



S. BURNETT
& ASSOCIATES LIMITED

ENGINEERING & ENVIRONMENTAL

REQUEST FOR PROPOSAL

TOWN OF SHELBURNE
WELL 1 UPGRADES

December 2025
SBA File No.: M20051

Closing Date: Thursday, January 29, 2026
Closing Time: 2:00:00 p.m., Eastern Time

PREPARED FOR:
TOWN OF SHELBURNE

PREPARED BY:
S. BURNETT & ASSOCIATES LIMITED

The material in this Contract reflects the best judgement in light of the information available at the time of preparation. S. Burnett & Associates accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this document.

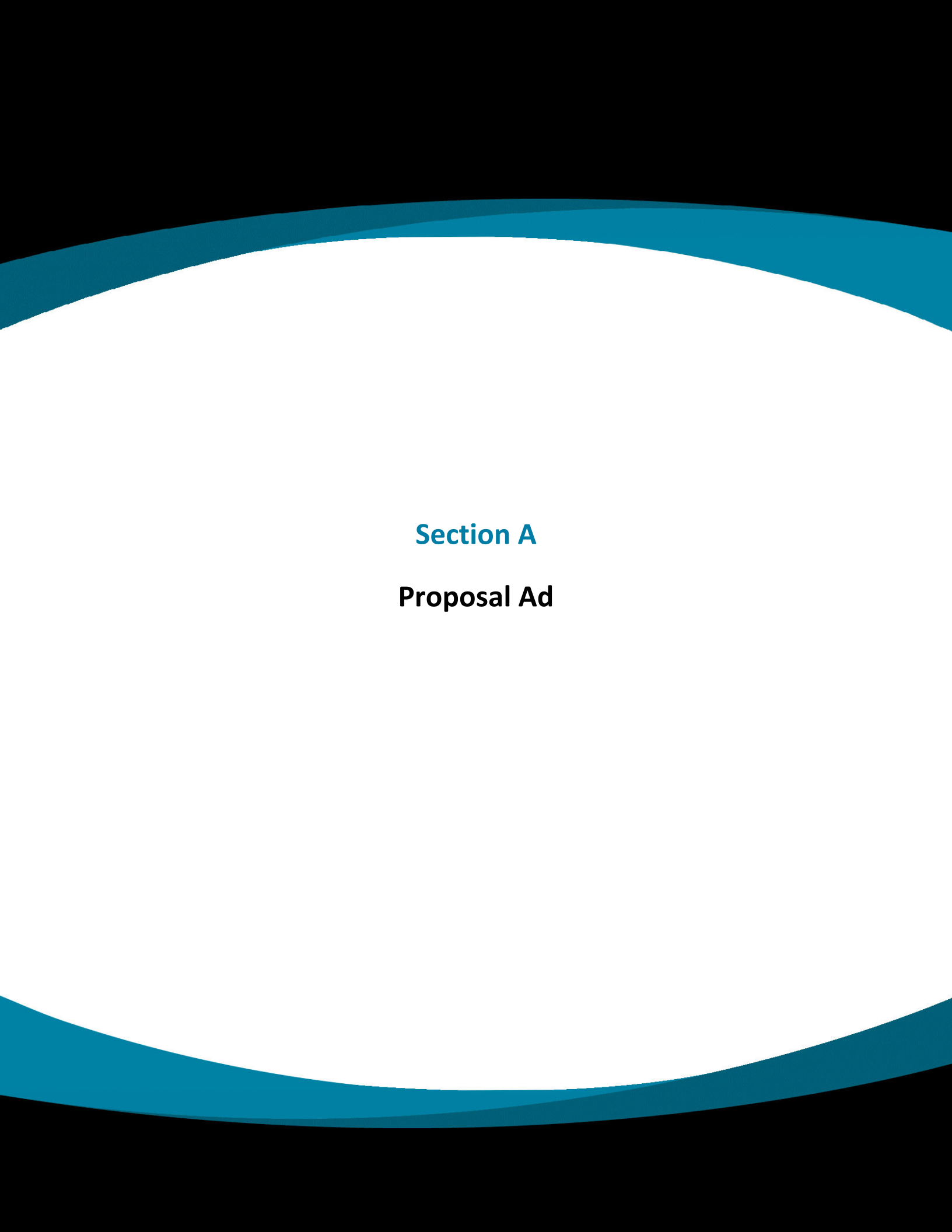
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1	Pre-Selected UV Equipment (Via Addenda)

The background of the slide features a dark teal/black top and bottom section. A large, white, rounded rectangular area occupies the center. This white area is framed by two horizontal, wavy teal bands that curve upwards at the ends, creating a sense of motion or a stylized horizon.

Section A

Proposal Ad

**Town of Shelburne
Well 1 Upgrades
Contract No.: M20051**

COMPLETED AND FINAL SUBMISSIONS, on forms supplied by the Consulting Engineer, will be received via email to:

info@sbaengineering.com

Thursday, January 29, 2026 at 2:00 p.m.

The Proposal includes:

- Removal of existing contact tanks and supply and installation of 60m, 450mm diameter watermain contact piping.
- Supply and installation of a new diesel generator, connection, and housekeeping pad.
- Removal and replacement of UV disinfection unit and control panel.
- Structural modifications to existing building including an interior block wall for the proposed chemical room.
- Supply and installation of new water quality monitoring equipment, chemical feed pumps, and chemical tanks/containment.
- Electrical and SCADA upgrades within the pumphouse.
- Site works, fencing and grading improvements.

Plans and Proposal documents may be obtained from Biddingo and Merx and the Town of Shelburne's procurement website.

Interested Bidders shall note that a non-mandatory but highly recommended site visit is scheduled on Thursday, January 8, 2026 commencing at 11:00 a.m. at 509 Andrew Street, Shelburne, ON L0N 1S4. All inquiries shall be submitted in writing prior to Thursday, January 22, 2026 and will be replied to Bidders before Monday, January 26, 2026. Written queries regarding this Proposal are to be directed to Connor Messner, Civil Engineering, connor.messner@sbaengineering.com.

Each Proposal submission must be accompanied by a certified check or bid bond to be retained by the Consulting Engineer for an amount of at least 10 percent (10%) of the total bid price made payable to the Town of Shelburne. This contract is subject to the approval of the Owner. The lowest or any Proposal will not necessarily be accepted.

Consulting Engineer
S. Burnett & Associates Limited
210 Broadway, Unit 203
Orangeville, ON, L9W 5G4
T: (519) 941-2949

Owner
Town of Shelburne
203 Main Street East
Shelburne, ON L9V 3K7
T: (519) 925-2600



Section B

Bidder Information

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1 GENERAL INFORMATION TO BIDDERS

1.1 Location and Scope of Work

The proposed work included in this Contract is located in the Town of Shelburne, located in the County of Dufferin.

The proposed work primarily involves the supply of all labour, materials and equipment as necessary for the Town of Shelburne, Well 1 Upgrades located at 509 Andrew Street, Shelburne, Ontario L0N 1S4, as indicated on the drawings and described herein. All work shall be completed in accordance with the Contract Documents and Drawings.

A Description of Work is listed in Section No. 01007: General Instructions, of the Supplemental Specifications.

1.2 Contract Approval

This Contract is subject to the approval of the Town of Shelburne.

1.3 Contractors Site Visit

Contractors shall note that a non-mandatory, but highly recommended site visit has been scheduled for **Thursday, January 8, 2026 at 11:00 a.m. Eastern Time**. The site visit will be held at 509 Andrew Street, Shelburne, Ontario L0N 1S4.

1.4 Questions / Clarifications

Enquiries regarding this Proposal must be submitted to the project coordinator and should be directed to Connor Messner, P.Eng., Civil Engineer at connor.messner@sbaengineering.com. No enquiries are to be directed to any other employee or elected Officials of the Client. Questions will be accepted until **Thursday, January 22, 2026 at 5:00 p.m. Eastern Time**.

All clarification requests are to be sent in writing to the individual mentioned above. No clarification requests will be accepted by telephone. Responses to clarification requests will be provided in the form of an addendum. All addendums will be provided on or before end of day on **Monday, January 26, 2026**.

Any changes to the Proposal, prior to the bid closing will be issued as an addendum. The Town of Shelburne and S. Burnett & Associates Limited will assume no responsibility for oral instruction or suggestions. Failure to acknowledge all addenda will result in your bid being rejected.

All addendum / addenda will be provided via Merx / Biddingo and the Town of Shelburne's procurement website only. It is the Bidders sole responsibility to acknowledge receipt. A bid

received without addendum / addenda acknowledgment and/or submitted as instructed will be rejected.

1.5 Delivering and Closing of Proposal

Electronic bid submissions of the complete and final Proposal Form and Schedule of Unit Prices in PDF format shall be received by email:

info@sbaengineering.com

2:00 p.m. Eastern Time on Thursday, January 29, 2026

Each Proposal will be marked with the time and date it was received.

The Proposal Form must be fully legible, signed and witnessed in the spaces provided, with the signature of the Bidder or a responsible official of the organization bidding.

1.6 Proposal Submission

Contractors are to submit their complete Proposal Bids electronically at the time and date specified above.

Contractors must submit the Proposal Form, including Addenda acknowledgement and any supplementary information upon Closing of the Proposal. The Cost Summary Schedule of Unit Prices Form must be submitted upon Closing; however, Schedule pages may be submitted with summary pricing only. ***A full breakdown of pricing must be completed and provided as a "hard copy" submission.***

Contractors are required to submit the "hard copy" of the complete Proposal Form package (including certified cheque or bid bond) to the offices of S. Burnett & Associates Limited within two (2) business days (**48 hours**) of the closing date and time on **Monday, February 2, 2026**, before 5:00 pm EDT. Failure to provide the "hard copy" submission within the time period will result in disqualification.

The unbound copy of the Proposal Form provided with the Proposal package shall be submitted in its entirety. All sections of the Proposal Form shall be completed.

1.7 Disqualification, Withdrawal and Qualifying Proposals

Under no circumstances will Proposals be considered which:

- a. Are received by the Owner (or their authorized representatives) after the closing time on the closing date specified herein.

- b. Are not accompanied by the Proposal Deposit as specified, if required.
- c. Are not accompanied with an Agreement to Bond, if required.

A Bidder who has already submitted a Proposal may submit a further Proposal at any time up to the official closing time. The last Proposal received shall supersede all Proposals previously submitted by that Bidder for this Contract. Facsimile transmissions will not be accepted.

A Bidder may withdraw or qualify their Proposal at any time up to the official closing time by submitting a letter bearing their signature and seal as their Proposal to the point of Proposal delivery where the time and date of receipt will be recorded and the letter placed with the other Proposals. Facsimile transmissions will not be accepted.

Proposal packages can be download from Biddingo.com or MERX.com or the Town of Shelburne's procurement website. Bidders not meeting submission criteria are, at the discretion of the Owner, subject to disqualification.

1.8 Informal or Unbalanced Proposals

Proposals which are incomplete, conditional, illegible or obscure, or that contain additions, reservations, erasures, qualifications, alterations or irregularities of any kind may, but will not necessarily, result in the Owner's rejection of the bid.

Proposals that contain prices which appear to be so unbalanced as likely to adversely affect the interests of the Owner may be rejected.

Proposals that are based upon an unreasonable period of time for the completion of the works may be rejected.

Wherever in a Proposal the amount Bid for an item does not agree with the extension of the estimated quantity and the Bid unit price, the unit price shall govern and the amount and the Total Bid Price shall be corrected accordingly.

The Owner reserves the right to waive formalities at their discretion.

Bidders who have submitted Proposals that have been rejected by the Engineer and/or Owner because of informalities will be notified of the reasons for the rejection within 10 days after the Proposal closing date.

1.9 Discrepancies In and Interpretation of Proposal Documents

Should a Bidder find discrepancies in, or omission from, the drawings, specifications, or other Proposal documents, or should they be in doubt as to their meaning, they should notify the Engineer who may send a written instruction to all Bidders.

No oral interpretation shall be made to a Bidder as to the meaning of any of the Proposal documents, or be effective to modify any of the provisions of the Proposal documents. Addenda shall be issued by the Engineer to items in the Proposal as they determine. Addenda shall be in writing via Merx.com, Biddingo.com and the Town of Shelburne's procurement website prior to Proposal closing. Email transmissions may be used by the Engineer to issue addenda.

1.10 Acceptance or Rejection of Proposals

The lowest or any Proposal will not necessarily be accepted. Proposals will be evaluated to ensure that the Contractor has the appropriate qualifications and experience to complete this project. This evaluation will be based upon the following criteria:

- a. Qualifications and related experiences of the Bidder, senior personnel and subcontractors to be assigned to this project.
- b. Amount of work to be completed by Bidders own forces versus subcontractors.
- c. Performance of the Bidder and subcontractors on past projects, including, without limitation, the Bidder's history with respect to quality of work, scheduling, changes in the work, claims, disputes, level of satisfaction of Owners and Consultants, etc.
- d. Price.
- e. Conformance with the requirements set forth in the Proposal Document.
- f. Local labour and equipment to be utilized during construction.
- g. Other such considerations as may be determined by the Owner to be in its own best interest.

The Engineer and the Owner reserve the right to reject any Proposal from a contractor not meeting these qualifications. Award will then be based on the lowest qualified bid.

The Engineer and the Owner reserve the right to reject any or all Proposals and to waive formalities, as the interests of the Owner may required, without stating reasons thereto.

The Bidder acknowledges that it shall have no claim against, or entitlement to damages from the Owner or the Engineer by reason of the Owner's rejection of its bid or of all bids, or by reason of any delay in the acceptance of a Proposal. Proposals are subject to a formal Contract being prepared and executed.

1.11 Proposal Deposit and Bonding Requirements

Each Proposal shall be accompanied by either:

- a. A Proposal deposit in the form of a certified cheque made payable to the Owner for an amount equal to at least 10 percent (10%) of the total Bid price; or,
- b. A Bid Bond of at least 10 percent (10%) of the Bid amount and sealed by a corporation duly authorized to transact the business of Surety slip.

The Bidder shall include with their Proposal an Agreement to Bond as per the format of the specimen enclosed in Section B, executed under its corporate seal by the surety company from which they propose to obtain the required bonds. Only bonds issued by insurers licensed in Ontario will be accepted as per the terms and conditions of the Proposal documents.

Prior to execution of a contract with the Owner, the Contractor will be required to furnish to the Owner a performance bond in the amount of 100 percent (100%) of the total bid price and a separate payment bond in the amount of 100 percent (100%) of the total bid price. The full cost of these bonds is deemed to be included in the total bid price for the project.

The Proposal deposit cheque of two (2) Bidders, as selected by the Owner, will be retained for 60 days or until such time as a Contract has been executed by the Owner and the successful Bidder.

1.12 Formation of Contract

The Engineer, when so instructed by the Owner, shall forward a complete digital copy of the Contract Documents to the successful Bidder for execution via DocuSign.

The Bidder agrees that if they have been notified that their Proposal has been recommended to the Owner for acceptance they will fully execute the Articles of Agreement bound in the Contract Documents within 10 days after receiving those same Documents in triplicate.

The successful Bidder shall execute and return with the digitally signed Contract Documents, to the Engineer within 10 days, the following in triplicate:

- a. Performance and Labour/ Materials Payment Bonds;
- b. Current Clearance Certificate from the Workplace Safety & Insurance Board;
- c. Health & Safety Policy;
- d. General and Commercial Liability Insurance Certificate as outlined in the General Conditions of Contract;

- e. All Risk Insurance Certificate as outlined in the General Conditions of Contract;
- f. Other Insurance, as required, as outlined below in Section 1.13; and,
- g. A work Schedule outlining the proposed timing of the works.

1.13 Insurance Definitions

1.13.1 Commercial General Liability Insurance

Commercial General Liability, underwritten by an insurer licensed to conduct business in the Province of Ontario for a limit of not less than \$5M per occurrence, an aggregate limit of not less than \$5M, within any policy year with respect to completed operations, and a deductible of not more than \$100,000. This policy shall include but not be limited to:

- a. Name the Client as an additional insured
- b. Cross-liability and severability of interest
- c. Blanket Contractual
- d. Products and Completed Operations
- e. Premises and Operations Liability
- f. Personal Injury Liability
- g. Contingent Employers Liability
- h. Owners and Contractors Protective
- i. Broad Form Property Damage
- j. Non-owned automobile liability
- k. The policy shall include 30 days' notice of cancellation.

1.13.2 Automobile Liability

Standard Form Automobile Liability Insurance that complies with all requirements of the current legislation of the Province of Ontario, having an inclusive limit of not less than \$5M per occurrence for bodily injury, death and damages to property, in respect of the use or operation of vehicles owned, operated or leased by the Contractor.

1.13.3 Environmental Liability (Contractor's Pollution Liability)

The policy should cover financial loss incurred by the insured as a consequence of or resulting from any negligent act, error or omission causing environmental damages. The Contractor shall take out and keep in force with a limit of not less than \$2M per incident per occurrence or series of occurrences for bodily injury, death and property damage arising from the spill, discharge, emission, dispersal, seepage, leakage, migration, release or escape of pollutants in the ground,

atmosphere, water course or any body of water caused by or as a result of any negligent act, error and/or omission of the Contractor. Coverage shall include third party bodily injury and property damage including restoration/remediation costs. If such insurance is issued on a claims-made basis, coverage shall contain a 24-month extended reporting period or be maintained for a period of 2 years subsequent to conclusion of services provided under this Agreement. If the policy is to be cancelled or non-renewed for any reason, 30-day notice of said cancellation or non-renewal must be provided to the Client.

1.13.4 Construction Project Insurance

1.13.4.1 Builder's Risk

Contractor shall maintain builder's risk insurance on a 100% completed value basis on the entire work in progress, including materials stored off-site, while in transit or on site preparatory to being incorporated in the Work. The policy shall be written on a full replacement cost basis. The Client shall be named as Additional Insured on Contractor's builder's risk policy. The policy deductible shall not exceed \$25,000 unless approved in advance by the Client in its sole discretion. Contractor shall be responsible for payment of claims within the deductible or above the policy limits. Contractor's insurance shall be primary to any builder's risk insurance maintained by the Client at its sole discretion and benefit. Contractor's insurer shall waive any right of subrogation or recovery against the Client.

Such insurance shall be written for not less than the Contract construction cost value covering:

- Builder's Risk;
- Personal Property & any tools, equipment, scaffolding, staging, towers, and forms owned or rented by Contractor.

Such insurance shall be written to include the following coverage:

- a. Written on an "All Risk" form;
- b. Insure against loss from perils of fire and physical loss or damage including theft, vandalism, malicious mischief, collapse, sinkhole, flood, and surface water, earthquake, windstorm and demolition and debris removal;
- c. Start up and testing;
- d. Ensuing loss resulting from faulty workmanship, materials or error in design;
- e. Transit and off-site storage;
- f. Waiver of Subrogation;
- g. \$25,000 deductible paid by Contractor;
- h. Additional Insured endorsement.

1.13.5 Additional Insurance Clauses

Certificate of Insurance. The Contractor shall provide a Certificate of Insurance evidencing the required coverage before the commencement of services or the supply of goods and shall be required to ensure the coverage is maintained throughout the Term of the Contract. Any claims-made policy needs to be maintained for at least 24 months following termination or expiration of the Agreement.

Additional Insured. At Contractor's sole expense, the Client, its affiliates and each of their respective officers, councillors, directors, agents and employees shall be named as Additional Insureds on a primary basis on all liability policies with the exception of professional liability.

Primary Coverage. The Contractor's insurance shall be primary coverage and not additional to and shall not seek contribution from any other insurance policies available to the Client.

Notice of Cancellation or Changes. Except as otherwise approved by the Client, the policies shall be endorsed to provide the Client with not less than 30 days written notice in advance of any cancellation, change or amendment which restricts coverage such that the Contract requirements are no longer met.

Insurance Not to Affect Other Contract Obligations. Insurance procured by Contractor shall not reduce or limit Contractor's contractual obligation to indemnify and defend the Client as provided in the Contract.

1.14 Subcontractors

The Bidders shall list, on the page provided in Section B, Item 2.3, the name and address of each Subcontractor used in preparing their Proposal, stating that portion of the work allotted to each. Only one (1) Subcontractor shall be named for each part of the work to be sublet. After a formal Contract has been executed, the Contractor shall not be permitted to substitute other Subcontractors in place of those named in their Proposal without the approval of the Engineer.

1.15 Proof of Ability

The Bidder shall, on the form provided in Section B, Item 2.4, provide proof of their experience and responsibility in successfully completing projects of a similar nature. This proof of ability shall apply in general to the Bidder's experience in similar work.

The Bidder's senior supervisory staff and the experience of each, the Bidder's construction plan, and the name and business address of each proposed Subcontractor will also be provided if so requested within three (3) days of such a request being made by the Engineer.

1.16 Construction Layout

The Contractor is responsible for the layout of all construction works. The Engineer may provide construction control points and benchmarks at the onset of the work. Replacement of the control points removed by the Contractor, subcontractor or suppliers shall be at the Contractor's expense.

1.17 Protection of Survey Bars and Monuments

Before commencing construction operations, the Contractor must acquaint himself with the location of all survey bars and monuments located in the area in which their construction operations will be conducted. Should any of the survey bars or monuments be unnecessarily disturbed by the Contractor, as determined by the Engineer, they will be required to reimburse the Owner for the expenditures incurred in restoring all of the survey bars and monuments disturbed. If any survey bars or monuments must be disturbed to complete the proposed works as determined by the Engineer, the Owner will cover the cost to restore. This must be determined prior to disturbing, or the Contractor will be responsible.

1.18 Construction Period, Working Days and Liquidated Damages

1.18.1 Working Time Allotment

The Contractor shall complete all works to the point of substantial completion described herein and on the Contract Drawings. It is anticipated that Contract Award will occur middle of February 2026. Therefore, it will be understood that the project working time allotted of 12 weeks will commence following mobilization of equipment and manpower to site by the Contractor based on a start date no later than April 2026. Substantial completion shall be performed by end of July 2026.

Due to delivery lead times on equipment and materials, Contractors shall provide proof of purchasing and schedules of timelines for equipment by the suppliers within one (1) week of signed Contract Agreement. Contractor is to be held responsible for delays in equipment deliveries that are sensitive to the Commissioning timeline of the project.

1.18.2 Working Day Extension

If the Contractor is delayed in the completion of the work for causes beyond the reasonable control of the Contractor, as determined by the Engineer, the time of completion shall be extended in writing at any time on such terms and for such period as shall be determined by the Engineer in accordance with OPS General Conditions of Contract.

1.18.3 Liquidated Damages

It is agreed by the parties to the Contract that in case of all work called for under the Contract is not finished or completed as set forth herein, damages will be sustained by the Owner and that it is and will be impractical and extremely difficult to ascertain and determine the actual damage which the Owner will sustain by reason of such delay and the parties hereto agree that the Contractor will pay to the Owner the sum of \$1,000 plus all costs for Engineering fees and expenses with respect to inspection, Contract Administration and related works for the liquidated damages for each and every calendar day delay in finishing the work in excess of the number of working days prescribed or the completion date specified and it is agreed that this amount is an estimate of the actual damage.

The Owner may deduct any amount due under this paragraph from any monies that may be due or payable to the Contractor on any account whatsoever. The liquidated damages payable under this paragraph are in addition to and without prejudice to any other remedy, action or other alternative that may be available to the Owner.

1.19 Preliminary Acceptance, Guaranteed Maintenance Period, Final Acceptance and Release of Holdback

1.19.1 General

For the purposes of this contract, Preliminary Acceptance and Substantial Completion will be assumed to have the same meaning except as distinguished in Section 1.19.2.

It is intended that the Contractor guarantee to the Owner under normal operating conditions the work included in this Contract for a period of time as further described in Section 1.19.4, however, under no circumstances shall the Guaranteed Maintenance Period be less than 12 months from the date of Preliminary Acceptance. Preliminary Acceptance is defined as the date that all services, as required by the Engineer, have been tested, cleaned, inspection and approved by the Owner's Engineer and the Town of Shelburne. For the purpose of this Contract, Preliminary Acceptance shall not be granted prior to:

1. The work or a substantial part thereof is ready for use or is being used for the purpose intended; and,
2. When the work remaining to be done under the Contract is capable of completion or correction at a cost of not more than:
 - i. 3 percent (3%) of the first \$1,000,000 of the Contract price;
 - ii. 2 percent (2%) of the next \$1,000,000 of the Contract price; and,
 - iii. 1 percent (1%) of the balance of the Contract price.

For the purpose of this Contract where the work or substantial part thereof is ready for use or is being used for the purpose intended and/or where the work cannot be completed expeditiously for reasons beyond the Control of the Contractor, the value of the work to be completed shall be deducted from the Contract price in determining the works remaining to be done under the Contract and at the discretion of the Engineer and Owner, Preliminary Acceptance may be granted. Similarly, if the Owner is not prepared to grant their Preliminary Acceptance, then at the discretion of the Owner and Engineer, Substantial Completion for the purposes of maintenance periods and holdbacks reduction may be granted to the Contractor for the work completed to date. The Owner reserves the right in the above cases to institute an independent maintenance period and associated holdback for work remaining to be completed under the Contract.

1.19.2 Procedure for Preliminary Acceptance

Following the completion of the works included in this Contract and when the works have satisfactorily passed all tests required under the Contract, the Engineer and the Owner will undertake a preliminary inspection. The Contractor shall, when required, clean all services and provide any assistance and equipment required for this inspection. Upon completion of any repairs or incomplete work by the Contractor, the Contractor will reapply for Preliminary Acceptance. Provided that no serious deficiencies exist in the completed work the Engineer will then declare a date for Preliminary Acceptance.

1.19.3 Release of Holdback

The 12 percent (12%) holdback shall be paid to the Contractor per the terms of the *Construction Lien Act* and as follows:

1. 10 percent (10%) (less the value of any deficient work), after the expiration of 60 days from the date of advertisement of the Certificate of Substantial Performance.
2. 2 percent (2%) at the termination of the Guaranteed Maintenance Period subsequent to satisfactory recertification of deficiencies as determined by the Engineer.

Upon Substantial Performance and written request from the Contractor, the Engineer will provide a Certificate of Substantial Performance. The Contractor shall publish a copy of the certificate once in a Construction Trade Newspaper, which shall include:

- i. The name and address for the service of the Owner and of the Contractor.
- ii. The name and address of the payment certifier, where there is one.
- iii. A short description of the improvement.
- iv. The date on which the Contract was substantially performed.

- v. Where the lien attaches to the premises, a concise description containing a reference to lot and plan or instrument registration number sufficient to identify the premises; and/or, where the lien does not attach to the premises, a statement of where the lien notice must be delivered to preserve lien rights and.
- vi. The street address, if any, of the premises.

Prior to the first release of reduction of holdback, the Contractor shall within 15 days of the date of the date of advertisement of the Certificate of Substantial Performance:

- a. Submit a statutory declaration in a form satisfactory to the Engineer that all liabilities incurred by the Contractor and their Subcontractors in carrying out the Contract have been paid and that there are no liens, garnishments, attachments or claims relating to the work.
- b. Submit a satisfactory clearance certificate from the Workplace Safety & Insurance Board.
- c. Submit proof of publication of the Certificate of Substantial Performance.
- d. Submit a release in a form satisfactory to the Engineer releasing the Owner from all further claims relating to the Contract, qualified by stated exceptions such as outstanding work or matters arising out of subsection GC3.13 of the General Conditions; Claims, Negotiations, Mediation.
- e. Submit a written statement as to the status of deficient and outstanding works complete with a schedule with respect to completion of these works.

1.19.4 Period of Guaranteed Maintenance

The Contractor shall be responsible for correcting any deficiencies, which occur due to defective material or faulty workmanship for a period of 12 months from Substantial Performance. Refer to General Conditions of Contract.

The Contractor shall maintain the required bonding in full force and effect until the date of Final Acceptance.

1.19.5 Procedure for Final Acceptance

Prior to Final Acceptance, the Engineer, together with the Contractor, the Owner and the Owner's Engineering Representative shall inspect the services. The Contractor shall, where required, clean all services and provide any assistance and equipment required for this inspection.

1.19.6 Release and Final Documentation

Following the Owner's Final Acceptance and prior to releasing the Contractor from their responsibility, obligation or liability under the Contract, the Contractor shall submit the following documents:

1. Contractor's final claim.
2. A release by the Contractor in a form satisfactory to the Engineer releasing the Owner from all further claims relating to the Contract.

Upon receipt of the foregoing documents, a release duly executed by the Owner shall be issued. This will release the Contractor and their surety or sureties from any term or provisions of, or any responsibility, obligation or liability under this Contract.

1.20 Harmonized Sales Tax (HST)

Bidders should prepare their proposals to include the current tax system which will be in place throughout the life of the Contract on the understanding that, once the transitional provisions are available, the Contract price will be adjusted, if necessary, so that the tax impact of the change is neutral to the Contractor, after taking into account the portion of the work affected by the change, any Input Credits received by the Contractor, and all other relevant factors, following the implementation of the Harmonized Sales Tax regime. In the event of any dispute between the parties concerning the necessary adjustment, the matter will be finally resolved by an independent audit firm acceptable to both parties.

1.21 Traffic and Pedestrian Control

The Contractor shall provide adequate control of traffic while operating equipment on municipal and highway road allowances. The Contractor will be required to maintain traffic flow and pedestrian flow at all times. The Contractor shall leave the work each night so that access is available to all driveways, roads and entrances. It shall be the Contractor's responsibility to notify all emergency services, if such notification is required, as a result of the work under the Contract.

The Contractor shall take special note that these sections shall be amended to read that the Contractor shall also pay for signing, and construction and maintenance of detours.

The Contractor shall be responsible for adequate fencing of any excavations overnight and on holidays, and shall provide adequate lights and barricades as per safety requirements and additionally as may be required in the opinion of the Engineer.

Further to the requirements of the General Conditions of the Contract, the Contractor shall meet the requirements of Ontario Traffic Manual – Book 7 (Temporary Conditions) including, but not limited to, preparation of a Traffic Control Plan and a Traffic Protection Plan. Book 7 shall govern traffic control.

1.22 Co-operation with Other Contractors

No additional payment will be made for provisions necessary to work around other Contractors.

1.23 Local Specifications

The work proposed under this Contract, and the materials to be used shall comply in every respect to the specifications and standards of the local municipal authority. Supervision of construction of the proposed works may be provided by the local authority's regulations with respect to notification prior to commencing work.

Each Bidder shall satisfy themselves by personal examination as to the local conditions, requirements and specifications. They are not to claim at any time after submission of their Proposal that there was any misunderstanding as to the requirements of the local municipal authority with respect to the proposed works.

1.24 Dispute Resolution

Disputes between the Owner and the Contractor not otherwise resolved may be settled through Binding Arbitration, with an arbitrator experienced in engineering, construction and contractual law, as per Section GC3.14 of the OPS General Conditions, or through other means agreed upon by both parties.

1.25 Existing Services

Before commencing work, establish location and extent of existing services in area of work and notify the Engineer of findings.

Whenever it is necessary to cut, interfere with, and/or connect to an existing services or facility, do so at hours and times recommended by governing authorities and approved by the Engineer; and with minimum disturbance to occupants, pedestrian and vehicular traffic and public and private property.

Submit schedule to and obtain approval from the Engineer for each proposed shutdown of active service of facility. Adhere to approved schedule and provide notice to affected parties.

If unknown services are encountered, immediately notify the Engineer and confirm findings in writing and/or on drawings. Obtain the Engineer's written direction if such services require cutting, capping or relocation to do work.

The Engineer has endeavoured to plot on the Contract Drawings known existing utilities, pipes, catchbasins, conduits, poles, chambers or other objects, being located underground, on the surface, or above ground; but should be plotting of such be found to be incorrect, incomplete or omitted, the Contractor shall have no claim on that account.

It is the duty of the Contractor to notify all local utilities requesting the staking or marking of cable, conduit, watermains, etc., before the start of construction. The Contractor shall be solely responsible for damages or disturbance caused to any utility, pipe or object listed in the preceding paragraph.

Throughout the execution of the works included in the Contract, the Contractor shall ensure that the necessary steps are taken to maintain the flow and use of the existing services except as otherwise herein specified and shall be responsible for all service and utility lines disturbed.

The Contractor shall pay for all costs associated with providing temporary bracing of poles necessary to complete work under this Contract. The Contractor shall have no claim for the delay sustained while waiting for the relocation or repair of services by other forces, as a result of the Contractor's work. Any such relocation deemed to be completed by others may be undertaken prior to the Contractor's work on the site, however, those which have not been completed or which are not originally foreseen as a problem shall be the Contractor's responsibility to the extent of contacting the utilities involved and sustaining their own work and forces under the Contract. The Owner shall bear the direct relocation cost charges resulting from the Contract work.

1.26 General Instructions

The General Information to Bidders should be read in conjunction with Section 01007 of the specifications, if applicable.

1.27 Equivalents or Approved Equals

Where pursuant to the Specifications, the Contractor is required to supply an article or group of related articles designated by a trade or other name or an "approved equal", the Proposal shall be based only upon supplying the article of quality required by the Specification. After the acceptance of a Proposal, the Contractor may apply to the Engineer to substitute as an approved equal another article or group of related articles identified by a different trade or other name for an article or group of related articles designated as aforesaid. The application shall be in writing and shall state the price for the proposed substitute article or group of related articles, the price for the article or group of articles designated as aforesaid and such other information as the Engineer may require.

No ruling on a proposed substitution will be made prior to the acceptance of a Proposal. No substitution shall be made without the prior approval of the Engineer. The approval or rejection of a proposed substitution shall be at the sole discretion of the Engineer, and their decision shall be final.

1.28 Occupational Health & Safety Act

- a. The Contractor, for the purposes of the Ontario Occupational *Health and Safety Act*, shall be designated as the Constructor for this project and shall assume all of the responsibilities of the Constructor as set out in the Act and its regulations. The foregoing shall apply notwithstanding that the successful Bidder has been referred to as the "Contractor" in this and any other related document.
 - i. The Contractor acknowledges that they have read and understood the *Occupational Health and Safety Act* (R.S.O. 1990), as amended).
 - ii. The Contractor agrees to observe strictly and faithfully the provisions of the said *Occupational Health and Safety Act*.
 - iii. The Contractor agrees to indemnify and save the Owner harmless for damages or fines arising from any breach or breaches of the said *Occupational Health and Safety Act*.
 - iv. The Contractor agrees to assume full responsibility for the enforcement of the said *Occupational Health and Safety Act* to ensure compliance therewith.
 - v. The Contractor further acknowledges and agrees that any breach or breaches of the *Occupational Health and Safety Act* whether by the Contractor or any of its Subcontractors may result in the immediate termination of this contract herein and the forfeiture of all sums owing to the Contractor by the Owner.
 - vi. The Contractor agrees that any damages or fines may be assessed against the Owner by reason of a breach or breaches of the *Occupational Health and Safety Act* by the Contractor or any of its Subcontractors will entitle the Owner to set-off the damages so assessed against any monies that the Owner may, from time to time, owe the Contractor under this contract or under any other contract whatsoever.
- b. The Contractor shall provide a list of all controlled hazardous materials or products containing hazardous materials, all physical agents or devices or equipment producing or emitting physical agent that is deemed to be or contains a designated substance as defined under the Ontario Occupational Health & Safety Act, and shall provide appropriate Material Safety Data Sheets for these substances used for the performance of the required work, all prior to the performance of said work.
- c. Where hazardous materials, physical agents and/or designated substances are used in the performance of the required work, the Contractor shall ensure that the requirements of the Ontario Occupational Health & Safety Act and associated regulations are complied with.

- d. Contractors are to abide by Community Health & Safety policies. Upon successful award, the Contractor must provide H&S policy documentation.

1.29 Pandemic Policy

In the event of a pandemic (e.g., COVID-19), as declared by the Province of Ontario, the conditions below shall apply to this Contract:

- i. Every effort shall be made in which to continue the Work as specified within this Contract. Contractors are advised to follow federal and provincial public health guidelines and measures if a pandemic is declared. Social distancing practices and wearing of any Personal Protective Equipment (PPE) related to pandemic protection (e.g., face masks, etc.), as necessary, during site visits, upon visiting or working in the Community may be enforced. In extreme cases, proof of vaccination against transmissible viruses and/or antigen testing (rapid tests) may be required. Pandemic policy enforcement is at the discretion of the Community.
- ii. Should circumstances arise due to a pandemic which significantly prevent the Contractor's ability to perform and/or complete the Work, to a degree which, in the sole judgement of the Contract Administrator (in consultation with the Owner and the Contractor), renders continuation of the Work substantially inefficient or impractical and/or completion of the Work impossible, then the Owner may suspend the Work or terminate the Contract, as appropriate under said circumstances.

1.30 OPS General Conditions of Contract

The Ontario Provincial Standard Specifications Municipal-Oriented General Conditions of Contract, November 2024 (OPSS.MUNI 100) shall apply to this Contract. These documents are available at the following URL, under the tab Vol. 7-8 OPSS (Municipal), OPSS.MUNI 100, MUNI General Conditions of Contract:

<https://www.library.mto.gov.on.ca/SydneyPLUS/TechPubs/Portal/tp/opsViews.aspx?lang=en-US>

The General Conditions, as referenced above, are hereby incorporated into, and apply, *mutatis mutandis*, to this Contract. It will be the Contractor's responsibility to obtain current copies of the OPS General Conditions.

1.31 Amendments to OPS General Conditions of Contract

All the requirements of the General Conditions of Contract, shall apply to this Contract with the following exceptions:

- a. The reference to “Contract Administrator” shall be deemed to be the duly appointed member of S. Burnett & Associates Limited.
- b. The 12 percent (12%) holdback shall be paid to the Contractor per the terms of the *Construction Lien Act* and as follows:
 - i. 10 percent (10%) (less the value of any deficient work) after the expiration of 60 days from the date of advertisement of the Certificate of Substantial Performance; and,
 - ii. 2 percent (2%) at the termination of the Guaranteed Maintenance Period.
- c. Subsection GC 1.04 shall be revised in that a Major Item will constitute only those items with a value equal to or greater than 20 percent (20%) of the total bid value.
- d. All references in Section B.3, General Conditions of Contract, to the Corporation shall be construed as referring to the Owner.
- e. The Contractor is required to provide All Risk Insurance as per GC6.03.05.01.01. All insurance shall include the Owner (Town of Shelburne), Engineer (S. Burnett & Associates Limited), and all affected Municipalities as co-insureds.
- f. Payment for equipment for extra work undertaken on a time and material basis (Subsection GC 8.02.05 shall be at 80 percent (80%) of OPSS 127 rates regardless of the total cost of the extra work item and regardless of whether the equipment is owned / leased by the Contractor or rental equipment.
- g. Further to Subsection GC8.02.04.11, the Owner reserves the right to retain up to two (2) times the estimated value of deficient work at any time from monies owing to the Contractor until such deficient work is satisfactorily rectified.
- h. Further to Subsection GC8.02.05.08, where the Contractor arranges for additional work to be performed by a subcontractor based upon a pre-approved lump sum price, the Owner will pay the subcontractor’s lump sum price plus a mark-up calculated on the following basis:
 - i. 10 percent (10%) of the first \$5,000 plus;
 - ii. 5 percent (5%) of the amount in excess of \$5,000.

1.32 Seasonal Roadway Load Restrictions

Seasonal road restrictions imposed on Municipal and Provincial roads may affect cost for transporting of equipment and materials the construction site (such as granulars, concrete, rebar reinforcement, etc.).

The Contractor is responsible for determining any road load size restrictions which may be applicable during the construction period and which may affect the load capacity of any truck using such roads. The Ministry of Transportation, local authorities having jurisdiction and Owner shall be contacted in this regard. The Contractor will not be compensated for any additional costs incurred due to any load restrictions after the Contract is awarded.

1.33 Supporting Documentation Disclaimer

Bidders are to note that all documentation provided in the attached Appendices is for reference only. Bidders shall satisfy themselves concerning the correctness of the information and shall do their own investigation of any and all services before commencing the work, if awarded. The Engineer, S. Burnett & Associates Limited, is not responsible for any damages or delays of the Work performed due to the information provided in the supporting documentation. No responsibility will be accepted by the Engineer or Owner for the correctness of any of the information given in the document.

2 PROPOSAL FORM

2.1 Proposal Submission

Town of Shelburne
Well 1 Upgrades
Contract No.: M20051

To: Town of Shelburne

This Proposal is submitted by:

Firm Name

Address

Telephone Number

Email Address

I,

Authorized Agent

Of

Company Represented
(hereinafter referred to as the "Bidder")

Having carefully examined the locality and site of the proposed works, and all Contract Documents relating thereto, including the Proposal Ad, Proposal Form, Specifications, Appendices, General Conditions of Contract, Schedule of Unit Prices, Standard Specifications and Drawings, **Addenda ___ to ___ inclusive**, do hereby submit an offer in accordance with the Contract Documents and all location specifications, including detailed drawings as may be supplied from time to time, to furnish all materials, labour, tools, plant, matters and all things necessary within the time specified as described in the following Sections.

The undersigned agrees to accept as full payment therefore, the sums calculated in accordance with the actual measured quantities at the unit prices set forth in Schedule of Unit Prices herein.

The Bidder also agrees:

1. That, this Proposal is made by the Bidder without any connection, knowledge, comparison of figures, or arrangement with any other person or persons making a Bid for the same work and is in all respects fair and without collusion or fraud.
2. That, this offer is to continue open to acceptance until the Contract is executed by the successful Bidder or for a period of 90 days commencing from the Date of Closing of Proposals, whichever event first occurs and that the Owner may, at any time within that Period accept this Proposal whether any other Proposal has been previously accepted or not.
3. That the Owner may reject any or all Proposals without explanation.
4. That, they will carry out any additional or extra work (including the supplying of any additional materials or equipment pertaining thereto) or will delete any work as may be required by the Engineer in accordance with the Contract.

That, the carrying out of any work referred to above or the issuance by the Engineer of a Contract Change Order relating to such work or the acceptance by the Bidder of such Contract Change Order shall not, except as expressly stated in such Contract Change Order, waive or impair any of the terms of the Contract or of any Contract Change Order previously issued by the Engineer or any of the rights of the Owner or of the Engineer under the Contract.

5. That, they will complete the works within the time period allotted.
6. That, failure by the Contractor to complete the entire work within said time or the extended time allowed by the Engineer will give the Owner the right to collect liquidated damages including additional engineering costs as spelled out in Section 1.18.3 from the Contractor for each day thereafter until the work is completed as specified. Said liquidated damages are not a penalty, but are the agreed damages which the Owner would suffer if the work were incomplete at the end of the time proposed in this Statement, with allowed extensions of time, if any.
7. That, if the Bidder withdraws this Proposal before the Owner shall have considered the Proposals and awarded the Contract in respect thereof, at any time not later than 90 days after the Proposal closing date, the amount of the deposit accompanying this Proposal shall be forfeited to the Owner or the bid bond shall be enforced.
8. That, the awarding of the Contract by the Owner based on this Proposal, shall constitute acceptance of this Proposal.

9. That, if this Proposal is accepted, to furnish approved Surety Bonds for the proper fulfillment of the Contract as required and to execute the Contract documents, in triplicate, within 10 days after being notified to do so. In the event of default or failure on the part of the Bidder to do so, the Bidder agrees that the Owner shall be at liberty to retain the Proposal Deposit for the use of the Owner and to accept the next lowest or any Proposal or to advertise for new Proposals, or to carry out the works in any other way they deem best.
10. This Proposal Form comprises of:
 - 2.1 Proposal Submission
 - 2.2. Proposal Agreement
 - 2.3. List of Proposed Subcontractors
 - 2.4. Bidder's Experience in Similar Completed Work
 - 2.5. Bidder's Client and Consultant References in Similar Completed Work
 - 2.6. Ontario Provincial Standard Drawings (OPSD)
 - 2.7. Ontario Provincial Standard Specifications (OPSS)
 - 2.8. Contract Drawings
 - 2.9. Schedule of Unit Prices
 - 2.10. Cost Summary Schedule of Unit Prices
 - 2.11. Bid Bond and Agreement to Bond

2.2 Proposal Agreement

That, this Proposal is submitted by:

Firm Name

Address

Telephone Number

Email Address

The Bidder solemnly declares that the several matters stated in the foregoing Proposal are in all respects true.

Signature and Seal of Bidder

President/Signature and Seal

Witness

Date of Submission

2.3 List of Proposed Subcontractors

The General Information to Bidders requires the Bidder to list on this statement sheet the name of each proposed subcontractor. Listed hereunder are the names of all subcontractors, concrete ready-mix supplier, precast concrete supplier, building material supplier, etc., as applicable whom the Bidder proposes to use:

Sub-Trade	Proposed Subcontractor	Address	Approximate Value of Sublet Work

2.4 Bidder's Experience in Similar Completed Work

Location	Owner's Engineer	Description of Contract	Completion Date	Value (\$)

2.5 Bidder's Client and Consultant References in Similar Completed Work *(Minimum 3 References Required)*

Project	Completion Date	Owner	Consultant	Contact Information

2.6 Ontario Provincial Standard Drawings (OPSD)

It will be the Contractor's responsibility to obtain current copies of the Ontario Provincial Standard Drawings as listed below, which form part of this Contract.

OPSD	219.110 (Nov 2021) – Light-Duty Silt Fence Barrier
OPSD	219.130 (Nov 2021) – Heavy-Duty Silt Fence Barrier
OPSD	220.010 (Nov 2019) - Barrier for Tree Protection
OPSD	351.010 (Nov 2018) - Urban Residential Entrance
OPSD	802.030 (Nov 2015) - Rigid Pipe Bedding, Cover, and Backfill, Type 1 or 2 Soil – Earth Excavation
OPSD	802.031 (Nov 2015) - Rigid Pipe Bedding, Cover, and Backfill, Type 3 Soil – Earth Excavation
OPSD	802.032 (Nov 2015) - Rigid Pipe Bedding, Cover, and Backfill, Type 4 Soil – Earth Excavation
OPSD	802.033 (Nov 2015) - Rigid Pipe Bedding, Cover, and Backfill – Rock Excavation
OPSD	972.101 (Nov 2012) – Fence, Chain-Link Component – Barbed Wire
OPSD	972.102 (Nov 2012) – Fence, Chain-Link Component – Gate
OPSD	972.132 (Nov 2012) – Fence, Chain-Link Details and Table
OPSD	1101.020 (Nov 2018) – Valve Operator
OPSD	1103.010 (Nov 2018) – Concrete Thrust Blocks for Tees, Plugs, and Horizontal Bends
OPSD	1104.010 (Nov 2018) - Water Service Connection, 19 and 25 mm Diameter Sizes
OPSD	1109.011 (Nov 2020) - Cathodic Protection for PVC Watermain Systems
OPSD	1109.012 (Nov 2020) - Cathodic Protection of Existing Metallic Watermains, Exposed Service or Pipe Method
OPSD	1109.025 (Nov 2015) - Waterproofing of Splices
OPSD	2101.01 (Apr 2024) – Duct Installation in Trenches

2.7 Ontario Provincial Standard Specifications (OPSS)

It will be the Contractor's responsibility to obtain current copies of the Ontario Provincial Standard Specification Forms as listed below, which form part of this Contract.

MUNI.100 (Nov. 2024)	MUNI.405 (Nov. 2017)	MUNI.602 (Nov. 2017)	MUNI.1541 (Apr. 2019)
MUNI.102 (Nov. 2018)	MUNI.407 (Nov. 2021)	MUNI.603 (Nov. 2024)	MUNI.1801 (Nov. 2019)
MUNI.106 (Apr. 2023)	MUNI.408 (Nov. 2021)	MUNI.604 (Nov. 2017)	MUNI.1841 (Nov. 2019)
MUNI.120 (Nov. 2019)	MUNI.409 (Nov. 2023)	MUNI.609 (Nov. 2019)	MUNI.1842 (Nov. 2020)
PROV.127 (Apr. 2024)	MUNI.410 (Nov. 2018)	MUNI.614 (Nov. 2019)	MUNI.1850 (Nov. 2020)
MUNI.180 (Nov. 2021)	MUNI.411 (Nov. 2021)	MUNI.615 (Nov. 2022)	MUNI.1853 (Nov. 2018)
MUNI.182 (Nov. 2021)	MUNI.412 (Nov. 2018)	MUNI.616 (Apr. 2018)	MUNI.1860 (Nov. 2018)
MUNI.201 (Apr. 2019)	MUNI.421 (Nov. 2018)	MUNI.703 (Apr. 2019)	MUNI.2401 (Nov. 2019)
MUNI.202 (Nov. 2022)	MUNI.441 (Nov. 2021)	MUNI.706 (Apr. 2018)	Mutatis Mutandis
MUNI.203 (Nov. 2019)	MUNI.442 (Nov. 2020)	MUNI.772 (Apr. 2019)	
MUNI.206 (Apr. 2019)	MUNI.450 (Nov. 2021)	MUNI.801 (Nov. 2019)	
MUNI.301 (Nov. 2018)	MUNI.460 (Nov. 2018)	MUNI.802 (Nov. 2019)	
MUNI.310 (Nov. 2017)	MUNI.490 (Nov. 2020)	MUNI.803 (Apr. 2018)	

MUNI.311 (Nov. 2018)	MUNI.491 (Nov. 2017)	MUNI.804 (Nov. 2014)	
MUNI.314 (Nov. 2023)	MUNI.492 (Nov. 2020)	MUNI.805 (Nov. 2021)	
MUNI.351 (Nov. 2021)	MUNI.501 (Nov. 2017)	MUNI.902 (Nov. 2021)	
MUNI.353 (Nov. 2021)	MUNI.506 (Nov. 2017)	MUNI.903 (Nov. 2020)	
MUNI.401 (Nov. 2024)	MUNI.510 (Nov. 2018)	MUNI.904 (Nov. 2023)	
MUNI.402 (Nov. 2024)	MUNI.511 (Nov. 2019)	MUNI.905 (Nov. 2017)	
MUNI.403 (Nov. 2023)	MUNI.517 (Nov. 2021)	MUNI.1351 (Nov. 2024)	
MUNI.404 (Nov. 2017)	MUNI.518 (Apr. 2017)	MUNI.1359 (Nov. 2016)	

2.8 Contract Drawings

The work to be done under this Contract is shown on the Contract Drawings and are made a part of this Contract. A list of drawings in their entirety can be found in Section F. Contract drawings are included as a separate document. Additional drawings showing details in accordance with which the work is to be constructed may be furnished from time to time by the Engineer, if found necessary, to supplement or supersede the drawings hereto attached and such additional drawings shall thereupon become a part of this Contract.

The Contractor shall be governed by the figured dimensions, as given on the drawings. Where required dimensions are not shown in figures, the Contractor shall obtain the said dimensions from the Engineer before proceeding with the construction of the portion of the work to which they refer.

In every case, detailed drawings shall take precedence over general drawings. In no instance shall dimensions be scaled from drawings.

2.9 Schedule of Unit Prices

- Where alternative materials are specified, the Contractor shall bid a Unit Price for each alternative, but shall extend only the lowest unit price.

2.

cu.m	Denotes	Cubic Metre (1,000 litres)
m(v)	Denotes	Vertical Metre
m(l)	Denotes	Linear Metre
LS	Denotes	Lump Sum
EA	Denotes	Each
sq.m	Denotes	Square Metre
CSP	Denotes	Corrugated Steel Pipe
t	Denotes	Tonne (2,204.6 lbs)
cu.m(c)	Denotes	Compacted Cubic Metres
ha	Denotes	Hectare
hrs	Denotes	Hours

SCHEDULE OF UNIT PRICES

S. Burnett & Associates Limited

Project No. M20051

Page No. 27

Contractor:

Address:

Contract Title:

Town of Shelburne, Well 1 Upgrades

SCHEDULE A - Miscellaneous Items

ITEM NO.	DESCRIPTION	CONTRACT QUANTITY	UNIT	UNIT PRICE	CONTRACT TOTAL
A1	Mobilization / Demobilization	1.00	LS		
A2	Bonding and Insurance:				
a)	Bonding	1.00	LS		
b)	Insurances	1.00	LS		
A3	Supply and Maintain Contractor Site Office	1.00	LS		
A4	Allowances:				
a)	Hydro One and Bell	1.00	LS	\$7,000.00	\$7,000.00
b)	Material Testing	1.00	LS	\$5,000.00	\$5,000.00
A5	<u>Manufacturer's Representation At/During:</u>				
a)	Start-Up & Training	1.00	LS		
b)	Commissioning (2 Day) Reliability Run	1.00	LS		
c)	Warranty Period	1.00	LS		
A6	Environmental Mitigation Measures	1.00	LS		
A7	Utility Location & Construction Layout	1.00	LS		
A8	Supply, Erect and Maintain Signs and Traffic Control Devices and Maintain Traffic Flow	1.00	LS		
				SUBTOTAL:	

SCHEDULE OF UNIT PRICES

S. Burnett & Associates Limited

Project No. M20051

Page No. 28

Contractor:

Address:

Contract Title: Town of Shelburne, Well 1 Upgrades

SCHEDULE B - Pumphouse Work

ITEM NO.	DESCRIPTION	CONTRACT QUANTITY	UNIT	UNIT PRICE	CONTRACT TOTAL
B1	Grubbing, Stockpiling and Disposal Off-Site	1.00	LS		
B2	<u>Watermain Upgrades:</u>				
a)	Removal of Existing Contact Tanks and Associated Components (Excavation, Disposal, Dewatering, etc.)	1.00	LS		
b)	Capping of Existing Watermain	2.00	LS		
c)	Supply and Installation of 60 m of New 450 mm Dia. PVC Watermain Contact Piping (Including all Fittings)	60.00	m(l)		
d)	Supply and Installation of 11.5 m of New 150 mm Dia. PVC Watermain (Including all Fittings)	11.50	m(l)		
e)	Connection of Watermain to Distribution System and Pumphouse	1.00	LS		
f)	Supply & Connection of New Water Service from New Watermain into Building (c/w Mainstop, Curbstop & Valve Box)	1.00	LS		
g)	Pressure Testing, Swabbing, Disinfection, Flushing & Bacteriological Sampling	1.00	LS		
h)	Restoration of Existing Driveway (Including: Removal and Reinstatement of all Granular B & A)	1.00	LS		
i)	Supply and Installation of Rigid Box Insulation (0.6m x 2.4m x 50mm Thick Rigid Sheets)	20.00	sq.m		
B3	<u>Structural / Site Work:</u>				
a)	Construction of Interior Masonry Block Wall for the Chemical Room (Includes Connections to Existing Wall/Roof and Painting)	1.00	LS		
b)	Removal of Existing Containment Curb and Reinstating Floor	1.00	LS		
c)	Supply and Installation of New 1.8m High Chain Link Fence and Removal of Existing Fence Section	1.00	LS		
d)	Supply and Installation of Concrete Pad for Generator	1.00	LS		
e)	Supply and Installation of Bollards	5.00	Ea.		
f)	Supply and Installation of Chemical Room Door Assembly	1.00	LS		
g)	Supply and Installation of Main Room Exterior Door Assembly	1.00	LS		
				SUBTOTAL:	

SCHEDULE OF UNIT PRICES

S. Burnett & Associates Limited

Project No. M20051

Page No. 29

Contractor:

Address:

Contract Title:

Town of Shelburne, Well 1 Upgrades

SCHEDULE B - Pumphouse Work CON'T

ITEM NO.	DESCRIPTION	CONTRACT QUANTITY	UNIT	UNIT PRICE	CONTRACT TOTAL
h)	Wall Penetration and Lockable Access Door for Bulk Chemical Hose Entry to Chemical Room	1.00	LS		
i)	Site Grading	1.00	LS		
j)	Site Restoration and Supply & Place Topsoil & Hvdroseed to all Disturbed Areas	1.00	LS		
B4	<u>Pumphouse Treatment Upgrades:</u>				
a)	Supply of Pre-select UV System by H2Flow	1.00	LS		
b)	All Coordination and Installation Costs by the General Contractor Related to Items B4 a) Including Final Positioning Installation of All Equipment etc.	1.00	LS		
c)	Supply and Installation of Motorized Valve	1.00	LS		
d)	Supply and Installation of Raw Water Turbidity Meter	1.00	LS		
e)	Relocation and Connection of Treated Water Turbidity Meter and Chlorine Analyzer	1.00	LS		
f)	Supply & Installation of New Prominent Chemical Pumps (c/w Chemical Panel and a Duty/Standby Pump for each Chemical)	1.00	LS		
g)	Supply and Installation of Chemical Day Tanks and Secondary Containment Skids	1.00	LS		
h)	Removal, Capping, and Grouting of Existing Process Piping	1.00	LS		
i)	Supply and Installation of Pre-Distribution Chlorine Analyzer and Control Panel	1.00	LS		
				SUBTOTAL:	

SCHEDULE OF UNIT PRICES

S. Burnett & Associates Limited

Project No. M20051

Page No. 30

Contractor:

Address:

Contract Title:

Town of Shelburne, Well 1 Upgrades

SCHEDULE C - Electrical & Mechanical Work

ITEM NO.	DESCRIPTION	CONTRACT QUANTITY	UNIT	UNIT PRICE	CONTRACT TOTAL
C1	<u>Electrical Demolition:</u>				
a)	Demolition of existing Electrical Equipment in Well No. 1 Building	1.00	LS		
C2	<u>Electrical Installations:</u>				
a)	Secondary ductbank including conduit and cable guards at hydro pole	1.00	LS		
b)	Communication Ductbanks (No.1 and No.2)	2.00	Ea.		
c)	Generator Ductbank	1.00	LS		
d)	Handhole	1.00	LS		
e)	Grounding System	1.00	LS		
f)	Main Breaker	1.00	LS		
g)	Utility Metering Cabinet and Meter Base Install	1.00	LS		
h)	MCC including ATS, Feeder Breakers, Soft-Starter	1.00	LS		
i)	MCC SPD	1.00	LS		
j)	LP-A SPD	1.00	LS		
k)	Lighting Panel and Transformer	1.00	LS		
l)	Stand-by Power Generator	1.00	LS		
m)	Lighting including Power Cable and Conduit	1.00	LS		
n)	Receptacles including Power Cable and Conduit	1.00	LS		
o)	Electric Heaters	1.00	LS		
p)	HVAC Power and Controls	2.00	Ea.		
q)	UV System Power and Control Wiring	1.00	LS		
r)	Process Equipment Instrumentation, Power and Control Wiring	1.00	LS		
				SUBTOTAL:	

SCHEDULE OF UNIT PRICES

S. Burnett & Associates Limited

Project No. M20051

Page No. 31

Contractor:

Address:

Contract Title:

Town of Shelburne, Well 1 Upgrades

SCHEDULE C - Electrical & Mechanical Work CON'T

ITEM NO.	DESCRIPTION	CONTRACT QUANTITY	UNIT	UNIT PRICE	CONTRACT TOTAL
r)	Autodialler Alarm Output Programming	1.00	LS		
s)	New PLC and Programming and SCADA Communication Equipment	1.00	LS		
C3	<u>General Mechanical Requirements:</u>				
a)	Air Balancing Report	1.00	LS		
C4	<u>Mechanical Demolition:</u>				
a)	Demolition of Mechanical Equipment	1.00	LS		
C5	<u>Mechanical Installations:</u>				
a)	Exhaust Fans (EF-1 and EF-2)	2.00	Ea.		
b)	Motorized Dampers (MD-1aa, MD-1ab, MD-1b, MD-2a, MD-2b)	5.00	Ea.		
c)	Louvres (LV-1aa, LV-1ab, LV-2)	3.00	Ea.		
d)	Ductwork	1.00	LS		
e)	Supply Air Grille (S1)	1.00	LS		
f)	Backflow Preventer (BFP-1)	1.00	LS		
g)	Pressure Reducing Valve (PRV-1)	1.00	LS		
h)	Electronic Trap Seal Primer (TSP-1)	1.00	LS		
i)	Electric Hot Water Tank (HWT-1)	1.00	LS		
j)	Emergency Eyewash (EW-1)	1.00	LS		
k)	Expansion Tank (EX-1)	1.00	LS		
l)	Domestic Water Piping and Insulation	1.00	LS		
m)	Controls	1.00	LS		
				SUBTOTAL:	

SCHEDULE OF UNIT PRICES

S. Burnett & Associates Limited

Project No. M20051

Page No. 32

Contractor:

Address:

Contract Title:

Town of Shelburne, Well 1 Upgrades

SCHEDULE D - Contingencies

ITEM NO.	DESCRIPTION	CONTRACT QUANTITY	UNIT	UNIT PRICE	CONTRACT TOTAL
D1	Supply and Installation of 150 mm dia. Watermain Shutoff Valve	2.00	Ea.		
D2	Supply, Place & Compact Granular including Excavation & Disposal of Existing Material:				
a)	Granular A	50.00	cu.m.		
b)	Granular B	50.00	cu.m.		
c)	19mm Clear Stone	25.00	cu.m.		
d)	Rip-Rap	25.00	cu.m.		
e)	Pre-mixed Concrete (25 MPA)	10.00	cu.m.		
D3	<u>Labour Rates for Additional Work:</u> (The rate shall include payroll burden, overhead & profit)				
a)	Project Manager	20.00	hrs		
b)	Site Supervisor / Foreman	20.00	hrs		
c)	Electrician	20.00	hrs		
d)	PLC Programmer	20.00	hrs		
e)	SCADA System Programmer	20.00	hrs		
f)	Plumber / Pipe Fitter	20.00	hrs		
g)	Ventilation System Installer	20.00	hrs		
h)	General Labourer	20.00	hrs		
i)	Operator	20.00	hrs		
D4	Supply & Install Additional Replacement Valves and Components within Pumphouse:				
a)	100 mm Gate Valve	2.00	Ea.		
b)	150 mm Gate Valve	2.00	Ea.		
c)	200 mm Gate Valve	2.00	Ea.		
				SUBTOTAL:	

2.10 Cost Summary Schedule of Unit Prices

COST SUMMARY SCHEDULE OF UNIT PRICES

S. Burnett & Associates Limited

Project No: M20051

Contractor:

Address:

Contract Title: Town of Shelburne, Well 1 Upgrades

DESCRIPTION	CONTRACT TOTAL
SCHEDULE A: Miscellaneous Items	\$
SCHEDULE B: Pumphouse Work	\$
SCHEDULE B: Pumphouse Work Cont'd	\$
SCHEDULE C: Electrical & Mechanical Work	\$
SCHEDULE C: Electrical & Mechanical Work Cont'd	\$
SCHEDULE D: Contingencies	\$

SUBTOTAL: \$

HST 13%: \$

TOTAL: \$

Estimated Cost of Material to be incorporated in the work: \$

Estimated Cost of Labour and all Other Charges: \$

Total (Must Equal Total Proposal Price): \$

A certified cheque or Bid Bond for the sum of: \$ is enclosed.
(Minimum of \$)

2.11 Bid Bond and Agreement to Bond

(EXAMPLE)

BID BOND

\$

No.

KNOW ALL MEN BY THESE PRESENTS, that

as Principal, hereinafter called Principal, and

as Surety, hereinafter called Surety, are held and firmly bound unto

as Oblige, hereinafter called Oblige, in the full and just sum of _____ Dollars (\$)

lawful money of Canada, for the payment of which sum, well and truly to be made, the Principal and the Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

SIGNED, SEALED AND DATED this _____ day of _____, 20____.

WHEREAS, the Principal has submitted a written Proposal to the Oblige, dated the ____ day of _____, 20____ for

NOW, THEREFORE, the condition of this obligation is such that if the Principal shall have the said Proposal accepted within sixty days from the closing date of the Proposal call and shall enter into a contract with the Oblige and furnish a Performance Bond and a Labour and Material Payment Bond each in the amount of 100% of the contract and satisfactory to the Oblige or other acceptable security, then this obligation shall be void, otherwise to remain in full force and effect.

PROVIDED, HOWEVER, that the Surety shall not be (a) liable for a greater sum than the specified penalty of this bond nor (b) liable for a greater sum than the difference between the amount of the Principal's Proposal and the amount of the Proposal that is accepted by the Oblige nor (c) subject to any suit or action unless such suit or action is instituted and process therefor served upon the Surety at its Head Office in Canada, within twelve months from the date of this bond.

IN TESTIMONY WHEREOF, the Principal has hereto set its hand and affixed its seal, and the Surety has caused these presents to be sealed with its corporate seal duly attested by the signature of its authorized signing authority, the day and year first above written.

Name of Contracting Company (Co. Seal)

Name of Bonding Company (Co. Seal)

Signature

Signature

(EXAMPLE)

AGREEMENT TO BOND

We, the undersigned, hereby agree to become bound as Surety for

in a Performance Bond in an amount equal to 100% of the total Bid price and a Payment Bond in an amount equal to 100% of the Contract amount, and conforming to the instruments of Contract attached hereto, for the full and due performance of the works shown as described herein if the Proposal for:

_____ is accepted by the Owner.

It is a condition of this Agreement that if the above-mentioned Proposal is accepted, application for a Performance and Payment Bond must be completed with the undersigned within 15 days of acceptance of the Proposal related thereto, otherwise this Agreement shall be null and void.

DATED this _____ day of _____, 20____.

EXAMPLE

Name of Contracting Company

Name of Bonding Company

for Contracting Co.
(Seal)

Signature of Authorized Person
Signing for Bonding Company (Seal)

Position

Position



Section C

Articles of Agreement

Articles of Agreement

THIS AGREEMENT made the <day> day of <Month> , 2026.

BY AND BETWEEN:

"Contractor's Name"

(herein and throughout the Contract Documents called the "Contractor")

and

Town of Shelburne

(herein and throughout the Contract Documents called the "Owner")

WITNESSETH

That the Owner and the Contractor in consideration of the fulfillment of their respective promises and obligations herein set forth covenant and agree with each other as follows:

ARTICLE I

- a. This Agreement applies to the supply of all labour, materials and equipment necessary for the construction of works indicated on the Contract Drawings and described in the Contract Documents for the Town of Shelburne, Well 1 Upgrades project.
- b. This Agreement, together with all Sections, Drawings, and Appendices of the Contract Documents constitute the "Contract" and are to be read herewith and form part of the Contract as fully and completely to all intents and purposes as through all the stipulations thereof had been embodied herein.
- c. That the date from which this Contract is to be in force is the <day> day of <Month> , 2025.
- d. Three (3) copies of the Contract have been signed for identification by both parties, which copies have been prepared by S. Burnett & Associates Limited, 210 Broadway, Unit 203, Orangeville, Ontario, L9W 5G4 acting as, and herein (and throughout the Contract) entitled the "Engineer".

ARTICLE II

THE CONTRACTOR UNDERTAKES AND AGREES:

- a. To do all the work and furnish all the labour, materials, tools, plant, appliances and transportation necessary or proper for the performing and completing of the work required under this Agreement, as set forth in the plans and specifications and in the manner and within the time specified in Section B: Bidder Information, Section 1.18, Construction Period, Working Days and Liquidated Damages.

The said plans and specifications are intended to cover and provide for proper completed work in all respects, and everything necessary to carry out this intent which may reasonably be implied from the plans and specifications must be done by the Contractor, even if not particularly referred to in the plans and specifications.

- b. To complete the work described in this Contract within the allotted time schedule.

All requests for extensions of said completion dates shall be by registered mail to the Owner and the decision of the Engineer with respect to such requests is to be considered final and binding upon the Contractor and the Owner.

- c. The Contractor shall guarantee the work free from any defects in materials and workmanship under normal operating conditions throughout the Period of Guaranteed Maintenance as defined in Section B: Bidder Information, Section 1.19, Preliminary Acceptance, Guaranteed Maintenance Period, Final Acceptance and Release of Holdback.
- d. The decision of the Engineer is to be final and binding on the Contractor and the Owner as to the nature and cause of any imperfections and as to the remedy required for each and as to which party shall bear the cost of such remedy. Failure to comply with the directions of the Engineer within 48 hours after written notice may result in the Engineer having the work performed by others and the cost thereof being deducted from the amount due to the Contractor.
- e. To furnish the following articles to validate this Contract:
 - i. 100% Performance Bond and 100% Labour and Material Payment Bond.
 - ii. Evidence of Liability and All Risk Insurance as per General Conditions of Contract in GC6, and following Section B2.
 - iii. Current Clearance Certificate from Workplace Safety & Insurance Board.
 - iv. Health & Safety Policy documentation.

- f. To furnish the items listed in Section 1.19 of Section B Bidder Information, prior to Release of Holdback and following the Owner's Final Acceptance of the work and prior to the Contractor being released from their responsibility.

ARTICLE III

THE OWNER UNDERTAKES AND AGREES:

- a. To provide the Contractor with access to and use of their lands and premises to such extent as may be necessary for the continuous and unrestricted prosecution of the Contractor's operation.
- b. That the Contractor shall receive payment for work done, and materials supplied according to the unit prices contained in the Proposal Form, in accordance with the provisions of this Contract. The unit prices will be applied by the Engineer to the actual quantities of work and materials supplied by the Contractor whether these quantities be more or less than those estimated on the said Proposal Form or shown on the Contract Drawings.
- c. That the Contractor shall receive payments monthly, or one (1) payment the month following completion of the work should the said work be completed in one (1) calendar month or less, at the rate of 88 percent (88%) of the work actually done and materials in place, according to the estimate of the Engineer, less all forfeitures and deductions provided for in the Contract. These payments shall be authorized on Contract Payment Certificates issued by the Engineer, which will be based upon approximate estimates only, and must not be construed as an acceptance of the work so estimated or as an admission of liability by the Owner in respect thereof.

Within 60 days following the date of preliminary acceptance, when all the work has been substantially completed in accordance with the Contract, a Substantial Performance Payment Certificate will be issued by the Engineer at the rate of 98 percent (98%) of the whole amount due under this Contract.

Within 30 days following the date of Final Acceptance, a Completion Payment Certificate will be issued by the Engineer for the balance of contract funds, including remaining 2 percent (2%) Warranty Holdback amount, due to the Contractor.

ARTICLE IV

All communications in writing between the parties, or between them and the Engineer, shall be deemed to have been received by the addressee:

- .1 if delivered personally, on the day that it was delivered;
- .2 if forwarded by mail, on the day it was received if earlier, or the sixth day after it was mailed;
- .3 if forwarded by facsimile or electronic mail (e-mail), 24 hours after it was transmitted;
- .4 if sent by prepaid registered mail and will be considered having been so given on the second next business day after deposit thereof in the post office.

If addressed to the party to whom it is intended at the address in the Contract or at the last address of which the sender has received written notice in accordance with this Section:

The Contractor at:	"Contractor Name"
	Address
	"City, Province, Postal"

And to the Owner at:	Town of Shelburne
	203 Main Street East
	Shelburne, ON L9V 3K7

And to the Engineer at:	S. Burnett & Associates Limited
	210 Broadway, Unit 203
	Orangeville, ON L9W 5G4

ARTICLE V

This Agreement shall ensure to the benefit of and be binding upon the parties hereto and their respective successors, executors, administrators and assigns.

IN WITNESS WHEREOF the Contractor and the Owner have respectively affixed their corporate seals and the hands of their proper officers on or about the day and year first above written.

"Contractor's Name"

Contractor

For the Contractor / Signature & Seal

Date Signed

Town of Shelburne

Owner

For the Owner / Signature & Seal

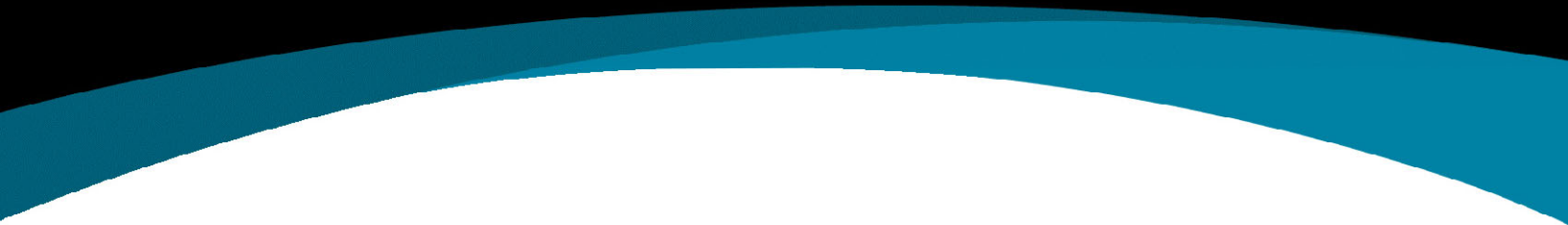
Date Signed

S. Burnett & Associates Limited

Engineer

Witness

Date Signed



Section D

Special Provisions

Special Provisions Table of Contents

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1. GENERAL REQUIREMENTS

- 1.1 The following Specifications apply specifically to the individual items of work listed in Sections A, B, C and D: Schedule of Unit Prices. The purpose of these Special Provisions is to list the work which shall be performed or to infer beyond reasonable doubt the work, which is required, under the items in Schedule A: Miscellaneous, Schedule B: Pumphouse Work, Schedule C: Electrical and Mechanical Work (N/A) and Schedule D: Contingencies.

The prices bid for all work included within all the Schedules, unless otherwise directed in the following specifications, shall be compensation in full for the complete supply of all labour, equipment and materials necessary to construct the work as specified in, shown on, or is reasonably inferable from, the Contract Specifications and Drawings.

- 1.2 The quantities shown for the items in Schedule A: Miscellaneous, Schedule B: Pumphouse Work, Schedule C: Electrical and Mechanical Work (N/A), and Schedule D: Contingencies are approximate only and subject to the stipulation of the General Conditions, are for the purpose of indicating to Bidders the general magnitude of the work and for comparison of Proposals received. Bidders shall prepare their Proposals with the foregoing in mind and ensure that overhead and other fixed costs are realistically apportioned amongst the items.
- 1.3 The site of which the work is to be performed is located within the Town of Shelburne. The Contractor and their forces shall maintain an appropriate and cooperative manner in the town at all times. Response to staff's concern or issue must be addressed by the Contractor in a timely manner and fully resolved within five (5) working days.
- 1.4 The Township maintains the right to remove any person from the site for inappropriate behavior or violation of laws.

2. SCHEDULE A: Miscellaneous

Item A1: Mobilization / Demobilization

The Contractor shall enter a lump sum amount for mobilization and demobilization, as well as for additional labour, equipment or materials required to complete the Contract but not specifically covered by or related to the other items in the Schedule of Items and Prices. Payment shall be full compensation for all the work necessary to carry out the following works:

- Mobilization (all costs associated with full mobilization to site for the duration of the project).
- Providing an initial construction schedule and updating monthly.
- Completing a pre-construction photo record.
- On-site washroom facilities.

- Site Meetings with the Contract Administrator and Town of Shelburne, as required.
- Site clean-up including removal of debris and construction materials.
- Demobilization: All costs associated with full demobilization from site following successful completion of project.

Basis of Payment

Partial payments will be made on the following basis:

- 60% upon mobilization, providing an initial construction schedule to the satisfaction of the Contract Administrator.
- 40% upon satisfactory site clean-up and demobilization to the satisfaction of the Contract Administrator.

Item A2 a) & b): Bonding & Insurance Requirements

The lump sum price bid for this Item shall be full compensation for providing all bonds and insurance as specified in Section B: Bidder Information, within the Contract Document.

Basis of Payment

One hundred percent (100%) of the price bid for this Item will be paid on the first payment certificate, subject to proof of Contractor issuance of bonding and insurances.

Item A3: Supply and Maintain Contractor's Site Office

Concurrent with mobilization the Contractor shall provide a Contractor site office.

Basis of Payment

Payment for this Item shall be pro-rated over the length of the construction period proportionate to the value of work completed relative to the total estimated value of the Contract.

Item A4: Allowances

a) Hydro One and Bell

This cash allowance is intended to cover all associated fees from coordination with Hydro One and Bell.

Basis of Payment

Hydro One and Bell will invoice the General Contractor for electrical work that has been approved by the Engineer.

Portions of the allowance listed will only be paid to the Contractor when there is evidence that the Contractor has paid Hydro One or Bell. The Contractor shall not be eligible for any markup on any invoiced amounts.

b) Material Testing

This cash allowance is intended to cover all materials testing as deemed necessary by the Engineer for this project. The Engineer will coordinate all required testing for soils and concrete with the geotechnical consultants.

Should testing results indicate deficient work, the Contractor shall pay for costs associated with any additional testing as required by the Engineer to verify acceptability of work.

Basis of Payment

The geotechnical consultant will invoice the General Contractor on a monthly basis, for material testing that has been completed and approved by the Engineer.

Portions of the allowance listed will only be paid to the Contractor when there is evidence that the Contractor has paid the geotechnical consultant. The Contractor shall not be eligible for any markup on any invoiced amounts from the geotechnical consultant.

Item A5: Manufacturer's Representation At/During:

The Contractor shall include a lump sum amount relative to the supplier and manufacturer labour support required for the following project phases. This lump sum item shall also include all sampling and testing apparatuses, material and equipment required to complete testing, and/or the warranty phase. The project works shall not be connected to the Town's water distribution system until Start-up and Commissioning has been successfully completed. During all testing, the water shall be discharged to the environment and the Contractor shall use a hose, diffuser and dechlorination measures to prevent damage to surrounding areas. The Contractor shall submit a plan for test water discharge to the Engineer for approval prior to proceeding.

a) Start-up & Training:

Material, equipment and labour requirements to shall conform to the requirements identified in Specification 01725: Commissioning, Start-Up and Warranty Period Inspection Requirements and Specification 01726: Operator Training.

Basis of Payment

Payment for this item, including full compensation for all labour, equipment, materials required to achieve the specifications of this item, shall be on a lump sum basis. Should additional Start-up and Training time be required, this will be at the Contractor's expense including all Engineer's associated costs.

Partial payments will be made on the following basis:

- 10% prior to completion of the start-up and training phase to support coordination for labour, equipment and material required to initiate the training of the operator(s).
- 90% upon successful completion of the start-up and training phase, pending approval by the Engineer and the Town of Shelburne.

b) Commissioning (2 Day) Reliability Run:

Material, equipment and labour requirements to shall conform to the requirements identified in Specification 01725: Commissioning, Start-Up and Warranty Period Inspection Requirements and Specification 01726: Operator Training.

Basis of Payment

Payment for this item, including full compensation for all labour, equipment, materials required to achieve the specifications of this item, shall be on a lump sum basis. Should additional time for the Commissioning and Reliability Run be required, this will be at the Contractor's expense including all Engineer's associated costs.

Partial payments will be made on the following basis:

- 10% prior to completion of the commissioning phase to support coordination for labour, equipment and material required to the Commissioning and Reliability Run.
- 90% upon successful completion of the commissioning phase, pending approval by the Engineer and the Town of Shelburne.

c) Warranty Period:

Material, equipment and labour requirements shall conform to the requirements identified in Specification 01725: Commissioning, Start-Up and Warranty Period Inspection Requirements.

Basis of Payment

Payment for this item, including full compensation for all labour, equipment, and materials required to achieve the specifications of this item, shall be on a lump sum basis upon successful completion of the warranty phase, pending approval by the Engineer and Town of Shelburne.

Item A6: Environmental Mitigation Measures

The Contractor shall take all reasonable precautions to prevent silt release from entering any waterway. These precautions shall include, but not be limited to, silt fences around stockpiled earth and topsoil, pump discharges onto grass flats, rock flow check dams and sediment traps. The Contractor shall also ensure all water discharged to the environment is dechlorinated using methods approved by the Engineer. All measures shall be in accordance with the standard details provided herein. Upon completion of the work, accumulated silt and debris shall be removed from the site along with the silt trap and sediment fence.

Basis of Payment

Payment for this Item shall be pro-rated over the length of the construction period proportionate to the value of work completed relative to the total estimated value of the Contract.

Item A7: Utility Location & Construction Layout

The lump sum price bid for this Item shall be compensation in full for all labour, equipment and materials required by the Contractor for all utility locations and construction layout of elevations and alignment of the proposed work in accordance with accepted survey procedures. Using qualified personnel and following accepted engineering practices, the Contractor shall calculate, layout, establish and maintain all lines and grades necessary for the construction and verification of the work. They shall provide such information on the calculations, layout, lines and grades at the request of the Contract Administrator. The Contractor shall coordinate on-site construction locates.

Basis of Payment

Payment for this Item shall be pro-rated over the length of the construction period proportionate to the value of work completed relative to the total estimated value of the Contract.

Item A8: Supply, Erect & Maintain Signs and Traffic Control Devices, and Maintain Traffic Flow

Under this Item, the Contractor shall be responsible for the supply, erection and maintenance of signs, barriers, traffic control and coordination within the Town of Shelburne during construction.

Payment for this Item, including full compensation for all labour, equipment, materials required to achieve the specifications of this Item, shall be on a lump sum basis.

The Contractor shall provide and maintain signs, fencing and barriers to prohibit the public, including pedestrians from entering the specified construction areas. All damages arising from insufficient protection of the site will be wholly the responsibility of the Contractor.

All traffic control / protection measures shall be inspected and maintained daily during construction.

If, in the opinion of the Contract Administrator or Town of Shelburne, proper traffic control is not maintained within the Town of Shelburne, the Contractor shall immediately modify the operation to the satisfaction of the Contract Administrator. If the Contractor fails to take immediate action, the Contract Administrator may take such action, as they consider necessary and/or required, and deduct the cost from monies owing to the Contractor. The performance of such work under the direction of the Contract Administrator shall in no way relieve the Contractor from any responsibility or damages that may occur during the performance of any traffic control measures after such precautions have been carried out by the Contract Administrator.

Basis of Payment

Payment for this Item shall be pro-rated over the length of the construction period proportionate to the value of work completed relative to the total estimated value of the Contract.

3. SCHEDULE B: Pumphouse Work

Item B1: Grubbing, Stockpiling and Disposal Off-Site

The Contractor shall clear, grub, stockpile and dispose of all necessary materials off site. The Contractor shall be responsible for maintaining material stockpiles with proper environmental mitigation measures. The Contractor shall remove and dispose of all unused material to an approved location designated by the Town of Shelburne.

Basis of Payment

Refer to schedule of unit prices for basis of payment. The Contractor shall include in the price bid for this item all labour, equipment and materials required to clear and grub the construction areas. The Contractor shall include costs associated with hauling in the bid price.

Item B2: Watermain Upgrades

Item B2 a): Removal of Existing Contact Tanks and Associated Components (Excavation, Disposal, Dewatering, etc.)

The Contractor shall excavate, remove, and dispose of the existing two (2) contact tanks and associated components. The associated components include shut off valves and watermain piping for tank connections. The Contractor is responsible for ensuring the excavation does not compromise the existing building structure. The Town of Shelburne has the first right of refusal for all removed components.

Basis of Payment

Payment for this item, including full compensation for all labour, equipment, materials required to achieve the specifications of this item, shall be on a lump sum basis.

Item B2 b): Capping of Existing Watermain

The Contractor shall supply and install two (2) end caps to the existing watermain leaving the building that supplies the existing contact tanks. Caps shall be installed with restraints and appropriate concrete thrust blocks.

Basis of Payment

Payment for this item, including full compensation for all labour, equipment, materials required to achieve the specifications of this item, shall be paid per end cap installed.

Item B2 c): Supply and Installation of 60m of New 450mm dia. PVC Watermain Contact Piping (Including All Fittings)

Reference:

- OPSS.MUNI 180, 201, 401, 441, & 442
- Section C: Specifications
- Contract Drawings and Details.

The Contractor shall provide a unit price for installation of the watermain. Payment shall be made under this Item for the supply of all labour, equipment and materials required to install new watermain as shown on the Contract Drawings. As indicated in the Schedule of Unit Prices and Contract Drawings, the Contractor shall provide a unit cost for installation of 60m of 450mm watermain at a minimum burial depth of 1.8m. Shall also include all restraints, thrust blocks, bedding material, backfill, and compaction. The watermain shall be insulated over the driveway area with Rigid Box Insulation (0.6m x 2.4m x 50mm Thick Rigid Sheets).

Basis of Payment

Refer to Schedule of Unit Prices for basis of payment. The Contractor shall include in the price bid for this item all labour, equipment and materials required to install new watermain as shown on the Contract Drawings.

All costs for clearing, grubbing, stripping, stockpiling and final restoration associated with the installation of the new watermain shall be included Item B1 and B2 h). Costs for insulation of the watermain shall be included in Item B2 i).

Item B2 d): Supply and Installation of 11.5m of New 150mm dia. PVC Watermain (Including All Fittings)

Reference:

- OPSS.MUNI 180, 201, 401, 441, & 442
- Section C: Specifications
- Contract Drawings and Details.

The Contractor shall provide a unit price for installation of the watermain. Payment shall be made under this Item for the supply of all labour, equipment and materials required to install new watermain as shown on Contract Drawings. As indicated in the Schedule of Unit Prices and Contract Drawings, the Contractor shall provide a unit cost for installation of 150mm watermain at a minimum burial depth of 1.8 m. Shall include all restraints, thrust blocks, bedding material, backfill, and compaction. The watermain shall be insulated over the driveway area with Rigid Box Insulation (0.6m x 2.4m x 50mm Thick Rigid Sheets).

Basis of Payment

Refer to Schedule of Unit Prices for basis of payment. The Contractor shall include in the price bid for this item all labour, equipment and materials required to install new watermain as shown on Contract Drawings.

All costs for clearing, grubbing, stripping, stockpiling and final restoration associated with the installation of the new watermain shall be included Item B1 and B2 h). Costs for insulation of the watermain shall be included in Item B2 i).

Item B2 e): Connection of Watermain to Distribution System and Pumphouse

Reference:

- OPSS.MUNI 401& 441
- Section C: Specifications
- Contract Drawings and Details.

Under this Item and for the Contract price, the Contractor shall supply all materials and shall perform all work necessary to connect the new watermain to the existing watermain at the locations shown on the Contract Drawings or as directed by the Contract Administrator. Connection to existing watermain shall be completed by connecting the existing 150mm diameter watermain to the new proposed 150mm diameter shut-off valve installed in item B2 d). The watermain will be connected to the pumphouse by connecting to the existing 150mm diameter shut-off valve located on the east side of the existing building.

Connection to existing watermain shall be made only after the section of the water distribution system has been isolated and the new main has been fully commissioned, and the project works have been successfully commissioned in accordance with Specification 01725: Commissioning, Startup and Warranty Period Inspection Requirements, including chlorination, testing, and flushing. Extreme care shall be taken to prevent contamination of the existing watermain, and new closure fittings shall be rinsed with a high chlorine solution prior to installation.

Basis of Payment

Payment at the Contract price shall be compensation in full for this work. The SBA inspector and Town of Shelburne Public Works Operator shall be scheduled and present on-site when connections are being made. The Contractor shall provide a minimum of 48 hours' notice.

Item B2 f): Supply & Connection of New Water service from New Watermain into Building (c/w Mainstop, Curbstop & Valve Box)

The Contractor shall supply and install a 19mm diameter copper service line from the location indicated on the drawings and to be cored through the slab of the building. Water service to be installed using a saddle on the 150mm diameter watermain, complete with a mainstop, curbstop and valve box.

Basis of Payment

Refer to Schedule of Unit Prices for basis of payment. The Contractor shall include in the price bid for this item all labour, equipment and materials required to install the new water service and associated components as shown on Contract Drawings.

Item B2 g): Pressure Testing, Swabbing, Disinfection, Flushing & Sampling

The Contractor shall commission the watermain per the requirements of Specification 02238: Watermains including pressure testing, super chlorination, flushing and swabbing. The Contractor shall submit a swabbing and flushing methodology to the Engineer for approval at least seven (7) days prior to proposed flushing and swabbing date. The methodology shall include swab size, routing and launch and retrieval locations. Flushing shall be completed until the water flows clear, and an acceptable level of chlorine residual is achieved. The Engineer shall witness the chlorine residual test performed by the Contractor. The Contractor shall use a hose, diffuser and dechlorination measures to prevent damage to surrounding areas.

Basis of Payment

Payment at the Contract price shall be compensation in full for this work. The SBA inspector and Town of Shelburne Public Work Operator shall be scheduled and present on-site for these scopes of work. The Contractor shall provide a minimum of 48 hours' notice.

Item B2 h): Restoration of Existing Driveway (Including: Removal and Reinstatement of All Granular B & A)

The Contractor shall reinstate the existing driveway with 300mm of granular B and 150mm of granular A to match the existing driveway width before the watermain excavation. Material shall be compacted to minimum 98% SPD.

Basis of Payment

Payment at the Contract price shall be compensation in full for this work as stipulated in the Schedule of Unit Prices.

Item B2 i): Supply and Installation of Rigid Box Insulation (0.6m x 2.4m x 50mm Thick Rigid Sheets)

The Contractor shall supply and install 50mm thick rigid insulation over the new watermain to span the full area of the driveway. Insulation shall be placed continuously over top of the watermain cover material.

Basis of Payment

Payment at the Contract price shall be compensation in full for this work as stipulated in the Schedule of Unit Prices.

Item B3: Structural/Site Work

Item B3 a): Construction of Interior Masonry Block Wall for the Chemical Room

The Contractor shall supply and install a 140mm thick, interior masonry block wall to enclose the chemical room. Work shall include connections to the existing walls and floor, spray foam insulation between the top of the wall and the existing ceiling and painting to match the existing interior colour.

Basis of Payment

Payment at the Contract price shall be compensation in full for this work as stipulated in the Schedule of Unit Prices.

Item B3 b): Removal of Existing Containment Curb and Reinstating Floor

The Contractor shall remove the existing containment curb in the chemical room. The Contractor shall reinstate the floor area to be flush with the existing floor. The Contractor shall reinstate the area with an epoxy coating to match the existing.

Basis of Payment

Payment at the Contract price shall be compensation in full for this work as stipulated in the Schedule of Unit Prices.

Item B3 c): Supply and Installation of New 1.8m High Chain Link Fence and Removal of Existing Fence Section

The Contractor shall supply and install a 1.8m high chain link fence to enclose the generator area. The Contractor shall remove the existing fence section as indicated on the contract drawings. Contractor to follow the fence specifications indicated on the drawings.

Basis of Payment

Payment at the Contract price shall be compensation in full for this work as stipulated in the Schedule of Unit Prices.

Item B3 d): Supply and Installation of Concrete Pad for Generator

The Contractor shall supply and install a concrete slab on grade with steel reinforcement and compacted granular material as shown on Detail 7 of Drawing A5.1.

Basis of Payment

Payment at the Contract price shall be compensation in full for this work as stipulated in the Schedule of Unit Prices.

Item B3 e): Supply and Installation of Bollards

The Contractor shall supply and install concrete bollards in front of the proposed generator as indicated on the drawings. Contractor to follow the bollard specifications indicated on the drawings.

Item B3 f): Supply and Installation of Chemical Room Door Assembly

The Contractor shall supply and install a 914mm W, 2184mm H, HM door complete with all associated hardware and finishes. Refer to the door schedule in the Contract Drawings.

Basis of Payment

Payment at the Contract price shall be compensation in full for this work as stipulated in the Schedule of Unit Prices.

Item B3 g): Supply and Installation of Main Room Exterior Door Assembly

The Contractor shall supply and install a 914mm W, 2184mm H, HM door complete with all associated hardware and finishes. Refer to the door schedule in the Contract Drawings.

Basis of Payment

Payment at the Contract price shall be compensation in full for this work as stipulated in the Schedule of Unit Prices.

Item B3 h): Wall Penetration and Lockable Access Door for Chemical Hose in Chemical Room

The Contractor shall supply and install a 200mm-by-200mm lockable, steel access door in the wall of the chemical room. Access door to be insulated with rigid R28 insulation on the inside of the door. Installation shall include a 10mm thick steel plate with 75mm bearing on both sides.

Basis of Payment

Payment at the Contract price shall be compensation in full for this work as stipulated in the Schedule of Unit Prices.

Item B3 i): Site Grading

The Contractor shall grade soil, eliminating uneven areas and low spots, ensuring positive drainage as shown on the drawings. Remove debris, roots, branches, stones in excess of 50mm diameter and other deleterious materials from the existing grade. Remove soil contaminated with calcium chloride, toxic materials and petroleum products. Remove debris which protrudes more than 75mm above surface. Dispose of removed material off site. Scarify the approved dry, un-frozen sub-grade to depth of 50 – 100mm. Cross-cultivate those areas where equipment used for hauling and spreading has compacted soil. Dispose of excavated material on site as directed, so as not to contaminate any topsoil or imported soils used for hauling and spreading has compacted soil.

Basis of Payment

Payment at the Contract price shall be compensation in full for this work as stipulated in the Schedule of Unit Prices.

Item B3 j): Site Restoration and Supply & Place Topsoil & Hydroseed to all Disturbed Areas

The Contractor shall ensure that final site restoration meets the criteria established within the Contract documents. The Contractor is responsible to remove all equipment and material as part of the construction project from site. The Contractor must ensure all grades meet project specification and site areas affected by construction works are repaired to a preconstruction state. The Contractor shall verify that restoration measures are approved by the Site Engineer.

Place topsoil after Contract Administrator has accepted subgrade. Spread topsoil in uniform layers not exceeding 100mm, over unfrozen subgrade free of standing water over scarified subgrade. Spread topsoil to a minimum 100mm depth after settlement and 80% compaction. Manually spread topsoil around trees, structures, shrubs and obstacles.

Grade topsoil to eliminate rough spots and low areas and ensure positive drainage. Prepare loose friable bed by means of cultivation and subsequent raking. Topsoil shall be placed to a grade at the final lines and levels as indicated on the Contract Drawings. Provide a finished topsoil surface that is smooth and firm against footprints, with a fine, loose texture before sod is placed. Owner's Authorized Representative will inspect topsoil in place and determine acceptance of material, depth of topsoil and finish grading. The Contractor is responsible for supplying a water source (i.e., water truck). No private hose bibs are to be used as a water source.

Hydroseeding shall consist of furnishing and applying seed, fertilizer, mulch, water, and tackifier as a slurry mixture using approved hydroseeding equipment. The seed mix shall conform to the specified blend and rates indicated on the plans or in the contract documents. Fertilizer shall be a commercial grade, uniform in composition, free from lumps or caking, and delivered in original, unopened containers. Mulch shall consist of virgin wood fiber or approved equivalent capable of forming a uniform, stable mat on the soil surface. Tackifier shall be used as necessary to ensure adhesion to slopes and reduce erosion. Application shall be performed during suitable weather conditions, avoiding periods of heavy wind or rainfall. The Contractor shall be responsible for maintaining seeded areas until a satisfactory stand of grass is established, as determined by the Engineer.

Basis of Payment

Payment at the Contract price shall be compensation in full for this work as stipulated in the Schedule of Unit Prices.

Item B4: Pumphouse Treatment Upgrades

Item B4 a): Supply of Pre-Select UV System by H2Flow

The Contractor shall supply the Pre-selected UV System by H2Flow. The UV System shall be TrojanUVSwift, Model 2L12 as specified in Appendix A. No markup to be included in this item. Markup to be included in Item B4 b), and not Overhead to be included in this line item.

Basis of Payment

Payment at the Contract price shall be compensation in full for this work as stipulated in the Schedule of Unit Prices.

Item B4 b): All Coordination and Installation Costs by the General Contractor Related to Items B4 a) Including Final Positioning, Installation of All Equipment, etc.

The Contractor shall be responsible for all coordination and installation of the UV System as indicated in B4 a), including final positioning and installation of all associated equipment. Markup for Item B4 a) for the supply of the pre-selected UV System shall be included in this line item.

Basis of Payment

Payment at the Contract price shall be compensation in full for this work as stipulated in the Schedule of Unit Prices.

Item B4 c): Supply & Installation of Motorized Valve

The Contractor shall supply and install the motorized valve, MV-101 upstream of the proposed UV System. MV-101 shall be installed on the existing 300mm process pipe with a flanged connection. The valve shall be the following model: Butterfly valve with Auma SQ07.2-AC02.2 Actuator as specified in Specification 15400: Process Piping & Control Devices.

Basis of Payment

Payment at the Contract price shall be compensation in full for this work as stipulated in the Schedule of Unit Prices.

Item B4 d): Supply and Installation of Raw Water Turbidity Meter

The Contractor shall supply and install a TU5300sc Low Range Laser Turbidimeter System specified in Specification 15425: Water Quality Monitoring Equipment. The raw water turbidity meter shall be securely mounted on Unistrut in the location shown on the contract drawings. This item includes the supply and installation of the sample port and drainage piping.

Basis of Payment

Payment at the Contract price shall be compensation in full for this work as stipulated in the Schedule of Unit Prices.

Item B4 e): Relocation and Connection of Treated Water Turbidity Meter and Chlorine Analyzer

The Contractor shall decommission the existing turbidity and chlorine analyzer panel and store the components on site until they can be relocated to the new chemical room wall. The turbidity and chlorine analyzer panel shall be connected to the new water service line coming from the end of the contact

watermain loop, through the slab of the building. Supply and installation of sample and drain lines to be included in this item.

Basis of Payment

Payment at the Contract price shall be compensation in full for this work as stipulated in the Schedule of Unit Prices.

Item B4 f): Supply and Installation of New Prominent Chemical Pumps (c/w Chemical Panel and a Duty/Standby Pump for each Chemical)

The Contractor shall decommission the existing chemical pumps and accessories. The Contractor shall supply and install four (4) new Prominent Chemical Pumps, two (2) for sodium hypochlorite, two (2) for long chain linear phosphate. The chemical pump assemblies shall include pre-mounted panels complete with backpressure valves, pressure relief valves, isolating ball valves, pressure gauges with diaphragm isolator, check valves and drain valves, a 100 mL calibration column, and one (1) flow monitoring sensor per pump with fault annunciating relay as described in Specification 15420: Chemical Feed Pumps and Accessories. This item shall include the supply and installation of new chemical lines and injectors for each chemical as shown on the drawings. Chemical lines for the sodium hypochlorite shall be rigid Teflon tubing. Chemical lines for the long chain linear phosphate can be flexible PVC tubing.

Basis of Payment

Payment at the Contract price shall be compensation in full for this work as stipulated in the Schedule of Unit Prices.

Item B4 g): Supply and Installation of Day Tanks and Secondary Chemical Containment Skids

The Contractor shall supply and install a 500 L day tank for sodium hypochlorite and a 220 L day tank for long chain phosphate. The secondary containment shall hold a minimum of 110% of the volume of each day tank.

Basis of Payment

Payment at the Contract price shall be compensation in full for this work as stipulated in the Schedule of Unit Prices.

Item B4 h): Removal, Capping, and Grouting of Existing Process Piping

The Contractor shall remove all indicated existing process piping and accessories as indicated on the contract drawings. The piping through the slab shall be capped on the exterior and grouted from the floor out to the outlet of the building. The floor shall be reinstated to match the existing conditions.

Basis of Payment

Payment at the Contract price shall be compensation in full for this work as stipulated in the Schedule of Unit Prices.

Item B4 i): Supply and Installation of Pre-Distribution Chlorine Analyzer and Panel

The Contractor shall supply and install a pre-distribution chlorine analyzer and panel. Analyzer shall be DACb CONTROLLER: DACbW00DVA0010010010EN complete with a flow sensor, pH sensor, and chlorine sensor as described in Specification 15425: Water Quality Monitoring Equipment.

Basis of Payment

Payment at the Contract price shall be compensation in full for this work as stipulated in the Schedule of Unit Prices.

4. SCHEDULE D: Contingencies

Item D1: Supply and Installation of 150mm dia. Watermain Shutoff Valve

The Contractor shall supply and install a 150mm dia. watermain shutoff valve as indicated in Specification 02238: Watermains, where required after receiving approval from the Owner and the Engineer.

Basis of Payment

Refer to Schedule of Unit Prices for basis of payment. Work must be approved by the Town and Engineer before proceeding.

Item D2 a) – e): Supply, Place & Compact Granular including Excavation & Disposal of Existing Material

The Contractor shall place additional material (Granular “A”, “B”, 19mm dia. clear stone, rip-rap, and pre-mixed concreted) where required after receiving approval from the Owner and the Engineer.

Basis of Payment

Refer to Schedule of Unit Prices for basis of payment. Work must be approved by the Town and Engineer before proceeding.

Item D3 a) – i): Labour Rates for Additional Work

The Contractor shall provide labour rates for the associated disciplines indicated in the schedule of unit prices. The rates shall include payroll burden, overhead & profit. These unit items require receiving approval from the Owner and the Engineer.

Basis of Payment

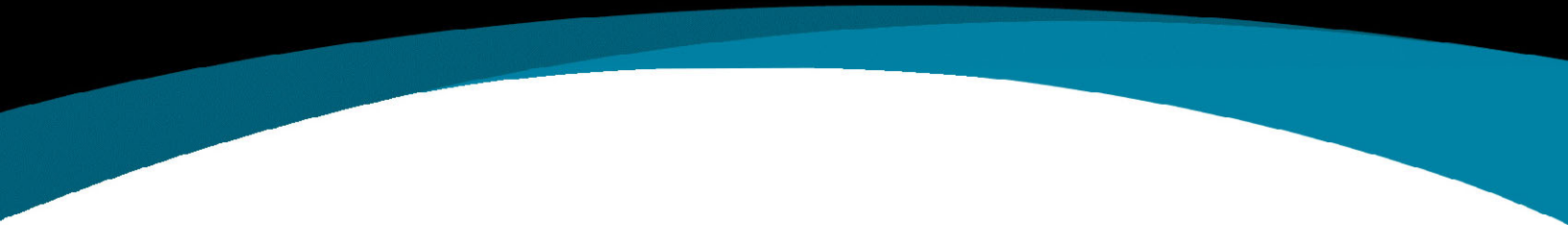
Refer to Schedule of Unit Prices for basis of payment. Work must be approved by the Town and Engineer before proceeding.

Item D4 a) – c): Supply & Install Additional Replacement Valves and Components within Pumphouse

The Contractor shall supply and install replacement valves where required after receiving approval from the Owner and the Engineer.

Basis of Payment

Refer to Schedule of Unit Prices for basis of payment. Work must be approved by the Town and Engineer before proceeding.



Section E

Specifications

Specifications Table of Contents

Spec Number	Description	Revision (Addenda No.)
01000	Division 1: General Requirements	
01000	General Requirements	
01007	General Instructions	
01050	Mobilization / Demobilization	
01070	Cash Allowances	
01075	Tools, Laboratory, Maintenance & Safety Equipment	
01340	Shop Drawings, Product Data & Samples	
01400	Quality Control & Assurance	
01410	Testing Laboratory Services	
01500	Temporary Facilities	
01545	Safety Measures	
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01564	Disinfection of Process Pipe and Inserted Fittings	
01600	Material & Equipment	
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01725	Commissioning, Start-Up and Warranty Period Inspection Requirements	
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02000	Division 2: Site Construction	
02060	Demolition	
02151	Shoring & Bracing	
02210	Site Grading	
02220	General Excavation, Dewatering & Backfilling	
02221	Rock Excavation	
02222	Excavation & Backfilling Around Structures	
02225	Aggregates	
02226	Restoration	
02230	Roads & Streets	
02232	Landscaping	
02238	Watermains	

Spec Number	Description	Revision (Addenda No.)
03000	Division 3: Concrete	
03100	Concrete Formwork	
03201	Concrete Reinforcement	
03305	General Concrete	
04000	Division 4: Masonry	
04200	Concrete Unit Masonry	
05000	Division 5: Metals	
05500	Miscellaneous Metals	
06000	Division 6: Wood & Plastic	
06100	Rough Carpentry	
07000	Division 7: Thermal & Moisture Protection	
07900	Caulking	
08000	Division 8: Doors & Windows	
08100	Steel Doors & Frames	
08710	Finishing Hardware	
08800	Glass & Glazing	
09000	Division 9: Finishes	
09650	Flooring	
09915	Painting & Finishing	
10000	Division 10: Specialties	
10999	Manufactured Specialties	
15000	Division 15: Mechanical	
15010	Mechanical General Provisions	
15011	Submission Log	
15021	Domestic Water Piping – Copper	
15022	Drainage Waste and Vent Piping – Plastic	
15027	Plumbing Piping Insulation	
15028	Hot Water Tank - Electric	
15031	Plumbing Specialties and Accessories	
15509	Dampers – Operating	
15510	Louvres	
15511	Metal Ducts – Low Pressure	
15522	Upblast Exhaust Fan	
15530	Testing, Adjusting and Balancing for HVAC	
15400	Process Piping & Control Devices	
15420	Chemical Feed Pumps	
15425	Water Quality Monitoring Equipment	

Spec Number	Description	Revision (Addenda No.)
15604	Pre-Selected Ultra-Violet Disinfection Equipment	
16000	Division 16: Electrical	
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16011	Shop Drawing Log	
16012	Field and Quality Control (Testing)	
16015	Short Circuit Coordination and Arc Flash Study	
16020	Electrical Removals	
16105	Underground Duct Systems and Electrical Handholes & Chambers	
16110	Raceway Systems	
16120	Wires & Cables	
16130	Electrical Boxes	
16140	Wiring Devices	
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16505	Lighting Equipment	
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16627	Automatic Transfer Switch	
16700	Telephone and Access Control Systems	
16745	Data (Ethernet) Systems	
16850	Services for Mechanical Equipment	
16865	Electric Heating and Cooling	
16900	Instrumentation & Control Equipment	
16901	Auto-Dialer System (Verbatim)	
16910	Process Control System (AB 1769)	
16915	SCADA Software and Workstations Revised	
16920	Control Narrative	

01000 – Division 1: General Requirements

PART 1 - GENERAL

- 1.1 The following Specifications apply specifically to the individual items of work listed in Section B: Schedule of Unit Prices, in all its Schedules inclusive. The purpose of these Supplemental Specifications is to list out the work which shall be performed, or to infer beyond reasonable doubt, that work which is required under an item in the Form of Tender, for the Contract price.
- 1.2 The prices bid for all work included in the Form of Proposal, unless otherwise directed in the following specifications, shall be compensation in full for the complete supply of all labour and equipment and materials necessary to construct the work as specified in, shown on, or is reasonably inferable from, these Contract Specifications.
- 1.3 Further to the above, the prices bid shall also include all costs for any dewatering operations necessary to maintain the groundwater level at a point at least 0.5 metres below the excavation bases, thus facilitating proper completion of the work.
- 1.4 Should access or services be affected by the work, the notification of emergency agencies and/or affected homeowners shall be the responsibility of the Contractor.
- 1.5 All dust control and clean-up of mud tracking on existing roads shall be deemed to be included in the Total Bid Price.
- 1.6 The requirements of the Ontario Provincial Standard Specifications (OPSS) will apply unless otherwise noted. OPSS and Contract Specification numbers referred to under the various items are provided for guidance only as other OPSS and Contract Specifications may also apply.
- 1.7 Payment shall be based upon the lump sum or unit price bid, as listed in the Schedule of Unit Prices, using actual as-constructed quantities as determined by the Engineer. In the event of any conflict between the Schedules of Unit Prices and OPSS, the basis of payment indicated in the schedules shall take precedence (as modified by "pay lines" indicated elsewhere in this document, if applicable).
- 1.8 The Contractor shall be aware of and conform to the latest Municipal Engineering Standards, specifications and requirements governing construction works.
- 1.9 Unless otherwise noted, all granular materials shall be compacted to 100 percent SPMDD and all subsoil to 95 percent SPMDD.

END OF SECTION

01007 – General Instructions

PART 1 - GENERAL

1.1 Request for Proposal / Contract Format

- .1 This is a Unit Price Construction Request for Proposal and Contract.
- .2 Include the total cost of doing all the work shown on the Contract Drawings and specified herein. The total cost shall include a fully operational system.
- .3 Include incidental costs incurred in completing the work in which the incidental cost is related.

1.2 Location of Work

- .1 The proposed work included in this Contract is located in the Town of Shelburne.

1.3 Description of the Project

- .1 Work to be completed under this Contract covers, but is not limited to, the following:
 - .1 Removal of existing contact tanks and supply and installation of 60m, 450mm diameter watermain contact piping.
 - .2 Supply and installation of a new diesel generator, connection, and housekeeping pad.
 - .3 Removal and replacement of UV disinfection unit and control panel.
 - .4 Structural modifications to existing building including an interior block wall for the proposed chemical room.
 - .5 Supply and installation of new water quality monitoring equipment, chemical feed pumps, and chemical tanks/containment.
 - .6 Electrical and SCADA upgrades within the pumphouse.
 - .7 Site works, fencing and grading improvements.
- .2 The Contractor shall conduct safety seminars for all employees new to construction site, so that they might be aware of potential hazards of a work site. The seminars are to be in accordance with the requirements of the Construction Safety Association. In addition, the Contractor shall appoint a Safety Officer, and make that person known to all workers.

1.4 Soils Investigation

- .1 Soils information is not included in this document.

1.5 Planning Locates

- .1 Planning locate information is not included in this document.

1.6 Site Security

- .1 The Contractor shall be responsible for the provision of site security throughout the construction period including start-up, commissioning and performance testing of the new upgrades and no less than a time frame as stipulated within Section B, Instructions for Bidders, Working Time Allotment. The Contractor shall be responsible for arranging for security when they are not on site, (i.e., after normal hours, weekends or other times of extended absence for the work site). The cost will be borne by the Contractor.

1.7 Work Hours

- .1 The Contractor and their workforce will be permitted to work Monday through Friday. Any work during weekends and holidays to be approved by the Owner and Engineer.
- .2 The successful Contractor will present their anticipated work schedule upon award of the Contract.
- .3 Minimum Standards

The Contractor shall execute work to meet or exceed the most current version of the following:

- .1 Ontario Building Code unless more stringent requirements of National Building Code of Canada apply;
- .2 Rules and regulations of authorities having jurisdiction;
- .3 Ontario Fire Code unless more stringent requirements of the National Fire Code of Canada apply;
- .4 Occupational Health and Safety Act, R.S.O. 1990, Ontario Regulations, 213/91 and 714/94;
- .5 Contract documents;
- .6 Ontario Plumbing Code;

- .7 Ontario Electrical Safety Code;
- .8 Relevant Ontario Provincial Standard Specifications (OPSS) and Drawings (OPSD).

1.8 Existing Services

- .1 Before commencing work, contact local utility companies and municipal representatives to establish location and extent of existing services and notify the Engineer of findings.
- .2 Whenever it is necessary to cut, interfere with, or connect to existing services of facility, do so at hours and times recommended by governing authorities and approved by the Engineer. Ensure this work causes minimal disturbance to occupants, pedestrian and vehicular traffic and public and private property.
- .3 Utility Supports in accordance with OPSD 1007.01 may need to be implemented to protect existing services.
- .4 Submit schedule and obtain approval from the Engineer for each proposed shutdown of active service or facility. Adhere to approved schedule and provide notice to affected parties.
- .5 If unknown services are encountered, immediately notify the Engineer and confirm findings in writing and/or on Contract Drawings. Obtain the Engineer's written direction if such services require cutting, capping or relocation to do work.
- .6 Should access or services be affected by the work, the notification of emergency agencies and/or affected homeowners shall be the responsibility of the Contractor.

1.9 Storage of Equipment and Materials

- .1 The Contractor will provide their own storage facilities to be located near the work site. The location will be ascertained during the pre-Tender site visit.
- .2 The Contractor will fence their storage area and provide 24-hour security.
- .3 The Contractor will note the requirements for temporary facilities specified under the appropriate sections.

1.10 Taxes

- .1 Refer to the Instructions for Bidders.

1.11 Fees, Permits and Certificates

- .1 Provide authorities having jurisdiction with information requested.
- .2 Pay fees and obtain certificates and permits required.
- .3 Furnish certificates and permits when requested.
- .4 Pay customs bonds as required when transporting through the United States.

1.12 Contract Documents

- .1 The Contract Documents consist of:
 - .1 Addenda, if any
 - .2 Table of Contents
 - .3 Instructions for Bidders
 - .4 Bid Form
 - .5 Contract Documentation Forms (including Form of Agreement, etc.)
 - .6 Special Provisions
 - .7 General Conditions
 - .8 Standard Specifications
 - .9 Contract Administration Forms
 - .10 Contract Drawings
- .2 Contract Drawings form part of Contract Documents:
 - .1 Keep one (1) copy of contract documents and shop drawings on the site.
 - .2 The Engineer will provide Contractor one (1) set of full-size hardcopy print of Contract Drawings for record purposes.
 - .3 The Contractor will be provided a digital PDF copy of the Contract Drawings. It will be the Contractor's responsibility to obtain additional hardcopy sets of the drawings as needed.

1.13 As-Built Record Drawing

- .1 As work progresses and as required, record significant deviations from the Contract Drawings.
- .2 Obtain and record all pipe elevations, pipe and conduit locations.
- .3 Assist Engineer in recording of as-built information.
- .4 ***Prior to Substantial Performance, submit one (1) copy of As-Built Drawings to Engineer. Holdback will not be released until drawings are furnished.***
- .5 Contractor is to be responsible for any extra engineering costs in correcting As-Built Drawings.

1.14 Additional Drawings

- .1 Engineer may furnish additional drawings to clarify work.
- .2 Such drawings become part of Contract Documents.

1.15 Material and Equipment

- .1 Use new products unless otherwise specified.
- .2 Deliver and store material and equipment to manufacturer's instructions with manufacturer's labels and seals intact.

1.16 Concealment

- .1 Conceal pipes, ducts, conduit and wiring in finished areas unless otherwise specified.

1.17 Cutting and Remedial Work

- .1 Coordinate work to keep cutting and remedial work to a minimum.
- .2 Execute cutting and remedial work required. Obtain Engineer's approval before cutting, boring or sleeving structural members.
- .3 Use specialists in affected material to execute cutting and remedial work.
- .4 Match work to adjoining construction and finishes.
- .5 Fit components tight to adjoining surfaces.

1.18 Fastenings

- .1 Provide fastenings of type, size and spacing required to assure secure anchorage.
- .2 Obtain Engineer's approval before using explosive actuated fasteners.

1.19 Inspection and Testing

- .1 When initial tests and inspections reveal work not to contract requirements, pay for tests and inspections required by Engineer on corrected work.

1.20 Construction Time and Scheduling

- .1 On award of contract, submit monthly cash flow projection and bar chart construction schedule for work, indicating anticipated progress stages within time of completion. When schedule has been approved by the Engineer, take necessary measures to complete work within scheduled time. Do not change schedule without Engineer's approval.
- .2 General Contractor shall ensure that all subcontractors and suppliers are notified of construction schedule. General Contractor shall be solely responsible for liquidated damages and associated costs if the construction completion deadline is not met.
- .3 In conjunction with and in form acceptable to Engineer, provide within 10 working days after Contract award, schedule showing dates for:
 - .1 Submission of shop drawings, material tests and samples.
 - .2 Delivery of equipment and materials.
 - .3 Commencement and completion of work of each major component of the work.
 - .4 Final completion date within time period required by Contract Documents.
- .4 Interim review of work progress based on schedule submitted will be conducted as decided by Engineer and schedule updated by Contractor in conjunction with and to approval of Engineer.
- .5 Engineer will arrange project meetings and assume responsibility for setting meeting times and recording and distributing minutes.

1.21 Energy Conservation

- .1 The policy of the Owner is to effectively conserve energy and non-renewable natural resources in the design and construction of public works.

- .2 The Contractor is encouraged to employ all reasonable means at their disposal to carry out an effective energy and natural resources conservation program and use energy saving construction techniques throughout the entire construction period.
- .3 With due regard for necessary protection of the property, the safety of workers and public, and overriding By-laws and Regulations, Contractor shall conserve energy and non-renewable natural resources, in such ways as:
 - .1 Switching off unnecessary lighting, particularly during inactive periods.
 - .2 Utilizing efficient methods, controls, equipment and enclosures to conserve temporary heating.
 - .3 Any other construction activities which may result in saving of energy and natural resources.

1.22 Setting Out of Work

- .1 Engineer will only provide construction control points and benchmarks at the onset of the work.
- .2 If the Contractor removes control points, they shall bear the cost of their replacement.
- .3 The Contractor is responsible for the layout of all construction works and the minimum degree of layout required is specified below.
 - .1 Set out works to correct lines, grades and levels.
 - .2 Establish control lines and levels for construction of work.
 - .3 Provide a minimum of three (3) consecutive reference points at a distance not exceeding 15 metres for each section of work.
 - .4 Provide reference points at closer spacing as required or as directed by Engineer.
 - .5 Control of lines and grades by use of lasers or other methods may be used if approved by Engineer.
 - .6 Do not lay pipe unless all reference points and levels are in place along section of work under construction.
- .4 Payment for setting out of works to be included with the applicable item for which layout is required.

1.23 Supervision

- .1 Provide the necessary supervision and qualified tradespeople to ensure the flow of materials and on-site installation compatible with the overall project schedule and progress.
- .2 No separate payment will be made under this item, and the Contractor shall include this cost in the cost of the work being supervised.

1.24 Protection of Survey Bars

- .1 Protect survey bars from damage or displacement.
- .2 Replacement of bars within the area of work is to be included in the cost of the related work.
- .3 Replacement of bars damaged or displaced during construction and which fall outside of the area of work is to be at the Contractor's expense. The Owner will pay for survey bars that must be disturbed to complete the proposed works as determined by the Engineer. This determination must be prior to the disturbance.
- .4 All survey bars damaged or displaced during construction are to be replaced by a Legal Surveyor prior to completion of the work.

1.25 Payment Items

- .1 Payment shall be based upon the lump sum or unit price bid, as listed in the Schedule of Unit Prices, using actual as-constructed quantities as determined by the Engineer. In the event of any conflict between the Schedules of Unit Prices and Specifications, the basis of payment indicated in the schedules shall take precedence (as modified by "pay lines" indicated elsewhere in this document, if applicable).
- .2 Provisional and Contingency Items
 - .1 The Contractor shall note that Provisional and Contingency items shall only become part of the contract when authorized in writing by the Owner and Engineer. The Contractor shall not have any basis if the Provisional and/or Contingency items are not included in whole or in part, in the contract.

1.26 Dust Control & Clean-Up During Construction

- .1 All dust control and clean-up of mud tracking on existing roads shall be deemed to be included in the Total Bid Price.

1.27 Equivalent or Approved Equals

- .1 Where pursuant to the Specifications, the Contractor is required to supply an article or group of related articles designated by a trade or other name or an "approved equal", the Tender shall be based only upon supplying the article or group of articles so designated, which shall be regarded as the standard of quality required by the Specification. After the acceptance of a Tender, the Contractor may apply to the Engineer to substitute as an approved equal another article or group of related articles designated as aforesaid. The application shall be in writing and shall state the price for the proposed substitute article or group of related articles, the price for the article or group of articles designated as aforesaid and such other information as the Engineer may require.
- .2 No ruling on a proposed substitution will be made prior to the acceptance of a Tender. No substitution shall be made without the prior approval of the Engineer. The approval or rejection of a proposed substitution shall be at the discretion of the Engineer and their decision shall be final.

1.28 Contractor's Use of Premises

- .1 The Owner has arranged for easements for construction, storage and access as shown on Contract Drawings.
- .2 Make arrangements with property owners if additional areas are required. Obtain written agreements and submit copies to Engineer.
- .3 Confine operations within easements for construction, storage and access as shown on Contract Drawings.
- .4 Install and maintain snow fencing along working and storage areas and access routes.
- .5 Do not enter upon or occupy with workers, tools or materials any lands other than public streets, roadways, rights-of-way or easements shown on Contract Drawings except after written consent has been received from property owner.

1.29 Project Coordination

- .1 Do not undertake any part of work without permission of Engineer.
- .2 Obtain approval in writing from Engineer for all arrangements made with other Contractor(s).

1.30 Public Relations and Notices

- .1 Appoint competent representative to receive and deal with any complaints from public in regard to safety, protection of traffic, condition of road surfaces along line of work, or nuisances on account of work. Note: this representative shall work directly with the Engineer and the Municipality.
- .2 Inform Engineer, Owner and local police of name, address, email address and telephone number of public relations representatives within two (2) weeks after date of order to commence work.
- .3 Deal promptly with all complaints received and carry out remedial actions to prevent further complaints.
- .4 Give adequate notice of schedule (timing and location) of movement of materials, construction activities, maintenance and repairs to affected landowners and occupants of properties adjacent to work areas.
- .5 Notify Engineer immediately of any complaints of damage to property or personal injury.
- .6 Notify Engineer as soon as possible of action taken in respect to any complaints and outcome of such actions.

1.31 Abbreviations

- .1 Abbreviations used in this document:

AASHTO	- American Association of State Highway and Transportation Officials
ACI	- American Concrete Institute
AISI	- American Iron and Steel Institute
ANSI	- American National Standard Institute
APWA	- American Public Works Association
ASME	- American Society of Mechanical Engineers
ASTM	- American Society for Testing and Materials
AWPA	- American Wood Preserver's Association
AWWA	- American Water Works Association
CGSB	- Canadian General Standards Board

CSA	- Canadian Standards Association
HEPC	- Hydro Electric Power Commission
ISC	- Indigenous Services Canada
MOECC	- Ontario Ministry of Environment & Climate Change
MTO	- Ministry of Transportation of Ontario
MNR	- Ministry of Natural Resources
OPSD	- Ontario Provincial Standard Drawings
OPSS	- Ontario Provincial Standard Specifications

1.32 Project Meetings

- .1 Attend any and all project meetings scheduled by Engineer.
- .2 Engineer will schedule meetings and notice will be given in writing at least two (2) days before date of meeting.
- .3 Pre-Construction Meeting:
 - .1 Location: Site Designated by Engineer.
 - .2 Attendance:
 - .1 Owner's Representative
 - .2 Contractor's Superintendent
 - .3 Resident Inspector
 - .4 Others as appropriate.
- .4 Progress Meetings:
 - .1 Location of meeting: Site Designated by Engineer
 - .2 Attendance:
 - .1 Owner's Representative
 - .2 Contractor's Superintendent
 - .3 Resident Inspector

.4 Others as appropriate.

- .5 Representatives of the Contractor attending meetings should be thoroughly informed and knowledgeable with respect to proposed topic of discussion and authorized to act and make commitments with respect to matters agreed to at the meetings.

1.33 Quality Control

- .1 Adhere to manufacturer's recommendations with respect to handling, preparation, installation, testing, operation or protection of any product or material to be incorporated in work.
- .2 Ensure that all materials supplied are compatible with each other unless specific adjacent materials have been specified. Correct any defective work caused by non-compatibility of materials.
- .3 Where practical or desirable, tests will be conducted by Engineer on materials and equipment to be incorporated into permanent works before delivery to site.
- .4 Submit to the Engineer full information on materials, equipment and related arrangements to be furnished.
- .5 Submit information in a form approved by Engineer.
- .6 Submit sufficient information to enable Engineer to determine whether proposed materials, equipment and arrangements meet Contract requirements.

1.34 Traffic Control

- .1 Adhere to following requirements when roads are to be closed to traffic:
- .1 Provide and maintain pedestrian access to all properties.
- .2 Provide and maintain emergency access for fire trucks, ambulances and other vehicles for emergency services.
- .2 Provide and maintain detours for traffic where required. Mark detours as directed by Police / Fire / Health Departments, Works Department and Engineer.
- .3 Supply and place crushed stone on road to maintain traffic as required.

1.35 Project Identification and Signs

- .1 Supply and erect signs at locations designated by Engineer.

- .2 Fabricate sign boards to dimensions and details specified.
- .3 Provide and erect a suitable, portable and stable framework to support each sign.
- .4 Remove and dispose of sign boards when directed or on completion of project.

1.36 Maintenance Work

- .1 Perform all maintenance work required during progress of work.
- .2 Submit to Engineer a letter setting out arrangements made for carrying out warranty work during period of guaranteed maintenance.
- .3 Include in letter telephone number, email address and address for receipt of notices relating to matters requiring action by Contractor at job site.
- .4 Maintenance During Construction
 - .1 Keep pavement surfaces adjacent to and within work area clean.
 - .2 Keep temporary road surfaces over backfilled excavations free from potholes.
 - .3 Maintain all surfaces in good condition.
- .5 Warranty Work During Guarantee Period
 - .1 Perform all warranty work required upon receipt of verbal or written notice from Engineer.
 - .2 Repair or make good sinkages and defects on surfaces of backfilled trenches or excavations.
 - .3 Repair all damages to structures caused by settlement of ground adjacent to or over excavations.
- .6 Maintenance by Owner
 - .1 The Owner will, without giving notice to the Contractor, repair shrinkages or defects which are dangerous in nature and constitute an emergency.
 - .2 Engineer will notify Contractor of emergency work performed by Owner.
 - .3 Cost of labour, equipment and material to perform emergency work to be charged to Contractor.

1.37 Remove and Salvage Items

- .1 Items designated to be removed and salvaged are to be dismantled by the Contractor and delivered to the Town of Shelburne Public Works.

1.38 Pre-Construction Photo Record

- .1 Prior to construction, the Contractor shall take photographs of each of the proposed work areas in order to record the pre-construction site conditions. The Contractor shall neatly compile and label the location of each photograph and submit the photo record to the Engineer in a PDF.
- .2 The Contractor shall be responsible to restore all disturbed areas to their pre-construction condition unless otherwise noted.

1.39 Pre-Construction House Assessment

- .1 Prior to construction, the Contractor shall identify to the Engineer any dwelling that may be potentially impacted or damaged as a result of construction operations. The Contractor will carry out a pre-construction house assessment of all dwellings. A qualified firm acceptable to the Engineer shall be carry out the inspection with video and photographs. The inspection firm shall provide two (2) hard copies and one (1) digital copy of their inspection report to the Engineer.
- .2 The Report shall contain the findings and recommendations for protecting any vulnerable dwellings. The Contractor is responsible for any impacts to dwellings that result from construction operation.

END OF SECTION

01050 – Mobilization / Demobilization

PART 1 - GENERAL

- 1.1 This portion outlines the payment for construction mobilization and demobilization.
- 1.2 The Contractor shall enter a price in the Schedule of Unit Prices to cover the costs of mobilization and demobilization.
- 1.3 The price entered for this item shall be consistent with the costs involved but shall not, in any event, exceed 10 percent (10%) of the total price.
- 1.4 If this item's Bid price is in excess of 10 percent (10%) of the total Bid price, the Owner shall, in preparing Contract Documents based upon the Bid, reduce the price for the said item to an amount not exceeding 10 percent (10%) of the total price and shall add the amount of the reduction to the price for another lump sum item so that the total Bid price shall not be affected.
- 1.5 The lump sum price entered for this item will include the cost of transportation of all personnel, construction equipment, fuel and other items which shall not become part of the permanent works. The transportation costs of materials incorporated into the works is to be included in the unit price proposed for its related item.
- 1.6 60 percent (60%) of the price for the mobilization and demobilization item shall be considered as relating to mobilization and the balance to demobilization.
- 1.7 The payment for mobilization shall be included in the first Payment Certificate issued for the Contract subject to the Engineer being satisfied that full mobilization has been carried out. If the Engineer is not satisfied, they shall allow a payment which, in their opinion, reflects the degree of mobilization effected to date.
- 1.8 The payment for demobilization shall become due following Preliminary. Acceptance of the works and subject to the Engineer being satisfied that full demobilization has been carried out. The Engineer may, in their discretion, allow partial payment for demobilization before full demobilization has been affected.

END OF SECTION

01070 - Cash Allowances

PART 1 - GENERAL

1.1 Scope

- .1 This section outlines the requirements associated with the items below included as Cash Allowances in the Schedule of Unit Prices:

- .1 Hydro One & Bell Canada Allowance
- .2 Materials Testing Allowance

1.2 Hydro One & Bell Canada Allowance

- .1 This cash allowance is intended to cover all work required to be done by Hydro One and Bell Canada for the extension or upgrade of primary services to the site of permanent works to be installed under this Contract. The Contractor shall coordinate the design and construction of the new or upgraded hydro and telephone service.
- .2 An allowance to cover these costs has been pre-determined and extended in the Schedule of Unit Prices. Portions of this amount will only be paid to the Contractor when there is evidence that the Contractor has paid the utility concerned for the actual work completed by the utility company. The Contractor shall not be eligible for any mark up on any invoiced amounts from Hydro One or Bell Canada. The Contractor shall issue purchase orders or deposits to Hydro One or Bell Canada as required.
- .3 This allowance is not intended to cover any costs associated with the Contractor's responsibility to obtain and pay for hydro inspections for other works included in this project. Also, it is not intended to cover any costs associated with the installation of secondary hydro services from transformers into permanent works installed under this Contract. **These costs shall be borne by the Contractor.**

1.3 Materials Testing Allowance

- .1 This cash allowance is intended to cover all materials testing as deemed necessary by the Engineer for this project. The Engineer will coordinate all required testing with the Geotechnical Consultants.
- .2 The geotechnical consultant will invoice the General Contractors, on a monthly basis, for material testing that has been completed and approved by the Engineer.

- .3 Portions of the allowance listed will only be paid to the Contractor when there is evidence that the Contractor has paid the geotechnical consultant. The Contractor shall not be eligible for any makeup on any invoiced amounts from the Geotechnical Consultant.
- .4 This section shall be read in conjunction with Specification 01410: Testing Laboratory Services, where compaction and concrete testing results reveal work that is not in accordance with contract requirements. Contractor shall pay for costs associated with additional testing as required by the Engineer to verify acceptability of work.

END OF SECTION

01075 – Tools, Laboratory, Maintenance and Safety Equipment

PART 1 - GENERAL

1.1 General

.1 Contractor shall note that the following tools and equipment are provisional. The Contractor may be required to provide some or all of these components.

.1 Tools

- None required

.2 Safety Equipment

- 2 - Safety Goggles, CSA Z94.3 certified, anti-fog, indirect vent
- 2 – UV Face Shields, CSA Z94.3 certified
- 2 – Neoprene Chemical Resistant Apron
- 2 - Sets Rubber Gloves (chemicals), sizes to be selected during shop drawing stage
- 2 - Dust Masks, 3M Half face piece #6500 with 3M filters #P-100

.3 Office and Cleaning Supplies

- 1 - First Aid Kit to be CSA Z1220-17 Type 3 Compliant, Small (2-25 workers)
- 2 - Floor Mats, Indoor Entry, Rubber Backed Carpet Mat, 3'x4'
- 1 – Wet Mop/String Mop, Heavy Duty, 24oz
- 1 – Rolling Industrial Mop Bucket with Wringer, Rubbermaid 2064915 or approved equal
- 1 – Industrial Broom and Dustpan
- 1 – Floor Squeegee

.4 Lab Equipment

- None required

END OF SECTION

01340 – Shop Drawings, Product Data and Samples

PART 1 - GENERAL

- 1.1 Submit to Engineer, for review, shop drawings, product data and samples specified.
- 1.2 Until submission is reviewed, work involving relevant product may not proceed.
- 1.3 The review of the shop drawings by the Engineer is for the sole purpose of ascertaining conformance with the general design concept. The Engineer will not approve the detail design inherent in the shop drawings. The Contractor submitting the shop drawings shall be responsible for the detail design inherent in the shop drawings. The Engineer's review shall not relieve the Contractor of responsibility for errors or omissions in the shop drawings or for meeting all requirements of the Contract Documents. The Contractor is 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 coordination of the work of all sub trades.
- 1.4 The Engineer **will not** provide digital copies of Contract Drawing files or base plans for shop drawing preparation.
- 1.5 The Engineer will review the first two (2) shop drawing submissions for each piece of equipment at the Engineer's cost. Any subsequent review required beyond the first two (2) submissions will be assessed against the Contractor and the related amount will be deducted from Payment Certificates.

PART 2 - SHOP DRAWINGS

- 2.1 Drawings to be originals prepared by Contractor, Subcontractor, Supplier or Distributor, which illustrate appropriate portion of work: showing fabrication, layout, setting or erection details as specified in appropriate sections. Promotional literature and catalogue sheets (except as noted in Item 2.3 below) will not be accepted as shop drawings.
- 2.2 Identify details by reference to sheet and detail numbers shown on Contract Drawings.
 - .1 Dimension in metric (SI) units.
 - .2 Maximum sheet size 860 mm x 1120 mm.
- 2.3 Product Data
 - .1 Certain specification sections specify that manufacturer's standard schematic drawings, catalogue sheets, diagrams schedules, performance charts, illustrations and other standard descriptive data will be accepted in lieu of shop drawings.

- .2 Above will only be accepted if they conform to following:
 - .1 Delete information which is not applicable to project.
 - .2 Supplement standard information to provide additional Information applicable to project.
 - .3 Show dimensions and clearances required.
 - .4 Show performance characteristics and capacities.
 - .5 Show wiring diagrams (when requested) and controls.
 - .6 Information is of suitable size to permit photocopy reproduction.
- .3 Samples
 - .1 Submit samples in sizes and quantities specified or as requested.
- .4 Coordination of Submissions
 - .1 Check and certify as correct shop drawings, product data and samples prior to submission.
 - .2 Verify:
 - .1 Field measurements.
 - .2 Field construction criteria.
 - .3 Catalogue numbers and similar data.
 - .5 Coordinate each submission with requirements of work and contract documents. Individual shop drawings will not be reviewed until all related drawings are available.
 - .6 Notify Engineer, in writing at time of submission, of deviations from requirements of contract documents.
 - .7 After Engineer review, distribute copies.
- 2.4 Submission Requirements
 - .1 Issue submissions at least 14 days before dates reviewed submissions will be needed.

- .2 Engineer will accept electronic and/or hard copy shop drawings for Engineer's review and approval. Should contractor choose to provide hard copies of shop drawings, provide sufficient copies (e.g.: 4 to 6 sets) for distribution.
- .3 Accompany submissions with transmittal letter in duplicate, containing:
 - .1 Date.
 - .2 Project title and number.
 - .3 Contractor's name and address.
 - .4 Number of each shop drawing, product data and sample submitted.
 - .5 Other pertinent data, such as:
 - .1 Reference drawing number and item tag identifications as per IFC drawings.
 - .2 Quantity of item being provided.
 - .3 Model number(s) of item(s) being provided.
- .4 Submissions shall include:
 - .1 Date and revision dates.
 - .2 Project title and number.
 - .3 Name of:
 - .1 Contractor.
 - .2 Subcontractor.
 - .3 Supplier.
 - .4 Manufacturer.
 - .5 Separate detailer when pertinent.
 - .4 Identification of product or material.
 - .5 Relation to adjacent structure or materials.
 - .6 Field dimensions, clearly identified as such.

- .7 Specification section number.
- .8 Applicable standards, such as CSA or CGSB numbers.
- .9 Contractor's stamp, initialed or signed, certifying approval of submission, verification of field measurements and compliance with contract documents.
- .10 Obtain and submit a list of manufacturer's recommended spare parts, lubricants and operation and maintenance equipment. List to include entire project with specific information as to manufacturer's suppliers, product names, model number, address and telephone numbers, etc.

2.5 Required Shop Drawings

- .1 Shop drawings to be submitted are to include, but not necessarily be limited to the following. Contractor is to notify Engineer of anticipated deviancies from Contract Drawings and Specifications, as additional shop drawings may be requested.

(*) denotes Stamp required by Registered Professional Engineer, registered in the Province of Ontario.

- .1 Reinforcing Steel:
 - Locations
 - Sizes
 - Bar List
 - Mill Reports
- .2 Concrete:
 - Design Mix
 - Method of Placement
 - Sealants
 - Formwork
 - Plasticizer
- .3 Mechanical:
 - Dimensioned (Isometric) Mechanical Layout
 - All Valves

- Backflow Preventer(s)
- Chemical Feed Pumps and Related Equipment
- Turbidity Monitor and Related Equipment
- Chlorine Analyzer and Related Equipment
- Couplings
- Pipe Hangers and Supports
- Heating and Ventilation Equipment
- Ultraviolet Disinfection Equipment
- Stand-By Power Diesel Electric Generator and Associated Components
- Process Piping
- Fittings & Supports
- Watermain & Restraints

.4 Miscellaneous Metals and Structural Steel:

- Lintels

.5 Architectural / Structural:

- Doors
- Door Hardware
- Concrete Brick / Block
- Paints & Coatings
- Colour Charts
- Chlorine Room Access Door/Hatch

.6 Electrical:

- Conduit Layout Plans
- Also Refer to Division 16: Electrical

.7 Miscellaneous:

- Floor Drains
- Plumbing Equipment

END OF SECTION

01400 Quality Control & Assurance

PART 1 – GENERAL

1.1 Section Includes:

- .1 Inspection and testing, administrative and enforcement requirements.
- .2 Tests and mix designs.
- .3 Mock-ups.
- .4 Mill tests.
- .5 Equipment and system adjustment and balancing.

1.2 Related Sections

- .1 All Divisions and Sections are related to this Section.

1.3 Inspection

- .1 Allow the Engineer access to the Works at all times. If part of Work is in preparation at locations other than the job site, allow access to such work whenever it is in progress.
- .2 Give timely notice requesting inspection if work is designated for special tests, inspections or approvals by the Engineer instructions.
- .3 If the Contractor covers or permits to be covered, work that has been designated for special tests, inspections or approvals before such is made, uncover such work, have inspections or tests satisfactorily completed and make good such work.
- .4 The Engineer may order any part of the Works to be examined if work is suspected to be not in accordance with Contract Documents. If, upon examination such work is found not in accordance with Contract Documents, correct such work and pay cost of examination and correction. If such work is found in accordance with Contract Documents, the Owner will pay the cost of examination and replacement.

1.4 Independent Inspection Agencies

- .1 The Owner's Testing Laboratory or an Independent Inspection / Testing Agencies will be engaged by *the Owner* for the purpose of inspecting and/or testing portions of Work. The cost of such services will be borne by the Owner.

- .2 Provide equipment required for executing inspection and testing by appointed agencies.
 - .3 Employment of inspection/testing agencies does not relieve the Contractor from responsibility to perform work in accordance with the Contract Documents.
 - .4 If defects are revealed during inspection and/or testing, the appointed agency will request additional inspection and/or testing to ascertain full degree of defect. Correct defect and irregularities as advised by the Engineer at no cost to the Owner. The Contractor is to pay costs for retesting and reinspection.
- 1.5 Pre-Construction Photographic Survey
- .1 Pre-construction photographic survey as described in the Special Provisions shall be undertaken by the Contractor to the satisfaction of the Engineer prior to the commencement of construction.
- 1.6 Access to Work
- .1 Allow inspection/testing agencies access to the Works, off-site manufacturing and fabrication plants.
 - .2 Co-operate to provide reasonable facilities for such access.
- 1.7 Procedures
- .1 Notify appropriate agency and the Engineer in advance of requirement for tests, in order that attendance arrangements can be made.
 - .2 Submit samples and/or materials required for testing, as specifically requested in specifications. Submit with reasonable promptness and in an orderly sequence so as not to cause delay in work.
 - .3 Provide labour and facilities to obtain and handle samples and materials on site. Provide sufficient space to store and cure test samples.
- 1.8 Rejected Work
- .1 Remove defective work, whether a result of poor workmanship, use of defective products or damage and whether incorporated in work or not, which has been rejected by the Engineer as failing to conform to Contract Documents. Replace or re-execute in accordance with Contract Documents.

- .2 Make good other Contractor's work damaged by such removals or replacements promptly.
- .3 If in opinion of the Engineer it is not expedient to correct defective work or work not performed in accordance with the Contract Documents, the Owner may deduct from Contract Price difference in value between work performed and that called for by Contract Documents, amount of which shall be determined by the Engineer.

1.9 Tests and Mix Designs

- .1 Furnish test results and mix designs as may be requested.
- .2 The cost of tests and mix designs beyond those called for in Contract Documents shall be appraised by the Engineer and may be authorized as recoverable.

1.10 Mock-ups

- .1 Prepare mock-ups for work specifically requested in specifications. Include for work of all Sections required to provide mock-ups.
- .2 Construct in all locations acceptable to the Engineer.
- .3 Prepare mock-ups for Engineer's review with reasonable promptness and in an orderly sequence, so as not to cause any delay in the Works.
- .4 Failure to prepare mock-ups in ample time is not considered sufficient reason for an extension of Contract Time and no claim for extension by reason of such default will be allowed.
- .5 If requested, the Engineer will assist in preparing a schedule fixing dates for preparation.
- .6 Mock-ups may remain as part of the Works.

1.11 Mill Tests

- .1 Submit mill test certificates as required of Specifications Sections.

1.12 Equipment and Systems

- .1 Submit adjustment and balancing reports for mechanical, electrical and building equipment systems.

1.13 Minimum Standard

- .1 The Specifications and the Contract Drawings define a minimum standard of Workmanship. The Contractor shall include in the Bid, the cost of any additional work or improvements in the quality of the Works that the Contractor considers necessary to unconditionally guarantee the performance of the completed work in conformity with the Contract for the Maintenance Period.

1.14 Workmanship

- .1 The quality of the workmanship and materials shall be first class and the Works shall present a neat and attractive appearance when finished.
- .2 If ordered by the Engineer, the Contractor shall make enough openings in the Works and/or materials as are necessary to inspect the works.
- .3 Should the Engineer find the work and/or materials so opened up to be faulty in any respect, the Contractor shall remove and make good all defective work and/or materials and shall bear the expense of all such opening, inspecting, and making good.
- .4 Should the Engineer find the work and/or materials so opened up to be in acceptable condition, the expense of such opening and closing will be borne by the Owner.

END OF SECTION

01410 – Testing Laboratory Services

PART 1 - GENERAL

1.1 Related Requirements Specified Elsewhere

- .1 Particular requirements for inspection and testing to be carried out by testing laboratory designated by Engineer are specified under various sections.
- .2 Testing of all works as instructed by the Engineer, shall be the responsibility of the General Contractor.
- .3 Testing of the works constructed by the sub-contractors shall be the responsibility of the respective sub-contractor.

1.2 Appointment and Payment

- .1 Engineer will appoint and the Owner will pay services of testing laboratory except for the following:
 - .1 Inspecting and testing required by-laws, ordinances, rules, regulations or orders of public authorities.
 - .2 Inspecting and testing performed exclusively for Contractor's convenience.
 - .3 Testing and adjustment of mechanical systems.
 - .4 Tests specified to be carried out by Contractor under the supervision of the Engineer.
 - .5 Additional tests specified by the Engineer.
- .2 Where tests or inspections by designated testing laboratory reveal work not in accordance with contract requirements, Contractor shall pay costs for additional tests or inspections as Engineer may be required to verify acceptability of corrected work.

1.3 Contractor's Responsibilities

- .1 Furnish labour and facilities to:
 - .1 Provide access to work to be inspected and tested.
 - .2 Facilitate inspections and tests.
 - .3 Make good work disturbed by inspection and test.

- .4 Provide storage on site for laboratory's exclusive use to store equipment and cure test samples.
- .2 Notify Engineer sufficiently in advance of operation to allow for assignment of laboratory personnel and scheduling of tests.
- .3 Where materials are specified to be tested, deliver representative samples in required quantity to test laboratory.
- .4 Pay costs for uncovering and making good work that is covered before required inspection or testing is completed and approved by Engineer.
- .5 Coordinate and pay for all costs associated with transporting of test samples to testing laboratory.

END OF SECTION

01500 – Temporary Facilities

PART 1 - GENERAL

1.1 Access

- .1 Provide and maintain adequate access to project site.
- .2 Build and maintain temporary road where directed and provide snow removal if required during period of work.
- .3 If authorized to use existing roads for access to project site, maintain such roads for duration of contract and make good damage resulting from Contractor's use of roads.

1.2 Storage Sheds

- .1 Provide adequate weather tight sheds with raised floors, for storage of materials, tools and equipment which are subject to damage by weather.

1.3 Sanitary Facilities

- .1 Provide sanitary facilities for work force and Engineer's staff in accordance with governing regulations and ordinances.
- .2 Post notices and take such precautions as required by local health authorities. Keep area and premises in sanitary condition.

1.4 Power

- .1 Arrange, pay for and maintain temporary electrical power supply in accordance with governing regulations and ordinances.
- .2 Install temporary facilities for power such as pole lines and underground cables to approval of local power supply authority.
- .3 Electrical power and lighting systems installed under this contract may be used for construction requirements without prior approval of Engineer provided that guarantees are not affected. Make good damage. Replace lamps which have been used over period of the duration of the contract.

1.5 Water Supply

- .1 Supply and install temporary potable water supply for work force and Engineer.

- .2 Permanent water supply system installed under this contract may be used for construction requirements with prior approval of Engineer provided that guarantees are not affected.
- .3 Temporary water shall be connected to outside hose bib taps with backflow preventers. Temporary lines to be run through the back yards to avoid conflict with driveways and access. The Contractor shall notify all residents of the work and advise them of any changes to be made to prevent damage to their property and equipment.
- .4 System Requirements:
 - .1 The system shall conform to the requirements of OPSS 493, and the following:
 - .1 Connections shall be made only to services tapped into existing mains, connections to hydrants will not be permitted.
 - .2 A backflow prevention device must be placed at each connection.
 - .3 Temporary distribution mains must be at least 50 mm in size.
 - .4 Temporary hydrants are not required.
 - .5 The Contractor shall be responsible for obtaining permission to enter private property to connect the temporary water supply, and for ensuring that all residents have been instructed as to how the temporary system operates. The Contractor shall be responsible for any damage caused by the temporary water system.
- .5 Operation, Testing and Inspection:
 - .1 The Contractor shall not operate any water valves or hydrants. All watermain operations shall be carried out by a Town of Shelburne Licensed Operator. The Contractor shall provide 48 hours' notice to the Town of Shelburne when shut-downs will be required.
 - .2 After each watermain shut-down which includes dewatering of the main, the Town of Shelburne will obtain samples for the purposes of carrying out chlorine residual and bacteriological tests. All connections to existing watermains shall be made under the inspection of a Town of Shelburne Licensed Operator. The Town of Shelburne will be responsible for all sampling, transporting, and testing of water.

- .3 The Contractor shall co-operate with the Town of Shelburne in meeting these requirements.

.6 Notification

- .1 The Contractor shall provide all affected residents and businesses with 48 hours' notice of any interruption in water service. The notification shall be in writing, and shall include a name and contact number for the Contractor. The notices shall be accompanied by the Town of Shelburne Standard Notice, copies of which will be provided to the Contractor.

1.6 Site Signs and Notices

- .1 Only Project Identification and Consultant / Contractor signboards and notices for safety or instruction are permitted on site.
- .2 Format, location and quantity of site signs and notices to be approved by Engineer.
- .3 Signs and notices for safety or instruction to be in English language, or commonly understood graphic symbols.
- .4 Maintain signboards, signs and notices for duration of project. Remove and dispose of signs off site on completion of project.

1.7 Removal of Temporary Facilities

- .1 Remove temporary facilities from site when directed by Engineer.

1.8 Fuel Storage

- .1 All fuel storage tanks shall have an earth containment berm built around them and shall be lined with a 60 mm high density polyethylene liner.
- .2 Berms shall be designed to hold 150% of the capacity of the tank they are containing.
- .3 Storage areas shall not be located within 150 meters of any watercourse.

END OF SECTION

01545 – Safety Measures

PART 1 - GENERAL

1.1 Construction Safety Measures

- .1 Observe and enforce construction safety measures required by National Building Code 2015 Part 8, Occupational Health and Safety Act and Regulations for Construction Projects, Revised Statutes of Ontario, 1990, Chapter O.1, Ontario Regulations 213/91 and 714/94, Workplace Safety and Insurance Board, and Government statutes and authorities.
- .2 Contractor to provide a site-specific Health & Safety Plan and company safety policy within five (5) working days after date of Notice to Proceed and prior to mobilization of equipment, materials and manpower to site.
- .3 In the event of conflict between any provisions of above authorities the most stringent provision governs.
- .4 Where applicable, the Contractor shall be designated the "Constructor" as defined by the Ontario Occupational Health and Safety Act.

1.2 Fire Safety Requirements

- .1 Comply with requirements of the current revision of the Ontario Fire Code O.Reg 213/07 and the National Fire Code of Canada. In the case of any conflict in requirements between the Codes, the most stringent requirement shall apply.

1.3 Overloading

- .1 Ensure no part of work is subjected to a load which will endanger its safety or will cause permanent deformation.

1.4 Falsework

- .1 Design and construct falsework in accordance with CSA S269.1-16 (R2021) or most current revision.

1.5 Scaffolding

- .1 Design and construct scaffolding in accordance with CSA S269.2-16 (R2021) or most current revision.

1.6 Excavations

- .1 The Contractor / Sub-Contractors shall be responsible for adequate fencing of all respective excavations overnight and on holidays and shall provide adequate lights and barricades as may be required in the opinion of the Engineer.

END OF SECTION

01560 – Environmental Protection

PART 1 - GENERAL

1.1 Fires

- .1 Fires and burning of rubbish on site will not be permitted.

1.2 Drainage and Erosion Control

- .1 Provide temporary drainage and pumping as necessary to keep excavations and site free from water.
- .2 Do not pump water containing suspended materials into waterways, sewer or drainage systems.
- .3 Control disposal or runoff of water containing suspended materials or other harmful substances in accordance with local authority requirements.
- .4 Prior to commencing topsoil stripping, excavation or site grading operations, erect siltation control fence to prevent disposal run off from carrying suspended materials from disturbed areas of stockpiles leaving the site. Acceptable product Terrafence with prepositional posts or approved equal.
- .5 Removal of vegetation from sloped approaches to watercourses to be kept to a minimum. Excavate and stabilize temporary channel beds prior to any diversion of flow. Compact, stabilize and rip-rap banks and riverbeds that have been disturbed or damaged during construction. Provide splash pads where water is discharged into watercourses. Removal of vegetation from slopes to be kept to a minimum.

1.3 Plant Protection

- .1 Protect all trees and plants that are designated to remain.
 - .1 Contractor will pay special attention to maintaining all existing trees and large shrubs within the limits of the construction zone as designated.
 - .2 Do not stockpile material within drip line.
 - .3 Do not allow traffic, vehicles or equipment to compact soil within drip line. To accomplish this, erect temporary snow fence around affected areas.
 - .4 Prune interfering branches to OPSS 503.

- .5 Do not cut tree roots. Tunnel under or around roots by hand digging or directional drilling without damaging roots. Treat all damaged roots over 25 mm in diameter immediately with approved tree paint.

.2 Raising Grades

- .1 When fill is less than 400 mm deep, place clean washed gravel around tree trunk to a minimum radius of 450 mm and approximately 50 mm above finished grade.
- .2 Use gravel graded 25 mm to 50 mm in size.
- .3 Place gravel before earth fill.
- .4 Do not leave earth fill in contact with trunks.
- .5 When fill is more than 400 mm deep, remove and replant tree to match finished grade.

.3 Lowering Grades

- .1 Provide broad rounded mounds for trees to be preserved and located above finished grade.
- .2 Cut all exposed or broken roots greater than 25 mm diameter cleanly and cover with topsoil.

.4 Damaged Trees

- .1 Contractor will be extra precaution in the protection of trees during this project.
- .2 Replace all trees that have been damaged beyond saving.
- .3 Replace trees with similar size and species or as approved by Engineer.

1.4 Pollution Control

- .1 **Refuelling Areas** Review in detail proposed route of construction to plan access routes and fuelling areas. Establish suitable fuelling and maintenance areas and obtain approval from Engineer. Do not refuel or maintain equipment adjacent to or in watercourses. Do not fuel equipment within thirty (30) metres of any watercourse unless non-spill facilities are used.

- .2 **Cleaning Equipment** Do not clean equipment in streams or lakes. Clean construction equipment prior to entering roadways. Do not clean equipment in locations where debris can gain access to sewers or watercourses.
- .3 **Spills** Submit procedures for interception, rapid clean up and disposal of spillage that may occur, for Engineer's review, prior to commencing work. Be prepared at all times to intercept, clean up and dispose of any spillage that may occur whether on land or water. Keep all materials required for clean-up of spillages readily accessible on site. Report immediately any spills causing damage to environment to Spills Action Centre of Ministry of Environment (Tel: 1-800-268-6060).
- .4 **Use of Herbicides and Pesticides** Coordinate use of herbicides and pesticides with land owners and occupants and Regional Pesticides Control Office of Ministry of Environment and Energy.
- .5 **Disposal**
 - .1 Do not empty fuel, lubricants or pesticides into sewers or watercourses.
 - .2 Dispose of all construction debris in an approved location.

1.5 Noise Control

- .1 Establish and maintain site procedures such that noise levels from construction areas are minimized.
- .2 Use vehicles and equipment equipped with efficient muffling devices.
- .3 Provide and use devices that will minimize noise level in construction area.

1.6 Dust Control

- .1 Prevent dust nuisance resulting from construction operations at all locations on site.
- .2 Use water or Calcium Chloride to control dust. Minimize use of Calcium Chloride particularly in close proximity to watercourses or agricultural lands. Transport dusty materials in covered haulage vehicles. Public roadways shall be kept clean and free of mud.
- .3 Payment for water Calcium Chloride or brine to be included with the applicable item for which dust control is required.

1.7 Environmental Mitigation Measures

- .1 The Contractor shall enter a lump sum price in the space provided in the Schedule of Unit Prices, for all labour, materials and equipment as required to mitigate all environmental impacts as listed in the attached document.

END OF SECTION

01564 – Disinfection of Process Pipe and Inserted Fittings

PART 1 - GENERAL

1.1 Reference Standards

- .1 AWWA C651: "AWWA Standard For Disinfecting Water Mains"
- .2 AWWA C652: "AWWA Standard For Disinfection of Water Storage Facilities"
- .3 AWWA C653: "AWWA Standard For Disinfection of Water Treatment Plants"
- .4 AWWA C654: "AWWA Standard For Disinfection of Wells".

1.2 Disinfection

- .1 Before new water storage structures, well supplies and piping systems for potable water can be put into service, observe the following procedures:
 - .1 Clean and flush to Engineer's approval.
 - .2 Fill tanks or piping systems with potable water, containing 50 mg/L residual chlorine, ensure even distribution and leave for 24 hours. If a residual of less than 25 mg/L remains at end of 24-hour period, repeat.
 - .3 To conserve water and chemical, reservoirs may be disinfected by spraying all surfaces with 250 mg/L chlorine solution. Wear special protective clothing and self-contained or air-supplied type respirator. Observe all other necessary safety precautions.
 - .4 Drain chlorinated water and dispose of as specified below.
 - .5 Flush system and fill with potable water.
 - .6 Wait 24 hours then obtain / submit samples for bacteriological analysis.
 - .7 Coordinate and pay all costs associated with all required bacteriological testing.
 - .8 When test results indicate that water is of acceptable quality, structures and piping systems may be connected and taken into service.

- .2 Before piping sections that cannot be isolated, or fittings to be inserted into existing pipelines, are taken into service, observe following procedure:
 - .1 Clean and flush to Engineer's approval.
 - .2 Swab or wash all surfaces in contact with potable water with 250 mg/L residual chlorine solution.
 - .3 Have all persons handling above equipment wear sterilized gloves.
 - .4 Complete insertion or connection under supervision of Engineer.

1.3 Discharge of Chlorinated Water

- .1 Chlorinated water used for disinfection is toxic to plants and wildlife and fish.
- .2 Permissible disposal methods are:
 - .1 Discharge to storm sewer or stream only if concentration at edge of mixing zone is below 0.002 mg/L.
 - .2 Open drainage ditch, well separated from receiving stream. Presence of weeds, sunlight and high temperature is required. Monitor rate of discharge.
- .3 If the above-noted disposal method conditions cannot be met, dechlorinate as follows:
 - .1 Use any of the chemicals listed.
 - .2 Determine quantity required from:
 - .1 "Excess chlorine residual x Factor = dosage required".
 - .2 Hydrogen Peroxide (Factor = .479). Most recommended. Overdose will add more oxygen to stream.
 - .3 Sulphur Dioxide (Factor = .901). Will lower pH in receiving water.
 - .4 Sodium Thiosulphate (Factor = 2.225). will cause harmless sulphur turbidity.
 - .5 Sodium Sulphate (Factor = 1.775). Excess will lower dissolved oxygen content in stream.

- .6 Sodium Pyrosulphate (Sodium Metabisulphite) (Factor = 1.338). Excess will lower dissolved oxygen content.
- .7 Example: 11,000 L of 21 mg/L to be discharged at 1.0 mg/L residual, using Hydrogen Peroxide. Dosage required $20 \times 0.479 = 9.6$ mg/L. Total amount needed $9.6 \times 10^{-3} \times 11,000 = 105.6$ g of H_2O_2 . For 35% commercial grade, total quantity required is $100/35 \times 105.6 = 302$ g.

END OF SECTION

01600 – Material and Equipment

PART 1 - GENERAL

1.1 Qualifications

- .1 The Contractor / sub-contractors shall provide a qualified superintendent for the job who is experienced in this scale of construction. The superintendent must not be changed without notifying the Engineer 48 hours in advance.

1.2 Protection

- .1 In the event of damage, each sub-trade will make all repairs and replacements necessary to the approval of the Engineer and at no additional cost to the Owner. In particular, each trade shall take the necessary precautions to minimize water penetration during construction.

1.3 Fastenings

- .1 Each trade, except where Contract is for supply only, shall be responsible for all fastening required to complete work of that particular trade.
 - .1 Supply all fastenings, anchors and accessories and adhesives required for fabrication and erection of the work.
 - .2 Exposed metal fastenings and accessories shall be of same texture, colour and finish as base metal on which they occur.
 - .3 Metal flashings shall be for the same material as the metal which will not set up an electrolytic action which would cause damage to the fastening or metal component under moist conditions. In general, exterior anchors for windows, roofing sheet metal and anchors occurring on or in an exterior wall or slab wall be non-corrosive or hot dip galvanized steel.
 - .4 Anchoring and fastening devices or adhesive shall be of appropriate type and shall be used in sufficient quantity in such a manner as to provide positive permanent anchorage of the unit to be anchored in position. Install anchors at spacing to provide for required load carrying capacity.
 - .5 Exposed fastenings will not be permitted without approval by the Engineer prior to use.

- .6 Supply adequate instructions and templates and, if necessary, supervise installation where fastenings or accessories are required to be built into work of other trades.
- .7 Fastenings which cause spalling or cracking of material to which anchorage is being made are not permitted.
- .8 Do not use power actuated fastening devices which are stressed in withdrawal on any part of this work without written approval from the Engineer. Take particular stringent safety precautions when using powder actuated fastenings. Only low velocity plunger-type devices are permitted.

1.4 Quality

- .1 Unless otherwise noted all equipment installed on this project shall be new.

END OF SECTION

01710 – Cleaning

PART 1 - GENERAL

1.1 General

- .1 Conduct cleaning and disposal operations to comply with local ordinances and anti-pollution laws.
- .2 Store volatile wastes in covered metal containers and remove from premises daily.
- .3 Prevent accumulation of wastes which create hazardous conditions.
- .4 Provide adequate ventilation during use of volatile or noxious substances.

1.2 Materials

- .1 Use only cleaning materials recommended by manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.

1.3 Cleaning During Construction

- .1 Maintain project site free from accumulations of waste materials and rubbish.
- .2 Provide on-site containers for collection of waste materials and rubbish.
- .3 Remove waste materials and rubbish from site.
- .4 Vacuum clean interior building areas when ready to receive finish painting.
- .5 Schedule cleaning operations so that resulting dust and other contaminants will not fall on wet, newly painted surfaces.

1.4 Final Cleaning

- .1 In preparation for substantial completion or occupancy, conduct inspection of sight-exposed interior and exterior surfaces.
- .2 Remove grease, dust, dirt, stains, fingerprints and other foreign materials from sight-exposed interior and exterior finished surfaces including glass and other polished surfaces.
- .3 Broom clean paved surfaces; rake clean other surfaces of grounds.

- .4 Remove debris and surplus materials from crawl areas and other accessible concealed spaces.
- .5 Replace heating and ventilation filters if units were operated during construction.

END OF SECTION

01715 – Testing

PART 1 - GENERAL

1.1 Scope

- .1 This section outlines the requirements of leakage and pressure testing of chambers, pipes and appurtenances.

1.2 Reference Standards

- .1 OPSS

1.3 Water for Testing Purposes

- .1 In pipes and liquid retaining structures designed to hold water or sewage, the Contractor may use potable water from the existing system for testing purposes, contingent on approval from the Town of Shelburne.
- .2 Water required for initial testing and filling shall be provided by the Owner directly from the Community water supply at no cost to the Contractor. The time and rate of supply shall be convenient to the Owner.
- .3 Water necessary for subsequent fillings required as the result of unsuccessful tests shall be charged to the Contractor at the normal Municipality rate.
- .4 The Contractor shall supply all necessary labour, pumps, gauges, caps, flanges, pipework and other apparatus necessary to complete the test.
- .5 The Contractor shall be responsible for disposing of test water as detailed elsewhere in these specifications.

1.4 Inspection

- .1 All tests shall be carried out in the presence of the Engineer.

PART 2 - PRODUCTS

2.1 Liquid Retaining Structures

- .1 Liquid retaining structures shall be tested for water tightness after the application of interior waterproofing materials (if applicable) and upon construction completion of the entire structure being tested. Structures cannot be tested until all concrete has cured

sufficiently and all structural related components (roof assemblies, supports, grout, tie rods, anchoring systems, etc.) are installed to the satisfaction of the Engineer.

- .2 Where liquid retaining structures are divided into compartments, each compartment shall be tested individually.
- .3 Tanks may be backfilled, but this shall not relieve the Contractor of the cost of re-excavation for necessary repairs.
- .4 Liquid retaining structures shall be filled to their maximum level over a 24-hour period. The tank shall then be topped up and checked over the next 24 hours for water tightness. Permissible leakage over this 24-hour period shall be 10 mm. Any leakage in excess of this quantity or any leak which is visible shall be repaired at the Contractor's expenses until the test is satisfactory.
- .5 Any visible leaks shall be repaired at the Contractor's expense using methods / materials approved by the Engineer.

2.2 Precast Concrete Structures

- .1 All precast concrete structures shall be watertight. No visible leakage into or out of the structure will be permitted.

2.3 Air Piping

- .1 Both interior and exterior air piping shall be subject to a compressed air test of 345 kPa for a period of 2 hours. During this period all valves shall be operated, and a soap solution applied to all visible joints.

2.4 PVC, Ductile Iron, Galvanized Steel, Stainless Steel, Copper (Pressure Pipe)

- .1 These pressurized pipe materials shall be tested in accordance with OPSS 412 and the specified test pressure shall be 1035 kPa or maximum pipe rated working pressure – whichever is less.

2.5 Concrete Pressure Pipe

- .1 This pressurized pipe material shall be tested in accordance with OPSS 412, however, the specified test pressure shall be 600 kPa or maximum pipe rated working pressure – whichever is less.

2.6 Polyethylene Pipe (Pressure Pipe)

- .1 This pressurized piping material shall be tested in accordance with OPSS 412 with the exceptions listed below.
- .2 The test pressure shall not exceed:

<u>DR Rating</u>	<u>Test Pressure</u> (kPa)
32.5	517
26	662
21	827
17	1034
15.5	1034
13.5	1034
11	1034
9	1034

- .3 After initial filling, the P.E. pipe shall be pressurized to the test pressure specified above for a period of 3 hours. This is to compensate for initial stretch.
- .4 The leakage shall be measured over the next 1-hour period.

2.7 Ribbed PVC (Permaloc), Reinforced Concrete, PVC (Non-pressure)

- .1 These pipe materials shall be tested in accordance with OPSS 410 and shall be subject to deflection and leakage testing.

END OF SECTION

01720 – Project Record Documents

PART 1 - GENERAL

1.1 Record Drawings

- .1 As work progresses, neatly record significant deviations from the Contract Drawings using fine, red marker on full-size (2x3') white prints.
- .2 Neatly print lettering and numbers in size to match original. Lines may be drawn free-hand but shall be neat and accurate. Add at each drawing title block note: "AS BUILT RECORD". Also circle on List of Drawings each title and number of drawings marked with "as-built" records.
- .3 Record following significant deviations:
 - .1 Depths of various elements of foundation.
 - .2 Horizontal and vertical location of underground utilities and appurtenances referenced to permanent surface improvement and geodetic elevation.
 - .3 Location of internal utilities and appurtenances concealed in construction referenced to visible and accessible features of structure.
 - .4 Field changes of dimensions.
 - .5 Other significant deviations which are concealed in construction and cannot be identified by visual inspection.
- .4 Turn one (1) set of As-built Record Drawings over to Engineer prior to Substantial Completion.
- .5 If project is completed without significant deviations from Contract Drawings, declare this in writing and submit to Engineer in lieu of As-Built Record Drawings.

END OF SECTION

01725 – Commissioning, Startup and Warranty Period Inspection Requirements

PART 1 - GENERAL

1.1 General

- .1 This section outlines the requirements for start-up and commissioning of the proposed works, including warranty inspection requirements by equipment manufacturer's representatives.
- .2 Start-up is the verification of the proper installation of all mechanical, electrical and instrumentation equipment, including all activities and tests necessary to advance the newly installed equipment, control systems and facility processes to an operational level.
- .3 Commissioning (also referred to as the "2-Day Performance and Reliability Run") is the verification of the proper functioning of the various systems individually and as a whole.
- .4 Substantial Performance will not be granted until the commissioning period has been successfully terminated as outlined herein.
- .5 There shall be no testing, start-up or commissioning scheduled between December 15 and January 7.
- .6 For clarification purposes, the following is a summary of the schedule tasks, in chronological order, to be coordinated by the General Contractor:
 - .1 Engineer to provide Pre-Commissioning Checklist to Contractor (1 month prior to anticipated date for start-up).
 - .2 Contractor to submit draft Operations & Maintenance Manual (O&M Manual) to Engineer (1 month prior to anticipated date for start-up).
 - .3 Contractor to verify that all mechanical, electrical and HVAC equipment is installed and operational.
 - .4 Contractor to verify that control and instrumentation equipment is installed and checked by authorized technician and/or manufacturer's representative.
 - .5 General Contractor to provide written notification to Owner and Engineer regarding equipment readiness. Completed Pre-Commissioning Checklists to be submitted by the Contractor with this notification.

- .6 Date for start-up will be established by Owner and Engineer upon receipt of written notification regarding equipment readiness.
- .7 Start-up period to commence. In attendance: Town of Shelburne facility operators, Engineer, General Contractor, Subcontractors, Suppliers and System Programmer / Integrator.
- .8 Engineer to complete the verification checklist sheets with assistance from the General Contractor.
- .9 Deficiencies list to be prepared by Engineer and issued to Contractor. Contractor to correct deficiencies and provide written notification to Town of Shelburne and Engineer when deficiencies have been corrected.
- .10 Completion of start-up period.
- .11 Minimum 7-day period between start-up and commissioning. Actual length of time will be dependent on the approved training program. Refer to Section 01726: Operator Training.
- .12 Operator Training shall be scheduled and completed following start-up and prior to commissioning activities. Refer to Section 01726: Operator Training.
- .13 Commissioning dates will be established by Owner and Engineer upon receipt of notification regarding correction of deficiencies.
- .14 Commissioning period to commence (2-Day Performance and Reliability Run). In attendance: Town of Shelburne facility operators, Engineer and General Contractors' Site Superintendent. Subcontractors, Suppliers, System Programmers / Integrator including mechanical and electrical personnel shall be "on call" and available on an "as needed" basis when required to demonstrate their respective equipment operation.
- .15 Contractor to provide final copies of Operations & Maintenance Manuals (O&M Manuals) (Section 01730: Operating & Maintenance Data).
- .16 Termination of the commissioning period will only be granted once the facility has successfully run for 2 consecutive days meeting the reliability requirements.
- .17 No additional compensation will be given to the Contractor for a failure to run for 2 consecutive days during the reliability requirements.

1.2 Attendance and Responsibility

- .1 The equipment to be commissioned is listed on Table A at the end of this section.
- .2 The General Contractor shall make arrangements for testing and shall ensure that all personnel, mechanical and electrical subcontractors, authorized equipment manufacturers and system programmer / integrator are present during the start-up and commissioning periods. It is the General Contractor's responsibility to ensure the qualified personnel are on-site to demonstrate the equipment operation and verify that all systems are operating as designed.
- .3 Contractor shall provide any and all equipment or supplies necessary for start-up / testing of the system and equipment.
- .4 The Contractor shall ensure that all of their respective components are installed and operating as designed prior to scheduling the start-up period. Additional site visits required by the Engineer to attend the start-up period and/or commissioning period as a result of the Contractor being unprepared shall be at the expense of the Contractor.
- .5 Contractor shall ensure that the facility operator(s) is present during the start-up and commissioning periods. Where possible, the operator(s) shall participate in the testing and verification process. The operator shall receive training in the operation and maintenance of all mechanical components including controls and instrumentation (refer to Section 01726: Operator Training).

1.3 Start-up

- .1 The start-up period shall take place prior to the commissioning period outlined herein. The Contractor shall notify the Owner and Engineer at least 7 days in advance of the anticipated date for start-up. Start-up activities shall occur over a 1-day period.
- .2 Testing and verification during the start-up period shall include, but is not limited to the following:
 - .1 Verification and operation of pump(s), valve(s) and actuator(s).
 - .2 Turbidity Monitor(s) operation.
 - .3 Chlorine Analyzer(s) operation.
 - .4 UV Disinfection Unit(s) operation.
 - .5 Instrumentation and Control Loops.

- .6 Calibration of instrumentation, including PLC programming.
 - .7 SCADA System.
 - .8 Back Up Generator.
 - .3 The General Contractor shall ensure that the relevant manufacturer/supplier has certified their respective equipment for operation readiness prior to booking the 1-day startup visit.
 - .4 Approximately one (1) month prior to the anticipated date of start-up, the Engineer will provide the Contractor with a **Pre-Commissioning Checklist** outlining items of work that must be in final working order prior to the Engineer attending the site. A sample Pre-Commissioning Checklist is included at the end of this Section (Table 1).
 - .5 The Contractor shall provide the completed Pre-Commissioning Checklist to the Engineer at least 7 days in advance of the date proposed for start-up. All manufacturer/installer start-up verification reports must also be submitted to the Engineer prior to the start-up date. The Engineer will not make arrangements to attend start-up until all items listed on the Pre-Commissioning Checklist are completed to their satisfaction.
 - .6 Provide services of an authorized manufacturer's technician to certify that equipment is operating as intended. See Table A below for minimum requirements for attendance by authorized manufacturer's representatives.
 - .7 During the start-up period, the Engineer will verify the checklist and complete additional verification checks and advise the Contractor of any deficiencies or corrections to be made. The Contractor shall employ whatever means are necessary to correct these deficiencies as quickly as possible. Once the Engineer is satisfied that all equipment is operating properly, and all noted deficiencies have been corrected, the Engineer, Contractor and Owner shall establish a date for commencement of the commissioning period described below. Note: There shall be a minimum seven (7) day period between the start-up and commissioning period.
- 1.4 Operator Training
- .1 The facility operator(s) shall be present during the start-up and commissioning period. The operator(s) shall receive training regarding the operation and maintenance of all mechanical components including controls and instrumentation as shown in Table A.

- .2 Training periods shall not coincide with equipment start-up or commissioning. Training shall commence following the successful completion of the 1-day start-up period and prior to the commissioning period (2- Day Performance and Reliability Run).
- .3 This Section shall be read in conjunction with Section 01726: Operator Training.

1.5 Commissioning

- .1 Regardless of the degree of completeness of the works, the commissioning period shall not occur either concurrent with or immediately following the start-up period. Commissioning shall be scheduled following correction of deficiencies and completion of Operator training. There shall be a minimum of seven (7) days between the end of successful equipment start-up and the commencement of the commissioning period.
- .2 The works shall be operated for a total period of 2 continuous days, commencing on a Monday or as approved by the Engineer. During this period the Contractor shall have qualified electrical and mechanical personnel on call and available to be on-site on an “as needed basis”. The Contractor’s personnel shall assist the Engineer and operators in verifying the operation of the system. Should a component fail to function properly during the commissioning period, it shall be corrected and, if deemed necessary by the Engineer, the commissioning period will re-commence again the following Monday or other day as approved by the Engineer.
- .3 During the commissioning period, the Engineer will complete System Verification sheets for each piece of equipment commissioned. The verification sheet must be signed by all parties in attendance during the testing process for that particular piece of equipment. Parties present can include, but are not limited to: a Municipality Representative, an Operator for the Municipality, General Contractor, Subcontractors and/or Suppliers, and Engineer. A sample System Verification sheet is attached at the end of this Section (Table 2). See Table A below for minimum requirements for attendance by authorized manufacturer’s representatives.
- .4 The commissioning period will only be terminated upon successful completion of the following:
 - .1 Verification / check-out of all equipment, systems and sub-systems to ensure they meet the design requirements.
 - .2 Successful completion of the continuous 2 -Day Performance and Reliability Run.
 - .3 Submission of all deliverables (performance test reports, equipment manuals, operations and maintenance manuals).

- .4 Confirmation that the works meets acceptable operational parameters during the 2 day continuous runtime.

1.6 Warranty Period Inspection

- .1 Prior to the conclusion of the warranty period, a site inspection shall be completed by representatives from the Municipality, Contractor and Engineer. This inspection will assess if all outstanding deficiencies and warranty items have been addressed and identify any new action items that require correction. Sub-contractors, suppliers, manufacturers and programmers/integrators will only be required to return to site to address deficiencies or warranty items on an as-needed basis.

1.7 Payment

- .1 The Contractor shall ensure that all subcontractors and suppliers are familiar with the requirements of this Section.
- .2 The Contractor shall enter the cost associated with the start-up, commissioning and warranty period inspection in the appropriate items in the Schedule of Unit Prices. The lump sum bid shall include manufacturer's representation at and during the periods listed including all relevant mechanical and electrical subcontractor(s) and system programmer / integrator.
- .3 There will be no additional payment made to the Contractor to compensate personnel, suppliers, subcontractors, etc., to revisit the site to start-up or commission the works in the event of equipment failure or non-performance of equipment.

1.8 Attendance Requirements

- .1 Table A lists the minimum duration required for the start-up, commissioning and warranty period. Each day represents an eight (8) hour day on-site. This does not include additional time required to correct deficiencies or defects or time required on-site prior to start-up.

Table A - Minimum Requirements for Attendance (Authorized Manufacturer's Representative)

Equipment	Start-up (No. of Days)	Training (No. of Days)	Commissioning (No. of Days)	Warranty Period (No. of Days)
Pre-selected Ultraviolet Disinfection System	1	.5	1	1
Motorized Valve	1	0	0	0
Chemical Feed and Water Quality Monitoring Equipment	1	.5	1	1
Electrical Control Equipment	1	.5	2	1
SCADA System	1	1	2	1
Stand-By Power Generator	1	.5	1	1

Table 1 - Pre-Commissioning Checklist (Sample)

Project Name:		Project No.	

Item	Description	Pre-Commissioning Requirement
Pumps, VFD's and Soft Start Controllers		☐ Factory Acceptance Test Report ☐ Certificate of Site Acceptance ☐ Testing by Manufacturer's Representative
Piping, Valves and Actuators		☐ Hydrostatic Leak Testing of Piping and Valves ☐ Labels and Tags ☐ All Valves Operational ☐ Acceptable Bacteriological test results received
Turbidity Monitors		☐ Certificate of Site Acceptance by manufacturer ☐ Calibration Report
Chlorine Analyzers		☐ Certificate of Site Acceptance by manufacturer ☐ Calibration Report
Instrumentation and Control Equipment		Instruments and installed and calibrated: ☐ Chlorine Analyzer ☐ Turbidimeter ☐ Valve Actuators ☐ Flow Indicators ☐ Pressure Switches ☐ Pressure Indicator Transmitters ☐ Level Switches ☐ Probes

		☐ Temperature Sensors ☐ Timing Relays ☐ Control wiring and terminal blocks properly labelled
Flow Meters, Motorized Valves, Special Valves (i.e: flow control, pressure sustaining, etc.). Limit Switches, etc.		☐ Certificate of Site Acceptance by manufacturer ☐ Calibration Report (where necessary)
Item	Description	Pre-Commissioning Requirement
PLC and SCADA		☐ Testing of Wirings termination to PLC ☐ Programming Complete ☐ Factory Acceptance Testing of software complete
Electrical Works		☐ Submit ESA Certificate

For each of the pre-commissioning requirements listed above, the General Contractor shall submit a report that verifies that each of the requirements have been tested and the equipment is in a state of perpetual readiness.

The Engineer and Owner representative(s) shall witness each of the verification procedures performed during the start-up (pre-commissioning) phase.

Contractor

Date

Consultant

Date

Owner Representative / Operator

Date

Table 2 - System Verification Sheet (Sample)

Project Name:		Project No.:	
Date of Commissioning:			
Equipment Details:			

Item	Status/Comments	Reviewed for Completeness
☐ Commissioned by authorized technician		
☐ Commissioning Report available		
☐ Raw and treated water turbidity accurately displayed locally and at PLC		
☐ High turbidity alarm verified		
☐ Chlorine residual and pH accurately displayed locally and at PLC		
☐ Low chlorine residual alarm verified		

Comment:

Contractor

Date

Consultant

Date

Owner Representative / Operator

Date

END OF SECTION

01726 – Operator Training

PART 1 - GENERAL

1.1 General

- .1 The facility operator(s) shall be present during start-up and commissioning periods outlined in Section 01725: Commissioning. The operator(s) shall receive training regarding the operation and maintenance of all mechanical components including controls and instrumentation as shown in Table A.
- .2 Training periods shall not coincide with equipment start-up or commissioning. Training shall commence following the successful completion of the start-up period and prior to the commissioning period.
- .3 The General Contractor shall be responsible for coordination of training for the facility operators in accordance with the requirements listed in this Section.
- .4 The Contractor shall arrange with the manufacturer and or supplier to train the Town of Shelburne Facility Operator(s) on the proper operation and maintenance of the new process equipment.
- .5 The training shall be conducted by qualified, experienced (2-year minimum), factory-trained representatives of the various equipment manufacturers at the site of the equipment. Training shall include instructions on the proper operation of the equipment, including normal preventative maintenance and repairs.
- .6 Video-record the training sessions(s) are to be performed by the General Contractor for use by the Community for later reference. The General Contractor shall ensure that all suppliers, trainers, etc., are aware of this.

1.2 Training Program and Materials

- .1 *Training materials shall be submitted three (3) weeks prior to the anticipated training period and shall include the following:
 - .1 Lesson(s) planned for each training session to be conducted by the manufacturer's representatives, including training manuals, handouts, visual aids and other reference materials.
 - .2 Lesson(s) shall include an outline of the material to be presented along with a description of visual aids to be utilized during the session. Each lesson will contain a time allocation for each subject.

- .3 Provide one (1) complete set of the original materials for the training manuals, handouts, visual aids and reference material, bound in the specified binder to the Town of Shelburne.
- .4 The Contractor shall furnish 10 copies of training manuals, handouts, visual aids and reference materials in advance of each planned training session.
- .5 Date, time and subject of each training session and identify and qualifications of individuals conducting the training should be provided.
- .6 Each training session shall comprise of time spent in a classroom (if required) and at the equipment or system location. As a minimum, a training session shall cover the following topics for each equipment item or system:
 - .1 Familiarization
 - .2 Process theory
 - .3 System and design configuration
 - .4 Safety
 - .5 Operation
 - .6 Process and production optimization
 - .7 Troubleshooting
 - .8 Preventative maintenance
 - .9 Corrective maintenance
 - .10 Parts
 - .11 Local representatives
 - .12 Equipment operation and maintenance manuals
 - .13 As a minimum, classroom equipment training shall include:
 - .1 Using slides and drawings, discuss the equipment specific location in the facility and an operational overview.
 - .2 Purpose and facility function of the equipment.

- .3 Start-up, shutdown, normal operation and emergency operation procedures including a discussion on system integration and electrical interlocks, if any.
 - .4 Identify and discuss safety items and procedures.
 - .5 Routine preventative maintenance, including specific details on lubrication and maintenance of corrosion protection of the equipment and ancillary components.
 - .6 Operator detection, without test instruments, of specific equipment trouble symptoms.
 - .7 Required equipment exercise procedures and intervals.
 - .8 Routine disassembly and assembly of equipment, if applicable, for operation inspection of equipment.
- .2 Hands-on equipment training for the Town of Shelburne Facility Operator(s) shall include the following:
 - .1 Identify location of equipment and review the purpose.
 - .2 Identify piping and flow options.
 - .3 Identify valves and their purpose.
 - .4 Identify instrumentation as follows:
 - .1 Location of primary element.
 - .2 Location of instrument readout.
 - .3 Discuss purpose, basic operation and information interpretation.
 - .5 Location and identify equipment components.
 - .6 Review the equipment function and theory of operation.
 - .7 Review normal repair procedures.
 - .8 Perform start-up and shutdown procedures.
 - .9 Review and perform the safety procedures.

- .10 Perform Client approved maintenance and repair work practices, including mechanical and electrical adjustments and calibration and troubleshooting equipment problems.
- .11 Review and use Equipment Operation & Maintenance manual(s) in the hands-on training.
- .3 Demonstrate and perform standard operating procedures and routine checks including:
 - .1 Preventative maintenance activities.
 - .2 Start-up and shutdown procedures.
 - .3 Equipment exercise procedures.
 - .4 Perform routine disassembly and assembly of equipment if applicable.
 - .5 Identify and review safety items and perform safety procedures if feasible.
- .4 Classroom equipment training for the Town of Shelburne Facility Operator(s) shall include:
 - .1 Theory of operation.
 - .2 Description and function of equipment.
 - .3 Start-up and shutdown procedures.
 - .4 Normal and major repair procedures.
 - .5 Equipment inspection and troubleshooting procedures including the use of applicable test instruments and the “pass” and “fail” test instrument readings.
 - .6 Routine and long-term calibration procedures.
 - .7 Safety procedure.
 - .8 Preventative maintenance such as lubrication; normal maintenance such as belt, seal and bearing replacement; and major repairs such as replacement of major equipment part(s) with the use of special tools, welding jigs, etc.
- .5 Training Schedule
 - .1 Concurrent classes will not be permitted under any circumstances.

- .2 Payment shall be on a lump sum price basis for the provision of the complete training program and materials as outlined in this section.

END OF SECTION

01730 - Operating and Maintenance Data

PART 1 - GENERAL

1.1 Maintenance Manual

- .1 This Section outlines the requirements of operational and maintenance data to be provided for this project.
- .2 On completion of project, Contractor shall submit to Engineer three (3) final copies of Operating and Maintenance data, in English, made up as follows:
 - .1 Bind data in six (6) vinyl hard covered, 3-ring loose leaf binder for letter-size paper.
 - .2 Enclose title sheet, labelled “Operating and Maintenance Data Manual”, project name, date and list of contents.
 - .3 Organize contents into applicable sections of work to parallel project specification break-down. For specifics as follows:
 - .1 Volume 1: Operation Manual
 - .2 Volume 2: Architectural / Structural
 - .3 Volume 3: Mechanical Operations & Maintenance
 - .4 Volume 4: Electrical & Instrumentation Operation.
 - .4 Mark each section by labelled tabs protected with celluloid covers fastened to hard paper dividing sheets.
 - .5 The Contractor shall provide two (2) draft copies of the Operating and Maintenance Manual prior to the commencement of the start-up period (1 copy for the WTP, and 1 copy for the Engineer).
 - .6 The Contractor will also provide the Engineer with an electronic file copy of the Operation & Maintenance Manuals in (Word and PDF format) when the draft final copy of the document has been approved.
- .3 Include the following information, plus the data specified:
 - .1 Maintenance instruction for finished surface and materials.
 - .2 Copy of hardware and paint schedules.

- .3 Description, operation and maintenance instructions for equipment and systems, including a complete list of equipment and parts list. Indicate nameplate information such as make, size, capacity, serial number.
- .4 Name, addresses and phone numbers of sub-contractors and suppliers
- .5 Guarantees, warranties and bonds showing:
 - .1 Name and address of projects.
 - .2 Guarantee commencement date (date of Final Certificate of Completion).
 - .3 Duration of Guarantee.
 - .4 Clear indication of what is being guaranteed and what remedial action will be taken under guarantee.
 - .5 Signature and seal of appropriate sub-contractor.
- .6 Additional material used in the Project listed under various sections.
- .4 Maintenance Manual
 - .1 Neatly type lists and notes. Use clear drawings, diagrams and manufacturer's literature.
 - .2 Include one (1) complete set of reviewed shop drawings (bound separately), indicating corrections and changes made during fabrication and installation.
 - .3 Include a list of all manufacturer's recommended spare parts, lubricants and operation and maintenance equipment. List to be a combined list including information obtained for all equipment, neatly typed and organized by section with a detailed table of contents.
- .5 Maintenance Manuals
 - .1 Where supply cartons, or if not supplied in cartons, they shall be strongly packaged.
 - .2 Clearly mark as to content.
 - .3 If applicable, give areas where material is used.
 - .4 Materials to be supplied three (3) months after preliminary acceptance.

END OF SECTION

02060 - Demolition

PART 1 - GENERAL

1.1 General

- .1 The General Conditions of the Contract, the Supplemental General Conditions and Special Provision 1 – General Information, shall be deemed to apply and be a part of this Section of the Specifications.

1.2 Definitions

- .1 Hazardous Materials: dangerous substances, dangerous goods, hazardous commodities and hazardous products, may include but not limited to: poisons, corrosive agents, flammable substances, ammunition, explosives, radioactive substances, or other material that can endanger human health or well being or environment if handled improperly.
- .2 Waste Management Coordinator (WMC): Contractor representative responsible for supervising waste management activities as well as coordinating related required submittal and reporting requirements.
- .3 Waste Audit (WA): detailed inventory of materials in building. Involves quantifying by volume / weight amounts of materials and wastes generated during construction, demolition, deconstruction, or renovation project. Indicates quantities of reuse, recycling and landfill.
- .4 Waste Reduction Work plan (WRW): written report which addresses opportunities for reduction, reuse, or recycling of materials. WRW is based on information acquired from WA.
- .5 Hand Demolition: Systematic demolition of structures by works using hand-held tools.
- .6 Mechanical Demolition: Systematic demolition of structures using powered equipment.
- .7 Systematic Demolition: Methodical dismantling of structures piece by piece, usually carried out in reverse order of construction.
- .8 Rapid Progressive Failure: Method of demolition where key elements of structure are removed causing a rapid and complete collapse of whole or part of the structure.

1.3 Description

- .1 The extent of work to be demolished includes mechanical process equipment, HVAC, electrical equipment, building products, yard piping, etc., that are to be removed. Quantities, dimensions will have to be ascertained by the Contractor.

1.4 Related Work

- .1 Disconnection and removal of electrical cable and other appurtenances.

1.5 Regulatory Requirements

- .1 Comply with applicable requirements of the following:
 - .1 CSA S350 – M1980 (R2003) “Code of Practice for Safety in Demolition of Structures”
 - .2 Canadian Environmental Protection Act (CEPA), 2012
 - .3 Canadian Environmental Assessment Act (CEAA), 2012
 - .4 Transportation of Dangerous Goods Act (TDGA), 1992
 - .5 Motor Vehicle Safety Act (MVSA), 1995
 - .6 Waste Audits and Waste Reduction Work Plans, O. Reg 102/94
 - .7 General – Waste Management, R.R.O 1990, Reg 347
 - .8 Conform to the Occupational Health and Safety Act Ontario Regulation 213/91, Amended to O.Reg. 628/05; Construction Projects.
 - .9 Occupational Health and Safety Act Revised Regulation of Ontario, Regulation 838, Amended to O.Reg.-104/04 Designated Substance-Asbestos on Construction Projects and in Building and Repairs Operations.
 - .10 Conform to the OBC, especially Division C, Part 1.2.2.3. (Demolition Permit)
 - .11 Conform to Fire Code, Regulation, under the Fire Protection and Prevention Act, especially Part 8.

1.6 Submittals

- .1 The Contractor is responsible for the preparation of a demolition plan and sequencing of the removals. The demolition plan shall be developed to ensure that no unexpected or progressive collapse of the structure occurs. Additionally, the methodologies put forth in the demolition plan shall minimize the potential for damage to adjacent properties, and annoyance to the occupants of the adjacent properties, as a result of ground vibration or noise or airborne pollution and dust. Where required by authorities having jurisdiction, submit drawings, diagrams or details showing sequence of dismantling work and shoring of structures during demolition.
- .2 Drawings for temporary works or shoring of structural elements shall be signed and sealed by a Professional Structural Engineer licensed in the Province of Ontario.
- .3 The WMC is responsible for ensuring all reporting requirements are fulfilled to the satisfaction of Owner.
- .4 Prior to commencement of work on site, submit detailed waste removal work plan indicating anticipated percentages of reuse (if any), recycling (if any) and landfill, schedule of selective demolition (if any), material description and quantities of materials to be salvaged (if any), number and location of dumpsters, anticipated frequency of tippage, and name and address of all haulers, waste facilities and waste receiving organizations.
- .5 Submit copies of certified weigh bills, bills of lading and receipts from authorized disposal sites and reuse and recycling facilities for all material removed from site on a weekly basis or upon request of the Owner's Representative. Written authorization from the Contractor's Engineer is required to deviate from the waste removal work plan.
- .6 The Contractor shall submit, in order to substantiate project performance and payment certification, official documentation verifying the acceptance of all designated substances and goods into and by a certified waste management site.

1.7 Qualifications

- .1 Use skilled personnel who have substantial experience in careful removal of materials, items and equipment.

1.8 Protection

- .1 Support affected structures and, if safety of adjacent structures or services appears to be endangered, take preventative measures and then cease operations and notify the Consultant.
- .2 Provide, erect and maintain required hoarding, sidewalk sheds, catch platforms, lights and other protection around the site before commencing work. Maintain such areas free of snow, ice, mud, water and debris. Lighting levels shall be equal to that prior to erection.
- .3 Protect existing adjacent work against damages which might occur from falling debris or other causes due to work of this Section.
- .4 If the Consultant considers additional bracing and shoring necessary to safeguard and prevent such movement or settlement, install bracing or shoring upon the Consultant's orders. Should Contractor fail to comply promptly with such request, such bracing and shoring may be placed by the Consultant at Contractor's Expense.
- .5 Take precautions to guard against movement, settlement or collapse of adjacent services, sidewalks, driveways, or trees or other landscaping except where items are designated for removal. Be liable for such movement, settlement or collapse caused by failure to take necessary precautions. Repair promptly such damage when ordered.
- .6 Maintain fire exits from site.
- .7 Where applicable, remove or neutralize hazardous or toxic materials identified during survey before demolition begins.
- .8 Prevent debris from blocking surface drainage system and any other systems which must remain in operation.
- .9 Ensure that demolition work does not adversely affect adjacent watercourses, groundwater and wildlife, or contribute to excess air and noise pollution.
- .10 Fires and burning of waste or materials is not permitted on site.
- .11 Do not bury waste or materials on site.
- .12 Do not dispose of waste or volatile materials such as: mineral spirits, oil, petroleum-based lubricants, or toxic cleaning solutions into watercourses, storm or sanitary sewers. Ensure proper disposal procedures are maintained throughout project.

- .13 Control disposal or runoff of water containing suspended materials into watercourses, storm or sanitary sewers, or onto adjacent properties.
- .14 Prevent extraneous materials from contaminating air beyond application area, by providing temporary enclosures during demolition work.
- .15 Cover or wet down dry materials and waste to prevent blowing dust and debris. Control dust on all temporary roads and site access points.

PART 2 - PRODUCTS

2.1 Materials

- .1 Gravel fill in accordance with OPSS 1010, 19mm Crusher-Run Limestone.
- .2 Provide materials necessary for temporary shoring. On completion, remove temporary materials from site.
- .3 Except as indicated on Drawings, materials forming permanent part of structure being demolished shall become property of this Section. Remove from Site.
- .4 Remove contaminated and dangerous material from Site and dispose of in safe manner to minimize danger involved at Site or at any time during disposal.

2.2 Equipment

- .1 Equipment and heavy machinery to meet or exceed all applicable emission requirements and be operate in compliance with EPA CFR 86.098-10 and EPA CFR 86.098-11 standards.
- .2 Leave machinery running only while in use, except where extreme temperatures prohibit shutting machinery down.

PART 3 - EXECUTION

3.1 Execution

- .1 Disconnect and cap or remove obsolete mechanical and electrical services as specified in the Contract Drawings. Verify with Owner that the services have been turned off. Identify and protect any active services passing through to adjoining floors or areas.
- .2 Before commencing demolition operations, examine Site to determine type of construction, condition of structure and Site conditions. Assess strength and stability of damaged or deteriorated structures.

- .3 Investigate the following conditions as required
 - .1 Presence of pre-stressed or post-tensioned elements.
 - .2 Effects of soils, water, lateral pressures on retaining or foundation walls.
 - .3 Basements, tunnels, vaults or similar underground, construction extending beyond perimeter of structure to be demolished or removed
 - .4 Presence of tanks, wells, other piping systems.
 - .5 Presence of hazardous materials.
- .4 Contact designated authorities or utility companies for assistance in locating and making service passing under, through, overhead or adjacent to structure to be demolished. Such services include but may not be limited to:
 - .1 Electrical power lines.
 - .2 Gas mains.
 - .3 Oil pipelines.
 - .4 Communication cables.
 - .5 Watermains.
 - .6 Drainage piping (storm and sanitary).
- .5 After determining demolition methods, determine area of possible vibration. Carefully inspect beyond those adjacent areas. List potential drainage areas and photograph each for record purposes before starting work. Record termination points referencing property lines or other permanent features of all utilities on a set of site plan prints and provide a copy to the consultant.
- .6 Obtain permission from adjacent property regarding use outriggers, swinging cranes and similar equipment.

3.2 Demolition

- .1 All demolition work to be coordinated by General Contractor.
- .2 Report any unforeseen conditions of demolition.
- .3 Remove all designated mechanical and electrical items.

- .4 Fill all open space more than 450 mm (18") below finished grade with rocks, bricks, broken concrete, or other approved material. For final 450 mm (18") of fill, place gravel or approved earth and topsoil.
- .5 Fill materials and areas to be filled shall be free of standing water, frost, frozen materials, trash and debris.

3.3 Disposal and Clean-up

- .1 At the end of each workday leave Place of Work in broom-clean condition.
- .2 All demolished materials, unless identified to be relocated or stored, shall become the Contractor's property and shall be removed from site and legally disposed.
- .3 Conform to requirements of local Municipal and Federal guidelines.
- .4 Materials prohibited from Government waste management facilities shall be removed from Site and disposed of at recycling companies specializing in recycled materials.
- .5 Conform to requirements of the Ministry of the Environment, Conservation and Parks for disposal of wastes.

3.4 Existing Services

- .1 Provide and maintain temporary services required during demolition to the satisfaction of authorities having jurisdiction, fire departments and utility companies.
- .2 Before commencing demolition, contact Electrical Department of local authorities and tour Site with them. Disconnect and seal electrical power lines and communications cables entering buildings to be demolished. Post warning signs on electrical lines and equipment, which must remain energized to serve other properties during the period of demolition.
- .3 In event of unexpected discovery of buried fuel or other tanks do no further work and immediately report discovery, orally and in writing to the Consultant. The Consultant will authorize remedial work if any, in writing, do such remedial work as additional to Contract.
- .4 Remove electrical equipment scheduled for removal on Drawings and as required by the Work.
- .5 Remove water lines indicated on Drawings and cap to prevent leakage.

- .6 Record termination points referencing property lines or other permanent features of all utilities on a set of site plan prints and provide a copy to the Consultant.

3.5 Performance

- .1 Ensure a competent foreman supervises demolition work at all times.
- .2 Materials and other debris shall not be stacked in building to extent that overloading of any part of structure will occur.
- .3 At end of each day's work, leave work in safe condition ensuring that no parts of structures are in danger of collapsing.
- .4 Until acceptance, maintain and preserve active utilities traversing premises.
- .5 Keep work wetted down to minimize dust.
- .6 Minimize noise. Avoid use of noisy machinery outside working hours.
- .7 Provide enclosed chutes for disposal of debris from heights more than 1-storey in accordance with CSA S350-M.
- .8 Provide protection around floor and/or roof openings.
- .9 Upon completion of demolition work, level and clear Site or prevent access to excavations by means of fences or hoarding.
- .10 Maintain safety of Site by shoring against collapsed below grade-structures and excavations resulting from demolition

3.6 Methods

- .1 Hand and mechanical demolition shall be acceptable for work of this section. Verify with the Consultant whether proposed methods of demolition are acceptable.
- .2 Following methods of demolition will not be permitted in work of this Contract:
 - .1 Use of rapid progress failure methods (explosive).
 - .2 Mechanical method of demolition whereby wrecking is accomplished by smashing walls and floors with heavy weight suspended by cable from boom hoist (balling).

3.7 Measurement and Payment

- .1 Measurement and payment for work of this Section shall be in accordance with the items in the Schedule of Unit Prices.

END OF SECTION

02151 – Shoring and Bracing

PART 1 - GENERAL

1.1 Scope

- .1 Designing, supplying, placing, bracing and removing any temporary shoring of the sides of excavations. Also covers excavations shoring to be left in place and underpinning and/or temporary supports for existing utilities which may be necessary in order to execute construction of works.
- .1 Protection of adjacent structures, utilities, pipelines, or other foundations on grade from damage and/or displacement.
- .2 It will be the Contractor's decision whether to carry out general excavation in open cut or to use shoring system to conserve space and/or control groundwater infiltration.
- .3 Shoring is mandatory where indicated and in all areas where excavation will potentially undermine existing structures, pipes, conduits, utilities or road.

1.2 Related Work

- .1 Applicable sections of Division 1.
- .2 Applicable sections of Division 2.

1.3 Geotechnical Report

- .1 A Geotechnical (Soils) Report is not included in this document.

1.4 Measurement for Payment

- .1 If required, include costs for shoring and bracing under applicable item in the Schedule of Unit Prices.

1.5 Responsibility for Shoring System

- .1 Engage a professional engineer, registered in the Province of Ontario, who has a minimum of five (5) years' experience in shoring and underpinning work, to design and supervise construction of temporary structures which are required in order to execute construction of permanent works.
- .2 Take full responsibility for design, supplying, placing, installation, maintenance and where applicable removal of shoring system.

- .3 Comply with all safety requirements of the Occupational Health and Safety Act and Ontario Building Code.

1.6 Design of Shoring System

- .1 Design shoring system for all applicable lateral pressures from soil and groundwater, including unsymmetrical surcharge loads from construction operations and frost action on retained soil.
- .2 Design excavation shoring and/or underpinning systems based on recognized geotechnical and structural theories and principles and site conditions encountered.
- .3 Design underpinning and temporary supports for existing structures and/or utilities to safely resist all loads including loads which may be imposed as a result of construction operations.
- .4 Design bracing to be fully effective at all stages of construction. Prestress bracing, if required, to control deflection.
- .5 Where shoring system retains materials which provides support for foundations at a higher level, design to limit deflections so that foundation materials are not disturbed or weakened.
- .6 For steel sheet piling of type with interlock at neutral axis, base design on complete slip of interlocks.
- .7 Coordinate design of shoring system with design of dewatering system to meet performance requirements specified herein.

1.7 Shop Drawing / Submittals

- .1 Submit shop drawings of temporary structures including shoring and bracing systems. Shop drawing to bear seal and signature of a Professional Engineer, registered in the Province of Ontario, who has carried out the design and who will provide construction supervision of temporary structures.
- .2 Indicate on shop drawings the following:
 - .1 Dimensions and elevations.
 - .2 Temporary struts and walers, etc., their relationship to permanent structure and schedule for removal (if applicable).
 - .3 Relationship to new and existing structures and utilities.

.4 Material designations, grades, sizes, etc.

.3 Take the full responsibility for design, supplying, placing installation and maintenance.

1.8 Shoring Performance Requirements

.1 General Requirements

.1 Construct substantially watertight excavation shoring systems suitable for geotechnical conditions encountered and which will meet all requirements of these performance Specifications. Prevent destabilization of subgrade, damage to any structure and/or works. Prevent disturbance, displacement or damage to sides and bottom of excavation to new and existing structures, pipelines, utilities, roads, embankments, etc., at any stage of construction of works. Prevent destabilization or failure of bottom of excavation from shear, heave, groundwater pressure or any other cause.

.2 Watertightness

.1 Shoring system to be watertight to the extent that any dewatering required inside the excavation shall not lower the water table on exterior side of the shoring system.

.3 Tolerances (if shoring section is to be used as a form for structural concrete)

.1 If to be used as a form of structural concrete, install shoring so that, exclusive of temporary walers or bracings, no part of temporary structure to be left in place above the bottom of the excavation in its deflected position will reduce structural concrete wall thicknesses below the dimensions indicated.

.2 If the shoring installation does not satisfy these requirements, alter it, at no extra cost to Owner, until it meets the requirements.

.3 Allow a minimum installation tolerance of 75 mm.

.4 Fill the space between shoring and structural member with concrete.

.4 Monitoring Deflection

.1 Monitor and keep a written record of deflections of the shoring system at all critical locations. The Engineer reserves the right to review and field check the Contractor's records.

PART 2 - PRODUCTS

2.1 Materials

.1 Structural Steel Members

- .1 CAN/CSA G40.21M 300W for walers, soldier pile and bracing.

.2 Steel Sheet Piling

- .1 Per CAN/CSA G40.20/21M interlocking type of type to meet design requirements.

.3 Welding

- .1 CSA W59.

.4 Steel Liner Plates

- .1 Corrugated proprietary steel liner plates with bolted joints and grouting nipples supplied on a sufficient number of plates to provide grouting connections at 3 m maximum around the circumference and every second ring of plates.

.5 Lumber

- .1 Graded lumber, sound, straight, free from cracks, shakes, large or loose knots. Use planks for sheeting, tongued and grooved, or grooved and splined as required.

.6 Grout as per Section 03305.

.7 Concrete as per Section 03305.

PART 3 - EXECUTION

3.1 Inspection

- .1 Before commencing work, inspect conditions upon which work depends. Inform the Engineer in writing of conditions not identified. Failure to inform the Engineer implies acceptance of existing condition.

3.2 Installation - General

- .1 Retain a Professional Engineer responsible for design and supervision of construction of temporary structures to verify that work is carried out in conformance with the design.

- .2 Do not place any part of shoring and bracing systems until permission by the Engineer has been given to proceed.
- .3 Install shoring so that there is no loose material or voids between shoring and sound undisturbed soil.
- .4 Provide and set all excavation, shoring and bracing necessary to prevent cave-in of banks and excavations.
- .5 Set all shoring to a true vertical and to dimensions and elevations indicated on shop drawings.
- .6 Do not encase any part of temporary structure in the structural concrete of the permanent structure without written permission from the Engineer.

3.3 Steel Sheet Piling

- .1 Provide temporary guide frames and bracing to hold sheet piles in proper alignment during setting and driving. Install piling to dimensions and elevations indicated on shop drawings.
- .2 Install walers and bracings so not to interfere with reinforcing bars or other parts of permanent structures.
- .3 Splices in walers shall develop full strength of member in bending, shear and axial compression.
- .4 If bracing members, such as walers, etc., are to be removed during construction, timing and procedure for removal shall not induce stresses in permanent structures or in steel sheet piling or bracing members in excess of those allowed by applicable codes.
- .5 Clean inside face of sheeting system of all dirt and loose material to make it suitable for use as outside form for concrete wall if applicable.
- .6 Leave sheeting in place unless otherwise specified.

3.4 Soldier Piles and Lagging

- .1 Install soldier piles to dimensions and elevations indicated on shop drawings. If soldier piles are installed in pre-drilled holes, fill void around piles with a lean concrete mix before commencing excavation.

- .2 Install walers and/or ringwalers, struts and bracing for soldier piles as excavation proceeds and follow behind as closely as possible with lagging installation. Install lagging to bottom of excavation at the end of each day's work.
- .3 Wedge lagging tightly against firm soil at all points.
- .4 If soil has been loosened, remove it and fill void with drypack concrete rammed tightly between the lagging and firm soil.
- .5 Fill all voids between lagging and firm soil with drypack rammed tightly in place.
- .6 If bracing members, such as walers, etc., are to be removed during construction, timing and procedure for removal shall not induce stresses in permanent structures or bracing members in excess of those allowed by applicable codes.

3.5 Liner Plates

- .1 Excavate to depth of one ring and place liner plates, set first ring true to circle and vertical position.
- .2 Excavate for next ring and place liner plates. Do not excavate further ahead of liner in place than the width of one (1) ring.
- .3 Grout voids between liner plates and ground, by means of a grout pump. Frequency of grouting to suit conditions but not less frequent than after every second ring has been placed. Do not leave any ring ungrouted overnight.
- .4 Do not leave the sides of the excavation exposed below the liner plates at the end of the day's work.
- .5 Clean inside face of liner plates of all dirt and loose material to make it suitable for use as outside form for concrete wall.
- .6 Provide reinforcing at openings as required by the design.
- .7 Clean inside face of sheeting system of all dirt and loose material to make it suitable for use as outside form for concrete wall if applicable.
- .8 Leave sheeting in place unless otherwise specified.

3.6 Closed Sheeting for Trenches

- .1 Provide and install braced closed sheeting where required for trench construction.

- .2 Sheeting system shall be adequate for all loading and pressures and for surcharge effects due to construction equipment and materials in accordance with the provision of the Occupational Health and Safety Act, and the Ontario Building Code.
- .3 Where sheeting is to be left in place, the top shall be cut to 1.2 m below grade or as directed by the Engineer.

3.7 Monitoring Deflection

- .1 Monitor deflection of shoring systems, on a daily basis, which retains materials that provide support for foundations at higher levels. Verify that their deflections are within specified requirements.
- .2 Monitor elevations at each corner and center of existing reservoir daily.
- .3 Report to the Engineer immediately if specified settlement limits are exceeded.
- .4 Submit written records of settlement and deflection result to the Engineer every week.

END OF SECTION

02210 – Site Grading

PART 1 - GENERAL

1.1 General Requirements

- .1 In general site grading including clearing and grubbing and topsoil stripping and stockpiling shall be completed in accordance with OPSS No's 201, 206 and as supplemented by this Section.
- .2 Conform to Sections of Division 1 as applicable.

1.2 Site Conditions

- .1 The location of underground utilities as shown on the Contract Drawings is approximate only and the Contractor shall be responsible for obtaining a stakeout of the utility from the company involved.

1.3 Protection

- .1 Prevent damage to landscaping, existing pavement, surface or underground utility lines which are to remain. Make good any damage.
- .2 The provisions of the Provincial "Guidelines on Erosion and Sediment Control for Urban Construction Sites" shall apply to this Contract. Necessary measures shall include, but not be limited to, the supply and installation of silt fence in disturbed areas made vulnerable to sediment transport.

PART 2 - PRODUCTS

2.1 Materials

- .1 Excavated or graded material to be approved before use as fill for grading work. Protect such approved material from contamination.

PART 3 - EXECUTION

3.1 Removal of Topsoil

- .1 Strip topsoil when dry enough to prevent contamination of sub grade material. Surplus topsoil is to be disposed of in an onsite location and in a manner acceptable to the Engineer.

- .2 Stockpile topsoil on site where directed in a neat and orderly manner acceptable to the Engineer.

3.2 Grading

- .1 Rough grade to levels, profiles and contours allowing for surface treatment as indicated.
- .2 Prior to placing fill over existing ground, scarify surface to depth of 150 mm. Moisture content of fill and existing surface to be approximately the same to facilitate bonding.
- .3 Compact filled and disturbed areas to Standard Proctor density to ASTM D698-78 as follows:
 - .1 85 % under landscape areas.
 - .2 100 % under paved and walk areas.
- .4 The Contractor shall be required to trim or build slopes at site boundaries to a grade not steeper than 3H:1V.

3.3 Testing

- .1 Inspection and testing of soil compaction will be carried out by designated testing laboratory.
- .2 Costs of test will be paid by the Contractor.

3.4 Surplus

- .1 Surplus or unsuitable fill is to be disposed of by the Contractor at a location approved of by the Owner.

END OF SECTION

02220 – General Excavation, Dewatering & Backfilling

PART 1 - GENERAL

1.1 General

- .1 General excavation, dewatering and backfilling shall be completed in accordance with OPSS No.'s 902, 501, 511, 514, 515, 517, 538, 1004, 1010 and as supplemented by this Section.
- .2 Conform to Sections of Division 1 as applicable.
- .3 Trenches and other excavations under this Contract shall conform to the requirements of the Occupational Health and Safety Act and Regulations for Construction Projects, Regulations 213/91 and 714/82 and Revised Statutes of Ontario, 1980 Chapter 321.

1.2 Methods of Excavation

- .1 Excavation shall be carried out by methods approved by the Engineer.

1.3 Topsoil

- .1 Topsoil shall be stripped from areas where excavation or filling is to be done. Care shall be taken in removing topsoil to avoid mixing it with the underlying clay, gravel, or other material.
- .2 Topsoil approved by the Engineer for re-use shall be stockpiled on the site of the work, as directed by the Engineer. Unsuitable surface material or topsoil shall be disposed of as provided herein.

1.4 Slides and Cave-Ins

- .1 Slides and cave-ins shall be rectified at the cost of the Contractor. They shall refill all such with suitable materials.

1.5 Surplus Excavation

- .1 The Owner has first right of refusal on surplus excavated material, after which it will be the property of the Contractor. The Contractor shall dispose of the material off-site in an area(s) approved by the Owner. The Contractor shall provide a signed Release Form (OPSF 1803) from any private disposal site owner and shall comply with the requirements of OPSS 180. Submit to Engineer Waste Quantity Report Form (OPSF 1805) for all Non-Hazardous Waste.

1.6 Open Excavation Protection

- .1 Whenever it is necessary to have excavation left open for any period while the construction crew is not working in the immediate area, or a watchman is not posted, the excavation shall be pumped out immediately after every storm, inspected twice daily for accumulation of water, and adequately barricaded with snow fences or equal, completely around the excavation, equipped with sufficient warning lights, as required by the Engineer. Costs for the above shall be the Contractor's responsibility.

1.7 Excavation Open For A Prolonged Time

- .1 If the work is stopped in the whole or any part of an excavation and the same is left open for what is, in the opinion of the Engineer, an unreasonable length of time, because of non-delivery of material, tests or for any other reasons, the Contractor shall, when so directed by the Engineer, refill such excavation or part thereof until he is ready to proceed with construction.
- .2 If the Contractor refuses, neglects or fails to completely refill such excavation within 48 hours after the receipt of a notice in writing to do so, the Engineer shall be entitled to refill the excavation and all the cost and expense thereof shall be charged to the Contractor, and the Owner may retain the amount of such cost and expense out of any monies due or to become due the Contractor. Any re-excavation costs made necessary by the above will be borne by the Contractor.

1.8 Tunnelling

- .1 Tunnelling not shown on the Drawings will not be allowed without the approval of the Engineer. The method of tunnelling and the location of all shaft, portals, and mechanical plant used in the tunnelling operations shall also be subject to the approval of the Engineer.

1.9 Support of Excavations

- .1 Material for sheet piling, sheeting and bracing shall be furnished and driven or set in place by the Contractor where necessary or wherever ordered by the Engineer.
- .2 The Contractor shall sheet and brace an excavation in Accordance with the Occupational Health and Safety Act and Regulations for Construction Projects, Regulation 213/91 and 714/82 where necessary in order to prevent injury to workmen, damage to gas pipes, water pipes, sewers, service pipes, or other structures and to prevent movement which could in any way disturb or weaken the supporting material below or beside the works.

1.10 Qualified Personnel

- .1 Lumber in foundations and sheeting and shoring on the work shall be driven or placed and moved by personnel especially skilled in such work.

1.11 Shoring Methods

- .1 Shoring shall be installed in such a manner as to prevent movement of the soil adjacent to the excavation and adjacent property.
- .2 Sheeting, shoring and bracing shall be withdrawn and removed as the excavation is backfilled except where and to such extent as removal will injure or cause settlement of the works and adjacent structures, pavement or property.
- .3 Where it may be withdrawn from an excavation, all shoring and sheeting shall be so arranged that it may be withdrawn as the excavation is backfilled, without injury to or settlement of the works and adjacent structures, pavements and property.
- .4 Sheeting against which concrete is placed shall not be removed. Such sheeting will not be paid extra. Sheeting may be cut off above concrete.
- .5 When sheeting is left in place, all cavities behind such sheeting shall be solidly filled as directed.

1.12 Sheeting

- .1 All planks used for sheeting or sheet piling, all timber used for braces, shore and stringers or walings shall be sound, straight and of dimensions satisfactory to the Engineer throughout. Planks shall be tongued and grooved if so required by the Engineer. Where, in the opinion of the Engineer, infiltration into the excavation or other conditions warrant, special sheeting and shoring or steel sheeting and other materials shall be used.

1.13 Foundation Timber

- .1 Cedar, Georgia Pine, Hemlock, or other approved timber shall be furnished, and laid in foundations where required; all timber shall be sound, straight, free from cracks or shakes or large or loose knots and squared to the dimensions required throughout its entire length.
- .2 When, in the opinion of the Engineer, it is necessary to lay a timber platform for foundations, the planks used shall be of a kind and quality above described and cut and laid in the manner designated. They shall be firmly spiked, nailed or bolted to the sills in the manner and to the extent required by the Engineer.

1.14 Dewatering

- .1 The Contractor shall remove such water as may be necessary to properly do the work and shall receive no extra payment for this measure.
- .2 The Contractor shall keep any excavation and ground adjacent to excavation, if necessary, free from water during construction progress. They shall build dams and do other work necessary for this purpose and provide and keep in operation necessary pumps of sufficient capacity to keep the bottom of the excavation dry and free from water at all times. They shall provide for the disposal of the water removed from the excavation in such a manner to ensure that it shall not be injurious to health, property, any portion of the work completed or under construction either by him or by any other contractor. Water removed from the excavation shall be discharged to the surface of the streets to ensure that it shall not be a nuisance to the public traversing the street.
- .3 There shall be no separate payment made to the Contractor for dewatering. Include the cost associated with dewatering in the item where dewatering may be required.

1.15 Backfilling General

- .1 Backfilling comprises providing acceptable excavated materials approved by the Engineer, or fill materials procured from approved sources, transporting them to the required location, placing, spreading, compacting and grading them to the levels and profiles shown on the drawings or designated by the Engineer. The Contractor shall dry out all materials of suitable gradation before backfilling to obtain specified Proctor Density.

1.16 Cut to Fill Balance

- .1 The Contractor shall perform their own calculations to determine the cut to fill deficit / excess. If a deficit exists, they shall import suitable backfill material necessary to balance the earthwork. If an excess exists, the surplus material shall be removed from the site to a suitable location approved by the Engineer.

1.17 Fill Materials

- .1 Materials shall be free from large or frozen lumps, wood or other extraneous materials.
- .2 Selected fill will consist of excavated materials free from stones having a maximum dimension no greater than 150 mm.
- .3 Native material will consist of approved suitable excavated materials.

- .4 Granular fill will consist of materials conforming to OPSS 1010 for Granular 'A', or for Granular 'B'.

1.18 Rip-Rap

- .1 Rip-rap shall be quarried rock of sizes averaging 200 mm with a maximum size of 300 mm and a maximum proportion of 10% by weight smaller stones and spalls less than 150 mm maximum dimension intermixed.
- .2 The quality of stone shall be approved by the Engineer. Weathered stone subject to excess deterioration will not be acceptable.
- .3 Stones shall be hand placed in such a manner as to minimize the volume of voids and also to present a uniform appearance. To prevent washing of the underlying material. Terrafix 270 R geotextile or approved equal shall be placed between the stone and underlying material.

1.19 Compacting

- .1 Backfill shall be compacted to achieve a density of not less than 95% Standard Proctor Density unless otherwise specified or as directed by the Engineer, or as detailed on the Contract Drawings.
- .2 Bedding material around the pipe and backfill material immediately over the pipe shall be placed carefully so as not to damage the pipe and shall be compacted using approved mechanical compaction equipment satisfactory for this application.
- .3 The following mechanical compaction equipment shall be used with corresponding lifts of backfill. Backhoes, loaders, dozers, etc., shall not be used for compacting.

NORMAL COMPACTED THICKNESS OF LIFTS		
<u>EQUIPMENT TYPE</u>	<u>COHESIVE SOIL</u>	<u>NON-COHESIVE SOIL</u>
Vibratory Sheepsfoot Packer	300 mm	300 mm
Sheepsfoot Packer	200 mm	--
Pneumatic Roller	200 mm	200 mm
Vibratory Roller (work width less than 760 mm)	150 mm	300 mm
Vibratory Roller (work width greater than 760 mm) Double vibrating drums with transverse 25 mm cleats every 100 mm the circumference of one drum	150 mm	300 mm
Pneumatic Tamper Driven by Compressor	100 mm	100 mm
Mechanical Tamper (diesel or gas) (Jumping Jack)	150 mm	150 mm

1.20 Compaction Tests

- .1 The cost of compaction tests will be borne by the Owner, but where re-testing is required due to unsatisfactory results such re-testing shall be paid for by the Contractor.

1.21 Unshrinkable Fill

- .1 **Scope:** The work included in this specification is the supply of all material, labour and equipment necessary for the production and placing of a Portland cement stabilized granular backfill known as Unshrinkable Fill in all underground service and utility trenches, and around in-ground structures where specifically shown on the Contract Drawings.
- .2 **Materials:** All materials shall conform to OPSS 1359 providing a maximum 28-day compressive strength of 0.4 MPa:
- .3 **Admixtures:** Admixtures shall conform to OPSS 1303. Calcium chloride or pozzolanic mineral admixtures shall not be used. Air entraining admixtures may be added if desired by the Contractor.
- .4 **Mix Proportions:** Mix proportions shall be selected in accordance with the latest revision of Section 14 of CSA specification CAN/CSA 3-A23.1-M77 where applicable.
- .5 Prior to the production of unshrinkable fill for use, the Contractor shall provide to the Engineer, a certificate from an independent testing company stating that the unshrinkable fill to be supplied conforms with the above requirements.

- .6 **Placing:** The unshrinkable fill material shall be placed at a slump between 150 and 200 mm. The material shall flow into the excavation so that it fills the entire space. Care shall be taken to ensure that no air is entrapped beneath horizontal projections or in other locations within the excavation. Where bracing, shoring and/or sheeting is used to support the sides of the excavation or to prevent movements that could damage other services or adjacent pavements, this support system shall be removed as backfilling proceeds.

If the excavation is within the travelled portion of the roadway, it shall be covered for at least 24 hours with steel plate of sufficient strength to support traffic during this period. Where road traffic is not to be accommodated, the backfilled excavation shall be covered with wooden planking or other protection for users of the road allowance until the unshrinkable fill will support the weight of an adult person.

END OF SECTION

02221 – Rock Excavation

PART 1 - GENERAL

1.1 General

- .1 The Contractor shall refer to the Geotechnical Information and Contract Drawings to determine the degree of rock excavation that is required. The Contractor shall accept responsibility for the removal of all required rock, regardless of the condition, and prior to bidding is to obtain all supplementary information and specialist assistance necessary to reliably estimate the nature and cost of the work.
- .2 The Contractor shall retain the services of a Specialist Blasting Consultant who is a member of the Association of Professional Engineers of Ontario and who has at least five (5) years of experience in the use of explosives and in blasting, shall blasting be required.
- .3 Prior to any blasting, a Specialist Survey Consultant shall complete a Pre-Blast Survey of all buildings and structures within 50 metres of the blast site. The Survey shall include the interior and exterior of each building and all accessible surfaces of each structure and shall be documented through digital photos, video or a combination thereof, sufficient to record the location, nature and extent of all pre-blast cracks and other damage. The Engineer is to receive a copy of this Survey prior to the start of blasting operations.
- .4 Prior to any hydraulic hammering for rock excavation, a Specialist Survey Consultant shall complete a Pre-Excavation Survey of all buildings and structures within 50 metres of the hammering site. The Survey shall include the interior and exterior of each building and all accessible surfaces of each structure and shall be documented through digital photos, video or a combination thereof, sufficient to record the location, nature and extent of all pre-excavation cracks and other damage. The Engineer is to receive a copy of this Survey prior to the start of hammering excavation operations.
- .5 The Specialist Blasting Consultant shall prepare and update a Blast Design giving recommendations on charge patterns and delays suitable for the anticipated conditions. They shall record and monitor a trial initial series of blasts to establish site factors and the maximum allowable charge per delay and shall supply a modified set of blast designs for trench and open excavations taking into account the results of the trials. They are to conduct further trials if rock conditions change substantially and are to modify the Blast Design accordingly. Prior to any blasting full information on the current Blast Design along with full records of previous blasting as executed are to be provided to the Engineer, and the Contractor is to follow all recommendations contained in the current Blast Design.

- .6 The Specialist Blasting Consultant or their representative shall monitor each blast by recording blast locations, rock characteristics, overbreak, structural damage if any, underbreak, and blast vibration levels at the nearest building or structure within 50 m of the blast site, and ***this data is to be submitted to the Engineer no later than the day following.*** Blast monitoring equipment shall be capable of recording longitudinal, transverse and vertical vibration waveforms as well as blast overpressure. Seismographs shall be capable of monitoring up to 200 mm/s peak particle velocity and provide a hard copy of the waveforms on site.
- .7 The Contractor shall monitor each hammering location including, rock characteristics, overbreak, structural damage if any, and vibration levels at the nearest building or structure within 50 m of the excavation, and ***this data is to be submitted to the Engineer no later than the day following.*** Monitoring equipment shall be capable of recording longitudinal, transverse and vertical vibration waveforms as well as overpressure. Seismographs shall be capable of monitoring up to 200 mm/s peak particle velocity and provide a hard copy of the waveforms on site.
- .8 In the event that complaints are received regarding damage caused by rock excavation, the Specialist Blasting Consultant or Contractor (if blasting is not used) will be required to perform a post-blast or post-excavation survey of the houses / buildings involved.
- .9 The supply, hauling, handling and storage of all explosives shall be in accordance with the rules and regulations of the Explosives Division, Department of Mines, Ottawa and the Mining Act and the Transportation of Dangerous Goods Act. Explosives shall be stored in a suitable, locked storage space.
- .10 It shall be the responsibility of the Contractor to ensure that blasting and excavation operations are carried out in a safe manner and that all regulations are adhered to. The Contractor shall assume all responsibility for all claims arising from the handling, hauling and storage of explosives, and all effects arising from blasts or other means of rock excavation, including injury, vibration, impact of flying material and movement of ground.
- .11 The blast site shall be covered with special blasting mats or other devices to prevent flying rock fragments.
- .12 The Contractor shall receive authorization from the Engineer for all rock excavation required under the various items and shall provide adequate time (minimum 48 hours) for the Engineer to verify the initial elevation of rock surface prior to blasting.

Where the trench bottom (subgrade) is in rock a minimum clearance of 150 mm of 19 mm clear stone or A gravel shall be provided below all parts of the pipe and appurtenances.

If 19 mm dia. clear stone or A gravel is not available and the Contractor elects to use sand for bedding, the bedding, pipe and cover material shall be wrapped in filtercloth equivalent to Terrafix 270R.

- .13 Payment for rock excavation will only be made when it is necessary to remove by blasting, hoe ram or similar heavy mechanical equipment integral parts of the Precambrian bedrock or boulders or fragments larger than 1.0 cubic metre in volume determined as the multiple of three (3) maximum rectilinear dimensions.

Materials that can be ripped or dug by excavator and also frozen earth, boulders or rock fragments smaller than 1.0 cubic metre shall be classified as General Excavation. Boulders or rock fragments that can be removed by hydraulic excavator shall be paid for at half the unit rate of rock excavation requiring blasting.

- .14 Payment limits for trench rock excavation shall be as follows:
- .1 Depth shall be the vertical distance from rock surface to 300 mm below the lowest pipe invert.
 - .2 Width shall be as indicated on the Contract Drawing for the number and diameter of pipes installed. Payment width to be to 300 mm on either side of the outside pipe or pipes.
 - .3 Length shall be measured horizontally along the centerline of the trench.
- .15 Payment limit for surface rock excavation (road construction) shall be to design elevation required for construction of ditching (ditch invert) or placement of road sub-base (final road surface minus 300 mm).
- .16 Payment limits for structures (water plant) shall be to 600 mm outside wall of structure, and 300 mm below underside of base slab.
- .17 Payment limit for water service shall be based on a 1 m trench width. Payment limit for depth and length shall be as per Item 14.

1.2 Backfilling Rock Excavation

- .1 Backfilling for rock excavation may be carried out under the following conditions:
- .1 Backfilling with Blasted Rock
 - .1 Rock no greater than 400 mm diameter in any direction may be placed in the trench for backfill. When rock shatter is used as trench backfill, it shall be combined with suitable approved fill material. In general, after

each 1.2 m lift of rock shatter is placed, fill material shall be placed over top of the rock and compacted prior to the next lift of rock shatter being placed.

- .2 The Contractor must place 600 mm of compacted granular material over the pipe before backfilling with blasted rock.
- .3 No rock blast material of 400 mm diameter or larger shall be placed directly over the buried infrastructure (i.e.: any watermain or sewermain, utility conduit, etc.) within the excavated trench in-order to mitigate any chance of point loading.

.2 Backfilling with Suitable Imported Select Fill

- .1 The Contractor shall backfill the complete trench with suitable imported select fill if excavated rock is greater than 400 mm diameter in any direction. Prior to backfilling with suitable select fill, the Contractor must place 300 mm of granular material over the pipe as shown on the Contract drawings.

END OF SECTION

02222 – Excavating and Backfilling Around Structures

PART 1 - GENERAL

1.1 General Requirements

- .1 In general, excavating and backfilling around structures shall be completed in accordance with OPSS No.'s 902, 501, 517, 1010 and as supplemented by this Section.
- .2 Conform to Sections of Division 1 as applicable.

1.2 Scope of Work

- .1 This section applies to the excavation and backfilling of structures.

1.3 Stockpiling

- .1 Material removed from excavations for structures shall be stockpiled as directed by the Engineer.

1.4 Excavation and Backfilling Around Structures

- .1 In general, excavation and backfilling around structures shall be completed in accordance with Section 02220: General Excavation, Dewatering and Backfilling with the following exceptions.
- .2 If excavation is in rock and the Contractor is required to place and compact structural granular fill from the rock level to the underside of a proposed foundation, filter cloth equivalent to Terrafix 270R shall be placed between the granular and rock interfaces.
- .3 Sand shall be used to fill an area within 600 mm in any direction of any structure, including manholes and catch basins, unless shown otherwise on the Drawings. Selected fill shall be used for the remainder of the area to be filled.
- .4 The fill adjacent to the structures shall first be placed so that its sides have a natural slope and the sand fill placed over those slopes.
- .5 Backfilling around structures shall not commence until all interconnected structural components are completed or until approved by the Engineer.

END OF SECTION

02225 – Aggregates

PART 1 - GENERAL

1.1 Scope

- .1 This section outlines the requirements for aggregates to be used on this project.

1.2 Reference Standards

- .1 OPSS No. 1010.
- .2 Conform to Sections of Division 1 as applicable.

PART 2 - MATERIALS

2.1 General

- .1 To OPSS No. 1010.

PART 3 - EXECUTION

3.1 General

- .1 To OPSS No. 1010.

3.2 Measurement for Payment

- .1 To be included in applicable work for which aggregates are required.

END OF SECTION

02226 – Restoration

PART 1 - GENERAL

1.1 Scope of Work

- .1 In general, restoration shall be completed in accordance with OPSS Nos. 310, 314, 353 507, 570, 571, 572, 540, 541, 552 and as supplemented by this Section.
- .2 Conform to Sections of Division 1 as applicable.
- .3 The work under this Section is comprised of the permanent restoration of roadways, shoulders, lanes, footpaths, driveways, ditches, catch basins, and any other areas or existing facilities disturbed or damaged during construction along and in the general vicinity of the works.
- .4 Surfaces shall be restored to their original condition using materials of a similar type and quality as, and corresponding to, the original surface but shall meet the minimum requirements defined in subsequent sub-sections of this Specification.
- .5 Restoration shall be to neat straight lines.

1.2 Treated Gravel Surfaces

- .1 All existing roads within the community that are disturbed by construction activities shall be reinstated as listed herein. The entire width of existing road surface shall be reinstated.
- .2 Existing asphalt material removed shall be disposed of at an off-site location or approved by the Town of Shelburne. Include all costs associated with removal and disposal in the total Bid price.

1.3 Granular Base and Sub-base

- .1 Unless otherwise shown on the Contract Drawings, minimum restoration of granular base and sub-base shall consist of a 300 mm layer of Granular 'B', followed by a 150 mm layer of Granular 'A' and both compacted to 98% Standard Proctor Density.

1.4 Gravel Shoulders

- .1 Unless otherwise shown on the Contract Drawings, minimum restoration of gravel shoulders shall consist of 100 mm of Granular 'A' compacted to 98% Standard Proctor Density.

1.5 Driveways

- .1 Unless otherwise shown on the Contract Drawings, minimum restoration of driveways shall consist of 200 mm layer of Granular 'B' sub-base course compacted to 98% Standard Proctor Density followed by 150 mm depth of Granular 'A' surface course.

1.6 Open Areas

- .1 Unless otherwise shown on the Contract Drawings, open areas shall be restored with a 100 mm layer of topsoil, free from weeds, roots, and debris. All open areas shall be seeded conforming to the requirements of Section 02232: Landscaping.

1.7 Payment

- .1 Payment for the reinstatement of the existing granular base and sub-base, including gravel shoulders, damaged during construction activities shall be on a linear meter basis of road, reinstated to original or better condition.
- .2 There shall be no separate payment for reinstatement of existing driveways inclusive of new driveway CSPs, if necessary. Include all costs in the Total Bid Price.

END OF SECTION

02230 – Roads & Streets

PART 1 - GENERAL

1.1 Scope of Work

- .1 Roads and streets shall be completed in accordance with OPSS Nos. 201, 206, 209, 501, 518, 1010 and as supplemented by this Section.
- .2 Conform to Sections of Division 1 as applicable.
- .3 The Contractor shall construct the streets and road and ditches to the grade, cross-section and lines as shown on the Contract Drawings unless otherwise directed by the Engineer.
- .4 All existing roads, which have been disturbed during construction shall be restored to their original condition by the Contractor to the satisfaction of the Engineer.

1.2 Road Materials

- .1 Fill Materials - Fill material shall consist of hard, durable particles of granular aggregates mixed with sand, clay, silt, stone dust and/or other similar cinder material. The material shall be well mixed and graded and in all respects shall meet with the approval of the Engineer.
- .2 Sub Base Course – Sub-base course material shall consist of crushed and screened material conforming to Class “B” of OPSS 1010.
- .3 Base Course – Base course material shall consist of crushed and screened material conforming to Class “A” of OPSS 1010 of latest revision.
- .4 Approval of Granular Materials – Prior to use, representative samples of all sub-base and base course materials to be supplied by the Contractor, proposed for use under this specification, shall be submitted by the Contractor to a testing laboratory for approval of their quality and nature. Each sample shall contain not less than 20 kg of material. Granular A and B shall not contain any recycled material (i.e., recycled concrete material, etc.)
- .5 During construction, the Engineer may require additional tests of the materials to satisfy themselves that the material being used meets the requirements.
- .6 All costs of obtaining, shipping and testing samples shall be borne by the Contractor.

- .7 Unit price bid for these items shall include supplying, placing, grading, and compacting the Granular B and Granular A layers for road, sidewalk, driveway base to depths as indicated on the drawing.

1.3 Road Construction

- .1 **Protection of Trees** - The Contractor should not cut any tree within the property lines of buildings and special attention should be given in the protection of such.
- .2 **Removal and Storing of Topsoil** – Contractor shall strip and stockpile topsoil from all surfaces, unless otherwise ordered by the Engineer.

Where practical, the Contractor shall place topsoil on areas adjacent to the road. Topsoil shall be graded to ensure existing drainage is not affected.

- .3 **Tolerance of Grading** – Rough grading is defined as all earth moving required to bring the grades to final sub-grade elevation with a tolerance of plus or minus 150 mm for a width extending to within 1.2 metres of the street lines.

Fine grading is defined as earth moving, shaping and consolidating required to bring the grades to accurate sub-grade elevation in preparation for the application of stone base and the construction of curbs and sidewalks. Fine grading shall also include grading of boulevards between curb and streetline, including the 1.2 m strip adjacent to the streetline, omitted from the rough grading operation.

- .4 **Grading** – Fill placed over access road shall be placed in layers not exceeding 105 mm and thoroughly compacted by appropriate equipment. Optimum moisture content for proper compaction is to be maintained through the application of water, if necessary.

Edges of cuts and fills are to be neatly sloped at 2H to 1V outside the road allowance.

- .5 **Consolidation of Sub-grade** – The Contractor shall be fully responsible for consolidating the sub-grade to a degree of compaction equal to 95% Standard Proctor Density. The Contractor shall include in their price all items such as the removal of soft material from trenches, replacement of material to sub-grade elevation with clean clay, sand or pit run gravel and all costs incidental to the preparation of a firm sub-base surface.

If ordered by the Engineer, the sub-base shall be watered during the process of compaction and charged as part of the compaction, must conform to the required cross-section.

- .6 **Balance of Cut and Fill** – The Contractor shall determine from the plans supplied whether a surplus or deficiency of earth will result from their rough and fine grading operations.

Surplus excavations, including topsoil and undesirable material removed below sub-grade, shall be placed in areas adjacent to access road and graded to ensure proper drainage.

Should there be a deficiency of fill available from the construction activities to bring the road to the required grade, the Contractor shall obtain suitable material from approved sources at no additional cost to the project.

- .7 **Frozen Ground** – Rough and fine grading operations may be carried out on frozen ground, only with the written permission of the Engineer.

No frozen fill shall be placed in fill sections as it cannot be compacted. Frozen ground in cut sections shall be stockpiled at an approved location and used only when thawed out.

- .8 **Sub-Base Approval** – After satisfactory compaction tests have been obtained, the sub-base shall be approved by the Engineer for grade and profile before the granular road base is applied.

- .9 **Placing of Road Base** – The Contractor shall exercise due care at all times to prevent the quality of the granular base course material becoming contaminated by clay or other types of deleterious materials. Any such contamination shall be removed, at the Contractor's expense, on the instruction of the Engineer.

Class "A" – All such base course material shall be placed on the sub-grade shaped to proper grade and contour in layers, each to a thickness not greater than 100 mm unless otherwise directed.

Class "C" – The requirements, under placing and spreading, for Class "C" shall be the same as for Class "A". However, in the case of sub-excavations or other conditions, an increased thickness shall be used if specified by the Engineer.

- .10 **Rolling and Compacting** – The rate of placing material shall be controlled by the adequacy of the compaction obtained. Regardless of the type of equipment used to deposit and spread the base course material, a minimum of one (1) compacting unit shall be required and maintained in effective operation for each 300 tonnes of material placed per hour. Granular base courses shall be compacted to 100% Standard Proctor Density.

- .11 **Final Rolling and Shaping** – After the required thickness has been attained, the surface shall be shaped and compacted by additional rolling and blading as necessary to produce the required contour of the surface. The tolerance in cross-section and longitudinal profile shall be not more than the following at any place on a 3-metre template.

- .1 13 mm when the Contract requires a gravel surface only:
- .1 The final compacted surfaces of both Class “A” and Class “B” bases will be checked by the Engineer for grade and profile.
- .12 **Compaction** – Each layer shall be thoroughly compacted to the satisfaction of the Engineer. In case of controversy, a minimum of 100% of the maximum Proctor density as determined by the MTO procedure, will be required. For the purpose of this Specification, maximum Proctor density shall be determined by dynamic compaction in a cylindrical metal mold 150 mm in diameter and 125 mm in height. The compaction effort shall consist of 55 blows (50 mm drop) of a solid metal hammer weighing 2.5 kg and have a circular striking face 50 mm in diameter on each of three (3) equal layers. Samples which represent the entire gradation of the material shall be used except, in the case of Class “B” material, the fraction retained on the 25 mm sieve shall be replaced with equal percentage by weight of material of size 25 mm to 13 mm and 13 mm to 4.6 mm.
- .13 **Water** –The material shall be sprinkled with water during rolling, tamping and blading when and if directed by the Engineer, either to aid compaction or reduce dust nuisance or both. However, where water is added for compaction, it shall be applied immediately ahead of the compacting unit.
- .14 **Maintenance and Repair** – The Contractor shall submit to the Engineer a statement prior to any road construction detailing whether paving or surface treatment is to be done immediately after the road base has been laid, or left until later, then the Contractor shall be responsible for maintenance of the roads during the interim period, and for their repair before paving. Maintenance shall be defined as keeping the travelled roadway in a reasonable state for vehicular traffic at all times, and shall include the repair of any settlement, bog holes, frost boils, etc., which are in the opinion of the Engineer in need of repair for the safe and convenient passage of vehicles. Such maintenance shall be performed by the Contractor within a maximum of 48 hours after being notified by the Engineer.
- Repair of the roads shall include all work necessary to make the base surface suitable for paving, including cleaning off dirt introduced by traffic and other means, the accurate adjustment of catch basins, valve chamber and manhole covers, the excavation of soft spots and replacements with fresh stone and the bringing to proper grade and shape of the stone base.
- .15 **Surface Drainage** – The Contractor shall maintain all ditches for surface water drainage during construction and shall be responsible for any damage that may be caused by reason of not doing so.

- .16 **Inspection of Materials** – The Engineer will at regular intervals require the Contractor to take samples of road materials for test by an approved testing company. These tests and transport of the samples shall be at the expense of the Owner. If the samples do not meet the requirements as specified, then the Engineer may reject the sampled material, which upon rejection will be removed immediately from the site of the work, at the expense of the Contractor.
- .17 **Damage to Existing Work** – Where, in the opinion of the Engineer, the Contractor is responsible for damage to curbs, water boxes, hydro poles, catch basins, manholes, culverts, sewers, field drainage tile, watermain, hydrants, valves, etc., the Contractor shall, at their own expense, repair or replace damaged works to the satisfaction of the Engineer. Road material which enters manholes, valve chambers, catch basins and sewers, shall be removed by the Contractor at their own expense.
- .18 **Order of Completing the Work** – So that free access to the site will be maintained at all times, the Engineer will direct the Contractor as to the order in which the roads are to be built. Also, where in the opinion of the Engineer ground conditions are not as yet suitable for the construction of either curb or road, or both, the Engineer may order the Contractor to defer construction in that area to a later date, and the Contractor shall not claim additional payment in this respect.
- .19 **Water Supply** – Before opening hydrants for the purpose of obtaining water for road sprinkling equipment or for any purpose, the Contractor shall first obtain written permission from the Engineer and take proper precautions against freezing, leaking and other damage.
- .20 **Settlement After Construction** – The Contractor shall maintain the access road against all settlement for the duration of the Guarantee Period. The Contractor shall allow for such repairs in the bid process and no extras will be paid for such repairs.
- .21 **Cleaning the Site** – After the work on any one section of this Contract has been completed, all debris, excess material and equipment shall be removed by the Contractor and the site left in a neat and workmanlike condition to the satisfaction of the Engineer.

END OF SECTION

02232 – Landscaping

PART 1 - GENERAL

1.1 Scope of Work

- .1 In general, landscaping shall be completed in accordance with OPSS Nos. 206, 501, 511, 565, 570, 571, 572 and as supplemented by this Section.
- .2 Conform to Sections of Division 1 as applicable.
- .3 The work in this section comprises supply of equipment and materials for tree protection, rough grading to within 12 cm of finished surface, placement of topsoil, fine grading, sodding, seeding, planting and maintenance until accepted for use by the Owner.

1.2 Existing Tree Protection

- .1 All existing trees which are to remain, shall be fully protected with hoarding, i.e., snow fencing, erected beyond their "drip line" prior to construction to the satisfaction of the Engineer. Groups of trees and other existing plantings to be protected, shall be done in a like manner with hoarding around the entire clump(s). Areas within the protective fencing shall remain undisturbed and shall not be used for the storage of building materials or equipment.
- .2 Where limbs or portions of trees are removed to accommodate construction work, they will be removed carefully in accordance with accepted arboricultural practice.
- .3 Where root systems of protected trees are exposed directly adjacent to or damaged by construction work, they shall be trimmed neatly, and the area backfilled with appropriate material to prevent desiccation.
- .4 The Contractor shall be aware that during the course of construction should the root system of any tree sustain damage which results in the decay of the tree within the maintenance period, the contractor will be required to remove this tree and re-establish tree(s) to the satisfaction of the Owner and the Engineer.

Trees affected by construction shall be supplemented by a fertilization program during the construction period.

1.3 Rough Grading

- .1 The Contractor shall do all rough grading and filling where required to establish the sub-grade under all landscape areas to a depth sufficient to allow the placing of topsoil to

the specified depth. All soft and unstable areas below sub-grade shall be excavated and filled with approved soil material.

- .2 The sub-grade shall be established parallel to the finished grades indicated on drawings unless shown otherwise and shall be shaped in such a manner so as to permit draining of water in event of heavy rain. Unless shown otherwise, areas shall be given uniform slopes between points for which finished grades are indicated on the drawings or between such points and existing grades. At the top and toe of slopes and banks grades shall be smoothly rounded.
- .3 The sub-grade under hard landscaped areas such as roads and paths shall be compacted to 95% Standard Proctor Density unless specified otherwise in the Contract Documents.

1.4 Placement of Topsoil and Fine Grading

- .1 The sub-grade shall be scarified to a minimum depth of 7 cm to produce an even, loose textured surface, free of all stones, roots, branches, etc., larger than 7 cm in diameter, and live weeds. The finished sub-grade shall be approved by the Engineer prior to placing topsoil. Where the sub-grade has been established by others, it shall be the Contractor's responsibility to verify such sub-grade and if required, make necessary adjustments to the sub-grade, and prepare such sub-grade in the manner described above. Where specified the topsoil mixture under all sodded areas shall be spread evenly over the approved sub-grade to the specified depth and compacted to 80-85% SPD. The minimum depth of topsoil under sodded and seeded areas shall be 10 cm.
- .2 The specified fertilizer shall be applied to and well worked into the topsoil by disking, raking or harrowing at the rates specified. This shall be done within 48 hours before laying sod. The finished surface shall be smooth, firm against footprints, with a fine, loose texture before sod is placed or seed spread.
- .3 Topsoil, where supplied by the Contractor, shall be a fertile, friable natural loam containing not less than 4% of organic matter for clay loams and not less than 2% for sandy loams with an acidity value ranging from pH 6.0 to pH 7.5 and capable of sustaining vigorous plant growth. It shall be free of any admixture of subsoil, clay lumps and free of stones and roots over 5 cm in diameter and other extraneous matter. The topsoil supplied by the contractor shall be tested as necessary for N., P., K., Mg. soluble salt contents, organic matter content and pH value.

- .4 Where topsoil is supplied by the Contractor, the quantities of fertilizers required shall be based on the following minimum rates and shall be considered as being included in the contract sum:

10 - 20 - 10 @ 9 kg/100 m²

0 - 20 - 10 @ 5 kg/100 m²

Superphosphate @ 11 kg/100 m²

1.5 Hydro-Seeding

- .1 All hydro-seeding mixtures shall adhere to OPSS.MUNI 804: Construction Specification for Seed and Cover, November 2014 under the Ministry of Transportation regulations. Contractors are to refer to Appendix Table A-1 for correct seed mixtures based on zoning areas in Ontario.
- .2 Contractors shall be aware that seed mixtures could vary based on growing location. All seed mixtures shall be approved by the Engineer:
- .1 Ditch
 - .2 Wetland
 - .3 Lawns.
- .3 Grass seed shall be a certified hydro-seed, meeting the requirements of the Seeds Act for Canada No. 1 Seed, and mixed as specified on the drawings, or as specified hereinafter. The mixture shall be mixed and supplied by a recognized seed house with tested rates for purity and germination of not less than government standard rates. Where specified all nurse crop seed shall meet the requirements of the Seeds Act for Canada No. 1 seed.
- .4 Hydro-seeding of grass shall be carried out during periods which are most favourable for the establishment of a healthy stand of grass. The seeding periods specified herein are listed in order of preference, generally accepted by the trade.
- .1 Period from July 15th to September 15th.
 - .2 Early spring, up to May 30th.
- .5 Seed shall be applied by Hydraulic Hydro-Seeder. Upon approval of finished grade by the Engineer, grass seed, nurse crop seed, where specified, and fertilizers shall be thoroughly mixed with water and applied to the designated areas by means of an approved hydraulic seeder.

All materials shall be measured accurately before being charged into the seeder, at the following rates:

- .1 Grass seed @ 150 kg per ha.
- .2 Nurse crop seed, where specified @ 60 kg/ha.
- .3 Water @ 4000 litres minimum per ha. Fertilizers at the specified rates.
- .6 All hydro-seeding shall be done during calm weather and on ground which is free of frost, snow or water. The Contractor shall be responsible for providing and maintaining warning signs for all seeded areas until acceptance, unless specified otherwise.

1.6 Planting (As Applicable)

- .1 Plant materials shall be in accordance with Canadian Nursery Trades Association Metric Guide Specifications for Nursery Stock Third Ed. April 1984. "Collected plants" not permitted unless approved in writing by the Engineer.
- .2 Provide plants true to type and structurally sound, well-branched, healthy and vigorous and free of disease, insect infestations, rodent damage, sun scald, frost cracks and other abrasions or scars to the bark, densely foliated when in leaf and having a healthy, well developed root system. Pruning wounds shall show vigorous bark on all edges and all parts shall be moist and show live, green cambium tissue when cut. Plant materials shall conform to the measurements specified in the Plant List; plants larger than specified may be used if approved by the Engineer and do not increase the contract price. Measure plants when branches are in normal position. Height and spread dimensions specified refer to the main body of the plant and not from branch tip to root base or from branch tip to branch tip.
- .3 Wrapping of tree trunks: first quality burlap, at least 200 gm/m² in weight and not less than 15 cm nor more than 25 cm in width, or a heavy waterproof crepe paper 10 or 15 cm wide.
- .4 Plant Installation (As Applicable)
 - .1 Locate planting pits and have approved by the Engineer prior to excavation. Plant during periods suitable with respect to weather conditions and locally accepted practice. Set plants plumb in the centre of the pits and at same relation to grade as originally grown, after settlement has taken place. Face trees and other plant materials to give the best appearance or relationship to adjacent structures, and to approval of the Engineer.

- .2 Set plants in partly filled pits or beds or prepared soil mixture at which time all burlap, ropes, wires, etc., shall be pulled away from the top of the ball. Place layer of loose unfrozen soil mixture at least 15 cm deep under plants. Place bare root plants so that roots lie in natural position. Backfill soil mixture shall be in layers not exceeding 15 cm in depth. Firmly tramp each layer in place so that plant retains vertical position. Ensure that no air pockets remain under or around roots. Thoroughly water soil mixture when hole is half full, and again when full.
- .3 Provide an earth saucer at base of individual plants, diameter as large as the excavated area to retain water around roots of plant.
- .4 Plant support shall be as specified on the Drawings.
- .5 Prune plants after planting. Prune to remove dead or injured branches and to compensate for loss of roots from transplanting operations. Preserve the natural character of the plants. Do not remove leaders. Use only clean, sharp tools. Leave no stubs. Remove cuts, bruises or scars on bark by tracing back to living tissue. Shape affected areas so as not to retain water. Paint treated areas with approved tree paint.

.5 Maintenance

- .1 Maintain plant materials after planting and continue until date of Substantial Performance. Maintain plant materials during Warranty Period.

1.7 Acceptance of Work

- .1 Hydro-seed shall be accepted for Substantial Performance when grass roots have secured to topsoil and grass has been mown once to a depth of 5 cm.
- .2 Plant materials shall be accepted for Substantial Performance upon completion of planting, staking and mulching.
- .3 All grass and plants shall be guaranteed for one (1) year following Substantial Performance. Any replacements made during the guarantee period shall be further guaranteed for one (1) year following the replacement date.

END OF SECTION

02238 – Watermains

PART 1 - SCOPE OF WORK

- 1.1 In general, watermains shall be supplied and installed in accordance with OPSS.PROV 441 and as supplemented by this Section.
- 1.2 Conform to Sections of Division 1 as applicable.
- 1.3 The supply and installation of all watermains and appurtenances shall be as detailed by these specifications and shown on the Contract Drawings.
- 1.4 The complete supply and installation of watermains and services shall include necessary fittings, bends, tees, thrust blocks, any necessary cutting, tracer wire, bedding, sand cover, insulation sheeting, backfill, flushing, pressure testing and disinfection of the pipe after installation.

PART 2 - MATERIALS

- 2.1 All watermains and appurtenances shall be supplied in the size and type as shown on the Contract Drawings.
- 2.2 The Engineer may order tests of any materials delivered to the site and may reject materials pending the result of the tests. Costs of all tests and inspections after delivery to the site will be borne by the Contractor only if material is faulty. Pipe shall bear the date of manufacture clearly stenciled or impressed on each pipe.
- 2.3 The Contractor is warned that any pipe or fittings found to be defective in manufacture, or damaged before or after acceptance from the carrier, will be rejected by the Engineer and the Contractor shall promptly remove such defective material from the site.
- 2.4 The Contractor shall be required to submit to the Engineer for their approval shop drawings for all piping details including the following:
 - .1 Jointing methods.
 - .2 Adaptors, restraints.
 - .3 Bends, tees and other fittings.
 - .4 Anchoring at terminal points.
 - .5 Anchoring at bends.
 - .6 Other special details as required.

- 2.5 The Contractor shall notify the Engineer a minimum of 10 days before pipe is delivered to the site of the work giving the following information:
- .1 Name of the firm which will be supplying the pipe.
 - .2 The locations of the pipe plant.
- 2.6 The Engineer may choose a number of pipes from each size of pipe that is proposed to be supplied for the Contract and visually inspect and gauge the pipe and record dimensions of the pipe ends. A sufficient number of pipes will be accurately measured so that the Engineer may satisfy himself as to the adequacy or otherwise of the pipes being offered. In the event the results of gauging and visual inspection indicate the pipe may not conform to the requirements of this specification, the Engineer may require differential load and hydrostatic tests.
- 2.7 Type of Pipe
- .1 The entire length of each pipeline shall be constructed from one of the alternative materials specified below (except as specified on the Drawings), namely, ductile iron, polyvinyl chloride, polyethylene and concrete pressure pipe.
 - .1 Polyvinyl Chloride (PVC)
 - .1 Unless noted otherwise, the pipe shall be polyvinyl chloride of the DR or pressure rating noted on the Contract Drawings meeting the requirements of AWWA C900 or C905.
 - .2 The pipe shall be CSA certified and ULC labeled where certificate programs are available, and shall contain ingredients, which are approved by the National Sanitation Foundation.
 - .3 The pipe shall be supplied in maximum lengths of 12 m.
 - .4 All fittings (elbows, tees, crosses, etc.) for PVC pipe shall be cast iron or ductile iron compatible with the size of pipe and shall conform with AWWA C110.
 - .5 PVC or fibreglass fittings may be used upon the written approval of the Engineer.
 - .6 PVC jointing method shall be bell and spigot with rubber rings to ASTM D3139.

- .7 Where PVC pipe is installed a 2 mm 0/TWH solid copper light-coloured plastic-coated tracer-wire must be installed with the pipe and brought to the surface at each valve box. Tracer wire is to be attached to pipes and valve box by means of tape.
 - .8 PVC pipe 350 mm diameter to 1,200 mm diameter (large diameter pipe) shall be designed to accommodate the operating pressure plus surge pressure and shall be certified to CSA B137.3, colour coded blue and have cast iron outside diameters.
 - .2 Contractor shall provide the following documentation for large diameter (350 to 1,200 mm) PVC pipe:
 - .1 Letter of compliance.
 - .2 Pipe design calculations.
 - .3 Summary of fittings and methods of restraint.
 - .4 Installation guide.
 - .5 Tabulated layout drawings indicating restrained lengths for fittings and valves.
- .2 Polyethylene
 - .1 The pipe and fittings shall be polyethylene pressure pipe series of the series or DR rating shown on the Contract Drawings in accordance with standard specification CSA B137.0 and B137.1, ASTM D3035 and D3350, and CGSB41-GP-25M.
 - .2 The pipe shall be CSA certified where certificate programs are available and shall contain ingredients, which are approved by the National Sanitation Foundation.
 - .3 The pipe shall be supplied in maximum lengths of 12 metres or in coils for pipe up to 75 mm diameter.
 - .4 All fittings (elbows, tees, crosses, etc.) for polyethylene pipe shall be cast iron or ductile iron compatible with the size of the pipe and shall conform to AWWA C110 flanged.
 - .5 Where polyethylene pipe is installed a 3.15 mm 0/ Canada Wire stranded, Type TWO 75 C 600 V or equal tracer wire must be installed with the pipe and

brought to the surface at each valve box. At dead end watermain lines, tracer wire shall be brought to the surface at the nearest service box to the dead end. Tracer wire is to be attached to pipes and valve box by means of tape.

.6 Preference will be given to plastic pipe manufactured in Canada from Canadian materials.

.7 Polyethylene pipe jointing method shall be Thermal Butt Fusion.

.3 Service Connections

.1 The service connections for all watermain pipe alternatives shall be Polyethylene Series 160 CSA B137.1 Certified O.D. sized tubing, unless otherwise specified on the Contract Drawings.

.2 All service connections shall have the following components:

.1 Main Stops: shall be bronze or brass with standard corporation inlet thread and copper flange outlet Mueller #A 220 or approved equal.

.2 Curb Stops: shall be bronze or brass with copper flare inlet and outlet, equipped with no drain Mueller #A616 or approved equal.

.3 Service Boxes: shall be cast iron extension type for minimum cover specified, Mueller #A726 for 15 mm to 25 mm services, Mueller #A728 for 50 mm services, all with Mueller #A 800 lids or approved equal.

.4 Couplings: shall be Mueller #A319 copper to copper, or Mueller #A312 (female) and #A314 (male) for copper to cast iron or approved equal.

.3 Polyethylene pipe connections shall be made with socket fusion fittings recommended by the manufacturer or with bronze Mueller compression fittings. Where compression fittings are used, stainless steel inserts shall be installed.

.4 When plastic pipe is installed as a mainline material, saddles will be required at all service connections.

.5 Service connections shall be marked with 50 mm x 100 mm wooden marker post not less than 300 mm above ground level and with the bottom placed at the invert of the pipe. The top 150 mm shall be painted blue for identification and marked showing depth from top of post to invert of pipe.

.4 Gate Valves

- .1 Gate valves shall be iron body, bronze mounted inside screw double disc parallel seat with 'O' rings and shall conform to AWWA C500. They shall open to the left and have a standard 50 mm square operating nut.
- .2 Gate valves shall be Mueller, Darling AVK Resilient Seat or approved equal.

.5 Valve Boxes

- .1 Unless otherwise shown on the drawings, valves shall be equipped with cast iron auger sleeve 2-piece sliding valve boxes with extra deep covers and shall be complete with guide plates.

.6 Tapping Sleeve and Valve

- .1 Pressure tapping sleeves and valves shall conform with AWWA Specifications C-100-55 and C500 and shall be installed in accordance to the manufacturer's instruction.

.7 Inspection of Pipe and Fittings

- .1 Pipes and fittings shall be inspected by the Contractor for damage in transit. No defective material shall be delivered to the site. Any material subsequently damaged shall be removed from the site immediately.

.8 Mainline Fire Hydrants

- .1 Mainline fire hydrants shall be self draining, Clow Canada M67/M93 Brigadier, open left with pumper nozzle complete with barrel of length to provide minimum cover as indicated on the drawings. On each hydrant lead an isolating valve and box meeting the requirements of Items 2.3 and 2.4 above shall be installed. If an extension to the barrel is necessary to bring the hydrant to finished grade, the extension shall be installed at the boot.

.9 Cathodic Protection

- .1 Zinc casting alloy shall conform to the latest edition of ASTM B418 Type II.
- .2 Magnesium casting alloy shall conform to the latest edition of ASTM B107 Type M-1 or AZ63A alloy Type H1.
- .3 Anode castings shall be surrounded with a minimum of 25mm of selected backfill material within a protective outer cover. The cover shall be a rugged moisture-

absorbent cardboard tube. Backfill material shall have an electrical resistivity less than 45 ohm-cm wet, a compacted density of 1.5 g/cm and the following composition by volume: Gypsum 77% $\pm$ 2%, Bentonite 15% $\pm$ 1% and Sodium Sulphate 8% $\pm$ 1%.

- .4 Packaged anodes to be supplied with #10/7 STR copper cable having TW75 or RWU90 insulation, 3.0m in length.
- .5 Packaged anodes shall be of the type manufactured by Bren Technologies Inc. (BTI), 231 King Street, Barrie, Ontario L4N 6B5, Phone: 705-722-3935, or approved equal.
- .10 Anode Requirements for Valves, Hydrants, Fittings and Watermains
 - .1 Fittings include bends, tees, crosses, sleeves, reducers, plugs, caps, joint restrainers and couplings.
 - .2 One (1) packaged 10.9 kg zinc anode, BTI type ZA-24 or approved equal, is to be installed on the lateral piping of each hydrant assembly.
 - .3 One (1) packaged 5.4 kg zinc anode, BTI type ZA-12 or approved equal, is to be installed on every isolation valve and metallic fitting less than 300mm in diameter, connected to a non-ferrous watermain.
 - .4 One (1) packaged 10.9 kg zinc anode, BTI type ZA-24 or approved equal, is to be installed on every isolation valve and metallic fitting greater than or equal to 300mm diameter, connected to a non-ferrous watermain.
 - .5 On ductile iron watermains only, one (1) packaged 10.9 kg zinc anode, BTI type ZA-24 or approved equal, is to be installed at the following maximum intervals along the entire watermain, starting within 2 m from the end of the watermain:

Table 1: Anode Spacing Interval

Watermain Diameter (mm)	Spacing (m)
100	22.0
150	8.0
200	6.0
300	4.0
400	3.0
600	2.0

.11 Anode Installation

- .1 Anodes shall be installed complete with their cardboard container and enclosed special backfill, and connected to the required fitting and piping with the included #10/7 STR copper lead wire having TW75 or RWU90 insulation.
- .2 Anodes shall be installed horizontally at the pipe depth, a minimum of 600mm to the side of the pipe.
- .3 The anode lead wire shall be wrapped around the watermain and secured with a knot. Sufficient slack shall be left in the wire to prevent any stress on the anode during backfilling and subsequent soil settlement.
- .4 The anode lead wire shall be attached to fitting, valve, or piping by connecting to either:
 - .1 A copper service pipe using a ground clamp, according to the clamp manufacturer's instructions; or
 - .2 The iron portions of the watermain, fitting, or hydrant using the thermite weld process. An area 50 mm x 50 mm of the surface shall be cleaned and filed to a white metal finish and the end of the copper cable shall be bared of insulation and attached to the prepared metal surface using a thermite weld. All thermite weld connections to be coated with Roybond 747 Primer and Royston "Handy Cap" or approved equal.

PART 3 - INSTALLATION OF WATERMAINS

3.1 Foundation and Bedding

- .1 Foundation and bedding shall be as shown on the Contract Drawings. Minimum bedding shall consist of 150 mm of Granular A compacted to 100% SPD.

3.2 Cover Material

- .1 Cover material shall be as shown on the Contract Drawings. Minimum cover shall consist of 300 mm of sand compacted to 100% SPD.

3.3 Trench

- .1 Conditions in the pipe trench shall be such that pipe jointing can be accomplished without getting mud, silt or other foreign material into the joint. In general, this means that the trench shall be adequately dewatered with a firm bottom free of mud.

3.4 Alignment and Grade

- .1 The watermains shall be laid to the alignment and grade shown on the drawings.
- .2 Care shall be taken to align the pipe properly before joints are forced home. During insertion of the tongue or spigot the pipe shall be partially supported by a hand sling or crane as required to maintain lateral pressure on the gasket and to maintain concentricity until the gasket is properly positioned. Once the joint has been made, deflection of the joint shall be held to an absolute minimum.
- .3 The Contractor shall carry out explorations where necessary to establish or discover the location of existing pipe, conduits or other buried objects.

3.5 Lowering and Laying

- .1 Pipe and fittings shall be carefully lowered into the trench with proper appliances. Before lowering and while suspended, the pipe shall be inspected for defects.
- .2 Foreign matter shall be removed from the inside of the pipe and fittings. The trench shall be kept dry and free from water, no pipe being laid in water except by permission of the Engineer. No water shall be allowed to run through installation during construction. No pipe shall be laid until the preceding pipe joint has been completed and the pipe carefully embedded and secured in place.
- .3 Installation shall be kept thoroughly clean throughout and during the progress of the work and until the completion and final acceptance thereof. They shall be left clean on the completion of the work.

3.6 Pull-Up Pressure

- .1 Sufficient pressure shall be applied in making the joint to assure that the joint is "home" as defined in the Standard Installation Instructions provided by the pipe manufacturer. Sufficient restraint shall be applied to the line to assure that joints, once "home" are held so by tamping fill material under and alongside the pipe, or otherwise. At the end of a day's work the last pipe shall be blocked in such a manner as may be required to prevent creep during "down time".

3.7 Manufacturer's Instructions

- .1 Pipe and fittings shall be installed strictly in accordance with the manufacturer's instructions. A copy of the manufacturer's manual of instructions shall be kept on the job site.

3.8 Bedding and Encasement

- .1 Pipes shall be laid to conform to their respective bedding or encasement as detailed on the Contract Drawings.
- .2 The depth of trench excavations shall be sufficient to allow for the bedding required below the pipe bottom.
- .3 The Contractor shall excavate for and provide at least 150 mm of approved and compacted granular material in the trench to support the pipe as described above, including the requirements shown on the Contract Drawings.
- .4 Selected material from the excavations, as allowed by the Engineer, shall then be carefully consolidated over the pipe and backfilling shall proceed as described under excavation.

3.9 Jointing Watermain

- .1 Where a concrete cradle or surround is to be provided, the trench bottom shall be carefully trimmed to receive it, and the pipe shall be supported upon bricks or concrete blocks and hardwood wedges and securely retained at the requisite line and level. After jointing of the pipes, the surround or cradle shall be poured and worked around and under the pipe to fully support the pipe.
- .2 Installation of push-on joint watermain pipe and mechanical joint fittings shall conform strictly to the manufacturer's instructions.

3.10 Valves and Fittings

- .1 Valves and boxes shall be installed plumb at the locations and in the manner shown on the drawings.
- .2 Bends, crosses, tees and other fittings shall be installed where shown and shall be anchored and supported by concrete thrust blocks.

3.11 Connecting to Existing Mains

- .1 The Contractor shall locate and make connections to existing watermains as shown on the drawings, and shall maintain a satisfactory service at all times. The Contractor shall submit a program for this work, which shall be approved by the Engineer before the work commences.

3.12 Intersecting Trenches

- .1 Where sewer or watermain trenches intersect, the trench of the lower pipe shall be backfilled with suitable granular material to the grade of the lower trench from wall to wall and shall be of a length along the trench not less than 600 mm greater than the nominal diameter of the higher pipe.

3.13 Watermain Location Tolerances

- .1 No watermain joint shall be deflected more than the maximum permitted by the manufacturer.
- .2 On straight lengths, no lateral deviation in excess of 150 mm will be tolerated and on straight grades no grade deviation in excess of 75 mm will be tolerated. The Engineer may require that lesser deviations be observed.
- .3 The Contractor shall supply all fittings to complete the installation to the lines and grades shown on the Drawings. Where vertical or horizontal curves are shown, the pipeline shall not deviate more than 300 mm from the line, nor more than 75 mm from grade.

PART 4 - TESTING AND STERILIZING WATERMAINS

4.1 Testing General

- .1 The Contractor shall test all watermains, pipework and pipelines in accordance with OPSS 441 in such lengths or sections as the Engineer shall direct, and provide all labour, water, pumps, gauges, caps, stoppers, air release cocks, pipework and other apparatus required to complete the tests.
- .2 The Contractor shall supply the Engineer with the pressure gauges intended to be used prior to the first test in order that they may be checked for accuracy. All equipment used by the Contractor in carrying out the testing shall be approved by the Engineer.

4.2 Test in Sections

- .1 The Contractor shall test the pipe in sections, the length of which shall be determined by the Engineer. Under no circumstances will the test length be permitted to exceed 1000 metres or 1.0 kilometres.
- .2 Pipe crossings under railway tracks, provincial roads, private rights-of-way, etc., shall be tested separately unless the Contractor receives written instructions from the Engineer to the contrary.

4.3 Blocking and Blanking

- .1 As soon as the Contractor has been notified by the Engineer to test a section of the pipeline, the Contractor shall check that all relevant open ends formed by tees, crosses, etc., are blanked off and that all bends, etc., are adequately blocked to safely withstand the pressure developed under the pressure test, and in a manner satisfactory to the Engineer.

4.4 Fitting and Air Release Taps

- .1 The section of the pipeline to be tested shall be slowly filled with water obtained by the Contractor at their own expense from a source approved by the Engineer. The pipeline shall remain filled for not less than 24 hours prior to the pressure test. The Contractor shall ensure that all the air has been removed from the section of the pipeline and shall install air release taps at all high points to accomplish this before the test pressure is applied.

4.5 Temporary Connection, Testing and Disinfection of Watermain

- .1 For the lump sum price bid, the Contractor shall supply all labour, equipment and materials for the temporary connection, swabbing, hydrostatic testing, disinfection, dechlorination, flushing and final connection of watermains and services in accordance with this specification, OPSS 441 for hydrostatic testing, and AWWA C651-99 for disinfection and connection to the existing water distribution system. The specifications listed in this section represent minimum requirements. Additional requirements of the Client, if any, shall also apply and are deemed to be included in the lump sum price for this item.
- .1 *Temporary Connection:* The new watermain shall be isolated from the existing water distribution system using a physical separation until satisfactory bacteriological testing has been completed and accepted by the Contract Administrator and the Client. Water required to (e.g.: pressure test, swab, disinfect and flush, etc.) the new main shall be supplied through a temporary connection between the existing water system and the new main supplied by the Contractor. The temporary connection shall incorporate an appropriate cross-connection control device, consistent with the degree of hazard for backflow protection of the active distribution system (e.g., a double check valve assembly or a reduced pressure zone backflow preventer per CAN/CSA B64.10). The cross-connection control device shall be disconnected (physically separated) from the new main during hydrostatic testing and reconnected afterwards.

- .2 *Swabbing and Preliminary Flushing:* The new watermain shall be cleaned with a minimum of two (2) clean new swabs. Additional swabbing is required at the Contractor's expense if the water is not clear after the second swab has passed through the watermain. Swab length shall be 1.5 x swab diameter. Swab diameter shall be 50 mm greater than the inside diameter of the watermain. Swab density to be 1.5 lb/board ft. (high memory foam). Supply, installation and subsequent removal of temporary swab retrieval stubs / ports and all associated costs shall be included in the lump sum price for this item.

The flow rate for swabbing / flushing should be sufficient to maintain the velocity in the main of 0.76m/s to 0.91 m/s in order to keep particles in suspension. Preliminary flushing of the main shall immediately follow the swabbing operation.

- .3 *Hydrostatic Leakage Test:* Hydrostatic leakage testing shall be undertaken in accordance with OPSS 701.07.22 under the supervision of the Contract Administrator. Prior to commencing the hydrostatic test, the Contractor shall operate all line valves for the Contract Administrator and verify that they are in the open position. The criteria for hydrostatic testing in this section pertain to all pipe materials, except polyethylene. Refer to OPSS 701.07.22.02 for polyethylene pipe testing criteria.

The test pressure shall be 1035 kPa, which shall be maintained continuously for the duration of the two-hour test. If necessary, additional water shall be added to the test section during the two-hour test in order to maintain the test pressure (i.e. the pressure should not be allowed to drop significantly throughout the two-hour test with all of the make-up water added at the end of the test).

The allowable leakage is 0.082 litres per millimetre of pipe diameter per kilometre of watermain for the 2-hour test period.

- .4 *Disinfection:* Watermains and services shall be disinfected in accordance with AWWA C651-99 and C653-97. The entire main shall be filled with heavily chlorinated water. The chlorinated water shall be retained in the main for at least 24 hours, during which time all valves and hydrants in the treated section shall be operated to ensure disinfection of the appurtenance. At the end of the 24-hour period, the treated water in all portions of the main shall have a residual of not less than 10 mg/L of free chlorine. If the chlorine residual is less than 10 mg/L of free chlorine in any portion of the test section, the disinfection procedure shall be repeated.

- .5 *Flushing and Dechlorination:* After the requirements of the disinfection section have been met, heavily chlorinated water shall be completely flushed from the

watermain and all branches until chlorine levels in the watermain are no higher than levels generally prevailing in the distribution system.

The environment to which the chlorinated water is to be discharged shall be inspected. If there is any possibility that the chlorinated discharge will cause damage to the environment, then a neutralizing chemical shall be applied to the water to be wasted to thoroughly neutralize the residual chlorine.

The discharge of chlorinated water directly to receiving waters can be detrimental to aquatic life and therefore, should not be considered as an option. A storm sewer should be considered directly connected with the receiving water, which eliminates it as an option in most cases. Discharge to an open ditch or a vegetated field are good alternatives, especially if the point of discharge is a considerable distance from the receiving water and the ditch is unlined, heavily vegetated and overrun with organic materials. Sunshine and high temperatures aid in dissipation of the chlorine. Slow discharge to a sanitary sewer, if approved by the Operating Authority, may be an option. In order to avoid upsetting the biological processes at the wastewater treatment facility, the distance between the point of discharge and the treatment facility must be taken into account along with the rate of discharge in order to sufficiently dilute the chlorinated water before it reaches the facility.

If dechlorination is necessary, there are several chemicals, which can be used effectively. Adequate dosage of the chemical and mixing with the chlorinated water must be ensured. The amount of dechlorination chemical required can be determined from the following equation:

Excess Chlorine Residual x Factor = Dechlorination Chemical Required

This can be calculated in mg/L or whichever unit is appropriate.

Five (5) examples of dechlorination chemicals are listed below:

- .1 Hydrogen Peroxide (Factor = 0.479); This may be the best option when discharging to an environmentally sensitive receiving water. It is inexpensive and an overdose will only add more oxygen to the watercourse.
- .2 Sulphur Dioxide (Factor = 0.901); This chemical is inexpensive, but it will slightly lower the pH in the receiving water.

- .3 Sodium Thiosulphate (Factor = 2.225); This will cause some sulphur turbidity but an excess is essentially harmless.
- .4 Sodium Sulphite (Factor = 1.775); Excess will lower the dissolved oxygen in the receiving water.
- .5 Sodium Pyrosulphate (Sodium Metabisulphite) (Factor = 1.338); Excess will lower the dissolved oxygen in the receiving water.

For example, a total chlorine residual of 20 mg/L measured in a disinfected watermain of 11,000 L could be neutralized with hydrogen peroxide. The dosage required would be:

$$20 \text{ mg/L} \times 0.479 = 9.6 \text{ mg/L}$$

and the total amount needed would be:

$$9.6 \text{ mg/L} \times 11,000 \text{ L} = 105,600 \text{ mg} = 105.6 \text{ gm of H}_2\text{O}_2$$

This would represent in terms of 35% commercial grade hydrogen peroxide (specific gravity 1.13 g/ml):

$$105.6 \times 100 \times 1 = 267 \text{ mL of concentrate}$$

$$35 \quad 1.13$$

The above information is offered as a guide only. The Contractor is ultimately responsible to ensure that no negative environmental impact results from the disposal of chlorinated or dechlorinated water from the disinfection process.

- .6 *Sampling and Bacteriological Testing:* Under the lump sum price bid, the Contractor shall provide sufficient blow-offs / sampling ports (including their eventual removal) to accommodate the sampling requirements detailed herein.

After the requirements of previous sections have been met, two (2) consecutive sets of water samples, taken at least 24 hours apart, shall be collected at the ends of all branches, stubs and not more than 350 m apart along the length of the watermain. In addition, it is recommended that the existing distribution system be sampled for testing as well. The watermain shall not be flushed or disturbed during the minimum 24-hour period between sets of samples. Samples shall be taken by Municipality staff using bottles provided by a provincially accredited laboratory.

All costs related to sampling and bacteriological testing will be the responsibility of the Contractor and shall be borne under a separate unit item for watermain installation.

Table 2: Bacteriological Testing Criteria

Item	Microbiological Parameter	Standard (expressed as a maximum)
1	Escherichia coli (E. coli)	Not detectable
2	Fecal coliforms	Not detectable
3	Total coliforms	Not detectable
4	General bacteria population expressed as background colony counts on the total coliform membrane filter	200 colony forming units (CFU) per 100 millilitres
5	General bacteria population expressed as colony counts on a heterotrophic plate count	500 colony forming units (CFU) per 100 millilitres

All samples from both sets of samples shall meet the above bacteriological testing criteria before the Municipality will grant approval for connection of the new watermain to the active distribution system.

- .7 Final Connection / Commissioning: The Contractor will be allowed to make the final connection(s) between the new watermain and the existing distribution system once the Municipality has granted its approval. The removal of the temporary connection apparatus and the installation of the final connection piping must be witnessed by the Contract Administrator.

All piping and appurtenances utilized in completing the final connection must be thoroughly disinfected with a 1 percent (1%) sodium hypochlorite solution (or equivalent).

The excavation must be maintained in a dry state in order to eliminate the possibility of trench water entering the watermain when the final connection is being made. The Contractor shall ensure that no foreign material whatsoever enters the watermain at this time. Should trench water or foreign material enter the watermain, the entire disinfection / sampling procedure shall be repeated at the Contractor's expense.

- .8 Payment for Testing: In addition to the regular 12 percent (12%) holdback amount, a further 10 percent (10%) holdback shall be retained until all watermain and service systems have been successfully tested.

END OF SECTION

03100 – Concrete Formwork

PART 1 – GENERAL

1.1 Related Work

- .1 Concrete Reinforcement: Section 03201
- .2 General Concrete: Section 03305
- .3 Applicable Sections of Division 1

1.2 Reference Standards

- .1 Do concrete formwork in accordance with CSA/CAN-A23.1-14.

1.3 Shop Drawings

- .1 Submit shop drawings in accordance with Section 01340: Shop Drawings, Product Data & Samples for falsework associated with walls and deck. All shop drawings shall be stamped by a Professional Engineer registered in the Province of Ontario and experienced in falsework design.

1.4 Measurement and Payment

- .1 No measurement will be made under this section. Include costs in items of work for which concrete formwork and falsework are required.

PART 2 – PRODUCTS

2.1 Materials

- .1 Formwork materials: to CSA/CAN-A23.1.14.
- .2 Form release agent: Chemically active release agents containing compounds that react with free lime present in concrete to provide water insoluble soaps, preventing set of film of concrete in contact with form. Acceptable product: Mineral Oil.
- .3 Form ties: Adjustable metal, designed to act as spreaders. When removed the remaining holes shall not be closer than 25 mm to the concrete surface. In water retaining walls, DO NOT use formwork ties or spacers that leave holes through the concrete and require grouting later. Snap ties are unacceptable.

PART 3 – EXECUTION

3.1 Execution

- .1 Verify lines, levels and centers before proceeding with formwork / falsework and ensure dimensions agree with drawings.
- .2 Construct forms produce finished concrete conforming to shape, dimensions, location and levels indicated within tolerances required by CAN/CSA-A23.1.14.
- .3 Obtain Engineer's approval for use of earth forms.
- .4 All exposed edges and corners shall be chamfered 20 mm x 20 mm unless otherwise shown on the drawings. All sides and edges to be chamfered.
- .5 Hand-trim sides and bottoms and remove loose earth from earth forms before placing concrete.
- .6 Align form joints and make watertight. Keep form joints to a minimum.
- .7 Leave formwork in place for following minimum periods of time after placing concrete.
- .8 Re-use of formwork and falsework subject to requirements of CAN/CSA-A23.1-14, Clause 11.9.

Period from Pouring to Stripping for: Portland Cement Concrete		
	Cold Weather (3°)	Normal Weather (above 18°)
Forms for Part of Structure	Days	Days
Beam sides, walls and columns	1	1
Slabs (props left under)	10	7
Beam supports (props left under)	14	7
Removal of props to slabs	28	28
Removal of props to beams	28	28

END OF SECTION

03201 - Concrete Reinforcement

PART 1 – GENERAL

1.1 Related Works

.1	Concrete Formwork	Section 03100
.2	General Concrete	Section 03305
.3	Applicable Sections of Division 1	

1.2 Reference Standards

- .1 Do concrete reinforcement work in accordance with OPSS 905, except where specified otherwise.
- .2 Do general work for concrete in accordance with OPSS 905. Detailed work relating to the proper placement, securing, supporting and bending of reinforcement to follow the latest version of CSA/CAN-A23.3-14.
- .3 Supply reinforcing steel in accordance with the latest version of CSA G30.18-M92.

1.3 Shop Drawings

- .1 Submit shop drawings in accordance with Section 01340: Shop Drawings, Product Data & Samples.
- .2 Clearly indicate bar sizes, spacing, location and quantities of reinforcement, mesh, chairs, spacers and hangers with identifying code marks to permit correct placement without reference to structural drawings; to ACI Manual Standard Practice for Detailing Reinforced Concrete Structures.
- .3 Detail placement of reinforcing where special conditions occur.

1.4 Measurement and Payment

- .1 No measurement will be made under this section. Include costs in items of concrete work for which reinforcement is required.

PART 2 - PRODUCTS

2.1 Materials

- .1 Reinforcing Steel: to OPSS 1440 billet steel grade 400, deformed bars.
- .2 Supports: to OPSS 1440.

2.2 Fabrication

- .1 Fabricate reinforcing steel to OPSS 1440 and in accordance with CAN/CSA-A23.1, ANSI/ACI 315 and Reinforcing Steel Manual of Standard Practice by the Reinforcing Steel Institute of Canada, unless indicated otherwise.
- .2 Obtain Engineer's approval for locations of reinforcement splices other than those shown on placing drawings.
- .3 Upon approval of Engineer, weld reinforcement in accordance with CSA W186.
- .4 Ship bundles of bar reinforcement clearly identified in accordance with bar bending details and lists.

2.3 Source Quality Control

- .1 Upon request, provide Engineer with certified copy of mill test report of reinforcing steel, showing physical and chemical analysis, minimum four (4) weeks prior to commencing reinforcing work.
- .2 Upon request, inform Engineer of proposed source of material to be supplied.

PART 3 – EXECUTION

3.1 Field Bending

- .1 Do not field bend or field weld reinforcement, except where indicated or authorized in writing by Engineer.
- .2 When field bending is authorized, bend without heat, applying a slow and steady pressure.
- .3 Replace bars that develop cracks or splits.

3.2 Placing Reinforcement

- .1 Accurately place reinforcing steel in positions indicated and hold firmly during placing, compacting and setting of concrete.
- .2 Tie reinforcement where spacing in each direction is:
 - .1 Less than 300 mm: tie at alternate intersections.
 - .2 300 mm or more: tie at each intersection.
- .3 Alternate bars to have lap splices staggered 1500 mm in each face and opposite faces.

3.3 Cleaning

- .1 Clean reinforcing before placing concrete.
- .2 Reinforcing steel to be clean of rust, mud, oil, laitance, concrete scale which could potentially reduce the concrete bond. Corrective action is to be taken prior to placing fresh concrete.

3.4 Inspection

- .1 Do not place concrete until Engineer has inspected and approved reinforcement work in place.

END OF SECTION

03305 – General Concrete

PART 1 - GENERAL

1.1 Related Work

- .1 Concrete Formwork: Section 03100
- .2 Concrete Reinforcement: Section 03201
- .3 Applicable Sections of Division 1

1.2 Reference Standards

- .1 Complete concrete Materials and Methods of Concrete Construction in accordance with the latest version of CAN/CSA A23.1-14.
- .2 Complete testing of concrete in accordance with the latest version of CAN/CSA A23.2-14, Methods of Test for Concrete.
- .3 Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete, ACI 211.1-91.

1.3 Measurement for Payment

- .1 No measurement will be made under this section. Include costs in items of work for which concrete work is required.

PART 2 - PRODUCTS

2.1 Materials

- .1 Cement: to CAN3-A5-M93, Type 10.
- .2 Aggregates: to CAN3-5-A23.1-14 or as otherwise specified. The maximum size shall be 25 mm. Actual size shall be determined by availability, thickness of concrete and reinforcement spacing. Use maximum aggregate size in all cases. To minimize shrinkage cracks, a mix design using 40 mm diameter coarse aggregate may be employed. Proportion mix design in accordance with ACI 211.1-91. Trial mix samples shall be submitted to the Engineer for testing prior to pouring any concrete. The Contractor is to confirm that the source of aggregate and the aggregate itself does not exhibit or have a history of Alkali-Aggregate reactivity. Samples are to be submitted for testing.
- .3 Concrete formwork to Section 03100: Concrete Formwork.

- .4 Concrete reinforcement to Section 03201: Concrete Reinforcement.
- .5 Curing Compound: to CAN3-A23.1-14, white chlorinated rubber.
- .6 PVC Waterstop:
 - .1 150 mm wide x 9.5 mm thick Artic grade PVC. Acceptable product: Sealtight PVC by W.R. Meadows Ltd., Durajoint Type 5 by Sternson Ltd. or approved equal.
 - As an alternate to PVC “dumbbell type” waterstop, the Engineer will permit the use of a flexible bentonite based “strip type” waterstop (12 mm thick by 300 wide) which swells when contacted by water. Acceptable product: Volclay RX, Superstop or approved equal.
 - Waterstop shall be capable of resisting minimum head pressure of 350 kPa. Submit material type and technical information to Engineer for approval.
- .7 Water: to CAN3-A23.1-14.
- .8 Admixtures:
 - .1 Air entraining admixtures: to latest revision of ASTM Standard C260. (CAN3-A266.1).
 - .2 Water reducing agent: to latest revision of ASTM Standard C494 Types A and F. (CAN3-A266.2 Type WN).
 - .3 Pozzolanic admixtures: to CAN/CSA-A23.5 M86 (R1992). (CAN3-A23.1 Clause 6.1-6.5).
 - .4 Engineer to approve accelerating or set retarding admixtures during cold and hot weather placing.
 - .5 Granulated Slag: To latest version of CAN/CSA A23.5 – M86 (R1992) Type G.
- .9 Joint filler: to be premolded fibre joint filler. Acceptable product: “Rodofill” by Sterson Ltd. or approved equal.
- .10 Grout: unless noted otherwise grout shall be non-metallic, non shrink, premixed with Type 20 cement, minimum strength 40 MPa @ 28 days.
- .11 Concrete:
 - .1 Mix design will be reviewed by Design Engineer.

- .2 Refer to drawings for location or specified otherwise, provide concrete strength.
- .3 Except where indicated or specified otherwise, provide concrete mix as follows:
 - .1 Minimum 28-day compressive strength 20 MPa,
 - .1 Slump: 75 mm $\pm$ 15 mm
 - .2 Max. Water/Cement Ratio: 0.60
 - .3 Min. Cement Content: 300 kg/cu.m.
 - .2 Minimum 28-day compressive strength 25 MPa,
 - .1 Slump: 75 mm $\pm$ 15 mm
 - .2 Max. Water/Cement Ratio: 0.52
 - .3 Min. Cement Content: 340 kg/cu.m.
 - .3 Minimum 28-day compressive strength 30 MPa,
 - .1 Slump: 75 mm $\pm$ 15 mm
 - .2 Max. Water/Cement Ratio: 0.45
 - .3 Min. Cement Content: 355 kg/cu.m.
 - .4 Minimum 28-day compressive strength 32 MPa,
 - .1 Slump: 75 mm $\pm$ 15 mm
 - .2 Max. Water/Cement Ratio: 0.45
 - .3 Min. Cement Content: 355 kg/cu.m.
 - .5 Minimum 28-day compressive strength 35 MPa,
 - .1 Slump: 75 mm $\pm$ 15 mm
 - .2 Max. Water/Cement Ratio: 0.45
 - .3 Min. Cement Content: 355 kg/cu.m.

- .4 All concrete shall be air entrained. Air entrainment shall be 6% + 2%, -0.5% which shall result in an air void system with the following characteristics:
 - .1 Spacing Factor:
 - .1 Less than 230 micro metres (average test).
 - .2 Less than 260 micro metres (any single test).
 - .2 Specific Surface Area:
 - .1 Greater than 24 mm²/mm³.
 - .3 Voids per 25 mm:
 - .1 n equal to 1.5 to 2.0 times % air.
- .5 The Engineer will consider the use of high range water reducers (i.e.: Superplasticiser). Proposed mix design shall be submitted to the Engineer for approval.
- .6 For concrete exposed to sewage the cement / slag blend ratio will be 75:25.

PART 3 - EXECUTION

3.1 Fillets and Chambers

- .1 The edges and re-entrant angles of all concrete exposed to view shall be bevelled to a 20 mm x 20 mm fillet or chamber unless large fillets or chambers are indicated on the drawings.

3.2 Build In

- .1 Wherever practical, fittings and pipework to be built-in, shall be installed at the time of pouring of the concrete structure, and boxing out will be done only with sanction and to the satisfaction of the Engineer. Forms shall be neatly fitting around the items built-in so as to prevent any leakage of mortar. All pipes passing through floors or through concrete walls retaining liquids shall have wall flanges cast in situ as approved by the Engineer.

3.3 Anchor Bolts

- .1 Wherever practical and approved, anchor bolts and securing bolts shall be built into the concrete as the work proceeds but when this is impractical or undesirable, suitable

pockets shall be left to receive the bolts which shall be securely grouted in after installation.

- .2 In hardened concrete, core and grout anchors with 40 MPa a non-shrink grout. Authorization to be obtained from the Engineer prior to using mechanical anchors cored into hardened concrete. Torque all nuts on anchor bolts to manufacturer's recommendations. When requested by Engineer torque nuts using a torque wrench in presence of Engineer.

3.4 Construction Joints

- .1 Provide construction joints where specified or shown on the drawings. Located and make other joints so as not to impair the strength, water tightness and appearance of the structure. Wall construction joints shall be staggered from those locations in roof and floor slabs. No intermediate horizontal expansion joints shall be used in walls of water-containing basins except where shown on the drawings. Joints are subject to the approval of the Engineer.
- .2 Construct construction joints with an approved waterstop, properly anchored against displacement during the placement of the concrete and properly sealed at all of the intersections. Join splices and intersections of waterstop by heat fusion in accordance with approved manufacturer's instructions. Delete waterstop at joints inside structure between dry areas unless otherwise specified on the drawings.
- .3 Unless otherwise shown, maximum distances between construction joints are:
 - .1 Walls – 10 m.
 - .2 Base slabs and slabs on grade – 11 m.
 - .3 Suspended slabs greater than 100 mm thick and super-structure beams and girders – 16 m.
- .4 No construction joints to be located within 2 m of wall corners unless specified on drawings.
- .5 The pouring of the base slab may be sequenced in either a linear or check-board pattern provided the maximum construction joint distances are maintained. The walls are to be poured in a linear rather than check-board fashion. Further, the pouring of the wall sections where applicable, must be scheduled to minimize the time delay between the slab and wall pours. A pouring sequence and proposed schedule must be submitted to the Engineer at least 14 days prior to the commencing of the work.

- .6 Beams, girders, brackets, column capitals, haunches and drop panels shall be placed with slabs.
- .7 In general, locate joints near middle spans of slabs, beams and girders unless a beam intersects a girder at this point, in which the girder joint shall be offset twice the beam width and additional shear reinforcement provided to the approval of the Engineer. Joints in slabs supported by walls or steel beams are preferably located over the support unless the beam acts compositively with the slab.
- .8 Provide a bulkhead at all construction joints.
- .9 All steel as shown on drawings is to be continuous through construction joints. Add dowels, if necessary, to make total steel passing through bulkhead at least the equivalent of 15 M @ 300 centers each face. Dowels shall be embedded at least 900 on each side of joint.
- .10 Before placing new concrete, remove all dirt, loose aggregate and laitance from face of existing concrete. This shall be accomplished by sandblasting, power washing or other method acceptable to the Engineer.
- .11 Allow adequate curing time to the satisfaction of the Engineer between placing adjacent sections separated by construction joints. Place concrete in alternate sections in necessary and place closing sections after alternate sections have cured.
- .12 All construction joints shall have a row of form ties located at a distance of approximately 150 mm from the joint to permit aligning and tightening of the forms for subsequent sections.
- .13 Curing compound not to be used on construction joints.

3.5 Waterstops

- .1 Horizontal and vertical construction joints in water-tight construction shall have suitable waterstops as shown on the drawings.

3.6 Testing

- .1 Tests shall be made throughout the progress of the work to determine whether the concrete is of the strength specified. Test cylinder shall be made by and at the expense of the Owner. At least one (1) set of cylinders for each 25 m³ (or as instructed by the Engineer) of concrete used shall be made unless specifically approved otherwise.

- .2 Where 7-day strength is less than 70% of specified 28-day strength, provide additional curing and make changes to mix proportions when directed by the Design Engineer.

3.7 Slump

- .1 The slump shall be 75 +\ - 15 mm and tests shall be in conformity with CSA A23.2. The slump may be increased with the addition of a “super plasticizer” after consulting with SBA. However, slump must be tested prior to the addition of a “super plasticizer” in order to satisfy Section 2.1.

3.8 Placing and Compacting

- .1 Mixing and placing equipment shall be such that when concreting has started, the depositing of concrete shall be carried on as a continuous operation until the placing of the panel or section is completed. Compacting shall be carried out at such a rate that the concrete is at all times sufficiently plastic to ensure proper bonding of the successive layers. Sufficient equipment shall be assigned to the job for a specific pour to ensure that the time interval between batches being placed does not exceed 20 minutes.
- .2 In walls or deep sections, when the Engineer permits the use of removable separators or spreaders, they shall not be removed until the concrete has reached their level. Suitable tools shall be provided for their removal and recovery. Wood spreaders shall not be used in any concrete wall.
- .3 Do not place concrete in water.
- .4 Before placing new concrete against existing concrete which is at a lower temperature than the new concrete, the area must be enclosed and heated until the concrete temperature rises to within 5°C of the temperature of the new concrete. However, at no time shall concrete be poured against frozen surfaces or any surface which is colder than 5°C.
- .5 Before placing floor slabs on subgrade which is below 3°C, enclose and heat the surrounding space until the subgrade is at least 10°C.
- .6 Before depositing new concrete on concrete that has set, the form ties shall be tightened, the surface of the set concrete suitably roughened, thoroughly cleaned of foreign matter and laitance, and saturated with water in advance of concreting. The first 15 cm layer of new concrete placed on hardened concrete should contain an excess of mortar to ensure bond. This may be obtained by first placing concrete of the quality specified for the work but from which 30 to 50 percent (30-50%) of the course aggregate has been omitted. The quality of this concrete and its method of distribution in the forms shall be as determined by the Engineer.

3.9 Vibrators

- .1 The use of mechanical vibrators are required. Vibrators shall be sturdy construction, adequately powered and capable of transmitting to the concrete not less than 3500 impulses per minute. A sufficient number of vibrators shall be employed so that at the required rate of placement vibration throughout the entire volume of each layer of concrete and complete compaction are secured. At least one (1) extra gasoline powered vibrator shall be on hand for emergency use.
- .2 Vibration shall not be continued in one spot to the extent that pools of grout are formed. Care shall be taken to avoid any but slight disturbance to concrete which has become too stiff to regain plasticity when vibrated. Vibration shall not be applied directly to steel which extends into partially hardened concrete. In wall pours vibration of concrete is to work from the toe of sloped concrete upwards to the top of the pour.

3.10 Summer Concreting

- .1 The Contractor must prepare the curing procedures to suit the environmental conditions. Shrinkage cracks are caused by rapid drying of the concrete and by thermal effects which include heat during curing, ambient conditions and shape considerations. The following requirements are designed to minimize those effects and thereby minimize the cracking of the concrete.
- .2 The maximum temperature of the concrete must be maintained at or below 24°C.
- .3 The maximum water / cement ratio is 0.40 and shall not exceed this value.
- .4 The concrete shall be air entrained.
- .5 The forms for walls shall be released within 24 hours of the pour and the concrete wetted down thoroughly.
- .6 The surface of slabs against which new concrete is poured shall be cooled using intermitted wetting techniques and the temperature shall not be more than 5°C greater than the new concrete at the time of pouring.
- .7 During periods of hot weather, the slabs and walls of structures shall be continuously cooled using wetted burlap or fog spraying with polyethylene sheets if the structure cannot be shaded. Windbreaks are to be erected when the above measures do not reduce the rate of allowable evaporation.
- .8 The concrete shall be “wet cured” for a least 14 days during hot weather above 30°C and 7 days for weather between 18°C and 30°C.

- .9 The use of curing compounds will be considered for conditions where the concrete will be shaded or otherwise protected from the sun and where the surface of the concrete will not be in contact with potable water under service conditions. The curing compound shall conform to the requirements of CGSB 90 GP1a, "Liquid Membrane-Forming Compounds for Curing Concrete".

3.11 Winter Concreting

- .1 Between September 1 and May 30 of the following year and at any time when the temperature is below 3°C, place concrete in accordance with the requirements of CSA-A23.1-14, "Cold Weather Requirements", or when in the opinion of the Design Engineer there is a probability of temperatures falling to that limit during the placing period, the temperature of the concrete, when deposited, shall be not less than 10°C nor more than 24°C. To accomplish this, the mixing water, and if necessary, the aggregates, shall be heated. Aggregates shall not be heated above 85°C.
- .2 The temperature difference as noted in Section 3.8.4 is of primary importance during winter concreting. However, during the actual pouring, and for 24 hours after the pour, the temperature within the enclosure shall not exceed 18°C and shall not drop below 5°C.
- .3 Means shall be provided to humidify the air within the enclosed space and to keep the concrete and formwork continuously moist if dry heat is used. Combustion type heaters may be used but they shall be constructed and placed so that their combustion gases shall not come in contact with surfaces of green concrete. Concrete shall be kept at 10°C or above for a minimum period of 7 days after placing.
- .4 The temperature shall be gradually reduced at the end of the period of protection at a rate not greater than 10°C per day until the outside air temperature is reached.

3.12 Repairing Concrete Surfaces

- .1 As soon as face forms are removed, the surfaces shall be thoroughly washed with clean water under pressure, and all fins, projections and off-sets smoothed off. Metal ties shall be cut and any defective areas, permitted by the Engineer to be patched shall be repaired at once before the concrete is thoroughly dry.
- .2 At the discretion of the Engineer, defective areas shall be chipped away to a minimum depth of 25 mm or to solid concrete, whichever is greater, with edges perpendicular to the surface. The area to be patched and a 150 mm wide band around it shall be thoroughly wetted. A grout of equal parts cement and sand shall then be brushed into the surface followed by a mortar of the same mix as the unit being repaired except for the absence of coarse aggregate.

- .3 The patch shall be left slightly higher than the surrounding area and allowed to reach initial shrinkage before the final screening.
- .4 Patches shall be cured continuously for a period of 10 days. Bonding of patch work to parent concrete and the curing of the completed repair work will require special attention. Filling shall be free from shrinkage cracks or dummy areas after the fillings have been cured and dried. The concrete constituents shall be mixed so as to avoid colour variations in surface finishes.
- .5 Any visible cracks caused as the result of the Contractor's failure to comply with these specifications shall be repaired at the Contractor's expenses using a method / materials approved by the Engineer.

3.13 Finishes for Formed Concrete

- .1 Type 1 – Unexposed or buried surfaces
 - .1 Such surfaces require no treatment after form removal other than such repair of defective concrete, tie holes and associated specified curing. Undressed lumber may be used for forming.
- .2 Type 2 – Exposes surfaces
 - .1 This finish applies to all permanently exposed formed surfaces such as interiors of buildings. After the surface has been repaired and is sufficiently hard, it shall be ground with carborundum stone and water until even and smooth.
- .3 After curing of all patches, their surfaces shall be finished as follows:
 - .1 A sack-rubbed finish is to be used to give a uniform colour and appearances to a smooth surface. After defects have been repaired, the surface shall be saturated thoroughly with water and kept wet at least 1 hour before finishing operations begin. A ground of 1-part cement, 1-1/2 to 2-parts of fine sand passing a 630 um sieve, and sufficient water for a thick, creamy consistency should be applied. It should be preshrunk by mixing at least 1 hour before it is used and then remixed without the addition of water and applied uniformly by brush, plasterer's trowel, or rubbed float to completely fill air bubbles and holes.
 - .2 The surface should be vigorously floated with a wood, sponge-rubber, or cork float immediately after applying the grout to fill any small air holes (bugholes) that are left to remove some excess grout. The remaining excess grout should be scraped off with a sponge-rubber float. If the float pulls grout from holes, a sawing motion of the tool should be correct the difficulty. The grout remaining on the

surface should be allowed to stand undisturbed until it loses some of its plasticity but not its damp appearance. Then the surface should be rubbed with clean, dry burlap to remove all excess grout. All air holes should remain filled, but no visible film of grout should remain after the rubbing. Any section being cleaned with grout must be completed in one (1) day, since grout remaining on the surface overnight is too difficult to remove.

- .3 If possible, work should be done in the shade and preferably during cool, damper weather. During hot or dry weather, the concrete can be kept moist with a fine fog spray.
- .4 The completed surface should be moist-cured by keep the area wet for 36 hours following the clean-down. When completely dry, the surface should have a uniform colour and texture.

3.14 Finishes for Unformed Concrete

- .1 Screeding: This finish shall apply to all surfaces to be covered by concrete or fill material. It is also the first step in other finishes and shall include sufficient levelling and screening to produce even, uniform surfaces at the elevation or slopes indicated.
- .2 Floated: This finish shall apply to unformed surfaces not permanently concealed by fill material or concrete where a trowelled or special finish is not indicated. It is also the second step where further finishing is specified. Floating may be performed by the use of hand or power-driven equipment and shall be started as soon as the screened surface has stiffened sufficiently to permit floating without drawing water or excess fines to the surface.
- .3 Trowelled: Where surfaces are to be finished without a topping or are to receive paint, tile or similar applications, they shall be finished by trowelling as follows:
 - .1 Slabs: Concrete shall be screened, tamped and floated to the correct elevation and compacted with a rotary discing machine. After the concrete has hardened sufficiently (not less than 30 minutes after placing), the surface shall be power trowelled to a hard, smooth surface and then protected from damage.

Slabs exposed to the weather (where hardening is not specified) shall be screened, floated and spin-trowelled using a finishing machine to produce a smooth, dense, non-slip surface.
 - .2 Top of Walls: The tops of walls and other locations unsuited for machine trowelling, shall be given a smooth steel trowel finish applied by hand. The concrete shall be screened and wood floated by hand to straight, level and even

lines and then allowed to stand until all weather sheen has disappeared before trowelling. Final trowelling shall be done manually, employing a steel trowel (in circular motion) after the concrete has hardened to a point that no mortar accumulates on the trowel and a ringing sound is produced as the trowel is drawn over the surface.

On thin walls, a stainless-steel finishing tool to leave 10 mm radius on the edge shall be used.

- .3 Roof Slabs: Roof slabs on buildings shall be carefully screened and wood floated followed by a light spin trowelling (or pinch finish) sufficient to produce a smooth, dense finish. Trowelling, as in Item 3.14.1 above, or steel trowelling by hand as in Item 3.14.2, shall not be allowed.

3.15 Defective Work

- .1 Concrete is defective when:
 - .1 Failing to meet all requirements of this specification.
 - .2 Concrete contains excessive honeycombing or embedded debris.
 - .3 28-day average strength in any defined area is less than 95% of specified minimum strength.

3.16 Reservoir Waterproofing

- .1 The Contractor shall the apply interior concrete waterproof coating of Krystol T1 material or approved equivalent meeting the NSF 61 standard as per manufactures specifications to all concrete in contact with water intended for consumption (i.e., concrete floor, perimeter and baffle walls).
- .2 The Contractor shall also include the addition of Xypex Admix C-500/C-500 NF or approved equivalent meeting the NSF 61 standard to the concrete mix as per manufactures specifications to all concrete intended to be in contact with potable water for consumption including the main floor slab over the reservoir.

END OF SECTION

04200 – Concrete Unit Masonry

PART 1 - GENERAL

1.1 General

- .1 The specifications are integral part of the Contract Documents.
- .2 Colours will be chosen later.

1.2 Work Included:

- .1 Supply and installation of:
 - .1 Concrete Block (plain & architectural).
 - .2 Reinforcement (vertical & horizontal).
 - .3 Mortar.
 - .4 Damp-proof coursing.
 - .5 Pointing and cleaning.
 - .6 Chases, openings, building in of anchor plates and anchor bolts.
 - .7 Hoarding and heating if applicable.
 - .8 Clean-up and removal of debris from site.
 - .9 Caulking of control joints.
 - .10 Cavity wall insulation and wedge.
 - .11 Air barrier.
 - .12 Ventilators.
 - .13 Concrete for bond beams.
 - .14 Installation loose lintels.

1.3 Reference Standard

- .1 Do masonry work to latest versions of CSA S304.1-04, CSA A371-04, CSA A370-94, CSA A65-04, CSA A179-94, CSA A82.1-M87.

1.4 Submittals

- .1 Submit samples of the following materials prior to starting the work: brick, architectural block, damp-proofing coursing and masonry reinforcement, ties and connector.

1.5 Product Handling

- .1 Ensure that materials arrive on the site dry and are kept dry.

1.6 Weather Conditions

- .1 When temperature is below 5°C, provide and maintain heating to the current work and for the previous 24 hours. Heat water to maximum 70°C and heat sand without scorching. Do not add calcium or other additives to the mortar.

1.7 Protection

- .1 Provide all necessary or required temporary bracing for masonry work and leave in place until permanent lateral support is in place. Protect built in items from damage. Cover end-of-day work to protect from rain / snow.

PART 2 - PRODUCTS

2.1 Materials

- .1 Block
 - .1 To CSA A165.1; H/15/A/M; colour to be selected by Owner or match existing block, where applicable.
 - .2 Use bullnose at exposed edges of doors, windows, openings and corners.
 - .3 Special profile blocks where shown on plan.
 - .4 Use 75-100% solid block where noted.
 - .5 Cull out blocks with chips or surface cracks.
- .2 Use bullnose at exposed edges of doors, opening and corners.
- .3 Block Veneer
 - .1 Full-face split block.

.4 Mortar

- .1 Exterior Walls: Type 'S', based on Proportion Specifications colour to match veneer.
- .2 Interior Walls – Type N based on Proportion Specifications colour to be white.
- .3 Use 20 MPa fire grout concrete mortar for piers, voids to receive vertical reinforcement and lintel and bond beams, use clean water that will not contribute to efflorescence.

.5 Damp-proofing / Flashing

- .1 Lay one (1) layer of rubberized fiber reinforced membrane at floor level and at headers or lintels and base of cavity wall (lay over base flashing). Seal lap joints with asphaltic sealant (Bakor Blueskin or approved equal).

.6 Ventilators

- .1 Provide weeping holes at bottom course at exterior width of cavity wall block – every second block and above all openings at 600 mm centers horizontally – use PVC type ventilator, colour to suit.

.7 Insulation

- .1 Mechanically fastened (see Division 7: Thermal & Moisture Protection).

.8 Control Joint Filler

- .1 Pre-formed rubber, neoprene or ten-test as per Section 3.4.

.9 Air-Barrier Blueskin by Bakor or approved equal.

- .1 Torch in place or peel and stick depending on temperature at the time of installation.

.10 Cavity Wall Horizontal Reinforcement

- .1 Ladder style with two (2) longitudinal side rods for each bed joint. Standard class carbon steel wire to ASTM A82, 9 gauge for both side and cross rods. Hot dipped galvanized finish (1.50 oz psf) to ASTM A153 – Class B-2. D/A 320 DSR by Dur-O-Wal or approved equal.

- .11 Single Wythe Horizontal Reinforcement
 - .1 Ladder style with two (2) longitudinal side rods. Standard class carbon steel wire to ASTM A82, 9 gauge material. Mill galvanized (0.10 oz psf) to ASTM A641. D/A 310 by Dur-O-Wal or approved equal.
- .12 Caulking
 - .1 Use caulking as approved for control joint application which will not harden or crack. Colour to match adjacent block surfaces.
- .13 Insulation Wedge
 - .1 Plastic retaining ring to hold insulation tight to masonry. Ins-o-grip by Dur-o-Wal or wedge-lok by Block lock.

PART 3 - EXECUTION

3.1 Laying (General)

- .1 Block – use running bond and pattern as per elevation. Lay plumb and true.
- .2 Assume complete responsibility for dimensions, plumbness and levels of the work and constantly check same. Layout architectural block to dimensions specified on drawings so that cutting of blocks is minimized.
- .3 Non-bearing walls to extend to within 25 mm of underside of floor and rood construction where noted. Install lateral 38 x 38 x 300 angle supports at 1600 c/c and install firestop material for gap filler.
- .4 Corners of bearing and non-bearing wall are to be tied with reinforcement.
- .5 Re-tempering will not be permitted.
- .6 No masonry may be laid in weather below 5°C without hording and heating protection. Contact Consultant for instructions for cold weather masonry.
- .7 Interior block to have concave joints except first 100 mm for cove base and for special wall finishes. See Finish Schedule. – Exterior split face block to have tooled joints. Single scored exterior block to have raked joints both vertically and horizontally. Joint between full split face and smooth face to be raked joints.
- .8 Brick to have tooled joints similar to exterior split face block.

- .9 Cover top of completed or partially completed wall which is not enclosed at the end of each day's work. Cover to extend 600 mm down each face of the wall.
- .10 Reference Standard CSA S304.1-04. Lap reinforcements 150 mm.
- .11 Insulation – all joints and corners to be tight fitting. Cracks to be sealed with foam.
- .12 Air barrier to be installed as per manufacturer's specifications to outside of back-up block prior to application of ridged insulation. Include installation of air barrier behind metal siding locations.

3.2 Build-In

- .1 Co-operate with other trades with respect to building in items supplied by others.

3.3 Control Joints

- .1 Provide continuous vertical control joints in masonry wall at location noted. No piece of wall shall be longer than 8 m without a control joint. Use 12 mm ten-test, backer rods or equal as backer board and caulk.

3.4 Clean-up

- .1 Upon completion, rub down the masonry work to remove excess mortar.
- .2 Fill in chipped or damaged corners, etc.
- .3 Scrub and rinse off to leave in A1 condition.
- .4 Remove debris from site.

END OF SECTION

05500 - Miscellaneous Metal Fabrications

PART 1 - GENERAL

1.1 Related Work

- .1 General Concrete Section 03305
- .2 Painting Section 09915
- .3 Mechanical General Provision Section 15010
- .4 Applicable Sections of Division 1

1.2 Reference Standards

- .1 Do welding work in accordance with the latest version of CSA W59 unless specified otherwise.

1.3 Shop Drawings

- .1 Submit shop drawings in accordance with Section 01340.
- .2 Clearly indicate materials, core thicknesses, finishes, connections, joints, method of anchorage, number of anchors, supports, reinforcement, details and accessories.

1.4 Measurement for Payment

- .1 Metal fabrication will not be measured separately but will be included in the unit or lump sum price for the work to which it is related.

PART 2 - PRODUCTS

2.1 Materials

- .1 Welding materials: to CSA W59.
- .2 Bolts and anchor bolts: to ASTM A307.
- .3 Galvanizing: un-passivated hot dipped galvanizing with minimum zinc coating of 600 g/sq.m. to CSA G164-M92.
- .4 Shop coat primer: to CAN/CGSB-1.40-M89.
- .5 Galvanized primer: zinc rich, ready mix to CGSB 1.181.

- .6 Grout: non-shrink, non-metallic, flowable, 24h. strength 15 MPa, pull- out strength 7.9 MPa.
- .7 Bituminous Paint: Best grade quick drying asphalt utility enamel.
- .8 Butyl Tape: Butyl Ribbon tape of required size.
- .9 Ferrous Materials
 - .1 Steel Sections, Plates, Bars and Shapes: CAN/CSA-G40.21, Grade 300W.
 - .2 Hollow Structural Sections: CAN/CSA-G40.20/G40.21, Grade 350W, Class H.
 - .3 Rolled Steel Shapes: CAN/CSA-G40.20/G40.21, Grade 350W.
 - .4 Steel Pipe: ASTM A53, extra strong.
 - .5 Reinforcing Bars: CAN/CSA-G30.18, Grade 400.
 - .6 Brackets, Flanges, and Anchors: Cast or formed metal.
 - .7 Welding Rods and Bare Electrodes: CWB specifications.
 - .8 Zinc-Coating: Hot-dip galvanized coating for materials in exterior assemblies or exterior walls, 600 g/m² to CSA G-164-M92.
- .10 Stainless Steel Materials
 - .1 Plate: ASTM A167, Type 316 or 304.
 - .2 Bars and Shapes: ASTM A276, Type 316 or 304.
 - .3 Finish: AISI finish 4.
- .11 Aluminum Materials
 - .1 Extruded structural shapes: 6061-T6.
 - .2 Smooth plates: 5052-H32.
 - .3 Checker plate: 6063-T6.
 - .4 Grating and bearing plates: 6351-T6.
 - .5 Handrail and posts: 6063-T6.

.6 Pipe: 6351-T6.

.12 Fasteners

.1 Bolts Miscellaneous: Hexagon head type, stainless steel.

.2 Bolts:

.1 For connections – ASTM A325M (galvanized or stainless steel as indicated).

.2 Machine bolts – ASTM A307.

.3 Anchor bolts – CSA G40.21, Grade 300W.

.3 Lag Bolts: Square head.

.4 Machine Screws: stainless steel.

.5 Wood Screws: stainless steel.

.6 Plain Washers: stainless steel.

.7 Drilled-In Chemical Anchors, Hilti Adhesive Type, stainless steel.

.8 Lock Washers: Spring type stainless steel.

.9 Zinc-Coating: Fasteners in exterior assemblies or exterior walls.

.13 Welding

.1 Thoroughly clean all joints to be welded and clean steel exposed for a sufficient area to properly perform the welding operation. Neatly finish all welds. Welds which will be exposed to view shall be continuous welded and ground smooth.

.2 All shop welding shall conform to the requirements of CSA W59 and shall be done by a firm fully certified in accordance with CSA W47.1 Division 1 or 2.1. All welders employed in the field shall be qualified as per CSA W47.1.

.3 All welding operations shall conform to the safety requirements of CSA W117.2.

.4 Schedule of finishes (refer to Contract Drawings for locations and quantities):

- .1 Angles at Overhead Door Jambs – Galvanized.
- .2 Cast-in-place Angle at Overhead Door Sill – Galvanized.
- .3 Loose Steel Beam at Overhead Door – Galvanized.
- .4 Loose Steel Lintels at Door and Windows – Galvanized.
- .5 Miscellaneous steel trim – Galvanized.
- .6 Shelf and relieving angles – Galvanized.
- .7 Gratings and associated frames – Aluminum.
- .8 Trench drain grating and associated frames – Aluminum.
- .9 Sump Pit Covers and associated frames – Aluminum.
- .10 Steel Pipe Bollards – Galvanized.
- .11 Miscellaneous fabrications as indicated on Contract Drawings – Aluminum.
- .12 Rough hardware – Galvanized.
- .13 Others as indicated on the Contract Drawings.

2.2 Fabrication

- .1 Fit and assemble work in shop, where possible. Execute work according to details and approved shop drawings. Where shop fabrication is not possible, make trial assembly in shop.
- .2 Welding shall conform to requirements of CSA W59 and be done by a fabricator fully approved by the Canadian Welding Bureau, to requirements of CSA W47.1-03 strength of connected members, unless otherwise detailed.
- .3 File or grind exposed welds smooth and flush. All welds to be chipped clean.
- .4 Weld connection shall be best grade of modern shop and field practice by fabricators known to be recognized manufacturers specializing in this work. Joints and intersection members shall be accurately fitted, made in true planes, with adequate fastening. Build and erect work, plumb, true square, straight, level and accurate to sizes detailed, free

from distortion, or defects detrimental to appearance and performance. All work shall conform to requirements of the local By-laws and all other authorities having jurisdiction.

- .5 Check all necessary site dimensions before proceeding with fabrication of work; accept concrete, steel framing and masonry as found and fabricate to “as-built” dimensions.
- .6 Use self-tapping shake-proof countersunk headed screws on items requiring assembly by screws or as indicated.
- .7 Coat all surfaces in contact with concrete with bituminous paint.

2.3 Shop Finishes

- .1 Apply one (1) coat of shop primer to metal items, with the exception of stainless steel, aluminum, galvanized or concrete encased items.
- .2 Prime Finish: After fabrication, clean, scrape and remove rust, scale, grease, or extraneous material. Except where specified otherwise, apply a full smooth priming coat in shop, to all miscellaneous metals. Work paint into corners and open spaces and deliver item to site with primer undamaged and to satisfaction of Engineer. Primer shall meet CAN/CGSB-1.40-M89. Consult manufacturer to determine minimum temperature required for application.
- .3 Use zinc rich primer on all surfaces, unless hot dip galvanizing is called for.
- .4 Galvanized Finish: Where galvanized finish is specified, prepare, work and hot dip galvanize in accordance with CSA G164-M92. Items shall be galvanized after fabrication where possible. Coating shall be applied at the rate of 600 g per square meter (2 oz. per sq. ft.).

2.4 Fabrication of Lintels

- .1 Use angle sizes and lengths as noted on the lintel schedule for the clear opening in masonry walls, plus bearing lengths as specified on the Contract Drawings.
- .2 Welding to be completed in accordance with CSA W59. Pairs of angles are to be stitch welded top and bottom at 600 mm on centre.
- .3 All lintels to be hot dipped galvanized as specified under materials of this section.

2.5 Ventilation Security Screens and Framing

- .1 Refer to Mechanical, Heating and Ventilation as well as Electrical Drawings and supply and install ventilation security screens and framing for all ventilation wall openings shown.
- .2 Screening to consist of 3 mm thick “heavy duty” expanded metal diamond mesh.
- .3 Screens to be welded to commercially available hot rolled standard steel shape framing.
- .4 Framing to be a minimum of 100 mm larger than ventilation opening.
- .5 Framing to be fastened to building wall with stainless steel lag bolts (masonry wall construction) or cad plated threaded rod or nuts and bolts (metal or wood wall construction).
- .6 All components to be of steel construction, hot dip galvanized after fabrication.
- .7 Submit shop drawing in accordance with Section 01340.

PART 3 - EXECUTION

3.1 Fabrications

- .1 Fabricate in accordance with CSA Standard S16, accepted shop drawings and all applicable codes and standards.
- .2 Undertake all welding activities to CSA W59. Grind all field welds flush and smooth.
- .3 Clean steel in accordance with SSPC 6 'Commercial Blast Cleaning. Complete finishing system according to schedule.

3.2 Erection and Installation

- .1 Erection in accordance with CSA Standard S16 or install according to other applicable CSA standards.
- .2 Erect all items in accordance with reviewed shop drawings.
- .3 Fit joints and intersecting members accurately. Make Work in true planes with adequate fastenings. Build and erect Work perfectly rigid, plumb or true to slope, square, straight, level and accurate to sizes detailed, free from distortion or defects detrimental to appearance or performance.

- .4 Continuously weld railings attached directly to stringers and grind smooth. Where railings return to wall, provide end returns and wall brackets.
- .5 Secure wall handrails to walls using concealed fastening system and adequate anchors. Where handrail is permanently attached to concrete floor, attach with stainless steel adhesive anchors, non-shrink cement grout under bottom plate and then caulk perimeter of plate.
- .6 Isolate dissimilar materials to prevent electrolysis.
- .7 Touch-up all damaged coatings after erection.

3.3 Clean-Up

- .1 Promptly as the Work proceeds and upon completion, clean-up and remove from the site, the rubbish and surplus material resulting from the Work of this Section.

END OF SECTION

06100 – Rough Carpentry

PART 1 - GENERAL

1.1 Related Work

- .1 Concrete Unit Masonry Section 04200

1.2 References

- .1 CSA O86-19, Engineering Design in Wood.
- .2 CSA O141-05 (R2014), Softwood Lumber.
- .3 CAN/CSA-O80 Series-15, Wood Preservation.
- .4 NLGA Standard Grading Rules for Canadian Lumber, 2017.
- .5 CSA O151-17, Canadian Softwood Plywood.
- .6 CSA O121-17, Douglas Fir Plywood.

1.3 Source Quality

- .1 Lumber identification: by grade stamp of an agency certified by Canadian Lumber Standards Accreditation Board.
- .2 Plywood identification: by grade mark in accordance with applicable CSA standards.
- .3 Coordinate with Sub-contractors for installation of escutcheons, plates and pipes through walls, etc.

PART 2 - PRODUCTS

2.1 Lumber Material

- .1 Lumber: unless specified otherwise, softwood, S4S, moisture content 19% or less in accordance with following standards:
 - .1 CSA O141-05 (R2014).
 - .2 NLGA Standard Grading Rules for Canadian Lumber, 2004 edition.
- .2 Grade: SPF 1/2. Machine stress-rated 'lumber is also acceptable for all purposes.

.3 Framing and board lumber: in accordance with NBC 2015 Subsection 9.3.2.

.4 Furring, blocking, nailing strips, grounds, rough bucks, fascia backing:

.1 S2S is acceptable.

.2 Board sizes: "Standard" or better grade.

.3 Dimension sizes: "Standard" light framing or better grade.

.4 Post and timbers sizes: "Standard" or better grade.

2.2 Panel Standards

.1 Panel standards: type, grade and thickness as specified indicated, in accordance with following standards:

.1 Douglas fir plywood (DFP): to CSA O121-17, standard construction.

.2 Canadian softwood plywood (CSP): to CSA O151-17, standard construction.

.3 Poplar plywood (PP): to CSA O153-19, standard construction.

.4 Interior mat-formed wood particleboard: to ANSI A208.1.

.5 Waferboard: to CSA O437.0.

.6 Hardboard: to CAN/CGSB-11.3-M87.

.7 Gypsum sheathing: to ASTM C1396. Type "X" where shown on Drawings.

2.3 Panel Materials End Uses

.1 Subflooring:

.1 Plywood, T&G edge, 19 mm thick.

2.4 Dampproof Membrane

.1 Polyethylene film: to CAN/CGSB-51.34-M86, Type 1, 0.15 mm thick.

2.5 Adhesives

.1 Subflooring adhesive: to CGSB-71.26-M88, cartridge loaded.

2.6 Fasteners

- .1 Nails, spikes and staples: to CSA B 111-1974.
- .2 Bolts: 12.5 mm diameter unless indicated otherwise, complete with nuts and washers.
- .3 Proprietary fasteners: toggle bolts, expansion shields and lag bolts, screws and lead or inorganic fibre plugs, explosive actuated fastening devices, recommended for purpose by manufacturer.
- .4 Galvanizing: to CSA G164-18, use galvanized fasteners for exterior work and interior highly humid areas.

PART 3 - EXECUTION

3.1 Construction

- .1 Comply with requirements of NBC 2015 Part 9 supplemented by following paragraphs.

3.2 Erection of Framing Members

- .1 Install members true to line, levels and elevations.
- .2 Construct continuous members from pieces of longest practical length.
- .3 Install spanning members with "crown-edge" up.

3.3 Defacement Marks

- .1 Install lumber and panel materials so that grade-marks and other defacing marks are not visible or are removed by sanding.

3.4 Panel-Type Subflooring

- .1 Install subflooring and combined subfloor and underlay with panel end-joints located on solid bearing, staggered at least 800 mm.
- .2 In addition to mechanical fasteners, apply subflooring adhesive under panels installed on wood joists. Place continuous adhesive bead in accordance with manufacturer's instructions, single-bead on each joist and double-bead on joists where panel ends butt. When weather conditions are unsuitable for adhesive, use drywall screws for mechanical fasteners.

3.5 Furring and Blocking

- .1 Install furring and blocking as required to space-out and support casework, cabinets, wall and ceiling finishes, facings, fascia, soffit, siding and other work as required.
- .2 Install furring to support siding applied vertically where there is no blocking and where sheathing is not suitable for direct nailing.
- .3 Align and plumb faces of furring and blocking to tolerance of 1:600.

3.6 Nailing Strips, Grounds and Rough Bucks

- .1 Install rough bucks, nailers and linings to rough openings as required to provide backing for frames and other work.

3.7 Fascia Backing

- .1 Install nailers and other wood supports as required and secure using galvanized steel fasteners.

3.8 Fasteners

- .1 Frame, anchor, fasten, tie and brace members to provide necessary strength and rigidity.
- .2 Countersink bolts where necessary to provide clearance for other work.
- .3 Use nailing disks for soft sheathing as recommended by sheathing manufacturer.

END OF SECTION

07900 - Caulking

PART 1 - GENERAL

1.1 General

- .1 The specifications are an integral part of the Contract Documents.

1.2 Work Included

- .1 Include: caulking at all openings and joints.

1.3 Environmental Conditions

- .1 Apply caulking and sealant only to completely dry surfaces and at air and material temperatures above minimum established by manufacturer's specifications.

1.4 Guarantee

- .1 Provide a written guarantee that caulking work is guaranteed for 3 years against leakage, cracking, crumbling, melting, shrinkage, running, loss of adhesion or staining adjacent surfaces.

PART 2 - PRODUCTS

2.1 Materials

- .1 Sealant - one part - Tremco or approved equal.
- .2 Backing - Tremco Joint Backing.
- .3 Void Filler - loose glass fibre.
- .4 All materials suitable for specific application.

PART 3 - MATERIALS

3.1 Preparation

- .1 Remove by brushing, scrubbing, scraping or grinding loose mortar, dust, oil, grease, oxidation and all other materials affecting bonds of sealant and caulking to adjacent materials.

3.2 Application

- .1 Work of this section shall include all caulking except where specified under the work of other sections, to make the building weathertight as indicated typically on drawings and as otherwise specified.

END OF SECTION

08100 - Steel Doors, Frames and Windows

PART 1 – GENERAL

1.1 Related Work

- .1 Caulking Section 07900
- .2 Finishing Hardware Section 08710
- .3 Painting and Finishing Section 09915

1.2 Reference Standards

- .1 Canadian Standards Association (CSA).
 - .1 CAN/ULC-S702.1-14 (R2019), Thermal Insulation, Mineral Fibre, for Buildings.
 - .2 CAN/CSA-G40.21-13, Structural Quality Steels.
 - .3 CSA W59-13, Welded Steel Construction (Metal Arc Welding).
- .2 Canadian General Standards Board (CGSB).
 - .1 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.
 - .2 CGSB 41-GP-10Ma-84, Rigid Vinyl Extrusions for Windows and Doors.
 - .3 CAN/ULC-S701.1:2017, Thermal Insulation, Polystyrene, Boards and Pipe Covering.
 - .4 CGSB 51-GP-21M-78, Thermal Insulation, Urethane and Isocyanurate, Unfaced.
- .3 Canadian Steel Door Manufacturers Association, (CSDMA).
 - .1 CSDFMA, Specifications for Commercial Steel Doors and Frames, 2006.
 - .2 CSDFMA, Recommended Selection and Usage Guide for Commercial Steel Doors, 2009.
- .4 National Fire Protection Association (NFPA).
 - .1 NFPA 80-2019, standard for fire doors and other opening protectives.
 - .2 NFPA 252-2017, standard methods of fire tests of door assemblies.

1.3 Shop Drawings

- .1 Provide shop drawings clearly indicating door and frame types, rates, swings, etc.
- .2 Submit shop drawings in accordance with Section 01340.

1.4 Product Handling

- .1 Protect materials from rust and damage during delivery and storage.

PART 2 - PRODUCT

2.1 Materials - Insulated Metal Doors

- .1 Exterior Doors: 16 ga. base steel with G90 galvanized finish. Label doors as noted on Schedule.
- .2 Interior Doors: 18 ga. base steel with W25 wipe coat galvanized finish.
- .3 Vinyl Closer Cap: snap in black vinyl cap.
- .4 Glazing or Panel Stop Screws: oval head counter sunk cadmium plated.
- .5 Filler: two component epoxy type.
- .6 Hinge Reinforcing: 14 ga. steel bars continuously welded.

2.2 Hollow Metal Frames (Metric Heads Where Noted)

- .1 Exterior Frames: 16 ga. base steel with G90 galvanized finish.
- .2 Interior Frames: 16 ga. base steel with W25 wipe coat galvanized finish.
- .3 Channel Spreader Floor Anchors and Wall Anchors: 18 ga. base steel to ULS regulations for thickness of materials, spacing and anchorage methods.
- .4 Welded in Place Hardware for Reinforcing:
 - .1 Mortise Locksets and Deadlock: 16 ga.
 - .2 Surface and Panic Devices: 16 ga.
 - .3 Bored or Cylindrical Lock: 16 ga.
 - .4 Surface Applied Closers: 12 ga.

.5 Hold Open Arms: 12 ga.

.5 Door Bumpers: black neoprene double stud.

.6 Reinforcing Channel: to CSA G40.21-13 (R2018) 350W.

.7 Anchor Screws: 10 mm diameter flat head counter sunk galvanized screw anchors.

2.3 Fabrication of Doors

.1 Fabricate doors in accordance with details, reviewed shop drawings and ULC requirements.

.2 Mortise, reinforce, drill and tap doors and reinforcements to receive hardware using templates provided by finish hardware supplier.

.3 Provide for glazing as indicated and provide necessary glazing stops. Provide additional reinforcing as required to accommodate glazing.

.4 Sand welds smooth with base metal surface.

.5 Fill seam depressions, intersecting corners completely with epoxy filler and sand smooth.

.6 Provide undercut doors where indicated.

.7 Doors to be square and true.

.8 Vinyl filler shall be installed and sealed to recessed channel and closure to top of doors.

.9 Fill interior voids of doors with sound deadening core material. Fill exterior doors with a solid slab of polyurethane insulation.

.10 After fabrication touch up doors with primer where galvanized finished damaged during fabrication.

.11 Attach ULC labels to fire rated doors as required.

2.4 Fabrication Hollow Metal Frames

.1 Fabricate frames as detailed to Canadian Steel Door Manufacturers Association "Recommended Specifications for Commercial Steel Doors and Frames Products", 2018; except where specified otherwise.

- .2 Cut mitres and joints accurately and weld continuously on inside of frame profile.
- .3 Grind welded corners and joints to flat plane fill with metallic paste filler and sand to uniform smooth finish.
- .4 Touch up frames with primer where galvanized finish damaged during fabrication.
- .5 Extend frames to finish floor line and provide concealed floor anchors and removable metal spreader.
- .6 Supply six loose galvanized corrugated 'T' jamb anchors per doorframe or as required by jamb type.
- .7 Anchors for labelled frames to conform to ULC regulations for thickness of materials, spacing and anchorage methods.
- .8 Reinforce head of frames wider than 1,200 mm.
- .9 Glazing or panel stops to be mitred or coped at corners and drilled for counter sunk screws.
- .10 Install three bumpers on strike jamb for each single door.
- .11 Fabricate thermally broken frames for exterior doors using steel core, separating exterior portion of frame from interior portion with polyvinyl chloride (PVC) thermal breaks.

2.5 Windows

- .1 Interior window frames to be 18 ga cold rolled base steel G90 galvanized finish and installed during wall construction.
- .2 Glazing panel to be 6 mm Georgian Wire glass.
- .3 Exterior window frame to be 16 ga cold rolled base steel with G90 galvanized finish and installed during wall construction. For glass refer to Section 08800.

PART 3 - EXECUTION

3.1 Erection

- .1 Erect all units plumb, square and true, in proper alignment with other units (by Section 04200: Concrete Unit Masonry or Section 06100: Rough Carpentry). On

completion, caulk neatly around complete unit between steel and adjacent materials with silicone sealant suitable for materials caulked. Apply isolation coating to steel in contact with dissimilar metals, concrete or masonry.

- .2 Touch up with primer, galvanized finish damaged during installation.

END OF SECTION

08710 – Finishing Hardware

PART 1 - GENERAL

1.1 Related Work

- .1 Steel Doors, Frames and Windows Section 08100

1.2 Reference Standards

- .1 Standard hardware location dimensions in accordance with Canadian Metric Guide for Steel Doors and Frames (Modular Construction) prepared by Canadian Steel Door Manufacturers Association.
- .2 ANSI/BHMA A 156.2-2017, Bored and Preassembled Locks and Latches.
- .3 ANSI/BHMAA156.1-2016, Butts and Hinges.
- .4 ANSI/BHMA A156.3-2014, Exit Devices.
- .5 ANSI/BHMA A 156.4-2019, Door Controls (Closers).
- .6 ANSI/BHMA A 156.5-2014, Cylinders and Input Devices for Locks.
- .7 ANSI/BHMAA156.7-2014, Template Hinge Dimensions.
- .8 ANSI/BHMA A156.8-2010, Door Controls - Overhead Holders.
- .9 ANSI/BHMAA156.13-2017, Mortise Locks and Latches.
- .10 ANSI/BHMA A156.16-2018, Auxiliary Hardware.
- .11 ANSI/BHMA A 156.17-2014, Self-closing Hinges and Pivots.
- .12 ANSI/BHMAA156.18-2016, Materials and Finishes.
- .13 ANSI/BHMAA156.20-2017, Strap and Tee Hinges and Hasps.

1.3 Hardware List

- .1 Door hardware as indicated on Contract Drawings.
- .2 Supply to the metal doorframe manufacturer templates for hardware to be mounted on the frames, locating holes and cut-outs and showing screw sizes and types.

- .3 Supply a hardware list to enable satisfactory job organization of hardware showing all items to be supplied, locations to be used, manufacturers, models, sizes, finishes, colours, etc. This is a list of shop drawings under Section 01340.

1.4 Delivery and Storage

- .1 General Contractor responsible for the delivery of all items.

1.5 Packaging

- .1 Pack and mark each individual item showing content and location so that unopened packages may be correctly selected for installation in accordance with the Hardware List and include all parts required in each package.

1.6 Maintenance Materials

- .1 Provide maintenance data, parts list and manufacturer's instructions for each type of closer, lockset, fire exit hardware.
- .2 Supply two (2) sets of wrenches for maintenance work.

PART 2 - PRODUCT

2.1 Materials

ITEM	MANUFACTURER Specified
Hinges	Stanley
Locks/Latches	Von Duprin
Exit Devices	LCN-High Traffic
Closures	Taylor-Low-Med. Traffic
Push-pull Kickplates	Ferrum
Door Stop Holders	Ferrum
Surface, Dutch Door Bolts	Ives
Thresholds	KN Crower

2.2 Finish

- .1 C26D - Brushed Aluminum
- .2 C32D - Brushed Aluminum (rated openings)

2.3 Locksets

- .1 All locksets to be supplied on this project are to be keyed alike.

2.4 Keys

- .1 Supply two (2) keys for each lockset whether keyed alike to other locksets or not. Three (3) master keys, all locks to be master keyed.

PART 3 - EXECUTION

3.1 Mounting Heights

.1	Locksets and Latchsets	900 mm
.2	Deadlocks	1525 mm
.3	Panic Sets	1065 mm
.4	Push and Pull Units	1120 mm

3.2 Installation Instructions

- .1 Furnish metal door and frame manufacturers with complete instructions and templates for preparation of their work to receive hardware.
- .2 Furnish manufacturer's instructions for proper installation of each hardware component.
- .3 Install hardware to standard hardware location dimensions in accordance with Canadian Metric Guide for Steel Doors and Frames (Modular Construction) prepared by Canadian Steel Door and Frame Manufacturers' Association.
- .4 Where doorstop contacts door pulls, mount stop to strike bottom of pull.

END OF SECTION

08800 – Glass & Glazing

PART 1 - GENERAL

1.1 Related Work

- .1 Steel Doors, Frames and Windows Section 08100

1.2 Reference Standards

- .1 Latest revision of CAN/CGSB-12.11-M90, Wired Safety Glass
- .2 Latest revision of CAN/CGSB-12.5-M86, Mirrors, Silvered

1.3 Environmental 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.

1.4 Product Handling

- .1 Replace scratched, etched or defective glazing resulting from manufacturing, setting, handling or storage before or during installation.

PART 2 - PRODUCTS

2.1 Materials

- .1 Glazing compound shall be compatible with materials used and in accordance with manufacturer's recommendation.

2.2 Wire Glass

- .1 Wired glass - 6 mm polished georgian (WPG).
- .2 Conforming to latest revision of CAN/CGSB 12.11.

2.3 Interior Glass

- .1 Plain glass 6 mm float glass (PG) (for screens).
- .2 Laminated plate glass, 6 mm clear safety CAN/CGSB-12.13-M91 (TPG) (for doors).

PART 3 - EXECUTION

3.1 Installation

- .1 Install materials in accordance with manufacturer's specifications.
- .2 Ensure that projections have been removed from rebates and that they provide sufficient width and depth for clearances.
- .3 Do not set any glass without glazing beds or gaskets.
- .4 Remove excess glazing compounds or sealants from glass and adjacent surfaces by methods not harmful to the surfaces.

3.2 Breakage and Cleaning

- .1 On completion, remove and replace all broken, cracked or damaged glass in this Division and replace. Touch-up painting. Clean glass of all dirt, putty, etc. Polish it and leave the job in first class condition.

END OF SECTION

09650 - Flooring

PART 1 - GENERAL

1.1 General

- .1 This specification is an integral part of the Contract Documents and shall apply wherever the floor is required to be re-instated after removals or damage due to other work under this contract.

1.2 Work Included

- .1 Supply and install epoxy flooring.

1.3 Related Work

- .1 Concrete finishing.

1.4 Environmental Conditions

- .1 Epoxy Floor: Concrete substrate shall have cured 30 days utilizing a dissipating curing membrane. Concrete finish colour to be determined by Engineer.

1.5 Delivery and Storage

- .1 Material shall be delivered to site and checked by flooring trade for completeness and shipping damage prior to job start.
- .2 Material shall be stored in a dry, enclosed area protected from exposure to moisture. Temperature of storage area shall be maintained between 15 deg. C. and 30 deg. C.

1.6 Special Protection

- .1 For the Epoxy Flooring special protection is required as follows:
 - .1 Work area to be free of all other trades during and for a period of 24 hours after floor installation.
 - .2 The finished floor shall be protected from damage by subsequent trades and this shall be the responsibility of the General Contractor.

1.7 Submittals

- .1 Supply one (1) sample of each material to be installed.

1.8 Maintenance Materials

- .1 Provide maintenance manual which gives clear instructions as to the maintenance and care of flooring material.

1.9 Guarantee

- .1 Provide written warranty for the epoxy flooring covering both material and workmanship for a period of one (1) full year from the date of installation.

PART 2 - PRODUCTS

2.1 Materials

- .1 Epoxy Floor: Caphard HPC as distributed by High Performance Engineered Coatings Ltd. or approved equal.
- .2 Cleaner: neutral compound that will not damage flooring or affect its colour.
- .3 Colour to match existing floor and shall be approved by Engineer.

PART 3 - EXECUTION

3.1 Examination

- .1 Before proceeding, examine surface material carefully. Fill any small holes and cracks. DO NOT PROCEED if the base surface is unacceptable and cannot be made good.
- .2 For the epoxy flooring, special preparations are required as follows:
 - .1 Mechanical - shall include use of scabbier, scarifier or shot blast machine for surface removal and etching.
 - .2 Chemical - shall include a thorough scrubbing using manufacture's special purpose detergent and acid etching to remove any laitance and open concrete pores.

3.2 Surface Priming

- .1 For the epoxy flooring, all properly prepared substrates shall be primed using appropriate manufacturer's penetrating primers with strict adherence to application instructions.

3.3 Installation

- .1 Epoxy Flooring - floor installation shall strictly adhere to the manufacturer's written instructions and directions.

END OF SECTION

09915 – Painting & Finishing (*As Applicable*)

PART 1 - GENERAL

1.1 Work Included

- .1 Supply and install:
 - .1 Painting to interior walls and floor (where applicable).
 - .2 Staining to wood trim.
 - .3 Painting of doors and frame.
 - .4 Painting to exposed mechanical and electrical equipment in finished rooms.
 - .5 Painting to pipe.

1.2 Related Work Specified Elsewhere

- .1 Mechanical General Provisions: Section 15010
- .2 Process Piping & Control Devices: Section 15400

1.3 Reference Standards

- .1 Do work in accordance with CAN/ULC-S705.2 and the Canadian Painting Contractors Association “Architectural Painting Specification Manual”.

1.4 Submittals

- .1 Submit colour samples and product data sheets for approval.

1.5 Additional Materials

- .1 Leave on the premises for touch-up a sufficient quantity of all colours and paint types. In any case not less than 1 litre.
- .2 Containers shall be full, tightly sealed and clearly labelled for identification.

1.6 Measurement for Payment

- .1 Payment for surface preparation and painting will not be made directly but shall be included in the lump sum price bid.

PART 2 - PRODUCTS

2.1 Concrete Floors and Housekeeping Pads

- .1 100 percent solids grey epoxy, chemically resistant, high abrasion resistance, low odour complete with non-slip finish. Acceptable product: Sikafloor - 261 as distributed by Sika or approved equal.

2.2 Interior Painted Wood

- .1 First Coat Enamel Undercoat (Sherwin Williams, Dulux or Benjamin Moore).
- .2 Two Coats Latex Semi-gloss (Sherwin Williams, Dulux or Benjamin Moore).

2.3 Interior Concrete Blocks

- .1 First Coat: Latex Block Filler (Sherwin Williams, Dulux or Benjamin Moore).
- .2 Finish Coats: Latex Semi-Gloss (Sherwin Williams, Dulux or Benjamin Moore).
- .3 Washroom & Shower Areas: First Coat: Latex Block Filler. Intermediate Coat: High Build Epoxy Undercoat 11 mils wet, 6 mils dry. Finish Coat Polyamide Epoxy Gloss 4 mils wet, 2 mils dry (Sherwin Williams, Dulux or Benjamin Moore).

2.4 Interior Painted Plain Steel

- .1 First Coat: Kormate Metal Primer (Sherwin Williams, Dulux or Benjamin Moore).
- .2 Finish Coats: Alkyd (Sherwin Williams, Dulux or Benjamin Moore).

2.5 Exterior Painted Galvanized Steel

- .1 First Coat: Galvanized Metal Primer (Sherwin Williams, Dulux or Benjamin Moore).
- .2 Finish Coats: Gloss Alkyd (Sherwin Williams, Dulux or Benjamin Moore).

2.6 Piping, Valves and Tanks in Buildings, Chambers and Pumping Stations

- .1 Galvanized pipe:
 - .1 Two coats 182 Series Coronado Direct to Metal Acrylic Enamel 4-5 mils wet, 1.6 to 2 mils dry per coat.

.2 Ferrous metal surfaces:

- .1 One coat 180-11 Coronado High Performance Rust Inhibiting Primer 4- 5 mils wet, 1.6 to 2 mils dry. Two coats 182 Series Coronado Direct to Metal Acrylic Enamel 4-5 mils wet, 1.6 to 2 mils dry per coat.

.3 Ductile iron pipe and bituminous coated fittings:

- .1 One coat 142-11 Amine Adduct Water Based Epoxy Primer 3.5 mils wet, 1.5 mils dry.
- .2 One coat 142 Amine Adduct Water Based Epoxy 4 mils wet, 1.8 mils dry.

.4 Piping in potable water reservoirs to be painted with non-toxic paint suitable for use with potable water meeting the requirements of NSF- 61.

2.7 Colour Code

- .1 Water Pipes - as specified in Section 3.8.
- .2 Interior Concrete Floor – Light Grey (or as per existing floor colour).
- .3 Interior Walls – Light Grey (or as per existing wall colour).
- .4 Ceiling – White.

PART 3 - EXECUTION

3.1 General

- .1 Paint all building surfaces, piping, fittings and equipment as directed.
- .2 Touch up shop applied finishes damaged during installation.
- .3 Apply finish coats to shop primed equipment.

3.2 Preparation of Wood Surfaces

- .1 Ensure all joints are sanded smooth.
- .2 Ensure all surfaces are clean and dry.

3.3 Preparation of Concrete Floors and Housekeeping Pads

- .1 Acid Etch (only required on new concrete surfaces).
- .2 Sand smooth old paint surfaces to allow adherence of new paint.
- .3 Clean and dry all surfaces with approved cleaning agent prior to painting.

3.4 Preparation of Equipment, Piping, Fittings and Valves

- .1 Commercial cleaning.
- .2 Sand smooth old paint surfaces to allow adherence of new paint.
- .3 Drain water from vessels to prevent condensation whenever possible.

3.5 Protection of Surfaces

- .1 Protect surfaces not to be painted and if damaged, clean and restore such surfaces as directed.
- .2 Apply primer, paint, or pre-treatment as soon as possible after surface has been cleaned and before deterioration of surface occurs.
- .3 If rusting occurs after completion of surface preparation, clean surfaces again.
- .4 Prevent contamination of cleaned surfaces by salts, acids, alkalids, other corrosive chemicals, grease, oil and solvents before prime coat is applied and between applications of remaining coats of paint. Remove contaminants from surface and apply paint immediately.
- .5 Protect cleaned and freshly painted surfaces from excessive dust.

3.6 Mixing Paint

- .1 Do not dilute or thin paint for brush application; use as received from manufacturer.
- .2 Mix ingredients in container before use and ensure breaking up of lumps, complete dispersion of settled pigment, and a uniform composition.
- .3 Mix paint often enough during application to keep pigment in suspension and composition uniform.
- .4 Do not mix or keep paint in suspension by means of air bubbling through paint.

- .5 Thin paint for spraying according to manufacturer's instructions. If directions are not on container, obtain instructions in writing from the manufacturer and provide a copy of instructions to Engineer.

3.7 Applying Paint

- .1 Apply paint by brushing, spraying or a combination of both. Use sheepskins or daubers only when no other method is practical in places of difficult access.
- .2 Use dipping or roller coating method of application only when specifically authorized by Engineer in writing.
- .3 Caulk open seams at contact surfaces of built up members with red lead paste, or other approved material. Apply second coat of primer to caulked areas.
- .4 Where surface to be painted is not under cover, do not apply paint when:
 - .1 Air temperature is below 5°C or when temperature is expected to drop to 0°C before paint has dried.
 - .2 Temperature of surface is over 50°C unless paint is specifically formulated for application at high temperatures.
 - .3 Fog or mist occur at site; it is raining or snowing; there is a danger of rain or snow; relative humidity is above 85%.
 - .4 Surface to be painted is wet, damp or frosted.
 - .5 Previous coats are not dry.
- .5 When paint must be applied in damp or cold weather apply paint under cover. Protect, shelter, or heat surface and surrounding air to comply with temperature and humidity conditions specified in Section 3.7.4. Protect until paint is dry or until weather conditions permit.
- .6 Permit drying of applied paint which has been exposed to freezing, excess humidity, rain, snow or condensation. Remove paint from damaged areas, prepare surface again and repaint same as undamaged areas.
- .7 Apply each coat of paint as a continuous film of uniform thickness. Repaint thin spots or bare areas before next coat of paint is applied.

.8 Brush application:

- .1 Work paint into cracks, crevices and corners and paint surfaces not accessible to brushes by spray, daubers or sheepskins.
- .2 Brush out runs and sags.
- .3 Leave a minimum of brush marks in finished paint surfaces.
- .4 Remove runs and sags from finished work and repaint.

.9 Spray Application:

- .1 Provide and maintain equipment that is suitable for intended purpose, capable of properly atomizing paint to be applied, and equipped with suitable pressure regulators and gauges.
- .2 Provide traps or separators to remove oil and water from compressed air and drain periodically during operations.
- .3 Keep paint ingredients properly mixed in spray pots or containers during paint application either by continuous mechanical agitation or by intermittent agitation as frequently as necessary.
- .4 Apply paint in a uniform layer, with overlapping at edges of spray pattern.
- .5 Brush out immediately all runs and sags.
- .6 Use brushes to work paint into cracks, crevices and places which are not adequately painted by spray. In areas not accessible to spray gun, use brushes, daubers or sheepskins.
- .7 Remove runs and sags from finished work and repaint.

.10 Shop painting:

- .1 Do shop painting after fabrication and before any damage to surface occurs from weather or other exposure.
- .2 Spray paint contact surfaces of field assembled, bolted, friction type joints with primer coat only. Do not brush primer after spraying.
- .3 Do not paint metal surfaces which will be embedded in concrete.

- .4 Paint metal surfaces to be in contact with wood with either full paint coats specified or three shop coats of specified primer.
- .5 Do not paint metal within 50 mm of edge to be welded. Give unprotected steel one coat of boiled linseed oil or other approved protective coating after shop fabrication is completed.
- .6 Remove weld spatter before painting. Remove weld slag and flux.
- .11 Field Painting:
 - .1 Paint steel structures as soon as possible.
 - .2 Touch up metal which has been shop coated with same type of paint and to same thickness as shop coat. This touch-up to include cleaning and painting of field connections, welds, rivets, nuts, washers, bolts and damaged or defective paint and rusted areas.
 - .3 Field paint surfaces (other than joint contact surfaces) which are accessible before erection, but which will not be accessible after erection.
 - .4 If possible do not apply final coat of paint until concrete work is completed. If concreting or other operations damage any paint, clean and repaint damaged area. Remove concrete spatter and droppings before paint is applied.
 - .5 Where painting does not meet with requirements of specifications, and when so directed by Engineer, remove all defective paint, thoroughly clean affected surfaces and repaint in accordance with these specifications.

3.8 Pipe Identification System

- .1 All piping shall be identified and painted in accordance with the following requirements:
 - .1 Flammable: For piping systems containing flammable gases or liquids
 - .1 Gasoline, fuel oil, digester gas, acetylene, propane, etc.
 - .2 Colour: Yellow-Orange; Canadian General Standards Board (CGSB) 508-103, plus identification labels consisting of black lettering and arrows on a yellow-orange background.
 - .3 Method: Complete painting of all piping, valves and fittings plus labelling every linear 3 meters maximum identifying the contents and the

direction of flow (comply with Occupational Health and Safety Act (OHSA) 66(1)(a), (b) and (c).

.2 Firefighting: For piping system containing firefighting substances:

- .1 Water, carbon dioxide, etc.
- .2 Colour: Red; CGSB 509-102 plus identification labels consisting of white lettering and arrows on a red background.
- .3 Method: Identical to piping systems containing flammable gases or liquids.

.3 Dangerous Substances: For other piping systems containing dangerous (highly hazardous) substances:

- .1 Chlorine gas, fluosilicic acid, other concentrated acids or caustics, etc. - i.e. - strongly corrosive, strongly toxic, temperature greater than 80°C (175°F) including steam, pressure greater than 700 kPa (100 psi).
- .2 Colour: Yellow; CGSB 505-110 plus identification labels consisting of black lettering and arrows on a yellow background.
- .3 Method: Identical to piping systems containing flammable gases or liquids.

.4 Other Chemical Substances: For other piping systems containing chemical substances (not highly dangerous):

- .1 Chlorine solutions, sodium hypochlorite, alum, polyelectrdolytes, lime solutions, fluoride solutions, etc. - i.e. - mildly corrosive, mildly toxic, temperature less than 80°C (175°F), pressure less than 700 kPa (100 psi).
- .2 Colour: Neutral or Background (colour of wall); identification labels consisting of black lettering and arrows on a white background.
- .3 Method: Label every 10 meters maximum identifying the contents and the direction of flow (comply with OHSA 66(1)(a), (b) and (c) - i.e. - colour coded painting or banding not required, only labelling to identify contents and direction.

- .5 Process & Drainage: For process and drainage, etc., piping systems, one colour for water being protected, one for sludges and one for other water and drainage systems. Within each group colour gradations to reflect the degree of contamination, as follows:

Description of Contents	Colour	CGSB Code
Raw Water	Dark Blue	502-103
Settled Water	Mid Blue	502-208
Finished or Potable Water	Light Blue	502-106
Raw Sewage, Sanitary Waste	Mid Grey	501-103
Non-potable Water (heating system), drainage, effluent water, final effluent	Light Grey	501-108

Method: Identical to piping systems containing flammable gases and liquids except labelling should occur at 10-meter rather than 3-meter intervals and should consist of white lettering and arrows on a background colour which matches the colour code for the pipe.

- .6 Identification Labels: For simplicity, identification labels can be purchased with the standard CGSB background colours and paint can be purchased locally to match a sample of the identification label.

There are several types of identification label materials available. The pipe size, material of pipe and/or insulation surface, working temperature range and environment (indoors, outdoors, etc.) lettering and arrow size should be specified when ordering labels.

Pipe/Label Letter Sizes

Outside Pipe Diameter	Letter Size
Less than or equal to 25 mm	12 mm
Greater than 25 mm – less than 100 mm	25 mm
Equal or greater than 100 mm	50 mm

It is suggested that lettering and arrows be on separate labels. Examples of identification labels available are:

- .1 Vinyl Cloth - General purpose pressure sensitive adhesive of high tensile strength - service temperature -40°C to 60°C.
- .2 Perma-Code Markers - for problem pipes - insulated or rough surface - pressure sensitive - thin film - conformable - temperature -40° to 100°C.
- .3 Pressure Sensitive Film - printed with weather resistant inks for outdoor durability - temperature -40° to 80°C.

The above identification labels are available from W.H. Brady Inc. (labels from other suppliers should be of equal quality).

END OF SECTION

10999 – Manufactured Specialties

PART 1 - GENERAL

1.1 General

- .1 The specifications are an integral part of the Contract Documents.

1.2 Work Included

- .1 Include all miscellaneous specialties listed below for installation by Section 06100.

1.3 Related Work by Others

- .1 Provision of backing for fastening purposes by Section 06100.

PART 2 - PRODUCTS

2.1 Fire Extinguishers

- .1 Include Type ABC dry chemical fire extinguishers bearing ULC labels. Size and locate as directed by local Fire Marshall as per NFPA 10.
 - .1 Over 18 kg – top of extinguisher not more than 1000mm off floor.
 - .2 Under 18 kg – top of extinguisher not more than 1500mm off floor.
 - .3 Supply and mount one (1) fire extinguisher for each room.
 - .4 Supply and mount one (1) fire extinguisher by each exterior door.

PART 3 - EXECUTION

3.1 Installation

- .1 Erect in accordance with manufacturer's instructions.

END OF SECTION

General Mechanical Requirements

1 GENERAL

1.1 Description

- .1 This Section covers items common to all sections of Division 15. This section supplements Division 1 – General Requirements.
- .2 In case of a discrepancy between statement(s) or value(s) in this section or contract drawing(s), the higher statement or value takes precedence and shall govern.

1.2 Related Work Specified Elsewhere

- .1 Applicable Sections of Division 15 and 16.

1.3 Definitions

- .1 The following are definitions of terms and expressions used in the documents:
 - .1 “Indicated” means as shown on contract drawings or noted in contract documents.
 - .2 “Provide” means fabricate, supply, install, test and commission the mechanical system, device and/or equipment.
 - .3 “Remove” or “Removal” means to disconnect, remove and dispose, including paying for any disposal costs.

1.4 Equipment Requirements and Installation

- .1 Drawings indicate only the general location of mechanical work. Except where definite locating dimensions are given, Contractor shall be responsible for the layout of all mechanical work to ensure a fully operational system.
- .2 Make any changes required to mechanical work in order to accommodate structural conditions.
- .3 Install all mechanical work to conserve head room and to interfere as little as possible with free working area.
- .4 Permit equipment maintenance and disassembly by use of unions, mechanical couplings or flanges to minimize disturbance to connecting

pipings and duct systems and without interference from building structure or other equipment.

- .5 Provide accessible means for lubricating equipment including permanent lubricated "lifetime" bearings.
- .6 Line-up equipment with building walls wherever possible.
- .7 Supply anchor bolts and templates for installation by other divisions.

1.5 Permits, Fees and Inspection

- .1 Submit drawings and specifications to the Authority Having Jurisdiction to obtain all required mechanical permits.
- .2 Coordinate and schedule all requirements for inspection with Authority Having Jurisdiction. Contractor is responsible for arranging multiple inspections (as required) to ensure the work has been properly inspected at the completion of the project.
- .3 Provide all licenses, permits and certificates required by the Authority Having Jurisdiction at no additional expense.
- .4 Arrange and pay for inspection(s) of the Works by the Authority Having Jurisdiction.
- .5 Contractor to keep a separate "logbook" related to the Mechanical inspections. Contractor must record inspector's name, date, and scope of inspections, recording all statements, decisions and permissions made during each inspection visit. Contractor to notify Engineer of any changes required by the Authority Having Jurisdiction prior to making any changes. Submit the logbook to the Engineer at the completion of the project.
- .6 Upon completion of the Work, provide the Engineer with final, unconditional certificates of approval by the local Authorities.

1.6 Examination of the Site and Contract Documents

- .1 Examine all drawings and specifications of the complete Project and become familiar with all local site conditions.
- .2 Submission of Tender confirms the Contractor accepts the Contract and site conditions without qualifications.
- .3 Failure to determine the existing conditions or the nature of the construction shall not be a basis for granting compensation.

1.7 Construction Drawings

- .1 Do not scale drawings unless a scale is identified. Confirm all measurements and distances with actual site conditions.
- .2 Review the location of panels, pumps, vents, piping and other equipment shown in the drawings with Engineer before proceeding with the installation. Inform the Engineer of significant changes in location of equipment to meet field conditions and receive their authorization before proceeding. Obtain from the Engineer the location of equipment not identified on the drawings.
- .3 Locations of panels, pumps, vents, piping and other equipment indicated in the drawings are approximate and may be subject to revision found necessary or desirable by the Engineer at the time the work is installed. The Engineer may at their discretion request the relocation of mechanical equipment within three metres of that shown prior to roughing in. This relocation shall be at no additional cost to the contract.
- .4 Contractor to review equipment layout with Engineer prior to installation.

1.8 Shop Drawings

- .1 Submit shop drawings in accordance with general Contract Conditions and include arrangement drawings, bill of materials, diagrams, nameplate drawings and product data as applicable.
- .2 Submittal Procedure:
 - .1 The Contractor shall submit digital copies in pdf format to the Owner and Engineer via email. All drawings are to be submitted electronically in pdf format.
 - .2 The drawings will be returned to the Contractor stamped and marked "NON-CONFORMING - REVISE & RESUBMIT", "CONFORMS WITH INTENDED DESIGN WITH REVISIONS NOTED" OR "CONFORMS WITH INTENDED DESIGN".
 - .3 When drawings are returned "NON-CONFORMING - REVISE & RESUBMIT", make the necessary alterations and resubmit.
 - .4 When drawings are returned "CONFORMS WITH INTENDED DESIGN WITH REVISIONS NOTED", the drawings may be used to execute the work in compliance with the Contract Documents. No other alterations are to be made to the drawings by the Contractor

subsequent to receipt of drawings stamped and marked as above. If further changes are made in addition to the Engineer's notations, then the drawings must be resubmitted for further review.

- .5 When drawings are returned "CONFORMS WITH INTENDED DESIGN", the Contractor shall be responsible for distribution of additional copies of Shop Drawings as necessary and as requested by the Engineer.
- .3 Shop drawings shall provide all necessary details and information:
 - .1 To allow Engineer to assess that the equipment is in accordance with the Contract requirements;
 - .2 To be suitable for binding into the operations and maintenance manuals; and
 - .3 To be stamped and signed by the Contractor, thereby indicating that they have checked that the equipment offered conforms to the requirements of the Contract Documents.
- .4 Product data sheets shall include the name of the manufacturer and be clearly marked to show which items, features and options are offered.
- .5 Shop drawings that are not presented as required will be returned for revision and resubmission.
- .6 The review of shop drawings by the Engineer does not relieve the Contractor of their responsibilities for compliance with the Contract Documents.

1.9 Record Drawings

- .1 Before commencing work, obtain two sets of mechanical drawings for showing "As Built" conditions. As the job progresses, mark on the field set of prints to indicate accurately all installed work. At completion of project, manually transfer all information onto the second set of drawings using red marker/pen and indicate "Contractors Certified Approval of Accuracy" before submitting to Engineer for review and record use.
- .2 Ensure that the latest issue drawings are marked up to reflect the work as installed and have these available for the Consultant's review at site.

1.10 Operating and Maintenance Manual

- .1 Produce operating and maintenance manuals for all Division 15 work and submit a preliminary pdf copy for the Engineer's review.
- .2 Submit final approved pdf copy of the operating and maintenance manuals at project completion.

1.11 Delivery, Storage, And Handling

- .1 Packing, shipping, handling, and unloading:
 - .1 Deliver, store and handle in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Waste Management and Disposal: separate waste materials for reuse and recycling.

1.12 Waste Management and Disposal

- .1 Separate and recycle waste materials in accordance with Waste Reduction Work plan.
- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3 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.
- .4 Divert unused metal and wiring materials from landfill to metal recycling facility approved by Owner's Representative.
- .5 Collect, package and store existing unit heaters for either reuse, recycling or rebuilding and return to recycler in accordance with Waste Management Plan.

1.13 Special Tools and Spare Parts

- .1 Furnish spare parts as follows:
 - .1 Identify spare parts containers as to contents and replacement parts number.
 - .2 Provide one set of special tools required to service equipment as recommended by manufacturers.

1.14 Tests

- .1 Provide the following supplementary requirements to tests specified:
 - .1 Give written 24 hr. notice of date when tests will be performed.
 - .2 Where possible, do not insulate or conceal work until tested and approved. Follow construction schedule and arrange for tests.
 - .3 Conduct tests in presence of Engineer.
 - .4 Pay all costs to include retesting and making good all components, devices, filters and equipment.
 - .5 Pay all costs for manufacturer's representatives of specialists required to perform tests.

1.15 Measurement for Payment

- .1 No measurement for payment will be made under this section.

1.16 Basis of Payment

- .1 All labour, materials and equipment necessary for the work in this Section shall be included in the lump sum prices in the Schedule of Items and Prices.

2 PRODUCTS

2.1 General Welding

- .1 All general welding shall be completed by welders certified by the Canadian Welding Bureau.
- .2 All pressure piping and vessel welding shall be completed by welders certified by ASME Section 9.

2.2 General Nuts and Bolts

- .1 All nuts and bolts, unless otherwise noted, shall be hex head machined to ASTM A307-78 American Heavy Series.
- .2 All nuts and bolts, unless otherwise noted, shall be grade 2 U.N.C. zinc or cad plated.
- .3 For submerged locations, all nuts and bolts shall be stainless steel conforming to ANSI B18-2-1, 1965 and B18-2-2, 1986.

2.3 Control Wiring

- .1 Complete all low voltage, (under 50 volts), control wiring for systems specified in Division 15.
- .2 Wiring, devices, boxes, conduit, and methods used shall comply with the requirements of the Ontario Electrical Safety Code, and be CSA certified.
- .3 Coordinate conduit installation with electrical contractor and the requirements of Division 16.

2.4 Cutting and Remedial Work

- .1 Cutting and remedial work is specified in OPSS.
- .2 Assume full responsibility for laying out mechanical work and for any damage caused by incorrectly located equipment and mechanical services.
- .3 Where sleeves or openings are installed in walls or partitions to accommodate ducts or mains, provide all necessary sealant and fire-resistant materials to restore the installation to its original fire rating to the satisfaction of the Building Code, governing authorities and the Owner's insurance underwriters. Work To be completed by authorized fireproofing contractor.
- .4 Pay all costs for cutting and patching resulting from failure to co-ordinate timely installation of mechanical inserts, sleeves, etc., into masonry structures.

2.5 Painting

- .1 Paint all equipment, supports, piping, valves, ductwork, etc., with finish painting system.
- .2 Apply at least one coat of corrosion resistant primer paint to ferrous supports and site fabricated work.
- .3 Prime and touch up marred finished paint work to match original.
- .4 Restore to new condition, finishes which have been damaged too extensively to be merely primed and touched up.

2.6 Equipment, Piping and Valving Identification

- .1 For all equipment supplied under this Division provide lamicoid identification labels or nameplates.

- .2 Labels shall be installed after all painting has been completed and shall be secured with self-tapping screws or self-adhesive.
- .3 Ensure that all stamped, etched or engraved lettering on plates is perfectly legible. Do not paint over nameplates and where apparatus is to be concealed attach the nameplate in an approved location on the equipment support or frame.
- .4 Identify all equipment with the corresponding remote controls overlaps.
- .5 Reference tag numbers as shown on drawings on all equipment.
- .6 Wording on nameplates and piping to be approved by Engineer prior to manufacture.
- .7 Identification to be English.
- .8 Identify equipment with nameplates as follows:
 - .1 Lamicoid 3 mm thick plastic engraving sheet, black face, white core, self-adhesive or mechanically attached unless specified otherwise, or otherwise required by applicable codes.
 - .2 Nameplate sizes:

Nameplate Sizes		
Size 1	10 x 50 mm	1 line 3 mm high letters
Size 2	12 x 70 mm	1 line 5 mm high letters
Size 3	12 x 70 mm	2 lines 3 mm high letters
Size 4	20 x 90 mm	1 line 8 mm high letters
Size 5	20 x 90 mm	2 lines 5 mm high letters
Size 6	25 x 100 mm	1 line 12 mm high letters
Size 7	25 x 100 mm	2 lines 6 mm high letters

- .9 Identify all piping with lettering as follows:
 - .1 Provide flow direction arrows with labelling identifying liquid/gas conveyed. Use double headed arrows where flow is reversible.
 - .2 Use capital letter as follows:

Pipe Outside Diameter	Letter Height

30 mm	13 mm
30 - 100 inches	19 mm
150 inches	32 mm
> 150 inches	50 mm

- .3 All labelling colors shall be in accordance with the Guidelines for the Design of Water Treatment Works, April 1982, MOE, and CSA and C.G.S.B. Standards.
- .4 For fuel oil lines, all labels shall be in accordance with latest edition of B139 Series 19, Installation of Oil-Burning Equipment, including amendments issued by TSSA.

2.7 Firestopping

- .1 Unless noted otherwise "F" and "T" ratings are required.
- .2 Systems shall be asbestos free and maintain an effective barrier against flame, smoke, and gases in accordance with CAN4 S115 and shall not exceed opening sizes for which they are intended.
- .3 Firestopping and smoke seals at openings around mechanical services shall be an elastomeric seal for sound and vibration control.
- .4 Fire resistance rating of firestopping assembly shall not be less than the fire resistance rating of surrounding floor or wall assembly.
- .5 Service penetration assemblies shall be ULC certified in accordance with CAN4 S115 and listed in ULC Guide No. 40 U19.
- .6 Service penetration firestop components shall be ULC certified in accordance with CAN4 S115 and listed in ULC Guide No. 40 U19.13 and ULC Guide No. 40 U19.15.
- .7 Firestopping and smoke seals shall be by Hilti, Tremco/Royal Quickstop, STI Firestop or 3M.
- .8 Firestop products shall be mold and mildew resistant.

3 INSTALLATION

3.1 Firestopping

- .1 Firestopping and smoke seal material and components shall be installed in accordance with the ULC Listing and manufacturers instructions. Examine

the sizes and conditions of the cavities to be filled to determine the correct thicknesses and installation of materials. All substrates and surfaces in contact with firestopping materials shall be dry and prepared in accordance with the Manufacturers instructions at appropriate ambient conditions.

3.2 Workmanship

- .1 Install all equipment in accordance with manufacturer's instructions, and to codes and regulations of Authorities Having Jurisdiction.
- .2 Provide Engineer written report of commissioning test results.
- .3 Coordinate dimensions of all piping steps/platforms with Engineer during construction.
- .4 Provide painting of all pipes, as outlines above, and prior to Substantial Performance is approved.
- .5 Containment areas: clean all surfaces prior to applying sealant, and allow drying time as per manufacturer's instructions before installing new equipment.

END OF SECTION

Submission Log

Item	Reviewed By	Review Status	Date Received	Date Returned	Comments
Section 15010 - General Mechanical Requirements					
Record Drawings					
Section 15027 - Plumbing Piping Insulation					
Pipe Insulation					
Section 15028 - Hot Water Tank					
Hot Water Tank, HWT-1					
Section 15031 - Plumbing Specialties and Accessories					
Expansion Tank, EX-1					
Eyewash, EW-1					
Backflow Preventer, BFP-1					
Pressure Reducing Valve, PRV-1					
Electronic Trap Seal Primer, TSP-1					
Section 15509 - Dampers - Operating					
Motorized Damper, MD-1aa					
Motorized Damper, MD-1ab					
Motorized Damper, MD-1b					
Motorized Damper, MD-2a					
Motorized Damper, MD-2b					
Section 15510 - Louvres					
Louvre, LV-1aa					
Louvre, LV-1ab					
Louvre, LV-2					

Item	Reviewed By	Review Status	Date Received	Date Returned	Comments
Section 15522 - Upblast Exhaust Fan					
Exhaust Fan, EF-1					
Exhaust Fan, EF-2					
Section 15530 - Testing, Adjusting and Balancing					
Air Balancing Report					

Review Status: C Conforms with Intended Design
 CRN Conforms with Intended Design with Revisions Noted
 NCR Non-Conforming - Revise and Resubmit

END OF SECTION

Domestic Water Piping - Copper

1 GENERAL

1.1 General Conditions

- .1 All sections of Division 1 form part of this Specification.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this section.
- .3 All sections of Division 1 to 16 inclusive form part of the Contract Documents. Refer to Section 15010 for General Mechanical Requirements related to this work.

1.2 Reference

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers International (ASME).
 - .1 ANSI/ASME B16.15, Cast Bronze Threaded Fittings, Classes 125 and 250.
 - .2 ANSI/ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
 - .3 ANSI/ASME B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
 - .4 ANSI/ASME B16.24, Cast Copper Alloy Pipe Flanges and Flanged Fittings, Class 150, 300, 400, 600, 900, 1500 and 2500.
- .2 American National Standards Institute/National Sanitation Foundation (ANSI/NSF).
 - .1 ANSI/NSF 61, Drinking Water System Components.
- .3 American Society for Testing and Materials International (ASTM).
 - .1 ASTM A 307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .2 ASTM B32, Standard Specification for Solder Metal.
 - .3 ASTM B 88M, Standard Specification for Seamless Copper Water Tube (Metric).
- .4 American Water Works Association (AWWA).

- .1 AWWA C111, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- .2 AWWA C606, Grooved and Shouldered Joints.
- .5 Canadian Standards Association (CSA International).
 - .1 CSA B242, Groove and Shoulder Type Mechanical Pipe Couplings.
- .6 Department of Justice Canada (Jus).
 - .1 Canadian Environmental Protection Act (CEPA).
- .7 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
 - .1 Material Safety Data Sheets (MSDS).
- .8 Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS).
 - .1 MSS-SP-67, Butterfly Valves.
 - .2 MSS-SP-70, Cast Iron Gate Valves, Flanged and Threaded Ends.
 - .3 MSS-SP-71, Cast Iron Swing Check Valves, Flanged and Threaded Ends.
 - .4 MSS-SP-80, Bronze Gate, Globe, Angle and Check Valves.
- .9 National Research Council (NRC)/Institute for Research in Construction.
 - .1 NRCC 38728, National Plumbing Code of Canada (NPC).
- .10 Transport Canada (TC).
 - .1 Transportation of Dangerous Goods Act (TDGA).

1.3 Warranty

- .1 Provide a written guarantee, signed and issued in the name of the owner, against defective materials and workmanship for a period of one (1) year from the date of Substantial Completion.

1.4 Measurement for Payment

- .1 No measurement for payment will be made under this section.

1.5 Basis of Payment

- .1 All labour, materials and equipment necessary for the work in this Section shall be included in the lump sum prices in the Schedule of Items and Prices.

1.6 Quality Assurance

- .1 Health and Safety Requirements: do construction occupational health and safety in accordance with- Health and Safety Requirements.

2 PRODUCTS

2.1 General

- .1 All components used in the domestic water piping systems including fittings and valves shall bear a CSA certification marking.

2.2 Piping

- .1 Domestic hot, cold and recirculation systems, within building.
 - .1 Above ground: copper tube, hard drawn, type L: to ASTM B88.
 - .2 Buried or embedded: copper tube, soft annealed, type K: to ASTM B88, in long lengths and with no buried joints.

2.3 Fittings

- .1 Bronze pipe flanges and flanged fittings, Class 150 and 300: to ANSI/ASME B16.24.
- .2 Cast bronze threaded fittings, Class 125 and 250: to ANSI/ASME B16.15.
- .3 Cast copper, solder type: to ANSI/ASME B16.18.
- .4 Wrought copper and copper alloy, solder type: to ANSI/ASME B16.22.
- .5 NPS2 and larger: roll grooved to CSA B242. Cast bronze to ANSI/ASME B16.18 or wrought copper ANSI/ASME B16.22.
 - .1 Fittings to be manufactured to copper-tube dimensions. Flaring of tube or fitting ends to accommodate IPS sized couplings is not permitted.
- .6 NPS 1 ½ and under: Cast copper, ANSI/ASME B16.18 or wrought copper, ANSI/ASME B16.22; with 301 stainless steel internal components, EPDM seal, and push-to-connect or press fit joints, for hard drawn copper tube type L or K, rated for 1300 kPa at ASTM B88.

2.4 Joints

- .1 Rubber gaskets, latex-free, 1.6 mm thick: to ANSI/AWWA C111.
- .2 Bolts, nuts, hex head and washers: to ASTM A307, heavy series.
- .3 Solders for solder joint fittings shall conform to ASTM B32, "Solder Metal" in accordance with the recommended use.
- .4 Solders and fluxes having a lead content in excess of 0.2 per cent shall not be used in a potable water system.
- .5 Push-to-connect: EPDM gasket, UL classified in accordance with ANSI/NSF 61 for potable water service.
- .6 Teflon tape: for threaded joints.
- .7 Grooved couplings: designed with angle bolt pads to provide rigid joint, complete with EPDM flush seal gasket. Gasket to be classified in accordance with ANSI/NSF 61 for potable water service. Couplings to be manufactured to copper-tube dimensions. Flaring of tube or fitting ends to accommodate IPS sized couplings is not permitted.
- .8 Dielectric connections between dissimilar metals: dielectric fitting to ASTM F492, complete with thermoplastic liner.

2.5 Gate Valves

- .1 NPS 2 and under, soldered:
 - .1 Rising stem: to MSS-SP-80, Class 150, bronze body, screw-in bonnet, solid wedge disc.

2.6 Globe Valves

- .1 NPS 2 and under, soldered:
 - .1 To MSS-SP-80, Class 150, bronze body, renewable composition disc, screwed over bonnet.

2.7 Swing Check Valves

- .1 NPS 2 and under, soldered:
 - .1 To MSS-SP-80, Class 150, bronze body, bronze swing disc, screw in cap, re-grindable seat.

2.8 Ball Valves

- .1 NPS 2 and under:
 - .1 ANSI/ASME B16.18, Class 150.
 - .2 Bronze body, stainless steel ball, PTFE adjustable packing, brass gland and PTFE seat, steel lever handle.

3 EXECUTION

3.1 Installation

- .1 Install in accordance with Ontario Building Code and local authority having jurisdiction.
- .2 Assemble piping using fittings manufactured to ANSI standards and Standard Council of Canada (SCC) standards.
- .3 Grooved joint couplings and fittings to be installed in accordance with the manufacturer's written installation instructions. Grooved ends to be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Gaskets to be verified as suitable for the intended service prior to installation. Gaskets to be molded and produced by the coupling manufacturer. The grooved coupling manufacturer's factory trained representative to provide on-site training for Contractor's field personnel in the use of grooving tools, application of groove, and installation of grooved joint products. The manufacturer's representative to periodically visit the jobsite and review installation. Contractor to remove and replace any joints deemed improperly installed.
- .4 Push-to Connect Piping: Prepare copper tube and install in strict accordance with installation instructions. Pipe ends to be cleaned, free from indentations, projections, burrs, and foreign matter. Use a tube preparation tool to clean and make installation mark. Push copper tube into fittings to installation depth mark, per installation instructions. Keep fittings free of dirt and oil.
- .5 Install CWS piping below and away from HWS and HWR and other hot piping so as to maintain temperature of cold water as low as possible.
- .6 Connect to fixtures and equipment in accordance with manufacturer's written instructions unless otherwise indicated.
- .7 Buried Tubing

- .1 Lay in well compacted washed sand in accordance with AWWA Class B bedding.
- .2 Bend tubing without crimping or constriction. Minimize use of fittings.

3.2 Valves

- .1 Isolate equipment, fixtures and branches with butterfly or ball valves.
- .2 Balance recirculation system using lockshield globe valves. Mark settings and record on as-built drawings on completion.

3.3 Pressure Tests

- .1 Water test pressure: withstanding without leakage a water pressure that is at least 1,000 kPa (145 PSig) for at least 1 hour.
- .2 Potable water shall be used to test a potable water system.
- .3 Isolate equipment where water test pressure exceeds equipment pressure rating.

3.4 Flushing and Cleaning

- .1 Flush entire system for 8 h. Ensure outlets flushed for 2 h. Let stand for 24 h, then draw one sample off longest run. Submit to testing laboratory for bacteriological testing to verify that system is clean to Provincial potable water guidelines. Let system flush for additional 2 h, then draw off another sample for testing.

3.5 Pre-Start-Up Inspections

- .1 Systems to be complete, prior to flushing, testing and start-up.
- .2 Verify that system can be completely drained.
- .3 Ensure that pressure booster systems are operating properly.
- .4 Ensure that air chambers, expansion compensators are installed properly.

3.6 Disinfection

- .1 Flush out, disinfect and rinse system to requirements of authority having jurisdiction and approval of Owner's Representative.

3.7 Start-Up

- .1 Timing: Start up after:
 - .1 Pressure tests have been completed.
 - .2 Disinfection procedures have been completed.
 - .3 Water treatment systems operational.
- .2 Provide continuous supervision during start-up.
- .3 Start-up procedures:
 - .1 Establish circulation and ensure that air is eliminated.
 - .2 Check pressurization to ensure proper operation and to prevent water hammer, flashing and/or cavitation.
 - .3 Bring domestic hot water heater storage tank up to design temperature slowly.
 - .4 Monitor domestic hot water supply and domestic hot water recirculation piping systems for freedom of movement, pipe expansion as designed.
 - .5 Check control, limit, safety devices for normal and safe operation.
- .4 Rectify start-up deficiencies.

3.8 Performance Verification

- .1 Timing:
 - .1 After pressure and leakage tests and disinfection completed, and certificate of completion has been issued by authority having jurisdiction.
- .2 Procedures:
 - .1 Adjust pressure regulating valves while withdrawal is maximum and inlet pressure is minimum.
 - .2 Sterilize domestic hot water supply and domestic hot water recirculation piping systems for Legionella control.
 - .3 Verify performance of temperature controls.
 - .4 Verify compliance with safety and health requirements.

- .5 Check for proper operation of water hammer arrestors. Run one outlet for 10 seconds, then shut off water immediately. If water hammer occurs, replace water hammer arrestor or re-charge air chambers. Repeat for outlets and flush valves.
- .6 Confirm water quality consistent with supply standards, verifying that no residuals remain as a result of flushing and/or cleaning.

END OF SECTION

Drainage Waste and Vent Piping - Plastic

1 GENERAL

1.1 General Conditions

- .1 All sections of Division 1 form a part of this Specification.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this section.
- .3 All sections of Division 1 to 16 inclusive form part of the Contract Documents. Refer to Section 15010 for General Mechanical Requirements related to this work.

1.2 References

- .1 American Society for Testing and Materials (ASTM)
 - .1 ASTM D2235, Specification for Solvent Cement for Acrylonitrille-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
 - .2 ASTM D2564, Specification for Solvent Cements for Poly(Vinyl-Chloride) (PVC) Plastic Piping Systems.
- .2 Canadian Standards Association (CSA)
 - .1 CAN/CSA-B181.1, ABS Drain, Waste and Vent Pipe and Pipe Fittings.
 - .2 CAN/CSA-B181.2, PVC Drain, Waste and Vent Pipe and Pipe Fittings.
 - .3 CAN/CSA-B182.1, Plastic Drain and Sewer Pipe and Pipe Fittings.
- .3 Underwriters Laboratory of Canada (ULC)
 - .1 CAN/ULC-S102.2 Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies.

1.3 Warranty

- .1 Provide a written guarantee, signed and issued in the name of the owner, against defective materials and workmanship for a period of one (1) year from the date of Substantial Completion.

1.4 Measurement for Payment

- .1 No measurement for payment will be made under this section.

1.5 Basis of Payment

- .1 All labour, materials and equipment necessary for the work in this Section shall be included in the lump sum prices in the Schedule of Items and Prices.

2 PRODUCTS

2.1 Piping and Fittings

- .1 For buried or below grade DWV piping to:
 - .1 CSA B181.1.
 - .2 CSA B181.2.
 - .3 CSA B182.1.
- .2 For aboveground DWV piping:
 - .1 Flame spread rating less than 25 in accordance with CAN/ULC-S102.2.
 - .2 CSA B181.2.
 - .3 Suitable material: IPEX System 15.

2.2 Joints

- .1 Solvent weld for PVC: to ASTM D2564, CSA certified.
 - .1 NPS 1 ½ to 6: one step or two step cement.
 - .2 NPS 8 and above: two step cement.
- .2 Solvent weld for ABS: to ASTM D2235.

3 EXECUTION

3.1 Installation

- .1 Install in accordance with the Ontario Building Code and local authority having jurisdiction.

3.2 Testing

- .1 Pressure test buried systems before backfilling in accordance with the Ontario Building Code.

- .2 Hydraulically test to verify grades and freedom from obstructions.

3.3 Performance Verification

- .1 Cleanouts:
 - .1 Ensure accessible and that access doors are correctly located.
 - .2 Open, cover with linseed oil and re-seal.
 - .3 Verify cleanout rods can probe as far as the next cleanout, at least.
- .2 Test to ensure traps are fully and permanently primed.
- .3 Ensure fixtures are properly anchored, connected to system and effectively vented.
- .4 Provide copies of test reports for Commissioning Manuals.

END OF SECTION

Plumbing Piping Insulation

1 GENERAL

1.1 General Conditions

- .1 All sections of Division 1 form a part of this Specification.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this section.
- .3 All sections of Division 1 to 16 inclusive form part of the Contract Documents. Refer to Section 15010 for General Mechanical Requirements related to this work.

1.2 References

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ASHRAE Standard 90.1, Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings (Including all Addenda).
- .2 American Society for Testing and Materials (ASTM)
 - .1 ASTM B209M, Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate Metric.
 - .2 ASTM C335, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .3 ASTM C411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C449/C449M, Standard Specification for Mineral Fibre-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .5 ASTM C533 Standard specification for Calcium Silicate Insulation Block and Pipe.
 - .6 ASTM C547 Standard Specification for Mineral Fibre Pipe Insulation.
 - .7 ASTM C795, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
 - .8 ASTM C921, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

- .9 ASTM D1784, Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
- .3 Canadian General Standards Board (CGSB)
 - .1 CGSB 51-GP-52Ma, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
 - .2 CAN/CGSB-51.53, Poly (Vinyl Chloride) Jacketting Sheet, for Insulated Pipes, Vessels and Round Ducts.
- .4 Department of Justice Canada (Jus)
 - .1 Canadian Environmental Assessment Act (CEAA), c. 37.
 - .2 Canadian Environmental Protection Act, (CEPA), c. 33.
 - .3 Transportation of Dangerous Goods Act (TDGA), c. 34.
- .5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets.
- .6 Manufacturer's Trade Associations
 - .1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards.
- .7 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102, Surface Burning Characteristics of Building Materials and Assemblies.
- .8 National Energy Code for Buildings (NECB).

1.3 Definitions

- .1 For purposes of this section:
 - .1 "CONCEALED" - insulated mechanical services in suspended ceilings and non-accessible chases and furred-in spaces.
 - .2 "EXPOSED" - will mean "not concealed" as defined herein.
- .2 TIAC ss:
 - .1 CRF: Commercial Rectangular Finish.
 - .2 CPF: Commercial Piping Finish.

1.4 Shop Drawings

- .1 Submit shop drawings in accordance with Section 15010 - General Mechanical Requirements.
- .2 Provide shop drawings for equipment listed in Section 15011 - Submission Log.

1.5 Warranty

- .1 Provide a written guarantee, signed and issued in the name of the owner, against defective materials and workmanship for a period of one (1) year from the date of Substantial Completion.

1.6 Measurement for Payment

- .1 No measurement for payment will be made under this section.

1.7 Basis of Payment

- .1 All labour, materials and equipment necessary for the work in this Section shall be included in the lump sum prices in the Schedule of Items and Prices.

2 PRODUCTS

2.1 Fire and Smoke Rating

- .1 In accordance with CAN/ULC-S102.
 - .1 Maximum flame spread rating: 25.
 - .2 Maximum smoke developed rating: 50.

2.2 Insulation

- .1 Mineral fibre specified includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24°C mean temperature when tested in accordance with ASTM C335.
- .3 TIAC Code A-3: Rigid moulded mineral fibre with factory applied vapour retarder jacket.
 - .1 Mineral fibre: to CAN/ULC-S702 and ASTM C547.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to CAN/ULC-S702.

2.3 Insulation Securement

- .1 Tape: Self-adhesive, aluminum, plain reinforced, 50 mm wide minimum.
- .2 Contact adhesive: Quick setting.
- .3 Canvas adhesive: Washable.
- .4 Tie wire: 1.5 mm diameter stainless steel.
- .5 Bands: Stainless steel, 19 mm wide, 0.5 mm thick.

2.4 Cement

- .1 Thermal insulating and finishing cement:
 - .1 Hydraulic setting or air drying on mineral wool, to ASTM C449/C449M.

2.5 Vapour Retarder Lap Adhesive

- .1 Water based, fire retardant type, compatible with insulation.

2.6 Indoor Vapour Retarder Finish

- .1 Vinyl emulsion type acrylic, compatible with insulation.

2.7 Jackets

- .1 Polyvinyl Chloride (PVC):
 - .1 One-piece moulded type and sheet to CAN/CGSB-51.53 with pre-formed shapes as required.
 - .2 Colours: to match adjacent finish paint. Confirm colour with Owner's Representative.
 - .3 Minimum service temperatures: -20°C.
 - .4 Maximum service temperature: 65°C.
 - .5 Moisture vapour transmission: 0.02 perm.
 - .6 Thickness: 0.55 mm.
 - .7 Fastenings:
 - .1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
 - .2 Tacks.

- .3 Pressure sensitive vinyl tape of matching colour.
- .8 Special requirements:
 - .1 Indoor: flame spread rating 25 (max.), smoke developed rating 50 (max.).
 - .2 Outdoor: UV rated material at least 0.5 mm thick.
- .2 Canvas:
 - .1 220gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
 - .2 Lagging adhesive: Compatible with insulation.

3 EXECUTION

3.1 Manufacturer's Instructions

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 Pre-Installation Requirement

- .1 Pressure testing of piping systems and adjacent equipment to be complete, witnessed and certified.
- .2 Surfaces to be clean, dry, free from foreign material.

3.3 Installation

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturer's instructions and this specification.
- .3 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Install hangers, supports outside vapour retarder jacket.
- .5 Supports, Hangers:

- .1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

3.4 Piping Insulation Schedules

- .1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.
- .2 Insulate vent pipes 3.0 m from roof penetration.
- .3 TIAC Code: A-3.
 - .1 Securements: Tape at 300 mm oc.
 - .2 Seals: VR lap seal adhesive, VR lagging adhesive.
 - .3 Installation: TIAC Code: 1501-C.
- .4 Thickness of insulation to be as listed in following table.
 - .1 Run-outs to individual units and equipment not exceeding 4000 mm long.
 - .2 Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.

Application	TIAC code	Pipe sizes (NPS) and insulation thickness (mm)					
			to 1	1 to 1-1/2	1-1/2 to 4	4 to 8	8 & over
Domestic HWS	A-3	25	25	25	38	38	38
Domestic CWS	A-3	25	25	25	25	25	25
Vent Pipe Plumbing	A-3	25	25	25	25	25	25

- .5 Finishes:
 - .1 Exposed indoors: PVC jacket.
 - .2 Exposed in mechanical rooms: PVC jacket.
 - .3 Concealed, indoors: canvas on valves, fittings. No further finish.

- .4 Use vapour retarder jacket on TIAC code A-3 insulation compatible with insulation.

3.5 Cleaning

- .1 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Hot Water Tank - Electric

1 GENERAL

1.1 General Conditions

- .1 All sections of Division 1 form a part of this Specification. Read and fully adhere to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this section.
- .3 All section of Division 1 to 16 inclusive form part of the Contract Documents. Refer to Section 15010 for General Mechanical Requirements related to this work.

1.2 References

- .1 American National Standards Institute (ANSI)
- .2 American Society of Heating, Refrigeration and Air Conditioning Engineers, Inc. (ASHRAE)
 - .1 Standard 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .3 Canadian Standards Association (CSA International)
 - .1 CAN/CSA C22.2 No.110, Construction and Test of Electric Storage Tank Water Heaters.
 - .2 CAN/CSA-C191 Series, Performance of Electric Storage Tank Water Heaters for Household Service.
 - .3 CAN/CSA-C309, Performance Requirements for Glass-Lined Storage Tanks for Household Hot Water Service.
- .4 National Appliance Energy Conservation Act (NAECA)
- .5 Underwriter's Laboratories (UL)
 - .1 Standard 174, Standard for Household Electric Storage Tank Water Heaters.

1.3 Shop Drawings

- .1 Submit shop drawings in accordance with Section 15010 - General Mechanical Requirements.

- .2 Provide shop drawings for equipment listed in Section 15011 - Submission Log.

1.4 Warranty

- .1 For the Work of this Section - Domestic Water Heaters, warranty for 3 years from date of Substantial Completion.

1.5 Measurement for Payment

- .1 No measurement for payment will be made under this section.

1.6 Basis of Payment

- .1 All labour, materials and equipment necessary for the work in this Section shall be included in the lump sum prices in the Schedule of Items and Prices.

1.7 Operating and Maintenance Manuals

- .1 Submit Operating and Maintenance Manuals in accordance with Section 15010 - General Mechanical Requirements.

2 PRODUCTS

2.1 Acceptable Manufacturers

- .1 AO Smith or equivalent.

2.2 Commercial Electric Water Heater

- .1 The heater shall be:
 - .1 Dura-Power Model DEL as manufactured by A.O. Smith or an approved equal.
 - .2 Heater shall be rated at 2 kW, 208 volts, 1-phase, 60 cycle AC and listed by Underwriters' Laboratories in Canada (ULC).
 - .3 Models shall meet the standby loss requirements of NRCan and current edition of ASHRAE/IES 90.1.
 - .4 The tank shall be 20-gallon capacity.
 - .5 Heater shall have 150 psi working pressure and be equipped with extruded high density anode rod.
 - .6 All internal surfaces of the heater exposed to water shall be glass lined with an alkaline borosilicate composition that has been fused-

to-steel by firing at a temperature range of 1400°F to 1600°F. Electric heating elements shall be medium watt density with zinc plated copper sheath.

- .7 Each element shall be controlled by an individually mounted thermostat and high temperature cut off switch.
- .8 The outer jacket shall be of backed enamel finish and shall enclose the tank with foam insulation.
- .9 Electrical junction box with heavy duty terminal block shall be provided (except on 120V and 277V).
- .10 The drain valve shall be in the front for ease of servicing.
- .11 The heater shall be equipped with a CSA certified and ASME rated temperature and pressure (T&P) relief valve.
- .12 Heater tank shall have a three-year limited warranty as outlined in the written warranty.

3 EXECUTION

3.1 Manufacturer's Instructions

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 Installation

- .1 Install in accordance with manufacturer's instructions.

END OF SECTION

Plumbing Specialties and Accessories

1 GENERAL

1.1 General Conditions

- .1 All sections of Division 1 form a part of this Specification.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this section.
- .3 All sections of Division 1 to 16 inclusive form part of the Contract Documents. Refer to Section 15010 for General Mechanical Requirements related to this work.

1.2 References

- .1 American National Standards Institute (ANSI)
 - .1 ANSI Z358.1 Emergency eyewash and shower equipment.
- .2 American National Standards Institute (ANSI) and American Water Works Association (AWWA)
 - .1 ANSI/AWWA C700, Cold-Water Meters - Displacement Type, Metal Alloy Main Case
 - .2 ASSE 1044, Performance Requirements for Trap Seal Primer - Drainage Types and Electric Design Types
- .3 American Society of Mechanical Engineers (ASME)
- .4 NSF/ANSI 61: Drinking Water System Components - Health Effects
- .5 American Society for Testing and Materials International (ASTM)
 - .1 ASTM B 584 Standard Specification for Copper Alloy Sand Castings for General Applications
- .6 Canadian Standards Association (CSA)
 - .1 CSA B64 Series, Backflow Preventers and Vacuum Breakers.
 - .2 CSA B356, Water Pressure Reducing Valves for Domestic Water Supply Systems.
 - .3 CSA-B79, Commercial and Residential Drains and Cleanouts
- .7 U.S. Food & Drug Administration (FDA)

1.3 Shop Drawings

- .1 Submit shop drawings in accordance with Section 15010 - General Mechanical Requirements.
- .2 Provide shop drawings for equipment listed in Section 15011 - Submission Log.

1.4 Warranty

- .1 Provide a written guarantee, signed and issued in the name of the owner, against defective materials and workmanship for a period of one (1) year from the date of Substantial Completion.

1.5 Measurement for Payment

- .1 No measurement for payment will be made under this section.

1.6 Basis of Payment

- .1 All labour, materials and equipment necessary for the work in this Section shall be included in the lump sum prices in the Schedule of Items and Prices.

1.7 Operating and Maintenance Manuals

- .1 Submit Operating and Maintenance Manuals in accordance with Section 15010 - General Mechanical Requirements.

2 PRODUCTS

2.1 Back Flow Preventers

- .1 Reduced Pressure Zone (RPZ) assembly, certified to CSA B64.4.
- .2 Application: install on domestic cold-water supply.
 - .1 Bronze body construction.
 - .2 Internal pressure differential relief valve located in a zone between two positive seating check modules with captured springs and silicone seat discs.
 - .3 Seats and discs replaceable in both check modules and the relief valve.
 - .4 Assembly to include two resilient seated isolation valves, four resilient seated test cocks, bronze strainer, quarter-turn ball valves and an air gap drain fitting.

- .5 Drain outlet fitting for connection to drainage piping shall be provided.
- .6 Lead Free
- .7 Acceptable Product: Watts Series LF009 or approved equivalent.

2.2 Electronic Trap Seal Primer

- .1 Acceptable manufacturer: MIFAB Inc. or approved equivalent.
- .2 Packaged type, wall mounted, electronic, automatic trap primer manifold.
- .3 Lead free, factory tested and certified to ASSE Standard 1044, IAPMO listed.
- .4 Suitable for an operating pressure from 35 to 80 psig and designed to supply equally a minimum of 2 ounces of water to each connected drain trap every 24 hours.
- .5 Cabinet: white powder epoxy coated, 16-gauge steel cabinet suitable for surface of flush wall mounting.
- .6 Cabinet cover: bolt-on steel cover.
- .7 Inlet piping assembly: 3/4" diameter NPT copper pipe inlet with brass ball type shut-off valve, a stainless steel, electronic, slow closing solenoid valve, and a BEECO atmospheric vacuum breaker.
- .8 Discharge manifold: copper discharge manifold with 1/2" diameter compression type copper tube connections in multiples of 5 with quantity to suit the number of traps to be primed. Trap number, locations and details: mechanical contract drawing govern.
- .9 Control panel: pre-wired control panel with 5 ampere circuit breaker, test button, 24-hour timer with relay and adjustable delay, and a manual override switch.
- .10 Electrical connection: 120 volt, AC power, hard wired connection.

2.3 Eye wash

- .1 Acceptable manufacturer: Guardian G1825P or approved equivalent.
- .2 Spray Head Assembly: Two spray heads with "flip top" dust cover, internal flow control and filter to remove impurities from water flow.
- .3 Valve: 1/2" IPS chrome plated brass stay-open ball valve constructed of chrome plated ball and Teflon seals.

- .4 Bowl: 11-1/2" diameter orange ABS plastic.
- .5 Mounting: Heavy duty cast aluminum wall bracket with corrosion resistant powder coated finish.
- .6 Supply: 1/2" NPT female inlet.
- .7 Waste: 1-1/4" NPT female outlet.
- .8 Sign: ANSI Z358.1 – compliant identification sign.
- .9 Valve, bowl and spray head assembly are factory assembled and water tested prior to shipment.
- .10 Provide thermostatic mixing valve to blend hot and cold water to deliver tepid water. Acceptable manufacturer: Guardian G6020 or approved equivalent.

2.4 Potable Water Thermal Expansion Tank

- .1 Application: absorb expanded water from domestic hot water tanks because of the inability to expand back into the Town potable water system due to the presence of a backflow preventer on the incoming water supply to the building.
- .2 ASME Section VIII, Division 1 construction and label.
- .3 FDA approved butyl bladder.
- .4 NSF/ANSI 61 certified.
- .5 3/4 NPTM stainless steel system connection.
- .6 Standard tire air charging valve connection.
- .7 1033 kPa (150 PSI) maximum working pressure.
- .8 Exterior red oxide primer finish.
- .9 Air pre-charge to be adjusted in field by the Mechanical Contractor to equal the residual cold-water pressure on the discharge side of the pressure reducing valve on the domestic water service.
- .10 Acceptable manufacturer: Amtrol or approved equivalent.

2.5 Pressure Reducing Valve

- .1 The water pressure reducing valve shall be certified to NSF/ANSI/CAN 61 and ASSE Listed 1003, available with single union, double union and less union end connections.
- .2 The main body shall be low lead cast bronze (ASTM B 584) alloy.
- .3 The bell shall be composite plastic.
- .4 The cartridge shall be acetal and incorporate an integral seat.
- .5 The seat disc elastomer shall be EPDM.
- .6 The assembly shall be accessible for maintenance without removing the device from the line.
- .7 Acceptable manufacturer: Zurn Industries Limited or approved equivalent.

2.6 Pipe Wall Penetration Seal

- .1 Application:
 - .1 Pipes penetrating exterior concrete walls below grade and concrete floors on grade.
- .2 Seal material to be EPDM.
- .3 Pressure plates to be glass-reinforced plastic.
- .4 Bolts and nuts to be stainless steel 18-8.
- .5 Suitable temperature range to be -40°C to 121°C.
- .6 Wall sleeves to be Schedule 40 black iron pipe. Sleeves in exterior walls to be galvanized.
- .7 Wall sleeves to be sufficiently long to mount flush with interior and exterior walls.
- .8 Acceptable Product: Metraseal MS Series, Link Seal.

3 EXECUTION

3.1 Manufacturer's Instructions

- .1 Comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and data sheet.

3.2 Installation

- .1 Install in accordance with Ontario Building Code, and local authority having jurisdiction.
- .2 Install in accordance with manufacturer's instructions and as specified.

3.3 Back Flow Preventors

- .1 Install in accordance with CSA-B64, where indicated and elsewhere as required by code.

3.4 Start-Up and Commissioning

- .1 Timing: Start-up only after:
 - .1 Pressure tests have been completed.
 - .2 Disinfection procedures have been completed.
 - .3 Water treatment systems operational.
- .2 Provide continuous supervision during start-up.

3.5 Testing and Adjusting

- .1 Timing:
 - .1 After start-up deficiencies rectified.
 - .2 After certificate of completion has been issued by authority having jurisdiction.
- .2 Adjustments:
 - .1 Verify that flow rate and pressure meet design criteria.
- .3 Vacuum breakers, backflow preventers, backwater valves:
 - .1 Test tightness, accessibility for O&M of cover and of valve.
 - .2 Simulate reverse flow and back-pressure conditions to test operation of vacuum breakers, backflow preventers.
 - .3 Verify visibility of discharge from open ports.
- .4 Access doors:
 - .1 Verify size and location relative to items to be accessed.
- .5 Cleanouts:

- .1 Verify covers are gas-tight, secure, yet readily removable.
- .6 Pressure regulators, PRV assemblies:
 - .1 Adjust settings to suit locations, flow rates, pressure conditions.
- .7 Tempered water assemblies:
 - .1 Verify proper discharge temperature setpoint for all tempered water assemblies including those serving emergency fixtures.

END OF SECTION

Dampers – Operating

1 GENERAL

1.1 General Conditions

- .1 All sections of Division 1 form a part of this Specification.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this section.
- .3 All sections of Division 1 to 16 inclusive form part of the Contract Documents. Refer to Section 15010 for General Mechanical Requirements related to this work.

1.2 References

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A653/A653M-[04a], Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process.
 - .2 ASTM C1363-97 – Thermal performance test in accordance with Architectural Testing Laboratories (ATI).
- .2 Air Movement and Control Association International (AMCA).
 - .1 AMCA 500-D – Laboratory Methods for Testing Dampers for Ratings.
 - .2 AMCA 511 – Certified Ratings Program for Air Control Devices.
- .3 IECC – International Energy Conservation Code.
- .4 ASHRAE Standard 62 – Ventilation for Acceptable Indoor Air Quality.

1.3 Maintenance Data

- .1 Provide maintenance data in English for incorporation into manual for all items specified in this section.

1.4 Related Work

- .1 Section 15010 -General Mechanical Requirements.
- .2 Division 16 - Electrical.

1.5 Shop Drawings

- .1 Submit shop drawings in accordance with Section 15010 - General Mechanical Requirements.
- .2 Provide shop drawings for equipment listed in Section 15011 - Submission Log.

1.6 Warranty

- .1 Provide a written guarantee, signed and issued in the name of the owner, against defective materials and workmanship for a period of one (1) year from the date of Substantial Completion.

1.7 Measurement for Payment

- .1 No measurement for payment will be made under this section.

1.8 Basis of Payment

- .1 All labour, materials and equipment necessary for the work in this Section shall be included in the lump sum prices in the Schedule of Items and Prices.

1.9 Operating and Maintenance Manuals

- .1 Submit Operating and Maintenance Manuals in accordance with Section 15010 - General Mechanical Requirements.

2 PRODUCTS

2.1 Thermally Insulated Dampers

- .1 Extruded aluminum (6063-T5) damper frame shall not be less than 0.080" (2.03 mm) in thickness. Damper frame shall be 4" (101.6 mm) deep x 1" (25.4 mm), with duct mounting flanges on both sides of frame. Damper frame shall have a 2" (50.8 mm) mounting flange on the rear of the damper, when installed as Extended Rear Flange install type. Frame to be assembled using zinc-plated steel mounting fasteners. Welded frames shall not be acceptable.
- .2 Blades shall be maximum 6" (152.4 mm) deep extruded aluminum (6063-T5) air-foil profiles with a minimum wall thickness of 0.06" (1.52mm). Blades shall be internally insulated with expanded polyurethane foam and shall be thermally broken. Complete blade shall have an insulating factor of R-2.29. All blades shall be symmetrically pivoted.

- .3 Blade seals shall be extruded silicone, secured in an integral slot within the aluminum blade extrusions and shall be mechanically fastened to prevent shrinkage and movement over the life of the damper. Adhesive or clip-on type blade seals will not be approved.
- .4 Frame seals shall be extruded silicone, secured in an integral slot within the aluminum frame extrusions and shall be mechanically fastened to prevent shrinkage and movement over the life of the damper. Metallic compression type jamb seals will not be approved.
- .5 Bearings shall be a dual bearing system composed of a Celcon inner bearing (fixed around a 7/16" (11.11 mm) aluminum hexagon blade pivot pin), rotating within a polycarbonate outer bearing inserted in the frame. Single axle bearing, rotating in an extruded or punched hole shall not be acceptable. Bearings are to be maintenance-free, requiring no lubrication.
- .6 Hexagonal control shaft shall be 7/16" (11.11 mm). It shall have an adjustable length and shall be an integral part of the blade axle. A field-applied control shaft shall not be acceptable. All parts shall be zinc-plated steel.
- .7 Linkage hardware shall be aluminum and corrosion-resistant zinc-plated steel, installed in the frame side, out of the airstream, and accessible after installation. Linkage hardware shall be complete with cup-point trunnion screws to prevent linkage slippage and a Celcon bearing between moving parts to reduce wear and increase longevity. Linkage that consists of metal rubbing metal will not be approved.
- .8 Dampers shall be designed for operation in temperatures ranging from -40°F (-40°C) to 212°F (100°C).
- .9 Dampers shall be AMCA rated for Leakage Class 1A at 1 in w.g. (0.25 kPa) static pressure differential. Standard air leakage data to be certified under the AMCA Certified Ratings Program.
- .10 Dampers shall be custom made to required size, with blade stops not exceeding 1-1/4" (31.7 mm) in height. The blade stop shall be a continuous and integral part of the head/sill. Welded and caulked blade stops shall not be acceptable.
- .11 Dampers shall be opposed blade action or parallel blade action as indicated on the plans.
- .12 Dampers shall be flanged to duct install type only.

- .13 Installation of dampers must be in accordance with TAMCO's current installation guidelines, provided with each damper shipment.
- .14 Field supplied intermediate structural support is required to resist applied pressure loads for dampers that consist of two or more sections in both height and width.
- .15 Acceptable product shall be TAMCO Series 9000 Thermally Insulated Damper, as manufactured by T. A. Morrison & Co., Inc.

2.2 Damper actuators:

- .1 Damper actuators shall be: 120vac 2-position, (spring close) electric motors.
- .2 Provide spring return for "fail-safe" in normally open or normally closed position.
- .3 Size actuators to control dampers against maximum pressure or dynamic closing pressure, whichever is greater, not more than 16 sq. ft. per actuator.
- .4 Provide adjustable external stops to limit stroke in either direction.
- .5 Mount each damper operator rigidly on a bracket. Mount each damper operator outside of air stream in a readily accessible location. Use positive positioning relays on all damper operators that are sequenced with other actuators and on all damper operators on modulating dampers.
- .6 Acceptable Material: Belimo, Johnson Controls or Honeywell.

3 EXECUTION

3.1 Manufacturer's Instructions

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 Installation

- .1 Install where indicated.
- .2 Install in accordance with recommendations of SMACNA and manufacturer's instructions.
- .3 Seal multiple damper modules with silicon sealant.
- .4 Install access door adjacent to each damper.

- .5 Ensure dampers are observable and accessible.

3.3 Cleaning

- .1 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Louvres

1 GENERAL

1.1 General Conditions

- .1 All sections of Division 1 form a part of this Specification.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this section.
- .3 All sections of Division 1 to 16 inclusive form part of the Contract Documents. Refer to Section 15010 for General Mechanical Requirements related to this work.

1.2 References

- .1 American Society for Testing and Materials International (ASTM)
- .2 ASTM E90-04, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
- .3 ASHRAE 62.1-2010, Ventilation for Acceptable Indoor Air Quality
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
- .5 Material Safety Data Sheets (MSDS).
- .6 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
- .7 Society of Automotive Engineers (SAE)

1.3 Maintenance Data

- .1 Provide maintenance data in English for incorporation into manual for all items specified in this section.

1.4 Shop Drawings

- .1 Submit shop drawings in accordance with Section 15010 - General Mechanical Requirements.
- .2 Provide shop drawings for equipment listed in Section 15011 - Submission Log.

1.5 Warranty

- .1 Provide a written guarantee, signed and issued in the name of the owner, against defective materials and workmanship for a period of one (1) year from the date of Substantial Completion.

1.6 Measurement for Payment

- .1 No measurement for payment will be made under this section.

1.7 Basis of Payment

- .1 All labour, materials and equipment necessary for the work in this Section shall be included in the lump sum prices in the Schedule of Items and Prices.

1.8 Operating and Maintenance Manuals

- .1 Submit Operating and Maintenance Manuals in accordance with Section 15010 - General Mechanical Requirements.

2 PRODUCTS

2.1 Fixed Louvres - Aluminum

- .1 Construction: Mechanically fastened.
- .2 Material: extruded aluminum alloy 6063-T5.
- .3 Blade: Drainable design, heavy gauge extruded 6063-T5 aluminum, 0.081-inch nominal wall thickness, positioned at 37- and 45-degree angles on approximate 4-inch centres.
- .4 Screen: 19 mm mesh x 1 mm diameter wire aluminum bird screen on inside face of louvres in formed U-frame.
- .5 Finish: Mill.
- .6 Acceptable products: Greenheck ESD-403 or approved equivalent.

3 EXECUTION

3.1 Manufacturer's Instructions

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 Installation

- .1 In accordance with manufacturer's and SMACNA recommendations.
- .2 Reinforce and brace as indicated.
- .3 Anchor securely into opening. Seal with caulking to ensure weather tightness.
- .4 Refer to ASHRAE 62.1-2010 Table 5-1 for minimum separation distances for air intakes.

3.3 Cleaning

- .1 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Metal Ducts - Low Pressure

1 GENERAL

1.1 General Conditions

- .1 All sections of Division 1 form a part of this Specification.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this section.
- .3 All sections of Division 1 to 16 inclusive form part of the Contract Documents. Refer to Section 15010 for General Mechanical Requirements related to this work.

1.1 Summary

- .1 Section includes:
 - .1 Materials and installation of low-pressure metallic ductwork, joints, and accessories.

1.2 References

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
- .2 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A 480/A480M, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
 - .2 ASTM A635/A635M, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, General Requirements for.
 - .3 ASTM A 653/A653M, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- .3 Department of Justice Canada (Jus).
 - .1 Canadian Environmental Protection Act (CEPA).
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS).

- .1 Material Safety Data Sheets (MSDS).
- .5 National Fire Protection Association (NFPA).
 - .1 NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - .2 NFPA 90B, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
 - .3 NFPA 96, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- .6 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).
 - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible.
 - .2 SMACNA HVAC Air Duct Leakage Test Manual.
 - .3 IAQ Guideline for Occupied Buildings Under Construction, 1st Edition.
- .7 Transport Canada (TC).
 - .1 Transportation of Dangerous Goods Act (TDGA).

1.3 Warranty

- .1 Provide a written guarantee, signed and issued in the name of the owner, against defective materials and workmanship for a period of one (1) year from the date of Substantial Completion.

1.4 Quality Assurance

- .1 Certification of Ratings:
 - .1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.
 - .2 Installers to be certified to journeyperson level in sheet metal work.

1.5 Measurement for Payment

- .1 No measurement for payment will be made under this section.

1.6 Basis of Payment

- .1 All labour, materials and equipment necessary for the work in this Section shall be included in the lump sum prices in the Schedule of Items and Prices.

2 PRODUCTS

2.1 Seal Classification

- .1 Classification as follows:

Maximum Pressure Pa	SMACNA Seal Class
> 1000	A
750	B
500	C
250	C
125	C

- .2 Seal classification:

- .1 Class A: longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant and tape.
- .2 Class B: longitudinal seams, transverse joints and connections made airtight with sealant tape or combination thereof.
- .3 Class C: transverse joints and connections made air tight with gaskets, sealant tape or combination thereof. Longitudinal seams unsealed.

2.2 Sealant

- .1 Sealant: oil resistant, polymer type flame resistant duct sealant. Temperature range of minus 30°C to plus 93°C.

2.3 Duct Leakage

- .1 In accordance with SMACNA HVAC Duct Leakage Test Manual.

2.4 Fittings

- .1 Fabrication: to SMACNA.
- .2 Radiused elbows:
 - .1 Rectangular: Centreline radius: 1.5 times width of duct.

- .2 Round: smooth radius or five piece with a centreline radius: 1.5 times diameter.
- .3 Mitred elbows, rectangular:
 - .1 To 400 mm: with single thickness turning vanes.
 - .2 Over 400 mm: with double thickness turning vanes.
- .4 Branches:
 - .1 Rectangular main and branch: with radius on branch 1.5 times width of duct or 450 entry on branch.
 - .2 Round main and branch: enter main duct at 450 with conical connection.
 - .3 Provide volume control damper in branch duct near connection to main duct.
 - .4 Main duct branches: with volume control damper.
- .5 Transitions:
 - .1 Diverging: 200 maximum included angle.
 - .2 Converging: 300 maximum included angle.
- .6 Offsets:
 - .1 Full short radiused elbows as indicated.
- .7 Obstruction deflectors: maintain full cross-sectional area. Maximum included angles: as for transitions.

2.5 Firestopping

- .1 Retaining angles around duct, on both sides of fire separation.
- .2 Firestopping material and installation must not distort duct.

2.6 Galvanized Steel

- .1 Lock forming quality: to ASTM A653, G90 zinc coating.
- .2 Thickness, fabrication and reinforcement: to SMACNA.
- .3 Joints: to SMACNA or proprietary manufactured duct joint. Proprietary manufactured flanged duct joint to be a class A seal.

2.7 Hangers and Supports

- .1 All supporting systems shall meet the minimum requirements outlined in Chapter 5 of SMACNA's HVAC Duct Construction Standards manual.
- .2 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct.
- .3 Hanger configuration: to SMACNA.
- .4 Hangers: galvanized steel angle with black steel rods.
- .5 Upper hanger attachments:
 - .1 For concrete: manufactured concrete inserts.
 - .1 Acceptable Product: Myatt, Grinnell, Hunt.
 - .2 For steel joist: manufactured joist clamp steel plate washer.
 - .1 Acceptable Product: Myatt, Grinnell, Hunt.
 - .3 For steel beams: manufactured beam clamps:
 - .1 Acceptable Product: Myatt, Grinnell, Hunt.

2.8 Insulation and Jacket

- .1 Fire and smoke rating: insulation and jacket used shall be in accordance with CAN/ULC-S102 with a maximum flame spread and maximum smoke developed rating of 25 and 50 respectively.
- .2 Thickness: apply 50 mm thick rigid duct insulation on exhaust fan discharge sections, intake air duct sections up to heating coils, and dehumidifier reactivation air duct outlet. See mechanical drawings for locations.
- .3 Jacket: canvas jacket and finished with vapour proof lagging that is compatible with the insulation.

3 EXECUTION

3.1 General

- .1 Do work in accordance with NFPA 90A, NFPA 90B, and SMACNA.
- .2 Do not break continuity of insulation vapour barrier with hangers or rods. Insulate strap hangers 100 mm beyond insulated duct.
- .3 Support risers in accordance with SMACNA.

- .4 Install breakaway joints in ductwork on sides of fire separation. Do not place fire stopping material in expansion space between damper sleeve and fire partition.
- .5 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.
- .6 Manufacture duct in lengths and diameter to accommodate installation of acoustic duct lining.
- .7 Install fire dampers at all penetrations through all fire rated assemblies. Where fire dampers are shown in grilles or diffusers at penetrating a fire rated ceiling they shall be a firestop flap.

3.2 Hangers

- .1 All supporting systems shall meet the minimum requirements outlined in Chapter 5 of SMACNA's HVAC Duct Construction Standards manual.
- .2 Strap hangers: install in accordance with SMACNA.
- .3 Angle hangers: complete with locking nuts and washers.
- .4 Hanger spacing: in accordance with SMACNA's supporting systems tables.

3.3 Sealing and Taping

- .1 Apply sealant to outside of joint to manufacturer's recommendations.
- .2 Bed tape in sealant and recoat with minimum of one coat of sealant to manufacturers recommendations. Sealant and tape to be applied to full perimeter of duct.

3.4 Leakage Tests/Commissioning

- .1 In accordance with SMACNA HVAC Duct Leakage Test Manual.
- .2 Do leakage tests in sections.
- .3 Make trial leakage tests as instructed to demonstrate workmanship.
- .4 Install no additional ductwork until trial test has been passed.
- .5 Test section minimum of 30 m long with not less than three branch takeoffs and two 90° elbows.
- .6 Complete test before insulation or concealment.

END OF SECTION

Upblast Exhaust Fan

1 GENERAL

1.1 Summary

- .1 This specification is based off Greenheck's CUE direct drive upblast centrifugal fan.

1.2 General Conditions

- .1 All sections of Division 1 form a part of this Specification. Read and fully adhere to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this section.
- .3 All section of Division 1 to 16 inclusive form part of the Contract Documents. Refer to Section 15010 for General Mechanical Requirements related to this work.

1.3 References

- .1 Air Movement and Control Association Inc (AMCA):
 - .1 99 - Standards Handbook
 - .2 200 - Publication, Air Systems
 - .3 201-90 - Publication, Fans and Systems
 - .4 202-88 - Publication, Troubleshooting
 - .5 203-90 - Publication, Field Performance Measurement of Fan Systems
 - .6 211-05 - Publication, Certified Ratings Program - Product Rating Manual for Fan Air Performance
 - .7 300-96 - Standard Reverberant Room Method for Sound Testing of Fans
 - .8 311-05 - Publication Certified Ratings Program - Product Rating Manual for Fan Sound Performance
 - .9 99-0401-86 - Classification for Spark Resistant Construction
 - .10 99-2408-69 - Operating Limits for Centrifugal Fans

- .2 Air Movement and Control Association Inc. (AMCA), American National Standards Institute (ANSI):
 - .1 204-05 - Standard Balance Quality and Vibration Levels for Fans
 - .2 210-99 - Standard Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
- .3 American National Standards Institute (ANSI):
 - .1 11-r1999 - Method of Evaluating Load Ratings of Bearings
- .4 American Society of Civil Engineers (ASCE):
 - .1 7-02 - Minimum Design Loads for Building and Other Structures
- .5 American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE):
 - .1 Chapter 45 - 2003 handbook, HVAC Applications
 - .2 Chapter 7 - 2001 Fundamentals handbook, Sound-Vibration
 - .3 Chapter 32 - 2001 Fundamentals handbook, Duct Design
 - .4 Chapter 18 - 1992 HVAC System and Equipment handbook, Fans
- .6 American Society for Testing and Materials (ASTM):
 - .1 E330-02 - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylight and Curtain Walls by Uniform Static Air Pressure Difference
- .7 National Fire Protection Association (NFPA)
 - .1 70 - National Electrical Code
 - .2 90A-02 - Standard for the Installation of Air-Conditioning and Ventilating Systems
 - .3 92A-06 - Recommend Practice for Smoke-Control System
 - .4 92B-05 - Standard for Smoke Management System in Malls, Atria, and Large Areas
 - .5 96-04 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- .8 Occupational Safety and Health Administration (OSHA):
 - .1 1910.212 - General requirements for Machine Guarding

- .2 1910.219 - General requirements for guarding safe use of mechanical power transmission apparatus
- .3 1926.300 - General requirements for safe operation and maintenance of hand and power tools
- .9 Underwriters Laboratories (UL):
 - .1 507 - Electric Fans
 - .2 555 - Fire Dampers
 - .3 555S - Smoke Dampers
 - .4 705 - Standard Power Ventilators
 - .5 705 - Supplement SC - Standard Power Roof Ventilators for Restaurant Exhaust Appliances
 - .6 793 - Snow Load

1.4 Maintenance Data

- .1 Provide maintenance data in English for incorporation into manual for all items specified in this section.

1.5 Shop Drawings

- .1 Submit shop drawings in accordance with Section 15010 - General Mechanical Requirements.
- .2 Provide shop drawings for equipment listed in Section 15011 - Submission Log.

1.6 Measurement for Payment

- .1 No measurement for payment will be made under this section.

1.7 Basis of Payment

- .1 All labour, materials and equipment necessary for the work in this Section shall be included in the lump sum prices in the Schedule of Items and Prices.

2 PRODUCTS

2.1 Acceptable Manufacturers

- .1 Greenheck Fan Corporation, Model CUE or equivalent.

2.2 Direct Drive Roof Upblast Centrifugal Exhaust Fan

.1 General Description:

- .1 Discharge air directly away from the mounting surface.
- .2 Upblast fan shall be for roof mounted applications.
- .3 Performance capabilities up to 14,700 cubic feet per minute (cfm) and static pressure to 3 inches of water gauge
- .4 Maximum continuous operating temperature for fan sizes 098-300 is 400 Fahrenheit (204.4 Celsius) and for fan sizes 060-095 is 160 Fahrenheit (71.1 Celsius)
- .5 Each fan shall bear a permanently affixed manufacture's engraved metal nameplate containing the model number and individual serial number.

.2 Wheel:

- .1 Material type: Aluminum.
- .2 Non-overloading, backward inclined centrifugal.
- .3 Statically and dynamically balanced in accordance to AMCA Standard 204-05.
- .4 The wheel cone and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency.

.3 Motors:

.1 AC Induction Motor:

- .1 Motor enclosures: EC Motor
- .2 Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and furnished at the specific voltage and phase on fan sizes 90 and larger. Fan sizes 60-80 use sleeve bearing.
- .3 Mounted on vibration isolators, out of the airstream.
- .4 For motor cooling there shall be fresh air drawn into the motor compartment through an area free of discharge contaminants.

- .5 Accessible for maintenance.
- .4 Shaft and Bearings:
 - .1 Fan shaft shall be ground and polished solid steel with an anti-corrosive coating.
 - .2 Permanently sealed bearings or pillow block ball bearings.
 - .3 Bearing shall be selected for a minimum L10 life in excess of 100,000 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed.
 - .4 Bearings are 100 percent factory tested.
 - .5 Fan Shaft first critical speed is at least 25 percent over maximum operating speed.
- .5 Housing:
 - .1 Constructed of heavy gauge aluminum includes exterior housing, curb cap, windband, and motor compartment housing. Galvanized material is not acceptable.
 - .2 Housing shall have a rigid internal support structure.
 - .3 Windband to be one piece uniquely spun aluminum construction and maintain original material thickness throughout the housing.
 - .4 Windband to include an integral rolled bead for strength.
 - .5 Curb cap base to be fully welded to windband to ensure a leak proof construction. Tack welding, bolting, and caulking are not acceptable.
 - .6 Curb cap to have integral deep spun inlet venturi and pre-punched mounting holes to ensure correct attachment to curb.
 - .7 Drive frame assemblies shall be constructed of heavy gauge steel and mounted on vibration isolators.
 - .8 Breather tube shall be 10 square inches in size for fresh air motor cooling, and designed to allow wiring to be run through it.
- .6 Motor Cover:
 - .1 Constructed of aluminum
- .7 Vibration Isolation:
 - .1 Double studded true isolators

- .2 No metal to metal contact
- .3 Sized to match the weight of each fan
- .8 Disconnect Switches:
 - .1 Provided by electrical contractor (others).
- .9 Drain Trough:
 - .1 Allows for one-point drainage of water, grease, and other residues.
- .10 Options/Accessories:
 - .1 Birdscreen:
 - .1 Construction of stainless steel.
 - .2 Protects fan discharge.
 - .2 Curb Seal:
 - .1 Type: Foam Seal.
 - .2 Mounted between the fan curb cap and the roof curb.
 - .3 Roof Curbs:
 - .1 Types: GPIIP
 - .2 Mounted onto roof with fan.
 - .3 Material: Aluminum
 - .4 Insulation thickness: 1 inch (R4.3)
 - .5 Coating Type: None
 - .4 Curb Seal:
 - .1 Types: Foam Seal
 - .2 Typically mounted between the fan curb cap and the roof curb

3 EXECUTION

3.1 Manufacturer's Instructions

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 Installation

- .1 Install as per manufacturer's instructions.

END OF SECTION

Testing, Adjusting and Balancing for HVAC

1 GENERAL

1.1 General Conditions

- .1 All sections of Division 1 form a part of this Specification. Read and fully adhere to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this section.
- .3 All sections of Division 1 to 16 inclusive form part of the Contract Documents. Refer to Section 15010 for General Mechanical Requirements related to this work.

1.2 Summary

- .1 Requirements of testing, adjusting, and balancing for HVAC.
- .2 TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do other work as specified in this section.

1.3 Qualifications of TAB Personnel

- .1 Perform TAB in accordance with the requirements of the standard for which TAB Firm's qualifications are approved:
 - .1 Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1-2002.
 - .2 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems-1998.
 - .3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing-2002.
- .2 Use TAB Standard provisions, including checklists, and report forms to satisfy Contract requirements.

- .3 Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.
- .4 TAB Standard quality assurance provisions such as performance guarantees form part of this contract.
 - .1 For systems or system components not covered in TAB Standard, use TAB procedures developed by TAB Specialist.
 - .2 Where new procedures, and requirements, are applicable to Contract requirements have been published or adopted by body responsible for TAB Standard used (AABC, NEBB, or TABB), requirements and recommendations contained in these procedures and requirements are mandatory.

1.4 Purpose of TAB

- .1 Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads.
- .2 Adjust and regulate equipment and systems to meet specified performance requirements and to achieve specified interaction with other related systems under normal and emergency loads and operating conditions.
- .3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.

1.5 Exceptions

- .1 TAB of systems and equipment regulated by codes, standards to satisfaction of authority having jurisdiction.

1.6 Coordination

- .1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule to ensure completion before acceptance of project.
- .2 Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems.

1.7 Pre-TAB Review

- .1 Review contract documents before project construction is started and confirm in writing to Departmental Representative Engineer Consultant adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.
- .2 Review specified standards and report to Engineer in writing proposed procedures which vary from standard.
- .3 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.

1.8 Start-Up

- .1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.

1.9 Operation of Systems During TAB

- .1 Operate systems for length of time required for TAB and as required by Engineer for verification of TAB reports.

1.10 Start of TAB

- .1 Notify Engineer 7 days prior to start of TAB.
- .2 Start TAB when building is essentially completed, including:
 - .1 Installation of ceilings, doors, windows, and other construction affecting TAB.
 - .2 Application of weather stripping, sealing, and caulking.
 - .3 Pressure and leak tests.
 - .4 Provisions for TAB installed and operational.
- .3 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:
 - .1 Proper thermal overload protection in place for electrical equipment.
 - .2 Air systems:
 - .1 Duct systems clean.

- .2 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.
- .3 Correct fan rotation.
- .4 Access doors, installed, closed.

1.11 Accuracy Tolerances

- .1 Measured values accurate to within plus or minus 5 % of actual values.

1.12 Instruments

- .1 Calibrate instruments in accordance with requirements of the most stringent referenced standard for either applicable system or HVAC system.
- .2 Calibrate within 3 months of TAB. If requested, provide certificate of calibration to Engineer.

1.13 TAB Report

- .1 Format in accordance with referenced standard.
- .2 TAB report to show results in SI units and to include:
 - .1 Project record drawings.
- .3 Submit electronic copy of TAB Report to Engineer for verification and approval, in English.

1.14 Verification

- .1 Reported results subject to verification by Engineer.
- .2 Provide personnel and instrumentation to verify up to 30% of reported results.
- .3 Number and location of verified results as directed by Engineer.
- .4 Pay costs to repeat TAB as required to satisfaction of Engineer.

1.15 Settings

- .1 After TAB is completed to satisfaction of Engineer replace drive guards, close access doors, lock devices in set positions, ensure sensors are at required settings.
- .2 Permanently mark settings to allow restoration at any time during life of facility. Do not eradicate or cover markings.

1.16 Completion of TAB

- .1 TAB considered complete when final TAB Report received and approved by Engineer.

1.17 Shop Drawings

- .1 Submit shop drawings in accordance with Section 15010 - General Mechanical Requirements.

1.18 Measurement for Payment

- .1 No measurement for payment will be made under this section.

1.19 Basis of Payment

- .1 All labour, materials and equipment necessary for the work in this Section shall be included in the lump sum prices in the Schedule of Items and Prices.

END OF SECTION

15400 – Process Piping & Control Devices

PART 1 - GENERAL

1.1 Related Work Specified Elsewhere

- .1 Mechanical General Provisions Section 15010
- .2 Pumps Division 15
- .3 Electrical Division 16
- .4 Applicable Sections of Division 1
- .5 Pre-selected Equipment – *(If applicable)*

1.2 NSF Certification

- .1 All materials in contact with potable water systems must be certified to NSF 61 Standards.

1.3 Maintenance Data and Shop Drawings

- .1 Provide maintenance data in English for **all** valves, analyzers, flow meters and controls for incorporation into maintenance manual specified in Section 01730.
- .2 Provide shop drawings in accordance with Section 01340.

1.4 Responsibility

- .1 Equipment included in this section is to be provided under Division 15 and wired under Division 16.

PART 2 - PRODUCTS

(NOTE: SOME ITEMS LISTED MAY NOT APPLY TO THIS PROJECT. PIPING AND FITTINGS SHALL BE OF THE TYPE LISTED ON THE CONTRACT DRAWINGS.)

2.1 Process Piping

- .1 All piping, valves and fittings within the treatment system shall be 316/316L stainless steel unless otherwise indicated on Contract Drawings.
- .2 Ductile Iron Pipe (D.I.)
 - .1 Manufacture: to AWWA C150, Pressure Class 350.

- .2 Cement lining to AWWA C104/A21.4.
- .3 Joints:
 - .1 Buried - Tyton or mechanical joint to AWWA C111.
 - .2 Nonburied - (in buildings and chambers) Flanged to AWWA C110 or grooved to C606.
- .4 Flanged joints shall be completed using 3 mm thick preformed synthetic full-face red rubber gaskets.
- .5 Fittings: Cast iron or ductile iron to: Buried - AWWA C 111, Non-buried -AWWA C110
 - .1 Where fitting is buried attached 11 kg zinc anode to fitting by means of CAD welding. Also supply and install sacrificial zinc washers on every other bolt.
- .3 Copper
 - .1 Manufacture: Type L, hard drawn manufactured to ASTM B88M.
 - .2 Joints: Solder/brazing: to contain less than 2 percent lead.
 - .3 Fittings: Sweat wrought copper to ANSI B16.22 except where compression fittings are required.
- .4 Stainless Steel (NOT APPLICABLE)
 - .1 Manufacture to ASTM A240.
 - .2 Joints
 - .1 Welded to ASME Standards for Stainless Steel and Part 9 of the ASME Boiler and Pressure Vessels Code A-240 specifications.
 - .2 Welded joints shall include at each location a full circumferential joint weld designed to be watertight and to transfer the full design thrust generated by the test pressure plus appropriate safety factors. Unless otherwise noted on Contract Drawings, provide Procedure Qualification Reports (PQR's) stamped and signed by TSSA for all shop welded joints. All welding work either in the shop or field shall be done in accordance with Part 9 of ASME Boiler and Pressure Vessels Code. Welders shall be

qualified under CSA W-47 by the Canadian Welding Bureau and welding must be carried out to the requirements of CSA W59.1

- .3 Flanged using angled (butt weld or slip on) collars and galvanized backing flanges to ASME B16.5 capable of withstanding 1034 kPag (150 psig) working pressure and a full vacuum for 150# pressure class. Flanged joints to be completed using 3 mm thick performed synthetic full-face rubber gasket. Grooved to fit AWWA Victaulic Style or 44 or 77 couplings.
- .3 Piping: Type 316/316L Schedule 10s to ASTM A-778 specifications.
- .4 Fittings: Type 316/316L Schedule 10s to ASTM A774 specifications. All fittings shall be of thickness to meet a minimum working pressure of 1034 kPag (150 psig) and a full vacuum. Fabricator shall provide a list of working pressures for all fittings at time of shop drawing submission. Reducers, reducing elbows, mitred reducing elbows, tees, laterals and special fittings must be designed and stamped by a Professional Engineer to criteria established in ASME B31.1 to confirm that these fittings can handle 1034 kPag (150 psig) working pressure and a full vacuum at 40 degrees Celsius. Schedule 10s Pipe and 90-degree elbows already have this capability and do not require any special design. Where shown on Contract Drawings, mitred 90-degree elbows shall have at least five (5) sections.
- .5 Stainless steel piping less than 75 mm dia. shall be Type 316/316L, Schedule 40 complete with welded, grooved or threaded joints.

The following shall be from stainless steel tubing:

- .1 Instrument connections.
- .2 Combination air valve piping from process to air valve base.
- .6 Provide neoprene bearing pad between process piping and concrete supports.
- .5 Galvanized Schedule 40 Steel (NOT APPLICABLE)
 - .1 Manufacture to: CSA B63-1966 galvanized to ANSI 8-63-1966 and 82.1.
 - .2 Joints: threaded.
 - .3 Fittings: 1034 kPag (150 psig) threaded, standard weight, malleable iron, galvanized to ANSI B16.3 and 82.1.

.6 Schedule 80 PVC

- .1 Manufacture to CSA B137 Series 17. Note: Exposed piping located on the exterior buildings and structures must be either copper, stainless steel or galvanized steel.
- .2 Joints: socket, threaded, flanged or socket fusion. Socket fusion shall not be allowed where pipe is supporting a mechanical device. Where socket fusion is used provided additional unions for ease of dismantling.
- .3 Fittings: Schedule 80 PVC threaded flanged or socket. Where socket fusion fittings are installed provide additional unions for ease of dismantling equipment. Fittings shall be compatible with pipe material manufactured to ASTM 02464, 02466 or 02467.
- .4 Cement: NSF 61.
- .5 Acceptable Products: IPEX AquaRise® or approved equal.

2.2 Miscellaneous Couplings and Unions

- .1 Uni-Flange: Only to be used in non-buried applications on ductile iron pipe. Flange to be secured to pipe with set screws tightened to torque recommended by manufacturer. "Uni-Flange" type flanges are only to be used where shown on the Contract Drawings or unless specifically approved in writing by the Engineer.
- .2 Plain pipe couplings, "Dresser type".
 - .1 Full circle, to suit outside diameter of pipe to be joined. Carbon steel sleeve, ductile iron follower, high strength low alloy steel bolts with hexagon nuts to AWWA C111 shop coat enamel finish, rubber gaskets suitable for use with potable water. Acceptable products are Rockwell, Smith Blair, Dresser.
 - .2 Dresser type couplings shall be installed on all pipes exiting structure to allow for differential settlement. Couplings shall be located not more than 1 m away from structures and shall have 11 kg zinc anodes, CAD welded to the casting.
 - .3 Dresser type couplings shall only be installed where shown on the Contract Drawings or where specifically approved in writing by the Engineer.

- .3 Rodded Reinforcement: In Buildings and Chambers Only: Wherever couplings such as "Uni-Flange" and "Dresser" are used, reinforce joint by installing threaded rod across coupling to nearest flange by flange joint. Threaded rod shall be galvanized and of same size as connecting flange bolt holes. Number of rods:
 - .1 200 mm dia. and less - two (2).
 - .2 250 mm dia. and greater - four (4).
- .4 Victaulic Couplings: to suit type of pipe being joined. Collar material, if required, shall be the same material as the adjoining pipe. For ductile iron pipe: Style 31 galvanized for pipe sizes to 600 mm dia. or Style 44 galvanized for larger piping. For carbon steel: Style 77 galvanized. For stainless steel: Style 75 galvanized or Style 77 galvanized. Gaskets provided shall be for portable water use. Victaulic couplings shall be galvanized. All components of Victaulic system must be rated for a minimum working pressure of 1035 kPa.
- .5 Pipe Supports
 - .1 Floor type: adjustable with matching saddle.
 - .2 Hangers: adjustable, clevis type, sized to suit.
 - .3 All supports to be ITT Grinnell or approved equal.
- .6 Nuts and Bolts
 - .1 Hex head of length required S.S. Spec. ASTM F594 or ASTM A193 and A194, GRB-8, Class 2, SS304.

2.3 Valves, Pressure Tanks, and Sample Taps

- .1 Butterfly Valves
 - .1 NPS 75 mm dia. and greater – cast iron body, epoxy coated inside and out meeting the requirements of AWWA C550, (ASTM A126) lug type, manual gear activated c/w handwheel unless noted otherwise, anti-friction coated, stainless steel shaft (and extension stem where required) with self-regulating nylon or teflon bearings, floating seat, replaceable 'BUNA-N' seats, adjustable watertight packings, stainless steel or bronze discs suitable for mounting with ANSI flanges, 1034 kPag (150 psig) CWP.
 - .1 Valve and valve coating to be suitable for use in potable water (NSF 61 Approved) applications.

- .2 Valves shall meet or exceed AWWA C504 and C516.
 - .3 Valves to be suitable for modulating and/or on/off operation. Suitable for dead service with downstream flange removed.
 - .4 Acceptable Products: Pratt, Keystone, Centre Line, Contromatics, Watts or approved equal.
- .2 Torque tube – 75 mm dia. Stainless steel inside and out meeting the requirements of AWWA C550 Tube to be watertight. Provide watertight seal between tube, extension stem and top of butterfly valve. Provide 304 stainless steel wall brackets for tube support. Gear box and handwheel to be located as shown on Contract Drawings. Orientation of handwheel to be agreed upon by site inspector prior to installation. Extension stem diameter as recommended by manufacturer for seating / unseating torques.
- .2 Gate Valves
 - .1 Valves shall meet or exceed AWWA C500 and C509.
 - .2 Copper pipe: NPS 25 mm and under - bronze body, solder joint, 1.4 MPa CWP, rising stem, solid wedge disc. Acceptable product: Crane or approved equal.
 - .3 Galvanized and Stainless-Steel Pipe: NPS 75 mm and under, bronze body, threaded, 1034 kPag (150 psig) CWP minimum, rising stem, solid wedge disc. Acceptable product: Crane, AVK or approved equal.
 - .4 Ductile Iron and Stainless-Steel Piping: NPS 100 mm and greater, iron body, epoxy coated inside and out meeting the requirements of AWWA C550, bronze trim, flanged, 1.4 MPa CWP, rising stem, solid wedge disc, OS and Y. Underwriters and FM approved.
 - .5 Acceptable product: Darling, Kennedy, AVK or approved equal.
- .3 Ball Valves
 - .1 Valves 4" (150mm) and larger shall meet or exceed AWWA C507.
 - .2 Copper Pipe: bronze body, solder joint compact pattern, teflon seats and packing, 2.7 CWP. Acceptable product: Crane, Kitz, Contromatics, Watts or approved equal.

- .3 Copper, Stainless Steel, Galvanized Steel Pipe: NPS 75 mm and under, bronze body threaded, compact pattern teflon seats and packing, 2.7 MPa CWP
Acceptable product: Crane, Kitz, Contromatics, Watts or approved equal.
- .4 PVC Pipe (Schedule 80): NPS 75 mm and under. PVC ball valves shall be used only on PVC piping. Valve shall have union ends, be of thermoplastic construction, have teflon seats and EDPM “O” rings, 1034 kPag (150 psig) CWP. Acceptable product: IPEX, Chemline, or approved equal.
- .5 Stainless Steel (Schedule 40): NPS 75 mm and under. Full Port 316L stainless steel ball, stem and packing. 304 S.S. handles. Acceptable product: Contromatics, Watts, Apollo, Worchester.
- .4 Knife Gate Valve (NOT APPLICABLE)
 - .1 Knife Gate Valves shall be of the diameter as shown of Contract Drawings with full port area and wafer face to face. Valve body shall be stainless steel solid 1-piece with tapped holes.
 - .2 Gate material shall be 316/316L stainless steel. Units shall be complete with resilient seat neoprene capable of handling bidirectional flow.
 - .3 Unless otherwise shown, valves to be complete with protector, stem extension and operating nut (50 mm) of non-rising stem design. Also included shall be the supply and placement of support brackets for support to valve stem assembly, as per manufacturer’s recommendation. Spacing maximum 2m.
 - .4 Valves without stem extensions to be rising stem complete with handwheel operator.
 - .5 Valves shall be rated at 1034 Pag (150 psig) C.W.P. (and shall be static and leak tested).
 - .6 Acceptable product: DeZurik, Safsjo, SMI or approved equal.
- .5 Plug Valve (NOT APPLICABLE)
 - .1 NPS 75 mm and greater cast iron body epoxy coated inside and out meeting the requirements of AWWA C550 round port equal to 90 percent flow area, cam-centric, non-lubricated, quarter turn valve capable of handling bidirectional flow, nickel or stainless-steel seat, manual operated gear activated handwheel unless otherwise noted, non-adjustable packings, 1.2 MPa, CWP.
 - .2 Acceptable product: Valmatic, DeZurik, Keystone, Clow or approved equal.

- .3 Torque tube - 75 mm dia. schedule 40 steel epoxy coated inside and out meeting the requirements of AWWA C550. Tube to be watertight. Provide watertight seal between tube, extension stem and top of plug valve. Provide galvanized wall brackets for tube support. Gear box and hand wheel to be located as shown on Contract Drawings. Extension stem diameter to be as recommended by manufacturer for seating / unseating torques.
- .6 Automatic Motorized Plug Valve
 - .1 Automatic motorized plug valve to be identical to above with electric actuator and gearbox suitably sized for the plug valve chosen. The actuator shall be CSA certified. The actuator shall be designed based on the actual torque required by the valve with a safety margin of not less than 1.5. Valve is to be used for start/stop or modulating flows based on 4-20 mA signals received from the plant PLC. Actuator shall be double sealed in a watertight NEMA 4 enclosure, and submersible to IP 68 (7 metres for 72 hours) be complete with a declutchable lockable manual override emergency handwheel, be of voltage shown on Contract Drawings. Actuator shall conform to AWWA C540, be equipped with end of travel, adjustable limit switches and spare contacts for remote indication. Actuator to be furnished with programmable speed controls and mechanical stops that restrict valve/actuator travel.
 - .2 The actuator shall have an internal self-regulating anti condensation heater. The actuator shall be permanently grease filled suitable for mounting in any position complete with plug and socket terminal connection.
 - .3 Actuator to have continuous local indicator, reversing starters, control transformer, feedback potentiometer, monitor relay, positioner "open-stop-close" pushbuttons, local off remote selector switch and all control and power circuits shall be protected against incorrect power supply. Actuator shall be designed to allow valve to fail closed on loss of command signal. Actuator to be provided with adjustable torque switches set to manufacturer's recommendations.
 - .4 Acceptable product: Rotork IQT or Auma equivalent.
 - .5 The electric actuator/plug valve combination shall be coordinated by one supplier. This supplier shall be responsible for supplying and commissioning on site the components to the satisfaction of the Engineer. Provide the services of the manufacturer's representative to commission the equipment on site on three (3) separate occasions in three (3) trips. The valve and actuator shall be supplied and installed under Division 15 and wired under Division 16.

- .7 Self-Contained Flange Back Weir Gate (NOT APPLICABLE)
 - .1 Provide self-contained, fabricated downward opening rectangle weir aluminum slide gates as shown on the Contract Drawings. Gates to be flange back type with elastomer seals, stainless steel (316/316L) rising stem, transparent graduated stem cover to indicate gate position, heavy duty handwheel operator and yoke. Gate shall be raised by stem connected to perimeter frame (stem shall not be in contact with liquid when gate is open).
 - .2 Acceptable Product: Armtec, Fontaine.
- .8 Self-Contained Flange Back Slide Gates (NOT APPLICABLE)
 - .1 Provide self-contained, fabricated downward closing circular aluminum slide gates as shown on the Contract Drawings. Gates to be flange back type with elastomer seals, stainless steel (316/316L) rising stem, transparent graduated stem cover to indicate gate position, heavy duty handwheel operator and yoke.
 - .2 Acceptable product: Armtec, Fontaine, Dynamic or approved equal.
- .9 Hand Pull Slide Gates (NOT APPLICABLE)
 - .1 Provide hand-pull type fabricated aluminum slide gates where shown on Contract Drawings. Gates to be furnished complete with elastomer seals and frame suitable for embedding in concrete channels. Frame to extend to top of concrete wall.
 - .2 Acceptable products: Armtec, Fontaine, Dynamic or approved equal.
- .10 Swing Flex Check Valve (NOT APPLICABLE)
 - .1 Standards & Approvals: Material to be ANSI/NSF-61 approved, valve and valve coatings must be suitable for use with potable water and meet the requirements of AWWA C550. Conform to ANSI/AWWA C508.
 - .2 Lubricants: To be FDA approved.
 - .3 Operation: Valves in tanks and chambers to be suitable for continuous submerged service.
 - .4 Service: Potable Water.

- .5 Parts and Materials: (For 50 mm diameter and greater) Body and Cover - Cast iron ASTM A126 Class B. Disc/Flapper - Buna-N with steel and nylon or equivalent reinforcement in hinge.
 - .1 Gasket - Compressed non-asbestos fibre.
 - .2 Coatings - ANSI/NSF-61 Epoxy coated inside and out meeting the requirements of AWWA C550.
 - .3 Ends - Flange Type, ANSI B16.1 Class 125 or if not available in size specified, ends to be threaded.
 - .4 Cover Bolts - Alloy Steel SAE Grade 5.
- .6 Cold Working Pressure: 1034 kPag (150 psig) minimum.
- .7 Flow Rate:
 - .1 Minimum = 23.0 Us Maximum = 23.0 Us.
- .8 Options Required: (None Required)
- .9 Remarks: To be full body flanged type with full size access cover to allow removal of the disc without removing the valve from the line. A threaded port with pipe plug shall be provided in the access cover to allow for field installation of a mechanical, disc position indicator.

The valve shall have only one (1) moving part, the flexible disc. The valve body shall have full flow equal to the nominal pipe diameter at all points through the valve. The seating surface shall be on a 45-degree angle to minimize disc travel. A threaded port with pipe plug shall be provided on the bottom of the valve to allow for field installation of a backflow actuator without special tools or removing the valve from the line.

The disc shall be of one-piece construction, precision molded with an integral O-ring type sealing surface and contain steel and nylon or equivalent reinforcement in the hinge. The flex portion of the disc shall be warranted for 25 years.

Non-slam closing characteristics shall be provided through a short 35-degree disc stroke and a memory disc return action.

The valve shall be cycle tested 1,000,000 times with no signs of wear, cracking, or distortion to the valve disc or seat and shall remain drop tight at both high and low pressures. The test results shall be independently certified.

.10 Acceptable Product: Val-Matic Series 500, Singer, or approved equal.

.11 Ball Check Valve

.1 The check valve shall consist of a cast iron body and cover and rubber or rubber coated ball. The ball shall be the only moving part. The ball shall seal tightly against a machined seat in the body and open to allow forward flow. Upon discontinuation of flow the ball shall automatically roll back to the closed position to provide a positive seal against back pressure or backflow. The design shall be self-cleaning and non-clogging.

.2 Sizes smaller than 3-inch shall have NPT connections and 3-inch to 12-inch size shall have integral flanged connections that are faced, drilled and of the thickness required by ANSI/ASME B16.1 Class 125.

.3 The body shall have a removable cover to allow easy extraction of the ball. Flanged valves shall have a bolted cover while NPT valves shall have a threaded cover.

.4 The valve body and cover shall be made from cast iron per ASTM A126 Class B rated for 150 PSI.

.5 The ball shall be solid nitrile rubber or have a metal core with a molded and vulcanized nitrile rubber coating.

.6 Cover bolts and nuts shall be 316 stainless steel.

.7 The interior and exterior ferrous surfaces of the valve shall be coated with a two-part epoxy.

.8 Acceptable Product: GA Industries Figure 240 or 242, or approved equal.

.12 Combination Pressure Reducing and Backpressure Sustaining Valve: (NOT APPLICABLE)

.1 Hydraulically operated, pilot controlled, modulated diaphragm type globe as shown on Contract Drawings.

.2 Cast iron body epoxy coated inside and out meeting the requirements of AWWA C550, stainless steel trim, stainless steel seat ring, adjustable relief range 150 to 400 KPA.

- .3 Valve to be suitable for submerged service.
 - .4 Valve coating to be suitable for potable water application (NSF- 61 Approved).
 - .5 Valve to include a mechanical drop check valve in main valve body.
 - .6 Valve to include a visual position indicator.
 - .7 Ends to be flanged ANSI 8161.1 Class 150 or if not available in size specified, ends to be threaded.
 - .8 Acceptable Product: Singer, Model 106-PR-R, X107-SIV or equivalent from Cla-Val, or approved equal.
- .13 Pressure Reducing Valve (NOT APPLICABLE)
- .1 Hydraulically operated, pilot controlled, modulated diaphragm type globe as shown on Contract Drawings.
 - .2 Cast iron body epoxy coated inside and out meeting the requirements of AWWA C550, stainless steel trim, stainless steel seat ring, adjustable relief range 150 to 400 kPag.
 - .3 Valve to be suitable for submerged service.
 - .4 Valve coating to be suitable for potable water application (NSF- 61 Approved).
 - .5 Valve to include a mechanical drop check valve in main valve body.
 - .6 Valve to include a visual position indicator.
 - .7 Ends to be flanged ANSI B16.5 Class 150 or if not available in size specified, ends to be threaded.
 - .8 Acceptable Product: Singer Model 106-RPS-RR, or equivalent from Cla-Val, or approved equal.
- .14 Pressure Relief Valve
- .1 Pilot operated, pressure relief valve which will open quickly when the inlet pressure meets or exceeds a predetermined pilot pressure setting to relieve damaging over-pressure and closes smoothly at an adjustable speed, as shown on Contract Drawings.

- .2 Cast iron body epoxy coated inside and out meeting the requirements of AWWA C550, or 316/316L stainless-steel trim, 316/316L stainless steel seat ring, adjustable relief setting, flanged end connection of size indicated to ANSI 816.1 Class 150 or if not available in size specified, ends to be threaded.
- .3 Valve bonnet, main valve and removable stem cap shall be constructed of ASTM A536 (Grade 65/45 12) ductile iron or 316/316L stainless steel.
- .4 Main valve trim, consisting of seat ring and stem shall be constructed of AISI B16L or 316/316L stainless steel.
- .5 All main valve fasteners (e.g.; bolts, nuts, studs, cap screws, etc.) shall be supplied as AISI 18-8 or 304 stainless steel.
- .6 The main valve elastomers: diaphragm, resilient disc and seals shall be EPDM or BUNA-N.
- .7 Valve to be suitable for potable water application (NSF61 Approved).
- .8 Valve to be provided with all necessary gauges and auxiliary equipment.
- .9 Acceptable Product: Singer (106-RPS-AC) or equivalent from Cla-Val or approved equal.
- .15 Flow Limiting Control Valve (Filter Backwash Lines) (NOT APPLICABLE)
 - .1 Hydraulically operated, pilot controlled modulating diaphragm type globe valve as shown on Contract Drawings.
 - .2 Cast iron body epoxy coated inside and out meeting the requirements of AWWA C550, bronze or stainless-steel trim, stainless steel seat ring, flanged ends or if not available in size specified, ends to be threaded.
 - .3 Valve to be suitable for submerged service. Valve coating to be suitable for potable water application.
 - .4 Valve to include a mechanical check valve, backpressure sustaining pilot, valve position indicator with air bleed valve on bonnet and orifice plate in housing bolted to outlet of valve.
 - .5 Acceptable Product: Model Singer 106/206 RF or equivalent from Cla-Val or approved equal.

.16 Rate of Flow Control Valve (NOT APPLICABLE)

- .1 Hydraulically operated, pilot controlled modulating diaphragm type globe valve as shown on Contract Drawings.
- .2 Cast iron body epoxy coated inside and out meeting the requirements of AWWA C550, bronze or 316/316L stainless-steel trim, 316/316L stainless steel seat ring, flanged ends or if not available in size specified, ends to be threaded.
- .3 Valve to be suitable for submerged service. Valve coating to be suitable for potable water application.
- .4 Valve to include a mechanical check valve, backpressure sustaining pilot, valve position indicator with air bleed valve on bonnet and orifice plate in housing bolted to outlet of valve.
- .5 Acceptable Product: Model Singer 106/206 RF or equivalent from Cla-Val or approved equal.

.17 Air Release, Air/Vacuum, and Combination Air Valves (NOT APPLICABLE)

- .1 Valves shall meet or exceed AWWA C512.
- .2 NPS 25 mm to 100 mm, cast iron body and cover epoxy coated inside and out meeting the requirements of AWWA C550, 316/316L stainless steel float, trim and internals, BUNA-N seat 1.7 MPA CWP meeting the requirements of C512.
- .3 Valves used in potable water service shall be certified to ANSI/NSF-61.
- .4 Valves for wastewater shall have bodies that are extended in length with a sloped bottom to prevent solid material from reaching the operating mechanism.
- .5 Combination air valves shall perform the functions of both air release and air/vacuum valves and be furnished as a single body.
- .6 Deep well service air/vacuum valves 75 mm and smaller shall be equipped with a dual port throttling device to control the discharge of air from the valve and allow full vacuum flow through a separate port. The device shall have an externally adjustable screw and locknut for adjusting the discharge control disc.
- .7 Deep well service air / vacuum valves 100 mm and larger will be equipped with a Regulated Exhaust Device to prevent valve pressure surges due to rapid changes in velocity and pressure.

- .8 Manufacturer or supplier shall provide the following information: Catalogue data, certified drawings, operating manual.
- .9 Acceptable product: VAL-MATIC, APCO, A.R.I., or approved equal.
- .18 Solenoid Valve
 - .1 Normally closed forged brass, resilient seating of voltage shown on Contract Drawings, 2.1 MPa C.W.P.
 - .2 Required opening and closing pressure 0 kPag.
 - .3 Acceptable Product: Asco or Burkert.
- .19 Sample Tap (No Threads on Outlet)
 - .1 6 to 12 mm dia. stainless steel body, replaceable composition disc, complete with hand wheel and 1034 kPag (150 psig) C.W.P. minimum.
 - .2 In lieu of providing a stainless-steel sample tap the following ball valve assembly is acceptable:
 - .1 6 to 12 mm dia. Threaded inlet pipe of Schedule 40 316/316L stainless steel construction.
 - .2 Stainless steel quarter-turn ball valve with 1034 kPag (150 psig) CWP.
 - .3 6 to 12 mm dia. Schedule 40 316/316L stainless steel outlet pipe c/w 90° elbow and 6 to 12 mm dia. outlet nozzle.
- .20 Pressure Tanks (NOT APPLICABLE)
 - .1 Hydro pneumatic tank with heavy duty butyl diaphragm or bladder
 - .2 Tank assembly shall be suitable for potable water and comply with NSF 61.
 - .3 Tank shall be ASME coded.
 - .4 Maximum working pressure 1207 kPag (175 psig).
 - .5 Painted steel shell complete with floor stand.
 - .6 Tank shall be constructed in accordance with Section VIII, Division 1 of the ASME Code.

.7 Tank to be charged by supplier or Contractor in accordance with tank supplier's recommendations. Minimum 35 kPa below pump cut in pressure.

.8 Acceptable product: Well-X-Trol or approved equal.

.21 Pressure Gauges – see Section 15010: Mechanical General Provisions.

2.4 Operators

.1 General

.1 Provide cast iron handwheels (epoxy-coated) with an arrow and the word "open" cast into the handwheel.

.2 Handwheels, nuts, wrenches and levers shall open when turned counterclockwise.

.3 Provide operators capable of seating and unseating the valves and gates under the specified design pressure or head with a maximum input force of not greater than 250 N pull.

.2 Manual Operators

.1 Provide worm gear operators conforming to AWWA C504.

.3 Motorized Valve Actuator

.1 Provide an actuator suitably sized for type of valve specified. Valve will be used for controlling the water entering the UV units.

.2 Power supply requirements: 120/240V, 1-phase, 60Hz

.3 Actuator to include the following features:

.1 Sealed watertight enclosure, rated NEMA/EEMAC 4.

.2 Declutchable and lockable manual override handwheel, for emergency purposes.

.3 Conforms to AWWA C540-93.

.4 Adjustable torque switch settings, 40 to 100% range.

.5 Adjustable mechanical stop position settings (end of travel).

- .6 Adjustable opening and closing speeds.
- .4 Actuator to include the following protection features:
 - .1 Over torque.
 - .2 Motor over temperature.
 - .3 Automatic phase rotation.
 - .4 Lost phase protection.
 - .5 Jammed protection.
 - .6 Instantaneous reversal (delay between opening and closing control signals).
 - .7 Self-diagnostic upon "power-up".
 - .8 Anti-condensation heater.
- .5 Actuator to include the following control features:
 - .1 Local/Stop/Remote control switch, pad lockable in each position.
 - .2 Open/Close control switch (for local control).
 - .3 Local position and monitoring indication:
 - .1 LCD display of open and closed positions.
 - .2 Three (3) LEDs for open, close and intermediate / traveling positions.
 - .3 Diagnostics for valve condition / alarms.
- .6 Actuator to include the following remote position and monitoring outputs:
 - .1 Valve control switch in "remote" mode.
 - .2 Two (2) valve Fully Closed position contacts (2-SPST).
 - .3 Two (2) valve Fully Opened position contacts (2-SPST).
 - .4 One (1) valve traveling contact (SPST), which opens at Fully Closed position.

- .5 One (1) valve traveling contact (SPST), which opens at Fully Opened positioned.
 - .6 Alarm (monitor) relay contact (SPOT), which activates under the following conditions: loss of power, phase loss, loss of control and motor thermostat trip.
 - .7 Actuator to be capable of the following forms of control:
 - .1 Open/Close; push to run.
 - .2 Open/Close; maintained control with mid-travel reversal.
 - .3 Open/Stop/Close; maintained control.
 - .4 Valve to fail in closed position upon loss of command signals.
 - .4 Coordinate the supply of motorized valve actuator and valve combination with one Supplier. The Supplier will be responsible for supplying and commissioning (on site) the valve components to the satisfaction of Engineer. The valve and actuator will be supplied and installed by Division 15, with field wiring by Division 16.
 - .5 Acceptable actuator manufacturers: Rotork or Auma.
- 2.5 Hose Bibs (Stainless Steel)
- .1 Stainless steel body, replaceable composition disc, threaded spout, complete with hand wheel and 19 mm dia. male threaded spout, 1034 kPag (150 psig) CWP.
 - .2 In lieu of providing a stainless-steel hose bib the following ball valve assembly is acceptable.
 - .1 19 mm dia. threaded inlet pipe of Schedule 40 316/316L stainless steel construction.
 - .2 316/316L Stainless steel 1/4 turn ball valve with 1034 kPag (150 psig) CWP.
 - .3 19 mm dia. Schedule 40 316/316L stainless steel outlet pipe c/w 45° elbow and 19 mm dia. male threaded outlet hose connection.

2.6 Hose Bib (Bronze)

- .1 Bronze body, replaceable composition disc, threaded spout, complete with hand wheel and 19 mm dia. male threaded spout 1034 kPag (150 psig) CWP.

PART 3 - EXECUTION

3.1 Piping Installation

.1 General

- .1 Install straight, parallel and close to walls and ceilings, with specified pitch. Use standard fittings for direction changes.
- .2 Install groups of piping parallel to each other; spaced to permit application of insulation, identification, and services access, on trapeze hangers.
- .3 Install eccentric reducers in horizontal piping to permit drainage and eliminate air pockets.
- .4 Where pipe sizes differ from connection sizes of equipment, install reducing fittings close to equipment.
- .5 Brass and copper pipe and tubing shall be free from surface damage. Replace damaged pipe or tubing.
- .6 Ream ends of pipes and tubes before installation.
- .7 Lay copper tubing so that it is not in contact with dissimilar metal and will not be kinked or collapsed.
- .8 Where copper pipe is embedded in concrete wrap copper pipe in 6 mil polyethylene sheeting to prevent copper from contacting concrete.
- .9 Use non-corrosive lubricant or Teflon tape applied to male thread.
- .10 Grooved pipe end - cut square, seating surface clean and free from indent and score marks.
- .11 Install flanges or unions to permit removal of equipment without disturbing piping systems.
- .12 Clean ends of pipes or tubing and recesses of fittings to be brazed or soldered. Assemble joints without binding.

- .13 Install approved Dielectric couplings where pipes and/or fittings of dissimilar metal are joined.
 - .14 Install all piping valves and fittings on downstream side of fire pumps in accordance with NFPA 20.
 - .2 Equipment drainage
 - .1 Install 20 mm minimum drain valves at low points.
 - .2 Extend equipment drain piping to discharge into floor or hub drain.
 - .3 Interior buried piping
 - .1 Lay pipe on compacted bedding of clean, coarse sand free from clay, snow or ice, organic matter or stones.
 - .2 Do not lay pipe in water or when in opinion of Engineer conditions are unsuitable.
 - .3 Run buried drains minimum 200 mm clear below grade.
 - .4 Water Piping
 - .1 Provide hose bibs at locations as specified.
 - .2 Water piping to be flushed, cleaned and pressure tested prior to being placed in service.
- 3.2 Chain Hoists
 - .1 Where operated valves are located more than 2,100 mm above floor level, lever or handwheel operators are to be replaced with chain wheel operators at no extra cost. Include wall mounted galvanized steel eyebolts and bungee cords to secure chains.
- 3.3 Testing
 - .1 Testing of piping shall be completed in accordance with Section 01715 and NFPA 20 1993 for fire pump systems.
 - .2 Testing to be done in the presence of Engineer.

3.4 Commissioning

- .1 Equipment: make tests to demonstrate capabilities and general operating characteristics of equipment, as instructed by Engineer.
- .2 Equipment installation will only be accepted after receipt of a satisfactory report submitted by the Manufacturer's representative.

3.5 Clean Up

- .1 Leave systems operating with work areas clean to satisfaction of Engineer.

3.6 Painting

- .1 To Section 09915: Painting & Finishing.

3.7 Disinfection (for potable water applications)

- .1 Disinfect all process piping and valves with high strength chlorine solution (minimum 12% chlorine) for 24 hours prior to use. Follow instructions of Owner's representative prior to starting disinfection.
- .2 For process piping and control devices installed in water treatment plants/water supply pumping station disinfect in accordance with AWWA C653, "AWWA Standard for Disinfection of Water Treatment Plants".

END OF SECTION

15420 – Chemical Feed Pumps and Accessories (*As Applicable*)

PART 1 - GENERAL

1.1 Related Work Specified Elsewhere

- .1 Applicable Sections of Division 1, 9, 15 and 16.

1.2 Shop Drawings and Maintenance Data

- .1 Submit shop drawings in accordance with Section 01340.
- .2 Submit operating and maintenance data in accordance with Section 01730.

1.3 Responsibility

- .1 Items listed under this section are to be supplied and installed by Division 15 and wired by Division 16. (*As Applicable*)
- .2 Contractor shall determine the extent of the equipment supply and shall provide all labour material and equipment necessary for completion of the work.
- .3 Contractor shall also as part of this work, remove the existing chemical feed system components (as designated on the contract drawings) and provide to the Town of Shelburne.
- .4 Contractor shall also as part of this work, remove and replace all existing (corroded) anchors supporting the existing chemical feed pumps.
- .5 Contractor shall install a Metcon duplex sodium hypochlorite and long chain linear phosphate dosing system complete with components listed under Part 2 – Products of this section.

1.4 Measurement for Payment

- .1 Payment will be on a lump sum basis under the appropriate item in the Schedule of Items and Prices.

1.5 Commissioning, Start-Up and Warranty Period

- .1 The Contractor shall note the requirements regarding manufacturer's representation for the commissioning, start-up and warranty periods as listed in Section 01725. Include all costs associated with manufacturer's representation.

PART 2 – PRODUCTS

2.1 Chemical Feed Pumps

- .1 Quantity: Four (4) pumps total; Two (2) for sodium hypochlorite feed system and two (2) for long chain linear phosphate feed system (duty and standby for each chemical).
- .2 Material Pumped: Sodium hypochlorite and Long chain linear phosphate solution.
- .3 Capacity: 1.3 L/hr @ 232 psi back pressure.
- .4 Drive size: Suitable for 120 V/1 pH/60 Hz.
- .5 Controls: Microprocessor based, solenoid driven, diaphragm-type programmable pump. Adjustment of the output per stroke (250:1) shall be via an adjustment knob. Pumps to have minimum 3.0 m electrical cord capable of being plugged into 120 V/60 Hz wall receptacle. Stroke length to be set and displayed digitally from 1 to 100%, with increments of 1%.
- .6 Chemical feed pumps and control system will have flow-pacing capability.
- .7 The liquid end shall be acrylic, self de-gassing designed to open at low pressure to allow off-gas to be discharged.
- .8 Feed pumps to be provided with pre-mounted panel as described in Item 2.2.1. Provide two (2) pre-mounted panels for sodium hypochlorite system and long chain linear phosphate system (2-pumps for each) + 2-day tanks and 2-secondary containment tanks to be installed in the chemical room.
- .9 Acceptable Product: **ProMinent Solenoid Driven Diaphragm Pump / GammaX: GMXA1602NPB9M000UD11300EN** or approved equivalent. Pumps and equipment listed in Item 2.2 are to be assembled on panels by one supplier.

2.2 Other Equipment

- .1 Each of the two (2) feed pump systems shall be provided complete with a pre-mounted panel to include the following:
 - .1 Backpressure valve(s).
 - .2 Pressure relief valve(s).
 - .3 Isolating ball valve(s).
 - .4 Pressure gauge(s) c/w diaphragm isolator.

- .5 Check valve(s) and drain valve(s).
- .6 100mL calibration column.
- .7 One flow monitoring sensor per pump c/w fault annunciating relay.
- .8 Pump panel to provide Duty/Standby feed pump operation with automatic switchover and fault re-transmission for systems (sodium hypochlorite and long chain linear phosphate). Acceptable Product: SCG Process Duplex Feed System on HDPE back board or Approved Equal.
- .2 Accessories:
 - .1 Foot valve for each pump suction.
 - .2 Polyethylene suction tubing.
 - .3 Injector assembly for each system.
 - .4 Low Level Switch
- .3 Spare Parts (for each pump size if parts differ):
 - .1 One (1) set spare gaskets.
 - .2 One (1) spare parts kit.
 - .3 One (1) spare diaphragm assembly.
- .4 Solution Tank:
 - .1 Sodium Hypochlorite
 - .1 One (1) tank made of translucent polyethylene.
 - .2 500 litre capacity.
 - .3 Graduated in litres.
 - .4 Lid complete with removable cap for filling.
 - .5 One (1) polyethylene secondary containment tank for sodium hypochlorite chemical. Secondary containment tank must be minimum 550 litre capacity.

.2 Long Chain Linear Phosphate

- .1 One (1) tank made of translucent polyethylene.
- .2 220 litre capacity.
- .3 Graduated in litres.
- .4 Lid complete with removable cap for filling.
- .5 One (1) polyethylene secondary containment tank for long chain linear phosphate. Secondary containment tank must be minimum 250 litre capacity.

END OF SECTION

15425 – Water Quality Monitoring Equipment

PART 1 - GENERAL

1.1 Related Work Specified Elsewhere

- .1 Applicable Sections of Divisions 1, 9, 15 & 16.

1.2 Shop Drawings

- .1 Submit shop drawings in accordance with Section 01340.
- .2 Submit operating and maintenance data in accordance with Section 01730.

1.3 Supply

- .1 Chlorine analyzers, turbidity analyzers and pH/temperature analyzers be provided under Division 15 and wired under Division 16.

1.4 Contractor's Responsibility

- .1 The Contractor shall note the requirements regarding manufacturer's representation for the commissioning, start-up and warranty periods as listed in Section 01725. Include all costs associated with manufacturer's representation.

1.5 Commissioning, Start-Up and Warranty Period

- .1 The Contractor shall note the requirements regarding manufacturer's representation for the commissioning, start-up and warranty periods a listed in Section 01725. Include all costs associated with manufacturer's representation.

PART 2 – PRODUCTS

2.1 Chlorine Residual Analyzer(s) (**PROVISIONAL**)

- .1 Supply and Install one (1) chlorine residual chlorine monitor/analyzer (AE/AIT-501) at location as indicated on the Contract Drawings.
- .2 Chlorine monitors are microprocessor based providing digital display of chlorine concentration and an isolated 4 – 2- mA output.
 - .1 Operating Voltage: 120V, 60 Hz.
 - .2 Display Range: 0 - 6.0 ppm.

- .3 Display Sensitivity: 2% of full scale.
- .4 Readout: 16 character 2-line LCD English display.
- .5 Outputs: Isolated 4 – 20 mA into 1000 ohms.
- .6 Alarms: Two (2) adjustable electro-mechanical relays, selectable high or low alarms with 5A resistive contacts.
- .7 Technology: Amperometric measurement.
- .8 Enclosure: NEMA 4X, wall mount.
- .9 Measuring and Flow Body: PVC.
- .3 Chlorine monitor/analyzer are Prominent DACb model chlorine on-line analyzers and are equipped with:
 - .1 3-point step control.
 - .2 Timer and modulated control
 - .3 pH compensation measuring range: 0.00 to 3.00 mg/L free chlorine.
 - .4 Input: four (4) digital inputs for sample water flow.
 - .5 Output: two (2) 4 – 20 mA analog output (free chlorine and pH).
 - .6 One (1) programmable alarm relay.
 - .7 Two (2) programmable relays for pH.

2.2 Turbidity Analyzers

- .1 Supply and Install one (1) new turbidity meter (AE/AIT-101).
- .2 The turbidimeter shall be continuous reading on-line instrument using the nephelometric method of measurement.
- .3 The control unit shall be microprocessor based providing a digital LED display with 4 digits and automatic decimal positioning and an isolated 4 – 20 mA output.
 - .1 Operating Voltage: 120V, 60 Hz.
 - .2 Range: 0 – 10 Nephelometric turbidity units (NTU).

- .3 Accuracy: +/- 2% of reading +/- 0.01 NTU from 0 to 40 NTU based on formazin primary standard at 25 degrees C.
 - .4 +/- 5% of reading from 0 to 400 NTU based on formazin primary standard at 25 degrees C.
 - .5 Repeatability: <1% of reading or 0.002 NTU, whichever is greater based on formazin primary standard at 25 degrees C.
 - .6 Resolution: 0.05% at 20mA
 - .7 Sample Flow 0.5 – 1.5 l/min.
 - .8 Sample Pressure: Up to 3 bar (43.5 psi)
 - .9 Operating Temp. Range: 0 °C to 50 °C.
 - .10 Enclosure – NEMA 4X with clear polycarbonate cover.
 - .11 Mounting: Wall.
- .4 Acceptable Product: Hach TU5300sc with bubble trap, SC4500 Controller

PART 3 – EXECUTION

- 3.1 All equipment provided under this section to be provided by one supplier and installed in accordance with manufacturer's recommendations and to be fully compatible and operational for this application.
- 3.2 All equipment be fully calibrated and commissioned by manufacturer's representative.

END OF SECTION

15604 – Pre-Selected Ultra Violet Disinfection Equipment

PART 1 - GENERAL

1.1 Related Work Specified Elsewhere

- .1 Applicable Sections of Division 1, 3, 15 and 16.

1.2 Reference Standards

- .1 Construct to manufacturer's instructions.

1.3 Shop Drawings and Maintenance Data

- .1 Submit shop drawings in accordance with Section 01340.
- .2 Submit operating and maintenance data in accordance with Section 01730.

1.4 Pre-Selection

- .1 H2Flow has been pre-selected to supply the Ultra-Violet Disinfection equipment (TrojanUVSwift 2L12) included in **Appendix A: Pre-Selected UV Equipment**. Equipment supplied is to be installed by the Contractor under this Contract. The Contractor is responsible for co-ordination with pre-selected supplier.

1.5 Contractor's Responsibility

- .1 The Contractor shall purchase and install the pre-selected equipment.
- .2 The Contractor shall be responsible for the installation of the equipment in accordance with the manufacturer's recommendations.
- .3 Pre-selected equipment package and related components to be installed under Division 15 and wired under Division 16.
- .4 Coordinate with electrical subcontractor.
- .5 Contractor shall determine extent of pre-selected equipment supply and shall provide all labour, material and equipment necessary for a complete operational system.

1.6 Measurement for Payment

- .1 Payment will be on a lump sum basis under the appropriate item in the Schedule of Unit Prices.
- .2 The Contractor shall be responsible for assuming all costs, contractual obligations and warranty period associated with installation of the pre-selected Ultraviolet system as provided by H2Flow.

1.7 Commissioning, Start-Up and Warranty Period

- .1 The Contractor shall note the requirements regarding manufacturer's representation for the commissioning, start-up and warranty periods as listed in Section 01725. Include all costs associated with manufacturer's representation.

END OF SECTION

Electrical General Requirements

1 GENERAL

1.1 Description

- .1 This Section covers items common to Sections of Division 16. This section supplements Division 1 – General Requirements.
- .2 In case of a discrepancy between statement(s) or value(s) in this section or contract drawing(s), the higher statement or value takes precedence and shall govern.

1.2 Scope of Work

- .1 Removal and replacement of equipment as indicated on contract drawings and as listed under specification 16020.
- .2 Provide new incoming electrical power service for well pumphouse.
- .3 Coordination with local utility company.
- .4 Provide new communication ductbanks to communication handhole and existing Bell pedestal.
- .5 Provide new MCC including ATS, starters, feeder breakers, etc.
- .6 Provide new standby diesel-engine generator complete with sound attenuating enclosure and sub-base fuel tank.
- .7 Reconnection of existing equipment as indicated on contract drawings.
- .8 Provide new grounding system.
- .9 Provide new controls, power and instrumentation equipment as listed on contract drawings.
- .10 Provide new PLC panel and controls.
- .11 Provide new autodialer including telephone line connection for alarm call outs.
- .12 Provide power and control wiring for relocated and new HVAC equipment. Coordinate all work with Division 15 contractor.
- .13 Provide control, power and instrumentation wiring for new UV equipment as indicated on contract drawings.

1.3 Definitions

- .1 The following are definitions of terms and expressions used in the documents:
 - .1 “Local Inspector, Inspection Department or Authority” mean agents of any authority having jurisdiction over construction and safety standards associated with any part of electrical work on site, such as ESA for Ontario.
 - .2 “Power Supply Authority” or “LUC” means electrical local utility company responsible for delivery of electrical power to project site.
 - .3 “Electrical Code” or “OESC” means Ontario Electrical Safety Code C22.1 or code in force at project location, latest edition.
 - .4 “Indicated” means as shown on contract drawings or noted in contract documents.
 - .5 “Provide” means fabricate, supply, install, test and commission the electrical system and/or equipment.
 - .6 “Remove” or “Removed” means to disconnect, remove, and dispose of equipment, material or item.
- .2 Refer to CSA C22.2 No.0 for “Definitions and General Requirements”.

1.4 Codes and Standards

- .1 Do complete installation in accordance with the latest editions of the Canadian Electrical Code – CSA C22.1, the Ontario Electrical Safety Code and any local codes and requirements which govern the installation. Where these regulations conflict, apply the most stringent condition.
 - .1 Do overhead and underground systems in accordance with CSA C22.3 No.1-10 and No.7-M86 except where specified otherwise.
 - .2 Electrical Abbreviations: to CSA Z85_1983.

1.5 Care, Operation and Start-up

- .1 Instruct Engineer and operating personnel in the operation (testing), care and maintenance of equipment.
- .2 Arrange and pay for services of manufacturer’s factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components.

- .3 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with all aspects of its care and operation.

1.6 Voltage Ratings

- .1 Operating voltages: to CAN3_C235_83.
- .2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.
- .3 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

1.7 Permits, Inspection and Fees

- .1 Submit drawings and specifications to Electrical Inspection Department and Supply Authority to obtain all required electrical permits.
- .2 Notify the Electrical Inspection Department in sufficient time for them to inspect work. Contractor is responsible to arrange multiple inspections (as required) to ensure the work has been properly inspected at completion of project.
- .3 Contractor to keep a separate "logbook" related to the Electrical Inspections. Contractor must record inspector's name, date and scope of inspections, recording all statements, decisions and permissions made during each inspection visit. Notify Engineer of any changes required by Electrical Inspection Department prior to making changes. Submit logbook to Engineer at completion of project.
- .4 Submit to Engineer "Certificate of Acceptance/ Approval" from Electrical Inspection Department at completion of project. Building Occupancy will not be granted unless electrical inspection certificate has been completed and submitted to engineer.
- .5 Division 16 Contractor to pay all associated fees for electrical permits, inspections and special product approvals.

1.8 Coordination with "Power Supply Authority"

- .1 The Engineer has submitted selected contract drawings to the Power Supply Authority prior to tendering. The contractor is responsible to coordinate and

satisfy all requirements of the Power Supply Authority, to ensure availability of (permanent) power service is provided at completion of project.

- .2 Refer to contract drawings for scope of work by Power Supply Authority.
- .3 Power Supply Authority: Hydro One
- .4 Division 16 Contractor to pay all associated connection fees or charges for power supply authority services.

1.9 Coordination with Other Trades:

- .1 Be responsible and coordinate other sub-trade work with electrical requirements and ensure that there is no interference with or delay caused by such work to the electrical or other trades work.
- .2 Notify other sub-trades of all openings, inserts, anchors, sleeves, hangers, foundations, etc., necessary for electrical work, and be responsible that these are provided and correctly installed at the proper time.
- .3 Fully cooperate with all trades in the provision and maintenance of electrical power in all areas throughout the period of construction.

1.10 Work by Control System Integrator (CSI) Contractor:

- .1 The CSI Contractor is to supply and commission the new PLC and the Municipality's existing SCADA network equipment and programming required to monitor and control the new electrical equipment and instruments as per the Municipality's standards.
- .2 Electrical Contractor is to install, test, and commission the new PLC Panel, including provide all wire tagging, wiring and conduit between the PLC Panel and all field devices.
- .3 The electrical contractor will also coordinate with the CSI to test and commission all PLC programming and all new SCADA programming and equipment.
- .4 All work performed by the CSI Contractor is to be paid as part of this contract, refer to the tender form for details.
- .5 Acceptable CSI:
 - .1 DataSoft Software Solutions
 - .2 Selog Norteck Inc.

1.11 Shop Drawings and Product Data

- .1 Submit shop drawings and product data in accordance with Section 01340 "Shop Drawings, Product Data and Samples" for review prior to commencement of manufacturing or installing with the exception of conduit, standard conduit fittings and low voltage wiring.
- .2 The Contractor shall review and approve all shop drawings prior to submission to the Engineer. Each submission must bear the Contractor's shop drawing stamp, indicating that the drawings have been checked for compliance with the contract documents.
- .3 Submittal Procedure:
 - .1 The Contractor shall submit digital copies in PDF format to the Owner and Engineer via email. All drawings are to be submitted electronically in pdf format.
 - .2 The drawings will be returned to the Contractor stamped and marked "Conforms with Intended Design", "Conforms with Intended Design with Revisions Noted", or "Non-Conforming - Revise and Resubmit".
 - .3 When drawings are returned "Non-Conforming - Revise and Resubmit", make the necessary alterations and resubmit.
 - .4 When drawings are returned "Conforms with Intended Design with Revisions Noted", the drawings may be used to execute the work in compliance with the Contract Documents. No other alterations are to be made to the drawings by the Contractor subsequent to receipt of drawings stamped and marked as above. If further changes are made in addition to the Engineer's notations, then the drawings must be resubmitted for further review.
 - .5 When drawings are returned "Conforms with Intended Design", the Contractor shall be responsible for distribution of additional copies of Shop Drawings as necessary and as requested by the Engineer.
- .4 Show all details of construction, dimensions, capacities, weights, and electrical performance characteristics of equipment or material.
- .5 Prepare composite construction drawings, fully-dimensioned of cables, conduit, cable tray, bus duct, sleeves, clearances, pipes, ducts, etc., and equipment in mechanical and electrical equipment rooms, ceiling spaces and all other critical locations to avoid a conflict of trades. Base drawings on

manufacturer's shop drawings. Drawings should be developed from consultation with and agreement of all trades involved.

- .6 Prepare drawings of equipment bases, anchors, slabs, floors and roof curbs, if needed, for the electrical work.
- .7 Include, but not necessarily limit to, the following:
 - .1 Single line diagram.
 - .2 Elementary control diagrams for motor starters, control circuits, etc. Include wire numbering system.
 - .3 Manufacturer's data and specifications of major electrical equipment, such as MCC, switchboard, panelboard, splitters, disconnect switches, etc.
 - .4 Control panel layouts, and all auxiliary controls and indicating panels.
 - .5 Lighting fixtures, including photometric data.
 - .6 Indicate the number or letter used on the drawings/specifications as an identification symbol on product data for panel boards, light fixtures, instruments and other equipment submitted.
 - .7 Shop drawings will be marked as "Reviewed", Reviewed as Modified" or "Revise and Resubmit for Review". The review of shop drawings is for the sole purpose of ascertaining conformance with general concept and does not in any way relieve the Contractor of responsibility for compliance with the contract document and specifications. No approval is given or responsibility assumed by the engineer or Contract Administrator for the detail design inherent in the shop drawing.
 - .8 Bind one complete set of construction/shop drawings showing "Record" conditions in each operating and maintenance instruction manual.

1.12 Record Drawings

- .1 Before commencing work, obtain two sets of electrical drawings for showing "As Built" conditions. As job progresses, mark on field set of prints to indicate accurately all installed work. At completion of project, manually transfer all information onto second set of drawings using red marker/pen, and indicate

“Contractors Certified Approval of Accuracy” before submitting to Engineer for review and record use.

- .2 Indicate on record drawings “As Built” stamp.
- .3 Include with the record drawings a list of all motors indicating motor or equipment number and name, name-plate voltage, horsepower and current, the size of overload and breaker or fuse protection provided for each motor.
- .4 Indicate on record drawings, location of all buried services. This information is to be certified correct by Engineer before backfilling commences.

1.13 Workmanship

- .1 Install all equipment, conduit and cables in a workmanlike manner to present a neat appearance and to function properly.
- .2 Install exposed systems and equipment neatly and grouped to present a neat appearance, without conflict to other services.
- .3 Install equipment and apparatus requiring maintenance, adjustment or eventual replacement with due allowance therefore, in terms of space and accessibility.
- .4 Include in the work all requirements of manufacturers shown on the shop drawings or manufacturers’ installation instructions and make provision for future plant and equipment as shown.
- .5 Replace without extra cost work unsatisfactory to the Engineer.
- .6 Protect all equipment from damage during delivery to the site and during installation. Make good any damage or deterioration whatsoever and have it covered by replacement guarantee.

1.14 Materials and Equipment

- .1 Equipment and material must be CSA certified. Where there is no alternative to supplying equipment, which is not CSA certified, obtain special approval from Electrical Inspection Department. Pay all associated fees.
- .2 Factory-assemble control panels and component assemblies.
- .3 Provide Canadian manufactured equipment and materials, except where specified otherwise or where Canadian made materials or equipment do not exist.

1.15 Finishes

- .1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.
 - .1 Paint outdoor electrical equipment "equipment green" finish to EEMAC Y1_1_1955.
 - .2 Paint indoor switchgear and distribution enclosures light grey to EEMAC 2Y_1_1958 (ASA #61).
- .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 non galvanized hangers, racks and fastenings to prevent rusting.

1.16 Equipment Identification

- .1 Supply and install identification nameplates on all equipment such as motor starters, safety switches, panelboards, pushbutton stations, control panels, etc., and any equipment not so supplied.
- .2 Nameplates:
 - .1 Lamicoid 3 mm thick plastic engraving sheet, black face, white ore, mechanically attached with double-sided tape. Nameplate sizes are as follows:

NAMEPLATES:
Size 1: 1 line, 3 mm high letters
Size 2: 1 line, 6 mm high letters
Size 3: 2 lines, 6 mm high letters
Size 4: 1 line, 12 mm high letters
Size 5: 2 lines, 12 mm high letters
Size 6: 1 line, 25 mm high letters
Size 7: 2 lines, 25 mm high letters
- .3 Wording on nameplates to be approved by Engineer prior to manufacture.
- .4 Allow for average of twenty-five (25) letters per nameplate.
- .5 Identification to be English.
- .6 Disconnect switches, starters and contactors: Size 4, indicate equipment description, tag description and voltage.

- .7 Terminal cabinets, pull and junction boxes: Size 2, indicate panelboard system, tag description and voltage.
- .8 Transformers: Size 5 indicate tag number, kVA capacity, phases, system primary and secondary voltages.
- .9 Control Panels: Size 4 or 5, indicating panel description and tag description.
- .10 Provide a typewritten circuit directory with clear plastic cover for each panel board in a suitable holder on the inside of each panel door. Indicate breaker circuit number, rating, load description, and associated load data. On outside of panel board door, indicate tag number, capacity, phases and voltages.
- .11 For all buried incoming ducts provide a "buried cable" marker on the building where the buried service enters.

1.17 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 code: to CSA C22.1_1986.
- .4 Use colour coded wires in communication cables, matched throughout system.
- .5 Use Control Panel/PLC wiring identification system on both ends for all associated field devices as indicated by panel builder shop drawing submissions.

1.18 Conduit and Cable Identification

- .1 Colour code conduits, boxes and metallic sheathed cables.
- .2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 10 m intervals.
- .3 Colours: 25 mm wide prime colour and 12 mm wide auxiliary colour.

	<u>Prime</u>	<u>Auxiliary</u>
up to 600 V	Yellow	green
up to 5 kV	Yellow	blue
up to 15 kV	Yellow	red
Telephone	Green	
Other communication systems	Green	blue
Fire alarm	Red	

Emergency voice	Red	blue
Other security systems	Red	yellow

1.19 Wiring Terminations

- .1 Lugs, terminals, screws used for termination of wiring to be suitable for copper conductors.

1.20 Manufacturers and CSA Labels

- .1 Visible and legible after equipment is installed.

1.21 Warning Signs

- .1 As specified and to meet requirements of Electrical Inspection Department and Engineer.
- .2 Decal signs, minimum size 175 x 250 mm.

1.22 Single Line Diagram

- .1 Provide electrical single line diagrams in glazed frames at main service entrance switch.
- .2 Drawings: 600 x 600 mm minimum size. Develop drawing using "AutoCAD 2015 version. Submit electronic copy of drawings to Engineer.
- .3 Submit diagram to Engineer for review prior to installation.

1.23 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:
 - .1 Local switches: 1200 mm.
 - .2 Wall receptacles:
 - .1 General: 300 mm.
 - .2 Above baseboard heater: 300 mm.
 - .3 Above top of counters or counter splash backs: 175 mm.
 - .4 In mechanical rooms: 1200 mm.

- .3 Panelboards: as required by Code or as indicated.
- .4 Telephone and interphone outlets: 300 mm.
- .5 Wall-mounted telephone and interphone outlets: 1500 mm.
- .6 Thermostats: 1500mm.
- .7 Fire alarm stations: 1200 mm.
- .8 Fire alarm bells: 2100 mm.
- .9 Television outlets: 300 mm.
- .10 Wall-mounted speakers (horns): 2100 mm.
- .11 Clocks: 2100 mm.
- .12 Doorbell pushbuttons: 1500 mm.
- .13 Exterior wall mounted fixtures: 2600 mm.

1.24 Load Balance

- .1 Measure phase current in each panelboard 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.
- .3 Submit, at completion of work, report listing phase and neutral currents in panel boards, dry-core transformers, switchboards, and motor control centers, operating under normal load. State hour and date on which each load was measured, and voltage at time of test.

1.25 Conduit and Cable Installation

- .1 Install conduit and sleeves prior to pouring of concrete or core-drilling through existing walls. Sleeves through concrete: schedule 40 steel pipe, sized for free passage of conduit, and protruding 50 mm.
- .2 Install cables, conduits and fittings to be embedded or plastered over, neatly and close to building structure so furring can be kept to minimum.
- .3 Arrange for holes through exterior walls and roof to be flashed and made weatherproof.

1.26 Insert, Sleeves, Fastenings and Supports

- .1 Provide all necessary inserts, hangers, fastenings, sleeves and curbs for electrical equipment, suspended from or passing through structural walls or floors, to suit the specific location, and as approved by the Engineer.
- .2 Sleeves: allow 12 mm clearance over the O.D. of all cables and conduits, 25 mm horizontally and vertically for rectangular openings.
- .3 Finish sleeves flush with wall finish (each side) or the ceiling to curb top.
- .4 Secure equipment to solid masonry, tile and plaster surfaces with lead anchors or nylon shields, properly sized for the load to be carried.
- .5 Secure equipment to poured concrete with expandable inserts, properly sized for the load to be carried.
- .6 Secure equipment to hollow masonry walls or suspended ceilings with factory made threaded or toggle type inserts, properly sized for the load to be carried.
- .7 Secure surface-mounted equipment with twist clip fasteners to inverted T-bars ceilings. Ensure that T-bars are adequately supported to carry weight of equipment specified before installation.

1.27 Cutting, Patching and Welding

- .1 Where installation of equipment by this section requires cutting or patching of new or existing work, the work shall be performed by, and under direction and supervision of, this section. Make good surface finishes to satisfaction of the Engineer.
- .2 No cutting or welding of beams, columns or structural surfaces is permitted without approval of the Engineer and all damage to finished or unfinished surfaces shall be made good to the satisfaction of the Engineer.
- .3 Pay all costs for cutting and patching resulting from failure to co-ordinate timely installation of electrical inserts, sleeves, etc., into masonry structures.

1.28 Fireproofing

- .1 Where sleeves or openings are installed in walls, floors, roof or partitions to accommodate raceways, cables or bus duct, provide all necessary seals, fittings, barriers and fire-resistant materials to restore the installation to its original fire rating to the satisfaction of the Building Code, governing

authorities and the Owner's insurance underwriters. Work To be completed by authorized fireproofing contractor.

1.29 Excavation and Backfill

- .1 Ensure that route and depth of excavation for underground electrical services is as indicated. Provide protective materials around and over services and be present at all times during excavation and backfilling to supervise work.
- .2 Contact Electrical Inspection Authority prior to backfilling of electrical service cables and ductbanks.

1.30 Field and Quality Control (Testing)

- .1 General
 - .1 Prior to the Owner's acceptance, all electrical equipment, materials and systems installed shall be subject to an inspection and applicable performance tests supervised by the Owner and/or the Engineer to ensure that the operation of the system and components satisfy the requirements of the Contract Documents.
 - .2 Ensure that the system and its components are ready prior to the inspection and test for acceptance.
 - .3 Conduct all testing by fully qualified personnel only. Tests requiring initial power energization of a system shall not be made without notification of the Owner and/or Engineer. Tests, checks and the like carried out by or on behalf of the Contractor shall be documented and certified at no additional cost to the Owner. Submit two copies of the test certificates to the Engineer.
 - .4 Carefully check wiring for each system and/or part of a system to ensure that the system will function properly as indicated by wiring and schematic diagrams, description of operation, etc.
 - .5 Manually operate alarms and control devices to check whether their operation during normal and abnormal operating conditions causes the proper effect.
 - .6 In addition to tests on purely electrical systems, supply the necessary labour and equipment for operational tests required by other Divisions where electrical services are involved and make final

adjustments to the electrical controls at no additional cost to the Engineer.

- .7 Perform tests on auxiliary or specialized systems with the assistance of the manufacturer's representative. Upon successful conclusion of the tests, obtain a certificate from the manufacturer stating that the system has been installed to their satisfaction and that it is in good working order.
- .8 Ensure circuit protection devices such as overcurrent trips, relays and fuses are installed to values and settings as indicated.
- .9 Replace at no additional charge all fuses, relays, or other devices destroyed during field quality control (testing).
- .10 Supply all instruments, meters and personnel required for the tests.
- .11 Clean equipment by vacuum. Clean, wax and polish all new exterior surfaces, check and tighten all electrical connections.
- .2 Cable and Wire - 1000 Volt and Below:
 - .1 Limit all tests on cables in this voltage range to insulation resistance measurements using a megger: 500 V instrument for circuits up to 350 V systems; 1000 V instrument for 351-600 V systems.
 - .2 Record all test results in a logbook and submit to the Engineer for reference. Replace or repair all circuits which do not meet minimum requirements specified in the governing Electrical Safety Code. Measure insulation resistance of the following circuits:
 - .1 Power, lighting and motor feeders (with equipment disconnected): phase-to-phase, and phase-to-ground.
 - .2 Control circuits: measure to ground only.
 - .3 Do not perform megger tests on control circuits containing transistorized or solid-state components.
 - .4 Where power factor correction equipment is installed, it may be necessary to disconnect the capacitors from the system prior to testing to avoid overvoltage.
- .3 Grounding System
 - .1 Test the ground system efficacy for compliance with CSA Standard C22.1 and Supply Authority requirements. Verify that the ohmic

resistance values specified therein are not exceeded. Provide method used to obtain results.

- .2 Notify Inspection Authority and Power Supply Authorities that they may be present to witness Contractor testing and provide any assistance required by these Authorities for their own testing procedures.

1.31 Coordination of Protective Devices (Coordination Study)

- .1 It is understood that the gather of information to complete the Protection Device Evaluation is the responsibility of the contractor.
- .2 Ensure all protective devices ratings and settings are properly coordinated to suit the actual equipment supplied and/or installed or to which it is being connected.
- .3 Record and submit to Engineer all protective devices settings.
- .4 Provide a system coordination time-current curves on Log-Log paper (Keuffel & Esser Co., #48-5258) for all protective devices. Include but not be limited to the following:
 - .1 All protective devices on 600V and 240/120V systems.
 - .2 Supply authority's power cables and fuse curves.
 - .3 Damage curves for main power supply transformer(s): 3-phase, phase-ground, phase-phase and inrush current point.
 - .4 Molded case circuit breaker trips - thermal and instantaneous.
 - .5 Starting current of largest motor on the system including the offset of the running load.
 - .6 Damage curves for high and low voltage power cables.
 - .7 Three-phase RMS bolted fault values, phase-to-phase and phase-to-ground.
 - .8 Engine-Generator Set 1-phase RMS bolted fault valves, phase-to-phase and phase-to-ground.
- .5 Submit all data for review sufficiently in advance of equipment ordering.

1.32 Measurement for Payment

- .1 No measurement for payment will be made under this section.

1.33 Basis of Payment

- .1 All labour, materials and equipment necessary for the work in this Section shall be included in the lump sum prices in the Schedule of Items and Prices.

END OF SECTION

Shop Drawing Log

Item	Reviewed By	Review Status	Date Received	Date Returned	Comments
Section 16010 - Electrical General Requirements					
Record Drawings					
Load Balance					
Section 16012 - Field and Quality Control (Testing)					
Field and Quality Control (Testing)					
Cable and Wiring Testing					
Section 16015 - Coordination, GPR Study & Relay Prog.					
Protective Device Evaluation					
Short Circuit Analysis Study/Ground Potential Rise Study					
Arc Flash Assessment Study					
Section 16105 - Underground Duct Systems, etc.					
Markers					
Precast Electrical Handholes					
Precast Cable Pulling Chamber					
Section 16110 - Raceway Systems					
Conduits					
Section 16120 - Wires & Cables					
Low Voltage Wire and Cable (1000V and Below)					
Instrumentation Signal Wiring					
Section 16400 Basic Electrical Equipment					
Disconnect Switches					

Item	Reviewed By	Review Status	Date Received	Date Returned	Comments
Meter Bases (Sockets)					
Fusing					
MCC Surge Protection Device (SPD)					
Power Panel Surge Protection Device (SPD)					
Power Filter Surge Protection Device (SPD)					
Dry Type Transformer (up to 600V Primary)					
Power Panelboards					
Motor Starters and Contactors					
AC Control Relays (Instantaneous)					
Relay Accessories					
Timing Relays					
Pushbuttons					
Selector Switches					
Indicating Lights					
Control Circuit Transformers					
Section 16450 Grounding					
Telecommunication System Grounding and Bonding					
Section 16480 Motor Control Centres					
Motor Control Centre					
Section 16482 Reduced Voltage Soft Starters					
Soft Starter					
Section 16505 Lighting Equipment					

Item	Reviewed By	Review Status	Date Received	Date Returned	Comments
Lighting Luminaire Schedule Type L1					
Section 16623 Standby Power Diesel Generator Set - Outdoor Unit (Integral Tank)					
Generator					
Section 16627 Auto-Transfer Switch Equipment					
Auto-Transfer Switch					
Section 16700 Telephone and Security Alarm Systems					
Telephone System					
Access Control System					
Section 16745 Data (Ethernet) System					
Data Ethernet Cabling					
Ethernet Switch					
Ethernet/IP to Modbus TCP/IP Communication Module					
Outlet Jacks					
Ethernet Patch Cables					
Section 16850 Services for Mechanical Equipment					
Exhaust fan control panels					
Section 16865 Electric Heating & Cooling					
Force Fan Heater					
Thermostats					
Section 16900 Instrumentation					
PLC Panel					
Pressure Measuring Instrument (PIT)					
Flood Switch					
Loop Power Supply Units					

Item	Reviewed By	Review Status	Date Received	Date Returned	Comments
Signal Isolators					
Uninterruptible Power Supply Unit (UPS)					
Temperature Alarm Low Thermostat					
Smoke Detector					
Enclosure Door Contact Switches					
Alarm Beacon					
Alarm Horn					
Section 16901 Auto Dialer					
Auto-Dialer Requirements					
Section 16910 Process Control System					
Process Controller (PLC)					
Operator Interface Device (HMI)					
Section 16915 SCADA Software and Workstations					
SCADA Software					
Alarm Notification Software					
Printing Equipment					
Workstation Accessories					

Review Status: C Conforms with Intended Design
 CRN Conforms with Intended Design with Revisions Noted
 NCR Non-Conforming - Revise and Resubmit

END OF SECTION

Field and Quality Control (Testing)

1 GENERAL

1.1 General Conditions

- .1 All sections of Division 1 form a part of this Specification. Read and fully adhere to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this section.
- .3 All sections of Divisions 1 to 16 inclusive form part of the Contract Documents. Refer to Section 16010 for General Electrical Requirements related to this work.

1.2 Scope

- .1 Furnish all labour, materials, supervision, equipment and services specified, indicated or requested to provide the Field and Quality Control (Testing) described herein.
- .2 This section relates to all equipment designed, supplied and installed under the Division 16 of Specifications.
- .3 It is the contractor's responsibility to collect all the required data for preparation of the testing requirements.
- .4 Work listed herein must be performed by fully qualified personnel trained in such type of work.

1.3 Measurement for Payment

- .1 No measurement for payment will be made under this section.

1.4 Basis of Payment

- .1 All labour, materials and equipment necessary for the work in this Section shall be included in the lump sum prices in the Schedule of Items and Prices.

2 PRODUCTS

Not Applicable

3 EXECUTION

3.1 General

- .1 Prior to the Owner's acceptance, all electrical equipment, materials and systems installed shall be subject to an inspection and applicable performance tests supervised by the Owner or the Engineer to ensure that the operation of the system and components satisfy the requirements of the Contract Documents.
- .2 Ensure that the system and its components are ready prior to the inspection and testing for acceptance.
- .3 Conduct all testing by fully qualified personnel only. Tests requiring initial power energization of a system shall not be made without notification of the Owner or Engineer. Tests, checks and the like carried out by or on behalf of the Contractor shall be documented and certified at no additional cost to the Owner. Submit two copies of the test certificates to the Engineer.
- .4 Carefully check wiring for each system or part of a system to ensure that the system will function properly as indicated by wiring and schematic diagrams, description of operation, etc.
- .5 Manually operate alarms and control devices to check whether their operation during normal and abnormal operating conditions causes the proper effect.
- .6 In addition to tests on purely electrical systems, supply the necessary labour and equipment for operational tests required by other Divisions where electrical services are involved and make final adjustments to the electrical controls at no additional cost to the Engineer.
- .7 Perform tests on auxiliary or specialized systems with the assistance of the manufacturer's representative. Upon successful conclusion of the tests, obtain a certificate from the manufacturer stating that the system has been installed to their satisfaction and that it is in good working order.
- .8 Ensure circuit protection devices such as overcurrent trips, relays and fuses are installed to values and settings as indicated.

- .9 Replace at no additional charge all fuses, relays, wiring or other devices destroyed during field quality control (testing).
- .10 Supply all instruments, meters and personnel required for the tests.
- .11 Clean equipment by vacuum. Clean, wax and polish all new exterior surfaces, check and tighten all electrical connections.

3.2 Cable and Wire Testing:

- .1 Limit all tests on cables in this voltage range to insulation resistance measurements using a megger: 500V instrument for circuits up to 350V systems; 1000V instrument for 351V to 600V systems including all high voltage cables.
- .2 Perform DC Hi-Pot testing on all new high voltage cables, as follows:
 - .1 Perform test procedures as per manufacturer's recommendations, and according to IEEE standards for cable type. Also, perform an "acceptance test" to verify and detect any defects in the cable insulation and terminations.
 - .2 Ensure all safety procedures are in place prior to testing of cables.
 - .3 Record all cable tests results from the DC Hi-Pot testing and submit to Engineer for review. Include a description of the testing method and procedure used, date of test, and name of operator, and test weather conditions.
- .3 Record all test results in a logbook and submit to the Engineer for reference. Replace or repair all circuits which do not meet minimum requirements specified in the governing Electrical Safety Code. Measure insulation resistance of the following circuits:
 - .1 Power, lighting and motor feeders (with equipment disconnected): phase-to-phase, and phase-to-ground.
 - .2 Control, CT and PT circuits and cables: measure to ground only.
 - .3 Do not perform megger tests on control circuits containing transistorized or solid-state components.
 - .4 Where power factor correction equipment is installed, it may be necessary to disconnect the capacitors from the system prior to testing to avoid overvoltage.

3.3 Grounding Grid System Testing (Fall-of-Potential method)

- .1 Test the ground grid system efficacy for compliance with CSA Standard C22.1, IEEE 81 and Supply Authority requirements. Verify that the ohmic resistance (impedance) value specified in the calculated GPR study is not exceeded, and the tolerable “touch and step voltages” (OESC Table 52) are confirmed.
- .2 Testing method: use the 3-point “fall-of-potential” method as per IEEE 81 standard for confirming the grounding grid impedance for the substation. Plotted measurements on a curve of resistance vs. distance. Correct earth resistance is read from the curve for the distance that is roughly 62% of the total distance between “C1” and “C2” probes, as the fall-of-potential method:
 - .1 Full fall-of-potential: perform a number of grounding tests, made up of different spaces/distances of “P” probe and plot the full resistance curve.
 - .2 Submit final curve and impedance value as a shop drawing submission.
- .3 Notify Inspection Authority, Power Supply Authorities and Engineer that they “may” be present to witness Contractor testing and provide any assistance required by these authorities for their own testing procedures.

3.4 Inspection, Testing and Start-up for 25kV High Voltage Switchgear

- .1 Prior to removal of equipment off transporting vehicle (i.e., while FOB), perform a general inspection of equipment noting any signs of damage. Review shop drawings and contract drawings to confirm if equipment is in general conformance with the intended installation. Provide a “verbal” recommendation to Engineer that the equipment is suitable for installation. Follow up with a written report within five business days.
- .2 Prior to energization of incoming power supply and after equipment is installed at its final position, perform the following tests and recommendations:
 - .1 Clean and inspect all bushings, insulators and lightning arrestors.
 - .2 Clean contacts on disconnect switch and coat with anti-corrosion protection (as per manufacturer’s recommendations).
 - .3 Fuses: check and measure resistance.

- .4 Inspect grounding system, mechanical interlock systems (for correct operation), and control wiring interfaces.
 - .5 Inspect and tighten (if necessary) all connections.
 - .6 Measure resistances of all bus bars and cables (incoming and feeders.)
 - .7 Provide a “verbal” recommendation that the equipment is suitable for energization.
- .3 Clean equipment by vacuum. Clean, wax and polish all exterior surfaces, check and tighten all covers and electrical connections.
 - .4 Prior to final energization, coordinate with the local utility company and Electrical Safety Authority (ESA) to ensure authorization is provided to allow energization of new equipment.
 - .5 Commissioning Report: Submit a final commissioning report within three weeks after new equipment has been energized. The report to include all test results prior to removal from transport vehicle and after installation was completed.

3.5 Inspection, Testing and Start-up for Main Power Transformer

- .1 Prior to removal of new transformer off transporting vehicle (i.e., while FOB), perform a general inspection of the transformer including primary and secondary bushings, connections, oil level, instrument gauges noting any signs of damage. Review the shop drawings and contract drawings to confirm if new transformer is in general conformance with the intended installation. Next, perform the following tests prior to removing transformer from vehicle:
 - .1 Turns ratio test on all tap positions.
 - .2 Insulation (windings) resistance tests of all tap positions: HV to ground, LV to ground and HV to LV.
 - .3 Meggar test for all tap positions.
 - .4 Provide a “verbal” recommendation to Engineer that the new transformer is suitable for installation. Follow up with a written report within five business days.

- .2 Prior to energization of incoming power supply and after transformer is installed at its final position, perform the following tests and recommendations:
 - .1 Turns ratio test on all tap positions.
 - .2 Insulation (windings) resistance test for “in service” tap position: HV to ground, LV to ground and HV to LV.
 - .3 Meggar test for “in service” tap position (coordinate with utility).
 - .4 Insulating liquid sample for an oil analysis to determine; dielectric breakdown, neutralization value, interfacial tension, colour, power factor, specific gravity and ppm of water content.
 - .5 Capacitance and dissipation factor tests.
 - .6 Coordinate with the manufacturer’s technician to certify that the transformer has been installed and operating correctly. Prior to energizing, obtain the “factory” test report from the technician confirming the above requirements.
 - .7 Provide a “verbal” recommendation that the new transformer is suitable for energization.
- .3 Clean equipment by vacuum. Clean, wax and polish all exterior surfaces, check and tighten all covers and electrical connections.
- .4 Prior to final energization, coordinate with the local utility company and Electrical Safety Authority (ESA) to ensure authorization is provided to allow energization of new transformer.
- .5 Commissioning Report: Submit a final commissioning report within three weeks after new transformer has been energized. The report to include all test results prior to removal from transport vehicle and after installation was completed.

END OF SECTION

Short Circuit Coordination and Arc Flash Study

1 GENERAL

1.1 General Conditions

- .1 All sections of Division 1 form a part of this Specification. Read and fully adhere to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this section.
- .3 All sections of Divisions 1 to 16 inclusive form part of the Contract Documents. Refer to Section 16010 for General Electrical Requirements related to this work.

1.2 Scope

- .1 Furnish all labour, materials, supervision, equipment and services specified, indicated or requested to supply and install the Short Circuit and Coordination Study described herein.
- .2 This section relates to all equipment designed, supplied and installed under the 16000 Series of Specifications. In particular, the Outdoor Substation and Overhead Power Distribution network.
- .3 It is the contractor's responsibility to collect all the required data for preparation of the studies and analysis.

1.3 Shop Drawings

- .1 Submit shop drawing in accordance with Section 01340 – Shop Drawings, Product Data and Samples.

1.4 Measurement for Payment

- .1 No measurement for payment will be made under this section.

1.5 Basis of Payment

- .1 All labour, materials and equipment necessary for the work in this Section shall be included in the lump sum prices in the Schedule of Items and Prices.

2 PRODUCTS

2.1 Protective Device Evaluation

- .1 It is understood that the gather of information to complete the Protection Device Evaluation is the responsibility of the contractor.
- .2 Ensure all protective devices ratings and settings are properly coordinated to suit the actual equipment supplied and/or installed or to which it is being connected.
- .3 Perform a short circuit study to determine the fault current values at all distribution levels/busses. Utilize latest IEEE, ANSI and CSA standards for determining short circuit values.
- .4 Provide system co-ordination time-current curves on Log-Log paper (Keuffel & Esser sheets) for all protective devices and components. Include but not be limited to the following:
 - .1 All protective devices on the high voltage distribution system (11000V)
 - .2 All protective devices on the low voltage distribution system (600/230V).
 - .3 High voltage Power cables and fuse curves.
 - .4 Damage curves for the Outdoor Substation: 3-phase, phase-ground, phase-phase and inrush current point.
 - .5 Fusing and circuit breaker tripping units (protective relay settings).
 - .6 Starting current of largest motor on the system including the offset of the running load.
 - .7 Damage curves for high and low voltage power cables.
 - .8 Three-phase RMS bolted fault values, phase-to-phase and phase-to-ground.
 - .9 Symmetrical and asymmetrical fault currents.
 - .10 One-line diagrams one each log paper of the coordinated devices.

2.2 Short Circuit Analysis and Ground Potential Rise Study

- .1 Provide calculation methods and assumptions, the base per unit quantities selected, one-line diagrams, source impedance data including Outdoor

Substation's system characteristics. Submit typical calculations, tabulations of calculations and results, conclusions and recommendations.

- .2 Calculate short circuit interrupting and momentary duties for an assumed 3-phase bolted fault at each supply switchgear line-up, switchboard, motor control centre, distribution panelboards and other significant locations throughout the distribution network.
- .3 Provide ground fault current study for same system areas, including the associated zero sequence impedance data.
- .4 Include in tabulation fault impedance, X/R ratios, asymmetrical faults, motor contribution, short circuit kVA/MVA, and symmetrical and asymmetrical fault currents.

2.3 Arc Flash Hazard Study

- .1 Provide an Arc Flash Hazard Study for the electrical distribution system shown on the single-line drawings. The intent of the Arc Flash Hazard Study is to determine hazards that exist at each major piece of electrical equipment shown on the single-line drawing. This includes switchgear, switchboards, panelboards, motor control centers, PDUs, UPS, ATSS and transformers.
- .2 The study will include creation of Arc Flash Hazard Warning Labels to be installed by the Contractor.
 - .1 The labels will include, as a minimum, the following:
 - .1 Flash hazard boundary (in mm).
 - .2 Incident energy (in cal/cm²) available at 457mm.
 - .3 Personal protection equipment rating description.
 - .4 Shock hazard (in volts).
 - .5 Approach Boundaries.
 - .6 Glove class.
 - .7 Name of MCC, switchgear, switchboard, etc.
 - .8 Equipment fuse size and part number.
 - .9 Date of issue.
- .3 The Arc Flash Hazard Study shall include the electrical distribution system equipment shown on the single-line drawing. Perform the short circuit and

protective device coordination study for the electrical distribution system before performing the Arc Flash Hazard Study. The Arc Flash Hazard Study shall consider operation during normal conditions alternate operations, emergency power conditions, and any other operations, which could result in maximum arc flash hazard.

- .4 The Contractor shall have the study prepared by qualified engineers of an independent consultant. The consultant shall be a Registered Professional Electrical Engineer (licensed in the Province of Ontario) who has at least ten (10) years of experience and specializes in performing power system studies.
- .5 The Arc Flash Hazard Study shall be performed using electrical engineering software computer software packages, such as EasyPower® or equivalent and in accordance with CSA 462, NFPA 70E, IEEE 1584 Standards and Ontario OH & S Act and Regulations.

2.4 Report Submission

- .1 Include the following sections in all reports and studies:
 - .1 Description, purpose, basis and scope.
 - .2 Tabulation of all device ratings versus calculated short circuit duties.
 - .3 Time-current curves, tabulations, trip relay settings, fuse selection, etc.
 - .4 Fault current calculations and GPR results.
 - .5 Commentary and conclusion.
 - .6 Arc Flash Hazard Study
 - .1 The Contractor shall submit the Arc Flash Hazard Study and arc flash warning labels at least 30 days prior to energizing the electrical equipment, complete with three (3) copies of the power systems study and one (1) set of warning labels.
 - .2 All pertinent data, rationale employed, and assumptions in developing the calculations shall be incorporated in the introductory remarks of the study.
 - .3 The report shall include an Arc Flash Evaluation Summary Sheet listing the following additional items:
 - .1 Bus name.

- .2 Upstream protective device name, type and settings.
- .3 Bus line to line voltage.
- .4 Bus bolted fault.
- .5 Protective device bolted fault current.
- .6 Arcing fault current.
- .7 Protective device trip/delay time.
- .8 Break opening time.
- .9 Solidly grounded column.
- .10 Equipment type.
- .11 Gap.
- .12 Arc flash boundary.
- .13 Working distance.
- .14 Incident energy.
- .15 Required protective fire-rated clothing type and class.

3 EXECUTION

3.1 General

- .1 Submit report to all parties related to the electrical works of the project.
- .2 Perform the field adjustments and protective devices as required to place the equipment in final operating condition. The settings shall be in accordance with the approved studies.
- .3 Verify all fuse selections as identified in the studies are installed in the proper fusible switch location.

END OF SECTION

Electrical Removals

1 GENERAL

1.1 General Conditions

- .1 All sections of Division 1 form a part of this Specification. Read and fully adhere to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this section.
- .3 All sections of Divisions 1 to 16 inclusive form part of the Contract Documents. Refer to Section 16010 for General Electrical Requirements related to this work.

1.2 Intent

- .1 Coordinate all work with existing use of facility (i.e., plant).
- .2 Maintain electrical service to all areas of the building, which are to remain energized. Schedule all electrical demolition work with Engineer and Owner in writing, by submitting a request at least ten working days prior to any power shut down. Indicate time and duration of power outage on notice. Demolition work to proceed only when request has been reviewed and approved by Owner.
- .3 Include cost of premium time in tender price for work performed on weekends, nights, or other "non-regular" time to maintain electrical power to existing pumping station.

1.3 Scope

- .1 Demolition work for removal, relocation and re-installation of electrical equipment and power feeders in areas as noted on contract drawings, and as follows:
 - .1 De-energizing, disconnection, removal of any electrical device, equipment, feeder and conduit to accommodate new work.
 - .2 Re-installation or re-work of wiring and conduits in related areas.
 - .3 Unless otherwise noted, maintain and protect any service equipment or conduit located within, or, passing through the area of demolition work.

- .4 Remove all unused wall-mounted devices and make safe all wiring, as required.
- .5 Removal and disposal of all abandoned electrical equipment, conduits and wiring. Where conduits are embedded in concrete, cut flush with floor and fill with grout.
- .6 Removal of existing concrete pads where old equipment was mounted.
- .7 Removal of existing lighting and life safety devices.

1.4 Disposal of Removed Material and Equipment

- .1 Dispose all material removed from the work area in accordance with all local environmental regulations. Separate and recycle as much as possible.
- .2 Any electrical equipment found to contain traces of PCB, asbestos or deemed hazardous, stop demolition work and notify Engineer and Owner immediately. Removal of such material must comply with the Ministry of Environment and Ontario regulations and procedures.

1.5 Measurement for Payment

- .1 No measurement for payment will be made under this section.

1.6 Basis of Payment

- .1 All labour, materials and equipment necessary for the work in this Section shall be included in the lump sum prices in the Schedule of Items and Prices.

2 PRODUCTS

Not Applicable.

3 EXECUTION

3.1 Existing Drawings and Site Conditions

- .1 Existing contract drawings are available for review from the Owner or Engineer during Project Site Meeting. The successful electrical contractor will be provided with a copy of the existing drawings at start of project.
- .2 Drawings are for reference only, as they may not reflect "As Built" conditions. Contractor is responsible for verifying the authenticity of the drawings as they relate to existing conditions.

- .3 Estimating of demolition work must be based on “on-site” visits. If necessary, contractor may contact Engineer and Owner to arrange additional site visit. No claims for extras will be allowed due to discrepancies between “As Built” drawings and site conditions.

3.2 Systems Remaining in Service

- .1 Unless otherwise noted on drawings, maintain in operation all services and equipment not shown on drawings during demolition. Provide new conduit and wiring to ensure existing conduits and devices do not interfere with new work. Remove existing conduits and devices, and reconnect as shown on drawings.
- .2 Make safe all circuits and remove all wiring where power feeders, circuits and cables interfere or enter in the demolition work area. Wiring to be removed back to its source (for example a panelboard).
- .3 Where existing services are abandoned, however, back boxes are to remain, remove all wiring and provide a blank cover plate over box.
- .4 Where applicable, provide a new “typed” directory for all existing panelboards that will be reused or maintained.
- .5 Maintain in operation all “life safety systems” to existing building. If disconnected or interrupted at any time, contractor must reconnect immediately and retest at contractor’s cost. No extra claim will be allowed.
- .6 Any circuit or system remaining in service that has been interrupted or disconnected due to the demolition work must be reconnected at contractor’s cost. No extra claim will be allowed.
- .7 Clean and inspect all remaining equipment and panels. Notify engineer of any defects or damages.
- .8 After existing panels and switchgear are placed back in operation, perform a thermographic survey on all connections and breakers to identify any “hot spots.” Replace or correct any device that fails the thermographic survey.
- .9 Provide, as necessary, any device or component required to interface with the new and existing system for proper operation.
- .10 Inspect, check and ensure proper operation of all systems and equipment that is to remain in the renovated area.

3.3 Removed Material

- .1 Consult Engineer if any existing device or equipment is to be returned to owner prior to removal. All equipment not required by owner will be deemed property of contractor.
- .2 No equipment may be burned or sold on the construction site.

3.4 Existing Underground Service Feeds

- .1 Unless otherwise noted on drawings, abandon any redundant underground services.
- .2 Remove all existing cables in underground ductbanks or conduits. Seal ductbanks (using non-shrink grout) inside building and ensure weatherproof/watertight.

END OF SECTION

Underground Duct Systems and Concrete Chambers

1 GENERAL

1.1 General Conditions

- .1 All sections of Division 1 form a part of this Specification. Read and fully adhere to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this section.
- .3 All sections of Divisions 1 to 16 inclusive form part of the Contract Documents. Refer to Section 16010 for General Electrical Requirements related to this work.

1.2 Scope

- .1 Furnish all labour, materials, supervision, equipment and services specified, indicated or requested to supply and install the underground duct systems, chambers, vaults, and handholes described herein.
- .2 Perform "locates" of existing site conditions prior to any excavation work.

1.3 Measurement for Payment

- .1 No measurement for payment will be made under this section.

1.4 Basis of Payment

- .1 All labour, materials and equipment necessary for the work in this Section shall be included in the lump sum prices in the Schedule of Items and Prices.

2 PRODUCTS

2.1 Rigid PVC

- .1 Direct Buried ducts: Rigid PVC conduit, schedule 40 pipe dimensions, complies with CSA C22.2 No. 211.2-06
- .2 Concrete encased ducts: PVC type DB2 conduit, complies with CSA C22.2 No.211.1-06.

2.2 PVC Duct Fittings

- .1 PVC, opaque solvent welded type couplings, bell end fittings, plugs, caps, adaptors, split ducts as required to make complete installation.
- .2 Expansion joints and wobble joints.
- .3 PVC angle couplings: 90°, 45° and 22.5° bends with 915mm diameter radius bends (long sweeps).
- .4 Solvent weld compound for all PVC duct joints.

2.3 Grounding

- .1 Ground rods: to Section 16450 - Grounding.

2.4 Markers

- .1 Concrete type cable markers: 600 x 600 x 100 mm, with the words "cable," "joint" or "conduit" impressed in top surface, with arrows to indicate change in direction of duct runs.

2.5 Duct Spacers and Wooden Mandrel

- .1 Rigid interlocking plastic material, for the conduit diameters and spacing required on drawings.
- .2 Wooden Mandrel: Condux International #CDX08020600

2.6 Cable Pulling Equipment

- .1 6 mm stranded nylon pull rope with tensile strength of 5 kN.

3 EXECUTION

3.1 Concrete-encased Duct Banks

- .1 Perform "locates" prior to any excavation work and coordinate all work with civil contractor (Division 3), as applicable.
- .2 Supply and install the concrete-encased underground duct banks indicated on the drawings. Supervise all excavation, formwork, reinforcement, concreting, and backfilling.
- .3 Build duct bank(s) and manholes on undisturbed soil or on well compacted granular fill not less than 150 mm thick, compacted to 95% of maximum proctor dry density.

- .4 Open trench completely between chambers to be connected before ducts are laid and ensure that no obstructions will necessitate change in grade of ducts.
- .5 Prior to laying ducts, construct "mud slab" not less than 75 mm thick.
- .6 Install ducts at elevations as indicated, with a minimum slope of 1 to 400. Solvent weld (glue) all PVC duct joints.
- .7 Install base spacers at maximum intervals of 1.5 m levelled to grades indicated for bottom layer of ducts.
- .8 Lay PVC ducts with configuration and reinforcing as indicated with preformed interlocking, rigid plastic intermediate spacers to maintain spacing between ducts horizontally and vertically as shown on drawings. Stagger joints in adjacent layers at least 150 mm and make joints watertight. Encase duct bank with concrete cover to elevation (or thickness) shown on drawings.
- .9 Make transpositions, offsets and changes in direction using 5° bend sections, do not exceed a total of 20° with duct offset.
- .10 Use bell ends at duct terminations in manholes or buildings.
- .11 Use conduit to duct adapters when connecting to conduits.
- .12 Terminate duct runs with duct coupling set flush with the end of concrete envelope when dead ending duct bank for future extension.
- .13 Cut, ream and taper end of ducts in field in accordance with manufacturer's recommendations, so that duct ends are fully equal to factory made ends.
- .14 Allow concrete to attain 50% of its specified strength before backfilling (minimum 24 hours after placing of concrete) unless otherwise authorized by Engineer. Ensure that backfill is placed in maximum 13 mm layers and compacted to the satisfaction of the Engineer.
- .15 Use anchors, ties and trench jacks as required to secure ducts and prevent moving during placing of concrete. Tie ducts to spacers with twine or other non-metallic material. Remove weights or wood braces before concrete has set and fill voids.
- .16 Clean ducts before laying. Cap ends of ducts during construction and after installation to prevent entrance of foreign materials.

- .17 Immediately after placing of concrete, pull through each duct a wooden mandrel not less than 300 mm long and of a diameter 6 mm less than internal diameter of duct, followed by stiff bristle brush to remove sand, earth and other foreign matter. Avoid disturbing or damaging ducts where concrete has not set completely. Pull stiff bristle brush through each duct immediately before pulling in cables.
- .18 Install four 3 m lengths of 15M reinforcing rods, one in each corner of duct bank when connecting duct to manholes or buildings. Wire rods to 15M dowels at manhole or building and support from duct spacers. Protect existing cables and equipment when breaking into existing manholes. Place concrete down sides of duct bank filling space under and around ducts. Rod concrete with flat bar between vertical rows filling voids.
- .19 In each duct install pull rope continuous throughout each duct run with 3 m spare rope at each end.
- .20 For long duct runs (greater than 50 m), install expansion couplings at 30 m intervals.
- .21 Provide removable watertight cap to seal each spare duct end. Install caps on all duct ends left open during construction.
- .22 Ensure that a responsible and competent supervisor is present during concreting operations, to protect against broken, damaged or disturbed ducts. Advise the Engineer in advance of concreting, so that he may inspect the ducts prior to pouring, and be present during the pour.

3.2 Direct Buried Duct Banks

- .1 Perform "locates" prior to any excavation work and coordinate all work with civil contractor (Division 3), as applicable.
- .2 Rigid ducts for direct burial shall be of the type approved for direct burial.
- .3 Ensure that the trench bottom is of undisturbed soil or soil compacted to a density of 95% of the maximum dry density, free of stones and uniformly graded to give continuous support to the rigid ducts throughout their entire length.
- .4 Slope ducts with 1 to 400 minimum slope. Solvent weld (glue) all PVC duct joints.

- .5 Ensure all couplings used to join PVC conduits are given a tight fit. Make connections with an approved PVC solvent supplied by the conduit manufacturer.
- .6 Provide protection covers or planks, where required or indicated.
- .7 Install pull cord in each duct with 3 m spare cord at each end and cap until ready for use.
- .8 Pull through each duct wooden mandrel not less than 300mm long and of diameter 12mm less than internal diameter of duct, followed by stiff bristle brush to remove sand, earth and other foreign matter. Pull stiff bristle brush through each duct immediately before pulling-in cables.
- .9 Install markers as required or as indicated.

3.3 Markers

- .1 Mark location of duct runs under hard surfaced areas not terminating in manhole with railway spike driven flush in edge of pavement, directly over run. Place concrete duct marker at ends of such duct runs. Construct markers and install flush with grade.
- .2 Mark ducts every 150 m along straight runs and changes in direction.
- .3 Where markers are removed to permit installation of additional duct, reinstall existing markers.
- .4 Lay concrete markers flat and centered over duct with top 25 mm above earth surface.
- .5 Provide drawings showing locations of markers.

3.4 Inspections

- .1 Advise Engineer so that he may inspect ducts prior to placing and be present during placement of concrete and clean out.

3.5 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 properly terminated, seal ends of lead covered cables with wiping solder, seal ends of nonleaded cables with moisture seal tape.
- .7 After installation of cables, seal duct ends with duct sealing compound.

3.6 Electrical Precast Concrete Handholes and Chambers

- .1 Install precast handholes and chambers, as indicated on drawings.
- .2 Terminate ducts in bell end fitting flush with window face.
- .3 Install frames and covers for handhole(s) and cable pulling chamber(s).
- .4 Provide minimum 457mm depth of 19mm dia. clear crush stone underneath each handhole and chamber as a base and drainage.
- .5 Coordinate with Civil contractor (Division 3).

END OF SECTION

Raceway Systems

1 GENERAL

1.1 General Conditions

- .1 All sections of Division 1 form a part of this Specification. Read and fully adhere to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this section.
- .3 All sections of Divisions 1 to 16 inclusive form part of the Contract Documents. Refer to Section 16010 for General Electrical Requirements related to this work.

1.2 Scope

- .1 Supply and install all conduits, fittings, supports, hangers and miscellaneous support materials and hardware required for the complete systems in accordance with the applicable codes and regulations and as specified herein and on the drawings.

1.3 Location of Conduit

- .1 Drawings do not indicate all conduit and supporting runs. Those indicated are in diagrammatic form only.

1.4 Measurement for Payment

- .1 No measurement for payment will be made under this section.

1.5 Basis of Payment

- .1 All labour, materials and equipment necessary for the work in this Section shall be included in the lump sum prices in the Schedule of Items and Prices.

2 PRODUCTS

2.1 Conduits

- .1 Minimum conduit size: 21mm (3/4").
- .2 Rigid steel metal threaded conduit, hot dip galvanized inside and outside with a coated layer to inhibit rust. Complies with CSA C22.2 No. 45 (R2003).

- .3 Epoxy coated conduit: with zinc coating and corrosion resistant epoxy finish inside and outside.
- .4 Rigid PVC conduit, manufactured to schedule 40 wall thickness. Solvent weld compound for all PVC joints. Complies with CSA C22.2 No. 211.2-06.
- .5 Flexible steel conduit and liquid tight flexible metal conduit, spirally wound interlocked aluminum armour construction with overall PVC jacket. Complies with CSA C22.2 No.56-04.
- .6 Flexible conduit (coupling) for hazardous areas: suitable for Class 1, Zone 1, Group II B areas. Length to suit installation
- .7 Electrical Metallic Tubing (EMT) conduit: size as indicated and complies with CSA C22.2 No.83 (R2003).

2.2 Conduit Fastenings and Supports

- .1 One-hole and two-hole hot dip galvanized steel straps.
- .2 Hot dipped galvanized steel beam clamps.
- .3 Hot dipped galvanized steel channel type supports, U shape, size 41x41 mm, 2.5 mm thick.
- .4 6 mm diameter threaded galvanized steel rods to support suspended channels. Provide all necessary galvanized steel spring-loaded bolts, nuts, washers and lockwashers.

2.3 Conduit Fittings

- .1 Fittings: manufactured for use with conduit specified. Coating: same as conduit. Fittings to incorporate nylon insulated throat or bushing.
- .2 Factory “ells” where 90° bends are required for 25 mm and larger conduits.
- .3 Pressure type terminals for all rigid steel conduit grounding wire connections.
- .4 Rigid steel conduit hub type connectors in wet or outdoor areas: nylon insulated with recessed neoprene ‘O’ ring.
- .5 Liquid tight flexible conduit fittings to incorporate a threaded grounding core, nylon compression ring and gland. Insulated throat, male thread and locknut or bushing with an integral ‘O’ ring seal.
- .6 Locknuts bonding type with sharp edges for digging into metal wall of enclosure

- .7 Thinwall (EMT) conduit fittings: die cast zinc, insulated compression type connectors (set screw type not acceptable).

2.4 Expansion Fittings for Rigid Conduit

- .1 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection in all directions.
- .2 Weatherproof expansion fittings for linear expansion at entry to panel.

2.5 Conduit Seal Fittings, Drains and Breathers

- .1 Suitable for Class 1, Zone 1, Group II B, hazardous areas.
- .2 Sealing compound: Chico A, restricts passage of gases, vapours, or flames between conductors and fitting.
- .3 Include drain to automatically remove condensation in each seal fitting.

2.6 Cable Trays

- .1 Type: Aluminum, 3m straight sections, elbows, tees and reducers as indicated on drawings
- .2 Class: C (100lbs/ft).
- .3 Width & Load Depth:
 - .1 914mm @ 152mm load depth
 - .2 152mm @ 102mm load depth
- .4 Rung Spacing: 229mm
- .5 Fabricated cable trays with rounded edges and smooth surfaces, free of any burrs.
- .6 Use aluminum expansion connector plates, 302/304 stainless steel bolts washers, lock washers and nuts.
- .7 Use stainless steel ground retainer clamps. Clamps to be placed at intervals as indicated on drawings. Bond jumpers are not to be used.
- .8 Acceptable manufacturers:
 - .1 Thomas & Betts
 - .2 Cooper B-line, series 1 - Aluminum
 - .3 Tyco, CopeHat series

2.7 Fish Cord

- .1 6 mm stranded nylon cord, tensile strength 5 kN.

3 EXECUTION

3.1 Installation

- .1 Use EMT conduit for all for all non-hazardous areas, indoor wiring. Use rigid PVC conduit for all underground or below grade installations. **OR** Use rigid PVC conduit for all non-hazardous areas, indoor and outdoor wiring. Solvent weld (glue) all PVC joints.
- .2 Install ground conductor in all types of conduits.
- .3 Use EMT conduit for any exposed "life-safety" circuit wiring in non-hazardous areas. Refer to Section 46 of the OESC.
- .4 Use rigid galvanized steel threaded conduit in all hazardous or classified areas, and as required by Ontario Electrical Safety Code.
- .5 Use epoxy coated conduit in damp and corrosive areas, as noted on drawings.
- .6 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .7 Use flexible metal conduit for connection to recessed incandescent fixtures without a pre-wired outlet box, connection to surface or recessed fluorescent fixtures.
- .8 Use liquid tight flexible metal conduit for connection to all motors or vibrating equipment.
- .9 Use hazardous area (Class 1, Zone 1, Group II B) flexible coupling for connection to explosion proof motors.
- .10 Install conduit sealing fittings in hazardous areas. Fill with compound.
- .11 Install breathers on conduit system and control panels in Hazardous areas.
- .12 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .13 Mechanically bend steel conduit over 19 mm diameter.
- .14 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.

- .15 Install fish cord in empty conduits.
- .16 For recessed panelboards, run two 25 mm spare conduits up to ceiling space and two 25 mm spare conduits down to ceiling space from each flush panel. Terminate these conduits in 152 x 152 x 102 mm junction boxes in ceiling space or in case of an exposed concrete slab, terminate each conduit in flush concrete type box.
- .17 Where conduits become blocked, remove and replace blocked section. Do not use liquids to clean out conduits.
- .18 Dry conduits out before installing wire.
- .19 Support equipment using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .20 Install expansion sleeves wherever conduits cross a structural expansion joint.

3.2 Surface Conduits

- .1 Use metal conduit (with separate ground wire) for all life safety devices such as emergency lighting and exit signage and as defined in Section 46 of the Ontario Electrical Safety Code.
- .2 Run parallel or perpendicular to building lines.
- .3 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.
- .4 Run conduits in flanged portion of structural steel.
- .5 Group conduits wherever possible on surface mounted channels.
- .6 Do not pass conduits through structural members except as indicated.
- .7 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.
- .8 Do not use 'C'-type clamps or perforated metal straps.
- .9 The maximum length of straight conduit run shall be 60 m between pull boxes or other terminations. Reduce this length by 15 m for each 90° bend or 7 m for each 45° bend or offset. Conduit runs to include not more than the equivalent of two 90° bends between pull boxes except where indicated otherwise on the drawings.
- .10 Make no holes in building structural members for supporting conduits without the permission of the Engineer.

- .11 Touch up and repair coated conduits and fittings on which the epoxy or PVC finish has been damaged; paint with a compound material supplied by the original conduit manufacturer.
- .12 Fasten exposed conduit to building construction or support system using straps.
 - .1 One-hole galvanized steel straps to secure surface conduits 50 mm and smaller.
 - .2 Two-hole galvanized steel straps for conduits larger than 50 mm.
 - .3 Beam clamps to secure conduit to exposed steel work.
- .13 Suspended support systems.
 - .1 Support individual conduit runs with 6 mm diameter threaded rods and spring clips.
 - .2 Support two or more conduits on channels supported by 6 mm diameter threaded rod hangers where direct fastening to building construction is impractical.
- .14 For surface mounting of two or more conduits use channels at 1.5 m o.c. spacing.
- .15 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit runs.

3.3 Concealed Conduits

- .1 Do not install horizontal runs in masonry walls.
- .2 Do not install conduits in terrazzo or concrete toppings.
- .3 Run concealed conduits in ceiling spaces in straight lines with large radius bends where applicable.
- .4 Install conduits in cores of concrete masonry walls as the walls are being erected.
- .5 Do not cut into the wall after the walls are in place, unless otherwise authorized by Engineer.

3.4 Conduits in Cast-in-Place Concrete

- .1 Locate to suit reinforcing steel. Install in middle third of concrete slab or wall.

- .2 Fix conduit to reinforcing bars (or provide chairs) to prevent conduit from moving during concrete placement.
- .3 Protect conduits from damage where they stub out of concrete. Terminate stub-ups 100 mm above finished floor and seal with threaded cap.
- .4 Install sleeves where conduits pass through slab or wall.
- .5 Where conduits pass through waterproof membrane provide oversized sleeve before membrane is installed. Use cold mastic between sleeve and conduit.
- .6 Do not place conduits in slabs in which slab thickness is less than 4 times conduit outer diameter.
- .7 Encase conduits completely in concrete with minimum 25 mm concrete cover.
- .8 Organize conduits in slab to minimize crossovers.

3.5 Conduits in Cast-in-Place Slabs on Grade

- .1 Run conduits 25 mm and larger below slab and encased in 75 mm concrete envelope. Provide 50 mm of sand over concrete envelope below floor slab.
- .2 Protect conduits from damage where they stub out of concrete. Terminate stub-ups 100 mm above finished floor and seal with threaded cap.
- .3 Install sleeves where conduits pass through slab or wall.

3.6 Conduits Underground

- .1 Slope conduits to provide drainage.
- .2 Waterproof joints (PVC excepted) with heavy coat of bituminous paint.

END OF SECTION

Wires and Cables

1 GENERAL

1.1 General Conditions

- .1 All sections of Division 1 form a part of this Specification. Read and fully adhere to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this section.
- .3 All sections of Divisions 1 to 16 inclusive form part of the Contract Documents. Refer to Section 16010 for General Electrical Requirements related to this work.

1.2 Scope

- .1 Furnish all labour, materials, supervision, equipment and services specified, indicated or requested to install the complete wiring systems specified herein including, but not limited to:
 - .1 Low voltage wire and cables.
 - .2 Instrumentation wiring.
 - .3 Thermostat (low voltage) wiring.
- .2 Include in the wiring system all wiring, terminations, wire markers, cable tags, cable ties, splice fittings, insulation tapes, connectors and miscellaneous materials necessary to complete the wiring system.

1.3 Measurement for Payment

- .1 No measurement for payment will be made under this section.

1.4 Basis of Payment

- .1 All labour, materials and equipment necessary for the work in this Section shall be included in the lump sum prices in the Schedule of Items and Prices.

2 PRODUCTS

2.1 Low Voltage Wire and Cable (1000V and Below)

- .1 Conductors: stranded Copper conductors, with minimum power conductor size: No. 12 AWG, minimum control conductor size: No. 14 AWG.

- .2 Power conductors: size as indicated, with cross linked polyethylene (XLPE) insulation rated 1000 V – RW90 or RWU90, as indicated.
- .3 Provide Sunlight Resistant (“SR” type) insulated conductors where exposed to weather.
- .4 Control conductors: XLPE insulation rated 600 V – RW90.
- .5 Control panel wiring: copper with thermoplastic insulation type TEW rated at 600 V.
- .6 Provide multi-conductor cables wrapped with interstitial fillers and an overall PVC (minus 40°C) flame retardant, low acid gas evolution jacket.
- .7 Insulated ground conductors forming part of a multi-conductor cable assembly shall have green colour coding.
- .8 Colour coding of insulated conductors:
 - .1 1-conductor cable-Black
 - .2 2-conductor cable-Black, White
 - .3 3-conductor cable-Red, Black, Blue
 - .4 4-conductor cable-Red, Black, Blue, White
 - .5 Multi-conductor cables-Number code
 - .6 Intrinsically safe field wiring: Yellow
- .9 Teck90 Cable requirements:
 - .1 Conductors: Class B compressed stranded Copper conductors, size as indicated, with cross linked polyethylene (XLPE) insulation rated 1000V – RW90.
 - .2 Include Hazardous Locations “HL” label on cable where installed in hazardous areas.
 - .3 Inner jacket: Black PVC flame-retardant, moisture resistant
 - .4 Armour: flexible interlocking aluminum armour.
 - .5 Overall jacket: PVC flame-retardant, moisture and sunlight resistant, with fully printed label of cable description on jacket.
 - .6 Compliances: cable rated for wet and dry installation, and hazardous locations. Compliant with CSA C22.2 Nos. 131 and 174, including CSA FT1 and FT4.

- .7 Armoured/Teck90 Cable connectors:
 - .1 Watertight connectors for non-hazardous areas.
 - .2 Class 1, Zone 1, Group II B rated connectors c/w sealing compound for hazardous areas.

2.2 Instrumentation Signal Wiring

- .1 Multi-conductor type with individually colour or number coding.
- .2 Twisted pairs or triplets (triads) as required. Provide grouped cables with multiple pairs or triplets as required.
- .3 Each pair or triplet to be wrapped in an aluminum / mylar shield with an overall bare stranded copper drain wire
- .4 Ratings: 600VAC, insulated, 90°C.
- .5 Minimum conductor size: #16AWG, stranded conductors, tinned-copper.
- .6 Non-armour cable: overall aluminum sheath and an outer FR-PVC jacket.
- .7 Armour cable (as indicated on drawings): overall interlocking aluminum flexible armour and an outer FR-PVC jacket.
- .8 Multiple pairs/triplets to incorporate an overall aluminum/mylar shield with a copper drain wire.
- .9 Armour cable connectors:
 - .1 Watertight connectors for non-hazardous areas.
 - .2 Class 1 Groups C-D rated connectors c/w sealing compound for hazardous areas.

2.3 Thermostat (low voltage) Cable

- .1 Low energy 300 V control cables: stranded anneal copper conductors, twisted pairs/triplets, multi-conductors as required, with PVC insulation rated 80°C, and a UV rated overall PVC jacket covering.
- .2 Minimum size: #18AWG.

2.4 Wiring Accessories

- .1 Wire markers: computer printed, black letters on white background, self-laminating - vinyl markers, number of markers as required.

- .2 Cable markers for cables or conductors greater than 13 mm diameter: strap-on type, rigid PVC, black letters on white background, with PVC covered aluminium straps.
- .3 Terminal blocks: minimum 600 V rated, modular, sized to accommodate conductor size used.
- .4 Where screw-type terminals are provided on equipment field wiring: terminate with pressure-type insulated copper fork tongue terminals.
- .5 Splice connectors for wire sizes Nos. 12-10 AWG inclusive: compression spring type.
- .6 Splice connectors for wire sizes No. 8 AWG and larger: split-bolt type, sized to suit number and size of conductors, c/w flame retardant foot-type insulator.
- .7 Cable ties shall be nylon, one-piece, self-locking type.
- .8 Connectors for Teck armoured cables installed in hazardous locations: design approved for the application.
- .9 Connectors for Teck armoured cables installed in wet areas or outdoors: watertight design.
- .10 Cable pulling lubricant: compatible with cable covering and will not cause damage and corrosion to conduits or ducts.

3 EXECUTION

3.1 Installation - General

- .1 Install all wire and cable according to the drawings, with a minimum power conductor size of No. 12 AWG and minimum control conductor size of No. 14 AWG.
- .2 Pull cable into ducts and conduits in accordance with the cable manufacturer's recommendations, using patented cable grips suitable for the type of cable or using pulling eyes to be installed directly onto the cable conductors.
- .3 Limit pulling tensions to those recommended by the manufacturer to avoid overstressing cable.
- .4 Utilize adequate lubricant when pulling cables through ducts and conduits to minimize wear on cable jackets.

- .5 Install all through wiring in junction and pull boxes having no connection within the box with a minimum of 150 mm of slack left inside the box.
- .6 Install instrument and thermocouple extension wiring separate from power and control wiring.
- .7 Make connections to equipment "pig-tails" with mechanical, insulated, screw-on connectors for wire sizes Nos. 12-10 AWG. For wire sizes No. 8 AWG and larger utilize split-bolt connectors, taped with three layers minimum of insulating tape.
- .8 No splices shall be permitted in cable or wiring runs, and shall only be permitted in junction boxes.
- .9 Unless otherwise specified, make all wiring tapes, splices and terminations with identified compression screw type terminal blocks, securely fastened to avoid loosening under vibration or normal strain. Make connections for interior and exterior lighting circuits and 120 V, 15 amp convenience receptacle circuits using screw-on or split-bolt connectors and insulating tape.
- .10 Identify each conductor by plastic slip-on markers at each termination indicating the circuit designation or wire number.
- .11 Identify each cable by attaching a suitable marker, stamped or indelibly marked with the cable number, at each end of the cable and in all intermediate manholes, junction boxes and pull boxes.

END OF SECTION

Electrical Boxes

1 GENERAL

1.1 General Conditions

- .1 All sections of Division 1 form a part of this Specification. Read and fully adhere to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this section.
- .3 All sections of Divisions 1 to 16 inclusive form part of the Contract Documents. Refer to Section 16010 for General Electrical Requirements related to this work.

1.2 Scope

- .1 Furnish all labour, materials, supervision, equipment and services specified indicated or requested to install all electrical boxes specified herein and on the drawings.

1.3 Measurement for Payment

- .1 No measurement for payment will be made under this section.

1.4 Basis of Payment

- .1 All labour, materials and equipment necessary for the work in this Section shall be included in the lump sum prices in the Schedule of Items and Prices.

2 PRODUCTS

2.1 Enclosure Ratings for all Equipment Listed Herein

- .1 Indoor and dry locations: NEMA/EEMAC 12, unless otherwise noted on drawings.
- .2 Below grade, damp or outdoor locations: NEMA/EEMAC 4X, unless otherwise noted on drawings.
- .3 Hazardous or classified areas: suitable for Class 1, Zone 1, Group II B areas.

2.2 Junction and Pull Boxes

- .1 Reference: CAN CSA C22.2 No. 85-14

- .2 Welded galvanized steel construction with screw-on flat covers for surface mounting and captive non-corroding chain.
- .3 Covers with neoprene gasket and 25 mm minimum extension all around, for flush mounted pull and junction boxes.
- .4 Piano-type hinges on boxes larger than 300 x 300 mm.

2.3 General Outlet and Conduit Boxes

- .1 Reference: CAN CSA C22.2 No. 18-M1987.
- .2 Size boxes in accordance with CSA C22.1.
- .3 102 mm square or larger outlet boxes as required for special devices.
- .4 Boxes in hazardous areas: suitable for Class 1 Zone 1, Group II B areas.
- .5 Gang boxes where wiring devices are grouped.
- .6 Blank cover plates for boxes without wiring devices.
- .7 Combination boxes with barriers where outlets for more than one system are grouped.

2.4 Sheet Steel Outlet Boxes

- .1 Electro galvanized steel single and multi-gang flush device boxes for flush installation, minimum size 76 x 50 x 38 mm or as indicated. 102 mm square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.
- .2 102 mm square or octagonal outlet boxes for lighting fixture outlets.
- .3 102 mm square outlet boxes with extension and plaster rings for flush mounting devices in finished plaster walls.

2.5 Masonry Boxes

- .1 Electro galvanized steel masonry single and multi-gang boxes for devices flush mounted in exposed block walls, c/w preformed knock-outs.

2.6 Concrete Boxes

- .1 Electro galvanized sheet steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.

2.7 Conduit Boxes

- .1 Cast FS or FD boxes with factory threaded hubs and mounting feet for surface wiring of switches and receptacle.

2.8 Fittings – General

- .1 Bushing and connectors with nylon insulated throats.
- .2 Knock out fillers to prevent entry of debris.
- .3 Conduit outlet bodies for conduit up to 32 mm and pull boxes for larger conduits.
- .4 Double locknuts and insulated bushings on sheet metal boxes.

2.9 Manufacturers

- .1 Acceptable manufacturers: Appleton, Crouse-Hinds, W.C. Pursley, BEL, Stelpro, Pyle National, Taylor, and C.E.B.

3 EXECUTION

3.1 Installation

- .1 Install splitters and mount plumb, true and square to the building lines.
- .2 Extend splitters full length of equipment arrangement except where indicated otherwise.
- .3 Install pull boxes in inconspicuous but accessible locations.
- .4 Mount cabinets with top not higher than 2 m above finished floor.
- .5 Only main junction and pull boxes are indicated. Install pull boxes so as not to exceed 30 m of conduit run between pull boxes.
- .6 Provide equipment identification in accordance with Section 16010 – Electrical General Requirements.
- .7 Provide access panels in ceilings where junction and pull boxes are located in spaces not otherwise accessible.
- .8 Make cut-outs for outlet boxes recessed in walls neatly and of the minimum practical size.
- .9 Install boxes to clear all building and mechanical services equipment. Where two or more devices are shown at one location, utilize multi-gang boxes. Supply all outlet boxes with covers or plaster rings as required.

- .10 Size all boxes to accommodate the number of conduits, conductors and terminal blocks. Provide junction boxes with 20% spare terminal blocks.
- .11 Securely fasten surface-mounted boxes to the building or mounting structure and support independently of the conduits entering the box.
- .12 Install junction and pull boxes mounted on brick, concrete or block walls with 3 mm thick lead or nylon washers between box and wall face.
- .13 Provide all boxes sized to the Ontario Electrical Safety Code requirements, in all conduit raceway systems to limit length of straight conduit runs to 60 m. Reduce this length by 15 m for each 90° bend or 8 m for each 45° bend or offset.
- .14 Mark location and size of all pull boxes on the record drawings.
- .15 Install boxes in hazardous locations as required and shown on the drawings. Provide conduit seals for all conduits entering enclosure.
- .16 Support boxes independently of connecting conduits.
- .17 Fill outlet and conduit boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.
- .18 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.
- .19 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.

END OF SECTION

WIRING DEVICES

1 GENERAL

1.1 General Conditions

- .1 All sections of Division 1 form a part of this Specification. Read and fully adhere to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this section.
- .3 All sections of Divisions 1 to 16 inclusive form part of the Contract Documents. Refer to Section 16010 for General Electrical Requirements related to this work.

1.2 Scope

- .1 Furnish all labour, materials, supervision, equipment and services specified indicated or requested to install all electrical boxes specified herein and on the drawings.

1.3 Measurement for Payment

- .1 No measurement for payment will be made under this section.

1.4 Basis of Payment

- .1 All labour, materials and equipment necessary for the work in this Section shall be included in the lump sum prices in the Schedule of Items and Prices.

2 PRODUCTS

2.1 General AC Switches

- .1 Single pole, double pole, 3-way, 4-way switches, as indicated, 20 Amp, 120 VAC, CSA approved.
- .2 Non-hazardous areas: manually operated, industrial grade AC switches. Colour to be advised by Engineer.
- .3 Hazardous or classified areas: manually operated c/w enclosure suitable for Class 1, Zone 1, Group II B areas.
- .4 Toggle operated fully rated for tungsten filament and fluorescent lamps, with silver alloy terminals.

- .5 Switches of one manufacturer throughout project.
- .6 Acceptable manufacturers:
 - .1 Non-hazardous: Arrow Hart, Pass & Seymour, Hubbell and Leviton.
 - .2 Hazardous: Crouse-Hinds and Appleton.

2.2 Automatic Wall Switch

- .1 Turns light on and off based on occupancy.
- .2 Operates between 100VAC and 300VAC.
- .3 To use advanced passive infrared technology to detect occupancy and turn lights on.
- .4 Once a space is vacated and the time delay elapses, light automatically turns off.
- .5 A separate switch will give the user the ability to manually switch on/off the light.
- .6 The switch is to have the following features:
 - .1 Time delay.
 - .2 Light level sensing.
 - .3 Sensitivity.
 - .4 Audible or visual alerts.
- .7 Sensitivity shall be adjustable. Lights whose sensitivity setting is not controllable will not be allowable.
- .8 Sensor to identify usage patterns to adjust the appropriate delays necessary for the appropriate time of the day (about seven minutes' delay for regular times and about 30 minutes for busier times).
- .9 To display occupancy detection via LED.
- .10 Lens coverage to be at least 180°, minimum of 300 ft2 unless otherwise mentioned on drawings.
- .11 Acceptable manufacturers: Leviton.

2.3 General AC Receptacles

- .1 Non-hazardous areas: industrial grade, 15A-125V AC rated, CSA type 5-15R configuration, U ground, CSA approved, single or duplex receptacle as indicated on drawings. Colour to be advised by Engineer.
- .2 Hazardous or classified areas: suitable for Class 1, Zone 1, Group II B areas, 15A-125V AC rated, CSA type 5-15R configuration, delayed action – circuit breaking receptacle with plug adapter. Single or two gang assemblies as indicated on drawings.
- .3 Other receptacles with ampacity and voltage as indicated.
- .4 Receptacles of one manufacturer throughout project.
- .5 Acceptable manufacturers:
 - .1 Non-hazardous: Arrow Hart, Pass & Seymour, Hubbell and Leviton.
 - .2 Hazardous: Crouse-Hinds and Appleton.

2.4 Ground Fault Interrupting Receptacles

- .1 Receptacle: Duplex CSA 5-15R configuration, 125V, 15A, Class A type interrupter.
- .2 Receptacle: Duplex CSA 5-20R configuration, 125V, 20A, Class A type interrupter.
- .3 Integral solid state ground sensing device.
- .4 Integral “test” and “reset” pushbuttons.
- .5 Acceptable manufacturers: Leviton, Hubbell and Bryant.

2.5 Isolated Ground Receptacles

- .1 Hospital Grade, 15A, 125VAC rated, U ground, CSA Certified, designated for “Isolated Ground” wiring.
- .2 Duplex receptacle with face colour, as indicated on drawings.
- .3 Receptacles of one manufacturer throughout project.
- .4 Decora style, rectangular shape, flush face.
- .5 Acceptable manufacturers: Hubbell, Pass & Seymour, Leviton.

2.6 Cover Plates

- .1 Cover plates from one manufacturer throughout project.
- .2 Stainless steel utility box cover for wiring devices installed in surface mounted utility boxes.
- .3 Stainless steel cover plates (1 mm thick) for wiring devices mounted in surface mounted FS or FD type conduit boxes.
- .4 Outdoor Receptacle Covers: Weatherproof (WP), UV rated, extra duty, continuous plastic cover complete with gaskets for duplex receptacles as indicated. Must be CSA and approved by Electrical Inspector (see ESA bulletin 26-28-2).
- .5 Outdoor Switch Covers: Weatherproof (WP), UV rated, extra duty, continuous plastic cover plate complete with gaskets for single switch.

3 EXECUTION

3.1 General Switch Installation

- .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.
- .3 Mount toggle switches at height specified in Section 16010 - Electrical General Requirements or as indicated.

3.2 General Receptacle Installation

- .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
- .2 Mount receptacles at height specified in Section 16010 - Electrical General Requirements or as indicated.
- .3 Where split receptacle has one portion switched, mount vertically and switch upper portion.
- .4 Provide a separate grounding wire from power source (panel board) to each receptacle, light switch, control panel, junction box, etc.

3.3 Cover Plate Installation

- .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.

3.4 Isolated Ground Receptacle

- .1 Provide a separate insulated ground wire from power source (panel board) to each Isolated Ground receptacle.
- .2 Provide a separate bonding wire from power source (panel board) to each receptacle box. Bonding wire to be in addition to the insulated ground wire for Isolated Ground receptacles.

END OF SECTION

Basic Electrical Equipment

1 GENERAL

1.1 General Conditions

- .1 All sections of Division 1 form a part of this Specification. Read and fully adhere to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this section.
- .3 All sections of Divisions 1 to 16 inclusive form part of the Contract Documents. Refer to Section 16010 for General Electrical Requirements related to this work.

1.2 Scope

- .1 Furnish all labour, materials, supervision, equipment and services specified, indicated or requested to install all equipment and materials specified herein and on the drawings.
- .2 All ventilation control panels, local control panels and pushbutton stations indicated on electrical contract drawings will be supplied, installed, and tested under this section.

1.3 Shop Drawings

- .1 Submit shop drawing in accordance with Section 01340 – Shop Drawings, Product Data and Samples.
- .2 For each control panel and pushbutton station include all layout drawings, terminal blocks, control relays, wire numbering system, panel dimensions, enclosure rating, wiring arrangement, nameplates, etc.

1.4 Measurement for Payment

- .1 No measurement for payment will be made under this section.

1.5 Basis of Payment

- .1 All labour, materials and equipment necessary for the work in this Section shall be included in the lump sum prices in the Schedule of Items and Prices.

2 PRODUCTS

2.1 Enclosure Ratings for Equipment Specified Herein

- .1 Refer to Table 65 in the OESC.
- .2 Indoor and dry locations: Type 12.
- .3 Below grade, damp or outdoor locations: Type 4X. Provide 316 stainless steel as indicated.
- .4 Explosion Proof or hazardous locations: rated for Class 1, Zone 1, Group D.

2.2 Disconnect Switches

- .1 Fusible and non-fusible disconnect switch: size as indicated, enclosure rated for applicable area (see Clause 2.1).
- .2 Provision for padlocking in "OFF" and "ON" switch positions.
- .3 Mechanically interlocked door to prevent opening when handle in ON position.
- .4 Fuses: size as indicated.
- .5 Fuseholders: suitable without adaptors, for type and size of fuse indicated.
- .6 Quick-make, quick-break action, non-teasible mechanism with visible blade – dead front construction.
- .7 ON-OFF switch position indication on switch enclosure cover.
- .8 Early break auxiliary contact (switch), as indicated on drawings.
- .9 Acceptable manufacturers: Allen-Bradley, Cutler-Hammer, Siemens, GE and Square-D (Schneider).

2.3 Fusing

- .1 CSA Certified to C22.2 Standard.
- .2 Type: Class J fuse body, Time Delay (unless otherwise indicated on drawings).
- .3 Interrupting rating: 200,000 Amps, with IEC Type 2 "no damage" protection.
- .4 Voltage rating: 600VAC.
- .5 Amperage rating: refer to contract drawings.
- .6 Include "blown fuse" indicator on fuse body.

- .7 Acceptable manufacturers: Bussman, Ferraz Shawmut.

2.4 Meter Bases (Sockets)

- .1 Heavy Duty rated, rated 600VAC Max., CSA Approved, suitable for overhead or underground services.
- .2 Tunnel type terminals for line, load and neutral copper or aluminum conductors.
- .3 Number of Jaws: 7. Coordinate meter base selection with Power Supply Authority.
- .4 Amperage rating: as indicated on drawings.
- .5 Enclosure rating: suitable for outdoors, EEMAC-3R.
- .6 Acceptable manufacturers: Microelectric, Cutler-Hammer, GE.

2.5 MCC Surge Protection Device (SPD)

- .1 Voltage rating: 600V, 3 wire (refer to drawings).
- .2 Peak surge capacity: 160kA per phase (verify with supplier).
- .3 Provide unit complete with the component level fusing option.
- .4 Provide the enhanced transient filter option.
- .5 Complies with ANSI/IEEE C62.41.1-2002, 41.2-2002, 45-2002, categories C1 and C3 bi-wave, 90-degree phase angle, positive polarity, measurements in peak voltage, all dynamic tests except N-G, which shall be no higher than:

C1 (6KV, 3KA)	C3 (20KV, 10KA)
L-G 1423V	L-G 1870V
L-L 1481V	L-L 1950V
- .6 Provide test report from a recognized independent testing laboratory verifying the suppressor components can survive published surge current rating on a per mode basis using the IEEE C 62.41, 8x20 microsecond current wave. Test data must be on a complete SPD with internal fusing in place. Test data on an individual module is not acceptable.
- .7 Response time of the components: less than or equal to 1 nanosecond.
- .8 Provide minimum NEMA 4 steel enclosure. Do not exceed 9.50" H, 7.35" W, and 5.25" D to allow "close to load" installation.

- .9 Alarm output contacts: Form C' dry contacts (NO/NC) for remote monitoring.
- .10 Installation must comply with U.L. 1283 and U.L. 1449 Second Edition listed as well as the components or modules.
- .11 Warranty: minimum thirty years. Include unlimited free replacements of the unit if destroyed by lightning or other transients during the warranty period. Special or optional warranties in excess of the unit's standard warranty for purposes of this bid are not acceptable.
- .12 Circuit design: parallel circuit (series elements are not permitted). Encapsulate all circuitry in a thermally conductive chemical compound. Transient energy dissipation must not be accomplished solely by air and/or by the electronics contained in the suppression unit.
- .13 The unit shall not short or crowbar the power that could result in interruption of current to the protected load. Include component level fusing (200kAIC).
- .14 Acceptable manufacturer: Innosys Power (Surge Track) Model No. TK-ST160-600NN-FL. Coordinate exact model with manufacturer's recommendations prior to purchase and installation.

2.6 Power Panel Surge Protection Device (SPD)

- .1 Voltage rating: 120/208V (refer to drawings).
- .2 Peak surge capacity: 80kA (verify with supplier).
- .3 Provide unit complete with the component level fusing option.
- .4 Provide the enhanced transient filter option.
- .5 Complies with ANSI/IEEE C62.41.1-2002, 41.2-2002, 45-2002, categories C1 and C3 bi-wave, 90-degree phase angle, positive polarity, measurements in peak voltage, all dynamic tests except N-G, which shall be no higher than:

C1 (6KV, 3KA)	C3 (20KV, 10KA)
L-N 546V	L-N 950V
L-G 564V	L-G 1010V
N-G 507V	N-G 860V
L-L 903V	L-L 1310V

- .6 Provide test report from a recognized independent testing laboratory verifying the suppressor components can survive published surge current rating on a per mode basis using the IEEE C 62.41, 8x20 microsecond current wave. Test data must be on a complete SPD with internal fusing in place. Test data on an individual module is not acceptable.
- .7 Response time of the components: less than or equal to 1 nanosecond.
- .8 Provide minimum NEMA 4 steel enclosure. Do not exceed 9.50" H, 6.28" W, and 6.5" D to allow "close to load" installation.
- .9 Alarm output contacts: Form C' dry contacts (NO/NC) for remote monitoring.
- .10 Installation must comply with U.L. 1283 and U.L. 1449 Second Edition listed as well as the components or modules.
- .11 Warranty: minimum thirty years. Include unlimited free replacements of the unit if destroyed by lightning or other transients during the warranty period. Special or optional warranties in excess of the unit's standard warranty for purposes of this bid are not acceptable.
- .12 Circuit design: parallel circuit (series elements are not permitted). Encapsulate all circuitry in a thermally conductive chemical compound. Transient energy dissipation must not be accomplished solely by air and/or by the electronics contained in the suppression unit.
- .13 The unit shall not short or crowbar the power that could result in interruption of current to the protected load.
- .14 Acceptable manufacturer: Innosys Power (Surge Track) Model No. TK-ST080-3Y208-FL. Coordinate exact model with manufacturer's recommendations prior to purchase and installation.

2.7 PLC Panel Power Filter Surge Protection Device (SPD)

- .1 Voltage rating: 120V (refer to drawings).
- .2 Peak surge capacity: 40kA/phase, 8 X 20 μ s waveform, single impulse. (verify with supplier).
- .3 Provide unit complete with dual component level fusing option. The unit shall have a SCCR of 100k AIC short circuit current rating with a 30-amp max Class T fuse.

- .4 The manufacturer shall provide written specifications showing let-through voltage of the unit pursuant to ANSI/IEEE C62.41 and C62.45, 2002, categories A1 and A3 ringwave and category B3/C1 impulse, 90 or 180 degree phase angle as listed below, positive polarity, dynamic or static test, which shall be no higher than:

AI (2kV, 67A)	A3 (6kV, 200A)	B3/C1 (6kV, 3kA)
(180 degrees)	(90 degrees)	(90 degrees)
L-N 28V	L-N 108V	L-N 444V
L-G 28V	L-G 104V	L-G 440V
N-G 24V	N-G 100V	N-G 456V

- .5 Provide test report from a recognized independent testing laboratory verifying the suppressor components can survive published surge current rating on a per mode basis using the IEEE C 62.41, 8x20 microsecond current wave. Test data must be on a complete SPD with internal fusing in place. Test data on an individual module is not acceptable.
- .6 The unit shall have an indicator light monitoring the status of the unit.
- .7 The unit shall be an ETL recognized component under UL 1449 3rd Edition as a type 4 SPD, and also under UL 1283.
- .8 For strength and fire-retardant properties, the unit shall be housed in an ABS UL94-5VA rated enclosure.
- .9 The SPD shall come standard with not less than a Fifteen Year Warranty, and the warranty shall include unlimited free replacements of the unit if destroyed by lightning or other transients during the warranty period. Special or optional warranties in excess of the unit's standard warranty for purposes of this bid are not acceptable.
- .10 Acceptable manufacturer: International Innosys Power (Load Track) Model No. TK-LTE120-30A-DIN2. Coordinate exact model with manufacturer's recommendations prior to purchase and installation.

2.8 Dry-type Transformers up to 600V Primary (Energy Efficient C802.2)

- .1 Design
- .1 Type: ANN, naturally air cooled, high efficiency.

- .2 kVA, voltage ratio and number of phases as indicated, 60 Hz.
- .3 Energy Efficient to C802.2 standard.
- .4 Voltage taps: 2 – 2½% FCAN, 2 – 2½% FCBN, silver plated.
- .5 Insulation Class: 220°C, with 80°C temperature rise.
- .6 Windings: copper, epoxy dipped.
- .7 K factor: K-13.
- .8 Angular displacement: secondary lagging primary by 30°C, as defined by IEC-DY-1.
- .9 Basic Impulse Level (BIL): 10 kV.
- .10 Hipot: standard.
- .11 Average sound level: meets NEMA ST-20 standards.
- .12 Impedance at 170°C: standard.
- .13 Enclosure: EEMAC 3R ventilated, removable metal front panel (perforated screen).
- .14 Mounting: floor and wall.
- .15 Finish: in accordance with Section 16010 – Electrical General Requirements.
- .16 Warranty: minimum 10-years.
- .2 Manufacturer's nameplate to indicate: angular displacement, connection diagram and taps, polarity type, phase, kVA capacity, voltage ratio, frequency, LIL (BIL), impedance, insulation class, insulation and winding material, temperature rise, sound level, weight, serial number, date of manufacture, manufacturer, CSA label, etc.
- .3 Acceptable manufacturers: Bemag, Hammond, Square D, GE and Marcus.

2.9 Power Panelboards (120/208V 3-Phase 4W)

- .1 Panelboards: product of one manufacturer.
- .2 Designed with main breaker (as indicated on drawings), rated 22kAIC. Main and feeder breakers must be "series" rated for 22kAIC.
- .3 Panelboard: bus and feeder breakers rated for 10,000 A (symmetrical) interrupting capacity or as indicated (see clause above).

- .4 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.
- .5 Panelboards: voltage mains, number of circuits, and number and size of branch circuit breakers as indicated.
- .6 Two keys for each panelboard (and key alike).
- .7 Copper buses with neutral of same ampere rating as mains, and Copper ground bar.
- .8 Panelboard tub mounting: Surface. Trim and door finish in accordance with Section 16010 - Electrical General Requirements.
- .9 Base panelboards on CSA C22.2 No. 29 - specification.
- .10 Panelboard Branch Breakers:
 - .1 Breakers with thermal and magnetic tripping in panelboards, suitable for bolt-on.
 - .2 Main breaker: separately mounted on top or bottom of panel to suit service and cable entry. When mounted vertically, down position should open breaker.
 - .3 Lock on devices as indicated.
 - .4 Bolt-on moulded case circuit breaker: quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40°C ambient.
 - .5 Common-trip breakers: with single handle for multi-pole applications.
 - .6 Ground fault protection circuit breakers: Class A type, 120V AC, complete with automatic shunt trip, zero sequence transformer and facilities for testing and reset pushbuttons.
 - .7 Provide "shunt trip", "alarm switch" and "auxiliary switch" contacts on breakers, as indicated on drawings.
- .11 Acceptable manufacturers: Schneider, Eaton, and Siemens.

2.10 Motor Starters and Contactors

- .1 General
 - .1 Starters: to EEMAC E14 1. Half size starters not acceptable.

- .2 Enclosure ratings: suitable for applicable area, as per clause 2.1.
- .2 Manual Motor Starters
 - .1 Single phase (one or two pole) manual motor starters of size, type, and rating to suit full load current of motor, with components as follows:
 - .1 Switching mechanism, quick make and break.
 - .2 One or two overload heater, manual reset, trip indicating handle.
 - .2 Accessories:
 - .1 Toggle switch: heavy duty – oil tight, labelled as indicated.
 - .2 Indicating light: heavy duty oil tight type and colour as indicated.
 - .3 Locking tab to permit padlocking in “OFF” position.
 - .3 Acceptable manufacturers:
 - .1 Non-Hazardous Areas: Square D, Allen-Bradley, GE and Siemens.
 - .2 Hazardous Areas: Crouse-Hinds and Appleton.
- .3 Full Voltage Magnetic Starters
 - .1 Magnetic starters of size, type, rating and enclosure type as indicated with components as follows:
 - .1 Contactor solenoid operated, rapid action type rated heavy duty and long life.
 - .2 Interchangeable bimetallic or eutectic alloy isothermic motor overload protective device in each phase, manually reset from outside enclosure.
 - .3 Power and control terminals.
 - .4 Elementary control diagrams as indicated on drawings, and locate inside starter enclosure in visible location.
 - .5 Identify each wire and terminal for external connections, within starter, with permanent number marking.
 - .6 Minimum starter size: EEMAC Size 1.

- .2 Magnetic starters to include fusible switch properly rated for motor, with operating lever on outside of enclosure with provision for:
 - .1 Locking in "OFF" position with up to 3 padlocks.
 - .2 Preventing switching to "ON" position while enclosure door open.
- .4 Heating/Lighting Contactors
 - .1 Contactors: to EEMAC No. 1CS-1970.
 - .2 Permanent magnet latch type controlled by pilot devices as indicated and rated for type of load controlled. Half size contactors not accepted.
 - .3 Complete with 2 normally open and 1 normally closed auxiliary contacts unless indicated otherwise.
 - .4 Contactor to include enclosure, disconnect switch - interlocked with enclosure door, control transformer with primary and secondary fusing, indicating lights, selector switches, pushbuttons, etc.
 - .5 Acceptable manufacturers: Allen-Bradley, Cutler Hammer, Siemens, GE and Square D (Schneider).

2.11 AC Control Relays (Instantaneous)

- .1 General purpose plug-in type relays, low coil current heavy-duty contacts with minimum three SPDT contact poles. Coil rating: 120 V, 60 Hz. Contact rating: 120 V, 10A resistive.
- .2 Acceptable manufacturers: Allen-Bradley, Potter Bromfield, Omron.

2.12 Relay Accessories

- .1 Overlap contact cartridges: supplied in pairs having NO contact that closes before NC contact opens (early make -late break).
- .2 Mounting strips: indexed strips easily cut to required length and bolted in place. Relays are installed in rows on strip with captive mounting screws. Rows of relays on mounting strip form their own wiring trough.

2.13 AC Control Relays (UPS Bypass)

- .1 Heavy-Duty Industrial relay, 600V maximum AC/DC rating, complete with standard 20A AC contact rating, 2 normally open, 2 normally closed contacts,

positively guided to insure all contacts open or close at the same time, DIN rail mountable, finger-safe protection. Coil rating: 120 V or as indicated in contract drawings, 60 Hz.

- .2 Acceptable manufacturers: Allen-Bradley 700-PKA1 or approved equal.

2.14 Timing Relays

- .1 General purpose plug-in type relays, low coil current heavy-duty contacts with multi-contact poles as indicated. Coil rating: 120 V, 60 Hz. Contact rating: 120 V, 10A.
- .2 Timing adjustment: self-contained to provide time interval adjustment. Timing range as indicated.
- .3 Acceptable manufacturers: Allen-Bradley, Potter Bromfield, Omron.

2.15 Pushbuttons

- .1 Momentary contact type: 30mm Heavy duty – oil tight, operator flush type, colour as indicated, 1-NO and 1-NC contacts rated 5A at 120V AC, labels as indicated.
- .2 Push-pull contact type: 30mm Heavy duty – oil tight, operator 30.5mm mushroom head type, red colour, provision for padlocking in “OFF” position, 2-NO and 2-NC contacts rated 5A at 120V AC, labels as indicated.
- .3 Pushbutton ratings:
 - .1 EEMAC/ NEMA type 13 for indoor control panels.
 - .2 EEMAC /NEMA type 4X for outdoor control panels.
 - .3 EEMAC/NEMA type 7 suitable for Class 1, Zone 1 & 2 hazardous areas.
- .4 Acceptable manufacturers: Allen-Bradley, Cutler-Hammer, Siemens, and Square D (Schneider).

2.16 Selector Switches

- .1 Maintained contact type, 30mm two or three positions (as indicated), heavy-duty, oil-tight, operators standard knob, contact arrangement as indicated rated 5A at 120V AC, labels as indicated.
- .2 Selector switch ratings:
 - .1 EEMAC/NEMA type 13 for indoor control panels.

- .2 EEMAC/NEMA type 4X for outdoor control panels.
- .3 EEMAC/NEMA type 7 suitable for Class 1, Zone 1 & 2 hazardous areas.
- .3 Acceptable manufacturers: Allen-Bradley, Cutler-Hammer, Siemens, and Square D (Schneider).

2.17 Indicating Lights

- .1 30mm Heavy duty – oil tight, universal LED, lens colour: as indicated, supply voltage: 120 V or as indicated in contract drawings, labels as indicated.
- .2 Indicating light ratings:
 - .1 EEMAC type 13 for indoor control panels.
 - .2 EEMAC type 4X for outdoor control panels.
 - .3 EEMAC/NEMA type 7 suitable for Class 1, Zone 1 & 2 hazardous areas.
- .3 Acceptable manufacturers: Allen-Bradley, Cutler-Hammer, Siemens, and Square D (Schneider).

2.18 Control Circuit Transformers

- .1 Single phase, dry type.
- .2 Primary: as indicated, 60 Hz AC.
- .3 Secondary: 120V or 24V AC as indicated.
- .4 Rating: as indicated plus 20% spare capacity.
- .5 Secondary fuse kit (terminal block type clips) and fuse, size as indicated.
- .6 Close voltage regulations as required by magnet coils and solenoid valves.
- .7 Acceptable manufacturers: Hammond or Marcus.

2.19 Local Control Panels (Non-Hazardous Areas)

- .1 General Requirements for Panels:
 - .1 Supply and install all control panels in accordance with the general arrangement shown on the drawings.
 - .2 Provide local control panels complete with instruments, pushbutton devices, indicating lights, relays, FVNR motor starters, fuses, flange

type disconnect switch, nameplates, terminal blocks, wiring, wire markers, ground bus, etc., as specified herein or as shown on the drawings.

.2 Enclosure Construction:

- .1 Fabricated of high grade, cold rolled, smooth sheet steel not thinner than 14 gauge.
- .2 All doors and edges neatly turned in and finished smoothly. Visible welded seams are not acceptable.
- .3 Rigidly constructed with angle iron or channel supporting frame, suitably braced and stiffened to prevent any "bowing" or "deformation".
- .4 Mounting arrangement and dimensions as indicated on contract drawings.
- .5 Integral welded brackets and front access door only.
- .6 Door: flush fitting, gasketed, hung on concealed piano type hinges. Include flange for disconnect switch mounting.
- .7 Removable 12 gauge inner panel.
- .8 Drawing pocket on inside of door.
- .9 Ground stud on box and bonding/ground stud on door.
- .10 Enclosure rating: as per Clause 2.1.
- .11 Acceptable manufacturers: Hammond Manufacturing, Ralston Metal Products Ltd., Eurobec and Rittal.

.3 Control Panel wiring:

- .1 Control wiring complete with wire markers: minimum #14 AWG, stranded copper, 600 V thermoplastic insulated, moisture resistant (TEW type).
- .2 Analog wiring: minimum #18 AWG, insulated copper, 600V rated, shielded twisted pairs or triads, aluminum-mylar shield, bare copper drain wire and overall PVC jacket.
- .3 Include plastic wire-ways (with covers) to neatly arrange wiring inside panel enclosure.
- .4 Control Wiring Colours:

- .1 Power: black.
 - .2 Control: red.
 - .3 Neutral: white.
 - .4 DC power: blue.
 - .5 Intrinsically safe wiring: yellow.
 - .6 Instrument ground: light green.
 - .7 Power ground: dark green.
- .4 Terminal Block Accessories:
- .1 Feed through, single-level control terminals:
 - .1 Voltage: 600 V.
 - .2 Current: 25A.
 - .3 Maximum wire size: #12 AWG.
 - .4 Single-level terminals.
 - .5 Colours: Blue – DC, Gray – AC.
 - .2 Instrument loop – LED blown fuse indicator type terminals:
 - .1 Voltage: 600 V.
 - .2 Current: 15A.
 - .3 Maximum wire size: #12 AWG.
 - .4 LED indicator (24V DC).
 - .3 Terminal block accessories:
 - .1 35mm terminal (DIN) rails.
 - .2 End brackets.
 - .3 Instrument ground (copper) busbar and power ground (copper) busbar, c/w support blocks.
 - .4 Marking tags for each terminal.
 - .5 Test plugs, as required.
 - .6 Clear plastic covers, as required.
 - .7 Mounting hardware, as required.

- .4 Acceptable Manufacturers: Weidmuller, Phoenix Contact and Wieland.
- .5 Rail-mounted Fuseholders:
 - .1 Voltage: 600VAC (max.).
 - .2 Current: as indicated on drawings.
 - .3 Fuse type: Midget fuses (1-1/2" x 13/32"), for 120V control, and Class J for 600v motor power.
 - .4 Maximum wire size: #6AWG.
 - .5 Finger-safe design, with blown-fuse indicator.
 - .6 Acceptable manufacturers: Ferraz Shawmut and Bussmann.
- .6 Main Panel Disconnect Switch (as indicated):
 - .1 Flange mounted handle mechanism, interlocked with enclosure door.
 - .2 Variable depth operating mechanism.
 - .3 Voltage rating: 600V AC, 3-pole.
 - .4 Current rating: as per drawings.
 - .5 Fuse type: Class J fuse holders.
 - .6 Coordinate with panel enclosure manufacturer.
 - .7 Acceptable manufacturers:
 - .1 Square D, Class 9422.
 - .2 Allen Bradley, 1494V series.
 - .3 Eaton Cutler-Hammer.
- .7 On/Off Disconnect Switch (for Local Control Panels)
 - .1 On/Off switch body, suitable for mounting on inside of panels.
 - .2 Amperage rating: 32A minimum, refer to contract drawings.
 - .3 Exterior handle: red handle with yellow body, suitable for pad locking.
 - .4 Auxiliary contacts: include 1NO and 1NC set of contacts.
 - .5 Approvals: CSA
 - .6 Acceptable manufacturer: Eaton Type P1 Series

- .8 All local control panels must bear a CSA or ESA Special Inspection sticker on front door.

2.20 Ventilation Equipment for Control Panels (as noted on drawings)

- .1 Provide heat-loss calculations to confirm sizing of all heaters, fans and louvres, based on final selection of internal layout and components for panels. Submit calculations as a shop drawing submission.
- .2 Each outdoor panel to include 25mm thick fiberglass insulation with foil back jacket, glued to inner surfaces of each panel. Seal all joints with aluminum tape.
- .3 Control Panel (Enclosure) Ventilation Filtered Fan:
 - .1 Description: fan complete with filter and grill unit to be mounted on side of outdoor enclosure. To be operated from separate thermostat on rising temperature inside enclosure.
 - .2 Voltage rating: 120VAC.
 - .3 CFM rating: as recommended from heat-loss calculations.
 - .4 Accessories: NEMA Type 4X rainhood covers for exterior of filter fan.
 - .5 Accessories: 2-packs of fan filters (5 filters per package).
 - .6 Acceptable manufacturer: Hammond FLH series Filtered Fan, with RHN4 rainhood.
- .4 Control Panel (Enclosure) Heater
 - .1 Description: fan heater with built-in thermostat, CSA approved, designed to prevent overheating and provide air circulation inside enclosures.
 - .2 Description: ventilation fan heater to prevent and provide minimum temperature inside enclosures.
 - .3 Include fan "on/auto" switch and pilot light.
 - .4 Voltage rating: 120VAC.
 - .5 Wattage: as recommended from heat-loss calculations.
 - .6 Acceptable manufacturer: Hammond FLT series.
- .5 Control Panel (Enclosure) Exhaust Filter:

- .1 Description: filter and grill unit to be mounted on side of outdoor enclosure.
- .2 Size: as recommended from heat-loss calculations.
- .3 Accessories: NEMA Type 4X rainhood covers for exterior of filter fan, Accessories: 2-packs of fan filters (5 filters per package).
- .4 Acceptable manufacturer: Hammond PFAG4 Series Filtered Fan, with RHN4 rainhood.
- .6 Control Panel (Enclosure) Ventilation Thermostat:
 - .1 Description: separately DIN-rail mounted thermostat to control operation of filtered fan on rising temperature inside enclosure.
 - .2 Contacts: N.O., rated 15Amps at 120VAC.
 - .3 Temperature range: 0 to 60°C.
 - .4 Acceptable manufacturer: Hammond SKT series

3 EXECUTION

3.1 Installation - General

- .1 Install and/or connect equipment as indicated.
- .2 Perform tests in accordance with Section 16010 - Electrical General Requirements and manufacturer's recommendations.

3.2 Disconnect Switches

- .1 Install disconnect switches complete with fuses as indicated.
- .2 Provide all necessary mounting hardware.
- .3 Provide disconnect switches - surface mounted on brick, concrete or block walls with 3 mm thick lead washers between enclosure and wall face.
- .4 Mounting height: 1500 mm above finish floor level to top of switch enclosure.
- .5 Provide a Nameplate: Size 4.

3.3 Surge Protective Device

- .1 Mount unit on the load side of the breaker as indicated on contract drawings. All leads shall be as short and straight as possible. Refer to manufacturer's instructions.

- .2 Installation must comply with U.L. 1283 and U.L. 1449 Third Edition listed.

3.4 Dry Type Transformers up to 600 V Primary

- .1 Mount dry type transformers up to 75 kVA as indicated.
- .2 Mount dry type transformers 75 kVA and above on floor.
- .3 Ensure adequate clearance around transformer for ventilation, as per manufacturer's instructions.
- .4 Install transformers in level upright position.
- .5 Remove shipping supports only after transformer is installed and just before putting into service.
- .6 Loosen isolation pad bolts until no compression is visible.
- .7 Make primary and secondary connections in accordance with wiring diagram.
- .8 Energize transformers after installation is complete.
- .9 Provide a Nameplate: Size 4.

3.5 Power Panelboards

- .1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.
- .2 Install surface mounted panelboards on melamine backboards. Where practical, group panelboards on a common backboard.
- .3 Mount panelboards to height required by code or as indicated.
- .4 Connect loads to circuits. Perform a "load balance" check after all loads are connected. Refer to Section 16010 - Electrical General Requirements.
- .5 Connect neutral conductors to common neutral bus with respective neutral identified.
- .6 Breaker sizes listed in the panelboard schedule(s) are provided as a general guide. Prior to installation, contractor to confirm all breaker sizes with final equipment loads
- .7 Contractor to size all panelboard feeder wiring and conduit based on Ontario Electrical Safety Code - latest edition. Include insulated ground conductor in all conduit raceways.
- .8 Provide a Nameplate: Size 4.

3.6 Motor Starters and Contactors

- .1 Perform tests in accordance with Section 16010 - Electrical General Requirements and manufacturer's instructions.
- .2 Operate starters and contactors to verify correct functioning.
- .3 Perform starting and stopping sequences of starters contactors and relays.
- .4 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.
- .5 Ensure all protective devices ratings and settings are properly coordinated to suit nameplate rating of actual equipment supplied and/or installed.
- .6 Manual motor starters nameplate: Size 2. Contactors and magnetic starters nameplate: Size 4.

3.7 Control Panel Installation and Testing

- .1 Install all control panels according to size and type indicated on contract drawings.
- .2 Arrange and mount pushbuttons, selector switches, etc. on control panels as indicated on drawings.
- .3 Where three or more control devices are mounted in a single enclosure, wire them to terminal blocks at bottom of enclosure for connection of field wiring. Identify all wiring at each termination point with wire markers.
- .4 Identify each control panel and each corresponding group of control device with nameplates, with identical wording as indicated on drawings.
- .5 Arrange all wiring within control panel systematically so that all circuits can be readily traced.
- .6 Wire runs up to ten conductors may be tie-wrapped. For wiring installations exceeding ten conductors, plastic wire ducts with covers shall be used.
- .7 Provide terminal block terminations for all outgoing wiring connections including spare terminals totaling at least 25% of those actually used.
- .8 Wiring connections to terminal blocks: do not exceed two wires per terminal. Use Bridge Bars if more than two wire connections are required.
- .9 Provide all terminals blocks with clear plastic snap-on safety covers.

- .10 Install all panels true, plumb and square to build lines, and to mounting height specified in Section 16010 - Electrical General Requirements.
- .11 Perform tests in accordance with Section 16010 - Electrical General Requirements.
- .12 Depending upon magnitude and complexity, divide control system into convenient sections, energize one section at a time and check out operation of section.
- .13 Where 'control modules' are supplied by other divisions for panel mounting, co-ordinate with the appropriate division.
- .14 Install strip heaters in outdoor enclosures to prevent condensation build-up. Install No. 12 AWG, copper, high temperature, heat resistant cables for all connections. Do not drill through enclosure wall to mount strip heater.

END OF SECTION

Grounding

1 GENERAL

1.1 General Conditions

- .1 All sections of Division 1 form a part of this Specification. Read and fully adhere to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this section.
- .3 All sections of Divisions 1 to 16 inclusive form part of the Contract Documents. Refer to Section 16010 for General Electrical Requirements related to this work.

1.2 Scope

- .1 Furnish all labour, materials, supervision, equipment and services specified, indicated or requested to install a complete grounding system.

1.3 Measurement for Payment

- .1 No measurement for payment will be made under this section.

1.4 Basis of Payment

- .1 All labour, materials and equipment necessary for the work in this Section shall be included in the lump sum prices in the Schedule of Items and Prices.

2 PRODUCTS

2.1 Equipment

- .1 AC System Grounding conductors: bare stranded copper, soft annealed size as indicated or as required by Ontario Electrical Safety Code.
- .2 Bonding Raceways and Equipment conductors: bare stranded copper, soft annealed size as indicated or as required by Ontario Electrical Safety Code.
- .3 Grounding electrodes (rods): copper clad steel, 19mm diameter by 3m long.
- .4 Provide clamps for grounding of conductor, size as required to outdoor grounding system.
- .5 Insulated grounding conductors: green, type RW90, rated 1000V, stranded copper, soft annealed copper conductor.

- .6 Non-corroding (copper) accessories necessary for grounding system, type, size, material as required, including but not necessarily limited to:
 - .1 Grounding and bonding bushings.
 - .2 Protective type clamps.
 - .3 Bolted type conductor connectors.
 - .4 Thermit welded type conductor connectors.
 - .5 Bonding jumpers, straps.
 - .6 Pressure wire connectors.
- .7 Ground electrode box (as indicated): galvanized steel construction, 250 mm diameter x 300 mm deep, 14 AWG (min.), open bottom with removable lid cover or as indicated otherwise on drawings.
- .8 Acceptable manufacturers: Burndy or Thomas & Betts.

2.2 Telecommunication System Grounding and Bonding

- .1 Main Grounding Busbars
 - .1 Meets BICSI and J-STD-607-A requirements for network system grounding applications.
 - .2 Made of high conductivity copper and tin plated to inhibit corrosion
 - .3 Come pre-assembled with brackets and insulators attached for quick installation.
 - .4 Acceptable manufacturer: Panduit, Part # GB4B0624TPI-1 or equivalent.
- .2 Grounding Busbars
 - .1 Meets BICSI and J-STD-607-A requirements for network system grounding applications.
 - .2 Made of high conductivity copper and tin plated to inhibit corrosion
 - .3 Come pre-assembled with brackets and insulators attached for quick installation.
 - .4 Acceptable manufacturer: Panduit, Part # GB2B0312TPI-1 or equivalent.
- .3 Grounding Busbar Labels

- .1 Meets BICSI and J-STD-607-A requirements for network system grounding applications.
- .2 Size: 25mm height x 50 mm wide
- .3 Content: Refer to contract drawings for specific wording in each telecommunications room.
- .4 Grounding and Bonding Conductor Labels
 - .1 Meets BICSI and J-STD-607-A requirements for network system grounding applications.
 - .2 Each telecommunication grounding and bonding conductor shall be labelled as close as practicable to its point of termination in a readable position.
 - .3 Content: Refer to contract drawings for specific wording in each telecommunications room.
 - .4 Cable must be applied as flag marker.
 - .5 Label must be a rigid yellow plastic tag printed with: "IF THIS CONDUCTOR OR CABLE IS LOOSE OR MUST BE REMOVED, PLEASE CALL THE BUILDING TELECOMMUNICATION MANAGER" and come complete with flame retardant cable ties.
 - .6 Acceptable manufacturer: Panduit, Part #LTYK or equivalent.
- .5 Copper Compression Fitting, Two Hole, Long Barrel
 - .1 Meets BICSI and J-STD-607-A requirements for network system grounding applications.
 - .2 Stud hole size: two (2) M6
 - .3 Stud hole spacing: 16mm
 - .4 Long barrel to maximize number of crimps and provide premium wire pull-out strength and electrical performance.
 - .5 Inspection window to visually assure full conductor insertion.
 - .6 Tin plated to inhibit corrosion.
 - .7 Acceptable manufacturer: Panduit, Part #LCC Series or equivalent.
- .6 Copper Compression Fitting HTAP and Clear Cover

- .1 Meets BICSI and J-STD-607-A requirements for network system grounding applications.
- .2 Includes all components to make a complete HTAP and cover installation: HTCT HTAP, matching CLRCVR clear cover and cable ties.
- .3 HTAPs to incorporate a slotted design to allow for quick and easy installation using cable ties.
- .4 Matching clear covers are made from high impact plastic and provide high impact strength and 360o viewing of installed HTAP.
- .5 Clear covers have a UL 94V-O flame rating and an oxygen index of 28 providing self-extinguishing, flame retardant properties.
- .6 Acceptable manufacturer: Panduit, Part #HTW and HTC Series or equivalent.
- .7 Bronze U-Blot Grounding Clamp
 - .1 Used to ground copper conductor parallel or at a right angle to a conduit.
 - .2 Made of high strength, electrolytic cast bronze.
 - .3 Incorporates high strength silicon bronze hardware to provide long term reliable assembly.
 - .4 Accommodates a wide range of pipe and conductor sizes.
 - .5 UL listed for ground and bonding with AWG conductor and suitable for direct burial in earth or concrete.
 - .6 Acceptable manufacturer: Panduit, Part #GPL Series or equivalent.

3 EXECUTION

3.1 Installation General

- .1 Install complete permanent, continuous, system and circuit, equipment, grounding systems including, electrodes, conductors, connectors, accessories, as indicated, and to conform to requirements of Engineer, and local inspection authorities having jurisdiction over installation.
- .2 Install connectors in accordance with manufacturer's instructions.
- .3 Protect exposed grounding conductors from mechanical injury.

- .4 Make buried connections, and connections to conductive water main, electrodes, using copper welding by thermit process or mechanical compression connectors utilizing hydraulic tools.
- .5 Use mechanical connectors for grounding connections to equipment provided with lugs.
- .6 Soldered joints not permitted.
- .7 Install bonding wire for flexible conduit, connected at both ends to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.
- .8 Install a minimum of one ground electrode box. Locate box where mechanical damage is avoided and accessible for inspection.
- .9 Install separate insulated ground conductor in each conduit, duct and raceway, including to outdoor lighting standards.
- .10 Connect building structural steel and metal siding to ground by welding copper to steel. Locate connections where they will not be subject to mechanical damage and, where possible, be accessible for inspection.
- .11 Where welding to building steel is prohibited or impractical, bolt the ground connection directly to the steel using pressure connectors and 9 mm diameter silicon bronze alloy bolts. Peen the bolts ends after installation. Drilled holes not to exceed 12 mm diameters.
- .12 Make connections to ground bus using mechanical clamp type connectors.
- .13 Clean surfaces to which ground conductors or bus are bolted to surfaces of paint, rust, etc., and lightly coat both contact surfaces with an oxide-preventing agent before bolting connection to steel member.
- .14 For areas requiring multiple connections, such as electrical rooms, attach copper ground loops to building steel or ground bus to which the multiple ground connection shall be made.
- .15 Protect ground conductors or bus subject to mechanical damage by rigid galvanized steel conduit or steel guards which shall be effectively grounded at both ends to the ground conductor they are protecting, regardless of length.
- .16 Terminate ground wires forming an integral part of cables to equipment ground stud of enclosure at all terminations unless otherwise noted for single

cables. Where stud is not provided, drill enclosure housing and install ground fitting.

- .17 Ground cable armouring, unless otherwise noted for single conductor cables, at both ends through a ground strip and suitable fittings.
- .18 Ground cable shielding at both ends unless otherwise specified. For high voltage cable, make ground connections through stress cones to ground stud or ground bus.
- .19 Connect instrumentation cabling drain wires to ground at one end (receiver) only. Where two or more drain wires are supplied in one cable, bond the wires together.
- .20 Install ground conductors passing through masonry walls, floors, foundations, etc., in rigid PVC conduit sleeves. Where sleeves are installed in walls or floors below grade, seal the sleeves watertight after installation of ground conductor.
- .21 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.
- .22 Ground secondary service pedestals.

3.2 System and Circuit Grounding

- .1 Install system and circuit grounding connections to neutral of secondary systems (120/208V, 120/240V and 600/347V).

3.3 Equipment Grounding

- .1 Install grounding connections to typical equipment included in but not necessarily limited to following list. Service equipment, transformers, switchgear, frames of motors, motor control centres, starters, all control panels distribution panels, outdoor lighting, fire alarm system, generators, building steel, etc.
- .2 Provide an insulated ground conductor in all conduit raceways, sized as required by the Electrical Code.

3.4 Telecommunication System Grounding and Bonding

- .1 Follow all requirements for installation as recommended by ANSI-J-STD-607-A, latest revision.

3.5 Field Quality Control

- .1 Perform tests in accordance with Section 16010 - Electrical General Requirements.
- .2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Consultant and local authority having jurisdiction over installation.
- .3 Perform tests before energizing electrical system.
- .4 Disconnect ground fault indicator during tests.

END OF SECTION

Motor Control Centres

1 GENERAL

1.1 General Conditions

- .1 All sections of Division 1 form a part of this Specification. Read and fully adhere to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this section.
- .3 All sections of Divisions 1 to 16 inclusive form part of the Contract Documents. Refer to Section 16010 for General Electrical requirement related to this work.

1.2 Scope

- .1 Furnish all labour, materials, supervision, equipment and services specified, indicated or requested to install the Motor Control Centres (MCC) specified herein and on the drawings.
- .2 Provide dedicated section for Automatic Transfer Switch, as indicated. Refer to Section 16627 for Automatic Transfer Switch specifications.

1.3 Conflicting Requirements

- .1 Any ambiguities in, or contradictions between sections of this Specification, or between this Specification and the local codes, must be resolved by the equipment manufacturer to the satisfaction of the Engineer.

1.4 Deviations from Specifications

- .1 Deviations from this Specification may occur due to special design conditions. Such deviations may be permissible if they are equal to or better than the specified requirements, and only when they are approved by the Engineer.

1.5 Codes and Standards

- .1 Materials and workmanship shall comply with codes and standards of the Province in which the work is located and local codes, regulation and standards.

- .2 In addition, the work shall confirm to the latest editions and amendments of the applicable Codes and Standards of the following agencies:
 - .1 EEMAC Standard ICS2-322.
 - .2 CSA Standard C22.2 - 14, "Industrial Control Equipment".
 - .3 CSA Standard C22.1, Canadian Electrical Code, Part I plus Provincial supplements.
 - .4 Applicable sections of ANSI (American National Standards Institute) Standards.

1.6 Source Quality Control (Testing)

- .1 Conduct equipment inspection at manufacturer's plant.
- .2 Provide manufacturer's type test certificates, and in accordance with the latest CSA, ANSI, IEEE, NEMA and EEMAC standards.
- .3 Manufacturer to provide standard factory testing of complete MCC including operation of switches, circuit breakers, starters and controls.
- .4 Submit certified written test results to Engineer prior to shipment.

1.7 Spare Parts and Tools

- .1 Provide an itemized list of spare parts as recommended for start-up.
- .2 Provide an itemized list of all recommended spare parts required for routine and minor overhauls for two (2) years of normal operation. Each piece of equipment shall have part number or designation.
- .3 Use identical equipment and components where practical to permit interchangeability of parts, minimize spare parts inventory, and to simplify maintenance.
- .4 Where two or more items of equipment perform similar functions, use the same make and, where practical, the same model number and size.
- .5 Provide a complete list with price list of special tools required for commissioning and servicing of the equipment.

1.8 Shop Assembly

- .1 Maximize shop assembly to minimize the on-site erection work.

- .2 Shipped the equipment in as few sub-assemblies as is practical and in accordance with overall erection schedule.

1.9 Packaging and Shipping

- .1 Pack, crate or otherwise protect each item so that it is not damaged in transit and arrives in serviceable condition at the site. In particular, ensure accumulation of water in equipment is prevented.
- .2 Include with the shipment one copy of erection drawings, instructions and maintenance manuals in English.
- .3 Clearly mark all crates, boxes and cartons to indicate the purchase order number and the name of the equipment.
- .4 Shipping invoice shall show the crate, box or carton number.

1.10 Guarantee

- .1 The performance of the MCC equipment shall be guaranteed throughout to perform the duty stated herein.
- .2 In addition, guarantee the equipment against faulty materials, construction and workmanship for a period of twelve (12) months from date of start-up (i.e., commissioning).

1.11 Metrication/Imperial

- .1 All design data, drawings, calculations, etc., shall be prepared using metric units in accordance with SI practice with imperial units shown in parentheses.

1.12 Shop Drawings

- .1 Indicate on the shop drawing submission:
 - .1 Outline dimensions and weights of each section.
 - .2 Configuration of identified compartments.
 - .3 Floor anchoring method and dimensioned foundation template.
 - .4 Cable entry and exit locations.
 - .5 Dimensioned position and size of busbars and details of provision for future extension.
 - .6 Elementary control diagrams, as indicated.

- .2 Submit shop drawing showing the proposed floor anchor system to secure MCC to floor. Anchor system must comply with local building code to meet the seismic criteria for the project area.

1.13 Operation and Maintenance Data

- .1 Provide 3-ring binder(s) and indexed copies of operating and maintenance manuals with the following:
 - .1 Complete parts list.
 - .2 Spare parts list.
 - .3 Installation instructions.
 - .4 Operating instructions.
 - .5 Maintenance instructions.
 - .6 Detailed trouble shooting procedures and fault correction schedules.
 - .7 Data for each type and style of starter, relays and circuit breakers.

1.14 Measurement for Payment

- .1 No measurement for payment will be made under this section.

1.15 Basis of Payment

- .1 All labour, materials and equipment necessary for the work in this Section shall be included in the lump sum prices in the Schedule of Items and Prices.

2 PRODUCTS

2.1 Service Entrance Supply Characteristics

- .1 600/347 V, 3-phase, 3 wire, 60 Hz.

2.2 General Description

- .1 Compartmentalized vertical sections with common power busbars.
- .2 Floor mounting, free standing, enclosed dead front.
- .3 Indoor NEMA/EEMAC 1A enclosure (gasketed).
- .4 Accommodating incoming circuit breaker combination starters and feeder/branch fusible switches as indicated.
- .5 Suitable for front mounting.

- .6 EEMAC Class II Type B assembly.
- .7 General arrangement of MCC as indicated on electrical contract drawings.
- .8 The number of unassigned compartments (spaces) may be increased but not decreased. If needed, provide additional MCC section(s) to maintain the number of spares or spaces indicated on drawings.
- .9 Provide all necessary warning signs as required by local Inspection Authorities.

2.3 Vertical Section Construction

- .1 Independent vertical sections fabricated from rolled flat steel sheets, bolted together to form rigid, completely enclosed assembly.
- .2 MCC Section dimensions: nominally 2286mm (90") high, 508mm (20") deep and 508mm (20") wide. Refer to drawings for sizes of all sections.
- .3 Each vertical section divided into compartment units, minimum 305 mm high, or as indicated.
- .4 Each unit to have complete top and bottom steel plate for isolation between units.
- .5 Horizontal wireways, equipped with cable supports, across top and bottom, extending full width of MCC, isolated from busbars by steel barriers.
- .6 Vertical wireways for load and control conductors extending full height of vertical sections, minimum 100 mm wide and equipped with cable tie supports. Installation wiring to units accessible with doors open and units in place.
- .7 Openings, with removable coverplates, in side of vertical sections for horizontal wiring between sections.
- .8 Main incoming cables to enter at top with terminals as indicated.
- .9 Provision for outgoing cables to exit via top or bottom with terminals.
- .10 Removable lifting means.
- .11 Provision for future extension of both ends of MCC including busbars without need for further drilling, cutting or preparation in field.
- .12 Divide assembly for shipment to site, complete with hardware and instructions for re assembly.

- .13 Provide each unit, including unused compartments, with a removable formed door with concealed hinges.

2.4 Sills

- .1 Continuous channel iron floor sills for mounting bases with 19 mm diameter holes for bolts.

2.5 Busbars

- .1 Provide main horizontal and branch vertical busbars, (three phase) of high conductivity tinned plated copper busbars in separate compartment bare self-cooled, extending entire width and height of MCC, supported on insulators and rated:
 - .1 Main horizontal busbars: 600 A.
 - .2 Branch vertical busbars: 300 A.
- .2 Branch vertical busbars for distribution of power to units in vertical sections.
- .3 No other cables, wires, equipment in main and branch busbar compartments.
- .4 Brace buswork to withstand effects of short circuit current of 42 kA rms symmetrical.
- .5 Bus supports: with high dielectric strength, low moisture absorption, high impact material and long creepage surface designed to discourage collection of dust.

2.6 Ground Bus

- .1 300A Copper ground bus (tin plated) size 50 x 3 mm extending entire width of MCC, located at bottom.
- .2 Provide lugs (2) suitable for a copper grounding (stranded) conductor, sized as indicated on drawings.

2.7 Motor Starter Contactors and Devices

- .1 Combination magnetic full voltage starters of size, type, and rating as indicated with the following features:
 - .1 Contactor solenoid operated, rapid action type rated heavy duty and long life.
 - .2 Overload element:

- .1 Integral bimetallic heater elements in each phase, with adjustable FLA current range.
- .2 Manual reset from MCC unit door (exterior).
- .3 Include normally open and normally closed auxiliary contacts.
- .4 Motor size and FLA requirements as per drawings.
- .3 Power and control terminal blocks.
- .4 Elementary control diagram inside starter enclosure invisible location.
- .5 Starter to include fusible switch (Class J type), properly rated for motor it is protecting.
- .6 Minimum starter size: NEMA/EEMAC Size 1 (10 HP @ 600V, 3-phase).
- .2 Control Transformer:
 - .1 Single phase, dry type, control transformer with primary voltage as indicated, and 120 V or 24 V secondary as indicated, complete with primary (2) and secondary (1) fuses.
 - .2 Size control transformer for control circuit load plus 20% spare capacity.
- .3 Provide each starter with two normally open and two normally closed 120 V spare contacts, wired to terminal blocks, unless otherwise indicated on drawings.

2.8 Motor Starter Unit Compartments (FVNR, FVR, SS, VFD, etc.)

- .1 Units NEMA/EEMAC size 3 and size 4, circuit breaker units 225 A and smaller, plug in type with self-disconnect.
- .2 Units NEMA/EEMAC size 1 and 2, circuit breaker or fusible (as indicated) plug-in type, with self-disconnect.
- .3 Guide rail supports for units to ensure that stabs make positive contact with vertical bus. Provision for units to be installed or removed, off load, while buses energized.
- .4 Unit mounting:
 - .1 Engaged position – unit stabbed into vertical bus.

- .2 Withdrawn position – unit isolated from vertical bus but supported by structure.
- .3 Provision for positive latching in either engaged or withdrawn position and padlocking in withdrawn position.
- .4 Stab on connectors free-floating silver-plated clips, self-aligning.
- .5 External operating handle of circuit breaker or fusible switch interlocked with door to prevent door opening with switch in “on” position. Provision for 3 padlocks to lock operating handle in “off” position and lock door closed.
- .6 Hinge unit doors on same side.
- .7 Overload relays manually reset from front with door closed.
- .8 Pushbuttons, ETMs and indicating lights mounted on door front.
- .9 Devices and components by one manufacturer to facilitate maintenance.
- .10 The number of unassigned compartments (spaces) may be increased but not decreased.

2.9 Automatic Transfer Switch (ATS) Section

- .1 Provide a section suitable for ATS equipment and instruments.
- .2 Provide sufficient space and all necessary structural supports to accommodate ATS equipment. Coordinate with ATS supplier.

2.10 Feeder/Branch Circuit Breakers

- .1 Circuit breaker to operate by means of a handle mechanism on each unit door, with a minimum 120° rotation between ON and OFF position. Include provision for locking the disconnect in the OFF position, with up to three padlocks.
- .2 Circuit breaker frame and trip rating: sizes as shown on drawings.
- .3 Breaker frame: frame size as indicated on drawings, 600V, 60Hz, 3-Pole, minimum 35,000 Amp interrupting capacity (symmetrical).
- .4 Mechanical interlock to prevent opening of unit door when disconnect switch is in the ON position. Also, mechanical interlock to prevent switch from closing when the unit door is open. Provide manual override for authorized personnel to defeat these two interlock conditions.

2.11 Wiring and Terminal Blocks

- .1 Provide internal power wiring from the line side of each starter to the bus stabs with a minimum of #10 AWG wire, stranded copper, XLPE, 1 kV rated. Size wiring to accommodate the largest horsepower that the line starter is capable of switching.
- .2 Control wiring complete wire markers: 600 V rated, XLPE insulated, minimum #14 AWG size stranded copper. Install wiring to panel doors utilizing extra flexible 49-strand conductors.
- .3 Identify all wiring by means of oil-resistant markers fixed to each conductor at both ends.
- .4 Wires colour code:
 - .1 Control circuits – Red.
 - .2 Power circuits – Black.
- .5 Terminal blocks: compression type, modular pull-apart construction, enabling unit wiring to be easily separated from field wiring. Identify all terminal blocks with numbers identical to the wire numbers.
- .6 No more than two wires per terminal screw (i.e. on terminal block).

2.12 Equipment Identification

- .1 Nameplates: lamicoid 3 mm thick plastic engraving sheet, black face, white core, mechanically attached with stainless steel screws.
- .2 Provide the following equipment identification:
 - .1 MCC main nameplate: 25 mm high white letters on black background.
 - .2 Individual compartment nameplates: 12 mm high white letters on black background.

2.13 Control Devices

- .1 Install operator's control devices for each starter or contactor unit on MCC units as indicated.
- .2 Pushbuttons: 30mm momentary contact type, heavy duty oil tight, operator flush type, colour as indicated, 1-NO and 1-NC contacts rated 5A at 120 V AC, NEMA/EEMAC 13 rating.

- .3 Selector switches: 30mm maintained contact type, 2 or 3 positions (as indicated), heavy duty oil tight (NEMA/EEMAC 13 rating), operator's standard knob, contact arrangement as indicated, rated 5A at 120 V AC.
- .4 Indicating lights: 30mm heavy duty oil tight (NEMA/EEMAC 13 rating), transformer type, push-to-test type, lens colour as indicated, 120V AC supply voltage rating, 6 V lamp voltage rating.
- .5 ETMs: 8-digit, non-resettable, NEMA/EEMAC 13 rating.
- .6 Control/Timing relays: plug-in type, low coil current, heavy duty contacts with multi-contact poles as indicated. Coil rating 120V AC-60 Hz, contact rating 10A @ 120V AC.

2.14 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 Paint MCC exterior ASA #61 light grey and interiors white.
- .3 Provide a 100 mL container of finish enamel for touch-up of scratches during installation.

2.15 MCC Manufacturers

- .1 Acceptable manufacturers: Allen-Bradley, Eaton/Cutler-Hammer and Square-D/Schneider.

3 EXECUTION

3.1 Installation

- .1 Set and secure MCC in place on channel bases, rigid, plumb and square to building floor and wall.
- .2 Make field power and control connections as indicated.
- .3 Install customer instrument transformers on load side of main circuit breaker, and downstream of utility metering section.
- .4 Make grounding connections between equipment ground busses and building grounding system.
- .5 Check all factory-made connections for mechanical security, electrical continuity and current phasing.

- .6 Provide floor anchors to secure MCC to floor. Anchor system must comply with the local building code to meet seismic criteria in the project area.

3.2 Tests

- .1 Perform tests in accordance with Section 16010 - Electrical General Requirements.
- .2 Ensure moving and working parts are lubricated where required.
- .3 Operate starters in sequence to prove satisfactory performance of MCC during 8-hour period.

END OF SECTION

Reduced Voltage Soft Starters

1 GENERAL

1.1 General Conditions

- .1 All sections of Division 1 form a part of this Specification. Read and fully adhere to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this section.
- .3 All sections of Divisions 1 to 16 inclusive form part of the Contract Documents. Refer to Section 16010 for General Electrical requirement related to this work.

1.2 Scope

- .1 Furnish all labour, materials, supervision, equipment and services specified, indicated or requested to install the Soft Starter specified herein and on the drawings.
- .2 Refer to Section 16480 for specifications of Motor Control Centres (MCC).

1.3 Conflicting Requirements

- .1 Any ambiguities in, or contradictions between sections of this Specification, or between this Specification and the local codes, must be resolved by the equipment manufacturer to the satisfaction of the Engineer.

1.4 Deviations from Specifications

- .1 Deviations from this Specification may occur due to special design conditions. Such deviations may be permissible if they are equal to or better than the specified requirements, and only when they are approved by the Engineer.

1.5 Codes and Standards

- .1 Materials and workmanship shall comply with codes and standards of the Province in which the work is located and local codes, regulation and standards.

1.6 Source Quality Control (Testing)

- .1 Conduct equipment inspection at manufacturer's plant.
- .2 Provide manufacturer's type test certificates, and in accordance with the latest CSA, ANSI, IEEE, NEMA and EEMAC standards.
- .3 Manufacturer to provide standard factory testing of complete soft starter unit including operation with motor prior to shipment.
- .4 Submit certified written test results to Engineer prior to shipment.

1.7 Packaging and Shipping

- .1 Pack, crate or otherwise protect each item so that it is not damaged in transit and arrives in serviceable condition at the site. In particular, ensure accumulation of water in equipment is prevented.
- .2 Include with the shipment one copy of equipment drawings, instructions and maintenance manuals in English.

1.8 Guarantee

- .1 Guarantee the performance of the equipment throughout to perform the duty stated herein.
- .2 In addition, guarantee the equipment against faulty materials, construction and workmanship for a period of twelve (12) months from date of start-up (i.e. commissioning).

1.9 Shop Drawings

- .1 Submit shop drawings in accordance with Section 01340, "Shop Drawings, Product Data and Samples".
- .2 Indicate on the shop drawing submission:
 - .1 Outline dimensions.
 - .2 Configuration of identified compartments.
 - .3 Cable entry and exit locations.
 - .4 Elementary control diagrams, as indicated.

1.10 Operation and Maintenance Data

- .1 Provide 3-ring binder(s) and indexed copies of operating and maintenance manuals (in English) with the following:

- .1 Complete parts list
- .2 Spare parts list
- .3 Installation instructions
- .4 Operating instructions
- .5 Maintenance instructions
- .6 Detailed trouble shooting procedures and fault correction schedules

1.11 Measurement for Payment

- .1 No measurement for payment will be made under this section.

1.12 Basis of Payment

- .1 All labour, materials and equipment necessary for the work in this Section shall be included in the lump sum prices in the Schedule of Items and Prices.

2 PRODUCTS

2.1 Soft Starter

- .1 General Requirements:
 - .1 Microprocessor controlled starter for 3-phase induction motors, containing a six SCR power section (two SCR's per phase) to provide variable AC output voltage. Include transient protection across SCR's on each phase using SIOV (MOV) type varistors.
 - .2 Solid state, reduced voltage, non-reversing motor starter complete with built-in bypass contactor.
 - .3 Provisions for future power factor correction contactor for externally mounted capacitors.
 - .4 Combination fusible type disconnect switch, flange handle, interlocked with enclosure door. Fuse holders to accept HRC1 Class J time delay fuses. Include fuses with starter panel.
 - .5 Enclosure: Soft Starter to be mounted within MCC. Refer to contract drawings and section 16480 – Motor Control Centres.
- .2 Technical Rating of Starter:
 - .1 Horsepower and voltage rating: refer to contract drawings.
 - .2 Starter type: closed-loop current control.

- .3 Power rating: 500% FLA for 30 seconds, 125% continuous.
- .4 Peak Inverse Voltage Rating: 2.5 x line volts (min. 1200 PIV).
- .5 Starting Torque: 0 to 100%.
- .6 Ramp Time: 0 to 120 seconds.
- .7 Maximum voltage rating: 1000VAC.
- .8 Standard insulation test: 2500VAC min.
- .9 Overall efficiency: 99% minimum.
- .10 Minimum fault current rating: 42,000Amps.
- .3 Soft Starter Input/Output and Control Requirements:
 - .1 Three (3) discrete output signals, Form C output contacts, programmable to the following function:
 - .1 Starter Faulted, Motor Power On, Starter Up to Speed (for By-Pass Contactor), Any Alarm, Starter Ready, Locked Out, Over Current Condition, Under Current Condition, Thermal Overload Warning, Shunt Trip Output, Ground Fault, Energy Saver Mode, Motor Heating.
 - .2 Control wiring: 120VAC, suitable for either two or three wire control for start/stop, and remote start/stop control capability.
 - .3 Include internal control transformer, with fused primary and secondary. Refer to contract drawings for further control wiring details.
- .4 Soft Starter Protective Functions:
 - .1 Electronic overload protection, selectable from Class 5, 10, 15, 20, 25, 30, N/A or "Bypass at Start".
 - .2 Protection from input transients by utilizing SIOV's (Varistors).
 - .3 Include the following adjustable protection features:
 - .1 Over/under line voltage detection.
 - .2 Line current imbalance detection.
 - .3 Shorted SCR detection.
 - .4 Ground fault detection.

- .5 Instantaneous over current trip detection.
- .6 Line Phase loss detection.
- .7 Motor thermal overload trip.
- .8 Motor “thermister” trip detection (separate module).
- .9 Over/under frequency trip detection.
- .4 Single phase protection, with a field selectable fault for loss of phase protection. If not available, provide a separate Phase Loss Relay.
- .5 Auto Restart function to automatically restart the drive after an Over Voltage, Over Current, Ground Fault, or Overload fault (selectable).
- .6 Motor speed search function to match the motor speed upon restart.
- .7 Include a warning on the operator display for a loss of internal cooling fan.
- .8 Allow reverse operation to be locked out for applications in which reverse operation would damage the equipment.
- .5 Soft Starter’s Operator Interface Features:
 - .1 Digital keypad for programming, monitoring, speed control, remote control and start/stop control.
 - .2 LCD true English display. LED keypads are not acceptable.
 - .3 As a minimum, protect and display the following faults on Operator Interface:
 - .1 Over/Under Voltage, Current Imbalance, Motor Over Temperature, Motor Overload, External Trip, Input Phase Loss, Shorted SCR, Heatsink Alarm, Computer Failure, Control Power Failure.
 - .4 External fault reset pushbuttons to clear starter’s computer and overload trips.
 - .5 Operator Interface Device to include metering and monitoring of the following functions:
 - .1 Phase Currents, Phase Voltages, Frequency, Power factor, Elapsed Time Running (hours), kW, kWhr, kVar, kVA, Ground Fault Current, Last Start Time, Peak Accelerating Current.

- .6 Battery back-up power of parameters
- .7 Password protection.
- .6 Soft Starter Programming Features:
 - .1 Adjustable Ramp-Up time, 0-120 seconds.
 - .2 Motor deceleration and S-curve deceleration.
 - .3 Adjustable Starting Current; 50-400%.
 - .4 Adjustable Maximum Current; 100-600%.
 - .5 True Torque Ramp profile selection.
- .7 Acceptable Soft Starter Manufacturer: Benshaw, Redistart RB2 c/w MX2 Controller or approved equivalent.
 - .1 Align with MCC suppliers, as necessary.

3 EXECUTION

3.1 Installation

- .1 Set and secure Soft Starter in place, rigid, plumb and square to building floor and wall.
- .2 Make field power and control connections as indicated.
- .3 Ensure field power and control connections as indicated.
- .4 Make grounding connections between equipment ground and building grounding system.

3.2 Start-up, Testing and Commissioning

- .1 Perform tests in accordance with Section 16010 - Electrical General Requirements.
- .2 Include services from manufacturer's technical representative to assist in setting-up and programming each Soft Starter unit at project job site.
- .3 Include all necessary site visits by manufacturer's representative to start-up and ensure "trouble free" operation of system. Extend these services during entire length of warranty period.

3.3 Training

- .1 Provide one (1) separate one-day (4 hours) session of on-site training for the operators of all equipment listed herein. Training to include operation, testing, program set-up, adjusting and routine maintenance for each device (as required).
- .2 Training sessions shall be dedicated to operator training and shall be completed separate from the commissions and start up process.

END OF SECTION

Lighting Equipment

1 GENERAL

1.1 General Conditions

- .1 All sections of Division 1 form a part of this Specification. Read and fully adhere to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this section.
- .3 All sections of Divisions 1 to 16 inclusive form part of the Contract Documents. Refer to Section 16010 for General Electrical Requirements related to this work.

1.2 Scope

- .1 Furnish all labour, materials, supervision, equipment and services specified, indicated or requested to install the lighting equipment specified herein and on the drawings.
- .2 Provide third party functional testing of all lighting control devices and systems as specified in contract drawings and specifications.

1.3 Submittals

- .1 Submit shop drawing in accordance with Section 01340 – Shop Drawings, Product Data and Samples.
- .2 Submit shop drawings for all luminaries and accessories, as specified herein and on the contract drawings.

1.4 Measurement for Payment

- .1 No measurement for payment will be made under this section.

1.5 Basis of Payment

- .1 All labour, materials and equipment necessary for the work in this Section shall be included in the lump sum prices in the Schedule of Items and Prices.

2 PRODUCTS

2.1 Lighting – Luminaire Schedule

- .1 Refer to Contract Drawings for all lighting products (i.e., luminaires, exit signs, emergency battery units, etc.).
- .2 Provide all necessary mounting brackets, hangers, etc., as required for installation.

2.2 LED Luminaire Assemblies

- .1 Driver
 - .2 The LED driver shall be securely mounted inside the fitter, for optimized performance and longevity.
 - .3 The LED driver shall be supplied with a quick-disconnect electrical connector on the power supply, providing easy power connections and fixture installation.
 - .4 The driver shall be UL Listed or Recognized, have a power factor not less than 90%, and a THD no greater than 20% at full load.
 - .5 The driver shall have overload as well as short circuit protection.
 - .6 The driver current shall be constant current design.
 - .7 The driver shall be a DC voltage output.
 - .8 The driver shall have a minimum efficiency of 90%.
- .2 Light Sources
 - .1 The luminaire shall use high output, high brightness LEDs.
 - .2 The LEDs shall be attached to the printed circuit board with not less than 90% pure silver to insure optimal electrical and thermal conductivity.
 - .3 The LEDs and printed circuit boards shall be protected from moisture and corrosion by a conformal coating of 1 to 3 mm.
 - .4 The LEDs and printed circuit board construction shall be environmentally friendly and 100% recyclable. They shall not contain lead, mercury or any other hazardous substances and shall be RoHS compliant.

- .5 The LED life rating data shall be determined in accordance with IESNA LM-80-08. Testing must be done with a complete assembled luminaire.
- .3 Optics
 - .1 The luminaire shall be provided with individual acrylic, refractor type optics applied to each LED.
 - .2 The luminaire shall provide light distribution per IESNA classifications. Testing shall be done in accordance with IESNA LM-79-08.
- .4 Performance
 - .1 The LED arrays are built in series-parallel circuits which maintain overall light output in the event of single LED failures.
 - .2 The LED and LED driver shall operate over -40°C to +50°C ambient air temperature range.
 - .3 The indoor high performance white LEDs will have a minimum 50,000 hour L₇₀ value rated at 25°C.
 - .4 The high brightness, high output LEDs shall be a maximum colour temperature of 3500K (indoor) and 4000K (outdoor) with a minimum 70 CRI (+/- 5%).
- .5 Warranty
 - .1 The outdoor luminaires and drivers shall be free from all defects in materials and workmanship for a minimum period of ten (10) years from the date of manufacture.
 - .2 The indoor luminaires and drivers shall be free from all defects in materials and workmanship for a minimum period of five (5) years from date of manufacture.
 - .3 Manufacturer shall warrant the LED boards/system, during the stated warranty period, against failure defined as more than three (3) simultaneous non-operating LEDs.
 - .4 Warranty shall include all labour costs associated with replacement of the luminaires.
- .6 Shop Drawings

- .1 All shop drawings must be submitted with the following tests:
 - .1 IESNA LM-79-08.
 - .2 IESNA LM-80-08, test must be done for the complete assembled luminaire.
- .7 Alternates
 - .1 LED luminaires not meeting the minimum requirements of this specification will not be considered.

2.3 Exit Signs

- .1 Complies with Minimum Energy Performance standards as dictated by Natural Resource Council of Canada (NRCC) and most recent CSA Standards (CAN/CSA C860-01).
- .2 Maximum power consumption: 5 Watts per face.

3 EXECUTION

3.1 Lighting Luminaires

- .1 Install lighting luminaries as shown on the drawings and in accordance with the manufacturer's installation recommendations.
- .2 Replace any new luminaries showing marks or scratches due to handling or tool marks at no cost to the Owner.
- .3 Install all luminaries accurately in line and level. Align luminaries shown in continuous rows and in straight lines.
- .4 Provide and install any additional support brackets, clamps, channels, hangers, etc., necessary to install the luminaries where shown. Do not support luminaries from ducts, piping or equipment. Ensure that all installed luminaries are freely accessible.
- .5 Check area for interference from piping, ductwork and equipment, and obtain written authorization from the Engineer before proceeding with fixture installation.
- .6 Cooperate with the ceiling materials contractor. Ensure installation of a luminaries are in correct location in relation to ceiling, and luminaries are suitable for the ceiling installed. Ensure no obstructions exist over ceiling, which will interfere with the installation of the luminaries.

- .7 Provide fire rated drywall enclosure for all recessed luminaires mounted in fire rated ceilings.
- .8 Coordinate work with all other divisions. If interferences are discovered advise the engineer immediately and do not proceed until adjustments are approved.
- .9 All interior fluorescent luminaires to be installed directly to ceiling structure or as noted on drawings

3.2 Wiring

- .1 Install wiring for all lighting luminaries in accordance with Section 16010.

3.3 Field Quality Control

- .1 After installation perform potential and continuity tests and ensure that all ground connections are properly made and made good any equipment or material which fails the tests before energizing the system.

3.4 Verification

- .1 Ensure emergency lighting system complies with Section 3.2.7.3 of the Ontario Building Code, latest edition and bulletins.
- .2 Provide (as a separate price item) manufacturer's on-site field certification/testing of the emergency lighting system.

END OF SECTION

Standby Power Diesel Generator Set – Outdoor Unit

1 GENERAL

1.1 Description

- .1 Supply, test, deliver, and install one diesel engine-generator set, as specified herein. Provide a complete set in all respects including diesel engine, generator, generator main circuit breaker, common base with vibration isolators, exhaust muffler, radiator, main control panel, protective relays, and all related controls and auxiliaries. Transfer switch will be specified in Section 16627.
- .2 Provide a fully complete diesel engine generator set in every respect for the purpose designated. It is hereby understood that the contractor agrees to furnish any item not specifically mentioned but necessary to complete the installation for proper functioning without extra cost.
- .3 The contractor is responsible for all fuel during testing and commissioning of the generator. The contractor is to utilize the Townships fuel supplier for all fuel for the generator. Contractor to coordinate fuel supplier details with the Township.
- .4 Following testing and commissioning and once substantial completion is awarded, the contractor is responsible to fill the fuel tank of fuel including obtaining the necessary Fuel Oil Inspection from the Township's fuel supplier.
- .5 Generator set consists of:
 - .1 Diesel Engine.
 - .2 Generator-mounted fuel tank (sub base).
 - .3 Alternator.
 - .4 Alternator control panel.
 - .5 Panelboard for auxiliary loads.
 - .6 Battery charger and battery.
 - .7 Exhaust system.
 - .8 Structural steel mounting base.
 - .9 Skid-mounted, sound-attenuated aluminum enclosure.

1.2 Related Work

- .1 Refer to Division 15 – Mechanical for all work and equipment required to install and operate the diesel engine-generator set.

- .2 Coordinate construction of concrete pads with general contractor, including overall pad size required, including size and locations of all underground electrical raceway entries.
- .3 Contractor to coordinate with Engine-Generator manufacturer to provide all necessary data to assist Engineer in submitting "Certificate of Approval" (Air and Noise) to the Ministry of Environment (MOE).

1.3 Shop Drawings

- .1 Submit shop drawings in accordance with Section 01340 - Shop Drawings, Product Data and Samples.
- .2 Manufacturer to provide a depiction of the nameplate as part of the shop drawing submission. As a minimum, the nameplate data shall include both prime and standby ratings in kilowatts and the model number.

1.4 Service

- .1 The engine-generator set will supply emergency standby power to the entire plant during power outages, and at such other times as initiated by the station controls, the engine-generator set will furnish the electrical power required to start and supply power to the plant's motors and auxiliary loads.
- .2 The generator set will receive a signal from the automatic transfer switch to start automatically on power failure and stop automatically on power restoration, both after suitable time delays. Emergency power transfer and re-transfer to plant's load will be controlled by the automatic transfer switch specified in Section 16627.
- .3 Except for initiation of auto start/stop as outlined in the preceding paragraph, all controls, protective devices and equipment required for safe and reliable operation of the generator set will be furnished with the generator set.
- .4 All services such as battery system for starting must be suitable for both manual and automatic, unattended operation.
- .5 The unit will also be operated on an as-required basis by manual starting and stopping, and will be exercised regularly.
- .6 Give special attention to minimizing environmental effects on the local area, particularly with respect to exhaust emissions and noise, under all conditions of load.

1.5 Measurement for Payment

- .1 No measurement for payment will be made under this section.

1.6 Basis of Payment

- .1 All labour, materials and equipment necessary for the work in this Section shall be included in the lump sum prices in the Schedule of Items and Prices.

2 PRODUCTS

2.1 Generator Set Data

- .1 Design based on the following supplier:
 - .1 Cummins Eastern Canada.
- .2 Alternate Suppliers:
 - .1 Kohler (Pritchard Power Systems)
 - .2 Sommers Generator Systems
- .3 Quantity and Location: One (1) for “Shelbnure Well #1 Pumphouse Expansion”
- .4 Generator set minimum continuous 48-hour Standby power rating: 80kW Standby rating, 347/600VAC, 3-Phase, 3-Wire, 60Hz, 1800 RPM.
- .5 Design the engine-generator set for emergency/standby service, based on CSA, C282-19, “Standard Specifications for Engine Generator Sets”.
- .6 CSA approved and conforms to EEMAC Design MG1, Part 32 standards.
- .7 Manufacturer to confirm that the selected generator is sized accordingly to meet the motor starting inrush, based on the loads shown on the single line diagram.
- .8 Method of grounding: solidly grounded neutral.
- .9 Engine cooling: radiator cooled, with integral fan and coolant pump.
- .10 Enclosure rating: sound-attenuated aluminum enclosure (outdoor).
- .11 Exhaust emissions must comply with EPA Tier 3 Emission Requirements. Supplier to submit for approval Exhaust Emission Data (Prime Rating), for the following:
 - .1 All values to be in grams per HP-Hour
 - .1 NOx + NMHC : 3.0
 - .2 Carbon Monoxide : 2.6
 - .3 Particular Matter : 0.15
- .12 Sound Power Levels (F217– Level 2)
 - .1 Supplier to submit for approval sound data for generator set as set out below not including exhaust noise.

Freq.	125	250	500	1K	2K	4K
dB(A)	88.1	89.2	92.7	92.6	90.2	87.6

.13 Performance Ratings

.1 Engine fuel Consumption at prime rating: ⁽²⁾

.1 Full-load, at most: 27.6 L/hr.

.2 Half-load, at most: 15.14L/hr.

.2 Frequency regulation within: ⁽³⁾

.1 0.25% – steady state, recovery to stable in 3 seconds

.3 Minimum voltage regulation: ⁽³⁾ +/-2% no-load to full load.

.4 Maximum Voltage-dip: ⁽⁴⁾ 25%

.5 Site conditions:

.1 Plant floor elevation at xx.xm above sea level.

.2 Maximum ambient at -40°C DB and 40°C WB.

Foot Notes:

⁽¹⁾ Intermittent: one-hour power rating in any consecutive 12-hour running period beyond the NET continuous rating.

⁽²⁾ Fuel: No.2 Diesel Oil: ISO 3046/1. Approximate LHV 42,780 kJ/kg

⁽³⁾ Based on steady state condition, no load to full load.

⁽⁴⁾ Based on instantaneous application or rejection of maximum incremental inrush.

2.2 Diesel Engine

.1 In general, the engines will conform to ISO 8528-5 and ISO3046 standards.

.2 The diesel engine to be of the radiator cooled type with turbocharger and after cooler as required. Furnish complete with all auxiliaries, instruments and controls. Engine rotation to be consistent with that of the generator.

.3 Statically and dynamically balance the engine such that it is free from critical speeds. The thermal efficiency will be as high as practical over a wide range of loads.

.4 Auxiliaries such as valve complexes, and accessories will be arranged as shown on the drawings.

2.3 Starting Arrangement

- .1 Provide electric starting motor(s) powered by a separate battery for starting the engine.
- .2 The starting equipment will consist of the following:
 - .1 12 volt DC positive engagement, solenoid shift starter motor(s).
 - .2 Batteries sized to provide 5 consecutive cranking cycles without recharging at a speed at least equal to that recommended by the manufacturer of the prime mover and at the lowest ambient temperature anticipated at the job site. A complete cranking cycle will comprise of approximately 15 seconds duration followed by a rest period of approximately 15 seconds.
 - .3 For each starter provide a 10-ampere automatic float and equalize battery charger with $\pm 1\%$ constant voltage regulation from no load over $\pm 10\%$ AC input line variation, current limited during engine cranking and short circuit conditions, temperature compensated for ambients from -40°C to 60°C , 5% accurate voltmeter and ammeter, fused, reverse polarity and transient protected. Alarm circuit board to meet the requirements of NFPA 110 for low battery voltage, high battery voltage, and battery charger malfunction. Battery charger to be wall mounted, adjacent to engine-generator set. Battery charger supply voltage: 120V AC, 60Hz.
 - .4 Battery thermostatic heater: 120V AC, 60Hz.
 - .5 Provide battery rack assembly, welded steel construction, all edges rounded, and c/w two coats of primer. Sized to mount all batteries on rack.

2.4 Engine Speed Governing Features

- .1 Electronic governor with controller and actuator.
- .2 Speed regulation: $\pm 2\%$, No-Load (NL) to Full-Load (FL), and FL to NL, steady state
- .3 Speed regulation: $\pm 8\%$, transient peak NL to FL and FL to NL and on starting any motor.
- .4 Stability: $\pm 1\%$ at any constant loads and free from hunting or oscillations.

2.5 Fuel System

- .1 Include with the engine fuel feed system, a final fuel filter, pump, gauge, injector, fuel/water separators and all other equipment required for proper operation. The engine will also be compatible with the fuel transfer system specified in section 2.10 of this specification, capable of returning recycled fuel back to the day tank.
- .2 Provide the following features:
 - .1 Fuel oil filter system with replaceable elements.

- .2 Piping fully secured to the engine for the fuel supply injector and bleed return.
- .3 Flexible stainless-steel connectors for the suction and return lines. (must comply with B139, section 5.2.1.6).
- .4 Base tank fuel alarms.

2.6 Lube Oil System

- .1 Provide the following features:
 - .1 Gear driven lubricating oil pressure pump.
 - .2 Oil pressure regulating valve.
 - .3 Oil sump electric heater (120VAC).
 - .4 Duplex lubricating oil filters with capability for changing elements while engine is running.
 - .5 Integral oil cooler.
 - .6 Piping valves and fittings to connect system with the engine.
 - .7 Oil sample cock so that oil may be removed from the system for testing.

2.7 Engine Cooling System

- .1 The engine is to be radiator cooled, c/w integral fan and coolant pump.
- .2 Cooling system design to 50C ambient.

2.8 Engine Coolant Heater

- .1 The engine is to be radiator cooled, c/w integral fan and coolant pump.
- .2 Engine mounted, thermostatically controlled, coolant heater(s) for each engine, rated 120/208-240 VAC, 1-phase, 60Hz. The coolant heater shall be UL499 listed and labeled.
- .3 The coolant heater shall be installed on the engine with silicone hose connections. Steel tubing shall be used for connections into the engine coolant system wherever the length of pipe run exceeds 12 inches. The coolant heater installation shall be specifically designed to provide proper venting of the system. The coolant heaters shall have provisions to isolate the heater for replacement of the heater element without draining the coolant from the generator set. The quick disconnect/automatic sealing couplers shall allow the heater element to be replaced without draining the engine cooling system or significant coolant loss.
- .4 The coolant heater shall be provided with a DC thermostat, installed at the engine thermostat housing. An AC power connection box shall be provided for a single AC power connection to the coolant heater system.

- .5 The coolant heater(s) shall be sized as recommended by the engine manufacturer to warm the engine to a minimum of 104°F (40°C) in a 40°F (4°C) ambient, in compliance with NFPA110 requirements, or the temperature required for starting and load pickup requirements of this specification.

2.9 Air Intake System

- .1 Provide the following:
 - .1 Air intake filter, dry replaceable element type.
 - .2 Air intake system engine mounted with the necessary flexible connectors between turbocharger and ducting.
 - .3 Ducting to interconnect filter with engine.

2.10 Exhaust System

- .1 This complete exhaust system shall be installed within the sound attenuating generator enclosure.
- .2 Provide the following features:
 - .1 Exhaust system to discharge via flexible connection, interconnecting piping and silencer mounted inside the sound attenuated enclosure.
 - .2 Flexible connections to be of stainless-steel construction with flanged ends.
 - .3 Open mesh safety guards around engine exhaust manifolds where required for operator protection.
 - .4 Pyrometer sensors at the exhaust outlet.
 - .5 Minimum dynamic insertion loss values for the critical grade silencer in unweighted decibels (dB) are as follows:

Freq.	125	250	500	1K	2K	4K
DIL	14	26	27	20	17	16

- .3 Ensure noise emitted from exhaust pipe does not exceed the limits for “Stationary Sources” as prescribed by the Model Municipal Noise Control By-law, Final Report, August 1978, and its publications, i.e., NPC-105, Section 4(2), page 87; and NPC-106, Table 106-2, page 92, of said document.

2.11 Sub-Base Diesel Fuel Storage Tank

- .1 Supply and install an integral fuel tank, double wall construction type with tapped connections for fuel fill, vent, emergency vent, fuel supply, fuel return, fuel sensors, drain, leak detector and outer tank emergency vent pipes. Tank to be integral with generator mounting base.
- .2 Fuel tank capacity: standard 24 Hours (effective) sub base, fuel tank.
- .3 Material – Steel sheet ASTM A569 or equal. Manufactured to Underwriters Laboratories of Canada Standard CAN4-S602 latest edition, finished with one coat zinc-rich primer. Tank to be ULC labeled.
- .4 Furnish a mechanical levelometer.
- .5 Provide and install low level alarm switch in the fuel tank. Switch must be suitable for diesel fuel oil. Additional auxiliary contacts to include Two (2) Form 'C' (SPDT) contact rated 5 amps at 120V AC or 24V DC with copper lead conductors wired out to an oil-tight junction box mounted on top of the storage tank (for customer use). Provide all necessary fittings and mounting hardware. All connections must be oil-tight.
- .6 Additional tank accessories to include condensate drain cock and plug. Provide tank supports to allow 150 mm minimum clearance between condensate cock and generator skid.
- .7 Provide electric high fuel level annunciator alarm panel, 12VDC c/w both LED and alarm horn, NEMA 3R enclosure.
- .8 Provide overfill protection and spill containment per the latest edition of B139.

2.12 Alternator (Generator)

- .1 Provide the following features:
 - .1 Capable of 10% overload for one hour beyond the continuous rating in any 12-hour period.
 - .2 Capable of at least 300% of full load current for at least ten (10) second under all fault conditions.
 - .3 Suitable for starting the electric motor(s) as indicated on electrical drawings such that the transient dip in the generator output voltage, as shown on an oscilloscope or undamped voltmeter, does not exceed 20%.
- .2 Alternator Features – Provide the following:
 - .1 Single bearing type alternator designed to be bolted directly to the engine. The alternator will be air cooled with a drip-proof enclosure.
 - .2 Alternator will be a three phase revolving field synchronous machine of salient pole construction with amortisseur windings.

- .3 Class H insulation.
- .4 Provide a 120VAC alternator anti-condensation heater.
- .5 Temperature rise not to exceed EEMAC MGI-22.40 for class of insulation specified, in 40°C ambient to maximum 105°C by resistance.
- .6 All leads brought out to a readily accessible power junction box.
- .7 Permanent magnet generator (PMG) rated to provide excitation of the alternator under all steady state and transient load conditions including overload conditions for the alternator.
- .8 Generator to be torsionally compatible with the diesel engine and other torsional analysis will be prepared by the engine manufacturer and submitted to the Engineer. No torsional incompatibility shall occur within 20% above or below the nominal speed range of the equipment.
- .9 Alternator and exciter to meet MOE, ANSI, and IEEE standards. Any deviations from the above Tender standards should be indicated in the Tender.
- .10 Alternator, exciter and voltage regulator must be supplied by the same manufacturer, as a complete coordinated package.
- .11 Provide grounding lugs mounted on the generator frame for connection to station ground. Lug sizes shall be suitable for up to #1/0AWG copper conductors.
- .3 Voltage Regulator – Provide the following:
 - .1 Capable of voltage restoration following a voltage dip of 25% following starting of electric motor(s).
 - .2 Automatic, static type with “fail safe” features, i.e., no excess voltage if the regulator fails.
 - .3 Voltage regulator to be located in the generator control panel only.
 - .4 Control potentiometers arranged for clockwise rotation to increase the related function.
 - .5 Control rheostat or tapped choke, voltage range $\pm 5\%$ of nominal volts.
 - .6 Steady state regulation better than $\pm 2\%$ NL to FL between unity and 80% PF lag.
 - .7 Voltage recovery time following 100% step load change better than two seconds.
 - .8 Capable of generator voltage build-up without batteries.
 - .9 Protection against generator overexcitation during underspeed running.
- .4 Generator Circuit Breakers

- .1 Provide two 3-pole, 3-cycle, generator circuit breakers rated not less than the peak generator nameplate rating.
- .2 The second generator breaker will be dedicated for load testing purposes. Interlock the testing breaker such as to automatically shunt trip if the external transfer switch requires operation of the generator during a power outage, via load shed signal from ATS.
- .3 Interrupting capacity not less than 18kA symmetrical.
- .4 Manually operated breaker with shunt trip, auxiliary alarm contacts and make/break position contacts.
- .5 Locate the generator circuit breaker in bottom section of generator control panel.
- .6 Wire the generator breaker to trip on activation of any of fault sensing devices.
- .7 Tripping power for the generator breaker to be supplied with emergency generator equipment.
- .8 Provide lugs for copper conductors, size as per electrical drawings. Power cable entry as shown on electrical drawings.

.5 Generator Terminal Box

- .1 Provide a NEMA rated terminal box with not less than 11 GA steel.
- .2 Provide lugs for copper conductors, size as per electrical drawings. Power cable entry as shown on electrical drawings.
- .3 Provide neutral lugs suitable for up to #1/0AWG copper ground conductor (solidly ground generator) and neutral conductor.

2.13 Engine Generator Control Panel

.1 Approvals

- .1 Ensure all components are CSA approved and the panel carries a CSA/ESA approval. Assemble the panel in Canada from components made or stocked in Canada.

.2 General Requirements

- .1 Provide an EEMAC 12 enclosure, to be unit mounted as part of the generator base/frame.
- .2 Provide engine controls and alarm annunciators in the upper portion of panel, c/w generator controls.
- .3 Locate the generator main breaker in the lower section. Arrange for bottom entry power cables.
- .4 Arrange terminal blocks for interconnecting cables.

- .3 Mount the following devices on the engine control panel:
 - .1 Analog voltmeter and phase selector switch.
 - .2 Analog ammeter and phase selector switch.
 - .3 Frequency meter, vibrating reed type, range 55 to 65Hz.
 - .4 Analog kW (kilo-Watt) meter.
 - .5 Front panel voltage adjustment (+/- 5%).
 - .6 Include all necessary current and potential transformers.
 - .7 Engine-Generator Annunciator Panel (see Clause 2.13).
 - .8 Manual (emergency) shutdown.
 - .9 Vibration isolators.
 - .10 Hour meter and Panel light.

2.14 Engine-Generator Annunciator Panel

- .1 Generator Annunciator Panel to include the following control and monitoring functions:
 - .1 Manual/Off/Automatic start-up, key operated selector switch.
 - .2 Emergency stop pushbutton.
 - .3 Alarm test pushbutton.
 - .4 Alarm silence pushbutton.
 - .5 Coolant temperature.
 - .6 Oil Pressure.
 - .7 Oil temperature.
 - .8 Engine Speed (in RPM).
 - .9 Generator Voltage.
 - .10 Generator Current.
 - .11 Generator Frequency.
 - .12 Battery Voltage.
 - .13 Fuel Pressure.
- .2 Generator Annunciator Panel to include the following alarm message functions:
 - .1 High jacket water temperature, warning and shutdown.

- .2 Low oil pressure warning and shutdown.
- .3 Engine lockout or emergency stop.
- .4 High oil temperature warning and shutdown.
- .5 Low coolant temperature warning.
- .6 Low coolant level alarm.
- .7 Over and under voltage.
- .8 Over and under frequency.
- .9 Generator breaker, open and close positions.
- .10 Low fuel warning.
- .11 High and low battery voltage alarm.
- .12 Generator fault: RPM sensor fail, over crank, under-speed, over-speed, start inhibit.
- .3 Provide a common engine-generator alarm relay (for external use), plug-in type with a minimum of 3PDT contacts rated 120/240VAC, 10Amps.
- .4 Provide a engine-generator on/off status relay (for external use), plug-in type with a minimum of 3PDT contacts rated 120/240VAC, 10Amps.

2.15 Wiring

- .1 Factory wire the panels completely, complying with the latest edition of the Ontario Electrical Safety Code.
- .2 Numbered at each wire end with printed sleeving to correspond with schematic diagram.
- .3 Adequately supported, run neatly and protected from mechanical damage by grommets and shields.

2.16 Engine-Generator Mounting Base/Frame

- .1 Engine and generator to be coupled and mounted on a common fabricated steel underbase, capable of maintaining alignment during shipping and operational service.
- .2 Complete unit to be mounted on steel spring type vibration isolators with levelling bolts and externally adjustable mechanical side snubbers.
- .3 Lifting lugs to facilitate handling of the complete generating set.
- .4 Anchor bolts suitable for securing the generator set base assembly to the concrete foundation to be furnished by the installation contractor.

2.17 Engine-Generator Sound-attenuating Aluminum Enclosure

- .1 Enclosure shall provide year-round weather-proof protection and be lockable.
- .2 Incorporated within enclosure “sound attenuation” with a maximum average sound level of 72dBA at 7m, or as required by MOE approval.
- .3 Provide enclosure from same manufacturer as the engine-generator set to ensure full coordination of the complete unit. Lockable access doors to all relevant sections of the generator set shall have identical keys.
- .4 Painting of hoses, clamps, wiring harnesses, and other non-metallic service parts shall not be acceptable. Fasteners used shall be corrosion resistant, and designed to minimize marring of the painted surface when removed for normal installation or service work.
- .5 Enclosure shall be constructed of minimum 14-gauge aluminum for framework and 14-gauge aluminum for panels. All hardware and hinges shall be stainless steel.
- .6 A factory-mounted exhaust silencer shall be installed inside the enclosure. The exhaust shall exit the enclosure through a rain collar and terminate with a rain cap. Exhaust connection to the generator set shall be through seamless flexible connections.
- .7 Provide motorized dampers to minimize air flow through the enclosure when generator set is not operating. Louvers shall include provisions to prevent accumulation of ice or snow that might prevent operation. Inlet damper to include limit switch that will alarm to genset control panel should damper fail to open.
- .8 Provide a factory mounted and wired electrical distribution panel to serve the generator set and enclosure. The provisions required include:
 - .1 50-amp distribution panelboard connected to a 120/208VAC 3-Phase power supply service by the installer.
 - .2 Duplex GFI receptacle.
 - .3 Two three-way switches controlling internal LED lamps mounted in vapor tight and gasketed fixtures.
 - .4 Enclosure thermostatic space heater designed to maintain enclosure temperature to 10C when the genset is not running.
 - .5 Factory-wired normal AC service from the panelboard to the engine coolant and alternator heaters, enclosure space heater, lighting and battery charger.
 - .6 Provide ESA Inspection prior to shipment to site

3 EXECUTION

3.1 Wiring and Piping Methods

- .1 All final conduit connections to the engine and generator to be in “Sealtite” flexible conduit.
- .2 Flexible braided copper connections shall be used in all piping to the generator, fuel pump, etc.
- .3 All field erected pipework, steel work etc., to be cleaned, primed and painted with two coats of paint. Type and colour to be as indicated by the Engineer.
- .4 All gas piping work to be in compliance with CSA Standard B149.1.

3.2 Flexible Connections

- .1 Provide approved flexible connectors for connection to all piping at the engine, including jacket water, fuel oil, compressed air, and similar services.

3.3 Tools and Spare Parts

- .1 Provide the following:
 - .1 One set of new standard wrenches sufficient to carry out routine maintenance service, including valve tappet clearance gauges.
 - .2 One set of new special wrenches for the fuel system, etc., including injector removal tool.
 - .3 One complete set of drive belts, alternator and radiator
 - .4 Two sets of electrical expendable spares – i.e., fuses, lamps, etc.
 - .5 Two replacements for each replaceable type fuel, lubricating oil filter, water separator and air filter required on the engine.

3.4 Maintenance

- .1 Provide five (5) copies of instruction manuals to include a procedure of a maintenance inspection and running test, long range maintenance schedule, schematic drawing of engine lubrication system, illustrated drawings showing lubrication points of all equipment furnished, all shop drawings, complete electric schematics, wiring diagrams of all equipment and controls and a list of all parts used in the diesel generator and control cubicles.
- .2 Provide maintenance instructions for the maintenance inspection and running tests.

3.5 Factory Inspection and Test Procedures

- .1 The Engineer reserves the right of inspection of the generating set at the Supplier’s plant by its authorized representative and to witness factory tests. Provide the Engineer at least 2 full days prior

notice that the equipment is ready for inspection and test at the factory. This permits the Engineer to make arrangements for the visit when it is considered necessary.

- .2 Ensure all equipment is available at the time of inspection. Set up the equipment for the test except for fuel and exhaust components supplied loose. Standard test shop facilities will be acceptable for such items.

3.6 Factory Test Facilities

- .1 Provide the following equipment in addition to the instruments supplied on the set and control panel:
 - .1 Clip-on ammeter, multi-range.
 - .2 Test volt/ammeter, multi-range, dc and ac.
 - .3 Oil gauge with bypass arrangement to check low oil pressure safety switch.
 - .4 Thermometers, mercury/glass type for temperature rise tests; minimum of six.
 - .5 Resistive load bank, readily adjustable in test area, stable performance and capacity up to 110% of generator rating.
 - .6 Tachometer, portable mechanical type.

3.7 Schedule of Factory Tests

- .1 Carry out the following tests as a minimum requirement and in addition to the Supplier's usual factory tests whether the equipment is witness tested or not. Performance tests will include:
 - .1 Operation of the set as per Section 1.4 – Service. Record the following time intervals:
 - .1 from "hydro failure" to crank initiation,
 - .2 from "hydro failure" to load transfer to generator,
 - .3 from "hydro restoration" to load transfer to "hydro",
 - .4 from load transfer to hydro to engine shutdown.
 - .2 Speed governor performance.
 - .3 Voltage regulator performance.
 - .4 Control panel instrument, relay, switch checks and performance. Also, record breaker trip setting.
 - .5 Note: Jumper wire tests are NOT acceptable for the following requirements.
 - .1 High temperature safety switch (water or air cooled).
 - .2 Low oil pressure safety switch.

- .3 Overspeed safety switch.
- .4 Cranking cut-out speed switch.
- .5 Cranking cut-out time relay.
- .6 Fault alarm and shutdown device performance in the control panel also interconnecting wiring.
- .7 Full load run for four hours at full load rating. Record at half-hour intervals the following data:
 - .1 Engine – all pressure and temperature readings.
 - .2 Generator – frequency and all voltage, current readings and winding temperature readings.
 - .3 Ambient temperature, input water or air, if applicable.
- .8 Check exhaust condition, vibration, noise, etc., and confirm satisfactory performance or report condition. Give quantitative figures if considered unreasonable. Record temperature rise, by thermometer, on the engine and generator.
- .9 Provide air quality testing data including clean air certification for exhaust.
- .10 Varying load tests at 25%, 50%, 75% and 100% load and record the reading.

3.8 Test Reports

- .1 Prepare certified test reports with results of the above tests, and the usual factory tests. Distribute the reports as a minimum:
 - .1 Six sets to the Engineer.
 - .2 One set in each Maintenance Manual.

3.9 Commissioning

- .1 When the Contractor has completed the installation work and before any equipment is operated, he shall instruct the Supplier to commission the equipment. The Supplier is to provide the services of a skilled technical representative, temporary load bank and power cables for a minimum period of two days (16 hours) at site to carry out the following work as a minimum requirement.
 - .1 Check the installation as to its workmanship.
 - .2 Check the operation of the set.
 - .3 Check that the operation of the engine cooling equipment is satisfactory.
 - .4 Check the interconnecting wiring of the engine safety devices (jumper wire tests at the sensor).
 - .5 Run four hour full load test c/w load bank and temporary cables

- .6 Perform further tests as directed by the Engineer.
- .7 Instruct the plant personnel in the operation and service of the equipment.

3.10 Painting and Finishes

- .1 Engine finish of standard equal to that normally supplied for power plant installations. Furnish colour samples for final selection by the Region.
- .2 Protect data labels on all equipment while painting and ensure labels are legible.
- .3 Coat liberally, all finished and machined parts with petroleum or wax base, temporary protective coating.
- .4 Finish the exhaust silencer and flexible connector with aluminum silicone alkyd paint, heat resistant to approximately 650°C.

3.11 Packing

- .1 Protect the equipment against corrosion, dampness, heavy rain, etc. Also provide adequate protection against damage or loss of components from the time the equipment leaves the manufacturer's factory until received at the destination. Ensure packing is acceptable to the transportation companies.
- .2 Include heavy duty plastic sheet or bags to cover components vulnerable to construction dust. Tag this packing suitably to instruct the Contractor to leave this protection in place (where practical) until construction and clean-up is complete.
- .3 Arrange the engine for shipment and tag suitably with warning labels.
- .4 Provide in each manual a complete inventory of all spare parts, tools and accessories, a copy to accompany the shipment and a copy forwarded to the Engineer and/or Site Engineer.

3.12 Shipment

- .1 Do not ship the equipment from the plant except by prior agreement with the purchaser.
- .2 Arrange the shipment on the transport to facilitate off-loading by the Contractor's crane or skids at the job site.

3.13 Information on Shop Drawings

- .1 Mark all shop drawings submitted with:
 - .1 Project name and number, specification number, issue and date.
 - .2 Manufacturer's name, order or reference number.
 - .3 Drawing number with issue or revision number, date of issue.

- .4 Signature of Manufacturer's responsible official certifying the drawing to be correct.

3.14 Shop Drawings for Review

- .1 As soon as possible, after receipt of an order, prepare six sets of the following drawings marked "SHOP DRAWINGS FOR REVIEW" for submission to the Engineer. Shop Drawings to be submitted in accordance with section 01340 Shop Drawings, Product Data and Samples.
- .2 General arrangement drawing of the complete set and include exact location and details where necessary of interconnecting services to permit final engineering by the Engineer, i.e.,
 - .1 Vibration isolators.
 - .2 Fuel oil piping connections.
 - .3 Generator terminal box.
 - .4 Engine control wiring terminal box(es).
 - .5 Engine exhaust connections and silencer.
 - .6 Engine cooling system (cooling water supply and drain connections).
- .3 General arrangement drawing of the control panel and include:
 - .1 General location of assemblies.
 - .2 Arrangement of components on the front panel.
 - .3 Power and control wire terminal locations.
 - .4 Bill of Material giving make, model and rating of components.
 - .5 Schematic wiring diagram for the complete electrical system.

3.15 Final Shop Drawings and Manuals

- .1 Prepare six complete sets of documents for distribution. Bind the documents in a hard cover, three-ring binder and include in each set the following:
 - .1 Approved drawings as listed in Section 3.14, with "as built" deviations, if any, marked thereon.
 - .2 Wiring diagram of the control panel, engine and interconnections.
 - .3 Specific instructions for the installation of the equipment. Instructions for placing the equipment into operation.
 - .4 Description of operation with reference to the schematic wiring diagram.
 - .5 Engine manual including operating and parts information.

- .6 Generator and voltage regulator manual(s) including wiring and assembly drawings.
- .7 Test report per Section 3.8.

END OF SECTION

Automatic Transfer Switch

1 GENERAL

1.1 General Conditions

- .1 All sections of Division 1 form a part of this Specification. Read and fully adhere to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this section.
- .3 All sections of Divisions 1 to 16 inclusive form part of the Contract Documents. Refer to Section 16010 for General Electrical Requirements related to this work.

1.2 Scope

- .1 Furnish all labour, materials, supervision, equipment and services specified, indicated or requested to install the automatic transfer switch specified herein and on the drawings.
- .2 Automatic Transformer Switch to be an open transition style, with a “delayed” neutral position as a three position ATS.

1.3 References

- .1 CAN3-C13-M83 Instrument Transformers.
- .2 CAN3-C17-M84 Alternating-Current Electricity Metering.
- .3 ANSI/NEMA ICS 10-1993, AC Automatic Transfer Switches.
- .4 IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.
- .5 Section 16623: Standby Power Diesel Engine Generator Set.
- .6 Section 16480: Motor Control Centre (MCC).

1.4 Design Criteria

- .1 Monitor voltage of normal power supply.
- .2 Initiate cranking of standby generator unit on normal power failure or abnormal voltage.

- .3 Transfer load from normal supply to standby generator when standby generator reaches rated speed and voltage.
- .4 Transfer load from standby generator to normal power supply when normal power restored.
- .5 Shut down standby generator.

1.5 Shop Drawings

- .1 Include make, model number and type, plus nameplate data and load classification.
- .2 Contractor to coordinate with VFD manufacturer(s) for ATS "time delay in Neutral position" setting for transfer and retransfer positions.
- .3 Single line diagram showing all controls and relays.
- .4 Description of equipment operation including:
 - .1 Automatic starting and transfer to standby unit and back to normal power.
 - .2 Test control.
 - .3 Manual control.
 - .4 Automatic shutdown.
 - .5 All recommended ATS time delay settings. Setting to be review by client/owner.

1.6 Operation and Maintenance Data

- .1 Detailed instructions to permit effective operation, maintenance and repair.
- .2 Technical data:
 - .1 Schematic diagram of components, controls and relays.
 - .2 Illustrated parts lists with parts catalogue numbers.
 - .3 Certified copy of factory test results.
- .3 Copy of all reviewed shop drawings.

1.7 Source Quality Control

- .1 Tests:
 - .1 Operate equipment

- .2 Check selector switch, in four positions (Test, Auto, Manual, Engine Start) and record results.
- .3 Check voltage sensing and time delay relay settings. Record all settings, both mechanically and electrically, to ensure proper performance.
- .2 Check:
 - .1 Automatic starting and transfer of load on failure of normal power.
 - .2 Retransfer of load when normal power supply resumed.
 - .3 Automatic shutdown.
- .3 Submit test results to Engineer after factory test.

1.8 Measurement for Payment

- .1 No measurement for payment will be made under this section.

1.9 Basis of Payment

- .1 All labour, materials and equipment necessary for the work in this Section shall be included in the lump sum prices in the Schedule of Items and Prices.

2 PRODUCTS

2.1 Materials

- .1 Meters: to CAN3-C17.
- .2 Instrument transformers: to CAN3-C13.
- .3 Contactors: to ANSI/NEMA ICS 2.

2.2 Auto-Transfer Switch Equipment

- .1 Provide either "contactor" type or "circuit breaker" type auto-transfer switch, as specified below:
 - .1 Contactor type:
 - .1 Two contactors mounted on common frame, in double throw arrangement, mechanically and electrically interlocked, solenoid operated.
 - .2 Transfer switch rating: as indicated on contract drawings (current, voltage, phases, and poles).

- .3 Fault withstand rating: 25 kA symmetrical for 3 cycles.
- .4 Main contacts: silver surfaced, protected by arc disruption means including separate arcing contacts, arc splitters and blow out coils for load current.
- .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 Auxiliary contact: to initiate emergency diesel engine-generator start-up on failure of normal power.
- .7 Lever to operate switch manually when switch is isolated.
- .2 Circuit Breaker type:
 - .1 One normal and one emergency, molded-case circuit breakers (non-automatic type), mounted on common base, designed for double throw action, motor operated, mechanically held and interlocked.
 - .2 Transfer switch rating: as indicated on contract drawings (current, voltage, phases, and poles).
 - .3 Fault withstand rating: 25 kA symmetrical for 3 cycles.
 - .4 Dead front construction with access to relays and controls for inspection and maintenance, and manual operating lever for transfer switch.
 - .5 Auxiliary contact: to initiate emergency diesel engine-generator start-up on failure of normal power.
 - .6 Lever to operate switch manually when switch is isolated.
- .2 Auto-Transfer Switch Controls
 - .1 Selector switch - four position "Test," "Auto," "Manual," Engine Start."
 - .1 Test position - Normal power failure simulated. Engine starts and transfer takes place. Return switch to "Auto" to stop engine.

- .2 Auto position – Normal operation of transfer switch on failure of normal power; retransfers on return of normal voltage and shuts down engine.
 - .3 Manual position – Transfer switch may be operated by manual handle but transfer switch will not operate automatically and engine will not start.
 - .4 Engine start position – Engine starts but unit will not transfer unless normal power supply fails. Switch must be returned to “Auto” to stop engine.
- .2 Control transformers: dry type with 120 V secondary to isolate control circuits from:
- .1 Normal power supply, and
 - .2 Emergency power supply.
- .3 Microprocessor Controller Features:
- .1 Include open-transition control sequence (break before make).
 - .2 Voltage sensing, one per phase, solid state type, 70% drop out and 90% pick up, close differential, 2 V minimum undervoltage – overvoltage protection.
 - .3 Time delay, normal power to standby, adjustable motor driven type 5 s to 180 s, no delay on engine start.
 - .4 Time delay on engine starting to override momentary power outages or dips, adjustable pneumatic type calibrated 1 to 300 s.
 - .5 Time delay on retransfer from standby to normal power, adjustable 20 s to 10 min.
 - .6 Time delay for engine cool-off to permit standby set to run unloaded after retransfer to normal power, adjustable motor driven type, 20 s intervals to 10 min.
 - .7 Time delay during transfer to stop transfer action in neutral position electrically to prevent fast transfer, adjustable, 5 s intervals to 180 s.

- .8 Frequency, to prevent transfer from normal power supply until frequency of standby generator reach preset values (90% of normal value).
- .9 All parameter settings to be configurable by a keypad/display unit and not by dip switches.
- .3 Enclosure: suitable for MCC cubicle mounting at location shown on contract drawings.
- .4 Accessories
 - .1 Pilot lights to indicate switch position, green for normal, red for standby, mounted on front of door.
 - .2 Include an auxiliary relay to provide 3 N.O. and 3 N.C. (3PDT) contacts for remote indication of normal position and standby/emergency position.
 - .3 Include a N.O./N.C. Form "C" contact indicating "Failure to Transfer" alarm.
 - .4 Include a N.O./N.C. Form "C" contact for Load Shedding.
 - .5 A full duplex RS485 interface to provide remote monitoring and control.
 - .6 A seven-day electronic time switch for automatic weekly testing of the engine - generator set. Provide an exerciser that is fully programmable and consists of a permanent battery back-up.
 - .7 ATS to include a "time delay in Neutral position" setting for transfer and re-transfer positions (as a 3-position ATS). This time value should be set to 30 seconds to allow all capacitors to completely discharge before re-applying generator/utility power.

2.3 Acceptable manufacturers: Cummins, TTI, ASCO, Eaton.

3 EXECUTION

3.1 Installation

- .1 Install and connect transfer equipment as indicated.
- .2 Check relays, solid state monitors and adjust as required.
- .3 Provide equipment identification in accordance with Section 16010 - Electrical General Requirements.

3.2 Field Quality Control – Auto Transfer Switch

- .1 Perform tests in accordance with Section 16010 – Electrical General Requirements.
- .2 Energize transfer equipment from normal power supply.
- .3 Set selector switch in “Test” position to ensure proper standby start, running, transfer, retransfer. Return selector switch to “Auto” position to ensure standby shuts down.
- .4 Set selector switch in “Manual” position and check to ensure proper performance.
- .5 Set selector switch in “Engine start” position and check to ensure proper performance. Return switch to “Auto” to stop engine.
- .6 Set selector switch in “Auto” position and open normal power supply disconnect. Standby should start, come up to rated voltage and frequency, and then load should transfer to standby. Allow to operate for 10 min, then close main power supply disconnect. Load should transfer back to normal power supply and standby should shutdown.
- .7 Repeat, at one-hour intervals, three times, complete test with selector switch in each position, for each test.

END OF SECTION

Telephone and Security Alarm Systems

1 GENERAL

1.1 General Conditions

- .1 All sections of Division 1 form a part of this Specification. Read and fully adhere to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this section.
- .3 All sections of Divisions 1 to 16 inclusive form part of the Contract Documents. Refer to Section 16010 for General Electrical Requirements related to this work.

1.2 Scope

- .1 Furnish all labour, materials, supervision, equipment and services specified, indicated or requested to supply and install systems described herein.
- .2 Contractor performing work in this section must be "Certified" as an acceptable installation contractor by the manufacturer's specified herein.
- .3 Division 16 Contractor to pay all associated fees for permits, licenses and certificates required to complete the work specified herein.

1.3 Shop Drawings

- .1 Submit shop drawings in accordance with Section 01340, Shop Drawings, Product Data and Samples.
- .2 Submit a "Bill of Material" of all components with technical characteristics. Include a cable numbering system identifying all data circuits.

1.4 Codes and Standards

- .1 All equipment and components to be CSA approved.
- .2 Cabling system in compliance with CSA-T529-95 (R2000) and T530-99.
- .3 Wiring standards to ANSI/EIA/TIA 568-B.2 and ISO/IEC 11801.

1.5 Related Work Specified Elsewhere

- .1 Section 16010 – Electrical General Requirements.
- .2 Section 16745 – Data (Ethernet) System.
- .3 Section 16110 – Raceway Systems.
- .4 Section 16130 – Electrical Boxes.
- .5 Section 16140 – Wiring Devices.

1.6 Measurement for Payment

- .1 No measurement for payment will be made under this section.

1.7 Basis of Payment

- .1 All labour, materials and equipment necessary for the work in this Section shall be included in the lump sum prices in the Schedule of Items and Prices.

2 PRODUCTS

2.1 Telephone System

- .1 Cables:
 - .1 Foil twisted 4-pair shielded cable (FTP), #24 AWG solid copper conductors, FT-6 rated, Independently Verified, Category 5E (enhanced) and grey jacket colour.
 - .2 Colour coding to follow “codes and standards” requirements.
 - .3 Acceptable manufacturers: Beldon, Berk-Tel (Nexans), General Cable, Nordx/CDT, Superior Essex.
- .2 Outlet Jacks:
 - .1 Category 5E FTP rated (up to 100MHz), RJ11 plug-in modules, white colour. Include a label or tag for each jack.
 - .2 Provide combination type “telephone and data jacks” where both systems are shown as grouped together on contract drawings.
 - .3 Cover Plates: refer to Section 16140 – Wiring Devices
 - .4 Acceptable manufacturers: Amp, Hubbell, Leviton, Nordx/CDT, Pass & Seymour.
- .3 Telephone backboard and accessories:

- .1 Provide a 19mm “fire-rated” wood backboard for telephone equipment. Size to suit requirements of Bell Canada.
- .2 Provide the following on backboard:
 - .1 120VAC duplex receptacle.
 - .2 Insulated #6 AWG ground conductor.
 - .3 All necessary BIX, cross-connect blocks and patch panels.
 - .4 Wire management system.
 - .5 Patch cables, length to suit.

2.2 Telephone Surge protection device

- .1 Multistage hybrid fail-safe design with 10-year unlimited free replacement warranty.
- .2 Strength: 2kA per pair.
- .3 Maximum Data Rate: 16Mbps.
- .4 Response Time: < 1 nanosecond.
- .5 Series Resistance: < 1 ohm.
- .6 Modes of Protection: All modes (tip-ring, tip-ground & ring-ground).
- .7 Operating Temperature: -40°C to 85°C.
- .8 TLP Performance Specifications:

MCOV (Peak)		Pairs	Let-Through Volt
L-L	190V	5 Pair	240V
L-G	190V	(10 wire)	240V
- .9 Acceptable manufacturer: International Innovative Systems (Surge Track) Model No. TK-CT2-190LP5-TB. Coordinate exact model with manufacturer's recommendations prior to purchase and installation.

2.3 Security Alarm System

- .1 Security Alarm System to include a fully supervised and programmable system for continuous monitoring of hardwired zones throughout a building.
- .2 Include an auxiliary alarm output relay c/w 1-SPDT (Form C) contacts for remote alarm annunciation. Contacts to be rated 120VAC @10amps resistive.

- .3 Power Supply Requirements:
 - .1 Transformer: provide a 120-16.5VAC, 40VA Class 2 control power transformer for normal power supply.
 - .2 Battery back-up: provide 12V, 4Amp/hr re-chargeable sealed lead acid batteries.
 - .3 Include charger system for batteries.
- .4 Internal EEPROM memory, to ensure system or program is not lost during complete power failure.
- .5 False Alarm Prevention Features:
 - .1 Audible exit delay and fault.
 - .2 Quick exit.
 - .3 Urgency on entry delay.
 - .4 Swinger shutdown.
 - .5 Cross zone alarm.
 - .6 Recent closing transmission.
 - .7 Communication delay.
 - .8 Arm/disarm bell squawk.
- .6 Acceptable Manufacturer: DSC "Power Series PC1832" Security System
- .7 Zone Expansion Modules
 - .1 Quantity: one (1)
 - .2 8 fully programmable zone.
 - .3 VAUX output: 12VDC, 250mA max.
 - .4 Current rating: 60mA
 - .5 Connection for external tamper
 - .6 Operating environment - 32 to 122°F (0 to 50°C).
 - .7 - 90% RH non-condensing.
 - .8 Acceptable Manufacturer: DSC "Power 1832" PC5108 eight zone expansion module.
- .8 Plain Language Entry Keypad

- .1 Number of zones: 16.
- .2 Connection of up to 8 keypads, combination LED and/or LCD.
- .3 Zone input, direct connection of detector to keypad.
- .4 Large 32-character display: zone identification, system instructions, system status, trouble conditions, 128-event buffer.
- .5 Automatic scrolling of alarms in memory.
- .6 12hr or 24hr clock display.
- .7 LED indicators: Ready, Armed and Trouble.
- .8 Backlit display.
- .9 Acceptable Manufacturer: DSC PK5500 LCD Full-Message Keypad
- .10 Accessories:
 - .1 Non-hazardous area magnetic reed door switches, number as indicated on contract drawings (GRI-29C).
 - .2 End of Line resistors.

3 EXECUTION

3.1 Telephone Installation - General

- .1 Telephone jacks are to be wired, assembled with jack, and installed at all locations shown on contract drawings.
- .2 Provide conduit and outlet boxes for each telephone location, as indicated on drawings.
- .3 Provide cable identification at each end of cable.
- .4 Properly assemble with jack (punched) and label all cables accordingly. Neatly install cables using plastic tie-straps and plastic wire-ways. Leave adequate length of cable for final connection by others into network hubs, switches and servers.

3.2 Telephone System Field Testing

- .1 Refer to Section 16012 for general Field Quality Control (Testing) requirements.
- .2 Field test all cables and devices for the following:
 - .1 Correct polarity.

- .2 Continuity.
- .3 Near-end cross talk.
- .4 Attenuation.
- .5 Cable length.
- .3 Perform tests after all cabling and devices have been installed using an approved "communication testing equipment" for the system, specified herein.
- .4 Replace and or repair any device or cable that fails the testing procedure.
- .5 Prepare a test report outlining the testing procedures performed and a table summarizing the results. Submit six copies of test reports to engineer for review.

3.3 Security Alarm System Field Testing

- .1 Refer to Section 16012 for general Field Quality Control (Testing) requirements.
- .2 Perform tests after all cabling and devices have been installed.
- .3 Replace and or repair any device or cable that fails the testing procedure.
- .4 Prepare a test report outlining the testing procedures performed and a table summarizing the results. Submit six (6) copies of test reports to engineer for review.

3.4 Door Contact Switch

- .1 Install device at locations indicated and to manufacturer's recommendations.
- .2 Provide control wiring and conduit as indicated and required. Testing of switch location will be required to determine actual sensing range for each door application. Review arrangement with Engineer prior to installation.
- .3 Provide all necessary mounting supports, brackets, hardware to suit each door application. Include backbox to interconnect lead wire

END OF SECTION

Data (Ethernet) Systems

1 GENERAL

1.1 Description

- .1 All sections of Division 1 form a part of this Specification. Read and fully adhere to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this section.
- .3 All sections of Divisions 1 to 16 inclusive form part of the Contract Documents. Refer to Section 16010 for General Electrical Requirements related to this work.

1.2 Scope

- .1 Furnish all labour, materials, supervision, equipment and services specified, indicated or requested to supply and install data system described herein.
- .2 Contractor performing work in this section must be "Certified" as an acceptable installation contractor by the manufacturers specified herein.
- .3 Division 16 Contractor to pay all associated fees for permits, licenses and certificates required to complete the work specified herein.

1.3 Shop Drawings

- .1 Submit shop drawings in accordance with Section 01340 - "Shop Drawings, Product Data and Samples."
- .2 Submit a "Bill of Material" of all components with technical characteristics. Include a cable numbering system identifying all data circuits.

1.4 Codes and Standards

- .1 All equipment and components to be CSA approved.
- .2 Cabling system in compliance with CSA-T529-95 (R2000) and T530-99.
- .3 Wiring standards to ANSI/EIA/TIA 568-B.2 and ISO/IEC 11801.

1.5 Related Work Specified Elsewhere

- .1 Section 16010 - Electrical General Requirements.
- .2 Section 16110 - Raceway Systems.

.3 Section 16130 – Electrical Boxes.

.4 Section 16140 – Wiring Devices.

1.6 Measurement for Payment

.1 No measurement for payment will be made under this section.

1.7 Basis of Payment

.1 All labour, materials and equipment necessary for the work in this Section shall be included in the lump sum prices in the Schedule of Items and Prices.

2 PRODUCTS

2.1 Data Ethernet Cabling

.1 Designed for high-security environments with foil twisted 4-pair shielded cable (FTP), #23 AWG solid copper conductors, FT-6 rated, minimum of CAT 6 rating.

.2 Colour coding to follow “codes and standards” requirements.

.3 Acceptable manufacturers:

.1 Belden

.2 Berk-Tek (Nexans)

.3 General Cable

.4 Nordx/CDT

.5 Superior Essex

.6 Hubell

2.2 PLC Panel Ethernet Switch

.1 Dual speed managed switch, to connect various Ethernet devices.

.2 Ethernet Protocol: IEEE 802.3i 10 BASE-T, and IEEE 802.3u 100BASE-Tx, with built-in “10-to-100 Mbps” bridge.

.3 Interface connection: seven (7) RJ45 ports (auto negotiation and auto crossing) + one (1) fibre optic (FO) port (SC_DUPLEX). Refer to contract drawings for exact locations.

.4 Status LED's: power, activity (10/100), operations link (10/100), receive data (10/100).

- .5 Power Supply: 18.5-30.2VDC, 4.8W
- .6 DIN rail mountable.
- .7 Acceptable manufacturer: Phoenix Contact, FL- SWITCH 2000 series.

2.3 Ethernet/IP to Modbus TCP/IP Communication gateway

- .1 Provide a communication gateway to support EtherNet/IP communications with Allen Bradley PLC system, as specified in Section 16910. Coordinate selection of gateway with Controls System Integrator.
- .2 Power Supply: 24VDC Nominal, 10-36VDC allowed.
- .3 Current Load: 610mA max @ 36VDC max.
- .4 Operating Temperature: -25°C to 70°C (-13°F to 158°F).
- .5 LED Indicators:
 - .1 Configuration (CFG).
 - .2 Error (ERR).
 - .3 Power (PWR).
 - .4 Hardware Fault (FLT).
 - .5 Network Status (NS).
 - .6 Module Status (MS).
- .6 Mounting: Din Rail.
- .7 Ethernet Port: 10/100Mbit full and half duplex RJ45 Connector, Link and Activity LED indicators.
- .8 Accessories: J180 power connector.
- .9 Acceptable manufacturer: ProSoft Technology Inc., Module PLX31-EIP-MBTCP.

2.4 Outlet Jacks

- .1 Category 6 FTP rated (up to 250MHz), RJ45 plug-in modules, blue colour. Include a label or tag for each jack.
- .2 Provide combination type "telephone and data jacks" where both systems are shown as grouped together on contract drawings.

- .3 Acceptable manufacturers: Amp, Hubbell, Leviton, Nordx/CDT, Pass & Seymour.

2.5 Ethernet Patch Cables

- .1 Independently verified, high quality Category 5E enhanced cable, with blue jacket colour.
- .2 350MHz stranded cable with snag-less molded boots (pre-manufactured ends) and gold plated RJ45 connectors.
- .3 Provide length of patch cable to suit installation, plus 20% spare length.

2.6 Cover Plates

- .1 Refer to Section 16140 – Wiring Devices.

3 EXECUTION

3.1 Installation - General

- .1 Data jacks are to be wired, assembled with jack (punched), and installed at all locations shown on contract drawings.
- .2 Provide rigid metal conduit and outlet boxes for each data location, as indicated on drawings. Include cable identification at each end of cable.

3.2 Data System Field Testing

- .1 Refer to Section 16010 for general Field Quality Control (Testing) requirements.
- .2 Field test all cables and devices for the following:
 - .1 Correct polarity.
 - .2 Continuity.
 - .3 Near-end cross talk.
 - .4 Attenuation.
 - .5 Cable length.
- .3 Perform tests after all cabling and devices have been installed using an approved “communication testing equipment” for the system specified herein.

- .4 Notify engineer in advance (min. one week's notice) when testing of system will be performed. Engineer may or may not be present during field testing.
- .5 Replace and or repair any device or cable that fails the testing procedure.
- .6 Prepare a test report outlining the testing procedures performed and a table summarizing the results. Submit electronic copy of test reports to engineer for review.

END OF SECTION

Services for Mechanical Equipment

1 GENERAL

1.1 Intent

- .1 Coordinate the work of all section of Division 16 with the power and control requirements for the equipment specified in Division 15 – Mechanical, and as shown on the process, mechanical and electrical drawings.

1.2 Related Work Specified Elsewhere

- .1 The following are specified in Division 15:
 - .1 Motor starters, contactors and interlocks where specified in Division 15 as components of “packaged” equipment.
 - .2 Control panels for mechanical equipment.
 - .3 Water Flow Magmeter and Transmitter.
 - .4 Instrument “backboards” and associated equipment.
 - .5 Level transducers and bracketing
- .2 Provide the necessary labour, materials and equipment to install, connect and operate the equipment/systems listed above.

1.3 Measurement for Payment

- .1 No measurement for payment will be made under this section.

1.4 Basis of Payment

- .1 All labour, materials and equipment necessary for the work in this Section shall be included in the lump sum prices in the Schedule of Items and Prices.

2 PRODUCTS

2.1 General

- .1 Refer to the applicable section under Division 16 for all the electrical material and equipment used or required to install and/or connect the equipment supplied under Divisions 15.

3 EXECUTION

3.1 Installation - General

- .1 For all mechanical equipment, supply and install the following:
 - .1 Power wiring and conduit or power cable, as indicated.
 - .2 Control wiring and conduit or control cable, as indicated.
 - .3 Motor starters, contactors, control relays, control devices and control panels to operate the equipment specified under Division 15 (except where indicated as components of 'packaged' equipment).
 - .4 'Packaged' equipment as specified under Divisions 15, to location shown on contract drawings.
 - .5 Interlocks between equipment.
 - .6 Analyzers, instrument "backboards" and feed pumps supplied 'loose' or removed under Division 15.
- .2 All necessary supports, fastenings, mounting hardware, outlet boxes, junction boxes, switches, etc. to provide a complete and safe operating system.

END OF SECTION

Electric Heating and Cooling

1 GENERAL

1.1 General Conditions

- .1 All sections of Division 1 form a part of this Specification. Read and fully adhere to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this section.
- .3 All sections of Divisions 1 to 16 inclusive form part of the Contract Documents. Refer to Section 16010 for General Electrical Requirements related to this work.

1.2 Scope

- .1 Furnish all labour, materials, supervision, equipment and services specified, indicated or requested to install the cabinet heaters specified herein and on the drawings.

1.3 Measurement for Payment

- .1 No measurement for payment will be made under this section.

1.4 Basis of Payment

- .1 All labour, materials and equipment necessary for the work in this Section shall be included in the lump sum prices in the Schedule of Items and Prices.

2 PRODUCTS

2.1 Force Fan Heater

- .1 Flush or surface wall mounted (refer to mechanical contract drawings), 20-gauge steel cabinet c/w beige epoxy/polyester powder paint finish
- .2 Tubular heating elements with fins and high-temperature overheat protection.
- .3 Control voltage (built-in thermostat and control knob): 24V AC.
- .4 Heater ratings: refer to drawings for kW rating, voltage and quantity.
- .5 Acceptable manufacturer: Ouellet, OAC Series

2.2 Thermostats

- .1 Abbreviation: Tv.
- .2 Heavy Duty Thermostat, wall mounted.
- .3 Temperature range: 8°C to 29°C, with 1°C differential.
- .4 Switching Action: SPDT, rated 7.4A @ 120VAC minimum.
- .5 CSA Approved.
- .6 Acceptable manufacturer:
 - .1 Non-hazardous Honeywell T4051A/B;

2.3 Temperature Thermostat

- .1 Abbreviation: TH.
- .2 Heavy Duty Thermostat, wall mounted with sub-base
- .3 Temperature range: 8°C to 29°C, with 1°C differential.
- .4 Switching Action: SPDT, rated 5A @ 120VAC.
- .5 CSA Approved.
- .6 Acceptable manufacturer: Honeywell, T6051A1057 complete with subbase Q651A1009.

3 EXECUTION

3.1 Installation

- .1 Install heaters and thermostats as indicated, and to manufacturer's instructions.
- .2 Provide power and control wiring and conduit for all heaters and thermostats, as indicated on drawings.
- .3 Provide Size 5 label on side of each heater to indicate unit heater identification number (e.g. UH-1), kW rating and voltage/phases.
- .4 Provide Size 3 label at each thermostat to indicate which unit heaters are controlled (e.g. UH-1) and voltage.
- .5 Coordinate with Division 15 for exact location of heaters and thermostats.

END OF SECTION

Instrumentation and Control Equipment

1 GENERAL

1.1 General Conditions

- .1 All sections of Division 1 form a part of this Specification. Read and fully adhere to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this section.
- .3 All sections of Divisions 1 to 16 inclusive form part of the Contract Documents.

1.2 Intent

- .1 This section covers the supply, delivery, install and satisfactory operation of instrumentation and control equipment as specified herein and/or detailed on the drawings.

1.3 Related Work Specified Elsewhere

- .1 Electrical General Requirements: Section 16010.
- .2 Basic Electrical Equipment: Section 16400.
- .3 Data (Ethernet) Systems: Section 16745.
- .4 Services for Mechanical Equipment: Section 16850.
- .5 Process Control System (PCS): Section 16910.
- .6 SCADA Software and Workstations: Section 16915.
- .7 Control Narratives: Refer to Control Narrative by SBA.

1.4 Scope

- .1 Supply, deliver and install the instrumentation and control equipment as specified herein in greater detail and as shown on the drawings.
- .2 Instrumentation and control equipment to include: PLC Panel, primary devices, transmitters, receivers, signal conditioning equipment, instrument and control panels, as specified herein and shown on the drawings.
- .3 Provide all necessary installation detail drawings and sufficient supervision to ensure that the installation of the instrument and control system components is done to the satisfaction of the Engineer as work progresses.

- .4 Provide all necessary adjusting, field calibration, testing and checkout of all equipment and control loops. After loop checkout, submit written test results to the Engineer. All instrument calibration procedures to be witnessed by the Engineer.
- .5 The instrumentation and control system supplier is to provide the following:
 - .1 All instruments and devices specified herein and shown on the drawings, including instrument manifolds and related piping where required.
 - .2 Shop constructed and shop prewired instrument and control panels.
 - .3 Submittals of all equipment descriptive data and drawings, schematic, and complete interconnecting wiring diagrams of all components in the loops.
 - .4 Provide a descriptive system document for all intrinsically safe circuits per OESC Section 18 and Appendix F and J. Descriptive System Document to be included in PLC Panel shop drawings and as a lamicoid nameplate on PLC Panel door.
 - .5 Provision of “as constructed” equipment drawings, detailed wiring diagrams, and instruction manuals.

1.5 Instrumentation and Control Suppliers

- .1 Contractor to install all instrumentation and control equipment under proper supervision by personnel qualified and experienced in such type of work.
- .2 The “Acceptable Instrumentation and Control Supplier” listed herein is responsible for, and is to include work associated with the following sections:
 - .1 Section 16910: Process Control System.
 - .2 Section 16920: Control Narratives.
- .3 Acceptable Instrumentation and Control Suppliers:
 - .1 DataSoft Software Solutions.
 - .2 Selog Norteck Inc.

1.6 Standards

- .1 Within the text of these specifications, reference is made to the following standards, practices and/or recommendations:
 - .1 EEMAC – Electrical and Electronics Manufacturers Association of Canada.
 - .2 NEMA – National Electrical Manufacturers Association.
 - .3 IEEE – Institute of Electrical and Electronic Engineers.
 - .4 CSA – Canadian Standards Association.

- .5 ISA – Instrument Society of America.
- .6 ANSI – American National Standards Institute.
- .7 CGA – Canadian Gas Association.
- .8 ASTM – American Society for Testing and Materials.
- .2 All instrumentation signal loop diagrams as per ISA S5.1 and S5.4. Instrument identification and tag numbers/letters as indicated on drawings.

1.7 Shop Drawings

- .1 Submit shop drawings in accordance with Division 1, Section 01340.
- .2 Shop drawings to include the following:
 - .1 Unless otherwise specified or indicated, submit detail design drawings, shop drawings, specification sheets or product data sheets for all instruments and devices. All dimensions, rating, curves, etc. to be in SI units.
 - .2 Submit, prior to the installation or fabrication of the instruments and panels, complete loop-wiring diagrams showing all the wiring between instruments and devices.
 - .3 Submit prior to installation, layout drawings of each Instrument and Control Panel showing construction details, materials and construction, bill of materials, location of instruments and devices, dimensions, etc.
 - .4 Interconnection wiring diagram of the PLC Panel, including power supplies, processing units, communication modules, I/O modules, and operator interface devices.
 - .5 Product description of each item (hardware and software) including wiring and installation instructions, functional description, performance data, physical, electrical and other environmental requirements.

1.8 Operating and Maintenance Manuals

- .1 Submit Operating and Maintenance Manuals in accordance with Division 1, Section 01730 1.3.3.
- .2 Operating and Maintenance Manuals to include the following:
 - .1 Process Control System.
 - .2 PCS software logic: hard copy and “memory stick” copy.
 - .3 Instrumentation equipment: List of all parts and equipment used (bill of material), including source of supply, catalogue descriptions, operating and maintenance instructions, supplier’s name, address, etc.

- .3 All operation and maintenance instruction manual data for control and instrumentation work is to be in a separate indexed section of the manual, and the data is to be arranged in a logical, indexed manner outlining a systematic narrative for operations personnel to start-up, shut-down, or manually override and operate all related equipment.
- .4 Prior to submission of final operating and maintenance instruction manuals, and at least thirty days prior to instrumentation and control system testing and commissioning commencing, submit to and review with the Engineer, two copies of the proposed data for the instrumentation and control work section of the operating and maintenance instruction manuals.

1.9 General Design Criteria

- .1 The drawings, specifications and tabulations do not purport to be complete in listing or indicating all the necessary components. Provide all the required power supplies, signal conditioners and all other accessories to make a complete working system for the various monitoring and control loops. Provide all the necessary relays, signal isolators, signal amplifiers, signal converters, etc., to realize the intent of the design.
- .2 The available power will be 120 V, 60 Hz, single-phase, alternating current. Power will be from lighting panels as shown on the drawings, with no other devices connected to the instrument power circuit.
- .3 Unless otherwise noted, the output signals of all instruments are to be linear.

1.10 Operation and Testing

- .1 All instrumentation equipment is to be checked and adjusted by a competent service representative of respective instrument manufacturer. After all calibration and other adjustments are carried out, and the equipment is fully operable, the accuracy, serviceability and function of all units are to be demonstrated to the Engineer's satisfaction. Upon completion of this work, provide copies of a written report to be filed with the Engineer.
- .2 Contractor shall note the requirements of section 01725 regarding "Commissioning, Start-up and Warranty Period Inspection Requirements."

2 PRODUCTS

2.1 General

- .1 Provide all indicator and gauge dials finished in permanent white with black graduations and figures in SI units unless indicated otherwise. Units shall be in scales of 1, 2, 5 or 10 and multiples, as the range requires.

- .2 Analog signals are to have a “live” zero or positive minimum value in the signal range. Unless otherwise indicated or specified, all signals are to be of the continuous 4-20 mA DC type and isolated.
- .3 Provide a “loop” signal opto-isolator for all analog signals to facilitate isolation, boosting, conversion, or diverting of signals.
- .4 Each component is to be carefully selected and designed for a long lifetime with ample margin to withstand transient and other surge voltages which may occur in the circuits from any source in the power supply.
- .5 Each component and composite instrument is to be suitable for the location and installation position, e.g., horizontal, vertical or sloped position.
- .6 Integrating counters and elapsed meters shall show the total quantity that has passed through the meter and are not to require the use of a multiplier.
- .7 All instruments mounted on panel face are to be suitable for flush mounting.
- .8 Unless otherwise indicated or specified, inline devices such as magnetic flowmeters, flow tubes, parshall flumes, etc., to be supplied under this Division but installed by other Divisions of the Contract. Coordinate with the appropriate Division.
- .9 All instrumentation and control equipment to be suitable for operation from a nominal 120 V, 60 Hz supply. Voltage tolerance: $\pm 10\%$, frequency tolerance: $\pm 2\%$.
- .10 Provide corrosion-resistant (i.e., stainless steel), instrument tag plates c/w chain to all local instruments and equipment. The use of “dyno” tape will not be acceptable. Indicate instrument description, tag number, range and/or setpoint (including units).
- .11 Provide local transmitters complete with indicators in SI units where tag numbers include “I” (for instance “FIT”, “PIT”), unless specified otherwise.
- .12 Local gauges such as pressure gauges or dial thermometers, that are line mounted, are to be plainly visible from grade or platform.
- .13 Provide all necessary instrumentation power wiring, control signal and alarm wiring complete with wire markers at both ends.
- .14 Measurement accuracy (unless otherwise specified or where applicable): $\pm 0.5\%$ of full-scale range and 2% of reading. Repeatability: $\pm 0.25\%$, response 1 sec.

2.2 PLC Control Panel (PLC Panel)

- .1 General Requirements for Panels:
 - .1 Supply and install all control panels in accordance with the general arrangement shown on the drawings.

- .2 Provide control panels complete with instruments, indicators switches, indicating lights, relays, PCS, expansion modules, Autodialer, telemetry equipment, fuses, disconnect switches, nameplates, terminal blocks, wiring, ground bus, etc., as specified herein or as shown on the drawings.
 - .3 Provide a descriptive system document for all intrinsically safe circuits and place lamicoid label on PLC Panel door, per OESC Section 18 and Appendix F and J. Descriptive System Document to be included in PLC Panel shop drawings.
 - .4 All control panels must bear a CSA or ESA Special Inspection sticker on front door, indicating that the panel assembly complies with all applicable electrical codes and regulations.
- .2 Panels Construction:
- .1 Fabricated of high grade, cold rolled, smooth sheet steel not thinner than 12 gauge.
 - .2 All doors and edges neatly turned in and finished smoothly. Visible welded seams are not acceptable.
 - .3 Rigidly constructed with angle iron or channel supporting frame, suitably braced and stiffened to prevent any "bowing" or "deformation".
 - .4 Mounting arrangement and dimensions as indicated on contract drawings.
 - .5 Integral welded brackets and front access door only.
 - .6 Door: flush fitting, gasketed, hung on concealed piano type hinges with a 3-point latch and automotive locking type handle.
 - .7 Removable 12 gauge inner panel.
 - .8 Drawing pocket on inside of door.
 - .9 Ground stud on box and bonding/ground stud on door.
 - .10 Enclosure rating: NEMA/EEMAC 12.
 - .11 Acceptable manufacturers: Hammond Manufacturing, Ralston Metal Products Ltd., Hoffman, Rittal.
- .3 Local Control Panel wiring:
- .1 Control wiring: minimum #14 AWG, stranded copper, 600 V thermoplastic insulated, moisture resistant (TEW type).
 - .2 Analog wiring: minimum #18 AWG, insulated copper, 600V rated, shielded twisted pairs or triads, aluminum-Mylar shield, bare copper drain wire and overall PVC jacket.
 - .3 Include plastic wire-ways (with covers) to neatly arrange wiring inside panel enclosure.

- .4 Control Wiring Colours:
 - .1 Power: black.
 - .2 Control: red.
 - .3 Neutral: white.
 - .4 DC power: blue.
 - .5 Intrinsically safe wiring: yellow.
 - .6 Instrument ground: light green.
 - .7 Power ground: dark green.
- .4 Terminal Block Devices and Accessories:
 - .1 Feed through, single-level control terminals:
 - .1 Voltage: 600 V.
 - .2 Current: 25A.
 - .3 Maximum wire size: #12 AWG.
 - .4 Single-level terminals.
 - .5 Colours: Blue – DC, Gray – AC, Green/yellow - GND.
 - .2 Instrument loop – LED blown fuse indicator type terminals:
 - .1 Voltage: 600 V.
 - .2 Current: 15A.
 - .3 Maximum wire size: #12 AWG.
 - .4 LED indicator (24V DC).
 - .3 Output Interface relay (interposing relay) for each DO:
 - .1 Coil voltage: refer to drawings.
 - .2 Contact arrangement: 1-NO (SPST).
 - .3 Contact rating: 10A at 250V AC.
 - .4 Width Dimension: 10mm Max.
 - .5 Rail: 32 mm DIN.
 - .6 LED indicating light.
 - .4 DIN Rail-mounted “Miniature” Style Circuit Breakers

- .1 Voltage: 24VDC or 120VAC/60Hz (AC/DC).
- .2 No. of Pole and Current rating: refer to contract drawings.
- .3 Type: Thermal-magnetic trip.
- .4 Lock-Off device for main breaker.
- .5 Interrupting Capacity: 10kA.
- .6 Accessories (as indicated on drawings):
 - .1 Auxiliary switch contact (SPDT): status of breaker position.
 - .2 Bell alarm switch (SPDT): status of trip condition only.
 - .3 Shunt Trip device.
 - .4 Lock-On device.
- .7 Dielectric Strength: 4000VAC.
- .8 Insulation Resistance: >100MΩ.
- .9 Ambient temperature: -35°C to +70°C
- .10 Operating Life: 20,000 mechanical cycles, 6000 electrical cycles.
- .5 Terminal block accessories:
 - .1 TS32 or TS35 terminal rails.
 - .2 End brackets, feeder terminals, bus bar, protective cap, etc.
 - .3 Instrument ground (copper) busbar and power ground (copper) busbar, c/w support blocks.
 - .4 Marking tags for each terminal, fuse and breaker.
 - .5 Test plugs, as required.
 - .6 Clear plastic covers, as required.
 - .7 Mounting hardware, as required.
- .6 Acceptable Terminal Block Devices and Accessories Manufacturers:
 - .1 Weidmuller.
 - .2 Phoenix Contact.
 - .3 Wieland.
- .5 Rail-mounted Fuseholders:
 - .1 Voltage: 600VAC (max.).

- .2 Current: 30A (max.).
- .3 Fuse type: Midget fuses (1-1/2" x 13/32").
- .4 Maximum wire size: #6AWG.
- .5 Finger-safe design, with blown-fuse indicator.
- .6 Acceptable manufacturers:
 - .1 Ferraz Shawmut.
 - .2 Bussmann.
- .7 Data Interface Port
 - .1 NEMA 12 rated.
 - .2 Housing: Steel c/w plastic cover.
 - .3 Configuration:
 - .1 One (1) GFCI duplex receptacle c/w 5A breaker.
 - .2 Two (2) USB 2.0 connectors c/w rear 3m cable and female USB2.0 connector.
 - .3 One (1) RJ45 connector front/rear.
 - .4 Housing: Steel c/w plastic cover.
 - .5 Acceptable manufacturers:
 - .1 Hoffman
 - .2 Grace Engineering
 - .3 Hubbell
- .8 Control Devices:
 - .1 All pushbuttons, selector/control switches and control relays to Section 16400 – Basic Electrical Equipment and Materials.

2.3 Pressure Measuring Instrument

- .1 Abbreviations: PE/PIT.
- .2 Ranges and liquid type: refer to Appendix Instrumentation List and/or contract drawings.
- .3 Enclosure: EEMAC/NEMA 4X.
- .4 Circuit board: solid-state electronics.
- .5 Power supply: 24VDC.

- .6 Sensing fluid: silicone filled.
- .7 Accuracy: $\pm 0.25\%$ of calibrated span.
- .8 Diaphragm and connection materials: 316SS.
- .9 Process flange and adapters: 316SS.
- .10 Process pipe connection: 6mm.
- .11 Output signal: 4-20 mA DC isolated signal, into 600 ohms loop loading.
- .12 Display: Integral LCD, scaled in engineering units.
- .13 Maximum working pressure: 2000psig.
- .14 Acceptable Manufacturer:
 - .1 ABB/Bailey F&P.
 - .2 Rosemount.
 - .3 Endress & Hauser.
 - .4 Honeywell.

2.4 Flood Level Switch

- .1 Vertically mounted level switch, with low level indication and control to monitor grey-water in sumps, and also for oils and fuel applications.
- .2 Hermetically sealed reed switches (N.O./N.C.) rated 30VA at 220VAC. Provide interposing relay for DC applications.
- .3 Float/Stem material: Buna-N and Epoxy.
- .4 Include mounting bracket for level switch.
- .5 Acceptable manufacturer: W.E Anderson (by Dwyer) Type F7-BT series.

2.5 Flood Switch

- .1 Abbreviation: LSH.
- .2 General purpose use for water applications.
- .3 316 Stainless steel with Teflon float.
- .4 CSA approved.
- .5 Operating Temperature: to 82.2°C.
- .6 Maximum pressure: 300psi.

- .7 Normally open, 20VA, selectable. Epoxy encapsulated sensing/control circuits.
- .8 Mounting: 1/8" NPT.
- .9 Acceptable manufacturers:
 - .1 Gems LS-1700, Teflon Float complete with mounting bracket.

2.6 Electronic Pressure Switches

- .1 ISA abbreviations : PSL, PSH.
- .2 Power: 2-wire, 12-30VDC @ 0.75 Amps derived from PLC discrete input.
- .3 Accuracy: 0.5% of full range span under normal conditions.
- .4 Operating Range: 0 – 100 psi with 100% adjustable set point and dead band over entire sensor range.
- .5 EEMAC 4X enclosure, epoxy coated.
- .6 Output States: two-state operation.
- .7 Display: Local 4 digital LCD capable of displaying process variable, units of measure, switch status, latch status, set point value, dead band value, min/max values and fault codes.
- .8 Control Mode: Configurable for change of state above or below set point with automatic or manual reset.
- .9 Gauge Pressure Sensor: Stainless steel welded diaphragm, micro-machined piezo 316 resistive strain gauged silicon element, 0.25 mL silicone oil fill.
- .10 Suitable for pipe mounting with 13 mm 316 SST pressure connection.
- .11 Acceptable manufacturer:
 - .1 United Electric, 1 Series (2W).
 - .2 Enderson Hauser.

2.7 Loop Power Supply Units

- .1 Power supply: 120V AC, 60 Hz complete with alarm contact and redundancy module.
- .2 Voltage output: 24V DC, $\pm 5\%$.
- .3 Current output: size to suit, plus 30% reserve capacity.
- .4 Suitable for DIN-rail mounting inside of PLC/SCADA Panel.
- .5 Automatic short circuit protected, crowbar and over-voltage protected.
- .6 Acceptable manufacturers:

- .1 Phoenix Contact Quint DC power supply and Quint-Diode redundancy module
- .2 Hammond, Omron equivalents.

2.8 Intrinsically Safe Interfaces (Barriers)

- .1 Service: Provide direct non-latching signals from digital control devices in hazardous area (Class 1, Division 1, Groups A-D) , with 2-channel isolated barrier outputs for two independent devices.
- .2 Features: line fault detection, reverse mode operation, LED power on light, and LED status lights for each input channel and output relay operation.
- .3 Output contact per channel: 1-SPDT (Form C), 2A @ 240VAC resistive.
- .4 Operating temperature: -20°C to 60°C
- .5 Power supply: 115VAC, 60 Hz
- .6 CSA Approved, and DIN rail mounted.
- .7 Acceptable manufacturers: Pepperl+Fuchs KFA5-SR2-Ex2 series

2.9 Multi-Channel Isolator (4-20mA splitter)

- .1 Description: "opto" isolated against ground loops and noise, RFI/EMI protected, DIN rail mounted.
- .2 Input signal: 4-20 mA.
- .3 Output signal: Two 4-20 mA.
- .4 Power supply: 24VDC.
- .5 Adjustable zero and span potentiometers.
- .6 Suitable for terminal rail mounting.
- .7 Acceptable manufacturers:
 - .1 Pribusin ITC222, Phoenix MINI MCR-2-UNI-UI-2UI-C (2905025), Action I/Q – Q406 series, or approved equivalent.

2.10 Signal Isolators

- .1 Description: "opto" isolated against ground loops and noise, RFI/EMI protected, DIN rail mounted.
- .2 Input signal: 4-20 mA.
- .3 Output signal: 4-20 mA, 600-ohm loop load.
- .4 Power supply: 24VDC.
- .5 Adjustable zero and span potentiometers.

- .6 Suitable for terminal rail mounting.
- .7 Acceptable manufacturers: Pribusin

2.11 Uninterruptible Power Supply Unit

- .1 Abbreviation: UPS.
- .2 Description: True Online Design, with protection for power failure, brownouts, sags, surges, over voltage, transients, noise, frequency variations and harmonic distortion.
- .3 Input power supply: 120V AC, single phase, 60 Hz, c/w cord and 5-20P plug (length to suit).
- .4 Output power supply: 120V AC, single phase, c/w six 5-20R receptacles. VA capacity as shown on drawings.
- .5 Battery back-up time: 15 minutes full load capability (min.).
- .6 Output voltage regulation: $\pm 3\%$ (max.).
- .7 Output frequency: 60 Hz, $\pm 0.2\%$ (max.).
- .8 Output Voltage THD: 5% (max.) for resistive or non-linear loads.
- .9 Ambient Operating Temperature: 0°C to 40°C.
- .10 Batteries: sealed lead-acid, maintenance-free batteries, minimum 5-year service life, and a 4hr recharging time to 90% capacity. Batteries mounted internally to UPS cabinet.
- .11 Circuit protection: batteries, input line and output line protected by circuit breaker or fuse.
- .12 Indication: LED indicating lights for Input Line On, Inverter On, alarm, bypass and battery indication.
- .13 Controls: master on/off switch, audible alarm on/off switch, and bypass switch.
- .14 Include a Relay Interface Card to provide alarm indication of: Utility Failure, Low Battery, UPS Alarm/Ok, and On Bypass as a minimum. Each alarm to include a separate SPDT (Form 'C') isolated dry contact.
- .15 Mounting: provide all necessary support brackets and hardware.
- .16 Accessories:
 - .1 Babel Buster ProV210 SNMP to Modbus TCP/IP converter.
- .17 Acceptable manufacturers: Powerware (Eaton) 9PX Series, Liebert (Vertiv) GXT4 Series.

2.12 UPS Bypass Switch

- .1 Description: Continuous-duty, single-phase, maintenance bypass / power output distribution system, designed to operate as a maintenance bypass system in the following modes:

- .1 Normal - The UPS is continuously supplied available utility power by the POD. The UPS output power is returned to the POD and distributed to the critical AC load through the POD output receptacles.
- .2 Maintenance Bypass - The bypass switch allows a transfer of the critical AC load from the UPS inverter to the utility source; to allow for service to or replacement of the UPS, without interrupting the load.
- .2 Ambient Operating Temperature: + 32°F to + 104°F (0°C to +40°C).
- .3 Relative Humidity: 0 to 95% non-condensing.
- .4 Two status indicators for Utility and UPS indication.
- .5 Spring-loaded rotary bypass switch that ensures a maximum transfer time of <6ms.
- .6 AC Input/Output requirements as per contract drawings. Receptacle/plug configuration as indicated on drawings.
- .7 Utility and UPS line cords included, sized to suit.
- .8 AC Input/Output requirements as per contract drawings.
- .9 Mounting: provide all necessary support brackets and hardware.
- .10 Acceptable manufacturers: Liebert MicroPod (hardwired)

2.13 Temperature Alarm Low Thermostat

- .1 Abbreviation: TSL.
- .2 Temperature range: 2°C to 32°C, with 1°C differential.
- .3 Output contacts: 2-SPDT, rated 5A @ 120VAC.
- .4 Corrosion resistant, wall mounted with slotted front and bottom for maximum air circulation.
- .5 CSA approved.
- .6 Acceptable manufacturer: Honeywell T631B series.

2.14 Smoke Detector

- .1 Abbreviation: SD.
- .2 Photo-electric technology.
- .3 Power supply: 120VAC, 60HZ, 9V battery backup.
- .4 Operating Temperature: 4°C to 38°C.
- .5 Alarm Level: 85dB @ 3m (10ft).

- .6 Indicator Lights:
 - .1 Green LED remains on when unit is powered.
 - .2 Red LED flashes when unit is in alarm.
- .7 Acceptable Manufacturer:
 - .1 Kiddie P12040CA Smoke Detector (include form “c” relay module, SM120X).

2.15 Enclosure Door Contact Switches

- .1 Abbreviation: DS-3 & 4.
- .2 Type: hermetically sealed reed type, overhead door type.
- .3 Contact type: 1-SPDT contact (Form C).
- .4 Contact rating: 0.5Amps, 30VDC.
- .5 Cable: includes length of armoured cable (“pig-tail”).
- .6 Operating Temperature: -40°C to +150°C.
- .7 Mounting: suitable for surface mounting.
- .8 Acceptable manufacturer: GE MPS51C series.

2.16 Alarm Beacon

- .1 Heavy duty – industrial type, weatherproof (NEMA4X) visual signal with flashing red LED. Supply voltage: 24 VDC.
- .2 Acceptable manufacturers: GE Security 105FLEDR-G1.

2.17 Alarm Horn

- .1 Heavy duty – industrial type, weatherproof (NEMA4X) audible alarm horn. Sound output adjustment from 78 – 103dB. Supply voltage: 24 VDC.
- .2 Acceptable manufacturers: GE Security 877-G1.

2.18 Training

- .1 Provide two (2) separate one-day (8 hours) sessions of on-site training for the operators of all instrumentation and control equipment listed herein. Training to include operation, testing, calibration, adjusting and routine maintenance for each instrument (as required).
- .2 Training sessions shall be dedicated for operator training and shall be completed separate from the commissions and start up process.

3 EXECUTION

3.1 PLC Control Panel Fabrication (PLC Panel)

.1 Internal work:

- .1 Arrange all internally mounted equipment for ease of access and removal when necessary.
- .2 Install flexible wiring harnesses with approved terminating connectors between internal equipment and door mounted equipment. Provide 20% spare capacity in each harness.
- .3 Neatly install and lace or bunch all wiring into suitable forms using plastic wiring clips and channels (with covers).
- .4 Provide hinged sub-chassis or racks for internally mounted equipment.
- .5 Provide rails for terminal blocks, relays and other necessary devices.
- .6 Provide a light fixture, two 120V AC duplex receptacles and two circuit breakers, one for light and the other for receptacle.
- .7 Provide a main disconnecting circuit breaker for interrupting main power to panel.
- .8 Clearly identify all items with size 1 nameplates.
- .9 Make all wiring connections only at equipment terminals or approved terminal blocks. Soldered or splice connections are not acceptable.
- .10 AC and DC conductors are to be separated, and not grouped together in the same wire channel.
- .11 Intrinsic Safety Wiring: provide dedicated and separate wireway and terminals for all field wiring for all "intrinsically safe" wired devices.
- .12 Provide an individual circuit breaker for each 120 V panel mounted equipment.
- .13 Provide a separate loop power supply unit for each instrument loop.
- .14 Provide all instrument loop power supply with a fused disconnect switch (with LED blown fuse indicator).
- .15 Arrange all terminal blocks in groups, such that low level signals (4-20 mA DC) and higher-level signals (120V AC) do not interfere.
- .16 Provide a signal isolator for each non-isolated 4-20 mA DC type signal.
- .17 All internal panel wiring to be connected to external devices must be terminated at terminal blocks. All field wiring must be connected to one side of the terminal block, with internal wiring connected to the opposite side.

- .18 Provide jumper bars to connect common wires and terminals. All common terminals to have the same number. Maximum number of wires per terminal block is two (2).

.2 Grounding system:

- .1 Install a common ground bus bar for all power equipment.
- .2 Install a common ground bus bar for all instrument equipment (separate from power equipment).
- .3 Power equipment includes: power supplies, control panel (shell), light fixture, receptacle, etc.
- .4 Instrument equipment includes: instrumentation equipment, control panel mounted back-plates, shields, intrinsic safety barriers, etc.
- .5 Completely isolate power equipment grounds from instrumentation grounds.
- .6 Ground all instrumentation wiring shields to terminal blocks. Ground shield at one location only (i.e., do not connect shield to ground at both ends of cable).

.3 Panel-mounted equipment:

- .1 Neatly cut, properly align and size cutouts for panel-mounted equipment so that the hole is completely covered by the front bezel.
- .2 Provide cutouts and blanking plates for future equipment, as indicated.
- .3 Provide rear connecting fittings to hold all instrument cases.
- .4 Provide a deadfront type panel with flush panel mounted equipment having back connection terminals.
- .5 Provide size 2 or 3 nameplates on all panel-mounted equipment.
- .6 Provide size 7 nameplate for control panel identification.

.4 Control panel finish

- .1 Refer to Section 16010 – Electrical General Requirements.

3.2 Pressure Measuring Instruments (switches and transmitters)

- .1 Install pressure instrument at location indicated on drawings and to manufacturer's recommendations. Note, instrument installed by Division 15.
- .2 Provide all necessary mounting supports and hardware.
- .3 Provide an isolating valve between each pressure transmitter or pressure switch and pipe connection. Coordinate work with Division 15.
- .4 Provide control (instrumentation) wiring and conduit as indicated or required.

- .5 Isolating valves to be installed at all field devices connected to water supply (pressure switches, pressure transmitter, etc.).

3.3 Pressure Transducer (switches and transmitters)

- .1 Install pressure transducer at location indicated on drawings and to manufacturer's recommendations.
- .2 Provide all necessary mounting supports and hardware.
- .3 Provide control (instrumentation) wiring and conduit as indicated or required.

3.4 Flood Level Switch

- .1 Install switches at locations indicated and to manufacturer's recommendations.
- .2 Provide control wiring and conduit as indicated and required.
- .3 Provide all necessary mounting supports and hardware.

3.5 Flow Checker Instruments

- .1 Install instrument at location indicated on drawings and to manufacturer's recommendations. Note, coordinate work with Division 15 - Mechanical.
- .2 Provide instrumentation wiring, conduit and terminal box as indicated.
- .3 Provide all necessary mounting supports and hardware.

3.6 Temperature Alarm Low Switch

- .1 Install switches at locations indicated and to manufacturer's recommendations.
- .2 Provide control wiring and conduit as indicated and required.
- .3 Provide all necessary mounting supports and hardware.

END OF SECTION

Auto-Dialer System (Verbatim)

1 GENERAL

1.1 General Conditions

- .1 All sections of Division 1 form a part of this Specification. Read and fully adhere to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this section.
- .3 All sections of Divisions 1 to 16 inclusive form part of the Contract Documents.

1.2 Intent

- .1 This section covers the supply, delivery, install, program and satisfactory operation of the Auto-Dialer equipment as specified herein and/or detailed on the drawings.
- .2 Equipment to be complete with all hardware, software and communication cabling, as specified herein and shown on the drawings.
- .3 Supply equipment complete with all required items, whether or not specifically mentioned herein, so as to provide a complete process control system.

1.3 Related Work Specified Elsewhere

- .1 Electrical General Requirements: Section 16010.
- .2 Instrumentation and Control Equipment: Section 16900.

1.4 Instrumentation and Control Suppliers

- .1 Refer to Section 16900 for a list of "Acceptable Instrumentation and Control Suppliers" to integrate the equipment specified herein.

1.5 Shop Drawings (Submittals)

- .1 Submit shop drawings in accordance with Section 01340 - Shop Drawings, Product Data and Samples.
- .2 Unless otherwise specified or indicated, submit detail design drawings, shop drawings, specification sheets or product data sheets for all devices.

- .3 Refer to Section 16900 for additional Shop Drawing submission requirements.

1.6 Measurement for Payment

- .1 No measurement for payment will be made under this section.

1.7 Basis of Payment

- .1 All labour, materials and equipment necessary for the work in this Section shall be included in the lump sum prices in the Schedule of Items and Prices.

2 PRODUCTS

2.1 General

- .1 Provide a fully functional auto-dialing unit, providing an interactive and two-way alarming, monitoring, reporting and control system with solid state message recording.
- .2 Provide all necessary hardware, software and communication cables for a fully operational process control system.

2.2 Auto-Dialer Requirements:

- .1 General Requirements:
 - .1 Power supply input: 105-135VAC, 60Hz.
 - .2 Enclosure: NEMA4X.
 - .3 Operating Temperature: -6°C to 50°C.
 - .4 Humidity: 0-90% RH, non-condensing.
 - .5 Internal battery back-up time: 20 hours.
 - .6 Ethernet Communication Protocol: Allen Bradley Ethernet/IP.
 - .7 Surge protection on all phone, power and signal lines utilizing integral gas-tube and solid state protectors.
 - .8 ULc or CSA Approved.
- .2 I/O Sensing:
 - .1 Normally Open/Normally Closed Dry contact.
 - .2 Number of inputs: 16.
- .3 Remote communication features:

- .1 Voice phone.
- .2 Compatible with most cell telephone systems.
- .4 Dialing Parameters:
 - .1 Dials up to 16 different numbers, each up to 60 digits long.
 - .2 Allows programming of PBX delays in 1 second increments.
 - .3 Alarm acknowledgement by TouchTone or calling back.
- .5 Software and Programming:
 - .1 User-recordable voice messaging.
- .6 Acceptable Manufacturer: RACO Verbatim Gateway.

2.3 Training

- .1 Provide one (1) half-day (4 hours) sessions of on-site training for the operators of all equipment listed herein. Training to include operation, testing, program set-up, adjusting and routine maintenance for each device (as required).
- .2 Training sessions shall be dedicated for operator training and shall be completed separate from the commissions and start up process.

3 EXECUTION

3.1 System Layout

- .1 Prepare and submit drawings and other information showing the design and layout of the system.
- .2 Revise the information submitted, as required, to the satisfaction of the Engineer.

3.2 Installation

- .1 Install and connect equipment at location shown on the drawings.
- .2 Provide control and power wiring as indicated on drawings.
- .3 Provide all necessary conduit, boxes and accessories to provide a complete installation compliant with current Electrical Safety Codes.

3.3 Programming and Testing

- .1 Program the auto-dialer to the satisfaction of the engineer and operator. Alarm messaging to be recorded as indicated on drawings.
- .2 Perform a 10-day Acceptance Test of the complete system with all hardware and software, after the system has been installed and operating at site.
- .3 Should the test prove the existence of any fault or defect in the system, contractor to correct the defect to the satisfaction of the Engineer.
- .4 Inspection and acceptance test does not relieve the contractor of responsibility of the performance of the system.
- .5 Provide training and maintenance services as specified in Part 2 of this section.

END OF SECTION

Process Control System (PLC)

1 GENERAL

1.1 General Conditions

- .1 All sections of Division 1 form a part of this Specification. Read and fully adhere to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this section.
- .3 All sections of Divisions 1 to 16 inclusive form part of the Contract Documents.

1.2 Intent

- .1 This section covers the supply, delivery, install and satisfactory operation of Process Control System (PLC) equipment as specified herein and/or detailed on the drawings.
- .2 Equipment to include: PLC processor, I/O modules, communication modules, PLC rack, power supply module, communication cables, modem, etc. as specified herein and shown on the drawings.
- .3 Supply equipment complete with all required items, whether or not specifically mentioned herein, so as to provide a complete process control system.
- .4 The Process Control System (PLC) specified herein will be located in PLC Panel, as specified in Section 16900.

1.3 Related Work Specified Elsewhere

- .1 Electrical General Requirements: Section 16010.
- .2 Instrumentation and Control Equipment: Section 16900.
- .3 Control Narrative: Refer to Control Narrative by SBA.

1.4 Instrumentation and Control Suppliers

- .1 Refer to Section 16900 for a list of "Acceptable Instrumentation and Control Suppliers" to integrate the equipment specified herein.

1.5 Shop Drawings (Submittals)

- .1 Submit shop drawings in accordance with Special Provisions.
- .2 Unless otherwise specified or indicated, submit detail design drawings, shop drawings, specification sheets or product data sheets for all devices.
- .3 Refer to Section 16900 for additional Shop Drawing submission requirements.

1.6 Measurement for Payment

- .1 No measurement for payment will be made under this section.

1.7 Basis of Payment

- .1 All labour, materials and equipment necessary for the work in this Section shall be included in the lump sum prices in the Schedule of Items and Prices.

2 PRODUCTS

2.1 General

- .1 Provide a fully functional control system, based on a PLC system with operator interface devices (Touch screen PC).
- .2 Process control system to perform functions such as data acquisition from field devices, automatic and manual control of field devices, and operator interface.
- .3 Provide all necessary hardware, software and communication cables for a fully operational process control system.
- .4 Provide an electronic copy (memory stick) of the finalized PLC application software and the HMI application software.

2.2 Process Controller (PLC)

- .1 Manufacturer and configuration: Allen Bradley 1769 Compact Logix Programmable Controllers and 1769 I/O Modules. PLC configuration as indicated on contract drawings.
- .2 PLC Processor: 1769-L36ERM Compact Logix Controllers c/w 1GB memory card
 - .1 Available User memory size: 3MB.
 - .2 Online programming.

- .3 Ethernet/IP and USB availability.
- .4 Built-in real time clock/calendar.
- .3 Power Supply: 1769-PB4
 - .1 Quantity: one (1).
 - .2 Input Voltage Range: 19.2 to 31.2 VDC.
 - .3 Input Voltage Nominal: 24VDC.
 - .4 Current Capacity @5V: 4.0A.
 - .5 Current Capacity @24V: 2.0A.
 - .6 Fuse Size: 6.3A.
- .4 Discrete Input Modules: 1769-IQ16
 - .1 Quantity: as indicated on contract drawings.
 - .2 Input type: current sourcing.
 - .3 Voltage: 24VDC.
 - .4 Number of inputs: 16.
 - .5 Status LEDs for each input.
 - .6 Terminals: removable, suitable for up to two (2) #14AWG wires.
- .5 Discrete Output Modules: 1769-OB16
 - .1 Quantity: as indicated on contract drawings.
 - .2 Output type: solid state.
 - .3 Voltage: 24VDC.
 - .4 Number of inputs: 16.
 - .5 Status LEDs for each input.
 - .6 Terminals: removable, suitable for up to two (2) #14AWG wires.
- .6 Analogue Input Module: 1769-IF8
 - .1 Quantity: as indicated on contract drawings.
 - .2 Input type: Voltage/Current differential or single-ended.
 - .1 Voltage (+/- 10V, 0-10V, 0-5V, 1-5V).
 - .2 Current (0-20mA, 4-20mA).

- .3 Rated working voltage: 30VAC/30VDC.
- .4 Number of inputs: 8.
- .5 Terminals: removable suitable for #22AWG- #14AWG wires.
- .7 Analogue Output Module: 1769-OF8C
 - .1 Quantity: as indicated on contract drawings.
 - .2 Input type: single-ended.
 - .1 Current (0-20mA, 4-20mA).
 - .3 Rated working voltage: 30VAC/30VDC.
 - .4 Number of outputs: 8.
 - .5 Terminals: removable suitable for #22AWG- #14AWG wires.
- .8 Programming software and accessories:
 - .1 RSLogix 5000 (Windows based), latest "Standard" version.
 - .2 Programming software must be license to the Municipality and returned to the Municipality at the end of the project.
 - .3 Include programming cable, and return to the Municipality at the end of project.

2.3 Operator Interface Device (PC)

- .1 15" resistive touch screen c/w MTBF back lighting, panel mountable.
- .2 Resolution: 1024 x 768 (XGA).
- .3 Processor: Intel® Core™ i7 (3.4GHz, 1333MHz FSB and 62cfm PWN air fan).
- .4 Tested Operating System: Windows® 7.
- .5 Memory: 8GB, DDR3 1066/1333MHz, high temperature version.
- .6 Graphics: ATI M690T graphic engine or equivalent.
- .7 Hard Drive memory: High speed flash SATA SSD 512GB.
- .8 Minimum I/O Ports (minimum):
 - .1 USB 2.0: 3 ports
 - .2 RJ45: 2 ports @ 10/100/1000BaseT LAN
- .9 Optical Drive: CD-DVD-R/W,SATA.

- .10 Operating Temperature: 0°C to 50°C.
- .11 Keyboard: 105 keys, USB.
- .12 Mouse: Logitech G5 Laser USB Mouse.
- .13 Acceptable manufacturers:
 - .1 Transduction, TR-7001 series or equivalent.

2.4 Programming Interface Port

- .1 One (1) receptacle c/w 3A circuit breaker.
- .2 Four (4) USB, Type A ports.
- .3 One (1) RJ45 Ethernet port.
- .4 NEMA 12 rated housing.
- .5 Acceptable manufacturer: Grace Engineering

2.5 Training

- .1 Provide two (2) separate one-day (8 hours) sessions of on-site training for the operators of all equipment listed herein. Training to include operation, testing, program set-up, adjusting and routine maintenance for each device (as required).
- .2 Training sessions shall be dedicated for operator training and shall be completed separate from the commissions and start up process.
- .3 Provide written operations narrative for the PLC.

3 EXECUTION

3.1 System Layout

- .1 Prepare and submit drawings and other information showing the design and layout of the system. The drawings and information to include but not limited to:
 - .1 Block diagrams, module descriptions and shop drawings.
 - .2 System I/O details including tag numbers.
- .2 Revise the information submitted, as required, to the satisfaction of the Engineer.

3.2 Review Meeting

- .1 Meet with the Engineer to discuss all aspects of the system including, but not limited to:
 - .1 System hardware architecture.
 - .2 Application software, as required.
 - .3 Communication links.

3.3 System Development

- .1 Configure the required hardware components and develop application software, as required, including all communication links.
- .2 Refer to Section 16920 "Control Narratives" for the application software development pertaining to station control and operator interfaces.

3.4 Shop Testing (PLC Panel)

- .1 Perform tests to demonstrate the complete working system in the contractor's premises in the presence of the Engineer.
- .2 Submit to the Engineer details of the test procedures for review no later than four weeks prior to the scheduled tests.
- .3 Use a simulation module for simulating field I/O.
- .4 Ship equipment to site after shop tests have been completed to the satisfaction of the Engineer.

3.5 Installation and Testing (PLC Panel)

- .1 Deliver and install all equipment at the site as specified in this document and the drawings.
- .2 Be responsible for any additional handling and transportation of the equipment that is necessary and for storage of the equipment on site.
- .3 Provide adequate protection against weather, dirt, dust, dampness and damage, in accordance with the manufacturer's instructions and to the satisfaction of the Engineer.
- .4 Provide to the Engineer a written notice of the contractor's readiness to carry out site inspection and testing.

- .5 Perform a 10-day Acceptance Test of the complete system with all hardware and software, after the system has been installed and operating at site.
- .6 Should the test prove the existence of any fault or defect in the system, contractor to correct the defect to the satisfaction of the Engineer.
- .7 Inspection and acceptance test does not relieve the contractor of responsibility of the performance of the system.
- .8 Provide training and maintenance services as specified in Part 2 of this section.

3.6 Spare Parts

- .1 Provide the following spare parts as part of this section:
 - .1 One power supply unit.
 - .2 One central processing unit (CPU) completely up-loaded and tested with the final software program.
 - .3 One Discrete Input module.
 - .4 One Discrete Output module.
 - .5 One Analog Input module.
 - .6 One Analog Output module.
- .2 Submit a list of spare parts as a shop drawing submission, with delivery of all spare parts to owner at the end of project (after commissioning).

END OF SECTION

SCADA Software and Workstations

1 GENERAL

1.1 General Conditions

- .1 All sections of Division 1 form a part of this Specification. Read and fully adhere to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this section.
- .3 All sections of Divisions 1 to 16 inclusive form part of the Contract Documents.

1.2 Intent

- .1 This section covers the supply, delivery, install and satisfactory operation of SCADA Software and Workstation equipment as specified herein and/or detailed on the drawings.
- .2 Equipment to include: workstations, printers, software, communication cables, etc. as specified herein and shown on the drawings.
- .3 Supply equipment complete with all required items, whether or not specifically mentioned herein, so as to provide a complete process control system.
- .4 The equipment specified herein will be located at the "Shelburne ."

1.3 Related Work Specified Elsewhere

- .1 Electrical General Requirements: Section 16010.
- .2 Instrumentation and Control Equipment: Section 16900.
- .3 Radio Communication System: Section 16911.
- .4 Control Narrative: Refer to Control Narrative by SBA.

1.4 Acceptable "SCADA Software and Workstation" Supplier

- .1 Refer to Section 16900 for a list of "Acceptable Instrumentation and Control Suppliers" to supply, install and integrate the equipment specified herein.

1.5 Shop Drawings (Submittals)

- .1 Submit shop drawings in accordance with Section 01340 – Shop Drawings, Product Data and Samples.
- .2 Unless otherwise specified or indicated, submit detail design drawings, shop drawings, specification sheets or product data sheets for all devices.
- .3 Refer to Section 16900 for additional Shop Drawing submission requirements.

1.6 Measurement for Payment

- .1 No measurement for payment will be made under this section.

1.7 Basis of Payment

- .1 All labour, materials and equipment necessary for the work in this Section shall be included in the lump sum prices in the Schedule of Items and Prices.

2 PRODUCTS

2.1 General

- .1 Provide a fully functional control system, a stand-alone SCADA system with capability of future integration to a Municipality wide SCADA/alarm annunciation system. The equipment will be able to communicate to an Ethernet based cellphone communication network.
- .2 The proposed SCADA system will perform applications such as data acquisition, data set point changes, real time trending, historical collection and display, report generation, alarm printing and alarm annunciation.
- .3 The future “server” workstation will access the stand-alone field I/O points and maintain process databases via the Ethernet based cellphone communication network. The current stand-alone SCADA system will become the future “client” workstation and will access data from the serve workstation via the Ethernet based cellphone communication network.
- .4 Provide all necessary hardware, software, drivers and communication cables for a fully operational SCADA software and stand-alone workstation system as outlined on the contract drawings and specified herein.
- .5 Refer to contract drawings for general arrangement of equipment and systems.

- .6 Provide an electronic copy (memory stick) of the finalized SCADA application software and the Alarm Notification application software.

2.2 SCADA Software

- .1 SCADA Software features:
 - .1 Server/client platform: Windows 10.
 - .2 Redundant remote server database backup capable for future expansion.
 - .3 Licenses:
 - .1 One (1) Development license (most current version) owned by integrator.
 - .2 One (1) Client node complete with one (1) Runtime with I/O.
 - .3 One (1) "Historian" license.
 - .4 Embedded VBA; components are exposed, managed and customized directly through VBA.
 - .5 Data historian to collect, archive and distribute real time information.
 - .6 Electronic record functionality (i.e., Signature).
 - .7 Real time and historical trending.
 - .8 Data collection and management.
 - .9 Alarming and alarm management.
 - .10 Alarm counter functionality; indicates number of alarm tags per node, priority of alarms and the condition of the alarm (acknowledge).
 - .11 Configurable individual and node base security, synchronized with Windows.
 - .12 High performance networking capability (TCP/IP via cellphone telemetry).
 - .13 Online configuration and Tag group editor.
 - .14 ActiveX controls for database connectivity.
 - .15 Process visualization and supervisory control (HMI/SCADA).
 - .16 Object-orientated graphics.
 - .17 Workspace development environment.

- .18 Built-in Wizards and Experts to perform simple and complex tasks.
- .19 Incorporates "plug and solve" technology for third party equipment.
- .20 Event scheduler, allowing tasks to run in the background or foreground.
- .21 Easily expandable software package
- .22 Refer to contract drawings for total number of I/O points to determine number of tags. Include 30% spare I/O tags for future expansion and additions.
- .23 Complete store and forward capabilities (i.e no data loss when communications between PLC and SCADA system/ Historian are disconnected. Automatic fill-in of missing data for historian).
- .2 Acceptable Manufacturers:
 - .1 Aveva, InTouch.
 - .2 RS View.

2.3 Printing Equipment

- .1 Alarm Event Printer:
 - .1 Device type: Impact Dot Matrix Printer.
 - .2 Printhead: 24 pin.
 - .3 Connectivity: Ethernet 10-base-T.
 - .4 Input buffer: 64 kB.
 - .5 Printer language: ESC/P-2.
 - .6 Printer speed: draft 310 cps at 10cipi.
 - .7 Paper feed mechanism: Push Tractor Feed.
 - .8 Paper path: rear in, rear out.
 - .9 Power supply: 120VAC (with cord).
 - .10 Acceptable manufacturers: Epson LQ-680Pro Impact Printer or equivalent.
- .2 Include all necessary communication cables. Include spare ink cartridges for each printer (all colours). Also, include 1000 sheets of paper for each printer.

2.4 Workstation Accessories

- .1 Workstation table:
 - .1 Table size: 940Hx1067Wx840Dmm.
 - .2 Independently adjustable keyboard platform (adjusts 635-940mm).
 - .3 Cable trays and desktop grommets.
 - .4 PC Workstation and UPS holders for side mounting.
 - .5 Construction: heavy duty, black powder coated steel frame.
- .2 Printer Stand: three (3)-tray system, c/w heavy-duty rolling casters and steel metal frame. Size to suit printing equipment.
- .3 Chair (for each workstation): mid back design, pneumatic seat height adjustment, 360o swivel, T- arm rests, five (5) leg support c/w rolling casters.
- .4 Power bar (for each workstation): 120VAC, six (6) outlet, EMI/RFI noise filtering, On/Off switch.

2.5 Training

- .1 Provide two (2) separate one-day (8 hours) sessions of on-site training for the operators of all equipment listed herein. Training to include operation, testing, program setup, adjusting and routine maintenance for each device (as required).
- .2 Training sessions shall be dedicated for operator training and shall be completed separate from the commissions and startup process.

3 EXECUTION

3.1 System Layout

- .1 Prepare and submit drawings and other information showing the design and layout of the system. The drawings and information to include but not limited to:
 - .1 Block diagrams, module descriptions and shop drawings.
 - .2 System I/O details including tag numbers.
- .2 Revise the information submitted, as required, to the satisfaction of the Engineer.

3.2 Review Meeting

- .1 Meet with the Engineer to discuss all aspects of the system including, but not limited to:
 - .1 System hardware architecture.
 - .2 Application software, as required.
 - .3 Communication links.

3.3 System Development

- .1 Configure the required hardware components and develop application software, as required, including all communication links.
- .2 Refer to Section 16920 Control Narrative, for the application software development pertaining to station control and operator interfaces.

3.4 Shop Testing

- .1 Perform tests to demonstrate the complete working system in the contractor's premises in the presence of the Engineer.
- .2 Submit to the Engineer details of the test procedures for review no later than four weeks prior to the scheduled tests.
- .3 Use a simulation module for simulating field I/O.
- .4 Ship equipment to site after shop tests have been completed to the satisfaction of the Engineer.

3.5 Installation and Testing

- .1 Deliver and install all equipment at the site as specified in this document and the drawings.
- .2 Be responsible for any additional handling and transportation of the equipment that is necessary and for storage of the equipment on site.
- .3 Provide adequate protection against weather, dirt, dust, dampness and damage, in accordance with the manufacturer's instructions and to the satisfaction of the Engineer.
- .4 Provide to the Engineer a written notice of the contractor's readiness to carry out site inspection and testing.

- .5 Perform a 10-day Acceptance Test of the complete system with all hardware and software, after the system has been installed and operating at site.
- .6 Should the test prove the existence of any fault or defect in the system, contractor to correct the defect to the satisfaction of the Engineer.
- .7 Inspection and acceptance test does not relieve the contractor of responsibility of the performance of the system.
- .8 Provide training and maintenance services as specified in Part 2 of this section.

END OF SECTION

16920 – Well 3 Treatment System Process Narrative

PART 1 – GENERAL

1.1 General Conditions

- .1 All sections of Division 1 form a part of this Specification. Read and fully adhere to exactly if repeated here in full.
- .2 Refer to all other Divisions of Specifications and these documents to determine their effect upon the work of this section.
- .3 All sections of Division 1 to 16 inclusive form part of the Contract Documents.
- .4 This section relates to proposed electrical work as defined within this Contract Document.

1.2 Scope

- .1 Supply, deliver and install the “Process Narrative” as specified herein in greater detail and as shown on the drawings.
- .2 Contractor is responsible for coordinating the “Process Narrative” specified herein with the information on the contract drawings. Ensure all processes will operate in accordance with these descriptions through the PLC and SCADA system. Any changes or additions to this document made in the field are to be updated by the Contractor and submitted to the Consultant Engineer for review.

1.3 Related Work Specified Elsewhere

- .1 Section 16010: Electrical General Requirements
- .2 Section 16400: Basic Electrical Equipment and Materials
- .3 Section 16745: Data (Ethernet) Systems
- .4 Section 16850: Services for Mechanical Equipment
- .5 Section 16900: Instrumentation and Control Equipment (lists the acceptable “instrumentation and Control Supplier” for this section).
- .6 Section 16910: Process Control System (lists the Process Control System, Operator Interface and Programming Software).

1.4 Intent

- .1 This section is to provide control narrative description of the process for the Town of Shelburne Pumphouse No. 1 Water Treatment System Upgrades Project. The process equipment covered within this document includes the facilities process instrumentation and SCADA control systems, alarms, monitors.
- .2 These descriptions are specifically written for use by a “PLC and SCADA System Programmers” to write the software program in the Process Logic Control System (PLC). They are to convey the control strategies that apply to the PLC, Master SCADA system (SCADA) and their relationship to the process equipment. Refer to the contract drawings as they supplement the description of this section.
- .3 In Part 2 “Products”, section is further subdivided into the following categories:
 - .1 Process Description:
 - .1 This section identifies the equipment involved and a general understanding of the process control strategies.
 - .2 PLC Program:
 - .1 This section describes the actual PLC Program function for the equipment involved. The modes of operation are identified, including list of conditions by which the appropriate mode is determined. Each mode of operation is individually described, listing all constraints and limitations.
 - .3 If applicable, a list of variables will be provided to identify those aspects of the program, which can be adjusted from the SCADA system. Examples of variables include timers, level setpoints, motor speeds etc.
 - .1 All the variables listed in this document are to be mapped for communication to be mapped for communication to the Water Treatment System PLC for interaction with the SCADA system.
 - .4 Monitoring and Alarm
 - .1 This section describes the alarms and status conditions of equipment involved.

1.5 Operating and Maintenance Manuals

- .1 Submit Operating and Maintenance Manuals in accordance with Division 1, Section 01730 “Operation and Maintenance Data”.

- .2 Operating and Maintenance Manuals to include the following:
 - .1 Programmer's contact name, complete with office number, mobile/cell number, mailing and civic address, and email address.
 - .2 General description of PLC program.
 - .3 PLC Programming code, complete with cross-references and related files.
 - .4 A detailed description of SCADA system functionality for system navigation, parameterization and alarm control.
 - .5 Prior to beginning programming the programmer shall provide a tagging convention, which will be used throughout the programming. Programming is not to begin until the Engineer approves the convention.

1.6 Operation and Testing

- .1 Contractor shall note the requirement of Section 01725 regarding "Commissioning, Start-up and Warranty Period Inspection Requirements".

PART 2 – PRODUCTS

2.1 General – System Overview

- .1 The Pumphouse No. 1 Treatment System will consist of electronic devices that will either be controlled or monitored by the PLC and/or SCADA system:
 - .1 Well No. 1 Pump
- .2 Instrumentation and monitoring as follows:
 - .1 Raw water line Flowmeter, FE/FIT-101
 - .2 Raw water line Pressure Transmitter, PE/PIT-101
 - .3 Raw water line Pressure Transducer, PT-1
 - .4 Raw water Turbidity Analyzer, AE/AIT-101
 - .5 Treated water line, Turbidity Analyzer, AE/AIT-301 (Existing)
 - .6 Treated water line, Pre-Chlorine Analyzer, AE-AIT-501 (Provisional)
 - .7 Treated water line, Post-Chlorine Analyzer, AE-AIT-601 (Existing)

.8 Motorized Actuated Valve, MV-101

.3 Miscellaneous Systems:

.1 UPS System

.2 Building Low Temperature

.3 Building Smoke Detection

.4 Communication System

.5 Building Access Control System

.6 Digital Power Meter

.7 Stand-by generator

.4 Refer to contract drawings for arrangement of Process Control System.

2.2 Well No. 1 Pump System

.1 Process Description:

.1 Well No. 1 pump supplies water to the north and south Water Towers.

.2 Well No. 1 pump is on a soft starter

.3 Pressure Transmitter, PE/PIT-101

.4 Flow meter, FE/FIT-101

.5 Turbidity Analyzer, AE/AIT-101

.6 Turbidity Analyzer, AE/AIT-301

.7 Chlorine Analyzer, AE/AIT-601

.8 Pressure Transducer, PT-1

.2 Continuous raw water flow meter readings are provided at Pumphouse No. 1 by FE/FIT-101. This instrument will produce a 4-20mA signal proportional to the well pump flow as an input to the PLC.

- .3 Continuous raw water pressure readings are provided at Pumphouse No. 1 by PE/PIT-101. This instrument will produce a 4-20mA signal proportional to the line pressure as an input to the PLC.
- .4 Continuous raw water turbidity readings are provided at Pumphouse No. 1 by AE/AIT-101. This instrument will produce a 4-20mA signal proportional to the raw water turbidity as an input to the PLC.
- .5 PLC Programming:
- .1 Provide programming such that when Well No. 1 pump is called to run, the Process Control Valve (PCV) will be set up to produce a speed equal to 13 L/s as measured by the flow meter FE/FIT-101. (Operator manually adjustable from PCV)
- .2 Upon a call for water, Well No. 1 pump must wait for UV1 to warm up completely and MV-101 to fully open before starting.
- .3 The following Table 1 indicates the proposed start/stop level setpoints for Well No. 1. The pumps will start/stop based on the water level in the existing and proposed water towers.

	Well 1 Level Setpoint (m)
Start Level	TBD
Stop Level	TBD

- .4 Provide programming such that when the Pressure Transmitter PIT-101 measures greater than 125 psig, (Operator adjustable from SCADA) the well pump shall turn OFF.
- .5 Provide programming such that when the Turbidity Analyzer AIT-101 measures greater than 5 NTU, (Operator adjustable from SCADA) the well pump shall turn OFF.
- .6 Provide programming such that when the Pressure Transducer PT-1 measures well level less than XX.X m (TBD), (Operator adjustable from SCADA) the well pump shall turn OFF.
- .7 Provide programming such that when the Chlorine Analyzer AIT-601 measures greater than 5 ppm, (Operator adjustable from SCADA) the well pump shall turn OFF.

- .8 Provide programming such that when the Turbidity Analyzer AIT-301 measures greater than 1 NTU, (Operator adjustable from SCADA) the well pump shall turn OFF.

.6 Monitoring and Alarm Conditions

- .1 Configure the PLC program (as manually selected by the Operator) and alarms as follows:
 - .1 Well Pump 1 start/stop set points, in m.
 - .2 Continuous PE/PIT-101 display, in psig
 - .3 Continuous AE/AIT-101 display, in NTU
 - .4 Continuous AE/AIT-301 display, in NTU
 - .5 Continuous AE/AIT-601 display, in mg/L
 - .6 Continuous PT-1 display, in m.
 - .7 PE/PIT-101 daily min, max, avg, in psig
 - .8 AE/AIT-101 daily min, max, avg, in NTU
 - .9 AE/AIT-301 daily min, max, avg, in NTU
 - .10 AE/AIT-601 daily min, max, avg, in mg/L
 - .11 AE/AIT-101 high/low level alarm setpoint, in NTU
 - .12 AE/AIT-301 high/low level alarm set point, in NTU
 - .13 AE/AIT-601 high/low level alarm set point, in mg/L
 - .14 PT-1 low level alarm set point, in m
 - .15 PE/PIT-101 signal lost or out of limits (<4 or >20mADC) alarm
 - .16 AE/AIT-101 signal lost or out of limits (<4 or >20mADC) alarm
 - .17 AE/AIT-301 signal lost or out of limits (<4 or >20mADC) alarm
 - .18 AE/AIT-601 signal lost or out of limits (<4 or >20mADC) alarm
 - .19 PT-1 signal lost or out of limits (<4 or >20mADC) alarm

- .2 Configure the PLC program to indicate each alarm. If any alarm is activated and after a pre-set time delay, the program will perform the following:
 - .1 Display a message of the activated alarm on the SCADA system.
 - .2 Remain in the alarm state until the alarm has been acknowledged and reset on the SCADA system.
 - .3 Program each alarm with the ability to be disabled via the SCADA System.

2.3 UV System

- .1 Process Description:
 - .1 The UV (UV1) is provided as a part of a two-stage primary disinfection process. One duty and one 100% standby UV units.
 - .2 The UV System is equipped with a “manual-off-auto” control switch on a local control panel. In “manual” mode, the UV System is started and stopped by the local control panel. In “auto” mode, operation of the UV System will be controlled through the PLC program.
 - .3 Control of all UV disinfection system manufacturer supplied equipment, PLC, local HMI signals are to be the responsibility of the UV disinfection system supplier.
 - .4 All interface signal between the UV disinfection System PLC and the Main PLC are via Allan Bradley / IP Ethernet communication.
- .2 PLC Programming:
 - .1 Refer to UV System information for programming and instrumentation requirements.
 - .2 All UV System control screens, set points and alarms are to be copied from the UV system to the SCADA system.
 - .3 The program will operate the UV System in automatic mode under the following conditions:
 - .1 UV System is selected to “auto” mode.
 - .2 UV System “fault” signal is not active.

- .3 Associated motorized valve control switch is selected to “remote” mode.
 - .4 Upon a call for water, the UV must warm up 100% before the actuated valve MV-101 opens and Well 1 Pump turns ON.
 - .5 If the well pump “stop” set point is reached, Well 1 Pump will turn OFF, the actuated valve MV-101 will CLOSE, and UV will turn OFF.
 - .6 In the event of an UV System “major fault” signal, Well 1 Pump will turn OFF, the actuated valve MV-101 will CLOSE, and UV will turn OFF.
 - .7 Generate a “not in remote” alarm for the actuated valve MV-101 if the value is not in remote, the UV unit is in auto and the well pump start set point is reached.
 - .8 Provide programming such that the UV unit intensity signal, scaled in mJ/cm², will be logged every 5 minutes and stored in memory for a trending display on the SCADA.
 - .9 Provide programming to calculate the daily minimum, maximum and average for display on the HMI and SCADA. Provide SCADA programming for selectable “date-to-date” minimum, maximum and average report generation for the UV unit’s intensity.
- .3 Monitoring and Alarm Conditions:
- .1 Configure the PLC program, HMI and SCADA to display items (as manually selected by the operator) and alarms as follows:
 - .1 UV unit “intensity” signal.
 - .2 UV unit “auto” mode.
 - .3 UV unit “major fault” signal.
 - .4 UV unit lamps “on/off” status.
 - .5 MV-101 “major fault” signal.
 - .6 MV-101 “remote/not in remote” signal.
 - .7 MV-101 “open/closed” signal.

- .2 The above list for each UV unit is to be considered the minimum requirement. The programmer is to arrange to consult with the engineer, client and equipment supplier to provide any additional signal display and alarming requirements.
- .3 Configure the PLC program to indicate each alarm. If any alarm is activated and after a pre-set time delay, the program will perform the following:
 - .1 Display a message of the activated alarm on the SCADA system.
 - .2 Remain in the alarm state until the alarm has been acknowledged and reset on the SCADA system.
 - .3 Program each alarm with the ability to be disabled via the SCADA System.

2.4 Chlorine Analyzers

- .1 Process Description:
 - .1 Chlorine Analyzer (AE/AIT-601) is provided to measure the residual chlorine in the treated water. AE/AIT-601 is a post-chlorine analyzer that will be used to measure the residual chlorine post the chlorine contact piping.
 - .2 The pre-chlorine analyzer AE/AIT-501 (provisional) is included for early warning of low chlorine residual. When the residual chlorine recorded by the pre-chlorine analyzer drops below 0.5 mg/L, a low level alarm will be generated which would intimate the operator to start the standby chlorine pump for top-up chlorination.
 - .3 Continuous treated water residual chlorine readings are provided at Pumphouse No. 1 by AE/AIT-601. These instruments will produce a 4-20mA signal proportional to the treated water pre and post chlorine residual as an input to the PLC.
- .2 PLC Programming
 - .1 The following Table 2 indicates the proposed high/low level alarm set points for both Pre and Post Chlorine Analyzers AIT-501 and AIT-601.

	Chlorine Analyzer Alarm Setpoint (mg/L)
High-High Level Alarm	3.00
High Level Alarm	2.00

Low Level Alarm	0.75
Low-low Level Alarm	0.60

.3 Monitoring and Alarm Conditions

.1 Configure the PLC program (as manually selected by the Operator) and alarms as follows:

- .1 Continuous AE/AIT-501 display, in mg/L
- .2 AE/AIT-501 daily min, max, avg, in mg/L
- .3 AE/AIT-501 low-low, low, high, high-high level alarm set point, in mg/L
- .4 AE/AIT-501 low-low, low, high, high-high level alarms
- .5 AE/AIT-501 signal lost or out of limits (<4 or >20mADC) alarm
- .6 Continuous AE/AIT-601 display, in mg/L
- .7 AE/AIT-601 daily min, max, avg, in mg/L
- .8 AE/AIT-601 low-low, low, high, high-high level alarm set point, in mg/L
- .9 AE/AIT-601 low-low, low, high, high-high level alarms
- .10 AE/AIT-601 signal lost or out of limits (<4 or >20mADC) alarm

.2 Configure the PLC program to indicate each alarm. If any alarm is activated and after a pre-set time delay, the program will perform the following:

- .1 Display a message of the activated alarm on the SCADA system.
- .2 Remain in the alarm state until the alarm has been acknowledged and reset on the SCADA system.
- .3 Program each alarm with the ability to be disabled via the SCADA System.

2.5 Chemical Dosing System

.1 Process Description:

- .1 The disinfection process of the potable water is achieved by chlorine injection of the UV reactor and before entering the chlorine contact loop.
 - .2 Long chain linear phosphate for corrosion control is injected downstream of the UV reactor before entering the chlorine contact loop.
 - .3 The chlorine dosing system package is comprised of a duty/standby pumping arrangement (CP-702/703) that is used for dosing chlorine.
 - .4 The phosphate dosing system package is comprised of a duty/standby pumping arrangement (CP-704/705) that is used for dosing phosphate.
- .2 PLC Programming
- .1 Provide programming such that chlorine dosing starts when residual chlorine post the chlorine contact piping drops below 0.5 mg/L. The chlorination process is flow-paced based on the raw water line flow reported by the flow meter (FE/FIT-101). The chemical package also consists of one chemical dosing tank with a low-level switch (LSL- 701). The level switch shall send a signal to turn OFF dosing pump at low level (200 mm from the tank bottom) to avoid dry run.
 - .2 Provide programming such that phosphate dosing is flow-paced based on the raw water line flow reported by the flow meter (FE/FIT-101). The chemical package also consists of one chemical dosing tank with a low-level switch (LSL- 702). The level switch shall send a signal to turn OFF dosing pump at low level (200 mm from the tank bottom) to avoid dry run.
 - .3 Provide programming such that the well pump will turn OFF at low-low level of Chlorine Analyzer AE/AIT-601.
- .3 Monitoring and Alarm Conditions
- .1 Configure the PLC program (as manually selected by the Operator) and alarms as follows:
 - .1 Continuous CP-1 dosing rate, in mg/L
 - .2 Continuous CP-2 dosing rate, in mg/L
 - .3 Continuous CP-3 dosing rate, in mg/L
 - .4 Continuous CP-4 dosing rate, in mg/L
 - .5 CP-1 daily min, max, avg dosing rate, in mg/L

- .6 CP-2 daily min, max, avg dosing rate, in mg/L
- .7 CP-3 daily min, max, avg dosing rate, in mg/L
- .8 CP-4 daily min, max, avg dosing rate, in mg/L
- .9 Dosing system “remote start” signal
- .10 Duty pump “started” signal
- .11 Standby pump “started” signal
- .12 “Remote selected” signal
- .13 “System running” signal
- .14 “Duty pump fault” alarm
- .15 “System fault” alarm
- .16 CP-1 dosing rate signal lost or out of limits (<4 or >20mADC) alarm
- .17 CP-2 dosing rate signal lost or out of limits (<4 or >20mADC) alarm
- .18 CP-3 dosing rate signal lost or out of limits (<4 or >20mADC) alarm
- .19 CP-4 dosing rate signal lost or out of limits (<4 or >20mADC) alarm
- .20 LSL-1 tank low level alarm
- .21 LSL-2 tank low level alarm
- .2 Configure the PLC program to indicate each alarm. If any alarm is activated and after a pre-set time delay, the program will perform the following:
 - .1 Display a message of the activated alarm on the SCADA system.
 - .2 Remain in the alarm state until the alarm has been acknowledged and reset on the SCADA system.
- .3 Program each alarm with the ability to be disabled via the SCADA System.

2.6 Distribution Pressure

.1 Process Description

- .1 The pressure transmitter (PE/PIT-101) is provided for well pump control based on system pressure.
- .2 Pressure switches PSH-101 and PSL-101 provide pre-set “back-up” pressure levels in the event of PE/PIT-101 failure.

.2 Continuous distribution water pressure readings are provided at Pumphouse No. 1 by PE/PIT-101. This instrument will produce a 4-20mA signal proportional to the line pressure as an input to the PLC.

.3 PLC Programming

- .1 Provide programming such that when the Pressure Transmitter PIT-101 measures greater than 125 psig, the well pump shall turn OFF and an alarm is generated.
- .2 Provide programming such that when PSL-101 or PSH-101 signals are active, an alarm is generated.

.4 Monitoring and Alarm Conditions

- .1 Configure the PLC program (as manually selected by the Operator) and alarms as follows:
 - .1 Continuous PE/PIT-101 display, in psig
 - .2 PE/PIT-101 low and high level set points
 - .3 PE/PIT-101 low level alarm
 - .4 PE/PIT-101 high level alarm
 - .5 PSL-101 alarm signal
 - .6 PSH-101 alarm signal
 - .7 PE/PIT-101 signal lost or out of limits (<4 or >20mADC) alarm

- .2 Configure the PLC program to indicate each alarm. If any alarm is activated and after a pre-set time delay, the program will perform the following:
 - .1 Display a message of the activated alarm on the SCADA system.
 - .2 Remain in the alarm state until the alarm has been acknowledged and reset on the SCADA system.
 - .3 Program each alarm with the ability to be disabled via the SCADA System.

2.7 Turbidity Meter

- .1 Process Description:
 - .1 The turbidity transmitter (AE/AIT-101) is provided for measuring raw water turbidity.
 - .2 The turbidity transmitter (AE/AIT-301) is provided for measuring treated water turbidity after the contact loop piping.
- .2 Continuous treated water turbidity readings are provided at Pumphouse No. 1 by AE/AIT-101 and AE/AIT-301. These instruments will produce a 4-20mA signal proportional to the line pressure as an input to the PLC.
- .3 PLC Programming
 - .1 Provide programming such that a high-level alarm for AE/AIT-101 and AE/AIT-301 is generated when the transmitters read 1 NTU or greater.
 - .2 Provide programming such that when AE/AIT-101 and AE/AIT-301 measure turbidity greater than 5 NTU the well pump shall shut OFF.
- .4 Monitoring and Alarm Conditions
 - .1 Configure the PLC program (as manually selected by the Operator) and alarms as follows:
 - .1 Continuous AE/AIT-101 display, in NTU
 - .2 Continuous AE/AIT-301 display, in NTU
 - .3 AE/AIT-101 high level set points
 - .4 AE/AIT-301 high level set points

- .5 AE/AIT-101 high level alarm
- .6 AE/AIT-301 high level alarm
- .7 AE/AIT-101 signal lost or out of limits (<4 or >20mADC) alarm
- .8 AE/AIT-301 signal lost or out of limits (<4 or >20mADC) alarm
- .2 Configure the PLC program to indicate each alarm. If any alarm is activated and after a pre-set time delay, the program will perform the following:
 - .1 Display a message of the activated alarm on the SCADA system.
 - .2 Remain in the alarm state until the alarm has been acknowledged and reset on the SCADA system.
 - .3 Program each alarm with the ability to be disabled via the SCADA System.

2.8 Miscellaneous Systems

- .1 Process Description:
 - .1 The miscellaneous systems consist of the following:
 - .1 UPS System
 - .2 Building Low Temperature
 - .3 Building Smoke Detection
 - .4 Communication System
 - .5 Building Access Control System
 - .6 Digital Power Meter
 - .7 Stand-by generator
- .2 PLC Programming
 - .1 At this level, the program will only monitor the input signals. Control is not available. The program will indicate the signals listed under the “Monitoring and Alarm Conditions”.

- .2 Provide programming such that communications to the SCADA System will be monitored and a “communication “alarm be generated if the SCADA System “heart beat” signal is not detected after a delay time of 10 minutes.
- .3 Provide programming such that a PLC “heart beat” signal will be available for use by SCADA System as well as an output signal to be used by process equipment.
- .4 UPS system communicate to PLC/SCADA via Ethernet communications. Allow for 10 parameters from UPS system for alarming.
- .5 The following Table indicates the proposed high/low level setpoints for incoming voltage monitoring (to two decimal places):

Table: High / Low Alarm Setpoints for Incoming Voltage

PHASE	Low Voltage Setpoint (VAC)	High Voltage Setpoint (VAC)
A-B	TBA	TBA
B-C	TBA	TBA
C-A	TBA	TBA

- .6 The following Table indicates the proposed high/low level setpoints for incoming amperage monitoring (to two decimal places):

Table: High Alarm Setpoint for Incoming Amperage

PHASE	High Amperage Setpoint (Amps)
A	TBA
B	TBA
C	TBA

- .7 The following Table indicates the proposed high/low level setpoints for incoming power factor monitoring (to two decimal places):

Table: High / Low Alarm Setpoints for Incoming Power Factor

	Low PF Setpoint	High PF Setpoint
Power Factor	TBA	TBA

- .8 All set points (in above Tables) will be an adjustable “variable” from the SCADA (scaled as indicated). All set point variables will be verified in the field during start-up and commissioning.
- .9 Provide programming such that a daily minimum, maximum, average for incoming voltage amperage and power factor scaled as indicated, will be logged once a day at the same time and stored in memory for display on the HMI / SCADA.
- .10 Provide SCADA programming that will log all readings every 5 minutes (SCADA adjustable 1 to 10 minutes), stored in memory with date and time stamp and trend displayed. Provide SCADA programming for selectable “date-to-date” report generation.
- .3 Monitoring and Alarm Conditions
- .1 Configure the PLC program (as manually selected by the Operator) and alarms as follows:
- .1 UPS alarms/status
 - .2 Building low temperature alarm, TSL-1
 - .3 Smoke detector alarm, SD-1
 - .4 smoke detector alarm, SD-2
 - .5 Filter room flood alarm, LSH-1
 - .6 Building access control security system alarm
 - .7 SPD-1 and SPD-2 alarms
 - .8 Building PLC communication “fault” alarm

- .9 SCADA system communication “fault” alarm
- .10 Phase A-B Incoming Voltage, in VAC
- .11 Phase B-C Incoming Voltage, in VAC
- .12 Phase A-C Incoming Voltage, in VAC
- .13 Phase A Incoming Amperage, in amps
- .14 Phase B Incoming Amperage, in amps
- .15 Phase C Incoming Amperage, in amps
- .16 Incoming Power Factor
- .17 Incoming voltage low/high alarm set points, in VAC
- .18 Incoming amperage low/high alarm set points, in amps
- .19 Incoming power factor low/high alarm set points
- .20 Generator “on/off” status
- .21 Generator general alarm
- .22 Generator low fuel pressure alarm
- .23 Generator “fault” alarm
- .2 Configure the PLC program to indicate each alarm. If any alarm is activated and after a pre-set time delay, the program will perform the following:
 - .1 Display a message of the activated alarm on the SCADA system.
 - .2 Remain in the alarm state until the alarm has been acknowledged and reset on the SCADA system.
 - .3 Program each alarm with the ability to be disabled via the SCADA System

PART 3 – EXECUTION

3.1 General

- .1 General

- .1 Refer to Section 16900 “Instrumentation and Control Equipment” and Section 16920 “Process Control Narrative” for details.

END OF SECTION



Section F

Contract Drawings

Note: Contract Drawings are included as a separate PDF to this Proposal Document.

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Appendix 1

Preselected UV Equipment (To be provided via Addenda)