to obtain a complete operating system within the scope of this project.

.3 The Contractor shall ensure that all workmanship, all materials employed, all required equipment and the manner and method of installation conforms to accepted construction and engineering practices, and that each piece of equipment is in satisfactory working condition to satisfactorily perform its functional operation.

.4 Provide quality assurance tests and operational check on all components of the electrical distribution system, all lighting fixtures, and communication systems.

3.5 LABELS AND SIGNS

.1 Labelling shall be as per TIA/EIA-606.

3.6 ADJUST AND CLEAN-UP

.1 The Contractor and associated sub trades, at all times during construction, to keep the site free of all debris, boxes, packing, etc., resulting from work of this Trade. At the completion of this work, the installation is to be left in a clean and finished condition to the satisfaction of the Engineer.

3.7 TESTS AND ACCEPTANCE

.1 The operation of the equipment does not constitute an acceptance of the work by the Owner. The final acceptance is to be made after the Contractor has adjusted his equipment and demonstrated that it fulfils the requirements of the drawings and the specifications.

.2 Testing of all systems shall be performed in the presence of the Owner's designated representative. The contractor shall give 72 hours advance notice to the Owner before beginning the tests.

.3 Upon completion of the installation, the Contractor shall furnish certificates of approval from all authorities having jurisdiction, as applicable. Contractor shall demonstrate that work is complete and in perfect operating condition. In the presence of the Owner, the Contractor shall demonstration the proper operation of all miscellaneous systems.

END OF SECTION

1 General

1.1 **DESCRIPTION**

.1 This section specifies general grounding and bonding requirements of telecommunication installations for equipment operations.

.2 "Grounding electrode system" refers to all electrodes required by Electrical Code, as well as including made, supplementary, telecommunications system grounding electrodes.

.3 The terms "connect" and "bond" are used interchangeably in this specification and have the same meaning.

1.2 **RELATED REQUIREMENTS**

.1 Section 26 05 26 – Grounding and Bonding for Electrical Systems.

.2 Section 27 11 16 – Communications Cabinets, Racks, Frames, and Enclosures.

1.3 **REFERENCES**

.1 Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.

.2 American Society for Testing and Materials (ASTM):
.1 B1-2001 - Standard Specification for Hard-Drawn Copper Wire
.2 B8-2004 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

.3 Institute of Electrical and Electronics Engineers, Inc. (IEEE):
.1 81-1983 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

.4 Canadian Standards Association (CSA):
.1 CSA C22.1-12 - Canadian Electrical Code, Part I (22nd Edition), Safety Standard for Electrical Installations.
.2 Ontario Electrical Safety Code (25th Edition / 2012).

.5 Telecommunications Industry Association, (TIA)
.1 J-STO-607-A - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

.6 Underwriters Laboratories, Inc. (UL):
.1 44-2005 - Thermoset-Insulated Wires and Cables
.2 83-2003 - Thermoplastic-Insulated Wires and Cables
.3 467-2004 - Grounding and Bonding Equipment
.4 486A-486B-2003 - Wire Connectors

1.4 **SUBMITTALS**

.1 Submit in accordance with Division 01.

.2 Shop Drawings:
- .1 Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
- .2 Include the location of system grounding electrode connections and the routing of aboveground and underground grounding electrode conductors.

.3 Test Reports: Provide certified test reports of ground resistance.

.4 Certifications: Two weeks prior to substantial performance, submit four copies of the following:
- .1 Certification that the materials and installation is in accordance with the drawings and specifications.
- .2 Certification, by the Contractor, that the complete installation has been properly installed and tested.

2 Products

2.1 **GROUNDING AND BONDING CONDUCTORS**

.1 Equipment grounding and bonding conductors shall be UL 83 insulated stranded copper, except that sizes 6 mm² (10 AWG) and smaller shall be solid copper. Insulation colour shall be continuous green for all equipment grounding conductors. Cable insulation shall be plenum rated (CMP).
- .1 Example: American Insulated Wire Corp, Telcoflex III series.

.2 Bonding conductors shall be ASTM B8 bare stranded copper, except that sizes 6 mm² (10 AWG) and smaller shall be ASTM B1 solid bare copper wire.

.3 Telecom System Grounding Riser
- .1 Telecom System Grounding Riser Conductor: Telecommunications Grounding Riser shall be in accordance with J STO-607A. Use a minimum 50mm² (1/0 AWG) insulated stranded copper grounding conductor unless indicated otherwise.

2.2 **TELECOMMUNICATION AND EQUIPMENT GROUND BUSBARS**

.1 Provide solid copper busbar, pre-drilled from two-hole lug connections with a minimum thickness of 6 mm (1/4 inch) for wall and backboard mounting using standard insulators sized as per details on the electrical drawings.

.2 Manufacturers:
- .1 Newton Instrument Company
- .2 Panduit
- .3 Burndy
- .4 Thomas and Betts.

2.3 **SPLICES AND TERMINATION COMPONENTS**

.1 Components shall meet or exceed UL 467 and be clearly marked with the manufacturer, catalog number, and permitted conductor size(s).

2.4 **GROUND CONNECTIONS**

.1 Above Grade:
- .1 Bonding Jumpers: compression type connectors, using zinc-plated fasteners and external tooth lockwashers.
- .2 Ground Busbars: Two-hole compression type lugs using tin-plated copper or copper alloy bolts and nuts.
- .3 Rack and Cabinet Ground Bars: two-hole compression-type lugs using zinc-plated or copper alloy fasteners.

3 Execution

3.1 **GENERAL**

.1 Ground in accordance with the Electrical Code, as shown on drawings, and as hereinafter specified.

.2 Equipment Grounding: IT cabinets, and other conductive items in close proximity with electrical circuits shall be bonded and grounded.

3.2 **SECONDARY EQUIPMENT AND CIRCUITS**

.1 Conduit Systems:
- .1 Ground all metallic conduit systems. All metallic conduit systems shall contain an equipment grounding conductor.
- .2 Non-metallic conduit systems shall contain an equipment grounding conductor, except that non-metallic feeder conduits which carry a grounded conductor from exterior transformers to interior or building-mounted service entrance equipment need not contain an equipment grounding conductor.
- .3 Conduit containing only a grounding conductor, and which is provided for mechanical protection of the conductor, shall be bonded to that conductor at the entrance and exit from the conduit.

.2 Feeders and Branch Circuits: Install equipment grounding conductors with all feeders and power and lighting branch circuits.

.3 Boxes, Cabinets, Enclosures, and Panelboards:
- .1 Bond the equipment grounding conductor to each pullbox, junction box, outlet box, device box, cabinets, and other enclosures through which the conductor passes (except for special grounding systems for intensive care units and other critical units shown).
- .2 Provide lugs in each box and enclosure for equipment grounding conductor termination.
- .3 Provide ground bars in panelboards, bolted to the housing, with sufficient lugs to terminate the equipment grounding conductors.

.4 Receptacles shall not be grounded through their mounting screws. Ground with a jumper from the receptacle green ground terminal to the device box ground screw and the branch circuit equipment grounding conductor.

3.3 CORROSION INHIBITORS

.1 When making ground and ground bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.

3.4 TELECOMMUNICATIONS SYSTEM

.1 Bond telecommunications system grounding equipment to the electrical grounding electrode system.

.2 Furnish and install all new wire and hardware required to properly ground, bond and connect communications raceway, cable tray, metallic cable shields, and equipment to a ground source.

.3 Ground bonding jumpers shall be continuous with no splices. Use the shortest length of bonding jumper possible.

.4 Provide ground paths that are permanent and continuous with a resistance of 1 ohm or less from raceway, cable tray, and equipment connections to the building grounding electrode. The resistance across individual bonding connections shall be 10 milliohms or less.

.5 Above-Grade Grounding Connections: When making bolted or screwed connections to attach bonding jumpers, remove paint to expose the entire contact surface by grinding where necessary; thoroughly clean all connector, plate and other contact surfaces; and apply an appropriate corrosion inhibitor to all surfaces before joining.

.6 Bonding Jumpers:
- .1 Use insulated ground wire of the size and type shown on the Drawings or use a minimum of #6 AWG insulated copper wire.
- .2 Assemble bonding jumpers using insulated ground wire terminated with compression connectors.
- .3 Use compression connectors of proper size for conductors specified. Use connector manufacturer’s compression tool.

.7 Bonding Jumper Fasteners:
- .1 Conduit: Fasten bonding jumpers using screw lugs on grounding bushings or conduit strut clamps, or the clamp pads on push-type conduit fasteners. When screw lug connection to a conduit strut clamp is not possible, fasten the plain end of a bonding jumper wire by slipping the plain end under the conduit strut clamp pad; tighten the clamp screw firmly. Where appropriate, use zinc-plated external tooth lockwashers.
- .2 Wireway and Cable Tray: Fasten bonding jumpers using zinc-plated bolts, external tooth lockwashers, and nuts. Install protective cover, e.g., zinc-plated acorn nuts on any bolts extending into wireway or cable tray to prevent cable damage.

.3 Ground Plates and Busbars: Fasten bonding jumpers using two-hole compression lugs. Use tin-plated copper or copper alloy bolts, external tooth lockwashers, and nuts.

.4 Unistrut and Raised Floor Stringers: Fasten bonding jumpers using zinc-plated, self-drill screws and external tooth lockwashers.

3.5 COMMUNICATIONS RACEWAY GROUNDING

.1 Conduit: Use insulated #6 AWG bonding jumpers to ground metallic conduit at each end and to bond at all intermediate metallic enclosures.

.2 Wireway: use insulated #6 AWG bonding jumpers to ground or bond metallic wireway at each end at all intermediate metallic enclosures and across all section junctions.

END OF SECTION

1 General

1.1 **SUMMARY**

.1 Provide a complete system of empty conduit, pull boxes, outlets, and sleeves for enclosure of communications cabling.

1.2 **RELATED REQUIREMENTS**

.1 Section 26 05 33.13 – Conduit for Electrical Systems.

.2 Section 26 05 33.16 – Boxes for Electrical Systems.

1.3 **REFERENCES**

.1 BISCI Telecommunications Distribution Methods Manual, 13th Edition (2014).

2 Products

2.1 **OUTLETS**

.1 Wall outlets shall be 115 mm square boxes with plaster rings to suit single gang devices unless otherwise noted.

.2 Provide 53 mm conduit through walls as noted.

2.2 **CONDUITS**

.1 Conduit size shall be in accordance with recommended standard for conduits in Building as published by BICSI.

.2 Minimum conduit size shall be 21 mm diameter.

.3 Minimum space requirements in pull boxes for 90 degree pulls, shall be as follows:

Maximum conduit size	Size of pull boxes in millimetres			For each additional conduit size increase width by:
	Width	Length	Depth	
21 mm	150 mm	300 mm	100 mm	50 mm
27 mm	200 mm	400 mm	150 mm	75 mm
35 mm	250 mm	450 mm	200 mm	75 mm
41 mm	300 mm	600 mm	250 mm	100 mm
53 mm	350 mm	750 mm	300 mm	125 mm

.4 Plenum cables are permitted in accessible ceilings. Provide ‘J’ hooks in these locations for cable installation.

.5 Plywood backboards shall be minimum 1200 mm by 2400 mm, 19 mm thick, painted with 2 coats of fire retardant light grey enamel.

.6 Provide a minimum of two 5-15R duplex receptacles on separate circuits at each backboard.

3 Execution

3.1 **INSTALLATION**

.1 Vertically mount outlet boxes, unless noted otherwise, 300 mm to centre above floor, or 150 mm above counter top where shown at counters or benches.

.2 Fish conduit, clear blockages and outlet and clean out pull boxes at completion of installation. Leave conduit free of water or excess moisture. Install No. 12 gauge galvanized soft iron pull wire, or 1/8 inch nylon pull cord continuously from outlet to outlet, through conduit and fasten at each box.

.3 Conduit shall have a bending radius of not less than nine times conduit diameter. Ream out conduit and identify ends with green paint.

.4 Install additional steel pull boxes in such a manner that, throughout entire system, there shall be not more than two 90 degree or equivalent bends or more than 30 000 mm in each run, so that wire or cables may be pulled in or withdrawn with reasonable ease. Minimum space requirements in pull boxes having one conduit each in opposite ends of the box, shall be as follows:

Maximum conduit size	Size of pull boxes in millimetres			For each additional conduit size increase width by:-
	Width	Length	Depth	
21 mm	150 mm	300 mm	100 mm	50 mm
27 mm	200 mm	400 mm	150 mm	75 mm
35 mm	250 mm	450 mm	200 mm	75 mm
41 mm	300 mm	600 mm	250 mm	100 mm
53 mm	350 mm	750 mm	300 mm	125 mm

.5 Show as-installed conduit routing and location of all pull boxes on the record drawings, prior to project completion. Include above noted information on final record drawings at project completion.

END OF SECTION

1 General

1.1 **SUMMARY**

.1 Provide a complete system of empty conduits, terminal cabinets, plywood backboards, pull boxes and outlet boxes for enclosure of cabling.

1.2 **RELATED REQUIREMENTS**

.1 Section 26 05 33.13 – Conduit for Electrical Systems.

.2 Section 26 05 33.16 – Boxes for Electrical Systems.

2 Products

2.1 **VIDEO SURVEILLANCE EQUIPMENT**

.1 Video Surveillance equipment shall be based on IP cameras. Size conduits based on industry practices based on Category 5e communications cabling.

2.2 **OUTLETS**

.1 Wall and door outlets shall be single boxes, or 115 mm square boxes with plaster rings to suit single gang devices unless otherwise noted.

2.3 **CONDUITS**

.1 Provide conduit in all walls, exposed areas and inaccessible ceilings. All conduit work shall be concealed.

.2 Minimum conduit size shall be 21 mm diameter.

.3 Provide J hooks in accessible ceilings for plenum rated wiring.

.4 Minimum space requirements in pull boxes for 90 degree pulls, shall be as follows:

Maximum conduit size	Size of pull boxes in millimetres			For each additional conduit size increase width by:-
	Width	Length	Depth	
21 mm	150 mm	300 mm	100 mm	50 mm
27 mm	200 mm	400 mm	150 mm	75 mm
35 mm	250 mm	450 mm	200 mm	75 mm
41 mm	300 mm	600 mm	250 mm	100 mm
53 mm	350 mm	750 mm	300 mm	125 mm

.5 Plywood backboards shall be minimum 1200 mm by 2400 mm, 19 mm thick, painted with 2 coats of fire retardant light grey enamel.

.6 Provide a minimum of two duplex receptacles on separate circuits at each backboard.

3 Execution

3.1 **INSTALLATION**

.1 Vertically mount outlet boxes, unless noted otherwise, 300 mm to centre above floor, or 150 mm above counter top where shown at counters or benches.

.2 Fish conduit, clear blockages and outlet and clean out pull boxes at completion of installation. Leave conduit free of water or excess moisture. Install No. 12 gauge galvanized soft iron pull wire, or 1/8 inch nylon pull cord continuously from outlet to outlet, through conduit and fasten at each box.

.3 Conduit bonds shall have a bending radius of not less than nine times conduit diameter. Ream out conduit and identify ends with green paint.

.4 Install additional steel pull boxes in such a manner that, throughout entire system, there shall be not more than two 90 degree or equivalent bends or more than 30 000 mm in each run, so that wire or cables may be pulled in or withdrawn with reasonable ease. Minimum space requirements in pull boxes having one conduit each in opposite ends of the box, shall be as follows:

Maximum conduit size	Size of pull boxes in millimetres			For each additional conduit size increase width by:
	Width	Length	Depth	
21 mm	150 mm	300 mm	100 mm	50 mm
27 mm	200 mm	400 mm	150 mm	75 mm
35 mm	250 mm	450 mm	200 mm	75 mm
41 mm	300 mm	600 mm	250 mm	100 mm
53 mm	350 mm	750 mm	300 mm	125 mm

.5 Show as-installed conduit routing and location of all pull boxes on the record drawings, prior to project completion. Include above noted information on final record drawings at project completion.

END OF SECTION

1 General

1.1 **SUMMARY**

.1 The work covered under this section consists of the furnishing of all necessary labor, supervision, materials, equipment, and services to completely execute the system of non-continuous cable supports ("J-Hooks") as described in this specification.

1.2 **SCOPE**

.1 Non-continuous cable supports.

.2 Adjustable non-continuous cable support sling.

.3 Multi-tiered non-continuous cable support assemblies.

.4 Non-continuous cable support assemblies from tee bar.

.5 Non-continuous cable support assemblies from drop wire/ceiling.

.6 Non-continuous cable support assemblies from beam, flange.

.7 Non-continuous cable support assemblies from C & Z Purlin.

.8 Non-continuous cable support assemblies from wall, concrete, or joist.

.9 Non-continuous cable support assemblies from threaded rod.

.10 Raised floor non-continuous cable support assemblies.

.11 Cantilever-Mounted Option for non-continuous cable supports.

.12 Installation accessories for non-continuous cable supports.

1.3 **DEFINITIONS**

.1 UTP: Unshielded twisted pair.

.2 ANSI: American National Standards Institute

.3 ASTM: American Society for Testing and Materials

.4 EIA: Electronic Industries Alliance

.5 TIA: Telecommunications Industry Association

.6 cULus: Listed by Underwriters Laboratories based on both Canadian and US (United States) standards requirements.

1.4 **SUBMITTALS**

.1 Submit product data on non-continuous cable support devices, including attachment methods. Product data to include, but not limited to materials, finishes, approvals, load ratings, and dimensional information.

1.5 **QUALITY ASSURANCE**

.1 Non-continuous cable supports and cable support assemblies shall be listed by Underwriters Laboratories for both Canadian and US standards (cULus).

.2 Non-continuous cable supports shall have the manufacturers name and part number stamped on the part for identification.

.3 Manufacturer: Company specializing in manufacturing products specified in this section with a minimum of five years documented experience in the industry, and certified ISO 9000.

2 Products

2.1 **ACCEPTABLE MANUFACTURERS**

.1 Subject to compliance with these specifications, non-continuous cable supports shall be as manufactured by ERICO, Inc or approved equal.

2.2 **REFERENCES**

.1 ASTM B633 Standard Specification for Electro-deposited Coatings of Zinc on Iron and Steel

.2 ASTM B 695-90 Standard Specification for coatings of Zinc Mechanically Deposited on Iron and Steel

.3 ASTM A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

.4 ASTM A924/A924M Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process

.5 ASTM A109 Standard Specification for Steel, Strip, Carbon, Cold-Rolled

.6 ASTM A167 Standard Specification for Stainless and heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

.7 ASTM A480/A480M Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.

.8 ASTM A568 Standard Specification for Steel, Sheet, Carbon, and High-Strength, Low-Alloy Hot-Rolled and Cold-Rolled

.9 A653 G60-Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-coated (Galvannealed) by the Hot-Dip process

.10 ASTM A666 Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar

.11 ASTM A682 Standard Specification for Steel, Strip, High-Carbon, Cold-Rolled, Spring Quality

.12 ASTM A879 Standard Specification for Steel Sheet, Zinc Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface

.13 ASTM B117 Standard Method of Salt Spray (Fog) Testing

.14 ASTM D610 Standard test Method for Evaluating Degree of Rusting on Painted Steel Surfaces UL 2043 - Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces.

.15 ANSI/ TIA/ EIA 568 Commercial Building Telecommunications Cabling Standard, current revision level.

.16 ANSI/ TIA/ EIA 569 Commercial Building Standard for Telecommunications Pathways and Spaces, current revision level.

.17 NFPA 70 National Electrical Code®

2.3 NON-CONTINUOUS CABLE SUPPORT SYSTEMS

.1 Non-continuous cable supports

.1 Non-continuous cable supports shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables; cULus Listed.

.2 Non-continuous cable supports shall have flared edges to prevent damage while installing cables.

.3 Non-continuous cable supports sized 1 5/16” and larger shall have a cable retainer strap to provide containment of cables within the hanger. The cable retainer strap shall be removable and reusable and be suitable for use in air handling spaces.

.4 Non-continuous cable supports shall have an electro-galvanized or G60 finish and shall be rated for indoor use in non-corrosive environments.

.5 Stainless Steel non-continuous cable supports are intended for indoor and outdoor use in non-corrosive environments or where only mildly corrosive conditions apply.

.6 Non-continuous cable supports shall be ERICO CableCatTM J-hook series CAT12, CAT21, CAT32, CAT64, CAT21SS, CAT32SS, CAT64SS; CAT-CMTM Double J-Hook CAT100CM; CAT-CMTM U-hook series CAT200CMLN, CAT300CMLN; and CAT-CMTM retainer CATRT200CM, CATRT300CM or approved equal.

.2 Adjustable non-continuous cable support sling

.1 Constructed from steel and woven laminate; sling length can be adjusted to hold up to 425 4-pair UTP; rated for indoor use in non-corrosive

environments. Rated to support Category 5 and higher cable, or optical fiber cable; cULus Listed.

.2 Adjustable non-continuous cable support sling shall have a static load limit of 100 lbs.

.3 Adjustable non-continuous cable support sling shall be suitable for use in air handling spaces.

.4 If required, assemble to manufacturer recommended specialty fasteners including beam clips, flange clips, C and Z purlin clips.

.5 Acceptable products: ERICO CADDY CableCatTM CAT425; or approved equal.

.3 Multi-tiered non-continuous cable support assemblies

.1 Multi-tiered non-continuous cable support assemblies shall be used where separate cabling compartments are required. Assemblies may be factory assembled or assembled from pre-packaged kits. Assemblies shall consist of a steel angled hanger bracket holding up to six non-continuous cable supports, rated for indoor use in non-corrosive environments; cULus Listed.

.2 If required, the multi-tier support bracket may be assembled to manufacturer recommended specialty fasteners including beam clamps, flange clips, C and Z purlin clips.

.3 The multi-tiered support bracket shall consist of ERICO CADDY CATHBA and CableCatTM J-Hooks with screws; or approved equal.

.4 Non-continuous cable support assemblies from tee bar

.1 Tee bar support bracket with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments; cULus Listed.

.2 Acceptable products: ERICO CADDY CAT12TS, CAT21528, CAT32528; or approved equal.

.5 Non-continuous cable support assemblies from drop wire/ceiling

.1 Fastener to wire/rod with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments; cULus Listed.

.2 Acceptable products: ERICO CADDY CAT124Z34, CAT126Z34, CAT214Z34, CAT216Z34, CAT324Z34 or CAT326Z34; or approved equal.

.6 Non-continuous cable support assemblies from beam, flange

.1 Fastener to beam or flange with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments; cULus Listed.

.2 Acceptable products: ERICO CableCatTM J-hook series CAT12, CAT21, CAT32, CAT64 with CADDY beam clamps and CADDY flange clips; or approved equal.

.7 Non-continuous cable support assemblies from C & Z Purlin

.1 Fastener to C or Z purlin with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments, cULus Listed.

.2 Acceptable products: ERICO CableCatTM J-hook series CAT12, CAT21, CAT32, CAT64 with CADDY Purlin hangers; or approved equal.

.8 Non-continuous cable support assemblies from wall, concrete, or joist
- .1 Fastener to wall, concrete, or joist with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments, cULus Listed.
- .2 Acceptable products: ERICO CableCatTM J-hook series CAT12, CAT21, CAT32, CAT64, with CADDY angle bracket; or approved equal.

.9 Non-continuous cable support assemblies from threaded rod
- .1 Fastener to threaded rod with one non-continuous cable support, factory or jobsite assembled, rated for indoor use in non-corrosive environments, cULus Listed.
- .2 The multi-tiered support bracket shall have a static load limit of 300 lbs.
- .3 U-hooks and Double J-hook shall attach directly to threaded rod using standard nuts.
- .4 Acceptable products: ERICO CableCatTM J-hook, CAT12, CAT21, CAT32, CAT64 with CADDY CATHBA series; CAT-CMTM Double J-hook CAT100CM, CAT-CMTM Direct mount U-hook CAT200CMLN, CAT300CMLN; or AFAB series; or approved equal.

.10 Raised floor non-continuous cable support assemblies
- .1 Fastener to raised (access) floor pedestal with one non-continuous cable support, factory or jobsite assembled, rated for indoor use in non-corrosive environments; cULus Listed.
- .2 Acceptable products: ERICO CADDY CAT12CD1B, CAT21CD1B or CAT32CD1B; CAT64CD1B; or approved equal.

.11 Cantilever-Mounted cable supports
- .1 U-hook shall be able to be assembled to a wide variety of wall mount brackets.
- .2 Spacing of individual U-hooks as needed, max of 4’ to 5’ apart.
- .3 U-hooks may have the optional attachment of a cable roller for ease in pulling cables.
- .4 Acceptable products: ERICO CAT-CMTM U-hooks CAT200CMLN, CAT300CMLN: CAT-CM roller assemblies CATRL200CM, CATRL300CM; CATWMCM bracket; or approved equal.

.12 Installation accessories for non-continuous cable supports
- .1 Cable Pulley
  - .1 Non-continuous cable supports may be used as an installation tool when a removable pulley assembly is included. The pulley shall be made of plastic and be without sharp edges. The pin and bail assembly must be able to be secured to the J-Hook during cable installation. The pulley must remain secured while cables are being pulled.
  - .2 The pin and roller assembly must be removed after cables are installed.
  - .3 Acceptable products: ERICO CADDY CAT32PLR, CAT64PLR, or approved equal.
- .2 Cable Protector
  - .1 The protective steel tube shall fit over threaded rod and be at least 4” in length.

.2 The tube shall prevent damage to cables placed in or pulled through CAT-CMTM U-hooks. The tube shall not inhibit the pulling of cables.

.3 Acceptable products: ERICO CAT-CMTM CATTBCM, or approved equal.

2.4 **FINISHES**

.1 ASTM B633 Standard Specification for Electro-deposited Coatings of Zinc on Iron and Steel

.2 ASTM B 695 Standard Specification for coatings of Zinc Mechanically Deposited on Iron and Steel

.3 ASTM A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

.4 ASTM A924/A924M Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process

.5 Non-continuous cable supports used where only mildly corrosive conditions apply shall be stainless steel, AISI type 304.

3 Execution

3.1 **INSTALLATION**

.1 Installation and configuration shall conform to the requirements of the current revision levels of ANSI/ EIA/TIA Standards 568 & 569, NFPA 70 (National Electrical Code), applicable local codes, and to the manufacturer's installation instructions.

.2 Install cables using techniques, practices, and methods that are consistent with Category 5 or higher requirements and that supports Category 5 or higher performance of completed and linked signal paths, end to end.

.3 Install cables without damaging conductors, shield, or jacket.

.4 Do not bend cables, in handling or in installing, to smaller radii than minimums recommended by manufacturer.

.5 Pull cables without exceeding cable manufacturer's recommended pulling tensions. Use pulling means that will not damage media.

.6 Do not exceed load ratings specified by manufacturer.

.7 Adjustable non-continuous support sling shall have a static load limit of 100 lbs.

.8 Follow manufacturer's recommendations for allowable fill capacity for each size non-continuous cable support.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Firestopping through penetrations in fire rated assemblies.

1.2 **RELATED REQUIREMENTS**

.1 Division 07.

1.3 **REFERENCES**

.1 ASTM E 84, “Surface Burning Characteristics of Building Materials”.

.2 ASTM E 119, “Fire Tests of Building Construction and Materials”.

.3 ASTM E 814, “Fire Tests of Penetration Firestop Systems”.

.4 ANSI/UL263, “Fire Tests of Building Construction and Materials”.

.5 ANSI/UL723, “Surface Burning Characteristics of Building Materials”.

.6 ANSI/UL1479, “Fire Tests of Through Penetration Firestops”.

.7 Underwriters Laboratories Inc. (UL) – Fire Resistance Directory

1.4 **PERFORMANCE REQUIREMENTS**

.1 Fire rated pathway devices shall be the preferred product and shall be installed in all locations where frequent cable moves, add-ons and changes will occur, such devices shall:
  .1 Meet the hourly rating of the floor or wall penetrated.
  .2 Permit the allowable cable load to range from 0% to 100% visual fill thereby eliminating the need to calculate allowable fill ratios.
  .3 Not require any additional action on the part of the installer to open or close the pathway device or activate the internal smoke and fire seal, such as, but not limited to:
    .1 Opening or closing of doors.
    .2 Twisting an inner liner.
    .3 Removal or replacement of any material such as, but not limited to, sealant, caulk, putty, pillows, bags, foam plugs, foam blocks, or any other material.
  .4 Permit multiple devices to be ganged together to increase overall cable capacity.
  .5 Allow for retrofit to install around existing cables.
  .6 Include an optional means to lengthen the device to facilitate installation in thicker barriers without degrading fire or smoke sealing properties or inhibiting ability of device to permit cable moves, add-ons, or changes.

.2 Where single cables (up to 0.27 in. (7 mm) diameter) penetrate gypsum board/stud wall assemblies, a fire-rated cable grommet may be substituted.

Acceptable products shall be molded from plenum-grade polymer and conform to the outer diameter of the cable forming a tight seal for fire and smoke. Additionally, acceptable products shall lock into the barrier to secure cable penetration.

.3 Where non- mechanical products are utilized, provide products that upon curing do no re-emulsify, dissolve, leach, breakdown or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture characteristic during or after construction.

.4 Where it is not practical to use a mechanical device, openings within floors and walls designed to accommodate telecommunications and data cabling shall be provided with re-enterable products that do not cure or dry.

.5 Cable trays shall terminate at each barrier and resume on the opposite side such that cables pass independently through fire-rated pathway devices. Cable tray shall be rigidly supported independent from fire-rated pathway devices on each side of barrier.

1.5 SUBMITTALS

.1 Submit under provisions of Division 01.

.2 Product Data: Provide manufacturer's standard catalog data for specified products demonstrating compliance with referenced standards and listing numbers of systems in which each product is to be used.

.3 Shop Drawings: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance ratings.

.4 Certificates: Product certificates signed by firestop system manufacturer certifying material compliance with applicable code and specified performance characteristics.

.5 Installation Instructions: Submit manufacturer's printed installation instructions.

1.6 QUALITY ASSURANCE

.1 Products/Systems: Provide firestopping systems that comply with the following requirements:
- .1 Firestopping tests are performed by a qualified, testing and inspection agency. A qualified testing and inspection agency is UL, or another agency performing testing and follow-up inspection services for firestop system acceptable to authorities having jurisdiction.
- .2 Firestopping products bear the classification marking of qualified testing and inspection agency.

.2 Installer Qualifications: Experience in performing work of this section who is qualified by the firestopping manufacturer as having been provided the necessary training to install firestop products in accordance with specified requirements.

1.7 **DELIVERY, STORAGE, AND HANDLING**

.1 Delivery:
- .1 Manufacturer's original, unopened, undamaged containers, identification labels intact identifying product and manufacturer, date of manufacture; lot number; shelf life, if applicable; qualified testing and inspection agency's classification marking; and mixing instruction for multicomponent products.
- .2 Handle and store products according to manufacturer's recommendations published in technical materials. Leave products wrapped or otherwise protected and under clean and dry storage conditions until required for installation.

.2 Storage and Protection:
- .1 Store materials protected from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.

1.8 **PROJECT CONDITIONS**

.1 Do not install firestopping products when ambient or substrate temperatures are outside limitations recommended by manufacturer.

.2 Do not install firestopping products when substrates are wet due to rain, frost, condensation, or other causes.

.3 Maintain minimum temperature before, during, and for a minimum 3 days after installation of materials.

.4 Do not use materials that contain flammable solvents.

.5 Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.

.6 Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.

.7 Schedule installation of firestopping after completion of penetrating item installation but prior to covering or concealing of openings.

2 Products

2.1 **MANUFACTURERS**

.1 Specified Technologies Inc., 200 Evans Way, Somerville, NJ 08876. Tel: (800) 992-1180, Fax: (908) 526-9623, Email: specseal@stifirestop.com, Website: www.stifirestop.com.

.2 Substitutions: as approved by the Engineer prior to tender closing.

.3 Single Source: Obtain firestop systems for each type of penetration and construction condition indicated only from a single manufacturer.

2.2 **MATERIALS**

.1 General: Use only firestopping products that have been tested for specific fire resistance rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire rating involved for each separate instance.

2.3 **FIRE RATED CABLE PATHWAYS**

.1 Steel raceway with intumescent foam pads allowing 0 to 100 percent cable fill, the following products are acceptable:
.1 Specified Technologies Inc. (STI) EZ-PATH™ Fire Rated Pathway.

3 Execution

3.1 **EXAMINATION**

.1 Before beginning installation, verify that substrate conditions previously installed under other sections are acceptable for installation of firestopping in accordance with manufacturer's installation instructions and technical information.

.2 Surfaces shall be free of dirt, grease, oil, scale, laitance, rust, release agents, water repellants, and any other substances that may inhibit optimum adhesion.

.3 Provide masking and temporary covering to protect adjacent surfaces.

.4 Do not proceed until unsatisfactory conditions have been corrected.

3.2 **INSTALLATION**

.1 General: Install through-penetration firestop systems in accordance with Performance Criteria and in accordance with the conditions of testing and classification as specified in the published design.

.2 Manufacturer's Instructions: Comply with manufacturer's instructions for installation of firestopping products.

3.3 **FIELD QUALITY CONTROL**

.1 Inspections: Engage qualified independent inspection agency to inspect through-penetration firestop systems.

.2 Keep areas of work accessible until inspection by authorities having jurisdiction.

.3 Where deficiencies are found, repair firestopping products so they comply with requirements.

3.4 **ADJUSTING AND CLEANING**

.1 Remove equipment, materials, and debris, leaving area in undamaged, clean condition.

.2 Clean all surfaces adjacent to sealed openings to be free of excess firestopping materials and soiling as work progresses.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labelling and identification requirements for communications systems.

1.2 **REFERENCES**

.1 ANSI/TIA/EIA-606-A – Administration Standard for Commercial Telecommunications Infrastructure.

.2 UL 969 – Marking and Labeling Systems.

2 Products

2.1 **SUMMARY**

.1 Adhesive cable labels to meet the legibility, defacement, and adhesion requirements specified in UL 969 (Ref. D-16). In addition, the labels shall meet the general exposure requirements in UL 969 for indoor use.

.2 Self-laminating vinyl construction cable labels with a white printing area and a clear tail that self laminates the printed area when wrapped around a cable. The clear area should be of sufficient length to wrap around the cable at least one and one-half times.

.3 ANSI/EIA/TIA-606 for colour codes shall be followed. Labels are to be mechanically printed using a laser printer. Hand written labels will not acceptable.

2.2 **LABEL PRINTER**

.1 Thermal Transfer Printer shall print high quality, industrial labels on a wide variety of materials for electrical and network applications such as wire/cable, components, safety and facility identification.

.2 Laminated Adhesive Label Cassettes:
.1 For flat label applications.
.2 Polyester material.

.3 Non-Laminated Adhesive Label Cassettes:
.1 For marking wire and cable and flat label applications.
.2 Polyester material

.4 Example Products:
.1 Panduit LS7 series hand-held printer.
.2 Panduit LS8 series hand-held printer.

2.3 **NAMEPLATES**

.1 Engraved three-layer laminated plastic, letters on contrasting background:

.2 Rack and Cabinet ID labels: 25 mm (1”) high White Text on Black Background

3 Execution

3.1 INSTALLATION

.1 Cable identification labels should appear at the following locations with the numbers indicated on the cable schedule and drawings:
- .1 300 mm (12 inches) from each end of the cable – after termination.
- .2 Front of patch panels.
- .3 Front of IDC termination blocks.
- .4 Front of workstation/communications outlet faceplates.
- .5 Each end of each Telecommunications Conduit.

.2 Fibre Optic safety labels shall appear at the following locations:
- .1 Along the length of the conduit or innerduct at 3 m (10 foot) intervals.
- .2 At all junction boxes
- .3 At all pull boxes.
- .4 On all fibre optic patch panels.

.3 Provide 25 per cent additional labels to be left in each telecommunications room on site for future growth.

.4 Provide two Rack/Cabinet nameplates. Mount one on the front, and one on the rear of the rack.

3.2 IDENTIFICATION CONVENTIONS

.1 All cabling will be labelled with the closet letter, followed by a dash and the wire number (i.e. A-001 would be the first wire in closet A).

.2 Labelling for backbone wiring will be preceded with BB followed by the wire number (i.e. BB-001 would be the first backbone.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Commissioning Requirements.

1.2 **REFERENCES**

.1 Refer to Section 27 05 00 for references.

1.3 **SUBMITTALS FOR REVIEW**

.1 Provide testing reports.

2 Products – Not Used

3 Execution

3.1 **INSTALLATION**

.1 Testing of all horizontal copper cables are to be completed in accordance with the follow test criteria:
- .1 Basic Link
- .2 Grounds
- .3 NEXT
- .4 ELFEXT
- .5 Continuity
- .6 correct polarity
- .7 PSNEXT
- .8 PSELFEXT
- .9 Shorts
- .10 Length
- .11 ACR
- .12 Return Loss
- .13 Opens
- .14 Attenuation
- .15 PSACR
- .16 Resistance

.2 Fibre strands in excess of 122m (400 ft) shall be tested with an Optical Time Domain Reflectometer for length and attenuation.

.3 Test each stand of fibre, bi-directionally, with a Power Meter / Light Source combination operating at wavelengths of 850 nm and 1300 nm for multimode fibres.

.4 Maximum multi-mode passive link loss (including patch cords) is not to exceed -2.35dB.

.5 Maximum single-mode passive link loss (including patch cords) is not to exceed -1.0dB.

3.2 DOCUMENTATION

.1 The Telecommunications Cabling Contractor is required to submit test results in native tester format or a format which can be read with a text reader (i.e. ".txt" extension). Paper results shall not be submitted for projects with 100 or more horizontal cable drops and/or fibre cables.

.2 The Telecommunications Cabling Contractor is required to provide the software required to view the results.

.3 The report should be divided into sections by Telecommunications Room.

.4 The report should indicate for each cable when it was tested successfully, the result, and the length.

.5 The Telecommunications Cabling Contractor shall sign off on the entire test report prior to submitting to the General Contractor/Construction Manager or The Consultant.

.6 The test result documentation is to be submitted to the General Contractor/Construction Manager or The Consultant for review no later than 10 working days following the completion of the installation.

.7 All deficiencies must be corrected before the General Contractor/Construction Manager or The Consultant will provide a certificate to release the Holdback on the project.

3.3 RECORD DRAWINGS

.1 The Telecommunications Cabling Contractor is required to maintain one set of correct and accurate record drawings on-site at all times. These drawings are to be made available to the General Contractor/Construction Manager or the Consultant for review during the project.

.2 The Telecommunications Cabling Contractor is required to provide record drawings of the telecommunication cabling installation in relation to the drawings provided in this specification.

.3 The record drawings shall be updated electronically and include, but are not limited to;

- .1 Horizontal cable numbers on the floor plans
- .2 Horizontal Cable Routing on the floor plans
- .3 Changes on the floor plans
- .4 Backbone cable Routing between Telecommunications Rooms
- .5 Paging Speaker Locations including daisy chain cable run
- .6 Wireless Access Points and Cell coverage
- .7 Cabinet/Rack Elevation drawings
- .8 Backboard Elevation Drawing

.4 The Telecommunications Cabling Contractor shall provide one soft copy in AutoCAD 2007 and one plotted copy for the Consultant to review prior to complete substantial performance and close-out documentation submission.

.5 After approval, the Telecommunications Cabling Contractor shall submit one plotted copy of the drawings for;
- .1 The Main Computer Room
- .2 Each Telecommunications Room
- .3 The Consultant

.6 All close-out documentation must be submitted to the General Contractor/Construction Manager or The Consultant within 10 working days of the completion of the project before the documentation holdback will be released.

END OF SECTION

1 General

1.1 SUMMARY

.1 Supply, install and test complete data cabling system and accessories, based on physical star wiring topology, and as specified herein and indicated on drawings for the new addition.

.2 Include data cabling system the following sub-systems:
- .1 Backbone Terminal Systems, located in Communications Closets, to serve as connection points between backbone cables and horizontal distribution cables.
- .2 Horizontal distribution system links backbone terminal system to telecommunications outlets.
- .3 Contractor is to submit details on equipment types and locations for review and approval prior to installation.

1.2 RELATED REQUIREMENTS

.1 Active electronics, including servers, hubs, routers, switchers, and, PCs are by Owner and are not part of this contract.

1.3 ABBREVIATIONS AND ACRONYMS

.1 MTER Main Telecommunication Equipment Room

.2 TC Telecommunications Closet

.3 TCs Telecommunications Closets

.4 RCDD Registered Communications Distribution Designer

.5 BICSI Building Industry Consulting Service International

.6 MDTS Main Distribution Terminal System

.7 IDC Insulation Displacement Connection

.8 OTDR Optical Time-Domain Reflectometer

.9 BCS Backbone Cabling System

.10 IDT Intermediate Distribution Terminal

.11 BTS Backbone Terminal System

1.4 REFERENCE STANDARDS

.1 Conform to CAN/CSA-T530 for new buildings and areas of substantial renovations of telecommunications, spaces and pathways.

.2 Ensure that cabling system shall conform to current issue of industry standard CAN/CSA-T529. This standard is currently being revised and is available as document EIA/TIA SP-2840A (future CAN/CSA-T529). All requirements of this new document must be followed including: Structural Return Loss (section 10.2.4.5), Power Sum Testing (section 10.3.4.7) and End to End Link Performance and continuity, attenuation, cable open and shorts, NEXT; mutual capacitance, pair polarity and cable impedance, S/N ratio, and Pass/Fail status. Tests are to be conducted and recorded using a Penta Scanner. Fibre optic cables shall be tested in conformance to ISO/IEC IS 11801 standards using an EXFO Optical Time Domain Reflectometer. Test results such as; dB loss, cable length and fibre deficiencies (if any) shall be conducted. Verification, documentation, and warranty shall be provided.

.3 Where applicable, have performance of Category 5e cabling components used, verified by nationally recognized testing laboratory. Submit test results upon request.

.4 Conform to applicable Building and Electrical Safety Codes.

1.5 SUBMITTALS

.1 Shop Drawings
- .1 Provide submittals in accordance with Division 01 prior to commencing installation.
- .2 Submit complete cabling system layout for Consultant review for data, cable routing summary and cable outlet designation. Have cabling system layout performed by accredited RCDD (Registered Communications Distribution Designer) as defined by BICSI (Building Industry Consulting Service International). The Data Cabling system will not be accepted without this submission.
- .3 Documentation proving compliance to End-to-End Link Performance test, as specified in Annex E of EIA/TIA SP-2840A shall be provided prior to structured cabling being installed.
- .4 Submit detailed layout drawings, including termination racks prior to commencing this installation.
- .5 Manufacturer's product information documents on all components of the cabling system, including horizontal and vertical cable management systems and all auxiliary components/devices and equipment prior to commencing this installation.
- .6 The following documentation shall be submitted with a following cover letter listing attachments prior to commencement of work.
  - .1 A list of personnel for the project that will include the name of the Project Manager, Site Manager(s), Lead Hands, and Installers.
  - .2 Permits and notifications as may be required for the project.

1.6 CLOSEOUT SUBMITTALS

.1 Provide manufacturer’s certificate at completion of installation certifying the installation.

.2 Prepare and submit "As-built" drawings reviewed by an RCDD.

.3 "As-built" drawings are to detail the exact location of equipment indicating wiring runs and raceways, pull, junction and terminal boxes. Also to include outlet locations, cable numbers and equipment rack profiles.

.4 Upon completion of work and prior to final acceptance, the contractor will submit to the Owner the required copies of Network Certification and Documentation in the form of manuals that will include the following:
- .1 Detailed information on types of materials and equipment used and their locations including: distribution frame equipment (rack), equipment types and locations; a detailed listing of cable and outlet types and locations.
- .2 Accurately and neatly recorded test results.
- .3 Accurately and neatly record locations including room numbers, of all network components in list form for easy reference.
- .4 Identify drawings as 'Project Record Copy' and maintain in new condition making available for inspection by Owner.
- .5 Bind all items listed above in a 3-ring hard covered binder suitably labelled with the names of each site/project.

1.7 QUALITY ASSURANCE

.1 Qualifications of Manufacturer
- .1 Supply equipment manufactured by experienced reputable manufacturer, whose installations have rendered satisfactory service for at least 2 years and who would provide factory trained technicians fully experienced in telecommunications wiring. Submit information regarding number of employees, and proof of VAR/CSV certification, including length of time Contractor or employee(s) have been certified to install Cable systems.
- .2 Provide certification that cabling solution offered will perform as a system as is defined in standards documents such as EIA-TIA SP-2840A and T568A configuration for Category 5E system standards. Provide certification supported by manufacturer of cabling components used.
- .3 In addition to certificate of assurance, evidence of support by manufacturer for above items shall be provided upon request in writing with bidding response.
- .4 Use components sourced completely from single manufacturer.

.2 Qualifications of Installer
- .1 Provide installation and supervision work supervised by telecommunications technicians qualified to install voice and data cabling system and to perform related tests as required by manufacturer. Installers/company must have valid certification.
- .2 Provide fully qualified telecommunications technicians, trained and certified by manufacturer in installation and testing of equipment specified. Provide evidence upon request in writing prior to work commencement of manufacturer's certification of supplier's ability to properly install structured cabling for building.
- .3 Submit proven track record in cabling projects of similar size. Include details of minimum 3 projects of similar size involving category 5E cabling, Multimode and Single-mode fibre optic cabling which have been completed in last 2 years. Include names, addresses, and phone numbers of references for 3 projects.

.3 Certifications
.1 UTP network wiring shall conform to T568A configuration, Category 5e system standards. All UTP cables shall provide minimum signal impairment by preserving wire pair twists as closely as possible to the point of mechanical termination at each end. The following tests will be conducted and recorded using a Penta Scanner:
.2 End to end continuity, attenuation, cable open and shorts; NEXT; mutual capacitance; pair polarity and cable impedance; S/N ratio and pass/fail status.

1.8 **WARRANTY**

.1 The structured cabling systems shall be warranted for 25 years, covering all system products manufactured and provided by the single source supplier. The warrantor shall guarantee the following:
.1 All passive system components, e.g. patch panels, UTP cable and outlet jacks are free from manufacturing defects in material or workmanship
.2 Approved cabling systems exceed the specifications of the T1A-568A standards and ISO/IEC IS 11801, if applicable.
.3 The installation exceeds attenuation and near end cross talk, loss and bandwidth requirements TIA Bulletin TIA TSB-67 and ISO/EIC IS 11801.

.2 General workmanship and apparatus installed under this contract shall be warranted against defects of workmanship and material for a period of one year after final acceptance of work by the Owner, unless otherwise specified. The contractor will make good any defects developed as a result of their work during such time without expense to the Owner.

2 Products

2.1 **MANUFACTURERS**

.1 Manufacturer List
.1 Belden.
.2 Commscope.
.3 Panduit.
.4 TE.
.5 Wirewerks.
.6 Approved equal.

.2 Substitution Limitations
.1 Copper cabling installation shall be of one manufacturer.

2.2 **UTP CABLING**

.1 100 ohm 4 pair UTP, compliant with TIA/EIA-568-C.2

.2 Category 3 cabling for telephone communication.

.3 Category 5e for data communication, security cameras.
.1 Unshielded twisted pair, 4 pair twisted, #24AWG, FT-6/CMP plenum rated, blue outer insulation,

.4 CMP (FT6) Plenum rated.

.5 No splicing of any data network cabling will be permitted.

2.3 DATA OUTLETS

.1 All data jacks must meet specifications.

.2 Computer outlets complete with termination jacks shall be single, duplex or quad flush faceplates complete with Category 5e, 8-position jacks.

.3 Supply and install one – 4 pair cable to the single outlet, two – 4 pair cables to the duplex outlet, and three – 4 pair cables to quad outlet.

2.4 PATCH PANELS/EQUIPMENT RACKS

.1 All data UTP, 4 pair, Category 5e horizontal cables are to be terminated on cabinet or rack mounted 24/48 port panels wired.
- .1 PS5 HD-BIX Patch panel, 1U, 24 Port (Belden AX100465 or equal)
- .2 PS5 HD-BIX Patch panel, 2U, 48 Port (Belden AX100473 or equal)

.2 Network rack must have the following features:
- .1 Free standing.
- .2 Standard 19” module compatible.
- .3 Lockable door.
- .4 Maximum dimensions of 22”w x 36”d x 85” h.
- .5 Acceptable products:
  - .1 RF Mote Cat. #RFM-1944-RHD c/w hinged lockable door.
  - .2 Anixter Cat. #175419 c/w hinged lockable door.

.3 Distribution panels must be category 5E rated BIX punchdown style with capacities as follows;

.1	24 port	Belden AX100465
.2	48 port	Belden AX100473
.3	96 port	Belden AX100485

.4 In addition to the above, provide all necessary ancillary equipment such as cable management, label holders, and patch cords.

2.5 PATCH CORDS

.1 Provide Category 5e patch cords, consisting of 4 pair stranded cable rated FT4 or higher and stamped accordingly. They must conform to EIA/TIA 568A and meet or exceed the EIA/TIA TSB-36 specifications for cordage.

.2 Patch cords at the workstation end shall be 3050 mm in length, one per data cable.

.3 Patch cords at the TC end shall be 2133 mm in length, one per data cable.

3 Execution

3.1 PATHWAYS FOR COMMUNICATIONS

.1 Conduit to Section 26 05 33.13. J-Hooks: as described in Section 27 05 29.

.2 Cabling between cable tray/j-hooks and data outlets to be enclosed in EMT conduit.

.3 Cables/data outlets may be enclosed in pre-finished non-metallic raceways computer labs, classrooms, etc. where indicated.

.4 Data network cables shall be installed in cable tray. Data network cables shall not be tie-wrapped to electrical conduits, mechanical piping, etc. and shall be run as far as possible from fluorescent lighting fixtures, transformers and electrical power service conduits.

3.2 INSTALLATION

.1 Each equipment rack shall be anchored securely to the floor and grounded to the building ground with a #6 AWG Insulated Ground Wire in accordance with applicable code requirements (refer to CAN/CSA T5238).

.2 Ground all data cables shields and associated equipment in Telecommunications rooms to meet applicable code requirements.

.3 Supply vertical cables and backbone cabling using cable clamps or wiring harnesses.

.4 Conform to Telecommunications Industry Standards (refer to EIA/TIA 568A) for all cable termination and pinning assignments.

.5 Utilize cable trays in MTER and TCs to manage cable in orderly fashion.

.6 All sleeves containing cable or unused shall be fire sealed. Coordinate with Division 07 for provision and installation of fire barriers.

.7 Cabling is to be run at 90 degrees to the building grid except where the distance would exceed 90m in length if installed in this manner.

.8 The maximum horizontal run length is not to exceed 90 metres. If the 90 metre constraint cannot be met, the Cabling Contractor is to notify the Owners Designee of any cables that exceed 90 metres, prior to the installation.

.9 Ensure all grounding conductors are rated FT-6. Tie into bundles and support using j-hooks outside of tray or conduit and fasten to under-slab at intervals not to exceed 1500 mm.

.10 Route all cable in such a way as to ensure minimum separations are maintained from sources of EMI as defined in EIA/TIA SP-2840A.

.11 Place all exposed cabling in TC in neat and professional manner and route as per specifications and drawings. Cables are to be combed, bundled, and routed in a neat and organized manner. Tie-wrap all exposed cable bundles at maximum of every 200 mm using black 'hook-and-loop- fastening ties.

.12 Securely mount voice outlets at all work area locations and locate so that cable required to reach work area equipment will be no more than 3 m long.

.13 Ensure that optical fibre splices, fusion or mechanical, do not exceed maximum optical attenuation of 0.3 dB when measured in accordance with EIA/TIA 455-34 and CSA Standard C22.2 No. 232.

.14 All cables must be properly handled and installed in accordance with the manufacturer's specification. Undue pulling tension, abrasion or rough handling must be avoided to ensure that the cables will permit transmission of the intended information with no impairment or degradation of signal quality. Cable runs between the wiring closets and wall plates must be performed with no splices or cuts to ensure the elimination of reflections, discontinuities, impedance, mismatches, and egress/ingress of undesired signals. Cables must be installed at a specified distance (shown below) from any electrical equipment such as radios, televisions, fluorescent lights or fixtures, motors, transformers, or other significant sources of RFI/EMI interference

.15 Label all cables in accordance with Industry Standards and CAN/CSA T528 specifications. Number cables as per drawings.

.16 In cases where the routing may bring the cable in close proximity to the above mentioned sources of disruption, the following minimum distances must be maintained:
- .1 125 mm (5 inches) from power lines of 2 kVA or less.
- .2 305 mm (12 inches) from lighting (including fluorescent).
- .3 914 mm (36 inches) from power lines of 5 kVA or greater
- .4 40 inches from transformers and motors

.17 As well, cables must be routed to avoid direct contact with steam pipes or other heat sources so as to avoid thermal degradation of the cable insulation or other undesired effects.

.18 Cables shall be located in ceiling spaces neatly, tied in bundles and installed in cable management "trays", J-hooks, and conduit as indicated on the drawings.

.19 All cables entering the wiring closets must be neatly dressed in bundles and run to the appropriate terminating location.

.20 Each cable sheath must be clearly and permanently identified with a labelling scheme acceptable to the owner. Each patch panel port a must be clearly and indelibly marked with a structured, user friendly numbering scheme. This numbering scheme must be capable of accepting cable additions so as not to disrupt the logical flow of the scheme. All testing documentation is to reference this numbering scheme.

.21 NOTE: The faceplate identification numbers/tags MUST be added to the electronic versions of the floor plans. This will be considered part of the As Built contract closeout submittals. The electronic version of the floor plan will be provided in ACAD 14 format by the consultant.

.22 The wiring closets shall be labelled C1 etc.

.23 Fibre optic cable installation procedures shall be as follows:
- .1 All cables must be properly handled and installed in accordance with the manufacturer's specification. Undue pulling tension, abrasion or rough handling must be avoided to ensure that the cables will permit transmission of the intended information with no impairment or degradation of signal quality. Cable runs between the wiring closets and must be performed with no splices or cuts to ensure the elimination of reflections, discontinuities, excess signal loss, or other undesirable problems.
- .2 All fibre cables shall be installed in conduits from end-to-end.
- .3 If, during the course of cable installation, it is necessary to bore holes through a firewall, the holes must be sealed with an acceptable sealing material of compound once the cables are in place.
- .4 All cables entering the computer room must be neatly dressed in bundles and run to the appropriate terminating location.
- .5 Cable runs shall be free of tension at both ends as well as over the length of the run.
- .6 Each cable sheath must be clearly and permanently identified at each end using an appropriate labelling scheme accepted by the Owner.

3.3 CABLE IDENTIFICATION AND LABELS

.1 To Section 27 05 53.

.2 All adhesive cable labels shall meet the legibility, defacement, and adhesion requirements specified in UL 969 (Ref. D-16). In addition the labels shall meet the general exposure requirements in UL 969 for indoor use.

.3 Cable labels shall be of self-laminating vinyl construction with a white printing area and a clear tail that self laminates the printed area when wrapped around a cable. The clear area should be of sufficient length to wrap around the cable at least one and one-half times.

.4 All labels must be mechanically printed using a laser printer. Hand written labels are not permitted.

.5 Labels are to be attached to:
- .1 front of the IDC connector or communication outlet faceplate
- .2 each patch panel jack
- .3 each end of the horizontal cable at maximum distance of 50mm from the end of the sheath

.6 Affix faceplate label printed with Workstation Identification number to faceplate cover of in-tile service box.

3.4 TESTING

.1 All UTP distribution cabling must be tested with a specialized UTP cable tester to measure the following characteristics:
- .1 DC Resistance
- .2 Characteristic Impedance
- .3 Cable Length
- .4 Pair Sequence Testing
- .5 Hardcopy checklists indicating room number and faceplate ID, should be prepared, These results should be documented and form part of the Certification Report, Any documentation supplied in hardcopy form should also be supplied in electronic format (suitable word processing file, spread sheet, graphics file (e.g. AutoCAD, etc.).
- .6 In addition to the above UTP testing, each cable and termination must be tested to 100 MBS standards.
- .7 The specific tests to be performed, after all jack plates are mounted on boxes and labelled, are as follows,
  - .1 Mutual Capacitance
  - .2 Attenuation
  - .3 Near End Cross Talk

.2 Fibre Optic Cable Testing Procedure
- .1 System acceptance tests must be performed to verify that the cable plant can be certified fully operational. All optical fibre strands must be properly measured with approved optical fibre test equipment for the following characteristics:
  - .1 End to end attenuation loss in dB as measured by a calibrated optical power meter.
  - .2 Splice loss (if any)
  - .3 Cable length
- .2 The above results are to be obtained by the following test procedures:
  - .1 Power meter and light source.
  - .2 OTDR - provide hard copy of signature trace in report.
- .3 Detailed results of these tests must be included as part of a Certification Report.
- .4 No connector should exceed 0.5 dB loss. Splices shall not exceed 0-3 dB loss. Total attenuation of link including fibre cable, connectors and splices shall not exceed 5 dB.

.3 These test results must be documented and form part of the Certification Report.

END OF SECTION

1 General

1.1 **SUMMARY**

.1 Section Includes
.1 Video Surveillance Remote Devices.

1.2 **REFERENCES**

.1 Canadian Standards Association (CSA)
.1 Complies with CSA product safety standards.

.2 HD standards
.1 Complies with the SMPTE 274M-2008 Standard in:
.1 Resolution: 1920x1080
.2 Scan: Progressive
.3 Color representation: complies with ITU-R BT.709
.4 Aspect ratio: 16:9
.5 Frame rate: 60 frames/s

.3 Complies with ICES-003 regulations.

.4 International Electrotechnical Commission (IEC)
.1 1. Complies with IEC Product Safety standards

.5 Underwriters Laboratories of Canada (ULC)
.1 Complies with ULC standards.

1.3 **SYSTEM DESCRIPTION**

.1 Section Includes
.1 Video Surveillance Remote Devices
.1 NDP-5512-Z30 PTZ dome 2MP 30x clear IP66 pendant with IR

.2 Performance Requirements
.1 The camera shall be an HD PTZ unit designed for discrete video surveillance applications in outdoor environments.
.2 The camera shall be a high performance 1/2.8-in. progressive scan CMOS sensor with 1080p resolution.
.3 The camera shall offer enhanced system flexibility with dual recording (iSCSI and microSDHC / microSDXC card) options.
.4 The camera shall support the following dual, redundant power options:
.1 Options:
.1 24 VAC
.2 PoE+ (IEEE 802.3at, class 4)
.2 The camera shall default to use power from the 24 VAC power supply, if connected.
.3 The camera shall switch to PoE+ power supply if power from the 24 VAC power supply is lost with interruption to camera operation.
.4 The camera shall switch to 24 VAC power supply if power from PoE+ power supply is lost with no interruption to camera operation.

.5 The camera shall offer a Wide Dynamic Range 120 dB for clear images in extreme high-contrast environments.
.6 The camera shall offer Essential Video Analytics.
.7 The camera shall provide direct network connection using H.265, H.264 and M-JPEG compression and bandwidth throttling to efficiently manage bandwidth and storage requirements while delivering outstanding image quality.
.8 The camera shall conform to the specifications of ONVIF Profiles S, G, T and Q to provide interoperability with other conformant systems.
.9 The camera shall offer configurable quad streaming with individually configurable HD streams.
.10 The camera shall have a minimum autofocus lens of 30x optical zoom, an a minimum 12x digital zoom.
.11 The camera shall have variable pan and tilt speeds, and autopivot capability for optimal camera control and viewing at all zoom levels.
.12 The camera shall offer bi-directional audio.
.13 The camera shall support 256 user-defined pre-positions (pre-positions).
.14 The camera shall offer IP66 environmental protection.
.15 The pendant-housing camera shall meet an IK rating of IK10.
.16 The camera housing shall be a durable, rugged design with an anti-reflective, anti-static, anti-scratch, hydrophobic, UV protective bubble.

1.4 SUBMITTALS

.1 Submit under provisions of Section [01 33 00.]

.2 Product Data:
.1 Manufacturer's data, user and installation manuals for all equipment and software programs including computer equipment and other equipment required for complete video management system.

.3 Shop Drawings; include
.1 System device locations on architectural floor plans.
.2 Full Schematic of system, including wiring information for all devices.

.4 Closeout Submittals
.1 User manual.
.2 Parts list.
.3 System device locations on architectural floor plans.
.4 Wiring and connection diagram.
.5 Maintenance requirements.

1.5 QUALITY ASSURANCE

.1 Manufacturer:
.1 Minimum of 10 years experience in manufacture and design Video Surveillance Devices.

.2 Video Surveillance System:
.1 Listed by CSA.

.2 Certified compliant to FCC and CE for the required loads. Test methods are in accordance with Industry Canada and the IEC. Provide evidence of compliance upon request.

.3 Installer:
.1 Minimum of 5 years experience installing Video Surveillance System.

1.6 **DELIVERY, STORAGE AND HANDLING**

.1 Comply with requirements of Section 01 60 00.

.2 Deliver materials in manufacture's original, unopened, undamaged containers; and unharmed original identification labels.

.3 Protect store materials from environmental and temperature conditions following manufacturer's instructions.

.4 Handle and operate products and systems according to manufacturer's instructions.

1.7 **WARRANTY**

.1 The warranty shall be a period of 3 years from the date of shipment against any proved defect in materials or workmanship.

.2 The warranty shall be for a period of one year from the date of original purchase for moving parts such as, but not limited to:
.1 Pan/Tilt drive and belts
.2 Electrical slip-ring contacts

1.8 **MAINTENANCE**

.1 Make ordering of new equipment for expansions, replacements, and spare parts available to dealers and end users.

.2 Provide factory direct technical support from 8:00 A.M. to 8:00 P.M. via phone and e-mail.

2 Products

2.1 **MANUFACTURERS**

.1 Acceptable Manufacturer:
.1 Bosch
.2 AXIS
.3 Avigilon
.4 Pelco

.2 All proposed substitutions must be approved by the Architect or Engineer professional.

.3 Proposed substitutions must provide a line-by-line compliance documentation.

2.2 BOSCH AUTODOME IP STARLIGHT 5000I IR CAMERA [NDP-5512-Z30L]

.1 General Characteristics:
- .1 The camera shall provide a 1/2.8-in. type progressive scan CMOS sensor with the following:
  - .1 1945 x 1097 (2.13 MP) effective picture elements.
  - .2 Sensitivity to below 19 mLux
  - .3 Sensitivity to 4 mLux with infrared (IR) enabled.
- .2 The camera shall offer 1080p resolution at 60fps for capturing fast motion.
- .3 The camera shall have an integrated IR illuminator for capturing clear video during night mode or scenes with no artificial illumination.
- .4 The camera shall have 4 illuminators that adjust IR power/intensity automatically according to zoom and focal length to ensure uniform illumination of scenes.
- .5 The camera shall support IR threshold, based on zoom value, where the illuminators will not be ON and functioning.
- .6 The camera shall provide direct network connection using H.265, H.264 and M-JPEG compression and bandwidth throttling to manage bandwidth and storage requirements efficiently while delivering outstanding image quality.
- .7 The camera shall utilize Intelligent Dynamic Noise Reduction (IDNR) technology to reduce the bitrate and storage requirements by removing noise artifacts.
- .8 The camera shall offer Essential Video Analytics.
- .9 The camera shall offer a dynamic range of 120 dB for clear images in extreme high-contrast environments.
- .10 The camera shall offer 256 user-defined pre-positions with 20-character titles.
- .11 The camera shall offer three configurable, pre-programmed user modes.
- .12 The camera shall offer bi-directional audio.
- .13 The camera shall be able to be mounted to a wall, mounted to a surface, or mounted to a pipe.
- .14 The camera shall offer IP66 environmental protection for pendant housing
- .15 The camera shall support the following languages:
  - .1 English
  - .2 French

.2 Imaging
- .1 The camera shall provide a 1/2.8-in. type progressive scan CMOS sensor.
- .2 The camera shall offer an effective number of pixels of 1945 x 1097 (2.13 megapixels).
- .3 The camera shall offer a 16:9 aspect ratio.
- .4 The camera shall offer a 30x optical zoom lens (4.5 to 135 mm).
- .5 The camera shall have 2.4° to 60.9° field of view.
- .6 The camera shall produce a color image with a minimum scene illumination of <19 mLux and a monochrome image, when in the night mode, with a minimum illumination of <4 mLux at 30 IRE.
- .7 The camera shall offer automatic focus control with manual override.
- .8 The camera shall offer automatic iris control with manual override.
- .9 The camera shall offer a dynamic range of 120 dB.
- .10 The camera shall offer the following White Balance modes: ATW, AWB Hold, Extended ATW, Manual, Sodium Lamp Auto, Sodium Lamp.

.11 The camera shall offer an intelligent defog image feature that assists the camera in registering a usable image through the heaviest fog.
.12 The camera shall offer a Signal-to-noise ratio (SNR) of >55 dB.
.13 The camera shall offer the following day/night modes: Mechanical switchable IR filter (Auto/On/off) and Monochrome.
.14 The camera shall offer Backlight Compensation.

.3 System Features
.1 The camera shall be compatible with the Bosch Video Client and the Bosch Video Management System (BVMS).
.2 The camera shall provide one (1) audio mono line in and one (1) audio mono line out.

.4 PTZ Features
.1 The camera shall provide the following modes for variable pan/tilt speeds:
.1 Turbo Mode (manual control):
.1 Pan: 1°/s to 240°/s
.2 Tilt: 1°/s to 120°/s
Normal Mode:
.3 Pan: 1°/s to 120°/s
.4 Tilt: 1°/s to 120°/s
.2 The camera shall provide a preposition speed of:
.1 Pan: 1°/s to 240°/s
.2 Tilt: 1°/s to 160°/s
.3 The camera shall provide a pan range of 360° continuous.
.4 The camera shall provide a tilt angle of 3° above the horizon for pendant housings.
.5 The camera shall divide the cameras 360º rotation into 16 independent sectors with 20-character titles per sector. Any or all of the 16 sectors can be blanked from the operator's view.
.6 The camera shall offer the ability to define 32 privacy masks with up to 8 masks per scene that prohibit areas of the field of view from being seen even if the camera is panned, tilted, or zoomed.
.7 The camera shall store up to 256 pre-position scenes with each pre-position programmable for 20 character titles.
.8 The camera shall support the following tour modes:
.1 One (1) pre-position tour capable of 64 sequential pre-positions and a configurable dwell time between positions.
.2 Two (2) separate tours of an operator's keyboard movements consisting of pan, tilt and zoom activities. The recorded tours can be continuously played back.
.3 One (1) 360° AutoPan mode.
.4 One (1) AutoPan mode between limits.
.9 The camera shall execute one of the following programmable options when an operator stops manual control of the camera, and a programmed period of time is allowed to expire: return to a stored pre-position number, return to the automated tour previously executed, and do nothing.

.5 Pre-programmed Modes
.1 The camera shall offer pre-programmed but configurable user modes.

.2 The pre-programmed modes shall be optimized with the best settings for the following environments:
  .1 Standard: For indoor LED lighting.
  .2 Outdoor-lighting: For scenarios where the video is captured under sunlight in the day or under LED at night.
  .3 Vibrant: For enhanced contrast, sharpness, and saturation.
.3 The camera shall allow users to customize these modes for the specific requirements of the camera site.

.6 Illuminator
  .1 The IR illuminator shall be part of the moving platform which can Pan/Tilt along with the camera head.
  .2 The IR illuminator shall be synchronized with the camera so that if IR is turned on manually, the camera shall switch to B/W mode.
  .3 The IR illuminator shall have variable illumination so that IR light is distributed evenly in the field of view to avoid dark spots or over-illuminated scenes.
  .4 The IR illuminator shall be capable of being configured on a per-zone basis to ensure a single dominant illumination source in a specific scene.
  .5 The IR illuminator shall comply to IEC-62471 (Eye Safety for IR LEDs).

.7 HD Characteristics
  .1 The camera shall support H.265, H.264 video compression.
  .2 The camera shall generate HD 1080p resolution using H.265/HEVC or H.264 compression.
  .3 The camera shall generate multiple simultaneous configurable HD video streams.
  .4 The camera shall allow simultaneous streaming of individual HD streams, and allow a choice of HD resolution in combination with SD resolutions.

.8 IP Connectivity
  .1 The camera shall allow full camera control and configuration capabilities via a TCP/IP network.
  .2 The camera shall be capable of capturing and storing images using H.265 or H.264 compression at 1080p resolution.
  .3 The camera shall deliver 1080p video, at rates up to 60 images per second via TCP/IP over Cat5/Cat6 UTP cable.
  .4 The camera shall support iSCSI devices to allow the network-enabled camera to stream video directly to an iSCSI RAID array.
  .5 The camera shall conform to the specifications of ONVIF Profiles S, G, and T.
  .6 The camera shall offer Quality of Service (QoS) configuration options.
  .7 The camera shall support the IPv4 and IPv6 internet-layer protocol for packet switched internetworking across multiple IP networks.

.9 Motion Detection
  .1 The camera shall include an algorithm for detecting movement on pre-positions or for alarm signaling.

.10 Access Security
  .1 The camera shall offer password protection.

.2 The camera shall support 802.1x authentication using a RADIUS (Remote Authentication Dial In User Service) server.
.3 The camera shall store a SSL certificate for use with HTTPS.
.4 The camera shall be capable of being independently AES encrypted with 128-bit keys.

.11 Installation Requirements
.1 The camera shall be capable of operating in an outdoor environment within the following temperature range:
.1 -40 °C to +60 °C (-40 °F to +140 °F)
.2 The camera shall accept power, transmit video, and accept control via TCP/IP connection.
.3 The camera shall support the following dual, redundant power options:
.1 Options:
.1 24 VAC
.2 PoE+ (IEEE 802.3at, class 4)
.2 The camera shall default to use power from the 24 VAC power supply, if connected.
.3 The camera shall switch to PoE+ power supply if power from the 24 VAC power supply is lost with interruption to camera operation.
.4 The camera shall switch to 24 VAC power supply if power from PoE+ power supply is lost with no interruption to camera operation.
.4 The camera shall provide a multi-language on-screen display.

.12 Housing Specifications and Options
.1 The camera shall be offered in an outdoor pendant aluminum housing.
.2 The camera shall provide built-in surge protection for power, data, and video and alarm inputs.
.3 The camera dome bubble shall be anti-reflective, anti-static, anti-scratch, hydrophobic, UV protective.
.4 The outdoor pendant housing shall:
.1 Use a hook, in place of a tether, to make installation easier and safer.
.2 Allow the camera to view 0º above the horizon.
.3 Conform to the IP66 standard.
.4 Provide an operating temperature of -40 °C to +60 °C (-40 °F to +140 °F).
.5 Be powder coated in white (RAL 9003).
.6 Include a sunshield of outdoor grade plastic.

.13 Mechanical
.1 Pan Range: 0 to 360° continuous
.2 Tilt Angle: -90° to 3°
.3 Pre-position Speed:
.1 Pan: 240°/s
.2 Tilt: 160°/s
.4 Pan/Tilt Modes:
.1 Turbo Mode:
.1 Pan: 1°/s to 240°/s
.2 Tilt: 1°/s to 120°/s
.2 Normal Mode:
.1 Pan: 1°/s to 120°/s
.2 Tilt: 1°/s to 120°/s

.3 Pre-position Accuracy: ± 0.1° typical

.14 Electrical
- .1 Input Voltage:
  - .1 24 VAC, 50/60 Hz (class 2)
  - .2 PoE+ (IEEE 802.3at, class 4)]
- .2 Power Consumption (typical):
  - .1 23 W (IR off)
  - .2 25 W (IR on)

.15 Software Control
- .1 Camera Setup/Control: Via Internet Explorer/Google Chrome/Mozilla Firefox/Safari Web browser.
- .2 Software Update: Network firmware upload

.16 Network
- .1 Communications Protocols: Standard Bosch IP protocol, including ONVIF and SNMP v1
- .2 Video Compression: H.265, H.264 (ISO/IEC 14496-10), M-JPEG, JPEG
- .3 Streaming: Two (2) individually configurable streams:
  - .1 Stream 1
    - .1 720P
    - .2 1080P
  - .2 Options with “720P” selected for Stream 1:
    - .1 SD
    - .2 720P
    - .3 D1 4:3 (cropped)
    - .4 640x480
  - .3 Options with “1080P” selected for Stream 1:
    - .1 SD
    - .2 720P
    - .3 1080P* (This option is valid only if the frame option is 30fps)
    - .4 D1 4:3 (cropped)
    - .5 640x480
    - .6 1280x960 (cropped)
- .4 Protocols: IPv4, IPv6, UDP, TCP, HTTP, HTTPS, RTP/RTCP, IGMP V2/V3, ICMP, ICMPv6, RTSP, FTP, ARP, DHCP, APIPA (Auto-IP, link local address), NTP (SNTP), SNMP (v1, v3, MIB-II), 802.1x, DNS, DNSv6, DDNS (DynDNS.org, selftHOST.de, no-ip.com), SMTP, iSCSI, UPnP (SSDP), DiffServ (QoS), LLDP, SOAP, Dropbox, CHAP, digest authentication, Stratocast Genetec
- .5 Ethernet: 10-Base T/100 Base-TX, auto-sensing, half/full duplex, RJ45
- .6 Encryption: TLS 1.0, SSL, DES, 3DES, AES
- .7 GOP Structure: IP, IBP, IBBP
- .8 Data Rate: 9.6 kbps to 6 Mbps (per stream)
- .9 Overall IP Delay: 200 ms (60fps)
- .10 Audio
  - .1 Standard:
    - .1 G.711, 8 kHz sampling rate
    - .2 L16, 16 kHz sampling rate
    - .3 AAC, 16 kHz sampling rate

.2 Signal-to-Noise Ratio: >50 dB
.3 Audio Streaming: Bidirectional (full-duplex)
.11 Local Storage
.1 Memory Card Slot: microSDHC or microSDXC memory card (maximum 2 TB)
.2 Recording: Continuous recording of video and audio, alarm/events/schedule recording
.12 Miscellaneous
.1 Sectors/Titling: 16 independent sectors with 20-character titles/sector
.2 Masking: 32, individually configurable
.3 Pre-positions: 256, each with 20-character titles
.4 Guard Tours: Two (2) types of tours:
.1 Recorded tours – two (2), total duration of 15 minutes
.2 Pre-position tour – one (1), consisting of up to 256 scenes consecutively, and one (1), customized up to 64 scenes
.5 Supported Languages: Chinese, Dutch, English, German, French, Italian, Japanese, Portuguese, Polish, Russian, and Spanish
.13 User Connections:
.1 Power
.1 RJ-45 100 Base-TX Ethernet PoE+ (IEEE 802.3at, class 4 standard)
.2 24 VAC, 50/60 Hz
.2 Video and Control: RJ-45 10/100 Base-TX Ethernet
.3 Alarm Inputs (2): 2 supervised / non-supervised; programmable for “normally open” or “normally closed”
.4 Alarm Outputs (1): 1 dry contact relay
.5 Audio:
.1 Signal Line In: 94 kOhm typical, 1 Vrms max.
.2 Signal Line Out: 1 kOhm typical, 1 Vrms max.
.14 Environmental
.1 Ingress Protection Rating/Standard: IP66
.2 Operating Temperature:
.1 -40 °C to +60 °C (-40 °F to +140 °F)
.3 Storage Temperature:
.1 -40 °C to +60 °C (-40 °F to +140 °F)
.4 Humidity:
.1 Up to 90% RH non-condensing
.15 Construction
.1 Product Weight: 4.6 kg (10.14 lb)
.2 Construction Material:
.1 Housing: Aluminum
.2 Sunshield: Outdoor grade plastic
.3 Standard Color: White (RAL 9003)

2.3 ACCESSORIES

.1 Mounts
.1 NDA-U-WMT Pendant wall mount, white
.2 NDA-U-PMT Pendant pipe mount ,31 cm (12 in.), white
.3 NDA-U-PMTE Pendant pipe extension pipe, 50 cm (20 in.), white
.4 NDA-U-CMT Corner mount adapter, white

.5 NDA-U-PMAL Pole mount adapter large, white
.6 NDA-U-WMP Wall mount plate for universal wall mount, corner mount and pole mount, white
.7 NDA-U-RMT Pendant parapet mount

.2 Power Supplies
.1 UPA-2450-60 Power Supply, 120 V, 60 Hz, white
.2 High PoE Midspan, 60 W
.3 NDA-U-PA0 24 VAC Power Supply Box
.4 NDA-U-PA1 110 VAC Power Supply Box
.5 NDA-U-PA2 230 VAC Power Supply Box

3 Execution

3.1 **EXAMINATION**

.1 Examine areas to receive devices and notify adverse conditions affecting installation or subsequent operation.

.2 Do not begin installation until unacceptable conditions are corrected.

3.2 **PREPARATION**

.1 Protect devices from damage during construction.

3.3 **INSTALLATION**

.1 Install devices in accordance with manufacturer's instruction at locations indicated on the floor drawings plans.

.2 Perform installation with qualified service personnel.

.3 Install devices in accordance with the National Electrical Code or applicable local codes.

.4 Ensure selected location is secure and offers protection from accidental damage.

.5 Location must provide reasonable temperature and humidity conditions, free from sources of electrical and electromagnetic interference.

3.4 **FIELD QUALITY CONTROL**

.1 Test snugness of mounting screws of all installed equipment.

.2 Test proper operation of all video system devices.

.3 Determine and report all problems to the manufacturer's customer service department.

3.5 **ADJUSTING**

.1 Make proper adjustment to video system devices for correct operation in accordance with manufacturer's instructions.

.2 Make any adjustment of camera settings to comply with specific customer's need.

3.6 **DEMONSTRATION**

.1 Demonstrate at final inspection that video management system and devices functions properly.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for earthwork work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM D698, Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort.

.2 ASTM D4253, Test Method for Maximum Index Density and Unit Weight of Soil Using a Vibratory Table.

.3 OPSS, Ontario Provincial Standard Specification.

1.3 **SUBMITTALS**

.1 Reports:
.1 Submit written laboratory test reports.
.2 Submit written field inspection and test report results after each inspection.

.2 Submit dewatering methods 30 days in advance for review by Consultant. If well point system is required, Engineer shall design system and supervise installation.

.3 Submit to Consultant details of locations where surplus soils and other materials are to be disposed of or reused. Include each disposal/reuse Site and type of surplus soil or other material, location of the disposal/reuse Site, operator's name and business address, type of license under which Site operates, and criteria used by Site to access suitability of surplus material for disposal.

.4 Submit to Consultant, within 48 hours of a load of surplus soil or other material leaving the Site, a daily register recording the time and place of disposal/reuse of each load signed by a representative of the disposal site. Such documentation must be submitted before payment for excavation will be made.

1.4 **QUALITY ASSURANCE**

.1 Have shop drawings signed and sealed by a Professional Engineer licensed in Province of Ontario and having experience in design and inspection of shoring, bracing, underpinning and dewatering (if required) required to complete Work.

1.5 **SITE CONDITIONS**

.1 Geotechnical conditions: For information on subsurface conditions refer to document appended to Section 02 32 00.

.2 Cultural heritage resources: If Cultural Heritage Resources (such as archaeological sites, artifacts, building and structural remains, and/or human burials) are encountered during performance of Work, contact Consultant immediately and suspend Work in immediate area until assessment has been completed by Ministry of Culture, Tourism and Recreation. Perform required measures to mitigate negative impacts on found resources to acceptance of Consultant.

1.6 **PROTECTION**

.1 Existing buried utilities and structures:
- .1 Size, depth and location of known existing utilities and structures are indicated for guidance only. Completeness and accuracy is not guaranteed.
- .2 Prior to commencing any excavation Work, have authorities stake out utility locations to prevent disturbance during Work.
- .3 Confirm locations of buried utilities by careful test excavations. Hand dig test excavations as necessary.
- .4 Maintain and protect from damage, water, sewer, gas, electric, telephone and other utilities and structures encountered. Obtain permission of Consultant before moving or otherwise disturbing utilities or structures.

.2 Existing buildings and surface features:
- .1 Conduct with Consultant, a condition survey of existing buildings, trees and other plants, lawns, fencing, service poles, wires, tracks and paving, survey bench marks and monuments which may be affected by Work.
- .2 Protect existing buildings and surface features which may be affected by Work from damage while Work is in progress and repair damage resulting from Work.
- .3 Where excavation necessitates root or branch cutting, perform Work in accordance with Authorities having Jurisdiction.
- .4 Confirm with Consultant, condition Survey of buildings and structures undertaken by Consultant.

.3 Temporarily cover local existing catch basins and maintenance holes to prevent entry of earth or debris. Ensure adequate surface drainage in affected area is maintained.

.4 Protect Work or work of other Contracts in progress or completed and protect existing properties, stored Products, services, utilities, trees, landscaping and natural features from damage.

.5 Protect excavations against flooding and damage and install and maintain appropriate warning devices during construction and during time when Work is closed down for any cause.

.6 Protect bottom of excavations that will support foundations, slabs, pavements etc. from frost or freezing.

.7 Keep access roads clear of debris and dirt resulting from Work of this Section to acceptance of Authorities having jurisdiction.

.8 Shoring, bracing and underpinning: Comply with local regulations, authorities having jurisdictions and requirements specified.

2 Products

2.1 **MATERIALS**

.1 Select fill: Subject to approval of Consultant consisting of reusable fill excavated from Site or imported fill that is free of organic matter, rubble and material other than soil. Maximum particle size of half thickness of lift specified, moisture content at time of placing 2% maximum over its optimum moisture content and is either non plastic or has a plasticity index of 25% maximum.

.2 Granular A fill: Imported Granular A fill, free of organic matter and, in accordance with OPSS 1010.

.3 Granular B Fill: Imported Granular B fill free of organic matter and in accordance with OPSS 1010.

.4 Sand fill:

.1 Sand fill, natural, coarse sand having clean, hard, strong, grains free from lumps, soft or flaking particles, shale, clay, organic matter and other deleterious substances, from approved source.

.2 Gradation requirements:

Sieve Size	% By Passing Weight
4.75 mm	100
2.36 mm	95 - 100
1.18 mm	60 - 100
0.60 mm	35 - 80
0.30 mm	15 - 50
0.15 mm	2 - 15
0.075 mm	0 - 5

.5 Clear stone fill: 19 mm clear stone in accordance with OPSS 1004, free of organic material.

.6 Unshrinkable fill: 0.7 MPa cement stabilized backfill conforming to requirements of CAN/CSA A23.1/A23.2-M.

3 Execution

3.1 **EXAMINATION**

.1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of Work means acceptance of existing conditions.

3.2 LINES AND ELEVATIONS

.1 Establish lines and elevations from Control Points shown on Contract Drawings.

.2 Have lines and elevations established by Registered Ontario Land Surveyor or qualified Civil Engineer registered in Province of Ontario.

.3 Protect and maintain Control Points and Bench Marks as long as they are required.

3.3 STRIPPING

.1 Do not handle topsoil while in wet or frozen condition or in manner in which soil composition is adversely affected.

.2 Strip topsoil from working area in locations shown.

.3 Strip topsoil to depths indicated. Avoid mixing topsoil with subsoil.

.4 Stockpile topsoil in locations directed by Consultant. Stockpile to height not exceeding 2 m. Remove excess topsoil from Site, unless otherwise approved by the Owner.

3.4 REMOVAL OF WATER

.1 Obtain letter of conditional approval from Authorities having Jurisdiction to dispose of ground water into sewer drainage system. Apply for and pay for water disposal permit.

.2 Keep excavations and trenches free of water throughout construction period.

.3 Groundwater removal:

- .1 Lower groundwater level and maintain at depth below lowest point of excavation to ensure a dry stable surface.
- .2 Dewater to prevent loss of soil and maintain stability of sides and bottom of excavation and of adjacent structures.
- .3 Dispose of water in conformance with applicable by-laws and in a manner not detrimental to public and private property, or portion of Work completed or under construction.
- .4 Supply and install flocculation tanks, settling basins, or other treatment facilities to remove suspended solids or other materials before discharging to sewers, water courses or drainage areas in accordance with authorities having jurisdiction. Perform testing on settlement tank discharge to confirm that effluent meets sewer bylaw requirements. Locate tanks to acceptable area determined by Consultant.
- .5 Should method of dewatering fail to achieve conditions specified above, Consultant reserves right to revise methods and procedures at no cost to Owner.

.4 Surface water removal:
- .1 Remove surface run-off in a manner that will prevent loss of soil and maintain stability of sides and bottom of excavation. Obtain Consultant's approval of dewatering method to be used.
- .2 Discharge surface water into existing storm drainage system to acceptance of Consultant and local authorities.

.5 Do not obstruct flow of surface drainage or natural water courses.

3.5 **EXCAVATION**

.1 Remove concrete, masonry, paving, demolished foundations and rubble and other obstructions encountered during excavation Work.

.2 Do not disturb soil within drip line of trees or shrubs that are to remain. If excavating through roots, excavate by hand and cut roots with sharp axe or saw in a manner acceptable to authorities having jurisdiction.

.3 Excavate to required lines and grades shown on Contract Drawings with allowance for subsequent Work including shoring, bracing and formwork. Make excavation clean and clear of loose material and true to size.

.4 Protect stockpiles of fill against contamination and moisture absorption.

.5 Do not undermine adjacent structures. Where it is necessary to have footings at different levels, found upper footing below imaginary 10-horizontal-to-7 vertical line, or as otherwise indicated, drawn up from base of lower footing. Protect adjacent foundations from frost.

.6 Have excavations in excess of 1200 mm in depth conform to requirements of Occupational Health and Safety Act, and Regulations for Construction Projects.

.7 Do not expose shale at subgrade elevation to drying cycles and in any case, following inspection, cover with minimum 50 mm of lean concrete within 4 hours after exposure.

.8 Fill excavations for foundations which are, through error, carried below elevation shown or approved depth, with 15 MPa concrete, or as directed by Consultant.

.9 Trim, and remove loose material, debris and organic material from excavations. Where material at bottom of excavation is disturbed, remove disturbed material and re-compact to density equal to or better than undisturbed soil or backfill with lean concrete as directed by Consultant.

.10 When excavations are complete, prior to commencement of subsequent Work, request Consultant for inspection of excavation Work.

3.6 TRENCHING

.1 Excavate trenches to lines and grades indicated and to a depth of 75 mm minimum below invert elevation and slope established for pipe, and backfill to invert elevation of pipe with specified granular material.

.2 Unless otherwise authorized by Consultant, do not excavate more than 30 m of trench in advance of installation operations and do not leave open more than 15 m at end of day's operation. Remove unsuitable material from trench bottom to extent and depth as directed by Consultant.

.3 Backfill over-excavation with granular material and compact.

.4 If unstable soil conditions are encountered, excavate trenches to depth directed by Consultant and backfill to correct elevation with backfill material.

.5 Remove loose material from bottom of trenches to ensure granular material is placed against undisturbed soil.

.6 Compact bedding and grade as required for even and uniform support on each length of pipe.

.7 Where excavating is required adjacent to and parallel with and below any footing, submit excavation and backfill procedures to Consultant for review prior to start of excavating.

.8 Keep width of trenches to a minimum to ensure minimum span for pipe to be supported.

.9 Make excavations around existing fire hydrant to remain. Hand place stone and tamp around and below existing hydrant elbow to ensure proper drainage of hydrant.

3.7 EXCAVATED MATERIAL DISPOSAL

.1 Except for material to be used as select fill, immediately remove and dispose of excavated material from Site.

.2 Remove and dispose of construction rubble, abandoned gas, water and sewer pipes, valves, valve boxes and fittings, maintenance holes, frames and covers and other material which may be encountered during excavation but not indicated on Contract Drawings.

3.8 BACKFILLING

.1 Do not proceed with backfilling operations until walls, slabs, waterproofing and below grade Work has been inspected and accepted by Consultant.

.2 Backfill areas which are free from debris, snow, ice, water and frozen ground.

.3 Do not use backfill material which is frozen or contains ice, snow or debris.

.4 Do not backfill on or against any membrane or protection board covered waterproofing with jagged rock or other sharp objects which might damage waterproofing.

.5 Limit vertical drop of backfill material to 2000 mm.

.6 To avoid pockets and voids, remove sheathing and shoring materials that require removal, as backfilling progresses.

.7 Prior to backfilling or placing concrete on exposed soil subgrade, proof roll subgrade to identify soft or loose areas. Proceed with placing backfill or concrete only after inconsistencies identified by above procedure have been reworked and compacted or excavated, backfilled and compacted as required to eliminate such conditions to acceptance of Consultant.

.8 Place backfill material, grade and compact to levels shown on Contract Drawings.

.9 Place backfill materials in uniform layers 200 mm maximum loose thickness unless specified otherwise.

.10 Ensure each layer is compacted, and accepted by Consultant, before placing succeeding layers.

.11 Unless otherwise indicated, use specified granular material from bottom of trench to 300 mm above top of pipe or 150 mm above top of electrical conduits. Hand place in 150 mm layers and compact carefully to ensure proper backfilling and compaction around bottom quadrants and sides of pipe.

.12 For backfill from 300 mm above top of pipe or 150 mm above electrical conduits to sub-grade level, use select fill unless otherwise noted. Compact either by hand or by machine.

.13 Do not backfill trenches until piping, conduits and cables therein have been inspected, tested, and approved by inspection authorities having jurisdiction and Consultant.

.14 Prior to backfilling of trenches, remove wood block or wedges used to prevent movement of piping during tests.

.15 Where there is a common boundary between select fill and granular fill or unshrinkable fill, place select fill after granular fill has been compacted. Place and compact fill around free standing structures evenly on all sides of structure simultaneously in layers sloping away from structure.

.16 During backfilling, take care to avoid displacing or damaging Utilities Work and Services.

.17 Notify Consultant prior to commencement of backfilling and compacting operations.

3.9 **COMPACTION**

.1 Compaction densities for select fill, granular and sand fill materials will be determined by ASTM D698. Compaction densities for clear stone will be determined by ASTM D4253.

.2 Add water if necessary to obtain required densities. Correct irregularities or depressions that may develop during compaction by removing or adding material to form a smooth and uniform surface.

.3 Shape and roll alternately to obtain smooth, even and uniformly compacted base.

.4 If material is excessively moist, aerate by scarifying with suitable equipment until moisture content is corrected.

.5 In areas not accessible to rolling equipment, compact to specified density with mechanical tampers acceptable to Consultant.

.6 Compact backfill materials in accordance with Geotechnical Report providing the following as a minimum:
.1 Imported fill: 98% standard Proctor maximum dry density (SPMDD).
.2 Under slabs, walks and pavements: 100% (SPMDD).
.3 All other areas: 95% (SPMDD).

3.10 **GRADING**

.1 Prior to placing fill over existing ground, scarify surface to depth of 150 mm. Maintain fill and existing surface at approximately same moisture content to facilitate bonding.

.2 Place material only on clean unfrozen surface, properly shaped and compacted and free from snow and ice. Ensure no frozen material is used in placing.

.3 Grade as necessary to bring Work areas to required elevations. Supply additional material required to obtain new grade levels. Place and compact as specified.

.4 Grade drainage ditches to elevations indicated on Contract Drawings.

.5 Maintain positive drainage.

.6 Grade materials using methods which do not lead to segregation or degradation of aggregate.

.7 Shape each layer to smooth contour and compact to specified density before succeeding layer is placed.

.8 Remove and replace that portion of layer in which material becomes segregated during spreading.

.9 Slope grade away from buildings 1:50 minimum.

.10 Make graded areas smooth to profile, free of debris, with local excavations and depressions filled and compacted.

.11 Do not disturb soil within branch spread of trees and shrubs remaining.

.12 Cultivate entire area which is to receive topsoil to a depth of 100 mm. Repeat cultivation in those areas where equipment used for hauling and spreading has compacted soil.

.13 Remove surface debris, roots, vegetation, branches and stones in excess of 50 mm in diameter.

3.11 FINISH GRADING

.1 Fine grade and loosen topsoil. Eliminate rough spots and low areas to ensure positive drainage. Prepare loose friable bed by means of cultivation and subsequent raking.

.2 Roll to consolidate topsoil for areas to be seeded or sodded leaving surface smooth, uniform, firm against deep foot printing, and with fine loose texture to approval of Consultant.

3.12 UNSHRINKABLE FILL

.1 Place unshrinkable fill in locations indicated on Contract Drawings or where Work area is too limited to permit proper placing and compaction. Obtain Consultants approval prior to placing unshrinkable fill. Place in accordance with supplier's written instructions.

.2 If embedded items occur in area being backfilled, coordinate with appropriate trades to ensure that disturbance of embedded items during backfilling is prevented.

3.13 RESTORATION

.1 Upon completion of Work, remove surplus materials and debris, trim slopes, and correct defects as directed by Consultant.

.2 Replace topsoil and reinstate existing pavement, sidewalk and landscaped areas to elevation and condition which existed before excavation.

.3 Clean and reinstate areas affected to acceptance of Consultant.

END OF SECTION

1. General

1.1. **GENERAL REQUIREMENTS**

1. Conform to the requirements stated in the General Conditions, Supplementary General Conditions of this Specification and all addenda for all work, including work outside the property line including work within Regional and Municipal right of way unless otherwise noted.

1.2. **RELATED WORK**

1.	Site Grading	Section 31 23 13
2.	Excavation, Trenching and Backfilling	Section 31 23 10
3.	Granular Base	Section 32 11 23
4.	Granular Sub-Base	Section 32 11 19
5.	Asphalt Paving	Section 32 12 16

1.3. **REFERENCES**

1. ASTM D4791-10, Test Method for Flat or Elongated Particles in Coarse Aggregate.
2. Ontario Provincial Standard Specification 1001.

1.4. **SAMPLES**

1. Submit samples in accordance with Section 01 33 00.
2. Allow continual sampling by Consultant during production.
3. Provide Consultant with access to source and processed material for sampling.
4. Install sampling facilities at discharge end of production conveyor, to allow Consultant to obtain representative samples of items being produced. Stop conveyor belt when requested by Consultant to permit full cross section sampling.

2. Products

2.1. **MATERIALS**

1. Aggregate quality: sound, hard, durable material free from soft, thin, elongated or

laminated particles, organic material, clay lumps or minerals, or other substances that would act in deleterious manner for use intended.

2. Flat and elongated particles of coarse aggregate: to ASTM D4791.
    1. Greatest dimension to exceed five times least dimension.
3. Fine aggregates satisfying requirements of applicable section to be one, or blend of following.
    1. Natural sand.
    2. Manufactured sand.
    3. Screenings produced in crushing of quarried rock, boulders or gravel.
4. Coarse aggregates satisfying requirements of applicable section to be one of or blend of the following:
    1. Crushed rock.
    2. Gravel and crushed gravel composed of naturally formed particles of stone.

2.2. SOURCE QUALITY CONTROL

1. Inform Consultant of proposed source of aggregates and provide access for sampling at least four weeks prior to commencing production.
2. If, in opinion of Consultant, materials from proposed source do not meet, or cannot reasonably be processed to meet, specified requirements, locate an alternative source or demonstrate that material from source in question can be processed to meet specified requirements.
3. Advise Consultant four weeks in advance of proposed change of material source.
4. Acceptance of material at source does not preclude future rejection if it fails to conform to requirements specified, lacks uniformity, or if its field performance is found to be unsatisfactory.

3. Execution

3.1. PREPARATION

1. Aggregate source preparation
    1. Prior to excavating materials for aggregate production, clear and grub area to be worked, and strip unsuitable surface materials. Dispose of cleared, grubbed and unsuitable materials as directed by Consultant.
    2. Where clearing is required, leave screen of trees between cleared area and roadways as directed.
    3. Clear, grub and strip area ahead of quarrying or excavating operation sufficient to prevent contamination of aggregate by deleterious materials.

4. When excavation is completed, dress sides of excavation to nominal 1.5:1 slope and provide drains or ditches as required to prevent surface standing water.
5. Trim and dress slopes and leave site in neat condition.

2. Processing
   1. Process aggregate uniformly using methods that prevent contamination, segregation and degradation.
   2. Blend aggregates, if required, to obtain gradation requirements, percentage of crushed particles, or particle shapes, as specified. Use methods and equipment approved by Consultant.
   3. Wash aggregates to meet specifications. Use only approved equipment.
   4. When operating in stratified deposits use excavation equipment and methods that produce uniform, homogeneous aggregate.
3. Handling
   1. Handle aggregates to avoid segregation, contamination and degradation.
4. Stockpiling
   1. Stockpile aggregates on site in locations as indicated unless directed otherwise by Consultant. Do not stockpile on completed surfaces.
   2. Stockpile aggregates in sufficient quantities to meet project schedules.
   3. Stockpiling sites to be level, well drained, and of adequate bearing capacity and stability to support materials and handling equipment.
   4. Except where stockpiled on acceptably stabilized areas, provide compacted sand base not less than 300 mm in depth to prevent contamination of aggregate. Stockpile aggregates on ground but do not incorporate bottom 300 mm of pile into work.
   5. Separate different aggregates by strong, full depth bulkheads, or stockpile far enough apart to prevent intermixing.
   6. Do not use intermixed or contaminated materials. Remove and dispose of rejected materials as directed by Consultant within 48 h of rejection.
   7. Stockpile materials in uniform layers of thickness as follows:
      1. Max. 1.5 m for coarse aggregate and base course materials.
      2. Max. 1.5 m for fine aggregate and sub-base materials.
      3. Max. 1.5 m for other materials.
   8. Uniformly spot-dump aggregates delivered to stockpile in trucks and build up stockpile as specified.
   9. Do not cone piles or spill material over edges of piles.
   10. Do not use conveying stackers.
   11. During winter operations, prevent ice and snow from becoming mixed into stockpile or in material being removed from stockpile.

3.2. CLEANING

1. Leave aggregate stockpile site in tidy, well drained conditions, free of standing surface water.
2. Leave any unused aggregates in neat stockpiles as directed by Consultant.

END OF SECTION

1. General

1.1. **GENERAL REQUIREMENTS**

1. Conform to the requirements stated in the General Conditions, Supplementary General Conditions of this Specification and all addenda for all work, including work outside the property line including work within Regional and Municipal right of way unless otherwise noted.

1.2. **RELATED WORK**

1.	Site Grading	Section 31 23 13
2.	Water System	Section 33 11 17
3.	Storm Sewers	Section 33 44 00
4.	Aggregates: General	Section 31 05 17

1.3. **DEFINITIONS**

1. Common excavation: excavation of materials of whatever nature, including dense tills, hardpan, frozen materials and partially cemented materials which can be ripped and excavated with heavy hydraulic excavating equipment.
2. Topsoil: material capable of supporting good vegetative growth and suitable for use in top dressing, landscaping and seeding.
3. Waste material: excavated material unsuitable for use in work or surplus to requirements.
4. Borrow material: Sub-soil material obtained from locations outside area to be graded, and required for construction of fill areas or for other portions of work. This material shall be of residential/agricultural origin and shall meet or exceed the confined fill material criteria as per MOE “Fill Quality Guidelines for Lake Filling in Ontario” of June 1992. Contractor shall provide consultant with one chemical test per source prior to hauling material to the site.
5. Unsuitable materials:
    1. Weak and compressible materials under excavated areas.
    2. Frost susceptible materials under excavated areas.
    3. Frost susceptible materials:
        1. Fine grained soils with plasticity index less than 10 when tested to ASTM D4318, and gradation within limits specified when tested to ASTM D422 and ASTM C136: Sieve sizes to CAN/CGSB-8.1

2. Coarse grained soils containing more than 20% by mass passing 0.075 mm sieve.

6. Un-shrinkable fill: very weak mixture of Portland cement, concrete aggregates and water that resists settlement when placed in utility trenches, and capable of being readily excavated.

1.4. SAMPLES

1. Submit samples of bedding or other granular backfill materials in accordance with Section 01 33 00.
2. Inform Consultant prior to commencing work, of proposed source of fill materials and provide access for sampling.

1.5. PROTECTION OF EXISTING FEATURES

1. Existing buried utilities and structures:
    1. Size, depth and location of existing utilities and structures as indicated are for guidance only. Completeness and accuracy are not guaranteed.
    2. Prior to commencing excavation work, notify Consultant or authorities having jurisdiction, establish location and state of use of buried utilities and structures. Consultant or authorities having jurisdiction shall clearly mark such locations to prevent disturbance during work.
    3. Confirm locations of buried utilities by careful test excavations.
    4. Maintain and protect from damage, water, sewer, gas, electric, telephone and other utilities and structures encountered. Obtain direction of Consultant before moving or otherwise disturbing utilities or structures.
    5. Record location of maintained, re-routed and abandoned underground lines.

2. Products

2.1. MATERIALS

1. Granular Base: to Section 32 11 23.
2. Granular Sub-Base: to Section 32 11 19.
3. Fill concrete: to Section 03 30 00 and following requirements:
    1. Minimum compressive strength at 28 days: 15 MPa.
    2. Maximum slump at time and point of discharge: 100 mm.
4. Unshrinkable fill: to the following requirements.
    1. Maximum compression strength at 28 days: 0.4 MPa.

2. Maximum cement content: 25 kg/m3 of concrete mix.
3. Slump at time and point of discharge: 150 to 200 mm.
4. Air content: 4 to 6%

5. Sewer pipe embedment shall be in accordance with OPSD 802.010. Bedding for watermains shall be in accordance with T-708.04.
6. Granular Backfill: Imported granular material conforming to a Granular 'B' Type I, as specified in OPSS 1010, or approved reclaimed granular materials free of organics.
7. Borrow material: See Part 1 – General, Definitions.

3. Execution

3.1. All trenching, backfilling and compacting is to be completed in accordance with OPSS 514.

3.2. **SITE PREPARATION**

1. Remove obstructions, ice and snow, from surfaces to be excavated within limits indicated.
2. Cut pavement or sidewalk neatly along limits of proposed excavation in order that surface may break evenly and cleanly.

3.3. **STOCKPILING**

1. Stockpile fill materials in areas designated by Consultant. Stockpile granular materials in manner to prevent segregation.
2. Protect fill materials from contamination.

3.4. **DEWATERING**

1. Keep excavations free of water while work is in progress.
2. Protect open excavations against flooding and damage due to surface run-off.
3. Dispose of water in a manner not detrimental to public and private property, or any portion of work completed or under construction.
4. Continuously dewater the excavations to control surface runoff or perched water table seepage for concreting and other work to be carried out in the dry condition.
5. Submit for Consultant's review details of proposed dewatering methods, such as dikes or well points.

3.5. TRENCH EXCAVATION

1. Excavate to lines, grades, locations, elevations and dimensions as indicated or directed by Consultant.
2. Remove excavated material and other obstructions encountered during excavation. Excavated trench material may be used as fill material on-site provided it is free from deleterious materials,
3. Excavation must not interfere with normal 45o splay of bearing from bottom of any footing.
4. Do not disturb soil within branch spread of trees or shrubs that are to remain. If excavating through roots, excavate by hand and cut roots with sharp axe or saw.
5. Unless otherwise authorized by Consultant in writing, do not excavate more than 30 m of trench in advance of installation operations and do not leave open more than 15 m at end of day's operation.
6. Do not obstruct flow of surface drainage or natural watercourses.
7. Earth bottoms of excavations to be undisturbed soil, level, free from loose, soft or organic matter.
8. Notify Consultant when bottom of trench excavation is reached.
9. Obtain Consultant approval of completed excavation.
10. Remove unsuitable material from trench bottom to extent and depth as directed by Consultant.
11. Correct unauthorized over-excavation as follows:
    1. Fill under bearing surfaces and footings with concrete specified for footings.
    2. Fill under other areas with Granular 'B' material specified in Section 32 11 19.
12. Hand trim, make firm and remove loose material and debris from excavations. Where material at bottom of excavation is disturbed, compact foundation soil to density at least equal to undisturbed soil. Clean out rock seams and fill with concrete mortar or grout to approval of Consultant.

3.6. SURPLUS EXCAVATED MATERIAL AND REMOVALS

1. The Contractor is to make his own arrangements for the disposal of all excavated materials, removals, grindings and all other debris not suitable for re-use in the construction. If the Contractor enters into an agreement with an individual for the use of land for the disposal of excavated materials or for any other reason, a copy of the said Agreement clearly stating the obligation of all concerned and signed by all parties shall be submitted to the Consultant. The Contractor shall comply with the requirements of all Federal, Provincial and Municipal Laws, Acts, Ordinances, Regulations, Orders-in-Council and By-Laws, which could in any way pertain to the work outlined in the Contract. The items in the Form of Tender include all costs for disposal of unsuitable or excess material off the site and the Contractor shall make

the arrangements for the disposal of the materials removed in accordance with MOE Reg. 558.

3.7. BEDDING AND SURROUND OF UNDERGROUND SERVICES

1. Place and compact granular material for bedding and surround of underground services as indicated and as specified.
2. Place bedding and surround material in unfrozen condition.

3.8. BACKFILLING

1. Do not proceed with backfilling operations until Consultant has inspected and approved installation.
2. Areas to be backfilled to be free from debris, snow, ice, water and frozen ground.
3. Trench backfill is to consist of Granular B Type I as specified in OPSS 1010 or reclaimed granular materials free of organics.
4. Place backfill material in uniform layers not exceeding 150 mm compacted thickness up to grades indicated. Compact each layer before placing succeeding layer to 98% SPMDD.
5. Backfill around installations.
    1. Place bedding and surround material as specified elsewhere.
    2. Do not backfill around or over cast-in-place concrete within 24 hr. after placing of concrete.
    3. Place layers simultaneously on both sides of installed work to equalize loading. Difference not to exceed 0.3 m.
    4. Where temporary unbalanced earth pressures are liable to develop on walls or other structures:
        1. Permit concrete to cure for minimum 14 days or until it has sufficient strength to withstand earth and compaction pressure and approval obtained from Consultant or;
        2. If approved by Consultant, erect bracing or shoring to counteract unbalance, and leave in place until removal is approved by Consultant.
6. Backfill within municipal right of way:
    1. Trench backfill for the storm, sanitary and water servicing connections to municipal servicing shall be un-shrinkable fill.

3.9. INSPECTION AND TESTING

1. Testing of materials and compaction will be carried out by testing laboratory designated by Consultant. Frequency of tests will be determined by Consultant.
2. The Owner will pay costs for inspection and testing.

3.10. RESTORATION

1. Upon completion of work, remove waste materials and debris, trim slopes, and correct defects as directed by Consultant. Any disturbed grassed areas are to be restored to original condition or better with 100 mm depth of topsoil, and sod. Damaged concrete or asphalt areas are to be restored to original condition or better. Repaired asphalt areas are to be matched with adjacent asphalt and include a lab joint as per the drawing detail provided.

END OF SECTION

1. General

1.1. **GENERAL REQUIREMENTS**

1. Conform to the requirements stated in the General Conditions, Supplementary General Conditions of this Specification and all addenda for all work, including work outside the property line including work within Regional and Municipal right of way unless otherwise noted.

1.2. **DESCRIPTION**

1. Provide all labour, materials, tools and equipment necessary for all excavation and backfill to the full extent of work shown on the plans and this specification, including but not limited to the following:
    1. Grading (cutting and filling) to subgrade elevations including compaction and fine grading of existing earth materials to +/- 25 mm of design subgrade elevations (not uniformly high or low) in accordance with OPSS 206.
    2. Proof rolling of subgrade with Geotechnical consultant present
    3. Excavation and disposal of all excess unsuitable materials off site.
    4. Supply and installation of earth borrow material as required to establish design subgrade elevations.

1.3. **RELATED WORK**

1.	Excavating, Trenching and Backfilling	Section 31 23 10
2.	Aggregates: General	Section 31 05 17

1.4. **SITE CONDITIONS**

1. Protection:
    1. Provide protection (i.e. shoring, cribbing, bracing and planking) to ensure no damage occurs to existing facilities and equipment situated on site. In certain areas only hand tools may be used.
    2. Provide adequate protection around bench marks, layout markers, survey markers, and geodetic monuments.
    3. Protect bottom of excavations from freezing.
    4. Protect bottoms of excavations from softening. Should softening occur, remove softened soil and replace with lean concrete. Keep bottoms of

excavations dry at all times.

5. Direct discharge from pumps, when draining excavations, so that damage to site and adjacent property does not occur.

6. Do not stockpile excavated material to interfere with site operation or drainage.

7. Effect approved measures to minimize dust as a result of all grading work and all other construction activities related to this contract.

8. Protect legal iron bars, bench marks, surface or underground utility lines which are to remain. If damaged, restore to original or better condition unless directed otherwise.

9. Ensure sufficient quantities of wood sheeting, timbers, steel members and other materials are available at all times in order to support, brace or protect utilities, structure and properties near to or occurring within excavations.

2. The Contractor shall take all the necessary precautions to protect all utilities against damage. The Contractor shall carry out his work in a safe manner with due regard for roadway traffic to the satisfaction of the Consultant, and any authority having jurisdiction.

3. The Contractor shall have full and sole responsibility for the safety of all excavation performed under this Contract until final acceptance of the work.

4. Utility Lines:

1. Before beginning work, establish location and extent of underground utility lines in area of excavation. Notify Consultant of all existing located services encountered, and do not continue with excavation without the Consultant's instructions. Repair and pay for damages to existing utility lines resulting from the work.

2. Relocate existing lines in area of excavation which must remain active as indicated on the drawings.

3. Remove abandoned utility lines, if any, to distance of 2 m from foundations. Cap lines at cut-off points.

4. Record locations, if any, of maintained, re-routed and abandoned underground utility lines.

5. Repair and pay for damage to existing underground lines as may result from this work.

5. Examination:

1. Ensure in examination of the site that all possible factors concerning earthwork are investigated, and that the following are known in particular:

1. Methods and means available for material handling, disposal, storage, and transportation.

2. Physical conditions of site, including ground water table and drainage course, extent of removals and grading completed under a previous contract (demolition and site demolition).

2. Unsatisfactory Soil Conditions:

2. Any unsatisfactory or questionable soil conditions revealed during excavation shall be reported immediately to the Owner's Consultant and Geotechnical Engineer.

3. All foundation and sub-structural work shall cease until the condition has been examined and approval to proceed has been issued.

6. Material Unsuitable for Backfill:

1. The Contractor shall be responsible for all costs associated with the excavation and removal, off site, of all materials unsuitable for backfill or re-use.

7. Water:

1. Keep excavation free from water at all times. Provide drainage trenches and sumps as necessary and pump water well away from excavation. Do not discharge water onto private property.

8. Inspection and Testing:

1. Testing of materials and compaction will be carried out by testing laboratory designated by the Consultant.

1.5. ENVIRONMENTAL REQUIREMENTS

1. Protect and repair exposed excavations where required to prevent adverse effects of rain, freezing weather and other weather conditions on subgrade of subsequent work.

2. Suspend construction operation at times when satisfactory results cannot be obtained on account of rain, snow, freezing weather or other unsatisfactory conditions.

3. Do not carry out filling or backfilling in freezing weather unless authorized by Consultant. Do not use frozen material nor place material where the material in place is already frozen.

4. Dispose of excess or unsuitable earth materials generated from the site grading in accordance with Ontario Reg. 558. The items in the Form of Tender include all costs for disposal of excess or unsuitable material off the site and the Contractor shall make the arrangements for the disposal of the materials removed in accordance with MOE Reg. 558.

2. Products

2.1. MATERIALS

1. Earth Borrow

1. Earth borrow shall be earth material obtained from outside the project limits that meets the requirements of Ontario Provincial Standard Specification 212.

2. Backfill

1. Site or imported material containing no organic or foreign matter, and which the subcontractor can demonstrate is compactable to a density of 98% SPMDD.

2.2. STOCKPILING

1. Fill Materials

1. Temporarily Stockpile fill materials in areas designated by Owner. Stockpile granular materials to prevent segregation.

2. Protection

1. Protect fill materials from contamination and freezing.

3. Execution

3.1. STRIPPING OF TOPSOIL

1. Do stripping of topsoil in accordance with this Section and Geotechnical Consultant requirements.
2. Do not handle topsoil while in wet or frozen condition or in any manner in which soil structure is adversely affected as determined by Consultant.
3. Commence topsoil stripping of areas as indicated after area has been cleared of brush, weeds and grasses and removed from site.
4. Strip all topsoil. Avoid mixing topsoil with subsoil.
5. Stockpile sufficient topsoil for restoration of all grassed areas impacted by the construction.
6. Remove and dispose of surplus topsoil, off site.
7. All silt fence and erosion control measures to be in place before start of topsoil stripping operation.

3.2. EXCAVATION/GRADING

1. Grade to subgrade levels (to a tolerance +/- 25 mm but not consistently high or low) allowing for surface treatment as indicated.
2. Do not place material which is frozen nor place material on frozen surfaces.

3. Prior to placing fill over existing ground, scarify surface to depth of 150 mm. Maintain fill and existing surface at approximately same moisture content to facilitate bonding.

4. Excavation, placing and compacting of fill materials are to be carried out in accordance with Ontario Provincial Standard Specification (OPSS) 206.

5. Do not disturb soil within branch spread of trees or shrubs to remain.

6. If any soft areas are detected during the proof rolling process, and with the Consultant's direction, sub-excavate as per Geotechnical Consultant's recommendations. Sub-excavated areas are to be backfilled with suitable native material, or imported approved granular material.

3.3. PROOF ROLLING

1. Proof rolling shall be carried out on completed subgrade prior to installing granular sub-base materials.

2. Proof rolling shall be carried out using a roller with a minimum static weight of 5 tonnes, and shall consist of a minimum of four passes per unit area. Wet areas or deleterious materials identified during proof rolling shall be sub-excavated and be replaced with engineered fill, consisting of Granular B, Type I as per OPSS 1010 or select native material, compacted to 98% SPMDD in maximum 200 mm lifts.

3.4. FIELD QUALITY CONTROL

1. Inspection and testing of materials and compaction will be carried out by the Geotechnical Consultant engaged by the Owner for this project. Costs of tests will be paid by Owner.

2. Sieve Analysis

    1. Proposed fill materials will be tested to confirm suitability for intended use and conformity with specifications.

3. Reinstatement

    1. All disturbed areas must be reinstated to Consultant's and Owner's satisfaction.

    2. Any damage to the existing rail right-of-way, due to the Contractor's operations, shall be made good at the Contractor's expense.

END OF SECTION

1. General

1.1. **GENERAL REQUIREMENTS**

1. Conform to the requirements stated in the General Conditions, Supplementary General Conditions of this Specification and all addenda for all work.

1.2. **RELATED WORK**

1. Aggregates Section 31 05 17

1.3. **REFERENCES**

1. ASTM D4791-10, Test Method for Flat or Elongated Particles in Coarse Aggregate.
2. Ontario Provincial Standard Specification 1001.

2. Products

2.1. **MATERIALS**

1. Aggregate quality: sound, hard, durable material free from soft, thin, elongated or laminated particles, organic material, clay lumps or minerals, or other substances that would act in deleterious manner for use intended.
2. Geotextile for siltation control fence shall be Class I non-woven geotextile fabric in accordance with OPSS 1860.

2.2. **SOURCE QUALITY CONTROL**

1. Inform Consultant of proposed source of aggregates and provide access for sampling at least four weeks prior to commencing production.
2. If, in opinion of Consultant, materials from proposed source do not meet, or cannot reasonably be processed to meet, specified requirements, locate an alternative source or demonstrate that material from source in question can be processed to meet specified requirements.
3. Advise Consultant four weeks in advance of proposed change of material source.
4. Acceptance of material at source does not preclude future rejection if it fails to conform to requirements specified, lacks uniformity, or if its field performance is found to be unsatisfactory.

3. Execution

3.1. **INSTALLATION**

1. Silt Control Fence

1. Install silt control fence along construction site perimeter including tee bars, geotextile filter fabric, clear stone along the upstream side of the fence in the instance the ground is frozen.

3.2. **MAINTENANCE**

1. Maintain silt control fencing for the duration of the construction and replace as required until the site is stabilized.

END OF SECTION

1. General

1.1. **GENERAL REQUIREMENTS**

1. Conform to the requirements stated in the General Conditions, Supplementary General Conditions of this Specification and all addenda for all work, including work outside the property line including work within Regional and Municipal right of way unless otherwise noted.

1.2. **RELATED WORK**

1.	Site Grading	Section 31 23 13
2.	Excavation, Trenching and Backfilling	Section 31 23 10
3.	Aggregates: General	Section 31 05 17
4.	Granular Base	Section 32 11 23

1.3. **REFERENCES**

1. ASTM C 117-17, Test Method for Material Finer than 0.075 mm Sieve in Mineral Aggregates by Washing.
2. ASTM C 131/C131M-14, Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
3. C 136/C136M-14, Method for Sieve Analysis of Fine and Coarse Aggregates.
4. ASTM D 422 (1990), Method for Particle-Size Analysis of Soils.
5. ASTM D698-12e2, Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort 12,400 ft-1lf/ft3 600 kN-m/m3.
6. CAN/CGSB-81.-88, Sieves Testing, Woven Wire, Inch Series.
7. CAN/CGSB-8.2-M88, Sieves Testing, Woven Wire, Metric.
8. Ontario Provincial Standard Specification 1010.

1.4. **DELIVERY, STORAGE AND HANDLING**

1. Refer to Section 32 11 23.

2. Products

2.1. **MATERIALS**

1. Granular sub-base material: Granular 'B', Type I or Type II, OPSS 1010, Section 31 05 17 and following requirements.
    1. Crushed, pit run or screened stone, gravel or sand consisting of hard durable angular particles free from clay lumps, cementation, organic material, frozen material and other deleterious materials.
    2. Gradations to be within limits specified when tested to ASTM C 136 and ASTM C 117. Sieve sizes to CAN/CGSB-8.1.

Sieve Designation	% Passing Type I
150 mm	100
26.5 mm	50-100
4.75 mm	20-100
1.18 mm	10-100
0.300 mm	2-65
0.075 mm	0-8

2. Other Properties as follows.
    1. Plasticity Index ASTM D4318-84.0.
    2. Crushed particles: at least 100% of particles by mass within each of the following sieve designation ranges to have at least 1 freshly fractured face for Type II. Not applicable for Type I material to be divided into ranges using methods of ASTM C135-84a.
    3. Petrographic Number MTO LS609 Maximum 250.

Passing	Retained on
26.5	4.75 MM

    4. Particles smaller than 0.02 mm AASHTO T88-78 maximum 3%.
    5. Soaked CBR AASHTO T193-72 Min 40 when compacted to 100% of AASHTO T180.74 Method D.

    Where indicated, structural soil is to be installed in lieu of granular sub-base. Structural soil as detailed later in this specification.

3. Execution

3.1. **PLACING**

1. Compact subgrade to 95% of SPMDD. Excavate all weak and soft spots as required and replace with granular sub-base compacted uniformly to 100% of SPMDD.
2. Place granular sub-base after subgrade is inspected and approved by Consultant.
3. Construct granular sub-base to depth and grade in areas indicated.

4. Ensure no frozen material is placed.
5. Place material only on clean unfrozen surface, free from snow or ice.
6. Place granular sub-base materials using methods which do not lead to segregation or degradation.
7. For spreading and shaping materials, use spreader boxes having adjustable templates or screens which will place material in uniform layers of required thickness.
8. Place material to full width in uniform layers not exceeding 150 mm compacted thickness.
9. Shape each layer to smooth contour and compact to specified density before succeeding layer is placed.
10. Remove and replace portion of layer in which material has become segregated during spreading.

3.2. COMPACTION

1. Compaction equipment to be capable of obtaining required material densities.
2. Efficiency of equipment not specified to proved at least as efficient as specified equipment at no extra cost and written approval must be received from Consultant before use.
3. Equipped with device that records hours of actual work, not motor running hours.
4. Compaction in accordance with ASTM D698 and ASTM D1577.
    1. Pavement Sub-base: Compact to density of not less than 100% SPMDD.
    2. Backfill of subgrade weak or soft spots: Compact to density of not less than 98% of SPMDD.
5. Shape and roll alternately to obtain smooth, even and uniformly compacted sub-base.
6. Apply water as necessary during compaction to obtain specified density.
7. In areas not accessible to rolling equipment, compact to specified density with mechanical tampers approved by Consultant.
8. Correct surface irregularities by loosening and adding or removing material unit surface is within specified tolerance.

3.3. SITE TOLERANCES

1. Finished sub-base surface to be within 10 mm of elevation as indicated but not uniformly high or low.

3.4. **INSPECTION AND TESTING**

1. Testing of materials and compaction will be carried out by testing laboratory designated by Owner. Frequency of tests will be determined by Consultant.
2. Owner will pay costs for inspection and testing.

3.5. **PROTECTION**

1. Maintain finished sub-base in condition conforming to this section until succeeding base is constructed, or until granular sub-base is accepted by Consultant.

SAMPLES AND SUBMITTALS

A. At least 30 days prior to ordering materials, the Contractor shall submit to the Engineer's representative samples, certificates, manufacturers literature and certified tests for materials specified below. No materials shall be ordered until the required samples, certificates, manufacturer's literature and test results have been reviewed and approved by the Engineer. Delivered materials shall closely match the approved samples. Approval shall not constitute final acceptance. The Engineer reserves the right to reject, on or after delivery, any material that does not meet these specifications.

1.02 DELIVERY, STORAGE AND HANDLING

A. Do not deliver or place soil in frozen, wet, or muddy conditions. Material shall be delivered at or near optimum compaction moisture content as determined by AASHTO T 99 (ASTM D 698). Do not deliver or place materials in an excessively moist condition (beyond 2 percent above optimum compaction moisture content as determined by AASHTO T 99 (ASTM D 698).

B. Protect soils and mixes from absorbing excess water and form erosion at all times. Do not store materials unprotected from large rainfall events. Do not allow excess water to enter site prior to compaction. If water is introduced into the material after grading, allow material to drain or aerate to optimum compaction moisture content.

END OF SECTION

1. General

1.1. **GENERAL REQUIREMENTS**

1. Conform to the requirements stated in the General Conditions, Supplementary General Conditions of this Specification and all addenda for all work, including work outside the property line including work within Regional and Municipal right of way unless otherwise noted.

1.2. **RELATED WORK**

1.	Site Grading	Section 31 23 13
2.	Excavation, Trenching and Backfilling	Section 31 23 10
3.	Aggregates: General	Section 31 05 17
4.	Granular Sub-base	Section 32 11 19

1.3. **REFERENCES**

1. ASTM C 117-17, Test Method for Material Finer than 0.075 mm Sieve in Mineral Aggregates by Washing.
2. ASTM C 131/C131M-14, Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
3. C 136/C136M-14, Method for Sieve Analysis of Fine and Coarse Aggregates.
4. ASTM D698-12e2, Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort 12,400 ft-1lf/ft3 600 kN-m/m3.
5. CAN/CGSB-81.-88, Sieves Testing, Woven Wire, Inch Series.
6. CAN/CGSB-8.2-M88, Sieves Testing, Woven Wire, Metric.
7. Ontario Provincial Standard Specification 1010.

1.4. **DELIVERY, STORAGE AND HANDLING**

1. Deliver and stockpile aggregates in accordance with Section 31 05 17 – Aggregates General. Stockpile minimum 50% of total aggregate required prior to commencing operation.
2. Store cement in weathertight bins or silos that provide protection from dampness and easy access for inspection and identification of each.

2. Products

2.1. **MATERIALS**

2.2.

1. Granular base material: Granular 'A' Type I or Type II OPSS 1010, Section 31 05 17 and following requirements:
    1. Crushed pit-run or screened stone, gravel or sand consisting of hard, durable, angular particles, free from clay lumps, cementation, organic material, frozen material and other deleterious materials.
    2. Gradations to be within limits of specified when tested to ASTM C 136 and ASTM C 117. Sieve sizes to CAN/CGSB-8.1.

Sieve Designation	% Passing
26.5 mm	100
19 mm	85 - 100
13.2 mm	65 - 90
9.5 mm	50 - 73
4.75 mm	35 - 55
1.18 mm	15 - 40
0.300 mm	5 - 22
0.150 mm	-
0.075 mm	2 - 8

    3. Plasticity Index ASTM D4318-17e1.
    4. Los Angeles Abrasion ASTM C131/C131M-14 Gradation 'A' Max. % loss by weight: 60.
    5. Crushed particles: at least 50% of particles by mass within each of following sieve designation ranges to have at least 10 freshly fractured face. Material to be divided into ranges using methods of ASTM C136-84a.

Passing	Retained on
19 mm	26.5 mm
4.75 mm	19 mm

    6. Petrographic number MTO LS 69, Maximum 250.
    7. Soaked CBR: AASHTO T193-72 when compacted to 100% of AASHTO T180-774 Method D, Min 80 for use under Portland cement and Min 100 for use under asphalt concrete.

3. Execution

3.1. **SEQUENCE OF OPERATION**

1. Place granular base after finished sub-base surface or subgrade is inspected and approved by Consultant.

2. Placing
    1. Construct granular base to depth and grade in areas indicated.
    2. Ensure no frozen material is placed.
    3. Place material only on clean unfrozen surface, free from snow and ice.
    4. Place material using methods which do not lead to segregation or degradation of aggregate.
    5. Place material to full width in uniform layers not exceeding 150 mm compacted thickness.
    6. Shape each layer to smooth contour and compact to specified density before succeeding layer is placed.
    7. Remove and replace that portion of layer in which material becomes segregated during spreading.
3. Compaction Equipment
    1. Compaction equipment to be capable of obtaining required material densities.
    2. Efficiency of equipment not specified to be proved at least as efficient as specified equipment at no extra cost and written approval must be received from Consultant before use.
    3. Equipped with device that records hours of actual work, not motor running hours.
4. Compacting in accordance with ASTM D 698 and ASTM D 1557.
    1. Compaction of Pavement Base: Compact to density of not less than 100% SPMDD.
    2. Compaction of Concrete Slab on Grade or Concrete Sidewalks Base: Compact to density of not less than 100% of SPMDD.
    3. Shape and roll alternately to obtain smooth, even and uniformly compacted base.
    4. Apply water as necessary during compacting to obtain specified density.
    5. In areas not accessible to rolling equipment, compact to specified density with mechanical tampers approved by Consultant.
    6. Correct surface irregularities by loosening and adding or removing material until surface is within specified tolerance.

3.2. SITE TOLERANCES

1. Finished base surface to be within plus or minus 10 mm of established grade and cross section but not uniformly high or low.

3.3. PROOF ROLLING

1. For proof rolling use roller of 45,400 kg gross mass with four pneumatic tires each carrying 11,350 kg and inflated to 620 kPa. Four tires arranged abreast with centre to centre spacing of 915 mm maximum.
2. Consultant may authorize use of other acceptable proof rolling equipment.
3. Proof roll top of base upon completion of fine grading and compaction.
4. Make sufficient passes with proof roller to subject every point on surface to three separate passes of loaded tire.
5. Where proof rolling reveals defective areas:
    1. Remove base, sub-base and subgrade material to depth and extent directed by Consultant.
    2. Backfill excavated subgrade with sub-base material and compact in accordance with Section 31 23 10.
    3. Replace sub-base material and compact in accordance with Sections 31 23 10 and 32 11 19.
    4. Replace base material and compact in accordance with this Section.

3.4. INSPECTION AND TESTING

1. Testing of materials and compaction will be carried out under Cash Allowance by testing laboratory designated by Consultant. Frequency of tests will be determined by Consultant.

3.5. PROTECTION

1. Maintain finished base in condition conforming to this section until succeeding material is applied or until acceptance by Consultant.

END OF SECTION

SECTION 321216
ASHPALT PAVING-LANDSCAPE

PART 1 GENERAL

1.1 DESCRIPTION

A. Supply all materials, labour, and equipment necessary for the placing and compaction of hot-laid asphalt concrete.

1.2 REFERENCES

A. Asphalt Institute MS-2, Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types.

B. ASTM C 136, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.

C. CAN/CGSB-8.1, Sieves Testing, Woven Wire, Inch Series.

D. CAN/CGSB-8.2, Sieves Testing, Woven Wire, Metric.

E. MTO Laboratory Testing Manual

F. OPSS 310 -Construction specification for Hot-Mix Asphalt

G. OPSS 1001 -Material Specification For Aggregates -General

H. OPSS.PROV 1003 – Material Specifications for Aggregates -Hot-Mix Asphalt

I. OPSS.PROV 1010 -Material Specification for Aggregates -Base, Subbase, Select Subgrade, and Backfill Material

J. OPSS 1103 – Material Specification for Emulsified Asphalt

K. OPSS 1150 – Material Specification for Hot-Mix Asphalt

1.3 SUBMITTALS

A. Submit asphalt concrete mix designs for Consultants approval one week prior to scheduled paving work.

B. Submit viscosity-temperature chart for asphalt cement to be supplied showing either Saybolt Furol viscosity in seconds or Kinematic Viscosity in centistokes, temperature range 105 to 175 degrees C one week prior to beginning Work.

C. Testing and Evaluation Reports for Materials to be tested by accredited testing agencies approved by Consultant.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials in accordance with General Requirements and with manufacturer's written instructions.

B. Store and protect aggregates from damage.

C. Replace defective or damaged materials with new.

1.5 SITE CONDITIONS

A. Place asphalt mixtures only when air temperature is 5 degrees C minimum.

B. When temperature of surface on which material is to be placed falls below 10 degrees C, provide extra rollers as necessary to obtain required compaction before cooling.

C. Do not place hot-mix asphalt on frozen base or when pools of standing water exist on surface to be paved, during rain, or when surface is damp.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of hazardous materials; and regarding labelling and provision of Material Safety Data Sheets (MSDS) acceptable to Health Canada.

1.7 MOCK-UP

A. N/A

1.8 QUALITY ASSURANCE AND TESTING

A. Execute work to the highest standards of workmanship in the industry.

B. Any work not accepted by the Consultant shall be immediately corrected by the Contractor to the Consultant's satisfaction at no extra cost to the Consultant and Owner.

C. Arrange for testing of asphalt and compaction of asphalt and granular courses by a Testing Firm approved by the Consultant.

D. Testing shall be for each type of asphalt to be placed and in accordance with OPSS 310 and MTO Laboratory Testing Manual. Material tests shall include full Marshall Property Tests, including asphalt cement content, aggregate gradation, air voids, flow, voids in mineral aggregate, and stability requirements. Marshall test results for hot mix samples based on LS test procedures shall meet the requirements specified in Table 8. The production air voids for all Hot Mixed Asphalt mixes shall be evaluated according to Table 9.

E. Compaction testing shall be performed at random. Nuclear density test gauge results shall be used to assess in-place compaction. Percent compaction shall be determined by comparing the nuclear density in situ Bulk Relative Density (BRD) according to MTO LS¬262 to the average plant produced HMA Maximum Relative Density (MRD) according to MTO LS-264. Carry out additional compaction should test results fail to comply with that specified. Arrange for retesting of compaction.

F. After final compaction, each course shall be smooth and true to the established crown and grade with adequate slope to drains. Hot Mix Asphalt binder and surface courses shall be free from deviations exceeding 6 mm and 3 mm, respectively, as measured in any direction with a 3 m straight edge.

G. Each course after final compaction shall be of uniform texture and shall be free of defects such as segregation, fat spots, oil spills, and roller marks.

1.9 WARRANTY

A. Contractor hereby warrants that the asphalt concrete will be free of defects related to workmanship or material deficiency, specifically but not limited to settlement, cracking, shifting, raveling, de-bonding of the asphalt courses, or any surface defects of the asphalt concrete for a period of two years.

B. Any repair required under the warranty will be performed in accordance to the recommendations of and to the satisfaction of the Consultant, and return any defects to as new condition.

PART 2 PRODUCTS

2.1 MATERIALS

A. Granular base material to OPSS.PROV 1010 , Granular A.

B. Asphalt Binder Course to OPSS 1150, HL 8, Minimum Marshall Stability 8000 N, compacted to a minimum 65 mm thickness.

C. Asphalt Surface Course to OPSS 1150, HL 3, Minimum Marshall Stability 8900 N, compacted to a minimum 30 mm thickness.

D. Asphalt tack coat to OPSS 1103 SS-1 Asphalt Emulsion

E. Hot Pour Joint Sealant conforming to OPSS 1212, Tremco PQ6190 or approved equivalent

2.2 EQUIPMENT

A. Pavers: mechanical grade controlled self-powered pavers capable of spreading mix within specified tolerances, true to line, grade and crown indicated.

B. Rollers: sufficient number of rollers of type and weight to obtain specified density of compacted mix.

C. Vibratory rollers:

.1 Minimum drum diameter: 750 mm.

.2 Maximum amplitude of vibration (machine setting) -0.5 mm for lifts less than 40 mm thick.

D. Ensure that paving and compaction equipment will not overload the structure.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine the drawings, specifications, and the site to determine the extent of the work involved.

B. Verify that conditions of substrate previously installed under other Sections are acceptable for asphalt paving. Inform Consultant of unacceptable conditions immediately upon discovery.

C. Proceed with installation only after unacceptable conditions have been remedied

3.2 SURFACE PREPARATION

A. Verify grades of drains and other items set in paving area for conformity with elevations and sections before placing asphalt, granular base or sub-base material.

B. When paving over existing asphalt surface, clean pavement surface. Apply tack coat prior to paving. Tack coat shall be applied to all pavement surfaces including, but not limited to, hot mix and Portland cement concrete.

C. Remove soft, yielding material or other portions of subgrade that will not compact to specification; replace with suitable material. Bring subgrade to firm unyielding condition with uniform density; compact at or above optimum moisture content to 98% Standard Proctor density.

3.3 GRANULAR SUB-BASE AND GRANULAR BASE

A. Place granular base and sub-base material on clean unfrozen surface, free from snow and ice.

B. Place granular base and sub-base to compacted thicknesses as indicated. Do not place frozen material.

C. Place in layers not exceeding 150 mm compacted thickness. Compact to density not less than 98 % maximum dry density in accordance with MTO LS-706

D. Finished base surface to be within 10 mm of specified grade, but not uniformly high or low. Ensure there is adequate slope to drains.

3.4 ASPHALT CONCRETE PAVING

A. Place asphalt concrete using a mechanical grade controlled self-powered paver in compacted layers not exceeding 50 mm per lift. In areas not accessible not accessible by paver, spread asphalt by hand.

B. Minimum 135 degrees C mix temperature required when spreading.

C. Maximum 160 degrees C mix temperature permitted at any time.

D. Compact each course as soon as asphalt paving can support the weight of the compaction equipment without undue cracking or displacement.

E. Compact to density not less than 96 % of the maximum relative density obtained with Marshall Specimens from samples of mix being used. Roll until roller marks are eliminated.

F. Keep roller speed slow enough to avoid mix displacement and do not stop roller on fresh pavement.

G. Moisten roller wheels with water to prevent pick up of material.

H. Compact mix with hot tampers or other equipment approved in areas inaccessible to roller.

I. Finish surface to be within 10 mm of design elevation and with no irregularities greater than 3mm in3m.

J. Repair areas showing checking, rippling or segregation as directed by Contract Administrator.

3.5 JOINTS

A. Remove surplus material from surface of previously laid strip. Do not deposit on surface of freshly laid strip.

B. Paint contact surfaces of existing structures such as manholes, curbs or gutters with bituminous material prior to placing adjacent pavement.

C. For cold joints, cut back to full depth vertical face and tack face with hot asphalt.

D. For longitudinal joints, overlap previously laid strip with spreader by 50 mm

E. For cold joints with existing paving, remove existing surface course to expose 100 mm of existing binder course. The edges shall be cut full depth of each course. Remove any loose material.

F. Provide a 20mm x 20 mm joint in the asphalt paving over joints in the concrete structure or between new and existing asphalt paving. Seal joint with approved hot pour joint sealant.

3.6 PROTECTION

A. Keep vehicular traffic off newly paved areas until paving surface temperature has cooled below 38 degrees C.

B. Do not permit stationary loads on pavement until 24 hours after placement.

C. Provide access to buildings as required.

D. Arrange paving schedule so as not to interfere with normal use of premises.

3.7 CLEAN UP

A. Leave Work area clean at end of each day.

B. Upon completion of paving work, remove surplus materials, rubbish, tools and equipment.

C. Reinstate any landscape areas adjacent to paving disturbed or damaged during paving work.

D. Reinstate traffic markings to match original configuration or as specified.

END OF SECTION 32 12 16

SECTION 321413.19
PERMEABLE PAVERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes the following:
1. Permeable Concrete Pavers
2. Permeable Joint Opening Aggregate
3. Permeable Joint Aggregate Type 1
4. Permeable Joint Aggregate Type 2
5. Permeable Setting Bed Aggregate (Open-graded)
6. Permeable Base Aggregate (Open-graded)
7. Permeable Subbase Aggregate (Open-graded)

1.02 REFERENCES

Note: Design street, industrial, port and airport pavement thicknesses in consultation with a qualified civil engineer, in accordance with established flexible pavement design procedures, LOCKPAVE® software, and in accordance with Interlocking Concrete Pavement Institute Technical Bulletins. Sample construction detail drawings are available from Unilock®. This specification may require modifications.

A. ASTM International, latest edition:
1. C 29 Bulk Density and Voids in Aggregate Materials.
2. C 33, Standard Specification for Concrete Aggregates.
3. C 67, Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile, Section 8, Freezing and Thawing.
4. C 136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
5. C 140, Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
6. C 144 Standard Specifications for Aggregate for Masonry Mortar.
7. D 448, Standard Classification for Sizes of Aggregate for Road and Bridge Construction.
8. C 936, Standard Specification for Solid Concrete Interlocking Paving Units.
9. C 979, Standard Specification for Pigments for Integrally Colored Concrete.
10. D 698 Test Methods for Moisture Density Relations of Soil and Soil Aggregate Mixtures Using a 5.5 lb (24.4 N) Rammer and 12 in. (305 mm) drop.
11. D 1557 Test Methods for Moisture Density Relations of Soil and Soil Aggregate Mixtures Using a 10-lb (44.5 N) Rammer and 18 in. (457 mm) drop.
12. C1645 Standard Test Method for Freeze-thaw and De-icing Salt Durability of Solid Concrete Interlocking Paving Units
13. D 1883, Test Method for California Bearing Ratio of Laboratory-Compacted Soils.
14. D 2940 Graded Aggregate Material for Bases or Subbases for Highways or Airports.
15. D 4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.

1.03 SUBMITTALS

A. Permeable Concrete Pavers:
1. Samples for verification: Three representative full-size samples of each paver type, thickness, color and finish that indicate the range of color variation and texture expected upon project completion.
2. Accepted samples become the standard of acceptance for the product produced.

3. Test results from an independent testing laboratory for compliance of concrete pavers with ASTM C 936.
4. Manufacturer's catalog product data, installation instructions, and material safety data sheets for the safe handling of the specified materials and products.

B. Permeable Joint Opening Aggregate:
1. Provide three representative one pound samples in containers of aggregate materials that indicate the range of color variation and texture expected upon project completion.
2. Accepted samples become the standard of acceptance for the product produced.
3. Test results from an independent testing laboratory for sieve analysis, including washed gradations per ASTM C 136.
4. Test results for void space percentage per ASTM C 29.

C. Permeable Setting Bed, Base and Subbase Aggregate:
1. Test results from an independent testing laboratory for compliance with ASTM D 448 No. 8, No. 57 and No. 2.
2. Test results from an independent testing laboratory for sieve analysis, including washed gradations per ASTM C 136.
3. Test results for void space percentage per ASTM C 29.

D. Paving Installation Contractor:
1. Job references from a minimum of three projects similar in size and complexity. Provide Owner/Client/General Contractor names, postal address, phone, fax, and email address.

1.04 QUALITY ASSURANCE

A. Utilize a Manufacturer having at least ten years of experience manufacturing interlocking concrete pavers on projects of similar nature or project size.

B: Source Limitations:
1. Obtain Permeable Concrete Pavers from one source location with the resources to provide products of consistent quality in appearance and physical properties.
2. Obtain Permeable Joint Opening Aggregate from one source with the resources to provide materials and products of consistent quality in appearance and physical properties.

C. Paving Contractor Qualifications:
1. Utilize an installer having successfully completed concrete paver installation similar in design, material, and extent indicated on this project.

D. Mockups:
1. Install a 1.5m x 1.5m paver area.
2. Use this area to determine joint sizes, lines, laying pattern(s) and levelness. This area will serve as the standard by which the workmanship will be judged.
3. Subject to acceptance by owner, mock-up may be retained as part of finished work.
4. If mock-up is not retained, haul offsite and dispose legally.

1.05 DELIVERY, STORAGE & HANDLING

A. In accordance with Conditions of the Contract and Division 1 Product Requirement Section.

B. Deliver Permeable Concrete Pavers in manufacturer's original, unopened and undamaged container packaging with identification labels intact.
1. Coordinate delivery and paving schedule to minimize interference with normal use of streets and sidewalks adjacent to paver installation.
2. Deliver concrete pavers to the site in steel banded, plastic banded or plastic wrapped packaging capable of transfer by forklift or clamp lift.
3. Unload pavers at job site in such a manner that no damage occurs to the product or adjacent surfaces.

C. Store and protect materials free from mud, dirt and other foreign materials.

1.06 PROJECT/SITE CONDITIONS

A. Environmental Requirements:
1. Install permeable pavers only on unfrozen permeable setting bed aggregate materials.
2. Install permeable setting bed only on unfrozen permeable base and subbase aggregates.
3. Install permeable base or subbase aggregates only over unfrozen subgrade.

1.07 PERMEABLE CONCRETE PAVER OVERAGE AND ATTIC STOCK

A. Provide a minimum of 5% additional material for overage to be used during construction.

B. Furnish 100 square feet of each product and size used to owner for maintenance and repair. Furnish Permeable Concrete Pavers from the same production run as installed materials.

C. Manufacture to supply maintenance and reinstatement manuals for Permeable Concrete Paver units.

PART 2 PRODUCTS

2.01 PERMEABLE CONCRETE PAVERS

A. Basis-of-Design Product: The permeable concrete paver shapes are based on:
1. Unilock:
d. Thornbury
2. As manufactured by:

Unilock Ontario
287 Armstrong Ave
Georgetown Ontario
Contact: David Robbins, Territory Manager P: 647-466-0227

3. Substitutions: No substitutions permitted.

B. Product requirements:
1. Permeable Paver Type 1: Unilock Thornbury
a. Color: Granite
b. Finish: Smooth (Premier) – this is a face mix finish.

c. Edge: 90 degree Riven
d. Size: Manufacture the sizes indicated with a maximum tolerance of plus or minus 3mm in all directions.

D. Accept only pigments in concrete pavers conforming to ASTM C 979.
Note: ACI Report No. 212.3R provides guidance on the use of pigments.

E. Maximum allowable breakage of product is 5%.

2.02 PERMEABLE JOINT OPENING AGGREGATE

A. Provide Permeable Joint Opening Aggregate materials conforming to ASTM C 33 and gradation requirements of ASTM D 448 No. 8 as shown in Table 1. Use granite chips listed in table 2 below.

TABLE 1 - THORNBURY
PERMEABLE JOINT OPENING AGGREGATE
GRADATION REQUIREMENTS
(CRUSHED LIMESTONE)

ASTM No. 8	
Sieve Size	**Percent Passing**
1/2 in (12.5 mm)	100
3/8 in (9.5 mm)	85 to 100
No. 4 (4.75 mm)	10 to 30
No. 8 (2.36 mm)	0 to 10
No. 16 (1.18 mm)	0 to 5

2.03 PERMEABLE SETTING BED AGGREGATE

A. Provide Permeable Setting Bed Aggregate materials conforming to ASTM C 33 and gradation requirements of ASTM D 448 No. 8 as presented in Table 3.

TABLE 3
PERMEABLE SETTING BED AGGREGATE
GRADATION REQUIREMENTS

ASTM No. 8	
Sieve Size	**Percent Passing**
½ in (12.5 mm)	100
3/8 in (9.5 mm)	85 to 100
No. 4 (4.75 mm)	10 to 30
No. 8 (2.36 mm)	0 to 10
No. 16 (1.18 mm)	0 to 5

2.04 PERMEABLE BASE AGGREGATE

A. Provide Permeable Base Aggregate materials conforming to ASTM C 33 and gradation requirements of ASTM D 448 No. 57 as presented in Table 4.

TABLE 4
PERMEABLE BASE AGGREGATE
GRADATION REQUIREMENTS

ASTM No. 57	
Sieve Size	**Percent Passing**
1-1/2 in (37.5 mm)	100
1 in (25 mm)	95 to 100
1/2 in (12.5 mm)	25 to 60
No. 4 (4.75 mm)	0 to 10
No. 8 (2.36 mm)	0 to 5

2.05 PERMEABLE SUBBASE AGGREGATE

A. Provide Permeable Subbase Aggregate materials conforming to ASTM C 33 and gradation requirements of ASTM D 448 No. 2 as presented in Table 5.

TABLE 5
PERMEABLE SUBBASE AGGREGATE
GRADATION REQUIREMENTS

ASTM No. 2	
Sieve Size	**Percent Passing**
3 in (75 mm)	100
2-1/2 in (63 mm)	90 to 100
2 in (50 mm)	35 to 70
1-1/2 in (37.5 mm)	0 to 15
3/4 (19 mm)	0 to 5

Note: For all aggregates, provide washed, clean, have zero plasticity, free from deleterious or foreign matter, crushed, angular rock and contain no No. 200 sieve size aggregate

materials used in the construction of permeable pavement. Aggregate materials serve as the structural load bearing platform of the pavement as well as a temporary receptor for the infiltrated water that is collected through the openings in the pavement's surface.

2.07 EDGE RESTRAINTS

A. Concrete Edge Restraint as indicated on drawings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas indicated to receive paving for compliance with requirements for installation tolerances and other conditions affecting performance for the following items before placing the Permeable Concrete Pavers.
   1. Verify that subgrade preparation, compacted density and elevations conform to specified requirements.
   2. Verify that Geotextiles, if applicable, have been placed according to drawings and specifications.
   3. Verify that Permeable Base and Subbase Aggregate materials, thickness, compacted density, surface tolerances and elevations conform to specified requirements.
   4. Provide written density test results for soil subgrade, Permeable Base and Subbase Aggregate materials to the Owner, General Contractor and paver installation subcontractor.
   5. Verify location, type, and elevations of edge restraints, concrete collars around utility structures, and drainage inlets.

B. Proceed with installation only after unsatisfactory conditions have been corrected.
   1. Beginning of bedding sand and paver installation signifies acceptance of base and edge restraints.

3.02 PREPARATION

A. Verify that the subgrade soil is free from standing water.

B. Stockpile Permeable Setting Bed, Joint, Base and Subbase Aggregate materials such that they are free from standing water, uniformly graded, free of any organic material or sediment, debris, and ready for placement.

C. Remove any excess thickness of soil applied over the excavated soil subgrade to trap sediment from adjacent construction activities before placing the Geotextile and Permeable Subbase Aggregate materials.

D. Keep area where pavement is to be constructed free from sediment during entire job. Remove and replace all Geotextile, Permeable Joint, Setting Bed, Base and Subbase Aggregate materials contaminated with sediment with clean materials.

E. Complete all subdrainage of underground services within the pavement area in conjunction with subgrade preparation and before the commencement of Permeable Subbase Aggregate construction.

F. Prevent damage to underdrain pipes, overflow pipes, observation wells, or inlets and other drainage appurtenances during installation. Report all damage immediately.

G. Compact soil subgrade uniformly to at least 90 percent of Standard Proctor Density per ASTM D 698 for pedestrian areas. Compact soil subgrade uniformly to at least 95 percent Modified Proctor per ASTM D 1557 for vehicular areas.

Note: Base compaction and proof-rolling of the subgrade soil on the recommendations of the Design Engineer. Request the Architect/Engineer to inspect subgrade preparations, elevations and conduct density tests for conformance to specifications.

Note: Mechanical tampers (jumping jacks) are recommended for compaction of soil subgrade and aggregate base around lamp standards, utility structures, building edges, curbs, tree wells and other protrusions. Compact areas, not accessible to roller compaction equipment, to the specified density with mechanical tampers. **CAUTION** – Proceed with

care around the perimeters of excavations, buildings, curbs, etc. These areas are especially prone to consolidation and settlement. Do not place wedges of backfill in these areas. If possible particularly in these areas, proceed with backfilling and compacting in shallow lifts, parallel to the finished surface.

3.03 INSTALLATION

A. EDGE RESTRAINTS

1. Provide edge restraints as indicated.
   a. restraints Install job-built concrete edge to comply with requirements in 03 33 00 Cast-In-Place Concrete.
   b. Provide concrete edge restraint along the perimeter of all paving as specified in drawings. Install the face of the concrete edge restraint, where it abuts pavers vertical down to the subbase.
   c. Construct concrete edge restraint to dimensions and level specified and support on a compacted subbase not less than 6 in (150 mm) thick.

B. GEOTEXTILES

1. Provide separation geotextile on bottom and sides of prepared soil subgrade. Secure in place to prevent wrinkling or folding from equipment tires and tracks.
2. Overlap ends and edges a minimum of 18 in. (450 mm) in the direction of drainage.

C. PERMEABLE BASE AND SUBBASE AGGREGATE

1. Provide the Permeable Subbase Aggregate in uniform lifts not exceeding 6 in., (150 mm) loose thickness and compact to at least 95 percent as per ASTM D 4254 to depths as indicated.
2. Compact the Permeable Subbase Aggregate material with at least two passes in the vibratory mode then at least two in the static mode with a minimum 10 ton vibratory roller until there is no visible movement. Do not crush aggregate with the roller.
3. Tolerance: Do not exceed the specified surface grade of the compacted Permeable Subbase Aggregate material more than ±3/4 in. (20 mm) over a 10 ft. (3 m) long straightedge laid in any direction.
4. Provide the Permeable Base Aggregate material in uniform lifts not exceeding 6 in. (150 mm) over the compacted Permeable Subbase Aggregate material and compact to at least 95 percent as per ASTM D 4254 to depths as indicated.
5. Compact the Permeable Base Aggregate material with at least two passes in the vibratory mode then at least two in the static mode with a minimum 10 ton vibratory roller until there is no visible movement. Do not crush aggregate with the compaction device.
6. Tolerance: Do not exceed the specified surface grade of the compacted Permeable Base Aggregate material more than ±1/2 in. (13 mm) over a 10 ft. (3 m) long straightedge laid in any direction.
7. Grade and compact the upper surface of the Permeable Base Aggregate material sufficiently to prevent infiltration of the Permeable Setting Bed Aggregate material both during construction and throughout its service life.

   Note: In-place density of the Permeable Base and Subbase Aggregate materials may be checked per ASTM D 4254. Establish a Compacted density of 95% of the laboratory index density for the subbase and base stone.

D. PERMEABLE SETTING BED AGGREGATE

1. Provide and spread Permeable Setting Bed aggregate evenly over the Permeable Base Aggregate course and screed to a nominal thickness of 1-1/2 in. (40 mm).
   a. Protect screeded Permeable Setting Bed Aggregate from being disturbed.
   b. Screed only the area which can be covered by pavers in one day.
   c. Do not use Permeable Setting Bed Aggregate material to fill depressions in the base surface.
2. Keep moisture content constant and density loose and constant until Concrete Pavers are set and compacted.
3. Inspect the Permeable Setting Bed Aggregate course prior to commencing the placement of the permeable concrete pavers.

4. Inspect the Setting Bed Aggregate course prior to commencing the placement of the Permeable Concrete Pavers. Acceptance of the Setting Bed Aggregate occurs with the initiation of Permeable Concrete Paver placement.

E. PERMEABLE CONCRETE PAVERS

1. Replace unit pavers with chips, cracks, voids, discolorations, and other defects that might be visible in finished work.
2. Mix Concrete Pavers from a minimum of three (3) bundles simultaneously drawing the paver vertically rather than horizontally, as they are placed, to produce uniform blend of colors and textures. (Color variation occurs with all concrete products. This phenomenon is influenced by a variety of factors, e.g. moisture content, curing conditions, different aggregates and, most commonly, from different production runs. By installing from a minimum of three (3) bundles simultaneously, variation in color is dispersed and blended throughout the project).
3. Exercise care in handling face mix pavers to prevent surfaces from contacting backs or edges of other units.
4. Provide Permeable Concrete Pavers using joint pattern as indicated. Adjust joint pattern at pavement edges such that cutting of edge pavers is minimized. Cut all pavers exposed to vehicular tires no smaller than one-third of a whole paver.
5. Use string lines or chalk lines on Permeable Setting Bed aggregate to hold all pattern lines true.
6. Set surface elevation of pavers 1/8 in. (3 mm) above adjacent drainage inlets, concrete collars or channels.
7. Place units hand tight against spacer bars. Adjust horizontal placement of laid pavers to align straight.

a. When installation is performed with mechanical equipment, use only unit pavers with spacer bars on sides of each unit.

8. Provide space between paver units of 1/32 in. (1 mm) wide to achieve straight bond lines.
9. Prevent joint (bond) lines from shifting more than ±1/2 in. (±15 mm) over 50 ft. (15 m) from string lines.
10. Fill gaps between units or at edges of the paved area that exceed 3/8 inch (10 mm) with pieces cut to fit from full-size unit pavers.
11. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
12. Prevent all traffic on installed pavers until Permeable Joint Aggregate has been vibrated into joints. Keep skid steer and forklift equipment off newly laid pavers that have not received initial compaction and Permeable Joint Aggregate material. .
13. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a to 5000-lbf (22-kN) compaction force at 80 to 90 Hz. Perform at least three passes across paving with vibrator. Vibrate under the following conditions:
    a. After edge pavers are installed and there is a completed surface.
    b. Compact installed concrete pavers to within 6 feet (1,800 mm) of the laying face before ending each day's work. Cover pavers that have not been compacted and leveling course on which pavers have not been placed, with nonstaining plastic sheets to prevent Permeable Setting Bed Aggregate from becoming disturbed.
14. Protect face mix Concrete Paver surface from scuffing during compaction by utilizing a urethane pad.
15. Remove any cracked or structurally damaged pavers and replace with new units prior to installing Permeable Joint Opening Aggregate material.
16. Provide, spread and sweep Permeable Joint Opening Aggregate into joints immediately after vibrating pavers into Permeable Setting Bed course until full. Vibrate pavers and add Permeable Joint Aggregate material until joints are completely filled, then remove excess material. This will require at least 4 passes with a plate compactor.
17. Remove excess Permeable Joint Aggregate broom clean from surface when installation is complete.

3.04 FIELD QUALITY CONTROL

A. Verify final elevations for conformance to the drawings after sweeping the surface clean.
   1. Prevent final Concrete Paver finished grade elevations from deviating more than ±3/8 in. (±10 mm) under a 10 ft (3 m) straightedge or indicated slope, for finished surface of paving.

B. Lippage: No greater than 1/32 in. (0.8 mm) difference in height between Permeable Concrete Pavers and adjacent paved surfaces.

3.05 REPAIRING, CLEANING AND SEALING

A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

B. Cleaning: Remove excess dirt, debris, stains, grit, etc. from exposed paver surfaces; wash and scrub clean.
   1. Clean Permeable Concrete Pavers in accordance with the manufacturer's written recommendations.

3.06 PROTECTION

A. Protect completed work from damage due to subsequent construction activity on the site.

3.07 PERMEABLE JOINT AGGREGATE MATERIAL REFILLING

A. Remove all debris from joint and provide additional Permeable Joint Aggregate material after 120 days and before 150 days after date of Substantial Completion/Provisional Acceptance.
   1. Fill Permeable Joint Aggregate material full to the lip of the paver.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 System for surface snow melting and anti-icing in concrete pavement with ambient and moisture sensing control, monitoring, integrated ground-fault circuit protection and Building Management System (BMS) communication capabilities.

.2 This Section includes a UL Listed and CSA Certified snow melting heat tracing system consisting of self-regulating heating cable, connection kits and electronic controller.

1.2 **RELATED REQUIREMENTS**

.1 Section 03 10 00 – Concrete Forming and Accessories.

.2 Section 03 30 00 – Cast-in-Place Concrete.

.3 Section 25 91 00 – Integrated Automation Control Sequences for Facility Equipment.

.4 Section 26 05 00 – Common Work Results for Electrical.

1.3 **SUBMITTALS**

.1 Product Data
- .1 Heating cable data sheet
- .2 UL, CSA approval certificates for snow melting
- .3 Snow melting design guide
- .4 System installation and operation manual
- .5 System installation details
- .6 Connection kits and accessories data sheet
- .7 Controller/Power Panel data sheet
- .8 Controller/Power Panel wiring diagram

.2 Provide installation layout, specific to this Project, and details.

.3 Design, installation and operating manual.

1.4 **CLOSEOUT SUBMITTALS**

.1 Submit results of all installation tests required by the manufacturer.

1.5 **QUALITY ASSURANCE**

.1 Manufacturers' Qualifications
- .1 Manufacturer to show minimum of thirty (30) years' experience in manufacturing electric self-regulating heating cables.
- .2 Manufacturer will be ISO 9001 registered.
- .3 Manufacturer to provide products consistent with IEEE 515.1 and CSA 22.2 No 130-03 requirements.

.2 Installer Qualifications

.1 Complete understanding of product and product literature from manufacturer or authorized representative prior to installation. Electrical connections to be performed by a licensed electrician.
.2 Subject to compliance with requirements of Contract Documents, installer shall be familiar with installing heat-trace cable and equipment.

.3 Regulatory Requirements and Approvals
.1 The system (heating cable, connection kits, and controller) shall be UL Listed and CSA Certified for snow melting.

1.6 DELIVERY, STORAGE, AND HANDLING

.1 General Requirements: deliver, store and handle products to prevent their deterioration or damage due to moisture, temperature changes, contaminates or other causes.

.2 Delivery and Acceptance Requirements: deliver products to site in original, unopened containers or packages with intact and legible manufacturers' labels identifying the following:
.1 Product and Manufacturer
.2 Length/Quantity
.3 Lot Number
.4 Installation and Operation Manual
.5 MSDS (if applicable)

.3 Storage and Handling Requirements
.1 Store the heating cable in a clean, dry location with a temperature range -18 degrees C (0 degrees F) to 60 degrees C (140 degrees F).
.2 Protect the heating cable from mechanical damage.

1.7 WARRANTY

.1 Extended Warranty
.1 Manufacturer's ten (10) year limited warranty for EM2-XR heating cables and components. Provide one (1) year warranty for all heat trace controllers.

2 Products

2.1 MANUFACTURERS

.1 Contract Documents are based on manufacturer and products named below to establish a standard of quality.

.2 Basis of Design
.1 Pentair Thermal Management, LLC
7433 Harwin Drive, Houston, TX 77036 94025
Tel: (800) 545-6258
www.thermal.pentair.com
.2 Snow Melting System
.1 Raychem ElectroMelt self-regulating heating cable
.2 Raychem EMK connection kits and accessories
.3 DigiTrace SMPG1 control panel.

.4 DigiTrace ProtoNode multi-protocol device server.

.3 Britech.

.4 Approved Equal.

2.2 **PRODUCTS, GENERAL**

.1 Single Source Responsibility: Furnish heat tracing system for snow melting from a single manufacturer.

.2 No parts of the system may be substituted or exchanged.

2.3 **PRODUCTS**

.1 Self-Regulating Heating Cable
- .1 Raychem ElectroMelt self-regulating heating cable manufactured by Pentair Thermal Management.
- .2 Consist of a continuous core of conductive polymer that is radiation cross-linked, extruded between two #14 AWG nickel-plated copper bus wires that varies its power output in response to temperature changes.
- .3 Modified polyolefin inner jacket and a tinned-copper braid to provide a ground path and enhance the cables ruggedness.
- .4 70-mil modified polyolefin outer jacket for enhanced mechanical and chemical protection.
- .5 Self-regulating factor of at least 75 percent. The self-regulating factor is defined as the percent reduction of the heating cable power output going from a 0 degree F to 80 degree F temperature.
- .6 Operate on line voltages of 208 volts without the use of transformers.
- .7 The outer jacket markings:
  - .1 Heating cable model number
  - .2 Agency listings
  - .3 Meter mark
  - .4 Lot/Batch ID

.2 Heating Cable Connection Kits
- .1 Raychem EMK connection kits.
- .2 Provide power connection, splice/tee and end seal kits compatible with selected heating cable.

.3 Heating Cable Installation Accessories
- .1 Expansion Joint Kit – Used to provide physical protection for the ElectroMelt heating cable beneath slab joints. An expansion tube is used to form an expansion loop for the heating cable. (PTM Catalog Number: EMK-XEJ)
- .2 Junction Box – The junction box is 825 cubic in (6,550 cubic cm), UL Listed weatherproof enclosure suitable for terminating both ends of an ElectroMelt heating cable circuit. The enclosure is made of molded structural foam and provides high impact strength, excellent chemical resistance, high dielectric strength, and excellent weathering capabilities. The junction box is large enough for 2 circuits of ElectroMelt heating cables. (PTM Catalog Number: EMK-XJB)

.3 Snow Melting Caution Sign – The snow melting caution sign is required by national electrical codes to indicate that an electrical snow melting system is installed in the slab. (PTM Catalog Number: SMCS)

.4 Control Methodology: Group Control
- .1 DigiTrace SMPG1 snow melting and de-icing power distribution and control panel.
- .2 Provide a group snow/ice melting controller with built-in GFPD compatible with selected heating cable.
- .3 Integrated 30 mA ground-fault circuit breaker.
- .4 Six (6) ground-fault circuit breakers rated up to 50 A.
- .5 Capable of operating with supply voltages of 208 V.
- .6 Capable of supporting up to six (6) type CIT-1 aerial and/or type SIT-6E slab mounted temperature and moisture sensors.
- .7 NEMA 3R/4 enclosure.
- .8 Adjustable hold-on timer (0 – 10 hours).
- .9 Integrated high-limit temperature sensor.
- .10 Contacts (10 mA dry switch contact) to interface with Integrated Automation System (BAS). Refer to Section 25 91 00.
  - .1 Inputs: Override On, Override Off
  - .2 Outputs: Supply, Snow, Heat, High Temp, Alarm

3 Execution

3.1 INSTALLATION

.1 Comply with manufacturer's recommendations in the ElectroMelt System Installation and Operation Manual (H58086).

.2 Install and secure the heating cable in accordance with the ElectroMelt System Installation and Operation Manual (H58086).

.3 Install electric heating cable according to the drawings and the manufacturer's instructions. The installer shall be responsible for providing a complete functional system, installed in accordance with applicable national and local requirements.

.4 Grounding of controller to Section 26 05 26.

.5 Connection of all electrical wiring to Section 26 05 19.

3.2 FIELD QUALITY CONTROL

.1 Start-up of system shall be performed by factory technician or factory representative.

.2 Field Testing and Inspections
- .1 The system shall be commissioned in accordance to the ElectroMelt Installation and Operation manual.
- .2 The heating cable circuit integrity shall be tested using a 2500 Vdc megohmmeter at the following intervals below. Minimum acceptable insulation resistance shall be 1000 megohms or greater.
  - .1 Before installing the heating cable

.2 After heating cable has been installed onto the pipe
.3 After installing connection kits
.4 After the thermal insulation is installed onto the pipe
.5 Prior to initial start-up (commissioning)
.6 As part of the regular system maintenance

.3 The technician shall verify that the control parameters are set to the application requirements.

.4 The technician shall verify that the alarm contacts are corrected connected to the BMS.

.5 The technician shall verify that the system is configured correctly with the BMS.

.6 All commissioning results will be recorded and presented to the owner.

3.3 MAINTENANCE

.1 Comply with manufacturer's recommendations in System Installation and Operation Manual.

END OF SECTION

SECTION 329121
PLANTING SOIL

Part 1 GENERAL

1.1 SUMMARY

A. The work in this section includes, but is not limited to, the following:

1. Mixing and testing of topsoil, sand and organic material to create planting mixes.
2. Installation of planting soil and structural soil.
3. Grading of planting soil
4. Adding organic material to the surface layer of planting soils.

B. References:

1. The following references and standards are used herein and shall mean:
   - .1 ASTM: American Society of Testing Materials.
   - .2 USDA: United States Department of Agriculture.
   - .3 U.S. Department of Agriculture, Natural Resources Conservation Service, 2003. National Soil Survey Handbook, title 430-VI. Available Online: http://soils.usda.gov/technical/handbook/
   - .4 Agriculture and Agri-Food Canada
     - .1 The Canadian System of Soil Classification, Third Edition, 1998.
   - .5 Canadian Council of Ministers of the Environment
     - .1 PN1340-2005, Guidelines for Compost Quality.

1.2 SUBMITTALS

A. CRITICAL PATH PROCESSING:

1. The Contractor shall be responsible for recognizing that these critical project materials warrant timely attention, that the testing process to achieve approved materials SHALL BE CONSIDERED A LEAD TIME ITEM, and that under no circumstance shall failure to comply with all specification requirements be a reason for expedient substitution of unacceptable material(s).
2. Certificates: Provide certificates required by authorities having jurisdiction. Contractor shall submit certification that all soil blend components and all soil blends meet all environmental standards of the Province of Ontario.

B. Product Data: Submit manufacturer product data and literature describing all products required by this section to the Construction Administrator for approval. Provide submittal 6 weeks before the installation of planting mix.

C. Material source locations: Submit locations of soil material sources. The Construction Administrator shall have the right to reject any material source. Submit the name, address and telephone number of the source contact, and the location of the soil source including directions to the specific field location on the property. Provide submittal six weeks before the installation of planting mix.

D. Samples: Submit samples of each product and material where required by the specification to the Construction Administrator for approval. Label samples to indicate product, specification number, characteristics, and locations in the Work. Samples will be reviewed for appearance only. Compliance with all other requirements is the exclusive responsibility of the contractor.

Delivered materials shall closely match the samples. Submit samples of all soil mix components a minimum of 6 weeks before the installation of planting mix.

1. Submit duplicate 4 litre samples (total 8 litres) of all soil mixes and soil additive products in this section. The number of samples shall be as required for each material.
   .1 Samples should be labeled to include the location of the source of the material.
   .2 Samples of all topsoil, sand, and planting mix shall be submitted at the same time as the particle size and physical analysis of that material.
   .3 Each test report shall be marked with the following information:
      .1 Date issued.
      .2 Project title and names of Contractor and material supplier.
      .3 Name of material and reference number from Part 2 of the specifications identifying the type of material.
      .4 Date, place, and time of sampling with a record of temperature and weather conditions.
      .5 Location of material source.
      .6 Testing laboratory name, address, and telephone number, and name(s), as applicable, of each field and laboratory inspector.
      .7 Type(s) of test
      .8 Results of tests including recommendations of acceptable ranges of the test data for the types of plants to be planted in the soil.
   .4 Samples and test reports for each material must be submitted at the same time. Samples and analysis of planting mix and organic matter must be submitted within 28 calendar days of sampling.
   .5 Samples of all products and planting mix components shall be submitted six weeks before the installation of planting mix. Planting mixes shall be submitted no less than two weeks after the approval of the mix component.

E. Submit for approval soil test analysis report to the Construction Administrator for each sample of topsoil and planting mix from an approved soil-testing laboratory.

1. The testing laboratory shall be approved by the Construction Administrator in advance. All soil and planting mix tests shall be conducted by soil laboratories accredited by The Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA), except as noted below. Current listing of accredited laboratories may be obtained on the web at http://www.omafra.gov.on.ca/english/crops/resource/soillabs.htm.
2. All soils shall also be tested for chemical characteristics in compliance with environmental standards established for the Project. See Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act Table 3 (http://www.ene.gov.on.ca/envision/gp/4697e.pdf).
3. All tests shall be performed in accordance with the current standards of the Association of Official Agriculture Chemists or the "Methods of Soil Analysis Part 1-3" as published by the Soil Scientist Society of America.
4. Provide a particle size analysis for all topsoil and planting mixes including the following gradient of mineral content:

USDA Designation	Size in mm.
Gravel	+2mm
Very Coarse Sand	1-2 mm
Coarse Sand	0.5 -1 mm
Medium Sand	0.25-0.5 mm

Fine Sand	0.1-0.25 mm
Very Fine Sand	0.05-0.1 mm
Silt	0.002-0.05 mm
Clay	minus 0.002 mm

.1 Particle size analysis for topsoil and planting mixes to include sand sieve analysis shall be performed and compared to the USDA Soil Classification System per ASTM D422 (hydrometer test) or ASTMF1632 (pipette test). The silt and clay content shall be determined on soil passing the #270 sieve and shall be reported separately.

5. Provide a chemical analysis including the following:
   .1 Reaction (pH and Buffer pH)
   .2 Nutrient levels by parts per million including nitrate, ammonium, phosphorus, potassium, calcium, magnesium, manganese, iron, copper, zinc and calcium. Nutrient test shall include the testing laboratory recommendations for supplemental additions to the planting soil.
   .3 Soluble salt by electrical conductivity of a 1:2 soil water sample measured in Milliohm per cm.
   .4 Cation Exchange Capacity (CEC).
   .5 Report suitability of topsoil or Planting Mix for growth of applicable planting material. Soil analysis tests shall include recommendations for normal acceptable ranges for the types of plants included in the project.
6. Provide percent of organic matter by weight as determined by ignition (Ash Burn Test or Walkley/Black Test, ASTM F1647) with the following modification. Samples of planting mix shall be screened through a 6mm screen rather than the standard 2mm screen. Planting mix samples shall not be "floated" to remove plant matter prior to testing for organic matter.
7. Provide a physical analysis of each planting mix to include the following test results:
   .1 Reaction (pH)
   .2 Salinity
   .3 Total Organic Nitrogen
   .4 C:N Ratio
   .5 Solvita Maturity Index
   .6 Percentage Moisture
   .7 Sodium (ppm)
   .8 Chloride (ppm)
   .9 Sodium Adsorption Ratio
   .10 Potassium
   .11 Calcium
   .12 Magnesium
   .13 Phosphorous
   .14 Sand Fraction
   .15 Silt Fraction
   .16 Clay Fraction
   .17 Total Salts
   .18 Cation Exchange Capacity
8. Certified reports shall be from samples taken within four months of the date of the sample submission

9. The Construction Administrator may request additional Planting Soil tests on different mix component ratios in order to attain results that more closely meet the mix requirements.
10. Submit the manufacturer's particle size analysis for all sand and gravel to the Construction Administrator for approval. Provide the manufacturer's Fines Modulus Index for each sand source.
11. Submit the manufacturer's particle size analysis, pH and certificate of length of composting period for all pine bark and other organic materials to the Construction Administrator for approval. The soil testing analysis performed shall include:
    .1 Reaction (pH)
    .2 Salinity
    .3 % Organic Matter
    .4 Carbon : Nitrogen (C:N) Ratio
    .5 Solvita Maturity Index
    .6 Percentage Moisture
    .7 Testing for physical, chemical, and biological contaminants and pathogens as required by local government regulations.
    .8 Certified reports shall be from samples taken within four months of the date of the sample submission.
12. Laboratory's comments or recommendations regarding amendment requirements or procedures shall not be interpreted to prescribe or dictate procedures or quantities of soil materials for the work of this Contract. Final approval of soil amendment procedures shall be approved by the Construction Administrator.
13. The Construction Administrator reserves the right to require additional soil analysis at any time such additional samples of materials are deemed necessary for verification of conformance to specification requirements. Contractor shall furnish samples for this purpose upon request and shall perform testing as requested.
14. All laboratory testing will be administered by the Construction Administrator, at the expense of the Contractor

1.3 SEQUENCING AND SCHEDULING

A. General: Prior to the start of Work, prepare a detailed schedule of the work for coordination with other trades.

B. Schedule the installation of planting mix after the area is no longer required for use by other trades and work.

C. Schedule all utility installations prior to beginning work in this section.

1.4 QUALITY ASSURANCE

A. Contractor is solely responsible for quality control of the Work.

B. The installer shall be a firm having at least 5 years of successful experience of a scope similar to that required for the Work, including the preparation, mixing and installation of custom planting soils in urban locations.

C. Comply with applicable requirements of the laws, codes, ordinances and regulations of federal, provincial and municipal authorities having jurisdiction. Obtain necessary approvals from all such authorities.

D. Comply with all requirements for control of silt and sediment during soil installation work as indicated in the contract documents.

E. Review of Work by the Construction Administrator: The Contractor shall comply with the requirements of the plans and specifications regardless of review or lack of review by the Construction Administrator.

1. Failure of the Construction Administrator to reject unsatisfactory workmanship or to notify the Contractor of their responsibility to repair and/or replace unsatisfactory work shall not constitute acceptance of the work.
2. The Construction Administrator reserves the right to take and analyze, at any time, such additional samples of materials as deemed necessary for verification of conformance to specification requirements. Contactor shall furnish samples for this purpose upon request and shall perform any additional testing requested.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Weather: Do not mix, deliver or place soils in frozen, wet, or muddy conditions.

B. Protect soil stock piles from rain and washing that can separate fines and coarse material. Cover stockpiles with plastic sheeting at the end of each work day.

C. Protect planting mix stock piles from contamination by chemicals, dust and debris that may be detrimental to plants or soil drainage.

1.6 SITE CONDITIONS

A. It is the responsibility of the Contractor to be aware of all surface and sub-surface conditions, and to report any circumstances that will negatively impact soil drainage. Do not proceed with work until unsatisfactory conditions have been corrected. Proceeding with work constitutes acceptance of existing or corrected conditions.

B. Utilities: Determine location of all utilities including vaults, conduits, pipes and wires adjacent to, below or within the areas of work. Perform all work in a manner, which will avoid damage to any utility. Hand excavate near any utility.

C. Waterproofing: Perform work in a manner, which will avoid damage to waterproofing membrane, protection board or other structural sealing materials.

D. Construction Sequencing:

1. Install all soils at the point in the project sequencing that the soil can be adequately protected from other work at the site.

E. Coordination: Coordinate work with that of other trades affecting or affected by work of this Section and cooperate to assure the steady progress of work.

F. Safety: The Contactor shall be responsible for pedestrian and vehicular safety and control all movement within and around the work site. Provide the necessary barriers, warning devices and ground personnel needed to give safety, warning and protection to persons and vehicular traffic within the area of work including the contractor's equipment and temporary storage within the public right of way. Provide any additional items required by the Construction Administrator.

G. Damage: During site preparation, soil installation and protection, the Contractor shall be responsible for all damage to existing features above and below ground incurred as a result of work operations. Repairs and/or replacements shall be made to the satisfaction of the Construction Administrator.

H. Protect all installed material for compaction, contamination and erosion. Install fences; utilize mulch, mats and geofabrics over the surface of the soil as required. In the event that any soil becomes compacted, contaminated or eroded, repair the damage using procedures required by the Construction Administrator.

I. Prior to importing topsoil, remove all construction debris on the orangutan habitat surface, including all rebar and wire ties associated with the construction of the shotcrete walls, to a minimum depth of 500mm. Use a metal detector to confirm that all ferrous debris has been removed.

Part 2 PRODUCTS

2.1 TOPSOIL (for Planting Soil Mixture)

A. Top soil shall be fertile, loam, sandy loam to sandy clay loam, suitable for the germination of seeds and the support of vegetative growth, which is a naturally produced soil harvested from the O or A horizon of the soil profile and meeting the following requirements.

1. Top soil texture shall be loam, sandy loam to sandy clay loam with clay content between 15 and 20% and a combined gravel and stone content of no more than 8%. No stone or gravel greater than 15mm diameter is allowed in the orangutan habitat portion of the project.
2. It is the intent of this specification to use naturally occurring soils available within the Toronto region.
3. Top soil shall retain a significant portion of the soils ped structure when stockpiled. Peds are defined as the clumps of soil naturally aggregated during the soil building process, by clays and soil biology.
4. Top soil shall contain between 2 to 5 percent, by weight, organic matter.
5. Top soil shall not contain materials and contaminants at levels that would be harmful to plant growth; or impair drainage, installation or maintenance of the resulting soil mix; or adversely impact its intended use including the following: refuse; roots; heavy or stiff lumps of clay; stones or gravel larger than 15 mm dia (.5”); wood or sticks larger than 25mm (1 inch) in diameter; construction debris; brush; litter; large clumps of root mats of plants; deleterious substances; subsoil; plant or soil pests; undesirable grasses including crabgrass or couch grass, noxious or weeds or weed seeds; foreign objects; and/or toxic materials. The Construction Administrator shall determine if the quantities of any of these materials is sufficient to cause rejection of the Top Soil.
6. Top soil shall not contain quack-grass rhizomes, Agropyron repens, and the nut-like tubers of nutgrass, Cyperus esculentus, and all other primary noxious weeds, in conformance with City of Toronto Weed Control Act.
7. Top soil pH value shall be between 6.5 and 7.5.
8. All screened top soil must be certified free of Atrazine.
9. Top soil shall have a maximum salinity of saturation extract conductivity: 3.0 mmhos/cm or dS/m at 25 degrees C.

B. Top soil shall be harvested from approved source locations that comply with all regulations governing the removal of topsoil.

C. Top soil may be purchased from a source of collected topsoil from development sites provided the sources of the soil stock pile is of similar textures and meets the requirements of this specification.

D. Top soil shall not be a soil mix including sand, fertilizer, or organic matter or compost added to soil in order to meet the texture, chemical or organic requirements for top soil. The organic matter content of the soil shall be residue of long term, natural soil building processes and not from added organic matter.

E. Top soil shall not be screened through sieves or screens smaller than 50mm to avoid eliminating the required soil ped sizes.

2.2 COARSE SAND (for Planting Soil Mixture)

A. Coarse concrete sand, ASTM C-33 Fine Aggregate, with a Fines Modulus Index of 2.8 and 3.2.

B. Physical Analysis:

SIEVE SIZE	% PASSING	% RETAINED	DIMENSION CLASS
25mm	100.0	0.0	Gravel
6mm	100.0	0.0	Fine Gravel
#10	96.6	3.4	Very Coarse Sand
#20	82.8	13.8	Coarse Sand
#40	38.4	44.4	Coarse Sand
#60	12.0	26.4	Medium Sand
#80	5.5	6.5	Fine Sand
#100	3.7	1.8	Very Fine Sand
#200	1.4	2.3	Very Fine Sand
Pan	0.0	1.4	Silt/Clay

C. The results must be submitted for Fines Modulus Index, percent (%) retained as well as (%) passing for all sieve sizes. Failure to include any of the aforementioned criteria will be cause for rejection of the test report.

D. Coarse Sand shall be clean, sharp, mineral sand.

E. Chemical analysis shall be as follows:

1. Organic matter content (% oven dry weight of soil) 0-0.5%.
2. pH shall be less than 8.6
3. Soluble salt content (Conductivity) Less than 0.5 mmhos/cm for 1:2 sample to water ratio.
4. Sand shall not contain toxic substance content at levels harmful to plant growth.

F. Provide an eight liter sample with manufacturer's literature and material testing certification that the product meets the requirements.

2.3 PINE BARK (For Planting Soil Mixture)

A. Horticultural grade milled pine bark size 0.1 mm - 15.0 mm. Pine bark shall be composted at least nine months. PH shall range between 4 and 5.0. Sap wood content less than 10%

B. Pine Bark shall be composted long enough to exhibit a dark brown color, approximately the color of dark chocolate candy with 70% chocolate content. Pine Bark the color of milk chocolate or lighter, or with an anaerobic odor or a pine sap odor shall be rejected.

C. Provide a two 4 liter sample with manufacturer's literature and material testing certification that the product meets the requirements.

2.4 COMPOST (for Planting Soil Mixture)

A. Compost for blending planting soil mixtures shall be a stable, humus-like material produced from the aerobic decomposition. Feedstock shall be yard waste trimmings and/or source-separated municipal solid waste of types that produce a fugally dominated Organic Matter, composted and cured until the maturity status complies with indices specified below. Except as specified herein, compost shall conform to the requirements for Category A Compost as

defined in the Guidelines for Compost Quality (2005), Canadian Council of Ministers of the Environment.

B. Compost shall not contain debris such as sharp objects, plastics, trace elements and foreign matter in excess of that defined for Category A Compost. Total of all stones, recognizable branches, wood chips and roots larger than 25mm in diameter shall be less than 5% by volume. A maximum of 10% of the compost (by volume) can be derived from bark feedstock.

C. Compost shall not be saturated with water or so dry as to produce dust.

D. Compost and Pine Bark shall be composted long enough to exhibit a dark brown color, approximately the color of dark chocolate candy with 70% chocolate content. Organic matter the color of milk chocolate or lighter shall be rejected.

E. Compost shall solely support the germination (greater than 90%) and establishment of perennial ryegrass (certified Canada #1 Grade). Test grasses shall not exhibit any phototoxic effects.

F. Compost shall have a strong aerobic (sweet) odor. Organic Matter lacking a strong aerobic odor or which has an anaerobic (sour) or pine or alcohol odor shall be rejected.

G. Certification: provide the following documentation:

.1 A statement that the Organic Matter meets all health and safety regulations.

.2 Feedstock type and percentage in the final Organic Matter product.

H. Testing: Organic Matter shall have one (1) composite sample tested from each 100 cubic meters of material intended for use in soil mixes. The results of Organic Matter analysis shall be provided by the Organic Matter supplier for approval by Construction Administrator. Organic Matter shall meet the following criteria as reported by the following laboratory tests:

1. Chemical and physical testing shall be conducted by soil laboratories accredited by The Compost Quality Alliance (CQA) utilizing test methods specified in The Test Methods for Examination of Composting and Compost (TMECC) except as specified herein.

PARAMETER	RANGE	TESTING METHOD
pH	5.5 – 7.5	TMECC 4.11A
Soluble Salt Concentration	< 4dS/m	TMECC 4.10-A
Moisture	35-55% wet weight basis	
Organic Matter	>35% dry weight basis	TMECC 5.07-A
Carbon to Nitrogen Ratio	15:1 – 25:1	
Particle Size	99% pass through 50mm screen or smaller; 25% pass through 10mm screen or smaller	TMECC 2.02-B
Solvita Maturity Index	6 to 8	Solvita
Physical contaminants (man-made inerts)	<1% weight basis	TMECC 3.08-A

2. Metal content shall comply with Interim Guidelines for the Production and Use of Aerobic Compost in Ontario (2004) except for copper and zinc, which must comply with Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act Table 3(medium to fine-textured soils).

3. Pathogen reduction shall meet Section 6.0 of Interim Guidelines for the Production and Use of Aerobic Compost in Ontario (2004).

I. Provide an eight liter sample with manufacturer's literature and material testing certification that the product meets the requirements.

2.5 CHEMICAL ADDITIVES

A. **No chemical additives shall be used within the orangutan habitat without specific approval of both the Zoo's veterinary and horticultural staffs.**

B. Chemicals and materials designed to increase soil fertility. All material shall be delivered to the site in unopened containers and stored in a dry enclosed space suitable for the material and meeting all environmental regulations. Biological additives shall be protected from extreme cold and heat. All products shall be freshly manufactured and dated for the season in which the products are to be used.

1. Fertilizer for planting shall be organic fertilizer, produced from organic sources. Fertilizer selections shall be based on the recommendations of the soil test. Specialty fertilizers and additives noted below shall be used where required by the specifications prior to the use of any additional fertilizer. Submit manufacturers product literature.
2. Sulfur shall be granular, bio-degradable sulfur, sized as follows:

PERCENT PASSING	SIEVE SIZE
100%	#6 mesh
0 – 10%	#4 mesh

.1 Sulfur content 90% minimum.

.2 Sulfur shall be "Lightning 90%" manufactured by International Sulfur, Inc., Mt. Pleasant, Texas. Submit manufacturer's product literature.

3. Or approved alternative.

Part 3 EXECUTION

3.1 SITE EXAMINATION

A. Examine the surface grades and soil conditions for any circumstances that might be detrimental to soil drainage, such as uneven sub grades and waterproofing that may hold or pond water, deposits of construction-related waste or soil contamination, storage of material or equipment, soil compaction or poor drainage. Confirm that all utility work and installation of planter drainage has been completed and tested. Examine the grading, verify all elevations. Confirm that all other work in the area of planting mix installation is completed. Notify the Construction Administrator in writing of any unsatisfactory conditions.

3.2 COORDINATION WITH PROJECT WORK

A. The Contractor shall coordinate with all other work that may impact the completion of the work. Protect installed planting mix from compaction by other trades.

B. Assure that all sediment control required by the project documents is in place during the installation of planting soil. Provide additional sediment control to retain planting mix within the project limits as needed.

C. Irrigation: Irrigation lines and heads encountered during the planting mix installation process shall be avoided. When unavoidable, advice Construction Administrator of

situation and do not proceed with work until direction has been given by the Construction Administrator.

3.3 GRADE AND ELEVATION CONTROL

A. Provide grade and elevation control during installation of planting mix. Utilize grade stakes, surveying equipment and other means and methods to assure that grades and contours conform to the grades indicated on the plans.

B. Maintain grade stakes until the grades have been viewed by the Construction Administrator.

3.4 SITE PREPARATION

A. Prior to importing topsoil, remove all construction debris on the orangutan habitat surface, including all rebar and wire ties associated with the construction of the shotcrete walls, to a minimum depth of 500mm. Use a metal detector to confirm that all ferrous debris has been removed.

B. In areas not above structure, excavate to the proposed sub grade. Maintain all required angles of repose of the adjacent materials as shown on the drawings. Do not over excavate compacted sub grades of adjacent pavement or structures. Remove all construction debris and material including any temporary construction roads.

C. Confirm that the sub grade is at the proper elevation and compacted as required. Sub grade elevations shall slope parallel to the finished grade and/or toward the subsurface drain lines as shown on the drawings.

D. Do not proceed with the installation of planting mix, until all utility work in the area has been installed.

E. Do not begin planting mix installation until all subsurface drainage, irrigation main lines, lateral lines, and irrigation risers (if applicable) shown on the drawings are viewed and approved by the Construction Administrator.

F. Protect adjacent walls, walks and utilities from damage or staining by the soil. Use 12mm plywood and or plastic sheeting as directed to cover existing concrete, metal and masonry work and other items as directed during the progress of the work.

1. Clean up any soil or dirt spilled on any paved surface, including at the end of each working day.
2. Any damage to the paving or architectural work shall be repaired by the Contractor at the Contractor's expense.

3.5 PLANTING SOIL MIXTURE INSTALLATION

A. Prior to installing any planting mix, the Construction Administrator shall approve the condition of the sub grade and the previously installed sub grade preparation and the installation of subsurface drainage material.

B. Planting soil composition is to meet the requirements show on standard City of Toronto detail PD-101 Planting Detail for Balled and Burlapped Trees in Turf.

C. In areas of soil installation above existing subsoil, till the planting mix into the bottom layer of subsoil.

1. Loosen or till the subsoil of the sub grade to a depth of 25-50mm with a backhoe or other suitable device.
2. Spread a layer of the specified planting mix 25-50mm deep over the sub grade. Thoroughly till the planting mix and the sub grade together.

3. Immediately install the remaining planting mix in accordance with the following specifications. Protect the tilled area from traffic. DO NOT allow the tilled sub grade to become compacted.
4. In the event that the tilled area becomes overly compacted, till the area again prior to installing the planting mix.

D. Install the remaining planting mix in 300-400mm lifts to the required depths. Work out from the installed soil such that equipment does not have to pass over installed soils.

E. The depths and grades shown on the drawings are the final grades after settlement and shrinkage of the organic material. The Contractor shall install the planting mix at a higher level to anticipate this reduction of planting mix volume depending upon predicted settling properties for each type of planting mix as indicated on the drawing.

F. Utilize grading and earth moving equipment that uses low impact tracks that is rated to exert a static force on the ground of no more than 20 kg/M2. All equipment used to install soil shall have buckets equipped with teeth to loosen soil compaction.

G. When any equipment passes over previously installed soil it shall reverse out of the soil area over the same path dragging the teeth of the bucket over the tracks to break surface compaction created by the equipment.

3.6 PLANTING MIX COMPACTION

A. Compact each 300-400mm lift to the compaction rates indicated and using the methods approved for the soil mock up.

1. Achieve a soil density of between 75 and 80% of maximum dry density as determined by Proctor test.
2. Planting mix compaction shall be tested at each lift using a cone penetrometer calibrated to the mock up soil and its moisture level. The same penetrometer and moisture meter used for the testing of the mock up shall be used to test installed soil throughout the work.
3. Maintain at the site a hand penetrometer with pressure dial and a soil moisture meter on the site at all times to measure the compaction rates relative to the mock up soil compaction. The Construction Administrator may utilize this equipment to verify compaction rates.

B. Compact Planting mix under and beside the rootballs of all trees to between 85 and 90% of maximum dry density to reduce settlement and provide a stable base for the tree as indicated on the drawings.

C. Maintain moisture conditions within the planting mixes during installation to allow for satisfactory compaction. Suspend installation operations if the planting mix becomes wet. Do not place planting mixes on wet or frozen sub grade.

D. Provide adequate equipment to achieve consistent and uniform compaction of the planting mixes. Use the smallest equipment that can reasonably perform the task of spreading and compaction.

E. Using the penetrometer and the moisture meter, test the compaction levels in the installed soil.

1. Testing shall be performed by the Contractor and included in the base contract.
2. Record the test results on a soil compaction testing log. This report shall include the location of the test, the depth of the test measures from the proposed finished grade, the penetrometer reading, the moisture meter reading, the penetrometer reading in the mock up soil and the moisture meter reading in the mock up soil.

3. Submit the compaction log to the Construction Administrator at the end of soil installation period. The soil compaction log shall be kept current and available at the site for review at all times.

F. At the end of the installation of the soil and prior to the installation of Organic matter and plants, take a minimum of four undisturbed soil samples from locations selected by the Construction Administrator to determine bulk density. Submit test results for approval.

3.7 INSTALLATION OF CHEMICAL ADDITIVES

A. **No chemical additives shall be used within the orangutan habitat without specific approval of both the Zoo's veterinary and horticultural staffs.**

B. Following the installation of each soil, apply chemical additives as recommended by the soil test, and appropriate to the soil type and specific plants to be installed.

C. Types, application rates and methods of application shall be approved by the Construction Administrator prior to any applications.

3.8 PROTECTION

A. Protect planting mix from compaction and contamination by dust, debris, and any toxic material harmful to plants or humans after placement. Any area, which becomes compacted, shall be tilled to a depth of 150mm. Any uneven or settled areas shall be filled and re graded.

B. Phase the installation of the planting mix such that equipment does not have to travel over already installed planting mix.

3.9 PLANTING SOIL MIXTURE FINE GRADING

A. The Construction Administrator shall view all rough grading prior to the installation of Organic Matter, fine grading, planting, and mulching.

B. Grade the finish surface of all planted areas to meet the grades shown on the drawings after the twelve-month settling period. Allow the finished grades to remain 50-75mm higher than the grades on the grading plan to anticipate settlement over the first year. Set grades at time of installation high enough relative to the type of planting mix and settlement anticipated so that the planting mix will be at the correct grades after the settlement period. At the end of the planting warrantee period, if grades have settled greater than 5% of the soil depth below the grades shown on the drawings, reset the grades to the final grades shown on the grading plan.

C. Adjust the finish grades to meet field conditions as directed.

D. Provide for positive drainage from all areas toward the existing inlets, drainage structures and or the edges of planting beds. Adjust grades as directed to reflect actual constructed field conditions of paving, wall and inlet elevations. Notify the Construction Administrator in the event that conditions make it impossible to achieve positive drainage.

E. Provide smooth transitions between slopes of different gradients and direction. Modify the grade so that the finish grade is flush with all paving surfaces or as directed by the drawings.

F. Fill all dips and remove any bumps in the overall plane of the slope.

1. The tolerance for dips and bumps in shrub and ground cover planting areas shall be a 25mm deviation from the plane in 2000mm.

G. Restore all grades after the installation of plants.

3.10 INSTALLATION OF ORGANIC MATTER IN AREAS OF PLANTING SOIL MIXTURE

A. After the specified PLANTING MIXTURE is installed, and just prior to the installation of tree, shrub or groundcover plantings, spread 100mm of Organic Matter over the area designated on the plans and details and roto till into the top 150mm of the planting mix.

3.11 CLEAN-UP

A. During installation, keep pavements clean and work area in an orderly condition.

B. Keep the site free of garbage at all times. Immediately dispose of wrappings or waste materials associated with products necessary for the completion of the work.

C. All garbage shall be kept in a central collection container. Do not bury garbage in back-fill.

D. Once installation is complete, remove any excess soil from pavements or embedded fixtures.

3.12 PROTECTION DURING CONSTRUCTION

A. The Contractor shall protect landscape work and materials from damage due to landscape operations, operations by other Contractors or trespassers. Maintain protection during installation until acceptance. Treat, repair or replace damaged planting mix installation work immediately.

B. Till compacted planting mix and replace planting mix that has become contaminated as determined by the Construction Administrator. Planting mix shall be tilled or replaced by the Contractor at no expense to the Owner.

3.13 REPAIR OF SETTLED PLANTING MIX

A. At the end of twelve months after the date of substantial completion of the planting mix installation work, inspect the site and restore any areas where the grades have settled beyond the elevations shown on the drawings by an amount greater than 5% of the soil depth.

1. In shrub planting areas where the settlement is 75mm or less, remove the mulch, top dress the area with the specified planting mix and re mulch.
2. In all ground cover areas and shrub planting areas where the settlement is greater than 75mm remove the mulch and plants, add the specified planting mix, re plant and re mulch.

END OF SECTION 32 91 21

SECTION 329310
TREES, SHRUBS, AND GROUNDCOVER PLANTING

PART 1 GENERAL

1.1 SUMMARY

A. The work in this section includes, but is not limited to the following:

1. Sourcing of Plant Material.
2. Review of plant material at source for conformance with specifications and adequate health prior to requesting digging and prior to request of delivery.
3. Review of plant material at source for conformance with specifications and adequate health prior to requesting digging and prior to request of delivery.
4. Coordination with Supplier for delivery and review and acceptance of plant material for conformance with specification and adequate health upon delivery to the site.
5. Installation of plant material, accessories, mulch, tree support, and maintenance for the duration of the warranty period.
6. Maintenance of all plant material for the duration of the two-year warranty period including watering, pruning and weeding as described throughout this section.

1.2 RELATED DOCUMENTS AND REFERENCES

A. Agriculture and Agri-Food Canada (AAFC).

1. Plant Hardiness Zones in Canada-2000.

B. Canadian Nursery Landscape Association (CNLA).

1. Canadian Standards for Nursery Stock-2001.

C. Health Canada/Workplace Hazardous Materials Information System (WHMIS).

1. Material Safety Data Sheets (MSDS).

1.3 SUBMITTALS

A. Make submittals in accordance with 01 33 00 – Submittal Procedures.

B. Product Data: Submit manufacturer product data and literature describing all products required by this section to the Construction Administrator for approval. Provide submittal twelve (12) weeks before the installation of plant material.

C. Material Certificates: Submit material certificates for all natural and bulk material indicating that the material meets the requirements of the specification to the Construction Administrator for approval. Provide submittal twelve (12) weeks before the installation of plant material.

D. Samples: Submit samples of each product and material where required by the specification to the Construction Administrator for approval. Label samples to indicate product, characteristics, and locations in the Work. Samples will be reviewed for appearance only. Compliance with all other requirements is the exclusive responsibility of the Contractor.

1.4 SEQUENCING AND SCHEDULING

A. Prior to the start of Work, prepare a detailed schedule of the work for coordination with other trades. Prepare planting schedule in accordance with normal planting time of the specified plant material.

B. Do not schedule installation of plant material in areas that require additional access for other work.

C. Unless otherwise approved in writing by the Construction Administrator, trees should be dug and planted as per section 3.3. Upon award of contract, Contractor responsible for securing stock, confirming and ensuring coordination of both digging and planting schedule with the Construction Administrator, supplier and associated trades in accordance with construction schedule.

1.5 QUALITY ASSURANCE

A. Acceptance:

1. The contractor is responsible for locating, review and acceptance of the plant material at the source and – once delivered to the site – for conformance with the contract drawings and to ensure specimens are of acceptable health. Any material which does not meet the requirements as stipulated here should be flagged and the Construction Administrator notified.
2. Acceptance of plant material by the Construction Administrator shall be for general conformance to specified size, character and quality and does not relieve the Contractor of responsibility for full conformance to the contract documents, including correct species.
3. The Construction Administrator will inspect all work for substantial completion upon written request of the Contractor. The request shall be received at least ten (10) working days before the anticipated date of inspection.
4. The Contractor is responsible for the condition and quality of work and materials during construction, and until Acceptance. Contractor shall bear the total cost of replacing any and all plant material until this time.
5. Upon acceptance of plant material by installer at time of delivery on site, plant material warranty shall be transferred from the supplying nursery to the installing Contractor.

B. Warranty:

1. Submit for the Owner's documentation. Furnish written warranty in form stipulated by the Construction Administrator, signed by the contractor and the installer, agreeing to replace defective Work, which has failed as a result of defects in the growth or health of the plant materials. Defective plant materials are defined as plant materials that are dead or not in a healthy, attractive condition as defined below.
2. Plant material warranty shall begin on the date of plant acceptance and continue for the following periods:
   - .1 All trees, shrubs and ground covers – Two (2) years.
   - .2 When the work is accepted in parts, the warranty periods shall extend from each of the partial acceptances to the terminal date of the last warranty period. Thus, all warranty periods for each class of warranty, shall terminate at one time.
   - .3 Plants shall be healthy, free of pests and disease, and in flourishing condition at the end of the warranty period. Plants shall be free of dead and dying branches and branch tips, and shall bear foliage of normal density, size, form, and color for the species.
   - .4 Plants that are dead, diseased, insect infested, or not in a vigorous, thriving condition, as determined by the Construction Administrator during or at the end of the warranty period, shall be deemed defective. Plants that have had more than 25% of their branches die or removed shall be replaced. Plants that have had a major branch or side of the plant removed such that current or future aesthetic appeal or structural integrity of the plant, as determined by the Construction Administrator, is diminished shall be considered defective. Plant material determined to be defective shall be replaced without cost to the Owner, as soon as weather conditions permit and within the specified planting period.
   - .5 The Contractor is exempt from replacing plants, after Acceptance and during the warranty period, that are removed by others, lost or damaged due to occupancy of project in any part, lost or damaged by a third party, vandalism, or any natural disaster.
   - .6 Replacements shall closely match adjacent specimens of the same species. Replacements shall be subject to all requirements stated in this specification. Make all

necessary repairs due to plant replacements. Such repairs shall be done at no extra cost to the Owner.

.7 The warranty of all replacement plants shall extend for an additional one-year period from the date of their acceptance after replacement. In the event that a replacement plant is not acceptable during or at the end of the said extended warranty period, the Construction Administrator may elect one more replacement items or credit for each item. These replacement items are not protected under a warranty period.

.8 At the end of the warranty period, and no less than five (5) days prior to final inspection, tree wrap, ties, and guying shall be removed from the site. Tree wraps should not be on trunks during active growing seasons. All trees that have leaned shall be straightened.

C. Final Acceptance:

1. At the end of the warranty period, the Construction Administrator shall inspect all warranted work, upon written request of the Contractor. The request shall be received at least ten (10) working days before the anticipated date for final inspection.
2. Final Acceptance will be given only when all the requirements of this specification have been met.

D. Contractor's Quality Assurance Responsibilities: Contractor is solely responsible for quality control of the Work.

E. Qualified Installer: the installer shall be a firm having at least 5 years of successful experience of a scope similar to that required for the Work, including the handling and planting of large specimen trees in urban areas.

F. Regulatory requirements: Comply with applicable requirements of the laws, codes, ordinances and regulations of federal, Provincial and municipal authorities having jurisdiction. Obtain necessary approvals from all such authorities.

1.6 STORAGE AND PROTECTION

A. Protect plant material from frost, excessive heat, wind and sun following delivery.

B. Immediately store and protect plant material, which will not be installed within 1 hour after arrival at site in storage location, approved by the Construction Administrator.

C. Protect stored plant material from frost, wind and sun and as follows:

1. For pots and containers, maintain moisture level in containers.
2. For balled and burlapped and wire basket root balls, place to protect branches from damage. Maintain moisture level in root zones.

D. Herbaceous plants must be planted the day they arrive on-site.

E. Woody plants must be planted within 3-days of arriving on site.

1.7 SCHEDULING

A. Obtain approval from the Construction Administrator of schedule 7 days in advance of shipment of plant material.

B. Schedule to include:

1. Quantity and type of plant material.
2. Shipping dates.
3. Arrival dates on site.
4. Planting Dates.

1.8 SELECTION OF PLANT MATERIAL

A. Plant material will be purchased by the Contractor on behalf of the Owner.

B. Contractor is responsible for reviewing and approving material at source prior to delivery.

C. Contract Administrator to tag trees at nursery.

D. Contractor may request review of material by the Construction Administrator at source prior to delivery.

1.9 REJECTION OF PLANT MATERIALS

A. The Construction Administrator has the right to reject any and all plant material that does not conform to the requirements of this specification at any time regardless of any previous approval.

B. When a plant has been rejected, immediately remove it from the area of the Work and replace it with a plant of the required species, size and quality at the earliest planting period consistent with these specifications. Replacement plant material shall meet all the requirements of this specification. Rejected plants shall be replaced at no cost to the Owner.

C. Acceptance shall not be given for the planting Work until all plants rejected during the course of the Work are replaced.

D. Any plant that has the following characteristics shall be cause for rejection:

.1 Any plant that has a canopy with 15% or more dead or removed limbs.

.2 Evidence of damage to plant material, which diminishes the aesthetic character and form or structural integrity of the plant or group of plants

.3 Evidence of improper digging; inadequate protection following digging; carelessness while in transit; evidence of desiccation or wind-related damage; cold damage; improper handing or storage; root zones that have dried to the point of leaf wilt; cracked, loose, damaged or distorted root balls.

.4 Plants with undersized root balls or containers, kinked or girdling roots, matted roots on the top, and edges of the container, excessive surface adventitious roots, root balls and containers with no structural roots in the top 75mm of the soil.

.5 Plants balled with synthetic, treated or non-biodegradable fabrics.

.6 Any tree that is of a species that characteristically has a dominant central leader, and if the leader is dead or removed, the tree will not have a form consistent with the species.

.7 Any tree that has open wounds (not completely healed over) that penetrates the cambium into the wood on trunks or major limbs the removal of which would result in the loss of 25% or more of the structure and form of the tree.

.8 Any tree found planted with the first proper root and/or the real root crown buried more than 2.5cm deep will be rejected and require replacement or replanting at the City of Toronto's discretion.

1.10 SITE CONDITIONS

A. It is the responsibility of the Contractor to be aware of all surface and sub-surface conditions, and to report any circumstances that would negatively impact the health of plantings. Examine the sub-grade per Part 3 Article, Site Examination. Do not proceed with work until unsatisfactory conditions have been corrected.

B. It is the responsibility of the Contractor to be familiar with the local growing conditions, and if any specified plant material will be in conflict with these conditions. Report any potential conflicts to the Construction Administrator.

C. Do not install plant materials into saturated or frozen soils. Do not install plant materials during inclement weather, such as rain or snow or during extremely hot, cold or windy conditions.

1.11 PLANTING AROUND UTILITIES

A. Contractor shall carefully examine the civil, record, and survey drawings to become familiar with the existing underground conditions before digging.

B. Determine location of underground utilities and perform work in a manner that will avoid possible damage. Hand excavate, as required. Maintain grade stakes set by others until parties concerned mutually agree upon removal.

PART 2 PRODUCTS

2.1 ACCEPTED SUPPLIERS

A. All nursery sources are noted on plant schedule.

2.2 PLANT MATERIAL: GENERAL

A. Provide trees and plants of quantity, size, genus, species, and variety or cultivars as shown and scheduled in contract documents. All plant material shall conform to the Canadian Standard for Nursery Stock unless specified otherwise by this specification.

B. Caliper Measurement for trees shall be taken at a point on the trunk 150mm above top of the root ball after harvesting in accordance with these specifications.

C. Plants larger than specified may be used if acceptable to the Construction Administrator. Use of such plants shall not increase the contract price. If larger plants are accepted the ball-of-earth shall be increased in proportion to the size of the plant.

D. Plants shall be measured when branches are in their normal position. Height and spread dimensions specified refer to the main body of the plant and not from branch tip to tip.

E. If a range of size is given, no plant shall be less than the minimum size and not less than 50 percent of the plants shall be as large as the maximum size specified. The measurements specified are the minimum size acceptable and are the measurements after pruning, where pruning is required.

F. Plants shall have outstanding form; symmetrical, heavily branched with an even branch distribution, densely foliated and/or budded, and a strong, straight distinct leader where this is characteristic of the species. Plants that meet the measurements specified, but do not possess a normal balance between height and spread, shall be rejected. The Construction Administrator shall be the final arbiter of acceptability of plant form.

G. Plants shall be true species and variety and shall conform to measurements, specified in the plant list.

H. Trees shall have a central leader to the terminal bud. Co dominant leaders or branch crotch unions without evidence of a bark ridge shall be cause for rejection.

I. Provide healthy, vigorous stock, grown in a recognized nursery in accordance with good horticultural practice and free of disease, insects, eggs, larvae, and defects such as knots, scrapes, broken or split branches, fresh limb cuts, sunscald, injuries, abrasions, or disfigurement. All graft unions shall be completely healed, free of extreme succulence. All graft unions shall be visible above the soil line. For grated and budded plants, a crook at the graft or bud point shall be acceptable.

J. Plants shall not be pruned before delivery. Trees, which have a damaged or crooked leader, or multiple leaders, unless specifically specified, will be rejected. Trees with abrasions of the bark, sunscalds, disfiguring knots, or fresh cut of limbs over 25mm, which have not completely callused, will be rejected.

K. All plants shall be harvested as required by ANSI Z60.1 and additional requirements cited in this section below. In the event that the required modifications are in conflict, the modifications shall take precedent.

L. All trees and shrubs shall be dug prior to leafing out (bud break) in the spring or after plants have gone dormant in the fall except for the plants known to require spring transplanting, which are only to be dug prior to leafing out in the spring. Plants that are required to be planted in summer

shall be dug in the spring and maintained in a mulched and sufficiently irrigated holding area. If required, reestablish any decayed burlap material prior to final delivery.

M. All new trees must arrive on site in balled-and-burlapped condition, with a minimum caliper of 70mm (or as specified if larger). Each tree shall have the burlap and wire cage opened and soil brushed away from the top of the root ball, until the first proper root is found, indicating the top of the real root crown. The tree is then to be planted with this level to be considered the top of root ball for any/all other instructions. Any tree found planted with the first proper root and/or the real root crown buried more than 2.5cm deep will be rejected and require replacement or replanting at the City of Toronto's discretion.

2.3 BALLED AND BURLAPPED PLANT MATERIAL

A. Provide field grown, quality plant material of height or caliper scheduled or shown and with branching configurations and spread characteristics.

B. Trees: quality single-stem balled and burlapped (B&B) deciduous trees. Container trees shall not be accepted, unless specified or approved by the Construction Administrator.

C. Shrubs: Provide quality balled and burlapped (B&B) deciduous shrubs, except where special forms are shown or listed.

D. For all trees, the following work shall be carried out by the supplying nursery; however, it is the installing contractor's responsibility to confirm the work listed below has been completed prior to material acceptance. Upon acceptance, material not in accordance with the specifications below will be replaced at the installer's expense.

E. Harvesting and Root Ball Requirements: All balled and burlapped trees and shrubs shall be harvested in accordance with Canadian Standards for Nursery Stock-2001, with the following modifications.

F. Prior to digging each tree and any shrub greater than 900mm in height, check for the location of the structural roots within the root ball area. Using a surveyor's chain pin, or other suitable device, probe into the soil around the trunk of the plant to locate the position and depth of the structural roots. A surveyor's chain pin is a metal rod between 5mm in diameter, 300mm long with a cone shaped point, of sufficient rigidity to probe into the soil around the tree.

G. A minimum of three radial roots shall be found in each plant. The top structural roots shall be defined as large woody roots found at a point 100mm from the face of the trunk. These roots shall be roughly radial to the trunk and be at approximately the same depth. Plants with roots that appear to be circling, or at depths differing greater than 75mm may be rejected. Plants with visible circling roots at the surface shall be rejected. The Construction Administrator may at any time request removal of soil from representative trees to confirm the location and distribution of the roots. Rejection of the sample tree shall be grounds to reject all the trees from that nursery source.

H. Apply a 10mm diameter, white dot of paint on the north side of all trees 300mm above the top structural root. The top of the root ball when dug shall be between 225mm and 300mm be low the center of this dot such that the top structural roots are no greater than 75mm below the top of the rootball when measured 100mm from the face of the trunk.

I. For trees or shrubs where the top structural roots are 75mm or less in depth, the soil at the top of the root ball may be left in place and the plant harvested. For trees with more than 75mm of soil cover above structural roots, soil should be carefully removed to the depth of the highest root. This will expose the root flare or the future flare point of the tree. Care must be exercised not to damage the bark at on the root flare and the top of the structural root.

J. Plants shall be burlap wrapped using drum lacing technique. If wire baskets are used, a low-profile basket shall be used. A low-profile basket is defined as having the top of the highest loops on the basket no less than 100mm and no greater than 200mm below the shoulder of the root ball as indicated on the drawings.

K. Twine and burlap used for wrapping the root ball shall be natural, untreated, biodegradable material.

L. Apply 3mm thick, wax sealed, corrugated cardboard trunk protection around the trunk of the tree from the top of the root ball to the first branch. Cardboard shall be coated to reduce water penetration, and fabricated for this application. Secure the cardboard with biodegradable twine.

2.4 CONTAINER GROWN PLANT MATERIAL

A. Container grown shrubs may be permitted when indicated on the drawing or approved by the Construction Administrator. Container grown trees or containerized trees shall not be permitted, unless accepted by the Construction Administrator.

B. Provide plants established and well rooted in removable containers or integral peat pots and with not less than the minimum number and length of runners required by Canadian Standards for Nursery Stock-2001 for the pot size listed in the planting schedule.

C. Container-grown stock shall have been grown in a container long enough for the root system to have developed sufficiently to hold its soil together but not so long as to have developed a girdling root mat around the edge of the container.

D. The root system of each container grown plant shall be inspected by the contractor to determine the condition of the roots as the plants are being installed. Remedial action to remove circling and matted roots on the edge of the container and in the interior of the pot soil mass as described in Part 3 of this section shall be performed on each plant.

2.5 MULCH

A. Mulch shall be chipped hardwood blend, the composition of which is to be reviewed by contract administrator and be free from roots, leaves, twigs, debris, stones, fungus, crabgrass rhizomes, or any material detrimental to plant growth. Material shall be mulching grade, uniform in size and foreign matter. Wood content shall not exceed 15% by volume. Mulch shall be composted to the point where all wood has turned dark brown within the interior of the fragment. Mulch that has become saturated with water and presents an anaerobic odor shall be rejected. Submit manufactures material certificate that product meets the requirements and an 8 liter sample packaged in two 4 liter bags for approval.

PART 3 EXECUTION

3.1 SITE EXAMINATION

A. Examine the surface grades and soil conditions for any circumstances that might be detrimental to plant growth, such as deposits of construction-related waste or soil contamination, storage of material or equipment, soil compaction or poor drainage. Examine the grading, verify all elevations, and notify the Construction Administrator in writing of any unsatisfactory conditions.

3.2 DELIVERY, STORAGE AND HANDLING

A. When weather conditions are such that exposure to sun, wind, and extremes of heat or cold temperatures during transit may adversely affect health of plants, transport plant material to site in controlled environment trailer. Use carrier experienced in handling live plants.

B. Protect materials from deterioration during delivery and while stored at the site. Adequately protect plants from drying out, exposure of roots to sun, wind or extremes of heat and cold temperatures. If planting is delayed more than 24 hours after delivery, set plants in location designated by the Construction Administrator and cover balled and burlapped root balls with moist mulch. Provide adequate water to the root ball or container during the storage period. Do not remove container stock from containers until planting time

C. Do not prune prior to delivery unless otherwise approved by the Construction Administrator. Do not bend or bind-tie trees or plants in a way that damages bark, breaks branches, or destroys natural shape.

D. Provide protective covering over all plants during delivery to prevent plants and rootballs from drying out. Mist plant tops, rootballs and tarp covers every 4 hours during delivery transit.

E. Deliver trees and plants after preparations for planting have been completed and plant immediately. If planting is delayed more than 6 hours after delivery:

1. Set trees and plants in designated area, protect from weather and mechanical damage, and keep roots moist by covering with mulch, burlap or other acceptable means of retaining moisture.
2. Mist plant tops regularly such that plant tops remain moist. Water root zones to maintain water levels in the root zone above wilt point but below soil saturation.
3. The duration, method and location of storage of plant materials shall be subject to the approval of the Construction Administrator.
4. Provide proper spacing for trees, such that the stockpiled plant material has full access to light and air. Take all precautions to prevent defoliation of stockpiled material.
5. Do not deliver more plants to the site than there is space with adequate storage conditions to receive the plants. Provide a suitable remote staging area for plants and other supplies.
6. Do not remove container-grown stock from containers until planting time. Prepare and plant container-grown stock immediately once removed from container.

3.3 PLANTING SEASON

A. Planting shall only be performed when weather and soil conditions are suitable for planting the materials specified in accordance with locally accepted practice. Install plant materials during the planting time as described below unless otherwise approved in writing by the Construction Administrator. In the event that the contractor request planting outside the dates of the planting season, approval of the request does not change the requirements of the warranty.

B. Deciduous Trees: April 15 - June 30 and September 1 – November 1

C. Deciduous Shrubs: April 15 – June 30 and September 1 - November 1

D. Perennials and Groundcover: May 1 – June 30 and September 1 - October 1

E. Evergreen Trees and Shrubs: April 15 – June 30 and September 1 – October 1

3.4 COORDINATION WITH PROJECT WORK

A. The Contractor shall coordinate with all other work that may impact the completion of the work.

B. Irrigation: not proceed with work until direction has been given by the Construction Administrator.

3.5 LAYOUT AND PLANTING SEQUENCE

A. When applicable, plant trees before adjacent shrubs, groundcovers, vines and other plants are in place. Where spacing dimensions or locations are not clear, notify the Construction Administrator before installation.

B. Notify the Construction Administrator, one (1) week prior to layout for approval. Layout trips shall be arranged to maximize the Construction Administrator's viewing time. Lay out all individual tree and shrub locations. Place plants above surface at planting location or place a labeled Irrigation lines and heads encountered during the planting mix installation process shall be avoided. When unavoidable, advice Construction Administrator of situation and do stake at planting location. Layout bed lines with paint for the Construction Administrator's approval. Secure the Construction Administrator's acceptance *before* digging and start of planting work.

C. It is understood that plants are not precise objects and that minor adjustments in the layout will be required as the planting plan is constructed. These adjustments may not be apparent until some

or all of the plants are installed. Make adjustments as required by the Construction Administrator, including relocating previously installed plants.

3.6 INSTALLATION OF BALLED AND BURLAPPED TREES AND SHRUBS

A. Inspect each plant after delivery and prior to installation for damage of other characteristics that may cause rejection of the plant. Notify the Construction Administrator of any condition observed.

B. Note the location of the coloured dot on the tree base and record the distance from the center of the dot to the top of the root ball. Note any discrepancies from the required dimension and immediately notify the Construction Administrator if the distance is greater than +/- 50mm. Trees that do not comply with the required remediation of the root ball soil level may be rejected, or the Construction Administrator may direct the contractor to remove soil from the top of the structural roots.

C. Excavate pits, beds, and trenches with vertical sides and with bottom of excavation slightly raised at center to provide proper drainage. When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, notify the Construction Administrator before planting. Dispose of subsoil removed from planting excavations. Do not mix with planting soil or use as backfill. Plants to be planted in prepared planting soil may utilize the soil removed from the planting hole as backfill around the root ball.

D. For plants to be planted in prepared planting soil, tamp the soil under the root ball using a motorized jumping jack tamper, to assure a firm bedding for the root ball. Assure the compaction under and around the root ball meets the requirements of the planting mix installation to the depths and profiles indicated on the drawings and in the specifications.

E. Set edge of the root ball at the elevation of the proposed finish. Consult the grading plan and utilize a builders level or transit to determine the grade at the tree grade. For trees on sloped surfaces, set the edge of the root ball at the average grade around the tree. Set the plant plumb and in the location indicated on the plan and approved by the Construction Administrator. The root flare and tree graft, if applicable, shall be visible at the top of the root ball, above the grade. Do not place soil on top of the root ball.

F. Trees shall be oriented so their north side, as marked by the white dot on the trunk in the nursery, faces north. The Construction Administrator may require trees to be oriented slightly in another direction based on the form of the tree or other conditions.

G. When set, brace root ball by tamping backfilled soil around the lower portion of the root ball. Place additional backfill around base and sides of ball in 150mm lifts. Work each lift to settle backfill and eliminate voids and air pockets. When excavation is approximately two-thirds full, water thoroughly before placing remainder of backfill. All wire baskets, burlap, twine, pots, etc. shall be removed from plant material and disposed of off site. No above or below ground tree staking is to be used within the orangutan habitat.

H. Repeat watering until no more is absorbed. Water again after placing final layer of backfill.

I. Do not remove nursery plant identification tags and ribbons, until instructed to do so by the Construction Administrator. The Construction Administrator's seals are to remain on plants until the end of the warranty period, or as directed by the Construction Administrator. The Contractor shall remove the Construction Administrator seals once the Owner has approved Final Acceptance.

3.7 INSTALLATION OF CONTAINER GROWN PLANTS

A. Remove plastic, paper or fiber pots from containerized plant material. Inspect the root system. Plants that have girdling roots including circling roots from smaller nursery containers used during the propagation and production process that cannot be removed without severely stressing the plant shall be rejected. Notify the Construction Administrator of any plants with circling or girdling roots. The Construction Administrator may request that random containerized plants be dug up after planting to inspect the roots for compliance with these specifications.

B. Pull roots out of the root mat. Cut any circling roots or girdling roots and circling or girdling roots in the interior of the root ball that are the result of smaller nursery containers used during the propagation and production process when these roots cannot be pulled out of the root mat. Cut roots with a sharp knife. Loosen the potting medium and shake away from the root mat. Remove any roots above the main structural roots including fibrous roots that form when potting mix is placed on top of earlier, smaller rootballs during the plant production process.

C. Dig holes large enough to allow for spreading of roots and backfill with planting soil. Do not dig the hole too deep such that the plant will settle. Normally the depth of the plant root ball will be half the depth of the container after shaking out the potting mix and pulling out the roots. Work soil around roots to eliminate air pockets. Pack planting mix with fingers around the exposed roots while planting. Leave a slight saucer indentation around plants to hold water. Water thoroughly after planting, taking care not to cover crowns of plants with wet soil.

D. Install the plant such that the top of the root ball is at the finish grade of the surrounding soil.

E. Water each plant on the day of installation to saturate the soil around the roots and wash the soil into the root zone. After the soil has drained, reset any settled plants or grades around the plant, adding soil if required.

F. The Construction Administrator may request that random containerized plants be dug up after planting to inspect the roots for compliance with these specifications.

3.8 INSTALLATION OF GROUND COVER, AND PERENNIAL PLANTINGS

A. Ground cover plantings holes shall be dug with a hand trowel or hoe. If beds have been mulched prior to planting, remove all mulch around the hole before digging so that each plant and bulb is planted in the plant mix. Do not mix mulch into the plant mix.

B. Before planting, biodegradable pots shall be crushed and non-biodegradable pots shall be removed. Root systems of all potted plants shall be split or crumbled to eliminate circling roots.

C. Each plant shall be planted so that the roots of the plants are surrounded by soil below the mulch. Potted plants shall be set so that the top of the pot is even with existing grade. Bare root plants shall be covered up to the crown of the plant or soil level.

D. Set all plants and bulbs spacing as per drawings.

E. Place mulch in the bed such that the entire bed is covered in mulch. Lift leaves and stems of plants out of the mulch when covered.

F. Thoroughly water all beds immediately after planting.

3.9 INSTALLATION OF BULBS

A. Flowering bulbs to be planted during Fall to ensure that they quickly re-root rather than dying back in dry / frosty weather.

B. Discard any bulbs that are soft or show signs of rot.

C. Plant bulbs at the rate and over the area shown on drawings.

D. Bulbs to be planted 75 to 100mm deep.

E. Mechanical installation is prohibited.

3.10 STRAIGHTENING TREES AND SHRUBS

A. Maintain all trees and shrubs in a plumb position throughout the warranty period. Straighten all trees including those not staked. Plants to be straightened shall be excavated and the root ball moved to a plumb position, and then re-backfilled.

B. Do not straighten plants by pulling the trunk with guys.

3.11 MULCHING OF PLANT MATERIAL

A. Mulch top of root balls and planting beds, covering the entire planting bed area. Provide the following thickness of mulch. Top of mulch shall be smooth and even in all directions.

1. Tree and shrub planting areas: 50mm thickness continuous from plant to plant
2. Groundcover and vine planting areas: 25mm minimum thickness

B. In no case shall mulch come in contact with any part of trunk or root flare.

C. Apply mulch after all plants have been installed and approved by the Construction Administrator.

D. Excess mulch shall be removed and disposed of off-site. Contractor shall not over-mulch planting beds with excess mulch.

E. Lift all leaves, low hanging stems and other green portions of plants out of the mulch if covered.

3.12 WATERING

A. The Contractor shall be fully responsible to ensure that adequate water is provided to all plants from the point of installation until the end of the warranty period.

B. Hand water root balls of all plants to assure that the root balls have adequate moisture. Test the moisture content in each root ball to determine the water content. The Contractor shall install one set of watering bags for each tree to be maintained and used for tree watering during the warranty period. Watering bags shall be removed between December 1 and March 1.

C. Maintain a log of all irrigation controller settings and adjustments and all times that the plants are hand watered.

3.13 CLEAN-UP

A. During installation, keep pavements clean and work area in an orderly condition.

B. Keep the site free of garbage at all times. Immediately dispose of wrappings or waste materials associated with products necessary for the completion of the work.

C. All garbage shall be kept in a central collection container. Do not bury garbage in back-fill.

D. Once installation is complete, remove any excess soil from pavements or embedded fixtures. Ensure that mulch is confined to planting beds and that all tags and flagging tape are removed from the site. The Construction Administrator seals are to remain, as per Article, Installation of B&B Trees and Shrubs.

3.14 PROTECTION DURING CONSTRUCTION

A. The Contractor shall protect landscape work and materials from damage due to landscape operations, operations by other Contractors or trespassers. Maintain protection during installation until acceptance. Treat, repair or replace damaged landscape work immediately.

B. Damage done to plant materials, or any of the work, by the Contractor, or any of their sub-trades, shall be replaced by the Contractor at no expense to the Owner.

C. Contractor shall not drive machinery on growing medium in the vicinity of planting to avoid compaction of soils. Small machinery operating on tracks rather than wheels shall be employed if required around plant material. Contractor shall fence off completed planting areas with snow fence, adjacent to uncompleted works by other trades to protect soils and vegetation.

D. Should soils become compacted due to construction activities, Contractor is responsible for tilling and working up soil, while not damaging vegetation to the satisfaction of the Construction Administrator.

3.15 PLANT MAINTENANCE

A. During the project and prior to Final Acceptance, the Contractor shall maintain the site, including completed work and existing conditions. Once the project is complete, the Contractor shall make

periodic site visits to inspect the site. A written record of each visit shall be submitted to the Construction Administrator.

B. Maintenance during the period prior to Acceptance shall consist of pruning, watering, cultivating, weeding, mulching, removal of dead material, repairing and replacing of tree stakes, tightening and repairing of guys, repairing and replacing of damaged tree wrap material, resetting plants to proper grades and upright position, and furnishing and applying such sprays as are necessary to keep plantings free of insects and disease, and in healthy growing condition. Planting areas shall be kept free of weeds, grass, and other undesirable vegetative growth.

C. Remove all tree wrapping and guying even if that work is to occur after the date of acceptance.

D. For the duration of the warranty period, fertilize all planting with organic, slow-release fertilizer at an application rate of five pounds per thousand square feet (5lbs/1000ft^2) at the nutrient ratios and dates specified on the following schedule:

Date	N	P	K
April 15*	30	10	10
May 1	20	20	20
May 15	30	10	10
June 1	20	20	20
June 15	20	20	20
July 1	20	20	20
July 15	20	20	20

*Starting date of fertilization schedule can vary each year by 1-2 weeks, pending a minimum of 10 consecutive frost-free days

Fertilizers shall be applied according to the manufacturer's instructions and standard horticultural practices. For fertilization applied immediately after planting, refer to Section 3.12.1.

3.16 MAINTENANCE DURING THE WARRANTY PERIOD

A. The Contractor shall maintain all plants as described above including watering, weeding, pruning as required to ensure healthy growth for the duration of the warranty period.

END OF SECTION 32 93 10

1. General

1.1. **GENERAL REQUIREMENTS**

1. Conform to the requirements stated in the General Conditions, Supplementary General Conditions of this Specification and all addenda for all work, including work outside the property line including work within Regional and Municipal right of way unless otherwise noted.

1.2. **RELATED WORK**

1.	Site Grading	Section 31 23 13
2.	Excavating, Trenching and Backfilling	Section 31 23 10
3.	Storm Sewers	Section 33 44 00
4.	Aggregates: General	Section 33 44 00

1.3. **REFERENCES**

1. ASTM A48/A48M-03 (2016), Specification for Gray Iron Castings.
2. ASTM C139-18 (1989), Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes.
3. ASTM C478M-90, Specification for Precast Reinforced Concrete Manhole Sections
4. CSA A3000, Portland Cement.
5. CSA A3000, Masonry Cement.
6. CAN/CSA-A23.1-M90, Concrete Materials and Methods for Concrete Construction.
7. CSA A82.56-M1976, Aggregate for Masonry Mortar.
8. CAN3-A165 Series-M85, CSA Standards on Concrete Masonry Units.
9. CAN/CSA-G30.18-M92, Billet Steel Bars for Concrete Reinforcement.
10. CAN/CSA-G164-M92, Hot Dip Galvanizing of Irregularly Shaped Articles.
11. Ontario Provincial Standard Specification 407.

2. Products

2.1. **MATERIALS**

1. Precast manhole units: to ASTM C478M, circular or oval. Top sections eccentric

cone or flat slab top type with opening offset for vertical ladder installation. Monolithic bases to be approved by Consultant and set on concrete slabs cast in place.

1. 1200 mm diameter manhole as per OPSD 701.010.

2. Precast catch basins: to ASTM C478M.

1. Catch basins as per OPSD 705.010

3. Joints: to be made watertight using rubber rings or cement mortar.

4. Mortar:

1. Aggregate: to CSA A82.56.

2. Cement: to CAN/CSA-A8.

5. Ladder rungs: to CAN/CSA-G30.18, No. 25M billet steel deformed bars, hot dipped galvanized to CAN/CSA G164 Rungs to be safety pattern (drop step type).

6. Adjusting rings: to ASTM C478M.

7. Concrete Brick: to CAN3-A165 Series.

8. Frames, gratings, covers to dimensions as indicated and following requirements:

1. Metal gratings and covers to bear evenly on frames. A frame with grating or cover to constitute one unit. Assemble and mark unit components before shipment.

2. Gray iron castings: to ASTM A48, strength class 30B.

3. Castings: coated with two applications of asphalt varnish.

4. Storm manhole frames and covers: heavy duty municipal type for road service. Cover cast without perforations and complete with two 25 mm square lifting holes, as per OPSD 400.010, unless otherwise specified.

5. Catchbasin frame and cover: as per OPSD 400.010.

6. Manhole frame and cover as per OPSD 401.010 Type A.

9. Granular bedding and backfill: Granular B Type I: to OPSD 1010 and Section 02701 – Aggregates: General and to Section 02315 – Excavating, Trenching and Backfilling.

10. Unshrinkable fill: to Section 02315 – Excavating, Trenching and Backfilling.

3. Execution

3.1. EXCAVATION AND BACKFILL

1. Excavate and backfill in accordance with Section 31 23 10 – Excavating, Trenching and Backfilling.

2. Obtain approval of Consultant before installing manholes or catch basins.

3.2. INSTALLATION

1. Construct units in accordance with details indicated, plumb and true to alignment and grade.
2. Complete units as pipe laying progresses. Maximum of three units behind point of pipe laying will be allowed.
3. Dewater excavation free of standing water or as directed by Consultant and remove soft and foreign material before placing concrete base.
4. Set precast concrete base on 150 mm minimum of granular bedding compacted to 100% Corrected Maximum Dry Density.
5. Precast units.
    1. Set bottom section of precast unit in bed of cement mortar and bond to concrete slab or base. Make each successive joint watertight with rubber ring gaskets, cement mortar, or combination thereof.
    2. Clean surplus mortar and joint compounds from interior surface of unit as work progresses.
    3. Plug lifting holes with precast concrete plugs set in cement mortar or mastic compound.
6. For sewers:
    1. Place stub outlets and bulkheads at elevations and in positions indicated.
    2. Bench to provide a smooth U-shaped channel in manholes.
7. Compact granular backfill to 98% Corrected Maximum Dry Density.
8. Place frame and cover on top section to elevation as indicated. If adjustment required use concrete ring.
9. Clean units of debris and foreign materials. Remove fins and sharp projections. Prevent debris from entering system.

3.3. LEAKAGE TEST

1. Visual inspection of leakage will be carried out. If any leakage is observed, correct leakage as directed by Consultant at no additional cost.

END OF SECTION

1. General

1.1. **GENERAL REQUIREMENTS**

1. Conform to the requirements stated in the General Conditions, Supplementary General Conditions of this Specification and all addenda for all work, including work outside the property line including work within Regional and Municipal right of way unless otherwise noted.

1.2. **Description**

1. The work included in this Section includes for all labour, equipment and materials required for the watermain construction within the site, and watermain construction within the municipal right of way connecting to existing municipal servicing.
2. Included in the work is coordination and cooperation with Municipal forces as required to complete the work including providing temporary blow offs, isolation valves, pressure testing and chlorination as required by Municipal forces.

1.3. **RELATED WORK**

1. Excavating, Trenching and Backfilling Section 31 23 10

1.4. **REFERENCES**

1. The Municipality Standards and Specifications for watermain construction.

1.5. **SCHEDULING OF WORK**

1. Schedule work to minimize interruptions to existing services.

2. Products

1. All products utilized within the water system to comply with the Municipality Standards and Specifications.

3. Execution

3.1. PREPARATION

1. Clean pipes, fittings, and appurtenances of accumulated debris and water before installation. Carefully inspect materials for defects to approval of Consultant. Remove defective materials from site as directed by Consultant.

3.2. TRENCHING

1. Do trenching work in accordance with Section 31 23 10 – Excavating, Trenching and Backfilling.
2. Trench depth to provide cover over pipe of not less than 1.75 metres from finished grade or as indicated.
3. Trench alignment and depth require Consultants' approval prior to placing bedding material and pipe.

3.3. GRANULAR BEDDING

1. Place granular bedding material in uniform layers not exceeding 150 mm compacted thickness to depth of 300 mm below bottom of pipe or to depth as indicated.
2. Do not place material in frozen condition.
3. Shape bed true to grade to provide continuous uniform bearing surface for pipe.
4. Shape transverse depressions in bedding as required to suit joints.
5. Compact each layer full width of bed to at least 95% of corrected maximum dry density.
6. Fill authorized or unauthorized excavation below design elevation of bottom of specified bedding in accordance with Section 31 23 10 – Excavating, Trenching and Backfilling with compacted bedding material.

3.4. PIPE INSTALLATION

1. Lay pipes to ANSI/AWWA C600 Manual of Practice and manufacturer's standard instructions and specifications. Do not use blocks except as permitted in 3.3.2.
2. Join pipes in accordance with ANSI/AWWA C600, ANSI/AWWA C206, AWWA Manual of Practice and manufacturer's recommendations.
3. Bevel or taper ends of PVC pipe to match fittings.
4. Handle pipe by methods approved by Engineer recommended by pipe manufacturer. Do not use chains or cables passed through pipe bore so that weight of pipe bears

on pipe ends.

5. Lay pipes on prepared bed, true to line and grade. Ensure barrel of each pipe is in contact with shaped bed throughout its full length. Take up and replace defective pipe. Correct pipe which is not in true alignment or grade or pipe which shows differential settlement after installation greater than 10 mm in 3 m.
6. Face socket ends of pipe in direction of laying. For mains on a grade of 2% or greater, face socket ends upgrade.
7. Do not exceed permissible deflection at joints as recommended by pipe manufacturer.
8. Keep jointing materials and installed pipe free of dirt and water and other foreign materials. Whenever work is stopped, install a removable watertight bulkhead at open end of last pipe laid to prevent entry of foreign materials.
9. Position and join pipes with equipment and methods approved by Consultant.
10. Cut pipes in an approved manner as recommended by pipe manufacturer, without damaging pipe or its coating and to leave smooth end at right angles to axis of pipe.
11. Align pipes carefully before jointing.
12. Install gaskets to manufacturer's recommendations. Support pipes with hand slings or crane as required to minimize lateral pressure on gasket and maintain concentricity until gasket is properly positioned.
13. Avoid displacing gasket or contaminating with dirt or other foreign material. Gaskets so disturbed or contaminated shall be removed, cleaned, lubricated and replaced before jointing is attempted again.
14. Complete each joint before laying next length of pipe.
15. Minimize deflection after joint has been made.
16. Apply sufficient pressure in making joints to ensure that joint is completed to manufacturer's recommendations.
17. Ensure completed joints are restrained by compacting bedding material alongside and over installed pipes or as otherwise approved by the Consultant.
18. Provide necessary fittings and adaptors as required between existing watermain pipe materials and proposed watermain pipe materials.
19. When stoppage of work occurs, block pipes in an approved manner to prevent creep during down time.
20. Recheck plastic pipe joints assembled above ground after placing in trench to ensure that no movement of joint has taken place.
21. Do not lay pipe on frozen bedding.
22. Contractor responsible for satisfactory completion of hydrostatic and leakage testing to Consultant's approval. Contractor also responsible for degree of backfilling complete prior to hydrostatic and leakage testing as well as isolation and correction of any leaks resulting in failed tests.
23. Backfill remainder of trench.

3.5. CATHODIC PROTECTION AND TRACER WIRE

1. Install as per Municipal Standards,

3.6. HYDROSTATIC AND LEAKAGE

1. Provide labour, equipment and materials required to perform hydrostatic and leakage tests hereinafter described as required by the Municipality standards.
2. Notify Consultant at least 24 h in advance of all proposed tests. Perform tests in presence of Consultant.
3. Where any section of system is provided with concrete thrust blocks, conduct tests at least 5 days after placing concrete or 2 days if high early strength concrete is used.
4. Test pipeline in sections not exceeding 365 m in length, unless otherwise authorized by Consultant.
5. Upon completion of pipe laying and after Consultant has inspected work in place, surround and cover pipes between joints with approved granular material placed to dimensions indicated or directed by Consultant.
6. Leave hydrants, valves, backflow preventer, water meter, joints and fittings exposed.
7. When testing is done during freezing weather, protect hydrants, valves, backflow preventer, water meter, joints and fittings from freezing.
8. Strut and brace caps, bends, tees, and valves, to prevent movement when test pressure is applied.
9. Open valves.
10. Expel air from main by slowly filling main with potable water. Install corporation stops at high points in main where no air-vacuum release valves are installed. Remove stops after satisfactory completion of test and seal holes with plugs.
11. Thoroughly examine exposed parts and correct for leakage as necessary.
12. Examine exposed pipe, joints, fittings and appurtenances while system is under pressure.
13. Remove joints, fittings and appurtenances found defective and replace with new sound material and make watertight.
14. Repeat hydrostatic test until all defects have been corrected.
15. Apply a leakage test pressure of equal to design pressure after complete backfilling of trench, based on elevation of lowest point in main and corrected to elevation of gauge, for period of 2 h.
16. Define leakage as amount of water supplied from water meter in order to maintain test pressure for 2 h.
17. Do not exceed allowable leakage of 0.03 L/mm diameter per 300 m of pipe, including lateral connections, per hour.
18. Locate and repair defects if leakage is greater than amount specified.

19. Repeat test until leakage is within specified allowance for full length of water main.

PIPE SURROUND

20. Upon completion of pipe laying and after Consultant has inspected work in place, surround and cover pipes as indicated.
21. Hand place surround material in uniform layers not exceeding 150 mm compacted thickness as indicated. Do not dump material within 5 m of pipe.
22. Place layers uniformly and simultaneously on each side of pipe.
23. Do not place material in frozen condition.
24. Compact each layer from pipe invert to mid height of pipe to at least 95% of SPMDD to ASTM D698.
25. Compact each layer from (mid height) of pipe to underside of backfill to at least 95% of SPMDD and in accordance with Geotechnical Report for site.

3.7. BACKFILL

1. Place backfill material above pipe surround in uniform layers not exceeding 150 mm compacted thickness up to grades as indicated.
2. Do not place backfill in frozen condition.
3. Compact native backfill to at least 95% of SPMDD.

3.8. FLUSHING AND DISINFECTING

1. The Municipality shall perform all chlorination works.
2. Flush water mains through available outlets with a sufficient flow of potable water to produce a velocity of 1.5 m/s, within pipe for 10 min., or until foreign materials have been removed and flushed water is clear.
3. Flushing flows shall be as follows:

Pipe Size NPS	Flow (L/s) Minimum
6 and below	38
8	75

4. Provide connections and pumps for flushing as required.
5. Open and close valves, hydrants and service connections to ensure thorough flushing.
6. Complete flushing to satisfaction of Consultant and The Municipal forces.

END OF SECTION

1. General

1.1. **GENERAL REQUIREMENTS**

1. Conform to the requirements stated in the General Conditions, Supplementary General Conditions of this Specification and all addenda for all work, including work outside the property line including work within Regional and Municipal right of way unless otherwise noted.

1.2. **RELATED WORK**

1.	Site Grading	Section 31 23 13
2.	Excavating, Trenching and Backfilling	Section 31 23 10
3.	Manholes and Catchbasins	Section 33 05 14
4.	Aggregates: General	Section 31 05 17

1.3. **REFERENCES**

1. ASTM D3034, Specification for Type PSM Poly Vinyl Chloride (PVC) Sewer Pipe and fittings.
2. CAN/CSA-B182.2, PVC Sewer Pipe and Fittings (PSM Type),
3. CAN/CSA-B182.11, Recommended Practice for the Installation of Plastic Crain and Sewer Pipe and Pipe Fittings.
4. Ontario Provincial Standard Specification 410.

1.4. **MATERIAL CERTIFICATION**

1. Submit manufacturer's test data and certification at least 2 weeks prior to commencing work.
2. Certification to be marked on pipe.

1.5. **SCHEDULING OF WORK**

1. Schedule work to minimize interruptions to existing services and to maintain existing flow during construction.

2. Products

2.1. **PVC PIPE**

Poly Vinyl Chloride pipe as specified in the Contract Drawings shall be in accordance with OPSS 410, Pipe Sewer Installation in Open Cut.

2.2. **PIPE BEDDING, SURROUND AND COVER MATERIALS**

1. Granular embedment materials to Section 31 05 17 – Aggregates.

2.3. **BACKFILL MATERIAL**

1. Backfill to Section 31 23 10 – Excavation, Trenching and Backfilling
2. Backfill within the public right of way to be un-shrinkable fill.

2.4. **JOINT MORTAR**

1. Portland cement: to CAN/CSA-A5, normal type 10.
2. Mortar: one part Portland cement to two parts clean sharp sand mixed with minimum amount of water to obtain optimum consistency for use intended. Do not use additive.

3. Execution

3.1. **PREPARATION**

1. Clean pipes and fittings of debris and water before installation, and remove defective materials from site.

3.2. **TRENCHING**

1. Do trenching work in accordance with Section 31 23 10 – Excavating, Trenching and Backfilling.
2. Do not allow contents of any sewer or sewer connection to flow into trench.
3. Trench alignment and depth to approval of Consultant prior to placing bedding material and pipe.

3.3. GRANULAR BEDDING

1. Place granular bedding material to details indicated in bedding detail OPSD 802.010 to OPSD 802.054, depending on type of soil and pipe. Use Class B bedding and place bedding in unfrozen condition. Type of soil to be defined in the field as Type 1, 2, 3, or 4 as per Health and Safety Act and Regulations for Construction Projects.
2. Place granular bedding material in uniform layers not exceeding 150 mm compacted thickness.
3. Compact each layer full width of bed to at least 95% corrected maximum dry density.
4. Shape bed true to grade and to provide continuous, uniform bearing surface for pipe. Do not use blocks when bedding pipes.
5. Shape transverse depressions as required to suit joints.
6. Fill excavation below bottom of specified bedding adjacent to manholes or catch basins with compacted common backfill.

3.4. INSTALLATION OF SANITARY SEWER PIPES

1. Lay and join pipe in accordance with manufacturer's recommendations and to approval of Consultant.
2. Handle pipe using methods approved by Consultant. Do not use chains or cables passed through rigid pipe bore so that weight of pipe bears upon pipe ends.
3. Commence laying at outlet and proceed in upstream direction with socket ends of pipe facing upgrade.
4. Do not exceed maximum joint deflection recommended by pipe manufacturer.
5. Do not allow water to flow through pipes during construction except as may be permitted by Consultant.
6. Whenever work is suspended, install removable watertight bulkhead at open end of last pipe laid to prevent entry of foreign materials.
7. PVC Pipe as specified in the Contract Drawings shall be installed in accordance with OPSS 410, Pipe Sewer Installation in Open Cut.
8. When any stoppage of work occurs, restrain pipes as directed by Consultant, to prevent "creep" during down time.
9. Cut pipes as required for special inserts, fittings or closure pieces, as recommended by pipe manufacturer, without damaging pipe or its coating and to leave smooth end at right angles to axis of pipe.
10. Make watertight connections to manholes and catch basins. Use shrinkage compensating grout when suitable gaskets are not available. Support connections as per OPSD 708.020.
11. Use prefabricated saddles or approved field connections for connecting pipes to existing sewer pipes. Joint to be structurally sound and watertight.

12. Temporarily plug open upstream ends of pipes with removable watertight concrete, steel or plastic bulkheads.

3.5. PIPE SURROUND

1. Place surround material in unfrozen condition.
2. Upon completion of pipe laying, and after Consultant has inspected pipe joints, surround and cover pipes as indicated.
3. Hand place surround material in uniform layers not exceeding 150 mm compacted thickness as indicated. Pipe surround material to extend 300 mm above crown of pipe.
4. Place layers uniformly and simultaneously on each side of pipe.
5. Compact each layer from pipe invert to mid height of pipe to at least 95% corrected maximum dry density.

3.6. BACKFILL

1. Place backfill material in unfrozen condition.
2. Place backfill material above pipe surround in uniform layers not exceeding 150 mm compacted thickness up to grades as indicated.

3.7. FIELD TESTING

1. Repair or replace pipe, pipe joint or bedding found defective.
2. When directed by Consultant, draw tapered wooden plug with diameter of 50 mm less than nominal pipe diameter through sewer to ensure that pipe is free of obstruction.
3. Remove foreign material from sewers and related appurtenances by flushing with water.

END OF SECTION

1. General

1.1. **GENERAL REQUIREMENTS**

1. Conform to the requirements stated in the General Conditions, Supplementary General Conditions of this Specification and all addenda.

1.2. **RELATED WORK**

1.	Excavating, Trenching and Backfilling	Section 31 23 10
2.	Manholes and Catchbasins	Section 33 05 14
3.	Aggregates: General	Section 31 05 17

1.3. **REFERENCES**

1. ASTM C14, Specification for Concrete Sewer, Storm Drain and Culvert Pipe.
2. ASTM C76, Specification for Reinforced Concrete Culvert, Storm Drain and Sewer Pipe
3. ASTM C443M-85a (1990), Specification for Joints for Circular Concrete Sewer and Culvert Pipe, using Rubber Gaskets.
4. CSA A3000, Portland Cement.
5. CAN/CSA-A257, Series M92, Standards for Concrete Pipe.
6. CAN3-G401-M81, Corrugated Steel Pipe products.
7. Ontario Provincial Standard Specification 410.

1.4. **MATERIAL CERTIFICATION**

1. Certification to be marked on pipe.

1.5. **SCHEDULING OF WORK**

1. Schedule work to minimize interruptions to existing services and to maintain existing flow during construction.

2. Products

2.1. **Concrete Pipe**

1. Non-reinforced circular concrete pipe and fittings: to CAN/CSA-A-257-2, ASTM C14M, Class 3 designed for flexible rubber gasket joints to ASTM C443 M and CAN/CSA A257.
2. Reinforced circular concrete pipe and fittings: to CAN/CSA-A257, ASTM C76M, strength classification as indicated in the Contract Drawings, designed for flexible rubber gasket joints to ASTM C443M and CAN/CSA A257.
3. Manufactured tees for pipe to pipe connections.
4. Lifting holes:
    1. Pipe 900 mm and less diameter: no lift holes.
    2. Pipe greater than 900 mm diameter: lift holes not to exceed two in piece of pipe.
    3. Provide pre-fabricated plugs to effectively seal lift holes after installation of pipe.

2.2. **PVC PIPE**

Poly Vinyl Chloride pipe as specified in the Contract Drawings shall be in accordance with OPSS 410, Pipe Sewer Installation in Open Cut.

2.3. **PIPE EMBEDMENT, SURROUND AND COVER MATERIALS**

1. Granular material to Section 31 05 17 – Aggregates.
2. Granular A to Section 31 23 13 – Site Grading
3. Pipe embedment shall be in accordance with OPSD 802.010

2.4. **BACKFILL MATERIAL**

1. Backfill shall be granular material as specified in Section 31 23 10 – Excavation, Trenching and Backfilling.

2.5. **JOINT MORTAR**

1. Portland cement: to CAN/CSA-A5, normal type 10.

2. Mortar: one part Portland cement to two parts clean sharp sand mixed with minimum amount of water to obtain optimum consistency for use intended. Do not use additive.

3. Execution

3.1. PREPARATION

1. Clean pipes and fittings of debris and water before installation, and remove defective materials from site.

3.2. TRENCHING

1. Do trenching work in accordance with Section 31 23 10 – Excavating, Trenching and Backfilling.
2. Do not allow contents of any sewer or sewer connection to flow into trench.
3. Trench alignment and depth to approval of Consultant prior to placing bedding material and pipe.

3.3. GRANULAR BEDDING

1. Place granular bedding material to details indicated in bedding detail OPSD 802.010 to OPSD 802.054, depending on type of soil and pipe. Use Class B bedding and place bedding in unfrozen condition. Type of soil to be defined in the field as Type 1, 2, 3, or 4 as per Health and Safety Act and Regulations for Construction Projects.
2. Place granular bedding material in uniform layers not exceeding 150 mm compacted thickness.
3. Compact each layer full width of bed to at least 95% corrected maximum dry density.
4. Shape bed true to grade and to provide continuous, uniform bearing surface for pipe. Do not use blocks when bedding pipes.
5. Shape transverse depressions as required to suit joints.
6. Fill excavation below bottom of specified bedding adjacent to manholes or catch basins with compacted common backfill.

3.4. INSTALLATION OF STORM DRAINAGE PIPES

1. Lay and join pipe in accordance with manufacturer's recommendations and to approval of Consultant.

2. Handle pipe using methods approved by Consultant. Do not use chains or cables passed through rigid pipe bore so that weight of pipe bears upon pipe ends.
3. Commence laying at outlet and proceed in upstream direction with socket ends of pipe facing upgrade.
4. Do not exceed maximum joint deflection recommended by pipe manufacturer.
5. Do not allow water to flow through pipes during construction except as may be permitted by Consultant.
6. Whenever work is suspended, install removable watertight bulkhead at open end of last pipe laid to prevent entry of foreign materials.
7. Joints
    1. Poly Vinyl Chloride Pipe

        PVC Pipe as specified in the Contract Drawings shall be installed in accordance with OPSS 410, Pipe Sewer Installation in Open Cut.
8. When any stoppage of work occurs, restrain pipes as directed by Consultant, to prevent “creep” during down time.
9. Cut pipes as required for special inserts, fittings or closure pieces, as recommended by pipe manufacturer, without damaging pipe or its coating and to leave smooth end at right angles to axis of pipe.
10. Make watertight connections to manholes and catch basins. Use shrinkage compensating grout when suitable gaskets are not available. Support connections as per OPSD 708.020.
11. Use prefabricated saddles or approved field connections for connecting pipes to existing sewer pipes. Joint to be structurally sound and watertight.
12. Temporarily plug open upstream ends of pipes with removable watertight concrete, steel or plastic bulkheads.

3.5. PIPE SURROUND

1. Place surround material in unfrozen condition.
2. Upon completion of pipe laying, and after Consultant has inspected pipe joints, surround and cover pipes as indicated.
3. Hand place surround material in uniform layers not exceeding 150 mm compacted thickness as indicated. Pipe surround material to extend 300 mm above crown of pipe.
4. Place layers uniformly and simultaneously on each side of pipe.
5. Compact each layer from pipe invert to mid height of pipe to at least 95% corrected maximum dry density.

3.6. BACKFILL

1. Place backfill material in unfrozen condition.
2. Place backfill material above pipe surround in uniform layers not exceeding 150 mm compacted thickness up to grades as indicated.
3. Trench backfill shall be imported granular material consisting of Granular B Type I, or reclaimed granulars free of organics.
4. Trench backfill within the public right of way is to be un-shrinkable fill.

3.7. FIELD TESTING

1. Repair or replace pipe, pipe joint or bedding found defective.
2. When directed by Consultant, draw tapered wooden plug with diameter of 50 mm less than nominal pipe diameter through sewer to ensure that pipe is free of obstruction.
3. Remove foreign material from sewers and related appurtenances by flushing with water.

END OF SECTION

1. General

1.1. **GENERAL REQUIREMENTS**

1. Conform to the requirements stated in the General Conditions, Supplementary General Conditions of this Specification and all addenda.

1.2. **RELATED WORK**

1.	Excavating, Trenching and Backfilling	Section 31 23 10
2.	Aggregates: General	Section 31 05 17

1.3. **REFERENCES**

1. OPSS 1801 – Corrugated Steel Pipe Products
2. OPSS 1840 – Polyethylene Pipe Products
3. OPSS 1860 – Geotextiles
4. CSA G164-M1981 – Hot Dip Galvanizing of Irregularly Shaped Articles.
5. CGSB 41-GP-29Ma-1983 - Tubing, Plastic, Corrugated, Drainage

1.4. **MATERIAL CERTIFICATION**

1. Certification to be marked on pipe.

1.5. **SCHEDULING OF WORK**

1. Schedule work to minimize interruptions to existing services and to maintain existing flow during construction.

2. Products

2.1. **PVC PIPE**

Poly Vinyl Chloride pipe as specified in the Contract Drawings shall be in accordance with OPSS 410, Pipe Sewer Installation in Open Cut.

2.2. PIPE EMBEDMENT, SURROUND AND COVER MATERIALS

1. Granular material to Section 31 05 17 – Aggregates.
2. Pipe embedment shall be in accordance with OPSD 802.010

2.3. BACKFILL MATERIAL

1. Backfill shall be granular material as specified in Section 31 23 10 – Excavation, Trenching and Backfilling.

3. Execution

3.1. PREPARATION

1. Clean pipes and fittings of debris and water before installation, and remove defective materials from site.

3.2. TRENCHING

1. Do trenching work in accordance with Section 31 23 10 – Excavating, Trenching and Backfilling.
2. Do not allow contents of any sewer or sewer connection to flow into trench.
3. Trench alignment and depth to approval of Consultant prior to placing bedding material and pipe.

3.3. GRANULAR PIPE SURROUND

1. Granular materials surrounding the pipe shall be in accordance with OPSS 1010.

3.4. INSTALLATION OF SUBDRAINS

1. Installation of subdrains is to be in accordance with OPSS 405.

3.5. PIPE SURROUND

1. Place surround material in unfrozen condition.

2. Pipe surround material shall be HL-8 Coarse Bedding Stone

3.6. BACKFILL

1. Place backfill material in unfrozen condition.
2. Place backfill material above pipe surround in uniform layers not exceeding 150 mm compacted thickness up to grades as indicated.
3. Trench backfill shall be imported granular material consisting of Granular B Type I, or reclaimed granulars free of organics.
4. Trench backfill within the public right of way is to be un-shrinkable fill.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for drainage board work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM F449, Standard Practice for Subsurface Installation of Corrugated Polyethylene Pipe for Agricultural Drainage or Water Table Control.

1.3 **SUBMITTALS**

.1 Product data:
.1 Submit manufacturer's Product data in accordance with Section 01 33 00 indicating:
.1 Performance criteria, compliance with appropriate reference standard(s), characteristics, and limitations.
.2 Product transportation, storage, handling and installation requirements.

.2 Shop drawings:
.1 Submit shop drawings in accordance with Section 01 33 00 indicating:
.1 Typical layouts, corner details, and special details, details of terminations, method of attachment, and accessories and other pertinent information required for proper and complete installations.
.2 Relationships with adjacent construction.

.3 Certificates: Qualification data for qualified installer.

.4 Samples:
.1 Submit following samples in accordance with Section 01 33 00:
.1 Two 300 x 300 mm samples of each type of drainage board.

1.4 **QUALITY ASSURANCE**

.1 Installers qualifications: Perform work of this Section by a company that has a minimum of five years proven experience in the installations of drainage boards of a similar size and nature and that is approved by manufacturer. Submit to Consultant, installer’s current certificate of approval by the material manufacturer as proof of compliance. Submit proof of experience upon Consultant’s request.

.2 Pre-installation meeting: Arrange with manufacturer's representative, Contractor, and Consultant to inspect substrates, and to review installation procedures 48 hours in advance of installation.

1.5 **SITE CONDITIONS**

.1 When habitat subdrainage mat is installed in conjunction with a waterproofing product, the subdrainage mat must be compatible with the waterproofing product and installed by methods acceptable to the waterproofing product manufacturer.

1.6 **DELIVERY, STORAGE, AND HANDLING**

.1 Packing, shipping, handling and unloading: Deliver materials in manufacturer's original, Unopened, undamaged containers with identification labels intact. Schedule deliveries to avoid construction delays but minimize jobsite storage.

1.7 **EXTENDED WARRANTY**

.1 Manufacturer's warranty: Upon completion and acceptance of the Work required by this section, the manufacturer will issue a warranty agreeing to promptly replace defective materials for a period of 5 years.

2 Products

2.1 **MATERIALS**

.1 Drainage boards:
- .1 Three-dimensional dimpled core and geotextile fabric complete with adhesive or fasteners as required for installation.
- .2 Vertical applications: 'CCW MiraDRAIN 6000' by Carlisle Coatings and Waterproofing.
- .3 Horizontal applications: 'CCW MiraDRAIN 9000' by Carlisle Coatings and Waterproofing.
- .4 Approved alternatives by Dorken Systems Inc., Tremco Inc. or W. R. Meadows will be considered.

3 Execution

3.1 **EXAMINATION**

.1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of Work means acceptance of existing conditions.

3.2 **PREPARATION**

.1 Prepare substrates in accordance with manufacturer' written instructions.

.2 Verify substrate surfaces are solid, free from surface water, frozen matter, dust, oil, grease, scaling or laitance, projections and any other foreign matter detrimental to installation.

3.3 INSTALLATION

.1 Install drainage board in accordance with ASTM F449, reviewed shop drawings, manufacturer's written instructions and as specified herein.

.2 Vertical surfaces:

.1 Completed caisson lagging and foundation walls: Install drainage board after installation of waterproofing membrane is complete and to caisson lagging or foundation wall as applicable to condition. Position board with flat side against lagging or wall substrate and filter fabric toward soil/drainage side and attach to intended wall substrate using manufacturer approved fastening system.

.2 Fabric overlaps on top of drainage boards are to be draped over back of core and if there is insufficient fabric, the core shall be cut out from the fabric by a depth of 3 dimples to provide excess fabric for wrapping the core. Immediately complete backfilling.

.3 Connecting adjacent boards: Connect adjacent boards at the longitudinal edge by pulling filter fabric back to expose the flange. The board edge is to be butted to edge of adjacent board dimple to dimple or edge of next board is to be placed over two dimples and interlocked. Board ends are to be attached in the same manner. Connections are to be completed in shingle fashion so moisture will flow with overlap and not against it. Overlap fabric in the direction of water flow. Cover all terminal edges with filter fabric flap by tucking in behind core and if there is insufficient fabric, the core shall be cut out from the fabric by a depth of 3 dimples to provide excess fabric for wrapping the core.

.3 Horizontal surfaces:

.1 Attach drain boards by adhering boards to waterproofing membrane with manufacturer recommended contact adhesive.

.2 Connecting adjacent boards: Connect adjacent boards at the longitudinal edge by pulling filter fabric back to expose the flange. The board edge is to be butted to edge of adjacent board dimple to dimple or edge of next board may be placed over two dimples and interlocked. Board ends are to be attached in the same manner. Connections are to be completed in shingle fashion so moisture will flow with overlap and not against it. Overlap fabric in the direction of water flow. Cover all terminal edges with filter fabric flap by tucking fabric behind the core.

3.4 CLEANING

.1 Remove temporary coverings and protection of adjacent work areas. Repair or replace damaged installed products.

.2 Clean installed products in accordance with manufacturer's written instructions prior to Owner's acceptance.

.3 Remove construction debris from project site and legally dispose of debris.

3.5 **PROTECTION**

.1 Protection installed products finished surfaces from damage during construction.

END OF SECTION

PROJECT SPECIFICATIONS

GENERATOR REPLACEMENT

INDO-MALAYA PAVILION

ISSUED FOR TENDER

Prepared for:

361A Old Finch Ave.
Toronto, ON M1B 5K7

Issued for Tender:
2019-12-19
Project: 2018282

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DIVISION 26 - ELECTRICAL

26 05 00 – Electrical General Requirements

26 05 01 – Basic Materials & Methods

26 05 21 – Wires & Cables

26 05 56 – Grounding & Bonding

26 05 53 - Identification for Electrical Systems

26 05 73 - Power System Studies

26 20 00 - Electric Service and Distribution

26 32 14 – Power Generation Diesel

26 32 16 – Walk-in Generator Enclosure

26 36 23 – Automatic Load Transfer Switch

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

28 31 00 - Fire Alarm Systems

1 GENERAL

1.1 SUMMARY

.1 This document is a specification for Electrical General Requirements.

1.2 RELATED SECTIONS

.1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

.2 This section to apply and form a part of all Sections of Division 26.

1.3 REFERENCES AND STANDARDS

.1 Left blank intentionally.

1.4 CONTRACT DOCUMENTS

.1 Neither the drawings nor the specifications to be used alone. Items or subjects omitted from one but mentioned or reasonably implied in the other to be considered as properly and sufficiently specified and shall, therefore, be provided under this Division.

.2 Misinterpretation of requirements of either the drawings or the specifications shall not relieve responsibility for fulfillment of contract requirements.

.3 Notify the Consultant, in writing, of discrepancies found in the drawings or specifications before submitting the tender. Abide by the decision given in writing regarding same.

.4 Where there are ambiguities in the specifications or drawings that are not clarified prior to closing of tenders, it is assumed that the contractor has carried the most stringent item, or option.

.5 Care to be taken with imperial versus S.I. metric conversions.

1.5 REGULATIONS, CODES AND STANDARDS

.1 The materials and work to be strictly in accordance with the latest revisions issued up to date of tender submission of all applicable codes, rules, standards, regulations, by-laws and requirements of all local, municipal, provincial and federal authorities having jurisdiction.

.2 The Codes and Standards identify the minimum requirements. In no instance reduce the standard established by the Contract Documents by applying any of the codes and standards.

.3 Division 26 is responsible to ensure that all partial or fully pre-assembled equipment and work associated with auxiliary systems provided under this Division but performed by other trade contractors comply with the requirements of national, provincial or local labour conditions and regulations and that all associated costs are borne in the Tender Price. No charges will be accepted by the Owner with respect to the above requirements.

.4 Drawings and specifications should not conflict with the Codes, Regulations and Standards but where there are apparent discrepancies the contractor shall notify the Consultant in writing and obtain clarification before proceeding with the work.

.5 The work of the Electrical Division shall conform to the applicable Codes, Regulations and Standards including, unless referred otherwise, latest revisions issued up to date of tender submission, as set by the following:

.1 OBC - The Ontario Building Code

.2 ANSI - American National Standards Institute

.3 CSA – Canadian Standards Association, Publications and Standards

.4 ULC – Underwriter Laboratories of Canada, Publications and Standards

.5 NETA ATS-2017 - National Electrical Testing Association, Standard for Acceptance Testing Specifications

.6 OESC – Ontario Electrical Safety Code

.7 ESA - Electrical Safety Authority

.8 ODL – Ontario Department of Labour

.9 Local Hydro Authority

.10 All other Codes, Standards and Regulations referred to in the above documents, adopted by the authorities having jurisdiction and/or applicable to the work of this Division.

.11 Provide copies when requested of codes and standards referred to in the Specifications for joint use of the Contractor and Engineer.

1.6 DEFINITIONS

.1 "concealed" – means hidden from normal sight in furred spaces, shafts, ceiling spaces, walls and partitions.

.2 "exposed" – means work normally visible, including work in equipment rooms, service tunnels, and similar spaces.

.3 "finished" - means when in description of any area or part of an area or a product which receives a finish such as paint, or in case of a product may be factory finished.

.4 "provision" or "provide" (and tenses of "provide") – means supply and install complete.

.5 "install" (and tenses of "install") – means secure in position, connect complete, test, adjust, verify and certify.

.6 "supply" – means to procure, arrange for delivery to site, inspect, accept delivery and administer supply of products; distribute to areas; and include manufacturer's supply of any special cables, standard on site testing, initial start-up, programming, basic commissioning, warranties and manufacturers' assistance to Contractor.

.7 "delete" or "remove" (and tenses of "delete" or "remove") – means to disconnect, make safe, and remove obsolete materials including back boxes and exposed piping and raceways; and patch and repair/finish surfaces to match adjoining similar construction; include for associated re-programming of systems and/or change of documentation

identifications to suit deletions, and properly dispose of deleted products off site unless otherwise instructed by Owner and reviewed with Consultant.

.8 "barrier-free" - means when applied to a building and its facilities, that building and its facilities can be approached, entered and used by persons with physical or sensory disabilities in accordance with requirements of the OBC.

.9 "BAS" – means building automation system; "BMS" – means building management system, "FMS" – means facility management system; and "DDC" means direct digital controls; references to "BAS", "BMS", "FMS" and "DDC" generally mean same.

.10 "governing authority" and/or "authority having jurisdiction" and/or "regulatory authority" and/or "Municipal authority" – means government departments, agencies, standards, rules and regulations that apply to and govern work and to which work must adhere.

.11 "OSHA" and "OHSA" – stands for Occupational Safety and Health Administration and Occupational Health and Safety Act, and wherever either one is used, they are to be read to mean local governing occupational health and safety regulations that apply to and govern work and to which work must adhere, regardless if Project falls within either authority's jurisdiction.

.12 "Mechanical Divisions" - refers to Divisions 20, 21, 22, 23, 25 and other Divisions as specifically noted, and which work as defined in Specifications and/or on drawings is responsibility of Mechanical Contractor, unless otherwise noted.

.13 "Electrical Divisions" – refers to Divisions 26, 27, 28 and other Divisions as specifically noted, and which work as defined in Specifications and/or on drawings is responsibility of Electrical Contractor, unless otherwise noted.

.14 "Consultant" – means person, firm or corporation identified as such in Agreement or Documents and is licensed to practice in Place of the Work and has been appointed by Owner to act for Owner in a professional capacity in relation to the Work.

.15 Wherever words "indicated", "shown", "noted", "listed", or similar words or phrases are used in Contract Documents they are understood, unless otherwise defined, to mean product referred to as "indicated", "shown", "listed", or "noted" on Contract Documents.

.16 Wherever words "reviewed", "satisfactory", "as directed", "submit", or similar words or phrases are used in Contract Documents they are understood, unless otherwise defined, to mean that work or product referred to as "reviewed by", "to the satisfaction of", "submitted to", etc., Consultant.

1.7 PERMITS, FEES INSPECTION

.1 Obtain all permits, give Notice of Project with the Ministry of Labour. Give all other notices and pay all fees for the work of this Division.

.2 Submit Drawings and Specifications to all authorities as required and obtain general approval before commencing any work. In addition, if required by the Inspection Authorities prepare and submit any other Drawings required obtaining approval.

.3 Arrange for the inspection of work by all inspection authorities having jurisdiction over the work of this Division. All changes and alterations required by an authorized inspector of any authority having jurisdiction to be carried out without charge or expense to the Owners.

.4 On completion of the work present all certificates of approval and acceptance.

1.8 EXAMINATION OF SITE

.1 Before submitting tenders, examine the site to determine the conditions which may affect the proposed work. No claims for extra payment will be considered because of failure to fulfill this condition. Tenders from contractors who fail to visit the site may, at the discretion of the Owner, be rejected.

1.9 STATEMENT OF PRICES

.1 To form a basis for progress payments the successful bidder shall submit a statement of his estimated prices for the various portions of the work, including both labour and materials indicated separately. The total price of the portion of the work shall equal the total price of the work covered under the Electrical Division.

1.10 PROGRESS PAYMENTS

.1 Submit a complete breakdown of the Contract with each progress billing, indicating percentage of work complete, in a form acceptable to the Owner/Consultant.

1.11 PROTECTION

.1 Protect exposed live equipment during construction for personnel safety.

.2 Shield and mark live parts 'LIVE 240 VOLTS', or with appropriate voltage in English.

.3 Install doors for temporary storage rooms containing the Contractors non-installed electrical equipment. Keep these doors locked, except when under direct supervision of Electrician.

.4 Protect finished and unfinished work of all Trades from damage due to the carrying out of the work of this Contract. Repair all damage to the building, resulting from the carrying out of this work, without extra expense to the Owner and to the approval of the Consultant.

.5 All necessary protection to be supplied, maintained and removed on completion, to the work of this Contract and adjacent work, to ensure that such work does not become damaged or disfigured during the progress of the Contract.

1.12 SEALING

.1 Where cables conduits pass through non fire-rated floors, walls or roof, provide internal and external sealing thereto.

.2 Comply with manufacturer's installation instructions for all **sealant applications.**

.3 For non-fire rated locations, Sealant to be silicone that meets requirements of CGSB 19-GP-23, for the size of the joint required, and the types of materials being bonded.

.4 For fire rated locations, the fire stop shall meet the requirements of OBC and ULC with regards to the type of assembly and the fire separation.

1.13 MATERIALS

.1 Materials and equipment are specifically described and named in these specifications for the purpose of establishing a standard of materials and workmanship which to be adhered to under this Division.

.2 Make and quality of materials in the construction of this project to be subject to the approval of the Consultant. Remove from site any equipment or materials condemned by Consultant as not approved for use. Replace condemned equipment and materials as required at no extra cost to the Owner.

.3 All equipment and material to be new, CSA certified and labeled and manufactured to CSA standards and shall incorporate additional specified requirements.

.4 Where there is no alternative to supplying equipment, which is not CSA certified, submit such equipment to Inspection Authorities for Special Inspection, and obtain approval before delivery of equipment to site.

.5 Use material and equipment available from regular production by manufacturer concerned.

.6 All control panels and component assemblies to be shop manufactured and CSA certified.

.7 Make known in writing to the Consultant fourteen (14) days prior to tender closing date any material specified or required to complete the work which is not currently available or will not be available for use as called for herein. Failing to do so, allow in tender for most stringent approved equivalent.

1.14 WORKMANSHIP

.1 All work to be neatly done and in workmanlike manner to the satisfaction of the Consultant. Any unsatisfactory workmanship, in the opinion of the Consultant, to be replaced without extra cost to the Owners.

1.15 CO-OPERATION AND CO-ORDINATION WITH OTHER DIVISIONS

.1 Examine the drawings and specifications of other Divisions to be familiar with the type of construction and the complexity of the project. Coordinate and arrange work of this Division in co-operation with work of other Divisions in such manner as not to interfere with other work. In areas where the ducts, pipes, wiring and equipment of other Division will be installed in proximity to pipes, wiring and equipment pertaining to this Division, co-operate to ensure that all pipes, ducts, wiring and equipment are installed to the best advantage.

.2 Supply all items to be built-in in ample time for rapid progress of work.

.3 Leave areas clear of conduits, cables and cable ducts and electrical equipment where space is indicated reserved for future equipment, and for Owners equipment or for work of other trades.

.4 Adequate space and provisions to be left for servicing of equipment, with minimum inconvenience to the operation of the systems.

.5 Locate wall and ceiling fixtures, devices, equipment in exact accordance with dimensions furnished by the ceiling installer, wall tile installer and masonry installer. Make any

necessary adjustments in conduits to allow fixtures, devices and equipment to coincide with ceiling and wall patterns.

.6 Changes and modifications necessary to ensure co-ordination and to avoid interference and conflicts with work of other trades, to accommodate existing conditions or Owners equipment, to be made at no extra cost to the Owner.

.7 The work under this Division to be carefully co-coordinated with all schedules and sequences of construction and interim target dates.

.8 Work in existing building shall not interfere with the normal operation of the building.

1.16 DRAWINGS, CHANGES AND INSTALLATION

.1 The drawings show the general character and scope of work and not the exact details of the installation. The installation to be complete with all accessories required for a complete and operative installation.

.2 The location, arrangement and connection of equipment and material as shown on the drawings represent a close approximation to the intent and requirements of the contract. The right is reserved by the Consultant to make reasonable changes required to accommodate conditions arising during the progress of the work, at no extra cost to the owner.

.3 Drawings indicate diagrammatically locations of electrical equipment. Generally, where locations of electrical equipment are shown on Architectural Drawings, the architectural locations shall govern.

.4 Obtain approximate dimensions by scaling drawings. Drawings are in general made to scale. However, accurate dimensions for installation details must be obtained at the site or from data from all drawings including Architectural, Mechanical, Electrical, Structural, shop and detail drawings. Figured dimensions supersede scaled dimensions.

.5 The location and size of existing services shown on the drawings are based on the best available information. The actual location of existing services to be verified in the field before work is commenced.

.6 Any discrepancies should be brought to the attention of the consultant immediately.

1.17 RECORD DRAWINGS

.1 The drawings for this project have been prepared on a CAD system using AutoCAD proprietary software. For the purpose of producing record (as-built) drawings, copies of contract drawings may be obtained from the Consultant.

.2 The Division 26 contractor will pay for one extra set of white prints on which the contractor shall clearly mark, as the job progresses, all changes and deviations from that shown on contract drawings. Drawings to be kept up to date during construction and in addition to field measurements shall include variation orders, field instructions and all other architectural and electrical changes made during construction.

.3 Changes and deviations include those made by addenda, change orders, and site instructions, and changes and deviations indicated on supplemental drawings issued with addenda, change orders, and site instructions. Maintain the “as-built” white prints at the site for periodic inspections by the Consultant throughout the duration of the work.

.4 Pay particular attention to accurately dimensioning the location of all concealed services terminated for future, all buried work and services, and work concealed within the building in inaccessible locations.

.5 The record drawings shall show "as built" all major junction boxes, outlets and equipment as well as services entering the building and on the property. Dimension underground services and concealed conduits at key points of every run in relation to structure and building.

.6 The up-to-date record drawing to be available for review by the Consultant at each site meeting.

.7 Pay for a set of drawings and revise to agree with the marked up white prints.

.8 Before applying for a Certificate of Substantial Performance of the Work, update a copy of the contract document drawing in accordance with the marked-up “as-built” white prints, thus forming an “as-built” drawing. Submit the “as-built” drawing white prints (hard copy drawing set) to Consultant for review. Once approved, Contractor to forward one hard copy drawing set and one electronic drawing set to the Owner.

.9 All submitted drawings to be of the same quality as the original contract document drawings.

.10 The Contractors shall append the name of their respective company on the drawings prepared as above, under their respective direction, and shall certify in writing thereon that, to the best of their knowledge and ability, the recorded information is complete and accurate in every detail.

1.18 SUBMITTALS

.1 Provide electronic copies of shop drawings for all major electrical components including all accessories.

.2 Shop drawings to be submitted for all equipment.

.3 As an alternate, the contractor may submit eight (8) copies of standard catalogue sheets where this is normal means of submission for a supplier. Shop drawings and brochures for catalogue items to be marked clearly to show the items being supplied.

.4 Shop drawings shall indicate clearly the materials and/or equipment being supplied, all details of construction, accurate dimensions, capacity, operating characteristics, performance, finish and accessories.

.5 Each shop drawing to bear the name of the project and give the identifying number of the specific item of equipment for which it was prepared (e.g. PP-F-2).

.6 Each shop drawing for non-catalogue items to be prepared specifically for this project.

.7 Each shop drawing or catalogue sheet to be stamped and signed by the contractor "Certified Correct for Construction" to indicate that he has checked the drawing for conformance with all requirements of the drawings and specifications; that he has co-coordinated this equipment with other equipment to which it is attached and/or connected and that he has verified all dimensions to ensure the proper installation of equipment within the available space and without interference with the work of other trades. Ensure that co-ordination with other sections is completed before submitting drawings for review.

.8 The Consultant will review shop drawings and will indicate his review status by stamping shop drawing copies as follows:

.1 **"REVIEWED"- If the Consultant's review of the shop drawing is final and the shop drawing is accepted, the Consultant will stamp the shop drawing "REVIEWED";**

.2 **"REVIEWED AS NOTED"- If the Consultant' review of the shop drawing is final; the Consultant will stamp the shop drawing "REVIEWED AS NOTED" mark the submission with his comments and return the submission.**

.3 **"REJECTED" - If the Consultant's review of shop drawing is not final, the Consultant will stamp the shop drawing "REJECTED". This shop drawing will not be accepted.**

.9 It is understood that the following to be read in conjunction with the wording on the Consultant's shop drawing review stamp applied to each shop drawing submitted:

"THIS REVIEW BY THE CONSULTANT IS FOR THE SOLE PURPOSE OF ASCERTAINING CONFORMANCE WITH THE GENERAL DESIGN CONCEPT.THIS REVIEW DOES NOT MEAN THAT THE CONSULTANT APPROVES THE DETAIL DESIGN INHERENT IN THE SHOP DRAWINGS, RESPONSIBILITY FOR WHICH REMAINS WITH THE CONTRACTOR, AND SUCH REVIEW DOES NOT RELIEVE THE CONTRACTOR OF THE RESPONSIBILITY FOR ERRORS OR OMISSIONS IN THE SHOP DRAWINGS OR OF HIS RESPONSIBILITY FOR MEETING ALL REQUIREMENTS OF THE CONTRACT DOCUMENTS.BE RESPONSIBLE FOR DIMENSIONS TO BE CONFIRMED AND CORRELATED AT THE JOB SITE, FOR INFORMATION THAT PERTAINS SOLELY TO FABRICATION PROCESSES OR TO TECHNIQUES OF CONSTRUCTION AND INSTALLATION, AND FOR CO-ORDINATION OF THE WORK OF ALL SUBTRADES."

.10 Installation of any equipment shall not start until after final review of shop drawings has been obtained.

.11 When requested, shop drawings to be supplemented by data explaining the theory of operation.

.12 Changes made to the Shop Drawings by the Consultant will not affect the Contract Price.

1.19 TEMPORARY USE OF EQUIPMENT BY THE CONTRACTOR

.1 Where the contractor has been granted permission to use the electrical system for his benefit during construction, he shall maintain the system and equipment in proper operating condition.

.2 Before any area of the building is turned over to the owner for acceptance and for beginning of the guarantee/warranty period, the systems and equipment to be returned to the initial new condition by replacing lamps and cleaning fixture lenses, etc.

1.20 TEMPORARY AND TRIAL USAGE BY THE OWNER

.1 The temporary or trial usage by the Owner of any device, machinery, apparatus, equipment or other work supplied under this Division before final completion and written acceptance by the Consultant is not to be construed as evidence of the acceptance by the Owner.

.2 The Owner shall have the privilege of such temporary and trial usage as soon as the Contractor claims that said work is completed in accordance with the Drawings and Specifications, for such reasonable length of time as the Consultant shall deem sufficient for making a complete and thorough test. No claim for damage to be made by this Division for the injury to or breaking of any parts of such work which may be used.

1.21 TESTING

.1 All equipment and electrical systems which are provided under this Division to be performance tested to standards and functions described in the specifications, to all applicable codes and for electrical and mechanical defects. Make necessary adjustments and replace defective parts and wiring at no cost to the Owners.

.2 Furnish labour, materials, instruments and bear all costs for tests as requested by inspection authorities and/or the Consultant. Forward written results of tests to the Consultant.

.3 All tests to be carried out in the presence of the Consultant, arrange for tests to suit Consultant's schedule.

.4 Conduct acceptance tests as specified in NETA ATS – 2017 and any other tests deemed necessary.

.5 The complete power distribution system including phasing, voltage, grounding and load balancing.

.6 Conduits and ducts which are required to be installed but left empty to be tested for clean bore and a fish tape installed.

.7 All motors, heaters and associated control equipment including sequenced operation of systems where applicable.

.8 Complete testing and operation verification of all systems i.e., fire alarm interconnection, communications, etc.

.9 Submit original copies of certificate or letter from manufacturer confirming that their technical representatives have inspected and tested the entire installation as it pertains to each system and are satisfied with the method of installation, wiring and operation.

1.22 SPECIFIED, ACCEPTABLE AND ALTERNATIVE EQUIPMENT AND MATERIALS

.1 Materials and equipment scheduled and/or specified on the drawings and in Sections of Division 26 of the Specification have been selected to establish a performance and quality

standard, and, in some instances, a dimensional standard. In most cases, acceptable manufacturers are stated for any material or equipment specified by manufacturer's name and model number. The tender price may be based on materials and equipment supplied by any of the manufacturers named as acceptable for the material or equipment. If acceptable manufacturers are not stated for a material or piece of equipment, base the tender price on material supplied by the specified manufacturers.

.2 If materials or equipment supplied by a manufacturer named as acceptable are used in lieu of the manufacturer specified, be responsible for ensuring that the substituted material or equipment is equivalent in quality, performance and operating characteristics (including energy consumption if applicable) to the specified materials or equipment, and, it to be understood that any additional costs, and changes to associated or adjacent work resulting from provision of materials supplied by a manufacturer other than the specified manufacturer is included in the tender price. In addition, in equipment spaces where equipment named as acceptable is used in lieu of specified equipment and the dimensions of such equipment differs from the specified equipment, prepare and submit for review, accurately dimensioned layouts of rooms affected.

.3 In addition to the manufacturers specified or named as acceptable, alternative manufacturers of materials or equipment may be proposed to the Consultant for acceptance, listing in each case a corresponding credit for each alternative proposed, however, the tender price must be based on equipment or materials specified or named as acceptable. Certify in writing to the Consultant that the alternative meets all space, power, design, energy consumption, and all other requirements of the specified or acceptable material or equipment. In addition, it to be understood that there will be no increase in the contract price by reason of any changes to associated equipment, mechanical and/or electrical, required by acceptance of proposed alternatives. The Consultant has sole discretion in accepting any such proposed material or equipment.

.4 Submit the names of the manufacturers for materials and equipment that you will supply, and which were specified or scheduled with a manufacturer's name. Note that the names of manufacturers on the list must be one (1) of the names stated as acceptable for the products, unless prior written permission has been given for use of products by alternative manufacturers. If names are not submitted, it to be assumed and expected that the base specified products will be provided.

.5 Unless otherwise specified, all materials and apparatus to be new.

1.23 BENEFICIAL USE BY OWNER

.1 Comply with requirements for staged handover of portions of the work for beneficial use by the Owner as outlined in the Construction Schedule, as prepared by the Contractor.

1.24 QUALIFICATION OF TRADESMEN

.1 The Electrical Division shall maintain at the job site, at all times, qualified personnel and supporting staff, with proven experience in erecting, supervising, testing and adjusting projects of comparable nature and complexity.

.2 The supervising personnel and their qualifications to be subject to approval by the Consultant.

1.25 RECEIPTS

.1 Turn over to Owner's representative and obtain receipts for:

.1 Maintenance materials and portable equipment specified.

.2 Keys for all equipment supplied.

.3 Spare parts.

.4 Submit photocopies of these receipts with final Certificates of Approval.

1.26 START UP AND OPERATION

.1 Thoroughly instruct Owner's representative on all aspects of the operation, care and maintenance, testing and startup of all systems and equipment.

.2 Arrange for and pay for services of Service Engineers and/or manufacturer's representatives of specialized systems or equipment to supervise initial start-up of equipment, check and adjust as required and instruct the Owner's representative.

.3 Provide these services for such period and for as many visits as necessary to put installation in working order, and to ensure that operating personnel are conversant with all aspects of its care and operation.

1.27 ADJUST OR CLEAN

.1 Upon completion of the work:

.2 Remove from the site all debris and surplus material resulting from the work and leave the premises in a broom clean condition.

.3 A complete and thorough cleaning up to be done not only on the surfaces of all equipment, but on the interior of switchboard panels and starters.

.4 Where equipment shows rust or because of damage by any division to the finish of panels or fixtures or devices, this Division shall touch up all surfaces to the satisfaction of the Consultant.

.5 All polished, painted or plated work to be left bright and clean. All fixtures to be left clean and burned out lamps replaced.

.6 Repair, adjust and lubricate mechanisms leaving them in operating condition.

1.28 FINAL INSPECTION

.1 Request in writing to be submitted for final inspection of electrical systems.

.2 Do not submit this written request until:

.3 Deficiencies noted during job inspections have been corrected.

.4 Completed data books have been submitted and approved.

.5 The cleaning up is finished in every respect.

.6 Certificates from Electrical Safety Authority and subcontractors stating work is complete.

.7 Spare parts and replacement parts specified have been provided and receipt of same acknowledged.

.8 Record drawings are completed and approved.

.9 Systems are complete, tested and ready for operation, and all fixtures lamped.

.10 Owner's operating personnel have been instructed in operation of systems.

.11 All lamacoid nameplates installed, all panel schedules complete, all touch-up painting completed.

1.29 WARRANTY

.1 Refer to General Conditions and other sections of the specifications.

.2 Provide a certificate of guarantee of workmanship, materials and equipment for one year after completion of the Contract. Repair or replace, without expense to the Owner, all defects due to imperfect materials or workmanship which appear within one year after acceptance of the work in such a manner that the re-appearance of the defects later will be rendered impossible. Instruct all suppliers and manufacturers in making up their quotations that guarantees on equipment will commence when the work has been officially accepted and not from the date that the equipment is actually put into operation.

2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

.1 Equipment and material to be CSA certified. Where CSA certified equipment and material is not available, submit such equipment and material to Inspection Authorities for special approval before delivery to site as described in PART 1 - SUBMITTALS.

.2 Factory assemble control panels and component assemblies.

2.2 WARNING SIGNS

.1 Warning Signs: in accordance with requirements of Authority Having Jurisdiction.

.2 Lamicoid, white lettering on red background.

.3 Size and text of warning signs to be submitted to Engineer for approval.

2.3 WIRING TERMINATIONS

.1 Ensure lugs, terminals, screws used for termination of wiring are suitable for either copper or aluminum conductors.

2.4 WIRING IDENTIFICATION

.1 Identify wiring with permanent indelible identifying markings, coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.

.2 Maintain phase sequence and colour coding throughout.

.3 Colour coding: to CSA C22.1.

.4 Use colour coded wires in communication cables, matched throughout system.

2.5 FINISHES

.1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.

.2 Colours: finish colours of equipment in accordance with Section 26 32 14 – Power Generation Natural gas.

3 EXECUTION

3.1 INSTALLATION

.1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.

3.2 NAMEPLATES AND LABELS

.1 Ensure manufacturer's nameplates, CSA labels and identification nameplates are visible and legible after equipment is installed.

3.3 CONDUIT AND CABLE INSTALLATION

.1 Holes through exterior walls, roof, and floor to be flashed and made weatherproof.

.2 Holes through fire separations to be sealed with removable fire-stop material of same rating as fire separation.

.3 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.

3.4 LOCATION OF OUTLETS AND SWITCHES

.1 Do not install outlets back-to-back in wall; allow minimum 150mm horizontal clearance between boxes.

.2 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000mm, and information is given before installation.

.3 Locate light switches on latch side of doors.

3.5 MOUNTING HEIGHTS

.1 Mounting height of equipment is from finished floor to centerline of equipment unless specified or indicated otherwise.

.2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.

.3 Install electrical equipment at following heights unless indicated otherwise:

.4 Local switches: 1200mm;

.5 Wall receptacles: 450mm;

.6 Panelboards: as required by Code or as indicated;

.7 Telephone and interphone outlets: 450mm;

.8 Wall mounted telephone outlets: 1200mm;

.9 Fire alarm stations: 1200mm;

.10 Fire alarm horns and strobes: 2100mm.

3.6 ARC FLASH AND SHORT-CIRCUIT AND PROTECTIVE DEVICE COORDINATION STUDY

.1 Refer to testing, coordination and arc flash requirements in Section entitled 26 05 73 – Power Systems Studies

.2 Limits of studies to be from primary substation to farthest downstream device that is affected by modifications to the electrical system. A copy of the latest coordination study, if completed before, for the primary substation can be sent to Contractor by the Client on a request.

.3 Each study shall cover normal conditions, alternate operations, emergency power conditions, any other operations, which could result in maximum fault and arch flash conditions.

.4 Each study to be based on actual equipment proposed and shall not use generic settings or equipment specifications.

.5 Each study to be sealed by a Professional Engineer, licensed in the Province of Ontario, Canada and qualified to undertake such studies.

.6 Submit results of each study, including breaker trip curves and list of arc flash labels, to the Client's Engineer for approval.

.7 Ensure circuit protective devices, such as: short circuit ratings, overcurrent trips, relays, fuses, arc flash labels are installed and configured to achieve required values and settings, reported in each study.

3.7 FIELD QUALITY CONTROL

.1 Load Balance:

.1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.

.2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.

.2 Conduct following tests:

.1 Power transformer phase rotation, ratio and insulation resistance testing.

.2 MV fuses, LV air and molded case breakers contact resistance and insulation resistance testing.

.3 Electrical distribution system phase rotation, RMS and THD voltage and current, grounding resistance and load balancing.

.4 Isolation test of each circuit from an energized branch distribution panel.

.5 Lighting and its control functioning test.

.6 Motors, heaters and associated control equipment NETA ATS prescribed testing, including sequenced operation of systems where applicable.

.3 Insulation resistance testing:

.1 Megger 15KV circuits, feeders and equipment.

.2 Megger low voltage circuits, feeders and equipment.

.3 Measure substation grounding resistance before energizing new service.

.4 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.

.4 Manufacturer's Field Services:

.1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.

.2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

.3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

3.8 CLEANING

.1 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.

.2 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

.3 Comply with all previously mentioned standards.

END OF SECTION 26 05 0000

1 GENERAL

1.1 SUMMARY

.1 This document is a specification for basic electrical materials and methods. This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section of Electrical Divisions and is to be read accordingly.

1.2 RELATED SECTIONS

.1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

.2 This section to apply and form a part of all Sections of Division 26.

.3 Provide all items, articles, materials, operations, or methods listed, mentioned or scheduled on the drawings and/or specifications, including all labour, supervision, testing and commissioning, and equipment incidentals necessary and required for a complete electrical installation.

1.3 REFERENCES AND STANDARDS

.1 Canadian Standards Association (CSA)

.1 C22.2 No.211.1 - Rigid Types EB1 and DB2/ES2 PVC Conduit

.2 CSA C22.2 NO. 83.1-07 - Electrical Metallic Tubing - Steel

.3 CSA-C22.2 No. 45.1-04 - Electrical Rigid Metal Conduit - Steel

.4 CSA C22.2 No 56-13 - Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit

.2 Ontario Electrical Safety Code (OESC)

1.4 SUBMITTALS

.1 Submit shop drawings for products of this Section.

.2 Additionally, as part of shop drawing submission process, submit following to Consultant for review:

.1 sample of each proposed type of access door if supplied under work of this Division, as well as electronic copies of reflected ceiling plan drawings and wall elevation drawings showing proposed access door locations;

.2 dimensioned location drawings indicating required sleeves and formed openings in structural poured concrete or precast concrete construction or in roofing, and locations of cutting or drilling required for Electrical Divisions work;

.3 samples of materials and any other items as specified in succeeding Sections of Electrical Divisions;

.4 weight loads of selected equipment (upon request);

.5 equipment nameplate and warning sign proposed nomenclature, print type, symbols, sizing and colours;

.6 fire stopping installation drawings with ULC certifications;

.7 copies of prior to start of construction approvals from local governing authorities having jurisdiction.

.8 Prior to application for Substantial Performance of the Work, submit following to Consultant for review (note: funds will be withheld until each of following items have been completed and documented to satisfaction of Owner and reviewed with Consultant):

.1 fire alarm system testing and verification report of each component of work; devices to be certified working and in proper order;

.2 final distribution system testing and arc flash study performed and documented to satisfaction of Consultant;

1.5 QUALITY ASSURANCE

.1 Comply with all previously mentioned standards.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

.1 Store materials only in dry areas and protect as necessary to maintain materials in new condition.

.2 The Contractor is responsible to check routing through building for all major pieces of equipment and schedule delivery and setting in place to suit construction schedule. Arrange in advance for necessary openings to be left.

.3 Any damage to new or existing floors, walls, door trims, doors, etc. caused by moving of equipment through the building to be repaired by the Contractor at no cost to the Owners.

1.7 DESIGNATED SUBSTANCES

.1 Hazardous materials and infectious materials are known to be present on site in existing building, including but not limited to following:

.1 aspergillus;

.2 mould;

.3 asbestos;

.4 PCB's;

.5 lead;

.6 mercury.

.2 Divisions 01 and 02 may identify specific requirements and if such materials are present, refer to Division 01. Comply with requirements and those of local governing authorities.

.3 Include for company specializing in removal and disposal of materials containing PCB's to remove and dispose off-site luminaire ballasts containing PCB's. Check luminaires being deleted for ballasts containing PCB's. Disconnect and dispose off-site such ballasts. Only companies that are certified and comply with Ministry of Environment and Ministry of Transport regulations with regards to hazardous waste materials are to be used to perform this Work. Prior to start of Work, submit to Consultant a copy of PCB disposal certificate and identification of Ministry authorized and designated disposal site.

.4 Fluorescent lamps being replaced and containing mercury are to be properly transported offsite and disposed of as per local governing Ministry guidelines.

1.8 NOISE AND VIBRATION

.1 Electrical equipment shall operate without objectionable noise or vibration.

.2 If such objectionable noise or vibration should be produced and transmitted to occupied portions of the building by apparatus, transformers, ducts, conduits, ballasts or other parts of the electrical work, make necessary changes and/or additions, as approved, without extra cost to the Owner.

1.9 MOTOR ROTATION

.1 Check rotation of all motors and revise as required for correct operation of the equipment.

.2 Install all new switchboards, transformers and panelboards with the phasing similar to the existing power distribution system.

1.10 LOAD BALANCE

.1 Measure phase current to panelboards with normal loads operating at time of acceptance. Adjust branch circuit connections as required to obtain best balance of current between phases and record all changes.

.2 Measure primary and secondary currents of transformer. If necessary, rearrange phase connections to selected branch feeders without changing phase rotation to obtain minimum unbalance. Change colour coding of feeder to suit these changes.

.3 Measure phase voltages at loads and adjust transformer taps to obtain, within 2%, rated voltage of equipment.

1.11 VOLTAGE RATINGS

.1 All motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard. Equipment must be able to operate in extreme operating conditions established in above standard without damage to equipment.

1.12 GROUNDING

.1 Equipment requiring grounding by CSA and or Ontario Electrical Safety Code, and inspection authorities to be so grounded, regardless of whether it has been shown on the drawings or called for in these specifications.

.2 The size of grounding conductor shall be as required by the Ontario Electrical Safety Code.

1.13 INSULATION RESISTANCE TESTING

.1 Megger all feeders to Panel Boards, MCC's, MCP's and to all major loads over 50 amperes.

.2 Ensure that resistance to ground meets Ontario Electrical Safety Code requirements before energizing.

.3 Identify and log all megger readings, submit to Consultant for review.

1.14 STEEL

.1 Supply and install steel construction required solely for the work of this Contract.

1.15 EQUIPMENT SUPPORT

.1 Build platforms and other necessary supports to hang or support equipment supplied under this Contract. Supports to be rugged, well-built and of ample strength to safely carry the loads under operating conditions without undue vibration or noise. Supports to be bracketed to the wall and to the ceiling or floor as required to if wall thickness is inadequate.

.2 Support of large or heavy equipment shall be from the floor, unless specifically indicated to the contrary.

.3 Electrical panels, splitters, MCP's, disconnect switches, starter or other wall-mounted electrical equipment may be lagged to concrete or solid 8" masonry walls. Install angle or channel iron supports to bear the equipment on or in hollow masonry block or metal stud walls.

.4 Provide channel iron or other metal supports where necessary, to adequately support lighting fixtures.

.5 Ensure that the support system is adequate to carry weight of equipment specified before installation, or independently support from structure.

.6 Do not use wire lashing or perforated strap to support or secure raceways or cables.

.7 Do not use supports or equipment installed for other trades for conduit or cable support except with permission and approval of Consultant.

.8 Install fastenings and supports as required for each type of equipment, cable and conduits, and in accordance with manufacturer's installation recommendations.

1.16 SPRINKLER PROTECTION

.1 Provide drip shields for protection of surface mounted equipment enclosures from water spray and dripping of liquids. Features of shields include:

.1 factory constructed by respective equipment manufacturers;

.2 constructed from non-combustible materials (sheet steel);

.3 enamel painted to match equipment;

.4 surfaces and edges filled/sanded smooth prior to painting;

.5 supported from equipment with structural steel rods/metal framing or other method reviewed with Consultant;

.6 structural support finish painted to match shield.

.2 Include with equipment shop drawings, detailed dimensions of drip shields and methods of supporting.

.3 Equipment with top cable/conduit entries to include additional sealing of entries with gasketing and/or waterproof sealant to prevent water from entering enclosure.

.4 Design ventilation louvers such that live components are not exposed to water spray and dripping liquids.

.5 Above requirements are additional minimum "sprinkler protection" standards for equipment specified as NEMA / (EEMAC) 1, 2 or 12.

.6 Obtain CSA approval where required by local governing authorities.

1.17 EQUIPMENT ENCLOSURES

.1 Electrical distribution and generation equipment in sprinklered areas to be fabricated by the manufacturer with suitable protection as to prevent sprinkler fluid from entering the equipment and/or interfering with its operation as per the requirements of CSA C22.1 Rule 26-006. This protection shall be of a type acceptable to the local Hydro Inspection Department. Review shop drawings with local inspector prior to fabrication of equipment.

.2 Equipment located indoors or outdoors to be in accordance with the requirements of CSA C22.2 No. 94 Standard as follows:

.1 Enclosures for indoor location, Types 2, 5, 12, 12K and 13;

.2 Enclosures for indoor or outdoor location, Types 3, 3R, 3S, 4, 4X, 6, and 6P;

.3 In damp locations shall have weatherproof EEMAC Type 3 enclosures

2 PRODUCTS

2.1 CONDUITS

.1 CSA approved, EMT (Thinwall), galvanized electrical metallic tubing, complete with factory made bends where site bending is not possible and joints and terminations made with steel couplers and steel set screw type connectors with insulated throats, and concrete tight where required. **CAST FITTINGS WILL NOT BE ACCEPTED.**

.2 CSA approved Galvanized steel flexible liquid tight metallic conduit, complete with Ideal "Steel Tough" liquid-tight flexible conduit connectors at terminations.

.3 CSA approved and labelled, FT-4 rated, rigid plastic (PVC) conduit complete with site made heat gun bends on conduit to 50 mm (2") diameter, factory made elbows in conduit larger than 50 mm (2") diameter, solvent weld joints, factory made expansion joints where required, and terminations made with proper and suitable connectors and adaptors.

2.2 OUTLET BOXES

.1 CSA approved stamped galvanized steel outlet boxes.

.2 Provide an outlet box for each lighting fixture, wiring device, telephone/DATA outlet and any other outlet specified herein or shown or specified on the drawings, unless otherwise noted.

.3 All standard boxes to be manufactured from Code gauge steel.

.4 Generally, mounting heights and locations for outlets are shown on the drawings and/or specified herein, however, confirm the exact location and arrangement of all outlets with the Consultant prior to roughing in. Architectural drawings and the Consultant's instructions have precedence over electrical drawing diagrammatic layouts and specified mounting heights and locations.

.5 Support and secure boxes independent of the conduit or cable connected thereto.

.6 All surface mounted boxes for switches, receptacles, thermostats, etc., to be FS type boxes with metal FS covers. FS boxes shall only be used in unfinished areas.

.7 Provide CSA certified rigid plastic (PVC) outlet boxes, as required to suit that application.

2.3 PULL BOXES AND JUNCTION BOXES

.1 CSA approved, Galvanized or prime coat plated steel, suitable in respects for application and complete with screw-on or hinged covers as required, and connectors suitable for connected conduit.

.2 Rigid plastic (PVC) applications, CSA approved, junction boxes and access fittings with solvent weld type joints and screw-on PVC covers.

.3 Physical size of pullboxes to be as required by OESC to suit number and size of conduits and conductors.

.4 Each box to be suitable in respects for application and complete with suitable securing lugs, connectors suitable for connected conduit, knockouts and, where necessary, suitable plaster rings, concrete rings, covers and any other required accessory.

.5 Boxes exposed exterior of building or in non-climate-controlled locations to be weatherproof boxes complete with gasketed covers.

2.4 SLEEVES

.1 Galvanized Steel sleeves to be as follows:

.1 Schedule 40 pipe;

.2 Schedule 40 rigid PVC sleeves.

2.1 FIRESTOPPING AND SMOKE SEAL MATERIALS:

.1 Asbestos-free, elastomeric materials and intumescent materials, tested, listed and labelled by ULC in accordance with CAN/ULC S115, and CAN/ULC S101 for installation in ULC designated firestopping, and smoke seal systems to provide a positive fire, water and smoke seal and a fire resistance rating (flame, hose stream and temperature) no less than fire rating for surrounding construction.

.2 Firestopping and smoke seal material system to be specifically ULC certified with designated reference number for its specific installation. As part of shop drawing submission, submit copies of firestopping drawings with ULC certificate and system number for each specific installation.

.3 Where fire-rated walls, floors, roof or partitions are pierced to accommodate conduits, wireways, raceways, cables or bus ducts, provide all necessary seals, fittings, barriers and fire-resistant materials to restore the installation to its original fire-rating to the satisfaction of the governing authorities.

.4 Provide products of a single manufacturer for use on work of this Division.

.5 Installer to be manufacturer trained and certified on specific product. Submit copy of certificate with shop drawings.

.6 Include for manufacturer's authorized representative to inspect and verify each installation and application. Submit test report signed and verified by system installer's authorized representative and manufacturer's representative.

.7 Acceptable certification to also include certification by Underwriters Laboratories of Northbrook IL, using tests conforming to ULC-S115 and given cUL listing published by UL in their "Products Certified for Canada (cUL) Directory".

.8 ULC listed products for the locations of the following manufacturers are acceptable:

.1 Flameseal by Electrovert Ltd.;

.2 Firestop Systems, Elasta Seal;

.3 Flamesafe Fire Stop System by Thomas and Betts Corp.;

.4 Dow Corning Silicone RTV Foam;

.5 3M Canada;

.6 HILTI Canada;

.7 Tremco.

2.2 ESCUTCHEON PLATES

.1 Provide escutcheon plates over all exposed conduit passing through walls, floors, ceilings, partitions, furring's, etc., in finished areas.

2.3 FASTENING AND SECURING HARDWARE

.1 Provide all inserts, beam clamps, fasteners, and similar hardware required for conduit, duct, raceway, conductor, etc., and equipment hanger and/or support materials unless otherwise noted.

.2 Accurately and properly set concrete inserts in the concrete framework.

.3 For runs of three (3) or more conduits, raceways, or conductors in concrete form work, use multiple type inserts used for the smallest conduit in the group.

.4 Where inserts are required in precast concrete and in concrete work where concrete inserts have not been installed, drill a neat hole of the proper diameter and depth in the concrete and insert an anchor to accept the hanger rod, bolt, etc. or where concrete mass permits, use self-drilling concrete anchors.

.5 Fasten hangers and support provisions to brick or masonry with expansion shields and machine bolts, or for light loads, use plugs and screws.

.6 In cavity walls and/or ceilings use two (2) wing toggles and for heavy loads, provide steel anchor plates with two (2) or more toggles to spread the load.

.7 Provide beam clamps for attaching, hanging and/or support provisions to structural steel, or where approved by the Consultant, weld the hanging and support provisions to the structural steel.

.8 Explosive power actuated fasteners will not be permitted unless specific approval for their use has been obtained from the Consultant.

.9 Use lead screw anchors for anchoring screws.

.10 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.

.11 Fasten exposed conduit or cables to building construction or support system using straps.

.1 One-hole steel straps to secure surface conduits and cables 50mm and smaller.

.2 Two-hole steel straps for conduits and cables larger than 50mm.

.3 Beam clamps to secure conduit to exposed steel work.

.12 Suspended support systems

.1 Support individual cable or conduit runs with 6mm dia. threaded rods and spring clips.

.2 Support 2 or more cables or conduits on channels supported by 6mm dia. threaded rod hangers where direct fastening to building construction is impractical.

.13 For surface mounting of two of more conduits, use channels at 1.5m o.c. spacing.

.14 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.

.15 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.

.16 All hangers to be directly suspended from the structure; pipes or equipment shall not be supported from other pipes, ducts, equipment, suspended ceilings, etc.

.17 Hangers, inserts and sleeves, shall generally be suspended from approved inserts in concrete or by beam clamps. Welding of rods to steel structural members to be done only with prior approval of welding methods by the Consultant and loads on such rods shall not exceed 90 kg (200 lb).

.18 Hangers to be protectively finished to protect against corrosion.

2.4 SPLITTER TROUGH (EXTERIOR)

.1 Provide CSA approved CUSTOM splitter box as per details on the drawings.

.2 Minimum NEMA 3R weatherproof galvanized steel construction with corrosion resistant finish of colour approved by Owner and reviewed with Consultant;

.3 unless otherwise indicated on drawings, sized as per CSA and ESA requirements;

.4 with hinged gasketted doors with 3-point latch and key lock with provisions for safety padlocks; key can only be removed when door is closed and locked;

.5 conduit entries with proper bushings and sealed to prevent egress of precipitation;

.6 tin plated copper bussing for cable tap off provisions with holes in each bus to accommodate feeders from distribution system; each lug on feeders to be dual annular crimped, long barrel and two hole type, bolted to bussing with 13 mm (1/2") bolts with lock washers, nuts and flat washers; bus to be angled to properly facilitate connection of cabling; bus to be suitably secured to handle weight of connection cables;

.7 copper ground bus and ground lugs;

.8 conduit entries and mounting provisions completely sealed weather-tight to prevent any ingress of water or precipitation into connection box;

.9 engraved lamacoid nameplates and signage on enclosure with appropriate component identification and box instructions regarding use; submit proposed scheme, colours and nomenclature with shop drawings.

.10 Review mounting requirements with Consultant. Locate and install boxes to be self-standing and secured to concrete bases with conduit/duct entries from below. Include required Unistrut type corrosion resistant stainless-steel C-channels for support of boxes. C-channels to raise boxes above bases. Refer to drawings.

.11 Provide required distribution conductors to suit applications to local code requirements, from splitter box to respective system components as shown and as required.

.12 Complete assembly to be approved by local governing electrical authorities and inspection authorities and be suitable for intended application.

.13 Acceptable manufacturers include:

.1 Phoenix Controls (Chris Wight, 289-291-0161 ext. 26);

2.5 IDENTIFICATION NAMEPLATES

.1 Provide Identification nameplates as described in Section 26 05 53.

.2 Laminated plastic (Lamacoid) black-white-black with bevelled edges, stainless steel screws, and proper identification engraving. Each nameplate to be sized to suit equipment for which it is provided and required wording. Various colour configurations to be used to differentiate systems. Confirm exact nomenclature, sizing, print type and colour scheme with Owner and review with Consultant.

.3 Brother "P-Touch" or approved equal, portable electronic labelling system complete with self-adhesive, permanent printed labels with required nomenclature.

.4 For non-climate-controlled areas: nameplates to be weather resistant, corrosion resistant and UV resistant to prevent fading. Mounting hardware to be corrosion resistant stainless-steel construction.

2.6 SIGNAGE

.1 Thomas & Betts Ltd., or approved equal, semi-rigid vinyl panels with drilled holes in each corner, stainless steel screws, pressure sensitive mounting pads on back, and required printed wording. Generally, wording to be red on a white background with black trim confirmed with Owner and reviewed with Consultant.

.2 For non-climate-controlled areas: signage to be weather resistant, corrosion resistant and UV resistant to prevent fading. Mounting hardware to be corrosion resistant stainless-steel construction.

.3 Warning signage to comply with applicable requirements of local governing authorities and codes.

2.7 EXCAVATION AND BACKFILL

.1 Do all excavating bedding backfill and related work for the work of Division 26 as specified therein.

.2 For all electrical excavation, excavate to 150mm below and a minimum of 200mm to either side of the cable or duct run. Fill back with a bedding of granular 'A' gravel or sand. Minimum coverage to be 750mm.

.3 Refer to details on the drawings and to utility company requirements for concrete encased duct installation.

.4 Where excavation is necessary in proximity to and below the level of any footings, bed with concrete to the level of the highest adjacent footing. Concrete strength to be as directed by the Consultant.

.5 Carry out pavement cutting, and repair of the Owners and Public Property as may be required for excavation and backfill work.

2.8 FLASHING

.1 Flash all electrical parts passing through or built into an outside wall, or a waterproof floor.

.2 Provide copper flashing for sleeves passing through exterior walls or waterproof floors.

.3 Provide counter flashing on conduits passing through roofs to fit over flashing or curb. Supply flashing to appropriate division for installation.

2.9 MISCELLANEOUS METALS FOR ELECTRICAL WORK

.1 Steel construction required solely for the Electrical work, and not shown on the Architectural and Structural drawings to be supplied and installed by this Contractor. All steel supports, grates, or frames supporting more than 136.0 kg (300 lbs.) to be designed by a Structural Engineer.

.2 Elevated equipment on steel frames to be properly braced to transfer weight evenly throughout the elevated structure, and in turn, transfer that weight evenly to the building structure.

2.10 MOUNTING HEIGHTS

.1 Refer to mounting height table on drawings for exact requirements.

.2 If mounting height of equipment is not indicated verify before proceeding with installation.

.3 Prior to rough-in, co-ordinate and have approved by the Consultant all mounting heights of devices.

3 EXECUTION

3.1 GENERAL INSTALLTION REQUIREMENTS

.1 Install conduit concealed in finished areas to a degree possible by finishes in partially finished and unfinished areas.

.2 Conduit may be exposed in unfinished areas such as Electrical and Mechanical Rooms, unless otherwise noted on drawings or specified herein. Refer to and examine architectural drawings and room finish schedules to determine finished, partially finished or unfinished areas of building.

.3 Documents do not identify exact routing. Where shown, routing is diagrammatic, identifying general requirements of routing and locations. Include for necessary offsets, fittings, transformations and similar items required as a result of obstructions and other architectural or structural details not shown.

.4 Where conduits are exposed, arrange them to avoid interference with other work, parallel to building lines and install as high as possible.

.5 Do not install conduits within 150 mm (6") of "hot" pipes or equipment unless conduits are associated with equipment. Independently run conduit to be supported from wall/ceiling structure, not from ceiling hangers, ductwork, piping, cable trays, formed steel decking, etc. Do not run conduits within 900 mm (3') of equipment access opening covers.

.6 For proposed use of conduit runs underground below slab include following provisions:

.1 concrete encased ductbank with conduits of non-ferrous materials and sloped to drain properly into pit;

.2 proper drain pit;

.3 system to be a pull-in system;

.4 20% spare conduits (with minimum of at least 1);

.5 system proposal to consider and address any effects of magnetic fields.

3.2 INSTALLATION OF CONDUIT

.1 Provide conduit as sized on drawings. Size conduit not sized on drawings in accordance with local governing electrical code with consideration that sizes of branch circuit conductors indicated are minimum sizes and must be increased as required to suit length of run and

voltage drop. Where conductor sizes are increased to suit voltage drop requirements, increase scheduled or specified conduit size to suit.

.2 Unless otherwise noted on drawings conduit to be of minimum size 13 mm (1/2") diameter. Communication cabling system conduit to be of minimum 19 mm (3/4") diameter, unless otherwise noted.

.3 Site made bends for conduit to maintain full conduit diameter with no kinking, and conduit finishes are not flake or crack when conduit is bent.

.4 Plug ends of roughed-in conduits which are exposed during construction with approved plugs.

.5 Ensure that conduit systems which are left empty for future wiring are clean, clear, capped and properly identified at each termination point. Provide end bushing and suitable fish wires in such conduits.

.6 Provide conduit for conductors except armoured cable and copper sheathed mineral insulated conductors, and except where duct or similar raceway materials are provided, as follows:

.1 for branch circuit conductors underground inside building, and underground outside building beneath concrete, asphalt, and similar paving material - rigid PVC;

.2 for short branch circuit connectors to motorized equipment and distribution transformers (minimum length 450 mm (18"), maximum length 600 mm (24") with 180° loop where possible) – galvanized steel flexible liquid-tight conduit;

.3 for interior conduit containing distribution conductors or communication systems conductors (fire alarm, telephone etc.) (except as noted above) – EMT with separate insulated ground conductor;

.4 for conductors except as noted above or elsewhere in this Specification – EMT.

.7 Run rigid conductors in rigid type conduits suitable for application. Do not use flexible conduit.

.8 Support underground conduit on a well-tamped flat bed of earth, free from rocks or protrusions of any kind. Grade and slope bed to provide conduits and ducts with proper drainage. Coordinate with General Trades Contractor for provision of means to carry away drainage water. Obtain required approvals of work from local governing electrical utility and review with Consultant prior to back filling and covering. Provide pull cord in each duct run.

.9 Provide manufactured expansion joints in rigid PVC plastic conduit at spacing as recommended by conduit manufacturer.

.10 Provide a separate ground conductor in plastic conduits.

.11 Support and secure surface mounted and suspended single or double runs of metal conduit at support spacing in accordance with local governing electrical code requirements by means of galvanized pipe straps, conduit clips, ringbolt type hangers, or by other proper manufactured devices.

.12 Support multiple mixed size metal conduit runs with Unistrut Ltd., Electrovert Ltd. "CANTRUSS" or Burndy Ltd. "FLEXIBLE" conduit racks spaced to suit spacing requirements of smallest conduit in group.

.13 Unless otherwise noted, provide conduit fittings constructed of same materials as conduit and which are suitable in respects for application.

.14 Provide proper adaptors for joining conduits of different materials.

.15 Cut square and properly ream site cut conduit ends.

.16 Provide conduit as sized on drawings. Size conduit not sized on drawings in accordance with local governing electrical code with consideration that sizes of branch circuit conductors indicated are minimum sizes and must be increased as required to suit length of run and voltage drop. Where conductor sizes are increased to suit voltage drop requirements, increase scheduled or specified conduit size to suit. Unless otherwise noted on drawings or required by local governing electrical code or specified elsewhere, conduit to be of minimum size 13 mm (1/2") diameter. Structured network cabling system conduit to be of minimum 19 mm (3/4") diameter, unless otherwise noted.

.17 Site made bends for conduit to maintain full conduit diameter with no kinking, and conduit finishes are not flake or crack when conduit is bent.

.18 Plug ends of roughed-in conduits which are exposed during construction with approved plugs.

.19 Ensure that conduit systems which are left empty for future wiring are clean, clear, capped and properly identified at each termination point. Provide end bushing and suitable fish wires in such conduits.

.20 Provide empty conduits to ceiling spaces from flush mounted panelboards located below and/or near hung ceiling.

.21

3.3 INSTALLATION OF OUTLET BOXES AND BACK BOXES

.1 Provide an outlet box or back box for each luminaire, wiring device, telephone and data outlet, fire alarm system component, communications systems components, and each other such outlet. Size and arrangement of outlet boxes to suit device which they serve.

.2 Size boxes to accommodate exact supplied components and for bending radii of installed cables. Confirm requirements with respective system vendors.

.3 Outlet boxes for surface mounted exterior lighting, receptacles, and other device outlets, boxes flush mounted in exterior building surfaces, and boxes mounted in interior device locations where connecting conduit is rigid and boxes in perimeter wall where insulation and vapour barrier is present, and boxes in non-climate controlled areas to be "FS" or "FD" Series cast boxes unless otherwise noted.

.4 Outlet boxes in plastic conduit systems to be rigid PVC plastic outlet boxes, unless otherwise noted.

.5 Mounting heights and locations for outlet boxes are typically indicated on drawings, however, confirm exact location and arrangement of outlets prior to roughing-in. Architectural drawings and Consultant's instructions have precedence over electrical drawing diagrammatic layouts and specified mounting heights and locations.

.6 Provide blank coverplates on existing obsolete boxes which are to remain in position.

3.4 INSTALLATION OF PULLBOXES AND JUNCTION BOXES

.1 Provide pullboxes in conduit systems wherever shown on drawings, and/or wherever necessary to facilitate conductor installations. Generally, conduit runs exceeding 30 m (100") in length, or with more than two - 90° bends, are to be equipped with a pullbox installed at a convenient and suitable intermediate accessible location.

.2 Size boxes to accommodate exact supplied system and for bending radii of installed cables. Confirm requirements with respective system vendors.

.3 Provide junction boxes wherever required and/or indicated on drawings and as required by local governing electrical code.

.4 Provide sealing around boxes in walls where insulation and vapour barrier is present or for walls of rooms that are sealed. Maintain sealing system of wall.

.5 Boxes in rigid conduit and EMT inside building to be stamped galvanized or prime coated steel.

.6 Boxes in plastic conduit to be rigid PVC plastic boxes complete with required couplings.

.7 Pullboxes and junction boxes to be accessible after work is completed.

.8 Accurately locate and identify concealed pullboxes and junction boxes on "As-built" record drawings.

.9 Clearly identify main pull or junction boxes (excluding obvious outlet boxes) by painting outside of covers. Spray painting is not permitted unless approved by Owner and reviewed with Consultant. Paint colours to be in accordance with following schedule:

.1 lighting-yellow;

.2 normal power-blue;

.3 essential power-orange;

.4 fire alarm-red;

.5 Voice and Data-green;

.6 miscellaneous signals brown.

.10 In addition to painting miscellaneous signal boxes, clearly identify specific system in which box is installed.

.11 Cover boxes in fire walls with aluminium tape and seal with caulking.

3.5 INSTALLATION OF SLEEVES

.1 Where conduits, raceways and conductors pass through structural poured concrete, provide sleeves, unless otherwise noted.

.2 Size sleeves, unless otherwise noted, to leave 12mm clearance around the conduit, raceway, etc. Pack and seal the void between the sleeves and the conduit, raceway, conductor etc. for the length of the sleeves.

.3 Pack all sleeves with a ULC and CSA approved one-part intumescent elastomer. Refer to firestopping and smoke seal articles.

.4 Supply sleeves of a water protecting type for installation in the following locations:

.1 In Mechanical and Fan Room floor slabs except where on grade;

.2 In slabs over Mechanical, Fan, Electrical and Telephone equipment rooms or closets;

.3 In all floors equipped with waterproof membranes;

.4 In the roof.

.5 "Gang" type sleeving will be permitted only with the Consultant's approval.

.6 Terminate sleeves for work which will be exposed so that the sleeve is flush at both ends with the wall, partition or slab surface so that the sleeves may be completely covered by escutcheon plates.

.7 Openings for multiple conduit or conductor runs, etc., will be provided by the Division responsible for the construction in which the opening is required. Carefully coordinate the opening locations with the Division that openings are suitably sized and located. Seal the space between the opening and the conduit, conductors, etc., for the length of the opening as for sleeves above.

.8 Where a round or formed opening is required, where placement of a sleeve has been missed, or where provision of an opening has not been properly coordinated with the Concrete Division, neatly cut a suitably sized hole or opening using proper tools to the approval of the Consultant. Prior to cutting any such holes or openings, determine whether or not any reinforcing steel or services, are concealed behind the surface where the hole or opening is to be cut and be responsible for all costs incurred for correcting any damage caused to the structure or services due to cutting holes or openings without prior study and approval.

3.6 INSTALLATION OF FIRESTOPPING AND SMOKE SEAL MATERIALS

.1 Where work penetrates or punctures fire rated construction, provide ULC certified, listed and labelled firestopping and smoke sealing packing material systems to seal openings and voids around and within raceway and to ensure that continuity and integrity of fire separation is maintained. Openings not in immediate vicinity of working areas are to be fire stopped and sealed same day as being opened.

.2 Install firestopping and smoke seal materials for each installation in strict accordance with specific ULC certification number and manufacturer's instructions. Comply with local governing building code requirements and obtain approvals from local building inspection

department. Ensure that openings through fire separations do not exceed maximum size wall opening, and maximum and minimum dimensions indicated in ULC Guide No. 40 U19 for Service Penetration Assemblies and firestopping materials.

.3 Ensure that continuity and integrity of fire separation is maintained and conform to requirements of latest edition of ULC publication "List of Equipment and Materials, Volume II, Building Construction".

.4 Comply with following requirements:

.1 Manufacturer's installation instructions for each specific application.

.2 Clean areas and surfaces before materials are installed.

.3 Examine substrates, openings, voids, adjoining construction and conditions under which firestop and smoke seal system is to be installed. Confirm compatibility of surfaces.

.4 Verify penetrating items are securely fixed and properly located with proper space allowance between penetrations and surfaces of openings.

.5 Report any unsuitable or unsatisfactory conditions to Consultant in writing, prior to commencement of work. Commencement of work will mean acceptance of conditions and surfaces.

.6 Mask where necessary to avoid spillage and over coating onto adjoining surfaces. Remove stains on adjacent surfaces.

.7 Prime substrates in accordance with product manufacturer's written instructions.

.8 Provide temporary forming as required and remove only after materials have gained enough strength and after initial curing.

.9 Tool or trowel exposed surfaces to a neat, smooth, and consistent finish.

.10 Remove excess compound promptly as work progresses and upon completion.

.5 Notify Consultant when work is complete and ready for inspection, and prior to concealing or enclosing firestopping and smoke seal materials and service penetration assemblies. Arrange for final inspection of work by local governing authority inspector prior to concealing or enclosing work. Make any corrections required.

.6 On completion of firestopping and smoke sealing installation, submit a Letter of Assurance to Consultant certifying the firestopping and smoke sealing installation has been carried out throughout the building to service penetrations and that installation has been performed in strict accordance with requirements of local governing building code, any applicable local municipal codes, ULC requirements, and manufacturer's instructions.

.7 Manufacturer's authorized representative to inspect and verify each installation and provide a test report signed by installing trade and manufacturer's representative. Test report to list each installation and respective ULC certification and number.

.8 Where work requires removal of existing firestopping materials and replacement of firestopping materials after cabling changes have been made, ensure that replacement

material is same material and manufacturer of existing if any remains in place, or ensure that all existing material is removed before installation of replacement material.

3.7 INSTALLATION OF FASTENING AND SECURING HARDWARE

.1 Provide fasteners, anchors and similar hardware required for conduit, duct, raceway, conductors, etc. and for equipment hanger and/or support material unless otherwise noted.

.2 Accurately and properly set concrete inserts in concrete framework. Where multiple type inserts are used, space same to suit requirements of smallest conduit, etc., in group.

.3 Fasten hanger and support provisions to masonry with expansion shields and machine bolts, or, for light loads, use plugs, and screws.

.4 In drywall or plaster walls and/or ceilings use two wing toggles and for heavy loads, provide steel anchor plates with two or more toggles to spread load.

.5 Provide beam clamps for attaching hanging and/or support provisions to structural steel, or where approved by Owner and reviewed with Consultant, weld hanging and support provisions to structural steel.

.6 Install devices in accordance with manufacturer's instructions to suit each respective application.

.7 **Explosive powder actuated fasteners are not permitted unless specific approval for their use and type has been obtained from Owner and reviewed with Consultant.**

.8 Under no circumstances use ceiling suspension hangers or grids for suspension of conduit and conductors. Install supports to permanent structure of building, limited to areas that will not damage structural stability.

.9 Comply with Consultant's (Structural Engineer's) limitations for maximum penetrations of securing hardware into concrete slabs.

3.8 INSTALLATION OF SPLITTER TROUGH (EXTERIOR)

.1 Provide splitter where shown and as detailed on the drawings.

.2 Secure in place on concrete pad. Provide suitable designed stele framework to support splitter.

.3 Install and connect conduits and conductors complete.

3.9 INSTALLATION OF IDENTIFICATION NAMEPLATES

.1 For each piece of electrical distribution equipment from electrical source of supply up to and including panelboards, for special control panels and cabinets, and for each other piece of electrical equipment, provide engraved Lamacoid identification nameplates secured to apparatus with stainless steel screws.

.2 Refer to Section 26 05 53 - Identification for Electrical Systems for details.

3.10 INSTALLATION OF SIGNAGE

.1 Provide signage as required.

.2 Provide warning signs as applicable for following:

.1 on doors into transformer vaults;

.2 on doors into high voltage switchgear rooms;

.3 on doors to genset room;

.4 on doors into main electrical rooms;

.5 for other applications as noted.

.3 Secure signs to equipment with stainless steel screws. Number of signs required and sign wording, symbols, and colours to be approved by Owner and reviewed with Consultant, and local electrical utility and other governing authorities, where applicable.

3.11 DISCONNECTION, REMOVAL AND RELOCATION WORK

.1 Where indicated on drawings or where required to perform Work of this Project, disconnect and remove items of existing obsolete electrical work. Relocate required devices as required to accommodate work of other Divisions. Where luminaires, switches, receptacles, and other devices and/or equipment is removed, disconnect at point of electrical supply, remove obsolete wiring and conduit up to source, unless otherwise noted, and make system safe to Owner's satisfaction and as reviewed with Consultant.

.2 Remove obsolete conduit/raceways in accessible ceiling spaces, exposed locations, etc. Where existing obsolete conduit and similar raceway material cannot be removed, such as embedded in concrete, cut back and cap obsolete conduit and raceways. Refer to specific notes on drawings.

.3 When respective work is deleted, such deletions are to in no way affect operation of any existing interconnected mechanical or electrical components that remain. When existing circuits are being disconnected, maintain supervision of area to ensure that such circuits do not affect essential existing circuits being retained.

.4 Unless otherwise noted, obsolete materials which are removed and are not to be relocated or reused are to become your property. Remove from site and properly dispose. Obtain from Owner and review with Consultant, a list of existing electrical items which are to be removed and turned over to Owner. Said items are to remain property of Owner.

.5 Where existing services pass through or are in an area to serve items which are to remain, or pass through areas that are to be deleted, maintain services, but re-route as required. Include for rerouting existing services concealed behind existing finishes and which become exposed during renovation work, to be concealed behind new or existing finishes. Confirm with Owner services which are to be kept in service and operational.

.6 Protect existing devices being relocated or deleted to ensure that they are not damaged. Test such devices prior to disconnection and de-energization, to ensure that each device is in proper working condition.

.7 Examine each device for damage. Report devices not working or with damage to Consultant prior to initiating any work. It will be assumed that devices are in proper working order and good condition if not reported.

.8 Provide junction boxes, outlet boxes, wiring, plates, etc., as necessary for complete relocation of devices. Clean relocated or temporary removed devices and equipment and ensure that they are in good operating condition before being reinstalled.

.9 Do not splice conductors unless approved by Owner and reviewed with Consultant. Utilize junction boxes and terminal devices for proper extension of circuits where approved. Otherwise replace circuits with home run continuous run of suitable lengths.

.10 Include for fire alarm verification company to verify any relocated devices and downstream affected devices, and verify system as required by local fire authority to suit actual relocation work. For other existing systems, engage manufacturers authorized representative or Owner's system maintenance contractor, to inspect and verify relocated devices. Review exact requirements with Owner and Consultant. Document testing in test reports, signed by testing technician. Submit copies to Consultant.

.11 providing fire stopping materials to maintain fire rating of the existing surfaces; refer to specification article entitled - Firestopping and Smoke Seal Materials.

.12 If at any time during course of building work, asbestos containing materials are encountered or suspected, cease work in area in question and immediately notify Consultant. Comply with local governing authority regulations. Do not resume work in affected area without approval from Owner and review with Consultant.

3.12 INTERRUPTIONS TO AND SHUT-DOWNS OF SERVICES AND SYSTEMS

.1 Shutdowns and interruptions to existing systems and services are to be coordinated fully with and performed at times acceptable to Owner and reviewed with Consultant. Generally, shutdown may be performed only between hours of 12:00 midnight Sunday until 6:00 a.m. Monday morning. Include for costs of premium time to perform work during nights, weekends or other times outside of normal working hours, which may be necessary to comply with stipulations specified herein this Article. Services for operation of existing non-renovated areas of building are to be maintained.

.2 Upon award of contract, submit to Consultant for review and approval, a list of anticipated shut-down times and their maximum duration.

.3 Prior to each shut-down or interruption, inform Consultant and Owner in writing minimum 7 working days in advance of proposed shut-down or interruption and obtain written consent to proceed. Do not shut down or interrupt any system or service without written consent. Note that shutdowns of some essential services may require additional advance notification time.

.4 Work associated with shut-downs and interruptions are to be carried out as continuous operations to minimize shut-down time and to reinstate systems as soon as possible. Prior to any shut-down, ensure that materials and labour required to complete work for which shut-down is required are available at site.

.5 For Critical work requiring interruption shutdown of equipment, provide detailed procedures, as follows:

.1 Review with Consultant if any feeder (conductor) is designated for special considerations and if designated as such and is to be interrupted, ensure that at least following preparations are met:

.2 provide a schedule of proposed feeders to be interrupted; propose one feeder at a time to be worked on per scheduled shutdown;

.3 provide a written method of procedure for work;

.6 prepare above documentation and submit for approval by Owner and review with Consultant at least 10 working days prior to date of each proposed work;

.7 On day/night of proposed feeder work, advise Consultant of which feeder is to be worked on; review with Consultant requirements for witnessing work;

.8 de-energize feeders and perform work as per Owner approved and Consultant reviewed schedule;

.9 after feeders are re-routed, megger test each feeder.

3.13 CONCRETE WORK

.1 Unless otherwise noted, concrete required for electrical work is to be provided as part of Work of Division 03. Coordinated exact requirements (sizes, locations) with General Trades Contractor.

.2 Layout, mark, coordinate and work with Division 03 contractor as required for installation of concrete necessary for duct banks, housekeeping pads, cubed openings, etc.

3.14 EQUIPMENT CURBS, BASES AND SUPPORTS

.1 Provide equipment bases and supports. Coordinate concrete pour for housekeeping pads and luminaire poles bases with Division 03. Ensure that applicable seismic restraint provisions are provided as per local governing building code.

.2 Secure floor mounted equipment in place on minimum 100 mm (4") high concrete housekeeping pads, minimum 100 mm (4") wider and longer than equipment base dimensions.

.3 Supply dimensioned drawings, templates, and anchor bolts for proper setting of equipment on bases and pads. Be responsible for required levelling, alignment, and grouting of equipment.

.4 Submit to Consultant for review, dimensioned shop drawings of structurally designed bases for support of large, heavy equipment. Indicate on shop drawings total weight of base, reinforcement, and equipment for which it is required.

.5 Perform work within formwork contractor’s schedule. Failure to meet formwork schedule will result in Electrical Division Contractor being responsible for providing concrete work including formwork and reinforcing steel, to standards of Division 03.

.6 Unless otherwise noted, support equipment suspended above floor level with suitable welded or bolted prime coat painted structural steel angles or channels bracketed to wall or secured by hanger rods.

3.15 EXCAVATION AND BACKFILL

.1 Before commencement of excavation for work, determine in consultation with Consultant, Owner, Municipality and utilities, presence, if any, of existing underground services at site. Engage local utilities to locate and mark out such services. Ensure that trades concerned are aware of their presence.

.2 Be responsible for any damage done to underground services caused by neglect to determine and mark out location of such services prior to excavation work commences.

.3 Inverts and locations of existing site services may have been site surveyed and approximate location may be shown on drawings. Be responsible for confirming that inverts and locations are correct, prior to commencing excavation. Where discrepancies are found, immediately inform Consultant, and await a direction.

.4 Where Work falls under jurisdiction of local governing utility, confirm requirements and comply with utility requirements.

.5 Provide excavation, backfill, and related work required for your work. Obtain a copy of soil test report if available from Owner or Consultant. Depth of excavations must accommodate local governing requirements and local standard practices to compensate for local frost levels of Place of Work.

.6 Grade bottom of excavation. In firm, undisturbed soil, lay services directly on soil. Backfill excess excavation with 13,790 kPa (2,000 psi) concrete. Grade bottom such that ducts are installed to drain as reviewed with Consultant.

.7 Prepare new bedding under service in unstable soil, in fill, and in cases where bedding has been removed in earlier excavation, particularly near perimeter walls of buildings, and at manholes and catch basins, compact to maximum possible density and support service by means of 200 mm (8") thick concrete cradles spanning full length between firm supports. Refer to detail on drawings.

.8 Where excavation is necessary in proximity to and below level of any footing, backfill with 13,790 kPa (2,000 psi) concrete to level of highest adjacent footing. Proximity is determined by angle of repose as reviewed with Consultant.

.9 Do not open trenches ahead of installation of services and backfilling more than weather permits. Break up rocks and boulders and remove by drilling and wedging. Do not use blasting unless specifically permitted by Owner and reviewed with Consultant.

.10 Before backfilling, arrange for inspection of work by Consultant Do not backfill work unless reviewed with Consultant. Failure to do so prior to backfilling will require re-excavating work and re-backfill at no additional cost to Owner. Remove shoring during backfilling.

.11 Backfill trenches within building with clean sharp sand in individual layers of maximum 150 mm (6") thickness, compacted to a density of 100% Standard Proctor. Hand compact first layers up to compacted level of 300 mm (12") above top of service. Hand or machine compact balance up to grade using approved equipment.

.12 Backfill trenches outside building (not under roads, parking lots or traffic areas), up to a compacted level of 450 mm (18") above service with Granular "A" material, hand

compacted to a density of 95% Standard Proctor. Backfill balance with 150 mm (6") layers of approved excavated material compacted to 95% Standard Proctor density, using approved equipment.

.13 Backfill trenches outside building under roads, parking lots or traffic areas with granular "A" material in layers not exceeding 150 mm (6") thickness, compacted to 100% Proctor density up to grade level.

.14 Fill depressions to correct grade level with appropriate material, after an adequate period has passed to reveal any settlement. Use maximum possible compaction. Pay costs required to make good damages caused by settlement. Generally, final surface toppings are responsibility of another Division of Work. Coordinate exact requirements with General Contractor to ensure surface toppings are provided as required to match adjacent surfaces.

.15 Unless otherwise directed, store and dispose of excavated materials as follows:

.1 during progress of contract, place material as directed in such a manner that minimum damage or disfigurement of ground and which in no cause's way impedes progress of work;

.2 separately place surplus topsoil and subsoil as directed; leave site clean and unencumbered.

.3 Provide pumping equipment as required to keep excavations free of water.

.4 Engage services of independent soils testing agency to test final backfill compaction density of each backfilled location. Compact backfill to satisfaction of testing agency and in accordance with Specification. Submit a copy of testing agency's report to Consultant for review.

.16 Patch and reinstate final surface toppings (concrete, asphalt, pavers, grass sod, etc.) to match existing, and to the approval of the consultant and owner.

3.16 CUTTING, PATCHING AND CORE DRILLING

.1 Perform cutting, patching, and core drilling of existing building required for installation of your work. Perform cutting in a neat and true fashion, with proper tools and equipment. Patching is to exactly match existing finishes and be performed by tradesmen skilled trade or application. Work is subject to acceptance by Owner and review with Consultant.

.2 Criteria for cutting holes for additional services:

.1 cut holes through slabs only; no holes to be cut through beams;

.2 cut holes 150 mm (6") diameter or smaller only; review with and obtain direction from Consultant (Structural Engineer) for larger holes;

.3 keep at least 100 mm (4") clear from beam faces;

.4 space at least 3-hole diameters on centre;

.5 for holes that are required closer than 25% of slab span from supporting beam face, use cover meter above slab to clear slab top bars;

.6 for holes that are required within 50% of slab span, use cover meter underside of slab to clear slab bottom bars;

.3 Where conduits and/or conductors penetrate existing construction, core drill or saw cut an opening. Size openings to leave 13 mm (1/2") clearance around conduit and/or conductors, and pack and seal and void between opening and conduit and/or conductor for length of opening with ULC listed and labelled material in accordance with article entitled "Firestopping And Smoke Seal Materials" specified herein this Section.

.4 Do not cut or drill any existing work without approval of Owner and review with Consultant. Be responsible for damage done to building and services caused by cutting or drilling.

.5 Prior to drilling or cutting an opening, determine, in review with Consultant and Owner, and by use of non-destructive radar scan (magnetic scan) of slab or wall, presence of any existing services and reinforcement bars concealed behind building surface to be cut and locate openings to suit. Be responsible for damage to existing services caused by core drilling or cutting openings. Coring is not permitted through concrete beams or girders.

.6 Fire stop and seal openings as specified, and patch as required before end of workday. No openings are to be left open overnight unless approved by Owner and reviewed with

3.17 FINISH PAINTING OF ELECTRICAL WORK

.1 Provide identification painting for electrical and distribution equipment. Review exact finish colours with Consultant. Equipment requiring special colour identification painting to include but not be limited to following:

.1 pull boxes and junction boxes;

.2 communication system conduit;

.3 genset exhaust piping.

.4 Spray painting is not permitted unless approved in writing by Owner and reviewed with Consultant.

.2 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.

.3 Clean and prime exposed hangers, racks, fastenings, etc. to prevent rusting.

.4 Paint all electrical equipment to ANSI-61 light grey, unless noted otherwise.

3.18 MISCELLANEOUS METALS FOR ELECTRICAL WORK

.1 Steel construction required solely for the Electrical work, and not shown on the Architectural and Structural drawings to be supplied and installed by this Contractor. All steel supports, grates, or frames supporting more than 136.0 kg (300 lbs.) to be designed by a Structural Engineer.

.2 Elevated equipment on steel frames to be properly braced to transfer weight evenly throughout the elevated structure, and in turn, transfer that weight evenly to the building structure.

3.19 MOUNTING HEIGHTS

.1 Refer to mounting height table on drawings for exact requirements.

.2 If mounting height of equipment is not indicated verify before proceeding with installation.

.3 Prior to rough in, co-ordinate and have approved by the Consultant all mounting heights of devices.

END OF SECTION 26 05 01

1 GENERAL

1.1 SUMMARY

.1 This document is a specification for wire and cables rated 0-1000V.

1.2 RELATED SECTIONS

.1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

.2 This section to apply and form a part of all Sections of Division 26.

1.3 REFERENCES AND STANDARDS

.1 Canadian Standards Association (CSA)

.1 CSA C22.2 No. 38 - Thermoset-insulated wires and cables

.2 CSA C22.2 No. 51-14 – Armoured Cables

.3 CSA 22.2 No. 123-96 - Aluminum Sheathed Cables

.4 CSA C22.2 No. 124-16 - Mineral-insulated cable

.5 CSA-C22.2 No.131 - Type TECK 90 Cable

.6 CSA C22.2 No. 0.3-09, Test Methods for Electrical Wires and Cables;

.7 CAN/CSA-C22.2 No. 131-07, Type TECK 90 Cable.

.2 Ontario Electrical Safety Code (OESC)

1.4 SUBMITTALS

.1 Submit shop drawings for products and accessories.

.2 Submit samples of conductors, when requested by Consultant.

1.5 QUALITY ASSURANCE

.1 Comply with all previously mentioned standards.

2 PRODUCTS

2.1 BUILDING WIRES

.1 CSA approved, ULC labelled and certified. Unless otherwise noted, conductors to be copper and be suitable for applications as noted in the OESC.

.2 Unless otherwise noted, Conductors to be solid for all conductors up to No. 10 AWG and stranded for No. 8 AWG larger. Minimum size conductors to be 12 AWG.

.3 "RW90" CSA certified, single copper conductor 600-volt insulation, maximum 90°C (194°F) conductor temperature, -40°C (-40°F) minimum installation temperature, X-link thermosetting polyethylene (XLPE) insulation, colour coded. Size as indicated on the drawings. For all wiring indoor above grade wiring.

.4 "RWU90" CSA certified, single copper conductor 1000 volt insulation, maximum 90°C (194°F) conductor temperature, -40°C (-40°F) minimum installation temperature, extra thickness X-link polyethylene (XLPE) insulation suitable for wet and buried installations related to service entrance feeders and site lighting applications. colour coded.

2.2 SECUREX CABLE

.1 Provide Securex II, copper, FT-4 rated, multi-conductor cable complete with a green ground conductor for all input/output device wiring for the Fire Alarm System. All cable to be shielded except for speaker wiring. NO SPLICES WILL BE PERMITTED.

.2 Securex cable to be installed in flexible conduit for drops to speakers located in accessible suspended ceilings. Install a pull box directly above the speaker location. Splices will not be permitted in any pull box.

3 EXECUTION

3.1 GENERAL

.1 Provide required conductors where shown on the drawings. Verify field measurements and conditions for the installation of the conductors.

.2 Unless specifically noted, cable routing on drawings is schematic/diagrammatic and approximate and not reflective of elevations. Route cable as required to meet project conditions. Determine exact routing and lengths on site, prior to rough-in.

.3 Confirm fire protection ratings of construction to ensure that rooms and paths of conductors are fire rated in accordance with local governing codes requirements. Include fire rated conductors as required to meet OBC requirements.

.4 In applications where multiple conductors in conduit are being run, provide trapeze configuration of Unistrut type metal C-channels and threaded rod hangers to support cable/conduit from ceiling slab. Wall mounted cable/conduit brackets and ring type conduit hangers may be permitted in applications approved by Owner and reviewed with Consultant. Provide required cable support system accessories which are not specified herein or shown on drawings but are required for proper installation.

.5 Co-ordinate work with work provided under other electrical work and work of other trades.

.6 Determine required separation between cable and other work.

.7 Determine cable routing to avoid interference with other work.

.8 Submit any alternative cable routing to Consultant for review prior to proceeding with work.

.9 Generally, conductor sizes are indicated on drawings. Such sizes are minimum requirements and must be increased, where required, to suit length of run and voltage drop in accordance with applicable conductor voltage drop schedule on drawings or obtained from Consultant. Conductors not sized or specified of type, to be sized and of type in accordance with requirements of the OESC. Maximum 2% voltage drop to furthest device on a loaded circuit.

.10 Do not use conductors smaller than No. 12 AWG in systems over 30 volts, unless otherwise noted. Do not use conductors smaller than No. 6 AWG for exterior luminaire wiring unless otherwise noted.

.11 Colour code conductors throughout to identify phases, neutrals and ground by means of self-laminating coloured tape, coloured conductor insulation, or properly secured coloured plastic discs. Colours, unless otherwise noted, to be as follows:

.1 Phase A - red;

.2 Phase B - black;

.3 Phase C - blue;

.4 Ground - green;

.5 Neutral - white;

.6 Control - orange.

3.2 INSTALLATION OF BUILDING WIRES

.1 Provide conductors, unless otherwise noted, as follows:

.1 Underground inside or outside building and for non-climate-controlled areas - "RWU90";

.2 Connections to electric heating coils in supply air ductwork systems, and for connections to other electric heating equipment where use of 90 degrees C. rated conductors are recommended by heating equipment manufacturer - "RW90";

.3 for climate-controlled areas wiring except as noted above or specified elsewhere in Specification or as noted on drawings - "RW90".

.4 Where shown on the drawings, splicing of conductors may permitted for replacement of existing conductors and extension as noted on drawings and where approved by Owner and reviewed with Consultant. Splicing of conductors is subject to following conditions:

.1 Splicing to extend existing conductors;

.2 Low voltage control and signal conductors, splicing made within an electrical box with terminal strips;

.3 Interior line voltage conductors, splicing made within an electrical box with cold shrink splice kits and mechanical compression connectors; full assembly to suit type and size of conductors and as reviewed with Consultant;

.4 Exterior line voltage conductors, splicing made with outdoor weatherproof cold shrink splice kits and mechanical compression connectors; full assembly to suit type and size of conductors and as reviewed with Consultant;

.5 splice/splice box to be properly identified with suitable painting or labelling, and clearly identified on "as-built" drawings;

.6 Use of pressure type twist connectors only with review with Consultant, but generally not permitted;

.7 Use of "split bolts" is not permitted.

.8 Install compression connectors with proper dies and compression tool as per connector manufacturer's instructions. Install cold shrink tubing and associated materials as per manufacturer's instructions.

.5 Low voltage conductors to typically be No. 18 AWG except for use in fire alarm system applications, unless otherwise noted. Provide specified fire alarm cables for fire alarm system applications or security system applications as approved by local governing code and local governing authorities. Conductors not installed in conduit or raceways to be fire insulated rated in accordance with latest governing code flame spread ratings requirements.

.6 When pulling wires into conduit use lubricant and ensure that wires are kept straight and are not twisted or abraded.

.7 Control conductors, in addition, to be numbered with Brady Ltd. or Electrovert Ltd. Z type markers.

.8 Colour code conductors for communications systems in accordance with system component manufacturer's recommendations.

.9 Neatly secure exposed wire in apparatus enclosures with approved supports or ties.

.10 **Install all low voltage conductors in conduits in accordance with the OESC, unless otherwise noted within documents.**

.11 **Install conductors in conduit without subjecting to excess strain or kink. Provide rubber grommets, where required, to prevent conductors from resting against metal enclosures.**

.12 Run conductors #8 AWG and larger in continuous run between power supply and load. Splices in feeder cables are not permitted.

3.3 INSTALLATION OF SECUREX CABLE

.1 All cabling for alarm detection and signaling device circuits to be sized by the Fire Alarm manufacturer and full voltage drop and conductor and conduit sizing information to be provided in the shop drawing submittals.

.2 Terminate cables in accordance with manufacturer's instructions. All terminations to be at the devices or control panels.

.3 Use watertight connectors in areas exposed to moisture or weather.

3.4 WIRING CONNECTIONS

.1 Connect branch circuit conductors and fixtures using Marrette type wire nut connectors.

END OF SECTION 26 52 00

1 GENERAL

1.1 SUMMARY

.1 This document is a specification for Grounding and Bonding.

1.2 RELATED SECTIONS

.1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

.2 Conform to Section 26 05 00 - General Electrical Requirements

1.3 REFERENCES AND STANDARDS

.1 Ontario Electrical Safety Code (OESC) for Grounding and Bonding Electrical Systems.

.2 CSA Standard C22.2 No. 41 for Grounding and Bonding Equipment;

1.4 SUBMITTALS

.1 Shop Drawings:

.1 Clearly present enough information to determine compliance with drawings and specifications.

.2 Include the location of system grounding electrode connections and the routing of aboveground and underground grounding electrode conductors.

.2 Test Reports:

.3 Provide certified test reports of ground resistance.

.4 Certifications:

.1 Two weeks prior to final inspection, submit four copies of the following to the Consultant:

.1 Certification that the materials and installation are in accordance with the drawings and specifications.

.2 Certification by the contractor that the complete installation has been properly installed and tested.

2 PRODUCTS

2.1 BASIC MATERIALS

.1 **GROUND RODS**

.1 Copper clad steel, 0.75 in [19 mm] diameter by 10 ft [3 M] long, conforming to CUL and CSA requirements.

.2 Quantity of rods shall be as required to obtain the specified ground resistance, as shown on the drawings.

.2 **GROUNDING AND BONDING CONDUCTORS**

.1 Equipment grounding conductors shall be CSA approved or CUL listed insulated stranded copper, except that sizes No. 10 AWG [6 mm²] and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes No. 4 AWG [25 mm²] and larger shall be identified per OESC.

.2 Bonding conductors shall be ASTM B8 bare stranded copper, except that sizes No. 10 AWG [6 mm²] and smaller shall be ASTM B1 solid bare copper wire.

.3 Conductor sizes shall not be less than shown on the drawings, or not less than required by the OESC, whichever is greater.

2.2 GROUND CONNECTIONS

.1 Below Grade: Exothermic-welded type connectors.

.2 Above Grade:

.1 Bonding Jumpers: Compression-type connectors, using zinc-plated fasteners and external tooth lock washers.

.2 Connection to Building Steel: Exothermic-welded type connectors.

.3 Ground Busbars: Two-hole compression type lugs, using tin-plated copper or copper alloy bolts and nuts.

.4 Rack and Cabinet Ground Bars: One-hole compression-type lugs, using zinc-plated or copper alloy fasteners.

3 EXECUTION

3.1 GENERAL

.1 Ground in accordance with the OESC, as shown on drawings, and as specified herein.

.2 System Grounding:

.1 Secondary service neutrals: Ground at the supply side of the secondary disconnecting means and at the related transformers.

.2 Separately derived systems (transformers downstream from the service entrance): Ground the secondary neutral.

.3 Equipment Grounding: Metallic structures, including ductwork and building steel, enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits, shall be bonded and grounded.

3.2 INACCESSIBLE GROUNDING CONNECTIONS

.1 Make grounding connections, which are normally buried or otherwise inaccessible (except connections for which access for periodic testing is required), by exothermic weld.

3.3 SECONDARY VOLTAGE EQUIPMENT AND CIRCUITS

.1 Main Bonding Jumper: Bond the secondary service neutral to the ground bus in the service equipment.

.2 Metallic Piping, Building Steel, and Supplemental Electrode(s):

.1 Provide a grounding electrode conductor sized per NEC between the service equipment ground bus and all metallic water pipe systems, building steel, and supplemental or made electrodes. Provide jumper insulating joints in the metallic piping. All connections to electrodes shall be made with fittings that conform to UL 467.

.2 Provide a supplemental ground electrode and bond to the grounding electrode system.

.3 Service Disconnect (Separate Individual Enclosure): Provide a ground bar bolted to the enclosure with lugs for connecting the various grounding conductors.

.4 Switchgear, Switchboards, Unit Substations, Panelboards, Motor Control Centers and Panelboards, Engine-Generators, and Automatic Transfer Switches:

.1 Connect the various feeder equipment grounding conductors to the ground bus in the enclosure with suitable pressure connectors.

.2 For service entrance equipment, connect the grounding electrode conductor to the ground bus.

.3 Provide ground bars, bolted to the housing, with enough lugs to terminate the equipment grounding conductors.

.4 Connect metallic conduits that terminate without mechanical connection to the housing, by grounding bushings and grounding conductor to the equipment ground bus.

3.4 RACEWAY

.1 Conduit Systems:

.1 Ground all metallic conduit systems. All metallic conduit systems shall contain an equipment grounding conductor.

.2 Non-metallic conduit systems, except non-metallic feeder conduits that carry a grounded conductor from exterior transformers to interior or building-mounted service entrance equipment, shall contain an equipment grounding conductor.

.3 Conduit that only contains a grounding conductor, and is provided for its mechanical protection, shall be bonded to that conductor at the entrance and exit from the conduit.

.4 Metallic conduits which terminate without mechanical connection to an electrical equipment housing by means of locknut and bushings or adapters, shall be provided with grounding bushings. Connect bushings with a bare grounding conductor to the equipment ground bus.

.2 Feeders and Branch Circuits: Install equipment grounding conductors with all feeders and power and lighting branch circuits.

.3 Boxes, Cabinets, Enclosures, and Panelboards:

.1 Bond the equipment grounding conductor to each pull box, junction box, outlet box, device box, cabinets, and other enclosures through which the conductor passes (except for special grounding systems for intensive care units and other critical units shown).

.2 Provide lugs in each box and enclosure for equipment grounding conductor termination.

.4 Wireway Systems:

.1 Bond the metallic structures of wireway to provide 100% electrical continuity throughout the wireway system, by connecting a No. 6 AWG [16 mm²] bonding jumper at all intermediate metallic enclosures and across all section junctions.

.2 Install insulated No. 6 AWG [16 mm²] bonding jumpers between the wireway system, bonded as required above, and the closest building ground at each end and approximately every 50 ft [16 M].

.3 Use insulated No. 6 AWG [16 mm²] bonding jumpers to ground or bond metallic wireway at each end for all intermediate metallic enclosures and across all section junctions.

.5 Fixed electrical appliances and equipment shall be provided with a ground lug for termination of the equipment grounding conductor.

3.5 GROUND RESISTANCE

.1 Grounding system resistance to ground shall not exceed 5 ohms. Make any modifications or additions to the grounding electrode system necessary for compliance without additional cost to the Government. Final tests shall ensure that this requirement is met.

.2 Resistance of the grounding electrode system shall be measured using a four-terminal fall-of-potential method as defined in IEEE 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not fewer than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

.3 Services at power company interface points shall comply with the power company ground resistance requirements.

.4 Below-grade connections shall be visually inspected by the engineer prior to backfilling. The contractor shall notify the engineer 24 hours before the connections are ready for inspection.

3.6 GROUND ROD INSTALLATION

.1 For outdoor installations, drive each rod vertically in the earth, until top of rod is 24 in [609 mm] below final grade.

.2 For indoor installations, leave 4 in [100 mm] of rod exposed.

.3 Where permanently concealed ground connections are required, make the connections by the exothermic process, to form solid metal joints. Make accessible ground connections with mechanical pressure-type ground connectors.

.4 Where rock prevents the driving of vertical ground rods, install angled ground rods or grounding electrodes in horizontal trenches to achieve the specified resistance.

END OF SECTION 26 05 26

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1 GENERAL

1.1 SUMMARY

.1 This document is a specification for Identification for Electrical System. This Section is common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section of Electrical Divisions and is to be read accordingly.

1.2 RELATED SECTIONS

.1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

.2 This section to apply and form a part of all Sections of Division 26.

1.3 REFERENCES AND STANDARDS

.1 Ontario Electrical Safety Code (OESC)

1.4 SCOPE OF WORK

.1 Provide identification of all equipment as specified herein.

2 PRODUCTS

2.1 IDENTIFICATION NAMEPLATES

.1 Provide nameplates on all electrical equipment supplied under this Division.

.2 Nameplates to be black lettering on white background for equipment connected to normal power. Laminate with bevelled edges and with machine engraved letters.

.3 Nameplates to be white lettering on red background for equipment connected to emergency power. Laminate with bevelled edges and with machine engraved letters.

.4 Wording on nameplates to be approved by the Consultant prior to manufacture and shall conform to base building typical standards.

.5 Nameplates for disconnects, starters, remote devices and contactors shall indicate equipment being controlled and voltage.

.6 Nameplates for terminal cabinets, junction boxes and pull boxes shall indicate system, and/or voltage, etc.

.7 Identification for mechanical equipment to be obtained from the Trades concerned. Submit proposed phrasing for Consultant's approval.

.8 Typical panelboard identification:

LP 2A	1/2" high letters
120/208V	3/16" high letters
Fed from PP "BB"	3/16" high letters

.9 Identification for mechanical equipment to be obtained from the Trades concerned. Submit proposed phrasing for Consultant's approval.

.10 Nameplates for other apparatus which have exposed faces in finished areas to be inside the panel door. Equipment in service rooms, etc. shall have nameplates on cover face.

.11 Plates to be installed after all painting has been completed and to be secured with self-tapping screws except on the inside of panel doors where gluing will be accepted.

2.2 BUS DUCTS, CONDUITS IDENTIFICATION

.1 After finished painting is completed, identify each bus duct, cable trough and all feeder conduits to each panelboards, motor control centres, MCP feeders.

.2 Locate identification:

.1 Behind each access door

.2 At each junction box

.3 At not more than 12 m (40 ft) apart in straight runs of exposed conduit and bus ducts, but on both sides of sleeves

.4 At not more than 12 m (40 ft) apart in straight runs of conduit and bus ducts behind removable enclosures such as lay-in ceiling, but on both sides of sleeves

.5 Above each floor or platform for vertical exposed conduits and bus ducts, preferably 1.5 m (5 ft) above floor or platform

.3 Use stencils and stencil paint on all conduit and ductwork.

.4 Use letters of minimum 25 mm (1") high.

.5 The identification shall describe system voltage and service, e.g. "120/208 Volt Feeder to Panel AA".

2.3 BRANCH CIRCUIT IDENTIFICATION

.1 Branch circuits have been indicated on the drawings for all receptacles and outlets. This Division shall identify the circuits in the lighting panels and power panels with cable markers. If the wiring is installed with different circuitry, this Division shall also revise the "As-Built" drawings in plan to show the new circuit number which has been given to the outlet or receptacle. The legends in all panels to be made up to agree with the wiring as installed. The Consultant will check branch circuit wiring at random and if it is found that the drawings do not agree, this Division will, at his own cost, revise all branch circuit wiring and circuitry to the satisfaction of the Consultant.

.2 When referring to room numbers on the directories (i.e. fire alarm, signals, paging system, lighting panels, etc.) to be revised as necessary to agree with the Owner's approved room numbering scheme.

.3 Identify the branch circuits installed in outlet boxes and pull boxes on box cover in all accessible ceiling spaces.

2.4 PHASING IDENTIFICATION

.1 Incoming power supply, all feeders to all high voltage switchgear, unit substations, switchboards, panelboards, transformers, Motor Control Centres, starters and motors, etc., shall have the feeders colour coded to indicate phase from left to right when viewing wiring from front.

.1 Phase A - Red

.2 Phase B - Black

.3 Phase C - Blue

.4 Neutral - White

.5 Ground - Green

.2 Refer also to OESC.

2.5 SYSTEMS WIRING IDENTIFICATION

.1 Use colour coded wires in control, communication, fire alarm and security systems matched throughout each system.

2.6 MANUFACTURERS AND CSA LABELS

.1 Manufacturers nameplates and CSA labels to be visible and legible after equipment is installed.

2.7 WIRE AND CABLE MARKERS

.1 All feeder cables or sub-feeder cables (other than branch circuit wiring) to be identified at both ends and in any pull boxes, etc., between ends with Electrovert Type Z markers or Electrovert strap-on markers or approved equal.

.2 All branch circuit wiring and all systems wiring to be identified at all panels and terminal boxes with Electrovert Type Z markers, Electovert strap-on markers, or approved equal.

3 EXECUTION

3.1 INSTALLATION OF IDENTIFICATION NAMEPLATES

.1 For each piece of electrical distribution equipment from electrical source of supply up to and including panelboards, for special control panels and cabinets, and for each other piece of electrical equipment, provide engraved Lamacoid identification nameplates secured to apparatus with stainless steel screws.

.2 Nameplates to indicate source of electrical supply and include Consultant’s equipment identification number. Identify whether equipment is on "NORMAL POWER SYSTEM" or "ESSENTIAL POWER SYSTEM". Comply with CSA 282 OR Z32 requirements.

.3 Equip large multiple cell or component apparatus such as switchboards and distribution panels with main nameplates identifying equipment, voltage characteristics, capacity and source of supply, and with sub-nameplates clearly identifying each cell or component and its service.

.4 Panelboard nameplates to identify panelboard number as designated on drawings, unless otherwise instructed. Nameplates for disconnect switches, control panels, and cabinets to outline their service and source of supply.

.5 In areas where equipment having removable doors that can be commonly installed on different equipment, ensure that each door is identified to which piece of equipment it is associated with, such that nameplates are with correct equipment.

END OF SECTION 26 52 0053

1 GENERAL

1.1 SUMMARY

.1 The specialist contractor to furnish short-circuit and protective device coordination studies as prepared by the electrical equipment manufacturer or an approved engineering firm.

.2 The specialist contractor to furnish an Arc Flash Hazard Analysis Study per the requirements set forth in CSA Z462 – Workplace Electrical Safety.

.3 The scope of the studies to include all distribution and equipment.

1.2 RELATED SECTIONS

.1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

.2 The equipment and related services to be provided shall comply with the following specifications, as modified herein:

.1 26 24 13 – Low Voltage Switchboards

.2 26 23 00 - Low Voltage Switchgear

.3 26 11 02 – Medium Voltage Unit Substation

.4 26 12 16 – Medium Voltage Dry Type Power Transformer

1.3 REFERENCES AND STANDARDS

.1 American National Standards Institute (ANSI):

.1 ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis.

.2 ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures.

.3 ANSI C 37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories.

.4 ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.

.2 CSA Group (CSA)

.1 CSA Z462-15 – Workplace Electrical Safety.

.3 Institute of Electrical and Electronics Engineers, Inc. (IEEE):

.1 IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems.

.2 IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings.

.3 IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.

.4 IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis.

.5 IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.

.6 IEEE 1584 – Guide for Performing Arc-Flash Hazard Calculations.

.4 Ontario Electrical Safety Code (OESC)

1.4 SUBMITTALS FOR REVIEW/APPROVAL

.1 The short-circuit and protective device coordination studies to be submitted to the Consultant prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing.

.2 If formal completion of the studies may cause delay in equipment manufacturing and/or project schedule, approval from the consultant may be obtained for preliminary submittal of enough study data to ensure that the selection of device and characteristics will be satisfactory.

1.5 SUBMITTALS FOR CONSTRUCTION

.1 The results of the short-circuit, protective device coordination and arc flash hazard analysis studies (and labels) to be summarized in a final report.

.2 The report to include the following sections:

.1 One-line diagram showing protective device ampere ratings and associated designations, cable size and lengths, transformer kVA and voltage ratings, motor and generator kVA ratings, and switchgear/switchboard/panelboard designations.

.2 Descriptions, purpose, basis and scope of the study.

.3 Tabulations of the worst-case calculated short circuit duties as a percentage of the applied device rating (automatic transfer switches, circuit breakers, fuses, etc.); the short circuit duties to be upward adjusted for X/R ratios that are above the device design ratings.

.4 Protective device time versus current coordination curves with associated one-line diagram identifying the plotted devices, tabulations of ANSI protective relay functions and adjustable circuit breaker trip unit settings.

.5 Fault study input data, case descriptions, and current calculations including a definition of terms and guide for interpretation of the computer printout.

.6 Incident energy and flash protection boundary calculations.

.7 Comments and recommendations for system improvements, where needed.

.8 Executive Summary to include but not be limited to the following:

.1 Purpose and source of information and assumptions made.

.2 Study Scope of Work;

.3 References and Standards;

.4 Protective Device Coordination;

.5 OESC Deficiencies;

.6 Identification of Underrated equipment;

.7 Short Circuit Analysis;

.8 Device Evaluation;

.9 ARC Flash Analysis (Purpose, Methods and Limitations);

.10 Results and Recommendations;

1.6 QUALIFICATIONS

.1 The short-circuit, protective device coordination and arc flash hazard analysis studies to be conducted by a specialist contractor, under the supervision and approval of a Registered Professional Electrical Engineer, skilled in performing and interpreting the power system studies.

.2 The Professional Electrical Engineer to be registered and licensed to practice in the Province of Ontario and have a minimum of five (5) years of experience in performing power system studies.

.3 The specialist contractor to demonstrate experience with Arc Flash Hazard Analysis by submitting names of at least ten actual arc flash hazard analysis it has performed.

2 PRODUCTS

2.1 STUDIES

.1 Specialist contractor to furnish short-circuit and protective device coordination studies as prepared by equipment manufacturer or an approved engineering firm. The coordination new and/or modified study to begin with the utility company's feeder protective device and include all the electrical protective devices down to and include the largest feeder circuit breaker in the 208 Volt panelboards.

.2 Study to also include variable frequency drives, harmonic filters, power factor correction equipment, transformers and protective devices associated with variable frequency drives, emergency standby generator and distribution switchgear.

.3 The specialist contractor to furnish an Arc Flash Hazard Analysis Study per CSA Z462.

2.2 DATA COLLECTION

.1 Specialist contractor to provide all data as required by the power system studies.

.2 All data collection MUST be completed without the requirements for a power shutdown or risk to the buildings power supply. Include all assumptions for the data collection in the executive summary, which can include PM verification reports, as-built drawings, etc.

.3 The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies to provide the Electrical Contractor with a listing of required data immediately after award of the contract.

.4 The Specialist contractor to expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

.5 Utility combination to include present and future utility supplies fault currents.

.6 Include fault contribution of all existing motors in the study. The Specialist contractor to obtain required existing equipment data, if necessary, to satisfy the study requirements.

2.3 SHORT-CIRCUIT AND PROTECTIVE DEVICE COORDINATION STUDY

.1 Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standard 141, latest edition.

.2 Transformer design impedances and standard X/R ratios to be used when test impedances are not available.

.3 Provide the following:

.1 Calculation methods and assumptions.

.2 Selected base per unit quantities.

.3 One-line diagram of the system being evaluated with available fault at each bus, and interrupting rating of devices noted.

.4 Source impedance data, including electric utility system and motor fault, contribution characteristics.

.5 Tabulations of calculated quantities.

.6 Results, conclusions, and recommendations.

.4 Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:

.1 Electric utility's supply termination point.

.2 Incoming switchgear.

.3 Unit substation primary and secondary terminals.

.4 Low voltage switchgear.

.5 Standby generators and automatic transfer switches.

.6 Branch circuit panelboards.

.7 Other significant locations throughout the system.

.5 For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.

.6 Protective Device Evaluation:

.1 Evaluate equipment and protective devices and compare to short circuit ratings.

.2 Adequacy of switchgear, motor control centres, and panelboard bus bracing to withstand short-circuit stresses.

.3 Adequacy of transformer windings to withstand short-circuit stresses.

.4 Cable and busway sizes for ability to withstand short-circuit heating.

2.4 PROTECTIVE DEVICE COORDINATION STUDY

.1 Proposed protective device coordination time-current curves (TCC) to be displayed on log-log scale graphs.

.2 Include on each curve sheet, a complete title and one-line diagram with legend identifying the specific portion of the system covered.

.3 Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.

.4 Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

.5 Plot the following characteristics on the curve sheets, where applicable:

.1 Electric utility's overcurrent protective device.

.2 Medium voltage equipment overcurrent relays.

.3 Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.

.4 Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands.

.5 Transformer full-load current, magnetizing inrush current, and ANSI through- fault protection curves.

.6 Conductor damage curves.

.7 Ground fault protective devices, as applicable.

.8 Pertinent motor starting characteristics and motor damage points, where applicable.

.9 Pertinent generator short-circuit decrement curve and generator damage point.

.6 Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

2.5 ARC FLASH HAZARD ANALYSIS

.1 The arc flash hazard analysis to be performed according to CSA Z462.

.2 The flash protection boundary and the incident energy to be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, panelboards, busway and splitters) where work could be performed on energized parts.

.3 The Arc-Flash Hazard Analysis to include all new and/or modified equipment where work could be performed on energized parts.

.4 Safe working distances to be based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm2.

.5 When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.

.6 The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating.

.7 The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:

.1 Fault contribution from induction motors should not be considered beyond 3-5 cycles.

.2 Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).

.8 For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary to include both the line and load side of the main breaker.

.9 Where performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.

.10 Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.

.11 Arc Flash calculations to be based on actual overcurrent protective device clearing time.

2.6 REPORT SECTIONS

.1 Input data to include but not be limited to the following:

.1 Utility 3-phase and L-G available contribution with associated X/R ratios.

.2 Feeder input data including feeder type (cable or bus), size, length, number per phase, conduit type (magnetic or non-magnetic) and conductor material (copper or aluminum).

.3 Transformer input data, including winding connections, secondary neutral- ground connection, primary and secondary voltage ratings, kVA rating, impedance, % taps and phase shift.

.4 Reactors and capacitors data, including voltage rating, and impedances.

.5 Generation contribution data, (synchronous generators and Utility), including short-circuit reactance (X"d), rated MVA, rated voltage, three-phase and single line-ground contribution (for Utility sources) and X/R ratio.

.6 Motor contribution data (induction motors and synchronous motors), including short circuit reactance, rated horsepower or kVA, rated voltage, and X/R ratio.

.2 Short-Circuit Output Data to include, but not be limited to the following reports:

.1 Low voltage Fault Report to include a section for three-phase and unbalanced fault calculations and to show the following information for each application location:

.1 Voltage

.2 Calculated fault current magnitude and angle

.3 Fault point X/R ratio

.4 Equivalent impedance

.2 Momentary Duty Report to include a section for three-phase and unbalanced fault calculations and to show the following information for each applicable location:

.1 Voltage

.2 Calculated symmetrical fault current magnitude and angle

.3 Fault point X/R ratio

.4 Calculated asymmetrical fault currents

.1 Based on fault point X/R ratio

.2 Based on calculated symmetrical value multiplied by 1.6

.3 Based on calculated symmetrical value multiplied by 2.7

.5 Equivalent impedance.

.3 Interrupting Duty Report to include a section for three-phase and unbalanced fault calculations and to show the following information for each applicable location:

.1 Voltage.

.2 Calculated symmetrical fault current magnitude and angle.

.3 Fault point X/R ratio.

.4 No AC Decrement (NACD) Ratio.

.5 Equivalent impedance.

.6 Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a symmetrical basis.

.7 Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a total basis.

.4 Recommended Protective Device Settings:

.1 Phase and Ground Relays:
  .1 Current transformer ratio.
  .2 Current setting.
  .3 Time setting.
  .4 Instantaneous setting.
  .5 Recommendations on improved relaying systems, if applicable.
.2 Circuit Breakers:
  .1 Adjustable pickups and time delays (long time, short time, ground)
  .2 Adjustable time-current characteristic.
  .3 Adjustable instantaneous pickup.
  .4 Recommendations on improved trip systems, if applicable.
.3 Fuses:
  .1 Short Circuit ratings;
  .2 Ampacity Ratings.

.5 Incident energy and flash protection boundary calculations:
  .1 Arcing fault magnitude.
  .2 Protective device clearing time.
  .3 Duration of arc.
  .4 Arc flash boundary.
  .5 Working distance.
  .6 Incident energy.
  .7 Hazard Risk Category.
  .8 Recommendations for arc flash energy reduction.

2.7 APPROVED COORDINATION AND ARC FLASH STUDY COMPANIES:

.1 C-INTECH

.2 GT Wood

.3 Enkompass Power & Energy Corp

.4 Eaton Electric Services Division;

.5 Schneider Electric Services Division;

.6 Siemens Electric Services Division.

3 EXECUTION

3.1 FIELD ADJUSTMENT

.1 At a time that is convenient to the building owner operator, schedule a power shutdown to Adjust relay and protective device settings according to the recommended settings table provided by the coordination study.

.2 Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

.3 Notify Owner's Representative in writing of any required major equipment modifications.

3.2 ARC FLASH WARNING LABELS

.1 The specialist contractor of the Arc Flash Hazard Analysis to provide a 90mm x 60mm thermal transfer type label of high adhesion polyester for each work location analyzed.

.2 All labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated in the system.

.3 The label to have an orange header with the working: "WARNING: ARC FLASH HAZARD" and to include the following information, at a minimum:

.1 Location designation

.2 Nominal voltage

.3 Flash protection boundary

.4 Hazard risk category

.5 Incident energy

.6 Working distance

.7 Engineering report number, revision number and issue date.

.4 Labels to be machine printed, with no field markings.

.5 Arc flash labels to be provided in the following manner and all labels to be based on recommended overcurrent device settings.

.1 For each 600 and 208-volt Panelboard with Main Lug Only, one arc flash label to be provided.

.2 For each 600 and 208-volt Panelboard with Main Breaker, two arc flash labels to be provided.

.3 For each motor control centre with Main Lugs Only, one arc flash label to be provided.

.4 For each motor control centre with Main Breakers, two arc flash labels to be provided.

.5 For each low voltage switchboard with Main Lugs Only, one arc flash label to be provided.

.6 For each low voltage switchboard with Main Breakers, two arc flash labels to be provided.

.1 For each switchgear, two arc flash labels to be provided.

.2 For medium voltage non-fused switches, one arc flash label to be provided.

.3 For medium voltage non-fused switches, two arc flash labels to be provided.

END OF SECTION 26 12 16

1 GENERAL

1.1 SUMMARY

.1 This document is a specification for miscellaneous electrical services and distribution.

1.2 RELATED SECTIONS

.1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

.2 This section to apply and form a part of all Sections of Division 26.

1.3 REFERENCES AND STANDARDS

.1 Local utility supply company

.2 Ontario Electrical Safety Code (OESC)

.3 Canadian Standards Association (CSA)

1.4 SUBMITTALS

.1 As soon as possible after the award of this contract the manufacturer to submit copies of detailed drawings, product data, material lists and specifications of equipment included in this contract for review. No fabrication to be started until drawings are reviewed and accepted by the Consultant. Customer name, customer location, project number and order number to be identify on transmittals.

.2 Product data to include:

.1 Equipment reviewed shop drawings;

.2 Equipment name/designation, voltage, capacity, diagnostics, and all specified accessories;

.3 Warranty

.4 Additional information requested by local governing authority or Consultant.

1.5 QUALITY ASSURANCE

.1 Comply with all previously mentioned standards.

1.6 WARRANTY

.1 All equipment to carry:

.1 12-month warranty from a date of commissioning; or

.2 18-month warranty from a shipping date.

2 PRODUCTS

2.1 ADDITIONAL DEVICES FOR EXISTING EQUIPMENT

.1 Additional breakers and switch and fuses assemblies for existing panelboards or switchboards are to match existing device standards and be completely compatible to board in which they are installed. During Bidding period, check and verify exact requirements of existing equipment to ensure that additional devices are accommodated. Make necessary modifications to equipment to accommodate device and feeder installation. Provide suitable engraved lamacoid identification nameplate on additional components. Revise typed circuit directory cards on branch circuit panelboards. Mount additional devices to standards of existing equipment manufacturer. Refer to notes on drawings.

.2 Switchboards:

.1 Submit shop drawing of proposed additional breakers to existing switchboard. Identify work proposed for existing switchboard to accommodate breakers.

.2 Provide additional breakers as shown and sized on drawings and with interrupting capacity to accommodate intended application and match existing devices. Install into existing switchboards, as required.

.3 Provide additional features not identified in issued documents to match existing features of existing devices in each respective switchboard. Confirm requirements of existing boards on site.

.4 Provide power circuit breaker(s) with solid-state trip units, and other required features to match existing devices. Adjust trip settings in accordance with electrical distribution system co-ordination study.

.5 Make necessary modifications to switchboards to accommodate device and feeder installation.

.6 Provide suitable engraved lamacoid identification nameplate and revise mimic bus (where applicable).

.7 Mount additional devices to standards of existing switchboard.

.8 Work to be performed by companies approved by respective switchboard manufacturer and approved by Owner and reviewed with Consultant.

.3 For additional breakers and components as noted specifically on drawings, provide following:

.1 required contacts;

.2 current transformers;

.3 potential transformers;

.4 wiring in conduits;

.5 test blocks and terminals;

.6 necessary components for remote connection of alarms and monitoring points to BAS; co-ordinate work with BAS Contractor.

.4 Provide additional retrofit work to existing equipment as noted on drawings.

.5 Products to be of types from existing equipment manufacturers.

3 EXECUTION

3.1 PROVISIONS FOR BUILDING AUTOMATION SYSTEM

.1 Provide alarm/communications circuits as required.

.2 Include for provision of conduits, boxes and control/signal wiring for interconnection to BAS. Coordinate with Mechanical Divisions BAS Contractor on location of BAS panel to be used for monitoring points and extend wiring in conduit from electrical equipment to location. Terminate in junction box leaving 3 m (10') of slack length of wiring (exact length to be coordinated between Mechanical and Electrical trades), for extending and termination to BAS panel by Mechanical Division BAS Contractor. Properly identify wiring and junction box.

END OF SECTION 26 20 00

1 GENERAL

1.1 SUMMARY

.1 This section relates to Diesel engine driven standby generator set(s). Refer to drawings for unit sizes.

1.2 RELATED SECTIONS

.1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

.2 The equipment and related services to be provided shall comply with the following specifications, as modified herein:

.1 26 32 13 – Power Generation Diesel

.2 26 36 23 - Automatic Load Transfer Equipment

.3 26 05 26 - Grounding and bonding.

.4 26 05 73 – Power System Studies

.5 26 05 53 – Identification for Electrical Systems

1.3 REFERENCES AND STANDARDS

.1 Genset must also meet applicable codes and standards enforced by the Province of Ontario and local governing authorities, including but not limited to:

.1 Ontario Building Code;

.2 Ontario Electrical Safety Code;

.2 Canadian Standards Association (CSA)

.1 CSA C282-15: Emergency Electrical Power Supply for Buildings.

.2 CSA B139-15: Installation Code for Oil-Burning Equipment

.3 C22.2 NO. 100-14 - Motors and Generators

.3 NEMA MG 1-2016 Motors and Generators;

.4 IEEE Standards;

.5 Technical Standards & Safety Authority

.1 FS-219-16: Fuel Oil Code Adoption Document Amendment

1.4 SUBMITTALS

.1 Provide one complete set of shop drawings, in PDF format for all products in this section, including but not limited to the following:

.1 Manufacturer’s product literature and performance data enough to verify compliance to specification requirements;

.2 A specification compliance statement describing in detail the differences between the specified and the proposed equipment;

.3 Shop drawings showing plan and elevation views with certified overall dimensions;

.4 Interconnection wiring diagrams showing all external connections required, with field wiring terminals marked in a consistent point-to-point manner;

.5 Lifting and rigging drawings showing pull points and rigging configuration;

.6 Manufacturer's installation instructions.

.7 **If the genset is being provided as part of a skin-tight or walk-in enclosure package, then the genset shop drawings and accessories, will be supplied with the enclosure shop drawings.**

.2 Each submittal shall include complete drawings, showing all aspects of the genset, including:

.1 Diesel engine, power and performance data;

.2 Electrical alternator;

.3 Generator set control panel;

.4 Battery charger and battery;

.5 Automatic engine ventilation system;

.6 Fuel supply system;

.7 Exhaust system and components;

.8 Steel mounting base;

.9 Generator and load bank circuit breakers enclosure as shown on the drawings;

.10 fully integrated synchronizing and paralleling control panels, as applicable;

.11 where applicable, modifications to existing genset to allow for integrated synchronization and paralleling, unless otherwise noted;

.12 system sequence of operation complete with software;

.13 Full design detailed layout and dimensioned drawings of all components;

.14 Dry weight and operating weight;

.15 Wiring Schematics;

.16 Intergraded systems;

.2 Calculated noise data, showing sound pressure levels in free-field conditions at 7m in all directions from the enclosure, including above and below.

.3 Major components and estimated weight of each lifting module, within 100kg.

.3 Maintain a copy of shop drawing submittals for a minimum period of 25 years.

1.5 QUALITY ASSURANCE

.1 Comply with all previously mentioned standards.

.2 Manufacturer to be specialized in the manufacturing of Emergency power generators with at least five years documented experience.

.3 Genset to be in compliance with O.Reg 524/98 and provide necessary technical data (environmental, noise and emissions and performance), such that genset and installation on this project is exempt from requirements in obtaining required approvals and/or certifications from and//or registration with Ministry of Environment – Climate Change – Environment Activity and Sector Registry (MOECC EASR) for generator registration.

1.6 CLOSEOUT SUBMITTALS

.1 Include the following in Operation and Maintenance Manual instructions for unit supplied and not general description of units manufactured by supplier:

.1 Operation and maintenance instructions for engine, alternator, control panel, automatic transfer switch, manual bypass switch, battery charger, battery, fuel system, engine room ventilation system, exhaust system and accessories, to permit effective operation, maintenance and repair;

.2 Technical data:

.1 Illustrated parts lists with parts catalogue numbers;

.2 Schematic diagram of electrical controls;

.3 Flow diagrams for fuel system, lubricating oil, and cooling system.

.3 Certified copy of factory test results;

.4 Maintenance and overhaul instructions and schedules;

.5 Precise details for adjustment and setting of time delay relays or sensing controls which require on site adjustment.

.2 Provide operation and maintenance data for diesel generator for incorporation into Operations & Maintenance manual.

.3 **If the genset is being provided as part of a skin-tight or walk-in enclosure package, then the genset operation and maintenance data, will be supplied with the enclosure Operation and Maintenance Manual.**

1.7 STORAGE AND HANDLING

.1 Store and handle in strict compliance with manufacturer's instructions and recommendations. Protect from potential damage from construction operations.

.2 Handle equipment using proper equipment for lifting and handling, use when necessary lifting eye and/or brackets provided for that purpose.

1.8 WARRANTY

.1 Provide warranty against defects in materials and workmanship for the enclosure and all appurtenances provided under this contract for a minimum period of thirty (30) months from the time of delivery or twenty-four (24) months from the time of commissioning acceptance, whichever comes first;

.2 Include all costs to extend the warranty beyond the manufacturer's standard warranty period in tender.

.3 Warranty to be comprehensive; it shall include all travel, service and parts costs required to repair the generator enclosure during the warranty period.

1.9 MANUFACTURER'S REPRESENTATIVE

.1 Upon award of the contract the manufacturer of genset to appoint a manufacturer's representative who to be qualified in the design, installation, commissioning and maintenance of the equipment supplied.

.2 The manufacturer's representative to be available throughout the life of the contract and to be available on site for equipment delivery, site meetings, equipment installation, testing and commissioning, start-up and instruction of owner's staff.

.3 The manufacturer's representative shall perform the following functions:

.1 review of equipment design with respect to specification requirements, required operation, code requirements, etc.;

.2 preparation and submission of shop drawings;

.3 design review with Consultants;

.4 response to questions by Owner, ESA, TSSA, Consultants, Contractor and Sub Contractors;

.5 monitoring and reporting on manufacturing progress at site meetings;

.6 preparation of production schedules and delivery arrangements;

.7 arrangement of factory tests including adequate notification of owner's witnesses;

.8 oversee unloading, hoisting, setting in place, and oversee site assembly;

.9 co-ordinate external wiring arrangements and connections;

.10 providing advice as required to all parties involved with the equipment;

.11 assist in equipment commissioning;

.12 training and instruction of Owner's staff;

.13 preparation and submission of manuals;

1.10 PROTECTIVE COORDINATION AND EQUIPMENT WITHSTAND RATINGS

.1 Obtain results of coordination study and short circuit calculations reports and Consultant comments and incorporate into shop drawings of electrical distribution equipment (high voltage and low voltage equipment as applicable). Do not order equipment until shop drawings submission process has been completed and reviewed with Consultant.

.2 Provide ratings for electrical equipment, circuit protective devices, bussing, and switches to interrupt and withstand short circuit faults greater than available fault current at its source of supply.

2 PRODUCTS

2.1 GENERAL

.1 All components of the generator set, including diesel engine, electric alternator, and all appurtenances, shall be standard product of current manufacture, from company regularly engaged in production of such equipment.

.2 Genset ratings:

.1 Rating of gensets to be as noted on drawings, which is at 0.8 power factor and includes 10% overload.

.2 Rating to be nameplate rating.

.3 Gensets to be capable of operating at 100% of nameplate rating at rated RPM in an ambient temperature of 50°C (122°F) without overheating, or suffering any other detrimental effects, at rated generator RPM when set is equipped with all necessary operating accessories.

.3 Generator sets (gensets) to be factory assembled and tested, radiator cooled, diesel engine driven electric gensets including necessary controls and accessories as outlined in this specification, to comprise a continuous, standby electric generating plant for operation in conditions stipulated below.

.4 Gensets to be equipped with necessary operating accessories such as air cleaner, radiator fan, lubricating oil pump, governor, alternating current generator and other specified and required engine driven components and accessories.

.5 **Base design gensets: Kholer, packaged model 400REOZJ, genset that complies with specification requirements and drawing requirements, and which may be customized to meet the following specified requirements.**

.6 Gensets and associated equipment to be constructed to and to perform in accordance with local governing authority enforced edition of CSA Standard CAN/CSA C282-15, "Emergency Electrical Power Supply of Buildings". Gensets to be factory tested in manufacturers plant.

.7 Genset emissions to meet required EPA exhaust Tier limits based upon engine maximum horsepower rating and any other required Ministry of Environment regulations, and requirements noted above.

.8 Gensets and associated equipment to comply with mechanical systems base design parameters (i.e. fuel consumption, cooling operating data, air/exhaust operating data, etc.) to ensure that design minimum standards and performance criteria for units are met. Review room/enclosure (as applicable) dimension and layouts and ensure that proposed gensets and associated equipment can be accommodated and allow for enough space for maintenance, repairs, and safety as per applicable code requirements.

.9 Advise Consultant of any changes due to manufacturer’s changes in equipment, and/or changes in manufacturers. Be fully responsible for provision and co-ordination of a designed solution that can meet design intent, space limitations, and performance requirements with no additional costs to Contract. Co-ordinate changes with Mechanical Division, as required.

.10 Genset driven radiator fan to be capable of overcoming a minimum of 0.75" water column pressure drop in an ambient temperature of 50°C (122°F) for gensets installed within a building, and 0.5” for gensets installed in skin-tight or walk-in enclosures.

.11 Moving parts such as flywheels, pulleys, belts, etc., and on manifolds and extending up to and including flexible exhaust pipes, to be enclosed with suitable guards to protect persons from injury. Guards to be easily removable for servicing equipment and are to comply with local governing authority and code requirements.

.12 Align and mount genset on a common fabricated steel base of enough rigidity to maintain adequate alignment. Provide adjustable steel spring vibration isolators. Include also for seismic restraints to comply with local governing authority and code requirements., if specified or applicable. Provide torsional vibration analysis and critical vibration analysis of genset and submit results to Consultant.

.13 Unless unit is being supplied as part of a skin-tight or walk-in enclosure, the following equipment is to be provided by the engine-generator set manufacturer and shipped loose with the unit for installation on site by others:

.1 Engine Silencer, Silencer flex connections, WYE fitting, etc.,

.2 Battery charger and batteries;

.3 Vibration isolators

.14 **All bids must include a detailed, line-by-line, compliance statement indicating non-conformity with this specification.**

2.2 PERFORMANCE

.1 Genset to meet frequency and voltage performance requirements, and well as one step loading as specified in CSA 282-15 code.

.2 Gensets and associated equipment to be fully integrated to comprise a standby power system which automatically functions as follows:

.1 start in event of a commercial power failure;

.2 stop when commercial power has been restored;

.3 be capable of operating at light loads for an extended period of time as normal power failure may occur when only part of full output of genset is required.

.3 Voltage regulation shall be ±1.0% for any constant load between no load and rated load. Random voltage variation with any steady load from no load to full load shall not exceed ±1.0%.

.4 Frequency regulation shall be isochronous from steady state no load to steady state rated load. Random frequency variation with any steady load from no load to full load shall not exceed ±0.25%.

.5 Generator set shall be capable of single-step load pick up of 100% nameplate kW at rated power factor, less applicable derating factors, at rated operating temperature.

.6 The time required to automatically start, accelerate to rated speed and voltage, and close the alternator onto the system bus on a normal power failure shall not exceed 15 seconds, provided that the generator set is in an ambient temperature of 4°C or greater, and water jacket heaters are operating properly.

2.3 ENGINE

.1 Engines to be a multi cylinder, 4-cycle, capable of operating at a nominal speed of 1800 RPM when directly connected to alternator, and free from critical vibrations throughout its entire operation range. The horsepower rating of the engine at its minimum tolerance level to be enough to drive the alternator and all connected accessories.

.2 Engines to operate satisfactorily on No. 2 diesel fuel and produce specified rated output.

.3 Engines to be complete with an electronic governor with speed control and magnetic pick up assembly capable of maintaining speed and voltage regulation within limits previously specified. Electronic governor to be of type recommended by genset manufacturer to provide performance to suit specific application. The electronic governor system shall provide automatic isochronous frequency regulation, regulated during steady state operation to +/- 0.2 Hz.

.4 Engine lubricating systems to be full pressure oiling type through internally mounted, high capacity, positive displacement type gear pumps with adjustable pressure regulators, lubricating oil cooler and full flow oil filters. Full pressure lubrication to be provided to main bearings, connecting rod bearings and camshaft bearings.

.5 Skid mounted radiator and cooling system rated to full load operation in 50 degrees C as measured at the generator air inlet.

.6 Radiator shall be provided with a duct adaptor flange. Rotating parts shall be guarded against accidental contact per OSHA requirements.

.7 Equip engines with required 12/24-volt D.C. electric starting motors, capable of three complete cranking cycles without overheating.

.8 Filters on air intake to engine are of dry vortex type with replaceable elements, with restriction indicator. Filters must be unit mounted.

.9 Generator set to be equipped with fuel shutoff solenoid, secondary fuel regulator, braided flex for supply (terminated at base rails).

.10 Full pressure lubrication shall be positive displacement, mechanical oil pump complete with full flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator.

.11 Engine mounted accessories to be readily removable without dismantling engine alternator, or any other accessories.

.12 Provide factory installed metal guards over all exposed engine exhaust components.

.13 Provide wire braided engine oil extension hoses on oil drain to extend out to engine base for easier access. Clip to side of base with proper clips.

.14 Extend oil fill pipe out beyond protection screens to allow for easier access.

.15 Provide lube oil level gauge switch on side of oil pan in easily accessible location.

.16 Extend fan hub grease fitting out beyond hub housing, for easier service.

.17 Equip engines with individual safety devices to shut down engine and to sound an alarm in event of conditions specified later in this Section. Provide contacts to pre-alarm for conditions specified later in this Section. Refer to control panel requirements specified elsewhere in this Section and requirements as detailed on drawings for additional requirements. Provide sensors to connect to electronic controls to monitor and display various engine performance characteristics.

2.4 STEEL MOUNTING BASE

.1 Complete generating set to be mounted on structural steel beam base of enough strength and rigidity to protect assembly from stress or strain during transportation, installation, and under operating conditions on suitable level surface.

.2 Assembly fitted with vibration isolators and control console resiliently mounted:

.1 Spring type isolators with adjustable side snubbers and adjustable for leveling.

.2 Include seismic restraints if required for installation location (as applicable).

.3 Sound insulation pads for installation between isolators and concrete base.

.4 Sound-attenuating insulation in open areas between support members to prevent transmission of generator noise through floor of generator assembly.

2.5 COOLING SYSTEM

.1 Cooling system for engines consists of unit mounted air water radiator system with protective screen and a 50% water/50% ethylene glycol coolant solution as recommended by the genset manufacturer.

.2 Thermostat maintains coolant temperature at manufacturer's rated temperature with genset operating at rated load. Size radiator to maintain these conditions and provide complete with high performance static pusher fan, fan motors, radiator core guard, duct adapter flange, mounting frame, expansion tank, thermostatic controls, disconnect switch, a suitable open mesh fan guard and shroud.

.3 Gate drain brass ball valves are provided for draining coolant from each engine block and radiator. Wire braided hoses, piping and fittings to be silicone and are to extend into drain containment pan under genset.

2.6 JACKET COOLANT HEATERS

.1 Engine jacket coolant heaters to be complete with silicone hoses, immersion type thermostats, pressure switches and ball type-isolating valves on engine water connections. Size of heaters to maintain coolant in engine at genset manufacturer's rated temperature requirements with unit operating at rated loads and conditions (approximately 6 kW, per engine at 208 V, 1-phase, but confirm with genset vendor and revise to suit).

.2 Jacket heaters to be automatically disconnected when engines are running via oil pressure switches/engine run relay.

.3 Heaters to be KIM "Hotstart" or approved equal, that connect to each engine with high temperature coolant silicone hoses and clamps, specifically used for and approved by governing authorities for such applications.

2.7 ENGINE FUEL SYSTEM

.1 Provide a gear driven high lift fuel transfer pump with each genset. If this option is not available, indication of same shall be noted on deviations form.

.2 Fuel injectors for engine are individual cylinder type, capable of quick replacement. Dual prime fuel filters are complete with receptacle elements, which can be easily removed without disturbing other parts of engine. Where required for proper system performance, genset to be complete with integral mounted auxiliary tank.

.3 For each genset provide two (2) fuel oil flexible connectors with braided stainless-steel covering, diameter to suit engine requirements and minimum 900 mm (36") long.

.4 Fuel lines to be ULC listed, 2 hours rated, flexible braided jacketed, high-pressure lines suitable for use with type of engine fuel, and complete with male swivel fittings.

.5 Provide ULC listed Racor water separator or OEM factory installed assembly consisting of unit with water sensor complete with gauge, fuel restriction sensor, alarm contacts to send signal to genset control panel, required relays and filter.

.6 Provide ULC listed fire safe valves.

.7 Include interconnected fuel cooler complete with fuel lines, power conductors, control conductors, and ancillary devices as required. Exact fuel cooler type and size to be as recommended by genset manufacturer to suit specific project requirements.

2.8 STARTING BATTERIES AND CHARGER

.1 Provide starting batteries:

.1 Full sealed calcium/lead antimony type, 12/24-volt DC, sized as recommended by the generator set manufacturer;

.2 Enough capacity in an ambient room temperature of 0°C (32°F) to crank each unit at engine manufacturer’s recommended cranking starting speed for a period of 60 seconds;

.3 Each generator set with battery cables and connectors.

.4 Battery stand,

.2 Provide UL listed/CSA certified voltage regulated battery charger as recommended by the genset manufacturer. The charger shall be wall mounted. Input AC voltage and DC output voltage as required. Chargers to include the following features:

.1 remote wall mounting, totally enclosed enclosure;

.2 fully automatic operation;

.3 operating voltage of 115-volt, 60 cycle AC;

.4 AC switch and overload protection isolating voltage ratio transformer, silicon-controlled rectifier assembly and DC protection, all suitable for two (2) rates of charging (trickle charge and high rate of charge for use after engine start);

.5 DC ammeter and DC voltmeter gauges;

.6 AC power "on" indicating light;

.7 AC power failure alarm;

.8 float voltage adjustment;

.9 equalize circuit;

.10 maximum charge rate to suit application;

.11 necessary contacts for connection of common alarm signal to control system.

.3 Battery chargers to recharge a battery discharged by two cranking cycles (30 seconds each) to 80% of capacity within 4 hours and to full capacity in maximum 12 hours.

2.9 ALTERNATOR

.1 Alternator features include following:

.1 voltage rating as noted on drawings;

.2 Capable of delivering rated output, at rated frequency and power factor, at any voltage not more than 5% above or below rated voltage.

.3 Produce a clean AC voltage waveform, with not more than 5% Total Harmonic Distortion at full linear load, when measured from line to neutral, and with not more than 3% in any single harmonic:

.1 Telephone Influence Factor: maximum 40.

.2 Provide radio interference suppressors where required to maintain radio interference levels in accordance with CSA Specifications.

.4 drip proof, single bearing and close coupled to engine with an SAE housing;

.5 2/3 pitch;

.6 Synchronous type.

.7 excitation boost not less than three (3) times rated current for 10 seconds;

.8 direct connected brushless exciters; rotating brushless permanent magnet pilot exciter to provide power via automatic voltage regulator to main exciter, and with dynamically balanced rotor permanently aligned to engine by SAE flexible disc coupling;

.9 full amortiseur windings;

.10 windings of Class H rating;

.11 temperature rise not to exceed 105C° as measured by resistance in an ambient temperature 50°C (122°F):

.1 100% full load continuously;

.2 150% full load for 1 min.

.12 Voltage regulator thyristor-controlled rectifiers with phase-controlled sensing circuit as recommended by the genset manufacturer.

.13 Voltage regulation systems are to maintain regulation within limits previously specified and include regulator and manual voltage adjustment potentiometer. Static voltage regulator with 3 phase sensing, radio suppression module, frequency choke to prevent damage to voltage regulator in case of lower than nominal engine speed, and adjustable stability circuit. Equipment is designed to minimize Radio Frequency Interference (RFI) under all operating conditions. "Balanced Telephone Influence Factor" (TIF) is not exceed fifty (50).

.14 Capable of sustaining 300% rated current for period not less than 10s permitting selective tripping of down line protective devices when short circuit occurs.

.15 Suitable for continuous operation with electronic / UPS type loads (as applicable),

.16 Anti-condensation heater:

.1 Provide AC power connection box for single AC power connection to anti-condensation heater;

.2 De-energize heater when generator set is running.

.17 Alternator is equipped with Resistor Temperature Detectors (RTD) type thermistors complete with required relays/contacts as required to send trouble signal to control panel. Control panel to monitor warning signal of high temperature of windings.

.18 meet or exceed CSA 22.2 No. 100, EEMAC MG 122 and current IEEE Standards;

.19 grounding provisions to suit OESC and electrical distribution system as per drawings.

.2 **ALTERNATOR CONNECTIONS**

.1 Wiring connections shall be in identified boxes on generator set.

.2 Separate boxes shall be provided for power and control wiring.

.3 Provide power wiring lugs to accommodate multiple cables per phase, plus neutrals, sized as per drawings.

.4 Provide common, permanently labelled terminal block assembly for control wiring.

.5 Load connections shall be silver- or tin-plated copper bus bars, drilled to accept mechanical or compression terminations of number and type shown on drawings.

.6 120V power connections to auxiliary devices (heaters, lights, etc.) shall be made at the devices, with required protection provided at a wall-mounted common distribution panel.

2.10 CONTROL PANEL

.1 Totally enclosed, mounted on the generator set, vibration-isolated from generator.

.2 Microprocessor-based controller specifically designed to provide automatic starting, monitoring, and control functions for the generator set.

.1 Capable of providing local and remote monitoring and control functions.

.3 Instruments:

.1 Digital, backlit LCD or LED display, minimum 2 lines, capable of displaying control parameter or status on one line and value on the second line, without scrolling.

.1 All control parameters and status information shall be available through the digital display;

.2 Three-phase output voltage Line-to-Line and Line-to-Neutral shall be available;

.3 Display voltage for all three phases simultaneously;

.4 Display current for all three phases simultaneously.

.5 Units for display of parameters shall be individually selectable between metric and imperial, where applicable:

.1 Engine oil pressure: psi or kPa;

.2 Engine coolant temperature: °F or °C;

.3 Engine oil temperature: °F or °C;

.4 Engine speed: rpm;

.5 Operating time: hours;

.6 Battery voltage: Volts dc.

.2 Analogue indicating type, 2% accuracy, rectangular face, flush panel mounting:

.1 Voltmeter: ac, scale 0 to 750V;

.2 Ammeter: ac, scale 0 to 600A;

.3 Wattmeter: scale 0 to 500kW;

.4 Frequency meter: scale 55 to 65Hz;

.3 Instrument Transformers, 0.5% accuracy:

.1 Current: dry type for indoor use:

.1 Ratio: 400 to 5;

.2 Rating: 600V, 60Hz, BIL 10 kV;

.3 Positive action automatic short-circuiting device in secondary terminals.

.4 Use same microprocessor output to drive digital and analogue meters to ensure consistent readings and performance.

.5 Include provision for historical data logging and display of:

.1 The last ten (10) warning or shutdown events;

.2 Total time, in hours, of operation at various loads, as a percentage of generator rated total load.

.4 Controls:

.1 Engine Mode Selector Switch:

.1 MANUAL: switch in manual position, generator shall start and accelerate to rated speed and voltage, as directed by the operator. This will bypass the automatic control system and cause an alarm to occur.

.2 AUTO: generator shall be ready to accept a remote signal to start and accelerate to rated speed and voltage.

.3 OFF: switch in "OFF" position causes an alarm to occur; switch in either "OFF" or manual position causes amber indicator lamp identifying "NOT IN AUTO" to illuminate when alarm occurs;

.2 Engine emergency stop button and provision for remote emergency stop button:

.1 Red “mushroom-head” type;

.2 EMERGENCY STOP: when activated, generator to immediately initiate the stop sequence.

.3 Emergency stop to lock out the generator from automatic restarting, until reset;

.4 Programmable input to accept dry contact closure for remote emergency stop.

.3 Reset switch: clear fault and allow automatic restarting of generator set.

.4 Voltage control rheostat: mounted on inside of control panel.

.5 The control system shall provide an environmentally sealed design including encapsulated circuit boards and sealed automotive style plugs for all sensors and circuit board connections.

.6 alarm horn with silencing button, and an annunciator to flash when any audible alarm is silenced until trouble has been cleared and reset;

.7 Provide controls, contacts and annunciation of shutdowns (red) and warnings (amber) alarms for following conditions, conditions as per applicable CSA 282 Standards and conditions as detailed on drawings:

.1 High-intensity Yellow LED indicator light for alarm with 1 set manually reset Form ‘C’ (NO/NC) contacts wired to terminal block for remote TROUBLE annunciation on:

.1 Generator Not-in-Auto.

.2 High-intensity Yellow LED indicator light for alarm with 1 set manually reset Form ‘C’ (NO/NC) contacts wired to terminal block for remote ALARM annunciation on:

.1 Low Fuel level;

.2 High Coolant Temperature;

.3 Low Coolant Temperature;

.4 Oil pressure Sender Failure;

.5 Engine Temperature Sender Failure;

.6 Low DC Voltage/Charger Failure;

.7 High DC voltage;

.8 Weak Battery;

.9 Over Current;
.10 Overload;
.11 Ground Fault;
.12 Generator Breaker Open;
.13 Engine Running.
.14 Intake Damper “Fail to OPEN”

.3 High-intensity Red LED indicator light for alarm with 1 set manually reset Form ‘C’ (NO/NC) contacts wired to terminal block for remote SHUTDOWN annunciation on:

.1 Low Oil Pressure;
.2 Hi Coolant Temperature;
.3 Over crank;
.4 Fail to Crank;
.5 Zero Speed Signal;
.6 Over speed;
.7 Under speed;
.8 Over current;
.9 Voltage outside limits (plus or minus 10%);
.10 Frequency outside limits (58 to 62 Hz);
.11 Emergency Stop;
.12 Low Coolant Level;
.13 Generator Breaker Tripped;
.14 Short circuit;
.15 Ventilation system failure.

.8 Lamp Test Button:

.1 Momentary contact, self-resetting after 10 seconds, or upon second press;
.2 Shall provide control voltage to all lamps on control panel to test operation of lamps.

.5 Engine Control Functions

.1 Cycle-cranking system, which includes user-adjustable crank time, rest time, and number of cranking cycles. Initial settings shall be for three cranking cycles of 15 seconds each, with a 15 second rest period between cycles.

.2 Idle mode: allows engine to run in idle mode in RUN position only. Alternator excitation shall be disabled in this mode.

.3 Engine governor control: user adjustable settings for gain and damping. Provide ramping function to control engine speed and limit exhaust smoke while engine is starting. Governor control shall be suitable for use in paralleling applications without component changes.

.4 User-adjustable time-delay start (0-300s) and user-adjustable time-delay stop. Time-delay stop shall include user adjustable engine cool-down cycle (0-600s).

.5 Sender failure monitoring: Engine controller logic shall be capable of discriminating between failed sender or wiring components, and actual failure conditions on the following instruments:

.1 Engine speed;

.2 Engine temperature;

.3 Engine oil and fuel pressure.

.4 Engine oil and fuel temperature;

.5 Engine coolant pressure and level;

.6 running hours;

.7 air temperature;

.8 battery voltage;

.6 DC Control and Starting Battery voltage: monitoring system that shall:

.1 Initiate alarm when DC control & starting voltage is less than 25Vdc or greater than 32Vdc;

.2 Disable low-voltage alarm during engine cranking;

.3 Initiate Weak Battery alarm if DC voltage drops below 14.4V for more than 2 seconds.

.7 Alternator Control Functions

.1 Voltage regulation: automatic digital voltage regulating system that is matched and prototype tested with the engine governing system provided shall:

.1 Provide a pulse-width modulated output to the alternator exciter;

.2 Be immune from mis operation due to load-induced voltage waveform distortion;

.3 Be equipped with three-phase RMS sensing circuitry;

.4 Control build-up of alternator voltage to provide a linear rise and limit overshoot;

.5 Include torque-matching characteristic which shall reduce output voltage in proportion to frequency, below a user-adjustable threshold of 58-59Hz;

.6 Include adjustments for gain, damping, and frequency roll-off, using digital raise/lower switches, with an alphanumeric readout to indicate setting value.

.2 Output voltage:

.1 Shut down and lock out generator set when output voltage exceeds 110% of operator-set voltage level for more than 10 seconds;

.2 Shut down and lock out generator set immediately when output voltage exceeds 130% of operator-set voltage level;

.3 Shut down and lock out generator set when output voltage is less than 85% of operator-set voltage level for more than 10 seconds.

.3 Output current: True RMS voltage monitoring system that shall:

.1 Initiate overcurrent alarm when load current exceeds 110% of the rated current on any phase for more than 60 seconds;

.2 Shut down and lock out generator set when output current level approaches thermal damage point of alternator (overcurrent / short circuit);

.4 Individually monitor all three phases of output current for short circuit conditions;

.5 kW load: monitor kW load and initiate alarm condition when total load exceeds the alternator load rating for more than 5 seconds.

.1 Provide one (1) set Form 'C' contacts for load shedding signals to customer load equipment.

.6 Ground Fault Monitoring: provide ground fault monitoring relay:

.1 Adjustable from 3.8 to 1200 Amps;

.2 Adjustable time-delay from 0 to 10 seconds;

.3 Indication only. Relay shall not trip or shut down the generator set;

.4 Provide relay that will function correctly under identified grounding & bonding system.

.7 External input board for dry type contacts c/w pre-programmable descriptors to monitor alarms of external devices.

.8 Control power:

.1 Provide switched 10A, 24Vdc fused circuit for customer use. Power shall be available on this circuit when generator is running.

.2 Provide un-switched 20A, 24Vdc fused circuit for customer use. Power to be available on this circuit at all times.

.9 Breakers mounted in control panel integral with genset include following:

.10 Molded case type main breaker:

.1 fixed mounted moulded case circuit breaker as required, and where frame size exceeds 250A, to be complete with solid state adjustable trip unit; in absence of direction, size and ampacity of breaker to be to suit application based on code requirements and genset manufacturer's recommendations; breaker setting to be such that generator short circuit output will trip breaker; trip unit to include adjustable long, short, instantaneous, ground fault (where applicable) and time delay; exact settings to be determined by genset manufacturer to meet specific applications; exact breaker type to be as recommended by breaker and genset manufacturer to meet such applications and be reviewed with Consultant prior to ordering.

.2 auxiliary contacts on main breaker for monitoring and alarm indication in open position;

.11 Molded case type load bank breaker:

.1 type and frame size as main breaker, to be provided interconnected to system to allow for connection of a load bank during regular testing of genset; provide DC shunt trip

and relays as required to interconnect with main transfer switch in manner such that if load bank breaker is closed and loss of normal power occurs, load bank breaker will open and main genset breaker will close; exact breaker type to be as recommended by breaker and genset manufacturer to meet such applications and be reviewed with Consultant prior to ordering;

.12 Auxiliary Molded case type breaker:

.1 moulded case type with solid state trip unit. Review with Consultant prior to ordering and refer to drawings;

.2 refer to drawings for additional requirements.

2.11 EXHAUST SYSTEM

.1 Engine exhaust system to consist of, but not be limited to the following:

.1 lengths of flexible stainless-steel flex connectors,

.2 exhaust silencers,

.3 WYE connector pieces,

.4 flanges and rigid exhaust piping.

.2 Each flexible exhaust connector to be a minimum of 458 mm (18") in length but, sized for thermal expansion and engine vibration.

.3 Turn over silencers, connector pieces, flanges and flexible stainless-steel piping to Mechanical Division for installation.

.4 Review issued Documents and supply appropriate silencers and exhaust system piping components between engine and silencer.

.5 Engine exhaust Silencers are to be equivalent to SMS "Hospital Plus SM4P" series to provide high degree of noise reduction and to suit each respective size of genset. Silencers and exhaust system components to be suitable in all respects for application and be as recommended by genset supplier to meet design requirements identified in Mechanical and Electrical Divisions Documents. Silencers are to include drain plug and other required accessories. Acceptable manufacturers of silencers are SMS Silencers Inc., Vibron Ltd., Nelson, Silex and Maxim.

.6 Rigid exhaust piping and exhaust stack is the responsibility of Mechanical Division. Coordinate work and responsibilities with Mechanical Division and ensure complete system is provided. Refer to Section 23 35 16 for Engine Exhaust system requirements.

.7 As applicable to design of engine, supply a properly sized black steel "Y" connection with two (2) lengths of flexible stainless-steel exhaust pipes installed between engine and "Y" connection. "Y" fitting and flex connections to be turned over to Mechanical Division for installation.

.8 Coordinate with Mechanical Division, exact silencer and exhaust system design requirements to meet specific project criteria and include products to comply with local governing noise and emission regulations. Height of stack to be provided to suit local air and noise limitations.

.9 **IF GENSET IS BEING SUPPLIED AS PART OF A SKIN-TIGHT OR WALK-IN ENCLOSURE, ALL EXHAUST COMPONENTS WILL BE INSTALLED AS PART OF THE ENCLOSURE ASSEMBLY. ALL COMPONENTS SHALL BE INSTALLED WITHIN THE ENCLOSURE SO THAT ONLY THE VERTICAL EXHAUST PIPE SHALL PENETRATE THE ENCLOSURE ROOF LINE.**

2.12 EQUIPMENT IDENTIFICATION

.1 Provide Identification nameplates as described in Section 26 05 53.

.2 Engraved nameplates, mounted on the face of the assembly, to be furnished for all main and feeder circuits as indicated on the drawings. Nameplates to be laminated plastic, black characters on white background. Characters to be 3/16-inch high, minimum. Nameplates shall give item designation and circuit number as well as frame ampere size and appropriate trip rating. Furnish master nameplate giving switchboard designation, voltage ampere rating, short-circuit rating, manufacturer's name, general order number, and item number.

.3 Each nameplate to be sized to suit equipment for which it is provided and required wording. Confirm exact nomenclature, sizing, print type and colour scheme on shop drawings, for approval by Owner and Consultant.

.4 Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., to be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.

.5 Warning signs to be lamacoid type with nomenclature confirmed with and approved by local governing electrical utility and reviewed with Consultant.

2.13 EXTRA MATERIALS

.1 The following spare parts to be included for ALL electric sets:

.1 Two (2) sets of fuel filter elements;

.2 Two (2) sets of air filter elements;

.3 Two (2) sets of oil filter elements;

.4 Two (2) sets of water separator elements;

.5 Four (4) containers of lube oil, 4 litres each, (1 US gal) of a grade and quality as recommended by the manufacturer;

.6 Four (4) containers anti-freeze 4 litres each, (1 US gal) of a grade and quality as recommended by the manufacture. The anti-freeze to be pre-mixed for minus (-) 40° C temperature;

.7 One (1) set of belts, one for each of the radiator and alternator;

.8 One (1) complete set of tools necessary to carry out routine maintenance on the enclosure, including any special tools required.

.9 Provide maintenance materials in accordance with manufacturer's recommendations.

.2 The following spare fuse and bulb parts to be included in a sturdy plastic container for electric sets:

.1 Two (2) sets of all fuses used for the control circuits;

.2 Two (2) sets of all bulbs used for pilot lamps and illumination (if applicable).

.3 Provide a heavy-duty prefinished metal storage cabinet, suitably sized to house all spare parts. The cabinet to be a general purpose, and constructed of corrosion resistant metal, multiple metal shelves, and complete with two door construction with a two-point latch and handle. The color of the cabinet to be "RED".

.4 Spare parts storage cabinet to be shipped loose, for installation by the installing contractor.

2.14 ACCEPTABLE MANUFACTURERS:

.1 Cummins Eastern LP;

.2 Wajax;

.3 Toromont CAT;

.4 Kolher (Paramount Power Systems);

3 EXECUTION

3.1 GENERAL:

.1 Prior to start of Work, prepare schedule of Work and submit to Consultant for review. Manufacturer/supplier to, upon successful factory witness testing of unit, arrange and coordinate delivery and transporting of unit to site.

.2 Coordinate controls work both at factory and on site and include for required interface work to equipment on site.

3.2 FACTORY ACCEPTANCE TESTS

.1 Perform a factory test of engine generator sets and enclosure prior to delivery to job site.

.2 Fuel and other consumables for generator factory test shall be provided by manufacturer.

.3 Generator set factory test may be witnessed by Owner and Consultant.

.1 Manufacturer to include travel costs in bid for Owner and Engineer to witness factory test if performed more than 250km from site of installation.

.2 Include for and arrange for Owner and Consultant to witness factory tests and schedule tests at a time acceptable to Owner and reviewed with Consultant. Include "out of town" expenses such as transportation, lodging, meals, etc., for Owner and Consultant to witness factory testing. Notify Owner and Consultant at least two (2) weeks in advance of tests. Should additional tests be required due to failure to comply with conditions specified in this article, costs (all travel expenses, accommodation if required, plus seven hundred and fifty dollars [$750.00] per day) for Consultant to witness these additional tests are to be borne by genset manufacturer/supplier. Genset manufacturer/supplier to be responsible for full arrangements.

.4 There will be a minimum of two (2) weeks notification prior the scheduled date of the tests. The tests shall only be carried after 100% readiness and completion of the work are

confirmed by the manufacturer's quality inspector, the consultant and the owner. A Factory acceptance test plan will be issued by the consultant to the manufacturer, prior to the test.

.5 Factory tests to include period(s) of minimum 4 hours continuous operation under full load conditions as directed by Consultant. Number of periods of testing to be quantity as required until successful testing of specified requirements to satisfaction of Consultant and Owner. Ensure that proper 100% capacity resistive type artificial load banks are available for tests. Factory testing to include use of strip chart recording instruments to confirm that engine generator set complies to specified requirements in frequency, voltage and current regulation as specified herein this Section. Testing to also be performed to demonstrate successful synchronization and paralleling (if applicable). Submit reports for Consultant's review. Do not ship gensets to site without Consultants approval.

.6 Test generator set with all systems properly installed and connected, at the factory. Coordinate with Owner and consultant and representative from generator manufacturer to perform factory acceptance test.

.7 Prior to factory acceptance test, manufacturer approved technician and Engineer to inspect the completed installation for deficiencies and defects, and to ensure installation is compliance with warranty requirements.

.8 A damper arrangement to be installed in the air flow output of the radiator to simulate a minimum of 0.5 in of water restriction. The test to be performed at the maximum allowable external static pressure for an operation at 40 deg C ambiance. A calibrated manometer to be used for proper adjustment of the damper. The specified back-pressure adjustment could be of a higher value if, for the installation on site, the restriction in the ventilation system is of a higher value and that the calculated SCFM will be enough for operation in the engine room in an ambient of 40°. The flow and restriction in inches of water to be measured during the test to validate the data provided by the distributor at time of submittal of shop drawings.

.9 The shop tests to be conducted in the presence of the consultant and the owner.

.10 There to be a minimum of two (2) weeks notification prior the scheduled date of the tests. The tests shall only be carried after 100% readiness and completion of the work are confirmed by the manufacturer's quality inspector, the consultant and the owner. A Factory acceptance test plan will be issued by the consultant to the manufacturer, prior to the test.

.11 The equipment in this contract to be pre-run for at least four (4) hours prior to confirming the scheduled date for the official tests.

.12 The shop tests to be conducted in the following fashion once set-up is approved:

.1 Visual inspection of the equipment by the consultant and Owner;

.2 Cold start at the jacket temperature maintained by the heater(s) (24°C);

.13 Test procedure to include:

.1 Prepare blank forms and check sheet with spaces to record data. At top of first sheet record:

.1 Date;

.2 Generator set serial no.;
.3 Engine, make, model, serial no.;
.4 Alternator, make, model, serial no.;
.5 Voltage regulator, make and model;
.6 Rating of generator set: kW, kVA, V, A, r/min, Hz;

.2 Mark check sheet and record data on forms in duplicate as test proceeds.

.3 Engineer's signature on completed forms to indicate concurrence in results of test.

.14 Tests:

.1 With 100% rated load, operate set for at least 4h, taking readings at 15m intervals, and record following:

.1 Time of reading;
.2 Running time;
.3 Ambient temp in °C;
.4 Lube oil pressure in kPa;
.5 Lube oil temp in °C;
.6 Engine coolant temp (inlet & outlet) in °C;
.7 Exhaust stack temp in °C;
.8 Alternator voltage: phase 1, 2, 3;
.9 Alternator current: phase 1, 2, 3;
.10 Power in kW;
.11 Frequency in Hz;
.12 Power Factor;
.13 Battery charger current in A;
.14 Battery voltage in V;

.2 After completion of 4h run, demonstrate following shut down devices and alarms:

.1 over cranking.
.2 Overspeed.
.3 High engine temp.
.4 Low lube oil pressure.
.5 Short circuit.
.6 Alternator overvoltage.
.7 Low battery voltage, or no battery charge.
.8 Manual remote emergency stop.
.9 High alternator temperature.

.3 Following 4h load test, install continuous strip chart recorders to record frequency and voltage variations, as well as vibration levels, during load switching procedures. Each

load change shall be delayed until steady state conditions exist. Switching increments to include:

.1 No load to full load to no load;

.2 No load to 75% load to no load;

.3 No load to 50% load to no load;

.4 No load to 25% load to no load;

.5 25% load to full load to 25% load;

.6 50% load to full load to 50% load;

.7 75% load to full load to 75% load;

.15 Demonstrate low oil pressure and high engine temperature shutdown devices operation without subjecting engine to these excesses.

.16 Demonstrate:

.1 Proper operation of generator set within the enclosure;

.2 Proper operation of ventilation controls and alarms.

.17 Run engine through five-minute cool-down period, with no load applied, before being shut down.

.18 Test results to include:

.1 Hour-meter readings at the beginning and completion of test.

.2 Time taken by the set to reach rated voltage and frequency following start signal.

.3 Amount of fuel consumed during test.

.4 Verification of meter accuracy.

.5 Verification of function of anticipatory and shutdown safety devices.

.6 Verification of function of auxiliary equipment such as pumps and heaters.

.19 Certify test results as authentic and correct for the generator set supplied, by seal of a Professional Engineer employed by the manufacturer.

.20 In the event the Factory Test results are rejected, the manufacturer shall correct the defects and repeat the Factory Test until satisfactory results are obtained. Test results will be rejected under any of the following conditions:

.1 Generator set or any component or auxiliary equipment fails to function as specified.

.2 Generator set fails to complete the test.

.3 Recorded parameters do not stabilize.

.4 Recorded parameters do not remain within acceptable limits.

.5 Start time exceeds 15 seconds.

.21 **Acceptable vibration test levels:**

.1 Vibration acceptable levels shall follow the general philosophy hereafter:

.1 The axial, the radial and the tensional vibrations to be reduced in order to improve components' life cycle.

.2 The result of vibration readings taken during shop and site tests to be at the disposal of the consultant.

.3 The maximum tolerated filtered vibrations level on the alternator to be respected in accordance with the manufacturer's specifications. The details on expected acceptable vibrations to be transmitted to the consultant prior to commencing the running tests.

.2 Vibration control tests to be according to the manufacturer's standards.

.3 Vibration parameters to be compared to those included in the shop drawings.

.4 Readings to be taken in the three (3) axis; on the subbase, on the exciter housing, on the stator housing at the bearing level, on the flywheel housing, on the front engine bearing housing. The preferred locations for the readings to be defined by the engine manufacturer.

.5 The results of the vibration analysis to be verified by a competent authority.

.22 **DO NOT SHIP GENERATOR SET FROM FACTORY PRIOR TO RECEIVING APPROVAL, IN WRITING, FROM THE CONSULTANT.**

3.3 TRANSPORTATION

.1 Following approval by Consultant and Owner of factory acceptance, prepare walk-in enclosure and components for shipping.

.2 Assemble modules on flatbed trailers for shipping to site in such a manner to allow for hoisting company to quickly and easily identify and connect to all lift points without removal or rearrangement of any equipment on the trailers.

.3 Clearly identify points where equipment is secured to trailer using welds, bolts, or other methods. Provide any special tools required to remove securing devices.

.1 Coordinate with installation contractor to ensure that qualified personnel are on site to remove welds, if required.

3.4 INSTALLATION OF GENSETS

.1 **THE GENSET FOR THIS PROJECT WILL INSTALLED AS PART OF A WALK-IN ENCLOSURE. BE RESPONSIBLE TO COORDINATED THE INSTALLATION OF GENSET INCLUDING ALL ACCESSORIES SPECIFIED IN THIS SECTION.**

.2 Provide gensets and enclosures as specified and detailed. Refer to drawing details and notes for additional requirements.

.3 Refer to Section 26 32 16 for enclosure requirements and installation requirements. Perform required installation work and coordinate work between trades. Furnish and install all systems required for proper operation of the genset, including generator set, fuel system, ventilation system, exhaust system, ATS, and all ancillary systems.

.4 Furnish and install all interconnecting wiring and piping between all major equipment provided as part of the enclosure and generator set.

3.5 GROUNDING AND BONDING:

.1 Provide complete grounding and bonding conductor system in compliance with the Ontario Electrical Safety Code requirements, complete with ground bar in enclosure for common connection of grounding and bonding conductors from equipment and exterior ground rods or for connection to main building grounding system. Refer to drawings and Section entitled Grounding and Bonding for additional grounding requirements.

3.6 TESTING, START-UP, VERIFICATION AND TRAINING:

.1 When genset and enclosure is complete, and ready to be tested, perform standard factory testing as integrated with factory witness testing of gensets specified in this Section.

.2 **THE GENSET MUST BE TESTED WITHIN THE ENCLOSURE. TEST EQUIPMENT AND SYSTEMS AND VERIFY PROPER OPERATION. DOCUMENT TESTING AND RESULTS IN REPORTS SIGNED BY GENSET ENCLOSURE MANUFACTURER'S AUTHORIZED TECHNICIAN. SUBMIT COPIES OF REPORT TO CONSULTANT.**

3.7 SITE ACCEPTANCE TESTS

.1 For site acceptance test procedures for generator and enclosure, refer to Section 26 32 16 for details.

3.8 ARC FLASH AND SHORT-CIRCUIT AND PROTECTIVE DEVICE COORDINATION STUDY

.1 Additionally, refer to testing, coordination and arc flash requirements in Section entitled 26 05 73 – Power Systems Studies

END OF SECTION 26 32 14

1 GENERAL

1.1 SUMMARY

.1 This section relates to Sound attenuating, weatherproof, walk-in enclosure with all equipment and accessories as noted here within this specification.

.2 All bids must include a detailed, line-by-line, compliance statement indicating non-conformity with this specification.

1.2 RELATED SECTIONS

.1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

.2 The equipment and related services to be provided shall comply with the following specifications, as modified herein:

.1 26 32 13 – Power Generation Diesel

.2 26 36 23 - Automatic Load Transfer Equipment

.3 26 05 26 - Grounding and bonding.

.4 26 05 73 – Power System Studies

.5 26 05 53 – Identification for Electrical Systems

1.3 REFERENCES AND STANDARDS

.1 The enclosure to drawings be approved and certified by:

.1 An engineer member, licensed in the Province of Ontario, for electrical, and structural drawings (Provided by the enclosure manufacturer);

.2 Enclosure must also meet applicable codes and standards enforced by the Province of Ontario and local governing authorities, including but not limited to:

.1 Ontario Building Code;

.2 Ontario Electrical Safety Code;

.3 National Fire Protection Association (NFPA);

.4 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA);

.5 American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE).

.3 Canadian Standards Association (CSA)

.1 CSA C282-15: Emergency Electrical Power Supply for Buildings.

.2 CSA B139-15: Installation Code for Oil-Burning Equipment

.4 Technical Standards & Safety Authority

.1 FS-219-16: Fuel Oil Code Adoption Document Amendment

.5 American National Standards Institute (ANSI)/American Petroleum Institute (API)

.1 API Std. 650: Welded Steel Tanks for Oil Storage Eleventh Edition; Addendum 3, Errata

.6 Underwriters' Laboratories of Canada (ULC)

.1 CAN/ULC S601-14: Standard for Shop Fabricated Steel Aboveground Horizontal Tanks for Flammable and Combustible Liquids.

.7 International Standards Organization (ISO)

.1 ISO 9001:2008: Quality Management Systems - Requirements.

1.4 SUBMITTALS

.1 Provide one complete set of shop drawings, in PDF format for all products in this section, including but not limited to the following:

.1 Manufacturer’s product literature and performance data enough to verify compliance to specification requirements;

.2 A specification compliance statement describing in detail the differences between the specified and the proposed equipment;

.3 Shop drawings showing plan and elevation views with certified overall dimensions;

.4 Interconnection wiring diagrams showing all external connections required, with field wiring terminals marked in a consistent point-to-point manner;

.5 Lifting and rigging drawings showing pull points and rigging configuration;

.6 Manufacturer’s installation instructions.

.2 Each submittal shall include complete drawings, showing all aspects of the enclosure, including:

.1 ALL enclosure accessories and components;
.2 Fuel tanks;
.3 Full design detail drawings;
.4 Equipment capacities;
.5 Layouts and Dimensions;
.6 Dry weight and operating weight;
.7 Finishes;
.8 Wiring Schematics;
.9 Intergraded systems;
.10 Engine cooling and room ventilation details;
.11 Connection details to building services.

.2 Calculated noise data, showing sound pressure levels in free-field conditions at 7m in all directions from the enclosure, including above and below.

.3 Major components and estimated weight of each lifting module, within 100kg.

.3 Maintain a copy of shop drawing submittals for a minimum period of 25 years.

1.5 QUALITY ASSURANCE

.1 Comply with all previously mentioned standards.

.2 Manufacturer to be specialized in the manufacturing of Emergency power generators in sound attenuated enclosures with at least five years documented experience.

1.6 CLOSEOUT SUBMITTALS

.1 Provide operation and maintenance data for diesel generator enclosure for incorporation into Operations & Maintenance manual.

.2 Include the following in Operation and Maintenance Manual instructions for unit supplied and not general descriptions of units manufactured by supplier:

.1 Operation and maintenance instructions for enclosure and all appurtenances supplied with enclosure;

.2 Technical data:

.1 Illustrated parts lists with parts catalogue numbers;

.3 Certified copy of factory test results;

.4 Maintenance instructions and schedules;

.5 List of manufacturer's recommended maintenance materials.

1.7 STORAGE AND HANDLING

.1 Store and handle in strict compliance with manufacturer's instructions and recommendations. Protect from potential damage from construction operations.

.2 Handle equipment using proper equipment for lifting and handling, use when necessary lifting eye and/or brackets provided for that purpose.

1.8 WARRANTY

.1 Provide warranty against defects in materials and workmanship for the enclosure and all appurtenances provided under this contract for a minimum period of thirty (30) months from the time of delivery or twenty-four (24) months from the time of commissioning acceptance, whichever comes first;

.2 Include all costs to extend the warranty beyond the manufacturer's standard warranty period in tender.

.3 Warranty to be comprehensive; it shall include all travel, service and parts costs required to repair the generator enclosure during the warranty period.

1.9 MANUFACTURER'S REPRESENTATIVE

.1 Upon award of the contract the manufacturers of genset and enclosure to appoint a manufacturer's representative who to be qualified in the design, installation, commissioning and maintenance of the equipment supplied.

.2 The manufacturer's representative to be available throughout the life of the contract and to be available on site for equipment delivery, site meetings, equipment installation, testing and commissioning, start-up and instruction of owner's staff.

.3 The manufacturer's representative shall perform the following functions:

.1 review of equipment design with respect to specification requirements, required operation, code requirements, etc.;

.2 preparation and submission of shop drawings;

.3 design review with Consultants;

.4 response to questions by Owner, ESA, TSSA, Consultants, Contractor and Sub Contractors;

.5 monitoring and reporting on manufacturing progress at site meetings;

.6 preparation of production schedules and delivery arrangements;

.7 arrangement of factory tests including adequate notification of owner's witnesses;

.8 oversee unloading, hoisting, setting in place, and oversee site assembly;

.9 co-ordinate external wiring arrangements and connections;

.10 providing advice as required to all parties involved with the equipment;

.11 assist in equipment commissioning;

.12 training and instruction of Owner's staff;

.13 preparation and submission of manuals;

1.10 PROTECTIVE COORDINATION AND EQUIPMENT WITHSTAND RATINGS

.1 Obtain results of coordination study and short circuit calculations reports and Consultant comments and incorporate into shop drawings of electrical distribution equipment (high voltage and low voltage equipment as applicable). Do not order equipment until shop drawings submission process has been completed and reviewed with Consultant.

.2 Provide ratings for electrical equipment, circuit protective devices, bussing, and switches to interrupt and withstand short circuit faults greater than available fault current at its source of supply.

1.11 FIELD INSTALLATION (BY INSTALLING CONTRACTOR)

.1 Make provision in enclosure assembly for connection to base-building systems, including:

.1 Power;

.2 Controls;

.3 fire alarm;

.4 Grounding.

.2 Provide custom components necessary for interconnection with base-building systems.

.3 Connection to base-building systems will be by installing contractor.

2 PRODUCTS

2.1 SYSTEM DESCRIPTION AND PERFORMANCE

.1 Walk-in, sound-attenuating, weatherproof enclosure to contain diesel generator set along with all appurtenances and accessories to properly operate and maintain the generator set. **Enclosure Sound attenuation: average sound pressure level at 7m in free-field condition to be less than 75dba in all directions.**

.2 Provide insulation to prevent transmission of noise through, doors and floor of generator enclosure.

.3 Selection of silencer (muffler) to be coordinated with design of enclosure to meet sound level requirements.

.4 Submit with shop drawings, certification letter from a recognized acoustical authority certifying factory testing acoustical performance of enclosure housed genset, with genset operating at full load rating in accordance with specification requirements.

.5 Enclosure performance shall meet or exceed the performance requirements described in this specification and in O.Reg. 245/11, Section 14, whichever is more stringent.

2.2 GENERAL

.1 The manufacturer to comply with all applicable Federal and Provincial building codes and standards, and the relevant revisions and associated documents, throughout the manufacturing of the walk-in enclosure.

.2 Enclosure to be constructed to include all requirements for a walk-in enclosure in compliance with CSA-C282-15 and CSA – B139-15.

.3 Enclosure to have a heavy-duty aluminum outer skin over the steel enclosure framework construction, and primed and finished with corrosion resistant paint finish. Exterior paint finishes to be confirmed by Consultant.

.4 The manufacturer shall provide the consultant with architectural drawings showing plan and elevation views of the walk-in enclosure. The consultant will submit to the municipal authorities the drawings for approval prior to construction works. Not following this procedure, the manufacturer to be liable for any additional costs pertaining to any design change requests.

.5 Design enclosure with structural framing for application for mounting on concrete structural slab on grade. Enclosure base structural steel members and overall enclosure structural design to be reviewed and endorsed by a professional engineer, licensed in The Province of Ontario. Submit stamped shop drawings for review. Enclosure to be sturdy enough to resist normal ice and snow loads in winter.

.6 The enclosure to be of non-combustible fire rated construction, for a minimum of two (2) hour fire resistance class.

.7 All materials to be new and exempt of defects that may alter their durability and their resistance.

.8 **Sound-attenuated housing rated to allow generator set to operate at full rated load in an ambient temperature of up to 40°C (104°F).**

.9 All components of the generator set enclosure, including all appurtenances, to be standard product of current manufacture, from company regularly engaged in production of such equipment.

.10 Include all accessories as specified in this section and other related sections.

.11 **THE ELECTRICAL INSTALLATION INSIDE THE ENCLOSURE TO BE IN ACCORDANCE WITH THE ONTARIO ELECTRICAL SAFETY CODE AND MUST BE INSPECTED AT THE FACTORY BEFORE SHIPMENT TO THE SITE.**

.12 **Enclosure Finishes**

.1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.

.2 Exposed metal surfaces to be cleaned, phosphate treated, primed, and finished in two coats of enamel.

.3 Colours:

.1 Enclosure exterior, including exhaust and inlet air hoods: coordinate with owner.

.2 Other ducts and racks: Grey.

2.3 DIMENSIONS

.1 Overall assembly dimensions are based on the following for length, width, and height:

.1 Length: 412.5”

.2 Width: 162”

.3 Height: 140” (plus exhaust termination height, 36” above enclosure)

.2 Identify deviations in dimensions on bid summary page.

2.4 WEIGHT RESTRICTIONS

.1 The wet weight for enclosure assembly, complete with generator set, fuel oil sub-base tank, and all appurtenances is estimated at 44,000lbs. This is what was used to design the concrete foundation pad. Manufacturer to confirm overall weight of enclosure during shop drawing stage.

2.5 GENERATOR ENCLOSURE (WALK-IN TYPE)

.1 Walk-in type genset enclosure to comply with general requirements noted previously, and to be suitably sized to house genset complete with silencers, ATS, control panel, batteries, fuel, exhaust, heating, ventilation, electrical, fire alarm, etc., identified in this specification and on the drawings.

.2 Generally, dimensions of enclosure to be to accommodate equipment and CSA requirement of a minimum 1m (39") of working access space on two sides and alternator end of the genset. Enclosure design to include service consideration of easy accessibility of replacement equipment/parts into enclosure.

.3 Provide minimum 1m (39") of clear working space in front of any electrical equipment, in accordance with Ontario Electrical Safety Code.

.4 Where draw-out type electrical equipment is installed, extend distance to provide 1.5m clear working space in front of fully drawn out equipment, and minimum 1m (39") working space at rear.

.5 **Enclosure Wall Construction:**

.1 Designed to withstand wind load conditions in accordance with Ontario Building Code requirements for installation location.

.2 Fully insulated with R-value in accordance with Ontario Building Code requirements for installation location. Thermal and acoustical insulation sandwiched between perforated minimum 22-gauge steel panels;

.3 minimum 2 hours fire rating;

.4 minimum 26-gauge metallic pre-painted vertical exterior siding of finish to Consultant's approval;

.5 building wrap;

.6 required reinforcement for wall mounted/supported equipment and devices (i.e. panel boards, battery chargers, fire extinguishers, air intake louver, etc.).

.6 **Enclosure Roof Construction:**

.1 Designed to withstand snow load conditions in accordance with Ontario Building Code requirements for installation location.

.2 Fully insulated with R-value in accordance with Ontario Building Code requirements for installation location. Thermal and acoustical insulation sandwiched between perforated minimum 22-gauge steel panels;

.3 minimum 2 hours fire rating;

.4 Roof to be sloped, and complete with steel roof panels, steel framing with required cross-members, and minimum 25mm crown to minimize ponding of water:

.5 building wrap;

.6 required reinforcement for ceiling mounted/supported equipment and devices (i.e. exhaust muffler, stack, etc.).

.7 **Enclosure Base Frame:**

.1 Entire base to be designed structurally to support the genset, enclosure, and house the subbase fuel tank.

.2 Perimeter channels reinforced locally at generator set location and floor mounted equipment.

.3 Cross members with holes for seismic hold down.

.4 All mounting to be designed for seismic restraints.

.5 Lifting lugs: minimum four (4) per lifting module, or as specified by manufacturer to provide enough stability during crane lift.

.8 **Enclosure Floor:**

.1 security type 6 mm (1/4") checker plate, with minimum two coats of grey epoxy paint;

.2 minimum 150 mm (6") high metal curbs around entire enclosure perimeter walls, distribution equipment and all openings, integrally constructed and sealed with floor construction to completely contain any liquid spills;

.3 leak detection alarm system to be provided to monitor any leaks within enclosure curb containment and localized spill/leak containment curbs;

.4 rubber mats over exposed flooring.

.5 Provide framed stub-up openings, complete with sleeves, number and size as required, through floor, for all systems requiring connection to base-building systems:

.1 Sub-base tank fuel supply and return piping;

.2 Power wiring;

.3 Control wiring;

.4 Fire alarm wiring;

.5 Provide minimum two spare 100mm sleeves for future use;

.6 The manufacturer to be aware that all field conduits for connection to base building systems will be fed through the floor of the enclosure. This will apply to fuel, electrical, fire alarm system, communication systems, etc.

.7 The connection points for every system to be centralized within the enclosure according to their function.

.6 Installing contractor to cap and seal all sleeves with removable 2h FRR material to prevent ingress of moisture and animals. Ensure caps can be easily removed by installing contractor without sawing or otherwise damaging sleeves.

.9 **Doors:**

.1 Exterior grade doors on sides of enclosure to be pre-finished, insulated to meet noise emission criteria and 1.5-hour fire rated to meet wall fire rating criteria.

.2 Minimum one (1) set 18 Gauge galvanized steel double doors 1830mm x 2132mm (72" wide x 84") high.

.3 Minimum one (1) 18 Gauge galvanized steel single door 915mm x 2132mm (36" wide x 84") high.,

.4 Doors to be complete with:

.1 Panic hardware;

.2 Tamper proof stainless-steel heavy-duty hinges.

.3 Heavy duty door closer and retaining chain.

.4 Exterior grade heavy duty anodized aluminium and rubber weather stripping, with high transmission loss seals.

.5 Mortised latched lockset with lever and trim.

.6 Drip edge.

.7 Aluminium threshold and sills.

.8 Adjustable astragals.

.9 Corrosion resistant and vandal proof hardware.

.10 Door sweep.

.5 Refer to sample layout on drawings for door locations.

.6 Keyed alike lever locksets with mortised locks, Keyed to Toronto Zoo standards.

.7 Provide doors on each side of the enclosure, suitably located to provide an escape route.

.10 **Exterior louvers:**

.1 Fixed louvers of extruded aluminium alloy construction and painted the same colour as of the enclosure.

.2 Blades to be constructed of storm proof pattern with centre watershed in blade.

.3 Frame, head, sill and jamb to be minimum 100 mm (4") deep, one-piece extruded aluminium, minimum 3 mm (1/8") thick with approved caulking slot, integral to unit.

.4 Stainless steel fasteners and nuts provided as required and complete with neoprene washers.

.5 Minimum 2 mm diameter (13 AWG gauge) wire aluminium U-frame bird screen provided on inside face of louvers.

.6 Provide sound attenuated deflector hood on exhaust air louver end of enclosure.

.7 Provide drip edge over louvres, extending at least 25mm beyond the edge of the louvre.

.8 Angle louvres to mitigate the ingress of driven rain and snow.

.11 **Rain and Snow Protections:**

.1 Rain and snow protection devices shall not compromise the sound attenuating capabilities nor the insulation rating of the enclosure.

.2 Exhaust ducting:

.1 Provide shield to prevent ingress of rain and snow through engine exhaust stack.

.2 Ensure that shield will allow generator to operate properly in all weather conditions. Provide freeze protection on shields with moving parts.

.3 Coordinate with generator manufacturer to ensure that no additional back pressure is created by the shield.

2.6 SUB-BASE FUEL TANK AND PIPING

.1 **Sub-Base Fuel Tank**

.1 Walk-in enclosure and all appurtenances, including generator set, mounted on structurally reinforced tank of enough strength and rigidity to protect assembly from stress or strain during transportation, installation, and under operating conditions on suitable level surface.

.2 Provide leak detection switch for leak detection in interstitial space of tank.

.3 Sub-base fuel tank to be ULC S601-14 listed and labelled, double wall, and complete with all accessories required to meet CSA, B139-15 and TSSA, FS-219-16: Fuel Oil Code Adoption Document Amendment, including but not limited to the following:

.1 Vent piping and cap, emergency vent piping and cap, fill piping complete with exterior fuel spill container, fill alarm, etc.

.2 50mm OPW, "Visiflow®" filler neck in fill pipe. Fill pipe to be routed from the base tank to the exterior of the enclosure and be terminated in the spill containment box specified below. Fill line to be located adjacent to vent pipe.

.3 Morrison Brothers Company Fig. 516 5 Gallon AST Spill Container, ULC listed, steel construction and powder coated white inside and out.

.4 Tank volume to be minimum 6,000L.

.2 **Fuel Oil Piping**

.1 Provide all fuel equipment within the enclosure as required to meet requirements of CSA B139-15 along with all TSSA amendments including, but not limited to:

.1 Fuel piping to be welded black iron pipe 150 PSI class per ASTM A 53.

.2 ULC listed Fusible link valve;

.3 Engine fuel oil pumps to be capable of reliable operation for application.

.4 Level control switches and contacts for remote alarm monitoring of low fuel level and overfill alarm.

.5 Flexible fuel lines to be CSA approved, ULC listed, and labelled, 2-hour fire rated, flexible, wire braided, jacketed, high pressure fuel lines suitable for use with type of engine fuel, complete with male swivel fittings and connections between tanks and pumps within enclosure.

.6 Provide full-size stainless-steel ball valves. Valve lever to be operated in the upright position to prevent accidental closure.

2.7 HEATING, VENTILATION AND CONTROLS

.1 **Engine Ventilation System**

.1 Provide ventilation system for genset combustion air-cooling and enclosure ventilation as required, and shall include but not be limited to the following:

.1 Size free air area of louver openings on air intakes to eliminate any snow or rain entering enclosure during operating and non-operating genset conditions. Ensure that air velocities do not exceed CSA B139 requirements of 500fpm.

.2 Intake and Exhaust dampers to be Multi-Leaf, leak proof, Insulated, and opposed blade type, and to be as manufactured by "Tamco®" series 9000BF or approved

equivalent and shall include a frame having a thermal barrier in their construction. The Dampers to be installed in accordance with the manufacturer's installation guide.

.3 All damper actuators to be manufactured by Belimo and to be 24 V electric actuator with "Failsafe" spring return and manual operator.

.4 Ventilation system to be adequately sized for generator set cooling under rated full load conditions.

.5 Exhaust air damper assembly with Belimo 24Vdc two position, "Fail safe" actuator and silencer designed to meet noise criteria as specified elsewhere in this specification.

.6 Recirculating damper assembly with Belimo, 24Vdc modulating actuator.

.7 Provide position limit switches on all intake air dampers for connection to damper alarm panel, and connection to building automation system for remote monitoring.

.8 Provide Modulating thermostat and all required low voltage wiring in conduit as required for complete operation.

.9 Provide Damper alarm panel complete with controller and connections to damper actuators. This panel shall have a local horn, as well as output contacts for Intake Damper actuator failure to allow for connection to the Building automation system.

.10 The Dampers and actuators to be suitable for operation in a -40°C to 90°C range (-40 to 155°F)

.2 **Engine Ventilation System Operation Sequence**

.1 Commercial power available (generator is OFF):

.1 Air intake Dampers and air exhaust Dampers are CLOSED.

.2 Recirc dampers are OPEN

.3 When the enclosure indoor ambient temperature falls below temperature thermostat's setting, space heater shall start and maintain space temperature.

.4 When enclosure ambient temperature is above temperature thermostat's setting, the heater shall shut-off, and enclosure ventilation fan shall run to maintain space temperature.

.2 Commercial power disrupted (generator starts)

.1 Upon commercial power failure signal from Automatic Transfer Switch and engine start, motorized intake and exhaust dampers move to their normal "fail safe" position within 30 seconds.

.2 During engine operation, recirc air dampers shall modulate according to modulating thermostat, engine temperature sensor and enclosure ambient temperature.

.3 **Ventilation Air Silencers**

.1 Ventilation silencers to be factory manufactured of galvanized steel to ASHRAE and SMACNA standards. Silencers to consist of outer casing and galvanized steel inner casing with clean cut circular perforations to enclose acoustic media. Inner casing to have pods running full length of silencer where any cross-sectional dimension exceeds 18" (450 mm). Protect media from corrosion with glass fibre cloth between media and perforated metal. Performance to meet genset enclosure specified noise criteria. Acceptable manufacturers are Vibro-Acoustics and Kinetics Noise Control Inc.

.4 **Actuators**

.1 All dampers to be equipped with 24 Vdc "**Belimo®**" "EF series" actuators.

.5 **Space Heaters**

.1 Thermostatically controlled 120 or 208Vac space heaters to be sized, supplied, and installed within the enclosure and to be sized to maintain 10°C indoor ambient temperature.

.2 Unit Heaters:

.1 Thermostatically controlled force air industrial heaters to allow easy genset starting.

.2 Maintain indoor enclosure temperature no less than 10°C with outside ambient temperature as low as minus 40°C.

.3 Install in suitable location affixed to wall or ceiling with suitable bracket supports.

.4 Thermostat to include alarm contacts and connections to control panel to annunciate a trouble signal in event of low temperature.

.3 Space heaters shall not operate when generator is running.

.6 **Enclosure Ventilation Exhaust fan**

.1 Provide separate ventilation system for the enclosure, which will be independent from the generator ventilations system, and shall include but not be limited to the following:

.1 Thermostatically controlled exhaust fan;

.2 Exhaust silencer;

.3 Room Thermostat;

.4 Interconnection with intake air dampers;

.5 All required accessories and wiring for a complete installation;

.2 The enclosure ventilation system to be sized and designed to operate independently, from the generator ventilation system. When the ambient temperature within the enclosure rises above the room thermostat's setpoint (adjustable), fan shall start and run continuously until setpoint is satisfied, then shut-off.

.3 Enclosure ventilation system shall not operate when the when generator is running.

2.8 EXHAUST SYSTEM AND SILENCERS

.1 The exhaust piping and components to be supplied as follow:

.1 Schedule 40, carbon steel;

.2 Carbon steel flanges, 150 Lbs. pattern

.3 steel hardware

.4 Double nut / lock arrangement to muffler flange

.5 Include all necessary hardware

.6 The piping to be installed with a 1% slope.

.7 Provide a 2" drainpipe from the exhaust muffler, extended to wall of enclosure, and terminated at floor level with a 2" drain valve, for easy service and access. Provide a drain container to recuperate the condensation

.2 The engine flexible piping shall not be welded to the piping.

.3 Engine exhaust system to be full factory installed within enclosure and shall consist of lengths of flexible stainless-steel exhaust pipe, flanges, mounting brackets, and exhaust silencers with drain plug and other required accessories. Size length of flexible piping for thermal expansion and engine vibration and to suit enclosure height restriction.

.4 **For type and performance of Exhaust Silencers refer to section 26 32 14 – POWER GENERATION DIESEL**

.5 Custom manufacture heavy duty steel exhaust flange to extend from silencer to roof thimble. Exhaust system exhausts out of enclosure roof through an insulated roof thimble designed for application and with weatherproof sealed prefabricated flashed roof curb. Thimble to be of heavy-duty galvanized steel corrosion resistant construction. Terminate exhaust pipe flange minimum 1500 mm (60") above roof line and top with required weatherproof stack termination.

.6 Exhaust stack design and materials of construction to be meet B139-15 standards.

.7 Maintain clearance to combustible and non-combustible materials per the requirements of CSA B139-15.

.8 Ensure that exhaust stack is positioned in location such that emissions do not become drawn into enclosure during operation. Weatherproof and seal openings in roof due to exhaust stack work.

.9 The exhaust outlet to be positioned in such a way that hot exhaust gas is mixed with the radiator's air flow to accelerate temperature cooling of exhaust. Provide additional lengths of exhaust piping supported on the roof of the enclosure as required.

.10 The exhaust silencers to be supplied taking in consideration:

.1 The admissible back pressure on engine exhaust stack

.2 The space available inside the enclosure

.3 The sound attenuation requirements

.11 Static tests

.1 The exhaust silencer to maintain a 3 PSI pressure during three (3) hours to confirm and validate tightness. The consultant to be advised three (3) days prior to beginning of tests. Provide copy of pressure test results to consultant.

2.9 THERMAL INSULATION OF EXHAUST SYSTEM

.1 The complete exhaust system within the enclosure to be insulated, including the silencer and connection to manifold.

.2 Accepted materials

.1 "**Firwin®**" high temperature ceramic fiber blanket to be used for the engine silencer.

.2 Interior exhaust piping to be insulated with minimum 75 mm (3") thick Rockwool type insulation suitable for application.

2.10 ELECTRICAL EQUIPMENT

.1 **Shore Power Panelboard:**

.1 Provide minimum 100A, 120/208V, 24-circuit shore power electrical panelboard on wall of enclosure. Panelboard to be factory prewired, with main breaker and branch breakers for feeding genset and enclosure components and accessories. Include three (3) additional spare 15A-1P breakers installed in panel. Connect all 120Vac circuits necessary for generator to operate, including, but not limited to:

.1 coolant heater;

.2 battery charger;

.3 Interior and exterior Lighting;

.4 Emergency Lighting with remote heads;

.5 Wiring for ancillary services, including receptacles, lights, and HVAC shall pre-wired prior to shipping to site.

.2 **Power Generation Diesel:**

.1 Provide diesel driven generator set within enclosure. Refer to Section 26 32 16 for specification and accessories. Coordinate and position all generator ancillary equipment within enclosure and ensure that enough space is provided for access and servicing. The generator and all accessories to be factory installed and internally wired at that the factory.

.3 **Automatic Transfer Switch**

.1 Provide Automatic Transfer Switch (ATS-2) within enclosure, as shown on the drawings. Refer to section 26 36 23 - Automatic Load Transfer Equipment for ATS specifications.

.2 ATS-2 including line and load connections within the enclosure to be factory installed and internally wired at that the factory.

.3 Ensure that conductors are properly isolated from the engine generator sets and that final connections are made with flexible couplers and with crimp type cable lugs at alternator box and mechanical lugs at the automatic transfer switch.

.4 **Load Bank Connection Box**

.1 Provide a CSA approved, Load bank connection box on the exterior of the enclosure, to allow for a resistive load bank to be connected. The connection box shall include, but not be limited to the following:

.1 Minimum NEMA 3R weatherproof steel construction, with corrosion resistant enamel finish of colour to match the enclosure;

.2 Camlock connections;

.3 Hinged gasketed door with 3-point latch and key lock with provisions for safety padlocks; key can only be removed when door is closed and locked;

.4 Provide cabling from the connection box and directly connected to the load bank breaker on the genset to be installed in conduit, and internally wired at the factory;

.5 Interior bussing to be tin plated copper bussing for cable tap off provisions;

.6 Provide engraved lamacoid nameplate and signage on enclosure with appropriate instructions regarding use; submit proposed scheme and nomenclature with shop drawings.

.5 **Provide emergency power off (EPO) station**

.1 Provide a momentary contact “Red mushroom head” emergency push button to be installed at each entrance door into the enclosure. Pushbutton to be minimum 38 mm (1-1/2") diameter mushroom head and recessed or semi-recessed in exterior wall of enclosure at each walk-in door. Lock operator to be keyed to Owner’s requirements.

.2 Connect all pushbuttons in series with a normally open engine running contact to assure engine starting sequence will take place, should one of the push button be manipulated while engine is at rest.

.3 Two (2) identical momentary contact type pushbuttons fitted with a finger guard, shall be supplied for each electric set and mounted:

.1 Two on the exterior of the generator enclosure. These buttons shall be protected against unforeseen or accidental operations with an STI 1100 lexan cover with integral horn.

.4 Provide "EMERGENCY POWER OFF" identification lettering. Review exact nomenclature with Consultant prior to ordering.

.6 **Lighting**

.1 Provide the following lighting provisions for the enclosure:

.1 Normal interior lighting provisions provided with use of LED type, weatherproof, impact resistant, totally enclosed vapourtite luminaries suitable for harsh and cold weather environments.

.2 Provide minimum 300 lux of average maintained illumination throughout enclosure, controlled by 3-way solid-state timer switch, with required features, or equivalent, compatible with system and luminaires.

.3 Emergency lighting to be CSA approved 24V dc battery system with 6W LED remote heads to provide minimum 50 lux illumination at the floor level along both sides of the enclosure paths of egress and shall operate for a minimum of 120 minute.

.4 Provide CSA approved AC/DC "Running Man" pictogram exit lights above all exit doors. Connect DC input to emergency lighting battery pack.

.5 Weatherproof and vandal proof LED luminaires complete with integral photocell to be provided above each entrance doorway.

.6 Provide weatherproof and vandal proof RED LED exterior strobe light and install on exterior wall above each door. Connect to genset control system with required relays/contacts to illuminate when genset is running.

.7 **Basic Electrical Materials and Methods**

.1 Provide the following provisions for the enclosure:

.1 Duplex convenience receptacles to be equal to Hubbell 5262 series, extra heavy duty, specification grade. Switches to be equal to Hubbell 1200 series, industrial grade with illuminated handles. Devices to be complete with stainless steel faceplates. Acceptable manufacturers are Hubbell, Eaton, Legrand, Cooper Wiring Division, and Leviton.

.2 Interior conduits to be EMT, surface mounted with compression fittings. Final connections to vibrating equipment such as motors and transformers to be liquid type flexible conduits with liquid type fittings.

.3 Ensure that all conduit connections to generator sets are made with liquid tight flexible conduits.

.4 Exterior surface mounted conduits to be of rigid galvanized steel. Exterior boxes to be weatherproof and corrosion resistant FS/FD type boxes.

.5 All electrical wiring inside the enclosure, whether power or controls to be made in EMT conduits. All EMT connectors to be steel. Zinc connectors are not accepted. Surface mounted boxes to be cast FS/FD type back boxes for all wiring devices.

.6 All electrical material installed inside the enclosure to be weatherproof.

.8 **Fire Detection**

.1 All fire detectors to be appropriate to operate in the operational environment and be compatible with units installed inside the building.

.2 Manual fire alarm pulls stations to be "ULC" approved and compatible with the manual units.

.3 Thermo-sensitive detector to have a fixed point at 190°C. The detector to be "ULC" approved and compatible with the base building thermal units.

.4 The detector network to operate on a two-wire circuit consisting of # 18 AWG run inside a metal conduit or a shielded pair of # 18 AWG if permitted by the local code.

.5 Installation to comply with requirements of the OESC and ULC S524.

.6 This fire detection system will be connected to the existing main building fire alarm control panel and will be considered an extension of the existing system. Terminated wiring in a junction box ready for connection by the installing contractor. Equipment and accessories to be installed and wired onsite by fire alarm contractor.

2.11 ANCILLARY EQUIPMENT

.1 Wiring for ancillary services, including receptacles, AC and DC Emergency lighting, 3 Way light switches, forced air space heater (sized to suit to maintain internal temperature to 10C when genset is not running) and HVAC to be pre-wired. Provide ESA Inspection prior to shipment to site.

.2 Exhaust fan for heat removal within the enclosure when generator is not running, wall mounted c/w thermostat. Provide technical data regarding number and size of exhaust fans required;

.3 Provide fire extinguishers of CO_2 type, minimum 10 pounds (4.5 kg), and mounted adjacent to each exit door; exact type of fire extinguisher to be as recommended by genset vendor.

.4 All auxiliary components installed inside the enclosure to be positioned in such a fashion that they are easily accessible for service and that space requirements are at a minimum. The final location of these components to be confirmed by the enclosure supplier and reviewed with the consultant.

2.12 FINISHES

.1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.

.2 Exposed metal surfaces to be cleaned, phosphate treated, primed, and finished in two coats of enamel.

.3 Colours:

.1 Enclosure exterior, including exhaust and inlet air hoods: coordinate with owner.

.2 Other ducts and racks: Grey.

2.13 EQUIPMENT IDENTIFICATION

.1 Identify electrical equipment with nameplates as follows:

.1 Nameplates: lamacoid, 3mm thick, matte black finish face, white core, lettering accurately aligned and engraved into core, mechanically attached with self-tapping screws.

.2 Sizes as follows:

Size 1	10mm x 50mm	1 Line	3mm High Letters
Size 2	12mm x 70mm	1 Line	5mm High Letters
Size 3	12mm x 70mm	2 Lines	3mm High Letters

Size 4	20mm x 90mm	1 Line	8mm High Letters
Size 5	20mm x 90mm	2 Lines	5mm High Letters

.2 Wording on nameplates and labels to be approved by the consultant prior to manufacture.

.3 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.

.4 Disconnects, starters and contactors: indicate equipment being controlled and voltage.

.5 Terminal cabinets and pull boxes: indicate system and voltage.

.6 Transformers: indicate capacity, primary and secondary voltages.

2.14 ACCEPTABLE PRODUCT AND ENCLOSURE MANUFACTURER:

.1 Cummins Eastern LP;

.2 Wajax;

.3 Toromont CAT;

.4 Paramount Power Systems;

3 EXECUTION

3.1 GENERAL:

.1 Prior to start of Work, prepare schedule of Work and submit to Consultant for review. Manufacturer/supplier to, upon successful factory witness testing of unit, arrange and coordinate delivery and transporting of unit to site.

.2 Coordinate controls work both at factory and on site and include for required interface work to equipment on site.

3.2 FACTORY ACCEPTANCE TESTS

.1 A damper arrangement shall be installed in the air flow output of the radiator to simulate a minimum of 0.5” in of water restriction. The test shall be performed at the maximum allowable external static pressure for an operation at 40 deg C ambiance. A calibrated manometer shall be used for proper adjustment of the damper. The specified back-pressure adjustment could be of a higher value if, for the installation on site, the restriction in the ventilation system is of a higher value and that the calculated SCFM will be enough for operation in the engine room in an ambient of 40°. The flow and restriction in inches of water shall be measured during the test to validate the data provided by the distributor at time of submittal of shop drawings.

.2 The shop tests shall be conducted in the presence of the consultant and the owner.

.3 There shall be a minimum of two (2) weeks notification prior the scheduled date of the tests. The tests shall only be carried after 100% readiness and completion of the work are confirmed by the manufacturer’s quality inspector, the consultant and the owner. A Factory acceptance test plan will be issued by the consultant to the manufacturer, prior to the test.

3.3 INSTALLATION OF WALK-IN ENCLOSURE

.1 Prior to start of work, review shop drawings of the enclosure, and co-ordinate exact weights, dimensions, installation requirements, wiring requirements, etc., such that the on-site installation fully accommodates the enclosure being installed. Submit applicable revised drawings to Consultant for review. Make necessary on-site revisions to accommodate genset after obtaining Consultant's approval.

.2 Co-ordinate on site installation and testing requirements.

.3 Prepare schedule of sequence of work and submit for Consultant's review.

.4 The final location for the set must be coordinated and confirmed on site prior to placement.

.5 Take delivery of Genset and enclosure, Transport/hoist into location on concrete pad as shown on the drawings.

.6 Secure enclosure in place on isolation pads as shown on the drawings to a concrete base by means of suitably sized high tensile strength steel anchor bolts. Ensure that the enclosure is plumb and level. Provide stainless steel shims as required.

.7 Engine will be shipped full of required coolant.

.8 Check the level of engine lubricating oil and add if required.

.9 **Provide incoming feeders into ATS-2 as shown on the drawings. Ensure that final connections are made with flexible couplers and with crimp type cable lugs.**

.10 Provide feeder as specified from the shore power panel to distribution panel within building as shown on the drawings. Ensure that conductors are properly isolated from the engine-generator sets and that final connections are made with flexible couplers and with crimp type cable lugs.

.11 **Provide feeder as specified from the ATS-1 feeder breaker on generator, to ATS-1 within building as shown on the drawings. Ensure that conductors are properly isolated from the engine-generator sets and that final connections are made with flexible couplers and with crimp type cable lugs.**

.12 Provide all control wiring from ATS-2, Generator control panel, and fire alarm devices within enclosure and connect to based building systems as shown on the drawings. Ensure that conductors are properly isolated from the engine-generator sets and that final connections are made with flexible couplers and with crimp type cable lugs.

.13 Provide all required low voltage relays, wiring in conduit and contactors from generator control panel to fire alarm system control panel for the common supervision and annunciation of "Generator Running", "Generator common Alarm".

.14 Check and test the starting battery assembly low voltage alarm and monitoring system. Adjust as required.

.15 Check and test operation of engine starting system, and jacket coolant heaters.

.16 Upon completion of installation of equipment, by the Contractor, the equipment manufacturers shall inspect the installation of each complete equipment assembly and

certify in writing to the Consultant the satisfactory installation and operations of same. Co-ordinate all work.

3.4 GROUNDING AND BONDING:

.1 Provide complete grounding and bonding conductor system in compliance with the Ontario Electrical Safety Code requirements, complete with ground bar in enclosure for common connection of grounding and bonding conductors from equipment and exterior ground rods or for connection to main building grounding system. Refer to drawings and Section entitled Grounding and Bonding for additional grounding requirements.

3.5 SITE ACCEPTANCE TESTS (SAT)

.1 Genset manufacturer to provide all consumables for generator installation test. Fuel for generator installation test shall be provided by this division.

.2 Provide the engine-generator set with fuel oil for the on-site testing as described above. The full load consumptions of the new generator are as follows:

.1 **New diesel generator = 35 Gal/hr (US).**

.2 **Provide fuel to top up tank after all site commissioning has been completed.**

.3 Onsite after installation inspection, testing, start-up, and verification to be integrated with genset testing, start-up, and verification work as specified in respective genset Sections. Genset manufacturer to Assist installing Contractor in installation of equipment and to inspect installation, test equipment, perform start-up and verify equipment. Coordinate work with Contractor. Document testing and results in reports signed by genset enclosure manufacturer's authorized technician. Submit copies of report to Consultant. Genset manufacturer to also:

.1 Be present to assist during SAT testing and commissioning.

.2 Perform testing at times reviewed with Consultant.

.3 Provide instructions on system operating and maintenance.

.4 Include for an inspection from the ESA as needed/required.

.4 Upon installation of the generator set and when it is ready to be load bank tested, under the direction and in the presence of the Consultant, genset suppliers and the owner, supervise the genset supplier's tests at the site on the engine-generator set. Be responsible for the installation of the load bank cabling and connection into the system. Supply authorized trained electricians to be present on site for the genset testing. The testing to be performed during off hours end weekends.

.5 For tendering purposes, the load bank tests shall include **one (1) four-hour period of continuous operation under load conditions** as directed by the owner and genset supplier.

.6 Tests to include:

.1 With 100% rated load, operate set for at least 4h, taking readings at 15m intervals, and record following:

.1 Time of reading;

.2 Running time;
.3 Ambient temp in °C;
.4 Lube oil pressure in kPa;
.5 Lube oil temp in °C;
.6 Engine coolant temp (inlet & outlet) in °C;
.7 Exhaust stack temp in °C;
.8 Alternator voltage: phase 1, 2, 3;
.9 Alternator current: phase 1, 2, 3;
.10 Power in kW;
.11 Frequency in Hz;
.12 Power Factor;
.13 Battery charger current in A;
.14 Battery voltage in V;

.2 After completion of 4h run, demonstrate following shut down devices and alarms:

.1 over cranking.
.2 Overspeed.
.3 High engine temp.
.4 Low lube oil pressure.
.5 Short circuit.
.6 Alternator overvoltage.
.7 Low battery voltage, or no battery charge.
.8 Manual remote emergency stop.
.9 High alternator temperature.

.3 Following 4h load test, install continuous strip chart recorders to record frequency and voltage variations, as well as vibration levels, during load switching procedures. Each load change shall be delayed until steady state conditions exist. Switching increments to include:

.1 No load to full load to no load;
.2 No load to 75% load to no load;
.3 No load to 50% load to no load;
.4 No load to 25% load to no load;
.5 25% load to full load to 25% load;
.6 50% load to full load to 50% load;
.7 75% load to full load to 75% load;

.7 Demonstrate low oil pressure and high engine temperature shutdown devices operation without subjecting engine to these excesses.

.8 Demonstrate:

.1 Proper operation of generator set within the enclosure;

.2 Proper operation of ventilation controls and alarms.

.9 Run engine through five-minute cool-down period, with no load applied, before being shut down.

.10 The testing to be performed to the satisfaction of the Project Manager and Owner upon completion of the load bank test, disconnect load bank and coil cables, which will be removed from site by the generator manufacturer.

.11 After successful Load bank testing, Under the direction and in the presence of the Consultant and the owner, supervise genset supplier's tests at the site on engine-generator set with **building load**, but before acceptance of same.

.12 Coordinate with the independent distribution system testing company to ensure that the engine-generator sets perform with the emergency power distribution system in accordance to the requirements of all applicable CSA Standards. Supply authorized trained electricians, controls contractor, and switchgear personnel to be present on site for the genset testing and commissioning. The testing to be performed during off hours and weekends. The licensed electrician to be present during all site testing to perform any required work to distribution system that may be affected by the testing. For tendering purposes, **the tests shall include one (1) period of two (2) hours continuous operation under building load conditions** as directed by the Consultant. The testing to be performed to the satisfaction of the Owner and Consultant, to show that genset performs to specified requirements.

.13 Demonstrate in the presence of the Owner and Consultant:

.1 Unit start, transfer to load, retransfer to normal power, unit shut down, on "Automatic" control.

.2 Unit start and shut down on "Manual" control.

.3 Unit start and transfer on "Test" control from ATS, and Automatic shutdown of engine on resumption of normal power;

.4 Unit start on "Engine start" from engine control panel.

.5 Operation of manual bypass switch.

.6 Operation of automatic alarms and shut down devices.

.7 That battery charger reverts to high rate charge after cranking.

.8 That all accessories and equipment installed in enclosure functions correctly.

.14 At end of test run, submit a sample of lubricating oil, retrieved from engine oil pan immediately following operation of generator set for a minimum of 1h, to an independent testing agency for analysis.

.1 Analysis to indicate presence of contaminants, such as alloys, fuel, coolant, etc., and degree of contamination of each type.

.2 Submit test results to Engineer for approval.

.3 Correct noted defects under warranty.

.4 Include test results in submittals, in accordance with Section 01 78 00 – Closeout Submittals.

.15 **TWO (2) SITE VISITS ARE REQUIRED FROM THE MANUFACTURER:**

.1 **1ST VISIT IS REQUIRED FOR LOAD BANK TESTING AND GENSET COMMISSIONING.**

.2 **2ND VISIT IS REQUIRED FOR ATS COMMISSIONING, BUILDING LOAD TEST, AND TRAINING.**

3.6 ARC FLASH AND SHORT-CIRCUIT AND PROTECTIVE DEVICE COORDINATION STUDY

.1 Additionally, refer to testing, coordination and arc flash requirements in Section entitled 26 05 73 – Power Systems Studies

3.7 TRAINING

.1 Following a separate training session on site, provide training for the Owner's maintenance and operating personnel, detailing operation and maintenance of the equipment provided. Allow for a minimum of a four (4) Hour session.

.1 Training date to be coordinated with facility Owner.

END OF SECTION 26 32 16

1 GENERAL

1.1 SUMMARY

.1 This section relates to materials and installation for automatic load transfer equipment which can monitor voltages and currents on all phases and overall power supply parameters, initiate cranking and shut down of standby generator units, manually and automatically transfer loads between two (2) power sources as per controller field adjustable parameters.

1.2 RELATED SECTIONS

.1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

.2 The equipment and related services to be provided shall comply with the following specifications, as modified herein:

.1 Section 26 05 00 – Electrical General Requirements

.2 Section 26 32 13 – Power Generation Diesel

.3 Section 26 32 16 - Walk-in Generator Enclosure.

1.3 REFERENCES AND STANDARDS

.1 Ontario Electrical Safety Code (OESC)

.2 Canadian Standards Association (CSA)

.1 CSA C22.2 No. 178.1: Requirements for Transfer Switches.

.2 CSA 282 -15: Emergency Electrical Power Supply for Buildings

.3 CSA C22.2 No. 5-16 (Molded Case Circuit Breakers)

.4 CSA 22.2 No. 5.2 – Moulded Case Switches

.3 ANSI C37.13/16 (Power Circuit Breakers)

.4 ANSI C37.17 (Trip Devices)

1.4 SUBMITTALS

.1 As soon as possible after the award of this contract the manufacturer to submit copies of detailed drawings, product data, material lists and specifications of equipment included in this contract for review. No fabrication to be started until drawings are reviewed and accepted by the Consultant. Customer name, customer location, project number and order number to be identify on transmittals.

.2 Product data shall include:

.1 equipment reviewed shop drawings;

.2 Detailed enclosure dimensioned plans, sections, and elevations.

.3 single line diagram;

.4 Schematic diagram

.5 Nameplate schedule

.6 Component list

.7 Conduit space locations within the assembly

.8 Assembly ratings including:

.1 Short-circuit rating

.2 Voltage

.3 Continuous current rating

.9 Major component ratings including:

.1 Voltage

.2 Continuous current rating

.3 Interrupting ratings

.10 Cable terminal sizes

.11 Product Data Sheets.

.12 Warranty

.13 Maintenance data in maintenance manuals

.14 component list;

.15 coordination study with short circuit ratings, voltage ratings, continuous current ratings and interrupt ratings;

.16 additional information requested by local governing authority or Consultant.

.3 Where applicable, the following additional information to be submitted to the Consultant:

.1 Busway connection

.2 Connection details between close-coupled assemblies

.3 Composite front view and plan view of close-coupled assemblies

1.5 QUALITY ASSURANCE

.1 Comply with all previously mentioned standards.

.2 Manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment to be provided demonstrating compliance with this request. Equipment to be also be CSA approved listed and labeled for ATS assemblies.

1.6 CLOSEOUT SUBMITTALS

.1 Include the following in Operation and Maintenance Manual instructions for unit supplied and not general description of units manufactured by supplier:

.1 Detailed instructions to permit effective operation, maintenance and repair.

.2 The following information to be submitted for record purposes:

.1 Final as-built drawings and information for items listed in section 1.04

.2 Wiring diagrams

.3 Illustrated parts lists with parts catalogue numbers;

.4 Certified production test reports

.5 Installation information

.6 Seismic certification (as applicable)

.2 The final (as-built) drawings shall include the same drawings as the construction drawings and shall incorporate all changes made during the manufacturing process.

1.7 STORAGE AND HANDLING

.1 Store and handle in strict compliance with manufacturer's instructions and recommendations. Protect from potential damage from weather and construction operations. Store so condensation will not form on or in the ATS housing and if necessary, apply temporary heat where required to obtain suitable service conditions.

.2 Handle equipment using proper equipment for lifting and handling, use when necessary lifting eye and/or brackets provided for that purpose.

.3 Protect equipment from weather and moisture by covering with heavy plastic or canvas and by maintaining heat within enclosure in accordance with manufacturer's instructions.

1.8 WARRANTY

.1 Provide warranty against defects in material and workmanship for period of twelve (12) months from date of commissioning or eighteen (18) months from shipping, whichever comes first.

.2 Maintain records of each automatic transfer switch and bypass isolation switch, by serial number, for a period of at least twenty (20) years.

1.9 MANUFACTURER'S REPRESENTATIVE

.1 Upon award of the contract the manufacturers of the Transfer Switches to appoint a manufacturer's representative who to be qualified in the design, installation, commissioning and maintenance of the equipment supplied.

.2 The manufacturer's representative to be available throughout the life of the contract and to be available on site for equipment delivery, site meetings, equipment installation, testing and commissioning, start-up and instruction of owner's staff.

.3 The manufacturer's representative to perform the following functions:

.1 review of equipment design with respect to specification requirements, required operation, code requirements, etc.;

.2 preparation and submission of shop drawings;

.3 design review with Consultants;

.4 response to questions by Owner, ESA, Consultants, Contractor and Sub Contractors;

.5 monitoring and reporting on manufacturing progress at site meetings;

.6 preparation of schedules;

.7 arrangement of factory tests including adequate notification of owner's witnesses;

.8 delivery arrangements;

.9 oversee unloading, hoisting and setting in place;

.10 oversee site assembly;

.11 co-ordinate external wiring arrangements and connections;

.12 providing advice as required to all parties involved with the equipment;

.13 assist in equipment commissioning;

.14 training and instruction of Owner's staff;

.15 preparation and submission of manuals;

1.10 SEQUENCE OF OPERATION OF ATS:

.1 Automatic transfer switch shall initiate signal to start generator under the following conditions:

.1 Voltage on any phase of normal source drops below 80% or rises above 120% of nominal;

.2 Frequency of normal source drops below 90% or rises above 110% of nominal;

.3 Voltage differential between phases is greater than 20%;

.4 Condition must persist for longer than programmed delay period.

.2 Automatic transfer switch shall transfer to “Emergency” power when generator has reached specified voltage and frequency on all phases.

.3 Following restoration and stabilization of normal power for longer than programmed delay period, automatic transfer switch shall return to “Normal” power.

.1 Switch shall automatically transfer to “Normal” power during this period in the event of failure of the emergency power source.

.4 Following transfer to normal power, automatic transfer switch shall provide signal to generator set to operate in a cool-down (no-load) mode for programmed period, following which, generator set to be signaled to shut down.

.5 Transfer load between two (2) power sources using bypass switching arrangements to provide a safe and convenient means of manually bypassing and isolating the automatic transfer switch, for maintenance and repair of the automatic transfer switch, and with the ability to be used as an emergency back-up system in the event of failure of the automatic transfer switch.

2 PRODUCTS

2.1 AUTOMATIC TRANSFER SWITCH ATS-1 (CONTACTOR TYPE)

.1 **GENERAL:**

.1 **ATS to be contactor type with manual bypass isolation switch.**

.2 **For ratings, refer to drawings.**

.3 Transfer switches to be OPEN TRANSITION type and provided with an in-phase monitor feature, which will permit a transfer or re-transfer between two live sources that have a phase angle difference of +/- 8 degrees or less. If the switch cannot transfer in-phase, the switch will default to a time delay in neutral transfer adjustable 0-120 seconds.

.4 Contactor Type Transfer Equipment to be CSA C22.2 No.178 compliant, including two (2) three-phase contactors mounted on common frame, in double throw arrangement, mechanically and electrically interlocked to prevent simultaneous closing, solenoid-operated.

.5 Switch and relay contacts, coils, spring and control elements accessible for inspection and maintenance from front of panel, without removal of switch panel or disconnection of drive linkages and power conductors.

.6 The transfer switch to be rated for application with upstream power circuit breakers and insulated case circuit breakers having short-time delay settings of up to 30 cycles. Contacts shall not weld when used with upstream overcurrent protective devices that do not incorporate instantaneous trip units.

.7 Transfer switches to be of withstand current ratings meeting available short circuit currents at location of each transfer switch as determined by electrical distribution system coordination study prepared as part of scope of Work. If at time of pricing such information is not identified in issued documents, allow in pricing for transfer cycle rating of 50kA symmetrical for 3 cycles @ 208V or as determined by coordination study, with a peak of 200kA when coordinated with current-limiting fuses.

.8 Transfer switch to be 100% equipment rated for continuous duty, 24 hours per day, 365 days per year and operate satisfactorily on electrical system as shown on drawings.

.9 The switching panel to consist of completely enclosed contact assemblies and a separate control logic panel. Control power for all transfer operations to be derived from the line side of the source to which the load is being transferred.

.10 On transfer switches requiring a fourth pole for switching the neutral as noted on the drawings, the neutral to be fully rated with equal withstand, closing and interrupting ratings to the power poles. Switched neutral poles which are add-on or overlap, or that are not capable of breaking full rated load current are not acceptable.

.11 If neutral is not switched as noted on the drawings, provide solid neutral bar, rated for full ampacity of transfer switch, where solid neutral is required.

.12 The automatic transfer switch and the bypass isolation switch sections to be interconnected with copper bus or cable.

.2 **ENCLOSURE:**

.1 Entire enclosure to be in accordance with minimum NEMA 2 requirements, and with additional sprinkler protection requirements. Provide a "drip shield" designed to shed water without dripping on cell. Enclosure to be designed to prevent penetration of water spray from activated sprinklers onto live components. Doors and component openings to be gasketed. Conduit/cable entries to be either from the bottom or top, and to be sealed watertight.

.2 To consist of self-contained, self-supporting structure with necessary facilities for proper ventilation. To be of welded or bolted construction, fabricated from sheet steel in accordance with NEMA and CSA requirements and reinforced wherever necessary to provide adequate strength.

.3 Fabricated from 12-guage steel.

.4 Front doors are formed type, fabricated with cold rolled sheet steel and complete with handle lock operators and locking tabs.

.5 Components and accessories typically removable from front for ease of service; pilot lights, selector switches and other controls typically mounted on “front” door of enclosure; ATS connections typically made from front;

.6 All exterior and interior steel surfaces of the ATS to be properly cleaned and provided with a rust-inhibiting phosphatized coating. Color and finish to be ANSA 61 light grey.

.3 **TRANSFER SWITCH:**

.1 ATS is double throw, operated by a single solenoid mechanism momentarily energized;

.2 Each transfer switch to be positively interlocked both mechanically and electrically to prevent simultaneous closing of both sources under either automatic or manual operation. Main contacts to be mechanically locked in both normal and emergency positions. A neutral position shall not be possible under normal electrical operation unless a delayed transition is required.

.3 Switch is positively locked mechanically on either source without hooks, latches, springs, etc.;

.4 Failure of any coil or part does not permit a neutral position;

.5 All main contacts to be silver composition. Switches to have segmented, blow-on construction for high withstand and close-on capability and be protected by separate arcing contacts.

.6 ATS provided with full protection to initiate transfer of load to generator power supply when voltage of normal power supply drops to 90% on any phase and re-transfers it to normal power when supply is restored to 90% in all phases as described above; voltage sensing relays have close differential of 2%, with independent adjustable pick up and drop out features;

.7 Provide source selector switch internal to the ATS. Normal power supply from the utility or main switchboard is construed as preferred power source.

.8 Switch capable to communicate via Ethernet or other protocol compatible with BAS.

.4 **BYPASS ISOLATION SWITCH**

.1 Two-way bypass isolation switch to allow automatic transfer switch to be manually bypassed and permit isolation of ATS (maintenance) from all sources of power and control without opening enclosure door and without disconnection of load power conductors. Bypass to load-carrying source accomplished with no interruption of power to load (make before break contacts);

.2 The bypass transfer switch shall have current, voltage, and withstand ratings equal to the interconnected automatic transfer switch.

.3 Transfer to bypass to be a manually initiated no-load break type transfer.

.4 Capable of isolating or bypassing the automatic transfer switch regardless of the position of the automatic transfer switch.

.5 Mechanical interlock to prevent any occurrence of short circuit while operating bypass isolation switch.

.6 Separate bypass and isolation handles utilized to provide clear distinction between functions; handles permanently affixed and operable without enclosure door;

.7 Main contacts manually driven;

.8 Power interconnections are silver-plated copper bus bar; only field installed power connections to be at service and load terminals of bypass-isolation switch;

.9 Control inter-wiring provided with disconnect plug type terminations;

.10 Bypass handle three operating modes, as follow:

.1 Bypass to normal;

.2 Automatic;

.3 Bypass to emergency.

.11 Operating speed of bypass contacts same as associated transfer switch and be independent of speed at which manual handle is operated;

.12 In ‘automatic’ mode, bypass contacts out of power circuit so that they will not be subjected to fault currents to which system may be subjected;

.13 Isolation handle three operating modes, as follow:

.1 Closed

.2 Open

.3 Test

.14 ‘Test’ mode permits testing of entire emergency power system, including ATSs with no interruption of power to load.

.15 'Open' mode completely isolates ATS from all sources and load power conductors; when in 'open' mode it is possible to completely withdraw ATS for inspection or maintenance to conform to code requirements without removal of power conductors or use of any tools;

.16 When isolation switch is in 'test' or 'open' mode, bypass switch functions as manual transfer switch.

.5 **CONTROL AND MONITORING FEATURES:**

.1 Microprocessor based ATS controller, which contain all voltage and frequency sensing, timing functions and metering, to control the operation of the transfer switch. All sensing and logic to be controlled by an onboard microprocessor for maximum reliability and minimum maintenance. The logic controller to be connected to the transfer switch by and interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the control panel to be disconnect from the transfer switch for routine maintenance.

.2 3-level security password system for ATS controller software program to access all programming functions; specific password levels provided for "read only", "read/write" and "master"; all programming set points for voltage, frequency and time delays are software programmable from front panel mounted keypad and all parameters displayed in alphanumeric format;

.3 Door mounted operator interface liquid crystal display (LCD) for ATS controller; LCD displays following:

.1 System time

.2 Transfer switch position

.3 Utility supply metering – 3-phase voltage and frequency

.4 Generator supply metering – 3-phase voltage and frequency

.5 Timer countdown display

.6 Test mode operation indication.

.4 Three-phase under voltage sensing for both utility and generator supplies; under voltage sensing function programmable as follows:

.1 Under voltage pick-up 70-100% of nominal, factory set at 90%

.2 Under voltage dropout 70-100% of nominal, factory set at 90%

.3 Under voltage delay 0-10 seconds, factory set at 1 second.

.5 Frequency sensing for generator supply to permit load transfer to generator supply if within nominal limits; generator frequency sensing function programmable, as follows:

.1 Under frequency 50–60.0 HZ, factory set at 57.0 HZ

.2 Under frequency time delay 0-10 seconds, factory set at 5 seconds

.3 Over frequency 60.0-70.0 HZ, factory set at 63.0 HZ

.4 Over frequency time delay 0-10 seconds, factory set at 5 seconds.

.6 The following Time Delay features to be supplied:

.1 Time delay on engine start to delay engine start signal after failure of utility source; time delay programmable, 0-120 seconds, factory set at 1 seconds;

.2 Time delay for engine warm-up, which permits transfer to generator supply after generator voltage and frequency exceed acceptable limits; time delay programmable 0-1800 seconds, factory set at 2 seconds;

.3 Time delay for retransfer to utility, which permits transfer to utility supply only after stable voltage conditions exist for specified time period; time delay programmable 0-30 minutes, factory set at 2 minutes;

.4 Time delay for engine cool down, which delays engine stop signal after load has retransferred to utility source until time delay period expires; time delay programmable, 0-30 minutes, factory set at 2 minutes;

.5 All delays to be field adjustable from the microprocessor-based controller without the use of special tools.

.7 Automatic exercise time function, for generator testing; 24 hour, 7-day, single occurrence programmable time clock; time clock programmable for test start and stop times (i.e. “day of week”, “hour of day”, and “minute of day”, and type of test (e.g. “on load” or “off load”);

.8 Control logic for immediate transfer to utility supply (if within acceptable limits) should generator set fail during any activated test mode.

.9 Diagnostic indicating light’s on ATS controller to allow simple visual indication of ATS operating conditions; individual lights provided for following functions:

.1 CPU running;

.2 Transfer to Utility supply signal initiated;

.3 Transfer to Generator supply signal initiated;

.4 Engine start signal initiated.

.10 ATS controller with a lamp test function to test all indicating lights and LCD display.

.11 Provision for operator-initiated Four-function test switch, on door of ATS; ATS positions provide following control functions:

.1 AUTO - Genset automatically operates during utility power failure condition as per sequence of operation.

.2 ENGINE START - Genset immediately starts and operates unloaded. Note: load automatically transfers to genset should a utility power failure condition occur.

.3 TEST - Genset immediately starts and transfers load upon expiration of warm-up time delay. Note: transfer switch automatically retransfers load back to utility supply should genset set fail on load.

.4 OFF - Genset disabled from automatic starting due to a utility power fail condition.

.12 Load Disconnected Contact -- Control logic to signal external load (e.g. elevator) of impending transfer to and from generator supply; output contact rated 10A, 230VAC resistive, closes prior to a transfer and remains closed until transfer is completed and post-transfer delay time expires; pre-transfer delay function provided, programmable 0-30 seconds, factory set at 10 seconds; post-transfer delay function provided, programmable 0-30 seconds, factory set at 10 seconds;

.13 Over-Voltage Sensing – Three-phase over-voltage sensing for both utility and generator supplies; voltage sensing function programmable as follows:

.1 Over-voltage pickup 100-130% of nominal, factory set at 110%;

.2 Over-voltage dropout 100-130% of nominal, factory set at 108%;

.3 Over-voltage time delay 0-10 seconds, factory set at 5 seconds;

.14 Utility Frequency Sensing – Frequency sensing for utility supply to permit load transfer to utility supply if within acceptable limits; utility frequency sensing programmable as follows:

.1 Under frequency 50.0-60.0 HZ, factory set at 57.0 HZ;

.2 Under frequency time delay 0-10 seconds, factory set at 5 seconds;

.3 Over frequency 60.0-70.0 HZ, factory set at 63.0 HZ;

.4 Over frequency time delay 0-10 seconds, factory set at 5 seconds;

.15 The following contacts to be provided with transfer switch:

.1 volt-free, 2 N.O. and 2 N.C. auxiliary contacts for remote indication of position of transfer switch.

.2 One (1) Form C contact for closure of the Generator start circuit. The contacts to be of silver alloy with gold flashing. The contacts to be rated for 5-Amp at 250-Vac and 5-Amp at 30-Vdc.

.3 One (1) Form C contact for PRE-TRANSFER SIGNAL. The contacts to be rated for 10-Amp at 250-Vac and 10-Amp at 30-Vdc. {Option 35A}

.4 One (1) Form C contact for ALARM SIGNAL. The contacts to be rated for 10-Amp at 250-Vac and 10-Amp at 30-Vdc {80a}

.5 Utility Power Available Contacts – Auxiliary contacts which operate when utility power is available; two spare auxiliary contacts supplied with rating of 10 A, 230 VAC resistive Form-C;

.6 Generator Power Available Contacts – Auxiliary contacts which operate when generator power is available; two spare auxiliary contacts supplied with rating of 10A, 230 VAC resistive Form-C;

.7 Fail to Transfer Contacts – Auxiliary contacts, which activate when transfer switch mechanism fails to operate within specified time delay; time delay programmable 0-60 seconds, factory set at 15 seconds; two spare auxiliary contacts supplied with rating of 10 A, 230 VAC resistive Form-C;

.8 Phase Balance Relay – A phase balance relay to protect connected motors in system against unbalanced supply voltages caused by "single phasing condition" (e.g. one fuse blown on a 3-phase supply); when unbalanced condition occurs on utility supply, system initiates transfer to generator supply;

.16 Transfer switch control power obtained from source being transferred to. controls do not require any connection to external power sources;

.17 Control circuit isolation plug, which isolates all control circuitry inside ATS to facilitate maintenance procedures; when isolated, there is not to be voltage present on control circuitry;

.18 Provide single-line graphic on door with signal lamps to indicate position of transfer switch;

.6 **INTEGRATED LOAD SIDE METERING:**

.1 Provide digital metering for ATS controller with an accuracy of +1% for all voltage and frequency readings; frequency displayed to at least one decimal; three-phase line-to-line voltages displayed for both generator and utility supplies.

.2 Digital metering system to follow ANSI C12.20 Class 0.2%, to provide complete electrical metering with waveform display and embedded WEB server. System measures and displays voltage, current, frequency and time, and calculates and displays kW, KWh, KW demand, ampere demand, kVA, kVA demand, kVAr, kVArh and individual current and voltage harmonics.

.3 Graphical backlit LCD display is provided on unit. Unit includes inputs/outputs, contacts, RS485/MODBUS/TCP/IP Ethernet interfaces as required for communications to remote monitoring terminal or printer or BAS. Suitable current transformers, potential transformers and control wiring to be provided. Include custom clear acrylic, hinged locking cover over each unit. Review exact requirements with Consultant prior to ordering.

.4 Current Transformers:

.1 Current transformers (CTs) have ratios to suit application, a mechanical rating equal to momentary rating of circuit breakers and be insulated for full voltage rating of ATS.

.7 **NAMEPLATES:**

.1 Engraved nameplates, mounted on the face of the assembly, to be furnished as indicated on the drawings. Nameplates to be laminated plastic, black characters on white background. Characters to be 3/16-inch high, minimum. Nameplates shall give item designation and circuit number as well as frame ampere size and appropriate trip rating. Furnish master nameplate giving ATS designation, voltage ampere rating, short-circuit rating, manufacturer's name, general order number, and item number.

.2 Each nameplate to be sized to suit equipment for which it is provided and required wording. Confirm exact nomenclature, sizing, print type and colour scheme on shop drawings, for approval by Owner and Consultant.

.3 Warning signs to be lamacoid type with nomenclature confirmed with and approved by local governing electrical utility and reviewed with Consultant.

.4 Refer to specification section 26 05 53 - Identification for Electrical Systems for further details and requirements.

2.2 ACCEPTABLE MANUFACTURERS

.1 Schneider Electric / Asco Power Technologies (7000 series)

.2 Eaton (Contactor-Based Bypass Isolation Transfer Switches)

2.3 OPERATION AND MAINTENANCE MANUALS

.1 Manuals for transfer switches to be bound together in a 3-ring binder. Manuals, material lists, and test reports shall either be typed, ink printed documents, or laminated high quality reproductions. Each manual shall contain a Table of Contents and the following information:

.1 Project name and location

.2 ATS number and/or name and assemblies.

.3 Manufacturer's shop order number

.4 Issue date.

.5 Revisions including designation, date, condensed summary of changes, and reason for revision.

.6 Bill of material (equipment summaries);

.7 Protective device test set;

.8 Control switches;

.9 Pilot lights and lamps;

.10 Control power transfer equipment;

.11 Control power transformer;

.12 Metering/monitoring equipment;

.13 Secondary cable lugs;

.2 **If the ATS is being provided as part of a skin-tight or walk-in enclosure package, then the ATS operation and maintenance data, will be supplied with the enclosure Operation and Maintenance Manual.**

2.4 AUTOMATIC TRANSFER SWITCH ATS-2 (BREAKER TYPE)

.1 **GENERAL:**

.1 **ATS TO BE LOW VOLTAGE STORED ENERGY POWER CIRCUIT BREAKER TYPE AUTOMATIC TRANSFER SWITCH.**

.2 **Refer to drawings for ratings.**

.3 Transfer switches to be OPEN TRANSITION type and provided with an in-phase monitor feature, which will permit a transfer or re-transfer between two live sources that have a phase angle difference of +/- 8 degrees or less. If the switch cannot transfer in-phase, the switch will default to a time delay in neutral transfer adjustable 0-120 seconds.

.4 Transfer switches applied in service entrance equipment applications provide power circuit breakers with electronic trip units c/w LSIG field adjustable settings. Where shown on the drawings, transfer switches applied as service entrance equipment, to be provided with over-current trip units and a service entrance label. A key-operated selector switch to be provided to disconnect the power supplies. Indicators to be provided to show the availability of each source as well as breakers in a disconnected position. Provide a neutral disconnect link for three-pole solid neutral switches, and a neutral-to-ground main bonding jumper for all switches to meet UL service entrance requirements. Ground fault protection to be provided for all switches (breakers) rated 1000 amperes or more applied.

.5 The transfer switch to be rated for application with upstream power circuit breakers and insulated case circuit breakers having short-time delay settings of up to 30 cycles. Contacts shall not weld when used with upstream overcurrent protective devices that do not incorporate instantaneous trip units.

.6 Transfer switches to be of withstand current ratings meeting available short circuit currents at location of each transfer switch as determined by electrical distribution system coordination study prepared as part of scope of Work. If at time of pricing such information is not identified in issued documents, allow in pricing for transfer cycle rating of 50kA symmetrical for 3 cycles @ 208V or as determined by coordination study, with a peak of 200kA when coordinated with current-limiting fuses.

.7 Transfer switch to be 100% equipment rated for continuous duty, 24 hours per day, 365 days per year and operate satisfactorily on electrical system as shown on drawings.

.8 The switching panel to consist of completely enclosed contact assemblies and a separate control logic panel. Control power for all transfer operations to be derived from the line side of the source to which the load is being transferred.

.9 The transfer switch to be mechanically interlocked to prevent cross connection of sources when operated either automatically, or manually.

.10 Transfer switches to be capable of being operated manually under full rated load conditions. Manual operation to be accomplished by a permanently attached manual operator, or by integrally mounted pushbuttons. Removable manual operating handles and handles that may move in the event of an electrical operation during the manual operation, are not acceptable. Manual operators requiring source or load disconnection prior to manual operation are not acceptable.

.11 On transfer switches requiring a fourth pole for switching the neutral, the neutral to be fully rated with equal withstand, closing and interrupting ratings to the power poles. Switched neutral poles which are add-on or overlap, or that are not capable of breaking full rated load current are not acceptable.

.2 **ENCLOSURE:**

.1 Entire enclosure to be in accordance with minimum NEMA 3R requirements, and with additional sprinkler protection requirements. Provide a "drip shield" designed to shed water without dripping on cell. Enclosure to be designed to prevent penetration of water spray from activated sprinklers onto live components. Doors and component openings to be gasketed. Conduit entries to be sealed watertight.

.2 To consist of self-contained, self-supporting structure with necessary facilities for proper ventilation. To be of welded or bolted construction, fabricated from sheet steel in accordance with NEMA and CSA requirements and reinforced wherever necessary to provide adequate strength.

.3 Fabricated from 12-guage steel.

.4 Components and accessories typically removable from front for ease of service; pilot lights, selector switches and other controls typically mounted on “front” door of enclosure; ATS connections typically made from front;

.5 **ATS to be designed for front accessibility with FIXED mounted Power breakers.**

.6 Front doors are formed type, fabricated with cold rolled sheet steel and complete with handle lock operators and locking tabs.

.7 All exterior and interior steel surfaces of the ATS to be properly cleaned and provided with a rust-inhibiting phosphatized coating. Color and finish to be ANSA 61 light gray.

.3 **TRANSFER SWITCH:**

.1 **ATS to be double throw, LOW VOLTAGE STORED ENERGY POWER CIRCUIT BREAKER TYPE AUTOMATIC TRANSFER SWITCH.**

.2 Each transfer switch to be positively interlocked both mechanically and electrically to prevent simultaneous closing of both sources under either automatic or manual operation. Main contacts to be mechanically locked in both normal and emergency positions. A neutral position shall not be possible under normal electrical operation unless a delayed transition is required.

.3 Failure of any coil or part does not permit a neutral position;

.4 Switch is positively locked mechanically on either source without hooks, latches, springs, etc.;

.5 Main contacts are silver surfaced and protected by arcing contacts and arc barriers;

.6 ATS provided with full protection to initiate transfer of load to generator power supply when voltage of normal power supply drops to 90% on any phase and re-transfers it to normal power when supply is restored to 90% in all phases as described above; voltage sensing relays have close differential of 2%, with independent adjustable pick up and drop out features;

.7 Provide source selector switch internal to the ATS. Normal power supply from the utility or main switchboard is construed as preferred power source.

.8 Switch includes magnetic blow-out coil;

.9 Switch capable to communicate via Ethernet or other protocol compatible with BAS.

.10 **CIRCUIT BREAKERS:**

.1 Power circuit breakers, with electrically operated, stored energy, fixed mounted breaker assembly mounted behind a full-sized flanged type heavy gauge steel panel and a nameplate giving breaker rating. Where current limiting is required for greater interrupting rating to suit specific application, provide air circuit breakers with integral current limiting fuses as per manufacturer's standards.

.2 Breaker assembly consists of an operating mechanism, 3-pole units, and a solid-state adjustable tripping unit. Operating mechanism provides 2-step stored energy closing. One stroke of operating handle charges spring, after which breaker may be closed by pushing a button. A tripping button and a breaker position indicator are provided. Breaker has facilities for padlocking in open position.

.3 Breakers are complete with microprocessor based solid state tripping unit having adjustable tripping functions including but not limited to, long time pick-up, long time delay, short time pick-up, short time delay; instantaneous pick-up; ground fault pick-up; and ground fault delay. Trip settings are to be as determined by distribution system testing and coordination study. Include for trip units and settings as required to provide coordinated protective devices throughout electrical distribution system as required by local governing electrical code and authorities.

.4 Tripping unit includes three sensors, one on each phase conductor, arranged such that a trip signal from any sensor opens all three poles of breaker.

.5 Trip unit includes LED indication of mode and trip and a display panel indicating protection function settings and system data. Unit is continuously self-checking and monitoring. Complete system selective coordination is provided with individually adjustable time/current shaping solid state elements. Unit is with auxiliary power module for power source. Trip unit includes energy monitoring and display of peak demand, present demand and energy consumption.

.6 Actuator mechanically trips breaker when a tripping pulse is emitted by trip unit. When solid-state unit does not have an instantaneous tripping element, it has a discriminator feature to provide instantaneous tripping only when breaker is being closed into a fault. Trip unit includes test plug terminals to permit convenient field checking of calibration, and is equipped with long, short, instantaneous, time delay, ground fault functions and ground tripping indication determined and required to suit distribution system testing and coordination study.

.7 Control wiring for connections to breakers to run outside of breaker cell to greatest extent possible. Where running of control wiring is necessary within breaker cubicle, bundle conductors and mechanically secure away from breaker and draw-out mechanisms.

.8 Breakers to be provided with 120 V fused secondary control circuit transformer for breaker closing and tripping current.

.9 Provide shunt trip operators, as required.

.10 Provide electrically operated breaker pushbuttons, manual trip button, breaker position indicators, breaker 'open/close' lamps, and "push to test" lights. Breaker open operators to be equipped with safety cover to prevent in advertent operation.

.11 Emergency charging handle provided for manual charging if control power is lost. A manual closing lever is included to permit closing circuit breaker with compartment door closed.

.12 Accessories supplied with breakers consist of manufacturer standard items, including three spare fuses of each type. Control fuses are form II HRC types.

.4 **BYPASS ISOLATION SWITCH**

.1 Two-way bypass isolation switch to allow automatic transfer switch to be manually bypassed and permit isolation of ATS (maintenance) from all sources of power and control without opening enclosure door and without disconnection of load power conductors. Bypass to load-carrying source accomplished with no interruption of power to load (make before break contacts);

.2 The bypass transfer switch shall have current, voltage, and withstand ratings equal to the interconnected automatic transfer switch.

.3 Transfer to bypass to be a manually initiated no-load break type transfer.

.4 Capable of isolating or bypassing the automatic transfer switch regardless of the position of the automatic transfer switch.

.5 Mechanical interlock to prevent any occurrence of short circuit while operating bypass isolation switch.

.6 Separate bypass and isolation handles utilized to provide clear distinction between functions; handles permanently affixed and operable without enclosure door;

.7 Main contacts manually driven;

.8 Power interconnections are silver-plated copper bus bar; only field installed power connections to be at service and load terminals of bypass-isolation switch;

.9 Control inter-wiring provided with disconnect plug type terminations;

.10 Bypass handle three operating modes, as follow:

.1 Bypass to normal;

.2 Automatic;

.3 Bypass to emergency.

.11 Operating speed of bypass contacts same as associated transfer switch and be independent of speed at which manual handle is operated;

.12 In ‘automatic’ mode, bypass contacts out of power circuit so that they will not be subjected to fault currents to which system may be subjected;

.13 Isolation handle three operating modes, as follow:

.1 Closed

.2 Open

.3 Test

.14 'Test' mode permits testing of entire emergency power system, including ATSs with no interruption of power to load.

.15 'Open' mode completely isolates ATS from all sources and load power conductors; when in 'open' mode it is possible to completely withdraw ATS for inspection or maintenance to conform to code requirements without removal of power conductors or use of any tools;

.16 When isolation switch is in 'test' or 'open' mode, bypass switch functions as manual transfer switch.

.5 **CONTROL AND MONITORING FEATURES:**

.1 Microprocessor based ATS controller, which contain all voltage and frequency sensing, timing functions and metering, to control the operation of the transfer switch. All sensing and logic to be controlled by an onboard microprocessor for maximum reliability and minimum maintenance. The logic controller to be connected to the transfer switch by and interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the control panel to be disconnect from the transfer switch for routine maintenance.

.2 3-level security password system for ATS controller software program to access all programming functions; specific password levels provided for "read only", "read/write" and "master"; all programming set points for voltage, frequency and time delays are software programmable from front panel mounted keypad and all parameters displayed in alphanumeric format;

.3 Door mounted operator interface liquid crystal display (LCD) for ATS controller; LCD displays following:

.1 System time

.2 Transfer switch position

.3 Utility supply metering – 3-phase voltage and frequency

.4 Generator supply metering – 3-phase voltage and frequency

.5 Timer countdown display

.6 Test mode operation indication.

.4 Three-phase under voltage sensing for both utility and generator supplies; under voltage sensing function programmable as follows:

.1 Under voltage pick-up 70-100% of nominal, factory set at 90%

.2 Under voltage dropout 70-100% of nominal, factory set at 80%

.3 Under voltage delay 0-10 seconds, factory set at 1 second.

.5 Frequency sensing for generator supply to permit load transfer to generator supply if within nominal limits; generator frequency sensing function programmable, as follows:

.1 Under frequency 50–60.0 HZ, factory set at 57.0 HZ

.2 Under frequency time delay 0-10 seconds, factory set at 5 seconds

.3 Over frequency 60.0-70.0 HZ, factory set at 63.0 HZ

.4 Over frequency time delay 0-10 seconds, factory set at 5 seconds.

.6 The following Time Delay features to be supplied:

.1 Time delay on engine start to delay engine start signal after failure of utility source; time delay programmable, 0-120 seconds, factory set at 1 seconds;

.2 Time delay for engine warm-up, which permits transfer to generator supply after generator voltage and frequency exceed acceptable limits; time delay programmable 0-1800 seconds, factory set at 2 seconds;

.3 Time delay for retransfer to utility, which permits transfer to utility supply only after stable voltage conditions exist for specified time period; time delay programmable 0-30 minutes, factory set at 2 minutes;

.4 Time delay for engine cool down, which delays engine stop signal after load has retransferred to utility source until time delay period expires; time delay programmable, 0-30 minutes, factory set at 2 minutes;

.5 All delays to be field adjustable from the microprocessor-based controller without the use of special tools.

.7 Automatic exercise time function, for generator testing; 24 hour, 7-day, single occurrence programmable time clock; time clock programmable for test start and stop times (i.e. “day of week”, “hour of day”, and “minute of day”, and type of test (e.g. “on load” or “off load”);

.8 Control logic for immediate transfer to utility supply (if within acceptable limits) should generator set fail during any activated test mode.

.9 Diagnostic indicating light’s on ATS controller to allow simple visual indication of ATS operating conditions; individual lights provided for following functions:

.1 CPU running;

.2 Transfer to Utility supply signal initiated;

.3 Transfer to Generator supply signal initiated;

.4 Engine start signal initiated.

.10 ATS controller with a lamp test function to test all indicating lights and LCD display.

.11 Provision for operator-initiated Four-function test switch, on door of ATS; ATS positions provide following control functions:

.1 AUTO - Genset automatically operates during utility power failure condition as per sequence of operation.

.2 ENGINE START - Genset immediately starts and operates unloaded. Note: load automatically transfers to genset should a utility power failure condition occur.

.3 TEST - Genset immediately starts and transfers load upon expiration of warm-up time delay. Note: transfer switch automatically retransfers load back to utility supply should genset set fail on load.

.4 OFF - Genset disabled from automatic starting due to a utility power fail condition.

.12 Load Disconnected Contact -- Control logic to signal external load (e.g. elevator) of impending transfer to and from generator supply; output contact rated 10A, 230VAC resistive, closes prior to a transfer and remains closed until transfer is completed and post-transfer delay time expires; pre-transfer delay function provided, programmable 0-30 seconds, factory set at 10 seconds; post-transfer delay function provided, programmable 0-30 seconds, factory set at 10 seconds;

.13 Over-Voltage Sensing – Three-phase over-voltage sensing for both utility and generator supplies; voltage sensing function programmable as follows:

.1 Over-voltage pickup 100-130% of nominal, factory set at 110%;

.2 Over-voltage dropout 100-130% of nominal, factory set at 108%;

.3 Over-voltage time delay 0-10 seconds, factory set at 5 seconds;

.14 Utility Frequency Sensing – Frequency sensing for utility supply to permit load transfer to utility supply if within acceptable limits; utility frequency sensing programmable as follows:

.1 Under frequency 50.0-60.0 HZ, factory set at 57.0 HZ;

.2 Under frequency time delay 0-10 seconds, factory set at 5 seconds;

.3 Over frequency 60.0-70.0 HZ, factory set at 63.0 HZ;

.4 Over frequency time delay 0-10 seconds, factory set at 5 seconds;

.15 The following contacts to be provided with transfer switch:

.1 volt-free, 2 N.O. and 2 N.C. auxiliary contacts for remote indication of position of transfer switch.

.2 One (1) Form C contact for closure of the GENERATOR START CIRCUIT. The contacts to be of silver alloy with gold flashing. The contacts to be rated for 5-Amp at 250-Vac and 5-Amp at 30-Vdc.

.3 One (1) Form C contact for PRE-TRANSFER SIGNAL. The contacts to be rated for 10-Amp at 250-Vac and 10-Amp at 30-Vdc. {Option 35A}

.4 One (1) Form C contact for ALARM SIGNAL. The contacts to be rated for 10-Amp at 250-Vac and 10-Amp at 30-Vdc {80a}

.5 Utility Power Available Contacts – Auxiliary contacts which operate when utility power is available; two spare auxiliary contacts supplied with rating of 10 A, 230 VAC resistive Form-C;

.6 Generator Power Available Contacts – Auxiliary contacts which operate when generator power is available; two spare auxiliary contacts supplied with rating of 10A, 230 VAC resistive Form-C;

.7 Fail to Transfer Contacts – Auxiliary contacts, which activate when transfer switch mechanism fails to operate within specified time delay; time delay programmable 0-60 seconds, factory set at 15 seconds; two spare auxiliary contacts supplied with rating of 10 A, 230 VAC resistive Form-C;

.8 Phase Balance Relay – A phase balance relay to protect connected motors in system against unbalanced supply voltages caused by "single phasing condition" (e.g. one fuse blown on a 3-phase supply); when unbalanced condition occurs on utility supply, system initiates transfer to generator supply;

.16 Transfer switch control power obtained from source being transferred to. controls do not require any connection to external power sources;

.17 Control circuit isolation plug, which isolates all control circuitry inside ATS to facilitate maintenance procedures; when isolated, there is not to be voltage present on control circuitry;

.18 Provide single-line graphic on door with signal lamps to indicate position of transfer switch;

.6 **INTEGRATED LOAD SIDE METERING:**

.1 Provide digital metering for ATS controller with an accuracy of +1% for all voltage and frequency readings; frequency displayed to at least one decimal; three-phase line-to-line voltages displayed for both generator and utility supplies.

.2 Digital metering system to follow ANSI C12.20 Class 0.2%, to provide complete electrical metering with waveform display and embedded WEB server. System measures and displays voltage, current, frequency and time, and calculates and displays kW, KWh, KW demand, ampere demand, kVA, kVA demand, kVAr, kVArh and individual current and voltage harmonics.

.3 Graphical backlit LCD display is provided on unit. Unit includes inputs/outputs, contacts, RS485/MODBUS/TCP/IP Ethernet interfaces as required for communications to remote monitoring terminal or printer or BAS. Suitable current transformers, potential transformers and control wiring to be provided. Include custom clear acrylic, hinged locking cover over each unit. Review exact requirements with Consultant prior to ordering.

.4 Current Transformers:

.1 Current transformers (CTs) have ratios to suit application, a mechanical rating equal to momentary rating of circuit breakers and be insulated for full voltage rating of ATS.

.7 **INTEGRATED SURGE PROTECTIVE DEVICES (SPD):**

.1 ATS to be complete with integral SPD unit. Unit to be factory installed and connected onto bussing through integral disconnect as recommended by manufacturer. Unit to include diagnostic package with status indicators on each phase, LCD surge counter display, audible alarm with silence button and Form C alarm contacts. Unit to be maintenance free.

.8 **CABLE TERMINATIONS:**

.1 Terminal blocks shall conform to NEMA ICS 4. Terminal blocks for remote connections to be arranged to facilitate the entrance of external conductors from the top or bottom

of the enclosure. The main transfer switch terminals to be suitable for the termination of conductors shown on the plans.

.9 **CONTROL WIRING:**

.1 All control wire to be type SIS, bundled and secured with nylon ties. Insulated locking spade terminals to be provided for all control connections, except where saddle type terminals are provided integral to a device. All current transformer secondary leads shall first be connected to conveniently accessible short-circuit terminal blocks before connecting to any other device. Provide wire markers at each end of all control wiring.

.10 **NAMEPLATES:**

.1 Engraved nameplates, mounted on the face of the assembly, to be furnished as indicated on the drawings. Nameplates to be laminated plastic, black characters on white background. Characters to be 3/16-inch high, minimum. Nameplates shall give item designation and circuit number as well as frame ampere size and appropriate trip rating. Furnish master nameplate giving ATS designation, voltage ampere rating, short-circuit rating, manufacturer's name, general order number, and item number.

.2 Each nameplate to be sized to suit equipment for which it is provided and required wording. Confirm exact nomenclature, sizing, print type and colour scheme on shop drawings, for approval by Owner and Consultant.

.3 Warning signs to be lamacoid type with nomenclature confirmed with and approved by local governing electrical utility and reviewed with Consultant.

2.5 ACCEPTABLE MANUFACTURERS

.1 EATON, ATC MAGNUM TRANSFER SWITCH

2.6 OPERATION AND MAINTENANCE MANUALS

.1 Manuals for transfer switches to be bound together in a 3-ring binder. Manuals, material lists, and test reports shall either be typed, ink printed documents, or laminated high quality reproductions. Each manual shall contain a Table of Contents and the following information:

.1 Project name and location

.2 ATS number and/or name and assemblies.

.3 Manufacturer's shop order number

.4 Issue date.

.5 Revisions including designation, date, condensed summary of changes, and reason for revision.

.1 Bill of material (equipment summaries);

.2 Power circuit breakers

.3 Protective device test set;

.4 Control circuit fuses;

.5 Control switches;

.6 Pilot lights and lamps;

.7 Control power transfer equipment;

.8 Control power transformer;

.9 Current transformers;

.10 Current/voltage test blocks and plugs;

.11 Metering/monitoring equipment;

.12 Protective device time current curves;

.13 Secondary cable lugs;

.14 Breaker compartment lubrication information, including points, lubricant type, and maintenance schedule.

.2 **If the ATS is being provided as part of a skin-tight or walk-in enclosure package, then the ATS operation and maintenance data, will be supplied with the enclosure Operation and Maintenance Manual.**

3 EXECUTION

3.1 ATS FACTORY TESTING

.1 Perform standard factory tests outlined below on ATS equipment provided under this section. Perform tests in accordance with CSA, UL and NEMA standards.

.2 Check insulation to ensure integrity of insulation and continuity of entire system.

.3 Visually inspect to ensure that switch matches specification requirements and to verify that fit and finish meet quality standards.

.4 Perform mechanical tests to verify that switch power sections are free of mechanical hindrances.

.5 Perform electrical tests to verify complete electrical operation of switch and to set up time delays and voltage sensing settings of logic.

.6 Provide certified copy of factory test reports to Consultant.

.7 ATS to include label indicating order number, catalog number and date of testing.

3.2 INSTALLATION OF ATS

.1 Provide transfer switches as required for each application, hoist and install where shown on the drawings.

.2 Refer to drawings for transfer switch type, designation, ratings and mounting locations.

.3 Where required in emergency power distribution system connected to gensets, provide wiring in conduit from genset control panel to appropriate transfer switches contacts to

initialize engine start-up upon loss of normal power and provide signals to transfer switches to initiate appropriate operations.

.4 **Where shown on the drawings or required by code, provide MI fire rated conductors to transfer switches used for life safety applications.**

.5 Where load banks are connected to genset control system during testing, include for required interconnection wiring in conduit for loss of normal power signal to load bank controllers to initiate dropping load bank to pick-up essential building loads.

.6 Advise transfer switch manufacturer of coordination study available fault current results to ensure transfer switches are provided of withstand current rating meeting available fault current at location of each transfer switch. Where initial pricing requirements included for ratings exceeding final coordination study findings, advise Consultant.

.7 Install in accordance with manufacturer's instructions to suit specific applications. Mount stand-alone units to concrete bases. Ensure adequate clearance is provided as per code requirements and as required for access for operation and maintenance. Connect complete.

.8 Where specified or shown on drawings, turn over ATS to generator enclosure manufacturer for installation within enclosure.

.9 Obtain required training from manufacturer's representative on any special installation procedures. Install products in accordance with manufacturer's instructions to suit specific installation requirements.

.10 Where shown or required on drawings, provide transfer switches connected to elevators, with relays and interlocking as required to control transfer of elevators. Coordinate and review exact requirements with Division 14 Consultant and elevator trades.

.11 Where shown or required on drawings, elevator transfer switch sensing panel initiates emergency mode of operation if a drop to 90% or less on any phase of normal service exceeds 3 seconds in duration. In emergency mode, transfer switch transfers to emergency bus and elevator controls to take over and bring elevators, one at a time, down to main lobby and maintains one elevator (firemen's elevator) to operate continually.

.12 Restoration to normal operation commences when phases of normal service have returned to 95% of nominal for an adjustable period of up to 2 minutes maximum. Transfer switch re-transfers to its normal position, allowing elevators to resume normal service, signal for emergency mode to elevator control to be cancelled, and system is then ready for next normal service failure without any manual resetting.

.13 Review electrical systems, fire alarm system, building automation system and elevator requirements with respective equipment vendors and coordinate required power, monitoring and control interconnections. Provide required contacts, relays and wiring in conduit between system equipment allowing for respective system equipment trades to make final connections to their own equipment. Provide MI fire rated conductors to equipment used for life safety applications and for applications required by local governing authorities and codes.

.14 Comply with applicable CSA standards with regards to provision of remote audible safety indicators for both automatic and bypass modes.

.15 Ground and bond switches as per code requirements. Refer also to requirements of grounding and bonding Section.

.16 When installation is complete, arrange for system manufacturer authorized technician to visit site to inspect installation, perform testing and start-up procedures, and certify system. In presence of Consultant, perform a complete operational test of system to ensure that system operates satisfactorily under operating conditions specified.

.17 Coordinate transfer switch testing with engine-generator set testing to ensure that complete emergency power plant operates correctly. Adjust as required.

.18 Arrange for manufacturer to provide a letter certifying compliance with requirements of this Specification. Certification to identify, by serial number(s), equipment involved.

.19 Provide engraved Lamacoid nameplates with nomenclature reviewed with Consultant.

.20 Additionally, refer to testing, coordination and verification requirements in Section entitled Electrical Work Analysis and Testing and include applicable requirements.

3.3 TESTING, START-UP, VERIFICATION AND TRAINING:

.1 Provide the services of a qualified factory-trained manufacturer's representative to assist the contractor in installation and start-up of the equipment specified under this section for a period of two (2) working days.

.2 The manufacturer's representative shall provide technical direction and assistance to the contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein.

.3 Perform tests in accordance with manufacturer's recommendations, programmed and wired sequence of operations.

.4 Method of Procedures to be prepared and approved by the Engineer at least one (1) week before the field testing with energized equipment.

.5 Verify operation of "inhibit to transfer", "transfer and pre-transfer" and "alarms" signals.

.6 Verify operation of "shunt trip signal" to a generator load bank breaker.

.7 Configure communication ports and verify operation.

.8 Coordinate testing with other parties involved.

3.4 TRAINING

.1 Contractor to provide a training session for up to five (5) owner's representatives for five (5) normal workdays at a jobsite location determined by the owner.

.2 The training session to be conducted by a manufacturer's qualified representative. The training program shall consist of the instruction on the operation of the assembly, circuit breakers and major components within the assembly.

3.5 FIELD SERVICE ORGANIZATION

.1 The manufacturer of the ATS shall have service offices in Ontario Canada that are available on call 24 hours a day, 365 days a year.

3.6 MANUFACTURER'S CERTIFICATION

.1 A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.

.2 The Contractor shall provide a copy of the manufacturer's representative's certification in the operation and maintenance manuals.

END OF SECTION 26 36 2323

1 GENERAL

1.1 SUMMARY

.1 This document is a specification for the modifications to the existing Fire Alarm System.

.2 This Specification Section forms an integral part of the Contract Documents.

1.2 RELATED SECTIONS:

.1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.3 REFERENCES AND STANDARDS

.1 Ontario Electrical Safety Code (OESC)

.2 Canadian Standards Association (CSA)

.1 Ontario Building Code, 2012 Edition.

.2 The Ontario Fire Code, Ontario Regulation 213/07.

.3 Underwriter's Laboratories of Canada (ULC), latest editions accepted by the Ontario Building Code of the following:

.1 CAN/ULC-S524, Standard for the Installation of Fire Alarm Systems;

.2 CAN/ULC-S525, Audible Signal Device for Fire Alarm Systems;

.3 CAN/ULC-S526, Visual Signal Devices for Fire Alarm Systems;

.4 CAN/ULC-S528, Manual Pull Stations for Fire Alarm Systems;

.5 CAN/ULC-S529, Smoke Detectors for Fire Alarm Systems;

.6 CAN/ULC-S530, Heat Actuated Fire Detectors for Fire Alarm Systems;

.7 CAN/ULC-S541, Speakers for Fire Alarm systems, including Accessories;

.8 CAN/ULC-S537, Standard for the Verification of Fire Alarm Systems;

.9 ULC-S527, Control Units for Fire Alarm Systems;

.10 ULC-S548, Alarm Initiating and Supervisory Devices for Water Type Extinguishing Systems;

.11 ULC-S533, Egress Door Securing and Releasing Devices.

1.4 SUBMITTALS

.1 Prior to the commencement of work, submit shop drawings for equipment and accessories specified in this Section. Shop drawings to include connection wiring schematic drawings for each system, system design drawings including dimensions and layouts, system riser drawings and copies of manufacturer's component literature sheets.

.2 Submit credentials for installing electrician indicating successful completion of a program or course approved by the AHJ.

.3 Submit shop drawings in accordance with Submittal Procedures Section 01 33 00. Include:

.1 Control equipment modifications and layout of equipment; Identify any control equipment not able to be located within the control equipment and required to be located on the exterior of control panels (isolation modules, synchronization modules, etc. to be located within the control panel) and not shown on the tender drawings. Provide a separate cabinet the same depth, width and colour as the control panel to contain any equipment not located in the control panel.

.2 Confirmation that the data communication link and signal circuit loading has not exceeded specified capacity. Provide voltage drop calculations for each signal circuit and capacitance calculations for each data communications link to confirm circuits have capacity and work with the supplier to confirm before work commences.

.3 Complete backup battery capacity calculations. Manufacturer to Identify calculated battery capacity, derating, total required battery capacity, and additional spare battery capacity to be provided to suit the additional work.

.4 Manufacturer’s data and installation instructions for each type of device installed and manufacturers surface back boxes where indicated as required where changes have been made to the following items;

.1 Sequence of operation.

.2 Fire Alarm Zone Schedule

.3 Fire Alarm Passive Graphic.

.4 Component wiring diagrams;

.5 Fire alarm cabling;

.5 Prior to commencing work, make up a Conduit and Wiring Layout for the modifications to the Fire Alarm System. Indicate conduit runs and the size, type and number of all conductors to meet the manufacturer’s requirements. The installation to be completed in accordance with these drawings. The drawings to be on site throughout the project and installation changes to be marked on the drawings daily. The completed layout to be included in Operation and Maintenance Manuals and turned over to the Owners on completion of the project.

.6 Prior to final programming review the zone and device descriptors with the owner's site representative. Submit a list of zone and device descriptors to the consultant for review.

1.5 QUALITY ASSURANCE

.1 Qualifications: installer to be an Electrical Contracting company specializing in fire alarm system installations with 5-years documented experience. The installing electricians to have CFAA Certification or successful completion of a program or course approved by The Authority Having Jurisdiction (AHJ) and the Building Owner.

.2 The manufacturer to provide a CFAA Certified Fire Alarm technician who is an employee of the system manufacturer or authorized representative, experienced in installation and operation of type of system being installed, to supervise the installation, provide instruction, adjustment, preliminary testing, and final testing of system and verification.

.3 Upon completion of the fire alarm system, demonstrate and test the fire alarm system to the approval of the AHJ.

1.6 CLOSEOUT SUBMITTALS

.1 Incorporate detailed instructions to permit the effective operation, maintenance and repair of the fire alarm system, into the manual specified in Section 01 77 00 – Closeout Procedures.

.2 Technical data:

.1 Illustrated parts list with parts catalogue numbers.

.2 Manufacturer's installation data and operating instructions for the system and each type of device installed.

.3 Copy of approved shop drawings with corrections completed, and marks removed.

.4 List of recommended spare parts for system.

.3 Complete as-built conduit and wiring layout showing all devices, conduit size and runs, wire type, size and number of conductors.

.4 Final calculations based on the verification testing for the completed system to verify the battery capacity exceeds supervisory and alarm power requirements required.

.5 Final calculations for the completed system to verify the data communication links and signal circuit capacities have not been exceeded.

.6 Provide the final verification and testing report, on ULC-S537 approved forms, showing correct operation of all new and existing affected devices.

1.7 SCOPE OF WORK

.1 Provide labour, materials, equipment, tools and technical assistance from the equipment manufacturers and suppliers necessary for the installation and verification for the addition and modifications to the existing Fire Alarm System.

1.8 SYSTEM DESCRIPTION

.1 Existing Fire Alarm system control panel and annunciator panel to be upgraded to suit the additional devices and zones as indicated on the drawings.

.2 Refer to floor plans for scope of work and additional devices to be provided.

.3 The existing fire alarm system is to remain in full operation until the installation of the new devices and equipment is complete, verified and accepted. Provide trained staff to perform a fire watch during shutdowns of any existing fire alarm components.

.4 The drawings indicate the final locations of the fire alarm system components. The equipment manufacturer/supplier is responsible for provision of all components necessary to ensure a complete and operative system in accordance with the intent of these documents. All modules (including isolator and sync) required to be located near the control panel to be in the control panel where possible. If space is not available modules shall be installed adjacent the panel and clearly labelled

.5 Maintain the integrity of each loop. All fire alarm wiring to be continuous and terminated at devices or control equipment only. Wire nuts (Marr connectors), junctions or splices will not be permitted. New devices to be connected between two existing devices sequentially installed on the loop. Modify and replace the existing conduit and wiring to extend the loop from between the existing devices to the new device(s).

.6 The Fire Alarm system modification scope of work to include but not be limited to the following ULC listed main components:

.1 Modifications to the existing Fire alarm control and annunciator panel located as indicated on the drawings.

.2 Update/replace the existing Main entry colour passive graphic display located adjacent to the remote annunciator panel in the main entry vestibule, to suit the new scope of work.

.3 Addressable Manual Stations.

.4 Automatic Alarm Initiating Addressable Devices.

.5 Addressable Monitoring Modules (supporting field devices).

.6 Addressable Relay Modules.

.7 Fault Isolation Modules

.8 Visual and Audible Signal Devices.

.9 End of Line Devices.

.10 Fire Alarm System wiring.

1.9 SEQUENCE OF OPERATION

.1 The existing sequence of operation for the system to be maintained.

1.10 ZONE SCHEDULE

.1 The zone schedule is indicated on the drawings.

2 PRODUCTS

2.1 FIRE ALARM SYSTEM COMPONENTS

.1 Existing Edward EST3 fire alarm control panel and annunciator to be modified as required to accommodate the work as shown on the drawings.

.2 Fire Alarm Work to include relocation work and provision of additional devices, necessary control panel and annunciator work to accommodate disconnection, relocation and re-connection of existing devices, installation of new devices, and system testing and verification.

.3 Engage the following base building fire alarm service contractor to provide and perform required system work

.4 Modify control panels and annunciators to supervise and annunciate additional and relocated devices.

.5 All additional components shall be ULC approved, cross listed for use with the existing fire alarm system equipment and supplied by the existing fire alarm system manufacturer.

.6 Include costs for manufacturer to update the existing system programming to accommodate new equipment and modifications required for the scope of work. The manufacturer to perform all work in control panels including the installation of additional modules, chargers power supplies and batteries.

.7 Devices:

.1 During tendering period, review base building system devices with system manufacturer's authorized representative to determine exact requirements required for the renovation work.

.2 Thermal Detectors - Addressable

.1 To match and be compatible with the existing system detectors. Twist-lock mounting automatic thermal detectors as follows:

.1 Combination 135°F (57°C) fixed temperature and 15°F (8°C) rate-of -rise type;

.2 135°F (57°C) fixed temperature type;

.3 197°F (92°C) fixed temperature type;

.2 Each detector to be complete with a baseplate for mounting on a standard 4" (100mm) outlet box. Where shown on the drawings provide wire guards over detectors.

.3 Visual/Audible Devices:

.1 Surface wall mounted horn and or horn strobe device to match existing types on site. Strobes to be provided to the standards of the existing system.

.4 Addressable Modules:

.1 Provide relay and monitor modules required for interconnection of equipment and devices to the fire alarm system.

.2 Provide addressable loop isolation modules to isolate wiring per ULC S524 to suit the installed conduit routing.

.3 All modules shall be provided by the fire alarm system manufacturer and ULC approved for use with this system.

.5 End-of-Line Resistors:

.1 Provide End-of-line resistors for standard alarm initiating circuits, sized to ensure the correct supervisory current flow in each circuit.

.2 Mount end-of-line in a single gang backbox with stainless-steel faceplate, and to bear the ULC label.

.8 Wiring:

.1 Wire and cable to be ULC listed and labelled for fire alarm circuits, colour coded insulation, solid copper conductors, as per OBC and ULC requirements, 105 degrees C rated.

.1 Provide Securex II, solid copper, FAS 105, FT-4 rated, multi-conductor twisted non-shielded minimum #14 AWG cable for signal circuits and minimum #18 for data communication wiring. Size conductors for a maximum 2% voltage drop from the no load circuit voltage at the end of line resistor or to meet the manufacturers recommendations whichever is less.

.2 Provide a separate #14 green ground conductor bonded to control equipment, each device, and back box.

.3 Wiring and cable to be sized and installed in accordance with the system manufacturer's instructions.

.4 Provide shielded cables where required by the fire alarm system manufacturer.

.5 Wiring and cable to be mechanically protected to satisfaction of local fire authority. All wiring and cable shall be installed in minimum ¾" conduit.

.9 Testing and Verification Work:

.1 Refer to Part 3 for system testing, verification and certification Work.

3 EXECUTION

3.1 INSTALLATION OF FIRE ALARM SYSTEM COMPONENTS

.1 Provide additional components and renovations work as required.

.2 All work in conjunction with this installation to meet the requirements of the latest editions of the OBC, OESC, Ontario Fire Code (OFC), ULC Installation Standard CAN/ULC S524 and any applicable local codes.

.3 All work performed on the existing fire alarm system to be provided and performed by the base building fire alarm service contractor as noted previously.

.4 If any requirements of these specifications are different, omitted or contrary to the ULC S524 Standard, then the ULC Standard governs and overrides these specifications, but in no instance will the standards established by the drawings and specifications be reduced by any Codes.

.5 During work to the existing fire alarm system, the time and duration of any interruption to be approved by the Owner. At any time, due to emergency situations, Owner may request by-passed zone(s) to be re-instated immediately. In all areas where the renovation work requires shutdown of any part of the fire alarm protection system, perform a Fire Watch by means of providing personnel to supervise the area as approved by the Authority Having Jurisdiction (AHJ). At no time shall the fire alarm system or any fire alarm zone be left inoperative overnight. Provide all required bypass wiring and temporary wiring as may be required to maintain all parts of the fire alarm system operative during construction and alterations. Include ULC S537 verification of all temporary and altered wiring by the manufacturer immediately following installation and provide a separate verification report.

.6 Verify with existing fire alarm system manufacturer during Bid period, the exact requirements needed to provide renovation work. If necessary, visit site with manufacturer to review existing conditions. Items of clarification or proposed revisions to Bid Documents must be reviewed with Consultant during Bid Period.

.7 When ceiling and/or wall work has been completed, disconnect temporary devices and existing devices in temporary locations. Locate devices in permanent locations to suit renovations work as per issued drawings and Consultant's directions. Connect, adjust, test and verify.

.8 Install the mounting plate of detectors to ceiling mounted boxes as required. Secure the detectors to the plates.

.9 Generally, audible device locations are indicated on drawings, however, exact audible device quantities and locations to be in accordance with results of audibility device coverage site tests. Provide suitable sound detection metering and personnel to make

necessary tests. Relocate audible devices and/or provide additional audible devices as required. Refer to system testing specified later in this Section.

.10 Provide end of line resistors to electrically supervise all wiring. Identify and locate to the latest OBC and ULC S524 requirements in corridors or service spaces.

.11 Refer to the drawing scope of work notes and or fire alarm riser diagram and schedule. Quantities of components to be as per the floor plans and not the riser diagram.

.12 Confirm the exact location of all components prior to roughing in.

.13 Install all wiring in conduit (except for MI). All wiring connections associated with the fire alarm system to be performed on terminal strips in junction boxes. When pulling wires into conduit, use lubricant and ensure that wires are kept straight and are not twisted or abraded. Neatly secure exposed wires in apparatus enclosures with approved supports or ties. All wires must be clearly identified at all termination points.

.14 Colour conductors for each part of the system in accordance with the system equipment manufacturer's recommendations.

.15 Alarm signaling circuits (horns/speakers/strobes) and alarm receiving circuits (pull stations, detectors) must be run in separate conduits from each other. All wiring connections to be performed on terminal strips in junction boxes; wiring to be continuous between devices, terminating only at device terminals. Splices, junctions or joints will not be permitted. Wire nut, crimp or “Marrette” connectors will not be permitted.

.16 Install all wiring in conduit (except for MI). When pulling wires into conduit, use lubricant and ensure that wires are kept straight and are not twisted or abraded. Neatly secure exposed wires in apparatus enclosures with approved supports or ties. All wires must be clearly identified at all termination points.

.17 Conduit, couplings, box covers and connectors for fire alarm system wiring to be and red in colour.

.18 Provide engraved Lamacoid identification nameplates for each cabinet, end of line resistor, addressable module and secure to the front of the housing. Provide self-adhesive typewritten labels for each initiating device indicating the address and device type. Exact wording designations and sizes to be reviewed and confirmed with the Consultant prior to manufacture.

.19 Verify nomenclature of the annunciator identification with the Consultant and obtain necessary approvals prior to ordering.

3.2 TESTING AND VERIFICATION

.1 When fire alarm system work is complete and ready for acceptance, include costs for and arrange for fire alarm system manufacturer to inspect test and verify the additional and relocated equipment, including initiating devices, signaling devices, control devices and

wiring. The inspection to comprise an examination of such equipment in accordance with the latest editions of CAN/ULC S537 for the following:

.1 to ensure that the entire system functions in accordance with approved sequence of operations;

.2 to ensure that the type of equipment installed is that designated by the contract documents;

.3 to ensure that the wiring connections to all equipment components show that the installer observed the requirements of the tender documents, ULC and ESA requirements;

.4 to ensure that the equipment was installed in accordance with the manufacturer's recommendations, and that all signalling devices were operated and tested to verify their operation complies with the tender documents and code requirements;

.5 to performed integrated system testing between multiple systems to verify and document the proper operation with various test scenarios to confirm that all required building functions occur. Systems include fire alarm, smoke control, elevators, fire pumps, fire suppression, electromagnetic locks, air handling systems, dampers, fans, generators, etc.

.2 Include costs for and arrange for the AHJ and the system manufacturer’s representative to be present on-site during the inspection by the AHJ. Correct deficiencies as identified by Consultant and by the AHJ. Include for manufacturer’s representative to provide re-verification and re-inspections of the deficiencies. Obtain final inspection documentation and building permit clearance from the AHJ.

.3 Arrange for the manufacturers to supply reasonable amounts of technical assistance with respect to any changes required to conform to the paragraphs above. During the period of inspection, testing and verification, make the installing Electricians available to do any required correction work and to assist during this Work.

.4 Test and verify each relocated device in both temporary locations and again in final relocated position. These are to be separate testing/verification sessions and reports. Move this paragraph ahead of AHJ inspection.

.5 On completion of the verification, inspection and testing of the system, obtain from the system manufacturer and forward to the Consultant, a certificate of liability insurance, of at least the amount of two million dollars ($2,000,000.00), and obtain from system manufacturer a verification certificate together with detailed inspection reports listing each and every system component, its location in the building and its acceptability. The verification certificate and inspection reports to be prepared and signed by the testing technician, confirming that the system is installed in accordance with requirements specified above.

.6 The Certificate of Liability Insurance to be registered for this project and to be supplied to show satisfactory proof of the manufacturer's coverage for both its product and personnel.

.7 Include costs for re verification of any failed device repaired or replaced.

.8 Note that open flame and/or smoke are not to be used for testing.

.9 The testing technicians to be certified and approved for fire alarm system testing and verification by the Canadian Fire Alarm Association (CFAA) and the Ontario Fire Marshall as applicable.

END OF SECTION 28 31 00