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CONTRACT DOCUMENTS

City of Port Alberni

Wastewater Lagoon Facility Upgrades
Effluent Pump Stations
Platform Contract

SEPTEMBER 2019

CONTRACT SPECIFICATIONS

FOR

CITY OF PORT ALBERNI

WASTEWATER TREATMENT LAGOON UPGRADES

EFFLUENT PUMP STATIONS PLATFORM CONTRACT

SEPTEMBER 2019

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA
M. V. SIMHON
44587

SEPT. 11, 2019

Seal

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA
L. A. MACRAE
33335

Sept. 11, 2019

Seal

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA
D. R. A. DESAULNIERS
45359

Sep 11, 2019

Seal

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA
M. K. D. WOO
34152

Sept 11, 2019

Seal

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA
C. G. BRUMPTON
30001

Sept. 11, 2019

Seal

Seal

ASSOCIATED ENGINEERING
QUALITY MANAGEMENT SIGN-OFF
Signature ....
Date ....

Prepared by Associated Engineering (B.C.) Ltd.

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2972-00-S-100	Structural - Site Plan
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FIGURE 1	Contractor Site Plan (For reference only)

END OF DOCUMENT

Sealed bids marked "Bid for City of Port Alberni's Wastewater Treatment Lagoon Upgrades, Platform Contract" will be received at the offices of the City of Port Alberni, Planning and Development, 4850 Argyle Street, Port Alberni, BC V9Y 1V8, up to 2:00 p.m., local time, October 4th, 2019.

The work involves the supply, manufacture, and installation of two steel effluent pump station platforms within a wastewater lagoon, as part of a larger Wastewater Treatment Facility upgrade project. Each pump station will be equipped with two axial flow pumps, which will be housed in draft tubes. These pumps have been pre-purchased by the Owner and the installation of these pumps is included in this contract. Within this contract, the following works are also included: supply and installation of pilings for platform support, supply and install of steel pipework, valves and fittings and supply and installation of effluent HDPE pipework.

Contract Documents may be examined at the offices of the City of Port Alberni, Planning and Development.

Contract Documents will be available for downloading from BC Bid on or after September 11, 2019.

Technical inquiries by bidders are to be directed to Wilf Taekema (Director of Engineering and Public Works, City of Port Alberni), and Hugo Masuda, P.Eng. (Project Engineer, Associated Engineering) at the contact information below. Addenda will be in written form and posted to BC Bid. All addenda become part of the Contract documents and must be considered when responding to this invitation to Bid. It is the sole responsibility of the Bidder to check for Addenda on BC Bid. Bidders are strongly encouraged to subscribe to BC Bid's email notification service to receive notices of Addenda. Verbal answers are binding only when confirmed by written addenda.

An optional Bidders' Briefing is scheduled for September 18 at 1:00 pm. It is in the best interest of the Bidder to attend this briefing.

Bids must be accompanied by the specified Bid Bond payable to the City of Port Alberni.

The lowest or any bid will not necessarily be accepted.

Wilf Taekema, Owner's Representative
Director of Engineering and Public Works
City of Port Alberni
Wilf_taekema@portalberni.ca
4850 Argyle Street
Port Alberni, BC V9Y 1V8

Hugo Masuda, P.Eng.
Project Engineer
masudah@ae.ca
236-317-2213
Associated Engineering
500 – 2889 East 12th Avenue
Vancouver, BC V5M 4T5

Part 1 General

1.1 DEFINITIONS

.1 Definitions

- .1 "**Bid Closing Time**" means the time and date stipulated for receipt of bids in Article 1.3.1.1 of this Section as may be amended by addendum
- .2 "**Bid Documents**" means the bid documents obtained in accordance with Article 1.3.1.1 of these Instructions to Bidders and comprising all of the documents and drawings listed in the Table of Contents thereof and any addenda that may be issued thereto.
- .3 "**Bid Form**" means Section 00 41 00 of the Bid Documents and the supplements thereto.
- .4 "**Bidder**" means any holder of Bid Documents.
- .5 "**Total Bid**" means the amount entered by the Bidder into the Bid Form as may be adjusted as provided for by Articles 1.9.7.1 and 1.9.7.4 of this Section.

.2 Additional Definitions

- .1 The definitions set out in Section 00 72 00 - General Conditions are incorporated into and form part of this Section 00 21 13 - Instructions to Bidders.

1.2 LIMITATION OF LIABILITY

.1 The Bidder agrees that the Owner's sole obligation, in return for the Bidder's preparation and submission of its bid, is to give consideration to the bid in accordance with the Contract Documents. The Bidder hereby waives any claim for damages or costs of any nature against the Owner and the Engineer (including, without limitation, the cost of preparing and submitting the bid, and any anticipated profits and contributions to overhead) arising out of the Owner's use of its discretion under the Contract Documents and the Engineer's advice to the Owner.

1.3 INVITATION

.1 Bid Call

- .1 Offers signed under seal, executed, and dated will be received by the City of Port Alberni, located at 4850 Argyle Street, Port Alberni, BC, V9Y 1V8 before 2 pm local time on October 4th, 2019.
- .2 Offers received after the Bid Closing Time will be returned to the Bidder unopened.
- .3 Offers will be opened privately shortly after the Bid Closing Time.

1.4 INTENT

.1 The intent of this bid process is to obtain an offer to perform work to complete supply, installation and any other associated works for the supply and installation of two effluent pump station platforms at the City of Port Alberni Wastewater Lagoon Facility located at 5600 Shoemaker Bay road (former Catalyst lagoon located at 49° 15' 3.9024" N 124° 49' 24.8520" W) for a Lump Sum Price contract, in accordance with the Contract Documents. Refer to Section 01 11 00 - Summary of Work for a description of work required and conditions under which work will be carried out.

1.5 CONTRACT/BID DOCUMENTS

.1 Availability

- .1 Bid Documents shall be obtained at BC Bid on or after September 11th, 2019.
- .2 General Contractors obtaining Bid Documents must provide contact information (fax number, phone number, email address, mailing address) when obtaining Bid Documents. Provide contact information to the persons listed in the Invitation to Bid. Accurate and complete contact information is required for distribution of addenda, if any.
- *.3* Bid documents irregularly obtained from sources other than those provided for in Article 1.5.1.1 (“unofficial bid documents”) are used entirely at the risk of the Person who holds them. Neither Engineer nor Owner undertakes to provide information or addenda to Persons holding unofficial bid documents. Any use which a Person makes of unofficial bid documents or any reliance on or decisions to be made based on them, are the responsibility of such Persons. Engineer and Owner accept no responsibility for damages, if any, suffered by any Person as a result of decisions made or actions based on unofficial bid documents. Bids received from Persons holding unofficial bid documents may be declared informal at the sole and unfettered discretion of the Owner and if so declared will be rejected.Bid Documents are made available only for the purpose of obtaining offers for this project. Their use does not confer a license or grant for other purposes.
- .5 Refer to Section 00 30 00 - Information Available to Bidders for identification of information available to Bidders.

.2 Examination

- .1 Upon receipt of Bid Documents, verify that documents are complete. Notify Engineer should the documents be incomplete.
- .2 Immediately notify Engineer upon finding discrepancies or omissions in Bid Documents.

.3 Queries/Addenda

- .1 Direct questions to Wilf Taekema, telephone: 250-720-2838, email: Wilf_taekema@portalberni.ca and Hugo Masuda, telephone: 236-317-2213, masudah@ae.ca.
- .2 Addenda will be in written form and may be issued during the bidding period. All addenda become part of the Contract Documents. Include costs in the Total Bid.
- .3 Verbal answers are only binding when confirmed by addendum.

.4 Clarifications requested by Bidders must be in writing not less than five (5) Business Days before Bid Closing Time. The reply will be in the form of an addendum, a copy of which will be forwarded to known Bidders.

.4 Proposed Substitutions

.1 Base Total Bid on use of specified products.

.2 Products other than those specified will be considered only if information is provided on the Document 00 43 25 - Substitution List in the Supplements to Bid Form.

.3 The submission shall provide sufficient information to enable Engineer to determine acceptability of such products.

.4 Provide complete information on required revisions to other work to accommodate each substitution. The dollar amount of additions to or reductions from the Total Bid, including revisions to other work, is to be shown on the Substitution List.

.5 Unless substitutions are submitted in this manner and subsequently accepted, provide products as specified.

.6 Approval to submit substitutions prior to submission of bids is not required.

.7 No ruling on a proposed substitution will be made prior to bid submission.

.8 Submit additional documentation supporting the proposed substitution(s) with the Bid Form.

1.6 SITE ASSESSMENT

.1 Site Examination

.1 Visit the Project Site and surrounding area before submitting a bid.

.2 Contact the City of Port Alberni (Wilf Taekema, telephone 250-720-2838, email Wilf_taekema@portalberni.ca) or Associated Engineering (Hugo Masuda, P.Eng., telephone 236-317-2213, email masudah@ae.ca) to arrange a site visit.

.3 A visit to the Project Site has been arranged for Bidders as follows: September 18, 2019, 1:00 pm. Bidders unable to attend the bidder’s briefing may schedule alternate times to visit the project site by contacting the Owner and Engineer. No visiting of project site without prior approval from the Owner and Engineer.

.2 Bidders Briefing

.1 An optional briefing for Bidders has been scheduled for September 18, 2019, 1:00 pm, on site. Bidders to wait at the entrance gate on Shoemaker Road.

.2 All general contract Bidders are invited.

.3 Representatives of Owner and Engineer will be in attendance.

.4 Material changes to the Bid Documents arising from the briefing will be recorded in an Addendum and issued to known Bidders.

1.7 QUALIFICATIONS

.1 Bidder’s Qualifications

.1 Submit completed Document 00 45 13 - Bidders' Qualification form with the Bid Form.

.2 Subcontractors

.1 Indicate on Document 00 43 36 - Subcontract List in the Supplements to Bid Form the names of all subcontractors proposed to be employed on the Work.

.2 Owner reserves the right to object to any of the subcontractors listed in Document 00 43 36 – Subcontract List and such objection may be valid cause for rejection of the bid. If Owner objects to a listed subcontractor then Owner will permit Bidder, within 5 days of such Notice, to propose a substitute subcontractor acceptable to Owner provided that there is no resulting adjustment in the Total Bid or the Contract Time. Bidder is not required to make such a substitution and, if Owner objects to a listed subcontractor, rather than propose a substitute subcontractor, Bidder may by Notice request that Owner rejects its bid and Owner will agree to that request. In that event, Owner shall return that Bidder’s Bid Deposit.

1.8 BID SUBMISSION

.1 Bid Ineligibility

.1 Bids that are unsigned, improperly signed or sealed, conditional, illegible, obscure, contain unbalanced prices, arithmetical errors, or irregularities of any kind, may, at the discretion of Owner, be declared informal. If so declared, the bid will be rejected.

.2 Bids with Bid Form Supplements to Bid Form, Bid Bond, or enclosures which are improperly prepared may, at the discretion of Owner, be declared informal. If so declared, the bid will be rejected.

.3 Bids that fail to include bonding or insurance requirements may be declared informal. If so declared, the bid will be rejected.

.2 Submissions

.1 Bidders shall be solely responsible for the delivery of their bids in the manner and time prescribed.

.2 Submit one copy of the executed offer on the Bid Form provided, signed with original signature(s), and corporate sealed where applicable, together with the required Bid Bond and Supplements to Bid Form in a closed opaque envelope, clearly identified with Bidder’s name, project name and Owner’s name on the outside. The second copy of the Bid Form is provided for Bidder’s records.

.3 Do not submit Bid Documents with Bid Form.

.4 Bids received by fax or email shall be rejected.

.3 Bid Modifications

.1 Written amendments to the submitted offer shall be permitted if received in hard copy or by fax at the office where bids are being opened prior to Bid Closing Time, provided that bid amendments are endorsed by the same party or parties who signed and sealed the offer. Written amendments transmitted by fax should be sent to 250-723-1003.

.2 The onus is on Bidder to ensure timely receipt of bid modifications. Owner makes no assurances regarding availability of fax communication lines or equipment. To be considered, fax transmissions of bid modifications must be received in full prior to Bid Closing Time.

.3 An amendment that expressly or by inference discloses Bidder's Total Bid or other material element of the bid, such that in the opinion of Owner the confidentiality of the bid is breached, shall be valid cause for Owner, at their sole discretion, to reject the bid.

.4 Amendments submitted via email shall not be permitted.

.4 Bid Withdrawal

.1 Bidder shall be permitted to withdraw bid without prejudice, provided a request, in writing or by fax, signed by the same person or persons who signed the Bid Form, is received at the office designated in the Bid Documents before Bid Closing Time. Error on the part of Bidder in preparing the bid confers no right to the withdrawal of the bid after it has been opened.

1.9 BID ENCLOSURES/REQUIREMENTS

.1 Bid Security

.1 Bids shall be accompanied by a Bid Bond in an amount not less than 10 percent of the Total Bid.

.2 Endorse the Bid Bond in the name of the City of Alberni as obligee, signed and sealed by the principal (Contractor) and surety.

.3 Use standard surety industry CCDC prescribed Bid Bond form. Bid Bond form CCDC 220 is included as a sample in Document 00 43 24.

.4 The Bid Deposit will be returned after execution of the Contract by the accepted Bidder.

.5 If no contract is awarded, all Bid Deposits will be returned.

.6 If the accepted Bidder fails for any reason to execute Section 00 52 00 - Contract Agreement or to provide the surety bonds stipulated in Section 00 72 00 - General Conditions or the insurance stipulated in Section 00 73 16 – Insurance within the time agreed to in the Bid Form, and such extension of time as may be granted by Owner, the accepted Bidder or the accepted Bidder's surety shall pay to the Owner the amount of the difference in money between the Total Bid and the amount for which Owner may legally contract with another party to perform the work, if the latter amount be in excess of the former.

.2 Surety Company

.1 Bid Bond and Consent of Surety must be issued by a surety company licensed to conduct business in the province or territory where the work is located.

.3 Performance Assurance

.1 The accepted Bidder shall provide Performance and Labour and Materials Payment Bonds as described in the Section 00 72 00 - General Conditions.

.4 Cost of Bonds

    .1 Include the cost of bonds in the Total Bid.

.5 Insurance

    .1 Provide a signed “Undertaking of Insurance”, on a standard form provided by the insurance company, stating their intention to provide insurance to Bidder in accordance with the insurance requirements of the Contract Documents.

.6 Bid Form Requirements

    .1 Fill in prices where indicated on Bid Form.
    .2 In the event of a discrepancy between unit prices and extension, unit prices will govern and Engineer will correct extensions accordingly.
    .3 In the event of a discrepancy between the sum of prices and Total Bid, prices will govern and Engineer will correct Total Bid accordingly.
    .4 Include in price(s) bid supply of all materials except those specified to be supplied by others, all supervision, labour and equipment, and a provision for sales taxes, duties, overhead and profit. Total Bid shall represent the entire cost to Owner for the completed works as specified and shown on the drawings, exclusive only of GST/HST payable by Owner.
    .5 The amount of GST or HST payable by Owner on goods and services provided under this Contract is in addition to the Total Bid and is to be shown on a separate line on the Bid Form.
    .6 Bid analysis will be based on the Total Bid price, exclusive of GST/HST.
    .7 Bidder, in submitting an offer, agrees to complete the Work by the date indicated in the Bid Form.

.7 Bid Signing

    .1 The Bid Form shall be executed by Bidder as follows:
        .1 Sole Proprietorship: signature of sole proprietor in the presence of a witness who will also sign. Insert the words "Sole Proprietor" under the signature.
        .2 Partnership: signature of all partners in the presence of a witness who will also sign. Insert the word partner under each signature.
        .3 Limited Company: signature of a duly authorized signing officer(s) in their normal signatures. Insert the officer's capacity in which the signing officer acts, under each signature. Affix the corporate seal.
        .4 Joint Venture: each party of the joint venture shall execute the bid under their respective seals in a manner appropriate to such party as described above, similar to the requirements of a Partnership.

.8 Supplements to Bid Form to be submitted with bid:

    .1 Document 00 43 23 - Alternatives. Identify the cost variations to the bid price(s) applicable to the work described in Section 01 23 00 - Alternatives.
    .2 Document 00 43 24 - Bid Bond.
    .3 Document 00 43 25 - Substitution List. List substitute products and resulting price variations proposed. Base Total Bid on specified products.

.4 Document 00 43 43 - Force Account Rates. List all personnel and equipment hourly rates likely to be used on the project. These rates will form the basis for payment for force account work carried out in accordance with Section 00 72 00 - General Conditions.

.5 Document 00 45 13 - Bidders' Qualification. Complete in all details and submit with the Bid Form.

.6 Document 00 43 45 - Fair Wage Declaration.

.9 Supplements to Bid Form for post-bid Submission

.1 Following bid submission, upon request from Engineer, Bidders under consideration for contract award are required to complete the following Supplements to Bid Form within two (2) Business Days of receipt of the request:

.1 Document 00 43 36 - Subcontract List. List the names of all subcontractors. Identify portion(s) of the work to be performed by each subcontractor.

.2 Document 00 43 27 - Lump Sum Price Breakdown. Provide an accurate and balanced breakdown of lump sum price(s) to be used for calculating progress payments and for cost accounting purposes.

.3 Document 00 43 83 - Construction Schedule. Provide the requested schedule information to demonstrate ability to plan work and respond to critical deadlines.

1.10 OFFER ACCEPTANCE/REJECTION

.1 Duration of Offer

.1 Bids shall remain open to acceptance and shall be irrevocable for a period of sixty (60) days after the bid closing date.

.2 Acceptance of Offer

.1 Owner reserves the right to accept any offer, waive defects in any offer, or reject any or all offers.

.2 After acceptance of an offer by Owner, Owner, will issue a written Notice of Award to accepted Bidder.

Part 2 Products

Not Used.

Part 3 Execution

Not Used.

END OF DOCUMENT

Part 1 General

1.1 GEOTECHNICAL REPORT (WSP)

.1 The geotechnical report bound with these documents has been prepared for Owner by an independent specialist consultant. While the data contained therein is believed to be accurate, any opinions or recommendations are solely those of the authors of the geotechnical report. Bidders must form their own conclusions from the data and shall make no claim at any time that any opinion or recommendation is incorrect or misleading. Neither Owner nor Engineer accepts responsibility for the contents of this report nor for the suggestions or recommendations contained therein, except for recommendations, if any, which have been specifically incorporated into the Specifications.

1.2 FOUNDATION PILES TECHNICAL MEMORANDUM (WSP)

.1 The foundation piles technical memorandum bound with these documents has been prepared for Owner by an independent specialist consultant. While the data contained therein is believed to be accurate, any opinions or recommendations are solely those of the authors of the technical memo.

1.3 OWNER SUPPLIED EQUIPMENT (Precision Services)

.1 The City of Port Alberni has entered into equipment supply agreements for the supply of four effluent pumps. Installation of these pumps are to be apart of this tender. Preliminary drawings for this equipment are included in the appendices. Approved drawings to be provided to proponent after award of this contract.

1.4 CONSTRUCTION AND OPERATIONS ENVIRONMENTAL IMPACT STUDY (Associated Engineering)

.1 The Construction and Operations Environmental Impact Study prepared for the project is included for the information of bidders. Current site conditions to be confirmed by the Contractor or the Contractors’ Qualified Environmental Professional (QEP) prior to construction.

Part 2 Products

Not Used

Part 3 Execution

Not Used

END OF DOCUMENT

CITY OF PORT ALBERNI
WASTEWATER LAGOON FACILITY UPGRADES
EFFLUENT PUMP STATIONS PLATFORM CONTRACT

TO: Wilf Taekema,
Director of Engineering and Public Works
City of Port Alberni
4850 Argyle Street
Port Alberni, BC V9Y 1V8

The undersigned Bidder, having carefully examined the Contract Documents and locality of the proposed work, and having full knowledge of the work required and the materials to be furnished and used, hereby agrees to provide all necessary materials, supervision, labour and equipment and perform and complete all work, and fulfill everything as set forth and in strict accordance with the Contract Documents and Addenda numbered [1]__________ for the sum of:

Lump Sum Price:	[2]	$
TOTAL BID: (excluding GST)	[2]	$
Goods and Services Tax:	[2]	$

[1] Bidder to fill in each Addendum No. received, e.g., 1, 2, 3, etc. as applicable.
[2] To be completed by Bidder.

The undersigned also agrees:

1 that Owner is in no way obligated to accept this bid;

2 that Owner may, at Owner's discretion, award to other than the low Bidder;

3 that, if the Bid Form is improperly completed or incomplete, Owner shall have the right to disqualify and/or reject this bid;

4 that this bid is made without knowledge of the bid prices to be submitted for this work by any other company, firm, or person;

5 that this bid is made without any connection or arrangement with any other company, firm, or person submitting a bid for this work;

6 that this bid is made without any undisclosed connection or arrangement with any other company, firm, or person having an interest in this bid or in the proposed Contract;

7 that this bid is irrevocable for sixty (60) days after the closing date for receipt of bids and that the Owner may, at any time within such period, accept this bid whether any other bid has previously been accepted or not and whether Notice of Award of a contract has been given or not;

8 to deposit with Owner a Performance Bond and Labour and Material Payment Bond on the forms provided in these documents and for the amount specified in the General Conditions and the

specified insurance endorsement certificates and execute the Contract Agreement in accordance with the time periods specified in the General Conditions, such time periods being extended only on the written approval of Owner;

9 to commence and proceed actively with the work promptly following receipt of the Notice to Proceed, and to complete all work under the Contract within the Contract Time subject to the provisions of the General Conditions for extension of Contract Time;

10 to compensate Owner in accordance with the Contract Documents if the work is not completed within the Contract Time;

11 to do all extra work not reasonably inferable from the specifications or drawings, but called for in writing by Engineer and to accept as full compensation therefor payment in accordance with the provisions of the General Conditions;

12 that payment for the work done will be made at the bid price(s) which shall be compensation in full for the work done under the terms of the Contract, exclusive of GST payable by Owner; and

13 that, in preparing this bid, the Bidder has drawn their own conclusions from the data contained in the geotechnical report bound with these documents and has not relied on the opinions or the recommendations of the authors of the geotechnical report.

SUPPLEMENTS TO BID FORM

The following Supplements to Bid Form are included with and form a part of our Bid. We understand that the information provided on these forms will be used by the Owner during Bid analysis.

00 43 23 - Alternatives
00 43 24 - Bid Bond
00 43 25 - Substitution List
00 43 27 - Lump Sum Price Breakdown
00 43 43 - Force Account Rates
00 43 83 - Construction Schedule
00 45 13 - Bidder's Qualifications

The following Supplements to Bid Form are not being submitted with our bid. These forms will be completed and submitted upon request. We understand that the information provided on these forms may be used by the Owner during bid analysis.

00 43 36 - Subcontract List
00 43 83 - Construction Schedule

This bid is executed under seal at ______________________this ________ day of _______, 20__.

Name of Firm

Address

For Individual or Partnership:
SIGNED, SEALED AND DELIVERED by:

Bidder (please print)

Signature

in the presence of:

Title

Name
Address
City/Province/PC
Occupation

Seal

For Limited Company or Corporation:
The Corporate Seal of:

Bidder (please print)
was hereunto affixed in the presence of:

Authorized Signing Officer
Title

Seal

Authorized Signing Officer
Title

NOTE: If the bid is by joint venture, add additional forms of execution for each member of the joint venture in the appropriate form or forms as above.

END OF DOCUMENT

Supplement to Bid Form

We, the undersigned Surety Company, do hereby consent and agree to become bound as guarantor in a Performance Bond and Labour and Material Payment Bond each in the amount of fifty percent (50%) of the total bid for the fulfilment of the Contract, with

…………………………………………………………………………………………………..
as principal for the works specified in the Contract Documents entitled

…………………………………………………………………………………………………..
which Contract may be awarded within sixty (60) days from the closing date of bids to

………………………………………………………………………………………………….
at the price(s) set forth in the Bid Form. The Bonds shall be issued in the form and manner specified within the Contract Documents. We hereby further declare that our Company is licensed to conduct business in the province or territory wherein the work is located and has a net worth greater than the amount of the required guarantee.

Surety Company

Signature for Surety Company

Title

Place ………………………………………

Date ………………………………………

END OF DOCUMENT

Supplement to Bid Form

1. Provide the Variation of Total Bid Price for Alternatives for the following:

.1 Provide variation of Total Bid Price for Alternatives to HDPE Effluent pipe as described in Section 01 23 00 – Alternatives.

Total Bid Price Variation for PVC is $__________________.

Total Bid Price Variation for Ductile Iron is $__________________.

END OF DOCUMENT

Supplement to Bid Form

Use CCDC standard form 220, an example of which follows.

BID BOND

No…………………………………………………………………… $...

KNOW ALL MEN BY THESE PRESENTS THAT ....

.... as Principal

hereinafter called the Principal, and ....

a corporation created and existing under the laws of ....

and duly authorized to transact the business of Suretyship in ....

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

.... as Obligee

hereinafter called the Obligee, in the amount 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.

WHEREAS, the Principal has submitted a written tender to the Obligee, dated the ....

day of……………………………………………., 20…………. for ....

....

....

....

NOW, THEREFORE, THE CONDITIONS OF THIS OBLIGATION is such that if the aforesaid Principal shall have the tender accepted within sixty (60) days from the closing date of tender and the said Principal will, within the time required, enter into a formal contract and give the specified security to secure the performance of the terms and conditions of the Contract, then this obligation shall be null and void. Otherwise the Principal and the Surety will pay unto the Obligee the difference in money between the amount of the bid of the said Principal and the amount for which the Obligee legally contracts with another party to perform the work if the latter amount be in excess of the former.

The Principal and the Surety shall not be liable for a greater sum than the specified penalty of this bond.

Any suit under this bond must be instituted before the expiration of six months from the date of this Bond.

IN WITNESS WHEREOF, the Principal and the Surety have Signed and Sealed this Bond this ....

…………………………………………..……………………… day of ……………………..……………..…………………, 20.............

SIGNED and SEALED
in the presence of

(
(
(
(………………………………………………………………………………………(Seal)
Principal
(
(
(
(………………………………………………………………………………………(Seal)
Surety

Supplement to Bid Form

We propose using the following equipment and/or materials as substitutes for those specified and shown on the drawings. Should any of these proposed substitutes be accepted, we will adjust our Total Bid in accordance with the price variations shown below. These prices will represent the total cost difference to the Owner for supply and installation of the proposed substitute products in lieu of those specified.

Item	**Product Brand Name or Manufacturer**	**Supplier**	**Price Variation**

END OF DOCUMENT

Supplement to Bid Form

We certify that the following is an accurate and balanced breakdown of our lump sum price(s). Work required, but not specifically mentioned, is included in the item with which it is most closely associated.

Item	**Description**	**Unit**	**Quantity**	**Unit Price**	**Extension**	**Lump Sum Price**
1	Mobilization/Demobilization	L.S.	1			
2	As-Built Drawings	L.S.	1			
3	Site Work	L.S.	1			
4	Foundation Piles	L.S.	1			
5	Steel Platforms	L.S.	1			
6	Aluminum Bridges	L.S.	1			
7	Civil Works	L.S.	1			
8	Process Mechanical Works	L.S.	1			
9	Electrical and Instrumentation Works	L.S.	1			
10	Material Salvage and Site restoration	L.S.	1			

END OF DOCUMENT

Supplement to Bid Form

It is our intention that the following work will, subject to Engineer's approval, be subcontracted to the firms indicated below. All other work will be performed by our own forces, except as authorized in writing by Engineer.

Trade	**Name and Address of Subcontractor**

END OF DOCUMENT

Supplement to Bid Form

SCHEDULE OF FORCE ACCOUNT RATES

The following personnel and equipment rates will form the basis of payment for force account work carried out in accordance with the General Conditions. The rates shown are all inclusive. Contractor overhead, small tool allowance and profit and, where applicable, subcontractor overhead and profit, are included in the rates. (Add additional pages, if necessary.)

PERSONNEL

List by Occupation	Hourly Rate	Overtime Rate

EQUIPMENT

(Complete with Operator)

Description	Hourly Rate	Model and Size

END OF DOCUMENT

Supplement to Bid Form

The Contractor will be required to sign and adhere to the attached form.

END OF DOCUMENT

Supplement to Bid Form

We provide the following information relative to the Construction Schedule in order that Owner may assess our ability to plan the work and respond to critical deadlines.

Item	**Schedule**						

END OF DOCUMENT

Supplement to Bid Form

We provide the following information in order that Owner may judge our ability to fulfil the Contract requirements.

1. The average number of men we will employ and maintain on the project is ___________.

2. The name of the superintendent we propose to place on the project and his previous experience on this type of construction is as follows:

Superintendent Name:			
Project Name and Value ($)	**Owner**	**Contact Name**	**Phone Number**

3. The project, owner and contact person for similar work:

Project Name and Value ($)	**Owner**	**Contact Name**	**Phone Number**

Project Name and Value ($)	**Owner**	**Contact Name**	**Phone Number**

END OF DOCUMENT

THIS AGREEMENT made this ________ day of ___________ in the year 2019 by and between the City of Port Alberni, herein called "Owner," and ____________________, herein called "Contractor".

WITNESSETH: That Contractor and Owner undertake and agree as follows:

ARTICLE 1.

Contractor shall:

1. Provide all necessary materials, labour, supervision and equipment, and perform all work and fulfill everything as set forth and in strict accordance with the Contract Documents and Addenda numbered ___ for the project entitled "City of Port Alberni, Wastewater Treatment Lagoon Upgrades, Effluent Pump Stations: Platform Contract" which have been prepared by Associated Engineering (B.C.) Ltd., acting as and hereby entitled Engineer; and

2. Commence to proceed actively with the work of the Contract promptly following receipt of the Notice to Proceed and achieve Total Performance of the Work by February 28, 2020, subject to the provisions for the extension of Contract Time stipulated in the General Conditions.

ARTICLE 2.

Owner will pay to Contractor, as full compensation for the performance and fulfilment of this Contract, the sum or sums of money specified herein in the manner and at the times specified in the Contract Documents.

ARTICLE 3.

All of the Contract Documents, including but not limited to the Invitation to Bid, Instructions to Bidders, Information Available to Bidders, Bid Form, Supplements to Bid Form, Bonds, Insurance, General Conditions, Supplementary Conditions, Special Provisions, Addenda, Appendices, Specifications and Drawings, whether annexed hereto or contained in a separate volume, are incorporated herein and form a part of this Agreement as fully to all intents and purposes as though recited in full herein, and the whole shall constitute the Contract between the parties, and it shall enure to the benefit of and be binding upon them and their successors, executors, administrators, and assigns.

ARTICLE 4.

No implied contract of any kind whatsoever, by or on behalf of Owner, shall arise or be implied from anything contained in this Contract or from any position or situation of the parties at any time, it being understood and agreed that the express contracts, covenants, and agreements contained herein and made by the parties hereto are and shall be the only contracts, covenants, and agreements on which any rights against Owner may be founded.

ARTICLE 5.

Subject to Article 3, this Agreement shall supersede all communications, negotiations, and agreements, either written or verbal, made between the parties hereto in respect of matters pertaining to this Agreement prior to the execution and delivery hereof.

ARTICLE 6.

Any Notice to be given by either Party pursuant to this Agreement, or Engineer, shall be in writing and delivered personally, by commercial courier or transmitted by email to the following addresses and fax numbers, as applicable:

Contractor at:
Address:
Fax:
E-mail:
Owner at:
Address: City of Port Alberni, 4850 Argyle Street, Port Alberni, BC V9Y 1V8
Fax:
E-mail:wilf_taekema@portalberni.ca
Engineer at:
Address: 500 – 2889 East 12th Avenue, Vancouver, BC V5M 4T5
Fax: (604) 291-6163
E-mail: masudah@ae.ca

A Notice delivered personally or by commercial courier shall be deemed to have been given and received on the date on which it was delivered if delivered on a Business Day during the regular business hours of the recipient or if it is delivered on a day that is not a Business Day or outside the regular business hours of the recipient, the Notice shall be deemed to have been delivered on the following Business Day.

A Notice transmitted by fax shall be deemed to have been given and received on the date on which it was delivered if delivered on a Business Day during the regular business hours of the recipient or if it is transmitted on a day that is not a Business Day or outside the regular business hours of the recipient, the Notice shall be deemed to have been delivered on the following Business Day.

A Notice transmitted by e-mail shall be deemed to have been given and received on the date on which receipt of the e-mail is acknowledged by the intended recipient or receipt by the intended recipient is confirmed by the sender of the e-mail.

A Party may change its address for receipt of Notices at any time by giving Notice of the change to the other Party and Engineer in accordance with this provision. Engineer may change its address for receipt of Notices at any time by giving Notice of the change to the Parties in accordance with this provision. Such changed address for receipt of Notices will be effective five (5) Business Days after receipt of the Notice by the recipient.

ARTICLE 7.

In accordance with Canadian anti-spam legislation, each Party and the Engineer consent to contacting each other and their personnel through electronic messages relating to the Project. Following completion of the Project, either Party may withdraw consent by providing Notice to the Party or Engineer in respect of which consent is withdrawn.

IN WITNESS WHEREOF the parties hereto have executed this Agreement the day and year above first written.

For Individual or Partnership:

SIGNED, SEALED AND DELIVERED by:

Contractor (please print)

Signature

in the presence of:

Title

Name

Address

City/Prov/PC

Seal

Occupation

For Limited Company:

The Corporate Seal of:

Contractor (please print)

was hereunto affixed in the presence of:

Authorized Signing Officer Title

Seal

Authorized Signing Officer Title

NOTE: If Contractor is a joint venture, add additional forms of execution for each member of the joint venture in the appropriate form or forms as above.

For Corporate Owner:

The Corporate Seal of:

Owner (please print full corporate name)

was hereunto affixed in the presence of:

Authorized Signing Officer Title

Seal

Authorized Signing Officer Title

For Individual Owner:

Owner (please print)

Signature

Signature of Witness

Address of Witness

Occupation

END OF DOCUMENT

Use CCDC standard form 221, an example of which follows.

PERFORMANCE BOND

No…………………………………………………………………. $ ....

KNOW ALL MEN BY THESE PRESENTS THAT ....

.... as Principal

hereinafter called the Principal, and ....

a corporation created and existing under the laws of ....

and duly authorized to transact the business of Suretyship in ....

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

.... as Obligee

hereinafter called the Obligee, in the amount 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.

WHEREAS, the Principal has submitted a written tender to the Obligee, dated the ....

day of ………………………………………………………., 20………….. for ....

....

....

....

in accordance with the Contract Documents submitted therefor which are by reference made part hereof and are hereinafter referred to as the Contract.

NOW, THEREFORE, THE CONDITIONS OF THIS OBLIGATION is such that if the Principal shall promptly and faithfully perform the Contract then this obligation shall be null and void; otherwise it shall remain in full force and affect.

Whenever the Principal shall be, and declared by the Obligee to be, in default under the Contract, the Obligee having performed the Obligee’s obligations thereunder, the Surety shall promptly remedy the default, or shall promptly:

(1) complete the Contract in accordance with its terms and conditions, or

(2) obtain a bid of bids for submission to Obligee for completing the Contract in accordance with its terms and conditions, and upon determination by the Obligee and the Surety of the lowest responsible bidder, arrange for a contract between such bidder and the Obligee and make available as work progresses (even though there should be a default, or a succession of defaults, under the contract or contracts of completion, arranged under this paragraph) sufficient funds to pay the cost of completion less the balance of the Contract price; but not exceeding, including other costs and damages for which the Surety may be liable hereunder, the amount set forth in the first paragraph hereof. The term “balance of Contract price”, as used in this paragraph, shall mean the total amount payable by the Obligee to the Principal under the Contract, less the amount properly paid by the Obligee to the Principal.

Any suit under this Bond must be instituted before the expiration of two (2) years from the date on which the final payment under the Contract falls due.

The Surety shall not be liable for a greater sum than the specified penalty of the Bond.

No right of action shall accrue on this Bond, to or for the use of, any person or corporation other than the Obligee named herein, or the heirs, executors, administrators or successors of the Obligee.

IN WITNESS WHEREOF, the Principal and the Surety have Signed and Sealed this Bond this ....

…………………..……………………………….. day of ………………………………………….., 20….

SIGNED and SEALED
in the presence of

(
(
(
(……………………………………………………………………………………….(Seal)
Principal
(
(
(
(……………………………………………………………………………………...(Seal)
Surety

Use CCDC standard form 222, an example of which follows.

LABOUR AND MATERIAL PAYMENT BOND
(TRUSTEE FORM)

No…………………………………………………………………………. $...

Note: This Bond is issued simultaneously with another Bond in favour of the Obligee conditioned for the full and faithful performance of the Contract.

KNOW ALL MEN BY THESE PRESENTS THAT ....

.... as Principal

hereinafter called the Principal, and ....

a corporation created and existing under the laws of ....

and duly authorized to transact the business of Suretyship in ....

as Surety, hereinafter called the Surety are, subject to the conditions hereinafter contained, held and firmly bound unto ....

.... as Trustee

hereinafter called the Obligee, for the use and benefit of the Claimants, their and each of their heirs, executors, administrators,

successors and assigns, in the amount 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.

WHEREAS, the Principal has submitted a written tender to the Obligee, dated the ....

day of ……………………………………………., 20 ………… for ....

....

....

....

which Contract Documents are by reference made a part hereof, and are hereinafter referred to as the Contract.

NOW, THEREFORE, THE CONDITIONS OF THIS OBLIGATION is such that, if the Principal shall make payments to all Claimants for all labour and material used or reasonably required for use in the performance of the Contract, then this obligation shall be null and void; other wise it shall remain in full force and affect, subject however to the following conditions:

1. A Claimant for the purpose of this Bond is defined as one having a direct contract with the Principal for labour, material, or both, used or reasonably required for use in the performance of the Contract, labour and material being construed that part of water, gas, power, light, heat, oil, gasoline, telephone service or rental equipment directly applicable to the Contract provided that a person, firm or corporation who rents equipment to the Principal to be used in the performance of the Contract under a contract which provides that all or any part of the rent is to be applied towards the purchase price thereof, shall only be a Claimant to the extent of the prevailing industrial rental value of such equipment for the period during which the equipment was used in the performance of the Contract. The prevailing industrial rental value of equipment shall be determined, insofar as it is practical to do so, in accordance with and in the manner provided for in the latest revised edition of the publication of the Canadian Construction Association titled “Rental Rates on Construction Equipment” published prior to the period during which the equipment was used in the performance of the Contract.

2. The Principal and the Surety hereby jointly and severally agree with the Obligee, as Trustee, that every Claimant who has not been paid as provided for under the terms of his contract with the Principal, before the expiration of a period of ninety (90) days after the date on which the last of such Claimant’s work or labour was done or performed or materials were furnished by such Claimant, may as a beneficiary of the trust herein provided for, sue on this Bond, prosecute to final judgment for such sum or sums as may be justly due to such Claimant under the terms of a contract with the Principal and have execution thereon. Provided that the Obligee is not obliged to do or take any act, action or proceeding against the Surety on behalf of the Claimants, or any of them, to enforce the provisions of this Bond. If any act, action or proceeding is taken either in the name of the Obligee or by joining the Obligee as a party to such proceeding, then such act, action or proceeding shall be taken on the understanding and basis that the Claimants or any of them, who take such act, action or proceeding, shall indemnify and save harmless the Obligee against all costs, charges and expenses or liabilities incurred thereon and any loss or damage resulting to the Obligee by reason thereof. Provided still further that, subject to the foregoing terms and conditions, the Claimants, or any of them, may use the name of the Obligee to sue on and enforce the provisions of this Bond.

3. No suit or action shall be commenced hereunder by any Claimant:

   (a) unless such Claimant shall have given written notice within the time limits hereinafter set forth to each of the Principal, the Surety and the Obligee, stating with substantial accuracy the amount claimed. Such notice shall be served by mailing the same by registered mail to the Principal, the Surety and the Obligee, at any place where an office is regularly maintained for the transaction of business by such persons or served in any manner in which legal process may be served in the Province or other part of Canada in which the subject matter of the Contract is located. Such notice shall be given:

(1) in respect of any claim for the amount or any portion thereof, required to be held back from the Claimant by the Principal under either the terms of the Claimant's contract with the Principal, or under the Builders' (Mechanics') Liens Legislation applicable to the Claimant's contract with the Principal, whichever is the greater, within one hundred and twenty (120) days after such Claimant should have been paid in full under the Claimant's contract with the Principal;

(2) in respect of any claim other than for the holdback, or portion thereof, referred to above, within one hundred and twenty (120) days after the date upon which such Claimant did, or performed, the last of the work or labour or furnished the last of the materials for which such claim is made under the Claimant's contract with the Principal;

(b) after the expiration of one (1) year following the date on which the Principal ceased work on the Contract, including work performed under the guarantees provided in the Contract;

(c) other than in a Court of competent jurisdiction in the Province or District of Canada in which the subject matter of the Contract, or any part thereof, is situated and not elsewhere, and the parties hereto agree to submit to the jurisdiction of the Court.

4. The Surety agrees not to take advantage of Article 1959 of the Civil Code of the Province of Quebec in the event that, by an act or an omission of the Claimant, the Surety can no longer be subrogated in the rights, hypothecs and privileges of said Claimant.

5. Any material change in the contract between the Principal and the Obligee shall not prejudice the rights or interest of any Claimant under this Bond, who is not instrumental in bringing about or has not caused such change.

6. The amount of this Bond shall be reduced by, and to the extent of any payment or payments made in good faith, and in accordance with the provisions hereof, inclusive of the payment by the Surety of Builders' (Mechanics') Liens which may be filed of record against the subject matter of the Contract, whether or not claim for such lien be presented under and against this Bond.

7. The Surety shall not be liable for a greater sum than the specified penalty of this bond.

IN WITNESS WHEREOF, the Principal and the Surety have Signed and Sealed this Bond this ....

day of ……………………………………………., 20…………

SIGNED and SEALED
in the presence of

(
(
(
(…………………………………………………………………………………...(Seal)
Principal
(
(
(
(…………………………………………………………………………………..(Seal)
Surety

Use standard two-sided form, which follows. Include ICBC forms APV-47 and APV-29 for owned and non-owned automobiles for all contracts in the Province of British Columbia.

CERTIFICATE OF INSURANCE

ISSUED TO:-

PROJECT:- DESCRIPTION:-

LOCATION:-

This is to certify that insurances as described herein, have been arranged through this office for the Insured named below on whose behalf this Certificate is executed and we hereby certify that such insurances are in full force and effect as of this date, but only with respect to the type(s) of insurance for which a policy number, policy period, and limits of liability or amount is shown.

INSURED:-

SCHEDULE OF INSURANCE

TYPE OF INSURANCE	COMPANY AND POLICY NUMBER	EFFECTIVE & EXPIRY DATES OF POLICY	LIMIT OF LIABILITY/AMOUNT
COMPREHENSIVE GENERAL LIABILITY		EFFECTIVE	BODILY INJURY
		EXPIRY	$ EACH PERSON
			$ EACH ACCIDENT
			$ AGGREGATE PRODUCTS
			PROPERTY DAMAGE $ EACH ACCIDENT
			$ AGGREGATE PRODUCTS
			BODILY INJURY & PROPERTY DAMAGE $ INCLUSIVE
		WRAP UP ☐	$ AGGREGATE PRODUCTS
EMPLOYERS LIABILITY		EFFECTIVE	$ EACH PERSON
		EXPIRY	$ EACH ACCIDENT
AUTOMOBILE LIABILITY OWNED/LEASED VEHICLES		EFFECTIVE	BODILY INJURY
		EXPIRY	$ EACH PERSON
			$ EACH ACCIDENT
			PROPERTY DAMAGE $ EACH ACCIDENT
			BODILY INJURY & PROPERTY DAMAGE $ INCLUSIVE
AUTOMOBILE LIABILITY NON-OWNED VEHICLES		EFFECTIVE	BODILY INJURY
		EXPIRY	$ EACH PERSON
			$ EACH ACCIDENT
			PROPERTY DAMAGE
			$ EACH ACCIDENT
			BODILY INJURY & PROPERTY DAMAGE
			$ INCLUSIVE
UMBRELLA LIABILITY		EFFECTIVE	$ LIMITS
		EXPIRY	EXCESS OF $
BUILDERS RISK/ INSTALLATION FLOATER		EFFECTIVE	$ SITE
		EXPIRY	$ OTHER LOCATION
		WRAP UP ☐	$ TRANSIT
CONTRACTORS		EFFECTIVE	$
EQUIPMENT WORKERS' COMPENSATION OTHER		EXPIRY	
		EFFECTIVE	AS REQUIRED BY THE ORDINANCE(S)
		EXPIRY	OF THE

PARTICULARS OF INSURANCE

GENERAL LIABILITY

☐ Premises Property and Operations
☐ Products and Completed Operations
☐ Blanket Contractual (all written agreements)
☐ Tenants Fire Legal Liability
☐ Owners and Contractors Protective
☐ Occurrence Bodily Injury and Property Damage
☐ Broad Form Property Damage
☐ Contingent Employers Liability
☐ Personal Injury
☐ Sudden and Accidental Pollution Liability
☐ Non-Owned Automobile Liability
☐ Severability of Interest or Cross Liability
☐ Exclusions pertaining to Blasting, Collapse, Underpinning, deleted
☐ Provides Coverage for Claims arising from Use of Machinery and Equipment attached to licensed construction machinery on Project Site
☐ Employees as Additional Insured
☐ Owner as Additional Insured
☐ Engineer as Additional Insured
☐ Waiver of Subrogation against Additional Insureds
☐ 30 Days Notice of Cancellation
☐
☐
☐

CONTINGENT EMPLOYERS LIABILITY

☐ 30 Days Notice of Cancellation
☐

BUILDERS RISK/INSTALLATION FLOATER

☐ All Risk Form
☐ Fire, Extended Coverages, Riot, Vandalism or Malicious Acts
☐ Difference in Conditions
☐ Flood Included
☐ Earthquake Included
☐ Excludes Faulty Workmanship, Faulty Construction or Faulty Design but not loss resulting therefrom
☐ Covers Transit by Land
☐ Covers Boiler Explosion during Installation, Temporary Operation and Testing
☐ Covers Owner as Additional Named Insured
☐ Grants Permission for Occupancy prior to completion
☐ Waiver of Subrogation Against Additional Insureds
☐ 30 Days Notice of Cancellation
☐
☐
☐
☐
☐
☐
☐

CONTRACTORS EQUIPMENT

☐ Subrogation Waived Against Owner
☐ Subrogation Waived Against Owner, Construction or Project Manager, Architects and Engineers
☐ 30 Days Notice of Cancellation
☐
☐

AUTOMOBILE

☐ 15 Days Notice of Cancellation
☐

NON-OWNED AUTOMOBILE

☐ 15 Days Notice of Cancellation
☐

MARINE/AIRCRAFT

☐ 30 Days Notice of Cancellation

MARINE/AIRCRAFT/CARGO

☐ 30 Days Notice of Cancellation
☐

OTHERS

☐
☐
☐
☐

☒ **INDICATES THAT THE COVERAGE/ENDORSEMENT INDICATED IS INCLUDED**

REMARKS (STATE DEDUCTIBLE IF ANY)

TERMS AND CONDITIONS

This Certificate is issued for convenience only. All of the terms and conditions of the Policies referred to are contained in the original document which are not modified or amended by this Certificate.

In the event of cancellation or material change of the Policies referred to herein, the Insurer and/or the undersigned will provide written notice as indicated above.

DATED ____

____
Authorized to sign on behalf of Insurers

PART 1 CONTRACT DOCUMENTS

GC 1. DEFINITIONS

In this Contract, the following definitions shall apply:

"Abnormal Weather" means adverse temperature, precipitation, wind or other adverse weather condition which, in any two (2) week period, differs from the statistical average for that condition in that period by more than one standard deviation, calculated based on relevant data available from Environment Canada, covering the twenty (20) year period immediately preceding the Notice of Award.

"**Business Day**" means any day other than a Saturday, Sunday or statutory holiday recognized in the province or territory wherein the Project Site is located.

"**Certificate of Insurance**" means a document issued by an insurance company or authorised broker to certify the extent, period and limits of insurance coverage under specific conditions granted to listed Persons.

"**Certificate of Substantial Performance**" means a certificate issued by the Engineer stating that Substantial Performance of the Work has been achieved.

"**Certificate of Total Performance**" means a certificate issued by the Engineer stating that Total Performance of the Work has been achieved.

"**Change**" means an increase or addition to, a reduction or deletion from or an extension of the Work or the Construction Schedule, or the replacement of a proposed subcontractor or supplier, which results in a material change to the Contract Time or Contract Price.

"**Change Directive**" means a written instruction signed by the Owner and issued by the Engineer to the Contractor directing the Contractor to proceed with a Change despite the absence of an agreement as to adjustment of the Contract Price or Contract Time, or both, as applicable.

"**Change Order**" means a written record of a Change prepared by the Engineer and signed by the Owner, the Engineer and the Contractor stating their agreement to a Change, and setting out a description of the Work covered by the Change Order, the price or method of valuation of the Work and the change in the Contract Price or adjustment of the Contract Time, or both, as applicable.

"**Claim**" means a written demand for adjustment of the Contract Price or Contract Time made by either Party against the other Party.

"**Confidential Information**" means all information that is acquired by, or becomes known to, the Contractor or any of its Personnel, or Subcontractors as a result of, directly or indirectly, performing the Work, or otherwise being involved in the Project and which is in the nature of one of the following categories of information:

(a) all information with respect to the Owner's operations, the Project and this Contract; or

(b) all personal information as defined in the Freedom of Information and Protection of Privacy legislation in the jurisdiction in which the Work is performed.

"**Consequential Damages**" means all damages except direct damages, including any one or more of: loss of profits or anticipated profits, loss of business opportunity, loss of revenue and loss of reputation.

"**Construction Equipment**" means all tools, machinery and equipment whether operated or not operated, which are required for preparing, fabricating, conveying, erecting or otherwise performing the Work but are not incorporated into the Work.

"**Construction Schedule**" means the schedule for the Work which is prepared by the Contractor and accepted by the Owner and the Engineer in accordance with GC 25 CONSTRUCTION SCHEDULE.

"**Construction Safety Plan**" means the plan developed by the Contractor to address safety on the Project Site, and anywhere else that the Work is performed.

"**Contemplated Change Notice**" means a written notification authorized and issued by or on behalf of the Owner, providing Notice and Specifications or Drawings, or both, to the Contractor and others of a contemplated Change and requesting a quotation for adjustments of Contract Price and Contract Time that would result from the Change.

"**Contract Documents**" or "**Contract**" means the complete set of documents, Specifications, Drawings, and addenda incorporated therein, as listed in the "Table of Contents" of the Contract, any Construction Memos and any amendments to the Contract.

"**Construction Memo**" means an instruction, not involving any adjustment to the Contract Price or Contract Time, in the form of Specifications, Drawings, schedules, samples, models or written instructions issued by the Engineer that in the opinion of the Engineer is necessary to supplement or clarify the Contract Documents as required for the performance of the Work.

"**Contract Price**" means, if the Contract is on the basis of a stipulated or lump sum, the lump sum price stated in Section 00 41 00 – Bid Form, as may be adjusted by Change Orders or Change Directives. If the Contract calls for payments on a unit price basis whether including lump sums or not, Contract Price shall mean the product of the units of Work actually performed and the appropriate unit prices plus the total of the lump sums prices all as stated in Section 00 41 00 – Bid Form, and all as may be adjusted by Change Orders or Change Directives.

"**Contract Time**" means the time stipulated in Article 1 of Section 00 52 00 - Contract Agreement as the period between the date of the Notice to Proceed and achievement of Total Performance of the Work, as may be adjusted by Change Orders or Change Directives.

"**Contractor**" means the Contractor named in Section 00 52 00 - Contract Agreement.

"**Deficiencies**" means one or more defects or deficiencies in the Work or Materials, including Work omitted or not performed as provided for in this Contract.

"**Dispute**" means any difference between the Contractor and the Owner as to the interpretation, application or administration of the Contract or any failure by the Owner and the Contractor to agree where the Contract Documents call for agreement.

"**Drawings**" means the graphic and pictorial drawings, sketches and representations, whether electronic or paper-based, prepared to represent the Work and issued by the Engineer, including plans, elevations, sections, details, schedules, and diagrams.

“**Engineer**” means Associated Engineering acting through a delegate duly appointed to act on its behalf, or such other engineer, architect or Person as may from time to time be duly authorized and appointed in writing by the Owner.

“**Force Account**” means the method of calculating payment the Contractor shall receive for the Work performed as set out in GC 56 FORCE ACCOUNT WORK.

“**Governmental Authority**” means any federal, provincial, first nation or municipal government, official, administrative, regulatory, or legislative authority, commission, tribunal or court or any of the respective agencies or departments thereof having jurisdiction over any aspect of the Project, the Work, this Contract, or any matters arising thereunder.

“**Law**” means the common law and all applicable decrees, statutes, laws, by-laws, rules, orders, codes, directives and regulations in effect from time to time and made or issued by any Governmental Authority having jurisdiction over any aspect of the Project, the Work, this Contract, the Owner, the Contractor and the Subcontractors, and includes any applicable replacement, amendment or supplementary legislation, and any applicable regulations, and further includes the OH&S Legislation.

“**Lien Act**” means the applicable provincial or territorial lien legislation, including regulations enacted pursuant to that lien statute, at the Project Site, current at the date of the Notice to Proceed and as may be revised during the Contract Time.

“**Materials**” means materials, supplies, machinery, equipment and fixtures which are or which are to be permanently incorporated into the Work, but excludes Construction Equipment.

“**Major Lien Fund Holdback**” means the total of lien holdbacks from progress payments for Work performed before Substantial Performance of the Work.

“**Milestone Date**” means any date or dates specified in the Contract Documents for completion of specified portions of the Work, including the dates of Substantial Performance of the Work and Total Performance of the Work.

“**Minor Lien Fund Holdback**” means the total of lien holdbacks from progress payments for Work performed after Substantial Performance of the Work.

“**Notice**” means a notice made in writing and delivered to one of the Parties or the Engineer at the address, or any replacement address, stipulated for and in the method required for, delivery or as set out in Article 6 of Section 00 52 00 - Contract Agreement.

“**Notice of Award**” is a communication from the Owner, or the Engineer on behalf of the Owner, advising a bidder that the bidder has been awarded the Contract.

“**Notice to Proceed**” is a direction from the Owner, or the Engineer on behalf of the Owner, advising the Contractor is to commence and proceed actively with the Work under the Contract.

“**OH&S Legislation**” means, collectively, all of the applicable decrees, statutes, laws, by-laws, rules, orders, codes, directives and regulations concerning occupational health and safety, which may be in force, from time to time at the Project Site.

"**Other Contractors**" means any other contractors or consultants which are retained directly by the Owner for other work at the Project Site, other than the Contractor, and includes the Owner's own forces.

"**Owner**" means the Person identified as such in Section 00 52 00 - Contract Agreement and includes any authorized representative of the Owner.

"**Party**" means one of the parties to this Contract and Parties means the Owner and the Contractor, collectively, as the case may be.

"**Payment Certificate**" has the meaning set out in GC 37 PROGRESS PAYMENTS.

"**Person**" means any one of an individual, partnership, limited liability partnership, limited liability company, corporation, sole proprietorship, trust, unincorporated organization, association, society, or Governmental authority.

"**Personnel**" means, without limitation:

(a) in relation to any Party and its affiliates, elected officials, directors, officers, employees, contract personnel, non-employed representatives, contractors, consultants and agents, including those who are assigned or seconded to the Project; and

(b) in relation to any other Person, each of their respective elected officials, directors, officers, employees, contract personnel, non-employed representatives, contractors, consultants and agents, including those who are assigned or seconded to the Project.

"**Pre-Contractual Statement**" means any communication or correspondence, including any agreement, undertaking, representation, warranty, promise, assurance, arrangement or draft of any nature whatsoever, whether or not in writing, relating to the subject matter of the Contract and which is not repeated in the Contract, made by any Person at any time before the date of the Contract Agreement.

"**Prime Contractor for Safety**" means "Prime Contractor", "Constructor", "Principal Contractor", or such other position of similar import as the case may be according to the location of the Project Site, as is defined in the OH&S Legislation.

"**Project**" means the project identified in Article 1 of Section 00 52 00 - Contract Agreement.

"**Project Record Drawings**" means a dedicated set of Drawings reserved and annotated by the Contractor on an ongoing basis during the performance of the Work for the purpose of recording differences between the built Work and Drawings.

"**Project Site**" means the designated location of the Work on the Project as identified in the Contract Documents, or, if not identified in the Contract Documents, as identified by the Owner by Notice to the Contractor, from time to time.

"**Project Takeover**" means the turnover by the Contractor and the takeover by the Owner of part, or all of, the Project, which may occur in phases, or not, as determined in the sole discretion of the Owner, and which shall occur when all of the prerequisites identified in this Contract have been completed by the Contractor, certified by the Engineer and accepted in writing by the Owner.

"**Project Takeover Date**" means the date that Project Takeover occurs in relation to a part, or all, of the Project.

"**Quantities**" means the quantities for the Work performed, measured in accordance with GC 39 QUANTITIES.

"**Records**" means the records of the Contractor and its Subcontractors relating to the Contract, the Project or the performance of the Work, and which include, paper and electronic copies, as the case may be, of:

(a) original invoices and accounts;

(b) records of account for all Work performed, itemizing the names and positions of Personnel, the hours worked by each, the type of services performed and the hourly rate charged, together with copies of all subcontracts and invoices for expenses;

(c) records of account for all amounts claimed related to termination or suspension, itemizing the names and positions of Personnel, the hours worked by each, the type of services performed and the hourly rate charged, together with copies of all subcontracts; and

(d) correspondence, minutes of meetings, notes, reports, incident reports and all other documentation including information relating to the Contractor's compliance with the Law and the Contract and the use of Confidential Information.

"**Shop Drawings**" means one or more Drawings, diagrams, illustrations, photographs, schedules, performance charts, technical brochures, samples, models and other data which are to be provided by or through the Contractor or the Subcontractors to illustrate details of a portion of the Work.

"**Specifications**" means those documents, whenever issued by the Engineer, setting out the requirements and standards for Materials, equipment, systems, workmanship and the services necessary for the proper performance of the Work or any part thereof.

"**Subcontractor**" means a Person who performs part of the Work, including the Supply of Materials, and either: (a) has a direct contract with the Contractor or (b) has no direct contract with the Contractor but is at any tier below the Contractor.

"**Substantial Performance of the Work**" means that the Work is substantially complete or substantially performed as defined in the Lien Act, the Work or a substantial part of it is ready for use or is being used in the way that was intended for the purpose intended, and the Engineer has issued a certificate verifying that, in the opinion of the Engineer, Substantial Performance of the Work has been achieved.

"**Superintendent**" means the Contractor's senior representative at the Project Site.

"**Supplier**" means a Person having a direct contract with the Contractor to Supply Materials not worked to a special design for the Work.

"**Supply**" means supply and pay for.

"**Surety**" means the Person who has supplied the performance and labour and material bonds for the Contract.

“**Temporary Work**” means temporary supports, structures, facilities, services and other temporary items, excluding Construction Equipment that is required for performing the Work but is not incorporated into the Work.

“**Total Performance of the Work”** means the Work, with the exception of Warranty Work, has been fully completed, including rectification of all known Deficiencies, and the Engineer has issued a certificate verifying that, in the opinion of the Engineer, Total Performance of the Work has been achieved.

“**Toxic or Hazardous Substances**” means any solid, liquid, gaseous, thermal or electromagnetic irritant or contaminant and includes all pollutants and hazardous substances or wastes whether or not defined in any Law.

“**Warranty Period**” means that period of time set out in GC 63 WARRANTY during which the Contractor is obligated to warrant the Work.

“**Warranty Work**” means the Work to remedy, correct or rectify any Deficiencies, including any Work required to access the Deficiencies and any Work required to make good the Deficiencies and any other Work or work performed by Other Contractors that is destroyed, disturbed or negatively affected by the performance of the Work to remedy, correct or rectify any Deficiencies, which shall be performed by the Contractor.

“**Work**” means and includes anything and everything required to be done for the fulfilment and completion of the Contract.

“**Workers Compensation Legislation**” means the applicable workers compensation legislation at the Project Site, current at the date of the Notice to Proceed and as may be revised during the Contract Time.

“**Working Day**” means any day that there is construction activity at the Project Site or any Business Day that construction activity is reasonably possible.

GC 2. INTERPRETATION AND GENERAL PROVISIONS

.1 Wherever this Contract requires an action to be performed or an obligation to be undertaken, unless otherwise specified, such action or obligation shall be performed in a prompt and commercially reasonable manner by the Party taking the action or fulfilling its obligation.

.2 This Contract supersedes all prior negotiations and Pre-Contractual Statements, relating in any manner to the subject matter of this Contract, including any bid documents that are not expressly listed in the Table of Contents of the Contract Documents.

.3 A Party shall have no right of action against any other Party arising out of or in connection with any Pre-Contractual Statement except to the extent that it is repeated in the Contract.

.4 This Contract may only be amended by a document in writing signed by the Parties.

.5 Wherever the term “including” is used, or any derivative thereof, it shall be read to mean “including, but not limited to” or an equivalent phrase for a derivative, as the case may be, if the context so permits such a construction.

.6 Wherever the singular or masculine or neuter is used it will be interpreted as meaning the plural or feminine or body politic or corporate, and *vice versa*, as the context requires.

.7 Documents comprising this Contract are complementary, and what is required by any one shall be as binding as if required by all.

.8 Words and abbreviations that have customary technical or trade meanings are used in this Contract in accordance with such recognized meanings.

.9 The failure of Owner, the Engineer or the Contractor at any time to require the performance of any provision or requirement of this Contract shall not affect the right of that Party to require the subsequent performance of that provision or requirement.

.10 All amounts referred to in this Contract are in Canadian dollars, unless otherwise indicated.

.11 In the calculation of time, the first day shall be excluded and the last day shall be included.

.12 If a court of competent jurisdiction determines that any provision of this Contract is invalid or unenforceable, such determination shall not affect the validity or enforceability of the remaining provisions of this Contract.

.13 The Parties have each had the opportunity of obtaining legal advice and accordingly any rule of construction to the effect that any ambiguity is to be resolved against the drafting Party shall not apply in the interpretation of this Contract.

GC 3. LAW OF THE CONTRACT AND ATTORNMENT

.1 This Contract shall be governed by the Laws of the Province or Territory where the Project Site is located and the Parties agree to attorn to the exclusive jurisdiction of the Courts of that Province or Territory.

GC 4. PRECEDENCE OF DOCUMENT FOR INTERPRETATION

.1 In case of any inconsistency or conflict between the provisions of the Contract Documents, the provisions of such documents and addenda thereto shall take precedence and govern in the following order:

1. Contract Agreement
2. Supplementary Conditions
3. General Conditions
4. Specifications
5. Drawings
6. Executed Bid Form
7. Instructions to Bidders
8. Invitation to Bid
9. All other documents

.2 Figured dimensions on a Drawing take precedence over measurements scaled from the Drawing.

.3 Large-scale Drawings take precedence over those of smaller scale.

.4 Supplementary Drawings and Specifications supersede their antecedents.

.5 In case of conflict between figured dimensions on a Drawing and the dimensions of a specified product, the dimensions of the specified product shall govern.

.6 If compliance with two or more standards or specifications is specified and the standards or specifications establish different or conflicting requirements, the Contractor shall comply with the most stringent requirement.

.7 Documents of a later date shall govern over a similar type of document of an earlier date.

GC 5. USE OF THE CONTRACT DOCUMENTS

.1 The intent of the Contract Documents is that the Contractor shall Supply, directly or through a Subcontractor, all labour, Materials, related services, equipment or other matters or things necessary for the Contractor to perform the Work.

.2 All Work described in the Specifications and not shown on the Drawings and all Work shown on the Drawings and not described in the Specifications shall be performed by the Contractor as if included in both.

.3 The Contractor shall review the Contract Documents provided by the Owner or the Engineer and shall promptly provide Notice to the Engineer of any of the following that the Contractor discovers or becomes aware of:

(a) any errors, inconsistencies, omissions or ambiguities in the Contract Documents;

(b) doubt as to the meaning or intent of any part of the Contract Documents;

(c) any variance between the content of the Contract Documents and the Law; or

(d) modifications required to be made to the Contract Documents as a result of revisions made to the Law.

.4 If the Contractor does discover any conditions described in GC 5.3, the Contractor shall not proceed with the Work affected until the Contractor has received clarification of or revisions to the Contract Documents from the Engineer.

.5 If Notice is given by the Contractor in accordance with GC 5.3 and clarifications or revisions to the Contract Documents are required, the Engineer shall revise the Contract Documents and any Change shall be dealt with in accordance with PART 11 CHANGES AND CONCEALED OR UNKNOWN CONDITIONS.

.6 If the Contractor fails to provide Notice as required in GC 5.3 or proceeds with the Work before receiving clarification of or revisions to the Contract Documents from the Engineer as provided for in GC 5.5, the Contractor shall be responsible for and shall bear the costs, expenses, and damages attributable to any such failure, or of proceeding in such manner.

.7 Unless otherwise expressly agreed to in writing by the Owner, nothing contained in the Contract Documents shall create any contractual relationship between:

(a) the Owner or its Personnel and any Subcontractor or its Personnel, or other Persons engaged in the performance of the Work; or

(b) the Engineer or its Personnel and the Contractor, or any Subcontractor, or their respective Personnel, or other Persons engaged by them in the performance of the Work.

GC 6. NO WAIVER

.1 No action or failure to act by the Owner, the Engineer or the Contractor shall constitute a waiver of any right or duty afforded or imposed on any of them under this Contract, and such action or failure to act shall not constitute an approval of, or acquiescence in, any breach of this Contract, except as may be expressly provided for or required by this Contract or otherwise agreed in writing by the Parties.

GC 7. NO ASSIGNMENT WITHOUT CONSENT

.1 Neither Party to this Contract shall assign their respective rights or responsibilities, or any portion thereof, without the prior written consent of the other Party.

GC 8. SURVIVAL

.1 Any provision of this Contract which expressly states or naturally implies that it survives the termination, cancellation, completion, suspension or expiration of this Contract, including any other provision that is necessary for the interpretation or enforcement of the same, shall continue as valid and enforceable notwithstanding any such termination, cancellation, completion, suspension or expiration.

PART 2 INSURANCE, WORKERS' COMPENSATION AND BONDS

GC 9. INSURANCE

.1 The Contractor shall obtain and continuously carry, while the Work is being performed and while any remedial or Warranty Work is being undertaken, at the Contractor's own expense and cost, the insurance coverage as specified in Section 00 73 16 – Insurance, unless otherwise indicated in writing by the Owner. The Owner reserves the right to supplement or add insurance coverage from time to time as may be required, by Change Order.

.2 The insurance maintained by the Owner or the Contractor shall in no manner limit the Contractor's obligations to indemnify or otherwise perform the obligations required of it pursuant to the terms of this Contract.

.3 Prior to commencing the Work, the Contractor shall provide the Owner with Certificates of Insurance in a form acceptable to the Owner and evidence the insurance coverage is in accordance with the requirements of the Contract.

.4 Deductibles, if any, which are applicable to the specified insurance, shall be borne by the Contractor.

GC 10. WORKERS' COMPENSATION

.1 The Contractor shall ensure all of its and the Subcontractors' respective Personnel, agents, representatives and visitors attending at the Project Site are registered for workers' compensation coverage. The Contractor shall indemnify and save harmless the Owner for any and all claims incurred by the Owner as a result of the Contractor failing to comply with GC 10.

.2 The Contractor shall at all times pay or cause to be paid any assessment or contribution required to be paid pursuant to the Workers Compensation Legislation applicable to the Project Site. If the Contractor fails to do so, the Owner, in addition to any of its other rights under this Contract, may retain the amount of the assessment or contribution from any payment then due, or to become due, to the Contractor under this Contract.

.3 At any time during the term of this Contract, when requested by the Owner, the Contractor shall provide evidence of compliance by the Contractor and Subcontractors with the obligations under GC 10. As minimum, the Contractor shall provide evidence, satisfactory to the Engineer, of compliance with the requirements of the Workers Compensation Legislation including payments due thereunder at the following times:

(a) prior to commencing the Work;

(b) as a condition of receiving a Certificate of Substantial Performance; and

(c) as a condition of receiving a Certificate of Total Performance.

.4 If at any time the performance of the Work is stopped because the Contractor unreasonably fails or refuses to comply with a regulation or order issued pursuant to the Workers Compensation Legislation, then such failure or refusal shall be considered a default under this Contract and the provisions of GC 49 OWNER'S RIGHT TO TERMINATE FOR DEFAULT shall apply.

GC 11. BONDS

.1 The Contractor shall, prior to commencement of the Work, pay for and provide to the Owner:

(a) a performance bond, in the amount of 50% of Contract Price, covering the performance of this Contract, including any warranty requirements; and

(b) a labour and material payment bond, in the amount of 50% of Contract Price.

.2 The Owner shall not be obligated to make any payment to the Contractor until such time as the bonds specified in GC 11.1 have been delivered to the Owner by the Contractor.

.3 The bonds specified in GC 11.1 shall be:

(a) in the form which is in accordance with the latest edition of the CCDC approved bond forms;

(b) issued by a duly licensed surety company authorized to transact the business of suretyship in the province or territory of the Project Site;

(c) acceptable to the Owner; and

(d) maintained in good standing until the fulfillment of the Contract.

PART 3 GENERAL PROVISIONS

GC 12. EXECUTION OF THE CONTRACT AGREEMENT

.1 The Contractor shall deliver the following documents to the Engineer within ten (10) Business Days of the date of the Notice of Award:

(a) Certificates of Insurance in accordance with GC 9 INSURANCE;

(b) evidence of compliance with the requirements of the Workers Compensation Legislation including payments due thereunder in accordance with GC 10 WORKERS' COMPENSATION;

(c) bonds in accordance with GC 11 BONDS; and

(d) draft Construction Schedule in accordance with GC 25 CONSTRUCTION SCHEDULE.

.2 The Engineer shall deliver the Contract Documents in a form ready for signing to the Contractor within ten (10) Business Days after receipt of the documents from the Contractor provided for in GC12.1 that are satisfactory and in strict compliance with the Contract Documents.

.3 The Contractor shall sign the Contract Documents and return them to the Engineer within five (5) Business Days after receiving them and the Engineer shall forward them to the Owner for signing.

.4 The Owner shall sign the Contract Documents and return them to the Engineer within fifteen (15) Business Days after receiving them and the Engineer shall deliver the Contractor's copies to the Contractor.

GC 13. CONDUCT OF THE WORK

.1 The Contractor shall perform the Work in strict accordance with the Contract Documents and in a professional, competent and safe manner with good workmanship which performance meets or exceeds the standards for construction on projects of a similar nature and locality.

.2 The Contractor shall perform the Work diligently and take all measures necessary to ensure that the Construction Schedule is met.

.3 The Contractor represents that it is highly knowledgeable and experienced in the type of work described in the Contract Documents. The Contractor is being retained by the Owner specifically because of its knowledge and expertise in that regard.

.4 The Contractor shall in all respects be an independent contractor.

.5 The Contractor shall not, in the performance of the Work, engage in practices which conflict with the Owner’s interest including, without limitation, disclosing information about the Owner’s business or operations; withholding information that could adversely affect the business interests or operations of the Owner; accepting gifts from or offering gifts to the Owner’s Personnel that may lead to a perceived obligation; or engaging in any activity that would contravene any Law. The Contractor shall inform the Owner, immediately and in writing, of any potential conflict of interest that may arise.

.6 The Contractor shall cooperate and work with any Other Contractors, who are appointed by the Owner from time to time.

.7 The Contractor shall perform the Work in such manner as to cause a minimum of interference with the Owner’s operations and the operations of Other Contractors. The Contractor and the Owner shall cooperate fully with each other, Other Contractors and all other parties with whom the Contractor and the Owner may be involved during the performance of the Work.

GC 14. ACTIVITIES

.1 The Owner will provide the Project Site. Where Work is to be performed on lands owned by others, the Owner will obtain the necessary easements or rights-of-way. Delay in providing the Project Site, or in obtaining easements or rights-of-way which, in the opinion of the Engineer, delays the Work will be deemed cause for extension of the Contract Time and the provisions of GC 47 DELAY shall apply.

.2 The Contractor will commence and proceed actively with the Work under the Contract immediately within five (5) Business Days of receipt of the Notice to Proceed. The Contractor shall not enter on the Project Site until the Owner or the Engineer has issued the Notice to Proceed.

.3 The Contractor shall ensure that all permits, licenses and building occupancy permits for the Project which are required by the Contract Documents to be obtained by the Contractor are obtained in a timely manner and in accordance with the Construction Schedule.

.4 The Contractor shall, by personal inspection, examination, calculations or tests, or by any other means, satisfy himself with respect to the local conditions to be encountered and the Quantities, quality, and practicability of the Work and of his methods of procedure.

.5 The Contractor shall be responsible for all ordering, scheduling and planning required to complete the Work in a timely manner. Without prejudice to Contractor’s obligation to perform on time, the Contractor shall give the Engineer prompt Notice in writing if any delay is foreseen for any reason.

.6 The Contractor shall monitor its progress in performing the Work and report regularly to the Engineer in a format acceptable to the Engineer, which shall include:

(a) actual progress reports, with itemization of Work complete, in progress and scheduled for the next period and the Materials delivered to the Project Site;

(b) forecasts for progress and labour deployment;

(c) identification of any portions of the Work which have, or have the potential to be, delayed and the mitigation efforts being deployed by the Contractor to address such delay or potential delay;

(d) lost time incident reports; and

(e) other reports which may be requested by the Engineer from time to time.

.7 The Owner shall make reasonable efforts to provide the Contractor with the necessary information regarding the Project which the Owner has available. It shall be the Contractor's responsibility to:

(a) advise the Engineer if any further or additional information is required; and

(b) obtain and assemble adequate information to permit the Work to be completed in a proper and expeditious manner as required by and in accordance with the Contract Documents and the Construction Schedule.

PART 4 ADMINISTRATION OF THE CONTRACT

GC 15. AUTHORITY OF THE ENGINEER

.1 The Engineer shall have authority to act on behalf of the Owner only to the extent provided for in this Contract or as the Owner may authorize, from time to time, but only to the extent that such authorization is communicated to the Contractor by Notice from the Owner.

.2 The duties, responsibilities, and limitations of authority of the Engineer shall only be modified or extended by a Notice issued by the Owner to the Contractor.

GC 16. ROLE AND RESPONSIBILITY OF THE ENGINEER

.1 The Engineer shall, to the extent specifically provided for in this Contract, be a representative of the Owner during the performance of the Work until the date of the Total Performance of the Work and the completion of the Warranty Work. The Engineer's instructions to the Contractor shall be forwarded directly from the Engineer, or alternatively through the Owner, as may be determined appropriate by the Owner from time to time.

.2 The Engineer shall visit the Project Site at intervals appropriate to the progress of the Work to observe the progress and quality of the Work and to determine if the Work is proceeding in general conformity with this Contract.

.3 The Engineer may provide at the Project Site one or more Personnel to assist in carrying out the Engineer's responsibilities.

.4 Based upon the Engineer's observations and evaluation of the Contractor's applications for payment, the Engineer shall make an assessment as to the amounts owing to the Contractor under this Contract and shall issue Payment Certificates as provided for in PART 7 PAYMENT AND ALLOWANCES.

.5 The Engineer shall not be responsible for, and shall not have control, charge, or supervision of construction means, methods, techniques, sequences, or procedures, quality assurance or safety or environmental protection programs and other programs required in connection with the Work in accordance with applicable Law or general construction practice.

.6 The Engineer shall not be responsible for the Contractor's failure to carry out its obligations in accordance with the Contract Documents. The Engineer shall not have control over, charge of, or be responsible for the acts or omissions of the Contractor or any Person for whom the Contractor is responsible at Law.

.7 The Engineer shall be, in the first instance, the interpreter of the requirements of this Contract and shall make determinations as to the performance under the Contract by the Owner and the Contractor and the Subcontractors. Interpretations and determinations of the Engineer shall be consistent with the intent of the Contract Documents.

.8 Claims, Disputes, and other matters in question relating to the performance of the Work or the interpretation of the Contract Documents, shall be referred initially by Notice to the Engineer for the Engineer's interpretation and determination. The Engineer's interpretation and determinations shall be given by Notice to both the Owner and the Contractor.

.9 The Engineer shall have authority to reject work which, in the Engineer's opinion, does not conform to the requirements of this Contract. Whenever the Engineer considers it necessary or advisable, the Engineer shall have authority to require inspection or testing of Work, whether or not such Work is fabricated, installed or completed. However, neither the authority of the Engineer to act, nor any decision either to exercise or not exercise such authority, shall give rise to any duty or responsibility of the Engineer to the Contractor.

.10 During the progress of the Work, the Engineer may issue Construction Memos to the Contractor. The Contractor shall comply with the Construction Memos with reasonable promptness or in accordance with a schedule for implementation of such Construction Memos agreed to by the Engineer and the Contractor.

.11 The Engineer may issue Field Instructions requiring the Contractor's immediate action to effect, maintain or restore compliance of the Work with the safety or environmental requirements of the Contract.

.12 The Engineer shall review and take appropriate action upon the Contractor's submittals such as Shop Drawings and samples, as provided in the GC31 SHOP DRAWINGS.

.13 The Engineer shall prepare Change Orders, Change Directives, and Contemplated Change Notices as provided in PART 11 CHANGES AND CONCEALED OR UNKNOWN CONDITIONS. Neither a Change Order nor a Change Directive shall constitute a Change unless signed by the Owner.

.14 The Engineer shall conduct reviews of the Work to verify Substantial Performance of the Work and Total Performance of the Work as provided in GC 40 SUBSTANTIAL PERFORMANCE OF THE WORK and GC 42 TOTAL PERFORMANCE OF THE WORK AND FINAL PAYMENT.

.15 The Engineer shall make reasonable efforts to promptly review and take appropriate action with respect to documents submitted by the Contractor, including written warranties and related documents, and upon the Owner's request, shall establish a process for the Owner's review of some or all such documents.

.16 In the event that the Contractor believes that the Engineer is not promptly reviewing or taking appropriate action with respect to any samples or documents submitted by the Contractor, the Contractor shall, within five (5) Business Days of such event occurring, provide Notice to the Engineer and the Owner setting out which samples or documents have not been promptly reviewed or in relation to which the Engineer has not taken appropriate action and the effect of such conduct. If the Contractor does not provide such Notice within the specified time, the Contractor shall have no Claim against the Owner for any reason relating to the conduct of the Engineer with respect to the review of samples or documents submitted by the Contractor.

GC 17. REVIEW AND INSPECTION OF THE WORK

.1 The Owner and the Engineer shall have access to the Work at all times provided they follow the Contractor's safety requirements.

.2 The Contractor shall Supply sufficient, safe, and proper facilities at all times for the review and inspection of the Work by the Owner, the Engineer and Governmental Authorities. If parts of the Work are in preparation at locations other than the Project Site, the Owner and the Engineer shall be given access to such parts of the Work.

.3 The Owner may review the Project Site at any time to observe whether the Contractor is fulfilling its responsibilities as Prime Contractor for Safety and under the OH&S Legislation. Reviews may include: Project Site conditions, work processes, procedures and documentation of Project Site safety related activities. Observed infractions or possible infractions will be reported to the Engineer and the Contractor for further investigation and action by the Contractor.

.4 If any portion of the Work is designated for tests, inspections or approvals in the Contract Documents, or by the Engineer, or by Law, the Contractor shall give the Engineer Notice of not less than five (5) Business Days of when the Work will be ready for review and inspection. The Contractor shall arrange for, and shall give the Engineer reasonable Notice of, the date and time of inspections by all Governmental Authorities.

.5 The Contractor shall promptly deliver to the Engineer two copies of any certificates and inspection reports relating to the Work, or any portion thereof.

.6 Within ten (10) Business Days of the commencement of the Work, the Owner and the Engineer, in conjunction with the Contractor, shall jointly develop a schedule of items of Work which are designated for special tests, inspections, or approvals.

.7 If the Contractor covers or permits to be covered, Work that has been designated for special tests, inspections, or approvals before such special tests, inspections, or approvals are made, given or completed, the Contractor shall, if so directed, uncover such Work, have the inspections or tests satisfactorily completed, and re-perform all covering Work, all at the Contractor's expense, regardless of the outcome of the tests.

.8 The Engineer may order any portion or portions of the Work to be examined to confirm the Work is in accordance with the requirements of this Contract. If the Engineer provides Notice to the Contractor that the Work is not in accordance with the requirements of this Contract, the Contractor shall correct the Work and pay the cost of examination, correction and restoration. If, on such examination, the Work has been completed in accordance with the requirements of this Contract, the Owner shall be responsible for the cost of examination and restoration, except as provided for in GC 17.7.

.9 Neither the failure of the Engineer, or an inspection agency appointed by the Owner or the Engineer, to carry out any reviews or inspections, nor errors or omissions in the performance of such reviews and inspections by the Engineer, or an appointed inspection agency, shall relieve the Contractor from responsibility that the Work, or any portion thereof, is performed in accordance with this Contract.

.10 The Contractor shall continuously monitor and inspect the Work of the Subcontractors for Deficiencies and ensure that all such Deficiencies are promptly corrected.

.11 The Contractor shall implement and follow a quality assurance program with respect to the performance of the Work, and shall ensure the compliance of the Subcontractors with its quality assurance program, to ensure that the quality of the Work meets or exceeds the standards of performance and quality required by this Contract.

GC 18. DEFICIENCIES

.1 At all times during the performance of the Work, the Contractor shall promptly remedy, correct and rectify any Deficiencies, whether or not the Deficiencies have been incorporated in the Work, and whether or not the Deficiencies are the result of poor workmanship, use of defective Materials, or vandalism, theft or damage through carelessness, negligence, inadequate security or protection or other act or omission of the Contractor or any Person for whom the Contractor is responsible at Law.

.2 The Contractor shall remedy, correct and rectify, as required to ensure the timely performance of the Work in accordance with the Construction Schedule, any and all:

(a) Deficiencies in a manner acceptable to the Engineer and the Owner; and

(b) Work, or other work, that is destroyed or damaged as a result of the Deficiencies or the remedying or correction thereof.

.3 If, in the opinion of the Owner, it is not expedient to correct any Deficiency as provided for in this Contract, after consultation with the Engineer and Contractor, the Owner may require the Contractor to deduct from the amount otherwise due to the Contractor the difference in value between the Work as performed and that called for by this Contract. If the Owner and the Contractor do not agree on the difference in value, they shall refer the matter for determination in accordance with PART 12 DISPUTE RESOLUTION.

.4 In the event that the Contractor does not remedy, correct or rectify the Deficiencies as required herein, the Owner may, upon expiry of ten (10) Business Days after giving Notice to the Contractor, take such steps as may be necessary to remedy, correct or rectify the Deficiencies in the Work or other work which is damaged or destroyed as a result of the Deficiencies or the remedying or correction thereof. In such event, the Contractor shall promptly pay the Owner for costs incurred by the Owner for remedying, correction or rectification of those Deficiencies, including both the Work or other work, if any, destroyed or damaged, or any alterations necessitated by the Contractor failing to remedy, correct or rectify the Deficiencies and any claims incurred by the Owner in so doing may be set-off against any monies due from the Owner to the Contractor.

PART 5 EXECUTION OF THE WORK

GC 19. CONTROL OF THE WORK

.1 The Contractor shall have total control of the Work and shall effectively control, direct and supervise the Work so as to ensure conformity with the Contract Documents and compliance with all Law.

.2 The Contractor shall be solely responsible for construction means, methods, techniques, sequences, procedures and safety and coordination of the various parts of the Work.

.3 Without limiting the generality of the foregoing, the Contractor is responsible for the coordination of the various parts of the Work so that no part is left in an unfinished or incomplete condition, unless otherwise required or specified by the Engineer to be unfinished or uncompleted.

.4 Prior to commencing any of the Work, the Contractor shall verify all measurements, dimensions, and levels necessary for the proper, timely and complete performance of all aspects of the Work. Where measurements, dimensions or levels are not included in the Contract Documents or exact locations or requirements are not apparent, the Contractor shall immediately provide Notice to the Engineer identifying the lack of information and shall obtain instructions from the Engineer prior to proceeding with any part of the Work affected thereby.

GC 20. ELECTRONIC INFORMATION

.1 At the Contractor’s request and at the Owner’s option, the Engineer may provide the Contractor with electronic copies of the Drawings, design digital terrain model, building information model or other such information.

.2 If the Engineer does provide such information, it is provided "as is" and at the Contractor's request, without warranty of any kind, whether express or implied. All implied warranties, including, without limitation, implied warranties of accuracy, completeness, merchantability, fitness for a particular purpose, and non-infringement, are hereby expressly disclaimed.

.3 Under no circumstances will the Owner or the Engineer be liable to any Person for any direct, indirect, special, incidental, or other damages including Consequential Damages and, without limitation, any loss of programs or information, based on any use of this information or any information referenced therein, even if the Owner or the Engineer has been specifically advised of the possibility of such damages.

GC 21. LAYOUT OF THE WORK

.1 The Engineer shall establish reference points for construction which are necessary for the Contractor to proceed with the Work.

.2 The Contractor shall preserve and protect the established reference points and shall not modify or relocate the established reference points without the approval of the Engineer.

.3 Unless otherwise stated in the Contract Documents, the Contractor shall be responsible for:

(a) laying out the Work;

(b) Supply of stakes, markers and related tools and equipment.

.4 Regardless of the layout methodology, the Contractor shall verify the accuracy of the proposed location of the elements of the Work as indicated by the layout, prior to their construction, by measurements to legal property lines and existing physical features at the Project Site.

GC 22. CONSTRUCTION BY THE OWNER OR OTHER CONTRACTORS

.1 The Owner reserves the right to award separate contracts for work at the Project Site to Other Contractors and to perform work with its own forces.

.2 The Contractor shall cooperate and work with any Other Contractors, who are appointed by the Owner from time to time.

.3 When separate contracts are awarded by the Owner to Other Contractors for work at the Project Site, the Owner shall:

(a) provide for the coordination of the activities and work of Other Contractors with the Work;

(b) provide Notice to the Contractor as to whether the Contractor will be Prime Contractor for Safety in relation to some, or all of the work that is performed by Other Contractors; and

(c) where the Contractor is Prime Contractor for Safety for the area of the Project Site where work is to be performed by Other Contractors, contractually require that those Other Contractors adhere to the work rules and procedures established by the Contractor to ensure safety and the protection of Persons and the Work.

.4 When separate contracts are awarded for work at the Project Site or when work is performed at the Project Site by the Owner’s own forces, the Contractor shall:

(a) provide the Other Contractors with a reasonable opportunity to bring onto the Project Site and store their respective materials and to use their construction equipment and temporary work to execute their respective work;

(b) coordinate and schedule the Work with the work of Other Contractors;

(c) connect such other work with the Work as specified or shown in the Contract Documents;

(d) participate and assist with Other Contractors and the Owner in reviewing and coordinating the construction schedules of those Other Contractors; and

(e) where part of the Work is affected by, or depends upon for its proper execution, the work of Other Contractors, promptly provide Notice to the Engineer, prior to proceeding with that part of the Work, of any apparent deficiencies in such work. Failure by the Contractor to promptly provide Notice will invalidate any Claims of the Contractor against the Owner by reason of the deficiencies in the work of Other Contractors.

.5 When a Change is required as a result of:

(a) assignment of Prime Contractor for Safety status by the Owner with respect to Other Contractors; or

(b) coordination of, interference or damage to the work of Other Contractors; or

(c) connection of the work of Other Contractors with the Work,

the Changes will be dealt with in accordance with PART 11 CHANGES AND CONCEALED OR UNKNOWN CONDITIONS.

GC 23. SUSPENSION OF WORK BY OWNER

.1 The Owner may at any time suspend the Work or delay commencement thereof, or any portion thereof, provided he gives the Contractor ten (10) Business Days' Notice of suspension or delayed commencement. The Contractor shall resume Work upon Notice from the Owner within ten (10) Business Days after the date set forth in such Notice to resume Work.

.2 In the event that the Owner chooses to delay the commencement of the Work or any portion thereof or implement a temporary suspension:

(a) the Contract Time shall be adjusted by the Owner to account for the period of delay or suspension affecting the Work and any seasonal impact on the Work directly resulting from the delay or suspension; and

(b) the Owner shall reimburse the Contractor for direct and provable costs and expenses incurred by the Contractor necessitated by such delay or suspension of the Work or portion thereof, but the Contractor shall not recover from the Owner payment for any loss of profits or any other form of damages.

.3 If the delay or suspension of the Work lasts more than forty-five (45) Business Days, the Contractor may, at its option and on ten (10) Business Days' Notice, terminate the Contract as provided for in GC 50 CONTRACTOR'S RIGHT TO TERMINATE FOR DEFAULT. The Contractor shall not be permitted to terminate the Contract when only a portion of the Work is delayed or suspended.

.4 A suspension of the Work because of seasonal climatic conditions, whether ordered by the Owner or the Engineer or not, shall not be deemed to be a suspension of the Work within the meaning of GC 23.

.5 Except as provided by GC 23, the Owner shall not be liable in any way to the Contractor in relation to a suspension or delayed commencement of the Work, or any portion of the Work, and under no circumstances shall the Owner be liable for Consequential Damages as a result of suspension or delayed commencement of the Work pursuant to GC 23.

GC 24. TEMPORARY SUPPORTS, STRUCTURES AND FACILITIES

.1 The Contractor shall have the sole responsibility for the design, erection, operation, maintenance and removal of Temporary Work and the design and execution of construction methods required in its use.

.2 The Contractor shall engage and pay for professional engineer(s) registered and in good standing in the Province or Territory where the Project Site is located and skilled in the appropriate disciplines to perform those functions referred to in GC 24.1 where:

(a) required by the Law or by the Contract Documents; and

(b) in all cases where such Temporary Work and its method of construction are of such a nature that professional engineering skill is required to produce safe and satisfactory results.

.3 Despite any other provision of this Contract, where the Contract Documents include designs for Temporary Work or specify a method of construction in whole or in part, such Temporary Work shall be considered to be part of the design of the Work and the Contractor shall not be held responsible for that part of the design or the specified method of construction. The Contractor shall, however, be responsible for the execution of such design or specified method of construction in the same manner as for the execution of the Work.

.4 At least fifteen (15) Business Days before construction or location of Temporary Work the Contractor shall submit representative designs and sketches of Temporary Work to the Engineer as provided for in GC 31 SHOP DRAWINGS. The Engineer shall review the Temporary Work drawings and sketches for compatibility with the Work and for possibilities of impediments to the operations of Other Contractors and the safe passage of the public.

GC 25. CONSTRUCTION SCHEDULE

.1 The Contractor shall:

(a) within ten (10) Business Days of award of this Contract, prepare a draft Construction Schedule including all of the construction phases of the Work that shall incorporate:
    (i) the sequence and timing of the required major Project decisions;
    (ii) the timing of major activities of the Work and sufficient detail of the critical events and their inter-relationship to demonstrate that the Work will be performed in conformity with the Contract Time; and

(b) within the time referred to in GC 25.1(a) deliver to the Engineer the draft Construction Schedule and:
    (i) at a time agreed to by the Engineer, make a presentation of the draft Construction schedule to the Engineer;
    (ii) where the draft Construction Schedule cannot be accepted by the Engineer without revision, the Contractor shall promptly revise the draft Construction Schedule and deliver and re-present it to the Engineer repeating the process until

the draft Construction Schedule is accepted and becomes the Construction Schedule;

(iii) break-down the Construction Schedule into phases of the Work and show the Milestone Dates for the various phases;

(iv) use the Construction Schedule as the baseline schedule which will be identified and compared to all subsequent schedule revisions and updates;

(v) at least monthly, or as more frequently requested by the Engineer:

1. provide proposed updates to the Construction Schedule, which updates shall include:
   a. a monthly forecast of the planned progress of the Work;
   b. adjustments resulting from Change Orders and Change Directives; and
   c. identification of potential variances between the Construction Schedule and probable completion dates for all elements of the Work;
2. review all schedules for Work not started or completed and when required prepare and plan for mitigation measures and submit the mitigation plan in writing to the Engineer for review.

.2 Acceptance by the Engineer of the Construction Schedule shall not diminish or lessen the Contractor's obligations and responsibilities under this Contract, including the obligation to meet the Milestone Dates and achieve the Total Performance of the Work within the Contract Time.

.3 The time for performance of the Work shall commence on the date specified in the Notice to Proceed, or if not so specified, on the date that the Notice to Proceed is issued.

GC 26. SAFETY

.1 Unless expressly directed otherwise pursuant to GC 22 CONSTRUCTION BY THE OWNER OR OTHER CONTRACTORS, the Contractor shall be solely responsible for construction safety at the Project Site and in performing the Work, and for the Contractor's compliance and that of the Subcontractors with all Law and practices relating to health and safety. The Contractor shall be responsible for initiating, maintaining and supervising all safety programs, including the preparation of applicable hazard assessments, in connection with the performance of the Work.

.2 The Owner delegates and the Contractor accepts the role and responsibilities of the Prime Contractor for Safety for the entire Project Site until the Project Takeover Date of the entire Work. A partial takeover of the Project by the Owner shall not affect this delegation, unless Notice of a Change in the designation of the Contractor as Prime Contractor for Safety is provided by the Owner to the Contractor, in which case, the Contractor shall follow the directions of the Owner as set out in the Notice.

.3 In the event of any occurrence, circumstance or condition that caused, or has the potential to cause, injury or damage to any Person, property, reputation, security or the environment, the Contractor shall:

(a) immediately verbally notify the Owner and the Engineer of the same and follow up with prompt Notice providing details of the occurrence, circumstance or condition;

(b) keep the Owner and the Engineer informed and provide copies of all relevant documentation to the Owner and the Engineer of all developments, including medical status and anticipated recovery of any individuals involved, investigations by any Governmental Authority, reports prepared by or submitted by the Contractor or any Subcontractor and the laying of any charges;

(c) cooperate and ensure the cooperation of all Subcontractors with investigations, whether instigated by the Owner or any Governmental Authority, and provide copies of any investigations undertaken by the Contractor to the Owner; and

(d) prepare a corrective action plan in a time period agreed to by the Owner and the Engineer and provide a copy to the Owner and the Engineer.

.4 The Owner may, acting reasonably but at its sole and absolute discretion, for reasons of health and safety, cause parts of, or all of, the Work or Project to be stopped, or the Contractor or any of the Subcontractors to be removed or excluded from the Project Site. Such action shall not relieve the Contractor from its obligations under this Contract or otherwise affect the Contract Price, the Contract Time or give rise to any Claim by the Contractor against the Owner.

GC 27. SUPERINTENDENT AND KEY PERSONNEL

.1 The Contractor shall assign to the Project the Superintendent identified in Section 00 45 13 – Bidder’s Qualifications. The Superintendent shall remain assigned to the Project up to and including the achievement of Substantial Performance of the Work and shall dedicate substantially all of their full working time and attention to the Project. The Contractor shall ensure that the Superintendent is available at no additional cost for consultation and to provide direction during the correction of Deficiencies and performance of any Warranty Work. The Superintendent shall not be removed, re-assigned to another project or have their role changed on the Project without the prior written consent of the Engineer, unless such individual leaves the employment of the Contractor.

.2 The Superintendent shall represent the Contractor at the Project Site until all Deficiencies noted at the time of Substantial Performance of the Work have been corrected to the satisfaction of the Engineer. Notices and Construction Memos given to the Superintendent shall be held to have been received by the Contractor.

.3 The Engineer, may, with reasonable cause at any time during the performance of the Work, by Notice to the Contractor, require the replacement of the Superintendent identified in Section 00 45 13 – Bidder’s Qualifications or other supervisory Personnel assigned to the Work. Upon receipt of the Notice, the Contractor shall immediately make arrangements to appoint a replacement acceptable to the Engineer.

GC 28. SUBCONTRACTORS

.1 The Contractor shall:

(a) enter into written subcontracts with Subcontractors to require them to perform their Work as provided in the Contract Documents;

(b) ensure that the relevant portions of this Contract are incorporated into and form part of, the subcontracts entered into between the Contractor and its Subcontractors, including:

  (i) provisions equivalent to those set out in PART 10 TERMINATION so that in the event of any kind of termination or delay the Contractor is only required to pay its Subcontractors for those types of costs and expenses that the Owner is required to pay the Contractor and the Contractor shall indemnify the Owner from any other claim by any of its Subcontractors; and
  (ii) an obligation for Subcontractors to protect the Work, the Owner's property, property on or adjacent to the Project Site and Materials stored off the Project Site on terms equal to, or more favourable, than the terms set out in PART 6 PROTECTION OF PERSONS AND PROPERTY AND TOXIC OR HAZARDOUS SUBSTANCES.

.2 The Contractor shall employ only those Subcontractors listed in Section 00 43 36 – Subcontract List or others as approved in writing by the Engineer and shall not change or employ additional Subcontractors without the approval of the Engineer and the Owner, which approval shall not be unreasonably withheld. Such changes in Subcontractors shall not result in an adjustment to the Contract Price or Contract Time.

.3 The Owner, through the Engineer, may at any time during the performance of the Work object to the use of a Subcontractor and give Notice to the Contractor to employ a different Subcontractor that is satisfactory to the Owner.

.4 If the Owner requires the Contractor to change a proposed Subcontractor or Supplier pursuant to GC 28.3 for any reason other than reasonable cause, the Contract Price or Contract Time, or both as the case may be, shall be adjusted by the differences, if any, occasioned by such required Change.

.5 Unless a Subcontractor is specified in the Contract Documents, the Contractor shall not be required to engage as a Subcontractor, a Person to whom the Contractor reasonably objects.

.6 If a Subcontractor provides the Engineer with a copy of the relevant executed subcontract agreement, then the Owner, through the Engineer, may provide to a Subcontractor information as to the percentage of the Subcontractor's Work which has been certified for payment. The Owner and the Engineer shall inform the Contractor of any such communications.

GC 29. LABOUR AND MATERIALS

.1 The Contractor shall Supply all services, labour, Materials, tools, Construction Equipment, Temporary Work, water, heat, light, power, transportation, and other facilities and services, including temporary access, access roads, parking areas, laydown areas and utilities, necessary for the performance of the Work.

.2 Materials Supplied shall be new, fit for the purposes intended by the Owner and otherwise of the quality as depicted in and required by the Contract Documents. Materials that are not specified shall be of a quality consistent with those specified and their use confirmed in advance as being acceptable to the Engineer.

.3 Materials that are used in the performance of the Work, for construction or incorporation into parts of the Work that will be in contact with partially treated or potable water, including water retaining structures and piping, shall be compatible with potable water in accordance with all applicable health and environmental regulations. This shall include, but not be limited to, all sealants, waterproofing agents, form release agents, concrete accessories, and valve and pipe coatings and linings.

.4 Until such time as the Materials are incorporated into the Work, the Contractor shall be responsible for the safe and secure storage and preservation of Materials on the Project Site, or elsewhere if located off of the Project Site, so as to avoid damage, destruction, contamination, alteration, waste or spoilage to the Materials, injury to Persons, damage or destruction to property or delay to the Project resulting from such Materials.

.5 The Contractor shall maintain good order and discipline among the Contractor's Personnel, and the Subcontractor's Personnel engaged in the performance of the Work, and shall not employ, or permit to be employed, any Subcontractor not skilled in the tasks assigned.

GC 30. DOCUMENTS AT THE SITE

.1 The Contractor shall keep at least two (2) copies of current Contract Documents, permits, licenses, authorizations, submittals, reports, the Construction Safety Plan, together with documentation applicable to safety procedures and compliance with the OH&S Legislation and Workers Compensation Legislation, and minutes of meetings for the Work at the Project Site, in good order and available for review by the Owner and the Engineer.

.2 The Contractor shall ensure that record Drawings, Project Record Drawings, maintenance manuals, operating instructions, and such similar construction documents, are properly completed and handed over to the Engineer in a timely manner, or as otherwise required by the Owner. The Contractor shall not achieve Total Performance of the Work until all record Drawings, Project Record Drawings, maintenance manuals, operating instructions and such similar construction documents are complete and delivered to the Engineer.

.3 The Contractor shall ensure that all manufacturers' maintenance manuals, service agreements, warranties and guarantees are in order, and shall prepare a register of the same and deliver the register and the documents to the Engineer in a timely manner, or as otherwise required by the Owner, and in any event, before Total Performance of the Work.

GC 31. SHOP DRAWINGS

.1 In consultation with the Engineer, the Contractor shall establish and implement procedures for timely receipt, processing and review of Shop Drawings and samples. Upon request of the Engineer, the Contractor shall prepare a target schedule of dates for submission, review and return of Shop Drawings for the consideration of the Engineer.

.2 The Contractor shall Supply Shop Drawings as described in the Contract Documents or as the Engineer may reasonably request.

.3 The Contractor shall review all Shop Drawings prior to submission to the Engineer and shall represent by its review that:

(a) the Contractor has determined and verified all field measurements and field construction conditions and shall ensure that any Subcontractor submitting Shop Drawings has also determined and verified all field measurements and field construction conditions, Material requirements, catalogue numbers, and similar data; and

(b) the Contractor and the Subcontractor have checked and coordinated all Shop Drawings with the requirements of the Work and the requirements of the Contract Documents.

.4 The Contractor shall confirm this review of each of the Shop Drawings by stamp, date, and signature of the individual responsible. Shop Drawings not reviewed, stamped and signed by the Contractor may be rejected by the Engineer.

.5 The Contractor shall submit Shop Drawings to the Engineer to review in an orderly sequence, in accordance with any schedule that may be agreed to for the submission of Shop Drawings and sufficiently in advance of the need for reviewed Shop Drawings, so as not to cause any delay to the Construction Schedule or to the work of Other Contractors. At the time of submission, the Contractor shall provide Notice to the Engineer of any deviations in the Shop Drawings from the requirements of the Contract Documents.

.6 Upon the Engineer’s request, the Contractor shall revise and resubmit Shop Drawings which the Engineer rejects as inconsistent with the Contract Documents. The Contractor shall provide Notice to the Engineer of any revisions made to resubmitted Drawings other than those requested by the Engineer.

.7 If the Contractor Supplies the Shop Drawings in accordance with the schedule agreed upon, the Engineer shall review and return Shop Drawings in accordance with the schedule agreed upon, or otherwise with reasonable promptness. In the event that the Contractor believes that the Engineer is not promptly reviewing Shop Drawings submitted by the Contractor, the Contractor shall, within five (5) Business Days of such event occurring, provide Notice to the Engineer and the Owner setting out which Shop Drawings have not been promptly reviewed and the effect of such conduct. If the Contractor does not provide such Notice within the specified time, the Contractor shall have no Claim against the Owner for any reason relating to the conduct of the Engineer with respect to review of Shop Drawings.

.8 The Engineer’s review of Shop Drawings is for general conformity to the design concept, and for general arrangement only, and shall not relieve the Contractor of responsibility for errors or omissions in the Shop Drawings or for meeting all requirements of this Contract.

.9 The Engineer’s authority to review Shop Drawings shall be for the benefit of the Owner and such authority shall not give rise to any duty or responsibility of the Engineer or the Owner to the Contractor, Subcontractors or their Personnel or other Persons performing any of the Work.

.10 Shop Drawings that require approval of any Governmental Authority shall be submitted to such Governmental Authority by the Contractor for approval, prior to submission to the Engineer, so as not to adversely impact the Construction Schedule.

GC 32. STEWARDSHIP OF THE PROJECT SITE

.1 The Contractor shall confine Construction Equipment, Temporary Work, storage of Materials, waste products and debris and operations of Personnel and Subcontractors to limits indicated by Law, ordinances, permits or the Contract Documents, as applicable, and shall not unreasonably encumber or obstruct the Work or the Project Site.

.2 The Contractor shall not load, or permit to be loaded, any part of the Work with a weight or force or in any other manner that will endanger the safety of the Work or any Persons.

.3 The Contractor shall maintain the Work and the Project Site in a tidy condition free from the accumulation of waste products and debris, other than that resulting from the operations of the Owner or Other Contractors.

.4 The Contractor shall remove waste products and debris, other than that resulting from the operations of the Owner or Other Contractors, and shall leave the Work and the Project Site clean and suitable for occupancy on each applicable Project Takeover Date. The Contractor shall remove tools, Construction Equipment, and equipment not required for the performance of the remaining Work.

.5 In the event that any products or debris resulting from the operations of the Owner or Other Contractors affects the Work or safety on the Project Site, the Contractor shall immediately verbally inform the Engineer and the Owner and provide Notice to the same of such condition within one (1) Business Day thereafter.

.6 Prior to application for the final Payment Certificate, the Contractor shall remove tools, Construction Equipment, Temporary Work, and waste products and debris, other than that resulting from the work undertaken by the Owner or the Other Contractors.

PART 6 PROTECTION OF PERSONS AND PROPERTY AND TOXIC OR HAZARDOUS SUBSTANCES

GC 33. PROTECTION OF WORK AND PROPERTY

.1 In performing the Work the Contractor shall protect the Work and the Owner’s property and any other Person’s property from damage. The Contractor shall at the Contractor’s own expense make good any such damage which arises as the result of the Contractor’s operations.

.2 At no additional cost to the Owner and as part of the Work, the Contractor shall provide all safety devices, signage and supervision at the Project Site that are necessary to protect Personnel and the public.

.3 Before commencing any Work at the Project Site the Contractor shall:

(a) expose and determine conclusively the location in the field of all underground utilities and structures indicated on the Contract Documents as being at the Project Site;

(b) consult with all utility corporations that provide electricity, communication, gas or other utility services in the area of the Project Site, to expose and conclusively determine the location of all underground utilities;

(c) expose and conclusively determine the location of any other utilities or underground structures that are reasonably apparent or inferable in an inspection of the Project Site; and

(d) survey and record the location, in three dimensions, of underground structures exposed in accordance with GC 33.3; and

(e) provide the information obtained under GC 33.3 (d) to the Engineer.

.4 If any underground utility or structure located under GC 33.3 is in conflict with the Work as indicated on the Drawings, immediately provide Notice to the Engineer. If the resolution of the conflict requires a Change that increases or decreases the Contract Price or the Contract Time, then the provisions of GC 57 CONCEALED OR UNKNOWN CONDITIONS shall apply.

.5 The Contractor shall pay the costs to repair any underground utility or structure that the Contractor damages in the performance of the Work which the Contractor was required to locate under GC 33.3.

.6 If, in the performance of the Work the Contractor causes damage to an underground utility or structure:

(a) which was unknown or unforeseeable to the Contractor at the time of the damage; and

(b) that the Contractor was not required to locate pursuant to GC 33.3,

then such event may be considered a concealed or unknown condition and the provisions of GC 57 CONCEALED OR UNKNOWN CONDITIONS shall apply.

.7 Unless the Owner provides Notice to the Contractor stating otherwise, in the event of a shutdown or suspension of the Work, the Contractor shall continue to be responsible for the care, protection, security and maintenance of the Work during the period of the shutdown or suspension.

.8 The Contractor shall provide, at no additional cost to the Owner, adequate site security at all times during the performance of the Work. The Owner shall not be responsible for the costs of any theft, damage, alteration, loss or replacement.

GC 34. TOXIC OR HAZARDOUS SUBSTANCES

.1 Unless otherwise specified in the Contract Documents the Contractor shall assume that the Owner has elected not to conduct tests or investigations for Toxic or Hazardous Substances at the Project Site.

.2 Subject to the provisions of GC 34, the Owner bears the risk that the Contractor will encounter Toxic or Hazardous Substances at the Project Site.

.3 The Contractor has no obligation or duty to conduct tests or investigations for Toxic or Hazardous Substances at the Project Site unless the Engineer gives written directions regarding Toxic or Hazardous Substances that are discovered or suspected at the Project Site.

.4 If, in the performance of the Work the Contractor encounters any materials at the Project Site that the Contractor knows or suspects may be Toxic or Hazardous Substances then the Contractor shall immediately:

(a) stop the Work, or portion of the Work, and take such steps as required so that such materials are contained and not disturbed; and

(b) give written Notice to the Engineer, the Owner and all other parties as required by Law.

.5 If the Engineer observes any materials at the Project Site that the Engineer knows or suspects may be Toxic or Hazardous Substances then the Engineer shall immediately give written Notice to the Owner and the Contractor, and the Contractor shall immediately stop the Work or portion of the Work as required by GC 34.4.

.6 If materials are encountered that are or are suspected to be Toxic or Hazardous Substances and Notice is given either by the Contractor pursuant to GC 34.4, or by the Engineer pursuant to GC 34.5, then the Engineer shall after consulting with the Contractor give the Contractor written directions specifying what, if any, measures are to be taken on account of such materials so as to reasonably permit the Contractor to proceed with the Work. The Contractor shall strictly comply with any such directions.

.7 The Work shall be performed in full compliance with all Laws applicable to any Toxic or Hazardous Substances encountered at the Project Site.

.8 Any adjustment that the Contractor is required to make to the performance of the Work on account of suspected or confirmed Toxic or Hazardous Substances encountered by the Contractor at the Project Site and that were not identified in the Contract Documents shall be considered a concealed or unknown condition and the provisions of GC 57 CONCEALED OR UNKNOWN CONDITIONS shall apply.

.9 Unless stated otherwise in the Contract Documents, the remediation, treatment or removal of any Toxic or Hazardous Substances shall be a Change and the provisions of Part 11 CHANGES AND CONCEALED OR UNKNOWN CONDITIONS shall apply.

.10 Provided that the Contractor strictly complies with the requirements of GC 34 then the Owner shall indemnify the Contractor against any costs, expenses and damages that the Contractor is required by Law to pay to any third party (excluding Subcontractors) as a direct result of encountering any Toxic or Hazardous Substances in the performance of the Work at the Project Site.

.11 If the Contractor fails to notice any materials that a competent contractor reasonably experienced in the Work would have noticed were Toxic or Hazardous Substances, or fails to comply with a direction given by the Engineer pursuant to GC 34.5, then the Contractor shall:

(a) pay all reasonable additional costs the Owner is required by Law to incur to deal with any Toxic or Hazardous Substances that have been disturbed or permitted to escape as a direct result of such failure; and

(b) indemnify the Owner from any and all additional costs, expenses and damages that the Owner is required by Law to pay to any third party as a direct result of such failure.

.12 The Contractor shall not bring to the Project Site any Toxic or Hazardous Substances and the Contractor shall indemnify the Owner from any costs, expenses and damages the Owner is required by Law to pay as a result of the Contractor bringing any Toxic or Hazardous Substances to the Project Site.

.13 Nothing in GC 34 shall be interpreted to prohibit or prevent the Contractor from bringing to the Project Site any Toxic or Hazardous Substances such as fuel oil, or other materials that the Contractor is specifically, or by necessary and reasonable implication, permitted or required to bring onto the Project Site in order to perform the Work as required by the Contract Documents.

.14 In the event that Toxic or Hazardous Substances are used or placed in the Work or onto the Project Site by the Contractor, or any Person for whom the Contractor is responsible at Law, the Contractor shall take the necessary steps to ensure that no Person suffers injury, sickness, or death, and that no property is damaged or destroyed as a result of exposure to, or the presence of, such Toxic or Hazardous Substances.

PART 7 PAYMENT AND ALLOWANCES

GC 35. GENERAL PROVISIONS RELATING TO PAYMENT

.1 Payments shall be made to the Contractor in accordance with this PART 7 PAYMENT AND ALLOWANCES and, as applicable, Section 00 52 00 - Contract Agreement.

.2 No payment by the Owner under this Contract, or partial or entire use or occupancy of the Work by the Owner shall constitute an acceptance of any portion of the Work which is not in accordance with the requirements of the Contract.

GC 36. FINANCIAL INFORMATION REQUIRED OF THE CONTRACTOR

.1 At the request of the Owner, from time to time, the Contractor shall provide to the Owner, in writing, such financial or corporate information as may be reasonably required by the Owner, to establish or confirm the ability of the Contractor to perform its obligations pursuant to this Contract.

.2 The Contractor shall keep the Owner apprised of any material or significant changes in the ownership or financial position of the Contractor which take place or are to take place during the term of this Contract or which may in any manner adversely impact on the Contractor’s ability to perform its obligations in a timely, competent or complete manner.

GC 37. PROGRESS PAYMENTS

.1 Within five (5) Business Days after the end of a calendar month the Engineer shall prepare and issue to the Owner a Payment Certificate for the period ending the last calendar day of the month.

.2 The Payment Certificate shall set out as of the end of last calendar day of the preceding month:

(a) the total value of the Work completed and the Materials incorporated into the Work;

(b) the total Quantities, or the percent complete for each pay item;

(c) all holdback amounts if any;

(d) the total amount owing by the Owner to the Contractor;

(e) any liquidated damages or other deductions; and

(f) set offs permitted by the Contract Documents.

.3 The Engineer shall not finalize a Payment Certificate without consulting with the Superintendent about the Quantities and amounts to be included in a Payment Certificate.

.4 The period referred to in GC 37.1 for the issuance of the Payment Certificate may be extended by any time that the Contractor takes to provide the consultation to the Engineer, or to provide any supporting documentation the Engineer requires to finalize the Payment Certificate.

.5 If the Engineer does not agree with the Superintendent regarding any aspect of the Payment Certificate then the Engineer shall without delay:

(a) prior to issuing the Payment Certificate, fully advise the Superintendent of the reasons for the disagreement; and then

(b) issue the Payment Certificate to the Owner, with a copy to the Contractor, in the amounts the Engineer determines are correct.

.6 The Contractor shall provide to the Engineer all documentation as required by the Contract Documents in support of the completed portion of the Work and Materials covered by the Payment Certificate including inspection reports, invoices, weigh tickets and daily Force Account records.

.7 If requested in writing by the Engineer the Contractor shall, as a precondition to the issuance of the Payment Certificate, provide a sworn declaration in a form acceptable to the Engineer that all amounts relating to the Work, due and owing to third parties, including all Subcontractors and Suppliers, as of the end of the month previous to that covered by the Payment Certificate, have been paid.

.8 Except for materials or products which are identified in the Contract Documents as being “Supply Only”, payments shall not be made for materials or products purchased by the Contractor but not fully incorporated into the Work at the Project Site.

.9 Subject to GC 44 WITHHOLDING OF PAYMENT AND SET OFF, the Owner shall make payment to the Contractor of amounts due by the Owner no later than twenty (20) Business Days after the receipt by the Owner of the Payment Certificate as issued by the Engineer.

.10 All Payment Certificates issued by the Engineer shall be to the best of the Engineer's knowledge, information, and belief.

.11 The monthly progress Payment Certificates shall not bind the Owner or Engineer in any manner in the preparation of subsequent Payment Certificates or the final progress Payment Certificate, but shall be construed and held to be approximate only. By issuing any Payment Certificate, the Engineer does not assume any of the responsibility of the Contractor with respect to the correctness or completeness of the Work, including the Contractor's responsibility to ensure that the Work has been completed in accordance with the Contract Documents.

GC 38. PROGRESS PAYMENT HOLDBACKS

.1 The Owner shall:

(a) hold back 10%, or other percentage as required by the Lien Act, of any amounts net of value-added taxes due to the Contractor, including those amounts due for payment for Work performed after Substantial Performance of the Work; and

(b) if the Project Site is a highway, Indian reserve or other lands that cannot be liened, then, notwithstanding that a lien cannot be registered against the Project Site, hold back the percentage that would have been required if the Lien Act did apply of any amounts due to the Contractor as a lien holdback, on the same conditions as though such holdback was a requirement of the Lien Act, including making payment from such holdback directly to Subcontractors.

.2 In addition to other holdbacks as provided by the Contract Documents, the Owner may hold back from payments otherwise due to the Contractor amounts as determined by the Engineer pursuant to GC 44 WITHHOLDING OF PAYMENT AND SET OFF, on account of deficient or defective Work already paid for. This holdback may be held, without interest, until such deficiency or defect is remedied.

.3 If after Substantial Performance of the Work is achieved the Contractor is unable to complete any portion of the Work because of climatic or other conditions beyond the Contractor's reasonable control then the Owner may hold back from payments otherwise due to the Contractor the amount, as estimated by the Engineer, by which the cost to have others complete the Work exceeds the Contract Prices for such completion work.

.4 The Contractor shall assist the Owner to establish a holdback account pursuant to the Lien Act, if required to be established under the Lien Act, at a savings institution acceptable to the Owner, including preparing and completing any and all documents and forms as the savings institution may require. Any Notice issued by the Contractor upon the Owner's failure to pay into the holdback account the amount the Owner is required to retain under the Lien Act shall be given in writing to the Engineer.

GC 39. QUANTITIES

.1 The estimate of Quantities shown in the Section 00 41 00 - Bid Form serves only to provide a basis for comparing bids and no representations have been made by either Owner or Engineer that the actual Quantities will even approximately correspond therewith.

.2 The Owner has the right to increase or decrease the Quantities in any or all items and to eliminate items entirely from the Work.

.3 Where there is a discrepancy between the measurement or calculations made by or for the Contractor to establish the Quantities and the measurement or calculations made by the Engineer to establish the Quantities, the Quantities shall be deemed to be the measurement made by the Engineer.

.4 Where the Quantities are disputed by the Contractor, upon request of the Contractor, the Parties will exchange their data, surveys and other information as the same relates to the measurements and calculations.

.5 If after reviewing the Engineer's data, surveys and other information the Contractor still disputes the Quantities, the Contractor may dispute the Quantities by providing Notice to the Engineer, within ten (10) Business Days of the Engineer providing its data, surveys and other information to the Contractor, stating:

(a) that it disagrees with the Quantities; and

(b) its measurements and calculation of the Quantities.

.6 If Notice is provided by the Contractor as set out in GC 39.5, the Parties shall take the necessary steps to have the Dispute resolved in accordance with PART 12 DISPUTE RESOLUTION. In the event that the Contractor does not provide Notice to the Engineer as set out in GC 39.5, the Contractor shall be deemed to have waived all of its rights to dispute the Quantities.

GC 40. SUBSTANTIAL PERFORMANCE OF THE WORK

.1 The Engineer shall be the payment certifier responsible for payment certification as required by the Lien Act for the Contractor. The Contractor shall be the Person responsible for payment certification as required by the Lien Act for all Subcontractors.

.2 When the Contractor considers that it has achieved Substantial Performance of the Work, the Contractor shall prepare and submit to the Engineer:

(a) a written application from the Contractor for a Certificate of Substantial Performance; and

(b) written confirmation that upon payment in the amount applied for, that the Contractor has no further Claim against the Owner for the Work, for any reason, except to the extent of any Claims for which the Contractor has previously provided Notice to the Owner and the Engineer.

.3 The Engineer will, no later than ten (10) Business Days after the receipt of a written application from the Contractor for a Certificate of Substantial Performance make an inspection and assessment of the Work to verify the validity of the application. The Engineer will prepare and issue a comprehensive list of items to be completed or corrected, and either:

(a) issue the Certificate of Substantial Performance, or

(b) if the Engineer determines that Substantial Performance of the Work has not been achieved, consult with the Contractor and advise the Contractor of the Work required to achieve Substantial Performance of the Work.

.4 Failure to include an item on the comprehensive list of items described in GC 40.3 does not alter the responsibility of the Contractor to complete the Work or remedy, correct or rectify any Deficiencies.

.5 If the Engineer determines that Substantial Performance of the Work has not been achieved, the Owner may deduct the cost of the inspection and assessment by the Engineer from payments otherwise due to the Contractor.

.6 The Contractor may, after performing the required Work, re-apply for the Certificate of Substantial Performance, and the provisions of GC 40 shall apply to the re-application.

.7 The Engineer shall include the date of Substantial Performance of the Work in the Certificate of Substantial Performance.

.8 The Contractor shall promptly post a copy of the Certificate of Substantial Performance at a prominent and visible location at the Project Site.

GC 41. RELEASE OF MAJOR LIEN FUND HOLDBACK

.1 Upon the expiry of the statutory time for filing liens under the Lien Act, the Contractor shall submit the following documents to the Engineer:

(a) an application for payment of the holdback amount;

(b) a sworn declaration in a form acceptable to the Engineer to state that all accounts for labour, subcontracts, Materials, Construction Equipment, and other indebtedness which may have been incurred by the Contractor in the Substantial Performance of the Work and for which the Owner might in any way be held responsible have been paid in full, except for amounts properly retained as a holdback or as an identified amount in dispute; and

(c) documents satisfactory to the Engineer showing compliance with the applicable Workers Compensation Legislation at the Project Site including payments due thereunder.

.2 After the receipt of an application for payment from the Contractor and the accompanying documents as provided in GC 41.1, the Engineer will issue a Payment Certificate for payment of the holdback amount.

.3 The Owner shall pay any lien holdback as required by the Lien Act, or on such other date as required by Law, but the Owner may set off from the holdback payment the amounts for any Deficiencies or filed liens as provided in GC 44 WITHHOLDING OF PAYMENT AND SET OFF.

GC 42. TOTAL PERFORMANCE OF THE WORK AND FINAL PAYMENT

.1 When the Contractor considers that it has achieved Total Performance of the Work, the Contractor shall prepare and submit to the Engineer:

(a) a written application from the Contractor for a Certificate of Total Performance; and

(b) written confirmation that upon payment in the amount applied for, that the Contractor has no further Claim against the Owner for the Work, for any reason, except to the extent of any Claims for which the Contractor has previously provided Notice to the Owner and the Engineer.

.2 The Engineer will, no later than ten (10) Business Days after the receipt of a written application from the Contractor for a Certificate of Total Performance make an inspection and assessment of the Work to verify the validity of the application, and either:

(a) issue the Certificate of Total Performance, or

(b) if the Engineer determines that Total Performance of the Work has not been achieved, the Engineer will prepare and issue a comprehensive list of items to be completed or corrected to achieve Total Performance of the Work.

.3 Failure to include an item on the comprehensive list of items described in GC 42.2(b) does not alter the responsibility of the Contractor to complete the Work or remedy, correct or rectify any Deficiencies.

.4 If the Engineer determines that Total Performance of the Work has not been achieved, the Owner may deduct the cost of the inspection and assessment by the Engineer from payments otherwise due to the Contractor.

.5 The Contractor may, after performing the required Work, re-apply for the Certificate of Total Performance, and the provisions of GC 42 shall apply to the re-application.

.6 The Engineer shall include the date of Total Performance of the Work in the Certificate of Total Performance.

.7 No later than ten (10) Business Days after issuance of the Certificate of Total Performance, the Engineer shall issue to the Contractor, a draft Payment Certificate for final payment, for the Contractor’s review and agreement. If after reviewing the Engineer’s Payment Certificate the Contractor disputes the Quantities or the payment amount, the provisions of GC 39 QUANTITIES will apply.

.8 If after reviewing the Engineer’s Payment Certificate the Contractor agrees with the Quantities and the payment amount, then no later than five (5) Business Days after receipt from the Contractor of Notice that the Contractor agrees with the Payment Certificate for final payment, the Engineer shall issue to the Owner, a Payment Certificate for final payment in the amount that the Engineer determines to be properly due.

.9 Subject to GC 44 WITHHOLDING OF PAYMENT AND SET OFF, the Owner shall make payment to the Contractor of amounts certified as due by the Engineer, no later than twenty (20)

Business Days after receipt of the Engineer's Payment Certificate for final payment and attainment of all of the following conditions:

(a) Total Performance of the Work has been achieved by the Contractor, verified by the Engineer and approved by the Owner;

(b) the period designated for the release of holdback pursuant to the Lien Act from the date of Substantial Performance of the Work has expired;

(c) no liens have been registered arising from the Work;

(d) there are no claims that have been made against the Owner by any Person other than the Contractor, arising from the performance of the Work.

GC 43. RELEASE OF MINOR LIEN FUND HOLDBACK

.1 Upon the expiry of the statutory time for filing liens under the Lien Act, the Contractor shall submit the following documents to the Engineer:

(a) an application for payment of the holdback amount;

(b) a sworn declaration in a form acceptable to the Engineer to state that all accounts for labour, subcontracts, Materials, Construction Equipment, and other indebtedness which may have been incurred by the Contractor in the Total Performance of the Work and for which the Owner might in any way be held responsible have been paid in full, except for amounts properly retained as a holdback or as an identified amount in dispute; and

(c) documents satisfactory to the Engineer showing compliance with the applicable Workers Compensation Legislation at the Project Site including payments due thereunder.

.2 After the receipt of an application for payment from the Contractor and the accompanying documents as provided in GC 43.1, the Engineer will issue a Payment Certificate for payment of the holdback amount.

.3 The Owner shall pay any lien holdback as required by the Lien Act, or on such other date as required by Law, but the Owner may set off from the holdback payment the amounts for any Deficiencies or filed liens as provided in GC 44 WITHHOLDING OF PAYMENT AND SET OFF.

GC 44. WITHHOLDING OF PAYMENT AND SET OFF

.1 Subject to GC 44.2, if for any reason there are any Deficiencies, any portion of the Work that is not performed or there is any claim by a third party made against the Owner arising from the Work, the Owner may withhold from payment to the Contractor such amounts as the Engineer determines are sufficient and reasonable to cover the cost of rectification, completion or resolution, until the Deficiencies are rectified, the Work is completed or such claim is resolved.

.2 The cost of rectifying Deficiencies or completing Work not performed shall be estimated by the Engineer and a value equivalent to twice that amount shall be withheld from any payment.

Subject to any other right the Owner may have, the holdback amount shall be paid to the Contractor after proper rectification of all the Deficiencies and completion of all Work.

.3 In preparing the estimate referred to in GC 44.2, the Engineer shall not be bound by the Contractor's unit prices and shall estimate the cost of rectifying Deficiencies or completing Work using his sole judgement of the influence of prevailing circumstances.

.4 Notwithstanding any other provision of this Contract, the Owner shall be entitled to withhold and set-off against any monies otherwise due and payable to the Contractor under this Contract, any sums which the Owner is permitted to withhold either pursuant to this Contract or to any other agreement between the Owner and the Contractor, howsoever arising.

GC 45. PROGRESSIVE RELEASE OF HOLDBACK TO SUBCONTRACTORS AND SUPPLIERS

.1 Where provided by the Lien Act and if the Contractor has certified that the work of a Subcontractor or Supplier is substantially or totally performed, upon application by the Contractor accompanied by the documents listed in GC 45.2 and expiry of the statutory time for filing liens under the Lien Act the Owner shall pay the Contractor the holdback amount retained for such subcontract work, or for the Materials supplied by such Supplier.

.2 Applications to the Engineer by the Contractor for progressive release of holdback to Subcontractors or Suppliers shall be accompanied by the following documents:

(a) A Certificate of Substantial or Total Performance of the subcontract work or supply contract, as the case may be, prepared by the Contractor in a form acceptable to the Engineer;

(b) a sworn declaration in a form acceptable to the Engineer to state that all accounts for labour, subcontracts, Materials, Construction Equipment, and other indebtedness which may have been incurred by the Subcontractor or Supplier, as the case may be, in the Substantial or Total Performance of the subcontract work, or the supply contract, as the case may be, and for which the Owner or Contractor might in any way be held responsible, have been paid in full, except for amounts properly retained as a holdback or as an identified amount in dispute;

(c) documents satisfactory to the Engineer showing compliance by the Subcontractor or Supplier, as the case may be, with the applicable Workers Compensation Legislation at the Project Site including payments due thereunder; and

(d) written confirmation that upon payment in the amount applied for, that the Subcontractor or Supplier, as the case may be, has no further Claim against the Contractor for subcontract work or Materials for any reason, except to the extent of any claims for which the Subcontractor or Supplier has previously provided Notice to the Contractor.

.3 After the receipt of an application for payment from the Contractor and the accompanying documents as provided in GC 45.2, the Engineer will issue a Payment Certificate for payment of the holdback amount.

.4 The Owner shall pay any lien holdback as required by the Lien Act, or on such other date as required by Law, or twenty (20) Business Days after receipt of the documents listed in GC 45.2 that are satisfactory to the Engineer, whichever is the latest.

.5 Progressive release of holdback to Subcontractors and Suppliers as provided for in GC 45 shall not affect the Warranty Period. The Warranty Period for the Work shall commence as provided for in GC 63 WARRANTY.

PART 8 TAXES AND DUTIES

GC 46. RESPONSIBILITY FOR TAXES AND DUTIES

.1 The Contract Price includes all customs duties and taxes, except Goods and Services Tax (GST) or Harmonized Sales Tax (HST) or provincial sales taxes (PST), in effect at the time of the execution of this Contract.

.2 The Contractor shall be responsible to pay all taxes.

.3 The amount of GST, HST or PST payable by the Owner on goods and services provided under this Contract is in addition to the Contract Price and is to be shown on a separate line on Payment Certificates.

.4 If the Owner is exempt from GST, HST or PST, a Certificate of Exemption will be issued to the Contractor following issuance of the Notice of Award.

.5 The Contract Price shall include any tax rebates which may be applicable under current legislation. Upon request by the Contractor, the Owner shall provide certificates, in support of the Contractor's rebate submission to a Governmental Authority. The Owner shall not be liable to compensate the Contractor for any tax rebates that are denied by Governmental Authorities.

.6 In the event that new or additional duties or taxes in respect of the Work are applicable or required by the Law after this Contract is executed, the Contract Price shall be adjusted to include such new or additional taxes and duties, if applicable.

PART 9 TIMELY CONSTRUCTION

GC 47. DELAY

.1 Subject to the limitations and requirements expressly stated in GC 47, and the Contractor’s obligation to mitigate the impact of any delay, if the Contractor is delayed in the performance of the Work:

(a) due to an action or omission of the Owner, the Engineer or any Person for whom the Owner is responsible at Law;

(b) by a “stop work” or similar order issued by a court or Governmental Authority, and providing that such order was not issued as the result of an act or fault of the Contractor or any Person for whom the Contractor is responsible at Law;

(c) where Changes to the Work are made as provided for in PART 11 CHANGES AND CONCEALED OR UNKNOWN CONDITIONS;

(d) where the Work is suspended or delayed in commencement as provided for in GC 23 SUSPENSION OF WORK BY OWNER;

(e) where the Work is delayed on account of the Owner not providing the Project Site, or not obtaining easements or rights-of-way;

(f) where the Work is delayed on account of conditions which could not have been foreseen or which were beyond the control of the Contractor and which were not the result of fault or negligence of the Contractor or any Person for whom the Contractor is responsible at Law;

(g) where the Work is delayed on account of Abnormal Weather;

(h) where the Engineer causes delay in providing Drawings or necessary information;

(i) where, in the opinion of the Engineer, the Contractor is entitled to an extension of Contract Time;

(j) where strikes, lockouts, or labour disputes prevent or substantially interfere with the progress of the Work,

then provided the Engineer determines that there is no concurrent delay that has been caused by the Contractor or any Person for whom the Contractor is responsible at Law, the Contract Time shall be extended for such reasonable time as is appropriate to account for the delay directly associated with the causes set out above, but not including concurrent delays caused by the Contractor or any Person for whom the Contractor is responsible at Law, as the Engineer, in the first instance, determines, or as may be subsequently determined in accordance with PART 12 DISPUTE RESOLUTION.

.2 No extension of the Contract Time shall be made and no adjustment in the Contract Price shall be made for any delay except for a delay described in GC 47.1 and then only if the Contractor provides Notice, in accordance with GC 47.4, of such a Claim to the Engineer within five (5) Business Days after the occurrence of the event which has caused the delay.

.3 Except as expressly provided within these General Conditions, the granting of an extension of Contract Time pursuant to GC 47 shall not give the Contractor grounds to make any Claims whatsoever for additional payment, except on the grounds set out in GC 47.1 items (b), (c), (d) or (e).

.4 The Notice prescribed by GC 47.2 must:

(a) contain sufficient detail to provide the Engineer with the opportunity to identify the cause of the delay and to take steps to mitigate the impact of such delay;

(b) be provided by the Contractor to the Engineer with respect to each and every event of delay; and

(c) be provided as a separate Notice.

.5 Knowledge by the Owner or the Engineer of any delay, or the impact of any delay, shall not constitute a waiver of the requirement for the Contractor to provide Notice in accordance with GC 47.2.

.6 The failure to provide separate express Notice in strict compliance with GC 47 shall be deemed to be prejudicial to the Owner and shall prohibit the Contractor from claiming, or being entitled to, any Claim for adjustment to the Contract Time or Contract Price with respect to such delay or any impact of such delay.

.7 In the event of a delay the Contractor shall take all reasonable measures to minimize the effects and the costs of the delay and this obligation shall be taken into account in the determination of the Contractor's entitlement to an extension of the Contract Time and reimbursement of delay costs, if any.

.8 The Owner shall not be liable for any penalties or claims by third parties incurred or suffered by the Contractor and under no circumstances shall the Owner be liable for Consequential Damages, as a result of delay pursuant to GC 47.

.9 If the Contractor is delayed in the performance of the Work by its own acts or omissions or those of its Personnel or Subcontractors, then the Contractor will not be entitled to any time extension or additional payment as a result of such delay.

.10 No extension of Contract Time shall be made and no adjustment in the Contract Price shall be made for any delay Claim that is based on the concept of the cumulative effect of multiple Changes.

GC 48. LATE COMPLETION

.1 The Contractor acknowledges that if the Contractor fails to complete the Work within the Contract Time or fails to meet a specified Milestone Date for any part of the Work, the Owner will incur additional administrative and overhead costs and will be required to pay additional compensation to the Engineer (collectively "Additional Overhead"). The Contractor agrees that in the event the Contractor fails to complete the Work within the Contract Time or fails to meet a specified Milestone Date for any part of the Work, the Owner may deduct from any monies owing to the Contractor for the Work, as a genuine pre-estimate of the Owner's Additional Overhead, the amount specified in the Supplementary Conditions for each Working Day the Work or any portion of the Work remains incomplete after the applicable Contract Time or Milestone Date.

.2 The rights set out in GC 48.1 are in addition to any other rights the Owner may have and are in no way exclusive. The Contractor acknowledges that in the event no amount for Additional Overhead is specified in the Supplementary Conditions the Owner may seek to recover from the Contractor any loss and damages suffered or incurred in respect of Additional Overhead, in addition to any other claim the Owner may have at law.

.3 No bonus will be allowed by the Owner for completion of the Work in less than the Contract Time.

PART 10 TERMINATION

GC 49. OWNER'S RIGHT TO TERMINATE FOR DEFAULT

.1 If the Contractor is unable to pay its lawful debts as they come due, is adjudged bankrupt, makes a proposal pursuant to the *Companies' Creditors Arrangement Act*, commits or threatens to do any act of bankruptcy, commits or seeks to liquidate or is involved in any similar action under any Law relating to bankruptcy or insolvency, the Owner may, without prejudice to any other right or remedy it has, terminate this Contract by giving the Contractor, trustee, monitor or receiver Notice that this Contract will be terminated immediately and that the applicable provisions of GC 49 apply.

.2 If the Contractor neglects to proceed with, undertake or complete any aspect of the Work promptly or properly, or otherwise fails to comply with the requirements of this Contract, the Owner may, without prejudice to any other right or remedy the Owner may have, give Notice to the Contractor that the Contractor is in default of the Contractor's contractual obligations and instruct the Contractor to correct the default within five (5) Business Days immediately following the receipt of the Notice.

.3 If the default cannot be corrected within the five (5) Business Days specified, the Contractor shall be in compliance with the Owner's instructions if the Contractor:

(a) commences the correction of the default in a manner acceptable to the Owner, within a different time agreed to by the Owner;

(b) provides the Owner with a written plan and schedule acceptable to the Owner for such correction; and

(c) corrects the default in accordance with such schedule.

.4 If the Contractor fails to correct the default in accordance with GC 49.2 or as subsequently agreed upon pursuant to GC 49.3, without prejudice to any other right or remedy the Owner may have, the Owner may, without further Notice to the Contractor, do one or both of the following:

(a) immediately correct such default and deduct the cost thereof, including any costs incurred by the Owner, from any payment then or thereafter due to the Contractor, provided that the Engineer has certified such cost as due to the Owner; or

(b) immediately terminate the Work, in whole or in part, or terminate this Contract, in whole or in part.

.5 In the event of default under GC 49, the Owner shall have the option, to be exercised in its absolute discretion, to terminate the right of the Contractor to perform all or any part or parts of the Work and permit the Contractor to continue to perform the rest of the Work.

.6 If the Owner terminates the Work, in whole or in part, or terminates this Contract, in whole or in part, whether pursuant to GC 49.1, GC 49.4 or GC 49.5, or otherwise:

(a) the Owner shall be entitled to take possession of the Work and Materials, and use the Construction Equipment and Temporary Work at the Project Site, subject to the rights of third parties, and finish the Work by whatever method the Owner may consider proper or expedient;

(b) the Owner shall be entitled to withhold further payment to the Contractor until the total cost of construction of the Work and all backcharges to the Contractor are known; and

(c) in addition to any other amount that may be owing under this Contract, the Contractor shall be liable to the Owner for the amount by which the following items added together exceed the Contract Price:
  (i) the total cost of construction of the Work;
  (ii) a reasonable allowance or amount, as determined by the Engineer, to cover the cost of Warranty Work;
  (iii) a reasonable allowance or amount, as determined by the Engineer, to compensate the Engineer;
  (iv) the costs and expenses both external and internal and including actual legal fees, disbursements and taxes incurred by the Owner for its additional services related to the termination of the Work, in whole or in part, or termination of this Contract, in whole or in part.

.7 In the event that the Owner terminates the Work in part or terminates this Contract in part, the Owner shall be entitled to apply GC 49.6 with an appropriate adjustment for the portion of the Work involved and the portion of the Contract Price attributable to that portion of the Work.

.8 The Owner shall not be liable for those costs incurred by the Contractor as a result of the termination.

.9 The Owner shall not be liable for any penalties or claims by third parties incurred or suffered by the Contractor and under no circumstances shall be liable for Consequential Damages as a result of termination pursuant to GC 49 and the Contractor shall indemnify and hold the Owner and its Personnel, including the Engineer, harmless from and against any such penalties or claims.

GC 50. CONTRACTOR'S RIGHT TO TERMINATE FOR DEFAULT

.1 If the Owner is adjudged bankrupt, makes a proposal pursuant to the *Companies' Creditors Arrangement Act*, commits or threatens to do any act of bankruptcy, commits or seeks to liquidate or is involved in any similar action under any Law relating to bankruptcy or insolvency, the Contractor may, without prejudice to any other right or remedy it has, terminate this Contract by giving the Owner, trustee, monitor or receiver Notice that this Contract will be terminated immediately and that the applicable provisions of GC 50 apply.

.2 If the Work is stopped or otherwise delayed for a period of forty-five (45) Business Days or more as provided for in GC 23 SUSPENSION OF WORK BY OWNER or under an order or decision of a court or decision of another Governmental Authority, and providing that such order was not issued as the result of an act or fault of the Contractor or any Person for whom the Contractor is responsible at Law, the Contractor may terminate the Work without prejudice to any other right or remedy the Contractor may have, by giving the Owner Notice five (5) Business Days prior to such termination. The Contractor shall not be permitted to terminate the Contract when only a portion of the Work that is incomplete is delayed or suspended until forty-five (45) Business days after the Work, except for that portion which is suspended or delayed, is substantially completed.

.3 The Contractor shall provide Notice to the Owner, with a copy to the Engineer, if the Owner is in default of its contractual obligations to pay the Contractor when due the amounts certified by the Engineer or awarded by a court of competent jurisdiction. The Notice shall state that if the default is not corrected in the thirty (30) Business Days immediately following the receipt of the Notice, the Contractor may, without prejudice to any other right or remedy it may have, stop the Work or terminate this Contract.

.4 If the Contractor terminates this Contract under the conditions set out in GC 50.1 or GC 50.2, the Contractor shall be entitled to be paid for all of the Work that has been properly performed in accordance with this Contract to the date of termination and which has not been paid for or reimbursed to that date, and such other costs and expenses that the Contractor may have sustained as a direct result of the Owner's default which the Engineer considers to be reasonable and which are supported by auditable documentation, but shall not be entitled to any claims for Consequential Damages.

.5 The Owner shall not be liable for any penalties or claims incurred or suffered by the Contractor and under no circumstances shall be liable for Consequential Damages as a result of termination pursuant to GC 50 and the Contractor shall indemnify and hold the Owner and its Personnel, including the Engineer, harmless from and against any such penalties or claims.

GC 51. TERMINATION FOR CONVENIENCE

.1 The Owner, in its sole discretion, shall have the right, which may be exercised at any time, to terminate all or a portion of the Work or this Contract, without reason or cause, by giving not less than twenty (20) Business Days' Notice to the Contractor.

.2 If the Work or this Contract is terminated by the Owner pursuant to GC 51.1, the Contractor shall be entitled to:

(a) the portion of the Contract Price owed but unpaid to the date of termination, computed in accordance with this Contract; and

(b) reasonable costs incurred by the Contractor in terminating the Work or this Contract, including the cost of materials that cannot reasonably be returned to their Supplier and any return-to-supplier costs.

.3 If the Work or this Contract is terminated by the Owner pursuant to GC 51, the Owner shall not be liable to the Contractor for any claims or Consequential Damages or any amounts other than as stated in GC 51.2, as applicable, except as expressly provided for herein, and the Contractor shall indemnify and hold harmless the Owner, its Personnel, including the Engineer, from any such claims for amounts not provided for in GC 51.

GC 52. OBLIGATIONS ON TERMINATION

.1 If the Owner terminates the Work, in whole or in part, or terminates this Contract, in whole or in part, whether pursuant to GC 49.1, GC 49.4 or GC 49.5 OWNER'S RIGHT TO TERMINATE FOR DEFAULT, or otherwise, the Contractor shall:

(a) subject always to considerations of safety and of the environment, immediately discontinue performance of the Work, except to the extent as may be necessary to carry out such discontinuance, and ensure that its operations and activities are brought to an orderly conclusion and that demobilization occurs in a proper and careful fashion with due attention being given to public safety and the protection of the Project and the Work;

(b) comply in full with the Owner's instructions regarding the termination;

(c) take such steps as may be necessary or desirable to minimize the costs to the Owner associated with the termination;

(d) promptly deliver to the Owner all of the deliverables and the Owner's Confidential Information and intellectual property, including the originals and all copies and all other documents required by the Owner;

(e) take all steps required by the Owner, to assign to and fully vest in the Owner the rights and benefits of the Contractor under all subcontracts with its Subcontractors and any licenses, warranties or guarantees for the Project; and

(f) assign to the Owner, or its nominee, as directed, rights and titles relating to all Materials for which the Contractor has been paid or will be paid through the termination process.

.2 The Contractor's obligations as to quality, correction, and warranty of the Work performed by the Contractor up to the date of termination shall continue in force after such termination. If Substantial Performance of the Work has not been reached by the date of termination, the Warranty Period shall nevertheless be deemed to commence from the date of Substantial Performance of the Work.

.3 Notwithstanding any other provision of this Contract, termination of this Contract in any manner by the Owner shall not limit, affect or invalidate in any manner:

(a) those provisions of this Contract for the benefit of the Owner which, expressly or by implication, are to operate or have effect after termination;

(b) any right of action the Owner may have as at the date of termination; or

(c) any other right or remedy the Owner may have as a consequence of the Contractor's default and the resulting termination of this Contract.

PART 11 CHANGES AND CONCEALED OR UNKNOWN CONDITIONS

GC 53. CHANGES

.1 The Owner, through the Engineer, without invalidating this Contract, may make Changes at any time.

.2 The Contractor shall not perform a Change without a written Change Order or Change Directive signed by the Owner and issued by the Engineer.

.3 The Contractor shall advise the Engineer of the effect a Contemplated Change Notice will have on the Contract Price and the Contract Time within five (5) Business Days of receipt of the Contemplated Change Notice, or within such other time period as may be agreed by the Parties.

.4 Where both additions and deletions are involved in a Change Order all calculations for profits and overhead shall be determined on a net basis for that Change Order.

.5 The Owner shall make the final determination as to whether any Change is to be implemented.

.6 It is intended in all matters related to Changes that the Owner, the Engineer and the Contractor shall act promptly so as not to adversely impact the Construction Schedule.

.7 No further claim for change in Contract Time, Contract Price or for delay, extended schedule, direct, indirect or impact of costs, or other such claims, shall be accepted as having resulted from a Change Order after it has been accepted by the Owner.

GC 54. CONTEMPLATED CHANGE NOTICES AND CHANGE ORDERS

.1 When a Change is proposed or required, the Engineer shall provide a Contemplated Change Notice describing the proposed Change to the Contractor. If, due to exceptional circumstances, a Contemplated Change Notice cannot be issued by the Engineer, the Owner or the Engineer may issue a Change Directive as provided by GC 55 CHANGE DIRECTIVES.

.2 The method of determining the value of a Change shall be decided by the Engineer. The value of the Change shall be determined by one or more of the following methods:

(a) by unit prices or combinations of unit prices found in the “Schedule of Quantities and Prices” in Section 00 41 00 - Bid Form;

(b) by unit prices submitted by the Contractor and accepted by the Owner;

(c) by lump sum submitted by the Contractor and accepted by the Owner; and

(d) on a Force Account basis as specified in GC 56 FORCE ACCOUNT WORK.

.3 Within five (5) Business Days of receipt of the Contemplated Change Notice, or within such other time period as may be agreed by the Parties, the Contractor shall present, in a form acceptable to the Engineer, a method of proposed adjustment or an amount of proposed adjustment to the Contract Price, if any, and the adjustment in Contract Time, if any, for the proposed Change.

.4 Any written quotation for a Change submitted by the Contractor shall be interpreted:

(a) to represent the total adjustment to the Contract Price;

(b) to represent the total adjustment to the Contract Time;

(c) to include compensation for all costs related to the Change, including but not limited to costs for direct, indirect, office, overhead, surety, insurance and all other costs, mark-ups and profits; and

(d) to have considered all effects on the Contract Time and if there is no mention of Contract Time adjustment in the quotation to mean that the Contractor will implement and complete the Change without any adjustment to the Contract Time, in which case the Change will not extend the Contract Time or entitle the Contractor to additional compensation or damages of any nature whatsoever for any scheduling issues or acceleration.

.5 In the case of Changes proposed to be paid for in whole or in part by lump sum, the Contractor shall include a cost breakdown to substantiate or justify the Contract Price adjustment, in addition to any other documentation the Engineer or the Owner may require.

.6 In the case of Changes to be paid for in whole or in part by unit rates or Force Account plus a fixed or percentage fee, the form of presentation of costs and methods of measurement shall be agreed to by the Engineer and the Contractor before proceeding with the Change. The Contractor shall keep accurate documentation of Quantities and costs for Changes, and present an account of the cost of the Change to the Engineer.

.7 When the Engineer and the Owner agree to adjustments to the Contract Price or the Contract Time, or both, and the method to be used to determine the adjustments, a Change Order signed by the Engineer, the Owner and the Contractor shall be issued revising the Contract Price or the Contract Time, or both, as applicable. The value of Work performed as the result of a Change Order shall be included in Payment Certificate.

.8 Administration of Changes to be paid for in whole or in part by Force Account plus a fixed or percentage fee, shall be in the manner set out in GC 56 FORCE ACCOUNT.

.9 The Owner reserves the right to withdraw any Contemplated Change Notice without additional compensation to the Contractor if such withdrawal occurs prior to issuance of the Change Order.

GC 55. CHANGE DIRECTIVES

.1 If the Owner requires the Contractor to proceed with a Change prior to the Owner and the Contractor agreeing upon the adjustment in Contract Price and Contract Time, the Owner, through the Engineer, may issue a Change Directive.

.2 Upon receipt of a Change Directive, the Contractor shall proceed promptly with the Change and, in the case of an emergency identified in a Change Directive, proceed immediately with the Change.

.3 An adjustment in the Contract Price for a Change carried out by way of a Change Directive shall be determined on the basis of Force Account in accordance with GC 56 FORCE ACCOUNT WORK.

.4 If the method of valuation, measurement or corresponding increase or decrease in the Contract Price and Contract Time cannot be promptly agreed upon then, the Engineer in the first instance, shall determine the method of valuation, measurement and corresponding increase or decrease in the Contract Price and the Contract Time subject to final determination in the manner set out in PART 12 DISPUTE RESOLUTION.

.5 In the case of a Dispute in the valuation of a Change Directive, and pending final determination of such value, the Engineer shall certify the value of Work performed in relation to the Change

Directive in accordance with the Engineer's evaluation of the Change Directive, and shall include that amount in a progress Payment Certificate.

.6 If, at any time after the start of the Work directed by a Change Directive, the Owner and the Contractor reach agreement on the adjustment to the Contract Price and to the Contract Time, such agreement shall be recorded in a Change Order.

GC 56. FORCE ACCOUNT WORK

.1 Compensation for Work done on a Force Account basis, authorized by a Change Order or Change Directive issued by the Engineer, shall be calculated as follows:

(a) Labour - All classifications of labour not priced separately in the Bid Form will be paid for at rates actually paid by the Contractor. A payroll assessment of thirty percent (30%) of the hourly wage will be allowed to cover all costs including pension, holiday pay, payroll administration, insurance and similar benefits. Small tool allowance will be at the rate of four percent (4%) of gross cost of labour. The Contractor will be allowed a further ten percent (10%) mark-up on the total of the foregoing as the allowance for overhead and a further ten percent (10%) mark-up on the resulting subtotal as allowance for profit.

(b) Construction Equipment - The rates for equipment, vehicles and power tools shall include operator's wages, all maintenance and operating costs and Contractor's profit. No additional mark-up of Construction Equipment charges shall be allowed.

(c) Materials supplied by the Contractor shall be paid for at Supplier's invoice price plus an additional payment of ten percent (10%) of cost to cover handling and indirect overhead costs, plus ten percent (10%) of all costs including indirect overhead as profit.

(d) Construction Equipment rentals - The allowance to the Contractor for profit, superintendence, and all other expense related shall be ten percent (10%) of the rental agency's invoice to the Contractor for the rental of tools and miscellaneous equipment.

(e) For subcontract Work, the allowance to the Contractor for profit, superintendence, and all other expenses shall be ten percent (10%) of the Subcontractor's invoice for such Work performed.

.2 In the event that, in its sole discretion, Engineer deems that, any or all prices and rates for Force Account that are included in the Bid Form are not fair and reasonable compared with normal industry standards, Engineer may order recalculation of any or all prices and rates based on the Contractor's actual costs, as provided for in GC 56.1 items (a) and (b).

.3 For the purposes of calculating Force Account rates as provided for in GC 56.1 items (a) to (e), upon request by Engineer, Contractor shall submit a detailed and verifiable statement of actual cost of labour, Construction Equipment, Materials and subcontracted Work. Pending receipt of such statements, Engineer shall apply normal industry-standard Force Account rates discounted by 20% to facilitate inclusion of interim payments for Force Account in Payment Certificates, on an ongoing basis.

.4 Subcontractor's Force Account invoices to the Contractor shall be calculated and submitted for review as described in GC 56.1 items (a) to (e), unless otherwise instructed by the Engineer.

.5 On a daily basis, the Contractor shall keep an accurate, complete and up-to-date record in a form satisfactory to the Engineer, showing on a shift-by-shift basis, all Contractor and Subcontractor labour, Construction Equipment and Materials to be paid by Force Account. Daily Force Account records shall be submitted by the Contractor to the Engineer for review within one (1) Business Day of the subject Work being performed. The submission to the Engineer or countersignature by the Engineer of daily Force Account records shall not at any time be deemed to be an admission that the Work is properly chargeable to Force Account.

.6 The Owner shall not be liable to pay for any Work based on Force Account for which the daily Force Account records were not prepared and submitted in accordance with GC 56.5.

GC 57. CONCEALED OR UNKNOWN CONDITIONS

.1 Subject to GC 57.2, should one Party discover conditions at the Project Site which:

(a) are subsurface or otherwise inaccessible and concealed physical conditions, which existed before the commencement of the Work, and which differ materially from those reasonably inferable from or indicated in the Contract Documents or studies, reports and other site data referenced therein; and

(b) materially affect the cost of the Work or the time required to perform the Work, then the discovering Party shall provide Notice to the other Party within one (1) Business Day of discovering such conditions and, in any case, before such conditions are disturbed.

.2 Physical conditions which are not visible but which are a logical extension, or part of a visible physical condition, and physical conditions which can be reasonably accessed for observation, shall not be considered as concealed for the purposes of GC 57.

.3 The Engineer shall promptly investigate and make a determination as to whether the conditions fit within the parameters described in GC 57.1.

.4 If the determination is that the conditions:

(a) fit within the parameters described in GC 57.1 and the performance of the Work with such conditions being present requires a Change that increases or decreases the Contract Price or the Contract Time, or both, then a Change Order or a Change Directive, as applicable, shall be issued to deal with the consequences of the conditions; or

(b) do not fit within the parameters described in GC 57.1 or do fit within the parameters described in GC 57.1 but do not cause an increase or decrease in the Contract Price or Contract Time, or both, the Engineer shall provide Notice of such determination to both the Owner and the Contractor.

.5 If either Party wishes to make a Claim that the Contract Time or Contract Price should be adjusted because of concealed or unknown conditions then such Party shall give the other Party and the Engineer Notice of such Claim immediately after that Party first becomes aware of the concealed or unknown condition. No adjustment of Contract Price or Contract Time shall be allowed for any Work undertaken prior to the delivery of such Notice.

.6 If either Party gives Notice of concealed or unknown conditions pursuant to GC 57.1, then as part of the Work the Contractor shall keep daily records in accordance with the requirements of GC 58 CLAIMS.

PART 12 DISPUTE RESOLUTION

GC 58. CLAIMS

.1 If the Contractor intends to make a Claim for an extension of Contract Time or for an increase to the Contract Price, or if the Owner intends to make a Claim against the Contractor for a credit to the Contract Price, the Party that intends to make the Claim shall give timely Notice in writing of intent to Claim to the other Party and to the Engineer.

.2 Upon commencement of the event or series of events giving rise to a Claim, the Party intending to make the Claim shall:

(a) take all reasonable measures to mitigate any delay, loss or expense which may be incurred as a result of such event or series of events, and

(b) keep such records as may be necessary to support the Claim.

.3 The Party giving Notice of intent to make a Claim shall submit to the Engineer a detailed account of the amount claimed and the grounds upon which the Claim is based, within a reasonable time.

.4 Where the event or series of events giving rise to the Claim has a continuing effect, the detailed account submitted pursuant to GC 58.3 shall be considered to be an interim account and the Party making the Claim shall, at such intervals as the Engineer may reasonably require, submit further interim accounts giving the accumulated amount of the Claim and any further grounds upon which it is based. The Party making the Claim shall submit a final account after the end of the effects resulting from the event or series of events.

.5 The Engineer’s findings, with respect to a Claim made by either Party, will be given by Notice in writing to both Parties within thirty (30) Business Days after receipt of the Claim by the Engineer, or within such other time period as may be agreed by the Parties.

.6 If such finding is not acceptable to either Party, the Claim shall be settled in accordance with this PART 12 DISPUTE RESOLUTION.

GC 59. APPLICABLE TO ALL DISPUTES

.1 In the event of a Dispute, the Contractor shall abide by the Engineer’s decision with respect to the Dispute, proceed diligently with the Work without prejudice to the Contractor’s right to advance any Claim it may wish to assert with respect to the Dispute and track all costs and impacts associated therewith.

.2 The Contractor shall not delay the Work or any portion of the Work, nor shall there be any extension of Contract Time solely on account of any Dispute Resolution pursuant to this PART 12 – DISPUTE RESOLUTION.

.3 Disputes between the Parties relating to or arising out of the Contract shall be settled in accordance with PART 12 DISPUTE RESOLUTION. No legal action shall be taken or maintained without these provisions having been complied with, except to the extent that such legal action is necessary to:

(a) preserve a right or commence a Claim that would otherwise be barred by statute or another agreement if such legal action is not commenced or maintained; or

(b) obtain injunctive relief.

GC 60. NEGOTIATION

.1 A Party seeking resolution of a Dispute shall commence the negotiation process by serving a Notice requiring negotiation of the Dispute on the other Party and the Engineer. The date of delivery, or deemed date of delivery, as the case may be, is referred to in PART 12 DISPUTE RESOLUTION as the "Negotiation Notice Date". The Notice shall describe the Dispute and reference any time or money claimed and reference all of the provisions of the Contract that are relied on in relation to the Dispute.

.2 The Parties shall meet in person for the purpose of negotiating a resolution of the Dispute within fifteen (15) Business Days of the Negotiation Notice Date. Failure to meet within this time period means that, subject to the Parties otherwise agreeing, the negotiation will be deemed complete and either Party can immediately commence mediation in accordance with GC 61 MEDIATION.

.3 Each of the Parties shall discuss the Dispute in a professional and amicable manner and negotiate in good faith. The Parties agree to use all reasonable efforts to resolve any Dispute, whether arising during the existence of this Contract or at any time after the expiration or termination of this Contract, which touches upon the validity, construction, meaning, performance or effect of this Contract or the rights or liabilities of the Parties or any matter arising out of, or in connection with this Contract.

.4 Disputes that are resolved by negotiation shall be formally concluded with a binding agreement between the Owner and the Contractor, executed within thirty (30) Business Days of the Negotiation Notice Date, stating the details of the resolution. Disputes that are not fully concluded in this manner will proceed to mediation, or otherwise, pursuant to GC 60.6.

.5 All meetings and communications during the negotiation are without prejudice and cannot be used in evidence in any proceeding. The Parties shall treat the negotiation as confidential and neither of the Parties shall disclose any part of the negotiation to any third party, except for the sole purpose of dealing with the Dispute.

.6 In the event that the Parties cannot resolve the Dispute within thirty (30) Business Days of the Negotiation Notice Date, then, subject to the Parties otherwise agreeing, the Parties shall participate in mediation in accordance with GC 61 MEDIATION.

GC 61. MEDIATION

.1 If the negotiation process provided for in GC 60 NEGOTIATION is initiated but a Dispute is not resolved within thirty (30) Business Days from the Negotiation Notice Date or the negotiation is deemed complete pursuant to GC 60.2 NEGOTIATION either Party is entitled by Notice to the other Party to call for the appointment of an individual to act as a mediator. The date of delivery, or deemed date of delivery, as the case may be, is referred to in GC 61 as the "Mediation Notice Date".

.2 Within fifteen (15) Business Days of the Mediation Notice Date, the Parties shall jointly nominate a mediator. The cost of the mediator shall be shared equally between the Parties. The mediator will be instructed to render invoices at monthly intervals. The Owner shall fully pay the mediator for services rendered upon presentation of an invoice by the mediator and deduct the Contractor's share from payments otherwise due to the Contractor. In the event that there are no payments due to the Contractor, the Owner shall invoice the Contractor for the Contractor's share of the cost of the mediator.

.3 The Parties shall submit their positions relating to the Dispute in writing to the mediator and afford to the mediator access to all Records, documents and information the mediator may reasonably request. The Parties shall meet with the mediator at such reasonable times as may be required and shall, as facilitated by the mediator, negotiate in good faith to resolve the Dispute. All meetings and communications with or involving the mediator are without prejudice and cannot be used in evidence in any proceeding. The Parties shall treat the mediation as confidential and neither of the Parties shall disclose any part of the mediation to any third party, except for the sole purpose of dealing with the Dispute.

.4 If the Dispute has not been resolved within forty (40) Business Days of the Mediation Notice Date then, subject to the Parties otherwise agreeing, the mediation shall be deemed to have been concluded.

.5 Once the mediation is concluded, or deemed to be concluded, any Dispute not settled may be litigated in accordance with the Law.

.6 If a mediator is not appointed within fifteen (15) Business Days of the Mediation Notice Date, the non-cooperating Party will be deemed to have agreed to arbitration by a sole arbitrator and the Party who gave the Notice to appoint a mediator may initiate arbitration proceedings pursuant to the ADR Institute of Canada Inc. ADRIC Arbitration Rules in effect at the date the arbitration proceedings are initiated. The arbitration shall be conducted in the jurisdiction of the Project Site.

PART 13 INDEMNIFICATIONS AND WARRANTY

GC 62. INDEMNIFICATIONS

.1 The Contractor shall at all times and without limitation, be fully liable for, and shall indemnify and save harmless the Owner and its Personnel, including the Engineer, from and against all liabilities, losses, injuries, costs, damages, legal fees and disbursements on a solicitor and own client basis, disbursements, fines, penalties, expenses, all manner of actions, causes of action, claims, demands and proceedings, all of whatever nature and kind, which any of the Owner and its Personnel, including the Engineer, may sustain, pay or incur or which may be brought or made against all or any of them, and whether or not incurred, in connection with any action or other proceedings or claims or demands made by third parties, relating to, or resulting from or arising out of all or any of the following:

(a) the misconduct, negligent action or negligent failure to act, as the case may be, of the Contractor or any of those Persons for whom the Contractor is responsible at Law (including, without limitation, any of its Personnel or Subcontractors);

(b) the costs of repairs, clean-up or restoration paid by the Owner and any fines levied against the Owner or the Contractor;

(c) any breach, violation or non-performance of any representation, warranty, obligation, covenant, condition or agreement in this Contract set forth and contained on the part of the Contractor to be fulfilled, kept, observed or performed, as the case may be;

(d) any damages to third parties caused by, resulting at any time from, arising out of or in consequence of the misconduct, negligent action or failure to act of the Contractor or any of those Persons for whom the Contractor is responsible at Law (including, without limitation, any of its Personnel or Subcontractors);

(e) any damages, costs, fines, expenses and penalties that the Owner is required to pay on account of the Contractor performing the Work in breach of any Workers Compensation Legislation order or regulation; or

(f) any damages, costs, fines, expenses and penalties arising out of or as a result of the Contractor’s failure, or the failure of any Person for whom the Contractor is responsible at Law, to comply with the requirements of GC 34 TOXIC OR HAZARDOUS SUBSTANCES.

.2 The provisions in GC 62 are in addition to and shall not prejudice any other rights of the Owner at Law or in equity.

.3 The Owner shall indemnify and hold harmless the Contractor and its Personnel from and against claims, demands, losses, costs, damages, actions, suits, or proceedings arising out of the Contractor’s performance of the Contract which are attributable to a lack of or defect in title to the Project Site.

.4 If the Owner performs work at the Project Site at the same time as the Contractor is performing the Work, then the Owner shall indemnify and hold harmless the Contractor and its Personnel from and against claims, demands, losses, costs, damages, actions, suits or proceedings by third parties that arise out of or are attributable to, any act or omission or alleged act or omission of the Owner and its Personnel in the performance of that work.

.5 If it becomes necessary for the Owner or its Personnel, including the Engineer, to take or to become involved in any action, including but not limited to legal proceedings, to enforce any term of this Contract, the Contractor shall be liable for and will pay to the Owner and its Personnel, including the Engineer, all costs, including but not limited to legal fees and disbursements on a solicitor and own client basis, incurred by the Owner and its Personnel, including the Engineer, in relation to the action to enforce any term of this Contract.

GC 63. WARRANTY

.1 The Contractor warrants that the Work, including all workmanship, labour, Materials and equipment supplied by the Contractor, either directly or indirectly, and incorporated into the Work, shall comply in all respects with this Contract and shall be free from Deficiencies.

.2 Subject to GC 63.3, the Warranty Period with regard to the Work shall be the longer of:

(a) one year from the date of Substantial Performance of the Work, for any Materials or portions of the Work which are supplied or completed before Substantial Performance of the Work is attained, unless a longer period is specified in the Contract Documents for such Materials or portions of the Work;

(b) one year from the date of Total Performance of the Work, for any Materials or portions of the Work which are supplied or completed after Substantial Performance of the Work is attained, unless a longer period is specified in the Contract Documents for such Materials or portions of the Work;

(c) one year from the date of Total Performance of the Work if some Work is excluded from the Substantial Performance of the Work assessment, where permitted by the Lien Act in effect at the Project Site, because a portion of the Work cannot be completed expeditiously for reasons beyond the control of the Contractor; and

(d) where a period longer than that described in GC 63.2(a) or GC 63.2(b) is specified in the Contract Documents, then that period specified in the Contract Documents shall apply from the date specified in the Contract Documents or, if no date is specified, from the date of Total Performance of the Work.

.3 Where Warranty Work is performed, regardless of the initial Warranty Period, the Warranty Period shall recommence for that Warranty Work for the same period as initially contemplated commencing on the date of completion of the Warranty Work.

.4 The Contractor shall promptly perform the Warranty Work, at the Contractor’s expense, for all Deficiencies which appear prior to and during the Warranty Period for which the Contractor is provided Notice by the Owner or the Engineer no later than thirty (30) Business Days after the end of the Warranty Period.

.5 All Warranty Work carried out by the Contractor shall be performed during periods of time acceptable to the Owner.

.6 The Contractor shall ensure that any Warranty Work which is of an emergency nature, as reasonably determined by the Owner, is performed immediately upon receipt of Notice from the Owner or the Engineer.

PART 14 CONFIDENTIALITY AND FREEDOM OF INFORMATION

GC 64. CONFIDENTIALITY

.1 The Contractor shall:

(a) hold, and shall take all reasonable steps to ensure that any Person employed, engaged or contracted by it holds all Confidential Information in strict confidence;

(b) not use, and shall take reasonable steps to ensure that any Person employed, engaged or contracted by it does not use any Confidential Information other than to perform the Work;

(c) not disclose, and shall take reasonable steps to ensure that any Person employed, engaged or contracted by it does not disclose, any Confidential Information to anyone other than those Persons engaged to perform the Work and then only to the extent that such Confidential Information is directly required to be disclosed in order to properly perform the Work; and

(d) not disclose, and shall take reasonable steps to ensure that any Person employed, engaged or contracted by it does not disclose any Confidential Information to any third party at any time during or subsequent to the duration of this Contract.

.2 The obligations set forth in GC 64.1 apply to any and all Confidential Information except that which:

(a) is required to be disclosed by applicable Law; or

(b) subject to the applicable Law, is in the public domain or is provided to its financial and legal advisors in confidence.

.3 The Contractor agrees that it shall not include any reference to the Owner, the Work or the Project in any advertisement, public announcement or statement, or promotional materials without the prior written consent being obtained from the Owner.

PART 15 INTELLECTUAL PROPERTY AND TITLE TO THE WORK

GC 65. INTELLECTUAL PROPERTY

.1 The Contract Documents and models provided by the Engineer in any format are to be used only with respect to the Project and are not to be used for other work and are not to be copied or altered in any manner without the prior written authorization of the Engineer and the Owner.

.2 The Contractor shall indemnify and hold harmless the Owner, its Personnel, agents and consultants, including the Engineer, from any and all claims arising out of or as a result of an infringement or an alleged infringement of a copyright, or a trademark, patent or invention used or incorporated into the Work by the Contractor, the Subcontractors, or any Person for whom the Contractor is responsible for at Law.

.3 Subject to any limitations of liability expressly provided for in this Contract and any Law, the Owner shall, to the extent it can provide an indemnity in accordance with the Law, indemnify the Contractor against claims arising out of or as a result of an infringement or an alleged infringement of a patent relating to a model, plan, equipment or design which was provided to the Contractor by the Owner as part of the Contract Documents.

GC 66. BUILDERS LIENS AND TITLE TO THE WORK

.1 The Contractor shall remove or cause to be removed all affidavits of claim of lien, claims of lien or liens filed or registered against the lands and premises on which the Work is being performed or has been performed which claim of lien or liens arise out of anything done or to be done under the Contract. Such removal shall be effected by the Contractor forthwith upon demand by the Owner or the Engineer. Upon receiving satisfactory security for its costs and a suitable indemnity, the Owner will authorize the Contractor to apply to the Court in the name of the Owner to have the affidavits of claim of lien, claims of lien or liens removed from the title to the lands upon payment into Court.

.2 Notwithstanding anything elsewhere contained in the Contract Documents, the Contractor shall indemnify and hold harmless the Owner against and from all demands, damages, costs, losses and actions arising in any way out of claims of lien or liens which arise out of anything done or to be done under the Contract.

.3 The obligations imposed on the Contractor by the provisions of GC 66 shall not extend to claims of lien or liens properly filed by the Contractor himself.

.4 The Contractor warrants that title to all of the Work and other matters or things produced for the benefit of the Owner shall be free of all claims.

.5 Title to all Materials shall, unless otherwise agreed in writing, vest in the Owner absolutely upon delivery to the Project Site or upon payment therefore, whichever shall first happen. All Materials shall remain at the risk of the Contractor until incorporated in the Work and Total Performance of the Work is achieved. Title to any Materials which are rejected by the Engineer or are ordered by him to be removed from the Project Site for any reason shall revest in the Contractor immediately upon receipt of Notice of rejection or order for removal.

.6 The Contractor warrants that Materials delivered to the Project Site shall:

(a) not be removed from the Project Site or changed except with the prior written authorization of the Owner; and

(b) at all times be kept secure.

GC 67. RECORDS

.1 The Contractor shall:

(a) maintain full Records of the estimated and actual costs of the Work together with all tender calls, quotations, contracts, correspondence, invoices, receipts and vouchers relating thereto. The Contractor shall maintain daily Records of the time, materials and equipment employed on the Work. Daily Records shall allocate the time, materials and equipment spent on each activity performed in a day to a description of that activity;

(b) preserve the Records for the Work during the term of the Contract and for a period of at least 3 years after Total Performance of the Work;

(c) make all Records and material referred to in GC 67.1(a) available to audit and inspection by the Owner and by Persons acting on behalf of the Owner when requested;

(d) allow any of the Persons referred to in GC 67.1(c) to make copies of and to take extracts from any of the Records and material referred to in GC 67.1(a); and

(e) provide any Person referred to in GC 67.1(c) with information that may be required from time to time in connection with such Records and material.

END OF DOCUMENT

MODIFICATIONS TO GENERAL CONDITIONS

The General Conditions are hereby revised as follows:

GC 29, LABOUR AND MATERIALS

Add GC 29.6 as follows:

Under the provisions of the Collective Agreement Article 31.02 (b) (between the City and C.U.P.E. Local 118) contracted employees engaged by the City of Port Alberni are to "receive wages and conditions of employment at least equal to the terms" of the current C.U.P.E Collective Agreement. Contractor's shall list all current wage rates in the "Contractor's Questionnaire" included in this tender package.

The City may request a random check of wages paid to employees. Failure to adhere to the confirmed wage rates may be considered to be a breach of contract.

The City may withhold funds equal to the value of wages not paid and require confirmation that the situation has been rectified.

Fill out Contractor's Questionnaire at the end of this Section.

GC 31. SHOP DRAWINGS

Delete GC 31.1 in its entirety and replace with the following:

.1 In consultation with the Engineer, the Contractor shall establish and implement procedures for timely receipt, processing and review of Shop Drawings and samples. Upon request of the Engineer, the Contractor shall prepare a target schedule of dates for submission, review and return of Shop Drawings for the consideration of the Engineer.

GC 48. LATE COMPLETION

Add GC 48.4 as follows:

.4 The pre-estimate of the Owner's additional costs pursuant to GC 48.1 shall be $1,000 per Working Day.

GC 56. FORCE ACCOUNT WORK

Delete GC 56.1 (b) in its entirety and replace with the following:

.1 (b) Equipment - The rates for equipment, vehicles, and power tools shall include operator's wages and fringe and other benefits, all maintenance and operating costs. Compensation will be paid at the rates listed in the latest edition of the Province of British Columbia, B.C. Government "Blue Book", Equipment Rental Rates. The Contractor will be allowed a ten percent (10%) fee based on the gross cost of equipment as described above. Such fees shall be applied to the rental charge for equipment and will be the maximum paid regardless of the ownership.

GC 63. WARRANTY

Delete all references to one (1) year Warranty Period and replace with two (2) year Warranty Period.

ADDITIONAL GENERAL CONDITIONS

The following General Conditions are hereby added:

GC69. EARLY USE OF THE WORK BY OWNER

.1 At the Owner's sole discretion and upon Notice to the Contractor, the Owner may take early possession of and use any completed or partially completed portions of the Work before Substantial Performance of the Work has been achieved. Such early possession and use by the Owner shall not constitute an acceptance of any portion of the Work which is not in accordance with the requirements of the Contract.

.2 If early use of particular completed or partially completed portions of the Work is expressly provided for in the Contract Documents then the Contractor will not be entitled to any adjustments of Contract Time or Contract Price as a result of such early use in accordance with those provisions.

.3 If early use of particular completed or partially completed portions of the Work is not expressly provided for in the Contract Documents, early possession or use of those portions of the Work shall be considered a Change and the provisions of GC 53 CHANGES shall apply.

.4 In the event that the Owner takes early possession of and uses any completed or partially completed portions of the Work before Substantial Performance of the Work has been achieved, then the Warranty Period for the portions of the Work that are under early possession or use by the Owner shall commence on the date the early possession and use commences.

.5 Despite the provisions of GC 69.3, under no circumstances shall possession and use of completed or partially completed portions of the Work be considered a Change if such possession and use commences after the expiry of the Contract Time. The Owner shall not be liable for any costs incurred by the Contractor after expiry of the Contract Time as a result of the Owner's possession and use of completed or partially completed portions of the Work.

Add the following:

GC70. CANADIAN ANTI-SPAM LEGISLATION

.1 In accordance with Canadian anti-spam legislation, each Party consents to contacting the other Party and its personnel through electronic messages relating to the Project. Following completion of the Project, either Party may withdraw consent by contacting the other Party.

Add the following:

GC71. PROFESSIONALISM

.1 The Contractor agrees that it and its sub-contractors and employees agree to comply with the following code of conduct:

(a) Carry out their responsibilities in a professional and competent manner.

(b) Continue to improve their knowledge, competence, skills, and professional ability.

(c) Be aware of and abide by the British Columbia Human Rights Code.

(d) Note engage in any action or conduct or make any comment, gesture, or contact which a reasonable person would regard as likely to cause offence or humiliation to anyone, whether in the workplace or any other location.

(e) Act, and be perceived by the public to act, in a fair and impartial manner in the performance of their duties or provisions of services.

(f) Note make any public comments that denigrate, disparage, or are disrespectful of the Owner, employees, and elected officials, and refrain from making negative comments about the credibility of the Owner employees, and elected officials.

(g) Conduct themselves in a friendly, courteous, and professional manner when dealing with the public.

(h) Refrain from engaging in any other practice that could unfavourably reflect upon the Owner as identified solely by the Owner.

END OF DOCUMENT

Without limiting any of Contractor's obligations or liabilities under the Contract Documents, Contractor shall, and shall cause its Subcontractors to, obtain and continuously carry, while Work is being performed and, unless otherwise specified in this Section, while any remedial or warranty work is being undertaken, at Contractor's own expense and cost, the following insurance coverage with minimum limits not less than those stated:

Commercial General Liability Insurance

Commercial General Liability Insurance, in a form acceptable to Owner, with limits of not less than $5,000,000.00 inclusive per occurrence for bodily injury, death and damage to property, including loss of use thereof.

Commercial General Liability policy shall include the following:

a. Additional Insured: Owner and Engineer are added as additional insured, but only with respect to liability arising out of the Contractor's performance of the Contract.
b. Bodily Injury and Property Damage to third parties arising out of the operations of the Contractor.
c. Products and Completed Operations: Coverage for bodily injury or property damage arising out of goods or products manufactured, sold, handled, or distributed by the Contractor and/or arising out of operations that have been completed by the Contractor.
d. Personal Injury: While not limited to, the coverage must include Violation of Privacy, Libel and Slander, False Arrest, Detention or Imprisonment and Defamation of Character.
e. Cross Liability/Separation of Insureds: Without increasing the limit of liability, the policy must protect all insured parties to the full extent of coverage provided. Further, the policy must apply to each Insured in the same manner and to the same extent as if a separate policy had been issued to each.
f. Blanket Contractual Liability: The policy must, on a blanket basis or by specific reference to the Contract, extend to assumed liabilities with respect to contractual provisions.
g. Employees must be included as Additional Insured.
h. Employers' Liability (or confirmation that all employees are covered by Worker's compensation (WSIB) or similar program)
i. Broad Form Property Damage including Completed Operations: Expands the Property Damage coverage to include certain losses that would otherwise be excluded by the standard care, custody or control exclusion found in a standard policy.
j. Notice of Cancellation: The Insurer will provide the Owner thirty (30) days written notice of policy cancellation.
l. Owners' or Contractors' Protective Liability: Covers the damages that the Contractor becomes legally obligated to pay arising out of the operations of a subcontractor.
m. Non-Owned Automobile Liability - Coverage for suits against the Contractor resulting from the use of hired or non-owned vehicles.
o. All Risks Tenants Legal Liability - to protect the Contractor for liabilities arising out of its occupancy of leased premises.
p. Sudden and Accidental Pollution Liability (minimum 120 hours): To protect the Contractor for liabilities arising from damages caused by accidental pollution incidents.

Automobile Insurance (Owned and Non-Owned)

Automobile Liability Insurance in an amount usual for a contract of this nature, but for not less than $2,000,000 per accident or occurrence., covering death and damage to property, effective for all licensed vehicles owned, leased, rented or used by Contractor.

The policy shall include the following:

a. Third Party Liability - $2,000,000 Minimum Limit per Accident or Occurrence
b. Accident Benefits - all jurisdictional statutes
c. Uninsured Motorist Protection
d. Notice of Cancellation: The Insurer will endeavour to provide the Contracting Authority thirty (30) days written notice of cancellation

Contractors' Equipment Insurance

"All-Risk" Contractors' Equipment Insurance to the full insurable value of construction machinery and equipment used by Contractor in the performance of Work, including boiler insurance for temporary boilers and pressure vessels as applicable.

Builders Risk Insurance

"All-Risks" Course of Construction Insurance in the joint names of Contractor, Owner and Engineer, with the subcontractors as unnamed insureds, insuring not less than one hundred and ten percent (110%) of the sum of the amount of the Contract Price and the full value of materials provided by the Owner for incorporation into Work, with a deductible not exceeding $5000.00. Such coverage to contain sublimits for materials in transit and materials stored at unnamed locations. Builders Risk Insurance shall be obtained and carried until Total Performance of the Work.

All policies of insurance shall be in a form acceptable to Owner and shall not allow subrogation claims by the insurer against Owner or Engineer.

All policies of insurance that Contractor is required to obtain will be considered as primary insurances in relation to insurances held by Owner or Engineer without any right of contribution from any policies of insurance held by Owner or Engineer.

All policies of insurance shall provide that at least 30 days prior written notice be given to Owner in the event of cancellation or amendment restricting coverage.

Prior to commencing Work, Contractor shall provide Owner with Certificates of Insurance in a form acceptable to Owner, and with a letter from the insurer stating that the insurance provided complies with the requirements of the Contract.

Deductibles, if any, which are applicable to the insurance specified herein, shall be borne by Contractor.

The specified limits of insurance and coverages in no way define or limit the obligation of Contractor to indemnify Owner in the event of loss.

Owner makes no representation or warranty with respect to the extent or adequacy of the insurance protection afforded by the insurance policies that are specified in this section. Contractor shall be fully responsible to determine additional insurance coverages that may be necessary and advisable for protection of Contractor or to fulfil Contractor’s obligations under this Contract.

END OF DOCUMENT

Part 1 General

1.1 PROJECT COORDINATION

.1 Coordinate progress of the Work, progress schedules, submittals, use of site, temporary utilities, construction facilities and controls with the Engineer and the Owner's Project Manager.

.2 It is the Contractor's responsibility to lead and provide overall Project Management of the Work in close collaboration and coordination with Owner's Project Manager, the City's operations staff, and the Engineer.

.3 The Contractor's Project Manager shall be the single point of contact through whom the Contractor shall communicate with the Owner. The Contractor's Project Manager shall be responsible for the overall management and coordination of the Work and for maintaining close contact with the Owner's Project Manager.

.4 The Contractor shall provide a detailed Project Management Plan including the following:

  .1 A detailed work program and schedule.
  .2 A worker Health and Safety Plan with sufficient details of how the Contractor plans to handle confined spaces, fall protection, and specific hazards of the work site.
  .3 A Communications Management Plan for coordination of activities with the City, especially any issues affecting plant access, operations, staff and the public including a report on a monthly basis at a minimum.
  .4 A Risk Management Plan including risk identification, analysis, planning and risk monitoring and control.
  .5 A Quality Management Plan including quality objectives, quality planning, quality assurance and quality control processes.

.5 Coordinate with the Owner's Project Manager to perform the work and provide effective communication that enables the City's staff to coordinate their operations activities. Where collaboration with the City's staff is required to undertake the work, ensure that each party clearly understands their roles and responsibilities.

1.2 HOURS OF WORK

.1 Perform Work in conformity with all municipal bylaws with respect to noise control, hours of work, night work and holiday work.

.2 Obtain written permission of Engineer before undertaking holiday work or night work.

1.3 RELICS AND ANTIQUITIES

.1 Relics and antiquities and items of historical or scientific interest such as cornerstones and contents, commemorative plaques, inscribed tablets, and similar objects found on site or in buildings to be demolished, remain property of Owner. Protect such articles and request directives from Engineer.

.2 Notify Engineer immediately if evidence of archaeological finds is encountered and await Engineer's written instructions before proceeding with work in area.

.3 Owner may choose to arrange for archeological monitoring by a third party of excavated material during certain portions of the work. Where Owner identifies portions of the work that would require archeological monitoring, Contractor to coordinate construction activities with Owner and archeologist to allow archeological sampling and inspections.

1.4 CUTTING AND PATCHING

.1 Approvals

- .1 Submit written request in advance of cutting or alteration which affects:
  - .1 Structural integrity of any element of Project.
  - .2 Integrity of weather-exposed or moisture-resistant elements.
  - .3 Efficiency, maintenance, or safety of any operational element.
  - .4 Visual qualities of sight-exposed elements.
  - .5 Work of Owner or separate contractor.
- .2 Inspection
  - .1 Inspect existing conditions, including elements subject to damage or movement during cutting and patching.
  - .2 After uncovering, inspect conditions affecting performance of work.
  - .3 Beginning of cutting or patching means acceptance of existing conditions.
- .3 Execution
  - .1 Perform cutting, fitting, and patching including excavation and fill, to complete the Work.
  - .2 Remove and replace defective and non-conforming work.
  - .3 Provide openings in non-structural elements of Work for penetrations of mechanical and electrical work.
  - .4 Perform Work to avoid damage to other work.
  - .5 Prepare proper surfaces to receive patching and finishing.
  - .6 Perform cutting and patching for weather-exposed and moisture-resistant elements and sight-exposed surfaces equivalent to original or better.
  - .7 Cut rigid materials using power saw or core drill. Pneumatic or impact tools not allowed.
  - .8 Restore work with new products in accordance with Contract Documents.
  - .9 Fit work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
  - .10 At penetration of fire-rated wall, ceiling, or floor construction, completely seal voids with fire-rated material, specified in the Contact Documents, full thickness of construction element.

.11 Refinish surfaces to match adjacent finishes; for continuous surfaces, refinish to nearest intersection; for an assembly, refinish entire unit.

1.5 SCHEDULE

.1 Schedules Required

- .1 Construction Progress Schedule.
- .2 Submittal Schedule for Shop Drawings, Product Data and Samples.
- .3 Cash Allowance Schedule for purchasing products.

.2 Refer to GC25 – Construction Schedule in Section 00 72 00 – General Conditions

.3 Submission

- .1 Refer to Section 01 33 00 – Submittals.

1.6 BASIC PRODUCT REQUIREMENTS

.1 Product and Material Quality

- .1 Products, materials, equipment and articles (referred to as Products throughout specifications) incorporated in Work shall be new, not damaged or defective, and conforming with specifications for purpose intended. If requested, furnish evidence as to type, source and quality of Products provided.
- .2 Defective Products, will be rejected, regardless of previous inspections. Inspection does not relieve responsibility, but is precaution against oversight or error. Remove and replace defective Products at own expense and be responsible for delays and expenses caused by rejection.

.2 Storage, Handling and Protection

- .1 Handle and store Products in manner to prevent damage, adulteration, deterioration and soiling and in accordance with manufacturer's instructions when applicable.
- .2 Store packaged or bundled Products in original and undamaged condition with manufacturer's seals and labels intact.
- .3 Store products subject to damage from weather in weatherproof enclosures.

.3 Manufacturer's Instructions

- .1 Unless otherwise indicated in specifications, install or erect Products in accordance with manufacturer's instructions. Do not rely on labels or enclosures provided with Products. Obtain written instructions directly from manufacturers.
- .2 Notify Engineer in writing, of conflicts between specifications and manufacturer's instructions, so that Engineer may establish course of action.
- .3 Improper installation or erection of Products, due to failure in complying with these requirements, authorizes Engineer to require removal and reinstallation at no increase in Contract Amount.

.4 Workmanship

.1 Execute Work by workers experienced and skilled in respective duties for which they are employed. Immediately notify Engineer if required Work is such as to make it impractical to produce required results.

.2 Do not employ any unfit person or anyone unskilled in their required duties. Engineer reserves the right to require the dismissal from site of workers deemed incompetent, careless, insubordinate or otherwise objectionable.

.5 Concealment

.1 In finished areas, conceal pipes, ducts and wiring in floors, walls and ceilings, except where indicated otherwise.

.2 Before installation, inform Engineer if there is a contradictory situation. Install as directed by Engineer.

1.7 PROJECT CLOSEOUT

.1 Systems Demonstration

.1 Prior to final inspection, demonstrate operation of each system to Owner and Engineer.

.2 Instruct personnel in operation, adjustment, and maintenance of equipment and systems, using provided operation and maintenance data as basis for instruction.

.2 Documents

.1 Collect reviewed submittals and assemble documents executed by Subcontractors, suppliers, and manufacturers.

.2 Submit material prior to final Application for Payment.

.3 Submit operation and maintenance data, record drawings.

.4 Provide warranties and bonds fully executed and notarized.

.5 Execute transition of Performance and Labour and Materials Payment Bond(s) to warranty period requirements.

.6 Submit a final statement of accounting giving total adjusted Contract Amount, previous payments, and monies remaining due.

.7 Engineer will issue a final change order reflecting approved adjustments to Contract Amount not previously made.

.3 Inspection/Takeover Procedures

.1 Prior to application for Certificate of Total Performance, carefully inspect the Work and ensure it is complete, that all construction deficiencies are complete, defects are corrected and building is clean and in condition for occupancy. Notify Engineer, in writing, of completion of the Work and request an inspection.

.2 During Engineer inspection, a list of deficiencies and defects will be tabulated. Correct same.

.3 Make application for Certificate of Total Performance. Refer to Section 00 72 00 - General Conditions for specifics of application.

Part 2 Products

Not Used

Part 3 Execution

Not Used

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Title and Description of Work.

.2 Contract Method.

.3 Work by others.

.4 Future work.

.5 Work sequence.

.6 Hours of work.

.7 Contractor use of premises.

.8 Owner occupancy or partial Owner occupancy.

.9 Owner furnished items and/or pre-ordered products and/or pre-bid work.

.10 Documents provided.

.11 Supplementary drawings.

1.2 WORK COVERED BY CONTRACT DOCUMENTS

.1 Work of this Contract comprises general construction of two effluent pumps stations, located at the City of Port Alberni's new Wastewater Lagoon (former Catalyst treatment lagoon); and related work identified in the drawings.

.2 The key components of the Work are generally described as follows (not listed in any particular order):

  .1 Project management and coordination, including coordination of work and site access with other contractors on site.
  .2 Detailed field measurement of all relevant and applicable dimensions.
  .3 All required temporary works in the former Catalyst lagoon to allow construction of the new platform.
  .4 Installation of pilings for each effluent pump station.
  .5 Supply and Installation of two effluent pump station platforms.
  .6 Installation of four effluent pumps including draft tube on the effluent pump station platforms. Supply, start-up and commissioning of effluent pumps and draft tube by others.

  - .7 Supply & installation process piping, valves, fittings, etc. from effluent pump draft tubes to the tie-in location at the berm, including initial testing after installation.
  - .8 Supply and installation of electrical cabling, junction boxes, lighting, cable trays on each pump station platform.
  - .9 Civil/site works preparation for the work area on the lagoon berm extensions, including stripping existing Imported Fill Type A as per Contract Drawings. Stockpiling or placing of temporary material in designated areas shown on the drawings or areas designated (on site) by the Engineer.
  - .10 Supply and installation of Treated Effluent pipeline along the berms and to the Pump Station Platforms.
  - .11 Other related work and/or matters including, but not limited to construction of access roads, pedestrian and traffic control, compliance with safety requirements.

.3 Construct the Work under a single lump sum contract.

1.3 WORK BY OTHERS

.1 Work of Project executed during Work of this Contract, and which is specifically excluded from this Contract:

  - .1 Supply of four axial effluent pumps and related draft tubes.

.2 Work of Project which will be executed after completion of Work of this Contract, and which is specifically excluded from this Contract:

  - .1 Commissioning of the Wastewater Treatment Facility, including the effluent pump stations.

1.4 HOURS OF WORK

.1 Perform Work in conformity with all municipal bylaws with respect to noise control, hours of work, night work and holiday work.

.2 Obtain written permission of Engineer before undertaking holiday work or night work.

1.5 CONTRACTOR USE OF PREMISES

.1 Contractor must coordinate work on site with the owner and owner’s Project Manager and Engineer. Contractor must attend weekly meetings with other General Contractor to coordinate work on site in shared areas that have shared access roads.

.2 Ascertain boundaries of Site within which work must be confined.

.3 Obtain written authorization from Owner to enter private lands which are the subject of easements or rights-of-way obtained by Owner.

.4 Ascertain and abide by conditions pertaining to use of easements or rights-of-way.

.5 Assume full responsibility for protection and safekeeping of products under this Contract.

.6 Obtain and pay for use of additional storage, access or work areas needed for operations under this Contract.

.7 Limit use of premises for Work, for storage, and for access, to allow:

  .1 Owner occupancy.
  .2 Work by other contractors.

.8 Coordinate use of premises under direction of Owner.

.9 Prior to final inspection, obtain and submit to Engineer written signed releases from all owners of lands affected by easements or rights-of-way, confirming that properties have been left in an acceptable condition and that owners have no further claims in this respect. Engineer will supply release form.

1.6 OWNER OCCUPANCY

.1 Owner will occupy premises during entire construction period for execution of normal operations.

.2 Cooperate with Owner in scheduling operations to minimize conflict and to facilitate Owner usage.

1.7 OWNER SUPPLIED EQUIPMENT

.1 The following items are being procured by Owner:

  .1 Four Axial Effluent pumps and related draft tubes.

1.8 DRAWINGS AND SPECIFICATIONS FURNISHED

.1 Owner Responsibilities:

  .1 Provide 2 copies of drawings and specifications to Contractor.
  .2 Provide printed pdf copy of drawings and specifications to Contractor.

.2 Contractor Responsibilities:

  .1 Pay for additional copies of drawings and specifications if required.
  .2 Maintain at Site one complete set of drawings and specifications (latest version). Make available to Engineer at any time.

1.9 SUPPLEMENTARY DRAWINGS

.1 Engineer may furnish supplementary drawings to assist proper execution of work. Such drawings will be issued for clarification only and will have same meaning and intent as if included with plans referred to in Contract Documents.

Part 2 Products

Not Used

Part 3 Execution

NOT USED

END OF SECTION

Part 1 General

1.1 CONTINUITY OF OPERATIONS

.1 The work sequences and tie-in procedures specified in this Section should enable the Contractor to perform construction activities concurrently with City and other General Contractor’s activities. The Contractor may propose alternative work sequences or procedures that maintain system operation, for the approval of the Engineer.

.2 Ensure that access is maintained for all operation and maintenance requirements of the existing systems at all times, housekeeping is maintained at the highest possible level to minimize interference, and the existing facilities are maintained.

1.2 SUBMITTALS FOR REVIEW

.1 In accordance with Section 01 33 00 - Submittals, submit electronic printed pdf copy of a detailed shutdown or tie-in plan and schedule no later than four weeks prior to the scheduled shutdown or tie-in. No shutdown, tie-in or outage will be allowed without approval by the Engineer of the appropriate plan. Coordinate the shutdown or tie-in with the Construction Schedule.

Part 2 Products

Not Used

Part 3 Execution

3.1 WORK SEQUENCE REQUIREMENTS

.1 Construct Work to accommodate Owner's continued use of existing wastewater lagoon during construction.

.2 Coordinate with Construction Schedule and with Owner Occupancy during construction.

.3 Maintain fire access/control.

.4 The sequences of work detailed are not intended to dictate the exact method of carrying out the work, only the sequence that shall be followed to ensure that the impact on operations is minimized. The Contractor is solely responsible to devise construction schedules to meet operation and contract requirements, and in recognition of construction conditions (i.e. weather conditions, seasonal conditions).

.5 The suggested work construction sequences are prepared, based on the Engineer’s understanding of the site limitations, supply requirements and construction problems. Irrespectively, neither the Engineer nor the Owner shall be held responsible in case of any delay in completion of the project on grounds of the suggested sequences.

Item	Description
.1	Mobilize and prepare work area for piling installation. Confirm method of construction for pilings, and pump station platform.
.2	Construct platform piles on-site for the two effluent pump stations.
.3	Install effluent pump stations platform, and pumps/piping/etc. Tie effluent pipe from each pump station to tie-in location.
.4	Remove temporary work areas, remediate and provide final grading of center berm as per designed. Relocate 10 kg rip-rap material in designated area on-site. Demobilize.

END OF SECTION

Part 1 General

1.1 GENERAL

.1 Referenced specification Sections contain pertinent requirements for materials and methods to achieve work described herein.

.2 Coordinate pertinent related work and modify surrounding work as required to complete project under each alternative designated.

1.2 ALTERNATIVES

.1 State in Bid Form variation in bid price for Alternatives described below and listed in Bid Form.

.2 Alternative No. 1:

  .1 Substitute AWWA C906 HDPE Treated Effluent pipe for AWWA C900 PVC, including all necessary fittings, connections and other details as per criteria indicated on Contract Drawings.

.3 Alternative No. 2:

  .1 Substitute AWWA C906 HDPE Treated Effluent pipe to AWWA C151 Ductile Iron, including all necessary fittings, connections and other details as per criteria indicated on Contract Drawings.

Part 2 Products

Not Used

Part 3 Execution

Not Used

END OF SECTION

Part 1 General

1.1 MEASUREMENT FOR PAYMENT

.1 For lump sum price item, Engineer will calculate payment based on tendered price and Engineer's estimate of percentage of work item completed, unless otherwise described in clauses below.

.2 Mobilization/Demobilization

  .1 This lump sum price includes mobilization and demobilization of labour, equipment, safety equipment, temporary facilities, and preparation of submittals, the cost of bonding, insurance permits, licences and security required for the work.

  .2 Payment for mobilization and demobilization as per Section 01 71 13.

  .3 The cost for mobilization and demobilization should not exceed five percent of the overall contract amount.

.3 As-Built Drawings

  .1 Payment for As-Built Drawings will be made at the lump sum price.

  .2 Payment for this item will be made at the lump sum price tendered after the As-Built Drawings have been accepted by the Engineer.

.4 Site Work

  .1 Payment for site work will be made at the lump sum price

  .2 Payment includes excavation, hauling and double-hauling; stockpiling on site; subgrade preparation of the surface prior to the placement of pipe and concrete; preparation of working surface that may be incidental as determined by the Contractor and generally indicated on the Contract Drawings, supply and placement of geotextile and riprap slope protection (riprap has been pre-ordered and must be purchased from Dolans Concrete Ltd) indicated on the Contract Drawings, supply and placement of Type B granular material as indicated on the Contract Drawings, reshaping of the existing adjacent berm side slopes at the location of the access ramps.

.5 Foundation Piles

  .1 Payment for eight (8) foundation piles will be made at the lump sum price

  .2 Payment includes labour, equipment, and materials for the supply and installation of the foundation piles, as shown on the Contract Drawings. This item includes the steel pipe piles, concrete and reinforcing required to complete the foundation piles to the minimum pile embedment depths and cut-off elevations as per Drawings and Specifications. This item includes the cost associated with preparing the concrete mix design, splicing details of the piles, cut-sheets of the piles and mill certificates.

.6 Steel Platforms

.1 Payment for two (2) steel platforms will be made at the lump sum price

.2 Payment includes labour, equipment and materials for the supply and installation of all structural elements in the steel platform as shown on the Drawings, including all beams, columns, steel plates, and steel grating. This item includes all welds, bolts and fasteners, steel coatings, bearing plates and other components required to complete the steel platform as per the Drawings and Specifications. This item includes the cost associated with the preparation of shop drawings, design of the steel connections, field review of the steel installation, and mill certificates.

.7 Aluminum Bridges

.1 Payment for two aluminum bridges will be made at the lump sum price

.2 Payment includes design, supply and installation of the aluminum bridges as shown on the Drawings, including all structural aluminum members, railing, decking and foundation. This item includes the cost associated with the design of the aluminum bridge and foundations as well as the field review of the aluminum bridge. This item includes the cost associated with the preparation of shop drawings and the mill certificates.

.8 Civil Works

.1 Payment for Civil Works will be made at the lump sum price.

.2 Payment will include supply and installation of all pipe, fittings, couplings, appurtenances, bedding, geotextile, related materials, and related hardware, concrete and reinforcement, bolts, adapters, tie-rods, as shown on the Contract Drawings, cleaning and pressure and leakage testing, flushing, all surface restoration as shown on the Contract Drawings, and all incidentals.

.9 Process Mechanical Works

.1 Payment for process mechanical works will be made at the lump sum price

.2 Payment includes labour, equipment and materials for the supply and installation of all process mechanical works under this contract. This includes, but is not limited to the steel pipe, steel pipe coatings, steel pipe fittings and flanges, steel pipe supports, four knife gate valves, four check valves, flexible couplings, as per the Contract Documents and Drawings. Payment includes labour, equipment and material to install Owner supplied pumps, draft tubes and prefabricated pump cabling.

.10 Electrical and Instrumentation Works

.1 Payment for electrical and instrumentation will be made at the lump sum price

.2 Payment includes labour, equipment and materials for the supply and installation of all electrical works under this contract. This includes, but, is not limited to cable, cable terminations, cable tray, cable tray supports, lighting, lighting supports, receptacles, disconnect switches, junction boxes and transmitter supports as per the Contract Documents and Drawings.

.11 Material Salvage and Site Restoration

.1 Payment for Material Salvage and Site Restoration will be made at the lump sum price.

.2 Payment includes labour, equipment for salvaging and moving of temporary work materials including lock blocks used in the construction works of the pilings and effluent pump stations. Remediate center berm (between two platforms) as per direction by the Engineer on site.

1.2 PROGRESS PAYMENTS

.1 Refer to GC 37 – PROGRESS PAYMENTS

1.3 CHANGES

.1 Refer to GC 53 - CHANGES.

Part 2 Products

Not Used

Part 3 Execution

Not Used

END OF SECTION

Part 1 General

1.1 ENGINEER TO ADMINISTER

.1 Engineer will administer preconstruction meeting and progress meetings to be held at intervals of bi-weekly.

.2 Contractor's superintendent, and senior representatives of major Subcontractors, to attend all meetings.

.3 Representatives of Contractor, Subcontractor and suppliers attending meetings shall be qualified and authorized to act on behalf of the party each represents.

.4 Contractor to provide physical space for meetings.

1.2 PRECONSTRUCTION MEETING

.1 Within 10 days after award of Contract, request a meeting of parties in contract to discuss and resolve administrative procedures and responsibilities.

.2 Senior representatives of the Owner, Engineer, Contractor, and major Subcontractors will be in attendance.

.3 Establish time and location of meeting and notify parties concerned minimum 5 days before meeting.

.4 Agenda to include the following:

  .1 Appointment of official representative of participants in the Work
  .2 Schedule of Work, progress scheduling
  .3 Schedule of submission of shop drawings, samples, colour chips
  .4 Requirements for temporary facilities, site sign, offices, storage sheds, utilities, fences
  .5 Delivery schedule of specified equipment
  .6 Site security
  .7 Contemplated change orders, procedures, approvals required, mark-up percentages permitted, time extensions, overtime, administrative requirements
  .8 Force account procedures
  .9 Owner provided Products
  .10 Record drawings
  .11 Maintenance manuals
  .12 Take-over procedures, acceptance, warranties
  .13 Monthly progress claims, administrative procedures, photographs, holdbacks
  .14 Appointment of inspection and testing agencies or firms
  .15 Insurance
  .16 Safety issues.

1.3 PROGRESS MEETINGS

.1 During course of Work and weeks prior to project completion, schedule progress meetings bi-weekly.

.2 Contractor, major Subcontractors involved in Work, Engineer and Owner are to be in attendance.

.3 Notify parties minimum 5 days prior to meetings.

.4 Engineer will record and circulate minutes of meetings to attending parties and affected parties not in attendance within 5 business days after meeting.

.5 Agenda to include the following:

  .1 Review, approval of record of meeting of previous meeting
  .2 Review of Work progress since previous meeting
  .3 Field observations, problems, conflicts
  .4 Problems which impede construction schedule
  .5 Review of off-site fabrication delivery schedules
  .6 Corrective measures and procedures to regain projected schedule
  .7 Revisions to construction schedule
  .8 Progress, schedule, during succeeding work period
  .9 Review submittal schedules: expedite as required
  .10 Maintenance of quality standards
  .11 Pending changes and substitutions
  .12 Review proposed changes for effect on construction schedule and on completion date
  .13 Safety issues
  .14 Other business.

1.4 COORDINATION MEETINGS WITH OTHER GENERAL CONTRACTORS

.1 During course of construction Work, attend weekly coordination meetings. Meetings to occur near the end of work week, to discuss the next week’s on-site activities and coordinate access to shared roads and spaces.

.2 Contractor, major Subcontractors involved in Work, other General Contractors on-site and Engineer and Owner are to be in attendance.

.3 Notify parties minimum 5 business days prior to meetings.

.4 Engineer to record minutes of meetings and circulate to attending parties and affected parties not in attendance within 5 business days after meeting.

.5 Agenda to include the following:

  .1 Review, approval of minutes of previous meeting

.2 Review and Coordination of work scheduled for upcoming week
.3 Health and Safety issues
.4 Other business.

Part 2 Products

Not Used

Part 3 Execution

Not Used

END OF SECTION

Part 1 General

1.1 REQUIREMENTS INCLUDED

.1 Construction schedule

.2 Shop drawings and product data

.3 Samples

.4 Operating and maintenance manuals

.5 Record drawings

.6 Progress photographs

.7 Certificates

1.2 ADMINISTRATIVE

.1 Provide to Engineer for review the submittals specified. Submit with reasonable promptness and in an orderly sequence so as to not cause delay in the Work. Failure to submit 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.

.2 Prepare and submit schedule fixing the dates for submission and return of shop drawings, product data or samples.

.3 Do not proceed with Work affected by the submittal until review is complete.

.4 Review submittals prior to submission to Engineer. This review represents that necessary requirements have been determined and verified, or will be, and that each submittal has been checked and coordinated with the requirements of the Work and the Contract Documents. Submittals not stamped, signed, dated and identified as to the specific project will be returned without being examined and shall be considered rejected.

.5 Notify Engineer, in writing at time of submission, identifying deviations from requirements of Contract Documents and stating reasons for deviation.

.6 Verify that field measurements and affected adjacent Work are coordinated.

.7 Contractor's responsibility for errors and omissions in submission is not relieved by Engineer review of submittals.

.8 Contractor's responsibility for deviations in submission from requirements of Contract Documents is not relieved by Engineer review.

.9 Keep one reviewed copy of each submission on Site.

1.3 CONSTRUCTION SCHEDULE

.1 Prepare schedule in the form of a horizontal bar chart, showing early start and finish date and total float for each activity.

.2 Provide a separate bar for each trade or operation. Show proposed progress of all activities for main work items and subtrades of Contract. Where applicable, indicate labour, construction crews, plant and equipment to be employed. Show shop drawing submission, shop drawing review by the Engineer, fabrication and delivery dates of major pieces of equipment.

.3 Milestone Dates:

- .1 Pump draft tubes delivery to site: January 10, 2020
- .2 Axial effluent pump delivery to site: February 14, 2020
- .3 Completion: February 28, 2020

.4 Provide horizontal time scale identifying the first work day of each week.

.5 Submit 3 copies of initial schedules within 10 days after award of Contract.

.6 Engineer will review schedule and return reviewed copy within 5 days after receipt.

.7 Resubmit finalized schedule within 7 days after return of reviewed copy.

.8 Distribute copies of the finalized schedule to:

- .1 Job site office
- .2 Subcontractors
- .3 Engineer
- .4 Owner
- .5 Other concerned parties

.9 Instruct recipients to report to Contractor, within 10 days, any problems anticipated by the timetable shown in the schedule.

.10 Revise and resubmit schedule and work plan within 5 days after notification by Engineer that previously reviewed schedule is not being met. Show changes in operations proposed to complete construction work within Contract Time.

.11 If, during course of work, Contract Time is extended, correct construction schedule and work plan to show revised commencement and completion dates of affected parts of work.

.12 No progress payment will be approved until receipt of a schedule acceptable to Engineer.

1.4 WORK PLAN

.1 Provide Work Plan for each key activity, as requested by Engineer, to show construction methods. Relate Work Plan to activities shown on Construction Schedule.

1.5 SHOP DRAWINGS AND PRODUCT DATA

.1 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by Contractor to illustrate details of a portion of Work.

.2 Detail all shop drawings using the metric system. Prepare to a drafting standard equivalent to Contract drawings.

.3 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, wiring diagrams, panel layouts with bills of material, explanatory notes and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been coordinated, regardless of the Section under which the adjacent items will be supplied and installed. Indicate cross references to design drawings and specifications.

.4 Adjustments made on shop drawings by Engineer are not intended to change the Contract Amount. If adjustments affect the value of Work, state such in writing to Engineer prior to proceeding with Work.

.5 Make such changes in shop drawings as Engineer may require, consistent with Contract Documents. When resubmitting, notify Engineer in writing of any revisions other than those requested.

.6 Engineer will supply a Shop Drawing Review Stamp. Stamp all transparencies and copies of shop drawings submitted for review.

.7 Fill in the following information on the Shop Drawing Review Stamp on each shop drawing prior to submitting the drawing to Engineer:

- .1 Associated Engineering Job. No. -- "2017-2972"
- .2 Drawing Number -- (see description in next paragraph)
- .3 Date of submission.

.8 Apply the following drawing numbers to Shop Drawings on this work:

- .1 Civil Shop Drawings:
  C-1001
  C-1002
  C-(etc.)
- .2 Architectural Shop Drawings:
  A-1001
  A-1002
  A-(etc.)
- .3 Structural Shop Drawings:
  S-1001
  S-1002
  S-(etc.)
- .4 Mechanical Shop Drawings:
  M-1001
  M-1002

M-(etc.)

.5 Electrical Shop Drawings:
E-1001
E-1002
E-(etc.)

.6 Instrumentation Shop Drawings:
I-1001
I-1002
I-(etc.)

.7 General Shop Drawings and drawings not covered by the above discipline categories:
G-1001
G-1002
G-(etc.)

.9 Maintain a complete Shop Drawing Record showing the review status of all shop drawings on the work. Provide Engineer with a copy of this record on a monthly basis or as requested by Engineer.

.10 Submittal submissions:

.1 Submit shop drawings and other submittals to Engineer for review with a Submittal Transmittal Form as provided by Engineer or in a form acceptable to Engineer.

.2 One original hard copy or an electronic file of the Submittal Transmittal Form (at Contractor’s choice) will be provided to Contractor by Engineer. An example of the form is annexed to this Section. Make photocopies of the form as needed for use on the project.

.3 For each submittal or submittal package, type or print the appropriate information on the form to fully describe the submittal(s) being sent for review.

.4 Number each transmittal form in sequential order, for record and tracking purposes.

.5 Sign the form in the space provided to acknowledge Contractor review of the submittal(s).

.6 Retain one photocopy of the form for filing and record purposes.

.7 Forward the form and the accompanying submittal(s) to Engineer.

.11 Submissions shall include:

.1 Date and revision dates.

.2 Project title and number.

.3 Name and address of:

.1 Subcontractor.

.2 Supplier.

.3 Manufacturer.

.4 Apply shop drawing stamp, signed by Contractor’s authorized representative certifying approval of submissions, verification of field measurements and compliance with Contract Documents.

.5 Details of appropriate portions of Work as applicable:
  .1 Fabrication.
  .2 Layout, showing dimensions, including identified field dimensions, and clearances.
  .3 Setting or erection details.
  .4 Capacities.
  .5 Performance characteristics.
  .6 Standards.
  .7 Operating weight.
  .8 Wiring diagrams.
  .9 Single line and schematic diagrams.
  .10 Relationship to adjacent work.

.12 Submit electronic PDF copies of product data sheets or brochures for requirements requested in specification Sections and as Engineer may reasonably request where shop drawings will not be prepared due to standardized manufacture of product.

.13 Submit electronic PDF copies of shop drawings for each requirement requested in specification Sections and as Engineer may reasonably request.

.14 Submittals will be returned with one or more of the following notations. Take action as noted:

.1 "REVIEWED" - Make and distribute additional copies as required for execution of Work.
.2 "REVISE & RESUBMIT" - Make the necessary revisions and resubmit revised drawings for review. Show the drawing number of the first such revised drawing and show the latest revision number applicable to the drawing by adding a suffix to the drawing number as - "REV. 1", "REV. 2", etc.
.3 “REVIEWED AS NOTED” – This notation indicates when Engineer has provided notations on the shop drawings that must be incorporated into the goods or work. Make and distribute additional copies as required for execution of the work.
.4 "NOT REVIEWED" - This notation indicates when Engineer has not reviewed the drawing. It may also be used in combination with the notation to revise and resubmit the drawing where Engineer lacks sufficient information to complete the review and requires to resubmit the drawing for review after revision.
.5 Drawings will be marked "REVIEWED" together with the notation to "REVISE & RESUBMIT" when Engineer requires Contractor to resubmit a revised drawing showing corrections made as a result of Engineer's notations on the shop drawings. This procedure will not relieve Contractor of responsibility for errors or omissions in the shop drawings or of responsibility for meeting all requirements of Contract.

.15 Use only those shop drawings on the work that bear the "REVIEWED" notation.

.16 Do not revise shop drawings marked "REVIEWED" unless resubmitted to Engineer for further review.

.17 Where more than one type of shop drawing has been specified for one item, e.g., wiring diagrams, layout details, and dimensional drawings, the shop drawings shall be submitted together, to enable Engineer to review the drawings as a package.

.18 Catalogue pages or drawings applicable to an entire family or range of equipment will not be accepted as shop drawings unless they are clearly marked to show the pertinent data for the particular materials.

.19 Manufacturers' catalogues, manuals, or price lists will not be accepted as shop drawings. Such materials may be used as supplemental information to the shop drawings.

.20 Indicate the tag number of instruments and valves and clearly show the features and details applicable to the equipment being supplied.

.21 Determine which shop drawings have, in addition to those drawings specifically mentioned in the Contract, design elements requiring the seal of a Professional Engineer registered in the Province or Territory where the work is located, in accordance with the applicable provincial or federal engineering acts or other governing legislation. Seal such drawings before submitting them for review. Submit for review engineering calculations signed by the registered Professional Engineer responsible for the shop drawing design elements.

.22 If upon review by Engineer, no errors or omissions are discovered or if only minor corrections are made, electronic PDF copies will be returned and fabrication and installation of Work may proceed. If shop drawings are rejected, noted copy will be returned and resubmission of corrected shop drawings, through the same procedure indicated above, must be performed before fabrication and installation of Work may proceed.

.23 Owner may deduct, from payments due to Contractor, costs of additional engineering work incurred if correct shop drawings are not submitted after one review by Engineer.

.24 Review by Engineer is for the sole purpose of ascertaining conformance with the general design concept. This review does not mean that Engineer approves the detail design inherent in the shop drawings, responsibility for which remains with Contractor, and such review does not relieve Contractor of the responsibility for errors or omissions in the shop drawings or of the responsibility for meeting all requirements of the Contract Documents. 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.

.25 Engineer will review shop drawing and return reviewed copy within 10 days after receipt.

1.6 SAMPLES

.1 Submit for review samples in duplicate as requested in respective specification Sections. Label samples as to origin and intended use in Work.

.2 Deliver samples prepaid to Engineer's site office.

.3 Notify Engineer in writing, at the time of submission, of deviations in samples from requirements of Contract Documents.

.4 Adjustments made on samples by Engineer are not intended to change Contract Amount. If adjustments affect the value of Work, state such in writing to Engineer prior to proceeding with Work.

.5 Make changes in samples which Engineer may require, consistent with Contract Documents.

1.7 OPERATING AND MAINTENANCE MANUALS

.1 Submit operating and maintenance manuals to Engineer, per Section 01 78 23.

1.8 RECORD DRAWINGS

.1 Submit record drawings to Engineer, per Section 01 78 39, upon completion of Work and prior to final inspection.

1.9 PROGRESS PHOTOGRAPHS

.1 On commencement of Work and at weekly intervals thereafter, supply Engineer with clear digital photographs from locations selected by Engineer. Clarity of the submitted photographs must be that the Engineer can discern the necessary details indicating progress of the Work. Photos shall be a minimum of 8 MB, in JPEG format, and shall be submitted via an FTP site, or similar.

.2 On completion of the Work, or at time designated by Engineer provide digital photographs of various views selected by Engineer.

Part 2 Products

Not Used

Part 3 Execution

Not Used

END OF SECTION

SHOP DRAWING / SUBMITTAL TRANSMITTAL

Submittal Description: ____________________ File Number: __________

Submittal Number: __________

Specification Section: __________

ENGINEER	**Associated Engineering**	CONTRACTOR	
	Attention: Christian Brumpton		Attention:
Associated Engineering Project No.: 2017-2972		Contractor Project No.:	

Routing:	Date Sent		**Contractor to Engineer**		Date Received
	Date Sent		**Engineer to Contractor**		Date Received

Owner:		**Contract:**	
Project:		**Contract Number:**	

Enclosed are the following ___ Submittals for Review ___ Submittals for Information ___ O&M Manual Data

Remarks: ____________________

CONTRACTOR			**ENGINEER**			
Item	**Copies Submitted**	**Description (Drawing Number, Revision Number, Title, Item Description)**	**Copies Returned**	**Review Action[1]**	**Reviewer Initials**	**Comments Attached**

[1] Review Action: **REV** = Reviewed; **RAR** = Revise and Resubmit; **NR** = Not Reviewed

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Contractor certification (certify either A or B):

A. We have verified that the material or equipment covered by this submittal meets all specified requirements, including coordination with all related work.

B. We have verified that the material or equipment covered by this submittal meets all specified requirements except for the noted deviations. (Record deviations below or on attachments. Be specific.)

Item Number	**Deviation**

Certified by: ____________________

Contractor's Signature

Part 1 General

1.1 RELICS AND ANTIQUITIES

.1 Relics and antiquities and items of historical or scientific interest such as cornerstones and contents, commemorative plaques, inscribed tablets, and similar objects found on site or in buildings to be demolished, remain property of Owner. Protect such articles and request directives from Engineer.

.2 Notify Engineer immediately if evidence of archeological finds is encountered and await his written instructions before proceeding with work in area.

Part 2 Products

Not Used

Part 3 Execution

Not Used

END OF SECTION

Part 1 General

1.1 REQUIREMENTS INCLUDED

.1 Regulations affecting the Work imposed by:

- .1 BC Ministry of Environment
- .2 BC Hydro and Power Authority
- .3 Fisheries and Oceans Canada
- .4 Navigation Protection Act
- .5 Environment Canada
- .6 National Building Code
- .7 BC Building Code
- .8 Occupational Health and Safety
- .9 Municipal by-laws and servicing standards
- .10 Municipal utilities
- .11 Regional Water and Sewer Commission

1.2 COMPLIANCE WITH REGULATIONS

.1 Ascertain requirements and regulations of authorities listed above.

.2 Comply with all such requirements and regulations as applicable to the Work.

.3 Requirements set out in this Section are for guidance and information and are not necessarily complete.

1.3 PERMITS

.1 Notwithstanding the provisions of GC 14 - Activities, Owner will obtain the building permits required for the work.

1.4 WORK IN VICINITY OF OVERHEAD POWER LINES

.1 Request power company to relocate, de-energize or guard any energized conductor where construction equipment may operate within 3 m of conductor.

.2 Obtain power company approval prior to operating any equipment within 3 m of energized conductor.

.3 Where practical, avoid storage of metallic pipe sections under high voltage overhead power lines.

.4 If pipe sections must be stored under power lines, protect personnel from effects of induced currents by grounding pipe sections at two (2) locations with AWG #2 copper ground conductors and grounding rods.

.5 Complete and submit WCB Form 30M33 prior to commencement of work.

Part 2 Products

Not Used

Part 3 Execution

Not Used

END OF SECTION

Part 1 General

1.1 LATEST EDITIONS

.1 All references to specifications, standards, or methods of technical associations refer to the latest adopted revision, including all amendments, in effect on the date of submission of bids, except where a date or issue is specifically noted.

1.2 ABBREVIATIONS

AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AFBMA	Antifriction Bearing Manufacturers Association
AGA	American Gas Association
AGMA	American Gear Manufacturers Association
AISC	American Institute of Steel Construction
AMCA	Air Moving and Conditioning Association
ANSI	American National Standards Institute
API	American Petroleum Institute
ARI	Air-Conditioning and Refrigeration Institute
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWMAC	Architectural Woodworkers Manufacturers Association of Canada
AWPA	American Wood Preservers Association
AWS	American Welding Society
AWWA	American Water Works Association
CAN	Canadian National Standard
CBM	Certified Ballast Manufacturers
CBTIC	Clay Brick and Tile Institute of Canada
CEC	Canadian Electrical Code
CEMA	Canadian Electrical Manufacturers Association
CGA	Canadian Gas Association
CGRA	Canadian Good Roads Association
CGSB	Canadian General Standards Board
CISC	Canadian Institute of Steel Construction
CITC	Canadian Institute of Timber Construction
CLA	Canadian Lumbermen Association
CMAA	Crane Manufacturers Association of America
CMHC	Canada Mortgage and Housing Corporation
CPCA	Canadian Painting Contractors Association
CPCI	Canadian Prestressed Concrete Institute
CRCA	Canadian Roofing Contractors Association
CRSI	Concrete Reinforcing Steel Institute
CSA	Canadian Standards Association
CSSBI	Canadian Sheet Steel Building Institute
CUA	Canadian Underwriters Association
CWB	Canadian Welding Bureau
CWC	Canadian Wood Council

CSPI	Corrugated Steel Pipe Institute
EEI	Edison Electric Institute
EEMAC	Electrical and Electronic Manufacturers of Canada
FFPC	Federal Fire Prevention Committee
FM	Factory Mutual Engineering Corporation
IAO	Insurers' Advisory Organization
IBRM	Institute of Boiler and Radiator Manufacturers
IEC	International Electrotechnical Commission
IEE	Institution of Electrical Engineers (U.K.)
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society
IGMAC	Insulated Glass Manufacturers Association of Canada
IPCEA	Insulated Power Cable Engineers Association
ISA	Instrument Society of America
ISO	International Standardization Organization
LEMA	Lighting Equipment Manufacturers Association
LTIC	Laminated Timber Institute of Canada
MMA	Millwork Manufacturers Association
NAAMM	National Association of Architectural Metal Manufacturers
NBC	National Building Code of Canada
NEC	National Electrical Code
NESC	National Electric Safety Code
NFPA	National Fire Protection Association
NLGA	National Lumber Grade Authority
OECI	Overhead Electrical Crane Institute
PCA	Portland Cement Association
PCI	Prestressed Concrete Institute
PMBC	Plywood Manufacturers Association of British Columbia
RCABC	Roofing Contractors Association of British Columbia
RLM	RLM Standards Institute
RTAC	Road and Transportation Association of Canada
SAE	Society of Automotive Engineers
SBI	Steel Boilers Institute
SJI	Steel Joist Institute
SSPC	Steel Structures Painting Council
TTMAC	Terrazzo, Tile and Marble Association of Canada
ULC	Underwriters' Laboratories of Canada
USFG	United States Federal Government
WCB	Workers' Compensation Board
WCLIB	West Coast Lumber Inspection Bureau

1.3 CONFORMANCE

.1 Conform to these standards, in whole or in part as specifically requested in Specifications.

.2 If there is question as to whether any product or system is in conformance with applicable standards, Engineer reserves the right to have such products or systems tested to prove or disprove conformance.

.3 The cost for such testing will be born by Owner in the event of conformance with Contract Documents or by Contractor in the event of non-conformance.

Part 2 Products

Not Used

Part 3 Execution

Not Used

END OF SECTION

Part 1 General

1.1 QUALITY MANAGEMENT PLAN

.1 Refer to Section 01 10 00 Clause 1.1.4.5.

1.2 INSPECTION

.1 Refer to GC 17 – Review and Inspection of Work.

1.3 TESTING LABORATORY SERVICES

.1 Particular requirements for inspection and testing to be carried out by testing laboratory designated by Engineer are specified under various sections.

.2 Engineer will appoint and pay for services of testing laboratory except for the following:

- .1 Inspection and testing required by laws, ordinances, rules, regulations or orders of public authorities.
- .2 Inspection and testing performed exclusively for Contractor's convenience.
- .3 Testing, adjustment and balancing of conveying systems, mechanical and electrical equipment and systems.
- .4 Mill tests and certificates of compliance.
- .5 Tests specified to be carried out by Contractor under the supervision of Engineer.

.3 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 require to verify acceptability of corrected work.

.4 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 operations to allow for assignment of laboratory personnel and scheduling of test.
- .3 Where materials are specified to be tested, deliver representative samples in required quantity to testing laboratory.
- .4 Pay costs for uncovering and making good work that is covered before required inspection or testing is completed and approved by Engineer.

1.4 ACCESS TO WORK

.1 Allow inspection/testing agencies access to Work, offsite manufacturing and fabrication plants.

.2 Co-operate to provide reasonable facilities for such access.

1.5 PROCEDURES

.1 Notify the appropriate agency and Engineer in advance of the 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 the Work.

.3 Provide labour and facilities to obtain and handle samples and materials on site. Provide sufficient space to store and cure test samples.

1.6 REJECTED WORK

.1 Refer to GC 18 - Deficiencies.

1.7 REPORTS

.1 Submit 1 hard copy and one printed pdf copy of inspection and test reports promptly to Engineer.

.2 Provide copies to Subcontractor of work being inspected/tested or manufacturer/fabricator of material being inspected/tested

1.8 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 or beyond those required by the Law of the Place of Work shall be appraised by Engineer and may be authorized as recoverable.

1.9 MOCKUPS

.1 Prepare mock-ups for Work specifically requested in the specifications. Include for Work of all Sections required to provide mock-ups.

.2 Construct in locations acceptable to Engineer.

.3 Prepare mock-ups for Engineer review with reasonable promptness and in an orderly sequence, so as not to cause any delay in the Work.

.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 Engineer will assist in preparing a schedule to establish the dates for preparation, if requested to do so.

.6 Remove mock-ups at conclusion of Work or when acceptable to Engineer.

1.10 MILL TESTS

.1 Submit mill test certificates as required of the specification Sections.

1.11 EQUIPMENT/SYSTEMS

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

.2 Refer to individual specification sections for definitive requirements.

Part 2 Products

Not Used

Part 3 Execution

Not Used

END OF SECTION

Part 1 General

1.1 INSTALLATION/REMOVAL

.1 Provide temporary utilities in order to execute the work expeditiously.

.2 Make necessary applications to authorities having jurisdiction, obtain required permits, and pay all fees and related charges.

.3 Remove from site all such work after use.

.4 Restore site to clean, sanitary condition.

1.2 SANITARY FACILITIES

.1 Provide sanitary facilities for work force in accordance with governing regulations and ordinances.

.2 Post notices and take such precautions as required by local health authorities.

.3 Keep area and premises in sanitary condition.

.4 Disinfect facilities frequently.

.5 Remove contaminated soil and material and replace with fresh, clean material.

.6 Dispose of sanitary wastes, in accordance with the applicable regulations, and subject to approval of Engineer.

.7 Provide all sanitary supplies required for use by Contractor's work force and staff of Engineer.

.8 Prohibit the committing of nuisance. Promptly discharge any employee violating such provision.

1.3 POWER

.1 Arrange, pay for (including monthly usage charges) and maintain temporary electrical power supply in accordance with governing regulations and ordinances.

.2 Provide temporary power (i.e. portable generators) as required, at an acceptable location subject to approval of Engineer.

1.4 WATER SUPPLY

.1 Arrange, pay for and maintain temporary water supply in accordance with governing regulations and ordinances.

.2 Non-potable water supply is available on site and will be provided for construction usage at no cost. A single 50mm connection will be provided by the main contractor on site.

1.5 TELEPHONE

.1 Provide and pay for (including monthly rental charges) temporary telephones necessary for own use.

.2 Pay for all long-distance telephone calls.

1.6 MAINTENANCE OF PUBLIC UTILITIES

.1 Arrange Work to avoid interruption of utilities serving the public. Pay for damage.

.2 Where interruption of public utilities is unavoidable, obtain prior approval for interruption from responsible authority.

.3 As required by utility authority, establish and pay for temporary relocation of utility during construction.

.4 Comply with utility authority requirements in giving notice to users prior to interruption of service.

Part 2 Products

Not Used

Part 3 Execution

Not Used

END OF SECTION

Part 1 General

1.1 INSTALLATION/REMOVAL

.1 Provide lockable temporary field offices and sheds as required during construction in locations directed by Engineer.

.2 Remove promptly from Site all such facilities after use.

1.2 CONTRACTOR'S SITE OFFICE

.1 Provide office heated to 22°C, lighted to 750 Lx and ventilated, of sufficient size to accommodate site meetings and furnished with drawing laydown table and telephone, pay telephone not acceptable.

.2 Located within area identified as “Contractor ‘B’” on FIGURE 1, see Section 00 01 15.

1.3 SITE DOCUMENTS

.1 Maintain the following documents and materials on-site, in Contractor's Site Office, at all times:

  .1 Contract Documents including Drawings.
  .2 Work Orders and Change Orders.
  .3 Shop Drawings.
  .4 Delivery Schedules.
  .5 Progress Estimates.
  .6 As-Built Drawings.

.2 Maintain documents in order and make available for viewing by Engineer at all times.

1.4 STORAGE SHEDS

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

.2 Provided heated storage structures.

.3 Maintain storage sheds in a neat, clean condition.

1.5 FIRST AID FACILITIES

.1 Provide and maintain on Site, in a clean orderly condition, completely equipped First-Aid facilities readily accessible at all times to Contractor's employees. Facilities and staffing to be in accordance with OH&S Legislation.

Part 2 Products

Not Used

Part 3 Execution

Not Used

END OF SECTION

Part 1 General

1.1 INSTALLATION/REMOVAL

.1 Provide temporary access and parking areas as required.

.2 Remove from Site all such work after use.

1.2 ACCESS ROADS

.1 Access road to site is a shared access route maintained by the other General Contractor on-site. See Section 01 31 19 – Project Meetings regarding requirement for weekly coordination meetings for use of shared access roads.

.2 Any shared access roads will be maintained, including snow clearing, by the other General Contractor. Any damage, to any existing access road, outside of regular wear and tear will be the responsibility of the contractor to repair.

.3 Build and maintain temporary roads where indicated [or directed] and provide snow removal during period of work.

.4 If authorized to use existing roads for access to Site, maintain such roads for duration of Contract and make good damage resulting from contractors' use of roads.

.5 Prior to final inspection, obtain and submit to Engineer written signed releases from owners of all roads used for Site access, verifying that roads have been adequately restored and left in a satisfactory condition.

.6 Trim loads of trucks hauling excavated material, cement, sand, stone, gravel, debris or other loose material before leaving the site, and ensure that the bodies of such vehicles are tight so that no spillage of loads occurs.

.7 Shared access and laydown areas for this contract identified as “Contractor ‘B’” on FIGURE 1, see Section 00 01 15.

1.3 ACCESS TO UTILITY INSTALLATIONS

.1 Do not obstruct hydrants, valve or control pit covers, valve boxes, curb stop boxes, fire or police call boxes, and all other utility controls, warning systems, and appurtenances.

.2 Provide and pay for bridges, walks, or other temporary facilities necessary to ensure that these controls or warning systems are free for use in their normal manner at all times during construction.

1.4 CONSTRUCTION PARKING

.1 Parking will be permitted on Site provided it does not disrupt the performance of Work.

Part 2 Products

Not Used

Part 3 Execution

Not Used

END OF SECTION

Part 1 General

1.1 INSTALLATION/REMOVAL

.1 Provide temporary barriers and enclosures as required to protect against injury and damage.

.2 Remove from Site all such work after use.

1.2 HOARDING

.1 Erect hoarding where indicated on drawings to protect the public, workers, public and private property from injury or damage.

.2 Provide hoarding with chain link fence 2 m high, protecting public and private property from injury or damage. Provide lockable gates within hoarding for access to site by workers and vehicles.

.3 Provide barricades and covered walkways required by governing authorities for public rights-of-way and for public access to building.

1.3 GUARD RAILS AND BARRICADES

.1 Provide secure, rigid guard railings and barricades around deep excavations, open shafts, open stair wells, open edges of floors and roofs.

.2 Provide as required by governing authorities.

1.4 TREE AND PLANT PROTECTION

.1 Protect trees and plants on site and adjacent properties where indicated.

.2 Wrap in burlap trees and shrubs adjacent to construction work, storage areas and trucking lanes, and encase with protective wood framework from grade level to height of 2 m.

.3 Protect roots of designated trees to dripline during excavation and site grading to prevent disturbance or damage. Avoid unnecessary traffic, dumping and storage of materials over root zones.

.4 Minimize stripping of topsoil and vegetation.

.5 Restrict tree removal to areas indicated or designated by Engineer.

Part 2 Products

Not Used

Part 3 Execution

Not Used

END OF SECTION

Part 1 General

1.1 CONSTRUCTION CLEANING

.1 Maintain the Work in tidy condition, free from the accumulation of waste products and debris, other than that caused by Owner or other contractors.

.2 Remove waste material and debris from the site and deposit in waste container at the end of each working day.

.3 Clean interior areas prior to start of finish work, maintain areas free of dust and other contaminants during finishing operations.

.4 Promptly clean up any spillage that occurs on site roads, access roads or public roads, or other areas where construction vehicles are travelling.

.5 If Contractor is negligent in maintaining cleanliness of roads, Owner will arrange for cleaning to be done at Contractor's expense.

1.2 FIRES

.1 Fires and burning of rubbish on site is not permitted.

1.3 DISPOSAL OF WASTES

.1 Do not bury, or permit to be buried, rubbish and waste materials on site unless approved by Engineer.

.2 Do not dispose, or permit the disposal, of waste or volatile materials, such as mineral spirits, oil or paint thinner into waterways, storm or sanitary sewers.

.3 Remove from Site wastes and materials specified or designated by Engineer to be disposed of. Dispose of these wastes and materials at designated landfill or recycling facility.

1.4 DRAINAGE

.1 Provide temporary drainage and pumping as necessary to keep excavations and site free from surface and ground 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 Maintain existing drainage facilities affected by Work in good operating condition at all times during construction.

1.5 WORK ADJACENT TO WATERWAYS

.1 Do not operate construction equipment in waterways unless specifically authorized to do so.

.2 Do not use waterway beds for borrow material without Engineer's approval.

.3 Do not dump excavated fill, waste material, debris, or other extraneous material in waterways under any circumstances.

.4 Design and construct temporary crossings to minimize erosion to waterways.

.5 Do not skid logs or construction materials across waterways.

.6 Avoid indicated spawning beds when constructing temporary crossings of waterways.

.7 Do not blast under water or within 100 m of indicated spawning beds.

1.6 POLLUTION CONTROL

.1 Maintain temporary erosion and pollution control features installed under this contract.

.2 Control emissions from equipment and plant to requirements of authorities having jurisdiction.

.3 Prevent sandblasting and other extraneous materials from contaminating air beyond application area, by providing temporary enclosures.

.4 Cover or wet down dry materials and rubbish to prevent blowing dust and debris. Provide dust control for temporary roads.

1.7 MATERIALS TO BE SALVAGED

.1 Remove, clean, deliver, unload and neatly stockpile rip-rap materials used for temporary construction works which are specified or designated by Engineer to be salvaged. Materials to be stockpiled in designated area, as indicated in Contract Drawings.

.2 Repair or replace at Contractor's expense salvaged materials damaged during removal, unloading or in transit.

1.8 BLASTING

.1 Obtain Owner's approval for blasting. Owner, in granting approval, does not assume any responsibility for Contractor's methods or for injury, loss of life or damage resulting therefrom.

.2 Obtain insurance coverage for blasting operations prior to commencing such operations.

.3 Repair or pay for any damage resulting from blasting operations

Part 2 Products

Not Used

Part 3 Execution

Not Used

END OF SECTION

Part 1 General

1.1 GENERAL

.1 All works shall be undertaken in accordance with:

  .1 Any permits or approvals granted for the Project.

  .2 'Land Development Guidelines for the Protection of Aquatic Habitat' developed by Fisheries and Oceans Canada (DFO) and the Ministry of Environment (http://www.dfo-mpo.gc.ca/Library/165353.pdf)

  .3 Standards and Best Practices for Instream Works' developed by the Ministry of Water, Land and Air Protection (https://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/standards-guidelines/best-management-practices/iswstdsbpsmarch2004.pdf).

  .4 Measures to Avoid Harm to Fish and Fish Habitat found on the DFO website, paying particular attention to advice related to Timing, Contaminant and Spill Management, Erosion and Sediment Control, Shoreline Re-vegetation and Stabilization and Operation of Machinery (http://www.dfo-mpo.gc.ca/pnw-ppe/measures-mesures/measures-mesures-eng.html)

.2 Environmental Protection measures will incorporate mitigation measures outlined in the Wastewater Treatment Plant Expansion Construction and Operations Environmental Impact Study, February 2018, prepared by Associated Engineering (AE) for the City of Port Alberni and provided as part of the tender (see Appendix C.)

1.2 CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN (CEMP)

.1 The Contractor shall provide a CEMP prepared and/or signed and accepted by a Qualified Environmental Professional (QEP), which describes in detail the approach to be taken in addressing environmental issues associated with the Project and the correlation of the CEMP to the project schedule. The plan must be based on recommendations and mitigations presented in AE’s Environmental Impact Study (see Appendix X) and be inclusive of all elements required to complete the Work, providing construction procedures as they relate to the protection of the environment.

1.3 ENVIRONMENTAL MONITORING

.1 The Contractor shall retain an Environmental Monitor. This person shall be an appropriately QEP. Environmental monitoring will be conducted by the QEP daily during environmentally sensitive works (e.g., vegetation clearing and in-stream works), and weekly during non-critical works. The QEP shall provide the Contractor and the Owner with bi-weekly environmental monitoring reports documenting construction activities, implemented mitigation measures, any environmental issues observed, and recommended corrective actions.

1.4 TEMPORARY EROSION AND SEDIMENT CONTROLS

.1 The Contractor will submit a Sediment and Erosion Control Plan as a separate document or as part of the Contractor’s CEMP. The Contractor will not commence with the Work until the Erosion and Sediment Control Plan is approved by the Engineer.” The standards for sediment and erosion control outlined in the “Land Development Guidelines for the Protection of Aquatic Habitat” must be adhered to.

.2 All work must be undertaken and completed in such a manner as to prevent the release of silt, sediment or sediment-laden water, raw concrete or concrete leachate, or any other deleterious substances into the Somass River and Somass Estuary.

.3 Construction and excavation wastes, overburden, soil, or other substances deleterious to aquatic life must be disposed of or placed in such a manner so as to prevent their entry into any the Somass River and Somass Estuary.

.4 Any fill used for this project must be free of contaminants and must be placed so that it will not gain entry into the Somass River and Somass Estuary.

1.5 SPILL PREVENTION AND EMERGENCY RESPONSE

.1 The Contractor will submit a comprehensive Spill Prevention and Emergency Response Plan prior to construction to be included in the CEMP. The plan will specify the measures to prevent introduction of deleterious substances.

1.6 WATER QUALITY

.1 The Contractor is responsible for planning, scheduling and performing this Work in such a manner that the quality of water flowing from and through the Site is within provincial and federal water quality guidelines for the protection of aquatic life, and will take immediate action to correct any deficiency in water quality, as outlined in an Erosion Sediment Control Plan. The Contractor is responsible for maintaining conditions which protect the environment not only during active construction on the Site, but also during periods when the Contractor has suspended its construction activity for any reason.

1.7 BREEDING BIRDS

.1 The Breeding Bird Nesting Window is mid-March to mid-August of any given year when birds are nesting. No clearing of vegetation is permitted during this critical bird breeding period unless the Contractor’s QEP performs a bird nest survey. If nests of species named in the BC Wildlife Act (i.e., great blue heron or various raptors including eagles, peregrine falcon and osprey) are identified in the vicinity of the Project area prior to construction, these must be protected year-round and cannot be disturbed. A QEP will identify and mark any active nests and provide guidance for protection.

1.8 SURVEYS AND SALVAGES

.1 The Contractor will be responsible for pre-construction surveys and salvages (e.g. pre-clearing bird nest survey, rare plant inventories, fish salvage) by a QEP as required by the Project’s permits and approvals, best management practices, and recommended by the Contractor’s Environmental Monitor. If required, the surveys and salvages shall be considered incidental to the Work and no additional payment will be made. The Contractor will be required to schedule the Work accordingly.

Part 2 Products

2.1 NOT USED

.1 Not Used

Part 3 Execution

3.1 NOT USED

.1 Not Used

END OF SECTION

Part 1 General

1.1 CONSTRUCTION SIGN

.1 Provide safety and warning signs, as required by regulations.

.2 Maintain sign in good condition for the duration of Work. Clean periodically.

.3 Upon completion of construction or within ten (10) working days of being so notified by Engineer, remove the Construction Sign and restore site of sign to satisfaction of Engineer.

Part 2 Products

Not Used

Part 3 Execution

Not Used

END OF SECTION

Part 1 General

1.1 QUALITY

.1 Products, materials, equipment and articles (referred to as Products throughout the specifications) incorporated in Work shall be new, not damaged or defective, and of the best quality (compatible with specifications) for the purpose intended. If requested, furnish evidence as to type, source and quality of Products provided.

.2 Defective Products, whenever identified prior to the completion of Work, will be rejected, regardless of previous inspections. Inspection does not relieve responsibility, but is a precaution against oversight or error. Remove and replace defective Products at own expense and be responsible for delays and expenses caused by rejection.

.3 Should any dispute arise as to the quality or fitness of Products, the decision rests strictly with the Engineer based upon the requirements of the Contract Documents.

.4 Unless otherwise indicated in the specifications, maintain uniformity of manufacture for any particular or like item throughout the building.

.5 Permanent labels, trademarks and nameplates on Products are not acceptable in prominent locations, except where required for operating instructions, or when located in mechanical or electrical rooms.

1.2 AVAILABILITY

.1 Immediately upon signing Contract, review Product delivery requirements and anticipate foreseeable supply delays for any items. If delays in supply of Products are foreseeable, notify the Engineer of such, in order that substitutions or other remedial action may be authorized in ample time to prevent delay in performance of Work.

.2 In the event of failure to notify Engineer at commencement of Work and should it subsequently appear that Work may be delayed for such reason, the Engineer reserves the right to substitute more readily available products of similar character, at no increase in Contract Amount.

1.3 STORAGE, HANDLING AND PROTECTION

.1 Handle and store Products in a manner to prevent damage, adulteration, deterioration and soiling and in accordance with manufacturer's instructions when applicable.

.2 Store packaged or bundled Products in original and undamaged condition with manufacturer's seals and labels intact. Do not remove from packaging or bundling until required in Work.

.3 Store products subject to damage from weather in weatherproof enclosures.

.4 Store cementitious products clear of earth or concrete floors, and away from walls.

.5 Keep sand, when used for grout or mortar materials, clean and dry. Store sand on wooden platforms and cover with waterproof tarpaulins during inclement weather.

.6 Store sheet materials, lumber on flat, solid supports and keep clear of ground. Slope to shed moisture.

.7 Store and mix paints in a heated and ventilated room. Remove oily rags and other combustible debris from site daily. Take every precaution necessary to prevent spontaneous combustion.

.8 Remove and replace damaged Products and to the satisfaction of Engineer.

1.4 TRANSPORTATION

.1 Pay costs of transportation of Products required in the performance of Work.

.2 Transportation cost of Products supplied by Owner will be paid for by Owner. Unload, handle and store such Products.

1.5 FASTENINGS

.1 Provide metal fastenings and accessories in same texture, colour and finish as adjacent materials, unless indicated otherwise.

.2 Prevent electrolytic action between dissimilar metals and materials.

.3 Use non-corrosive hot dip galvanized steel fasteners and anchors for securing exterior work, unless stainless steel or other material is specifically requested in the affected specification Section.

.4 Space anchors within their load limit or shear capacity and ensure they provide positive permanent anchorage. Wood, or any other organic material plugs are not acceptable.

.5 Keep exposed fastenings to a minimum, space evenly and install neatly.

.6 Fastenings which cause spalling or cracking of material to which anchorage is made are not acceptable.

1.6 QUANTITIES

.1 Schedules of piping, fittings, reinforcing, or other materials indicating quantity and/or dimension, which are shown on the drawings or in the specifications, are intended only to assist Contractor with quantity takeoff. Quantities and dimensions shown therein are not guaranteed to be accurate and must be checked by Contractor prior to placing an order for such materials.

.2 Claims for additional payment resulting from variations between quantities shown on the schedules and those actually installed will not be accepted.

Part 2 Products

Not Used

Part 3 Execution

Not Used

END OF SECTION

Part 1 General

1.1 MOBILIZATION

.1 Mobilization shall consist of preparatory work and operations including, but not limited to, those necessary to the movement of personnel, equipment, supplies and incidentals to Site; and for all other work and operations which must be performed or costs incurred prior to beginning work on the various items on Site.

1.2 DEMOBILIZATION

.1 Demobilization shall consist of cleanup work and operations including, but not limited to, those necessary to the removal of personnel, equipment, and incidentals from Site.

1.3 PAYMENT

.1 Any amount of the lump sum price for mobilization and demobilization that exceeds 5% of the Total Bid shall be paid upon completion of the contract and removal of equipment and cleanup of the work areas to the satisfaction of Engineer.

.2 Payment for that portion of the lump sum price for mobilization and demobilization that is less than or equal to 5% of the Total Bid will be made as follows:

- .1 75% will be paid on the first progress payment certificate due after Contractor has established their operations and facilities and submitted the following documents in a form acceptable to the Engineer:
  - .1 Construction Environmental Management Plan
  - .2 Project Management Plan
- .2 The remaining 25% will be paid upon completion of the contract and removal of equipment and cleanup of the work areas to the satisfaction of Engineer.

Part 2 Products

Not Used

Part 3 Execution

Not Used

END OF SECTION

Part 1 General

1.1 SUBMITTALS

.1 Make submittals in accordance with Section 01 33 00 - Submittals.

.2 Submit site specific Health and Safety Program: Within 14 days after date of Notice to Proceed and prior to commencement of Work. Health and Safety Program must include:

  .1 Results of site specific safety hazard assessment.
  .2 Results of safety and health risk or hazard analysis for site tasks and operation.

.3 Submit Construction Safety Checklists after completion.

.4 Submit copies of all reports or directives issued by Federal and/or Provincial health and safety inspector(s).

.5 Submit copies of incident and accident reports.

.6 Submit on site Contingency and Emergency Response Plan: Address standard operating procedures to be implemented during emergency situations.

.7 Submit Material Safety Data Sheets (MSDS).

.8 Submit personnel training requirements including names of personnel and alternates responsible for site safety and health, hazards present on site, and use of personal protective equipment.

.9 Submit, and post at the Work site, the emergency numbers for police, fire and ambulance for the locale of the Work, as well as the names and after hours numbers for key site personnel related to health, safety or security of the site.

1.2 SAFETY ASSESSMENT

.1 Perform site specific safety hazard assessment related to project.

.2 Submit hazard assessment report to Engineer.

1.3 MEETINGS

.1 Attend health and safety pre construction meeting.

.2 Arrange for "tool box" safety meetings and submit reports.

.3 Attend weekly coordination meetings with all contractor’s on site to discuss overall site health and safety, and safety responsibility in shared areas. See Section 01 31 19 – Project Meetings.

1.4 REGULATORY REQUIREMENTS

.1 Comply with specified standards and regulations to ensure safe operations at site containing hazardous or toxic materials.

1.5 GENERAL REQUIREMENTS

.1 Develop written site specific Health and Safety Program based on hazard assessment prior to commencing any site Work and continue to implement, maintain, and enforce plan until final demobilization from site. Health and Safety Program must address project specifications.

.2 Correct deficiencies and re submit Health and Safety Program when so requested by Engineer.

1.6 RESPONSIBILITY

.1 Be responsible for health and safety of persons in their Work Area on site, safety of property on site and for protection of persons adjacent to Work Area and environment to extent that they may be affected by conduct of Work.

.2 Comply with and enforce compliance by employees with safety requirements of Contract Documents, applicable federal, provincial, territorial, and local statutes, regulations, and ordinances, and with site specific Health and Safety Program.

1.7 COMPLIANCE REQUIREMENTS

.1 Comply with OH&S Legislation

1.8 UNFORSEEN HAZARDS

.1 Should any unforeseen or peculiar safety related factor, hazard, or condition become evident during performance of Work, immediately stop work and follow procedures in place for employee's right to refuse work in accordance with the OH&S Legislation. Advise Engineer verbally and in writing.

1.9 CORRECTION OF NON COMPLIANCE

.1 Immediately address health and safety non compliance issues identified by Engineer or designated safety inspector.

.2 Provide Engineer with written report of action taken to correct non compliance of health and safety issues identified.

.3 Be aware that Engineer may stop Work if non compliance of health and safety regulations is not corrected.

1.10 WORK STOPPAGE

.1 Give precedence to safety and health of public and site personnel and protection of environment over cost and schedule considerations for Work.

.2 Stop Work when necessary or advisable for reasons of health and safety.

.3 Be aware that Engineer or designated safety inspector may stop Work when deemed necessary or advisable for reasons of health and safety.

Part 2 Products

Not Used

Part 3 Execution

Not Used

END OF SECTION

Part 1 General

1.1 QUALIFICATIONS OF SURVEYOR

.1 Qualified registered land surveyor, acceptable to Owner.

1.2 SURVEY REFERENCE POINTS AND LEGAL SURVEY MARKERS

.1 Existing base horizontal and vertical control points are designated on drawings.

.2 Locate, confirm and protect control points and legal survey markers prior to starting site work. Preserve permanent reference points during construction.

.3 Make no changes or relocations without prior written notice to Engineer.

.4 Report to Engineer when a reference point or legal survey marker is lost or destroyed, or requires relocation because of necessary changes in grades or locations.

.5 Require surveyor to replace control points in accordance with original survey control.

.6 Require surveyor to replace legal survey markers lost or destroyed as a result of construction activities.

1.3 SURVEY REQUIREMENTS

.1 Establish lines and levels, locate and lay out, by instrumentation.

.2 Stake for grading, fill and topsoil placement and landscaping features.

.3 Stake slopes and berms.

.4 Establish pipe invert elevations.

.5 Stake batter boards for foundations.

.6 Establish foundation column locations and floor elevations.

.7 Establish lines and levels for mechanical and electrical work.

.8 Provide competent worker(s) to assist Engineer with checking of layout, measurement of quantities, and compilation of record data. Reserve worker(s) for this purpose and make available as required by Engineer.

1.4 RECORDS

.1 Maintain a complete, accurate log of control and survey work as it progresses.

.2 On completion of foundations and major site improvements, prepare a certified survey showing dimensions, locations, angles and elevations of Work.

1.5 SUBMITTALS

.1 Submit name and address of Surveyor to Engineer.

.2 On request of Engineer, submit documentation to verify accuracy of field engineering work.

.3 Submit certificate signed by Surveyor certifying that elevations and locations of completed Work are in conformance, or nonconformance with Contract Documents.

1.6 SUBSURFACE CONDITIONS

.1 Promptly notify Engineer in writing if subsurface conditions at Site differ materially from those indicated in Contract Documents, or a reasonable assumption of probable conditions based thereon.

.2 After prompt investigation, should Engineer determine that the conditions do differ materially, instructions will be issued for changes in Work as provided in GC 53 - Changes.

1.7 ENGINEER'S ASSISTANT AND STAKES

.1 Provide Engineer with all stakes, batter boards, straight edges, and other materials, with the exception of technical instruments and apparatus, required by Engineer to set out lines and levels for Work.

.2 Supply Engineer with competent worker(s), as required, to assist in the setting of lines and levels for Work.

1.8 EXISTING SURVEY MARKERS

.1 Replace legal survey markers, disturbed or removed by the construction operation, that existed at a horizontal distance of 1.5 m or more from the centreline of pipe being installed. If it is necessary to remove or disturb existing legal survey markers that are within 1.5 m of the pipe centreline, notify Engineer before such removal or disturbance and replacement will be at Owner's expense.

Part 2 Products

Not Used

Part 3 Execution

Not Used

END OF SECTION

Part 1 General

1.1 PREPARATION

.1 Inspect existing conditions, including elements subject to damage or movement during cutting and patching.

.2 After uncovering, inspect conditions affecting performance of Work.

.3 Beginning of cutting and patching means acceptance of existing conditions.

.4 Provide temporary structural supports to ensure structural integrity of surroundings.

.5 Provide devices and methods to protect other portions of project from damage.

.6 Provide protection from elements for areas which may be exposed by uncovering work.

.7 Maintain excavations free of water.

1.2 MANUFACTURER'S INSTRUCTIONS

.1 Unless otherwise indicated in the specifications, install or erect Products in accordance with manufacturer's instructions. Do not rely on labels or enclosures provided with Products. Obtain written instructions directly from manufacturers.

.2 Notify Engineer, in writing, of conflicts between the specifications and manufacturer's instructions, so that Engineer may establish the course of action.

.3 Improper installation or erection of Products, due to failure in complying with these requirements, authorizes Engineer to require removal and re-installation at no increase in Contract Amount.

1.3 WORKMANSHIP

.1 General:

  .1 Execute work by workers experienced and skilled in the respective duties for which they are employed. Notify Engineer immediately if required Work is such as to make it impractical to produce required results.
  .2 Do not employ any unfit person or anyone unskilled in their required duties. Engineer reserves the right to require the dismissal from the site, of workers deemed incompetent, careless, insubordinate or otherwise objectionable.
  .3 Decisions as to the quality or fitness of workmanship in cases of dispute rest solely with Engineer, whose decision is final.

.2 Co-Ordination:

  .1 Ensure co-operation of workers in laying out Work. Maintain efficient and continuous supervision.

  - .2 Be responsible for co-ordination and placement of openings, sleeves and accessories.

- .3 Protection of Work in Progress:
  - .1 Adequately protect Work completed or in progress. Work damaged or defaced due to failure in providing such protection is to be removed and replaced, or repaired, as directed by Engineer, at no increase in Contract Amount.
  - .2 Prevent overloading of any part of the building. Do not cut, drill or sleeve any load bearing structural member, unless specifically indicated, without written approval of Engineer.
- .4 Remedial Work:
  - .1 Refer to Section 00 72 00 - General Conditions and Section 00 73 00 - Supplementary Conditions.
  - .2 Perform remedial work required to repair or replace the parts or portions of Work identified as defective or unacceptable. Coordinate adjacent affected Work as required.
  - .3 Perform remedial work by specialists familiar with the materials affected. Perform in a manner to neither damage nor endanger any portion of Work.
- .5 Location of Fixtures:
  - .1 Consider the location of fixtures, outlets, and mechanical and electrical items indicated as approximate.
  - .2 Inform Engineer of a conflicting installation. Install as directed.
- .6 Concealment:
  - .1 In finished areas, conceal pipes, ducts and wiring in floors, walls and ceilings, except where indicated otherwise.
  - .2 Before installation, inform Engineer if there is a contradictory situation. Install as directed by Engineer.

1.4 EXISTING UTILITIES

- .1 When breaking into or connecting to existing services or utilities, execute Work at times directed by local governing authorities, with a minimum of disturbance to Work, and vehicular traffic.

- .2 Protect, relocate or maintain existing active services. When inactive services are encountered, cap off in a manner approved by authority having jurisdiction, stake and record location of capped service.

Part 2 Products

Not Used

Part 3 Execution

Not Used

END OF SECTION

Part 1 General

1.1 MATERIALS

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

1.2 FINAL CLEANING

.1 In preparation for Certificate of Completion or Total Performance of the project, perform final cleaning.

.2 Prior to final review, remove surplus products, tools, construction machinery and equipment.

.3 Remove waste products and debris other than that caused by Owner or other Contractors.

.4 Inspect finishes, fitments and equipment and ensure specified workmanship and operation.

.5 Clean roofs, downspouts, and drainage systems.

.6 Remove grease, dust dirt, stains, labels, fingerprints, and other foreign materials, from interior and exterior finished surfaces including glass and other polished surfaces.

.7 Clean lighting reflectors, lenses, and other lighting surfaces.

.8 Vacuum clean and dust building interiors, behind grilles, louvres and screens.

.9 Wax, seal, shampoo or prepare floor finishes, as recommended by manufacturer.

.10 Broom clean paved surfaces; rake clean other surfaces of grounds.

.11 Remove debris and surplus materials from crawl areas and other accessible concealed spaces.

.12 Remove snow and ice from access to building.

.13 Inspect valve boxes, manholes and hydrants to check for debris and proper operation.

.14 Operate valves, including those existing prior to construction, to ensure that no damage has occurred or debris accumulated, due to cleanup activities.

Part 2 Products

Not Used

Part 3 Execution

Not used

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Requirements for placing Work in a state of readiness for acceptance by Owner.

.2 Section supplements, but does not supersede, specific requirements of other Sections.

1.2 DEFINITIONS

.1 Pre-Start-Up: Pre-start-up consists of the non-operating functions required to bring Work to a state of readiness for placing systems into service. It includes, but is not limited to; cleaning, leakage and pressure testing, cold alignment checks, disinfection, system flushing, lubrication of mechanical equipment, rotation checks and wiring loop checks. Contractor shall conduct inspections of all components and sub-components and shall arrange for inspections of equipment installations by qualified equipment manufacturers' representatives as required by Contract Documents. At this stage, deficiency lists are prepared and Contractor is to remedy outstanding incomplete or incorrect work in accordance with terms of Contract. Contractor shall obtain completed Equipment Installation Certification Forms for each specified piece of equipment and shall submit these to Engineer for review. Once Engineer is satisfied that each piece of equipment in a system or subsystem has been properly checked out and all apparent deficiencies have been remedied, a Green “Ready-to-Start” tag shall be placed on the equipment designating that the Pre-Start-Up Phase for that particular system is complete.

.2 Start-Up: Start-Up consists of individual system started and tested. Contractor is not responsible for the start-up activities, under this contract. Start-up to be completed by another Contractor as per an existing contract. Contractor will be available during the start-up of the pumps to provide support in regard to the pumps, draft tubes, valves, electrical and any other components installed by the Contractor.

.3 Commissioning: Commissioning consists of placing all the various systems in Work into continuous operation in an orderly manner. Contractor is not responsible for the commissioning activities, under this contract. Commissioning to be completed by another Contractor as per an existing contract. .

1.3 QUALITY CONTROL

.1 Appoint a professional engineer or qualified operations specialist as Testing and Commissioning Manager to manage, coordinate and supervise the Testing, Start-up and Commissioning Program. Qualifications to include minimum 5 years experience managing testing, start-up and commissioning of mechanical, electrical, instrumentation, building systems and piping systems. Provide resume to Engineer for review prior to commencement of program.

.2 When specified in individual Sections of Contract Documents, require manufacturer or supplier to provide authorized representative(s).

.3 Testing:

  - .1 Provide all required testing equipment and ancillary equipment to verify specified performance.
  - .2 Calibrate all test equipment to plus or minus 2 percent of actual value at full scale.
  - .3 Employ recognized, industry standard calibration procedures or as specified in individual Sections.
  - .4 Submit calibration plans and results to Engineer.

.4 Attend and participate in Pre-start-up, Start-up and Commissioning workshops with Engineer and Owner representatives.

1.4 SAFETY

.1 Ensure all requisite safety equipment, devices, detectors, materials and procedures are in place, tested and operational before commencing.

.2 Conform to requirements of all regulatory authorities having jurisdiction.

.3 Maintain communications with fire, police, environmental and health authorities.

1.5 ENVIRONMENTAL PROTECTION

.1 Comply with all requirements of federal, provincial and local jurisdictions having authority.

1.6 PRE-START-UP

.1 Prepare Pre-start-up Equipment Checkout Listing which includes all Process Mechanical, Commodity-retaining Structures, Building Mechanical, Instrumentation and Controls and Electrical Equipment. Group listing into logical systems or sub-systems for orderly progression of activities during start-up.

.2 Identify all pieces of equipment by Tag Numbers.

.3 To extent practical, remove all scaffolding, debris, planks tools and other construction-related material.

.4 Remove all sand, silt, dirt and debris from tanks, channels, chambers, instrumentation and control panels and electrical panels and vacuum clean.

.5 Clean all surfaces of tanks and conduits, including walls, roofs, floors and columns with high pressure water jets or as specified in individual Sections.

.6 Clean interior of all pipes and fluid-carrying equipment, including pumps and inspect with Engineer present.

.7 Conduct leakage and pressure tests in accordance with individual Sections.

.8 Conduct disinfection procedures in accordance with requirements of individual Sections.

.9 Provide Checkout Tag for each piece of equipment.

.10 Checkout Tags to be filled in by each applicable trade verifying that all appropriate checks have been made, including but not limited to, cleaning, inspection, leakage testing, lubrication, rotation, calibration, adjustment and wire loop checks.

.11 Equipment Manufacturer's Representatives to inspect equipment in accordance with applicable individual Sections. Certify equipment has been properly installed and is ready to start.

.12 Contractor to submit Equipment Checkout Listing to Engineer. Equipment Checkout Listing to include the following:

  .1 System description.
  .2 Equipment Name and Tag Number of each component within System.
  .3 Supplier's Name of each equipment component, complete with sign-off where applicable.
  .4 Mechanical Trade sign-off (Blue and White Cards completed).
  .5 Electrical/Instrumentation Trades sign-off (Red, Yellow and White Cards completed).
  .6 Contractor sign-off (all cards completed).

.13 Attach the following to Equipment Checkout Listing:

  .1 Manufacturer's Representatives' Installation Certification Form.
  .2 Hydrostatic Test Certification Forms for Process Tanks.
  .3 Pressure Test Certification Forms for Process Tanks.
  .4 Disinfection Certification Forms where applicable.
  .5 Instrumentation and Electrical Equipment Loop Check Forms.
  .6 Instrumentation Calibration Forms.
  .7 Listing of outstanding contract deficiencies for each system.

.14 Request, in writing, a Pre-Start-Up Inspection by Engineer. Once Engineer has conducted the Pre-Start-Up Inspection and is satisfied that each piece of equipment has been properly checked-out, a green "Ready-to-Start" tag will be attached to each piece of equipment in the system.

1.7 START-UP

.1 Contractor will be available during the start-up of the pumps to provide support in regard to the pumps, draft tubes, valves, electrical and any other components installed by the Contractor.

.2 Not Used.

1.8 COMMISSIONING

.1 Commissioning by others.

.2 Notwithstanding, Contractor to be available on call on 24/h notice during commissioning period to provide support for commissioning of valves and other works as part of this contract, in the event that support is required.

Part 2 Products

Not Used

Part 3 Execution

Not Used

END OF SECTION

Part 1 General

1.1 MANUAL

.1 An organized compilation of operating and maintenance data including detailed technical information, documents and records describing operation and maintenance of individual products or systems as specified in individual sections of Divisions 02 to 49.

1.2 GENERAL

.1 Prepare three (3) hardcopies and one (1) electric copy of documentation including as-constructed shop drawings to instruct Owner's operations and maintenance staff in the operation and associated maintenance of each piece of equipment and system as supplied and installed.

.2 The electric copy to be PDF text searchable.

.3 Submit the completed O & M Manuals before 90% of the work is approved for payment. No payment for any work will be made over 90% of the Contract value until completed O & M Manuals are received and accepted as satisfactory.

1.3 BINDERS

.1 Provide the material in 80 mm or 135 mm spine, 215 x 280 mm black, heavy-duty d-ring binders or approved alternative.

1.4 CONTENTS

.1 Arrange the material in volumes as described below. Provide a separate binder for each volume unless directed otherwise by Engineer. Where more than one binder is required to accommodate the documentation for a volume, increase or decrease the number of volumes and renumber as necessary.

Volume 1 - Operating Manual
Volume 2 - Architectural/Structural
Volume 3 - Mechanical Operations and Maintenance
Volume 4 - Electrical and Instrumentation Operations

.2 Permanently number each set.

.3 Letter the spine of the binder with the full identification title of the project and the front face with the following on the respective binders:

Full identification title of the project
Volume Number
Volume Title
City of Port Alberni
Number of Sets (e.g. 1 of 3)

.4 Engineer will prepare the manual content in Volume 1. All other Volumes are the responsibility of Contractor. Provide the binders and the dividing tabs to Engineer for the compilation of Volume 1.

.5 Arrange the binders according to the Construction Specifications Institute MASTERFORMAT - Master List of Sections, Titles and Numbers, utilizing laminated mylar plastic divider tabs, colour coded according to section. Markings on the tabs are to be type written. Tab colours are to be as follows:

- .1 Division – white
- .2 Sections – orange
- .3 Subsections – yellow

.6 Make up each binder as follows:

- .1 Tab: Table of Contents - details the titles of various divisions of the manual in the binder.
- .2 Tab: Introduction to manual - written explanation of the layout of the manual and intended use.

.7 Include separately the following:

- .1 Consultant: name, address, email, telephone and FAX numbers, name of Project Manager.
- .2 Contractor: name, address, email, telephone and FAX numbers, name of Project Manager.
- .3 Major Sub-Contractors: name, address, email, telephone and FAX numbers of sub-contractors included in that binder.

.8 Provide the following for each respective discipline:

- .1 Tab: Division number xx:
- .2 Index - information in that division in order of appearance in the specification,
- .3 List of sub-contractors and suppliers - name, address, and telephone and FAX numbers,
- .4 Specification section cross reference, and
- .5 Drawing List.

.9 Organize the various applicable sections under separate divider tabs labelled division/number as required by the project. A typical outline is as follows:

Tab: DIVISION 7 - THERMAL AND MOISTURE PROTECTION
07 11 13 - Bituminous Dampproofing
07 16 19 - Metal Oxide Waterproofing
07 18 00 - Traffic Coatings
07 19 00 - Water Repellents
07 21 13 - Board Insulation
07 21 16 - Blanket Insulation
07 21 23 - Loose-Fill Insulation
07 24 00 - Exterior Insulation and Finish Systems
07 26 00 - Vapour Retarders
07 31 29 - Wood Shingles and Shakes
07 61 00 - Sheet Metal Roofing
07 62 00 - Sheet Metal Flashing and Trim
07 72 33 - Roof Hatches
07 92 00 - Joint Sealing

.10 Provide the information given below, where applicable, for each system and major piece of equipment. Refer to each piece of equipment by its name and tag number. Where manufacturer's literature covers several models or options, highlight the applicable information, using a non fading marker, and cross out redundant information.

  .1 Index of information in that section in order of appearance;
  .2 Description of system, components and technical data. Include interfaces, sequences, operations; characteristic changes for seasonal operation;
  .3 Maintenance and operating instructions including:
    .1 Installation instructions
    .2 Procedure for starting
    .3 Proper adjustment
    .4 Test procedures
    .5 Procedure for operating
    .6 Procedure for shutdown
    .7 Safety precautions
    .8 List of electrical relay settings and control and alarm contact settings.
  .4 Troubleshooting data;
  .5 Preventative maintenance program complete with:
    .1 Suggested check list sheets
    .2 List of points to be greased or oiled
    .3 Recommended type, grade and temperature range of lubricants
    .4 List of wear points to be inspected and/or adjusted regularly.
    .5 Suggested schedule for lubrication and inspection
  .6 Schematic, single line, and wiring diagrams;
  .7 Valve tag list;
  .8 Recommended spare parts list;
  .9 Certification, guarantee, warranty;
  .10 Service representatives - name, address and telephone number;
  .11 Suppliers for replacement parts - name, address, and telephone numbers;
  .12 Test results; witness testing and commissioning, reports;
  .13 Test data for piping systems (degreasing, flushing, disinfection);
  .14 Hydrostatic or air tests performance;
  .15 Equipment alignment certificates;
  .16 Balancing data for air and water systems;
  .17 Inspection approval certificates for all types of systems; plumbing and piping, hot air and ventilating, electrical supervisory, etc.

.11 The material submitted in accordance with the contractual requirements for "As-Constructed Shop Drawings" is generally bulky and difficult to file in a binder. If requested by Engineer, provide copies of all "As-Constructed Shop Drawing" material in a single drawer legal size cardboard file cabinet. Arrange in accordance with the Construction Specifications Canada MASTERFORMAT. Identity any material located in the file cabinet as such in the appropriate location in the binders.

.12 At Engineer's discretion, provide the information in plastic map pockets in appropriate sections in the binders.

Part 2 Products

Not Used

Part 3 Execution

Not Used

END OF SECTION

Part 1 General

1.1 GENERAL

.1 Specific requirements for maintenance materials, tools and spare parts are specified in individual specification sections.

.2 Supply special tools, wrenches, and accessories that are required for removing worn parts, making adjustments, and carrying out maintenance works.

.3 Deliver maintenance materials, special tools and spare parts for inclusion in operations and maintenance manuals.

.4 Prepare lists of maintenance materials special tools and spare parts for inclusion in operations and maintenance manuals.

1.2 MAINTENANCE MATERIALS

.1 Deliver specified items packaged to prevent damage.

.2 Identify, on carton or package, colour, room number, system or area, as applicable, where item is to be used.

1.3 SPECIAL TOOLS

.1 Assemble special tools as specified.

.2 Include following:

  .1 Identification tag reference.
  .2 Identification of equipment or system for which tools are applicable.

.3 Instruction on intended use of tool.

.4 Identify special tools to indicate equipment or system for which tools are intended.

1.4 SPARE PARTS

.1 Assemble spare parts as specified.

.2 Include the following in the list:

  .1 Part number.
  .2 Identification of equipment or system for which parts are applicable.
  .3 Installation instructions as applicable.
  .4 Name, address and contact information of nearest supplier.

.3 Identify spare parts to indicate equipment or system for which parts are applicable.

Part 2 Products

Not Used

Part 3 Execution

Not Used

END OF SECTION

Part 1 General

1.1 RECORD DRAWINGS

.1 Engineer will provide two sets of clean white prints and electronic full-size PDF copy for record drawing purposes.

.2 Identify drawings as "Project Record Copy".

.3 Maintain record drawings in new condition.

.4 Make record drawings available for inspection on-site by Engineer.

.5 Record neatly and accurately deviations from Contract Documents.

.6 Mark changes in red coloured ink.

.7 Record following information on one set of prints:

  .1 Depths of various elements of foundation in relation to geodetic datum.
  .2 Horizontal and vertical location of underground utilities and appurtenances referenced to permanent surface improvement.
  .3 Location of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of structure.
  .4 Field changes of dimension and detail.
  .5 Changes made by Change Order or field direction.

.8 At completion of project and prior to final inspection, neatly transfer notations to second set of prints and submit both sets of record drawings to Engineer.

Part 2 Products

Not Used

Part 3 Execution

Not Used

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 CSA Group (CSA)

  .1 CSA-A23.1/A23.2, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.

  .2 CAN/CSA-O86, Engineering Design in Wood.

  .3 CSA O121, Douglas Fir Plywood.

  .4 CSA O151, Canadian Softwood Plywood.

  .5 CSA O153, Poplar Plywood.

  .6 CAN/CSA-O325.0, Construction Sheathing.

  .7 CSA O437 Series, Standards for OSB and Waferboard.

  .8 CSA S269.1, Falsework and Formwork.

  .9 CAN/CSA-S269.3, Concrete Formwork.

.2 American Concrete Institute (ACI)

  .1 ACI-347, Guide to Formwork for Concrete

1.2 ADMINISTRATIVE REQUIREMENTS

.1 Pre-installation Meetings: in accordance with MMCD Division 01, convene pre-installation meeting one week prior to beginning of concrete works.

  .1 Ensure key personnel and site supervisor attend.

  .2 Verify project requirements.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittals.

.2 Product Data:

  .1 Submit manufacturer's instructions, printed product literature and data sheets for proprietary materials used in formwork liners and coatings and include product characteristics, performance criteria, physical size, finish, and limitations.

.3 Submit shop drawings for formwork and falsework, if applicable according to requirements as per below:

  .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of British Columbia, Canada.

  .2 Erection drawings to be prepared in accordance with WorkSafe BC Occupational Health and Safety Regulations and signed and sealed by a professional engineer registered or licensed in the Province of British Columbia, Canada.

  .3 Prepare Shop Drawings in accordance with CSA S269.1 for formwork and falsework, if applicable.

.4 Indicate formwork design data: permissible rate of concrete placement, and temperature of concrete, in forms.

.5 Indicate method and schedule of construction, shoring, stripping and re-shoring procedures, materials, arrangement of joints, special architectural exposed finishes, ties, liners, and locations of temporary embedded parts.

.6 Indicate sequence of erection and removal of formwork and falsework, if applicable.

.7 Include the following information on falsework Shop Drawings (if applicable):

  .1 Longitudinal, lateral, vertical, dead, live and impact loads used in design.

  .2 Safe bearing capacity of soil underneath mud sills.

  .3 Maximum column, post and support loads.

  .4 Deflection diagrams for beams with deflection of 10 mm or more.

  .5 Deflection diagrams indicating initial and final elevation of deck surfaces, roofs and soffits.

  .6 Grade of structural steel.

  .7 Indicate steel posts, girders, beams, connections, bracing and welding, providing sufficient detail for safe performance of falsework.

  .8 Fully detailed steel frame shoring.

  .9 Species, grades and sizes of wood.

  .10 Type and weight of equipment (moving or stationary) supported by falsework.

  .11 Sequence, methods and rate of concrete placement.

  .12 Proprietary equipment, adequately identified for checking purposes.

  .13 Full details and locations of splices.

1.4 QUALITY CONTROL

.1 Quality Control: in accordance with Section 01 45 00 – Quality Control.

.2 Retain a professional engineer registered or licensed in Province of British Columbia, Canada, with experience in formwork and falsework (if applicable) design of comparable complexity and scope, to perform following services as part of Work of this Section:

  .1 Design of formwork and falsework, if applicable.

  .2 Review, stamp, and sign fabrication and erection Shop Drawings, design calculations and amendments.

  .3 Conduct on-site inspections and prepare and submit inspection reports verifying this part of Work is in accordance with Contract Documents, reviewed Shop Drawings and WorkSafe BC Occupational Health and Safety Regulation. Perform inspections a minimum of once per fortnight.

.3 The design and inspection of the formwork and falsework is the responsibility of the Contractor.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store, and handle materials in accordance with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

  .1 Store materials off ground in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

  .2 Store and protect formwork from damages.

  .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 MATERIALS

.1 Formwork materials:

  .1 For concrete without special architectural features, use wood and wood product formwork materials to CSA-O121 and CAN/CSA-S269.3.

.2 Form ties:

  .1 For concrete not designated 'Architectural': removable or snap-off metal ties, fixed or adjustable length, of a type that no metal will be within 40mm of the concrete surface when forms have been removed, and free of devices leaving holes minimum 25 mm diameter in concrete surface. Use tapered plastic cones at faces of concrete to allow for grouting or filling with precast concrete plugs. Use waterstop flange at mid-length of single wire tie for watertight structures. Multiple strand ties are not permitted.

  .2 For Architectural concrete; snap ties complete with plastic cones and light grey concrete plugs.

.3 Taper bolts:

  .1 Provide a neoprene waterstop plug installed at centreline of hole with adhesive. Fill holes on each side of waterstop to within 40 mm of surface with nonshrink grout. Pack 40 mm depth to surface with crystalline waterproofing, specified in Section 03 30 00 – Cast-in-Place Concrete. Submit cleaning and installation procedure for review by Engineer.

.4 Form liner:

  .1 Plywood: medium density overlay Douglas Fir to CSA O121.

.5 Form release agent (NSF approved): Proprietary, non-volatile material not to stain concrete or impair subsequent application of finishes or coatings to surface of concrete, derived from agricultural sources, non-petroleum containing, non-toxic. Chemically active release agent containing compounds that react with free lime present in concrete to provide water insoluble soaps, preventing concrete from sticking to forms. Apply form release agent in accordance with manufacturer’s recommendations, prior to placing reinforcing steel, anchoring devices and embedded parts. Do not apply form release agent where concrete surfaces are to receive finishes which are affected by the agent.

.6 Falsework materials: to CSA-S269.1.

Part 3 Execution

3.1 FABRICATION AND ERECTION

.1 Verify lines, levels, and centres before proceeding with formwork/falsework and ensure dimensions agree with drawings. Report discrepancies to the Engineer.

.2 Obtain Engineer’s approval for use of earth forms framing openings not indicated on drawings.

.3 Hand trim sides and bottoms and remove loose earth from earth forms before placing concrete.

.4 Fabricate and erect falsework in accordance with CSA S269.1.

.5 Do not place shores and mud sills on frozen ground.

.6 Provide site drainage to prevent washout of soil supporting mud sills and shores.

.7 Fabricate and erect formwork in accordance with CAN/CSA-S269.3 to produce finished concrete conforming to shape, dimensions, locations and levels indicated within tolerances required by CSA-A23.1/A23.2.

.8 Align form joints and make watertight.

    .1 Keep form joints to minimum.
    .2 Do not stagger joints of form lining materials.
    .3 Align joints to obtain uniform pattern.

.9 Locate horizontal form joints for exposed columns 1200 mm above finished floor elevation.

.10 Use 20 mm chamfer strips on external corners and 20 mm fillets at interior corners, joints, unless specified otherwise.

.11 Form chases, slots, openings, drips, recesses, expansion and control joints as indicated.

.12 Build in anchors, sleeves, and other inserts required to accommodate Work specified in other sections.

    .1 Ensure that anchors and inserts will not protrude beyond surfaces designated to receive applied finishes, including painting.

.13 Provide formed openings where required for pipes, conduits, sleeves or other work to be embedded in and passing through concrete members. Obtain Engineer's permission before framing openings in concrete slabs, walls or columns not indicated on the drawings.

.14 Form joint at base of wall forms to be sealed tight to the base slab to prevent leakage of cement paste.

.15 Line forms for following surfaces:

  .1 Outer face of outside.

  .2 Soffit of girders and underside of bridge decks if exposed.

  .3 Exposed faces of abutments, wingwalls, piers and pylons: do not stagger joints of form lining material and align joints to obtain uniform pattern.

  .4 Secure lining taut to formwork to prevent folds.

  .5 Pull down lining over edges of formwork panels.

  .6 Ensure lining is new and not reused material.

  .7 Ensure lining is dry and free of oil when concrete is poured.

  .8 Application of form release agents on formwork surface is prohibited where drainage lining is used.

  .9 If concrete surfaces require cleaning after form removal, use only pressurized water stream so as not to alter concrete's smooth finish.

  .10 Cost of textile lining is included in price of concrete for corresponding portion of Work.

.16 Clean formwork in accordance with CSA-A23.1/A23.2, before placing concrete.

3.2 REMOVAL AND RESHORING

.1 Leave formwork in place for following minimum periods of time after placing concrete.

  .1 3 days for footings and abutments.

.2 Do not remove forms and falsework until concrete has gained sufficient strength to carry its own weight, plus construction loads and other design loads that are liable to be imposed. Remove falsework progressively and ensure that no shock loads or unbalanced loads are imposed on the structure.

.3 Provide necessary reshoring of members where early removal of forms may be required or where members may be subjected to additional loads during construction as required.

.4 Space reshoring in each principal direction at not more than 2400 mm apart.

.5 Re-use formwork and falsework subject to requirements of CSA-A23.1/A23.2.

.6 Time intervals given to be the cumulative number of days or fractions thereof, not necessarily consecutive, during which the temperature of the air in contact with concrete is above 10°C and concrete has been damp or thoroughly sealed from evaporation and loss of moisture.

.7 Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.

3.3 CLEANING

.1 Progress Cleaning: MMCD Division 03.

  .1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 23 – Final Cleaning.

.3 Waste Management: separate waste materials for reuse and recycling in accordance with the project site waste management plan.

  .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 American Concrete Institute (ACI)

  .1 SP-66, ACI Detailing Manual.
  .2 315-R, Guide to Presenting Reinforcing Steel Design Details

.2 American Society for Testing and Materials (ASTM)

  .1 ASTM A 1064/A 1064M, Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.

.3 CSA Group

  .1 CSA-A23.1 /A23.2, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.
  .2 CAN/CSA-A23.3, Design of Concrete Structures.
  .3 CSA-G30.18, Carbon Steel Bars for Concrete Reinforcement.
  .4 CSA-G40.20/G40.21, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
  .5 CSA W186, Welding of Reinforcing Bars in Reinforced Concrete Construction.

.4 Reinforcing Steel Institute of Canada (RSIC)

  .1 RSIC, Reinforcing Steel Manual of Standard Practice.

1.2 ADMINISTRATIVE REQUIREMENTS

.1 Pre-installation Meetings: convene pre-installation meeting one week prior to beginning of concrete works.

  .1 Ensure site supervisor and key personnel attend.
  .2 Verify project requirements.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittals.

.2 Product Data:

  .1 Submit manufacturer's instructions, printed product literature and data sheets for proprietary materials used in cast-in-place concrete and additives and include product characteristics, performance criteria, physical size, finish, and limitations.

.3 Shop Drawings:

  .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of British Columbia, Canada.
  .2 Prepare reinforcement drawings in accordance with ACI SP-66 and ACI 315-R.

    - .3 Indicate placing of reinforcement and:
        - .1 Bar bending details.
        - .2 Lists.
        - .3 Quantities of reinforcement.
        - .4 Sizes, spacings, locations of reinforcement, locations of chairs, locations of spacers, locations of hangers and mechanical splices if approved by Engineer, with identifying code marks to permit correct placement without reference to structural drawings.
    - .4 Detail lap lengths and bar development lengths to CAN/CSA-A23.3, unless otherwise indicated.
        - .1 Provide type B unless otherwise indicated.
    - .5 Indicate position and size of openings in slabs and walls. Coordinate with trades requiring openings.
    - .6 If lap splices are not specifically indicated on the drawings, provide Engineer with a preliminary shop drawing of the lap splice locations for the Engineer's approval prior to submitting the shop drawings. If lap splices are not specifically indicated, lap splices should be located at points of minimum stress and should be outside of high stress regions and rebar congested areas. The number of splices should be minimal, and the splices should stagger and alternate.
- .4 Quality Assurance Submittals:
    - .1 Submit in accordance with Section 01 45 00 - Quality Control.
    - .2 Mill Test Report: upon request, submit to Engineer certified copy of mill test report of reinforcing steel, showing physical and chemical analysis, minimum 4 weeks prior to beginning reinforcing work.
    - .3 Upon request submit in writing to Engineer proposed source of reinforcement material.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
    - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
    - .2 Replace defective or damaged materials with new.
    - .3 Store reinforcing steel above ground on platforms, skids or racks and protect from prolonged exposure to weather.
    - .4 Deliver, store and handle reinforcing steel, welded wire fabric and accessories in a manner that prevents contamination which reduces bond, and damage to fabricated forms.

.5 Protect reinforcement from rust, dirt, grease, form oil, deleterious matter and other bond-breaking substances

Part 2 Products

2.1 MATERIALS

.1 Substitute different size bars only if permitted in writing by Engineer.

.2 Reinforcing steel: billet steel, grade 400W, deformed bars to CSA-G30.18, unless indicated otherwise.

.3 Reinforcing steel: weldable low alloy steel deformed bars to CSA-G30.18.

.4 Cold-drawn annealed steel wire ties: to CSA-G30.18.

.5 Chairs, bolsters, bar supports, spacers: to CSA-A23.1/A23.2. Chairs to be plastic or plastic-coated steel. Precast concrete blocks may be used for the base slab if approved by Engineer. If precast concrete blocks are approved by Engineer, precast concrete blocks cannot be stacked.

.6 Tie wire: 1.5 mm diameter annealed wire.

.7 Mechanical splices: subject to approval of Engineer.

.8 Plain round bars: to CSA-G40.20/G40.21.

.9 Do not use materials with loose, scaly rust, dirt, oil, paint or other bond-breaking coatings.

2.2 FABRICATION

.1 Fabricate reinforcing steel in accordance with CSA-A23.1/A23.2, SP-66, ACI Detailing Manual and 315-R, ACI Guide to Presenting Reinforcing Steel Design Details

.2 Obtain Engineer's written 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 Provide Engineer with certified copy of mill test report of reinforcing steel, showing physical and chemical analysis, minimum 4 weeks prior to beginning reinforcing work.

.2 Inform Engineer of proposed source of supplied material.

Part 3 Execution

3.1 FIELD BENDING

.1 Do not field bend or field weld reinforcement except where indicated or authorized by Engineer.

.2 When field bending authorized, bend without heat, applying slow and steady pressure.

.3 Replace bars, which develop cracks or splits.

3.2 PLACING REINFORCEMENT

.1 Cutting or puncturing vapour retarder is not permitted; repair damage and reseal vapour retarder before placing concrete.

.2 Place reinforcing steel as indicated on reviewed placing drawings and in accordance with CSA-A23.1/A23.2. Conform to CSA A23.1 and CSA A23.3 for hooks, bends, laps, and similar details not specifically shown.

.3 Use plain round bars as slip dowels in concrete.

  .1 Paint portion of dowel intended to move within hardened concrete with one coat of asphalt paint.

  .2 Apply thick even film of mineral lubricating grease when paint is dry.

.4 Prior to placing concrete, obtain Engineer's approval of reinforcing material and placement.

.5 Notify the Engineer minimum 48h in advance to concrete pour to give sufficient time for rebar inspection.

.6 Maintain cover to reinforcement during concrete pour.

.7 Slab reinforcement to be supported at maximum 1200 mm each way. Tie every other bar intersection for slab top reinforcing at 300 mm or greater spacing.

.8 Protect projecting dowels from damage and cold bending.

.9 Wall reinforcing to be supported with plastic side form spacers at minimum 2.4 m vertically and 1.2 m horizontally o.c. unless noted otherwise.

.10 Do not use bury bars unless authorized in writing by Engineer.

.11 Place, support and secure reinforcement against displacement. Do not deviate from required position.

.12 Do not displace or damage vapour barrier. Repair and reposition vapour barrier as required. All penetrations through the vapour barrier should be taped and sealed with tuck tape or equivalent as approved by Engineer.

.13 Provide horizontal “L” shaped corner bars of same cross section and spacing as horizontal bars or welded wire fabric around wall and grade beam corners.

.14 Reinforce slab and wall openings, unless otherwise shown, as follows:

  .1 Openings with greatest dimension of 600 mm or less: four 15M diagonal bars, 900 mm longer than greatest opening dimension.

.2 Openings with greatest dimension larger than 600 mm: two 15M bars on each side, top and bottom, 1500 mm longer than greatest opening dimension.

.3 Reinforce circular openings as square.

3.3 FIELD QUALITY CONTROL

.1 Site tests: conduct tests as follows:

  .1 Reinforcing steel and welded wire fabric.

.2 Inspection and testing of reinforcing and reinforcing materials carried out by testing laboratory designated by Departmental Representative for review to CSA A23.1/A23.2.

  .1 Ensure testing laboratory certified to CSA A283.

.3 Ensure test results distributed for discussion at pre-pouring concrete meeting between testing laboratory and Departmental Representative, and Engineer.

.4 Departmental Representative will pay for costs of tests.

.5 Inspection or testing by Engineer not to augment or replace Contractor quality control nor relieve Contractor of contractual responsibility.

3.4 CLEANING

.1 Progress Cleaning:

  .1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 23 – Final Cleaning.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 ASTM International

  .1 ASTM C260/C260M, Standard Specification for Air-Entraining Admixtures for Concrete.

  .2 ASTM C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

  .3 ASTM C494/C494M, Standard Specification for Chemical Admixtures for Concrete.

  .4 ASTM C 881/C881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.

  .5 ASTM C1017/C1017M, Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.

  .6 ASTM C C1059/C1059M, Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete.

  .7 ASTM D412, Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.

  .8 ASTM D624, Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomer.

  .9 ASTM D1751, Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).

  .10 ASTM D1752, Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.

.2 Canadian General Standards Board (CGSB)

  .1 CAN/CGSB-51.34, Vapour Barrier, Polyethylene Sheet for Use in Building Construction.

.3 CSA Group

  .1 CSA A23.1/A23.2, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.

  .2 CSA A283, Qualification Code for Concrete Testing Laboratories.

  .3 CSA A3000, Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005),

.4 American Concrete Institute (ACI)

  .1 305R, Specification for Hot Weather Concreting

1.2 ABBREVIATIONS AND ACRONYMS

.1 Portland Cement: hydraulic cement, blended hydraulic cement (XXb - b denotes blended) and Portland-limestone cement types:

  .1 GU, GUb and GUL - General use cement.

  .2 MS and MSb - Moderate sulphate-resistant cement.

  .3 MH, MHb and MHL - Moderate heat of hydration cement.

  .4 HE, HEb and HEL - High early-strength cement.

  .5 LH, LHb and LHL - Low heat of hydration cement.

  .6 HS and HSb - High sulphate-resistant cement.

.2 Fly ash types:

  .1 F - with CaO content maximum 8%.

  .2 CI - with CaO content 15 to 20%.

  .3 CH - with CaO minimum 20%.

.3 GGBFS - Ground, granulated blast-furnace slag.

1.3 ADMINISTRATIVE REQUIREMENTS

.1 Pre-installation Meetings: convene pre-installation meeting one week prior to beginning of concrete works.

  .1 Ensure key personnel, site supervisor attend.

  .2 Verify project requirements.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals to be submitted to Engineer for review in accordance with Section 01 33 00 - Submittals.

.2 Provide certification that plant, equipment, and materials to be used in concrete comply with requirements of CSA A23.1.

.3 Provide certification that mix properties selected will produce concrete of quality, yield and strength as specified in concrete mixes, and will comply with CSA A23.1.

.4 Submit proposed mix design for each concrete type to Engineer for review 2 weeks prior to commencement of work.

  .1 Mix design shall specify the 28 or 56-day compressive strength, cement type, water cementing materials ratio, SCM content, maximum size aggregate, slump and air content. Mix design shall list all chemical admixtures.

  .2 Recent test results for the proposed mix from at least five (5) separate sets of tests.

    .1 28-day (or 56-day) compressive strength.

    .2 Air content.

    .3 Slump.

  - .3 Mix design to be signed and sealed by a qualified professional engineer registered in the Province of British Columbia and must include a letter confirming that:
    - .1 The proposed mix design will meet the requirements of this specification.
    - .2 The cement, supplementary cementing material, admixture, aggregates and water meet the requirements of this specification.
- .5 Submit maximum heat of hydration for each watertight mix design, by testing concrete cylinders in insulated container. Monitor concrete temperature and ambient temperature during test.
- .6 Submit proposed method of curing for watertight concrete. Watertight concrete refers to all concrete in the channels, submerged or partially submerged in liquid.
- .7 Submit pour schedule with proposed locations of construction joints.
- .8 Submit details of cold weather and hot weather protection.
- .9 Submit quality control procedures.
- .10 Submit manufacturer's data on joint sealants.
- .11 Submit method of crack repair.

1.5 QUALITY CONTROL

- .1 Quality Control: in accordance with Section 01 45 00 – Quality Control.
- .2 Provide Departmental Representative and Engineer, minimum 4 weeks prior to starting concrete work, with valid and recognized certificate from plant delivering concrete.
  - .1 Provide test data and certification by qualified independent inspection and testing laboratory that materials and mix designs used in concrete mixture meet specified requirements.
- .3 At least 4 weeks prior to beginning Work, inform Departmental Representative and Engineer of source of fly ash.
  - .1 Changing source of fly ash without written approval of Engineer is prohibited.
- .4 Minimum 4 weeks prior to starting concrete work, provide proposed quality control procedures for review by Departmental Representative and Engineer on following items:
  - .1 Falsework erection.
  - .2 Hot weather concrete.
  - .3 Cold weather concrete.
  - .4 Curing.
  - .5 Finishes.
  - .6 Formwork removal.
  - .7 Joints.

.5 Quality Control Plan: provide written report to Departmental Representative Engineer verifying compliance that concrete in place meets performance requirements of concrete as established in PART 2 - PRODUCTS.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Delivery and Acceptance Requirements:

.2 Concrete hauling time: deliver to site of Work and discharged within 120 minutes maximum after batching.

    .1 Modifying maximum time limit without receipt of prior written agreement from Engineer or laboratory representative and concrete producer as described in CSA A23.1/A23.2. is prohibited.
    .2 Deviations submitted for review by Engineer.
    .3 Concrete delivery: ensure continuous concrete delivery from plant meets CSA A23.1/A23.2.

1.7 SITE CONDITIONS

.1 Placing concrete during rain or weather events that could damage concrete is prohibited.

.2 Protect newly placed concrete from rain or weather events in accordance with CSA A23.1/A23.2.

.3 Cold weather protection:

    .1 Refer to CSA A23.1 Clause 7.4.1.5. Cold Weather Concreting.
    .2 Maintain protection equipment, in readiness on Site.
    .3 Use such equipment when ambient temperature below 5°C, or when temperature may fall below 5°C before concrete cured.
    .4 Placing concrete upon or against surface at temperature below 5°C is prohibited.
    .5 Maintain temperature of reinforcing bars and forms above 10°C prior to placing concrete.
    .6 Maintain temperature of concrete when deposited in forms not less than 15°C and not higher than 25°C.
    .7 Maintain temperature of concrete at surfaces at least 10°C for a minimum period of seven (7) days after placing and achieving minimum 75 percent of specified strength. Concrete temperature may then be lowered to ambient air temperature at a rate of 1.2°C per hour or 10°C per day.

.4 Hot weather protection:

    .1 Refer to CSA A23.1 Clause 7.4.1.4 Hot Weather Concreting.
    .2 Protect concrete from direct sunlight when ambient temperature above 27°C.
    .3 Prevent forms of getting too hot before concrete placed. Apply accepted methods of cooling not to affect concrete adversely.
    .4 Monitor concrete temperatures. After concrete temperature has peaked, control rate of cooling to ambient air temperature at a rate of ½°C per hour to prevent cracking.

.5 Protect from drying. Keep concrete continuously moist during the curing period.

Part 2 Products

2.1 MATERIALS

.1 Portland Cement: GU.

  .1 Reduction in cement from Base Mix to Actual Supplementary Cementing Materials (SCMs) Mix, as percentage.

.2 Supplementary cementing materials: with minimum 20% fly ash replacement, by mass of total cementitious materials to CSA A3001.

.3 Supplementary Cementing Materials: to CSA A3001 Type CI or F.

.4 Water: to CSA A23.1.

.5 Aggregates: to CSA A23.1/A23.2. Coarse aggregates to be normal density.

.6 Admixtures:

  .1 Air entraining admixture: to ASTM C260.
  .2 Chemical admixture: to ASTM C494. Engineer to approve accelerating or set retarding admixtures during cold and hot weather placing. Do not use admixtures containing calcium chloride.
  .3 Superplasticizing Admixtures: to CSA A3001. Superplasticizer to be added on site, not at batch plant.

.7 Curing compound: to CSA A23.1/A23.2.

.8 Waterstops: Hydrophilic waterstop or ribbed extruded PVC of sizes 100 mm across containment curbs within building:

  .1 Tensile strength: to ASTM D412.
  .2 Elongation: to ASTM D412.
  .3 Tear resistance: to ASTM D624.

.9 Protective coating on concrete:

  .1 Liquid epoxy resin and liquid polyamine hardener on slab and walls within buildings within channels against liquid contents. Submit product data sheet for engineer to approve. Contractor to confirm coating systems will work with air contents specified for the concrete mix design. Acceptable products: Sikagard E.W.L., with Sikagard 75 EpoCem if reprofiling is required, or approved equal.
  .2 Penetrating silane sealing slab surface sealant for exposed concrete, other than apron or exterior equipment pads. Submit product data sheet for engineer to approve. Contractor to confirm sealant system will work with air contents specified for the concrete mix design. Acceptable product: W. R. Meadows Intraguard, or equal.

.10 Joint Sealants:

  .1 Joints Sealant: Sikaflex 2C SL Polyurethane Sealant primed with Sikaflex Primer 202. Sealant and primer by Sika Canada Inc., or as approved.

  .2 Joint Sealant: Krystol T1 and T2 by Kryton International, or Xypex Patch and Plug and Xypex Concentrate by Xypex Chemical Corporation, for wet conditions.

2.2 MIXES

.1 Provide **structural concrete mix No.1** to meet following hard state requirements:

  .1 Durability and class of exposure: A-1.

  .2 Compressive strength at 28days of age: 35 MPa minimum.

  .3 Intended application: Pile Infill Tremie Mix

  .4 Aggregate size: normal-density, maximum size 20 mm.

  .5 Admixture: air-entraining.

  .6 Supplementary cementing materials: with minimum 30% fly ash replacement, by kg/m^3 of total cementitious material.

  .7 Water: 0.40.

  .8 Air content category: 1.

  .9 Slump: at time and point of discharge 150 mm -200 mm.

  .10 Volume stability: acceptable volume change range.

  .11 Calcium chloride shall not be added to concrete.

  .12 Quality Plan: 01 45 00 - Quality Control.

.2 Provide **structural concrete mix No. 2** to meet following hard state requirement.

  .1 Class of exposure: C-1.

  .2 Compressive strength at 28 days of age: 35 MPa minimum.

  .3 Intended application: Aluminum Bridge Footing/Abutment

  .4 Aggregate: normal-density, maximum size 20 mm.

  .5 Admixture: air-entraining.

  .6 SPEC NOTE: Use the following paragraph when SCMs are used as partial replacement of cement. Select and proportion by mass required.

  .7 Supplementary cementing materials: with maximum 30 % fly ash replacement, by kg/m^{3}of total cementitious material.

  .8 Water: 0.40.

  .9 Air content category: 1.

  .10 Slump: at time and point of discharge 60 mm-100 mm.

  .11 Volume stability: acceptable volume change range.

  .12 Calcium Chloride shall not be added to concrete.

  .13 Quality Plan: 01 45 00 - Quality Control.

Part 3 Execution

3.1 PREPARATION

.1 Obtain Engineer's written approval before placing concrete.

  .1 Provide 48 hours minimum notice prior to placing of concrete.

.2 Place concrete reinforcing in accordance with Section 03 20 00 - Concrete Reinforcing.

.3 Roughen all construction joints to minimum 6 mm amplitude with exposed aggregate finish by sandblasting or water blasting (minimum 35 MPa (5000 psi)) green concrete or other technique approved by Engineer.

.4 Minimum of 7 days to elapse between adjacent wall or slab pours.

.5 Pumping of concrete permitted only after approval of equipment and mix.

.6 Disturbing reinforcement and inserts during concrete placement is prohibited.

.7 Prior to placing of concrete obtain Engineer's approval of proposed method for protection of concrete during placing and curing.

.8 Protect previous Work from staining.

.9 Clean and remove stains prior to application for concrete finishes.

.10 Maintain accurate records of poured concrete items to indicate date, location of pour, quality, workability, air content, temperature and test samples taken.

.11 In locations where new concrete dowelled to existing work, drill holes in existing concrete.

  .1 Place steel dowels of deformed steel reinforcing bars and pack solidly with epoxy grout to anchor and hold dowels in positions as indicated.

.12 Do not place load upon new concrete until authorized by Engineer.

3.2 INSTALLATION/APPLICATION

.1 Do cast-in-place concrete work to CSA A23.1/A23.2.

.2 Sleeves and inserts:

  .1 Do not permit penetrations, sleeves, ducts, pipes or other openings to pass through joists, beams, column capitals or columns, except where indicated or approved by Engineer.
  .2 Where approved by Engineer, set sleeves, ties, pipe hangers and other inserts and openings as indicated or specified elsewhere.
  .3 Sleeves and openings greater than 100 x 100 mm not indicated reviewed by Engineer.
  .4 Do not eliminate or displace reinforcement to accommodate hardware. If inserts cannot be located as specified, obtain written approval of modifications from Engineer before placing of concrete.
  .5 Confirm locations and sizes of sleeves and openings shown on drawings.

        .6 Set special inserts for strength testing as indicated and as required by non-destructive method of testing concrete.

    .3 Anchor bolts:

        .1 Set anchor bolts to templates in co-ordination with appropriate trade prior to placing concrete.

        .2 Grout anchor bolts in preformed holes or holes drilled after concrete has set only after receipt of written approval from Engineer.

            .1 Drilled holes: to manufacturers' recommendations.

        .3 Protect anchor bolt holes from water accumulations, snow and ice build-ups.

        .4 Set bolts and fill holes with epoxy grout.

        .5 Locate anchor bolts used in connection with expansion shoes, rollers and rockers with due regard to ambient temperature at time of erection.

    .4 Finishing and curing:

        .1 Finish concrete to CSA A23.1/A23.2.

            .1 Aluminum Bridge Footing/Abutment: Finish all formed concrete with a smooth form finish to CSA A23.1. Concrete surface shall be free of all honeycomb, fins, projections, offsets, streaks or other surface imperfections. Fill all bugholes and defects in concrete greater than 6 mm.

            .2 Concrete finish under Bearings: Concrete bearing surface shall be finished level. The maximum permitted deviation from level is 0.005 radians.

        .2 Do not sprinkle dry cement or dry cement sand mixture over concrete surfaces.

        .3 Use procedures as noted in CSA A23.1/A23.2 to remove excess bleed water. Ensure surface not damaged.

        .4 Patching:

            .1 Cutback all tie embedded in concrete to a minimum depth of 40 mm.

            .2 Fill tie holes in watertight concrete with crystalline waterproofing materials applied in accordance with manufacturer’s instructions.

        .5 Cure concrete to CSA-A23.1 except where otherwise specified. Curing compounds shall not be used without the written authorization of the Engineer.

        .6 Cure structural concrete as follows:

            .1 For a minimum of 7 days at a minimum temperature of 10°C by maintaining concrete surfaces continuously moist.

            .2 Until concrete reaches 70% of specified 28-day strength as determined by field cured cylinders.

            .3 Maintain continuous supply of water to top of wall to keep inside of forms wet.

        .7 Provide screed finish unless otherwise indicated.

        .8 Rub exposed sharp edges of concrete with carborundum to produce 3 mm minimum radius edges unless otherwise indicated.

.5 Repair honeycombed and defective concrete with method approved by Engineer.

.6 Repair of honeycombed and defective concrete to be at the expense of the Contractor.

3.3 CRACK REPAIR

.1 Visible cracks to be repaired by method approved by Engineer.

.2 Visible cracks in the walls within the zone of permanent backfill to be repaired by routing out cracks and installing Crystol T1 by Kryton or Xypex Concentrate by Xypex in accordance with manufacturer's instructions. Submit proposed method of repair to Engineer for approval prior to proceeding with repairs.

.3 Visible cracks in the slabs shall be repaired by epoxy injection. Contractor to submit procedure to Engineer for review two weeks prior to commencing with repair.

3.4 FIELD QUALITY CONTROL

.1 The Contractor will engage a Testing Laboratory to carry out concrete testing in accordance with CSA A23.1 and Section 01 45 00 – Quality Control. Take concrete samples and conduct testing in accordance with CSA-A23.2. Field testing technicians to be certified under an industry-recognized program.

.2 A strength test will consist of 5 standard cylinders, one tested at 7 days, 2 at 28 days, and 2 at 56 days.

.3 Frequency of testing to CSA-A23.1 except minimum one strength test for each 50 m^3 of concrete.

.4 Take additional test cylinders during cold weather concreting. Cure cylinders on job site under same conditions as concrete which they represent.

.5 Take additional air content tests for concrete exposed to freezing and thawing in accordance with CSA A23.1, Clause 17.

.6 All sampling and testing costs will be paid for by the Contractor.

.7 Results of the concrete tests will be forwarded to the Engineer. Included with the results will be the following information: Name of Project, Date of Sampling, Name of Supplier, Delivery Truck Number, Identification of Sampling and Testing Technician and exact location in the structure of the concrete sampled.

.8 Concrete failing to meet the requirements to be retested, strengthened or rejected in accordance with CSA A23.2. All additional testing, strengthening, and/or replacement to be at the Contractor's expense.

.9 The Engineer may monitor the mixing and handling of concrete, take additional strength and slump tests, and check all matters affecting quality control of the concrete. Extend full cooperation and assistance to the Engineer, including provision of access and samples for testing.

.10 Non-Destructive Methods for Testing Concrete: to CSA A23.1/A23.2.

.11 Inspection or testing by Engineer not to augment or replace Contractor quality control nor relieve Contractor of contractual responsibility.

3.5 HOT WEATHER CONCRETING

.1 Hot weather curing procedures are required when forecasts predict that the ambient air temperature will exceed 27°C during the placing and curing period.

.2 Keep concrete temperature at the time of placing within the limits specified in CSA A23.1 Table 14.

.3 If the concrete temperature is above the stated limits, concrete shall be cooled by addition of ice to the mixing water.

.4 Follow recommendations from ACI 305R and the hot weather curing procedures listed below when the ambient air temperature exceeds 27°C during the curing period:

  .1 Provide additional initial curing for concrete slab in accordance with recommendation by ACI 305R.
  .2 Keep the slab, footing and mat foundation surface moist by fogging until bleeding has stopped.
  .3 Apply evaporate retardant if the rate of evaporation exceeds the rate of bleeding.
  .4 Use Extended Wet Cure methods if the ambient air temperature exceeds 20°C during the initial three days.
  .5 Temperature of concrete placed during hot weather not to exceed the following limits:
    .1 All other concrete = 30°C.

3.6 COLD WEATHER CONCRETING

.1 Cold weather curing procedures are required when forecasts predict the ambient air temperature will fall below 5°C during the placing and curing period.

.2 Keep the concrete temperature at the time of placing within the limits specified in CSA A23.1 Table 14.

.3 Cold weather curing procedures in accordance with CSA A23.1 and ACI 306R.

.4 Keep the maximum difference between placing temperature and mean ambient temperature during curing period to 5°C.

.5 Minimize the use of hot water in the wall concrete during the winter, in order to reduce the risk of early-age thermal cracking. Concrete placing temperature to be as close as possible to the minimum permitted by CSA A23.3.

3.7 CLEANING

.1 Prevent admixtures and additive materials from entering drinking water supplies or streams.

.2 Using appropriate safety precautions, collect liquid or solidify liquid with inert, noncombustible material and remove for disposal.

.3 Dispose of waste in accordance with applicable local, Provincial/Territorial and National regulations.

.4 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 23 – Final Cleaning.

END OF SECTION

Part 1 General

1.1 DESIGN REQUIREMENTS

.1 Design precast elements to CSA A23.3, CSA A23.4 and ASTM C1433 to carry handling stresses and buoyancy forces imposed on the pipe.

.2 Design precast elements to carry loads in accordance with applicable codes, and requirements for transportation and erection.

.3 Product requirements:

  .1 Durability and class of exposure: A-1
  .2 Minimum dimensions: shown on the drawings.
  .3 Minimum 28-day compressive strength: 35 MPa.
  .4 Minimum concrete cover to reinforcing steel: 60 mm.
  .5 Aggregate Size: normal-density, maximum size 20mm.
  .6 Maximum crack width equal 0.2 mm.
  .7 Maximum water/cementing material ratio: 0.40.
  .8 Range in air content: 5% to 8%.
  .9 Cement: Type HS.
  .10 Supplementary cementing materials: with maximum 25 % fly ash replacement, by kg/m3 of total cementitious material.
  .11 Reinforcing steel: billet steel, grade 400W, deformed bars to CSA-G30.18.
  .12 Provide openings and inserts as detailed on the drawings.
  .13 Forms: to Section 03 10 00 – Concrete Forming and Accessories
  .14 Anchors and supports to: CAN/CSA-G40.21 Type 300W galvanized after fabrication.
  .15 Welding materials: to CSA W48.
  .16 Welding electrodes: to CSA W48 certified by Canadian Welding Bureau.
  .17 Galvanizing: hot dipped galvanizing with minimum zinc coating of 600 g/m^2 to CAN/CSA-G164.
  .18 Joints: to be made watertight using rubber rings equal to Butyl Mastic Joint Sealant or bituminous compound and Sikaflex 2C non-shrink, non-metallic grout or equal. Design connections/attachments of precast elements.

.4 Submit detailed design drawings for typical precast elements and connections to the Engineer for review prior to manufacture.

.5 Design connections/attachments of precast elements to load/forces specified by Engineer.

1.2 PERFORMANCE REQUIREMENTS

.1 Tolerance of precast elements to ASTM C1433 and CSA A23.4.

.2 Length of precast elements not to vary from design length by more than plus or minus 10 mm.

.3 Cross sectional dimensions of precast elements not to vary from design dimensions by more than plus or minus 5 mm.

.4 Deviations from straight lines not to exceed 3 mm in 1 m.

.5 Precast elements not to vary by more than plus or minus 6 mm from true overall cross sectional shape as measured by difference in diagonal dimensions.

1.3 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Section 01 10 00 – General Requirements, Section 01 33 00 - Submittals, and in accordance with CSA A23.3 and CSA A23.4.

.2 Include the following items:

  .1 Design calculations for all structural components and connections.
  .2 Details of prestressed and non-prestressed members, reinforcement and their connections.
  .3 Finishing schedules.
  .4 Methods of handling and erection.
  .5 Openings, sleeves, inserts and related reinforcement.
  .6 Details of lining, anchoring of stop log frames, custom hatches and other custom details as shown in Contract Drawings.

.3 Ensure each drawing submitted bears stamp and signature of qualified professional engineer registered or licensed in province of British Columbia, Canada.

.4 Quality Control Plan: submit written report to ensure products are in compliance with the performance requirements.

.5 Submit concrete supplier’s certification.

.6 Submit quality control test results as detailed in Quality Control Plan, and as specified in CSA A23.4.

.7 Submit certified copy of mill test report of reinforcing steel supplied, showing physical and chemical analysis.

1.4 QUALIFICATIONS

.1 Precast concrete elements to be fabricated and erected by manufacturing plant certified by Canadian Standards Association in appropriate categories according to CSA-A23.4.

.2 Precast concrete manufacturer to be certified in accordance with CSA's certification procedures for precast concrete plants prior to submitting tender and to specifically verify as part of tender that plant is currently certified in appropriate category, Structural.

.3 Only precast elements fabricated in such certified plants to be acceptable to owner, and plant certification to be maintained for duration of fabrication, erection until warranty expires.

.4 Welding companies certified to CSA-W47.1.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, handle and store precast/prestressed units according to manufacturer’s instructions.

Part 2 Products

2.1 MANUFACTURED UNITS

.1 Precast concrete ballast.

.2 Manufacture units in accordance with ASTM C1433 and CSA A23.4.

.3 Mark each precast unit to correspond to identification mark on shop drawings for location with date cast on part of unit which will not be exposed.

.4 Provide hardware suitable for handling elements.

.5 Shop prime anchors and steel inserts after fabrication and touch up primer on anchors after welding. Do not apply primer to embedded portion of anchor or inserts.

.6 Galvanize anchors and steel embedments after fabrication and touch up with zinc-rich primer after welding.

.7 Joints: make watertight using cement mortar or rubber gaskets to ASTM C443M, or combination of above.

.8 Mortar:

    .1 Aggregate to CSA A82.56.
    .2 Cement to CAN/CSA-A8.

.9 Lining

    .1 Provide lining as shown in the Contract Drawings.

2.2 FINISHES

    .1 Finish units to Commercial grade, Standard Grade to CSA A23.4.

Part 3 Execution

3.1 ERECTION

.1 Do precast concrete work in accordance with ASTM C1433.

.2 Do welding in accordance with CSA-W59, for welding to steel structures and CSA-W186, for welding of reinforcement.

.3 Erect precast elements within allowance tolerances as indicated.

.4 Non-cumulative erection tolerances in accordance with CSA A23.4.

.5 Set elevations and alignment between units to within allowable tolerances.

.6 Install units as indicated on the Contract Drawings, true to alignment and grade, and not resting on pipe.

.7 Install precast units on firm, compacted ground as specified on Contract Drawings.

.8 Clean field welds with wire brush and touch-up galvanized finish with zinc-rich primer.

.9 Clean surplus mortar and joint compounds as work progresses.

.10 Plug lifting holes with mortar.

.11 Protection, storage, and handling of precast concrete units to Manufacturer’s recommendations.

3.2 CLEANING

.1 Obtain approval of cleaning methods from Engineer before cleaning soiled precast concrete surfaces.

.2 Clean units of debris and foreign materials. Remove fins and sharp projections.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 Comply with the latest edition of the following statutes codes and standards and all amendments thereto.

- .1 CAN/CSA S16 Limit States Design of Steel Structures.
- .2 CAN/CSA G40.20/G40.21 General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
- .3 CSA S157/S157.1 Strength Design in Aluminum/Commentary on CSA S157, Strength Design in Aluminum.
- .4 CSA W47.1 Certification of Companies for Fusion Welding of Steel.
- .5 CSA W47.2 M Certification of Companies for Fusion Welding of Aluminum.
- .6 CSA W55.3 Resistance Welding Qualification Code for Fabricators of Structural Members used in Buildings.
- .7 CSA W59 Welded Steel Construction (Metal Arc Welding).
- .8 CSA W59.2 M Welded Aluminum Construction.
- .9 ASTM A36 Standard Specification for Carbon Structural Steel.
- .10 ASTM A48 Standard Specification for Gray Iron Castings.
- .11 ASTM A53 Standard Specification for Pipe, Steel, Black and Hot Dipped, Zinc Coated, Welded and Seamless.
- .12 A108 Standard Specification for Steel Bars, Carbon and Alloy, Cold-Finished.
- .13 ASTM A123/A, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- .14 ASTM A153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- .15 ASTM A167 Standard Specification for Stainless and Heat Resisting Chromium Nickel Steel Plate, Sheet, and Strip.
- .16 ASTM A193 Standard Specification for Alloy Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and other Special Purpose Applications.
- .17 ASTM A194 Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
- .18 ASTM A307 Standard Specification for Carbon Steel Bolts and Studs, 60000 psi Tensile Strength.
- .19 ASTM A312 Standard Specification for Seamless, Welded and Heavily Cold Worked Austenitic Stainless Steel Pipe.
- .20 ASTM A325 Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
- .21 ASTM A511 Standard Specification for Seamless Stainless Steel Mechanical Tubing.

.22 ASTM A653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip.

.23 ASTM A563 Standard Specification for Carbon and Alloy Steel Nuts.

.24 ASTM A666 Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

.25 ASTM A276 Standard Specification for Stainless Steel Bars and Shapes Structural Members

.26 ASTM A780 Standard Practice for Repair of Damaged and Uncoated Areas of Hot Dip Galvanized Coatings.

.27 ASTM A786 Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.

.28 ASTM A793 Standard Specification for Rolled Floor Plate, Stainless Steel.

.29 ASTM A1008 Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.

.30 ASTM A1011 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.

.31 ASTM B26 Standard Specification for Aluminum Alloy Sand Castings.

.32 ASTM B209 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

.33 ASTM B221 Standard Specification for Aluminum Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

.34 ASTM B241 Standard Specification for Aluminum and Aluminum Alloy Seamless Pipe and Seamless Extruded Tube.

.35 B308 Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.

.36 ASTM A429 Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.

.37 ASTM B468 Standard Specification for Welded UNS N08020, N08024 and N08026 Alloy Tubes.

.38 ASTM B632 Standard Specification for Aluminum Alloy Rolled Tread Plate.

.39 ASTM F436 Standard Specification for Hardened Steel Washers.

.40 ASTM F738 Standard Specification for Stainless Steel Metric Bolts, Screws, and Studs.

.41 ANSI B36.10 Pipe, Steel.

.42 ANSI/NAAMM MBG 531-88/NAAMM Metal Bar Grating Material.

.43 British Columbia Building Code (BCBC), 2012.

1.2 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Section 01 33 00 - Submittals.

.2 Indicate complete details necessary for fabrication and erection of the component parts of the structure, including:

  .1 Location, type, size, and extent of welds.
  .2 Include plans and elevations, details of sections and connection.
  .3 Detail items indicating all dimensions, methods of anchorage and fixing, and accessory items.
  .4 Confirm dimensions on site.
  .5 Materials, core thicknesses, finishes, connections, joints, method of anchorage, number of anchors, supports, reinforcement, details, and accessories.

1.3 SYSTEM DESCRIPTION

.1 Design Requirements

  .1 Design miscellaneous metal items in accordance with applicable standards and as indicated on the drawings.
  .2 Design work of this Section, which will support other items or will be required to support structural loads of any nature, by a professional structural engineer licensed in the Province of British Columbia. Affix professional seal and signature to shop drawings for such items.
  .3 Design connections and splices using high strength bolts or welds. Use bearing type bolts for bolted connections.
  .4 Where overlapping or contacting surfaces cannot be avoided, completely seal weld these surfaces. Where there is any evidence of rusting or deterioration of finish in such areas, carry out remedial seal welding and refinishing.
  .5 Design aluminum work to CSA S157/S157.1 and CSA W59.2-M.
  .6 Anchor sizing requires a minimum factor of safety of 4 to 1 (allowable load vs. actual load).

1.4 SUBMITTALS

.1 Comply with Section 01 33 00 - Submittals.

.2 Shop Drawings: Submit shop drawings before fabrication commences of each metal fabrication item, showing in large scale fabrication details, thickness, anchors, location, dimensions, erection details, connections and jointing details, and finishes. Shop drawings to be signed and sealed by a Professional Engineer registered in BC.

.3 Connection design calculations signed and sealed by a Professional Engineer registered in the Province of British Columbia.

.4 CWB fabricator certification to Division 2 or better in accordance with CSA W47.1.

.5 CWB welder qualifications in accordance with CSA W47.1.

.6 CWB approved weld procedure data sheets in conjunction with shop drawings.

.7 Fabrication, delivery, and erection schedules.

.8 Fabrication quality control and inspection test plans.

.9 Submit welding procedure specification for each type of material.

.10 Coating applicator's Certificate of Compliance that hot-dip galvanized coating meets or exceeds the specified requirements of ASTM 123 or A153, as applicable. Coating applicator to also provide product data showing conformance to the specified product and indicating coating thickness.

1.5 QUALITY ASSURANCE

.1 Ensure workmanship of the highest quality throughout by employing only metal workers that have demonstrated the highest skills in this type of work and qualified welders certified to weld the materials used in fabrication of the miscellaneous metals.

1.6 QUALITY CONTROL

.1 Visual Requirements:

  .1 Comply with the following requirements for steel exposed to view. Compliance will be judged from the closest in-service reviewing distance.

  .2 Make all sections true, straight, with no dents, bends or other noticeable damage.

  .3 In addition to the structural requirements, make all connection details meet, the aesthetic requirements of the Engineer.

  .4 For all connections, respect the exposed nature of the element. Make all weld passes continuous with uniform bead size. Protect surrounding steel from damage due to weld spatter. Grind all welds to a smooth uniform surface to the approval of the Engineer.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Coordinate deliveries with construction schedule and arrange ahead for off the ground, covered storage locations.

.2 Handle and store metal materials at job site to prevent damage to other materials, existing buildings, structure, finishes or property.

.3 Handle components with care, and provide protection for surfaces against marring or other damage. Ship and store members with cardboard or other resilient spacers between surfaces.

.4 Use removable coatings or wrappings to protect exposed surfaces of prefinished metal work which does not receive site finishing. Use materials recommended by finishers or manufacturers to ensure that method is sufficiently protective, easily removed, and harmless to the finish.

.5 Prevent the formation of wet storage stain on galvanized members with the following measures:

- .1 Stack members or bundle to allow air between the galvanized surfaces during transport from supplier. Load materials in position that continuous drainage could occur.
- .2 Raise members from the ground and separate with strip spacers to provide free access of air to most parts of the surface. Incline in a manner which will allow continuous drainage. Do not lay galvanized steel on cinders, clinkers, wet soil or decaying vegetation.
- .3 Handle galvanized members in such a manner as to avoid any mechanical damage and to prevent distortion.

1.8 COORDINATION

.1 Supply to concrete and/or other Sections, materials requiring setting and/or building-in in concrete or other trades. This includes inserts, anchors, frames, sleeves, etc. Verify locations of these materials on site before fabrication and erection.

Part 2 Products

2.1 GENERAL

.1 Where anchors, lifting hooks, screws, bolts, nuts, washers, hangers and other fasteners are not specifically shown or specified, provide such items with at least the strength and corrosion resistance properties of the metal fabrication for which they are required. Nuts and washers to be of same material and of equal or greater strength than bolts.

2.2 MATERIALS

- .1 All metal fabrications and Fasteners to be as follows:
  - .1 Exterior or exposed stair platforms: Hot dip galvanized or epoxy coated, unless noted otherwise.
- .2 Metal Fabrications:
  - .1 W and H Shapes:
    - .1 CAN/CSA-G40.20/G40.21 Grade 350W.
    - .2 ASTM A992, Grade 50 ksi.
  - .2 Shapes Except W and H-Shapes, Rolled plates and Bars:
    - .1 CAN/CSA-G40.20/G40.21 Grade 300W.
  - .3 Steel Pipe: ASTM A53, Type E or S, Grade B.
  - .4 Hollow Structural Sections (HSS): CAN/CSA-G40.20/G40.21 Grade 350W Class C.
  - .5 Cold Formed Sections:
    - .1 ASTM A653 Grade 340 (Grade 50), Fy = 345 MPa for coated sections.
    - .2 ASTM A1011 Grade 340 (Grade 50), Fy=345 MPa for uncoated sections.

.6 Pipe Sleeves:

  .1 ASTM A53/A53M, Schedule 40 steel pipe sleeves with continuously welded 5mm-thick seep ring with outside diameter 75 mm greater than sleeve outside diameter. Hot-dip galvanize in accordance with ASTM A123/A123M.

.7 High strength bolts:

  .1 For structural connections at platforms, support frames and similar items; use ASTM A325 carbon steel high strength bolts hot dip galvanize to ASTM A153 with nuts and washers.

  .2 Nuts: ASTM A563 and the recommended nut grade and style listed in Appendix X1, Table X1 thereof, hot dip galvanized.

  .3 Washers: Bolted connections hardened steel washers conforming to ASTM F436. Hot dip galvanized washers with galvanized bolts

.3 Stainless steel: AISI Type 304.

.4 Welding materials: to CSA W59.

.5 Galvanizing: hot dipped galvanizing with zinc coating 600 g/m^2 to ASTM A123.

.6 Drilled-in anchors: Hilti Kwik -Bolts 3, galvanized. If submerged, Type 304, stainless steel, with isolation washers, unless noted otherwise.

.7 Adhesive Anchors: Hilti HY200 or RE-500 with galvanized HAS anchor rods.

.8 Zinc primer: zinc rich, ready mix to CGSB 1- GP-181M.

.9 Bituminous Paint: CAN/CGSB-1.108 without thinner. Sealtight Galvafroid Zinc Rich Coating by W.R. Meadows Ltd.

.10 Isolation coating: CAN/CGSB 1.184, Coal Tar-Epoxy Coating.

.11 Grouting: Set 45 by Master Builders Technologies Ltd. M Bed Standard by Sternson Ltd., Sika Grout 212 by Sika Canada Inc.

2.3 FABRICATION

.1 Where possible, verify dimensions on site before preparing shop drawings or proceeding with shop work. Fit and shop assemble insofar as possible various sections of the work and deliver to the project site in the largest practical sections.

.2 The general dimensions and details of the metal fabrications are shown on the Drawings where practical. Such details and dimensions are suggested concepts for design.

.3 Assume responsibility for the correctness of the actual detailed dimensions used in fabrication and carefully check the same, by field measurement.

.4 Variations from suggested details are subject to acceptance in writing by the Engineer. Such acceptance does not in any way waive the above-mentioned responsibility.

.5 Wherever overlapping or contacting surfaces cannot be avoided, completely seal weld these surfaces. Rusting or deterioration of finish in such areas will require remedial seal welding and refinishing.

.6 Fabricate the work true to dimensions and square. Accurately fit members with hairline joints and join using adequate fastening. Assemble members without twists or open joints.

.7 Construct finished work free from distortion and defects detrimental to appearance and performance.

.8 File or grind exposed welds smooth and flush. Do not leave grinding marks. Construct internal and external corners with sharp lines. Provide continuous welds unless otherwise accepted by the Engineer in writing. Brighten and buff aluminum and stainless steel welds to match appearance of adjacent surface.

.9 Remove weld spatter and slag. After finish grinding and smoothening welds, passivate welds with pickling paste.

.10 Fabricate metal work complete with components required for anchoring to concrete; bolting or welding to structural steel frames; standing free; or resting in frames or sockets, in a safe and secure manner.

.11 Countersink exposed fastenings, where such are accepted in writing, and make as inconspicuous as possible with bolts cut off flush with nuts. Construct fastenings of the same material and finish as the base material on which they occur. Where possible, fit and shop assemble work, ready for erection.

.12 Ensure exposed welds are continuous for length of each joint. File or grind exposed welds smooth and flush.

.13 Provide drainage and vent holes as required for galvanizing.

.14 Use full length columns without splices unless shown otherwise.

.15 Cut steel to size by shearing, flame cutting, or plasma cutting. Finish edges by planing or grinding.

.16 Drill or punch bolt holes to CISC Code of Standard Practice for Structural Steel. Holes to be 2mm larger than the nominal bolt diameter. Oversized or slotted holes are not permitted without the approval of the Engineer.

.17 Do not use intermittent welds in areas subject to corrosion or fatigue. Seal weld welded joints.

.18 Close hollow structural sections air tight with end plates and seal welds.

.19 Fabricate guardrail, handrail, and kickplate to allow field alignment and adjustment. Detail and fabricate guardrails to fit around equipment. Field measure for guardrails near equipment after equipment is in place.

.20 Weld in a manner that will minimize distortion and residual stress.

.21 Provide grout and vent-holes in base plates.

.22 Remove welding slag, splatter, burrs, grease, oil, paint and other deleterious material prior to delivery.

.23 Shop installed shear studs and concrete anchors to be installed and tested in strict conformance with requirements of CSA-W59 and manufacturer’s instructions.

2.4 STAIRS, GUARDS, AND LADDERS

.1 Accurately form connections with exposed faces flush; mitres and joints tight. Make ladder rungs of equal height within ± 3 mm.

.2 Install and fabricate stair rise and run to BCBC-2012 tolerances.

.3 Grind or file exposed welds and steel sections smooth.

Part 3 Execution

3.1 ERECTION

.1 Do welding work in accordance with CSA W59 unless specified otherwise.

.2 Do stainless steel welding in accordance with AWS D1.6 unless specified otherwise.

.3 Erect metalwork square, plumb, straight, and true, accurately fitted, with tight joints and intersections.

.4 Provide suitable means of anchorage acceptable to Engineer such as dowels, anchor clips, bar anchors, expansion bolts and shields, and toggles.

.5 Touch-up galvanized surfaces with zinc rich primer where burned by field welding.

.6 Paint aluminum surfaces in contact with concrete with bituminous paint.

.7 Install isolator washers between aluminum and dissimilar metals.

3.2 GRATING INSTALLATION

.1 Floor grating to be installed in accordance with manufacturer’s instructions.

.2 Grating to be installed flush with surrounding concrete.

3.3 INSTALLATION - ANCHORS AND FASTENERS

.1 Use anchor bolts of sufficient length to embed into concrete to develop full strength of the anchor or 200 mm minimum, the maximum governs, and project the threaded portion a minimum of 50 mm for the installation of the nuts.

.2 Set anchor bolts accurately in holes in concrete using plywood templates prepared from manufacturer's shop drawings. Set items in grout. Use anchor grout for submerged and exterior conditions.

.3 Do not offset bolts by deformation.

3.4 ANCHOR BOLT SCHEDULE

.1 Unless indicated otherwise on the Drawings, provide fasteners as follows:

Service Use and Location	**Product**	**Remarks**
1. Anchor Bolts Cast into Concrete for Structural Steel, Metal Fabrications and Castings		
Interior Dry Areas, e.g. Electrical Room, Screen Room, UV Room.	Hot-dip galvanized steel, headed anchor bolts, unless indicated, otherwise.	
Submerged, Interior Wet channels, and Corrosive Areas	Stainless steel 304 headed anchor bolts.	
Exterior Areas, e.g. Stair Platform, Exterior equipment space	Hot-dip galvanized steel, headed anchor bolts, unless indicated, otherwise.	
2. Anchor Bolts Cast into Concrete for Equipment Bases		
Interior Dry Areas	Hot-dip galvanized, carbon steel headed, anchor bolts, unless, otherwise specified with equipment.	
3. Post-Installed Drilled Anchors for Metal Components to Cast-in-Place Concrete (e.g., Ladders, Handrail Posts, Electrical Panels, and Equipment)		
Interior Dry Areas and exterior	Hot-dip galvanized, carbon steel headed, anchor bolts, unless, otherwise specified with equipment.	

.2 Anti-seizing Lubricant: Use on all stainless steel threads.

.3 Do not use adhesive anchors to support fire-resistive construction or where ambient temperature will exceed 49°C.

.4 Install expansion anchors in accordance with manufacturer's instructions.

.5 Use alternative fastener if edge distances less than recommended.

.6 Tighten to recommend torque.

3.5 ADHESIVE ANCHOR INSTALLATION

.1 Install in accordance with manufacturer’s instructions.

.2 Install adhesive anchors with minimum 150 embedment.

.3 Thoroughly clean and brush out holes prior to injecting adhesive.

3.6 ANCHOR TESTING

.1 Test a minimum of six anchors selected by the Engineer to 130% of the specified load. If the working load is not specified test to the lesser of:

  .1 150% of the safe working load specified by the manufacturer, or
  .2 75% of the ultimate working load specified by the manufacturer.

.2 Apply the test load to the anchor for a minimum of five (5) minutes.

.3 Anchors to be tested with a jack and gauge calibrated within six (6) months of the test by a testing laboratory.

.4 Engineer’s representative to witness the test.

.5 Anchors that fail to be replaced and additional anchors tested as directed by Engineer.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 Environmental Protection Agency (EPA)

  .1 Test Method for Measuring Total Volatile Organic Compound Content of Consumer Products, EPA Method 24 - Surface Coatings.
  .2 SW-846, Test Methods for Evaluating Solid Waste: Physical/Chemical Methods.

.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

  .1 Material Safety Data Sheets (MSDS).

.3 Master Painters Institute (MPI)

  .1 The Master Painters Institute (MPI)/Architectural Painting Specification Manual (ASM).
  .2 Standard GPS-1, MPI Green Performance Standard.
  .3 Standard GPS-2, MPI Green Performance Standard.

.4 National Research Council Canada (NRC)

  .1 National Fire Code of Canada (NFC).

.5 National Sanitary Foundation (NSF)

  .1 NSF Standard 61, Drinking Water System Components – Health Effects

.6 Society for Protective Coatings (SSPC)

  .1 SSPC Painting Manual, Volume Two, 8th Edition, Systems and Specifications Manual.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide in accordance with Section 01 33 00 - Submittals.

.2 Product Data:

  .1 Provide manufacturer's instructions, printed product literature and data sheets for paint and paint products and include product characteristics, performance criteria, physical size, finish and limitations.
  .2 Confirm products to be used are in MPI's approved product list.

.3 Upon completion, provide records of products used. List products in relation to finish system and include the following:

  .1 Product name, type and use.
  .2 Manufacturer's product number.
  .3 Colour numbers.
  .4 MPI Environmentally Friendly classification system rating.
  .5 Manufacturer's Material Safety Data Sheets (MSDS).

.4 Samples:

  .1 Submit full range colour sample chips in accordance with Section 01 33 00 – Submittals. Indicate where colour availability is restricted.

.5 Manufacturer's Instructions:

  .1 Provide manufacturer's installation / application instructions.

1.3 CLOSEOUT SUBMITTALS

.1 Operation and Maintenance Data: Provide operation and maintenance data for painting materials for incorporation into manual.

.2 Include:

  .1 Product name, type and use.
  .2 Manufacturer's product number.
  .3 Colour numbers.
  .4 MPI Environmentally Friendly classification system rating.

1.4 QUALITY CONTROL

.1 Qualifications:

  .1 Contractor: to have a minimum of 5 years proven satisfactory experience. When requested, provide list of last 3 comparable jobs including, job name and location, specifying authority, and project manager.
  .2 Qualified journeypersons as defined by local jurisdiction to be engaged in painting work.
  .3 Apprentices: may be employed provided they work under direct supervision of qualified journeyperson in accordance with trade regulations.
  .4 Conform to latest MPI requirements for exterior painting work including preparation and priming.
  .5 Materials: in accordance with MPI Painting Specification Manual "Approved Product" listing and from a single manufacturer for each system used.
  .6 Retain purchase orders, invoices and documents to prove conformance with noted MPI requirements when requested. Standard of Acceptance:
    .1 Walls: no defects visible from a distance of 1000 mm to surface.
    .2 Final coat to exhibit uniformity of colour and uniformity of sheen across full surface area.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with manufacturer’s written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer’s name and address.

  .1 Labels: to indicate:

        .1 Type of paint or coating.
        .2 Compliance with applicable standard.
        .3 Colour number in accordance with established colour schedule.

.3 Storage and Handling Requirements:

    .1 Store materials in dry location indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
    .2 Observe manufacturer's recommendations for storage and handling.
    .3 Store materials and supplies away from heat generating devices.
    .4 Store temperature sensitive materials and equipment in well ventilated area with temperature range as recommended by manufacturer.
    .5 Keep areas used for storage, cleaning and preparation, clean and orderly. After completion of operations, return areas to clean condition to approval of Engineer.
    .6 Remove paint materials from storage only in quantities required for same day use.
    .7 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling storage, and disposal of hazardous materials.
    .8 Fire Safety Requirements:
        .1 Handle, store, use and dispose of flammable and combustible materials in accordance with the National Fire Code of Canada (NFC).

1.6 SITE CONDITIONS

.1 Heating, Ventilation and Lighting:

    .1 Provide heating facilities to maintain ambient air and substrate temperatures above 10°C for 24 hours before, during and after paint application until paint has cured sufficiently.
    .2 Provide continuous ventilation for 7 days after completion of application of paint.
    .3 Provide temporary ventilating and heating equipment where permanent facilities are not available or supplemental ventilating and heating equipment if ventilation and heating from existing system is inadequate to meet minimum requirements.
    .4 Provide minimum lighting level of 323 Lux on surfaces to be painted.
    .5 Temperature, Humidity and Substrate Moisture Content Levels:
        .1 Unless pre-approved written approval by engineer and product manufacturer, perform no painting when:
            .1 Substrate and ambient air temperatures are not expected to fall within MPI or paint manufacturer's prescribed limits.
            .2 Rain or snow are forecast to occur before paint has thoroughly cured or when it is foggy, misty, raining or snowing at site.
            .3 Ensure that conditions are within specified limits during drying or curing process, until newly applied coating can itself withstand 'normal' adverse environmental factors.

        .4 Perform painting work when maximum moisture content of the substrate is below:
            .1 12% for concrete and masonry (clay and concrete brick/block). Allow new concrete and masonry to cure minimum of 28 days.
            .2 15% for hard wood.
            .3 17% for soft wood.
            .4 12% for plaster and gypsum board.
        .5 Test for moisture using calibrated electronic Moisture Meter. Test concrete floors for moisture using "cover patch test".
        .6 Test concrete, masonry and plaster surfaces for alkalinity as required.
    .6 Surface and Environmental Conditions:
        .1 Apply paint finish in areas where dust is no longer being generated by related construction operations or when wind or ventilation conditions are such that airborne particles will not affect quality of finished surface.
        .2 Apply paint to adequately prepared surfaces and to surfaces within moisture limits.
        .3 Apply paint when previous coat of paint is dry or adequately cured.
    .7 Additional interior application requirements:
        .1 Apply paint finishes when temperature at location of installation can be satisfactorily maintained within manufacturer’s recommendations.

1.7 ITEMS TO BE PAINTED

.1 All items customarily or specified to be shop painted shall be primed and finish in the shop. Field painting will not be allowed unless requested in writing to the Engineer, and written consent is given by the Engineer.

.2 All piping, mechanical and electrical equipment not prefinished and directed. This includes sleeves through floors and miscellaneous metals.

.3 The following exterior surfaces require painting:
    .1 Structural Steel and Connections
    .2 Guardrails and Connections
    .3 Grating and Connections
    .4 Steel Plate Floor Panels and Connections
    .5 Exposed portion of the steel pipe pile. Coat the steel pipe pile 300mm below the mudline to the top of the steel pipe pile.

.4 Paint valve position indicators red where directed.

.5 PVC, HDPE, copper pipe, stainless steel, fibreglass, electrical conduit and galvanized cable trays are not to be painted unless directed.

1.8 INSPECTION AND GUARANTEE

.1 Provide and pay for either the local MPI Accredited Quality Assurance Association's two (2) year guarantee, or, alternatively, a 100% two (2) year Maintenance Bond - both in accordance with MPI Painting Manual requirements. The Maintenance Bond shall warrant that all painting work has been performed in accordance with MPI Painting Manual requirements.

.2 The cost of the maintenance bond or guarantee shall be included in the Contract Price.

.3 If the maintenance bond option is used, provide a letter of consent from a surety licensed to do business in Canada prior to award of the painting subcontract.

1.9 SCHEDULING

.1 Schedule painting operations to prevent disruption of and by other trades.

1.10 EXISTING CONDITIONS

.1 Investigate structural problems related to safe execution of preparation of structure to be painted and report unsatisfactory conditions to Engineer before beginning work.

.2 Report to Engineer conditions of deteriorated materials found during preparation, not previously disclosed.

1.11 PROTECTION

.1 Protect paint and painting equipment before use and during length of contract from climatic elements.

.2 Protect structure from markings and other damage. Protect completed work from paint droppings. Use non-staining coverings.

.3 Remove all electrical plates, surface hardware, fittings and fastenings, prior to painting operations. These items shall be carefully stored, cleaned and replaced on completion of work in each area. No solvent shall be used to clean hardware that will affect the finish of the hardware.

.4 Provide for protection of passing pedestrians and the general public.

1.12 MAINTENANCE MATERIALS

.1 At project completion, provide 4 litres (1 gallon) of each type and color of paint from same production run (batch mix) used in unopened cans, properly labelled and identified for Owner's use in maintenance. Store where directed.

Part 2 Products

2.1 MATERIALS

.1 All materials used in this Contract shall be of the highest quality, as manufactured by nationally recognized manufacturers and of the type indicated on the drawings and in this specification

.2 Only Paint materials listed in the MPI Approved Products List (APL) are acceptable for use on this project.

.3 Provide paint materials for paint systems from single manufacturer.

.4 Conform to latest MPI requirements for painting work including preparation and priming.

.5 For submerged surfaces, internal or external use only products approved for use in contact with potable water by one or more of the following:

- .1 Health and Welfare Canada.
- .2 American Water Works Association.
- .3 United States Environmental Protection Agency.
- .4 National Sanitation Foundation.
- .5 Use only products/manufacturers listed in the CPCA Manual unless specifically approved otherwise.

.6 Tactile Warning Strips

2.2 TOOLS AND EQUIPMENT

.1 Painting equipment to best trade standards for type of product and application.

.2 Engineer will determine areas where power tools or equipment may be used for both preparing and painting of substrate.

2.3 COLOURS

.1 Match colour schedule exactly. The nearest match of a standard line will not be accepted.

- .1 Valve hand wheels and operating levers red CGSB 509-103.

2.4 MIXING AND TINTING

.1 Perform colour tinting operations prior to delivery of paint to site.

.2 Mix paste, powder or catalyzed paint mixes in accordance with manufacturer's written instructions.

.3 Use and add thinner in accordance with paint manufacturer’s recommendations. Do not use kerosene or similar organic solvents to thin water-based paints.

.4 Thin paint for spraying in accordance with paint manufacturer’s instructions.

.5 Re-mix paint in containers prior to and during application to ensure break-up of lumps, complete dispersion of settled pigment, and colour and gloss uniformity. Strain as necessary.

2.5 GLOSS/SHEEN RATINGS

.1 Paint gloss shall be defined as the sheen rating of applied paint, in accordance with the following values:

Gloss Level Category	Units @ 60°	Units @ 85°
G1 - matte finish	0 to 5	max. 10
G2 - velvet finish	0 to 10	10 to 35
G3 - eggshell finish	10 to 25	10 to 35

G4 - satin finish	20 to 35	min. 35
G5 - semi-gloss finish	35 to 70	
G6 - gloss finish	70 to 85	
G7 - high gloss finish	> 85	

.2 Gloss level ratings of painted surfaces shall be as specified herein.

2.6 PAINT SYSTEMS

.1 All paint products shall have NSF 61 certification for potable water.

.2 Steel and Iron Piping and Equipment:

- .1 Finished dry film thickness shall be 150 microns (6 mils).
- .2 Approved products:
  - .1 Bar-Rust 233H by ICI Devoe.
  - .2 Amercoat 395FD by General Paints.

.3 Structural Steel and Miscellaneous Metals:

- .1 Surface preparation requirements to minimum of SSPC-SP1 Near-White Metal Blast Cleaning.
- .2 Finished dry film thickness shall be 600 microns (24 mils).
- .3 Approved products:
  - .1 Novaguard 840 by PPG cream colour and gloss finish
  - .2 Novaguard 260 Primer or Phenguard 930 Primer by PPG

Part 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 data sheet.

3.2 GENERAL

.1 Perform preparation and operations for interior painting in accordance with MPI Architectural Painting Specifications Manual except where specified otherwise.

.2 Apply paint materials in accordance with paint manufacturer’s written application instructions.

3.3 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable to be painted in accordance with manufacturer's written instructions.

.2 Conduct moisture testing of surfaces to be painted using properly calibrated electronic moisture meter, except test concrete floors for moisture using simple "cover patch test".

Do not proceed with work until conditions fall within acceptable range as recommended by manufacturer.

.3 Maximum moisture content as follows:

  .1 Stucco, plaster and gypsum board: 12%.
  .2 Concrete: 12%.
  .3 Clay and Concrete Block/Brick: 12%.
  .4 Hard Wood: 15%.
  .5 Soft Wood: 17%.

3.4 PREPARATION

.1 Protection:

  .1 Protect existing building surfaces and adjacent structures from paint spatters, markings and other damage by suitable non-staining covers or masking. If damaged, clean and restore surfaces as directed by Engineer.
  .2 Protect factory finished products and equipment.

.2 Surface Preparation:

  .1 Report to the Engineer any condition adversely affecting this work. Do not commence work until all deficiencies have been corrected.
  .2 Prepare all surfaces in accordance with the requirements of MPI Manuals.
  .3 Do not paint unless substrates are acceptable and/or until all environmental conditions (heating, ventilation, lighting and completion of other subtrade work) are acceptable for applications of products.
  .4 Protect all adjacent surfaces and areas from painting operations and damage by drop cloths, shields, masking, templates, or other suitable protective means and make good any damage caused by failure to provide such protection.
  .5 Remove and securely store all miscellaneous hardware and surface fittings and fastenings including by not limited to electrical plates, mechanical louvers, light fixtures and trim, mouldings, etc. prior to repainting and replace upon completion. Carefully clean and replace all such items upon completion of repainting work in each area. Do not use solvent or reactive cleaning agents on items that will mar or remove finishes.
  .6 Sand, clean dry etch, neutralize and/or test all surfaces under adequate illumination, ventilation and temperature requirements.
  .7 Remove electrical cover plates, light fixtures, surface hardware on doors, surface mounted equipment, fittings and fastenings prior to undertaking painting operations. Identify and store items in secure location and re-installed after painting is completed.
  .8 Place "WET PAINT" signs in occupied areas as painting operations progress.

.3 Clean and prepare surfaces in accordance with MPI Architectural Painting Specification Manual requirements. Refer to MPI Manual regarding specific requirements. Preparation of iron and steel surfaces:

.1 Iron and steel surfaces that are not galvanized and will be subject to normal exterior or interior atmospheric exposure: Clean either in the shop or in the field by means of solvents, emulsions, cleaning compounds, steam cleaning, or similar materials or methods to the specifications issued by the Steel Structures Painting Council, SSPC-SP1. After solvent cleaning, blast the metal with abrasives to standards specified by SSPC-SP6 or CGSB 31-GP-404, Type 2. Prime cleaned surfaces as soon as practicable after cleaning with the appropriate specified primer. Prior to applying subsequent coats, clean and reprime all welds and other damaged areas of shop primed surfaces. Neutralize and remove all slag and weld spatter by acid washing.

.2 Submerged exposures: All iron and steel surfaces that are not galvanized and will be subject to immersion, or which will be wet by spray or condensation, or as specified in the schedule: clean of all rust, millscale and other foreign matter to bright base metal by solvent cleaning to specification SSPC-SP1 issued by the Steel Structures Painting Council and then blast cleaning to Standard SSPC-SP10 to CGSB 31-GP-404 Type 1. Carry out blast cleaning using abrasives of such particular shape, hardness and gradation as to effectively clean the metal and leave a roughened surface suitable for adequate bonding of subsequent coatings. As soon after cleaning as practicable, and prior to the formation of any corrosion from atmospheric moisture or other causes, clean all blast-cleaned metal surfaces of dust and coat with the specified primer, protective coating, or paint. Do not leave blast cleaned surfaces overnight prior to receiving the priming coat. Where manufacturer's requirements for surface preparation are more stringent than the foregoing. The manufacturer's requirement shall be followed.

.3 Prior to field application of subsequent coats, thoroughly clean the surfaces of shop applied coating with mineral spirits.

.4 Properly clean all welds or other unpainted areas as specified for the adjacent area. Give one coat of primer as specified.

3.5 EXISTING CONDITIONS

.1 Conduct moisture testing of surfaces to be painted using properly calibrated electronic moisture meter, except test concrete floors for moisture using simple "cover patch test" and report findings to Engineer. Do not proceed with work until conditions fall within acceptable range as recommended by manufacturer.

.2 Maximum moisture content as follows:

.1 Stucco: 12%.

.2 Concrete: 12%.

.3 Clay and Concrete Block/Brick: 12%.

.4 Hard Wood: 15%.

.5 Soft Wood: 17%.

3.6 APPLICATION

.1 Do not paint unless substrates are acceptable and/or until all environmental conditions (heating, ventilation, lighting, weather conditions and precipitation, or completion of other work) are acceptable for application of products.

.2 Cold weather painting, when temperatures are less than 10°C, is only permitted when paints formulated for lower temperatures are used and manufacturer’s limitations are observed for maximum humidity levels and minimum temperatures. Contractor to submit technical information regarding paint manufacturer’s recommendations for cold weather work and protection.

.3 Paint and repaint all surfaces requiring paint, stain or coating to minimum MPI Manual finish requirements with application methods in accordance with best trade practices for type and application of materials used.

.4 Painting coats specified are intended to cover surfaces satisfactorily when applied at proper consistency and in accordance with manufacturer’s recommendation.

.5 Method of application and uniform coats of specified film thickness be in agreement with paint supplier and Engineer.

.6 Apply each coat at the proper consistency as recommended by the manufacturer.

.7 Sand lightly and dust between coats to achieve an anchor for the next coat and to remove defects visible from a distance up to 1000 mm.

.8 Do not apply finishes on surfaces that are not sufficiently dry. Unless manufacturer’s directions state otherwise, each coat shall be sufficiently dry and hard before a following coat is applied.

.9 Mechanical/Electrical Equipment and Related Surfaces

  .1 Leave exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment in original finish and touch up scratches and marks. Do not paint over nameplates.

  .2 Refer to Mechanical and Electrical specifications for painting, banding, stenciling of surfaces / equipment as required.

.10 Finish tops, bottoms, edges and areas not readily visible.

3.7 MECHANICAL/ELECTRICAL EQUIPMENT

.1 Paint finished area exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment with colour and finish to match adjacent surfaces, except as indicated.

.2 Other unfinished areas: leave exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment in original finish and touch up scratches and marks.

.3 Do not paint over nameplates.

3.8 SITE TOLERANCES

.1 Final coat to exhibit uniformity of colour and uniformity of sheen across full surface area.

3.9 FIELD QUALITY CONTROL

.1 Field inspection of painting operations to be carried out by Engineer or designate.

.2 Advise Engineer when surfaces and applied coating is ready for inspection. Do not proceed with subsequent coats until previous coat has been approved.

.3 Painted, repainted and primed surfaces shall be considered to lack uniformity and soundness if any of the following defects are apparent:

  .1 Runs, sags, hiding or shadowing by inefficient application methods.

  .2 Evidence of poor coverage at rivet heads, plate edges, lap joints, crevices, pockets, corners and re-entrant angles.

  .3 Damage due to touching before paint is sufficiently dry or any other contributory cause.

  .4 Damage due to application on moist surfaces are caused by inadequate protection for the weather.

  .5 Damage and/or contamination of paint due to window blown or air born contaminants.

  .6 Evidence of poor paint bonding.

.4 Painted, repainted or primed surfaces rejected by the Engineer shall be made good at the expense of the Contractor.

.5 Examine surface for adequate preparation.

.6 Check all materials for correctness.

3.10 CLEANING

.1 Progress Cleaning:

  .1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 23 – Final Cleaning.

.3 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.11 RESTORATION

.1 Clean and re-install hardware items removed before undertaken painting operations.

.2 Remove protective coverings and warning signs as soon as practical after operations cease.

.3 Remove paint splashings on exposed surfaces that were not painted. Remove smears and spatter immediately as operations progress, using compatible solvent.

.4 Protect freshly completed surfaces from paint droppings and dust. Avoid scuffing newly applied paint.

.5 Restore areas used for storage, cleaning, mixing and handling of paint to clean condition.

END OF SECTION

Part 1 General

1.1 GENERAL

.1 This Section covers items common to Sections of Division 26.

.1 Not all systems and components identified in this specification section are required for this project.

.2 Components and systems identified is this section that are required to complete the scope of the work, or are incidental to complete the scope of work, or is required by other specification sections, shall be supplied in accordance with the relevant parts of this section.

1.2 CODES AND STANDARDS

.1 Except where specified otherwise, do complete installation in accordance with CSA C22.1 Part I and as amended for use in the Province of British Columbia, henceforth alternatively referred to as the Rules and Regulations.

.2 Do overhead and underground systems in accordance with CSA C22.3, No.1 and CSA C22.3 No. 7, except where specified otherwise.

.3 Abbreviations for electrical terms: to CSA Z85.

.4 In addition to the above, the requirements related to electrical installations that are not governed by the Rules and Regulations but are required by the BC Building Code, BC Hydro, Telus, and WorkSafe BC, shall be met.

1.3 CARE, OPERATION AND START-UP

.1 Refer to Division 1 for Pre-start-up, Start-up and Commissioning requirements.

.2 Instruct operating personnel in the operation, care and maintenance of equipment.

.3 Arrange and pay for services of manufacturer's qualified field service representative (FSR) to supervise start-up of installation, check, adjust, balance and calibrate components.

.4 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.

.5 Submit a service and commissioning report, by the FSR, for each applicable piece of equipment or system.

1.4 SCOPE OF WORK

.1 Contractor to install Owner supplied pumps and prefabricated pump cables.

.2 Contractor to install cable tray on the effluent pump station platforms and bridge. Contractor shall be responsible for providing all supports required for the installation of the lighting in accordance with BCBC 2018.

.3 Contractor to supply and install motor disconnect junction boxes, motor control junction boxes, motor hand-off-auto station for each effluent pump.

.4 Contractor shall supply and install lighting, lighting supports, receptacles, junction boxes and cabling necessary to complete the installation per the Contract Documents. The main feeder cable is supplied by others.

Contractor shall be responsible for providing all supports required for the installation of the lighting in accordance with BCBC 2018.

.5 Contractor to supply and install level transmitter supports for each effluent pump station platform. Level transducer, level transmitter and cabling to be installed by others.

.6 VFDs and control panel will be installed in the treatment building and programming completed in a separate contract. Pump supplier to certify the final installation.

1.5 VOLTAGE RATINGS

.1 Operating voltages: to CAN3-C235.

.2 Electric equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard. Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

1.6 PERMITS, FEES AND INSPECTION

.1 Submit to Technical Safety BC and Supply Authority the necessary number of drawings and specifications for examination and approval prior to commencement of work.

.2 Pay associated fees.

.3 Upon request of Contractor, Engineer will provide drawings and specifications to Contractor, as required by Technical Safety BC and Supply Authority at no cost.

.4 Notify Engineer of changes required by Technical Safety BC prior to making changes.

.5 Furnish Certificates of Acceptance from Technical Safety BC and authorities having jurisdiction on completion of work. The Contractor’s Declaration of Completion, countersigned by the Electrical Inspector will be accepted as the Final Certificate.

.6 Pay all fees and charges for FSR for testing, start-up, and commissioning of equipment.

1.7 MATERIALS AND EQUIPMENT

.1 Equipment and material to be of manufacturer’s current design and to be certified by CSA or an equivalent certification agency as identified in the Rules and Regulations.

Where there is no alternative to supplying equipment which is thus certified, obtain special approval from Technical Safety BC.

.2 Factory assemble control panels and component assemblies.

.3 Listing of a company as an acceptable manufacturer or supplier of equipment and materials is conditional to compliance with the specified requirements.

.4 Uniformity of equipment: Materials and equipment of similar or identical nature shall be of same manufacture and type.

.5 Upgrades to existing equipment: materials and equipment required for modifications to existing electrical equipment to be supplied and installed by the manufacturer’s service group.

1.8 FINISHES

.1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish air dry enamel.

  .1 Paint outdoor electrical equipment "dark transformer green" finish to EEMAC Y1-2.

  .2 Paint indoor switchgear and distribution enclosures and outdoor junction boxes light grey air dry enamel to EEMAC 2Y-1.

.2 If acceptable to Engineer, 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.

.4 If acceptable to Engineer, apply Galvacon touch-up paint to damaged portions of galvanized threads and surfaces.

1.9 EQUIPMENT IDENTIFICATION

.1 Identify electrical equipment, instruments, control devices and mechanical equipment which have an electrical component with nameplates and labels as follows.

.2 Nameplates:

  .1 Lamacoid 2-ply, 3 mm thick plastic engraving sheet, white face, black backing, attached with foam-tape 3M Scotch-Mount No. 4032 adhesive backing where used in controlled environment indoor areas and with self tapping screws (rivetting not acceptable) where used outdoors or in wet, damp or contaminated indoor areas. Epoxy glued where integrity of enclosure would be impeded by screwholes.

NAMEPLATE SIZES			
Size 1	13 x 50 mm	1 line	4 mm high letters
Size 2	13 x 70 mm	1 line	4 mm high letters

Size 3	20 x 50 mm	2 lines	4 mm high letters
Size 4	20 x 70 mm	2 lines	4 mm high letters
Size 5	27 x 70 mm	3 lines	4 mm high letters
Size 6	27 x 90 mm	4 lines	3 mm high letters
Size 7	70 x 150 mm	as required	min. 10 mm high letters

.3 Labels:

  .1 Embossed plastic labels with 6 mm high letters unless specified otherwise, for use inside cabinets and panels only.

.4 Nameplates shall include the device, loop number, and the description from the single line diagrams and schematics as typically shown below.

P-101
WATER PUMP #1

SF-250
CHEMICAL ROOM
SUPPLY FAN

.5 Nameplate sizes shall be verified as being adequate before they are fabricated.

.6 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.

.7 Disconnects, starters and contactors: indicate equipment being controlled and voltage.

1.10 CONDUIT AND CABLE IDENTIFICATION

.1 Identify conduits and cables which are numbered on the drawings or schedules using the alpha-numeric tag number as shown. Attach a tag at each point of termination or connection.

.2 Identify conduits and cables installed in non-hazardous or non-corrosive indoor areas or within enclosures with white nylon marker plates, Panduit #MP xxx-C, fastened with locking-type black nylon ties. Use intermediate grade ties, Panduit #PLT xxI-CO. If tie also serves as cable strap, use heavier grade tie.

.3 Identify conduits and cables installed outdoors or in hazardous or corrosive areas with stainless steel, embossed metal marker plate, Panduit #MMP, fastened with stainless steel, Panduit #MLT PANSTEEL ties. Use #304 or #316 stainless steel as appropriate.

.4 Identify conduits and cables installed in areas where they are subjected to chemical attack with stainless steel marker plates as specified above and fastened with Panduit #PLT xx -x76 Pan-Ty TEFZEL ties.

.5 Provide the required embossing and printing equipment, complete with software where applicable. Keep equipment on-site until plant commissioning is complete.

.6 Catalogue numbers specified are for the purpose of illustrating features and quality of the conduit and cable identification system. Products from other manufacturers are acceptable subject to meeting or exceeding the specified products.

1.11 WIRE IDENTIFICATION

.1 Identify control and instrument wires with permanent, indelible numbered markings on both ends of wires, i.e. at all points of terminations and splices. Characters to be no less than 2 mm high. Numbering shall not be handwritten.

.2 Unless otherwise specified or shown, wire numbers and terminal block numbers shall be the same.

.3 Maintain phase sequence and colour coding of wires throughout.

.4 Colour code wires to CSA C22.1 and as follows:

  .1 Power wires: phase A-B-C from left to right or front to back, red-black-blue
  .2 Neutral: white
  .3 AC, control: red
  .4 AC, ground: green
  .5 DC + (ungrounded): yellow
  .6 DC- (grounded): blue
  .7 Instrument wires: shielded twisted pairs, white for higher potential, black for lower potential, grey overall jacket.
  .8 Taping for the purpose of colour coding will not be accepted for conductors less than #2 AWG.

1.12 CONDUCTOR TERMINATIONS

.1 Lugs, terminals, screws used for termination of conductors to be suitable for copper and aluminum conductors.

1.13 MANUFACTURERS AND APPROVAL LABELS

.1 Visible and legible after equipment is installed.

1.14 WARNING SIGNS

.1 As specified and to meet requirements of BC Electrical Safety Authority and Engineer.

.2 Decal signs, minimum size 175 x 250 mm.

1.15 CONDUIT AND CABLE INSTALLATION

.1 Install conduit and sleeves prior to pouring of concrete. Sleeves through concrete, unless otherwise shown: Schedule 40 PVC, sized for free passage of conduit and cable, and protruding 50 mm.

.2 Install cables, conduits, and fittings to be plastered over, neatly and close to building structure so furring can be kept to minimum.

1.16 QUALITY CONTROL

.1 Test, calibrate and, unless otherwise specified, program and configure the new works to ensure that they are operating in accordance with the intent of the drawings and specifications. Any clarification required as to the intent of the drawings and specifications must be obtained prior to bid closing.

.2 Supply all necessary instruments, meters, equipment and qualified personnel to perform tests and calibrations.

.3 Furnish manufacturer's certificate or letter confirming that entire installation, as it pertains to each system, has been installed to manufacturer's instructions.

.4 Insulation resistance testing:

    .1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument; use a 1000 V instrument for system voltages above 350 V. Note: Disconnect cables connected to instruments, controllers and similar devices.
    .2 Check resistance to ground before energizing.
    .3 Carry out tests in presence of Engineer.
    .4 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project. Instruments should be calibrated within the last 12 months.
    .5 Submit test results for Engineer's review.

.5 Check electrical equipment and motor nameplates to ensure that the breakers, fuses, overload heaters and conductors are sized in accordance with the Rules and Regulations.

.6 Ensure that circuit protective devices such as overcurrent trips, relays, fuses, and the like, are set to required values.

.7 Provide Engineer with list of test results including, but not limited to, the following:

    .1 Nameplate full load current of each motor.
    .2 Measured operating current of each motor.
    .3 Cat. No. and current range of installed O/L heater or settings, as applicable.
    .4 Setting of circuit breakers.
    .5 Settings of all protective relays.
    .6 Thermostat settings.
    .7 Calibration calculations.
    .8 Analog and control setpoints.

.9 Parameter setting record sheets for devices and equipment which need programming, e.g. UV control panel, chlorination control, and the like.

.10 All other relevant and similar data.

.8 Submit a completed Motor Data Sheet as shown appended to this Section.

1.17 GUARDING

.1 Guard exposed live equipment during construction for personnel safety.

.2 Shield and mark live parts "LIVE 120 VOLTS", or with appropriate voltage.

1.18 PROTECTION

.1 Protect equipment and material from the weather, moisture, dust and physical damage.

.2 Cover equipment openings and open ends of conduit piping and pullboxes as work progresses. Failure to do so will result in the Contractor being required to adequately clean or replace materials and equipment at no extra cost to the Owner.

.3 Refinish damaged or marred factory finish to as-new condition.

.4 Protect all existing services encountered. Obtain instructions from the Engineer when existing services require relocation or modification, further to that defined in these contract documents.

1.19 CLEANING

.1 Do final cleaning in accordance with Section 01 74 23 – Final Cleaning.

1.20 WORKMANSHIP

.1 Workmanship shall be in accordance with well established practice and standards accepted by Engineer.

.2 The Engineer has the right to reject any item of work that does not conform to the contract documents and accepted standards of performance, quietness of operations, finish and appearance.

1.21 SEISMIC RESTRAINTS

.1 Provide seismic restraints for cable tray, luminaries, control panels and the like to BCBC 2018.

1.22 DRAWINGS AND MEASUREMENTS

.1 Drawings are generally diagrammatic and are intended to indicate the scope and general arrangement of the work. Do not scale the drawings.

.2 Take field measurements where equipment and material dimensions are dependent upon buildings.

.3 Ensure adequate clearance in front of all electrical panels and equipment.

.4 Ensure that all suppliers of equipment and material have sufficient information to determine that their equipment and material is suitable for the intended use shown in these documents.

1.23 EXAMINATION

.1 Locations shown on the Drawings must be verified and the responsibility for any error resulting from failure to exercise such precaution shall be the responsibility of this Contractor.

.2 Examine the documents for details of work included. Obtain written clarification from the Engineer, in the event of conflict within the Specification, between the Specification and Drawings, or in the Drawings. Obtain written clarification from the Engineer if work affecting the installation is not clear.

1.24 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings and product data as specified.

.2 Shop drawings depicting schematic and single line diagrams, connection diagrams, panel layouts, and the like must be prepared by electronic drafting means.

.3 Include information for the following:

  .1 Electrical distribution equipment, such as junction boxes, disconnect switches and local operating stations.
  .2 Lighting equipment including ballasts and applicable photometrics with coefficient of utilization tables.

.4 Information for the above listed items to include, but not be limited to, wiring diagrams, bills of materials, dimensional data and operating descriptions. Catalogue sheets may be submitted as shop drawings provided they are for actual piece of equipment supplied; literature which covers an entire family of equipment is only acceptable if the equipment proposed is clearly highlighted.

1.25 INSTALLATION INSTRUCTIONS

.1 Obtain the manufacturer's instructions necessary for the correct installation, calibration and adjustment for all equipment well in advance of commencement of shop and site work.

1.26 RECORD DRAWINGS

.1 Contractor to provide project record documents.

.2 Record drawings and information is to include but is not limited to the following:

  .1 Field Instrument Manufacturer calibration certification sheets.
  .2 Shop drawings, revised to as constructed status; refer also to another clause in this Section entitled Shop Drawings.

  - .3 Design drawings, revised to as constructed status.
  - .4 Instrument and calibration record forms.
  - .5 Data sheets with listing of programming and configuration variables of such equipment as Transmitters, Metering Systems, and the like.

1.27 OPERATIONS AND MAINTENANCE MANUAL

- .1 Provide operation and maintenance data for incorporation into Operation and Maintenance Manual.

- .2 The data must include all information listed under another item of this Section entitled Shop Drawings and Product Data, supplemented by illustrated parts lists, catalogue numbers and detailed instructions to permit effective operation, maintenance and repair of the equipment.

- .3 Include data for each type and style of device.

- .4 For each manual, provide 1 print of each shop drawing, revised to as-built status, including all final settings and sizes of circuit breakers, fuses, relays, and the like.

- .5 Information must be for actual piece of equipment supplied; literature which covers an entire family of equipment is only acceptable if the equipment in use is clearly highlighted.

1.28 TERMINOLOGY

- .1 Unless further qualified, the following definitions apply:
  - .1 Wiring - refers to any or all of conduits, cables, wires, conductors and associated fittings and hardware.
  - .2 Conductor - refers to the current carrying portion of an insulated or non-insulated wire.
  - .3 Wire - refers to a single, insulated conductor.
  - .4 Cable - refers to an assembly of a single or multiple wires with shield, jacket, sheath or armour.
  - .5 Field wiring - refers to wiring outside a control panel or kiosk.
- .2 Wherever the term 'duct' appears, it applies equally to conduit.

Part 2 Products

Not Used

Part 3 Execution

Not Used

END OF SECTION

Part 1 General

1.1 REQUIREMENTS

.1 This section is a general specification for the supply and installation of the electrical systems and components, as identified here-in.

.2 The electrical scope of the work for this project is identified in Section 26 05 02 – Electrical: General Requirements.

.3 Not all systems and components identified in this specification section are required for this project.

.4 Components and systems identified is this section that are required to complete the scope of the work, or are incidental to complete the scope of work, or is required by other specification sections, shall be supplied and installed in accordance with the relevant parts of this section.

1.2 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings and product data in accordance with the requirements of Division 1 and Section 26 05 02 – Electrical: General Requirements.

1.3 OPERATION AND MAINTENANCE DATA

.1 Provide operation and maintenance data for inclusion into manual specified in Section 26 05 02 – Electrical: General Requirements and Division 01.

Part 2 Products

2.1 CONDUITS

.1 Conduit sizes, unless otherwise specified, are given in metric trade sizes as listed in the Rules and Regulations.

.2 Minimum size 21 mm, except as otherwise specified.

.3 Abbreviations shown in brackets correspond to type identification shown on drawings.

.4 Rigid PVC conduit (RPVC) to CSA C22.2 No. 211.2.

2.2 CONDUIT FASTENINGS AND SUPPORTS

.1 For outdoor and corrosive environment applications, two hole ultra-violet stabilized PVC straps to secure surface conduits 50 mm and smaller. Two hole PVC-coated steel straps for conduits larger than 50 mm.

.2 Beam clamps to secure conduits to exposed steel work.

.3 Channel type supports for two or more conduits at spacing required by the Rules and Regulations.

.4 6 mm diameter threaded rods to support suspended channels.

2.3 CONDUIT FITTINGS AND COUPLINGS

.1 Fittings: manufactured for use with conduit specified. Coating: same as conduit.

.2 Factory "ells" where 90° bends are required for 25 mm and larger conduits.

.3 Liquid tight connectors for flexible conduit; dry-type will not be accepted.

.4 Non-metallic connectors for non-metallic conduits.

.5 Threaded couplings for metal conduit. Solvent-weld couplings for PVC conduit.

2.4 PULLSTRING

.1 6 mm stranded nylon pull string, tensile strength 5 kN.

2.5 WIREWAYS

.1 Sheet steel with hinged cover to give uninterrupted access, non-metallic (polyester or fibreglass) in outdoor and corrosive environments.

.2 Cross section dimensions: minimum 50 x 50 mm.

.3 Finish: baked grey enamel for metallic enclosures.

.4 Elbows, tees, couplings and hanger fittings manufactured as accessories to wireway supplied.

2.6 TECK CABLES AND CONNECTORS

.1 Compliance: CSA C22.2, No. 03 and No. 131.

.2 CSA Type TECK.

.3 Conductors:

- .1 Grounding conductor: copper.
- .2 Circuit conductors: copper, size as specified.

.4 Insulation:

- .1 Chemically cross-linked thermosetting polyethylene rated type RW90.
- .2 600 V insulation for circuits up to nominal 240 VAC.
- .3 1000 V insulation for circuits above 240 VAC.

.5 Inner jacket: thermosetting polyvinyl chloride material.

.6 Armour: interlocking aluminum.

.7 Overall covering: polyvinyl chloride material, rated -40°C and meeting low gas emission and FT4 flame test requirements set forth in CSA C22.2, No. 03.

.8 Fastenings and Supports:

- .1 Refer to another clause in this specification, entitled Conduit Fastenings.
- .2 6 mm dia threaded rods to support suspended channels.
- .3 Except as otherwise noted, cable ties are only to be used with the approval of the Engineer, and shall meet the requirements specified in Section 26 05 02 – Electrical: General Requirements.

.9 Connectors:

- .1 Watertight, approved for TECK cable; dry-type not accepted.
- .2 Approved for hazardous location where applicable.
- .3 Acceptable products: Thomas and Betts "STAR TECK" series.

2.7 FLEXIBLE CABLES

.1 Compliance: CSA C22.2, No. 49.

.2 CSA Type SOW, size and number of conductors as shown.

.3 Other flexible cable as factory-supplied with equipment.

2.8 SHIELDED CABLES

.1 Compliance CSA C22.2 No. 239.

.2 CSA Type CIC (unarmoured) for installation into conduit.

.3 CSA Type ACIC (armoured) for surface or direct buried installation, or installation into non-magnetic conduit.

.4 Common features:

- .1 Single or multiple twisted pair #16 AWG copper conductors, number as specified.
- .2 300 V insulation, except 600 V insulation where required by the Rules and Regulations for installation on common raceway (tray) with other 600 V circuits.
- .3 Shield with drain wire for each pair and overall shield with drain wire for multiple pair cables.
- .4 PVC outer jacket, 90°C and -40°C, FT-4 rated.

.5 Acceptable products, in alphabetical order:

- .1 for CSA Type CIC (unarmoured)
    - Belden Series 224XX
    - Nexans Series 900 000

- Shawflex Series 6B021M16XX

.2 For CSA Type ACIC (armoured)

- Belden Series 245XX (aluminum armour)
- Nexans Series 910 000 (aluminum armour)
- Shawflex Series 6B222M16XX (aluminum armour)

.3 The above product numbers are for 300 V-rated cables; adjust as required for 600 V-rated cables.

.6 Factory-supplied shielded cables where forming part of an instrument assembly.

2.9 INSTRUMENTATION WIRING

.1 Instrumentation and control wiring external of cabinets shall be as minimum:

.1 For control, no smaller than #14 AWG stranded copper or as indicated in drawings.

.2 For instrumentation, #16 AWG stranded copper or as indicated in drawings. All instrumentation wiring pairs shall be individually shielded.

.2 Control wires which terminate to a screw stud which are not equipped with terminal saddles shall be made using fork lugs that are insulated and locking.

.3 Wiring shall be free from abrasion and tool marks and shall have a minimum bending radius of 1¼ inch.

.4 Unsupported wiring on panels will not be permitted. Control wire and cable shall be formed in accordance with good wiring practices. Where cable bundles must be carried across hinges to devices mounted on doors, each cable or wire bundle shall be looped and carried between a clamp on the door and one on the fixed portion of the cabinet in such a manner that torsion and flexure in the loop shall be minimized. The cables shall be protected against abrasion with "spiral" or "snakeskin" protection material.

.5 Wiring between terminals of various devices shall be "point-to-point" (no splicing or tee connections of wire will be permitted), with wires neatly tucked along the back of the panels. Adequate support shall be provided to prevent sagging or damage from vibration in transit and operation.

.6 All wire shields / drain wires shall be grounded on the PLC side of the cable. Instrument side to be ground isolated.

.7 Refer to the Control Block drawing.

.8 Conductor color coding as follows:

.1 120 VAC line: Black.
.2 120 VAC neutral: White.
.3 120V control: Red.
.4 Ground: Green.
.5 24 VDC +: Yellow
.6 24 VDC Control: Yellow

   - .7 24 VDC -: Blue
   - .8 Input: Yellow.
   - .9 Output: Orange.
   - .10 Shielded twisted pairs: Black is positive; White or Clear is negative.

2.10 CABLE TRAYS AND SUPPORTS

.1 CSA Standard CSA22.2, No. 126.

.2 Acceptable manufacturers, subject to compliance with specified requirements, in alphabetical order: Canadian Electrical Raceways (CER), MP Husky, and Code Electric (Tech Tray).

.3 Catalogue numbers specified are for the purpose of illustrating features and to establish the grade of quality of the cable tray system. Products from other listed manufacturers which have identical features and characteristics are acceptable.

.4 Stainless Steel Tray:

   - .1 Made of AISI 316 stainless steel, with minimum 100 mm loading depth.
   - .2 Ladder-type CSA Load Class D, with 150 mm rung spacing, CER Type LDA5 for instrumentation cables and 300 mm rung spacing for other cables.

.5 Horizontal elbows, drop-outs, tees, wyes, reducers, and plates and vertical risers as required, of same material and finish as straight lengths. Fittings: manufactured accessories for the cable tray supplied. Radii on fittings: 300 mm and 600 mm as required.

.6 Support brackets, steel columns, Unistrut, clamps and all necessary accessories as required for complete installation, made from Omnistrut fibreglass for metallic tray.

2.11 JUNCTION, PULL AND TERMINAL BOXES

.1 To CSA C22.2, No. 40.

.2 Non-metallic, NEMA 4X PVC with screw-on vandal proof covers for outdoor, wet and corrosive areas as shown on the drawings.

.3 Complete with terminal block kit assembly, where applicable.

.4 Provide appropriate terminations and identification in control terminal boxes (CTB) and instrument terminal boxes (ITB).

2.12 OUTLET AND CONDUIT BOXES GENERAL

.1 Compliance: CSA C22.2, No. 18.

.2 Size boxes in accordance with CSA C22.1.

.3 102 mm square or larger outlet boxes as required for special devices.

.4 Blank cover plates for boxes without wiring devices.

.5 Combination boxes with barriers where more than one system is present.

.6 Boxes suitable for area classification shown or specified and where available or noted, made of same material or to have same finish as connecting conduit.

.7 Gang boxes where wiring devices are grouped.

.8 Surface-type FS or FD style fibreglass or PVC boxes with hubs and mounting feet for corrosive and wet locations.

2.13 LIGHTING EQUIPMENT

.1 Provide luminaires complete with lamps of type as shown on the drawings.

.2 Provide stanchion mount supports that meet the requirements of BCBC 2018.

.3 Lamps.

- .1 Stanchion mounted.
  - .1 Colour temperature 5000K.
  - .2 CRI not less than 80%.
  - .3 120Vac powered 10,000 lumens
  - .4 Rated life at 70% lumen maintenance (L70) minimum 50,000 hours.
  - .5 Power Factor at 85% of better, unless otherwise specified.
  - .6 Options to be included:
    - .1 Built in photocell
    - .2 Damp/Corrosion resistant rating

2.14 RECEPTACLES

.1 Duplex receptacles, CSA type 5-15 R, 125 V, 15 A, U ground, premium specification-grade, with following features:

- .1 Urea moulded housing.
- .2 Suitable for No. 10 AWG for back and side wiring.
- .3 Break-off links for use as split receptacles.
- .4 Eight back wired entrances, four side wiring screws.
- .5 Double wipe contacts and rivetted grounding contacts.
- .6 Wet location cover plates
- .7 Tamper resistant.

2.15 WIRING DEVICE COVER PLATES

.1 Cover plates for wiring devices from one manufacturer throughout project.

.2 Lever-type Ipex/Sceptre, Type VSC 15/10, switchplates for weatherproof, wet or corrosive locations.

.3 PVC coverplates for PVC boxes.

.4 Cast aluminum with double lids "cover open" type, Hubbell Series 520*WO, receptacle plates for weatherproof, wet or corrosive locations.

2.16 DISCONNECT SWITCHES

.1 Non-fusible, heavy duty, horsepower rated disconnect switch in a NEMA 4X rated enclosure type as specified and size as indicated, CSA certified.

.2 Provision for padlocking in both the on and off position. Padlocking in the off position shall be provisioned for 3 locks while the on position shall only require a single lock. Note that

.3 Mechanically interlocked door to prevent opening when handle in ON position.

.4 Quick-make, quick-break action.

.5 ON-OFF switch position indication on switch enclosure cover.

2.17 INSTRUMENT JUNCTION BOX (ONE PER PLATFORM)

.1 NEMA Type 4X enclosure, weatherproof PVC or stainless steel construction, as shown on contract drawings.

.2 Panel door with formed edges and 3-point automotive handle with provision to accept a lock and a pocket for schematic drawings.

.3 Removable equipment mounting pan made from minimum 2.6 mm (12 gauge) steel.

.4 Exterior finish light grey, interior white.

.5 Size control panel generously, to allow for future additional equipment. As a minimum allow for the future addition of:

    .1 20 terminal blocks.

.6 Utilize plastic wiring ducts such as Panduit for organization of all interior and field wiring. Ducts are to be filled to no more than 50% of capacity.

.7 A space of no less than 300 mm must be kept clear across the top or bottom of the panel for field wiring.

.8 Provide buss bars for grounding connection as shown on drawings.

.9 Acceptable manufacturers, in alphabetical order: Hammond and Hoffman.

2.18 CABLE GRIPS

.1 Sized to suit cable diameter.

.2 With stainless-steel or non-metallic mesh.

2.19 FITTINGS

.1 Bushing and connectors with nylon insulated throats.

.2 Knock-out fillers to prevent entry of foreign materials.

.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 or enclosures.

2.20 SUPPORT CHANNELS

.1 C-shape, size 41 x 41 mm, 2.5 mm thick, surface mounted or suspended.

.2 Steel for dry indoor location, fibreglass for outdoor and wet and corrosive locations.

.3 Acceptable products: for fibreglass, Champion, available from Milham Industries, Delta, B.C.

2.21 CONNECTORS

.1 Pressure type wire connectors: with current carrying parts sized to fit copper/ aluminum conductors.

.2 Fixture type splicing connectors: with current carrying parts of copper sized to fit copper conductors 10 AWG or less.

.3 Clamps or connectors for armoured cable, flexible conduit, as required.

2.22 GROUNDING

.1 Unless specifically differentiated, the terms "grounding" applies equally to the system grounding and equipment bonding requirements.

.2 Clamps for connection of conductor, size as required to electrically conductive underground water pipe or ground electrode.

.3 Rod electrodes, copper clad steel 19 mm dia by 3 m long.

.4 Grounding conductors, bare and insulated stranded copper, size as indicated.

.5 Equipment bonding conductors, bare and insulated stranded soft annealed copper size as indicated or as required by the Rules and Regulations.

.6 Insulated grounding conductors: green, insulation to match circuit conductors.

.7 Non-corroding 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 Compression type conductor to conductor connectors.

.4 Exothermic welded type conductor connectors.

.5 Bonding jumpers, straps.

.6 Pressure type conductor to equipment connectors.

.8 All grounding connections should be cleaned of oxidation prior to connection, and protected against corrosion by corrosion inhibiting compound, such as De-ox or approved similar.

Part 3 Execution

3.1 WIRING

.1 Where wiring is subject to mechanical injury, provide additional mechanical protection.

.2 Unless otherwise specified, minimum conductor size is #12 AWG, except for control and instrumentation wiring which may be done with #14 AWG and #18 AWG respectively.

.3 Line voltage wiring for the HVAC system shall be done to the same standards as specified in this Section. Low voltage wiring method must provide protection against physical damage.

.4 Run surface wiring parallel or perpendicular to building lines; where applicable, run wiring in flanged portion of structural steel. Wherever possible, group wiring on profile channels. Do not pass wiring through structural members except as indicated.

.5 Install wiring to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.

.6 Use rigid PVC conduit or Teck cable, except where specified otherwise.

.7 Use liquid tight flexible metal conduit or Type SOW cable, as permitted by the Rules and Regulations, for connection to motors and other devices requiring flexible connection. Maximum length 450 mm.

.8 Where permitted by the Rules and Regulations, Teck and Teck-style cable may be used in lieu of liquid-tight conduit for motors, control and instrumentation wiring respectively.

.9 In corrosive areas, and as permitted by the Rules and Regulations, liquid-tight conduit shall be non-metallic.

.10 Use rigid PVC conduit for wiring in wet and damp areas.

.11 CSA Type AC cable ("BX" cable) is not acceptable.

.12 Slightly snake direct-buried U/G cable when laying into trench, to allow for some take-up during settlement of ground.

.13 original diameter.Bend metal conduit cold. Replace conduit if kinked or flattened more than 1/10th of its

.14 Mechanically bend metal conduit over 19 mm diameter.

.15 After installation of conduit or cable, seal voids with approved compounds such as Duxseal or expandable foam material. Seal larger-sized openings, provided for passage of cables from one area to another, in a similar fashion. Seal all openings around wiring entering or leaving the wet well and building.

.16 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.

.17 Conduit joints for PVC conduits to be done with solvent cement; push-fit couplings not acceptable.

.18 Where conduits become blocked, remove and replace blocked section. Do not use liquids to clean out conduits.

.19 Dry conduits out before installing wire.

.20 Install pullstring in empty conduit.

.21 Use non-metallic boxes, fittings and straps in wet, damp and corrosive environments.

.22 Unless otherwise specified, terminate conduit sleeves and spare conduits in a coupling or end bell.

3.2 WIREWAYS

.1 Wireways and auxiliary gutters may be used to facilitate multiple conduit or cable entries into an enclosure.

.2 Keep number of elbows, offsets, connections to minimum.

.3 Install supports, elbows, tees, connectors, fittings.

.4 Install barriers where required.

.5 Install gutter to full length of equipment.

3.3 SHIELDED CABLES

.1 Unless cable has its own magnetic armour, install shielded cables for instrumentation wiring into magnetic, i.e. steel, conduit.

.2 Ground cable shield.

.3 Maintain a separation of not less than 300 mm between analog instrumentation and power wiring where they run parallel to each other.

3.4 JUNCTION AND PULL BOXES

.1 Install pull boxes in accessible locations.

.2 Only main junction boxes are indicated. Install pull boxes as required.

3.5 CABLE TRAYS AND SUPPORTS

.1 Install a complete tray system as shown and specified. Cut to length section of tray as required to fit into the available space. Supports shall be cantilevered beams sized in accordance with BCBC 2018 off of the pump station platform and bridge. The tray shall be mounted with power on the bottom and instrumentation on top.

.2 Install cable tray on wall brackets where tray runs beside structural columns.

.3 Space supports as required by classification rating and weight of cables to be installed. Allow for 50% additional cable weight in determining tray support spacing. Secure tray to supports by suitable brackets and bolts.

.4 At corners provide a support installed as close as possible to the corner.

.5 Provide vertical clearance of 300 mm above the trays. This clearance can be reduced at piping or duct crossovers, but shall not be less than 150 mm.

.6 Maintain minimum 20 mm clearance between tray and any surface.

.7 All trays are shown diagrammatically on the drawings. The exact location is to be determined in the field. Determine the exact location of tray supports and runs in the field to prevent interferences with other structures and to maintain clearance for tray access.

.8 Use manufactured links to bolt individual tray lengths together or, where there is a separation between metallic tray sections, use a #4/0 copper bonding conductor between two sections.

.9 Install a #2 copper bonding conductor along the full length of the metallic tray system. Solidly bond the tray to the building steel and grounding system at the intervals required by the Rules and Regulations.

.10 Run trays parallel to building lines unless otherwise shown on the drawings.

.11 Remove sharp burrs or projections to prevent damage to cables or injury to personnel.

.12 Use beam clamps to fasten support systems to structural steel. Welding, drilling and cutting of structural steel is not permitted without approval by the Engineer.

3.6 CABLE INSTALLATION IN TRAY

.1 Arrange cables so as to provide a minimum of cable crossovers. Except where otherwise noted, use random spacing with appropriate cable derating. Do not tie random spaced cables in horizontal tray.

.2 Maintain specified cable spacing for cables designated for maintained spacing.

.3 Lay cables into cabletray. Use rollers when necessary to pull cables.

.4 Provide cable support in cabletrays inclined by more than 30° and in vertical cable trays if vertical distance exceeds 2 m or if cables terminate vertically, to an enclosure or box. Position cable ties such that they cause no damage to other cables being pulled.

.5 Provide mechanical support for cables which exit trays.

.6 Generally, install cables of different voltage classes in separate trays. Where a common tray is shown on drawings, separate the cables for different voltage classes from each other by barriers as manufactured by the tray manufacture.

.7 After installation of cables, seal voids around cables and cable tray where they pass through an exterior wall or a fire-rated wall with an approved re-enterable fire stop compound. Trim any excess materials to obtain a neat appearance. Strictly follow the fire stop manufacturer’s instructions.

3.7 CONDUIT AND OUTLET BOXES

.1 Use FS-style boxes for surface installations; sheet steel utility boxes not acceptable.

.2 Use non-metallic boxes in wet, damp or corrosive areas.

.3 Support boxes independently of connecting conduits and cables.

.4 Provide correct size of openings in boxes for conduit and cable connections. Reducing washers not allowed.

3.8 WIRING DEVICES

.1 Install wiring devices as indicated.

.2 Do not use coverplates meant for flush outlet boxes on surface-mounted boxes.

3.9 CONNECTORS

.1 Remove insulation carefully from ends of conductors.

.2 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CSA C22.2, No. 65.

.3 Install fixture type connectors and tighten. Replace insulating cap.

3.10 FASTENING AND SUPPORTS

.1 Secure equipment to metal members by clamping or by drilling and tapping. Welding will not be acceptable.

.2 Secure equipment to poured concrete with non-corroding expandable inserts.

.3 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members. In outdoor or corrosive areas use non-metallic, stainless steel or brass materials and brass or stainless steel screws and bolts.

.4 Fasten exposed conduit or cables to structures or support system using PVC straps or other non-metallic straps. Straps exposed to daylight must be of ultra-violet stabilized materials.

.5 Suspended support systems:

  .1 Support individual cable or conduit runs with 6 mm dia threaded rods and spring clips.
  .2 Support 3 or more cables or conduits on channels supported by 6 mm dia threaded rod hangers where direct fastening to building construction is impractical.

.6 For surface mounting of 3 or more conduits or cables use channels at spacing in accordance with the Rules and Regulations.

.7 Provide brackets, frames, hangers, clamps and related types of support structures as required to support conduit and cable runs.

.8 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.

.9 Do not use wire lashing or perforated strap to support or secure raceways or cables.

.10 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Engineer.

.11 Install fastenings and supports as required for each type of equipment, cables and conduits, and in accordance with manufacturer's installation recommendations.

3.11 DISCONNECT SWITCH

.1 Install disconnect switches as indicated.

.2 Contractor shall supply all supports necessary for installing disconnect switches in locations as indicated in the contract drawings.

3.12 INSTRUMENT JUNCTION BOX (ONE PER PUMP)

.1 Install junction boxes as indicated on Contract Drawings.

.2 Contractor shall supply all supports necessary for installing junction boxes in locations as indicated in the contract drawings.

3.13 LOCAL OPERATING STATION (ONE PER PUMP)

.1 Install local operating stations as indicated on Contract Drawings.

.2 Contractor shall supply all supports necessary for installing junction boxes in locations as indicated in the contract drawings.

3.14 LIGHTING EQUIPMENT

.1 Locate and install luminaires as required and in accordance with manufacturer's instructions.

.2 Install lighting support structures per Contract Documents. Contractor shall be responsible for ensuring the supports can be braced to the structure.

.3 Support luminaires level and plumb and true with the supporting structure as intended.

.4 Remove any noisy ballasts from the luminaires and replace at no additional cost to the Owner prior to completion and final acceptance of the installation.

.5 Completely clean all luminaires, including lenses and lamps at completion of project and before final acceptance of project.

.6 Perform tests in accordance with Section 26 05 02 – Electrical: General Requirements. Do not megger the luminaires.

3.15 RECEPTACLES

.1 Install receptacles as indicated on Contract Documents. Receptacles shall be installed using non-metallic rigid PVC connection boxes.

3.16 GROUNDING SYSTEM

.1 Install complete system grounding and equipment bonding systems including number of electrodes, conductors, connectors and accessories to conform to requirements of Engineer, and local authority having jurisdiction over installation.

.2 Install a grounding conductor in each conduit run unless otherwise indicated.

.3 Install connectors in accordance with manufacturer's instructions.

.4 Protect exposed grounding conductors from mechanical injury.

.5 Make buried connections to electrodes using copper welding by exothermic process or high pressure compression connectors. Bolt-type connectors are not acceptable.

.6 Install an electrode box, placed flush with finished grade, high pressure compression connectors. Bolt-type connectors are not acceptable for access to top of ground rods.

.7 Use mechanical connectors for grounding connections to equipment provided with lugs.

.8 Use Penetrox "E" joint compound on all connections.

.9 Soldered joints not permitted.

3.17 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 02 – Electrical: General Requirements.

.2 Identify each phase conductor of feeders and check phase rotation for 3-phase systems.

.3 Check each feeder for continuity, short circuits and grounds. Ensure resistance to ground of circuits is not less than 50 megohms.

.4 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Engineer, to ensure compliance with the Canadian Electrical Code, but not to be less than 5 ohms. The test to include the complete grounding system.

.5 Provide Engineer with list of test results.

.6 Remove and replace entire length of cable if cable fails to meet any of test criteria.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 ASTM International

  .1 ASTM D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000ft-lbf/ft^3) (2,700kN-m/m^3).

.2 CSA International

  .1 CSA A23.1/A23.2, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.

  .2 CSA A3000, Cementitious Materials Compendium.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit shop drawings as required by the Contract Drawings, in accordance with Section 01 33 00 - Submittals.

.2 Contractor to submit samples of all proposed fill materials to be used on site for testing at the Contractor’s cost. Results of testing (including sieve test and proctor density test if applicable) to be submitted to Engineer for review no later than 1 week before backfilling or filling work.

.3 Contractor to submit construction methodology for review by Geotechnical Engineer prior to construction.

.4 Site Quality Control Submittals: submit in accordance with Section 01 45 00 - Quality Control.

  .1 Submit testing results as described in PART 3 - FIELD QUALITY CONTROL.

.5 Sustainable Design Submittals:

  .1 Erosion and Sedimentation Control: submit erosion and sedimentation control plan in accordance with Provincial and Municipal authorities having jurisdiction, and Section 01 57 01 Environmental Protection.

Part 2 Products

2.1 GENERAL

.1 Gravel to be composed of inert, durable material, reasonably uniform in quality and free from soft or disintegrated particles. In absence of satisfactory performance records over a five-year period for particular source of material, soundness to be tested according to ASTM C88 or latest revised issue. Maximum weight average losses for course and fine aggregates to be 30% when magnesium sulphate is used after five cycles.

.2 All crushed gravel when tested according to and ASTM C136 and ASTM C117 or latest revised issue, to have a generally uniform gradation and conform to following gradation limits and 60% of the material passing each sieve must have one or more fractured faces.

Determination of the amount of fractured material shall be in accordance with the Ministry of Transportation and Highways' Specification I-11, Fracture Count for Coarse Aggregate, Method which determines fractured faces by count. The Plasticity index for crushed gravel to not exceed 6.0.

2.2 MATERIALS

.1 Imported Fill Type A

.1 Imported Engineered Fill Type A shall consist of 75 mm minus well graded sand and gravel conforming to the following gradations. Contractor shall submit sieve analysis results of proposed fill material to Geotechnical Engineer for approval.

SIEVE DESIGNATION (MM)	PERCENT PASSING HIGH (%)	PERCENT PASSING LOW (%)
75	100	100
37.5	100	60
19	80	35
9.5	60	26
4.75	40	20
2.36	30	15
1.18	20	10
0.6	15	5
0.3	10	3
0.075	5	0

.2 Imported Fill Type B

.1 Imported Fill Type B shall be well graded 150 mm minus crushed rock fill conforming to the following gradations. Contractor shall submit sieve analysis results of proposed fill material to Geotechnical Engineer for approval.

SIEVE DESIGNATION (MM)	PERCENT PASSING HIGH (%)	PERCENT PASSING LOW (%)
150	100	100
75	100	40
37.5	65	20
9.5	40	5
2.36	25	0
0.075	5	0

.3 Granular Base

.1 To be 25 mm crushed sand and gravel conforming to following gradations. Contractor shall submit sieve analysis results of proposed fill material to Geotechnical Engineer for approval:

SIEVE DESIGNATION (MM)	**PERCENT PASSING**
25	**100**
12.5	**75-100**
9.5	**60-90**
4.75	**40-70**
2.36	**27-55**
1.18	**16-42**
0.600	**8-30**
0.300	**5-20**
0.075	**2-8**

.4 Clear Crush

.1 To be 25 mm clean crushed rock conforming to the following gradations Contractor shall submit sieve analysis results of proposed fill material to Geotechnical Engineer for approval:

SIEVE DESIGNATION (MM)	**PERCENT PASSING**
25	**100**
19	**0-100**
9.5	**0-5**
4.75	**0**

.5 Geotextile to Section 31 32 19 - Geotextile.

.6 Riprap to Section 31 37 00 – Rip-rap.

Part 3 Execution

3.1 EXAMINATION

.1 Evaluation and Assessment:

.1 Examine geotechnical design report (171-04753-02) prepared by WSP Canada Inc (WSP) dated August 21, 2019.

.2 Examine project site and local conditions at time of construction.

3.2 PREPARATION/PROTECTION

.1 Temporary erosion and sedimentation control:

  .1 Provide temporary erosion and sedimentation control measures to prevent soil erosion, according to requirements of Provincial and Municipal authorities having jurisdiction, and Section 01 57 01 - Environmental Protection.

  .2 Inspect, repair, and maintain erosion and sedimentation control measures during construction.

  .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

.2 Protection of in-place conditions:

  .1 Protect natural and man-made features required to remain undisturbed. Unless otherwise indicated or located in an area to be occupied by new construction, protect existing trees from damage.

  .2 Protect buried services that are required to remain undisturbed.

  .3 Notify Engineer immediately of any unidentified buried structures encountered during excavations.

.3 Removal:

  .1 Remove obstructions, ice and snow as applicable, from surfaces.

  .2 On the berm extensions, strip existing Imported Fill Type A and any build-up (if applicable) to the dimensions and elevations as shown on Contract Drawings.

3.3 WORK ON BERM EXTENSIONS

.1 Install geotextiles in accordance with Section 31 32 19 - Geotextile.

.2 Place Riprap in accordance with Section 31 37 00 – Rip-rap.

.3 Place Imported Fill Type B.

.4 For Pipe Installation, refer to Section 33 34 00 – Sanitary Utility Forcemains.

3.4 FIELD QUALITY CONTROL

.1 The Contractor shall be responsible for the quality of all work performed and shall carry out testing of materials as required by the Engineer to ensure the quality of the work.

.2 Do not proceed with the work until material has been approved for use by Engineer.

.3 Any omissions or failure on the part of the Owner to disapprove or reject any work or materials shall not be construed as an acceptance of any defective work or materials.

.4 The Contractor is responsible for the cost of any repair, correction work and associated additional inspection and testing.

.5 Operations shall be suspended immediately whenever the conditions of climate, materials, equipment or workmanship are determined by the inspection and testing agency or the Owner to be unsatisfactory for the operations.

.6 Accuracy of graded elevations to be within +/- 25 mm tolerance.

3.5 SURFACE RESTORATION

.1 General

.1 Restore all disturbed surfaces outside berm crest with topsoil and hydraulic seeding to requirements of Section 01 57 01 – Environmental Protection.

.2 Make good any damage to adjacent lands or improvements.

.3 Resolve all reasonable claims arising from Contractor's actions and obtain written releases from land owners following final restoration.

.4 Restore vegetated areas with approved topsoil and hydraulic seeding as shown on the Contract Drawings and as required by Section 01 57 01 – Environmental Protection.

.5 Contractor to submit proposed hydraulic seeding extents, documentation of proposed procedure and materials, proposed erosion control as recommended by hydraulic seeding supplier, and references of hydraulic seeding supplier to Engineer for review 30 days prior to commencement of seeding operations.

.2 Gravelled roads and berm crest

.1 Restore surface to match existing conditions.

.2 Compact to minimum 95% Modified Proctor density.

3.6 CLEANING

.1 Progress Cleaning:

.1 Leave Work area clean at end of each day.

.2 Dispose of cleared and grubbed material off site daily.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 MEASUREMENT AND PAYMENT

.1 Include in appropriate pay item. Payment will be incidental to other items.

1.2 REFERENCE STANDARDS

.1 American Society for Testing and Materials (ASTM)

  .1 ASTM D 4491, Standard Test Methods for Water Permeability of Geotextiles by Permittivity.

  .2 ASTM D 4595, Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.

  .3 ASTM D 4716, Standard Test Method for Determining the (In-Plane) Flow Rate Per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head.

  .4 ASTM D 4751, Standard Test Method for Determining Apparent Opening Size of a Geotextile.

.2 Canadian General Standards Board (CGSB)

  .1 CAN/CGSB-4.2, Textile Test Methods.

  .2 CAN/CGSB-148.1, Methods of Testing Geotextiles and Geomembranes.

    .1 No.2, Mass per Unit Area.

    .2 No.3, Thickness of Geotextiles.

    .3 No.7.3, Grab Tensile Test for Geotextiles.

    .4 No.6.1, Bursting Strength of Geotextiles Under No Compressive Load.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions. During delivery and storage, protect geotextiles from direct sunlight, ultraviolet rays, excessive heat, mud, dirt, dust, debris and rodents.

Part 2 Products

2.1 MATERIAL

2.2 NON-WOVEN GEOTEXTILE

.1 The geotextile material shall be non-woven needle-punched polypropylene. The geotextile material shall be a minimum weight per the table below. The material Specifications shall be based on a minimum average roll values (MARV) not typical values.

.2 Geotextile to be as specified on the drawings or approved equal.

.3 The geotextile for the protection layer exhibits the properties described in the GRI GT12 Standards - "Test Methods and Properties for Non-woven Geotextiles used as Protection (or Cushioning) Materials".

.4 The rolls must be tagged to identify lot, batch, unique roll number, roll dimensions, manufacturer and material type. Provide QC testing certificate for each roll delivered, in accordance with the following required minimum properties:

Property	**ASTM Test Method**	**Unit**	**MARV**
Mass per unit area	D5261	oz/yd^2, g/m^2	12, 407
Grab tensile strength	D4632	N	1335
Grab tensile elongation	D4632	%	50
Trapezoidal tear strength	D4533	N	512
CBR Puncture strength	D6241	N	3671
UV resistance	D4533	% retained at 500 hrs	70
Apparent Opening Size	D4751	Mm	0.150
Permittivity	D4491	L/s	1.0
Water Flow Rate	D4491	L/m/m^2	3056

2.3 WOVEN GEOTEXTILE

.1 The geotextile material shall be woven polypropylene filaments. The material Specifications shall be based on a minimum average roll values (MARV) not typical values.

.2 Geotextile to be as specified on the drawings or approved equal.

.3 The rolls must be tagged to identify lot, batch, unique roll number, roll dimensions, manufacturer and material type. Provide QC testing certificate for each roll delivered, in accordance with the following required minimum properties:

Property	**ASTM Test Method**	**Unit**	**MARV**
Tensile Strength at 2% strain	D4595	kN/m	7.0
Tensile Strength at 5% strain	D4595	kN/m	21.0
Water Flow Rate	D4491	L/m/m^2	3056
Permittivity	D4491	L/s	1.0
Apparent Opening Size	D4751	Mm	0.425
UV resistance	D4533	% retained at 500 hrs	90

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for geotextile and GCL material installation in accordance with manufacturer's written instructions.

  .1 Visually inspect substrate in presence of Geotechnical Engineer, provide 72 hours notice prior to placement of geotextile or GCL and commencement of filling.

  .2 Inform Engineer immediately of any deviations from the design.

3.2 INSTALLATION

.1 Place geotextile material by unrolling onto graded surface in orientation, manner and locations indicated and retain in position with securing pins.

.2 Place geotextile material smooth and free of tension stress, folds, wrinkles and creases.

.3 Overlap each successive strip of geotextile 500 mm over previously laid panel.

.4 Protect installed geotextile material from displacement, damage or deterioration before, during and after placement of material layers.

.5 Replace damaged or deteriorated geotextile to approval of Engineer.

.6 Loose edges of geotextile fabric shall not be exposed and shall be anchored per indicated.

3.3 PROTECTION

.1 Vehicular traffic not permitted directly on geotextile.

.2 Do not overload soil or aggregate covering on geotextile prior to installation.

END OF SECTION

Part 1 General

1.1 MEASUREMENT PROCEDURES

.1 Include in appropriate pay item where indicated in schedule of prices.

.2 Measurement for graded riprap will be for actual quantity placed based on weigh tickets provided to Site Inspector as loads are delivered with rip-rap placed beyond the designed limit to be deducted from the weight of rip-rap delivered. Measurement for such deduction will be by the most equitable volume measurement and conversion into weight as decided by Site Inspector.

Part 2 Products

2.1 ROCK

.1 Hard, durable, and angular quarry rock able to interlock with adjacent rock riprap, that will not disintegrate on exposure to water or the atmosphere. The rock will have a relative density (formally specific gravity) not less than 2.65, free from seams, cracks or other structural defects. Rock to be well graded, to meet following size distribution for use intended:

- .1 Graded rip-rap:
  - .1 Size gradation for 10 kg riprap:

Percent Heavier Than	Weight (kg)	Equivalent Diameter (mm)
85	1	90
50	10	195
15	30	280

  - .2 Size gradation for 50 kg riprap:

Percent Heavier Than	Weight (kg)	Equivalent Diameter (mm)
85	5	155
50	50	330
15	150	475

  - .3 Minimum apron thicknesses for graded riprap unless shown otherwise on the Contract Drawings:

Graded Riprap Size (kg)	Minimum Thickness (mm)
10	350
50	550

.2 Rounded river rock or pit run stone not acceptable.

Part 3 Execution

3.1 PLACING

.1 Strip and grade area where riprap is to be placed to uniform and even surface. Fill depressions with approved material as specified on Contract Drawings.

.2 Place geotextile on prepared surface in accordance with Section 31 32 19 - Geotextile and as indicated in the Contract Drawings. Place rocks to avoid dropping riprap and do not puncture geotextile. Vehicular traffic over geotextile not permitted.

.3 Place riprap to thickness and details as indicated in the Contract Drawings with suitable equipment.

.4 Place rock to secure surface and create a well-graded, interlocking, stable mass of large and small rocks (per gradation specifications in 2.1 above) to fill voids. Compact rocks, interlocking smaller rocks into voids of larger rocks.

.5 Finished tolerances

  .1 Ensure finished riprap within +100 mm to -100 mm of specified grade.

  .2 Ensure riprap slope within +2 degrees to -2 degrees of specified slope in degrees.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

.1 ASTM International Inc.

  .1 ASTM A252, Standard Specification for Welded and Seamless Steel Pipe Piles

.2 American National Standards Institute

  .1 American Petroleum Institute, API Specification 5L

.3 Canadian Standards Association (CSA International)

  .1 CSA W59, Welded Steel Construction (Metal Arc Welding)
  .2 CSA W47.1, Certification of Companies for Fusion Welding of Steel
  .3 CSA S16 Limit States Design of Steel Structures
  .4 CSA G40.20/G40.21 General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel

.4 British Columbia Marine and Pile Driving Contractors Association (BCMPDCA)

  .1 BCMPDCA Best Management Practices for Pile Driving and Related Operations
  .2 ASTM 4945, Standard Test Method for High-Strain Dynamic Testing of Deep Foundations

1.2 MEASUREMENT PROCEDURES

.1 Payment for mobilization and fixed costs for pile installation will be made at the Lump Sum Price Bid.

.2 Payment for supply and installation of piling will be made at the Unit Price for each pile. The Unit Price shall apply for installation from cut-off to pile tip elevation and up to 20% of pile length (from cut-off to pile tip elevation) below the anticipated pile tip elevation.

.3 No separate payment will be made for splices.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittals.

.2 Product Data: submit manufacturer's printed product literature, specifications and datasheet.

.3 Copies of Mill Certificates and mill test reports showing chemical analysis and physical tests for all piling material shall be submitted to the Engineer for review prior to commencement of pile driving. Where Mill test certificates originate from a mill outside of Canada or the United States of American, the Mill test reports shall be verified by a certified laboratory in Canada.

.4 Non-destructive testing records confirming seam weld quality of the piling material.

.5 Submit details in a consolidated manner and a narrative on procedures, including mobilizing equipment, sequencing, erection and temporary restraints, schedule, and quality control, in accordance with the requirements of Section 01 33 00 – Submittals. The details shall be submitted to the Engineer for review a minimum of 4 weeks prior to mobilization of equipment.

.1 Include details regarding protective measures proposed for existing structures (such as vibration monitoring, survey, etc.);

.2 Include details regarding how the work program is to interface with existing construction activities and equipment/crew access through and/or between work areas;

.3 Include a traffic management plan indicating equipment delivery routes, equipment parking and access, material storage, etc. Note that stockpiles of materials should not be located above existing pipes without approval of the Engineer due to the potential for inducing settlement that could adversely affect the performance of existing facilities; and,

.4 Include details regarding any additional equipment access preparations that may be needed and how areas will be reinstated upon completion of pile installation.

.6 Spliced piles: when authorized, submit welding procedures and design details of splice, conforming to CSA W59 and W47.1 complete with signature and stamp of qualified professional engineer registered or licensed in the Province of British Columbia, Canada. The following shall be included in the submittal:

.1 Locations of the splices.

.2 The welding process, position of weld, filler metal, flux, shielding gas if required, joint configurations, number and size of passes, preheat and inter-pass temperatures if required, sequence of passes, current, rate of pass, electrode size, electrical stick-out and polarity.

.3 Methods proposed for edge preparation.

.4 Measures proposed to control distortion, shrinkage and residual stresses.

.5 Proposed methods and sequence of assembly.

.6 Welding equipment to be used.

.7 Copies of welding certificates confirming that the individuals are currently certified by the CWB in the processes in which they are to be employed.

.7 Equipment:

.1 Submit prior to pile installation for review and approval by the Engineer, list and details of equipment for use in installation of piles - such as vibratory and hammers. Submit to the Engineer for review a minimum of 4 weeks prior to mobilization of equipment. Include a completed Hammer Form Appendix A.

.2 Impact hammers: submit manufacturer's written data as specified (include name, type, rated energy per blow at normal working rate, mass of striking parts of hammer, mass of driving cap and type and elastic properties of hammer and pile cushions).

.3 Non-impact methods; submit characteristics to evaluate performance.

.4 Pile installation equipment shall be capable of installing the pile to the anticipated pile tip elevations and to a resistance of at least 2.5 times the maximum factored load as shown on the Drawings. Pile tip not to extend below Elevation -10 m without input from the Geotechnical Engineer.

.8 Submittals for the concrete infill in accordance with Section 03 30 00 - Cast-in-place Concrete.

.9 Quality assurance submittals:

  .1 Test reports: submit certified test reports for piles from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.

  .2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

  .3 Detailed survey of all pile locations prior to prior to cutting off any piles.

  .4 Detailed survey of the final pile cut-off elevations prior to final acceptance of the piles.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in a manner that avoids damage to the piling materials in accordance with manufacturer’s instructions.

.2 Loading and unloading of the crane shall be by crane, loader or other appropriate hoisting equipment.

.3 In the handling and lifting of the piles, do not drag them along the ground.

.4 Piles shall be stock-piled off the ground on timber blocking and handled in a manner to avoid any damage.

.5 Protect piles from damage due to excessive bending stresses, impact, abrasion or other causes during delivery, storage and handling.

.6 Replace damaged piles as directed by the Engineer. If piles are damaged due to the Contractor’s handling operations, replace all damaged piles with piles meeting the requirements of this Specification at the expense of the Contractor.

.7 Separate waste materials for reuse and recycling and divert unused metal materials from landfill to metal recycling facility.

1.5 EXISTING CONDITIONS

.1 Information regarding sub-surface conditions is available in WSP Geotechnical Design Summary Report for the Piled Pump Platform dated 21 August 2019 for reference purposes only and independent interpretation by the Contractor.

.2 The information provided in the geotechnical reports shall not be considered as indicative of the construction methods and procedures appropriate for the work indicated in the drawings and specifications. The subsurface information provided in the geotechnical reports is intended to provide general representation of the materials which may be encountered.

.3 The project area is located within an active construction site. Contractor to perform construction activities concurrently with City and other General Contractor's activities in accordance with Section 01 11 60 – Work Sequence and Tie-ins.

.4 The Contractor shall review all information pertinent to the work, visit the site and carry out all necessary examinations and shall make independent interpretations of all available information regarding the requirements, limitations, and constraints of the Work and the conditions under which the Work will be performed.

.5 The Contractor shall promptly notify the Engineer of any ambiguity, inconsistency, or error in the Contract documents that may be discovered.

Part 2 Products

2.1 MATERIALS

.1 Steel pipes piles shall conform to the requirements of ASTM Specification A252, Grade3. Previously used or coated pipe will not be accepted. The boron content of steel piling shall not exceed 0.0008%. Pipes fabricated to ASTM A252 are subject to the following additional requirements:

  .1 Piles with seams shall be fabricated with full penetration butt welds.

  .2 Chemical analysis of the material shall show an equivalent carbon content of less 0.43%, and a total carbon content of less than 0.3%.

  .3 The full length of external welds and reasonable accessible internal welds shall be visually inspected by the Contractor in accordance with CSA W59. Alignment deviations shall be less than 3mm.

  .4 Welds shall be ultrasonically tested by an independent testing firm in accordance with W59.

  .5 Manufacturer's identification marks on the pile shall be readily identifiable on Site and shall match the heat numbers on the mill certificates provided.

  .6 Sections of piling shorter than three (3) meters shall not be used except to finish a pile to final cut off elevation.

.2 Supply or fabricate full length piles as indicated and provide equipment to handle full length piles with minimal cutting and splicing.

.3 Pile tips shall conform to the requirements of CSA G40.21M, Grade 300W. Pile tips shall be subject to approval by the Engineer and the Geotechnical Engineer. External driving shoes are not permitted.

.4 Splice piles only with written approval of the Engineer.

  .1 When permitted, provide details for the Engineer for review.

  .2 Design details of splice to bear dated signature stamp of professional engineer registered or licensed in the Province of British Columbia, Canada.

  .3 Splice backer materials shall conform to the requirements of CSA G40.21M, Grade 300W.

  .4 All welding materials conform to the requirements of Section 05 12 23 - Structural Steel for Buildings and Section 05 50 00 – Metal Fabrications.

.5 Concrete infill shall conform to Section 03 30 00 - Cast-in-place Concrete.

2.2 EQUIPMENT

.1 It is the Contractor’s responsibility to fully assess the appropriate pile installation method. Employ whatever methods that are necessary to ensure proper installation of pile foundations to the Engineer’s satisfaction. The Contractor is responsible for installing all piles to the minimum penetration below mudline and elevations as specified on the Drawings.

.2 All pile driving equipment shall be in good mechanical condition and shall be capable of delivering the manufacturer's rated energy output and shall be operated in accordance with the manufacturer's instructions.

Part 3 Execution

3.1 PREPARATION

.1 Protection:

  .1 Protect adjacent structures, services and work of other sections from hazards due to pile driving operations.

  .2 Arrange sequencing of pile driving operations and methods to avoid damages to adjacent existing structures and limit impacts to adjacent on-going construction activity.

  .3 When damages occur, remedy damaged items to restore to original or better condition at own expense.

.2 Ensure that ground conditions at pile locations are adequate to support pile driving operation and load testing operation.

  .1 Make provision for access and support of piling equipment during performance of Work.

3.2 INSTALLATION

.1 Mark the exterior of the pile with paint markings at 0.25 m intervals, with a label at each 1.0 m interval, starting from the toe of the pile for pile installation monitoring purposes. Alternatively, markings at 1 foot intervals with labels at 5 foot intervals would be acceptable.

.2 Use driving caps, cushions and/or reinforcement to protect pile head.

.3 Hold piles securely and accurately in position while driving. Pile driver leads (if used) shall be constructed in a manner which affords freedom of movement of the hammer and they shall be held in position by guys, stiff braces or by attaching to cranes or derricks so as to ensure proper support for the pile during driving.

.4 Deliver hammer blows along axis of pile.

.5 Driving of all piles shall be continuous and without interruption until the pile has been driven to the design tip elevation. Approval from the Geotechnical Engineer is required prior to advancement deeper than -10 m elevation. If installation is interrupted before final penetration is reached, do not take the record for final penetration until at least 0.3 m of penetration has been obtained after resumption of installation.

.6 Take adequate precautions to minimize upheaval of the piles and shall monitor adjacent piles for potential upheaval. If upheaval does occur, re-drive the lifted piles to the specified elevations and set.

.7 Water jetting of piles is not acceptable.

.8 Pre-boring will not be allowed unless approved in writing by the Engineer.

.9 Pile may be installed to within 3 m of design tip elevation (i.e. near to the top of the sand deposit) with vibratory method followed by impact driving for at minimum the final 3 m of installation.

.10 Cut off piles neatly and squarely at elevations as indicated to tolerance of plus or minus 25 mm.

  .1 Provide sufficient length above cut-off elevation so that part damaged during driving is cut off.

  .2 Do not cut tendons or other reinforcement, which will be used to tie pile caps to pile.

.11 Remove cut-off lengths from site on completion of work.

.12 All steel pipe piles shall be temporarily capped after installation for safety reasons.

3.3 PILE ACCEPTANCE CRITERIA AND DRIVING TOLERANCES

.1 Piles shall be driven in the positions shown on the Drawings. Maximum horizontal tolerance to be within 25mm at the cut-off location.

.2 Piles shall be driven vertically and shall not deviate more than 2 percent out of plumb.

.3 Take adequate precautions to ensure that piles are in proper alignment. The method of maintaining alignment shall be accepted by the Engineer.

.4 Piles shall not be jacked or pulled into their final positions.

.5 Pile tip not to extend below Elevation -10 m without input from the Geotechnical Engineer.

.6 Installation of each pile will be subject to approval of the Engineer.

  .1 The Engineer will be sole judge of acceptability of each pile with respect to final driving resistance, depth of penetration or other criteria used to determine load capacity.

  .2 The Engineer to approve final driving of all piles prior to removal of pile driving rig from site.

.7 It shall be the Contractor's responsibility to undertake all quality control testing necessary to ensure that the Work is performed in accordance with the Contract Documents.

.8 The Owner may develop quality assurance reports during pile installation, including but not be limited to detailed and accurate pile and casing installation logs and survey data in accordance with standard practice. Quality Assurance work does not relieve the

Contractor from the responsibility for proper installation and maintenance of records for all piles.

3.4 OBSTRUCTIONS

.1 Remove all shallow depth (i.e. less than 2 m depth) and surface obstructions around the vicinity of the pile location prior to commencement of pile driving.

.2 Where obstruction is encountered that causes sudden unexpected change in penetration resistance or deviation from specified tolerances, submit written notification to the Engineer before proceeding further.

3.5 REPAIR AND RESTORATION

.1 All piles crushed excessively or bent through during driving operations shall be replaced at the expense of the Contractor.

.2 Unless directed by the Engineer, leave rejected pile in place and cut off the pile at a cut-off elevation as directed by the Engineer.

.3 Piles damaged by improper driving, or driven out of proper location, or driven below the cut-off elevation shall be corrected by one of the following methods accepted by the Engineer prior to implementation of the corrective measures:

  .1 The piles shall be withdrawn and replaced by new piles, or

  .2 Replacement piles shall be driven adjacent to defective or low piles, or

.4 No extra compensation will be made for removing and replacing or other work made necessary through rejection of defective piles.

3.6 SPLICING AND PILE TIP MODIFICATION

.1 Piling shall be spliced if authorized in writing by the Engineer. Piling shall be aligned so that the finished piles are straight from end to end.

.2 Pile tips shall be subject to approval by the Engineer and the Geotechnical Engineer.

.3 All welding shall conform in quality and workmanship to the latest CSA W59. The weld area shall be dry and wind free during welding and shall cool without chilling following welding.

.4 Welding shall be undertaken by a company approved by the Canadian Welding Bureau (CWB) to the requirements of CSA W47.1, Division 2 or better.

.5 Prior to commencement of welding, the Contractor shall submit welding procedures and data sheets, approved by the CWB, for the type of weld being performed and copies of welding certificates for all welders confirming that the individuals are currently certified by the CWB in the processes in which they are to be employed.

3.7 CONCRETE INFILL

.1 Mixing and placing concrete infill shall be done in accordance with Section 03 30 00 - Cast-in-place Concrete.

.2 Concrete shall not have a free fall of more than 1.5 m and shall be placed so that that the aggregates do not separate or segregate.

.3 Concrete shall be placed to the elevations as shown on the drawings. Laitance on top of the pile shall be removed before placing the pile cap. The concrete shall be vibrated through-out the length of the pile.

.4 The shaft shall be free of water prior to placing of concrete. Concrete shall not be placed in or through water unless authorized by the Engineer.

3.8 FIELD QUALITY CONTROL

.1 Measurement:

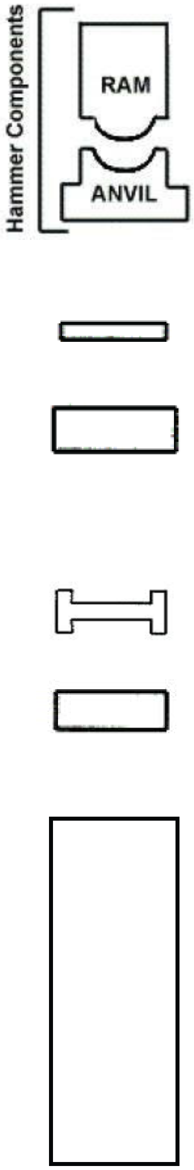
- .1 Maintain accurate records of driving for each pile, including:
  - .1 Date and time.
  - .2 Type and make of hammer, stroke or rated energy.
  - .3 Other driving equipment including vibro-hammer, driving cap, cushion, etc.
  - .4 Pile size, length and location.
  - .5 Number of blows per metre for entire length of pile and final set achieved.
  - .6 Final tip and cut-off elevations.
  - .7 Other pertinent information such as interruption of continuous driving, pile damage, etc.
  - .8 Elevation taken on adjacent piles before and after driving of each pile.
  - .9 Actual and rated energy output of driving equipment at the time of final set, along with final penetration readings. The required set per blow will be subject to acceptance by the Engineer, showing regard of the actual and rated energies for the hammer at refusal.
- .2 Provide Engineer with copies of records.

3.9 CLEANING

.1 Proceed in accordance with Section 01 74 23 – Final Cleaning.

.2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

3.10 HAMMER FORM



Structure No. ______________________________

Pile Driving Contractor or Subcontractor: ______________________________

Hammer

Manufacturer:__________Model No.:___________ Hammer

Type: Serial No.:___________________________

Manufacturer's Maximum Rated Energy:_____________(Joules) Stroke at Maximum

Rated Energy:________________________________(meters) Range in Operating

Energy:__________________________________to__(Joules) Range in Operating

Stroke:______________________________to___(meters) Ram Weight:_____(kg)

Modifications: ____________________________

Striker Plate

Weight:_______________(N) Diameter:_____________(mm) Thickness:__________(mm)

Hammer Cushion

Material #1	Material #2 (for Composite Cushion)
Name:____________________	Name: ______________________________
Hammer Area:_________(mm2)	Area:_________________________(mm2)
Cushion Thickness/Plate:____(mm)	Thickness/Plate:__________________(mm)
No. of Plates:_______________	No. of Plates: ________________________

Total Thickness of Hammer Cushion: _________

Helmet (Drive Head)

Weight:_______________(kN)

Pile Cushion

Material:______________________________

Area:_______________(mm2) Thickness/Sheet:_________(mm) No. of Sheets:_____

Total Thickness of Pile Cushion:____(mm)

Pile

Pile Type: _______________

Wall Thickness:_________(mm) Diameter : ______________________________________

Cross Sectional Area: (mm2) Weight/Meter: ___________________________________

Driven Length:_________ (m)

Design Load:_____________(kN) Ultimate Pile Capacity:________________(kN)

Driving Shoe, End Detail or Closure Plate Description: ______________________________

Submitted By:_________________Date:_______________________________________

Telephone No.:_________________Email.: ____________________________________

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 American National Standards Institute/American Water Works Association (ANSI/AWWA), latest edition,
    - .1 AWWA C104/A21.4-08, Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
    - .2 AWWA C105/A21.5- Polyethylene Encasement for Ductile-Iron Pipe Systems.
    - .3 ANSI/AWWA C111/A21.11, Rubber Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
    - .4 AWWA C151/A21.51, Ductile-Iron Pipe, Centrifugally Cast.
    - .5 AWWA C153/A21.53, Ductile Iron Compact Fittings
    - .6 ANSI/AWWA C207, Steel Pipe Flanges for Waterworks Service, Sizes 4 Inch Through 144 Inch (100 mm Through 3,600 mm).
    - .7 AWWA C900, Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 60 In. (100 mm Through 1,500 mm).
    - .8 ANSI/AWWA C906, Polyethylene (PE) Pressure Pipe and Fittings, 4 In. Through 65 In. (100 mm Through 1,650 mm), for Waterworks.
- .2 ASTM International
    - .1 ASTM F714, Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter
    - .2 ASTM D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
    - .3 ASTM D3035, Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR). Based on Controlled Outside Diameter.
- .3 Canadian General Standards Board (CGSB)
    - .1 CGSB 41-GP-25M, Pipe, Polyethylene, for the Transport of Liquids.
- .4 CSA International
    - .1 CSA B137 Series, Thermoplastic Pressure Piping Compendium.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittals.
- .2 Product Data:
    - .1 Submit manufacturer's instructions, printed product literature and data sheets for pipes, fittings, and appurtenances, include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:

  - .1 Submit drawings of connections per Contract Drawings stamped and signed by professional engineer registered or licensed in British Columbia, Canada.
  - .2 Submit shop drawings showing proposed method of installation for sewage force main (treated effluent).
- .4 Certification to be marked on pipe.
- .5 Test and Evaluation Reports: submit manufacturer's test data and certification at least 2 weeks prior to beginning Work.
- .6 Manufacturer's Instructions: submit to Engineer copy of manufacturer's installation instructions.
- .7 Provide marked up field record drawings and sketches as necessary for the Engineer to produce accurate, complete office record drawings.
- .8 Provide detailed operating and maintenance instructions for all equipment installed.
- .9 Provide detailed lists of any special or proprietary tools or equipment which are required to assemble, disassemble, operate or maintain any device installed on this project.
- .10 Where requested by Engineer, provide certified test results for materials to be employed.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials in accordance with manufacturer's recommendations.
  - .2 Store and protect pipes, fittings, appurtenances, and hardware from damage.
  - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 MATERIALS

- .1 Polyethylene pressure pipes to AWWA C906, CSA B137.1., PE 4710
  - .1 Pipe Pressure Class and Dimension ratio as identified on Contract Drawings.
  - .2 Joints: Unless otherwise specified, pipe lengths shall be assembled by thermal butt fusion to ASTM F2620 and in accordance with manufacturer’s recommendations.
  - .3 Fittings:
    - .1 Polyethylene fittings for use with the pipe shall be heat fusion fittings made of the same material of the pipe and be completely fibreglass reinforced as required to achieve at least the same pressure rating as the pipe to which it is to be joined.

        .2 Flanged fittings shall comprise of a stub end, butt fused to the pipe end, together with a slip-on flange which shall comply with ANSI B16.5 Class 150 bolt circles for the pipe size and shall be manufactured from ductile iron and epoxy coated. Ductile iron backup flange to Class 250. The securing bolts, nuts and washers shall be made of 316 stainless steel and be of a size and length to suit the flanges.
        .3 Butt-fused fittings shall be used except where electro-fusion or flanged fittings are identified on drawings.
        .4 Fabricated fittings to AWWA C906 suitable for pipe pressure rating.
        .5 Moulded fittings to ASTM 3261 suitable for pipe pressure rating.
    .4 UV Stabilization
        .1 The raw material shall contain a minimum of 2%, well dispersed, carbon black, to ASTM D3350 and ASTM D3035, and any additional requirements or additives recommended by the manufacturer to provide UV stabilization for continuous above ground and outdoor use. Additives that can be conclusively proven not to be detrimental to the pipe may also be used, provided the pipe produced meets the requirements of this standard.
        .2 Contractor to submit documentation from manufacturer detailing proposed pipe material and manufacturer’s signed letter of support certifying raw material resin design life of at least 50 years for continuous UV exposure during above ground and outdoor use.

.2 Ductile-iron pipe to AWWA C151
    .1 Pressure Class or Special Thickness Class to be equal to or greater than HDPE DR26.
    .2 Standard double cement mortar lined (interior) and petroleum asphaltic coated (exterior) to AWWA C104/A21.4-08.
    .3 Double polyethylene encasement to AWWA C105/A21.5-10.
    .4 Joints: TR Flex joint restraint with Rubber Gasket Joints to AWWA C111.
    .5 Ductile iron fittings to AWWA C153.

.3 Polyvinyl Chloride (PVC) to AWWA C900. All pipes to be certified by Canadian Standards Association – CSA B137.3.
    .1 Pressure rating of all pipes to be equal to or greater than HDPE DR26.
    .2 Outside diameter to be Cast iron pipe size or Iron Pipe size.
    .3 To be compatible with specified mechanical joint and push-on joint fittings; transition gaskets can be to ASTM F477.
    .4 Joints: Fully restrained, push-on integrally thickened bell and spigot type to ASTM D3139 with single elastomeric gasket to ASTM F477.

.4 The pipe shall contain no recycled compound except that generated in the manufacturer’s own plant from resin of the same specification and from the same raw material supplier.

.5 Compliance with the requirements shall be certified in writing by the pipe supplier, upon request.

2.2 NUTS AND BOLTS

.1 Stainless steel bolts and nuts on direct buried or submerged applications conforming to ASTM A193 Grade B8M or 316L.

2.3 CORROSION PROTECTION

.1 All nuts, bolts, transition couplings, restrainers and metal fittings to be coated with Denso Mastic and Denso Tape. Provide isolators when connecting dissimilar metals.

.2 Other corrosion protection method to be approved by the Engineer.

2.4 BEDDING

.1 Compacted fill as indicated on the Contract Drawings.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify conditions of substrate previously installed under other Sections or Contracts are acceptable for pipe installation in accordance with manufacturer's written instructions.

  .1 Visually inspect substrate in presence of Site Inspector.

  .2 Inform Engineer of unacceptable conditions immediately upon discovery.

  .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Site Inspector.

3.2 PREPARATION

.1 Pipes and fittings to be clean and dry.

.2 Prior to installation, obtain Engineer’s approval of pipes and fittings.

3.3 INSTALLATION

.1 Lay pipes in accordance with manufacturer's recommendations.

.2 Join pipes in accordance with manufacturer's recommendations.

.3 Installation to replicate long term project thermal conditions to limit post installation expansion/contraction. Refer to drawings for details.

.4 Avoid damage to machined ends of pipes in handling and moving pipe.

.5 Lay pipes on prepared bed, true to line and grade. Ensure barrel of each pipe is in contact with shaped bed throughout its full length. Take up and replace defective pipe. Correct pipe which is not in true alignment or grade or pipe which shows differential settlement after installation greater than 10 mm in 3 m.

.6 Do not exceed permissible deflection at joints as recommended by pipe manufacturer.

.7 Keep jointing materials and installed pipe free of dirt and water and other foreign materials. Whenever work is stopped, install a removable watertight bulkhead at open end of last pipe laid to prevent entry of foreign materials.

.8 Cut pipes in an approved manner as recommended by pipe manufacturer, without damaging pipe or its coating and to leave smooth end at right angles to axis of pipe.

.9 Align pipes carefully before jointing.

.10 Do not lay pipe on frozen bedding.

.11 Remove any pipe which has floated due to trench flooding and reinstall only after acceptable trench and bedding conditions have been re-established.

.12 Tie-in to existing connection indicated on the Contract Drawings.

.13 Protect pipe and fittings from excessive exposure to direct sunlight or other damage. Replace any pipe or fittings which have become discoloured, cracked or otherwise marred or damaged.

.14 Ensure proper operation of all fittings and appurtenances having moving parts both prior to and after installation.

.15 Coat direct buried metallic objects with a Denso paste and tape, or as approved.

.16 Tolerances:

  .1 Horizontal tolerance: +/- 50 mm from specified alignment.
  .2 Vertical tolerance: +/- 25 mm from specified grade.

3.4 COUPLINGS

.1 Provide Engineer with proposed assembly of couplings and connections for review prior to the installation.

.2 Coupling pressure capacity to pipe dimension ratio or greater.

.3 Install coupling and insert to manufacturer’s instructions.

3.5 CONCRETE BALLAST

.1 To be installed in accordance with Section 03 41 00 – Precast Structural Concrete and as shown on Contract Drawings.

.2 All concrete weights to be sequentially marked with a permanent numbering system from start of the on-land connection towards the terminus to permit subsequent inspections to be coordinated with the weight numbers and their discrete locations.

3.6 BEDDING

.1 Place compacted fill as indicated on Contract Drawings.

3.7 FIELD TESTING OF FORCEMAIN

.1 General

.1 The initial fill of water for pressure testing will be supplied by the Owner at no cost to the Contractor. However, any subsequent refills of the line required by failure to meet the requirements of the tests will be charged to the Contractor at standard water rates.

.2 Notify the Site Inspector a minimum of 48 hours in advance of all proposed tests. Perform tests in the presence of the Site Inspector.

.3 When testing is done during freezing weather, protect hydrants, valves, joints and fittings from freezing.

.4 Control rate of filling of pipes to a velocity of less than 0.45 m/sec (1.5 ft/sec).

.5 Ensure that all air is purged from the force main before performing leakage or pressure testing the system.

.6 Where new force main sections cannot be isolated from existing mains, the Contractor may apply to the Site Inspector to establish an alternate test pressure or have the leakage testing requirement waived. Warranty obligations of the Contractor remain fully in effect in either event.

.2 Pressure Testing

.1 Do test in accordance with one of the following procedures:

.1 HDPE pipe: Pressure test all pipes, couplings, joints and other appurtenances under a hydrostatic pressure in compliance with AWWA M55 and ASTM F2164 latest edition. No leakage allowed.

.2 Ductile-iron pipe: Perform pressure and leakage test to AWWA C600.

.3 PVC pipe: Perform pressure and leakage testing to AWWA C605 and M23.

.2 Should any test disclose excessive leakage, repair or replace defect and retest section at the Contractor’s own expense until specified testing requirement is achieved.

3.8 CLEANING

.1 Progress Cleaning:

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 GENERAL

.1 This section of the specifications refers to the installation of equipment, piping, fittings, valves and all piping specialties and supporting devices provided under this contract. Also included are the equipment, valve and commodity identification legends for all piping systems to be installed within the building.

1.2 REFERENCE STANDARDS

.1 Conform to the following reference standards:

- .1 ANSI A13.1, Scheme for the Identification of Piping Systems
- .2 ANSI B1.20.1, Pipe Threads, General Purpose
- .3 ANSI B16.1, Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800
- .4 ANSI B16.3, Malleable Iron Threaded Fittings Class 150 and 300
- .5 ANSI B16.5, Pipe Flanges and Flanged Fittings
- .6 ANSI B16.9, Factory-Made Wrought Steel Butt Welding Fittings
- .7 ANSI B16.11, Forged Steel Fittings, Socket Welding and Threaded
- .8 ANSI B16.12, Cast Iron Threaded Drainage Fittings
- .9 ANSI B16.15, Pipe Flanges and Flanged Fittings, Classes 150 and 300
- .10 ANSI B16.18, Cast Copper Alloy Solder Joint Pressure Fittings
- .11 ANSI B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
- .12 ANSI B16.26, Cast Copper Alloy Fittings for Flared Copper Tubes
- .13 ANSI B31.1, Power Piping
- .14 ANSI B31.3, Chemical Plant and Petroleum Refinery Piping
- .15 ANSI B31.9, Building Services Piping
- .16 ANSI B32, Solder Metal
- .17 ANSI B36.10M, Welded and Seamless Wrought Steel Pipe
- .18 ANSI B36.19M, Stainless Steel Pipe
- .19 ASME Section IX, Boiler and Pressure Vessel Code; Welding and Brazing Requirements
- .20 ASTM A47, Malleable Iron Castings
- .21 ASTM A53, Pipe, Steel, Black and Hot Dipped, Zinc Coated Welded and Seamless
- .22 ASTM A74, Cast Iron Soil Pipe and Fittings
- .23 ASTM A105/A105M, Forgings, Carbon Steel, for Piping Components
- .24 ASTM A106, Seamless Carbon Steel Pipe for High Temperature Service
- .25 ASTM A126, Grey-Iron Castings for Valves, Flanges, and Pipe Fittings
- .26 ASTM A135, Electric-Resistance-Welded Steel Pipe

.27 ASTM A139, Electric-Fusion (ARC)-Welded Steel Pipe (NPS 4 and Over)

.28 ASTM A167, Stainless Steel and Heat-Resisting Chromium-Nickel Steel Plate

.29 ASTM A181/181M, Forgings, Carbon Steel, for General Purpose Piping

.30 ASTM A182/182M, Forged or Alloy Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service

.31 ASTM A193/193M, Alloy Steel and Stainless Steel Bolting Materials for High Temperature Service

.32 ASTM A194/194M, Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service

.33 ASTM A197, Cupola Malleable Iron

.34 ASTM A234/A234M, Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures

.35 ASTM A240, Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels

.36 ASTM A269, Seamless and Welded Austenitic Stainless Steel Tubing for General Service

.37 ASTM A276, Stainless and Heat-Resisting Steel Bars and Shapes

.38 ASTM A307, Carbon Steel Bolts and Studs, 60 000 psi Tensile Strength

.39 ASTM A312/312M, Seamless and Welded Austenitic Stainless Steel Pipe

.40 ASTM A320/320M, Alloy Steel Bolting Materials for Low-Temperature Service

.41 ASTM A403/A403M, Wrought Austenitic Stainless Steel Piping Fittings

.42 ASTM A409/A409M, Welded Large Diameter Austenitic Steel Pipe for Corrosive or High Temperature Service

.43 ASTM A480/A480M, General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip

.44 ASTM A536, Ductile Iron Castings

.45 ASTM A563, Carbon and Alloy Steel Nuts

.46 ASTM A570/A570M, Hot-Rolled Carbon Steel Sheet and Strip, Structural Quality

.47 ASTM A774/A774M, As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures

.48 ASTM A778, Welded, Unannealed Austenitic Stainless Steel Tubular Products

.49 ASTM B88, Seamless Copper Water Tube

.50 ASTM C76, Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe

.51 ASTM C564, Rubber Gaskets for Cast Iron Soil Pipe and Fittings

.52 ASTM D638, Test Method for Tensile Properties of Plastics

.53 ASTM D792, Test Method for Specific Gravity and Density of Plastics by Displacement

.54 ASTM D1248, Polyethylene Plastics Moulding and Extrusion Materials

.55 ASTM D1457, PTFE Moulding and Extrusion Materials

.56 ASTM D1784, Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds

.57 ASTM D1785, Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120

.58 ASTM D2241, Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR)

.59 ASTM D2466, Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40

.60 ASTM D2467, Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80

.61 ASTM D2513, Thermoplastic Gas Pressure Pipe, Tubing, and Fittings

.62 ASTM D2564, Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings

.63 ASTM D2665, Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings

.64 ASTM D2996, Filament-Wound Reinforced Thermosetting Resin Pipe

.65 ASTM D3212, Joints for Drain and Sewer Plastic Pipes using Flexible Elastomeric Seals

.66 ASTM D3261, Butt Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Fittings

.67 ASTM D4101, Propylene Plastic Injection and Extrusion Materials

.68 ASTM D4174, Cleaning, Flushing, and Purification of Petroleum Fluid Hydraulic Systems

.69 ASTM F441, Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80

.70 ASTM F894, Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe

.71 AWWA C105, Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids

.72 AWWA C110, Ductile-Iron and Grey-Iron Fittings, 3 Inch Through 48 Inch, for Water and Other Liquids

.73 AWWA C111, Rubber-Gasket Joints for Ductile-Iron and Grey-Iron Pipe and Fittings

.74 AWWA C115, Flanged Ductile-Iron and Grey-Iron Pipe with Threaded Flanges

.75 AWWA C151, Ductile-Iron Pipe, Centrifugally Cast in Metal Moulds or Sand-Lined Moulds, for Water and Other Liquids

.76 AWWA C200, Steel Water Pipe, 6 Inches and Larger

.77 AWWA C203, Coal Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot Applied

.78 AWWA C205, Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 Inches through 144 Inches

.79 AWWA C206, Field Welding of Steel Water Pipe

.80 AWWA C207, Steel Pipe Flanges for Waterworks Services - Sizes 4 Inch Through 144 Inch

.81 AWWA C208, Dimensions for Fabricated Steel Water Pipe Fittings

.82 AWWA C209, Cold-Applied Tape Coating for Special Sections, Connections, and Fittings for Steel Water Pipelines

.83 AWWA C210, Coal-Tar Epoxy Coating System for the Interior and Exterior of Steel Water Pipe

.84 AWWA C214, Tape Coating Systems for the Exterior of Steel Water Pipelines

.85 AWWA C301, Prestressed Concrete Pressure Pipe, Steel Cylinder Type, for Water and Other Liquids

.86 AWWA C303, Reinforced Concrete Pressure Pipe - Steel Cylinder Type, Pretensioned, for Water and Other Liquids

.87 AWWA C600, Installation of Ductile-Iron Water Mains and their Appurtenances

.88 AWWA C606, Grooved and Shouldered Joints

.89 AWWA C651, Disinfecting Water Mains

.90 AWWA C900, Polyvinyl Chloride (PVC) Pressure Pipe, 4 Inches through 12 Inches, for Water

.91 AWWA M11, Steel Pipe - A Guide for Design and Installation

.92 CGA, Canadian Gas Association Standards

.93 CAN/CGA B105 - Installation Code for Digester Gas Systems

.94 CISPI 301, Specification Data for Hubless Cast Iron Sanitary System with No-Hub Pipe and Fittings

.95 CPC, Canadian Plumbing Code

.96 CSA B52, Mechanical Refrigeration Code

.97 CSA B64 Series CSA Standards on Vacuum Breakers and Backflow Preventers

.98 CAN3-B70 Cast Iron Soil Pipe, Fittings, and Means of Joining

.99 CSA B137.3, Rigid PVC Pipe for Pressure Applications

.100 CSA B139 Installation Code for Oil Burning Equipment

.101 CSA B140.0 General Requirements for Oil Burning Equipment

.102 CSA B158.1 Cast Brass Solder Joint Drainage, Waste and Vent Fittings

.103 CAN3-B181.2 PVC Drain, Waste and Vent Pipe and Pipe Fittings

.104 CSA CAN3-Z299.3, Quality Verification Program Requirements

.105 CSA CAN-Z183, Oil Pipeline Systems

.106 CSA Z184 Gas Pipeline Systems

.107 CSA B242 Groove and Shoulder Type Mechanical Pipe Couplings

.108 EJMA STDS, Standards of Expansion Joint Manufacturers' Association, Edition No. 6

.109 Fluid Sealing Association Technical Handbook, Rubber Expansion Joint Division

.110 FEDSPEC, L-C-530B (1), Coating, Pipe, Thermoplastic Resin or Thermosetting Epoxy

.111 MIL-H-13528B, Hydrochloric Acid, Inhibited, Rust Removing

.112 MIL-S-8660C, Silicone Compound

.113 MIL-STD-810C, Environmental Test Methods

.114 MSS SP25, Standard Marking System for Valves, Fittings, Flanges and Unions

.115 MSS SP43, Wrought Stainless Steel Butt Welding Fittings

    - .116 SAE J1227, Assessing Cleanliness of Hydraulic Fluid Power Components and Systems
    - .117 SSPC-P3, Canadian Government Standards Board
    - .118 SSPC-SP6, Canadian Government Standards Board
    - .119 SSPC-SP10, Canadian Government Standards Board
    - .120 Plumbing and Drainage Regulations of the Province of British Columbia
    - .121 Gas Protection Branch Regulations of the Province of British Columbia
    - .122 Pressure Vessels Act of the Province of British Columbia
- .2 The American Society of Mechanical Engineers. (ASME)
    - .1 ASME Boiler and Pressure Vessel Code, Part I - Power Boilers
    - .2 ASME Boiler and Pressure Vessel Code, Part IV - Heating Boilers
    - .3 ASME Boiler and Pressure Vessel Code, Part VIII - Pressure Vessels
    - .4 ASME Boiler and Pressure Vessel Code, Part IX - Welding and Brazing Qualifications
- .3 The American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
- .4 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA)
- .5 Department of Environment of the Province of British Columbia
- .6 Air-Conditioning and Refrigeration Institute (ARI)
- .7 National Fire Protection Association (NFPA)
- .8 Air Movement and Control Association (AMCA)
- .9 Canadian Gas Association
    - .1 CAN/CGA B149.1 Natural Gas Installation Code
    - .2 CAN/CGA-B149.2 Propane Installation Code

1.3 OPERATING AND MAINTENANCE DATA

- .1 Provide as specified in Section 01 78 23 – Operating and Maintenance Data.

1.4 SUBMITTALS FOR REVIEW

- .1 Provide as specified in Division 1.
- .2 Submit document listing pipe, fittings, flexible connectors, linings, coatings, and valving to be used for each pipe system.
- .3 Radiographic Weld Testing: Submit the name and qualifications of at least two independent firms for the radiographic weld testing to be undertaken by the Contractor. The selected firm will be subject to the review and acceptance of the Engineer.

.4 Manufacturer's affidavit of compliance with specified AWWA standards for valves, pipe, fittings, linings, and coatings.

.5 Design, select, locate and provide piping supports, pipe guides, seismic bracing, expansion joints and anchors required for final piping layout. Typical details and acceptable attachments shown on the drawings are provided only for general guidance.

1.5 SUBMITTALS FOR INFORMATION ONLY

.1 For all pipe greater than or equal to 50 mm diameter, submit isometric drawings, to indicate the assembly details, the welds, flanges, valve placement, cathodic protection, seismic restraint system, expansion joints, guides, anchors, hangers, supports, and the provisions for thrust restraint, as well as any other pertinent details.

.2 Submit piping layout drawings by plant area which indicate location and placement of valves, fittings and other appurtenances for all piping, greater or equal to 150 mm diameter, in that area. Indicate location and clearances from structures and other utilities (ductwork, conduit, electrical tray, etc.).

.3 Submit copies of all original submittals and all related correspondence made as part of the regulatory submissions required by regulatory authorities.

.4 Product Samples: Where specified or when directed by the Engineer, provide mill test results or product samples.

.5 Provide hanger, expansion joint, guide, anchor, support and seismic restraint system design details including locations, load information, design calculations and illustrative drawings, stamped and signed by a Professional Engineer registered in the Province of British Columbia.

.6 For expansion joints submit manufacturer's catalogue data, shop drawings and assembly drawings confirming general arrangement, dimensions, and tolerances, materials of construction, weights and installation details. Submit calculations to substantiate expansion joint selection and amount of pre-compression, stamped and signed by a professional Engineer registered in the Province of British Columbia.

.7 Radiographic weld test results.

.8 Submit current and complete documentation of the welder's qualifications prior to the commencement of welding.

1.6 PIPE MATERIALS - GENERAL

.1 All pipe materials to be new, free from defects and conforming to applicable reference standards.

.2 All materials, linings and coatings in contact with water to be NSF approved for potable water.

.3 Where any standard referenced has been superseded prior to bidding, the Contractor shall comply with the current standard.

1.7 JOINTS - GENERAL

.1 Connect piping using joints not readily disassembled only where shown and where not otherwise specified. Provide joints which may be disassembled at the minimum, within 1.0 m of any connection to equipment, on both sides of structural penetrations, within 0.6 m of all threaded end valves, and at the spacing specified in the detailed piping specification sheets.

.2 For carbon steel piping less than 75 mm in diameter, butt-weld or use threaded couplings. Use unions where disassembly is required.

.3 For steel piping equal to or greater than 75 mm in diameter, where not specified or shown otherwise, butt-weld according to ASME Boiler and Pressure Vessel Code or furnish slip-on flanges, conforming to ANSI B16.5, Class 150. Unless indicated otherwise on the drawings or detail specifications, where disassembly is required, use flanges.

Part 2 Products

2.1 FLANGES

.1 General requirements for flanges are as follows:

  .1 Compatible flanges for mating to equipment or valves.
  .2 For steel piping, provide weld neck flanges on both sides of wafer or lug body valves.

.2 Do not use slip-on flanges that are attached to a pipe by means of set screws and gaskets.

2.2 THREADED COUPLINGS

.1 Make screwed joints using American Standard threads to ANSI B1.20.1.

.2 Use Teflon tape as thread lubricant for threaded joints.

.3 Provide threaded-end to flanged-end adaptors where required to connect to flanges.

2.3 GROOVED JOINT COUPLINGS

.1 Where grooved joint piping systems connect to equipment or to flanged valves, meters, or other sensing devices; use grooved joint flanges or flange adapters. Acceptable products are: Tyler Groove to Flange Fittings or Victaulic Flange adaptors. Where the Contractor chooses to use grooved joint flanges rather than the indicated adapters, piping modifications required to suit this change are the responsibility of the Contractor. Make full allowance for piping disassembly and access to the face of equipment.

2.4 FLEXIBLE COUPLINGS

.1 Flexible Couplings - Type I:

  .1 Flexible sleeve type couplings: cylindrical centre ring, two follower rings, two resilient gaskets, and connecting bolts. Acceptable products are:
    .1 Dresser Style 38
    .2 Ford Meter Box FC1
    .3 Robar 1408
    .4 Rockwell Type 411
    .5 Viking Johnson Quick-Fit
  .2 Flanged flexible sleeve type couplings: flanged cylindrical centre ring, a companion flange, one follower ring, one resilient gasket, and connecting bolts. Acceptable products are:
    .1 Dresser Style 128
    .2 Ford Meter Box FCA
    .3 Robar 7808
    .4 Rockwell Type 913
    .5 Viking Johnson Quickfit Flange Adapter
  .3 Transition flexible sleeve type couplings: Cylindrical centre ring, two follower rings two resilient gaskets, and connecting bolts. Acceptable products are:
    .1 Dresser Style 62
    .2 Robar 1408
  .4 Centre ring: steel, shop coated for corrosion protection.
  .5 Gaskets: fabricated of material suitable to the service conditions.
  .6 For submerged, buried or below structure applications, use stainless steel bolts, nuts and washers.
  .7 Provide the necessary amount and appropriate size of restraining rods and gussets as recommended by the manufacturer.
  .8 Type 1 - Restrained; use a flexible sleeve-type coupling with restraining rods, and gussets welded to the pipe to AWWA M11. Provide sufficient restraint to resist pressure equal to twice the system test pressure.

.2 Flexible Couplings - Type II:

  .1 Flexible pipe couplings: progressive sealing, capable of two degrees angular deflection in all directions, leakproof. Acceptable manufacturers:
    .1 Straub.
    .2 Victaulic Bolted Split-Sleeve (previously called Depend-o-lok)
  .2 Casing: 304 or 316 stainless steel.
  .3 Lockparts: Steel, shop coated for corrosion protection. 304 stainless steel for buried or submerged services.
  .4 Gaskets: fabricated of material suitable to the service conditions.

.3 Unless specifically shown otherwise use Type I flexible couplings where a flexible coupling is shown or required.

2.5 EXPANSION JOINTS

.1 Design and fabricate expansion joints in accordance with EJMA standards and to meet the requirements of this Division.

.2 Provide expansion joints as shown and in accordance with this Division. Unless otherwise specified provide elastomer spool type expansion joints.

.3 Ensure corrugated type expansion joints are capable of a minimum 10,000 pressure, temperature and deflection cycles, not concurrent.

.4 For metal expansion joints of the metal bellows type, in systems handling gases, air, water or other liquids, provide liners to produce a smooth flow path, reduce vibration and reduce noise through the expansion joint.

.5 Provide sufficient bends and expansion joints to allow for thermal movement of piping from 0°C to maximum service temperature.

.6 Provide factory precompressed expansion joints where required to suit installation temperature.

.7 Elastomer General:

  .1 Select materials suitable for service commodity, temperature and pressure. Conform to the requirements of the Fluid Sealing Association, Rubber Expansion Joint Division.
  .2 Provide control rods on expansion joint connectors to prevent excessive axial elongation and to accept the static pressure thrust in the piping system. Manufacturer to determine number and sizes of control rods.
  .3 Provide elastomer cover of the same material as the elastomer tube liner. For service temperatures between 80°C and 120°C, use chlorobutyl or EPDM for the elastomer tube. For temperatures below 80°C, use EPDM, Neoprene or Buna-N tube elastomer.
  .4 For single arch or single spherical rubber expansion joints in piping up to and including 200 mm diameter, make expansion joint face-to-face dimension 150 mm, nominal. For pipe greater than 200 mm and less than or equal to 300 mm, make expansion joint face-to-face dimension 200 mm, nominal.

.8 Elastomer Spool Type:

  .1 Unless otherwise specified, provide spool, resilient arch type expansion joints.
  .2 Construct of multiple plies of woven fabric impregnated with elastomer and reinforced with steel rings or wire embedded in the body.
  .3 Provide backup or retaining rings of galvanized steel construction. Make retaining rings a nominal 10 mm thick, split type.

.4 Use filled arch type expansion joints on all piping systems conveying fluids containing solids and at connection to Process Air blowers.

.5 Acceptable manufacturers are:

- .1 Senior Flexonics
- .2 Garlock
- .3 Mercer
- .4 Techniquip

2.6 EQUIPMENT CONNECTIONS

.1 Unless specified otherwise provide the following pipe end for equipment connections. See below for Dissimilar Metal Connections.

	Equipment End: Tubing/Various	Equipment End: Brass or Bronze Female Thread	Equipment End: Cast Iron or Steel Female Thread
Piping Material	**Pipe End (Diameter Range)**		
d) Steel: Standard Wt. and Schedule 40		(10 - 65 mm) 150 mm Galvanized Threaded Nipple and Union Rating: Class 250	(10 - 65 mm) 150 mm Galvanized Threaded Nipple and Union Rating: Class 250

	Equipment End: Cast Iron / Flanged	Equipment End: Steel/Stainless / Flanged	Equipment End: Steel/Stainless / Plain End
Piping Material	Pipe End (Diameter Range)		
d) Steel: Standard Wt. and Schedule 40	(10 - 65 mm) Threaded Steel Flange Rating: Class 125 FF (>65 mm) Steel Flange Rating: Class 125 FF	(10 - 65 mm) Threaded Steel Flange Rating: Class 150 RF (>65 mm) Steel Flange Rating: Class 150 RF	Flexible Joint Flanged One End Rating: Class 150 RF

	Equipment End: Tubing/Various	Equipment End: Brass or Bronze Female Thread	Equipment End: Cast Iron or Steel Female Thread
Piping Material	**Pipe End (Diameter Range)**		

	Equipment End: Steel or Stainless Welding End	Equipment End: Fibreglass Flanged	Equipment End: PVC Female Thread
Piping Material	Pipe End (Diameter Range)		
d) Steel: Standard Wt. and Schedule 40	Butt Welded (Steel Equip. End)		(10 - 65 mm) 150 mm Galv. Threaded Nipple and Union Rating: Class 250

2.7 FITTINGS

.1 For steel pipelines 75 mm in diameter or greater, fittings to conform to ANSI B16.9, ANSI B16.11 or ANSI B16.5. Provide fittings with a wall thickness equal to or greater than the pipe. In steel pipelines less than 75 mm in diameter provide threaded malleable iron fittings, conforming to ANSI B16.3.

.2 Provide long radius steel grooved-joint fittings conforming to ANSI B16.9 in steel grooved-joint pipeline systems. Grooved joint adapters may be welded to fitting ends; dimension and cut the groove of the adapter in accordance with the coupling manufacturer's recommendations; materials and inside diameter to be the same as the pipe; grind the interior weld smooth and meet the lining manufacturer's recommendations.

.3 For steel grooved-joint pipe of diameters of 150 mm and less, the Contractor may provide ductile iron grooved-joint fittings which have an outside diameter equal to the steel pipe diameter. Provide ductile iron to ASTM A536, dimensioned to 1.5 diameter radius bends, and cut grooving dimensions to AWWA C606 IPS dimensions. The lining and coating of the ductile iron fittings must equal the lining and coating of the steel pipeline system.

.4 Standard radius elbows to dimensions of ANSI B16.5 may be provided on clean water grooved-joint piping systems only.

.5 Provide long radius elbows unless otherwise shown. Provide smooth flow carbon or stainless steel elbows 350 mm and less, to ANSI B16.9. Provide mitred elbows greater than 350 mm, to AWWA C208 unless otherwise shown or specified. Use 3-piece construction unless otherwise shown or specified.

2.8 GASKETS

.1 For flat faced flanges, use full-face gaskets. For raised-face flanges, use ring type gaskets. Conform to ASTM B16.21.

.2 Use gasket materials for flanged connections suitable for the temperature, pressure, and corrosivity of the fluid conveyed in the pipeline. Refer to detailed pipe specifications for recommended gasket material. Material designations used in the detailed pipe specification sheets are as follows:

- .1 EPDM: ethylene-propylene-diene-terpolymer 70 durometer.
- .2 Bl. Neoprene: neoprene (black) 70 durometer.
- .3 Nitrile: nitrile (Buna N).
- .4 SBR: Styrene-butadiene (red).
- .5 Natural rubber: natural rubber.
- .6 Compressed synthetic fibres (Kevlar): ASTM F104 (F712400), and neoprene binder: 1.7 MPa (ASTM F152), 0.2 mL/h Leakage Fuel A (ASTM F37).
- .7 Compressed synthetic fibres (Kevlar): ASTM F104 (F712400) and SBR binder: 1.7 MPa (ASTM F152), 0.1 mL/h Leakage Fuel A (ASTM F37).
- .8 Gylon - Type 1: Garlock Style 3500, 1.35 MPa (ASTM F152), 0.22 mL/h Leakage Fuel A (ASTM F37).
- .9 Gylon - Type 2: Garlock Style 3510, 1.35 MPa (ASTM F152), 0.04 mL/h Leakage Fuel A (ASTM F37).
- .10 CPE - Chlorinated Polyethylene.

.3 Unless otherwise specified, minimum Gasket Material Thickness for full face gaskets:

- .1 75 to 250 mm pipe diameter; 1.6 mm thick.
- .2 Greater than 250 mm pipe diameter; 3.2 mm thick.

.4 Unless otherwise specified, minimum gasket material thickness for raised face ring gaskets:

- .1 75 to 100 mm pipe diameter; 1.6 mm thick.

  .2 Greater than 100 mm pipe diameter; 3.2 mm thick.

.5 Grooved joint gasket materials to be as recommended by the manufacturer for the service conditions indicated. Unless otherwise specified, provide flush seal type gaskets for all grooved joint systems. Acceptable products: Gustin-Bacon Rigigrip, Victaulic Flush-Seal.

2.9 BOLTS AND NUTS

.1 Provide hex head bolts and nuts. Threads to be ANSI B1.1, standard coarse thread series.

.2 For general service, use bolts and nuts conforming to ASTM A307, Grade A; nuts conforming to ASTM A563, Gr.A. For general interior service, use bolts and nuts conforming to ASTM A307, Grade A; nuts conforming to ASTM A563, Gr.A.

.3 Provide stainless steel bolts, nuts and washers for submerged, buried and concrete encased service; bolts conforming to ASTM A193, Gr. B8, C1.1; nuts conforming to ASTM A194, Gr.8. For exposed (exterior), submerged, buried and concrete encased service, provide stainless steel bolts, nuts and washers; bolts conforming to ASTM A193, Gr.B8, C1.1; nuts conforming to ASTM A194, Gr.8.

.4 Provide hot dip galvanized bolts, nuts and washers for use with hot dip galvanized Van Stone flange back-up rings and Lap-joint flange back-up rings.

.5 Provide hex nuts equal to or less than 25 mm. Greater than 25 mm, provide heavy hex.

2.10 WELDING MATERIALS

.1 Use welding materials conforming to CSA W48.1.

.2 Provide electrodes compatible with the material welded and which deposit metal with strength and corrosion resistance properties at least equivalent to the base metal.

.3 Provide proper storage for welding rod. Provide rod ovens in cold or inclement weather.

2.11 DISSIMILAR METAL CONNECTIONS

.1 Where dissimilar metals are to be connected, furnish dielectric fittings and/or isolating flanges.

2.12 CATHODIC PROTECTION

.1 Provide cathodic protection of piping, pipe fittings and appurtenances where specified.

2.13 HEAT TRACING

.1 Provide heat tracing for all piping and appurtenances where specified.

2.14 INSULATION

.1 Provide insulation where specified.

2.15 INTERIOR FINISHES

.1 Provide products with factory applied coatings and finishes unless otherwise noted. Fittings and pipe of any one pipe system to be lined by the same manufacturer.

.2 Unless otherwise specified, finish fittings in the same manner as the pipe run.

2.16 EXTERIOR FINISHES - SHOP APPLIED

.1 Provide products with factory applied coatings and finishes as specified in the detailed pipe specification sheets.

2.17 EXTERIOR FINISHES - FIELD APPLIED

.1 Use field applied finishes only for: short lengths of metal pipe in a piping system where the length of pipe which requires coating is less than 3.0 m unless otherwise specified; to repair shop-applied exterior finishes; to make up cutback distances at joints; and for fittings, couplings, valves and other appurtenances.

2.18 QUICK DISCONNECTS

.1 Provide quick disconnects which are not disconnectable under pressure. Unless otherwise shown or specified, provide products listed below.

.2 For water service, sizes as shown. Acceptable products are:

  .1 For 25 mm or less diameter hose, two lug, malleable iron, female NPT: Dixon Air King.
  .2 For 38 mm and 50 mm diameter hose, two four lug, malleable iron, female NPT: New Line Dixon Air King.
  .3 For 75 and 100 mm diameter or greater; quick-acting, dual clip: Rite-pro, Dixon.

2.19 FLUSHING CONNECTIONS

.1 Provide flushing connections on all piping for the conveyance of sludge, scum, grit or other liquid containing solids greater than 0.5 percent. Locate flushing connections adjacent to all isolation valves, on dead end branches, at tees and 90 degree elbows, and at intermediate locations which limit the distance between flushing connections to less than 30 to 50 m. Show flushing connections on piping submittals.

2.20 PURGE CONNECTIONS

.1 Provide purge connections on all gas lines. Locate adjacent to both sides of all isolation valves and spectacle flanges, and at any other locations shown in the drawings. Purge points shall be a minimum of 20 mm NPS pipe, fitted with a shut-off valve which shall be capped.

2.21 MECHANICAL BRANCH CONNECTIONS

.1 Provide mechanical branch connections as required for flushing connections and pipe tappings. Provide branch connection recommended by the manufacturer for the service and pipe installed. Acceptable products are:

  .1 Gruvlock Clamp T
  .2 Ford Service Saddles (F/FS)
  .3 Victaulic Mechanical T

2.22 DIELECTRIC COUPLINGS

.1 Wherever pipes of dissimilar metals are joined.

.2 Insulating unions for pipe sizes 50 mm and smaller and insulating flanges for pipe sizes larger than 50 mm.

2.23 DRAIN VALVES

.1 Locate at all low points and section isolating valves unless otherwise specified.

.2 Minimum 20 mm size unless otherwise specified: straight pattern bronze with hose end male thread and complete with cap and chain.

2.24 VIBRATION ISOLATION

.1 Elastomeric Pads:

  .1 Type P1: neoprene waffle or ribbed, 9 mm minimum thickness, 50 durometer, maximum loading 350 kPa.
  .2 Type P2: rubber waffle or ribbed, 9 mm minimum thickness, 30 durometer natural rubber, maximum loading 415 kPa.
  .3 Type P3: neoprene-steel-neoprene, 9 mm minimum thick neoprene bonded to 1.71 mm steel plate, 50 durometer neoprene, waffle or ribbed, holes sleeved with isolation washers.
  .4 Type P4: rubber-steel-rubber, 9 mm thick rubber bonded to 1.71 mm steel plate, 30 durometer natural rubber, waffle or ribbed, holes sleeved with isolation washers.
  .5 Acceptable product: Korfund, Vibron, Vibro-Acoustics.

.2 Elastomeric Mounts:

  .1 Type M1: colour coded, neoprene-in-shear, maximum durometer of 60, threaded insert and two bolt-down holes, ribbed top and bottom surfaces.
  .2 Acceptable product: Korfund, Vibron, Vibro-Acoustic.

.3 Springs Mounts:

  .1 Design stable springs so that ratio of lateral to axial stiffness is equal to or greater than 1.2 times the ratio of static deflection to working height. Select for 50% travel beyond rated load. Units to be complete with levelling devices.

    .2 Cadmium plate for outdoor installations.
    .3 Colour code springs
    .4 Zinc or cadmium coated hardware, housings coated with rust resistant paint.
    .5 Type M2: stable open spring, support on bonded 6 mm thick ribbed neoprene or rubber friction and acoustic pad.
    .6 Type M3: stable open spring, 6 mm minimum thickness ribbed neoprene or rubber friction and acoustic pad, bonded under isolator and on isolator top plate, internal adjustment, equipment bolting not necessary.
    .7 Type M4: Restrained stable open spring, supported on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad, built-in resilient limit stops, removable spacer plates.
    .8 Type M5: enclosed spring mounts with snubbers, for isolation up to 23 kg maximum.
    .9 Performance: as indicated.
    .10 Acceptable product: Korfund, Masdom VM, Vibron, Vibro-Acoustics.

.4 Spring Hangers:

    .1 Colour coded springs, rust resistant, painted, box type hangers. Swivel arrangement to permit hanger box or rod to move through a 20° arc without metal-to-metal contact.
    .2 Type H1: neoprene, in shear.
    .3 Type H2: stable spring, elastomeric washer.
    .4 Type H3: stable spring, elastomeric element.
    .5 Type H4: stable spring, elastomeric element with lockout plate and indicator.
    .6 Performance: as indicated.
    .7 Acceptable product: Korfund, Masdom VM, Vibron, Vibro-Acoustic.

.5 Acoustic Barriers for Anchors and Guides:

    .1 Acoustic barriers: between pipe and support, consisting of 25 mm minimum thick heavy duty duck and neoprene isolation material.
    .2 Acceptable product: Masdom VM, Vibron, Vibro-Acoustics.

.6 Horizontal Thrust Restraint:

    .1 Spring and elastomeric element housed in box frame, assembly complete with rods and angle brackets for equipment and ductwork attachment, provision for adjustment to limit maximum start and stop movement to 9 mm.
    .2 Restraints arranged symmetrically on either side of unit and attached at centerline of thrust.
    .3 Acceptable product: Korfund, Masdom VM, Vibron, Vibro-Acoustic.

.7 Structural Bases:

    .1 Type B1 - prefabricated steel base: integrally welded on sizes up to 2400 mm on smallest dimension; split for field welding on sizes over 2400 mm on smallest dimension and reinforced for drive and drive alignment, without supplementary hold down devices; complete with isolation element attached to base brackets arranged to minimize height; pre-drilled holes to receive equipment anchor bolts; and complete with adjustable built-in motor slide rail where indicated.

.2 Type B2 - steel rail base: structural steel, positioned for drive and driven alignment, without supplementary hold down devices; complete with isolation element attached to base brackets arranged to minimize height; and pre-drilled holes to receive equipment anchor bolts.

.3 Bases to clear housekeeping pads by 25 mm minimum.

.4 Acceptable product: Korfund, Masdom VM, Vibron, Vibro-Acoustic.

.8 Inertia Base Forms:

.1 Type B3 - Full depth perimeter structural or formed channel frames: welded in place, reinforcing rods running in both directions; spring mounted units carried by gusseted height saving brackets welded to frame; and clear housing pads by 50 mm minimum.

.2 Bases: "T" shaped, where applicable, to provide support for pump elbows.

.3 Concrete: to Division 03.

.4 Acceptable product: Korfund, Masdom VM, Vibron, Vibro-Acoustic.

.9 Roof Curb Isolation Rails:

.1 Structural steel or aluminum upper and lower members: separated by continuous flexible reinforced water- and air-tight seal, fastened to upper and lower members, complete with a removable metal weather shield to protect seal. Supply in one piece, no field joints, support to curb by stable steel springs, maximum deflection 50 mm, with closed cell neoprene gasket bonded to upper and lower surfaces of curb base. Provide neoprene cushioned restraints which become engaged and resist a wind load in any direction.

.2 Acceptable product: Korfund, Masdom VM, Vibron, Vibro-Acoustic.

2.25 DRIVES, GUARDS AND LUBRICATION ACCESSORIES

.1 Select variable and adjustable pitch sheaves unless otherwise specified.

.2 Provide motor driven equipment using 3 or more belts with fixed sheaves.

.3 Fit reinforced belts in sheave matched to drive. Multiple belts on unit to be matched set.

.4 Use cast iron or steel sheaves secured to shafts with removable keys.

.5 Standard adjustable pitch drive sheaves having + 10% range to be used on motors from 0.25 kW to 7.5 kW. Use mid-position of range for specified RPM.

.6 For drives larger than 7.5 kW, sheaves to be split tapered bushing and keyway having a fixed pitch, unless specifically required for item concerned. Provide sheave of correct size for balancing.

.7 Minimum drive rating to be 1.5 times nameplate rating of motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.

.8 Motor slide rail adjustment plates to allow for centerline adjustment.

.9 Provide guards for exposed drives.

.10 Guards for drives to have:

- .1 Expanded metal screen welded to 25 mm steel angle frame.
- .2 18 Ga. galvanized sheet metal tops and bottoms.
- .3 Removable sides for servicing.
- .4 40 mm diameter holes on both shaft centers for insertion of a tachometer.

.11 Secure guards to driven machine, foundations or floors with heavy angle supports and anchor bolts.

.12 Do not short circuit vibration isolators.

.13 Provide means to permit lubrication, use of speed counters, or other maintenance and testing operations, with the guard in place.

.14 Install belt guards to permit movement of motors for adjusting belt tension.

.15 For flexible couplings, provide removable "U" shaped guards fabricated from 12 Ga. galvanized steel frame with 18 Ga. expanded mesh face.

.16 Provide protective screen on both inlet and outlet of exposed fan blades. Screen to be fabricated from 20 mm mesh minimum galvanized expanded metal such that the net free area of openings is not less than 80% of the original opening.

.17 Provide oil gauges, grease cups, oil cups or grease gun fittings at all points requiring lubrication. Extend all fittings as required to be fully accessible without requiring any disassembly or removal of guards.

Part 3 Execution

3.1 VALVES AND EQUIPMENT IDENTIFICATION

.1 Valves and equipment are identified in the following manner:

- .1 Valve Identification:
  - .1 Valve Designation Example:

GAV - 100

Where:

GAV	Identity Symbol
1	Area Number
00	Sequence Number (00, 01, 02…)

.2 Valve Identity Symbols

SYMBOL	**VALVE TYPE**
CHV	Check Valve
KGV	Knife Gate Valve

.3 Valve Marking: Each valve to bear the manufacturers name or trademark and reference symbol to indicate the service conditions for which the manufacturer guarantees the valve. The marking to be in accordance with MSS-SP-25.

.4 Valve Tagging: Valves to be tagged as follows:

CHV - 100
Component
Area Number
Sequence Number

.2 Equipment Identification

.1 Equipment Designation: Equipment to be identified in the following manner:

AER - 105 A

Where:

AER	Identity Symbol
1	Area Number
00	Sequence Number (00, 01, 02…)
A	Duplication Identifier (optional usage)

i.e.: Aerator, Equipment sequence No. 100, Item A.

.2 Symbols

SYMBOL	**EQUIPMENT**
PMP	Pump

3.2 PIPING INSTALLATION

.1 General:

.1 Conform to requirements of ANSI B31 code for pressure piping.

.2 Install straight, parallel and close to walls and ceilings, with specified pitch. Use standard fittings for direction changes.

.3 Install groups of piping parallel to each other, spaced to permit application of insulation, identification, and service access, on trapeze hangers.

.4 Install eccentric reducers in horizontal piping to permit drainage and eliminate air pockets.

.5 Where pipe sizes differ from connection sizes of equipment, install reducing fittings close to equipment. Reducing bushings are not permitted.

  .6 Install flanged or welded nozzles, branch connections, welding outlets, adapters and taps, true and faced at right angles to the axis of the pipe. Do not extend connection inside of pipe.

  .7 Make pipe ends round and true, suitable for weld connection.

  .8 Prepare pipe ends in accordance with ANSI B16.25 for butt welding.

  .9 Copper pipe and tubing to be free from surface damage. Replace damaged pipe or tubing.

  .10 Ream ends of pipe and tubes before being made up.

  .11 Lay copper tubing so that it is not in contact with dissimilar metal and will not be kinked or collapsed.

  .12 Use non-corrosive lubricant or teflon tape applied to male thread only.

  .13 Groove pipe ends, cut square, seating surface clean and free from indent and score marks.

  .14 Install dielectric fittings wherever piping of dissimilar metals are joined.

  .15 Install flanges or unions to permit removal of equipment without disturbing piping systems, as required by piping standard.

  .16 Clean ends of pipes or tubing and recesses of fittings to be brazed or soldered. Assemble joints without binding.

  .17 Support piping during construction to prevent abnormal stresses on the pipe works.

  .18 Install pipe supports where indicated on the drawings or as required.

  .19 Install pipe hangers as required.

.2 Flanges Bolting to Valves:

  .1 Do not weld adjacent flanges on butterfly valves when the valve is in place.

  .2 Remove valve prior to welding.

  .3 Clean gasket surfaces, flange faces and butt welding connections.

  .4 Protect connecting surfaces.

.3 Bolted Connections:

  .1 Clean pipe ends and gaskets.

  .2 Lubricate gaskets with soapy water and bolts with thread lubricant.

  .3 Tighten bolts progressively by crossover method and not in rotation around the joint.

  .4 Tighten bolts to the torque recommended by the manufacturer.

  .5 Use properly sized wrenches for bolt tightening to prevent rounding of nut and bolt heads.

.4 Branch Connections: branch connections to be in accordance with the following for ANSI 150, 300, 600, 900 and 1500 ratings:

BRANCH

MAIN	20	25	40	50	65	75	100	150	200	250
20	T									
25	RT	T								
40	RT	RT	T							
50	C	TH	RT	T						
65	C	RT	RT	RT	T					
75	C	C	C	RT	*RT	T				
100	C	C	C	*W	*RT	RT	T			
150	C	C	C	*W	*RT	W	RT	T		
200	C	C	C	*W	*W	W	W	RT	T	
250	C	C	C	*W	*W	W	W	RT	RT	T
300	C	C	C	*W	*W	W	W	RT	RT	RT
350	C	C	C	*W	*W	W	W	RT	RT	RT
400	C	C	C	*W	*W	W	W	RT	RT	RT
450	C	C	C	*W	*W	W	W	W	RT	RT
500	C	C	C	*W	*W	W	W	W	RT	RT
600	C	C	C	*W	*W	W	W	W	W	W
750	C	C	C	*W	*W	W	W	W	W	W

BRANCH

MAIN	300	350	400	450	500	600	750
300	T						
350	RT	T					
400	RT	RT	T				
450	RT	RT	RT	T			
500	RT	RT	RT	RT	T		
600	RT	RT	RT	RT	RT	T	
750	RT	RT	RT	RT	RT	RT	T

Legend:
T - Straight Tee
RT - Reducing Tee
TH - Thredolet
C - Coupling
W - Weldolet

*For Class 150 - A1 line class, including A1A and A1B, but not A1C, piping 65 mm size and under to be screwed connections. The branch connections will, therefore, be TH (thredolet).

3.3 VALVES INSTALLATION

.1 Storage of Valves:

- .1 Store valves in cool and clean location, away from moving vehicles or other objects.
- .2 Prevent dirt and debris entering the valve internals.
- .3 Protect the valve seats against painting.

.4 Store valves with their handwheels, operator shafts and operators in an upright position.

.2 Handling Valves:

  .1 Do not place chains, cables and ropes through valve ports or attached to operators or handwheels.
  .2 Use sling either around valve body or with bolts or rods through the flange holes.
  .3 Installation of Valves:
    .1 Installation of valves to be by competent personnel and in strict accordance with manufacturer's instructions.
    .2 Inspect pipe and remove all foreign debris or objects that may prevent closing of valves prior to the installation of any valves.
    .3 Install butterfly valves with their operating shafts in the vertical position unless otherwise directed by the Engineer.

3.4 PROTECTION OF OPENINGS

.1 Protect equipment and system openings from dirt, dust and other foreign materials.

.2 Thoroughly clean piping, ducts and equipment of dirt, cuttings, and other foreign substances prior to being put into operation.

3.5 EQUIPMENT LUBRICATION

.1 All equipment placed in operation prior to the completion of the contract to be maintained and adequately lubricated in accordance with the manufacturer's instructions.

.2 All equipment to be lubricated in accordance with the manufacturer's instructions prior to acceptance of any system.

.3 Oil level gauges, grease cups and grease fittings for all machinery bearings, etc., to be provided as recommended by the manufacturer. Locate oil level gauges for easy viewing.

.4 All bearings to be flushed out and refilled with new change of oil prior to final acceptance.

.5 Protect bearings and shafts during installation. Grease shafts and sheaves to prevent corrosion.

END OF SECTION

Part 1 General

1.1 SCOPE

.1 This Section specifies hangers and supports for piping systems.

.2 Design, select, locate and provide pipe hangers and supports for piping in accordance with the requirements of the specifications and as shown.

.3 This section does not include pipe supports for fire sprinkling systems, seismic restraints or pipe anchors and guides specified elsewhere.

1.2 REFERENCE STANDARDS

.1 Conform to the following reference standards:

  .1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME).
  .2 ANSI/ASME B31.1, Power Piping, (SI Edition).

.2 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS):

  .1 MSS SP-58, Pipe Hangers and Supports - Materials, Design and Manufacture.
  .2 MSS SP-69, Pipe Hangers and Supports - Erection and Application.
  .3 MSS SP-89, Pipe Hangers and Supports - Fabrication and Installation Practices.
  .4 ULC, Underwriters' Laboratories of Canada.
  .5 WW-H-171E, Federal Specification.
  .6 British Columbia Building Code.
  .7 British Columbia Plumbing Code.
  .8 CAN/CGA B149.2 Natural Gas Installation Code.

1.3 DESIGN REQUIREMENTS

.1 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's's regular production components, parts and assemblies.

.2 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS SP-58.

.3 Ensure that supports, guides, anchors do not transmit excessive quantities of heat to building structure.

.4 Design hangers and supports to support systems under all conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment.

.5 Provide for vertical adjustments after erection and during commissioning. Amount of adjustment to be in accordance with MSS SP-58.

1.4 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings and product data in accordance with Section 01 30 00 - Submittals.

.2 Submit shop drawings and product data for following items:

- .1 All bases, hangers and supports.
- .2 Connections to equipment and structure.
- .3 Structural assemblies.

.3 Submittals to include all design details for pipe hangers and supports systems, including, but not limited to, locations, load information, design calculations, type of support system and illustrative drawing. Submittal and design details to be stamped and signed by Professional Engineer registered in the Province of British Columbia.

.4 Design detail and drawings to be coordinated with and inclusive of all seismic requirements specified in Section 40 05 01 – Mechanical General Requirements.

1.5 MAINTENANCE DATA

.1 Provide maintenance data.

Part 2 Products

2.1 MATERIALS

.1 Unless otherwise specified, pipe hangers and supports, structural attachments, fittings and accessories are to be hot-dipped galvanized after fabrication. Pipe hangers and supports which are not standard copper plated and are to be plastic coated or lined with dielectric material or neoprene, are to be hot dip galvanized before coating or lining.

.2 Provide AISI Type 304 stainless steel nuts, bolts, washers and threaded rods, for submerged and exposed, above ground conditions. Provide cadmium plated steel nuts, bolts, washers and threaded rods in non-corrosive, controlled environment areas.

.3 Pipe hangers and supports in submerged locations to be 304 stainless steel.

2.2 PIPE HANGERS AND SUPPORTS

.1 Type 1 - Clevis Pipe Hanger: Provide carbon steel clevis hangers with configuration and components as follows:

- .1 Steel pipe (insulated) - B-Line B3100, Grinnell Fig. 260, Superstrut C-710, or Taylor No. 24, or Hunt 32; with insulation shield.
- .2 Steel pipe (uninsulated) - B-Line B3100, Grinnell Fig. 260, Superstrut C-710, or Taylor No. 24 or Hunt 32.
- .3 Cast and ductile iron pipe - B-Line B3102, Grinnell Fig. 590, Superstrut C-710, or Taylor No. 24 or Hunt 32 sized for DI pipe.

  - .4 Copper pipe (uninsulated) - B-Line B3104 CTC, Grinnell Fig. CT-65 (plastic coated), Superstrut CTL-710 (plastic coated), or Taylor No. 56CT or Hunt 30C (plastic coated).
  - .5 Copper pipe (insulated) - B-Line B3100, Grinnell Fig. 260, Superstrut C-710, or Taylor No. 24 or Hunt 32; with insulation shield.
  - .6 Plastic pipe - B-Line B3100 C, Grinnell Fig. 260 (plastic coated), or Taylor No. 24 (plastic coated), or Hunt 32 (plastic coated).

- .2 Type 2 - "J" Pipe Hanger: Provide carbon steel hangers with configuration and components as follows:
  - .1 Steel pipe - B-Line B3690, Grinnell Fig. 67, Superstrut C-711 or Unistrut J1205-J1280 Series.
  - .2 Steel pipe (insulated) - B-Line B3690, Grinnell Fig. 67, Superstrut C-711 or Unistrut J1205-J1280 Series; with insulation shield.
  - .3 Copper pipe (insulated) - B-Line B3690, Grinnell Fig. 67, Superstrut C-711 or Unistrut J1205-J1280 Series; with insulation shield.
  - .4 Copper (uninsulated) and plastic pipe - B-Line B3690C (plasticoat) Grinnell Fig. 67 (plastic coated), Superstrut C-711P or Unistrut J 1205N - J1280N series.

- .3 Type 3 - Pipe Clamp: Provide carbon steel pipe clamps, with configuration and components as follows:
  - .1 Steel pipe (insulated) - Double Bolt Pipe Clamp: B-Line B3144, or Grinnell Fig. 295, or Hunt 70H.
  - .2 Steel pipe (uninsulated) - Single Bolt Pipe Clamp: B-Line B3140, or Grinnell Fig. 212, or Hunt 60.
  - .3 Copper pipe (insulated) - Double Bolt Pipe Clamp: B-Line B3144, or Grinnell Fig. 295, or Hunt 70H; lined with dielectric material.

- .4 Type 4 - Adjustable Roller Hanger: Provide cast iron rollers, carbon steel yoke and cross bolt with configuration and components as follows:
  - .1 Steel pipe (insulated) - B-Line B3110, Grinnell Fig. 181, or Superstrut C-729, or Hunt 3436; with insulation shield.
  - .2 Steel pipe (uninsulated) - B-Line B3110, Grinnell Fig. 181, or Superstrut C-729, or Hunt 3436.
  - .3 Copper pipe (insulated only) - B-Line B3110, Grinnell Fig. 181, or Superstrut C-729, or Hunt 3436; with insulation shield.
  - .4 Plastic pipe - B-Line B3110, Grinnell Fig. 181, or Superstrut C-729, or Hunt 3436.

- .5 Type 5 - Single Pipe Roll: Provide cast iron rollers and sockets, and steel cross rods with configuration and components as follows:
  - .1 Steel pipe (insulated) - B-Line B3114, or Grinnell Fig. 171, or Hunt 37; with insulation shield.
  - .2 Steel pipe (uninsulated) - B-Line B3114, or Grinnell Fig. 171, or Hunt 37.
  - .3 Plastic pipe - B-Line B3114, or Grinnell Fig. 171, or Hunt 37.

.6 Type 6 - Framing Channel Pipe Clamp: Provide steel pipe clamps with configuration and components as follows:

  .1 Steel pipe (uninsulated) - B-Line 2007, Powerstrut PS1100, or Unistrut P1109 Series.
  .2 Steel pipe (insulated) - B-Line 2007, Powerstrut PS1100, or Unistrut P1109 Series; with insulation shield.
  .3 Copper pipe (uninsulated) - B-Line B2023 Series, Powerstrut PS 1200 or Unistrut P2024PC Series; plastic coated or lined with a dielectric material.
  .4 Copper (insulated) - B-Line B2023 Series, Powerstrut PS 1200 or Unistrut P2024 Series; with insulation shield.

.7 Type 7 - U-Bolt: Provide carbon steel U-bolts with configuration as follows:

  .1 Steel pipe (uninsulated) - Grinnell Fig. 137, B-Line B3188, or Superstrut H-115, or Hunt 80.
  .2 Steel pipe (insulated) - Grinnell Fig. 137, B-Line B3188, or Superstrut H-115, or Hunt 80; with insulation shield.
  .3 Cast and ductile iron pipe - Grinnell Fig. 137, B-Line B3188DI, or Superstrut H-115, or Hunt 80.
  .4 Copper pipe (uninsulated) - B-Line B3188C, Grinnell Fig. 137C, Superstrut H-115 (with plastic coating), or Unistrut No. 13 (with plastic coating), or Hunt 80 (with plastic coating).
  .5 Copper pipe (insulated) - Grinnell Fig. 137 or B-Line B3188, Superstrut H-115, or Hunt 80; with insulation shield.

.8 Type 8 - Adjustable Pipe Roll Support: Provide cast iron rollers and sockets, and carbon steel cross rod and support rods with configuration and components as follows:

  .1 Steel pipe (insulated) - B-Line B3122, or Grinnell Fig. 177, or Hunt 37 (with support rods and nuts); with insulation shield.
  .2 Steel pipe (uninsulated) - B-Line B3122, or Grinnell Fig. 177, or Hunt 37 (with support rods and nuts).
  .3 Copper pipe (insulated only) - B-Line B3122, or Grinnell Fig. 177, or Hunt 37 (with support rods and nuts); with insulation shield.
  .4 Plastic pipe - B-Line B3122, or Grinnell Fig. 177, or Hunt 37 (with support rods and nuts).

.9 Type 9 - Welded Pipe Stanchion: provide a carbon steel, standard schedule pipe stanchion, cut stanchion to match contour of pipe elbow. Use only for ambient commodity systems.

.10 Type 10 - Pipe Stanchion saddle: Provide carbon steel saddles and yokes as follows:

  .1 Steel pipe (insulated) - B-Line B3090, or Grinnell Fig. 259, or Hunt 500S; with insulation shield.
  .2 Steel pipe (uninsulated) - B-Line B3090, or Grinnell Fig. 259, or Hunt 500S.
  .3 Cast and ductile iron pipe - B-Line B3090 DI, or Grinnell Fig. 259, or Hunt 500S.

- .4 Copper pipe (uninsulated) - B-Line B3090, or Grinnell Fig. 259, or Hunt 500C; with insulation shield or lined with dielectric material.
- .5 Copper pipe (insulated) - B-Line B3090, or Grinnell Fig. 259, or Hunt 500C; with insulation shield.
- .6 Plastic pipe - B-Line B3090, or Grinnell Fig. 259, or Hunt 500S; lined with 1.6 mm thick neoprene.

.11 Type 11 - Offset Pipe Clamp: Provide carbon steel pipe clamps with configuration and components as follows:

- .1 Steel pipe - B-Line B3148, or Grinnell Fig. 103, or Hunt 301.
- .2 Cast and ductile iron pipe - B-Line B3148 NS, or Grinnell Fig. 103, or Hunt 301.
- .3 Copper pipe - B-Line B3148 (plastic coated), or Grinnell Fig. 103 (plastic coated), or Hunt 301 (plastic coated).
- .4 Plastic pipe - B-Line B3148 (plastic coated), or Grinnell Fig. 103, (plastic coated), or Hunt 301 (plastic coated).

.12 Type 12 - Riser Clamp: Provide carbon steel riser clamps with configuration and components as follows:

- .1 Steel pipe - B-Line B3373, Grinnell Fig. 261, Superstrut C-720, or Taylor No. 82, or Hunt 40.
- .2 Cast and ductile iron pipe - B-Line B3373, Grinnell Fig. 261, Superstrut C-720, on Taylor No. 82, or Hunt 40.
- .3 Copper pipe - B-Line B3373 CTC, Grinnell Fig. CT-121C, Superstrut C-720 (plastic coated), or Taylor No. 86, or Hunt 42C (plastic coated).
- .4 Plastic pipe - B-Line 3373C, Grinnell Fig. 261 (plastic coated), or Superstrut C-720 (plastic coated), or Taylor No. 82 (plastic coated), or Hunt 40 (plastic coated).
- .5 Type 13 - Framing Channel Pipe Strap: Provide carbon steel pipe strap with configuration as follows:
- .6 Steel pipe (uninsulated) - B-Line B2400 Series, Powerstrut PS3126, Superstrut C-708-U, or Unistrut P2558 Series, or Hunt 67.
- .7 Steel pipe (insulated) - B-Line B-2400 Series, Powerstrut PS3126, Superstrut C-708-U, or Unistrut P2558 Series, or Hunt 67; with insulation shield.
- .8 Copper pipe (uninsulated) - B-Line B-2400 Series, Powerstrut PS3126, Superstrut C-708-U, or Unistrut P2558 Series, or Hunt 67; with insulation shield or lined with dielectric material.
- .9 Copper pipe (insulated) - B-Line B-2400 Series, Powerstrut PS3126, Superstrut C-708-U, or Unistrut P2558 Series, or Hunt 67; with insulation shield.
- .10 Plastic pipe - B-Line B-2400 Series, Powerstrut PS3126, Superstrut C-708-U, or Unistrut P2558 Series, or Hunt 67. Use only if hanging pipe below framing channel.

.13 Constant Support Spring Hangers:

  .1 Springs: alloy steel to ASTM A 125, shot peened, magnetic particle inspected, with +/- 5% spring rate tolerance, tested for free height, spring rate, loaded height and provided with CMTR.
  .2 Load adjustability: 10% minimum adjustability each side of calibrated load. Adjustment without special tools. Adjustments not to affect travel capabilities.
  .3 Provide upper and lower factory set travel stops.
  .4 Provide load adjustment scale for field adjustments.
  .5 Total travel to be actual travel + 20%. Difference between total travel and actual travel 25 mm minimum.
  .6 Individually calibrated scales on each side of support calibrated prior to shipment, complete with calibration record.

.14 Variable Support Spring Hangers:

  .1 Vertical movement: 13 mm minimum, 50 mm maximum, use single spring pre-compressed variable spring hangers.
  .2 Vertical movement greater than 50 mm: use double spring pre-compressed variable spring hanger with 2 springs in series in single casing.
  .3 Variable spring hanger to be complete with factory calibrated travel stops. Provide certificate of calibration for each hanger.
  .4 Steel alloy springs: to ASTM A 125, shot peened, magnetic particle inspected, with +/-5% spring rate tolerance, tested for free height, spring rate, loaded height and provided with CMTR.

2.3 RACK AND TRAPEZE SUPPORTS

.1 Unless otherwise specified, provide steel trapeze and pipe rack components having a minimum thickness of 2.7 mm with a maximum deflection 1/240 of the span.

.2 Type 20 - Trapeze Pipe Support: Provide trapeze pipe support cross members. Provide 41 mm square carbon steel flat plate fittings of standard design manufactured by framing channel manufacturer, B-Line B202-2, Powerstrut PS619, or Unistrut P2471.

.3 Type 21 - Pipe Rack Support: Provide post and cross member framing channels. Provide carbon steel pipe rack fittings of standard design manufactured by framing channel manufacturer. Provide gusset type, 90° fittings B-Line B844, Grinnell PS3373, or Unistrut P2484.

2.4 STRUCTURAL ATTACHMENTS

.1 Type A - Malleable Iron Concrete Insert: Provide malleable iron concrete inserts with insert nuts; B-Line B3014 with B3014N, Grinnell Fig. 282, or Unistrut M26 with M2808 through M2824.

.2 Type B - Side Beam Bracket: Provide malleable iron or carbon steel bracket; Grinnell Fig. 202, or B-Line B3062, or Hunt 50.

.3 Type C - Malleable Beam Clamp With Extension Piece: Provide malleable iron clamp and extension pieces with steel tie rods; Grinnell Fig. 218 with Fig. 157 extension piece, or B-Line B3054 with Fig. B3203 extension piece, Hunt 812.

.4 Type D - Steel Beam Clamp with Eye Nut: Provide forged steel beam clamps and weldless eye nuts; Grinnell Fig. 292, B-Line B3291 series.

.5 Type E - Steel channel clamp: Provide malleable iron clamp and heel plates, and steel bolts and nuts; Grinnell Fig. 226 with Fig. 157 extension piece.

.6 Type F - Welded Beam Attachment: Provide carbon steel beam attachments; B-Line B3083, or Grinnell Fig. 66, or Hunt 52B.

.7 Type G - Adjustable Beam Attachment: Provide carbon steel beam attachments; B-Line B3082, or Hunt 50S.

.8 Type H - Double Channel Bracket: Provide single channel attachment. Provide a carbon steel double framing channel cantilever bracket assembly; B-Line B297-12 through B297-36, Powerstrut PS809, or Unistrut P2542 series.

.9 Type J - Single Channel Bracket: Provide single channel attachment. Provide a carbon steel single framing channel cantilever bracket assembly; B-Line B198-6 through B198-24, Powerstrut PS661, or Unistrut P2231 through P2234.

.10 Type K - Wall mounted channel: Provide 41 mm x 62 mm carbon steel framing channel; B-Line B12 or Unistrut P5500.

.11 Type L - Pipe stanchion attachment: Provide minimum 12 mm thick carbon steel baseplate. Anchor bolt holes: 1.6 mm larger than bolt diameter. Provide non-shrink grout between the baseplate and upstand.

.12 Type M - Welded Steel Bracket: Provide carbon steel brackets which comply with MSS Type 32 and FEDSPEC Type 33 for medium welded bracket; Grinnell Fig. 195. Heavy welded bracket to comply with MSS Type 33 and FEDSPEC Type 34; Grinnell Fig. 199.

.13 Type P - Framing Channel Post Base: Provide carbon steel post bases of standard design manufactured by framing channel manufacturer. Single channel: Unistrut P 2072A, B-Line B280, Powerstrut PS 3033. Double channel: Unistrut P2073A, B-Line B281, or Powerstrut PS3064.

.14 Type Q - Continuous concrete inserts: provide 300 mm long carbon steel concrete inserts; Unistrut P3253.

2.5 ACCESSORIES

.1 Hanger Rods: Provide AISI Type 304 stainless steel rods, threaded on both ends or continuous threaded and sized as required.

.2 Weldless Eye Nut: Provide forged steel eye nuts and comply with MSS and FEDSPEC Type 17; Grinnell Fig. 290, or B-Line B3200, or Hunt 88.

.3 Welded Eye Rod: Provide carbon steel eye rods with eye welded closed. Inside diameter of eye to accommodate a bolt diameter 3.2 mm larger than the rod diameter; Grinnell Fig. 278, or B-Line B3211, or Hunt 95R.

.4 Turnbuckle: Provide forged steel turnbuckles; Grinnell Fig. 230, or B-Line B3202, or Hunt 84.

.5 Framing Channels: Provide 41 mm x 62 mm roll formed carbon steel framed channel, having a thickness of 2.7 mm. Channel to have a continuous slot along one side with in-turned clamping ridges. Single Channel: Unistrut P5500, B-Line B12, Powerstrut PS150. Double Channel: Unistrut P5501, B-Line B12A, Powerstrut PS 150 2T3.

2.6 THERMAL PIPE HANGER SHIELD

.1 Provide thermal shields or protective saddles on pipe requiring insulation. Type 3, Type 11, and Type 12 hangers clamp directly to pipe therefore thermal shields are not required but insulation shall be continued around the hangers.

.2 The shield consists of an insulation layer encircling the entire circumference of the pipe and a steel jacket encircling the insulation layer. Minimum shield length is as follows:

Pipe, mm	Shield Length, mm
12 - 38	100
50 - 150	150
200 - 250	225
300 - 450	300

.3 Thermal shield to same thickness as the piping system insulation.

.4 Use standard shield for hot systems and vapour barrier shield for cold systems.

.5 Use stainless steel band clamps to ensure against slippage between the pipe wall and the thermal shield.

.6 Standard Shield

- .1 Insulation:
  - .1 Hydrous calcium silicate, high density, waterproof.
  - .2 Compressive strength: 700 kPa average.
  - .3 Flexural strength: 500 kPa average.
  - .4 R. unit: 2.16 at 37.8°C mean.
  - .5 Temperature range: -7°C to 260°C.
- .2 Steel Jacket: galvanized steel, thickness as per manufacturer's standard, supplied for the given pipe size. For pipe in "submerged" location, provide stainless steel jacket.

.3 Connection: Steel jacket and insulation to be flush with end of thermal shield. Butt connect shield to pipe insulation.

.7 Vapour Barrier Shield

- .1 Insulation:
  - .1 Hydrous calcium silicate, high density, waterproof.
  - .2 Compressive strength: 700 kPa average.
  - .3 Flexural strength: 500 kPa average.
  - .4 R. unit: 2.16 at 37.8°C mean.
  - .5 Temperature range: -7°C to 260°C.
- .2 Steel Jacket: Galvanized steel, thickness as per manufacturer's standards, supplied for the given pipe size. For pipe in "submerged" locations provide stainless steel jacket.
- .3 Connection: Insulation to extend 25 mm each side of steel jacket for vapourtight connection to pipe insulation vapour barrier. Butt connect shield to pipe insulation

Part 3 Execution

3.1 HANGER AND SUPPORT LOCATION

.1 Design and locate hangers and supports as near as possible to concentrated loads such as valve, flanges, etc. Locate hangers, supports and accessories within appropriate span lengths to support continuous pipeline runs unaffected by concentrated loads.

.2 Provide hangers and/or base supports within one metre of each change in direction on each leg, on one side of each valve, and on the first spool piece or fitting extending from a piece of equipment.

.3 Locate hangers and supports to ensure that connections to equipment, tanks, etc. are substantially free from loads transmitted by the piping.

.4 Support piping so that temporary pipe supports will not be required when removing parts of the piping system for equipment maintenance.

.5 Support piping so that no pockets will be formed in the span due to sagging of the pipe between supports caused by the weight of the pipe, medium in the pipe, insulation, valves and fittings.

.6 Provide supplementary structural steel members where structural bearing does not exist or where inserts are not in suitable locations.

.7 Use approved constant support type hangers where:

- .1 Vertical movement of pipework is 13 mm or more.
- .2 Transfer of load to adjacent hangers or connected equipment is not permitted.

.8 Use variable support spring hangers where:

.1 Transfer of load to adjacent piping or to connected equipment is not critical.

.2 Variation in supporting effect does not exceed 25% of total load.

3.2 INSTALLATION

.1 Unless otherwise specified, do not drill or burn holes in the building structural steel.

.2 Do not use hanger components for purposes other than for which they were designed. Do not use hanger components for rigging and erection purposes.

.3 Install items to be embedded before concrete is poured. Fasten embedded items securely to prevent movement when concrete is poured.

.4 Use embedded anchor bolts instead of concrete inserts for support installations in areas below water surface or normally subjected to submerging.

.5 Install thermal pipe hanger shields on insulated piping at required locations during hanger and support installation. Butt joint connections to pipe insulation to be made at the time of insulation installation in accordance with the manufacturer's recommendation.

.6 Hanger and support components in contact with plastic pipe to be free of burrs and sharp edges.

.7 Rollers to roll freely without binding.

.8 Finished floor beneath Type L structural attachments and framing channel post bases to be roughened prior to grouting. Grout between base plate and floor to be free of voids and foreign material.

.9 Cut and drill baseplates to specified dimensions prior to welding stanchions or other attachments and prior to setting anchor bolts.

.10 Provide plastic or rubber end caps at the exposed ends of all framing channels that are located up to 2200 mm above the floor.

.11 Recoat ends of framing channels cut to length with zinc dust-zinc oxide coating.

.12 Include any piping support modifications on the shop drawings submitted prior to fabrication or installation.

.13 Review the drawings prior to installation of piping, conduit, and fixtures by this or any other Division. Identify any conflicts, and confirm the routing of each section of pipework prior to commencement of installation. Advise of any conflicts with existing services. Where necessary, amend the routing of pipework to avoid conflict and provide shop drawings showing proposed routing.

.14 Prior to installation, inspect and field measure to ensure that previous work is not prejudicial to the proper installation of piping.

.15 All minor modifications to accommodate installed equipment and structural components are subject to review. Do not commence work on related piping until Engineer’s review is complete.

3.3 ADJUSTMENTS

.1 Adjust hangers and supports to obtain required pipe slope and elevation. Use shims made of material that is compatible with the piping material. Adjust stanchions prior to grouting of baseplates.

END OF SECTION

Part 1 General

1.1 SCOPE

.1 This section refers to shop and field welding of carbon steel pipe.

1.2 CODES

.1 All work associated with the welding process such as welder qualifications, line-up, welding and weld testing, is to be performed in accordance with the latest edition of AWWA C206 and CSA Z662 except when the terms of these standards are added to or modified by these specifications.

Part 2 Products

2.1 PIPE MATERIAL

.1 The chemical and physical characteristics of the pipe are specified in Section 40 23 24 - Detailed Piping Specification.

2.2 FILLER MATERIAL

.1 Manual arc-welding electrodes for welding carbon steel to carbon steel are to conform to the latest edition of CSA W48.1. The grade is to be E70XX equivalent or better depending on the ultimate tensile strength of the parent metal, and be suitable for the electric current characteristics, position of welding, and other conditions of intended use.

2.3 END BEVELS

.1 Pipe ends to be provided with mill bevels. Bevels are to be 30° to 40° with a vertical lip of 1.5 mm ±0.75 mm unless specified otherwise. Field bevels are to be reasonably smooth and uniform and in conformance with mill bevels.

2.4 EQUIPMENT

.1 Welding equipment is to be 200 A or larger DC machines, and be designed and maintained in a condition so as to obtain the specified results.

Part 3 Execution

3.1 GENERAL

.1 Perform welding using procedures qualified to CSA Z662, Clause 7.2.5. Surfaces to be welded are to be smooth, uniform, free of fins, laminations, tears, slag, grease, paint and other deleterious materials which might adversely affect welding. The joint design is to conform with the welding procedures specifications to be used.

3.2 JOINT PREPARATION

.1 Clean the pipe ends and bevels and make free of all detrimental materials.

3.3 WEATHER CONDITIONS

.1 Welding is not to be done when the quality of completed weld would be impaired by prevailing weather conditions, including but not limited to, moisture, blowing sands, high winds or low temperatures. Reference CSA Z662, Clause 7.2.7.7. The use of wind shields may make conditions for welding satisfactory.

.2 If, in the opinion of the Engineer, protection from prevailing weather conditions is necessary, cease welding until this protection has been placed correctly. The Contractor will not be compensated for downtime delays of this nature.

.3 Metal surfaces in and adjacent to the welding groove are to be dry before welding commences and while welding is in progress.

.4 When ambient temperature is below -12°C, cease welding operations unless a sub-zero welding procedure is approved.

3.4 WELDED JOINTS

.1 Unless specified otherwise, prepare pipe joints and fittings for single butt V-joints. Carefully fit the end of each pipe to mate to the preceding end in accordance with AWWA C206 and CSA Z662 and retained in position during the welding operation.

.2 Pipe which must be cut in the field for closing pieces and other field joints is to be cut with an approved, mechanical cutting machine to the required bevel. Edges are to be smooth and serrated. After cutting, grind smooth rough edges. Hammering rough edges in an attempt to make them smoother will not be permitted.

.3 Mitering pipe in the field will only be permitted providing the cutting and bevelling of welding edges, design of weld and welding are satisfactory to the Engineer.

.4 Weld penetration on butt welds is to be flush with inside surface of steel pipe.

.5 Deposit the entire root bead with the pipe in a stationary position. Take care that the pipe is not stressed nor the lineup of the joint changed while the root bead is being deposited.

.6 Remove scale and slag from each bead and groove. Cleaning may be done with either hand or power tools. Cleaning is not to affect the geometry of the joints.

.7 Make position welds with the parts to be joined, secure against movement and with adequate clearance around the joint to allow the welder or welders space in which to work.

.8 Unless the welding procedure provides otherwise, and has been qualified accordingly, commence no bead until the preceding bead has been completed. The number of beads is to be such that the completed weld will have substantially uniform cross-section around the entire circumference of the pipe and be uniformly convex. At no point is the crown surface to be below the outside surface of the pipe nor be raised above the parent metal by more than 3 mm.

.9 No pup shorter than 1200 mm or three pipe diameters, whichever dimension is greater, is to be installed in the line unless shown on the drawings.

.10 Each welder is to identify his work in a manner specified by the Engineer. Steel dye stamping of the pipe for this purpose is prohibited.

.11 Provide a list of identification symbols assigned to each qualified welder. This list is to be kept up-to-date at all times and copies of updated list sent to the Engineer.

.12 Protect the pipe lining from damage during the welding operation.

3.5 LINE-UP CLAMPS

.1 Use line-up clamps for butt-welded joints in conformance with CSA Z662, Clause 7.2.7.4. Use internal line-up clamps whenever practicable and when used do not remove until the root bead is complete. Ensure that the clamps are compatible with the internal pipe coating and do not cause irreparable damage to the coating. Root bead segments used in connection with external line-up clamps to be uniformly spaced around the circumference of the pipe and have an accumulative length of not less than 50% of the pipe circumference before the clamp may be removed. The pipe is to remain supported and stationary until the root bead is complete.

3.6 CLEARANCE

.1 Clearance in accordance with CSA Z662, Clause 7.2.7.8. When the pipe is welded in a trench, the bell hole is to be of sufficient size to provide the welder or welders ready access to the joint so that their skill is not impaired. When the pipe is welded above ground, the working clearance around the pipe at the weld is not to be less than 400 mm unless shown otherwise on the drawings.

3.7 PIPE HANDLING

.1 Exercise extreme care to prevent damage to pipe. Repair damage as directed by the Engineer and at the expense of the Contractor. Repair bevel ends if damaged.

.2 Remove all dents in the pipe deeper than 3 mm by cutting the dented portion of the pipe out, re-bevelling the cut ends, welding up and recoating. No compensation will be allowed the Contractor for such work.

3.8 WELDING PROCEDURE SPECIFICATIONS

.1 Prior to carrying out of any welding, submit three (3) copies of the proposed welding procedure to the Engineer for approval. Submit proposed welding procedure using the forms provided at the end of this section. The Engineer will return one copy with his approval, after which welding may be started. No change is to be made in this procedure without first obtaining the Engineer 's approval in writing.

.2 All passes are to have no more than five (5) minutes elapse between the previous pass termination and the commencement of the next pass. When the ambient temperature is below 0☜C, the maximum lapse time allowable will be four (4) minutes.

.3 No two weld beads are to be started or stopped in the same location.

.4 Visually examine each weld pass and repair any defects (pin holes, slag inclusions, gas pockets and undercutting) prior to welding the next pass.

.5 Do not strike the arc on the pipe at any other point, other than the welding groove. Any section of pipe which has been arc burned may, at the Engineer's discretion, be cut out and replaced at the Contractor's expense.

.6 All dirt and debris is to be swabbed from inside the pipe before welding into the line.

.7 Night caps are to be put on the welded part of the line to prevent entry of foreign materials.

.8 Do not subject welds to sudden variations in temperature and subject no welded sections to stresses, such as due to movement of pipe and loading on pipe until the welds are cooled below 38°C.

.9 Measure all temperatures by pyrometric crayons or other suitable devices approved by the Engineer.

.10 Damage to the welded pipe, due to the pipe being subjected to stresses before complete cooling of welds, will be completely corrected at the Contractor's expense.

.11 Prepare lap joint test joints and sections and air test in accordance with AWWA C206, Article 6.2. Give the Engineer timely written notice of when and where he will be conducting the welding of the test joints so as the Engineer can be present. Submit the qualification test results to the Engineer for approval. Written approval of the Engineer must be obtained prior to proceeding with the weld operation.

.12 Prepare a butt weld test joint and qualify using non destructive test methods (radiographic) to CSA Z662.

3.9 WELDER QUALIFICATIONS

.1 Welders engaged on the work are to possess a valid certification of qualification from the appropriate governing authority for pipeline welding in the flat, vertical and overhead positions. Certificates are to be for the Shielded Metal Arc Method of Welding. Submit copies of these certificates to the Engineer by the Contractor when the qualification test results are submitted to the Engineer.

.2 Welders are to qualify under CSA Z662, Clause 7.2.6. Each welder will also be required to demonstrate his ability to produce acceptable welds using the approved procedure. Make test welds under the supervision of the Engineer. Take filler metal for tests from the Contractor's stock at the site of the work.

.3 If, in the opinion of the Engineer and the Contractor, failure of a welder to pass is due to conditions beyond his control, he may be given a second opportunity to qualify. No further retests, beyond the second opportunity, will be given until the welder has submitted proof of subsequent welder training acceptable to the Engineer.

.4 Make a record of the test given to each welder and of the detailed results of each test. Maintain this record and a list of qualified welders and procedures in which they are qualified and provide to the Engineer. A welder may be required to requalify if there is a question about his ability.

.5 Provide a yard in Sooke for testing of the welding crews.

3.10 WELD SPREAD

.1 All welding undertaken in any day is to be completed that same day.

3.11 COATED PIPE PROTECTION AND FIELD COATING

.1 Protect and prepare for field welding all steel water pipe which has been previously coated.

.2 After field welding of steel water pipe, pipe coating of welded joints to be completed as follows:

  .1 Coating of welded joints in the field to be done in accordance with AWWA C210, Section 3.5. Primer and field coating of bare surfaces to be the same materials as used for shop coating of pipe.

.3 If damage of the coating occurs in the field, repair damaged portions in accordance with AWWA C210, Section 3.4.

3.12 INSPECTION

.1 Conduct inspection and testing of production welds in accordance with CSA Z662, Clause 7.2.8. After completion of the welding operation, leave the pipe uncoated for a period sufficient to permit the Engineer to inspect the welds. The Engineer will not unduly delay the inspection of the welds.

.2 Rigidly inspect work performed. Such inspection will not relieve the Contractor of his responsibility for performing work in conformance with the specifications. Notify the Engineer in advance of performing any work in order that inspection may be arranged. The Engineer may reject any work that does not comply with the specified requirements. Furnish reasonable facilities and space for inspection, testing and obtaining any information he desires respecting the character of materials used and progress and condition of the work.

.3 The Engineer may use any method of inspection necessary to establish quality control and ensure adherence to welding procedures. The Engineer has the right to accept or reject any weld not meeting the specified approved procedures and/or requirements.

.4 Air test pipe closures using butt strap or lap joint welds in accordance with AWWA C206 Article 6.2.

.5 Radiographically inspect ten percent of welds in accordance with CSA Z662, Clauses 7.2.9 and 7.2.12.8, the cost of which will be borne by the Contractor. Engineer to select welds for testing.

3.13 REPAIR OF DEFECTIVE WELDS

.1 Repair or removal of weld defects is to be in accordance with CSA Z662, Clause 7.2.8.4.

.2 Major defects and all cracks are to be cut out mechanically and the joint rewelded.

.3 Bear all cost for repairing defective welds, including radiographic inspection of the corrected work.

3.14 STORAGE OF ELECTRODES

.1 Protect the welding electrodes from any deterioration prior to use and any portion of carton or box found to be damaged or damp will be cause for rejection of entire box or carton.

.2 Closely follow manufacturer's recommendations for the care and storage of electrodes.

.3 Store welding electrodes which are susceptible to adverse effects of atmospheric moisture, such as the low hydrogen type electrodes and lime-coated stainless steel electrodes, in heated ovens when not in use. These ovens are to have an internal temperature of at least 150°C. Electrodes of this type, which have been exposed to the atmosphere more than 4 hours, are to be returned to the heated oven for a minimum of 8 hours before they may be used.

PROPOSED WELDING PROCEDURE

DATE ______________________________

JOB TITLE ______________________________

ASSOCIATED ENGINEERING PROJECT NO. ______________________________

CLASSIFICATION OF PIPE ______________________________

MINIMUM TENSILE STRENGTH ______________________________

MINIMUM YIELD STRENGTH ______________________________

PERCENTAGE ELONGATION IN 50 mm ______________________________

MILL TEST FORWARDED TO ASSOCIATED ENGINEERING (YES/NO) ______________

LADLE ANALYSIS FORWARDED TO
ASSOCIATED ENGINEERING (YES/NO) ______________________________

CARBON CONTENT ______________________________

CARBON EQUIVALENT ______________________________

EXTERNAL COATING ______________________________

INTERNAL COATING ____

PROCESS ____

DIAMETER AND WALL THICKNESS ____

JOINT DESIGN ____

FILLER METAL

Pass	Size	AWS Classification	Voltage	Amperage	Polarity	Brand
1						
2						
3						
4						
5						

POSITION ____

DIRECTION OF WELDING ____

NUMBER OF WELDERS ____

TIME LAPSE BETWEEN PASSES ____

INTER-PASS HEATING (IF REQUIRED) ____

METHOD OF HEATING ____

CLEANING BETWEEN PASSES ____

____

PREHEAT ____

MINIMUM AMBIENT TEMPERATURE ____

END OF SECTION

Part 1 General

1.1 DESCRIPTION

.1 The following pages provide a summary of the valve body materials, valve performances and reference specifications for use in the Work. Furnish all valves in accordance with the requirements of this Section and other Sections in Division 40. Where there is a conflict, conform to the most stringent requirements.

.2 Unless otherwise specified, provide the valve type as indicated in the drawings by the valve symbol shown. Match the symbol, commodity and line size to the Detailed Valve Specification Sheet. Table 1 references commodities and the valves acceptable for use with these commodities. The valve abbreviations of Table 1 indicate the Detailed Valve Specification Sheet to be referenced.

.3 Named Acceptable Products are given in this Section to define basic materials and performance criteria required for each valve type. Modify valves as specified to meet the service requirements of the system and detailed specifications.

1.2 DEFINITIONS

.1 Abbreviations used in Detailed Valve Specification Sheets:

CHV	Check Valve
KGV	Knife Gate Valve

1.3 PROCESS FLUIDS AND VALVE TYPES

Process Commodity	Detailed Valve Specification Abbreviation
Secondary Effluent	CHV 401, CHV 402, CHV 403, CHV 404
Secondary Effluent	KGV 401, KGV 402, KGV 403, KGV 404

Part 2 Products

Detailed Valve Specification Sheets follow.

CHV

GENERAL

TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (ºC)	PRESSURE (kPag)	TEMP. (ºC)
Check Valve	**CHV401** CHV 402 CHV 403 CHV 404	Liquid	350	5 to 100	1100	100

TYPICAL SERVICE

Secondary Effluent

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	ANSI/AWWA C508
Body	Cast Iron	Size Range	600 mm
Disc	Cast Iron or Ductile Iron	Rating	Class 125
		Valve Ends	Flanged, FF
		Type of Disc	Swing Check
		Operator	Spring-Loaded lever. Note 1
Shaft	Stainless Steel	Actuator	
		Lining	
		Coating	

NOTES

1. No check valves supplied to have weighted lever arm.

ACCEPTABLE PRODUCTS

Pratt 8001			

KG**V**

GENERAL

TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (ºC)	PRESSURE (kPag)	TEMP. (ºC)
Knife Gate Valve	**KGV401** KGV402 KGV403 KGV404	Liquid	860	90	1100	110

TYPICAL SERVICE

Secondary Effluent

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	ANSI/AWWA C520
Body	Ductile Iron	Size Range	600 mm
Gate	Stainless Steel (316)	Rating	Class 125
Packing	PTFE	Valve Ends	Flanged, FF
		Operator	bidirectional Note 1.

NOTES

1. Bevel gear with chain operator

ACCEPTABLE PRODUCTS

. Bray 740			

Part 3 Execution

Not Used

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
    - .1 Vibration isolation materials and components, seismic control measures and their installation.
- .2 Related Requirements:
    - .1 Seismic control measures to meet requirements of NBC.
    - .2 Provide seismic restraints on all cable trays, lighting, transformers and all other electrical equipment. Restraints to be in accordance with the latest edition of the Seismic Restraint Standards Manual - Guidelines for Electrical Systems, published by the Electrical Contractors Association of BC (ECABC).
    - .3 Where rotating equipment is factory installed in a cabinet or enclosure and the vibration isolation mounts are also factory installed, they are to have factory installed seismic restraints and provisions for anchoring complete unit to structure. The manufacturer is to supply certificates verifying the design of the seismic restraints in accordance with the provisions of this section.
    - .4 Before substantial performance, Contractor’s professional engineer for seismic design is to visit the site to verify seismic restraints installation and provide a Schedules S-B and S-C for the design and field review of seismic restraint in accordance with the applicable building code.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals:
    - .1 Submit manufacturer's printed product literature, specifications and datasheets in accordance with Section 01 33 00 - Submittals. Include product characteristics, performance criteria, and limitations.
    - .2 Provide stamped and signed letter of assurance by Contractor’s Professional Seismic Engineer.
- .2 Submit shop drawings in accordance with Section 01 33 00 - Submittals.
    - .1 Provide separate shop drawings for each isolated system complete with performance and product data.
    - .2 Provide detailed drawings of seismic control measures for equipment.

1.3 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
    - .1 Deliver, store and handle in accordance with Section 01 61 00 - Basic Product Requirements.
    - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

1.4 SEISMIC CONTROL MEASURES

- .1 General:
  - .1 Emergency lighting system to remain operational during and after earthquakes.
  - .2 Seismic control systems to work in all directions.
  - .3 Fasteners and attachment points to resist same maximum load as seismic restraint.
  - .4 Drilled or power-driven anchors and fasteners not permitted.
  - .5 No equipment, equipment supports or mounts to fail before failure of structure.
- .2 Static equipment: Anchor equipment to equipment supports. Anchor equipment supports to equipment pad or slab.
- .3 Suspended equipment: Use one or more of following methods or as indicated.
  - .1 Install tight to structure.
  - .2 Cross brace in all directions.
  - .3 Brace back to structure.
  - .4 Cable restraint system.
- .4 Seismic restraints:
  - .1 Cushioning action to be gentle and steady.
  - .2 Never to reach metal like stiffness.
- .5 Vibration isolated equipment:
  - .1 Seismic control measures not to jeopardize noise and vibration isolation systems. Provide 6 to 9 mm clearance during normal operation of equipment and systems between seismic restraint and equipment.
  - .2 Incorporate seismic restraints into vibration isolation system to resist complete isolator unloading.
- .6 Piping systems:
  - .1 To be compatible with requirements for anchoring and guiding of piping systems.
- .7 Bracing methods:
  - .1 Designed by Professional Engineer registered in British Columbia.
  - .2 Structural angles or channels.
  - .3 Cable restraint system incorporating grommets, shackles and other hardware to ensure alignment of restraints and to avoid bending of cables at connection points. Incorporate neoprene into cable connections to reduce shock loads.

Part 2 Products

2.1 CABLE RESTRAINTS

- .1 Provide slack cable restraint systems and/or other approved systems, for general seismic bracing of suspended equipment.
- .2 Acceptable material: Mason, Vibron.

.3 Other approved systems are conventional pipe guides, rigid restraint where the piping is non-isolated or passes through a block, or a cable strap and space piece attached to the structure, used where conventional slack cable/rigid restraints cannot be used.

2.2 ELASTOMERIC MOUNTS

.1 Colour coded; neoprene in shear; maximum durometer of 60; threaded insert and two bolt down holes; ribbed top and bottom surfaces.

.2 Acceptable material: Mason, Korfund, Vibron.

2.3 SPRINGS

.1 Design stable springs so that ratio of lateral to axial stiffness is equal to or greater than 1.2 times the ratio of static deflection to working height. Select for 50% travel beyond rated load. Units to be complete with levelling devices.

.2 Ratio of height when loaded to diameter of spring between 0.8 to 1.0.

.3 Cadmium plate for all installations.

.4 Colour code springs.

2.4 SPRING MOUNT

.1 Zinc or cadmium plated hardware; housings coated with rust resistant paint.

.2 Restrained stable open spring: supported on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad; built in resilient limit stops, removable spacer plates.

.3 Performance: 25 mm deflection.

.4 Acceptable material: Mason, Korfund, Vibron.

2.5 HANGERS

.1 Colour coded springs, rust resistant, painted box type hangers. Arrange to permit hanger box or rod to move through a 30° arc without metal to metal contact.

.2 Type H1 - neoprene - in shear, molded with rod isolation bushing which passes through hanger box.

.3 Type H2 - stable spring, elastomeric washer, cup with molded isolation bushing which passes through hanger box.

.4 Acceptable material: Korfund, Mason, Vibron.

2.6 HORIZONTAL THRUST RESTRAINT

.1 Spring and elastomeric element housed in box frame; assembly complete with rods and angle brackets for equipment; provision for adjustment to limit maximum start and stop movement to 10 mm.

.2 Arrange restraints symmetrically on either side of unit and attach at centreline of thrust.

.3 Acceptable material: Korfund, Mason, Vibron.

Part 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 vibration isolation equipment in accordance with manufacturer’s instructions and adjust mountings to level equipment.

.2 Ensure piping, and electrical connections to isolated equipment do not reduce system flexibility and that piping and conduit through floors do not transmit vibrations.

.3 Where isolation is bolted to floor use vibration isolation rubber washers.

.4 Block and shim level bases so that piping connections can be made to a rigid system at the operating level, before isolator adjustment is made. Orient restrain wires on equipment at approximately 90° to each other (in plan), and tie back to the ceiling slab at an angle not exceeding 45° to the slab.

.5 Select the restraints for the specified seismic requirements. (These requirements are generally 0.8 g for normal piping and 1.4 g for piping and equipment containing toxic materials).

.6 Install cables using appropriate grommet, shackles, and other hardware to ensure alignment of the restraints and to avoid bending the cables at connection points. Cables can be directly wrapped around the pipe as opposed to using collars.

.7 On piping systems, provide transverse slack cable restraints at a maximum spacing of 12.5 m and longitudinal restraints at 25 m maximum spacing, or as limited by anchor/slack cable performance.

.8 Vary adjacent spacing of restraints on a piping by 10% to 30% to avoid coincident resonances.

.9 Transverse bracing for one pipe section may also act as longitudinal bracing for the pipe connected perpendicular to it, provided the bracing is installed within 600 mm of the elbow or tee, and if the connected pipe is the same or smaller in size. Do not use branch lines to restrain main lines.

.10 Install restraints at least 25 mm clear of all other equipment and services.

.11 Adjust restraint cables such that they are not visibly slack, or that the flexibility is approximately 35 mm under thumb pressure for a 1500 mm cable length (equivalent ratio for other cable lengths). Adjust the clearance at cable/spacer piece restrains to not exceed 6 mm.

.12 Bolt all non-isolated equipment to structure.

3.3 CLEANING

.1 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 DESCRIPTION

.1 This section specifies the supply, installation and testing of manually operated valves used for isolation, manual throttling, and bypass and for specialty valves requiring electric, hydraulic or pneumatic actuation.

1.2 DEFINITIONS

.1 Valve Identification

- .1 Process valves are identified on the drawings by valve symbols. Refer to the drawings for lists of valve symbols and labels.

.2 Actuators

- .1 Supply valves with standard operators as detailed herein unless otherwise noted in the Contract Documents.
- .2 All valves must be operable from grade.

1.3 SUBMITTALS FOR REVIEW

.1 Submit the following:

- .1 Catalogue cuts and/or shop drawings for each type of valve indicating valve number, materials of construction, dimensions, head loss characteristics through the valve, operating torque and valve end configuration.
- .2 An amended Detailed Valve Specification Sheet or Specialty Valve Data Sheet for all valves. Indicate with check marks where valve supplied meets requirements specified and with written amendments where product differs from the specification.

1.4 SUBMITTALS FOR INFORMATION ONLY

.1 Submit the following:

- .1 Operating and Maintenance data for incorporation in operation and maintenance manual, as specified in the Contract Documents. Include complete description of operation together with detailed drawings, a complete list of replacement and repair parts, and parts manufacturer's identifying numbers.
- .2 Affidavits and registration numbers described below in Quality Assurance.

1.5 QUALITY ASSURANCE

.1 Provide Canadian Registry Number (CRN) designated by the Province of British Columbia for each valve type.

.2 Valves are to be marked in accordance with MSS SP25.

1.6 SHIPMENT, PROTECTION AND STORAGE

.1 Deliver valves to site using loading methods which do not damage casings or coatings.

.2 Clearly tag valves, stating size, type, coating and mating parts.

.3 Store on site until ready for incorporation in the work using methods recommended by manufacturer to prevent damage, undue stresses, or weathering.

.4 Deliver and store valves in accordance with Section 01 61 00 – Basic Product Requirements.

Part 2 Products

2.1 GENERAL

.1 Provide valves of the same type, size range and service from a single manufacturer.

.2 Provide new, unused valves for the work.

.3 Valve materials to be free from defects or flaws, with true alignment and bores.

.4 Unless otherwise indicated, valves shall be the same size as the pipe run in which they are to be installed.

.5 Clearly mark valve bodies in raised lettering to indicate the valve type, rating, and where applicable, the direction of flow. Conform to MSS SP25.

.6 Provide padlockable lockout feature on all sizes of the following valve types or where indicated on drawings.

  .1 Manual Isolation and Shut-off Valves: Knife Gate Pump Discharge only.

.7 Valves to open counter-clockwise.

2.2 VALVE SPECIFICATION

.1 Refer to specification Section 40 23 24 – Detailed Piping Specifications for each valve specification according to type and line code.

2.3 OTHER VALVE SPECIFICATION

.1 Refer to Section 40 23 24 – Detailed Piping Specification according to type and line code for valves not specifically specified in this section.

2.4 DRAWINGS

.1 Process schematics indicate major process valves required for the process to operate as intended.

.2 Detailed process drawings indicate the valves on the process schematics plus other valves required for isolation.

.3 In pipe runs less than 100 mm diameter, in addition to the valves indicated on the detailed drawings and standard drawings, provide isolation valves in straight pipe runs at intervals no greater than 60 m and at takeoffs to individual services. Provide ball isolation valves in pipe of 65 mm diameter and less, or in pipe of less than 100 mm diameter and carrying solids.

.4 Provide valves and taps on top of pipe at high point in all liquid pipe runs greater than 60 m length where the change in slope exceeds 4 percent.

2.5 VALVE ENDS

.1 In pipe runs less than 75 mm diameter provide valves with female threaded ends, unless indicated otherwise. Threads to conform to ANSI B1.20.1.

.2 Valves in pipe runs equal to or greater than 75 mm diameter to be flanged unless indicated otherwise.

.3 For cast iron body valves, drill flanges to Class 125 pattern conforming to ANSI B16.1. For steel body valves, flanges to be Class 150 pattern or Class 300 pattern conforming to ANSI B16.5 or as noted.

.4 Do not use grooved joint valve ends.

.5 Use flanged joints for buried and exterior valves. Flanges to be compatible with pipe and jointing technique used.

.6 Lug style wafer body valves shall have tapped holes, suitable for the bolt spacing of the pipe flanges placed on either side.

.7 Wafer body valves shall have positioning holes, suitable for the bolt spacing of the pipe flanges placed on either side.

2.6 MANUAL OPERATORS

.1 Valves must be operable from grade elevation unless otherwise noted.

.2 Provide valves with manual operators unless specifically indicated otherwise.

.3 For hand wheels, clearly show direction of opening in raised lettering and symbols.

.4 Hand wheel diameter to conform to the following:

Nominal Valve Size (mm)	Minimum Hand Wheel Diameter (mm)
12	50
20	50
25	60
38	75
50	85
65	105
75	200
100	250
150	300
200	350
250	400
300	450
350	450
400	550
450	600
500	600
600 / 750	600

.5 Maximum rim pull on a hand wheel not to exceed 300 N when one side of the valve is at test pressure and the other side is at atmospheric pressure. Provide gear operator where a shaft mounted hand wheel would require greater than this force to operate. Unless different operators are scheduled or shown in the drawings, conform to the following minimum requirements:

  .1 Knife Gate Valves: less than 300 mm, hand wheel; equal to or greater than 300 mm, gear operator.

.6 Match existing operating nuts. Provide two eight-point operating wrenches.

.7 Supply stem extensions and valve boxes for buried valves. Provide two operating tees.

.8 Lever operators to conform to the following dimensions:

Nominal Valve Size (mm)	Minimum Length of Lever (mm)
6	80
12	80
20	100
38	150
50	150
65	150
75	175
100	225
150	250
200	300
250	450
300	450

.9 Quarter turn lever operators to be perpendicular to the pipe run when the valve is closed.

.10 Gear operator to be worm gear type, equipped with a hand wheel and a visual indicator of the valve position. Equip operators with adjustable, self-locking mechanical stop-limiting devices designed to hold the valve in any intermediate position between full open and full closed to prevent overtravel of the disc/ball in the open and closed positions. Gear operators to be grease lubricated. Where gear operators are intended for direct bury or submergence, seal units with long life lubricant.

.11 Gear and manual operators for submerged service to be permanently lubricated and sealed for operation at water pressures to 700 kPa.

.12 Provide chain wheel gear operators for manual valves on lines 75 mm and greater, mounted over 1.0 m above the operating floor. Design the operator so that a force of 150N is sufficient to open the valve when one side of the valve is at test pressure and the other side is at atmospheric pressure. The chain pulley to mesh positively with the chain. Chain to extend from valve operator to operating height 1.2 m above the floor or as directed by the Engineer. Exact dimensions to be field determined. Provide approved chain hooks where required to prevent chain from hanging within traffic paths.

2.7 VALVE STEM EXTENSIONS

.1 Provide valve stem extensions where additional clearance is required for pipe insulation or where valve operation without the extension is difficult and in manholes.

.2 Where angle valve stem extensions are employed, they shall be angle geared. Universal joint types are not permitted.

2.8 PROTECTIVE COATINGS

.1 Provide valves coated in accordance with Section 40 46 16 – Protective Coating and Lining for Steel Pipe unless otherwise specified.

2.9 SPARE PARTS

.1 Provide spare parts in accordance with Section 01 78 24 – Spare Parts and Maintenance Materials.

.2 Provide one spare valve including the appropriate operator for each valve type and size equal to or less than 250 mm in diameter.

.3 Provide a list of all spare parts which would be expected to be required under normal conditions for a period of five years. At the Engineer's request, provide a price for these parts.

Part 3 Execution

3.1 PREPARATION

.1 Valve and piping arrangement indicated in the drawings is based on typical dimensions for valves of the specified type. Make the necessary modifications in piping to allow for discrepancies between valve dimensions shown and those supplied for the work.

.2 Field measure and check all equipment locations, pipe alignments, and structural installation prior to installation of valves. Ensure that valve locations and orientations provide suitable access to manual operators and that sufficient space and accessibility is available for pneumatic and electric actuators.

.3 Where conflicts are identified, inform the Engineer and initiate the necessary piping modifications at no cost to the Owner.

3.2 VALVE INSTALLATION

.1 In horizontal pipe runs, other than in locations where space does not permit, mount all valves with a vertical operating shaft with the actuator at the top. In no case install a valve with the operator shaft pointing down.

.2 Do not overtorque bolts to correct for misalignment when joining valves to pipe or fittings,

.3 Support valves in position using temporary supports until valves are fixed in place.

.4 Permanently support valves to prevent transmission of loads to adjacent pipework and/or equipment.

.5 Where valves are installed in PVC pipework greater than 100 mm diameter, support valves independently and brace against operating loads and torque to prevent transmission of stresses to adjacent pipework.

.6 Generally pipe supports and hangers are not shown for indication purposes.

.7 Install valves which are bubble tight in one direction to seal in a direction opposite to normal flow unless otherwise noted or directed by the Engineer.

.8 Unless otherwise specified, install knife gate valves with the seat downstream. Install in dry conditions on pump discharge and suction lines with seat adjacent to the pump.

.9 Install all valves in accordance with manufacturer's recommendations.

3.3 VALVE EXTENSIONS

.1 Install valve stem extensions where necessary to provide clearance from insulation.

.2 Install valve stem extensions where indicated on drawings.

3.4 VALVE TESTING

.1 Operate valves under simulated and/or real process conditions to ensure operation as intended.

.2 Valves to be pressure tested in conjunction with the pipes in which the valves are installed.

END OF SECTION

Part 1 General

1.1 GENERAL

.1 This section contains detailed piping specifications.

1.2 PIPING IDENTIFICATION

.1 The drawings designate the size and line service specification of pipe to be supplied by the Contractor in the following manner:

.1 Line Identification: Line identification is placed on each line in the following manner:

150 - PW - A1 - A - D

Where:

150	Line Size
PW	Commodity
A1	Piping Line Code
A	Internal Lining
D	External Pipe Coating

.2 Commodity Symbols for Line Identification

SYMBOL	COMMODITY
AAS	Aeration Air Supply
EFF	Effluent
PSW	Plant Service Water (non potable)
RWW	Raw Waste Water (Sewage)

.3 Line Codes: The following is a description of the general line code classifications. For specifics, refer to the appropriate commodity sheet.

Pipe or Line Codes	Flange Ratings	Basic Material	Maximum Design Pressure	Maximum Design Temp.	Suitable Services
A1	ANSI 150	Steel	1034 kPa	100°C	EFF

.4 Special Treatment Code

SYMBOL	DESCRIPTION
(A)	Cement mortar lining
(B)	Internal hot applied coal tar lining
(C)	Internal epoxy lined
(D)	Yellow jacket coated
(E)	External hot applied coal tar lining
(F)	External epoxy coated
(G)	Insulated
(H)	Flexible elastomeric insulation

(I) Insulation c/w jacket (high temperature)

Part 2 Products

.1 As follows:

SERVICE: EFF		LINE CODE: A1
PRIMARY FLANGE RATING:	CLASS 150 ANSI B16.5	DESIGN PRESSURE: 1034 kPa
TEMPERATURE (MAX): 100°C		CORROSION ALLOWANCE: 1.3 mm
ITEM	SIZES	GENERAL DESCRIPTION
Pipe	750 to 900 mm	Steel, ASTM A139 Grade B, or API 5L Grade B, seamless or welded, 9.5 mm wall.
	80 mm to 600 mm	Steel, ASTM A53 or ASTM A106 Grade B, seamless or welded, standard weight.
	40 mm to 65 mm	Steel, ASTM A53 Grade B, seamless or welded, Sch. 40.
	30 mm or smaller	Steel, ASTM A53 Grade B, seamless or welded, Sch. 80.
Fittings	750 to 900 mm	Steel, ASTM A234 Grade WPB, butt weld, 9.5 mm wall.
	80 mm to 600 mm	Steel, ASTM A234 Grade WPB, standard weight, butt weld. Dimensions to ANSI B16.9.
	65 mm or smaller	Steel, ASTM A197 Class 300, malleable iron, screwed.

NOTE: Elbows to be long radius unless otherwise specified.

Coatings / Linings	All sizes	Refer to spec. 404616.
Flanges	750 mm	Steel, ANSI B16.47 Series A Class 150 or AWWA C207 Class E, slip-on, flat faced with serrated finish.
	80 mm to 600 mm	Steel to ANSI B16.5 Class 150, or AWWA C207 Class E, slip-on or weld-neck, raised face. Orifice Flanges to be Class 300 Carbon Steel to ASTM A105, slip-on, raised face. Flanges mated to equipment with cast iron flat faced flanges or rubber seated butterfly valves to be flat faced.

NOTE: Flanges attached to fittings to be weld neck type equal in material, dimensions and rating to the Class E flange.

SERVICE: EFF		LINE CODE: A1
PRIMARY FLANGE RATING:	CLASS 150 ANSI B16.5	DESIGN PRESSURE: 1034 kPa
TEMPERATURE (MAX): 100°C		CORROSION ALLOWANCE: 1.3 mm

ITEM	SIZES	GENERAL DESCRIPTION
Bolts	All sizes	ASTM A193 Grade B7 hex head.
Nuts	All sizes	ASTM A194 Grade 2H, hex head semi-finished.
NOTE: Buried flanges to come with 316SS bolts and nuts.		
Flange Gaskets	All sizes	EPDM, ring type for RF flanges, full face for FF flanges, to ASTM B16.21
Unions	80 mm & larger	Use flanges.
	65 mm & smaller	Class 300, malleable iron, ground joint, bronze to iron seat.
Pipe Couplings	65 mm & smaller	Use unions.
	80 mm & larger	The coupling type to be as shown on the drawings and to suit outside diameter of pipe. Flanged adaptor couplings to be Dresser Style 128 with AWWA C207 Class E flange. Flexible couplings to be Dresser Style 38, Robar or Viking Johnson. Flanged adaptor and flexible couplings to be internally lined as specified for pipe. Flexible joints to be neoprene expansion joint. Acceptable product: Metraflex 100 HT Spool Type.
	80 mm to 300 mm	Victaulic Style 07 and 77 standard weight.
	350 mm to 750 mm	Victaulic Style W07 and W77, per pipe schedule.
	750 mm to 900 mm	Victaulic Style 232, epoxy coated.
NOTE: Gaskets for pipe couplings rated for line code maximum temperature and intended service.		
NOTE: For buried service, pipe couplings rated/approved for buried service, fasteners to be 316SS.		
Victaulic Gasket	All Sizes	To match Couplings and intended service.
Thread Compound	As required	Teflon tape.

SERVICE: EFF		LINE CODE: A1
PRIMARY FLANGE RATING:	CLASS 150 ANSI B16.5	DESIGN PRESSURE: 1034 kPa
TEMPERATURE (MAX): 100°C		CORROSION ALLOWANCE: 1.3 mm
ITEM	SIZES	GENERAL DESCRIPTION

Part 3 Execution

.1 Not applicable.

END OF SECTION

Part 1 General

1.1 GENERAL

.1 Apply protective coatings and linings to all exposed surfaces of all steel pipe in accordance with the requirements of this specification.

1.2 SAFETY

.1 Safety of the public, workers and the environment is the responsibility of all parties directly or indirectly related to this project as described above.

.2 All work relating to this project must be in accordance with WorkSafe BC regulations.

.3 It is expected that the all workers be properly trained, all equipment and facilities be in good repair, and safe work practices be followed throughout the duration of this project.

1.3 PRE-JOB MEETING

.1 A pre-job meeting shall be held to verify project requirements, manufacturer's application instructions, manufacturer's warranty requirements and quality control procedures and requirements. The Contractor and/or his QC representative, the shop coating applicator, and the Owner's Coating Inspector (CI) shall be present at the pre-application meeting.

1.4 REFERENCES

.1 The Society for Protective Coatings SSPC-SP1, Solvent Cleaning.

.2 The Society for Protective Coatings SSPC-SP10, Near White Blast Cleaning.

.3 The Society for Protective Coatings SSPC-VIS 1, Pictorial Surface Preparation Standards for Painting Steel Surfaces.

.4 SSPC-PA COM - Commentary on Paint Application.

.5 SSPC-Guide 15 - Field Methods for Retrieval and Analysis of Soluble Salts on Substrates.

.6 ASTM D4541 - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.

.7 ANSI/AWWA C210 (Latest Edition) Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.

.8 ANSI/AWWA C216 (Latest Edition) Heat-Shrinkable Cross-Linked Polyolefin Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.

Part 2 Products

2.1 GENERAL

.1 Coating materials shall be standard products produced by recognized manufacturers who are regularly engaged in production of such materials for essentially identical service conditions. Products must have five (5) years of case histories on similar steel pipe coating projects.

.2 Pipeline coating materials shall be the products of a single manufacturer, unless otherwise noted in this specification. Product substitutions during the project will not be considered or permitted.

.3 Coating applicator shall provide a monitoring system approved by the coating manufacturer that constantly records pipe and coating conditions during coating application. Recorded monitoring parameters shall include pipe temperature, line speed, surface preparation, holiday test and other parameters applicable to the type of coating.

2.2 SURFACE PREPARATION

.1 All products used for the preparation and application of the work shall be new and purchased from the same Manufacturer. Materials provided shall meet the provisions of this specification. Materials that fail to meet the requirements at any time during the work may be rejected at any time prior to final acceptance of the work.

.2 Blasting material: All blasting material shall be WCB accepted. The following blast cleaning abrasives are pre-accepted:

  .1 Lane Mountain 20/30 Silica Sand (shop only)
  .2 Steel shot with minimum 15% steel grit content
  .3 Garnet - Emerald Creek and Ruby Creek Garnet
  .4 Copper Slags - Kleenblast, Tuf-Cut or Tru-Grit
  .5 Nickel Slags - Green Diamond
  .6 Coal Slags - Black Pearl
  .7 Recycled Glass

.3 The blasting material shall be in accordance with AWWA specification for the particular coating system.

.4 The Engineer may approve other combinations, provided the proposed materials are shown to perform as well or better than those stipulated in this Section.

2.3 COATING SYSTEMS

.1 Shop coating (Exterior)

- .1 The pipe coating shall be liquid-epoxy meeting the requirements of AWWA C210 (Latest Edition) Liquid-Epoxy Coating Systems for the Exterior of Steel Water Pipelines and shall have NSF 61 certification for potable water. Approved epoxy paint includes BarRust 233H or approved alternate.

.2 Shop Lining (Interior)

- .1 The pipe lining shall be liquid-epoxy meeting the requirements of AWWA C210 (Latest Edition) Liquid-Epoxy Coating Systems for the Interior of Steel Water Pipelines and shall have NSF 61 certification for potable water. Approved epoxy paint includes BarRust 233H or approved alternate.

.3 Field coating (Exterior). The field applied exterior girth weld coatings shall be one of the following systems:

- .1 ANSI/AWWA C216 (Latest Edition) Heat-Shrinkable Cross-Linked Polyolefin Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines. The following products are acceptable:
  - .1 Canusa-K-60 Canusa Wrap. Wrap Around Girth Weld Sleeve.

.4 Field Lining (Interior)

- .1 The field applied lining shall be liquid-epoxy meeting the requirements of AWWA C210 (Latest Edition) Liquid-Epoxy Coating Systems for the Interior of Steel Water Pipelines and shall have NSF 61 certification for potable water.
- .2 The field applied lining product shall be the same product as the shop applied lining.

2.4 REPAIR COATINGS

.1 The coating manufacturer for the shop applied coating and lining shall recommend a suitable field repair coating system for the coating and lining systems.

.2 The manufacturer shall provide written application procedures for field repairs.

.3 Coating Schedule

- .1 Pipe segments shall be supplied in 20 m (60 ft.) segments (maximum).
- .2 The coating cut-back at each end of each pipe segment, interior and exterior, shall be 200 mm.

2.5 SHIPPING AND STORAGE OF MATERIALS

.1 All coating material shall be delivered to the coating Applicator's shop or project site in the original factory-sealed containers bearing the coating Manufacturers' labels identifying the product number, batch number, name, color, instructions for use and WHMIS requirements.

.2 Material Safety Data Sheets shall accompany the material and remain in the shop or on site at all times.

.3 All coating materials shall be stored in an area which shall protect the materials from weather and temperature extremes, as recommended by the coating manufacturer.

Part 3 Execution

3.1 SURFACE PREPARATION

.1 Any areas on the pipe surface that are contaminated with oil and/or grease shall be solvent cleaned prior to abrasive blast cleaning.

.2 Steel surfaces to be coated are to be tested for the presence of soluble chemical salts prior to abrasive blast cleaning. A suitable CSN Salt Test Kit shall be utilized to test for chlorides, sulfates and nitrates. If soluble salts are found to be present then the surface shall be washed with a suitable salt removal product such as Chlor-Rid®. One (1) of every five (5) pipe segments shall be randomly tested on the interior and exterior for soluble salts.

.3 All steel surfaces, prior to coating shall be abrasive blast cleaned to Near White Blast Cleaning and the appearance shall be in accordance with appropriate visual standards.

.4 The achieved surface profile shall be as specified by the coating manufacturer.

.5 All traces of abrasive materials shall be removed from the surface by blowing clean, dry compressed air onto the surface, or using clean bristle brushes or vacuum.

.6 The compressed air shall have water/oil traps on the line to prevent contamination of the steel by oil or water.

3.2 SHOP COATING (EXTERIOR)

.1 All coating application shall be done in accordance with the coating manufacturer's recommendations and in conformance with the principles of good workmanship.

.2 The coating application shall conform to the requirements of ANSI/AWWA C210 (Latest Edition), NSF 61 certification for potable water, and the coating manufacturer's recommendations.

.3 All steel must be clean and dry prior to coating application. Any cleaned steel not coated within eight hours shall be blast cleaned again.

.4 No coating applications work shall be performed under unfavorable weather conditions unless a suitable enclosure is provided which shields the steel from precipitation.

.5 No coatings shall be applied if the conditions for relative humidity, ambient temperature and steel temperature do not satisfy the coating manufacturer's requirements.

.6 All products shall be thoroughly mixed as per the coating manufacturer's recommended procedures.

.7 Thinning shall not be allowed except as recommended by the coating manufacturer.

3.3 SHOP LINING (INTERIOR)

.1 All lining application shall be done in accordance with the coating manufacturer's recommendations and in conformance with the principles of good workmanship.

.2 The lining application shall conform to the requirements of ANSI/AWWA C210 (Latest Edition), NSF 61 certification for potable water, and the coating manufacturer's recommendations. In the event of a difference between the two, the more stringent requirement shall be followed.

.3 All steel must be clean and dry prior to coating application. Any cleaned steel not coated within eight hours shall be blast cleaned again.

.4 No coating applications work shall be performed under unfavourable weather conditions unless a suitable enclosure is provided which shields the steel from precipitation.

.5 No coatings shall be applied if the conditions for relative humidity, ambient temperature and steel temperature do not satisfy the coating manufacturer's requirements.

.6 All products shall be thoroughly mixed as per the coating manufacturer's recommended procedures.

.7 Thinning shall not be allowed except as recommended by the coating manufacturer.

3.4 FIELD COATING (EXTERIOR)

.1 Field coating procedures will depend on the specific product selected and shall be provided by the coating manufacturer.

.2 Exposure to UV must not exceed manufacturer’s recommendation.

3.5 FIELD LINING (INTERIOR)

.1 The lining application shall conform to the requirements of ANSI/AWWA C210, NSF 61 certification for potable water, and the coating manufacturer's recommendations.

3.6 REPAIR COATINGS

.1 The coating and lining system on the steel pipe shall be repaired if damaged prior to installation. After field repairs are made, the Contractor shall ensure that the coated and lined pipe is protected from any damage caused by Contractor's forces and construction activities.

.2 The coating manufacturer shall recommend a suitable field repair coating for the specific applied coating system. The manufacturer shall provide written application procedures for field repairs.

.3 Repairs to the coatings and linings shall be performed by tool cleaning the repair area to remove rust and loose coating. Edges of intact coating shall be feathered and new coating applied as specified herein or in accordance with the manufacturer's recommendations.

3.7 QUALITY CONTROL/ASSURANCE

.1 Arrange and pay for third party National Association of Corrosion Engineers (NACE International) CIP (Coating Inspection Program) Level 2 (minimum) - Certified, Quality Control inspection and provide certified reports showing compliance with specified performance characteristics and physical properties of the specified coating and lining systems. Reports should include, at a minimum but not limited to, ambient environmental conditions, achieved surface profile, achieved surface cleanliness, dry film thickness (DFT) measurements after each coat, holiday testing results and verification of any repairs.

.2 The Owner may retain the services of an independent, third party, NACE certified CI to verify conformance with all of the specification requirements for the lining and coating.

.3 Submit a Quality Control Inspection and Testing Plan (ITP), detailing the type and frequency of inspection and testing to be performed by the Contractor's QC representative. The ITP plan shall conform to the requirements of this section and shall be prepared in coordination with the Owners CI. The ITP shall include a work plan schedule so the CI can carry out his function without delay.

.4 Holiday testing shall be conducted on the coating and lining and all holidays shall be appropriately repaired prior to acceptance.

.5 Measurement of Dry Film thickness shall be conducted and shall comply with the requirements on the applicable ANSI/AWWA coating system standard.

.6 Coating and lining tensile adhesion testing in accordance with ASTM D4541 shall be conducted by the Contractors QC on representative sample plates. The Owner's CI shall be present to witness the adhesion testing.

.7 Exterior Epoxy Coating: Two sample plates shall be prepared over the course of the shop coating operation. A minimum of three separate ASTM D4541 pull-off adhesion tests shall be conducted on each sample plate. The average adhesion for each sample plate shall exceed 3.44 MPa (500 psi).

.8 Interior Epoxy Coating: Two sample plates shall be prepared over the course of the shop coating operation. A minimum of three separate ASTM D4541 pull-off adhesion tests shall be conducted on each sample plate. The average adhesion for each sample plate shall exceed 3.44 MPa (500 psi).

.9 The shop coating applicator shall monitor the wet film thickness of the coatings during application to ensure the proper thickness is attained as recommended by the coating manufacturer for each specific product.

.10 The Owner's CI will inspect the steel for the degree of cleanliness prior to any coating or lining application. No coating work shall be allowed until the Owner's CI has inspected and approved the surface preparation.

.11 The Owner's CI will measure and verify the DFT of the coatings and linings on the painted items to ensure that the thickness conforms to these specifications, prior to the pipe leaving the coating shop. Notify the CI when painted items are ready for measurement.

3.8 SHIPPING AND HANDLING OF COATED PIPE

.1 Ensure the coating system has dried hard prior to handling and transporting the coated items.

.2 Coated pipe shall be shipped and stored on wood dunnage covered with carpet to minimize damage to the coating.

.3 Coated pipe shall be handled with appropriate cloth slings to minimize damage to the coating during handling and installation.

3.9 DOCUMENTATION AND SUBMITTALS

.1 Proposed coating product literature, including product data sheets, recommended application instructions and/or requirements as well as MSDS sheets, shall be submitted to the Owner's representative for Owner's approval prior to application of shop, field and repair coatings.

.2 A Quality Control Inspection and Testing Plan (ITP) shall be submitted to the Owner's CI for Owner's approval prior to application of the coatings.

.3 Quality Control Inspection reports shall be submitted to the Owner's CI by the Contractors QC representative upon request during the course of the shop coating and lining application. Following completion of the shop coating and lining application a complete set of QC inspection reports shall be provided for review prior to final acceptance of the coated and lined pipe. No pipe will be installed before final acceptance of coated and lined pipe by Owner’s CI and Engineer.

.4 Manufacturer's recommended repair product literature, application procedures, and MSDS sheets shall be submitted to the Owner's representative for Owner's approval prior to application of the repair coatings. Ensure the coating system has dried hard prior to handling and transporting the painted items.

END OF SECTION

Part 1 General

1.1 SCOPE

.1 This section refers to the hydrostatic and pressure testing of all water retaining structures and piping.

.2 All new water retaining or carrying pipes shall be tested for leakage.

.3 All testing shall be as specified herein or elsewhere in these specifications or as directed by the Engineer’s representative.

.4 Furnish suitable temporary service connections, testing plugs or caps, pressure pumps, pipe connections, gauges, thrust supports, and all other required equipment and labour necessary for filling the structure, expelling air, and dewatering the structure without additional compensation.

.5 Coordinate with local utility personnel during testing.

1.2 MEASUREMENT AND PAYMENT

.1 There shall be no additional payment for items specified in this section. Payment shall be included in relevant bid items. Priced as lump sum.

Part 2 Products

2.1 WATER

.1 Owner will provide all water used for the initial pressure testing at no cost to the Contractor. However, all water required for re-testing, following failure of their initial test, will be supplied by Owner at the Contractor's expense.

.2 Supply and install all temporary pipework, pumps and other equipment required to transport the water from Owner’s point of supply at the existing structure or piping to be tested.

.3 Provide the Engineer and Owner with at least seventy-two (72) hours of notice of his requirement for water for testing.

Part 3 Execution

3.1 CLEANING

.1 Prior to pressure testing, thoroughly clean all water pipework. Remove all dirt and loose material.

.2 Cleaning to include all necessary provisions to thoroughly wash down interior surfaces, and to remove all wash down water and solids from the pipe.

.3 Leave all systems operating with work areas clean to the satisfaction of the Engineer and Owner.

3.2 DISPOSAL OF TESTING WATER

.1 Dispose of water used for the initial testing of the piping and chambers into the lagoon at a rate that will not cause hydraulic overloading. The Contractor is responsible for the necessary equipment required to pump the test water to the lagoon.

3.3 INSTRUMENTATION PROTECTION

.1 Remove or isolate all instruments that have a maximum range of less than the hydrostatic or pneumatic test pressure during the pressure test. On successful completion of the system test, lower the pressure and re-pressurize if required, to a pressure within the range of the instruments to test the isolated or removed instruments in accordance with other sections of these specifications.

3.4 PRESSURE TESTING OF PIPING

.1 Where any section of system is provided with concrete thrust blocks, do not conduct tests until at least five (5) days after placing concrete or two (2) days if high early strength concrete is used.

.2 Strut and brace caps, bends, tees, and valves, to prevent movement when test pressure is applied.

.3 Pipeline should be left at low pressure for a period of forty-eight (48) hours prior to testing to saturate concrete lining where applicable.

.4 Thoroughly examine exposed parts while under pressure and correct for leakage as necessary. Remove joints, fittings, and appurtenances found defective and replace with new sound material and make watertight.

.5 The amount of leakage during the test period shall be zero. Repeat pressure test until all defects have been corrected and no loss of water is observed.

.6 Pressure testing shall be conducted on the pipelines to the pressures and durations as follows (or the maximum rated pressure of the pipeline whichever is less):

Pipe Description	Test Pressure (kPa)	Duration (hours)
Steel Piping, Class 150	1030	4

3.5 DEFECTS AND REPAIRS

.1 Defects disclosed in the work shall be made good and retested or the work replaced without additional cost to the Owner.

.2 Repairs to piping systems shall be made with new material. No caulking of screwed joints, cracks or holes will be accepted. Where it becomes necessary to replace pieces or pipe, such replacements shall be the same lengths as the defective pieces. Where repairs are required to PVC pipe, the pipe shall be replaced as far as the first detachable fitting in each direction from the defect. Under no circumstances shall a new section of pipe be installed with solvent welded couplings.

.3 Tests shall be repeated after any work has been replaced if, in the judgement of the Engineer’s Representative, it is necessary.

.4 All pressure testing shall be done in the presence of the Engineer’s Representative.

END OF SECTION

APPENDIX A - DESIGN DRAWINGS

DRAWING INDEX

SHEET	DRAWING NAME	REVISION	DRAWING TITLE	DRAWING DESCRIPTION
GENERAL				
1	2972-00-G-001	0	DRAWING INDEX AND COVER SHEET	
CIVIL				
2	2972-00-C-141	0	PLAN AND PROFILE	PUMP STATION EFFLUENT PIPING
3	2972-00-C-142	0	PLAN AND PROFILE	PUMP STATION EFFLUENT PIPING
4	2972-00-C-341	0	DETAILS	PUMP STATION EFFLUENT PIPING
STRUCTURAL				
5	2972-00-S-001	0	GENERAL NOTES SHEET 1	EFFLUENT PUMP STATION PLATFORM
6	2972-00-S-002	0	GENERAL NOTES SHEET 2	EFFLUENT PUMP STATION PLATFORM
7	2972-00-S-100	0	SITE PLAN	EFFLUENT PUMP STATION PLATFORM
8	2972-00-S-101	0	FOUNDATION PILES LAYOUT	EFFLUENT PUMP STATION PLATFORM
9	2972-00-S-102	0	B/O STEEL FRAMING LAYOUT	EFFLUENT PUMP STATION PLATFORM
10	2972-00-S-103	0	T/O STEEL PLATFORM LAYOUT	EFFLUENT PUMP STATION PLATFORM
11	2972-00-S-201	0	ELEVATIONS	EFFLUENT PUMP STATION PLATFORM
12	2972-00-S-301	0	SECTIONS SHEET 1	EFFLUENT PUMP STATION PLATFORM
13	2972-00-S-302	0	SECTIONS SHEET 2	EFFLUENT PUMP STATION PLATFORM
14	2972-00-S-501	0	CONNECTION DETAILS SHEET 1	EFFLUENT PUMP STATION PLATFORM
15	2972-00-S-502	0	CONNECTION DETAILS SHEET 2	EFFLUENT PUMP STATION PLATFORM
16	2972-00-S-503	0	PILE CONNECTION DETAILS	EFFLUENT PUMP STATION PLATFORM
17	2972-00-S-504	0	PIPE SUPPORT DETAILS	EFFLUENT PUMP STATION PLATFORM
PROCESS MECHANICAL				
18	2972-00-D-003	0	HYDRAULIC PROFILE	
19	2972-00-D-141	0	SITE PLAN	
20	2972-00-D-142	0	PLAN	PUMP STATION #1
21	2972-00-D-143	0	PLAN	PUMP STATION #2
22	2972-00-D-341	0	SECTION 1	PUMP STATION #1
23	2972-00-D-342	0	SECTION A	PUMP STATION #1
24	2972-00-D-562	0	DETAILS	
ELECTRICAL				
25	2972-00-E-102	0	SITE GRADING	
26	2972-00-E-501	0	DETAILS	

CITY OF PORT ALBERNI, B.C.
WASTEWATER LAGOON
EXPANSION UPGRADES

AE Project No. 20172972
Issued for Tender

PLOT DATE: 9/11/2019 2:10:45 PM
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Associated Engineering

BEST MANAGED COMPANIES
Platinum member

THE CITY OF Port Alberni

CITY OF PORT ALBERNI

WASTERWATER LAGOON
EXPANSION UPGRADES

20172972-00

C. G. BRUMPTON
#30001

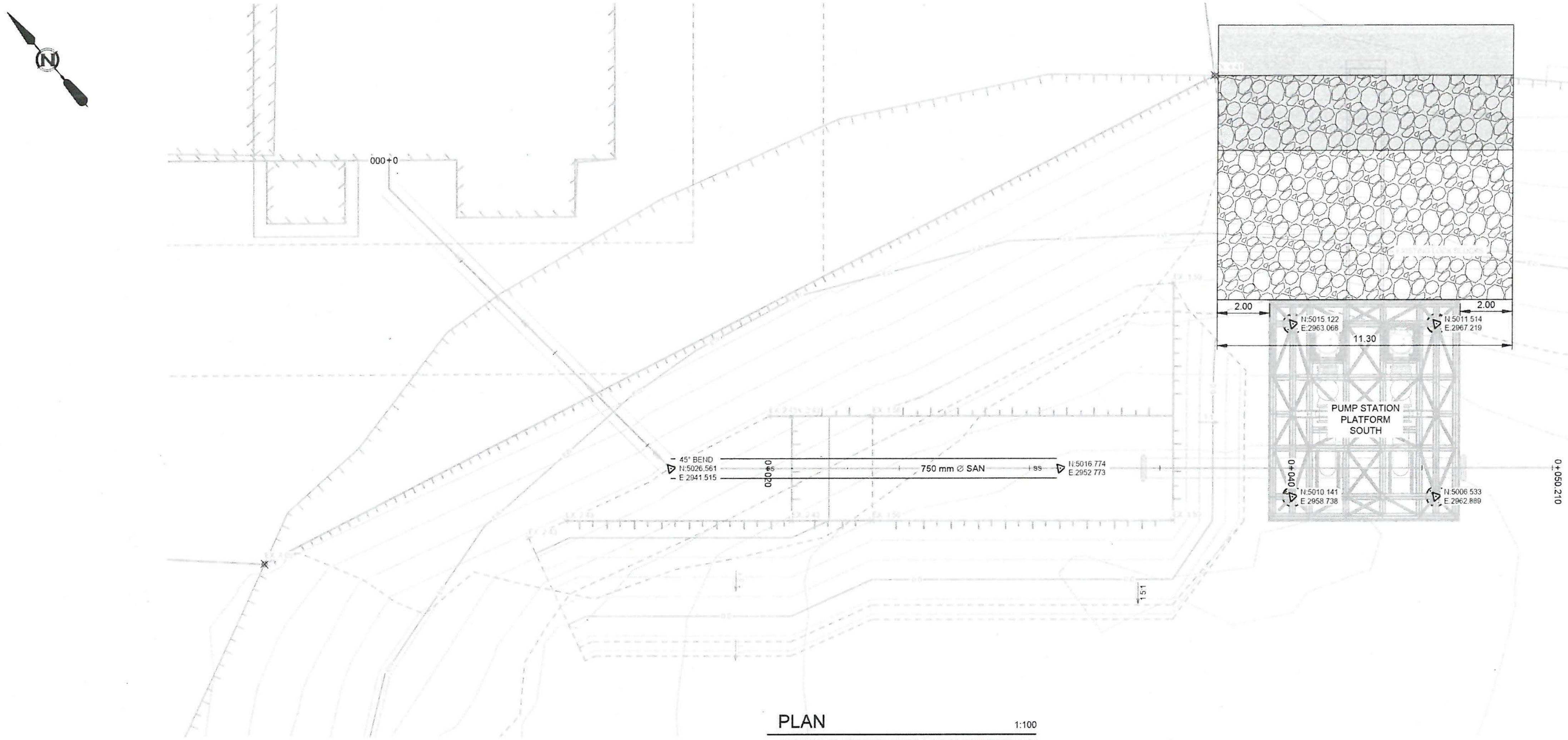
Sept. 11, 2019

REV	DATE	DESIGN	DRAWN	DESCRIPTION
0	2019SEP11	C. BRUMPTON	K. CHAU	ISSUED FOR TENDER

DRAWING	REVISION	SHEET
2972-00-G-001	0	1

IF NOT 50 mm ADJUST SCALES
50 mm

SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS, TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE



PLAN
1:100

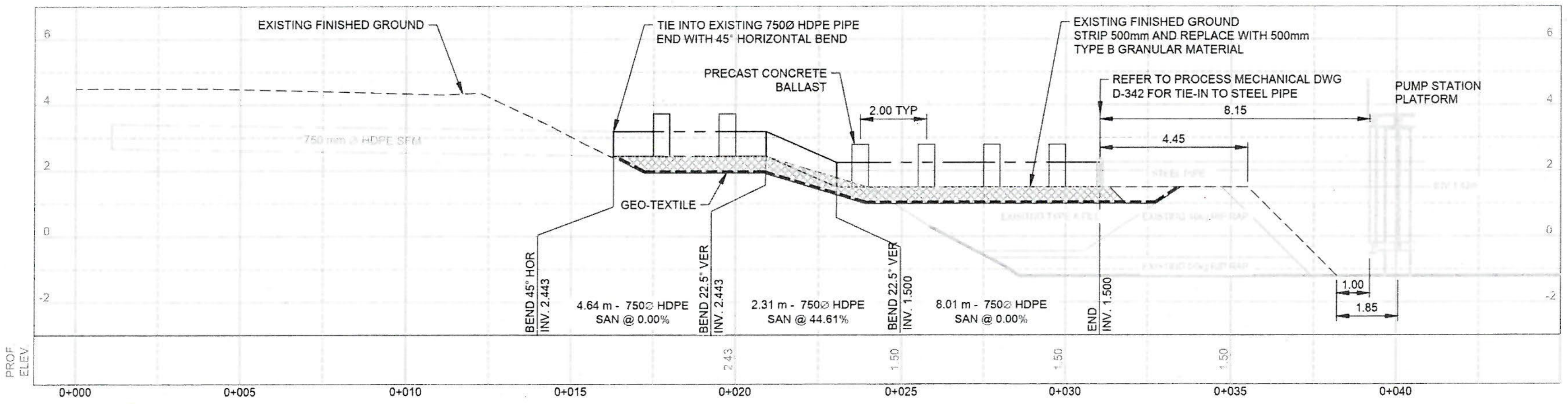
SOUTH TREATED EFFLUENT FORCEMAIN

▨ 50kg RIP-RAP ON EXISTING SLOPE

▨ 50kg RIP-RAP AND NEW GEO-TEXTILE

▢ LIMIT OF NEW GEO-TEXTILE

GENERAL NOTES:
1. INSTALLATION OF HDPE TO BE PERFORMED IN AMBIENT TEMPERATURE REPLICATING LONG TERM PROJECT THERMAL CONDITIONS (APPROXIMATELY BETWEEN 8° AND 22° CELSIUS) TO LIMIT POST INSTALLATION EXPANSION/CONTRACTION.
2. FOR ALTERNATIVE PIPE MATERIAL, CONTRACTOR TO PROVIDE SIGNED SEALED DRAWINGS DEMONSTRATING THAT THE PROPOSED PIPE CONFIGURATION WITHSTANDS UNDER SETTLEMENT OF THE BERM AS SPECIFIED ON GEOTECHNICAL REPORT.



PROFILE
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SOUTH TREATED EFFLUENT FORCEMAIN

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CITY OF PORT ALBERNI

WASTERWATER LAGOON
EXPANSION UPGRADES

20172972-00

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PLAN & PROFILE
PUMP STATION EFFLUENT PIPING

DRAWING	REVISION	SHEET
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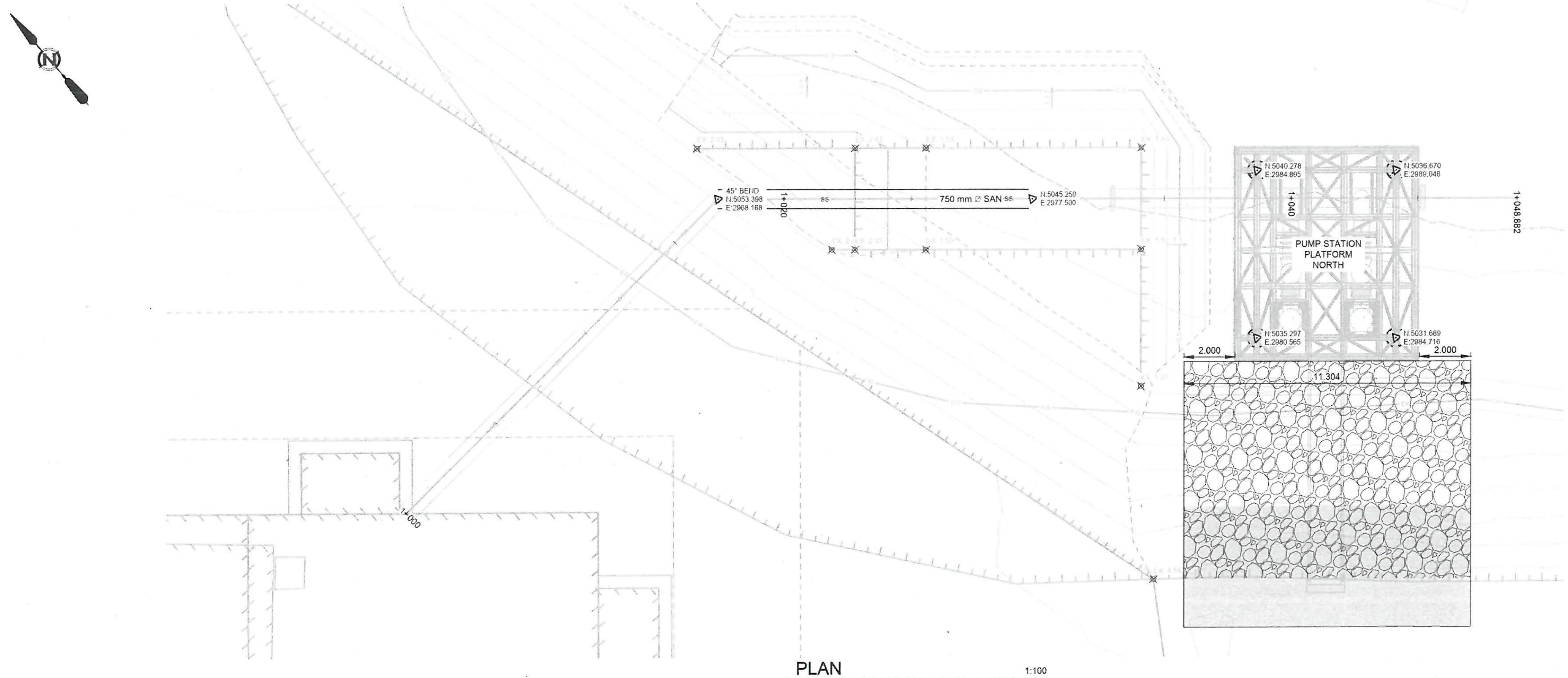
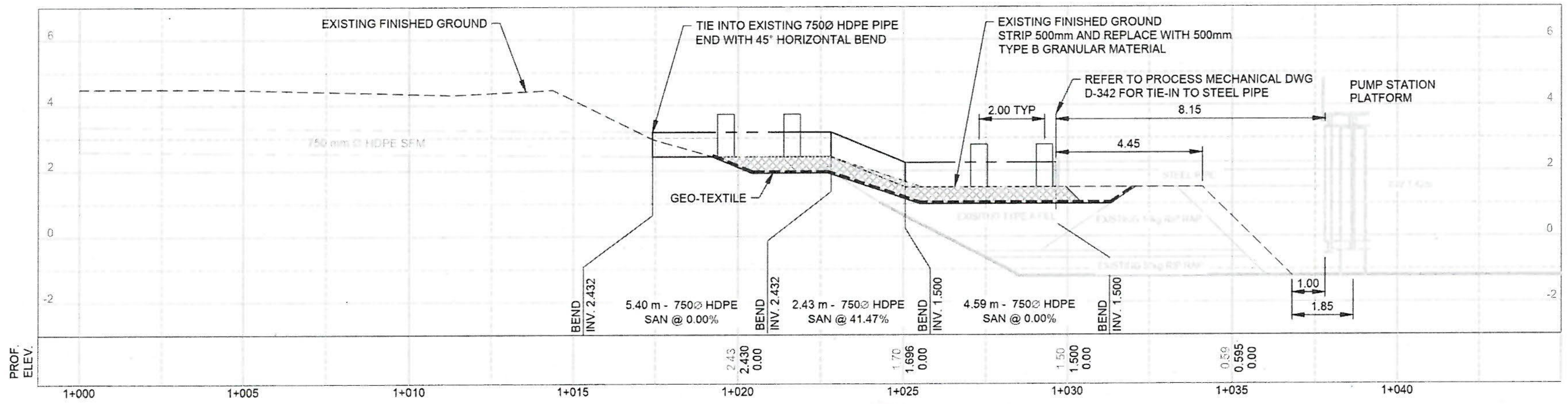


PLAN
1:100

NORTH TREATED EFFLUENT FORCEMAIN

▨	50kg RIP-RAP ON EXISTING SLOPE
▨	50kg RIP-RAP AND NEW GEO-TEXTILE
▢	LIMIT OF NEW GEO-TEXTILE

GENERAL NOTES:
1. INSTALLATION OF HDPE TO BE PERFORMED IN AMBIENT TEMPERATURE REPLICATING LONG TERM PROJECT THERMAL CONDITIONS (APPROXIMATELY BETWEEN 8° AND 22° CELSIUS) TO LIMIT POST INSTALLATION EXPANSION/CONTRACTION.
2. FOR ALTERNATIVE PIPE MATERIAL, CONTRACTOR TO PROVIDE SIGNED SEALED DRAWINGS DEMONSTRATING THAT THE PROPOSED PIPE CONFIGURATION WITHSTANDS UNDER SETTLEMENT OF THE BERM AS SPECIFIED ON GEOTECHNICAL REPORT.



PROFILE
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NORTH TREATED EFFLUENT FORCEMAIN

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CITY OF PORT ALBERNI

WASTERWATER LAGOON
EXPANSION UPGRADES

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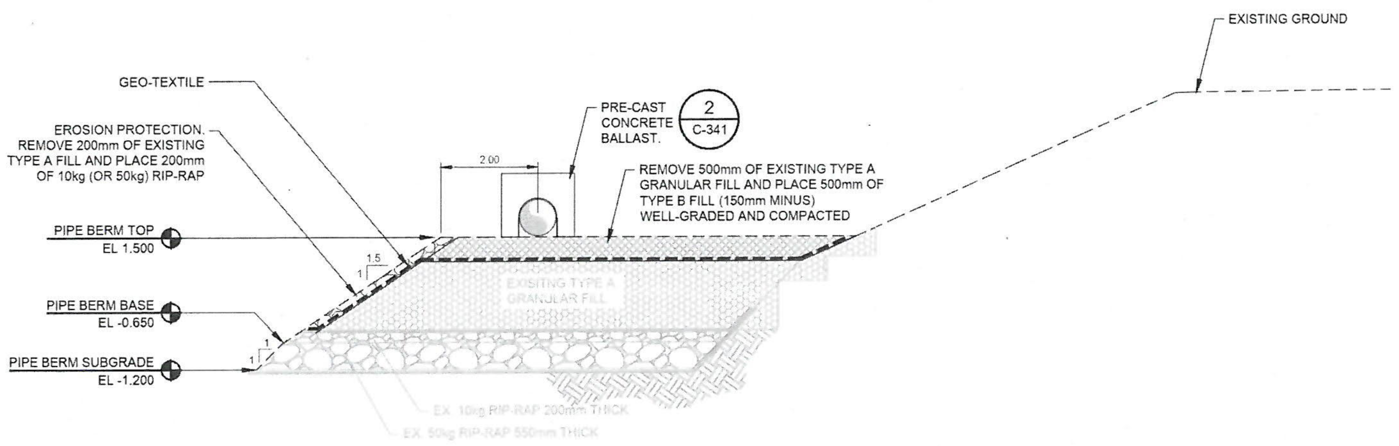
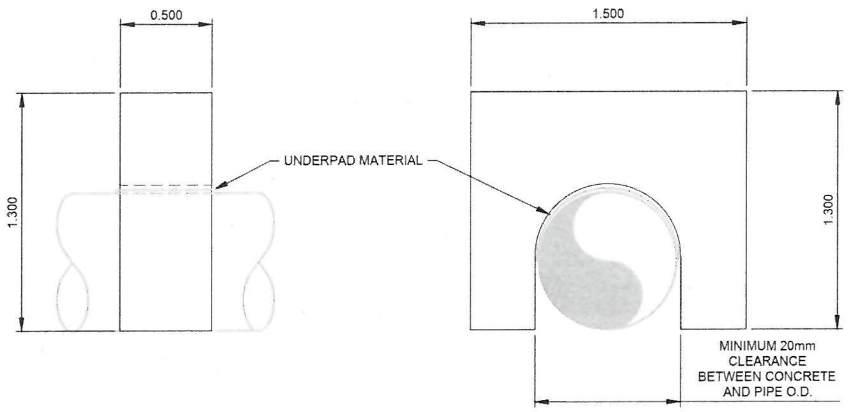
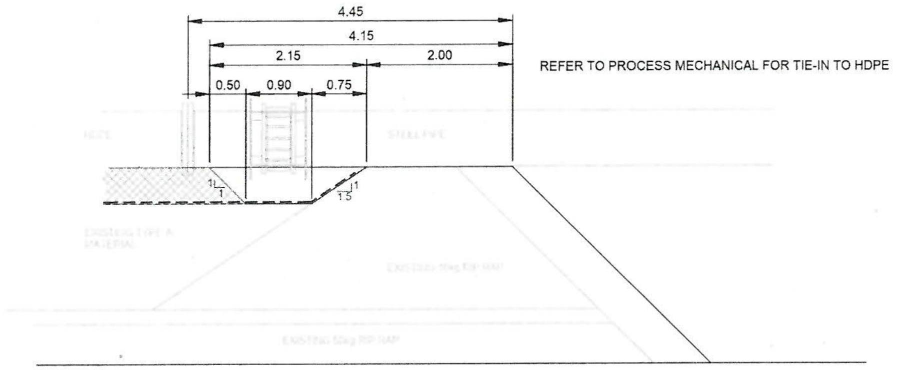


1 TYPICAL SECTION NTS
PIPE SUPPORT BENCH AT STA 0+030

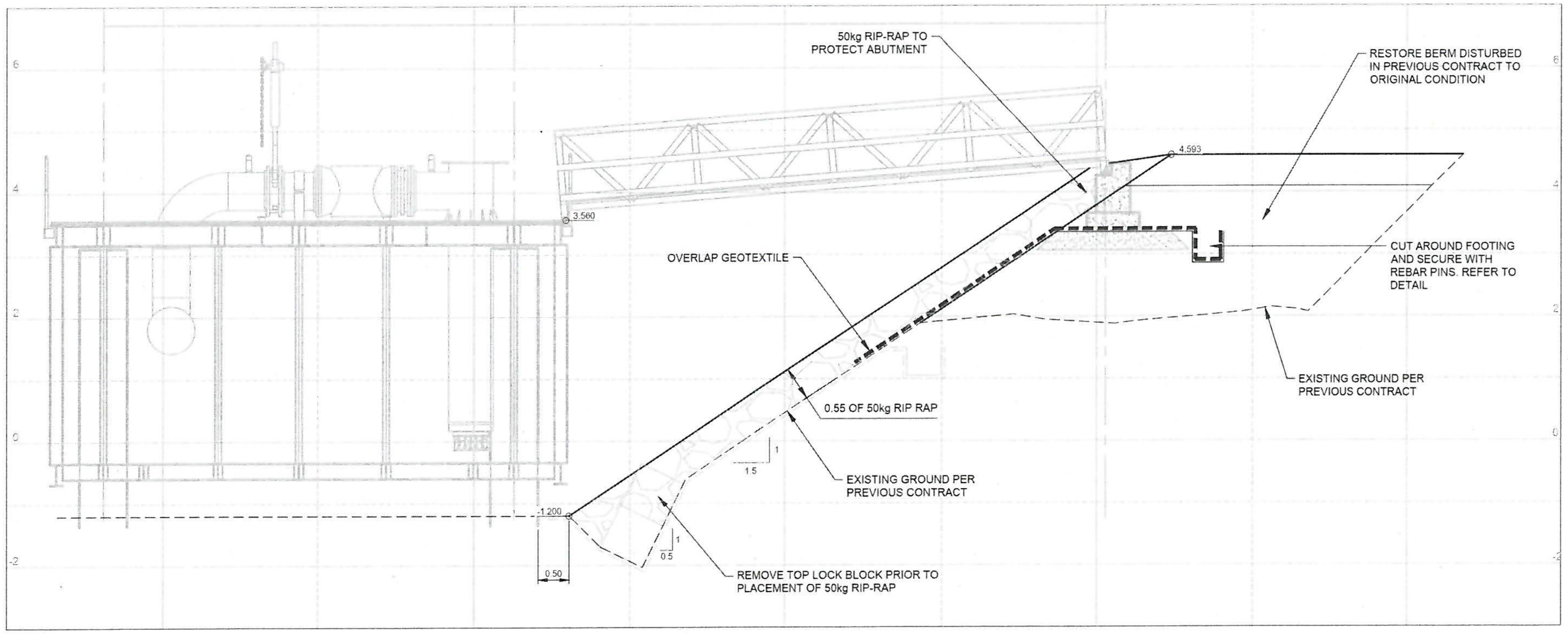


2 TYPICAL DETAIL NTS
PRE-CAST CONCRETE BALLAST

NOTES:
1. UNDERPAD MATERIAL 6.4mm NEOPRENE SPONGE PADDING OR APPROVED EQUAL.
2. CONCRETE INTERIOR SURFACE SHOULD BE SMOOTH.
3. CONCRETE MINIMUM 3000psi @ 28 DAYS.
4. INCLUDE PLUG LIFTING HOLES.
5. PRE-CAST CONCRETE BALLAST TO BE DESIGNED BY THE PRECAST CONCRETE SUPPLIER'S ENGINEER. DESIGN CRITERIA TO BE AS PER SPECIFICATION SECTION 03 41 00 - PRECAST STRUCTURAL CONCRETE



3 TYPICAL DETAIL NTS
PIPE SUPPORT BENCH END DETAIL



4 TYPICAL DETAIL NTS
BERM REPAIR

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Associated Engineering

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L. A. MACRAE
33335
Sept 11, 19

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0	2019SEP11	D. ANGGABRATA	A. SHEWAN	ISSUED FOR TENDER

CITY OF PORT ALBERNI

WASTERWATER LAGOON
EXPANSION UPGRADES

20172972-00

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2972-00-C-341	0	4

IF NOT 50 mm ADJUST SCALES
50 mm

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GENERAL NOTES:

1. THE GENERAL NOTES AND STRUCTURAL STANDARD DETAILS ARE GENERAL AND APPLY TO THE ENTIRE PROJECT EXCEPT WHERE THERE ARE SPECIFIC INDICATIONS TO THE CONTRARY.
2. READ THIS SET OF DRAWINGS IN CONJUNCTION WITH OTHER CONTRACT DOCUMENTS AND SPECIFICATIONS RELATING TO STRUCTURAL ENGINEERING AND OTHER DISCIPLINES. THESE DRAWINGS AND SPECIFICATIONS SHALL BE CONSIDERED AN INTEGRAL PART OF THE CONTRACT DOCUMENTS, NEITHER THE DRAWINGS NOR THE SPECIFICATIONS SHALL BE USED ALONE. CONTRACTOR SHALL REPORT OF ANY DISCREPANCIES IMMEDIATELY FOR CLARIFICATION TO THE ENGINEER. IN THE EVENT OF A DISCREPANCY BETWEEN THE VARIOUS DOCUMENTS, THE MORE STRINGENT PROVISIONS SHALL APPLY.
3. DESIGN AND CONTRUCTION TO BE IN ACCORDANCE WITH THE LATEST EDITION CODES, STANDARDS, RULES AND REGULATIONS (AND LOCAL AUTHORITIES HAVING JURISDICTION). THE LATEST EDITION CODE TO GOVERN EXCEPT WHERE OTHER APPLICABLE CODES OR THE FOLLOWING NOTES ARE MORE RESTRICTIVE.
4. DO NOT CONSTRUCT FROM THESE DRAWINGS UNLESS THEY ARE MARKED "ISSUED FOR CONSTRUCTION" IN THE REVISION COLUMN.
5. STRUCTURAL DIMENSIONS CONTROLLED BY OR RELATED TO ARCHITECTURAL, CIVIL, PROCESS MECHANICAL, BUILDING MECHANICAL, ELECTRICAL OR LANDSCAPING TO BE VERIFIED BY THE CONTRACTOR PRIOR TO CONSTRUCTION. CONTRACTOR SHALL REPORT OF ANY DISCREPANCIES AND CONFLICTS IMMEDIATELY FOR CLARIFICATION TO THE ENGINEER.
6. NO SLEEVES, DUCTS, PIPES OR OTHER OPENINGS SHALL PASS THROUGH STRUCTURAL MEMBERS EXCEPT WHERE DETAILED ON THE DRAWINGS. DO NOT CUT OR DRILL OPENINGS OR GROUPS OF OPENINGS THROUGH STRUCTURAL MEMBERS WITHOUT WRITTEN PERMISSION BY THE ENGINEER. CONTRACTOR TO PROVIDE APPROPRIATE ATTACHMENTS AND CONNECTIONS FOR MECHANICAL, ELECTRICAL, AND OTHER SERVICES WITHOUT CUTTING OR DRILLING.
7. FOR CONDITIONS NOT EXPLICITLY SHOWN, CONTRACTOR SHALL REQUEST FOR CLARIFICATION FROM THE ENGINEER.
8. BEFORE CONCRETING, ENSURE THAT ALL EMBEDDED ITEMS, SUCH AS ANCHOR BOLTS, SLEEVES AND WATER STOPS ARE IN POSITION AND SECURELY FASTENED IN PLACE TO THE SATISFACTION OF THE ENGINEER.

CONSTRUCTION:

1. THESE DRAWINGS SHOW THE REQUIREMENTS FOR PERMANENT AND COMPLETED STRUCTURE ONLY. CONTRACTOR IS RESPONSIBLE FOR DESIGNING AND PROVIDING ALL TEMPORARY WORKS INCLUDING BUT NOT LIMITED TO BRACING, FALSEWORK, SHORING, AND TEMPORARY SUPPORTS. TEMPORARY WORKS MUST BE CAPABLE OF TRANSFERRING ALL IMPOSED CONSTRUCTION AND DEAD LOADS WITHOUT EXCEEDING SPECIFIED DESIGN LOADS TO THE STRUCTURE. TEMPORARY WORKS TO BE DESIGNED BY A PROFESSIONAL ENGINEER REGISTERED IN THE PROJECT PROVINCE/TERRITORY IN ACCORDANCE WITH WCB STANDARDS AND LOCAL RULES AND REGULATIONS.
2. THE CONTRACTOR WILL BE REQUIRED TO ASSUME SOLE AND COMPLETE RESPONSIBILITY FOR JOB SITE CONDITIONS DURING THE COURSE OF CONSTRUCTION OF THE PROJECT, INCLUDING SAFETY OF ALL PERSONS AND PROPERTY.
3. BUILDING CONTROL LINES, REFERENCE LINES, GRID LINES AND TEMPORARY BENCH MARKS TO BE CLEARLY IDENTIFIED AND MAINTAINED DURING THE ENTIRE CONSTRUCTION PERIOD.
4. ACCURACY OF THE SITE SURVEY AND LAYOUT IS THE RESPONSIBILITY OF THE CONTRACTOR. REMEDIAL ACTIONS RESULTING FROM INACCURACIES, ERRORS AND OMISSIONS WILL BE AT THE CONTRACTOR'S OWN EXPENSE.
5. ALL DIMENSIONS, ELEVATIONS AND SLOPES SHALL BE CHECKED AND VERIFIED WITH THE DRAWINGS AND EXISTING SITE CONDITIONS PRIOR TO CONSTRUCTION AND FABRICATION. DO NOT SCALE DRAWINGS.
6. CONTRACTOR SHALL BE RESPONSIBLE FOR VERIFICATION OF ALL UNDERGROUND AND SUB-GRADE SERVICES PRIOR TO COMMENCING SITE WORK.
7. CONTRACTOR TO SUBMIT TO THE ENGINEER IN WRITING ALL PROPOSED ALTERNATE PRODUCTS, STRUCTURAL DETAILS, AND STRUCTURAL SYSTEMS, INCLUDING TECHNICAL SPECIFICATIONS, CALCULATIONS AND DATA SHEETS FOR REVIEW AND APPROVAL PRIOR TO COMMENCING WITH WORK. ALTERNATE PRODUCTS MUST HAVE DESIGN PROPERTIES EQUIVALENT TO OR GREATER THAN THOSE SPECIFIED ON THE DRAWINGS AND SPECIFICATIONS.

EXCAVATION & BACKFILL:

1. THIS SECTION IS APPLICABLE FOR THE ALUMINUM BRIDGE ABUTMENT ONLY.
2. REFER TO GEOTECHNICAL REPORT PREPARED BY WSP CANADA INC., FILE # 171-04753-02, FOR DESCRIPTION OF EXISTING SOIL CONDITIONS AND SITE PREPARATION REQUIREMENTS.
3. ENSURE THE BOTTOM OF EXCAVATION IS UNDISTURBED SOIL, LEVEL AND FREE OF ALL LOOSE, SOFT OR ORGANIC MATTER AND IS PROTECTED AND KEPT DRY DURING EXCAVATION AND DURING CONCRETE PLACEMENT. THOROUGHLY COMPACT THE BASE OF THE EXCAVATION PRIOR TO FOUNDATION CONSTRUCTION IN ORDER TO DENSIFY THE SOIL LOOSENED BY THE EXCAVATION EQUIPMENT.
4. ENSURE THAT THE SOIL BELOW A FOUNDATION IS NOT ALLOWED TO FREEZE, EITHER DURING OR AFTER CONSTRUCTION. UNDER NO CIRCUMSTANCES SHALL CONCRETE BE PLACED ON FROZEN SOIL.
5. USE HAND-OPERATED COMPACTION EQUIPMENT WITHIN 1m OF WALLS AND FOOTINGS.
6. BACKFILL AGAINST GRADE BEAMS AND FOUNDATIONS AS SPECIFIED AFTER CONCRETE HAS ACHIEVED 20 MPa STRENGTH, AND AFTER APPROVAL FROM THE ENGINEER.
7. NOTIFY ENGINEER BEFORE COMMENCING WITH EXCAVATION. SOIL CONDITIONS SHALL BE APPROVED BY ENGINEER DURING EXCAVATION AND PRIOR TO CONSTRUCTION OF FORMWORK OR REINFORCEMENT FOR FOUNDATIONS.
8. TEST LAYER COMPACTION AS SPECIFIED, FREQUENCY AS FOLLOWS:
    - AT LEAST FOUR (4) RANDOM LOCATIONS FROM SAME LAYER, FOR AT LEAST THREE (3) LAYERS EQUALLY SPACED THROUGH DEPTH.

8. THE GEOTECHNICAL ENGINEER SHALL BE NOTIFIED A MINIMUM OF 24 HRS. BEFORE COMMENCEMENT OF EXCAVATION. SOIL CONDITIONS SHALL BE INSPECTED BY THE GEOTECHNICAL ENGINEER DURING EXCAVATION AND PRIOR TO CONSTRUCTION OF FORMWORK FOR FOUNDATIONS.

CONCRETE:

1. PERFORM CONCRETING WORK TO CAN/CSA A23.1.
2. TEST CONCRETE IN ACCORDANCE WITH CAN/CSA A23.2.
3. CONCRETE MIXES SHALL BE PROPORTIONED IN ACCORDANCE WITH CAN/CSA A23.2 TO MEET THE FOLLOWING REQUIREMENTS:

LOCATION	28 DAY COMP. STRENGTH (MPa) MIN	CEMENT TYPE	AIR %	SLUMP mm	NOMINAL COARSE SIZE AGG. mm	EXP. COND.
PILE MIX	35	GU	5-8	150-200	20	A-1
BRIDGE ABUTMENT	35	GU	5-8	60-100	20	C-1

- WATER/CEMENT RATIO FOR EXPOSURE CLASSES AS PER CAN/CSA A23.1
- MAX W/C = 0.40 MAX.
- WHERE SPECIFIED STRENGTH EXCEEDS THOSE IMPLIED BY EXPOSURE CLASS, SPECIFIED STRENGTH GOVERNS.
- ALL CONCRETE TO BE NORMAL WEIGHT 2400 kg/m³
- MIX DESIGNS SHALL BE SUBMITTED TO THE ENGINEER FOR REVIEW
- SUPPLEMENTAL FLYASH TO A MAXIMUM OF 30% MAY BE PERMITTED AT THE DISCRETION OF THE ENGINEER.
- SEE SPECIFICATIONS FOR OTHER TYPES OF CONCRETE REQUIREMENTS

4. STRENGTH OF CONCRETE TO BE DETERMINED BY FIELD-CURED CYLINDERS. ALTERNATE METHODS, IF ACCEPTABLE TO THE ENGINEER, MAY BE USED.
5. LOCATIONS & DETAILS OF CONSTRUCTION JOINTS NOT SHOWN ON DRAWINGS ARE TO BE SUBMITTED TO THE ENGINEER FOR REVIEW AND APPROVAL PRIOR TO CONSTRUCTION.
6. BEFORE CONCRETE PLACEMENT, ENSURE THAT ALL EMBEDDED ITEMS SUCH AS ANCHOR BOLTS, SLEEVES, AND WATER STOPS ARE IN POSITION AND SECURELY FASTENED IN PLACE TO THE SATISFACTION OF THE ENGINEER.
7. ANCHOR BOLTS AND DOWELS SHALL BE PLACED BEFORE CONCRETE IS POURED. TEMPLATES SHALL BE USED TO ENSURE CORRECT PLACEMENT OF ANCHOR BOLTS AND DOWELS. DOWELS TO MATCH VERTICAL BARS IN SIZE AND SPACING.
8. BEFORE PLACING CONCRETE, ENSURE THAT THE REINFORCING STEEL AND FORMS ARE CLEAN, FREE OF LOOSE SCALE, DIRT AND OTHER FOREIGN MATERIALS WHICH WOULD REDUCE THE BOND BETWEEN THE REINFORCING STEEL AND THE CONCRETE.
9. ALL EXPOSED CONCRETE CORNERS TO HAVE 20x20 CHAMFER.
10. SUBMIT TO THE ENGINEER FOR REVIEW AND APPROVAL NO LATER THAN THREE WEEKS PRIOR TO CONSTRUCTION:

- REBAR SHOP DRAWINGS, METRIC
- CONCRETE MIX DESIGN
- DETAIL AND LOCATION OF CONSTRUCTION JOINTS

FIELD REVIEW AND TESTING:

1. CONTRACTOR IS RESPONSIBLE FOR REVIEWING THE WORK AND ENSURING CONFORMANCE TO DRAWINGS AND CONTRACT DOCUMENTS PRIOR TO THE FIELD REVIEW OF THE ENGINEER.
2. THE CONTRACTOR SHALL GIVE REASONABLE ADVANCE NOTICE OF WHEN THE STRUCTURAL WORK IS GENERALLY COMPLETED AND READY FOR REVIEW. THE STRUCTURAL WORK CANNOT BE CONCEALED BY FINISHES OR OTHER MEANS WITHOUT PRIOR PERMISSION BY THE ENGINEER. THE CONTRACTOR SHALL NOTIFY THE ENGINEER AT LEAST 48 HOURS IN ADVANCE FOR THE FOLLOWING FIELD REVIEWS:

- CONCRETE REINFORCEMENT   BEFORE EACH CONCRETE POUR
- STRUCTURAL STEEL FRAMING BEFORE CONCEALMENT
- STEEL DECKING BEFORE CONCEALMENT

3. THE STRUCTURAL WORK MUST BE SUBSTANTIALLY COMPLETE AT THE TIME OF FIELD REVIEW. ANY WORK FOUND INCOMPLETE OR DEFICIENT AT THE TIME OF FIELD REVIEW MAY REQUIRE ADDITIONAL FIELD REVIEWS BY THE ENGINEER OR ADDITIONAL MATERIAL TESTING AT THE EXPENSE OF THE CONTRACTOR.
4. THE FIELD REVIEW IS CONDUCTED FOR THE SOLE PURPOSE OF ENSURING GENERAL CONFORMANCE TO THE DRAWINGS AND CONTRACT DOCUMENTS. THE REVIEW IS CONDUCTED AT ANY STAGE AT THE DISCRETION OF THE ENGINEER AND DOES NOT GUARANTEE THE WORK OF THE CONTRACTOR.

STRUCTURAL STEEL AND FABRICATIONS:

1. FABRICATE AND ERECT STRUCTURAL STEEL TO CSA CAN-S16.1. SUBMIT SHOP DRAWINGS SHOWING ALL DETAILS AND MATERIAL SPECIFICATIONS FOR REVIEW PRIOR TO FABRICATION.
2. PROVIDE STRUCTURAL STEEL TO CSA G40.21 WITH THE FOLLOWING GRADES:
   WIDE FLANGE BEAMS AND COLUMNS: 350 W
   CHANNELS AND ANGLES: 300 W
   HSS SECTIONS (CLASS C): 350 W
   STRUCTURAL BARS AND PLATES: 300 W
   MISCELLANEOUS STEEL: 300 W
3. PROVIDE ERECTION BOLTS TO ASTM A325, MINIMUM 19mm DIAMETER. DESIGN BOLTED CONNECTIONS TO ASTM A325. TIGHTEN BOLTS BY THE "TURN OF NUT" METHOD TO BOLT TENSIONS SPECIFIED IN CSA S16.1. ANCHOR RODS TO ASTM A307 (UNLESS NOTED OTHERWISE).
4. WELD TO CSA W59 BY FABRICATORS CERTIFIED TO CSA W47.1 DIV.1 OR DIV. 2.1.1. WELDING OF REINFORCING SHALL CONFORM TO CSA W186.
5. MINIMUM WELDS FOR CONNECTIONS SHALL BE 6mm FILLET WELD AND WHERE EXPOSED IN FINISHED BUILDING, WELD SHALL BE GROUND SMOOTH.
6. NO BURNING OF HOLES SHALL BE ALLOWED IN STRUCTURAL STEEL.
7. ALL STEEL STUD TO CONFORM TO CAN/CSA-S136, 228 MPa MIN.
8. GALVANIZED STEEL TO BE HOT DIP GALVANIZED TO CSA-G-164.
9. NON-GALVANIZED STEEL TO BE PAINTED WITH A NSF CERTIFIED NOVAGUARD 840 BY PPG.
10. STEEL FABRICATOR SHALL DESIGN ALL STEEL-TO-STEEL CONNECTIONS INDICATED ON THE DRAWINGS. ALL CONNECTIONS SHALL BE SHOP WELDED AND FIELD BOLTED UNLESS NOTED OTHERWISE. DESIGN BOLTED CONNECTIONS ASSUMING THE BOLT THREADS INTERCEPT THE SHEAR PLANE. CONNECTIONS SHALL BE DESIGNED TO TRANSFER FORCES THROUGH THE CENTERLINE OF MEMBERS WITHOUT IMPOSING ROTATIONAL LOADS.
11. DESIGN CONNECTIONS FOR THE HIGHER OF THE FORCES AS INDICATED ON THE DRAWINGS OR FOR FACTORED END SHEAR OF A MINIMUM OF 60% OF THE TOTAL BEAM LOAD CAPACITY AS LISTED IN THE BEAM LOAD TABLES OF THE CISC HANDBOOK.
12. SUBMIT TO THE ENGINEER FOR REVIEW AND APPROVAL:
    - SHOP DRAWINGS AND CALCULATIONS SIGNED AND SEALED BY SUPPORTING REGISTERED PROFESSIONAL FOR THE CONNECTION DESIGN OF STEEL-TO-STEEL CONNECTIONS.
    - FIELD REVIEW REPORT FROM SUPPORTING REGISTERED PROFESSIONAL
    - SCHEDULES S-B AND S-C FROM SUPPORTING REGISTERED PROFESSIONAL

REINFORCEMENT:

1. REINFORCING STEEL: NEW DEFORMED BARS TO CSA G30.18. "BILLET" STEEL BARS FOR CONCRETE REINFORCEMENT, WITH MIN. YIELD STRENGTH OF 400WMPa. WELDED WIRE FABRIC TO CONFORM TO CSA G30.5 WITH MIN. YIELD STRENGTH OF 450MPa. PLACE REBAR TO CSA/CAN A23.1. REINFORCEMENT REQUIREMENTS ARE SHOWN ON DETAIL DRAWINGS. WHERE DETAILS OF BAR SIZING AND SPACING ARE NOT SHOWN, ALLOW FOR MINIMUM REINFORCEMENT IN ACCORDANCE WITH CSA/CAN A23.1
2. PROVIDE CLEAR CONCRETE COVER OVER REBAR AS FOLLOWS U.N.O.:

   CONCRETE PLACED DIRECTLY ON GROUND
   75mm

   FORMED SURFACES EXPOSED TO WEATHER & SEWAGE
   - WALLS AND SLABS
     50mm
   - BEAM PRINCIPAL REINFORCING
     50mm
   - BEAM STIRRUPS
     40mm

   TOP SLAB REINF. & BEAM STIRRUPS IN BUILDING
   40mm
   BOTTOM SLAB REINFORCING IN BUILDING
   40mm

   FORMED SURFACES EXPOSED TO EARTH
   50mm

3. REBAR SPLICE LENGTHS (UNLESS NOTED OTHERWISE):
   LENGTHS SHOWN ARE IN mm

REBARS		10M	15M	20M	25M	30M	35M
WALLS	HORIZONTAL	500	650	800	1300	1700	2000
	VERTICAL	400	400	650	1000	1300	1500
SLABS	TOP	500	700	900	1400	1700	2000
	BOTTOM	400	600	750	1100	1300	1500

4. LAP WIRE MESH REINFORCING 200mm AND MINIMUM 2 LONGITUDINAL MESH BARS.
5. UNLESS OTHERWISE NOTED, EDGE OF ALL SLABS SHALL HAVE 2-15M CONT. LAPPED 600mm
6. UNLESS NOTED OTHERWISE, ALL OPENINGS IN SLAB SHALL HAVE 2-15M BARS PARALLEL TO ALL EDGES EXTENDING BEYOND CORNERS 600mm
7. ALL REINFORCEMENT REQUIRED TO BE WELDED SHALL BE GRADE 400W (WELDABLE)
8. PLACE ADDITIONAL REINFORCEMENT AT ALL OPENINGS FOR PIPING, MECHANICAL AND ELECTRICAL EQUIPMENT, DOORS AND OTHER OPENINGS UNLESS NOTED OTHERWISE.
9. PLACE REINFORCING BARS SYMMETRICALLY OVER SUPPORTS AND SYMMETRICALLY IN SPANS UNLESS NOTED OTHERWISE.
10. UNLESS NOTED OTHERWISE, SLAB REINFORCING SHALL NOT BE CUT AT OPENINGS. SPREAD REINFORCING AROUND OPENINGS.
11. PROVIDE SUFFICIENT CHAIRS AND SUPPORT BARS TO MAINTAIN SPECIFIED CONCRETE COVER AND TO SECURE REINFORCING STEEL IN PLACE DURING CONCRETE PLACEMENT.
12. RESERVE MINIMUM OF 1% TOTAL VOLUME OF REINFORCEMENT TO BE USED AS DIRECTED BY THE ENGINEER FOR FIELD ADJUSTMENT.
13. REINFORCEMENT REQUIREMENTS ARE SHOWN ON DETAIL DRAWINGS. WHERE DETAILS OF BAR SIZING AND SPACING ARE NOT SHOWN. ALLOW FOR A MINIMUM 0.5% REINFORCING IN EACH DIRECTION, EACH FACE.

STRUCTURAL STEEL ELEMENTS:

1. DESIGNS OF PRIMARY AND SECONDARY STEEL ELEMENTS ARE NOT THE RESPONSIBILITY OF THE ENGINEER-OF-RECORD. SUCH COMPONENTS OF THE PROJECT SHALL BE DESIGNED, DETAILED, SPECIFIED AND REVIEWED IN THE FIELD BY A SUPPORTING REGISTERED PROFESSIONAL. EXAMPLES INCLUDE, BUT ARE NOT LIMITED TO:
    - HANDRAILS, GUARDRAILS AND RAILINGS, STAIR AND PLATFORM
    - ANCHORAGE, SUPPORTS AND BRACINGS OF ELECTRICAL, PROCESS MECHANICAL AND BUILDING MECHANICAL SYSTEMS AND OTHER EQUIPMENT FOR BOTH GRAVITY AND LATERAL LOADS
    - OPEN WEB STEEL JOISTS, STAIR, TOWERS, WALKWAYS, AND THEIR CORRESPONDING CONNECTIONS
2. STRUCTURAL DESIGN OF NON-STRUCTURAL AND ITS SECONDARY STRUCTURAL ELEMENTS IS TO BE PERFORMED BY SUPPORTING REGISTERED PROFESSIONAL RETAINED BY THE CONTRACTOR AND/OR SUPPLIER IN ACCORDANCE TO PART 4 OF THE BUILDING CODE.
3. IN ADDITION TO CONSTRUCTION TOLERANCE, NON-STRUCTURAL AND SECONDARY STRUCTURAL ELEMENTS ARE TO BE DESIGNED FOR VERTICAL DEFLECTIONS AND HORIZONTAL DEFLECTIONS OF THE PRIMARY STRUCTURE.
4. NON-STRUCTURAL AND SECONDARY STRUCTURAL ELEMENTS ARE TO BE DESIGNED TO MINIMIZE TORSIONAL LOADING TO THE PRIMARY STRUCTURAL ELEMENTS.
5. SUBMIT TO THE ENGINEER FOR REVIEW AND APPROVAL:
    - SHOP DRAWING AND CALCULATIONS SIGNED AND SEALED BY SUPPORTING REGISTERED PROFESSIONAL SHOWING THE ELEMENT, DESIGN LOADS, LOADS IMPOSED ON THE PRIMARY STRUCTURE, AND METHOD OF ATTACHMENT TO PRIMARY STRUCTURE
    - FIELD REVIEW REPORT FROM SUPPORTING REGISTERED PROFESSIONAL TO THE RESPECTIVE ELECTRICAL, BUILDING MECHANICAL, PROCESS MECHANICAL ENGINEER-OF-RECORD
    - SCHEDULES S-B AND S-C FROM SUPPORTING REGISTERED PROFESSIONAL TO THE RESPECTIVE ELECTRICAL, BUILDING MECHANICAL, PROCESS MECHANICAL ENGINEER-OF-RECORD.

STEEL PIPE PILES:

1. STEEL PIPE PILES SHALL BE INSTALLED IN ACCORDANCE WITH THE RECOMMENDATIONS IN THE GEOTECHNICAL REPORT PREPARED BY WSP CANADA INC., FILE # 171-04753-02 DATED AUGUST 21, 2019.
2. PILES ARE STEEL PIPE PILES:
    - 762mm DIAMETER
    - CONFORMS TO ASTM A252 GRADE 3
    - 17.48mm MINIMUM WALL THICKNESS (BEFORE CORROSION ALLOWANCE)
    - 4.30mm MINIMUM CORROSION THICKNESS ALLOWANCE
    - PILES SHALL HAVE A RESISTANCE OF AT LEAST 2.5 TIMES THE MAXIMUM FACTORED LOAD SHOWN ON THE DRAWINGS.
3. OBTAIN FROM THE GEOTECHNICAL CONSULTANT INSTRUCTIONS FOR DRIVING THE PILES INCLUDING THE PREPARATION, MINIMUM PENETRATION, RESTRIKING REQUIREMENTS, MINIMUM HAMMER WEIGHT, AND OTHER DRIVING SPECIFICATIONS.
4. SPLICES IN PILES SHALL BE COMPLETE PENETRATION GROOVE WELDS WITH A BACKING BAR. MEMBERS SHALL BE HELD IN ALIGNMENT DURING SPLICING.
5. PILE CAP ELEVATIONS, IF SHOWN, ARE FOR REFERENCE ONLY AND MUST BE MODIFIED TO SUIT SITE CONDITIONS, BEARING LEVEL, FLOOR SLOPES AND ELEVATIONS, SERVICES, ETC.
6. FOR DEPTHS OF BASE BEARING LEVEL FOR PILES, REFER TO INSTRUCTIONS FROM THE GEOTECHNICAL ENGINEER.
7. TOLERANCES FOR LOCATION OF PILES TO BE +/- 25mm FROM INTENDED LINE AND POSITION. PROVIDE TO THE ENGINEER, PRIOR TO FABRICATION OF STEEL, A SURVEY OF AS BUILT PILE POSITIONS INDICATING ANY VARIATIONS FROM INTENDED POSITION. TOLERANCE FOR PLUMB TO BE 2 PERCENT MAXIMUM SLOPE OF SHAFT. DO NOT FILL PILES WITH CONCRETE WITHOUT FIRST OBTAINING ACCEPTANCE OF PILE POSITIONS FROM THE ENGINEER AND GEOTECHNICAL ENGINEER.
8. MAINTAIN AND SUBMIT ACCURATE RECORDS OF THE PILE INSTALLATION. PROVIDE TO THE ENGINEER WRITTEN CONFIRMATION THAT THE PILES WERE INSTALLED IN ACCORDANCE WITH THE REQUIREMENTS OF THE DRAWINGS, INSTRUCTIONS OF THE GEOTECHNICAL ENGINEER, AND GOOD WORK PRACTICES.
9. DESIGN AND TESTING OF PILES FOR COMPRESSION, TENSION OR SHEAR LOADS SHALL BE ACCOMPLISHED AS DIRECTED BY THE GEOTECHNICAL ENGINEER.
10. ALL PILING WORK SHALL BE PERFORMED BY TRAINED PERSONNEL WITH SPECIFIC EXPERIENCE IN THE INSTALLATION OF DRIVEN STEEL PILES. ALL SITE WELDING TO BE ACCORDANCE WITH THE LATEST CSA W59 BY CWB CERTIFIED WELDERS.

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REV	DATE	DESIGN	DRAWN	DESCRIPTION
0	2019SEP11	D. WOO	K. CHAU	ISSUED FOR TENDER

CITY OF PORT ALBERNI

WASTEWATER LAGOON
EXPANSION UPGRADES

20172972-00

SCALE: AS SHOWN

THE CITY OF
Port Alberni

STRUCTURAL
GENERAL NOTES - SHEET 1
EFFLUENT PUMP STATION PLATFORM

DRAWING	REVISION	SHEET
2972-00-S-001	0	5

IF NOT 50 mm ADJUST SCALES
50 mm

SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS. TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE

POST-INSTALLED ANCHORS

1) EXCEPT WHERE INDICATED ON THE DRAWINGS, POST-INSTALLED ANCHORS SHALL CONSIST OF THE FOLLOWING ANCHOR TYPES AS PROVIDED BY HILTI, INC. CONTACT HILTI AT (800) 879-8000 FOR PRODUCT RELATED QUESTIONS.

a) ANCHORAGE TO CONCRETE

i) ADHESIVE ANCHORS FOR CRACKED AND UNCRACKED CONCRETE USE:
(1) HILTI HIT-HY 200 SAFE SET SYSTEM WITH THE HILTI HIT-Z ROD
(2) HILTI HIT-HY 200 SAFE SET SYSTEM (TE-CD OR TE-YD, HILTI HOLLOW DRILL BIT AND VC 20/40 VACUUM SYSTEM) WITH HAS-E THREADED ROD
(3) HILTI HIT-RE 500v3 SAFE SET SYSTEM (TE-CD OR TE-YD, HILTI HOLLOW DRILL BIT AND VC 20/40 VACUUM SYSTEM) WITH HAS-E THREADED ROD
(4) HILTI HIT-RE 500v3 SAFE SET SYSTEM WITH HILTI ROUGHENING TOOL (HIT RT) WITH HAS-E THREADED ROD PER ICC ESR-3814 FOR DIAMOND CORED HOLES

ii) MEDIUM DUTY MECHANICAL ANCHORS FOR CRACKED AND UNCRACKED CONCRETE USE:
(1) HILTI KWIK HUS EZ AND KWIK HUS EZ-I SCREW ANCHORS PER ICC ESR-3027
(2) HILTI KWIK BOLT-TZ EXPANSION ANCHORS PER ICC ESR-1917
(3) HILTI KWIK BOLT 3 EXPANSION ANCHORS (UNCRACKED CONCRETE ONLY) PER ICC ESR-2302

iii) HEAVY DUTY MECHANICAL ANCHORS FOR CRACKED AND UNCRACKED CONCRETE USE:
(1) HILTI HDA UNDERCUT ANCHORS PER ICC ESR 1546
(2) HILTI HSL-3 EXPANSION ANCHORS PER ICC ESR 1545

b) REBAR DOWELING INTO CONCRETE

i) ADHESIVE ANCHORS FOR CRACKED AND UNCRACKED CONCRETE USE:
(1) HILTI HIT-HY 200 SAFE SET SYSTEM (TE-CD OR TE-YD, HILTI HOLLOW DRILL BIT AND VC 20/40 VACUUM SYSTEM) WITH CONTINUOUSLY DEFORMED REBAR PER ICC ESR-3187
(2) HILTI HIT-HY 500v3 SAFE SET SYSTEM (TE-CD OR TE-YD, HILTI HOLLOW DRILL BIT AND VC 20/40 VACUUM SYSTEM) WITH CONTINUOUSLY DEFORMED REBAR PER ICC ESR-3814
(3) HILTI HIT-RE 500v3 SAFE SET SYSTEM WITH HILTI ROUGHENING TOOL (HIT RT) WITH CONTINUOUSLY DEFORMED REBAR PER ICC ESR-3814 IN DIAMOND CORED HOLES

c) ANCHORAGE TO SOLID GROUTED MASONRY

i) ADHESIVE ANCHORS USE:
(1) HILTI HIT-HY 200 SAFE SET SYSTEM.
(2) STEEL ANCHOR ELEMENT SHALL BE HILTI HAS-E CONTINUOUSLY THREADED ROD OR CONTINUOUSLY DEFORMED STEEL REBAR

ii) MECHANICAL ANCHORS USE:
(1) HILTI KWIK BOLT-3 EXPANSION ANCHORS PER ICC ESR 1385

d) ANCHORAGE TO HOLLOW / MULTI-WYTHE MASONRY

i) ADHESIVE ANCHORS USE:
(1) HILTI HIT-HY 70 MASONRY ADHESIVE ANCHORING SYSTEM PER ICC ESR-3342.
(2) STEEL ANCHOR ELEMENT SHALL BE HILTI HAS-E CONTINUOUSLY THREADED ROD OR CONTINUOUSLY DEFORMED STEEL REBAR
(3) THE APPROPRIATE SIZE SCREEN TUBE SHALL BE USED PER ADHESIVE MANUFACTURER'S RECOMMENDATION

2) ANCHOR CAPACITY USED IN DESIGN SHALL BE BASED ON THE TECHNICAL DATA PUBLISHED BY HILTI OR SUCH OTHER METHOD AS APPROVED BY THE STRUCTURAL ENGINEER OF RECORD. SUBSTITUTION REQUESTS FOR ALTERNATE PRODUCTS MUST BE APPROVED IN WRITING BY THE STRUCTURAL ENGINEER OF RECORD PRIOR TO USE. CONTRACTOR SHALL PROVIDE CALCULATIONS DEMONSTRATING THAT THE SUBSTITUTED PRODUCT IS CAPABLE OF ACHIEVING THE PERFORMANCE VALUES OF THE SPECIFIED PRODUCT. SUBSTITUTIONS WILL BE EVALUATED BY THEIR HAVING AN ICC ESR SHOWING COMPLIANCE WITH THE RELEVANT BUILDING CODE FOR SEISMIC USES, LOAD RESISTANCE, INSTALLATION CATEGORY, AND AVAILABILITY OF COMPREHENSIVE INSTALLATION INSTRUCTIONS. ADHESIVE ANCHOR EVALUATION WILL ALSO CONSIDER CREEP, IN-SERVICE TEMPERATURE AND INSTALLATION TEMPERATURE.

3) INSTALL ANCHORS PER THE MANUFACTURER INSTRUCTIONS, AS INCLUDED IN THE ANCHOR PACKAGING.

4) OVERHEAD ADHESIVE ANCHORS MUST BE INSTALLED USING THE HILTI PROFI SYSTEM.

5) THE CONTRACTOR SHALL ARRANGE AN ANCHOR MANUFACTURER'S REPRESENTATIVE TO PROVIDE ONSITE INSTALLATION TRAINING FOR ALL OF THEIR ANCHORING PRODUCTS SPECIFIED. THE STRUCTURAL ENGINEER OF RECORD MUST RECEIVE DOCUMENTED CONFIRMATION THAT ALL OF THE CONTRACTOR'S PERSONNEL WHO INSTALL ANCHORS ARE TRAINED PRIOR TO THE COMMENCEMENT OF INSTALLING ANCHORS.

6) ANCHOR CAPACITY IS DEPENDANT UPON SPACING BETWEEN ADJACENT ANCHORS AND PROXIMITY OF ANCHORS TO EDGE OF CONCRETE. INSTALL ANCHORS IN ACCORDANCE WITH SPACING AND EDGE CLEARANCES INDICATED ON THE DRAWINGS.

7) EXISTING REINFORCING BARS IN THE CONCRETE STRUCTURE MAY CONFLICT WITH SPECIFIC ANCHOR LOCATIONS. UNLESS NOTED ON THE DRAWINGS THAT THE BARS CAN BE CUT, THE CONTRACTOR SHALL REVIEW THE EXISTING STRUCTURAL DRAWINGS AND SHALL UNDERTAKE TO LOCATE THE POSITION OF THE REINFORCING BARS AT THE LOCATIONS OF THE CONCRETE ANCHORS, BY HILTI FERROSCAN, GPR, X-RAY, CHIPPING OR OTHER MEANS.

8) PROOF LOADING PROGRAM

a) WHEN SUBSTITUTING EMBEDDED ANCHORAGE SYSTEM OR WHERE REQUIRED BY ENGINEER, A PROGRAM FOR ON-SITE PROOF LOADING, THAT IS, PROOF LOADING PROGRAM, TO BE CONDUCTED AS PART OF THE INSPECTION PROGRAM AT THE COST OF CONTRACTOR EXPENSE. THE PROOF LOADING PROGRAM SHALL CONFORM TO THE FOLLOWING MINIMUM REQUIREMENTS AS PER ACI 308
i) FREQUENCY OF PROOF LOADING BASED ON ANCHOR TYPE, DIAMETER, AND EMBEDMENT.
ii) PROOF LOADS BY ANCHOR TYPE, DIAMETER, EMBEDMENT, AND LOCATION
iii) ACCEPTABLE DISPLACEMENT AT PROOF LOAD.
iv) REMEDIAL ACTION IN THE EVENT OF FAILURE TO ACHIEVE PROOF LOAD OR EXCESSIVE DISPLACEMENT.
b) UNO, PROOF LOADS SHALL BE APPLIED AS CONFINED TENSION TEST (4.7.3.2). PROOF LOAD LEVELS SHALL NOT EXCEED THE LESSER OF 67% OF THE LOAD CORRESPONDING TO THE NOMINAL BOND STRENGTH AS CALCULATED FROM THE CHARACTERISTIC BOND STRESS FOR UNCRACKED CONCRETED MODIFIED FOR EDGE EFFECTS AND CONCRETE PROPERTIES OR 80% OF THE MINIMUM SPECIFIED ANCHOR ELEMENT YIELD STRENGTH. MAINTAIN THE PROOF LOAD AT THE REQUIRED LOAD LEVEL FOR A MINIMUM OF 10 SECONDS.

SHOP DRAWINGS AND SPECIALTY ENGINEER:

1. CONTRACTOR IS RESPONSIBLE FOR REVIEWING THE SHOP DRAWINGS AND ENSURING CONFORMANCE TO DRAWINGS AND CONTRACT DOCUMENTS PRIOR TO THE SHOP DRAWING REVIEW OF THE ENGINEER. THE CONTRACTOR IS RESPONSIBLE FOR COORDINATING ALL SUB-TRADES, SUBCONTRACTORS, SUPPLIERS AND SUPPORTING REGISTERED PROFESSIONALS.

2. SUBCONTRACTORS AND SUPPLIERS SHALL SUBMIT SHOP DRAWINGS TO THE ENGINEER AND CONTRACTOR FOR REVIEW PRIOR TO FABRICATION. SHOP DRAWINGS ARE TO BE SIGNED AND SEALED BY A PROFESSIONAL ENGINEER REGISTERED IN THE PROJECT PROVINCE/TERRITORY WHO WILL BE THE SUPPORTING REGISTERED PROFESSIONAL (SRP) RESPONSIBLE FOR THE DESIGN AND FIELD REVIEW OF THE PARTICULAR COMPONENT OR SYSTEM.

3. WHERE REQUIRED IN THE FOLLOWING SECTIONS, THE SUPPORTING REGISTERED PROFESSIONAL (SRP) SHALL CONDUCT FIELD REVIEWS DURING CONSTRUCTION AT THE DISCRETION OF THE SRP AND SUBMIT A WRITTEN FIELD REVIEW REPORT TO THE ENGINEER. THE SRP SHALL SUBMIT SEALED LETTERS OF ASSURANCE B AND C-B OR SCHEDULES S-B AND S-C FOR ASSURANCE OF DESIGN AND FIELD REVIEW OF THE PARTICULAR COMPONENT OR SYSTEM.

4. THE SHOP DRAWING REVIEW IS CONDUCTED FOR THE SOLE PURPOSE OF ENSURING GENERAL CONFORMANCE TO THE DESIGN CONCEPT. THE SHOP DRAWING REVIEW DOES NOT GUARANTEE THE SUBCONTRACTOR OR SUPPLIER'S DESIGN, DETAILS, QUANTITIES, DIMENSIONS, METHOD OF CONSTRUCTION, AND SAFETY MEASURES. THE CONTRACTOR IS RESPONSIBLE FOR ANY ERRORS/AND OR OMISSIONS IN THE SHOP DRAWINGS AND MEETING THE REQUIREMENTS OF THE CONSTRUCTION AND CONTRACT DOCUMENTS.

5. THE SHOP DRAWINGS SHALL INDICATE THE METHOD AND MEANS OF ATTACHMENT TO THE PRIMARY STRUCTURAL SYSTEM AS WELL AS THE DESIGN LOADS AND CRITERIA USED AS THE BASIS OF DESIGN OF THE PARTICULAR COMPONENT OR SYSTEM.

DESIGN DATA:

1. DESIGN LIVE LOADS (SERVICE):

TOP OF PLATFORM	4.8 kPa
BOTTOM OF PLATFORM	3.6 kPa

2. SEISMIC LOADING:

SITE CLASS	E
IMPORTANCE FACTOR	Ie = 1.0
S (0.2)	0.386
S (0.5)	0.265
S (1.0)	0.139
S (2.0)	0.074

DESIGN SPECTRAL ACCELERATION VALUES ARE SITE-SPECIFIC AND ARE FOR 1 IN 100 YEAR EVENT.
MODIFICATION FACTORS (SEISMIC) Rd = 1.5
Ro = 1.3

3. SNOW LOADING:

IMPORTANCE FACTOR	Is = 1.0
GROUND SNOW LOAD	Ss = 2.6 kPa
RAIN LOAD	Sr = 0.4 kPa

4. WIND LOADING:

IMPORTANCE FACTOR	Iw = 1.0
WIND 1/10	q = 0.25 kPa
WIND 1/50	q = 0.32 kPa

DESIGN CODES STANDARDS REGULATIONS:

- BRITISH COLUMBIA BUILDING CODE 2018

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Associated Engineering

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0	2019SEP11	D WOO	K CHAU	ISSUED FOR TENDER

CITY OF PORT ALBERNI

WASTEWATER LAGOON
EXPANSION UPGRADES

20172972-00

SCALE: AS SHOWN

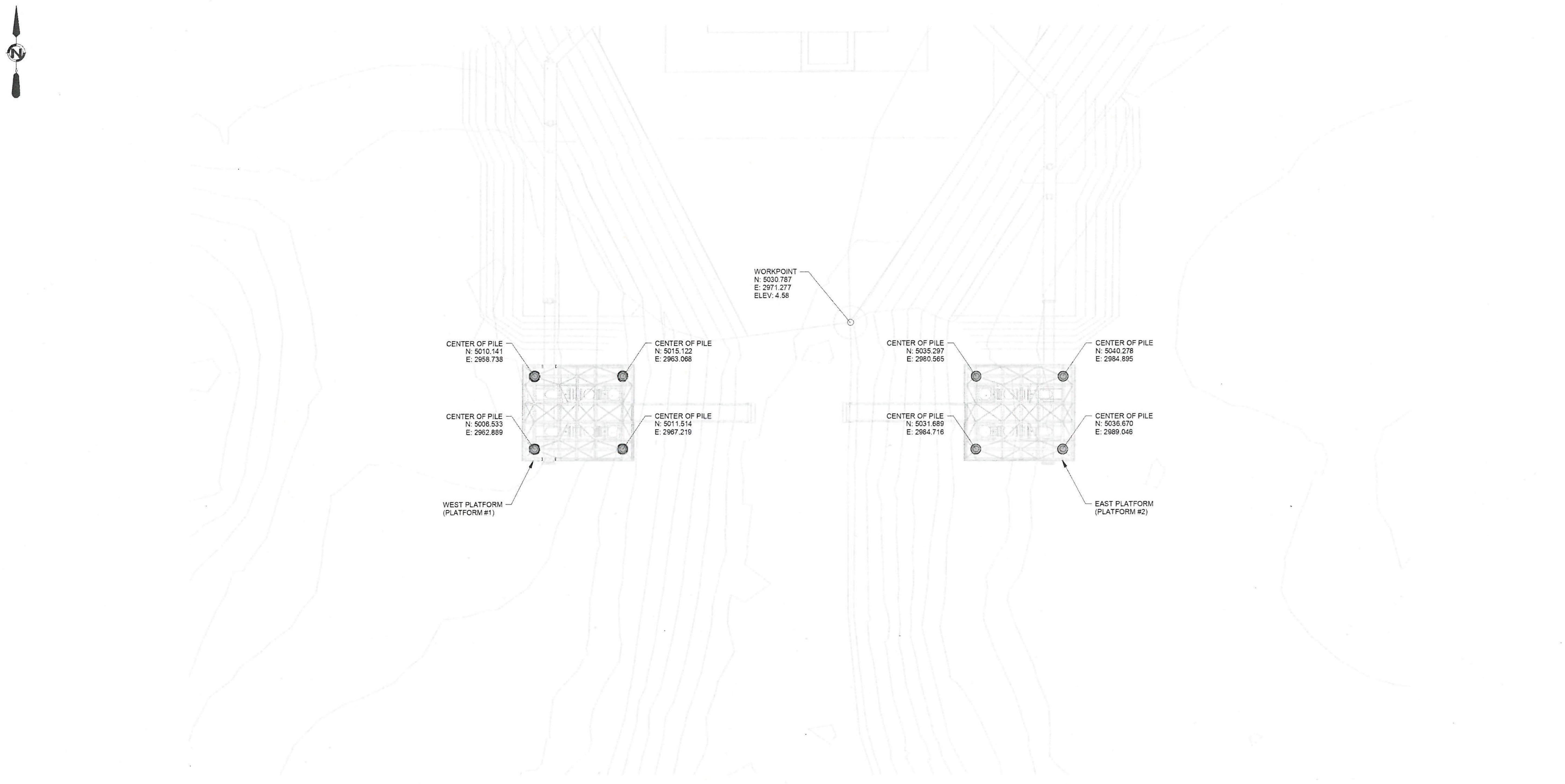
THE CITY OF
Port Alberni

STRUCTURAL
GENERAL NOTES - SHEET 2
EFFLUENT PUMP STATION PLATFORM

DRAWING	REVISION	SHEET
2972-00-S-002	0	6

IF NOT 50 mm ADJUST SCALES
50 mm

SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS. TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE



1 PLAN 1 : 150
SITE PLAN

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CITY OF PORT ALBERNI

WASTEWATER LAGOON
EXPANSION UPGRADES

20172972-00

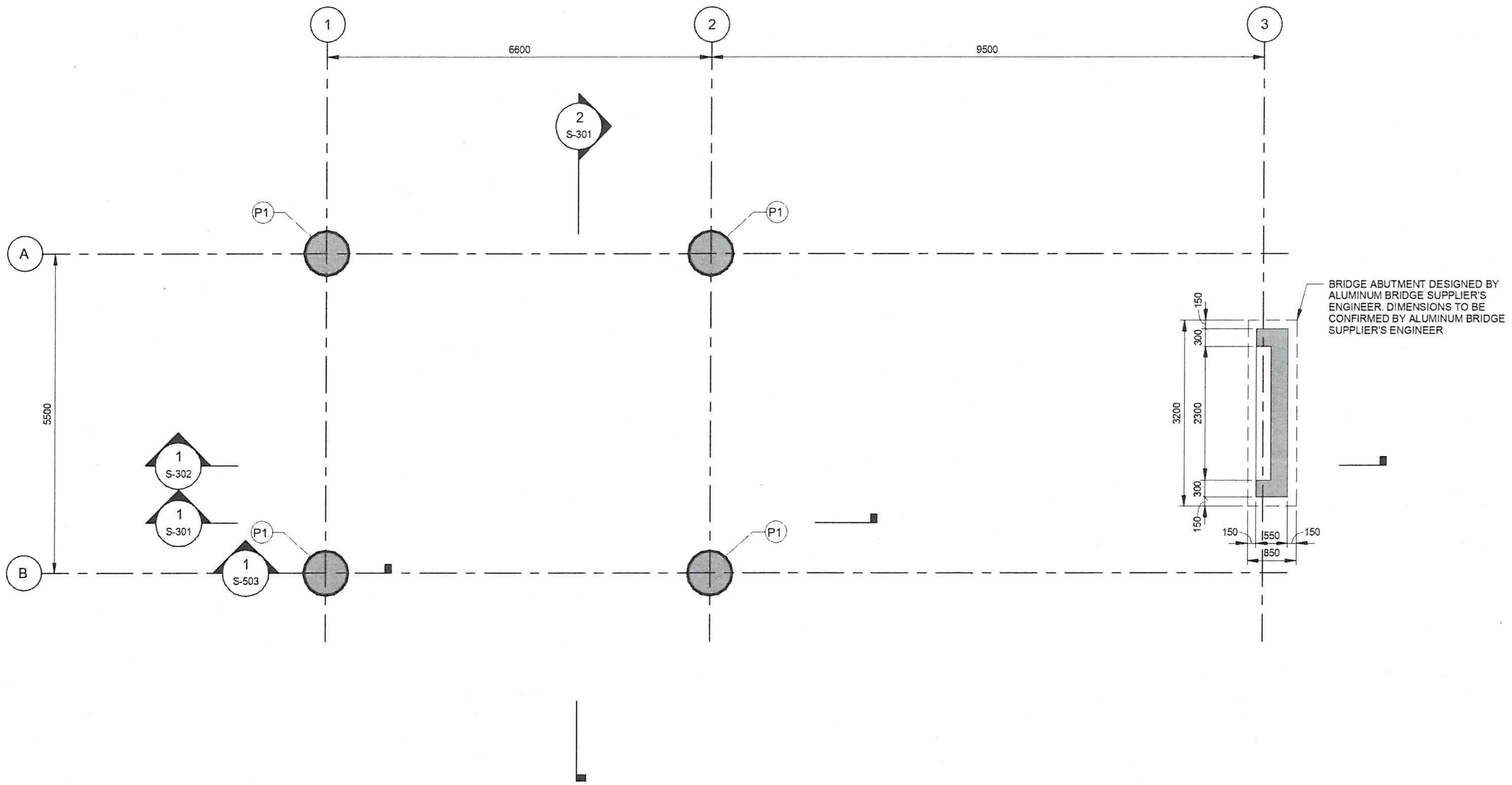
SCALE: AS SHOWN

THE CITY OF
Port Alberni

STRUCTURAL
SITE PLAN
EFFLUENT PUMP STATION PLATFORM

DRAWING	REVISION	SHEET
2972-00-S-100	0	7

IF NOT 50 mm ADJUST SCALES
50 mm
SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS. TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE



BRIDGE ABUTMENT DESIGNED BY ALUMINUM BRIDGE SUPPLIER'S ENGINEER. DIMENSIONS TO BE CONFIRMED BY ALUMINUM BRIDGE SUPPLIER'S ENGINEER

1
-
PLAN 1 : 50
FOUNDATION PILES
FOR WEST PLATFORM
EAST PLATFORM
SIMILAR BUT HANDED

PILE SCHEDULE					
SYMBOL	SIZE	MATERIAL	AXIAL	SHEAR AT TOP OF PILE 1/100 YEAR SEISMIC EVENT	SHEAR AT TOP OF PILE DUE TO PIPE THRUST
P1	762Ø x 17.8mm	ASTM A252 GRADE 3	450 kN	63 kN	68 kN (W/ 1.25 FACTOR)

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CITY OF PORT ALBERNI

WASTEWATER LAGOON
EXPANSION UPGRADES

20172972-00

SCALE: AS SHOWN

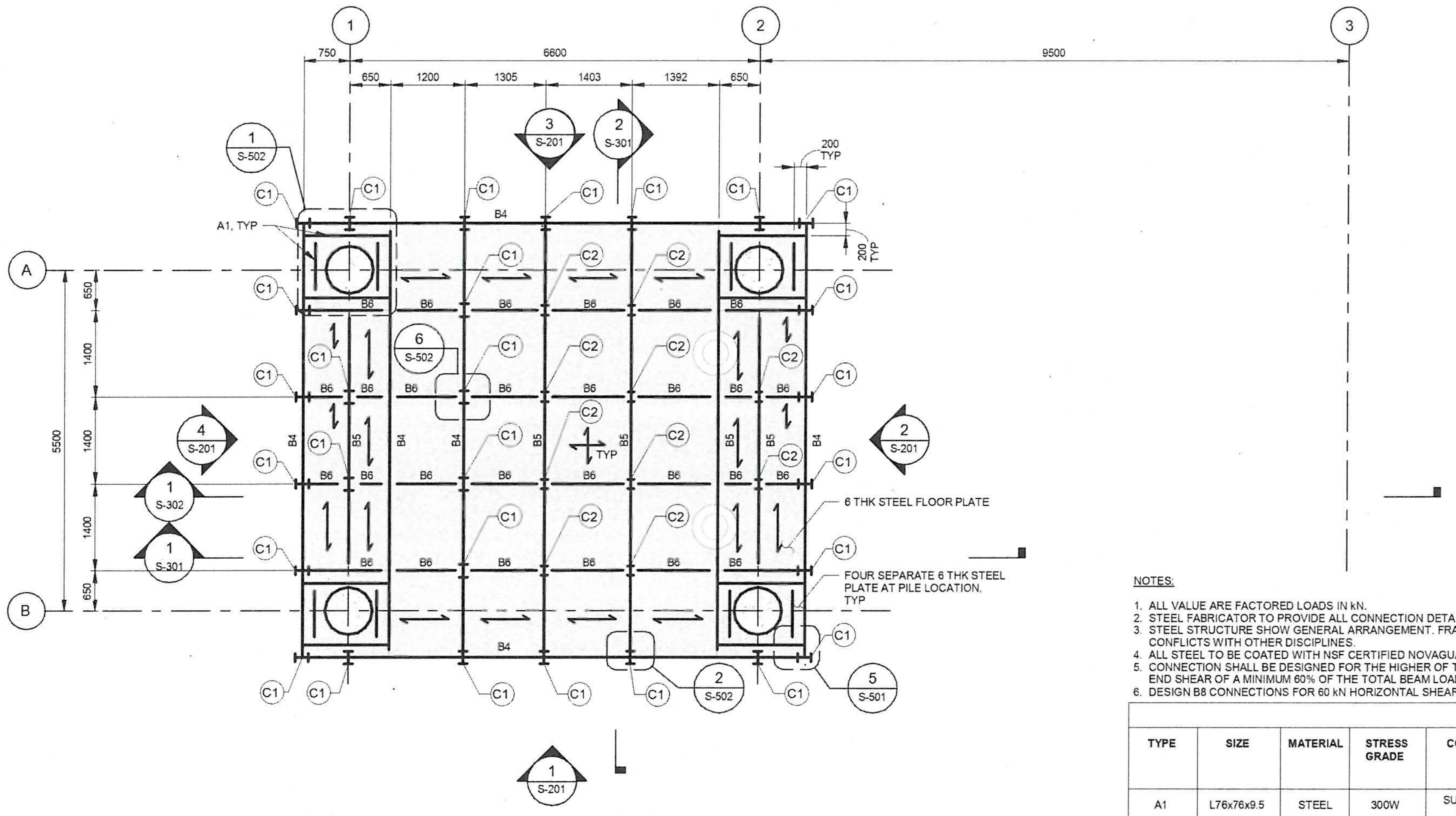
THE CITY OF
Port Alberni

STRUCTURAL
FOUNDATION PILES LAYOUT
EFFLUENT PUMP STATION PLATFORM

DRAWING	REVISION	SHEET
2972-00-S-101	0	8

IF NOT 50 mm ADJUST SCALES
50 mm

SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS. TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE



1
-
PLAN
1 : 50

PLAN AT ELEVATION
-0.690m

NOTES:

1. ALL VALUE ARE FACTORED LOADS IN kN.
2. STEEL FABRICATOR TO PROVIDE ALL CONNECTION DETAILS.
3. STEEL STRUCTURE SHOW GENERAL ARRANGEMENT. FRAMING MAY BE ADJUSTED TO SUIT SITE CONDITIONS AND TO AVOID CONFLICTS WITH OTHER DISCIPLINES.
4. ALL STEEL TO BE COATED WITH NSF CERTIFIED NOVAGUARD 840 EPOXY BY PPG.
5. CONNECTION SHALL BE DESIGNED FOR THE HIGHER OF THE FORCES AS INDICATED ON THE DRAWINGS OR FOR FACTORED END SHEAR OF A MINIMUM 60% OF THE TOTAL BEAM LOAD CAPACITY.
6. DESIGN B8 CONNECTIONS FOR 60 kN HORIZONTAL SHEAR AND 60 kNm TORSION.

BEAM SCHEDULE

TYPE	SIZE	MATERIAL	STRESS GRADE	COMMENTS	FACTORED CONNECTION DESIGN FORCES			
					COMPRESSION (kN)	TENSION (kN)	SHEAR (kN)	MOMENT (kNm)
A1	L76x76x9.5	STEEL	300W	SUPPORT FOR GRATING	5	5	10	5
A2	L64x64x9.5	STEEL	300W	HORIZONTAL BRACE	55	55	-	-
A3	L152x102x19	STEEL	300W	VERTICAL BRACE	190	105	-	-
B1	W360x72	STEEL	350W	STEEL GIRDER	55	35	140	120
B2	W360x72	STEEL	350W	STEEL BEAM	80	55	65	95
B3	W360x72	STEEL	350W	SECONDARY STEEL BEAM	30	130	80	55
B4	W360X72	STEEL	350W	STEEL GIRDER	30	50	60	105
B5	W250x39	STEEL	350W	STEEL BEAM	20	15	70	35
B6	W250x39	STEEL	350W	SECONDARY STEEL BEAM	20	20	140	30
B7	W360x72	STEEL	350W	PIPE SUPPORT BEAM	30	30	45	-
B8	HSS 356x254x9.5	STEEL	350W	PIPE SUPPORT BEAM	40	40	55	-

COLUMN SCHEDULE

SYMBOL	SIZE	MATERIAL	STRESS GRADE	FACTORED CONNECTION DESIGN FORCES			
				COMPRESSION (kN)	TENSION (kN)	SHEAR (kN)	MOMENT (kNm)
C1	W200x27	STEEL	350W	30	90	5	20
C2	W150X18	STEEL	350W	45	75	-	-

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Associated Engineering

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M. K. D. WOO
34152
SEP 11 2019

REV	DATE	DESIGN	DRAWN	DESCRIPTION
0	2019SEP11	D. WOO	K. CHAU	ISSUED FOR TENDER

CITY OF PORT ALBERNI

WASTEWATER LAGOON
EXPANSION UPGRADES

20172972-00

SCALE: AS SHOWN

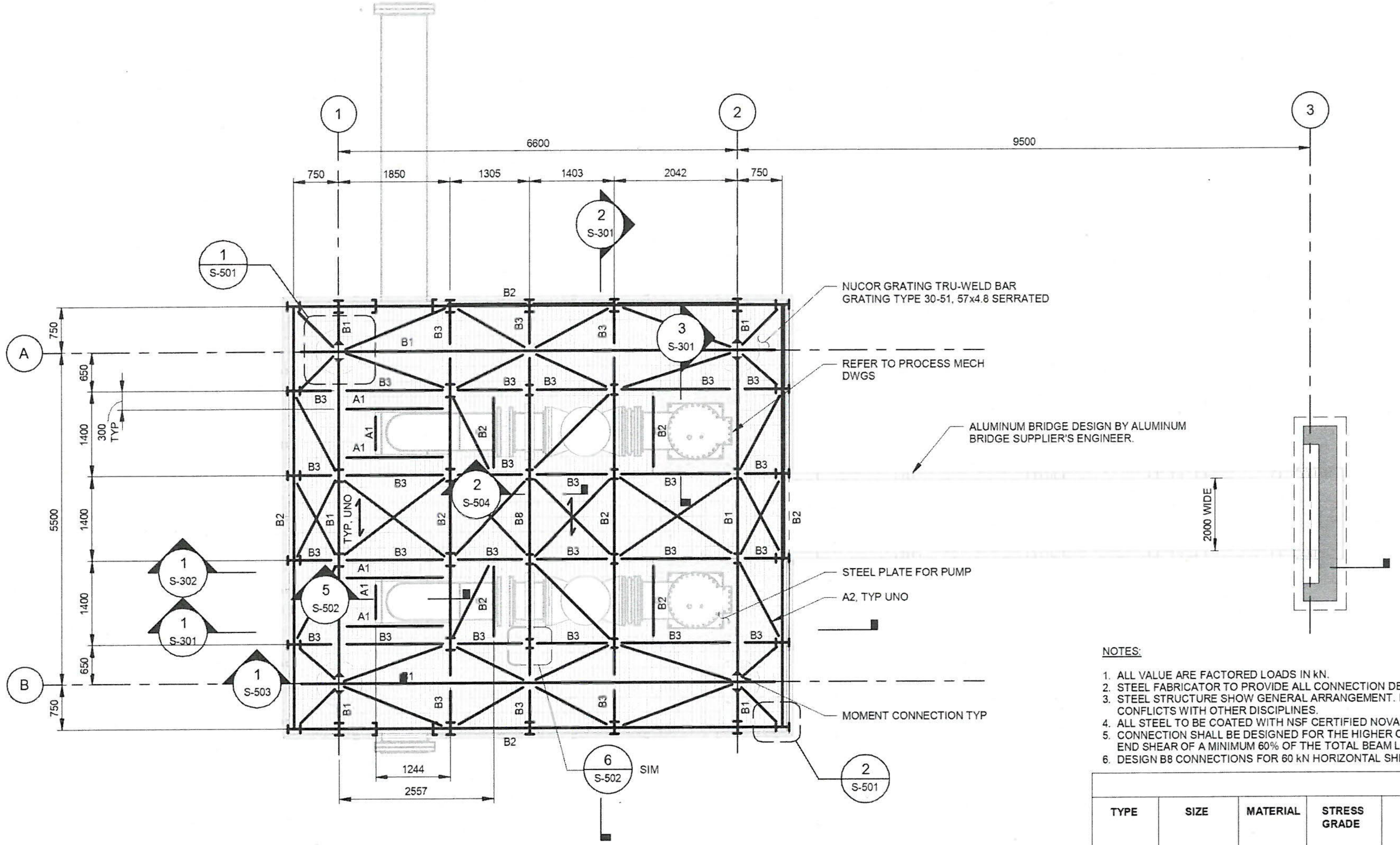
THE CITY OF
Port Alberni

STRUCTURAL
B/O STEEL FRAMING LAYOUT
EFFLUENT PUMP STATION PLATFORM

DRAWING	REVISION	SHEET
2972-00-S-102	0	9

IF NOT 50 mm ADJUST SCALES
50 mm

SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE



1 PLAN 1 : 50
PLATFORM LAYOUT

NOTES:

1. ALL VALUE ARE FACTORED LOADS IN kN.
2. STEEL FABRICATOR TO PROVIDE ALL CONNECTION DETAILS.
3. STEEL STRUCTURE SHOW GENERAL ARRANGEMENT. FRAMING MAY BE ADJUSTED TO SUIT SITE CONDITIONS AND TO AVOID CONFLICTS WITH OTHER DISCIPLINES.
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5. CONNECTION SHALL BE DESIGNED FOR THE HIGHER OF THE FORCES AS INDICATED ON THE DRAWINGS OR FOR FACTORED END SHEAR OF A MINIMUM 60% OF THE TOTAL BEAM LOAD CAPACITY.
6. DESIGN B8 CONNECTIONS FOR 60 kN HORIZONTAL SHEAR AND 60 kNm TORSION.

BEAM SCHEDULE

TYPE	SIZE	MATERIAL	STRESS GRADE	COMMENTS	FACTORED CONNECTION DESIGN FORCES			
					COMPRESSION (kN)	TENSION (kN)	SHEAR (kN)	MOMENT (kNm)
A1	L76x76x9.5	STEEL	300W	SUPPORT FOR GRATING	5	5	10	5
A2	L64x64x9.5	STEEL	300W	HORIZONTAL BRACE	55	55	-	-
A3	L152x102x19	STEEL	300W	VERTICAL BRACE	190	105	-	-
B1	W360x72	STEEL	350W	STEEL GIRDER	55	35	140	120
B2	W360x72	STEEL	350W	STEEL BEAM	80	55	65	95
B3	W360x72	STEEL	350W	SECONDARY STEEL BEAM	30	130	80	55
B4	W360X72	STEEL	350W	STEEL GIRDER	30	50	60	105
B5	W250x39	STEEL	350W	STEEL BEAM	20	15	70	35
B6	W250x39	STEEL	350W	SECONDARY STEEL BEAM	20	20	140	30
B7	W360x72	STEEL	350W	PIPE SUPPORT BEAM	30	30	45	-
B8	HSS 356x254x9.5	STEEL	350W	PIPE SUPPORT BEAM	40	40	55	-

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REV	DATE	DESIGN	DRAWN	DESCRIPTION
0	2019SEP11	D WOO	K CHAU	ISSUED FOR TENDER

CITY OF PORT ALBERNI

WASTEWATER LAGOON
EXPANSION UPGRADES

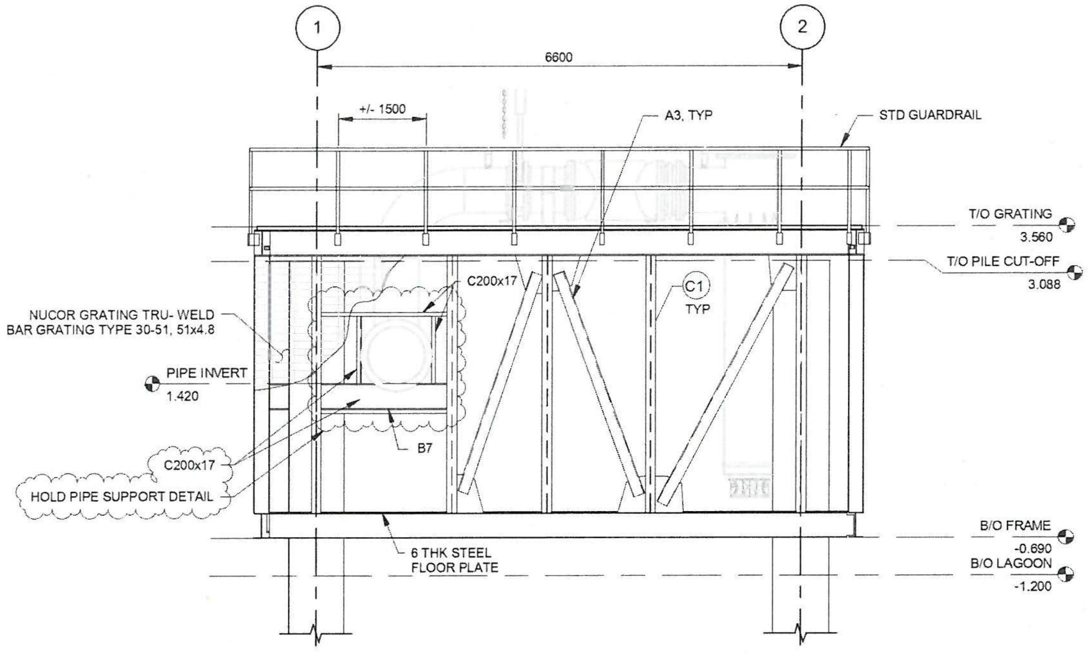
20172972-00

SCALE: AS SHOWN

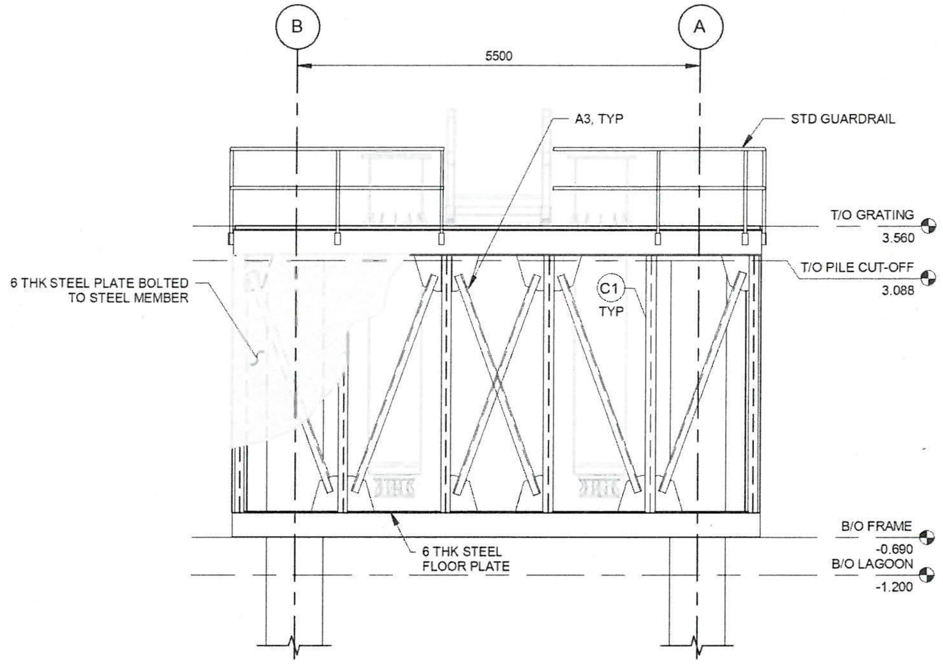
THE CITY OF
Port Alberni

STRUCTURAL
T/O STEEL PLATFORM LAYOUT
EFFLUENT PUMP STATION PLATFORM

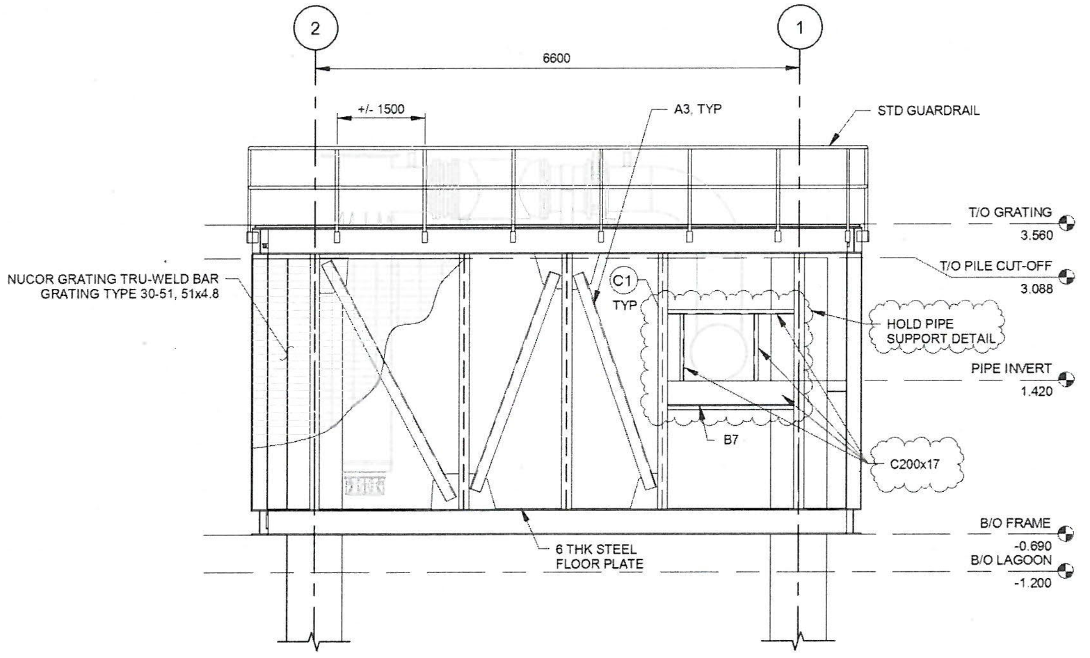
DRAWING	REVISION	SHEET
2972-00-S-103	0	10



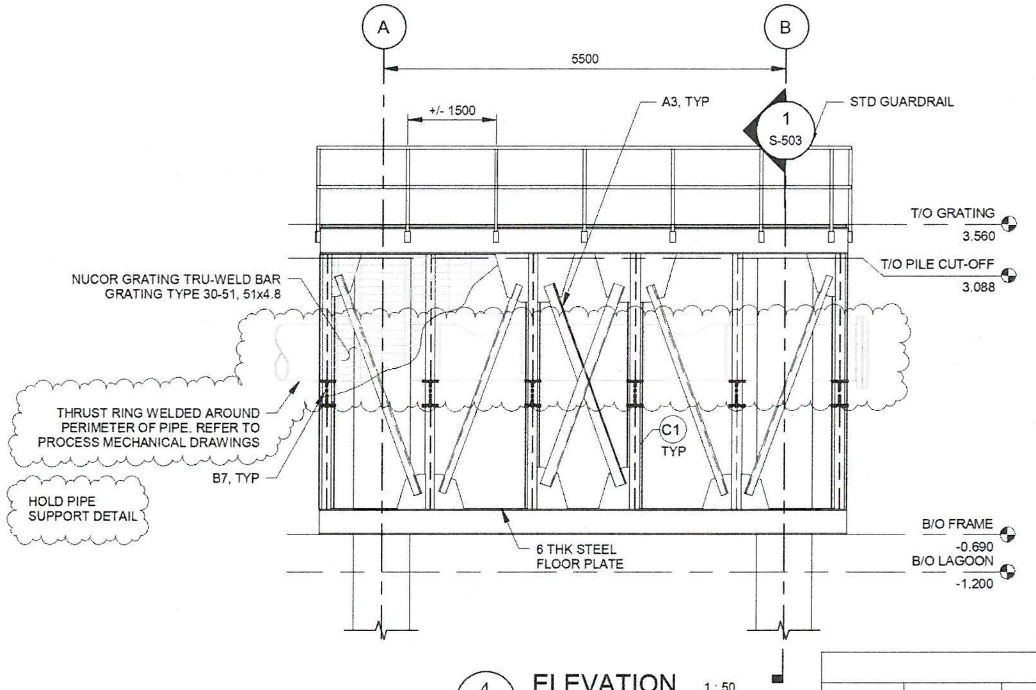
1
S-102
ELEVATION 1 : 50
NORTH VIEW



2
S-102
ELEVATION 1 : 50
EAST VIEW



3
S-102
ELEVATION 1 : 50
SOUTH VIEW



4
S-102
ELEVATION 1 : 50
WEST VIEW

NOTES:

1. ALL VALUE ARE FACTORED LOADS IN kN.
2. STEEL FABRICATOR TO PROVIDE ALL CONNECTION DETAILS.
3. STEEL STRUCTURE SHOW GENERAL ARRANGEMENT. FRAMING MAY BE ADJUSTED TO SUIT SITE CONDITIONS AND TO AVOID CONFLICTS WITH OTHER DISCIPLINES.
4. ALL STEEL TO BE COATED WITH NSF CERTIFIED NOVAGUARD 840 EPOXY BY PPG.
5. CONNECTION SHALL BE DESIGNED FOR THE HIGHER OF THE FORCES AS INDICATED ON THE DRAWINGS OR FOR FACTORED END SHEAR OF A MINIMUM 60% OF THE TOTAL BEAM LOAD CAPACITY.
6. DESIGN B8 CONNECTIONS FOR 60 kN HORIZONTAL SHEAR AND 60 kNm TORSION.

COLUMN SCHEDULE

SYMBOL	SIZE	MATERIAL	STRESS GRADE	FACTORED CONNECTION DESIGN FORCES			
				COMPRESSION (kN)	TENSION (kN)	SHEAR (kN)	MOMENT (kNm)
C1	W200x27	STEEL	350W	30	90	5	20
C2	W150X18	STEEL	350W	45	75	-	-

SAVE DATE 9/11/2019 3:05:27 PM
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Associated Engineering

BEST MANAGED COMPANIES
Platinum member

M. K. D. WOO
34152
SEP 11 2019

REV	DATE	DESIGN	DRAWN	DESCRIPTION
0	2019SEP11	D WOO	K CHAU	ISSUED FOR TENDER

CITY OF PORT ALBERNI

WASTEWATER LAGOON
EXPANSION UPGRADES

20172972-00

SCALE: AS SHOWN

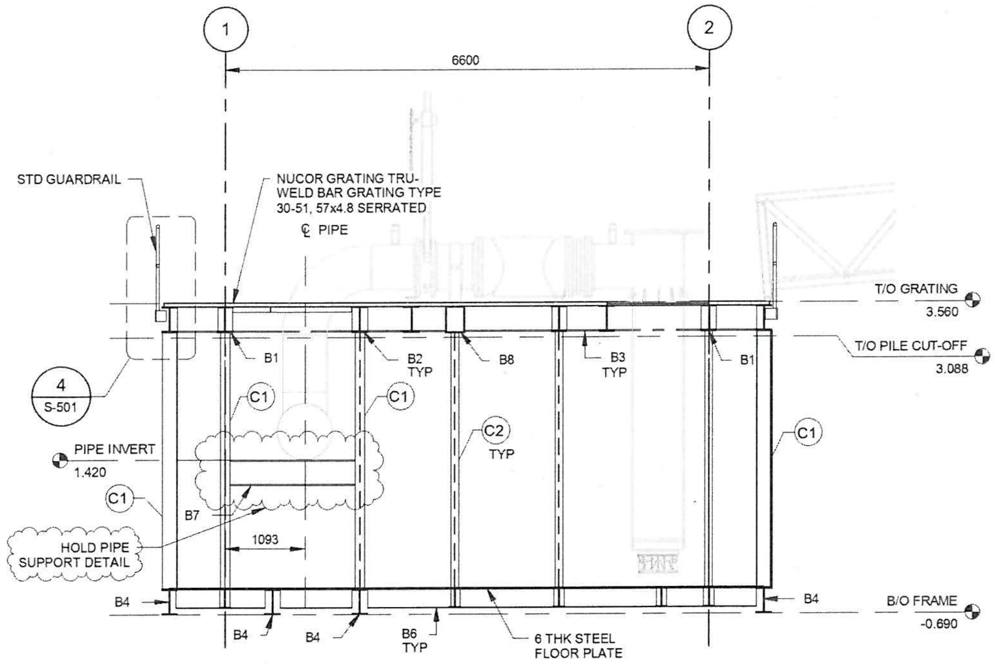
THE CITY OF
Port Alberni

STRUCTURAL
ELEVATIONS
EFFLUENT PUMP STATION PLATFORM

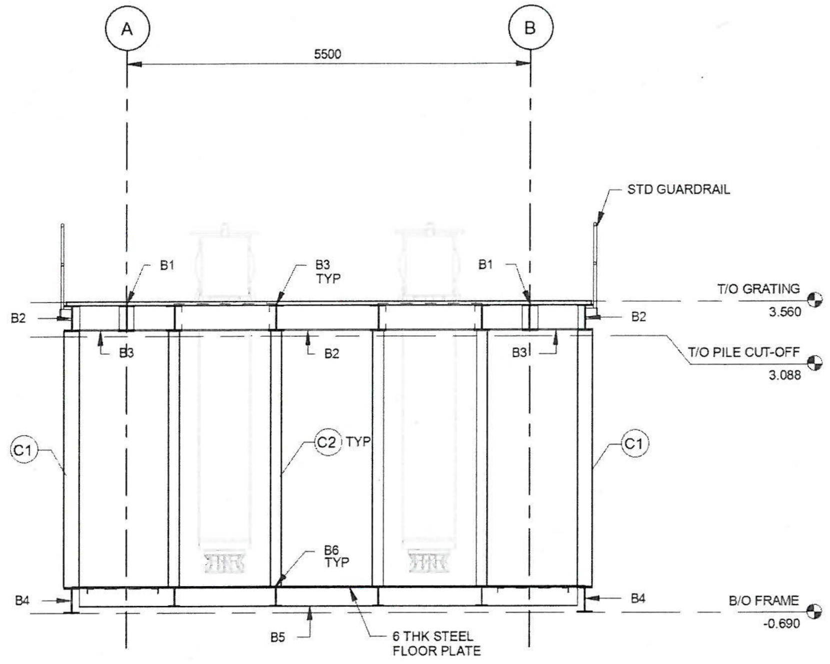
DRAWING	REVISION	SHEET
2972-00-S-201	0	11

IF NOT 50 mm ADJUST SCALES
50 mm

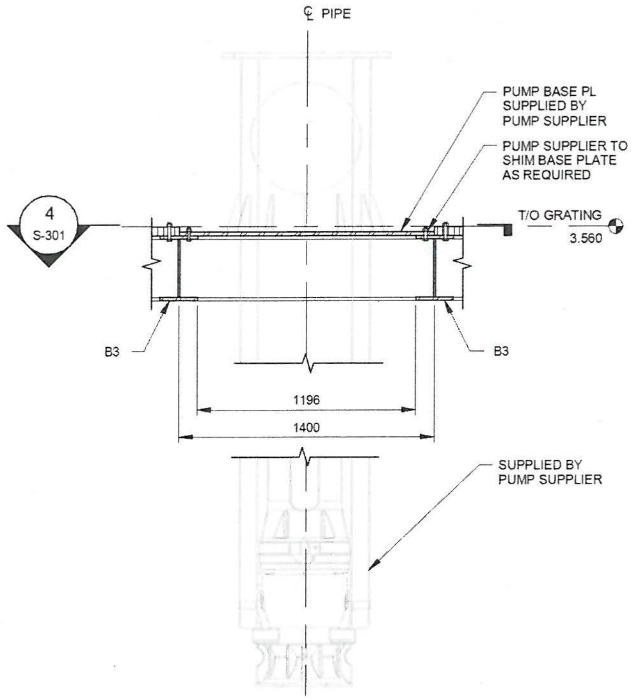
SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS. TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE



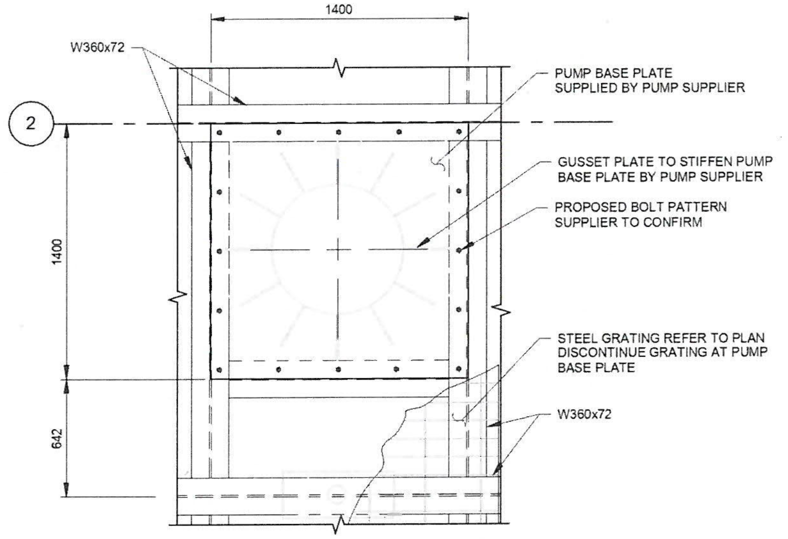
1 S-101 SECTION 1 : 50
LONGITUDINAL SECTION



2 S-101 SECTION 1 : 50
TRAVSVERSE SECTION



3 S-103 SECTION 1 : 20
PUMP BASE PLATE



4 S-301 SECTION 1 : 20
PUMP BASE PLATE

NOTES:

1. ALL VALUE ARE FACTORED LOADS IN kN.
2. STEEL FABRICATOR TO PROVIDE ALL CONNECTION DETAILS.
3. STEEL STRUCTURE SHOW GENERAL ARRANGEMENT. FRAMING MAY BE ADJUSTED TO SUIT SITE CONDITIONS AND TO AVOID CONFLICTS WITH OTHER DISCIPLINES.
4. ALL STEEL TO BE COATED WITH NSF CERTIFIED NOVAGUARD 840 EPOXY BY PPG.
5. CONNECTION SHALL BE DESIGNED FOR THE HIGHER OF THE FORCES AS INDICATED ON THE DRAWINGS OR FOR FACTORED END SHEAR OF A MINIMUM 60% OF THE TOTAL BEAM LOAD CAPACITY.
6. DESIGN B8 CONNECTIONS FOR 60 kN HORIZONTAL SHEAR AND 60 kNm TORSION.

COLUMN SCHEDULE

SYMBOL	SIZE	MATERIAL	STRESS GRADE	FACTORED CONNECTION DESIGN FORCES			
				COMPRESSION (kN)	TENSION (kN)	SHEAR (kN)	MOMENT (kNm)
C1	W200x27	STEEL	350W	30	90	5	20
C2	W150X18	STEEL	350W	45	75	-	-

BEAM SCHEDULE

TYPE	SIZE	MATERIAL	STRESS GRADE	COMMENTS	FACTORED CONNECTION DESIGN FORCES			
					COMPRESSION (kN)	TENSION (kN)	SHEAR (kN)	MOMENT (kNm)
A1	L76x76x9.5	STEEL	300W	SUPPORT FOR GRATING	5	5	10	5
A2	L64x64x9.5	STEEL	300W	HORIZONTAL BRACE	55	55	-	-
A3	L152x102x19	STEEL	300W	VERTICAL BRACE	190	105	-	-
B1	W360x72	STEEL	350W	STEEL GIRDER	55	35	140	120
B2	W360x72	STEEL	350W	STEEL BEAM	80	55	65	95
B3	W360x72	STEEL	350W	SECONDARY STEEL BEAM	30	130	80	55
B4	W360X72	STEEL	350W	STEEL GIRDER	30	50	60	105
B5	W250x39	STEEL	350W	STEEL BEAM	20	15	70	35
B6	W250x39	STEEL	350W	SECONDARY STEEL BEAM	20	20	140	30
B7	W360x72	STEEL	350W	PIPE SUPPORT BEAM	30	30	45	-
B8	HSS 356x254x9.5	STEEL	350W	PIPE SUPPORT BEAM	40	40	55	-

SAVE DATE 9/11/2019 3:05:31 PM
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Associated Engineering

BEST MANAGED COMPANIES
Platinum member

M. K. D. WOO
34152
SEP 11 2019

REV	DATE	DESIGN	DRAWN	DESCRIPTION
0	2019SEP11	D WOO	K CHAU	ISSUED FOR TENDER

CITY OF PORT ALBERNI

WASTEWATER LAGOON
EXPANSION UPGRADES

20172972-00

SCALE: AS SHOWN

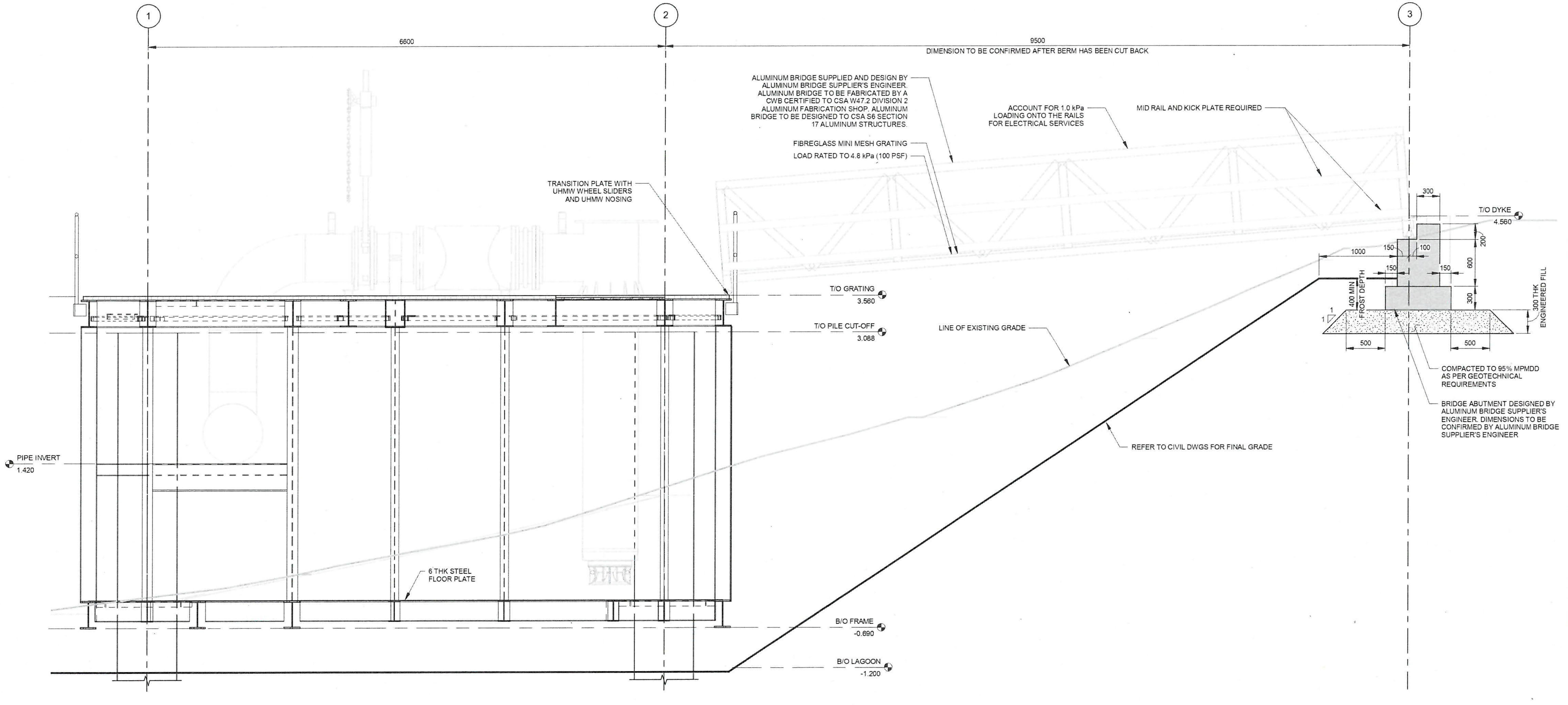
THE CITY OF
Port Alberni

STRUCTURAL
SECTIONS - SHEET 1
EFFLUENT PUMP STATION PLATFORM

DRAWING	REVISION	SHEET
2972-00-S-301	0	12

IF NOT 50 mm ADJUST SCALES
50 mm

SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS. TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE



1
S-101
SECTION 1 : 25

SAVE DATE 9/11/2019 3:05:36 PM
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Associated Engineering

BEST MANAGED COMPANIES
Platinum member

M. K. D. WOO
34152
SEP [illegible] 2019

REV	DATE	DESIGN	DRAWN	DESCRIPTION
0	2019SEP11	D. WOO	K. CHAU	ISSUED FOR TENDER

CITY OF PORT ALBERNI

WASTEWATER LAGOON
EXPANSION UPGRADES

20172972-00

SCALE: AS SHOWN

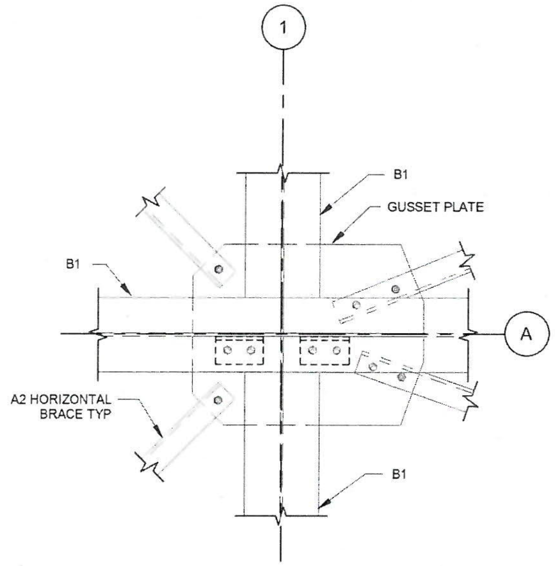
THE CITY OF
Port Alberni

STRUCTURAL
SECTIONS - SHEET 2
EFFLUENT PUMP STATION PLATFORM

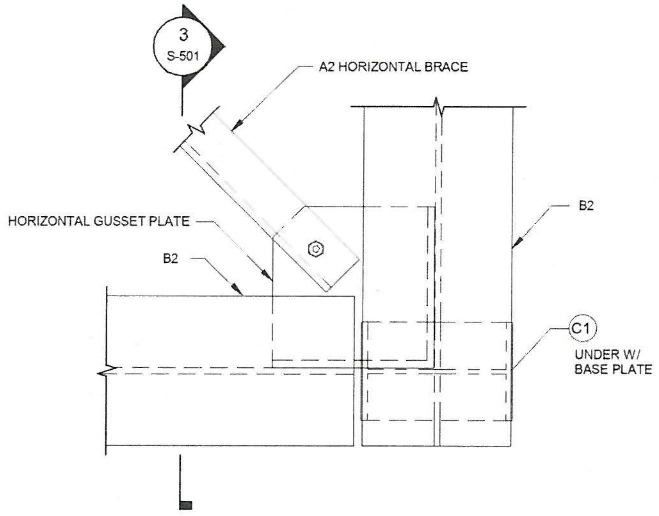
DRAWING	REVISION	SHEET
2972-00-S-302	0	13

IF NOT 50 mm ADJUST SCALES
50 mm

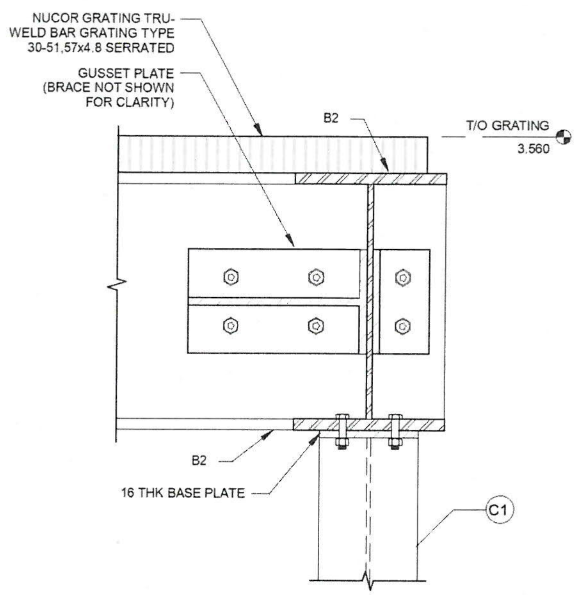
SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS. TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE



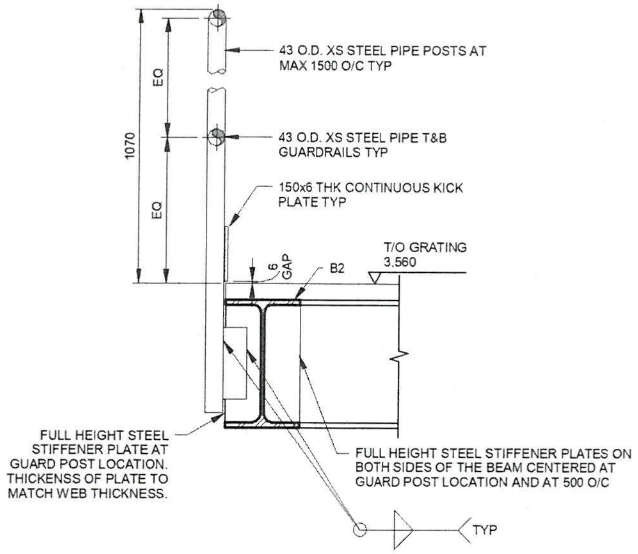
1 / S-103 **DETAIL** 1 : 10
TOP PLATFORM - MOMENT CONNECTION



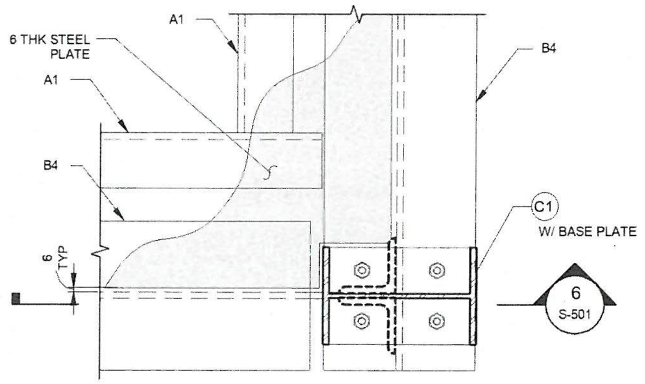
2 / S-103 **DETAIL** 1 : 5
TOP PLATFORM - CORNER CONNECTION



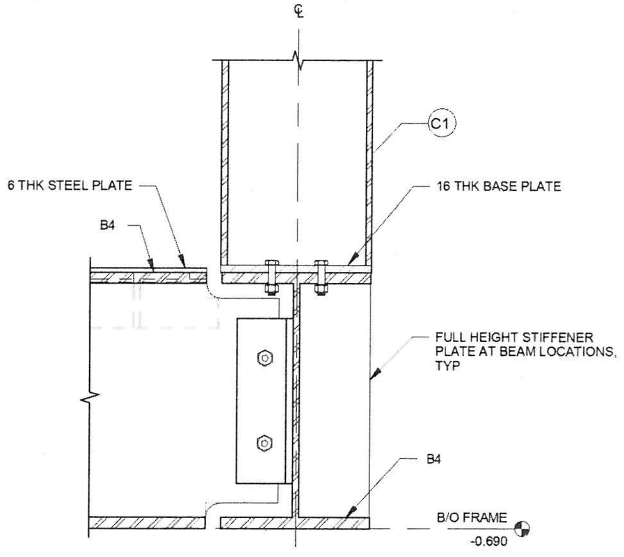
3 / - **SECTION** 1 : 5
TOP PLATFORM - CORNER CONNECTION



4 / S-301 **DETAIL** 1 : 10
HANDRAIL DETAIL



5 / S-102 **DETAIL** 1 : 5
BOTTOM PLATFORM - CORNER CONNECTION



6 / - **SECTION** 1 : 5
BOTTOM PLATFORM CORNER CONNECTION

SAVE DATE: 9/11/2019 3:05:37 PM
FILE PATH: C:\ae\revit_2017\2972-00-s-mp-plfm_chauk7EZBF.rvt

Associated Engineering

BEST MANAGED COMPANIES
Platinum member

M. K. D. WOO
34152
SEP 11 2019

REV	DATE	DESIGN	DRAWN	DESCRIPTION
0	2019SEP11	D. WOO	K. CHAU	ISSUED FOR TENDER

CITY OF PORT ALBERNI

WASTEWATER LAGOON
EXPANSION UPGRADES

20172972-00

SCALE: AS SHOWN

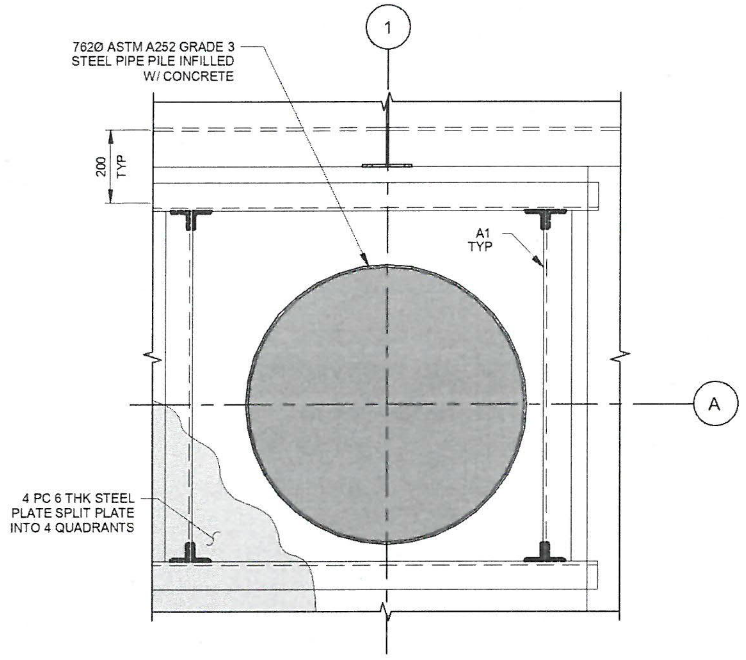
THE CITY OF
Port Alberni

STRUCTURAL
CONNECTION DETAILS - SHEET 1
EFFLUENT PUMP STATION PLATFORM

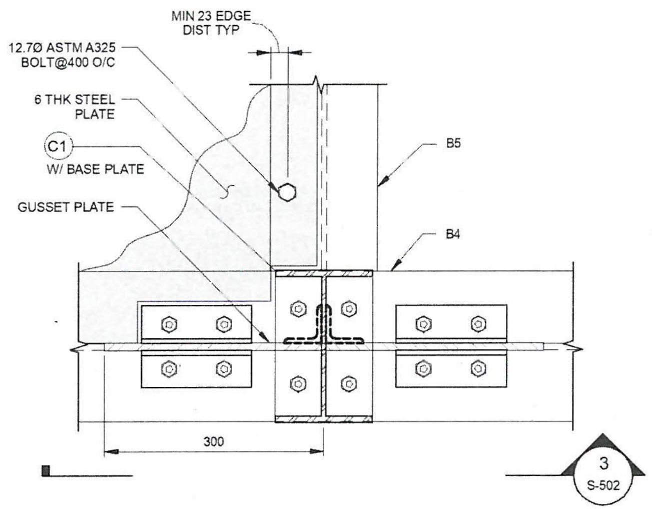
DRAWING	REVISION	SHEET
2972-00-S-501	0	14

IF NOT 50 mm ADJUST SCALES
50 mm

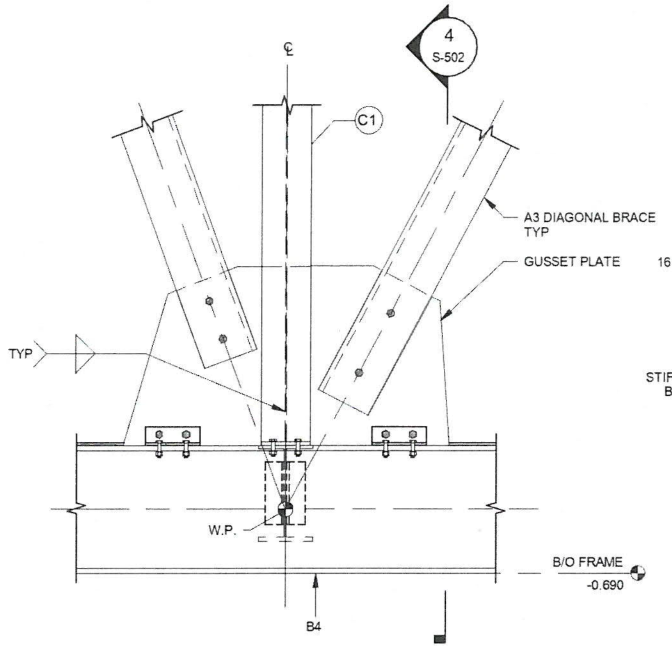
SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS. TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE



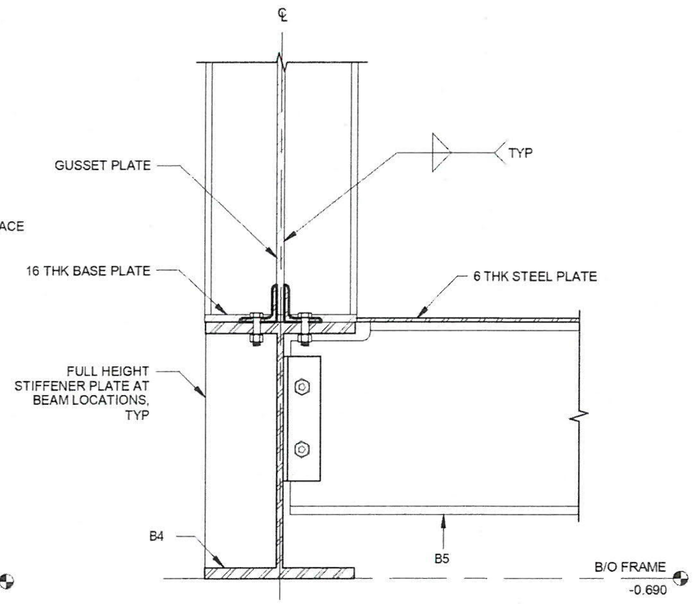
1 S-102 **DETAIL** 1 : 10
BOTTOM PLATFORM - PILE



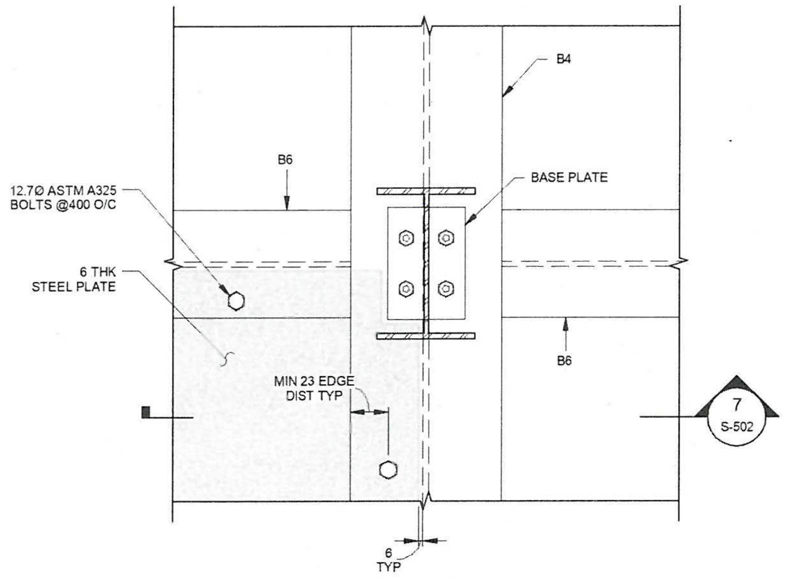
2 S-102 **DETAIL** 1 : 5
BOTTOM PLATFORM - ANGLE CONNECTION



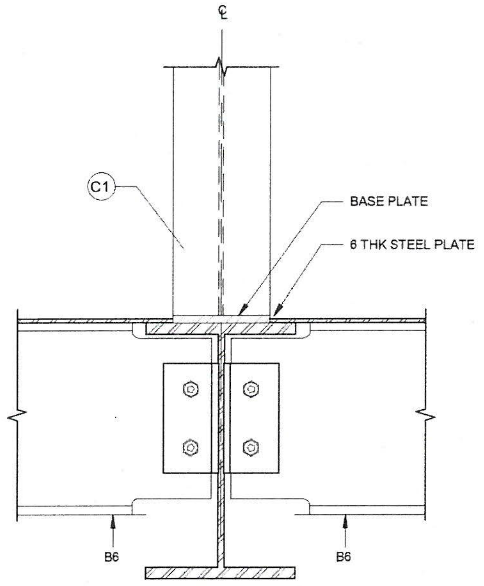
3 - **SECTION** 1 : 10
BOTTOM PLATFORM - ANGLE CONNECTION



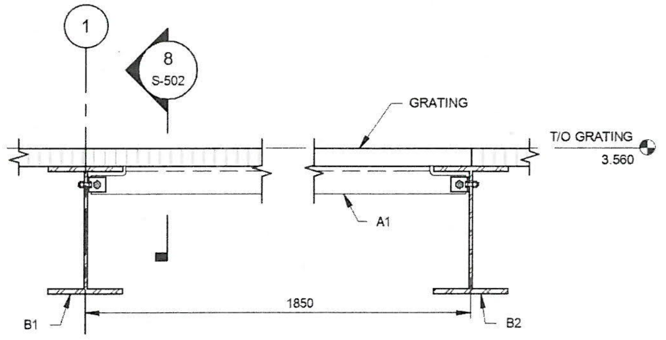
4 - **SECTION** 1 : 5
BOTTOM PLATFORM - ANGLE CONNECTION



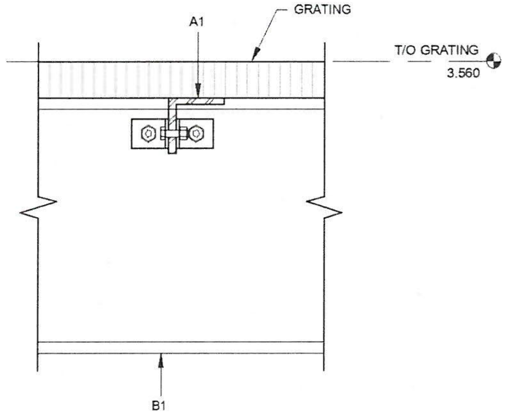
6 S-102 **DETAIL** 1 : 5
BOTTOM PLATFORM - HANGER



7 - **SECTION** 1 : 5
BOTTOM PLATFORM - HANGER



5 S-103 **DETAIL** 1 : 10
PIPE OPENING REINFORCING DETAIL



8 S-502 **DETAIL** 1 : 5
PIPE OPENING REINFORCING DETAIL

SAVE DATE 9/11/2019 3:05:38 PM
FILE PATH C:\ae\revit_2017\2972-00-s-mp-plfm_chauk7EZBF.rvt

Associated Engineering

BEST MANAGED COMPANIES
Platinum member

M. K. D. WOO
34152
SEP 1 2019

REV	DATE	DESIGN	DRAWN	DESCRIPTION
0	2019SEP11	D WOO	K CHAU	ISSUED FOR TENDER

CITY OF PORT ALBERNI

WASTEWATER LAGOON
EXPANSION UPGRADES

20172972-00

SCALE: AS SHOWN

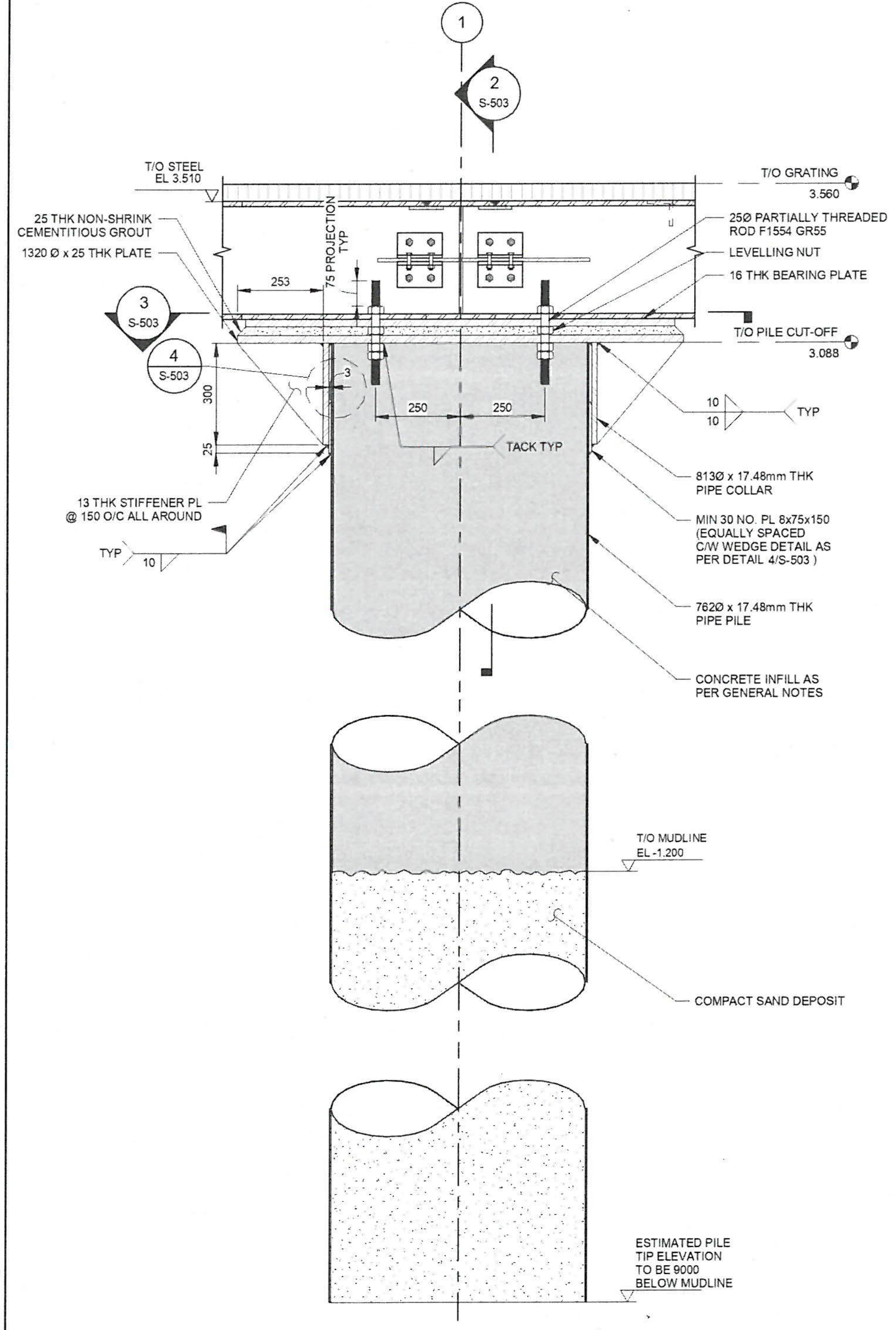
THE CITY OF
Port Alberni

STRUCTURAL
CONNECTION DETAILS - SHEET 2
EFFLUENT PUMP STATION PLATFORM

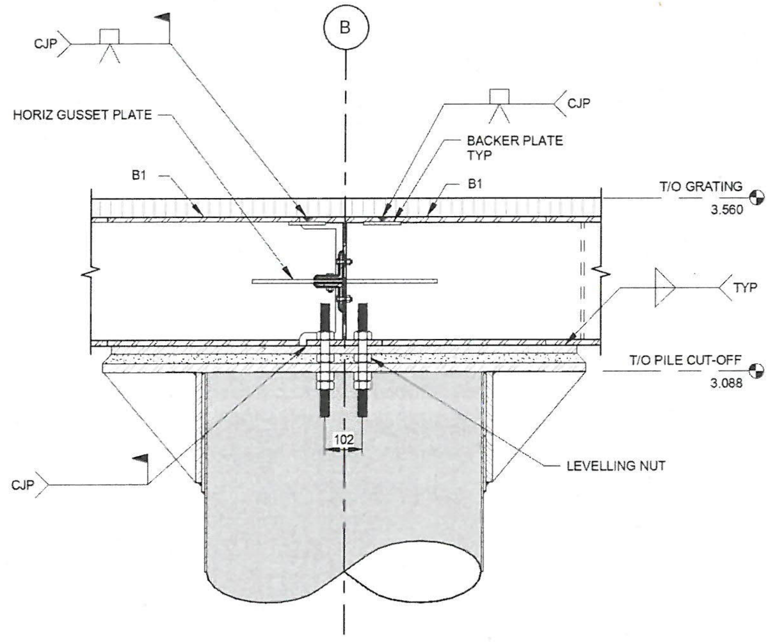
DRAWING	REVISION	SHEET
2972-00-S-502	0	15

IF NOT 50 mm ADJUST SCALES
50 mm

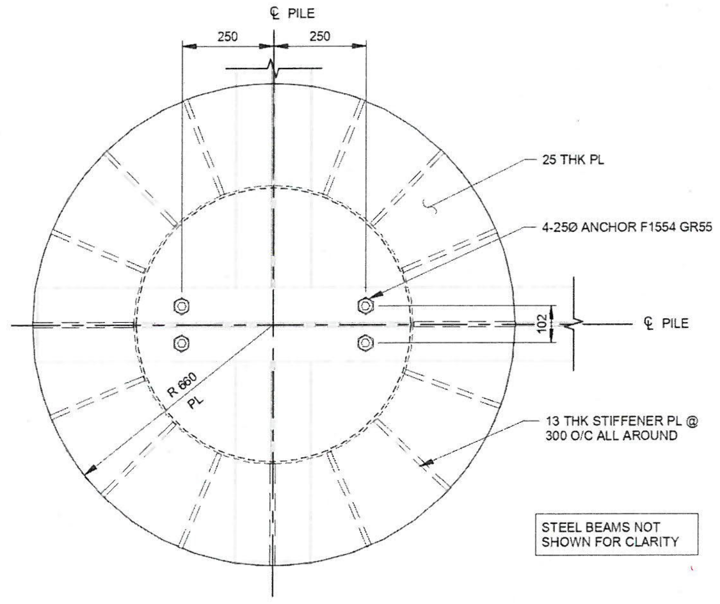
SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS. TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE



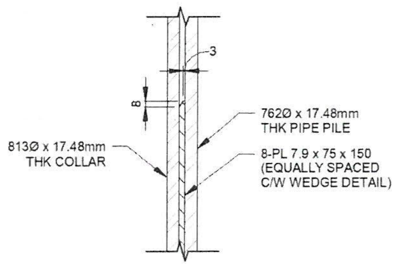
1 SECTION 1 : 10
S-101
PILE CONNECTION



2 SECTION 1 : 10
S-503
STEEL BEAM
MOMENT
CONNECTION



3 SECTION 1 : 10
PILE CONNECTION



4 DETAIL 1 : 5

SAVE DATE: 9/11/2019 3:05:40 PM
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Associated Engineering

BEST MANAGED COMPANIES
Platinum member

M. K. D. WOO
34152
SEP 11 2019

REV	DATE	DESIGN	DRAWN	DESCRIPTION
0	2019SEP11	D. WOO	K. CHAU	ISSUED FOR TENDER

CITY OF PORT ALBERNI

WASTEWATER LAGOON
EXPANSION UPGRADES

20172972-00

SCALE: AS SHOWN

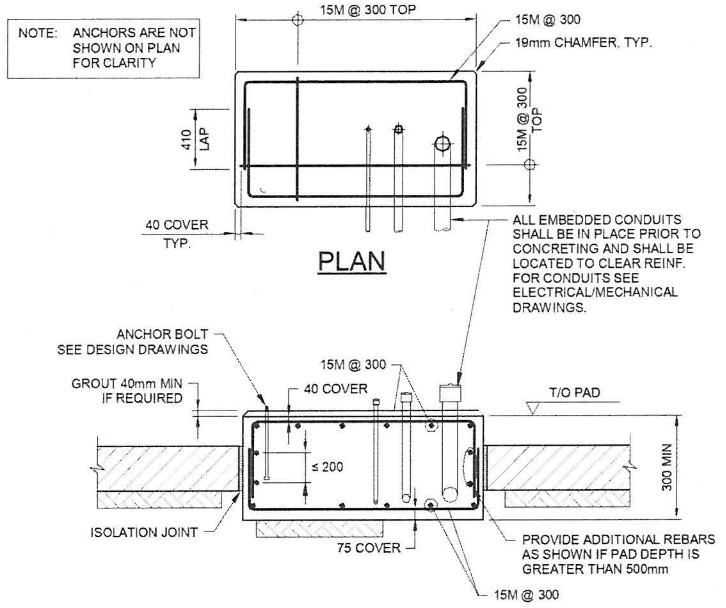
THE CITY OF
Port Alberni

STRUCTURAL
PILE CONNECTION DETAILS
EFFLUENT PUMP STATION PLATFORM

DRAWING	REVISION	SHEET
2972-00-S-503	0	16

IF NOT 50 mm ADJUST SCALES
50 mm

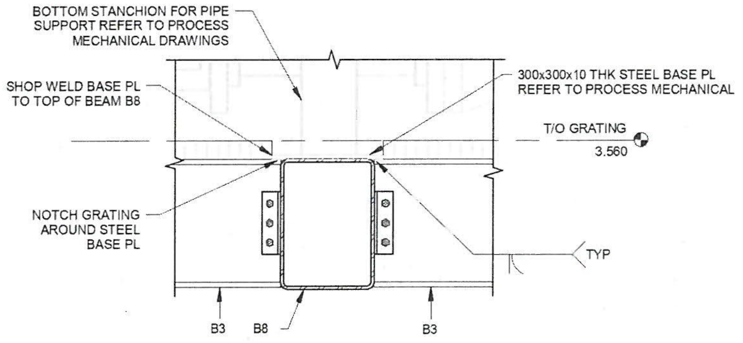
SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS. TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE



NOTES:

1. THIS DETAIL IS NOT APPLICABLE FOR EQUIPMENT WITH DYNAMIC LOADING OR SIGNIFICANT UPLIFT FORCES OR OVERTURNING MOMENTS.
2. MINIMUM TOTAL AREA OF VERTICAL REINFORCEMENT TO BE 1.5 TIMES THE TOTAL AREA OF ANCHOR BOLTS.
3. MINIMUM PAD DEPTH TO BE 300mm.
4. MIN. f'c = 25 MPa.

1 DETAIL 1 : 25
EQUIPMENT PAD ON GRADE



2 S-103 DETAIL 1 : 10
PIPE SUPPORT TO STEEL BEAM

SAVE DATE: 9/11/2019 3:05:45 PM
FILE PATH: C:\ae\revit_2017\2972-00-s-mp-plfm_chauk7EZBF.rvt

Associated Engineering

BEST MANAGED COMPANIES
Platinum member

M. K. D. WOO
34152
SEP 11 2019

REV	DATE	DESIGN	DRAWN	DESCRIPTION
0	2019SEP11	D. WOO	K. CHAU	ISSUED FOR TENDER

CITY OF PORT ALBERNI

WASTEWATER LAGOON
EXPANSION UPGRADES

20172972-00

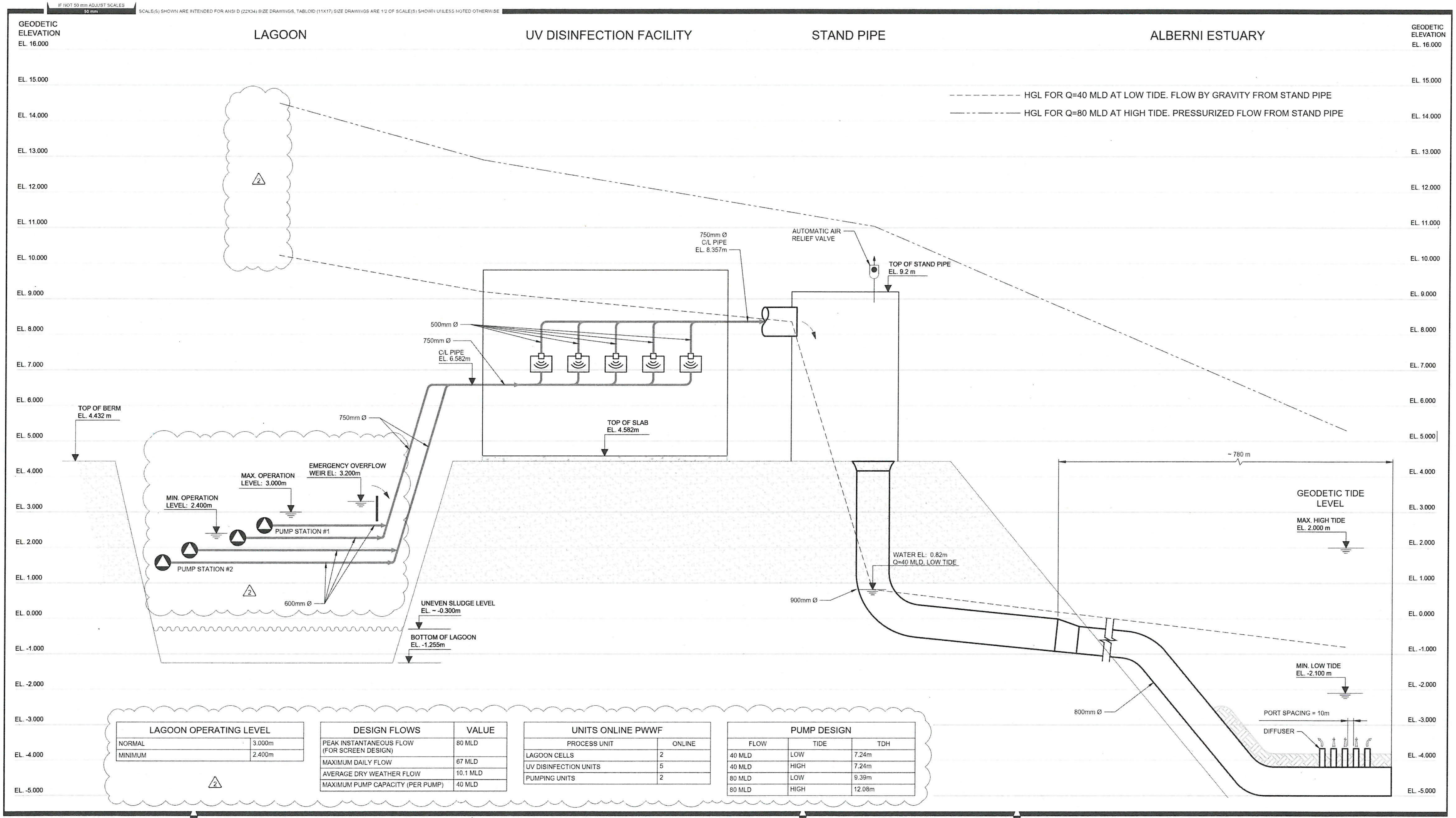
SCALE: AS SHOWN

THE CITY OF
Port Alberni

STRUCTURAL
PIPE SUPPORT DETAILS
EFFLUENT PUMP STATION PLATFORM

DRAWING	REVISION	SHEET
2972-00-S-504	0	17

IF NOT 50 mm ADJUST SCALES
50 mm
SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS, TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE



LAGOON OPERATING LEVEL	
NORMAL	3.000m
MINIMUM	2.400m

2

DESIGN FLOWS	VALUE
PEAK INSTANTANEOUS FLOW (FOR SCREEN DESIGN)	80 MLD
MAXIMUM DAILY FLOW	67 MLD
AVERAGE DRY WEATHER FLOW	10.1 MLD
MAXIMUM PUMP CAPACITY (PER PUMP)	40 MLD

UNITS ONLINE PWWF	
PROCESS UNIT	ONLINE
LAGOON CELLS	2
UV DISINFECTION UNITS	5
PUMPING UNITS	2

PUMP DESIGN		
FLOW	TIDE	TDH
40 MLD	LOW	7.24m
40 MLD	HIGH	7.24m
80 MLD	LOW	9.39m
80 MLD	HIGH	12.08m

\\S-VAN-FS-01\projects\20172972\00_WstWtr_Trtmnt_Upg\Working_Dwgs\400_Process_Mech\2972-00-d-003.dwg
DATE: 2019-09-11, Robin Wang

Associated Engineering

BEST MANAGED COMPANIES
Platinum member

M. V. SIMHON
#44587

SEPT. 11, 2019

REV	DATE	DESIGN	DRAWN	DESCRIPTION
0	2019SEP11	M.SIMHON	R.WANG	ISSUED FOR TENDER

CITY OF PORT ALBERNI

WASTERWATER LAGOON
EXPANSION UPGRADES

20172972-00

SCALE: AS SHOWN

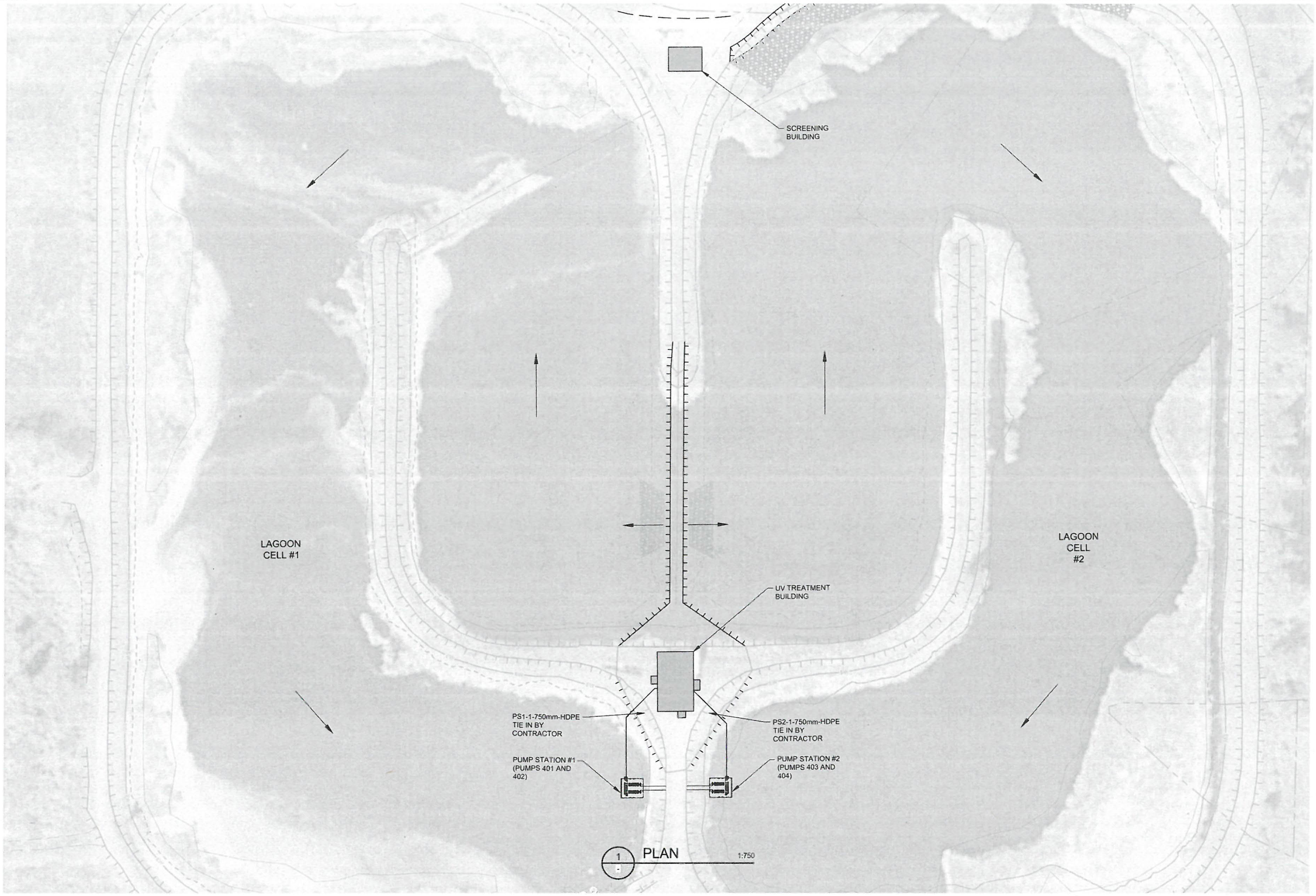
THE CITY OF
Port Alberni

PROCESS MECHANICAL
HYDRAULIC PROFILE

DRAWING	REVISION	SHEET
2972-00-D-003	0	18

IF NOT 50 mm ADJUST SCALES
50 mm

SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS, TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE



1 - PLAN 1:750

NOTES:
1. PUMPS (AND DRAFT TUBES) PRE-PURCHASED BY THE CITY. TOTAL OF FOUR.
2. PUMP STATION #2 IS A MIRROR IMAGE OF PUMP STATION #1.

\\S-VAN-FS-01\projects\20172972\00_WstWtr_Trtmnt_Upg\Working_Dwgs\400_Process_Mech\2972-00-d-141.dwg
DATE: 2019-09-11, Robin Wang

Associated Engineering

CANADA BEST MANAGED COMPANIES
Platinum member

M. V. SIMHON
#44587

SEPT. 11, 2019

REV	DATE	DESIGN	DRAWN	DESCRIPTION
0	2019SEP11	M.SIMHON	R.WANG	ISSUED FOR TENDER

CITY OF PORT ALBERNI

WASTERWATER LAGOON
EXPANSION UPGRADES

20172972-00

SCALE: AS SHOWN

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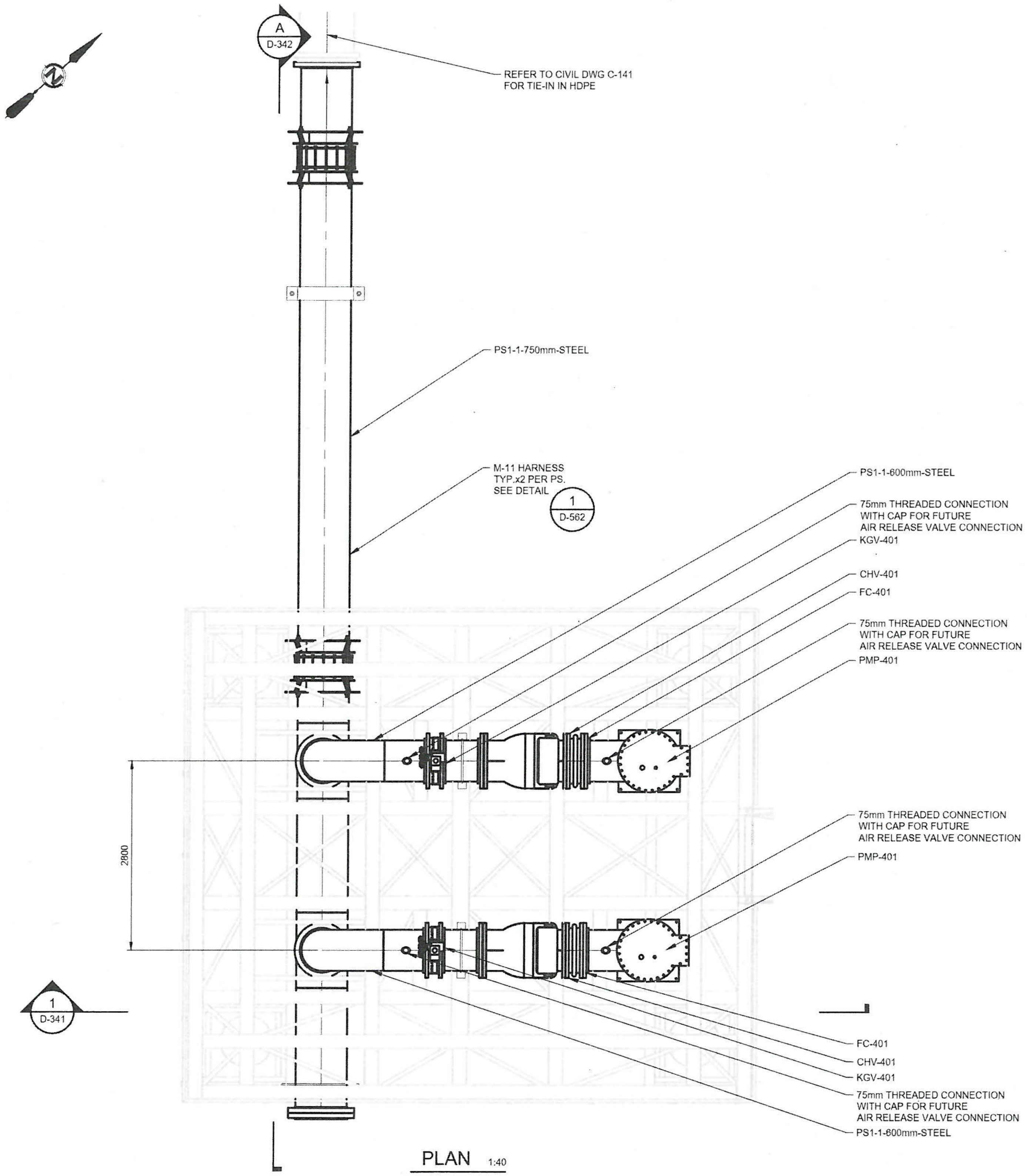
Port Alberni

PROCESS MECHANICAL
SITE PLAN

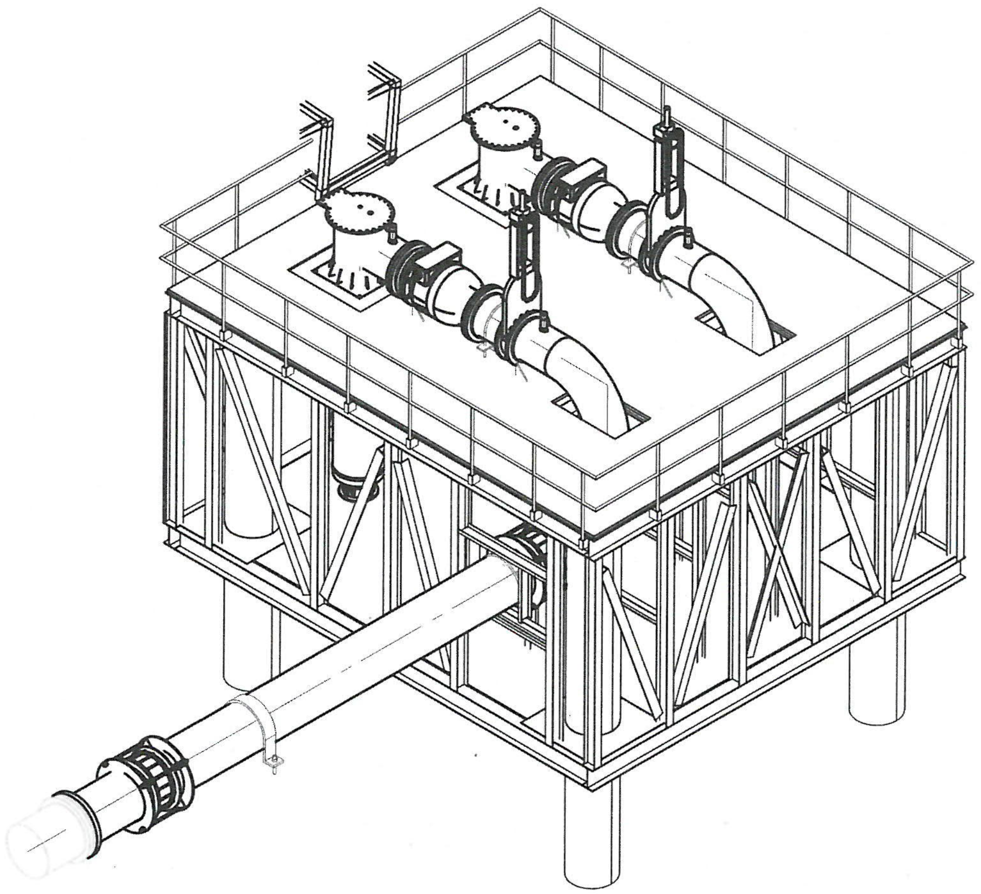
DRAWING	REVISION	SHEET
2972-00-D-141	0	19

IF NOT 50 mm ADJUST SCALES
50 mm

SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS, TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE



PLAN 1:40
PUMP STATION #1



NOTES:
1. PUMPS (AND DRAFT TUBES) PRE-PURCHASED BY THE CITY. TOTAL OF FOUR.
2. ALL STEEL PIPING TO BE NSF CERTIFIED, EPOXY COATED, REFER TO SPECIFICATION 404616

\\S-VAN-FS-01\projects\20172972\00_WstWtr_Trtmnt_Upg\Working_Dwgs\400_Process_Mech\TEMP_P3D\2972-00-d-142.dwg
DATE: 2019-09-11, Robin Wang

Associated Engineering

BEST MANAGED COMPANIES
Platinum member

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
M. V. SIMHON
44587

SEPT. 11, 2019

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WASTERWATER LAGOON
EXPANSION UPGRADES

20172972-00

SCALE: AS SHOWN

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Port Alberni

PROCESS MECHANICAL
PUMP STATION #1
PLAN

DRAWING	REVISION	SHEET
2972-00-D-142	0	20

IF NOT 50 mm ADJUST SCALES
50 mm

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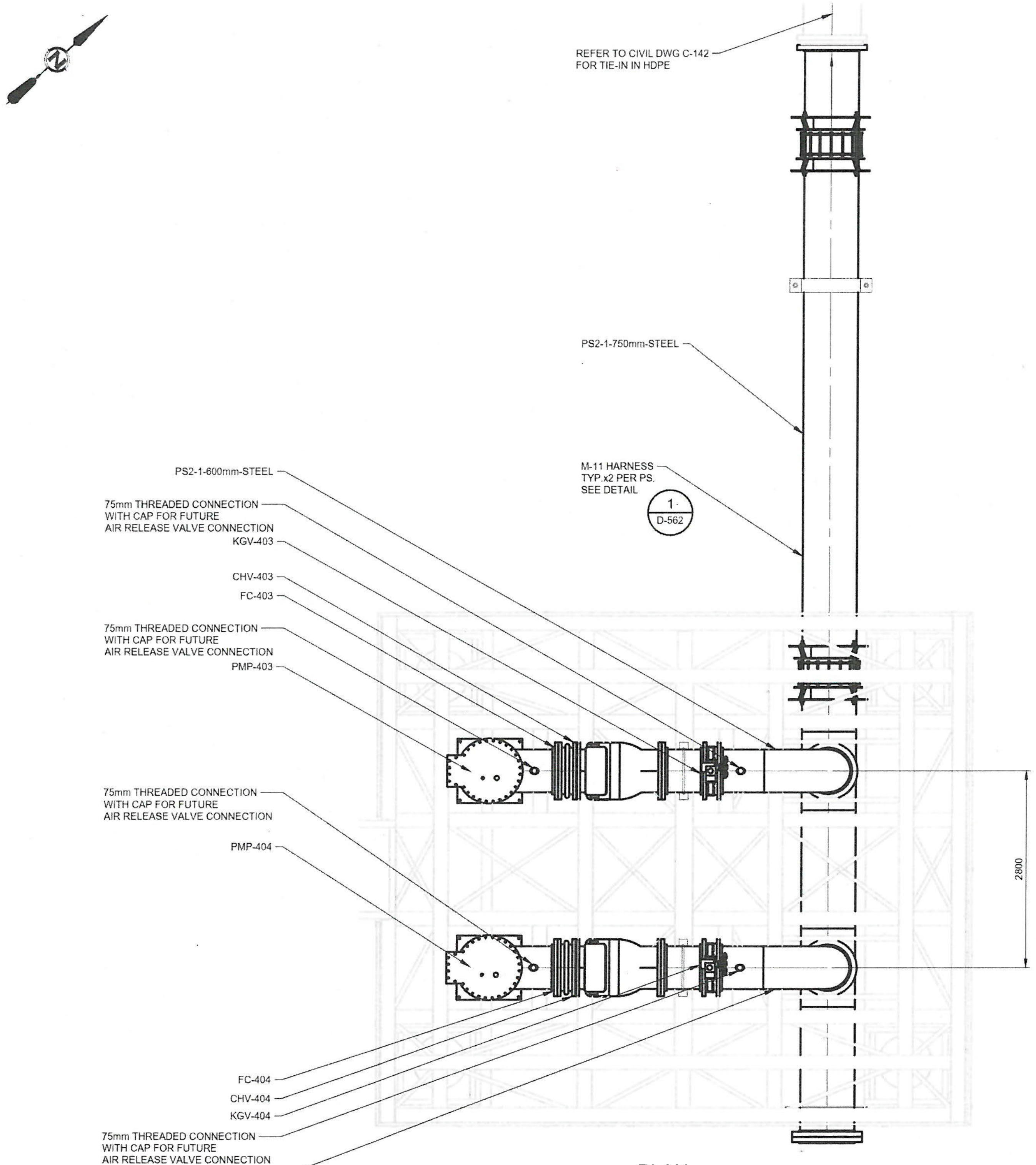
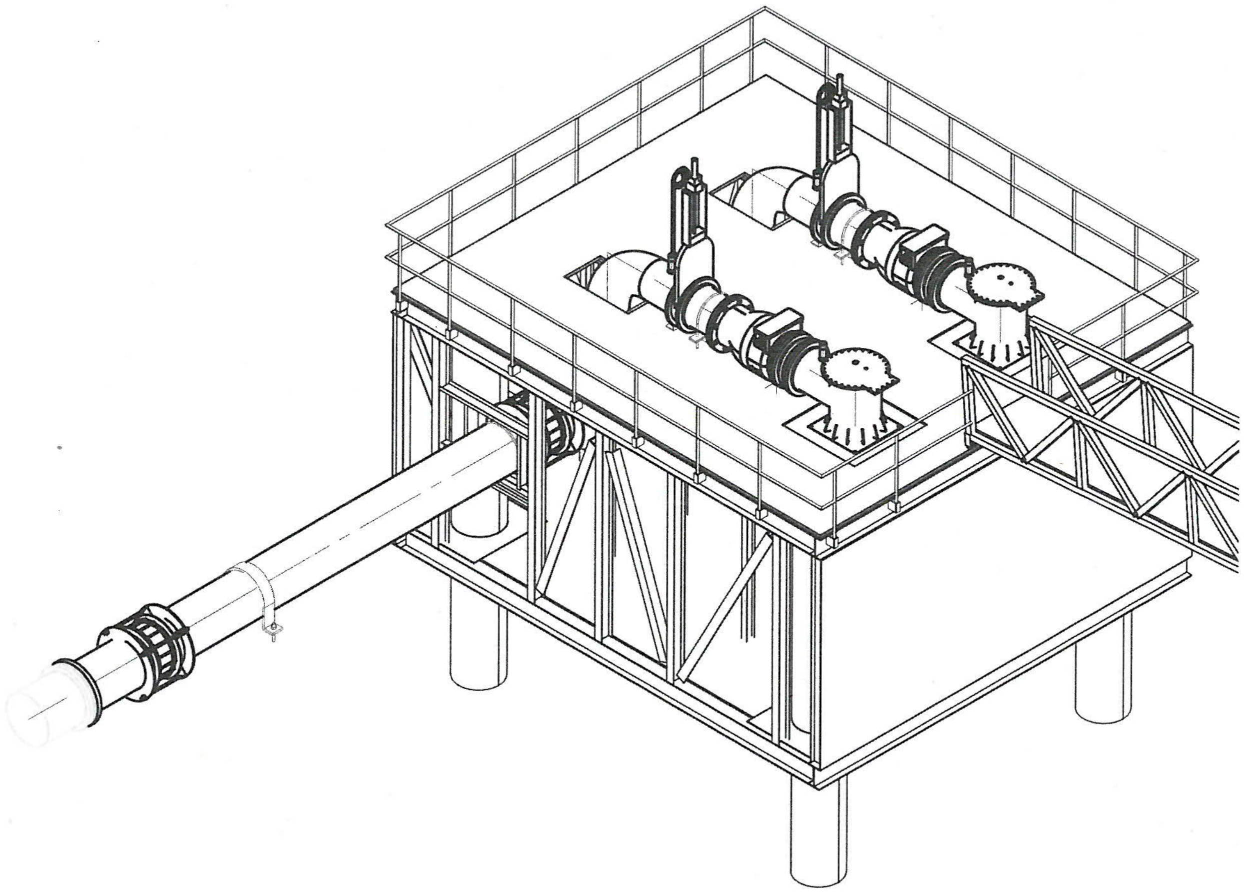


PLAN 1:40

PUMP STATION #2



NOTES:
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44587

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WASTEWATER LAGOON
EXPANSION UPGRADES

20172972-00

SCALE: AS SHOWN

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PROCESS MECHANICAL
PUMP STATION #2
PLAN

DRAWING	REVISION	SHEET
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IF NOT 50 mm ADJUST SCALES
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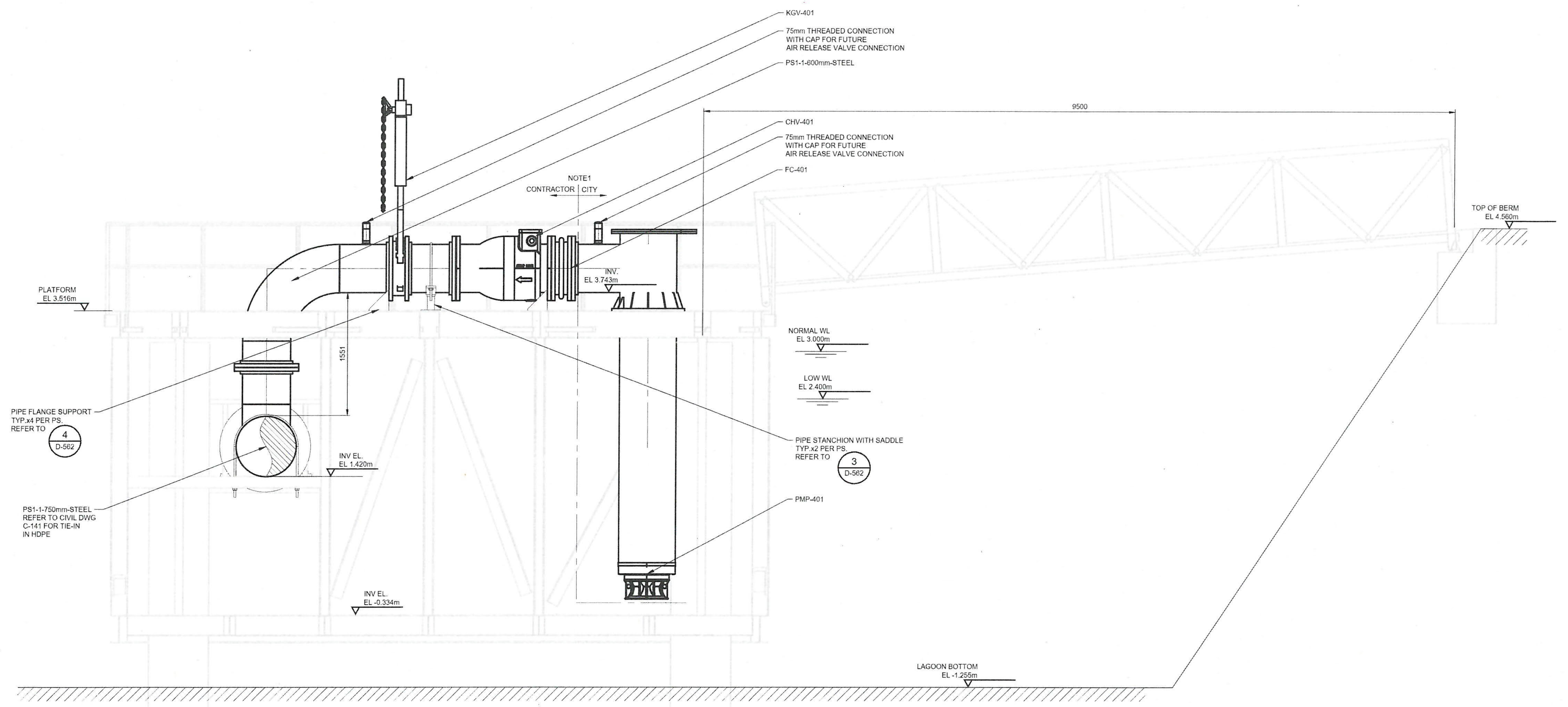

1 SECTION 1:25
PUMP STATION #1

NOTES:
1. PUMPS (AND DRAFT TUBES) PRE-PURCHASED BY THE CITY. TOTAL OF FOUR. INSTALLATION BY CONTRACTOR.
2. PUMP STATION #2 IS A MIRROR IMAGE OF PUMP STATION #1.
3. 750mm HDPE DISCHARGE PIPING TO BE KEPT SUBMERGED AT VARYING LAGOON WATER LEVELS.
4. ALL STEEL PIPING TO BE NSF CERTIFIED, EPOXY COATED, REFER TO SPECIFICATION 404616.

\\S-VAN-FS-01\projects\20172972\00_WstWtr_Trtmnt_Upg\Working_Dwgs\400_Process_Mech\TEMP_P3D\2972-00-d-341.dwg
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Platinum member

M. V. SIMHON
44587

SEPT. 11, 2019

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CITY OF PORT ALBERNI

WASTERWATER LAGOON
EXPANSION UPGRADES

20172972-00

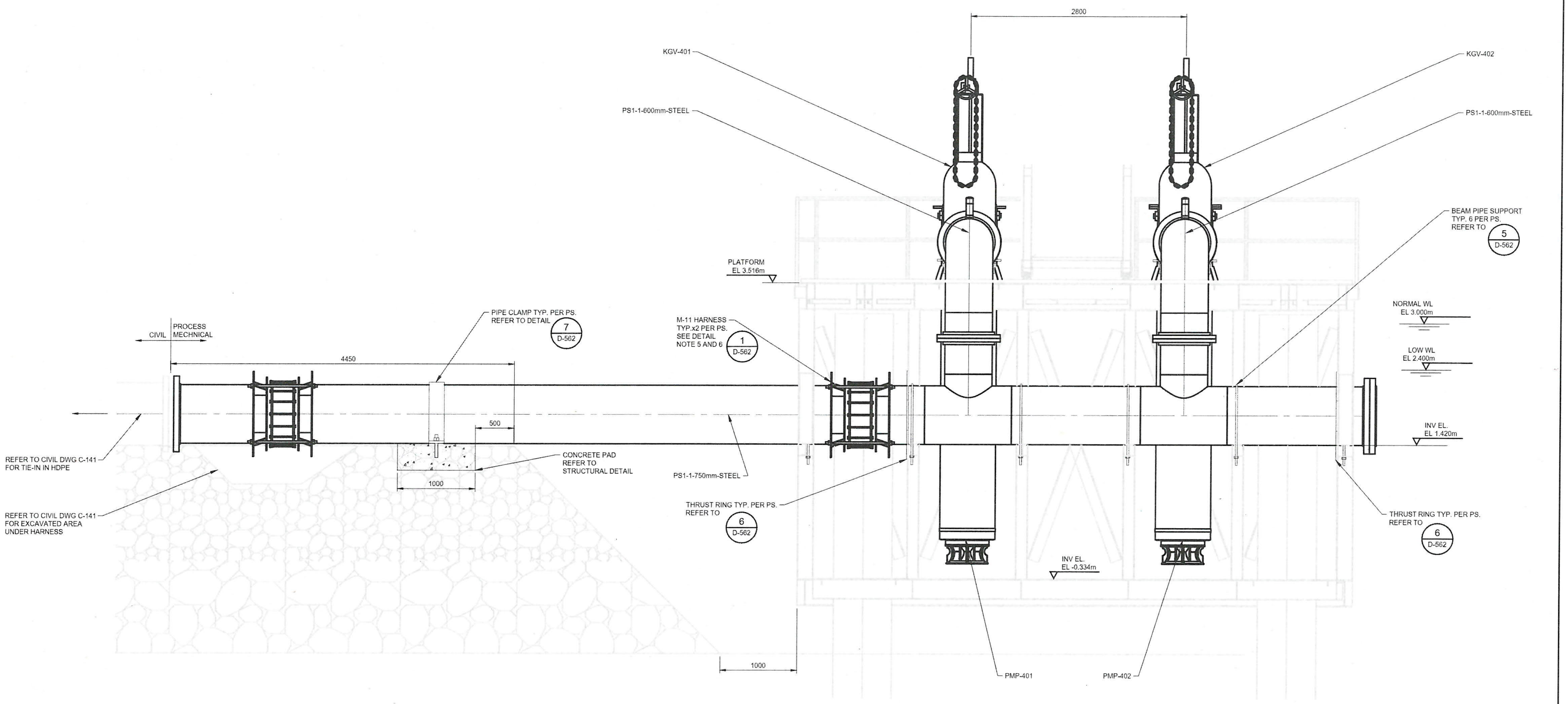
SCALE: AS SHOWN

THE CITY OF
Port Alberni

PROCESS MECHANICAL
PUMP STATION #1
SECTION 1

DRAWING	REVISION	SHEET
2972-00-D-341	0	22

IF NOT 50 mm ADJUST SCALES
50 mm
SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS. TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE



A SECTION 1:25
-
PUMP STATION #1

NOTES:
1. PUMPS (AND DRAFT TUBES) PRE-PURCHASED BY THE CITY. TOTAL OF FOUR. INSTALLATION BY CONTRACTOR.
2. PUMP STATION #2 IS A MIRROR IMAGE OF PUMP STATION #1.
3. 750mm HDPE DISCHARGE PIPING TO BE KEPT SUBMERGED AT VARYING LAGOON WATER LEVELS.
4. ALL STEEL PIPING TO BE NSF CERTIFIED, EPOXY COATED, REFER TO SPECIFICATION 404616.
5. ALL OTHER COATING PER SPEC 099124.
6. TIE RODS TO BE ROTATED ON HARNESS FOR ACCESSIBILITY.
7. TIE RODS ON HARNESS TO NOT BE FULLY TIGHTENED.

\\S-VAN-FS-01\projects\20172972\00_WstWtr_Trtmnt_Upg\Working_Dwgs\400_Process_Mech\TEMP_P3D\2972-00-d-342.dwg
DATE: 2019-09-11, Robin Wang

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BEST MANAGED COMPANIES
Platinum member

PROFESSIONAL ENGINEER
M. V. SIMHON
44587
BRITISH COLUMBIA

SEPT. 11, 2019

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CITY OF PORT ALBERNI

WASTERWATER LAGOON
EXPANSION UPGRADES

20172972-00

SCALE: AS SHOWN

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Port Alberni

PROCESS MECHANICAL
PUMP STATION #1
SECTION A

DRAWING	REVISION	SHEET
2972-00-D-342	0	23

IF NOT 50 mm ADJUST SCALES
50 mm
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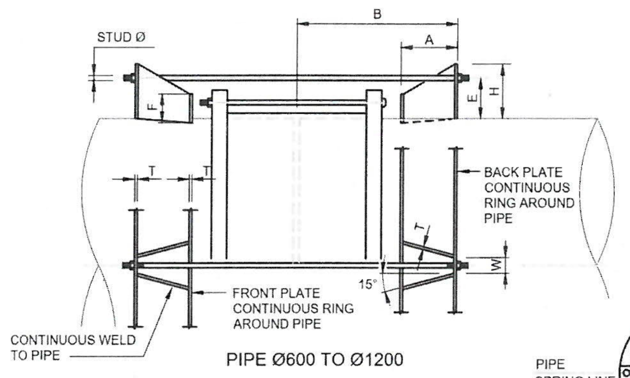
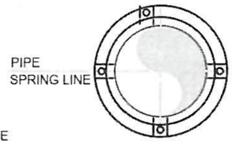


DIMENSIONS BASED ON DRESSER STYLE 38 OR ROBAR STYLE 1506 COUPLING USING 178 mm LONG MIDDLE RING

DESIGN PRESSURE 1724 kPa (250 PSI) MAX. PLACE JOINT HARNESS TIE BOLTS ON PIPE AS SHOWN FOR STAINLESS STEEL PIPE - FABRICATE LUG PLATES FROM SAME MATERIAL AS PIPE

FOR CARBON STEEL PIPE - FABRICATE LUG PLATES FROM CARBON STEEL PIPE ASTM A283, GRADE B, OR ASTM A285, GRADE C OR EQUAL STUD DIAMETER DETERMINED ASSUMING 52000 PSI ALLOWABLE STRESS BOLTS AND NUTS TO BE STAINLESS STEEL



HARNESS LOCATION FOR 4 TIE BOLTS

NOTE:

HARNESS CHART INFORMATION BASED ON MAX. PRESSURE AND LARGEST BOLT SIZE FOR THAT PARTICULAR PIPE SIZE, FOR OTHER BOLT SIZES REFER TO AWWA M-11 TABLES 13-4,13-5, 13-5A AND HARNESS LUG DETAIL FIGURE 13-20

NOMINAL PIPE SIZE MILLIMETRES	CPLG OD (MAX)	MAX STUD DIA	MAX HOLE DIA	LUG DIMENSIONS (MILLIMETRES)									TIE BOLT
				A	W	T	H	E	F	Y	X	B	
600	736	29	32	178	48	13	121	92	64	RING	RING	367	4
750	914	35	38	222	54	16	136	95	64	RING	RING	449	4
900	1067	41	44	273	60	19	143	98	64	RING	RING	500	4
1050	1220	38	41	254	57	19	140	98	64	RING	RING	500	4
1200	1372	41	44	273	60	19	143	98	64	RING	RING	500	4
1350 AND LARGER REFER TO AWWA M-11 TABLE 13-4 AND 13-5													

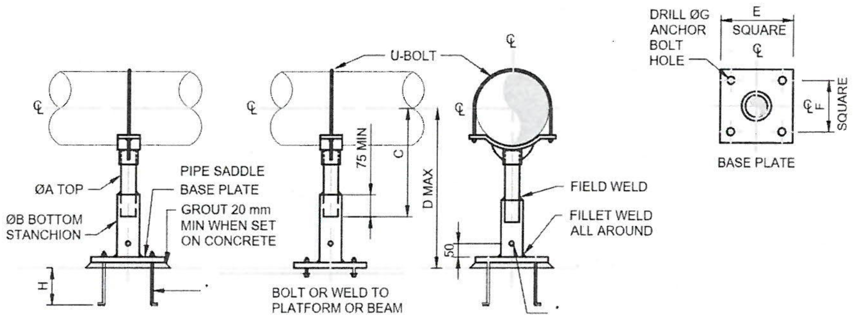
1 DETAIL NTS
PIPE HARNESS - AWWA TYPE RR HARNESS LUG

TABLE "A" PIPE LINES UP TO 343.3°C WITH STANDARD WEIGHT TO EXTRA STRONG WALL THICKNESS, INSULATED OR UNINSULATED. SUPPORTED FROM STRUCTURES THAT CAN UTILZE THE MAXIMUM SPACING FOR THE PIPE.

MAXIMUM HORIZONTAL SPACING BETWEEN PIPE SUPPORTS										
	NOMINAL PIPE SIZE IN MILLIMETRES									
	15	20	25	40	50	65	80	100	150	200
MAX. SPAN (mm) WATER SERVICE	2100	2100	2100	2700	3000	3300	3600	4200	5100	5800
MAX. SPAN (mm) VAPOUR SERVICE	2400	2700	2700	3600	3900	4200	4500	5100	6400	7300
RECOMMENDED HANGER ROD SIZE	10	10	10	10	10	13	13	16	19	19

MAXIMUM HORIZONTAL SPACING BETWEEN PIPE SUPPORTS								
MAX. SPAN (mm) WATER SERVICE	NOMINAL PIPE SIZE IN MILLIMETRES							
	250	300	350	400	450	500	600	750
MAX. SPAN (mm) VAPOUR SERVICE	6700	7000	7600	8200	8500	9100	9700	10000
RECOMMENDED HANGER ROD SIZE	7900	9100	9700	10900	11300	11800	12800	10300
	22	22	25	25	25	32	38	38

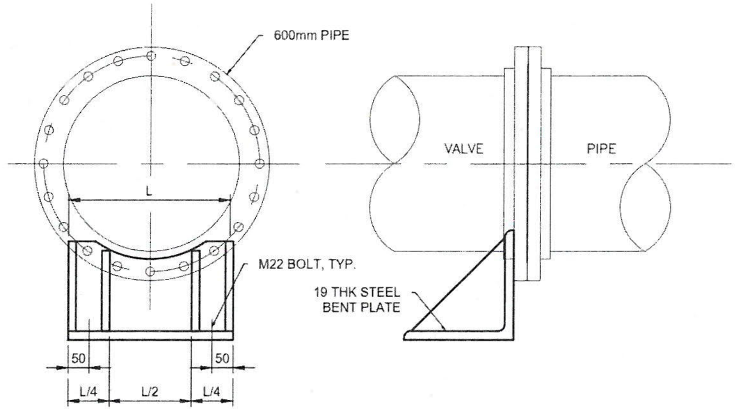
2 DETAIL NTS
MAXIMUM HORIZONTAL SPACING BETWEEN PIPE SUPPORTS



NOTES:
STANCHION MATERIAL SCH. 40 PIPE, OR AS PER SPECIFICATIONS.
BASE PLATE - CARBON STEEL
SHOP PRIME -PAINT AND PRIMER AS PER SPECIFICATION SECTION 099124 - PAINTING
TOUCH UP FIELD WELDS AS PER SPECIFICATION SECTION 099124 - PAINTING
PIPE STANCHION SADDLE - MAY BE MYATT FIG. 306/306S OR MUELLER (ANVIL) FIG. 259/265

PIPE SIZE		100	125	150	200	250	300	350	400	450	500	600	750	900	-
A		80	80	80	80	80	80	80	80	90	90	100	100	100	-
B		100	100	100	100	100	100	100	100	150	150	150	150	150	-
C	MIN	240	255	270	310	350	370	380	425	485	510	590	670	745	-
	MAX	350	370	390	425	460	485	515	540	600	625	705	785	860	-
D MAX		1200	1200	1200	1200	1200	1200	1200	1200	1850	1850	1850	1850	1850	-
THICK x E SQUARE		10 mm x 300	10 mm x 300	10 mm x 300	10 mm x 300	10 mm x 300	10 mm x 300	10 mm x 300	10 mm x 300	10 mm x 300	10 mm x 300	10 mm x 300	10 mm x 300	10 mm x 300	-
F SQUARE		200	200	200	200	200	200	200	200	200	200	200	200	200	-
G DIA. x No. HOLES		24 DIAMETER x 4													
BOLT DIA. x H		M22x100 GALVANIZED OR AS APPROVED EXIST. CONCRETE USE M16 HSL HILTI													

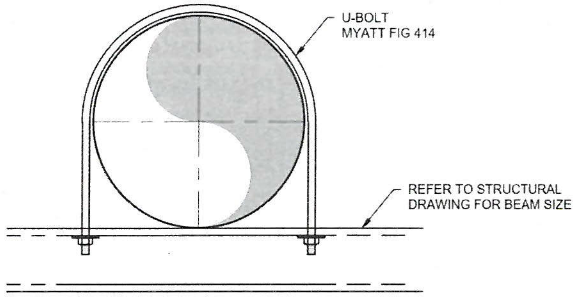
3 DETAIL NTS
PIPE SUPPORT - PIPE STANCHION WITH SADDLE (ADJUSTABLE)



NOTES:

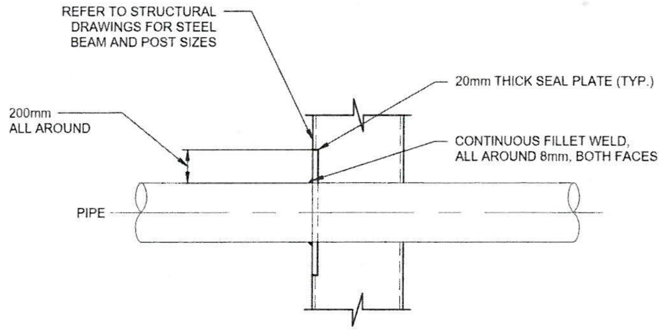
R TO SUIT FLANGE CLEARANCES
BOLT HOLES TO SUIT FLANGE DRILLING
FLANGE TO HAVE MINIMUM 4-13 THK STIFFENER PLATES

4 DETAIL NTS
FLANGE PIPE SUPPORT



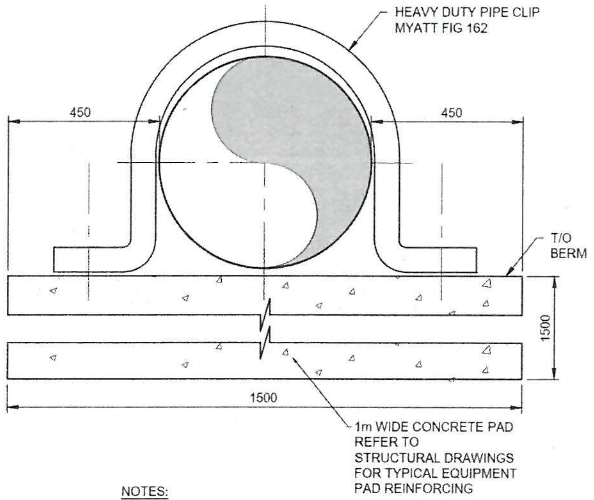
NOTES:
NEOPRENE COMPRESSIBLE MATERIAL AROUND PIPE COATING PER SPECIFICATION 099124

5 DETAIL NTS
BEAM PIPE SUPPORT



NOTES:
COATING PER SPECIFICATION 099124

6 DETAIL NTS
THRUST RING



NOTES:
NEOPRENE COMPRESSIBLE MATERIAL AROUND PIPE COATING PER SPECIFICATION 099124

7 DETAIL NTS
CONCRETE SUPPORT

\\S-VAN-FS-01\projects\20172972\00_WstWtr_Trtmnt_Upg\Working_Dwgs\400_Process_Mech\TEMP_P3D\2972-00-d-562.dwg
DATE: 2019-09-11, Robin Wang

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Platinum member

M. V. SIMHON
44587

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REV	DATE	DESIGN	DRAWN	DESCRIPTION
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CITY OF PORT ALBERNI

WASTERWATER LAGOON
EXPANSION UPGRADES

20172972-00

SCALE: AS SHOWN

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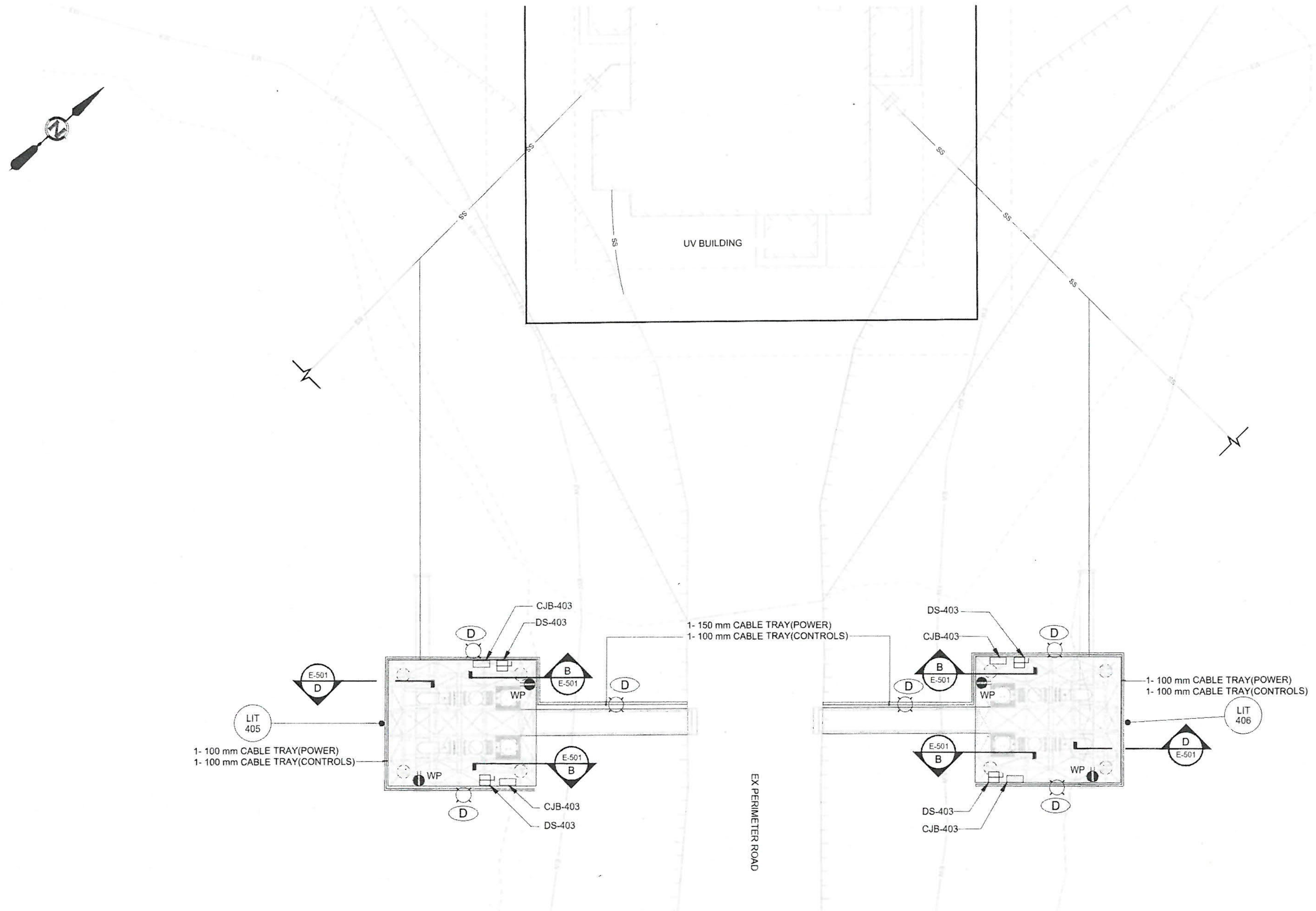
PROCESS MECHANICAL
DETAILS

DRAWING	REVISION	SHEET
2972-00-D-562	0	24

IF NOT 50 mm ADJUST SCALES
50 mm

SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS. TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE



LEGEND

○ D STANCHION MOUNTED LIGHT. SEE DETAIL 'A' ON DWG E-501

● WP GFCI RECEPTACLE C/W WEATHERPROOF COVER.

NOTES:

1.

1 PLAN 1:150
BUILDING SITE PLAN

\\s-van-fs-01\projects\2017\2972\00_wstwtr_trtmnt_upg\working_dwgs\600_Electrical\2972-00-e-102.dwg
DATE: 2019-09-11, Grace Shen

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D. R. A. DESAULNIERS
45359

11-Sep-19

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CITY OF PORT ALBERNI

WASTERWATER LAGOON
EXPANSION UPGRADES

20172972-00

SCALE: AS SHOWN

THE CITY OF
Port Alberni

ELECTRICAL
SITE GRADING

DRAWING	REVISION	SHEET
2972-00-E-102	0	25

IF NOT 50 mm ADJUST SCALES
50 mm

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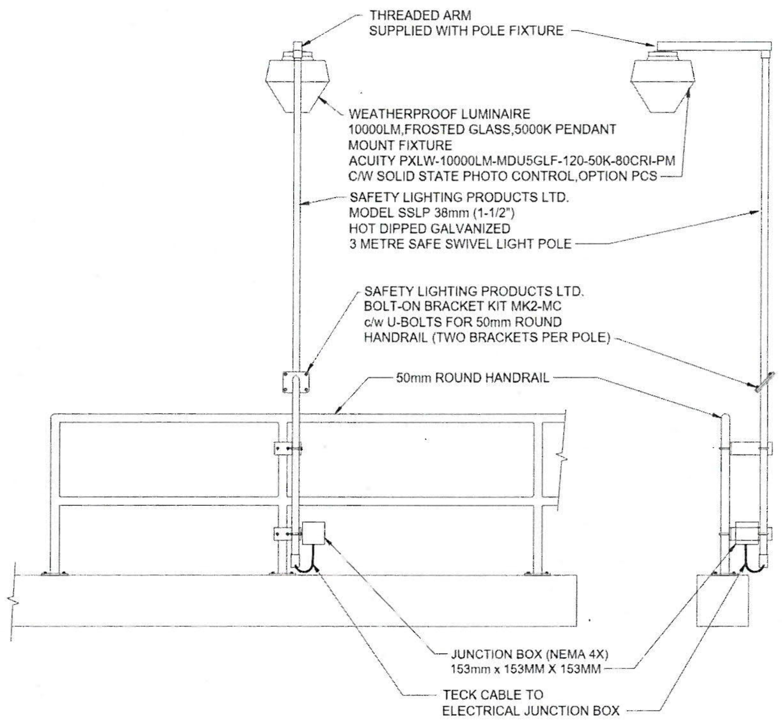
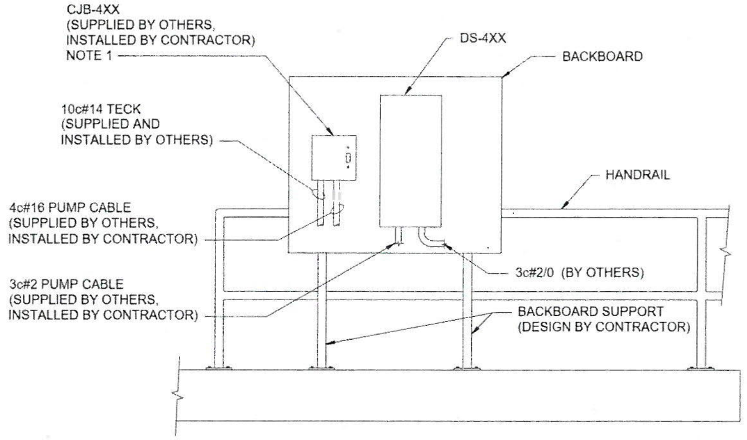
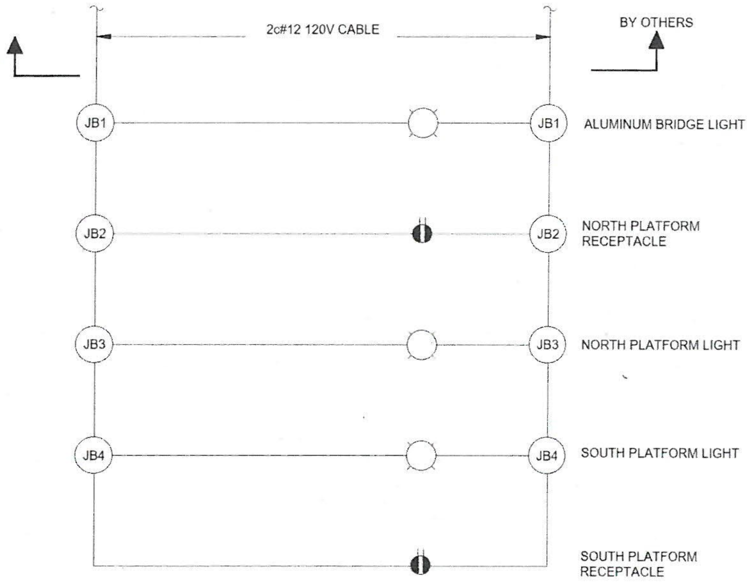


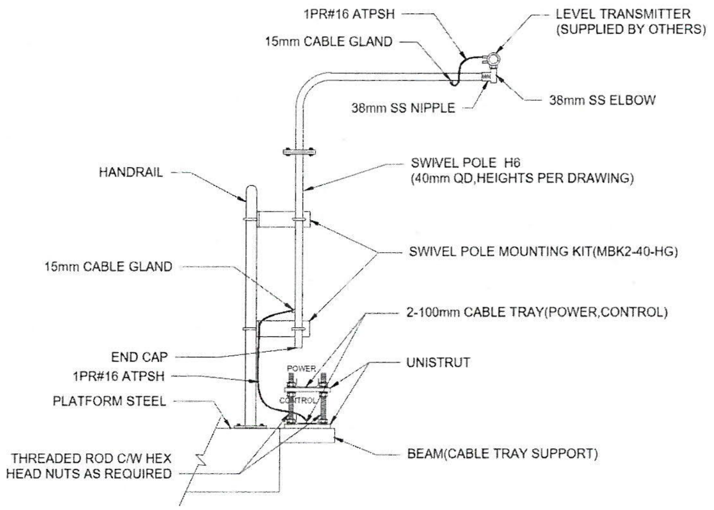
A
-
DETAIL 1:25
LIGHT POLE



B
-
DETAIL 1:25
EQUIPMENT BACKBOARD



C
-
DETAIL N.T.S
EXTERIOR LIGHTING CONTROL



D
-
SECTION 1:20

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DATE: 2019-09-11, Grace Shen

Associated Engineering

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D. R. A. DESAULNIERS
45359

11-SEP-19

REV	DATE	DESIGN	DRAWN	DESCRIPTION
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WASTERWATER LAGOON
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Port Alberni

ELECTRICAL
DETAILS

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IF NOT 25 mm ADJUST SCALES
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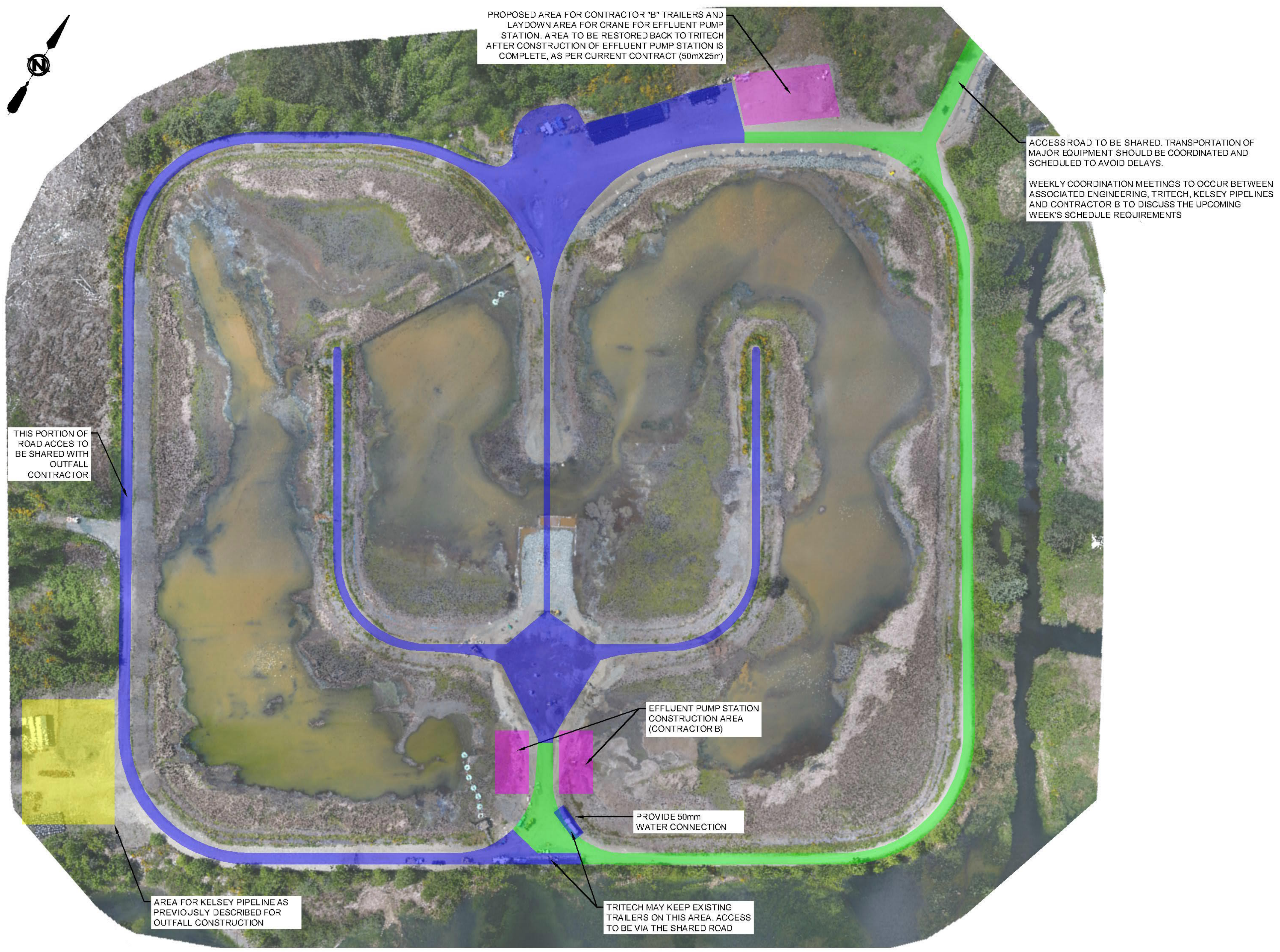

PLAN 1:1250

LEGEND:

🟦 AREA DESIGNATED FOR TRITECH
🟪 AREA DESIGNATED FOR CONTRACTOR "B"
🟩 SHARED AREA BETWEEN TRITECH AND CONTRACTOR "B".
🟨 OUTFALL CONTRACTOR

PLOT DATE: 8/21/2019 4:57:16 PM
SAVE DATE: 8/21/2019 4:56:59 PM SAVED BY: BRACHOC
DWG PATH: p:\20172972\00_wstwtr_trtmnt_upg\working_dwgs\100_civil\2972-00-c-7003.dwg

Associated Engineering

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Platinum member

THE CITY OF Port Alberni

AE PROJECT No.	20172972-00
SCALE	AS SHOWN
APPROVED	A. APPROVED
DATE	2019AUG21
REV	0
DESCRIPTION	ISSUED FOR CHANGE ORDER

FIGURE 1

CITY OF PORT ALBERNI

CONTRACTOR SITE PLAN

APPENDIX B - GEOTECHNICAL REPORT

PORT ALBERNI WWTP

GEOTECHNICAL DESIGN REPORT

ASSOCIATED ENGINEERING LTD.

PROJECT NO.: 171-04753-00
DATE: 19 JANUARY 2018

WSP
1935 BOLLINGER ROAD
NANAIMO, BC, CANADA V9S 5W9

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WSP.COM

1935 Bollinger Road
Nanaimo, BC, Canada V9S 5W9
T +1 250 753-1077
F +1 250 753-1203
wsp.com

16 January 2018

Associated Engineering Ltd (AEL).
Suite 300 - 4940 Canada Way
Burnaby, BC V5G 4M5

Attention: Christian Brumpton, M.Eng., P.Eng.

Subject: **Port Alberni WWTP – Geotechnical Design Report**

WSP Canada Inc (WSP) is pleased to submit the attached geotechnical design report to Associated Engineering Ltd. (AEL) in support of design of upgrades to the Port Alberni Wastewater Treatment Plant.

This report summarizes our understanding of the project, and provides details of the site, the results of field and laboratory testing and detailed seismic analyses. Geotechnical recommendations are provided related to civil and structural design and construction including discussion on deep ground improvement measures intended to meet the seismic performance requirements.

This report supersedes interim project updates and a draft version that was presented for client review on 8 December 2017. This final version incorporates client feedback received in late December/early January 2018.

We look forward to the next phases of the project. If you have any questions or comments relating to this report, please do not hesitate to contact the undersigned.

Sincerely,

WSP Canada Inc.

D.W. FUREY
25783
Jan 2018

Darryl Furey, M.Eng., P.Eng.
Senior Geotechnical Engineer

Encl. Geotechnical Design Report

WSP Ref.: 171-04753-00

SIGNATURES

PREPARED BY

D.W. FUREY
25783

Jan 2018

Darryl Furey, M.Eng., P.Eng.
Senior Geotechnical Engineer

REVIEWED BY

Don Kaluza, P.Eng.
Senior Geotechnical Engineer

The work outlined herein was carried out in accordance with our current contract with Associated Engineering Ltd. and the attached Terms or Reference for Geotechnical Reports. The City of Port Alberni is an approved user of this report subject to the terms under which it was prepared.

We trust that the information presented herein meets your current requirements. If you have any questions, or require further information, please contact the undersigned.

The original of the technology-based document sent herewith has been authenticated and will be retained by WSP for a minimum of ten years. Since the file transmitted is now out of WSP's control and its integrity can no longer be ensured, no guarantee may be given with regards to any modifications made to this document.

TABLE OF CONTENTS

TABLES

FIGURES

PHOTOGRAPHS

APPENDICES

EXECUTIVE SUMMARY

WSP Canada Inc. (WSP) conducted a geotechnical assessment at the former industrial sewage treatment plant in Port Alberni, BC in support of detailed design of proposed upgrades to the City of Port Alberni's (the City) wastewater treatment plant (WWTP) by Associated Engineering Ltd. This report discusses geotechnical aspects of each component of the project including: a new Screening Building, UV/Aeration Building, floating pump stations, approximately 100 lineal meters of new division berm with an overflow apron, and supply and outfall piping. New HDPE pipes are proposed at the inside edge of the berms extending between the supply main and the screening building, between the two new buildings and from the UV building towards a new outfall. Plans include raising the existing berm to a common elevation with filling primarily occurring in the southeast part of the berm with a preliminary final berm elevation of approximately 4.5 m (Geodetic) under consideration. This would involve potentially in the order of 1 m of fill in places.

The project risk-based design philosophy is described in a separate Technical Memorandum prepared by AEL (dated March 2017) and is summarized as follows:

- The current BC Building Code applies (2012);
- Structures are to be designed as “post-disaster” but moderate damage related to the 1:2475 year earthquake is acceptable provided the structures can be operational within a reasonable time period;
- Tsunami impacts are to be considered (forces by others); and,
- The performance of existing lagoon berms are excluded.

A subsurface assessment was carried out which involved the advancement of two test pits, five sonic boreholes and four cone penetration test (CPT) holes. The CPT holes and two of the boreholes were advanced relatively deep to 20 to 30 m below ground surface. The depth to firm ground was not confirmed. The general subsurface conditions about 22 m of loose/soft interbedded silts and sands underlain by intermediate plastic silt/clay.

Two dimensional FLAC analyses were conducted to assess seismic ground deformations and impacts of ground improvement. Based on these analyses liquefiable layers with a cumulative thickness ranging from about 9 to 12.5 m are present in the upper 22 m and the underlying soft silt/clay is moderately susceptible to strain-softening. Without ground improvement, seismically induced movements are larger than can be accommodated in the civil and structural design (i.e. 0.4 to 0.8 m vertically and 1 to 3 m laterally) and ground improvement is necessary to mitigate liquefaction and reduce post seismic movements.

Ground improvement in combination with a raft slab foundation is recommended for the two buildings. Design recommendations are provided for two ground improvement concepts: compaction piles (i.e. timber piles, Geopier Grouted Impact® Pier System, or similar) and deep soil-cement mixing (DSM). In general, ground improvement will need to extend to about 15 m below ground surface and 5 to 6 m beyond the perimeter of the building depending on the method selected. The intent of the design is to create an area below each of the buildings that will generally move together and reduce local differential movements to a tolerable level.

Notwithstanding this, deep seated soil strain, local berm movements and/or flow failures in the surrounding ground that cannot be practically mitigated may still occur. These movements are expected to affect infrastructure pipe connections and the functionality of the overall water treatment system. In consideration of all the various elements, the DSM method is more robust and will have greater resistance to impacts from local berm slope movements, flow failures and/or tsunami forces and as such, is geotechnically preferred.

In addition to seismic considerations, the underlying soils are compressible and the building foundation design includes recommendations to limit new building load. The floor slab elevation required to meet tsunami/flood design criteria (i.e. +/- 1 m above the top of the raft slab) is to be achieved with the use of light weight fill. In other areas where new soil loads are to be applied, such as the new division berm location and parts of the lagoon which are to be raised, use of a preload approach is recommended to generate settlements prior to installation of settlement sensitive elements (such as pipes, splitters, overflow aprons, etc.). Similarly, recommendations include avoidance of the organic core of the existing berm for the outfall pipe layout on the southeast perimeter lagoon.

Construction challenges include restrictions on equipment access that will require careful planning/ sequencing, potential loading limits for a crane on the existing berm that is constructed of variable soils and anticipated groundwater seepage in the area of the proposed division berm. Recommendations for berm construction include alternative materials that allow for placement of fill below water if complete dewatering cannot be achieved.

Conditions at the new screening building location have not been assessed directly as the layout changed after the subsurface drilling program and it is recommended that conditions be verified through further subsurface assessment. Geotechnical input is recommended for preparation of the preload and ground improvement specifications.

1 GENERAL

WSP Canada Inc. (WSP) conducted a geotechnical assessment at the former industrial sewage treatment plant in Port Alberni, BC in support of detailed design of proposed upgrades to the City of Port Alberni's (the City) wastewater treatment plant (WWTP) by Associated Engineering Ltd. The assessment was completed in general accordance with WSP's proposal dated 11 May 2017 (File Reference: P16-11140-76). Comments provided herein are based on the general project risk-based design philosophy outlined in a Technical Memorandum prepared by AEL in March 2017 (summarized in Section 2.2 below). Environmental sampling and analysis of ground water and soils was not part of the scope of this assignment.

In support of an interactive design process, Geotechnical Progress Updates were provided in June and July 2017 that presented a summary of ground conditions, initial results of FLAC analyses to assess seismic ground response and preliminary recommendations for ground improvement and construction of a new section of berm. This final report incorporates the results of further analyses and subsequent design discussions with AEL and supersedes the interim updates.

Presented in the following sections are an overview of the project, a description of the subsurface conditions, a summary of the seismic analyses and results, and geotechnical discussion and recommendations for ground improvement and foundation design for the buildings, design and construction recommendations for the new section of berm that is proposed to divide the existing lagoon into two cells (seismic design excluded). Appended to this report are site and test hole location plans, a Seismic Hazard Calculation, photographs of typical soil conditions, updated concept development plans, borehole logs, laboratory soil test results and CPT summary logs.

2 PROJECT DESCRIPTION

2.1 GENERAL

The City of Port Alberni is proposing to upgrade the former industrial sewage treatment facility to expand their existing facilities, which are located immediately north of the former industrial lagoons. In general, the project includes the construction of a new Screening Building, UV/Aeration Building, floating pump stations, approximately 100 lineal meters of new division berm with an overflow apron, and supply and outfall piping. New HDPE pipes are proposed at the inside edge of the berms extending between the supply main and the screening building, between the two new buildings and from the UV building towards a new outfall. Conceptual design drawings that illustrate the proposed structure layout and building concepts provided by AEL are included in Appendix 1. A summary of the concepts for the UV/Aeration Building, Screening Building and new division berm, an overview of the existing berm conditions, and proposed pipe alignment are provided in Section 2.3 below. Geotechnical comment in relation to outfall piping is to be provided under separate cover.

2.2 PROJECT DESIGN PHILOSOPHY

In summary of AEL's Technical Memorandum that discusses risk (March 10, 2017) we understand that:

- Design of the structures is to be in accordance with BC Building Code 2012;
- Buildings will be designed as "post-disaster" structures, as such moderate damage related to a 1:2475 year earthquake is acceptable with the intent that operations can be resumed within a reasonable time period;
- Foundation design should consider impacts from a tsunami and sloshing associated with a significant seismic event (forces determined by others);
- Review of the condition or performance of the existing lagoons or berms is excluded from the scope; and,
- The new internal berm will not be designed to withstand a seismic event.

2.3 DEVELOPMENT SUMMARY

The proposed design at the time of report preparation included:

2.3.1 UV/AERATION BUILDING

- Proposed in the central area of the lagoon on the existing interior berm;
- One storey, 11.4 m x 17.2 m concrete block structure supported on a raft slab (top of slab at 4.5 m elevation (Geodetic) (i.e. approximate existing grade)).
  - Approximate unfactored structural load of 40 kPa (offset by partial burial of raft slab at 0.5 m below ground surface – net new load of 30kPa);
- Concrete floor slab at 5.5 m elevation to meet tsunami/flood hazard criteria. This is approximately 1 m above current berm elevation in this area and metal entrance stairs will be provided. The interior slab will be supported on lightweight fill (i.e. EPS foam block, or similar) contained within a perimeter upstand concrete wall that extends to 5.5 m elevation;
- Local lateral extension of the crest of the existing berms at the south end of the building to facilitate vehicle traffic around the building to access blower and generator rooms; and,
- Buried pipes connecting from the building to the floating pump stations in each of the two lagoon areas. Concrete pump stations on the edges of the berm in lieu of the pile supported pump stations within the lagoons were considered during the design but ruled out due to complications in relation to construction sequencing, potential dewatering needs, and expansion of the ground improvement footprint.

2.3.2 SCREENING BUILDING

- Proposed at the north-central edge of the existing lagoon berm (i.e. location changed during design);
- One storey, 8.6 m x 12.2 m concrete block structure supported on a split level raft slab foundation and an upstand perimeter concrete wall to 5.5 m elevation (Geodetic).
    - The main area of the Screening Building will have a floor slab elevation of 4.5 m (i.e. top of raft slab);
    - An electrical room (3.6 x 2.7 m in plan) with a floor slab structure similar to the UV/Aeration building with a floor slab elevation of 5.5 m (Geodetic);
    - A reinforced concrete channel with an invert of 2.3 m (Geodetic) (approximate invert of 2 m below existing grade) and a grate elevation of 5.0 m (Geodetic);
- Approximate unfactored structural loads of:
    - 45 kPa for the screen room floor and electrical room (offset by partial burial of raft slab at 0.5 m below ground surface – net new load of 35kPa;
    - 70 kPa in the channel (offset by a buried invert elevation and raft slab at the channel base - net new load of 30 kPa); and,
- Possible expansion of the berm crest toward the north for additional parking.

2.3.3 NEW DIVISION BERM

- A new berm is proposed to divide the existing lagoon into two cells, extending from the north edge of the existing inner berm at the proposed UV/Aeration Building approximately 100 lineal meters towards the north;
- The new berm is to be constructed with a similar configuration to the existing berm (i.e. 2H:1V side slope with an approximate 5 m crest width);
- An approximate 16 m long hard surfaced, overflow apron and a splitter/distribution box are proposed within the new division berm approximately 30 m north of the new UV/Aeration Building; and,
- New pipes to convey fluids between the screening building, UV/Aeration Building and splitter/distribution box are proposed to be installed within the new berm and at the edge of the existing berm.

2.3.4 EXISTING BERMS & PROPOSED GRADE INCREASE

Existing berms vary in elevation from 3.6 m (Geodetic) (south) to 5 m (Geodetic) (north). We understand from AEL that the survey information also indicates that historical, post-construction berm elevation difference of the existing berms is greater than 0.5 m in places (inferred settlement. The base of the existing lagoon ranges from about -1.25 m (Geodetic) in the center to 1 m (Geodetic) in places where sludge has accumulated.

As-built drawings indicate that the existing lagoon berms have been constructed with three configurations:

- **NW/NE Berms** (Section A-A, Drawing 13.030) – sand and gravel berm with 2H:1V interior side slopes and 1.5H:1V exterior side slopes with exterior slopes covered with "organic silt and muck" placed at a 6H:1V side slope (BH17-05);
- **SW/SE Berms** (Section A-A, Drawing 13.007) – variable, non-organic soil (potentially re-worked on site soils) with a lower permeable core of "peat, silt and organic material" on the inside edge of the crest and approximately 3H:1V side slopes (TP17-02, BH17-03 and BH17-04); and,
- **Interior Berms** (Section B-B, Drawing 13.007) - sand and gravel with approximately 2H:1V side slopes (BH17-01, TP17-01).

As built information indicates that where the perimeter berm sections transitioned from one type to another (i.e. Points A and B on Drawing 13.006 in Appendix 2), a continuous water stop was accomplished with the use of polyethylene sheets.

We understand that plans include raising the existing berm to a common elevation. At the time of reporting the final berm elevation was not known. Based on discussions that indicated filling would primarily occur in the southeast part of the berm with a preliminary final berm elevation of approximately 4.5 m (Geodetic) under consideration. This would involve potentially up to 1 m new fill on the existing berms with fill thickness being differential and reducing towards the north. While review of the condition or performance of the existing lagoons or berms is excluded from the scope of our review, the proposed grade change has implications related to building foundation design that are discussed herein.

2.3.5 PIPES

In general, to manage and reduce the impacts of potential on-going settlement on the pipes generated by raising the existing berms to a common elevation, and facilitate post disaster access to pipes that could be damaged by berm movements, pipes are to be installed at or near the existing granular slope surface. The new pipe will be buried at about 1.5 to 2.5 m depth at some locations, such as near the buildings, between the buildings and the floating pump station, and at the overflow apron. Proposed pipes re approximately 800 to 1050 mm diameter HDPE to accommodate potentially large movements. Flexible couplers may be installed in select areas such as near the transition between improved and unimproved ground.

3 SUBSURFACE CONDITIONS

Subsurface conditions were assessed through a combined test pit, sonic drilling and electric cone penetration testing (CPT) program conducted in April 2017. A total of two test pits, five boreholes and four CPT test holes were advanced at the approximate locations shown on the attached Figure 2. Test holes were advanced to depths below ground surface ranging from 1.2 to 3.8 m at the test pit locations 20 to 30.5 m at the borehole and CPT locations. Several shallow boreholes (i.e. 3 to 5 m depth) were also advanced to confirm near surface conditions for the proposed pipes.

The general subsurface conditions encountered during the field program (i.e. boreholes, test pits, and CPT probing) in order of increasing depth near the proposed UV/Aeration Building (i.e. central part of the existing lagoon) includes:

- 3 m thickness of **SAND AND GRAVEL (FILL)** - compact with trace to some fines;
- 12 m thickness of **SAND AND SILT** loose/soft interbedded layers of with variable gravel and silt content, low plastic;
- 7 m thickness of interbedded loose **SANDY SILT/SILTY SAND** with trace gravel, shells, wood debris and organics, low plastic; underlain by,
- Below +/- 22 depth: More than 8 m thickness of soft, intermediate plastic **SILT/CLAY** with variable sand content.

Traces of shells and wood debris typical of deltaic/estuarine deposits were encountered throughout. Firm ground (i.e. till-like deposits or bedrock) was not encountered within the maximum exploration depth of 32.8 m.

Gradation Analyses and Atterberg Limits Testing were conducted on select samples to characterize the soils for seismic analyses, and in the case of shallow soils, potential for reuse. Results are summarized in Tables 1 and 2, below. Borehole logs, gradation analyses test results, and CPT logs are presented in Appendixes 3 and 4.

Table 3.1 Summary of Gradation Analyses

Sieve #	Test Hole	Depth (m)	Gradation per CFEM			Moisture Content %		D50 (mm)	D10 (mm)	Comments
			Gravel %	Sand %	Fines %					
1	BH17-01	4.9	17	69	14	19		0.3	<0.075	Sand seam
2	BH17-01	11.4	33	64	3	13		1.5	0.3	
3	BH17-01	20.5	0	49	51	40		0.07	<0.075	
4	BH17-02	5.3	24	72	4	19		0.6	0.18	
5	BH17-02	8.5	63	33	4	9		3.5	0.5	
6	BH17-02	15.8	2	88	10	19		0.3	0.07	
7	TP17-01	0.8	55	42	3	2		3.1	0.4	Berm fill

Table 3.2 Summary of Atterberg Limits Results

Test Hole	Depth (m)	Atterberg Limits						Comments
		Plastic Limit	Liquid Limit	Plasticity Index	Liquidity Index	Moisture Content %	Classification	
BH17-01	7.9	32	48	16	0.6	41	ML	Shells in Sample
BH17-01	23.5	23	29	5	1.3	30	ML	Shells in Sample
BH17-01	29.3	26	44	18	0.5	35	CI	
BH17-02	26.8	26	47	20	0.5	37	CI	

Soil conditions at the proposed screening building (approximately 200 m northwest of the proposed UV/Aeration building on the north side of the existing lagoon) were similar. At the screening building site, there is a potential greater thickness of firm silt with organics at the inferred fill/natural soil interface, particularly on the northwest edge of the lagoon (Refer to TP17-01 and BH17-05). It is also noted that the underlying natural soils at the north edge of the city lagoon (approximately 400 m north of the UV/Aeration building) were coarser grained with a higher sand and/or gravel content throughout a thicker zone relative to the UV/Aeration Building area. It is not known which of the conditions are representative of the revised Screening Building location.

Based on water level measurements, observations of moisture in the soil samples, and dissipation tests groundwater level was estimated to be approximately 2 to 3 m below ground surface, approximately equal to the water level in the lagoons at the time of drilling. It is anticipated that the groundwater level will be influenced by tides.

4 ANALYSES

4.1 SEISMIC ANALYSES

Two-dimensional (2D) FLAC analyses (Fast Lagrangian Analysis of Continua, Version 8.0; Itasca, 2016) were conducted to identify the global (large scale) ground deformation mechanism, to assess the potential for deep-seated failures, and to quantify the order of magnitude of movements. The Aeration/UV Building is the closest of the proposed facilities to the Somass River and Alberni Inlet, is surrounded by lagoon structures and is at greater risk of being impacted by ground movements relative to the Screening Building. Accordingly, the primary focus of the analyses was the Aeration/UV building. The details of FLAC analyses such as model development, soil characterization, and results are presented in Appendix 5.

Liquefaction potential and movements were assessed considering both localized berm failure and deep-seated, larger scale movements caused by the drop in grade in proximity to the Somass River that may impact a larger area. In general, the results from FLAC analyses were consistent with the results obtained using simplified one-dimensional liquefaction triggering assessment competed using SHAKE2000 (Ordenez, 2011). Results indicate that loose to compact sand-like soil encountered in the upper 20 m to 24 m are potentially liquefiable, with a cumulative thickness of liquefiable layers ranging from about 9 m to 12.5 m. In addition, the underlying soft silt/clay is moderately susceptible to strain-softening. In summary, without ground improvement, seismically induced movements were estimated to be in the order of 0.4 to 0.8 m vertically and 1 to 3 m laterally towards the inlet and/or Somass River. For preliminary design considerations differential settlement may be considered to be about ½ of the total settlement over distance of 10 m. The largest displacements were predicted in relation to the Cascadia subduction earthquake.

Liquefaction of sand-like soil was predicted to occur within a few seconds of shaking with the long duration of the interface motion contributing to the accumulation of permanent ground deformation. The estimated ground displacements were compared against the database of permanent ground displacements compiled by Ishihara et al (1997) for near-shore areas following the 1995 Kobe earthquake. The predictions from FLAC and simplified methods were generally in agreement with these past earthquake observations, and expected to decrease away from the shoreline.

We understand that these movements are larger than can be accommodated in the civil and structural design. Accordingly, ground improvement is necessary to mitigate liquefaction and reduce post seismic movements to a tolerable magnitude.

4.2 GROUND IMPROVEMENT ANALYSES

Two general concepts for ground improvement were analyzed with FLAC to identify a solution that reduces predicted ground movements, namely: Compaction Piles and Deep Soil-Cement Mixing Method (DSM). Conventional, permeable forms of ground improvement are not considered acceptable due to potential negative effects on the containment function of the existing lagoons. Compaction piles could include timber piles, concrete piles or grouted impact piers. DSM is typically achieved with an interlocking panel/cell pattern with panel widths in the order of 1 m wide. For the purposes of the analyses ground improvement was extended 15 m below the proposed building and approximately 5 to 7 m beyond the perimeter of the structure. The lateral extent of improvement will be dependent upon the technique used, and structural/civil ground movement tolerances and will generally be less for DSM.

The results from the modelling indicate that ground improvement will reduce predicted seismically induced ground displacements to in the order of 0.2 to 0.3 m vertically and about 0.5 to 1 m laterally at the UV/Aeration Building. These relatively large lateral displacements were related to the Subduction input motions. Lateral displacements estimated for the Crustal and Inslab motions were less (i.e. in the order of 0.3 m). Based on the FLAC analyses, these movements occur through a slip surface that develops below the ground improved zone which is associated with the larger scale drop in grade at the Somass River. A positive aspect of the ground improvement is that differential movements within the ground improved zone are anticipated to be relatively small (i.e. the building and improved zone will largely move together with predicted movements less than 0.1 m inside a perimeter buffer within the ground improved zone). Extending the depth of the ground improvement zone to cut-off deep slip surfaces to reduce global movements further has technical complications associated with the proximity of the underlying sensitive clay deposit and a reduced cost-benefit ratio tied to large cost implications. It is noted that the DSM method will create a more robust solution that has a significantly reduced potential for differential movements within the improved soil zone.

4.3 SHALLOW SLOPE FAILURES TOWARD LAGOON

Besides the deep-seated global movements estimated using FLAC, shallow slope movements of the berm can also occur towards the lagoon. Simplified limit-equilibrium based analysis were undertaken using the SLOPE/W (GeoStudio 2012) computer program to review two conditions: (1) stability of the new division berm under variable fluid levels on either side of the berm; and, (2) stability of the existing berm in relation to the proposed buildings. Results are discussed below.

4.3.1 NEW DIVERSION BERM

Stability analyses for the new division berm were completed for a potential fluid elevation difference between the two lagoons of approximately 2.4 m (i.e. 4.4 m (Geodetic, peak operating level) and 2 m (Geodetic, lowest operating level) which is similar to the differential fluid elevation anticipated during maintenance activities. The Factor of Safety of stability under variable water level conditions was in the order of 1.5 assuming that the new berm is constructed in accordance with recommendations presented herein.

4.3.2 SEISMIC BERM STABILITY IN RELATION TO BUILDINGS

The slope of the berm material and setback from the building/ground improvement zone were varied in the model that was used to assess stability of the existing berm in relation to the proposed buildings under seismic loading conditions. Based on these analyses, a preliminary set-back of 6 m from the crest of the lagoon berms was provided as a guideline to AEL during facility layout/configuration planning. However, we understand that this setback could not be accommodated without switching to a multi-storey structure which would have introduced other (more adverse) challenges including potentially significant long term settlement. In addition, it is possible that breach of berm and/or sloshing of the liquid contained in the berms may trigger shallow localized flow failures that may encroach into the building footprint.

Accordingly, seismically induced lagoon berm failures near to the structures could result in large differential displacements between the existing berms and the improved ground zone leaving a scarp that could encroach into the improved zone and affect the buildings. Further discussion is provided in Section 5 below regarding mitigation measures that could be considered.In general, the DSM method of ground improvement will be less affected by lagoon berm failures.

4.4 STATIC SETTLEMENT ESTIMATES

The new buildings, new diversion berm, and raising the existing berms will add new load to the ground that will generate settlement under static loading conditions. Based on historical information, settlements could be relatively large and would be expected to be differential. The light-weight fill proposed within each of the structures is intended to reduce the magnitude of settlement at the building locations. Estimated settlement based on one dimensional consolidation theory is in the order of:

Buildings:

- 25 mm total settlement in the main building core area. Settlement is potentially greater at the edges of the UV/Aeration building due to settlements generated by new fill in the vicinity of the new diversion berm and widening of the crest of the existing berms on the south side of the building. The magnitude of total static settlement at those locations could be in the order of 50 mm resulting in some differential settlement across the building footprint;

New Diversion Berm:

- In the order of 300 mm total settlement and 100 mm of differential settlement over a distance of 10 m in the central part of the new diversion berm. Settlements will also be differential due to the variation in new fill thickness across the berm section and at the tie-in points to the existing berms; and,

Berm Raising:

- In the order of 25 to 50 mm of settlement related to 1 m of fill placement on the berm. These settlements would be in addition to settlement generated by the new buildings. Settlement generated by the proposed berm raising will be variable in relation to varying thicknesses of new fill, variations in the existing berm shape and configuration and an inferred variable thickness of compressible soils below the berm. The proposed new fill thickness is in the area of largest inferred historical settlement. Larger settlement could also occur in areas underlain by thicker organic silt.

Preloading to mitigate the impacts of settlement associated with new berm construction and/or raising of the existing berm crest is discussed in Section 5 below.

5 GEOTECHNICAL DISCUSSION & RECOMMENDATIONS

5.1 GENERAL

Ground conditions at the site are geotechnically poor and challenging from both a static and seismic design perspective. The underlying soils are compressible under new loads and/or susceptible to liquefaction and/or strain softening under seismic loading conditions. In particular, the order of magnitude of seismically induced movements is relatively large and ground improvement is recommended in the areas of the proposed buildings to reduce liquefaction and predicted movements to a more tolerable level in relation to structural and civil design (i.e., reduction but not elimination of the impacts). The selection of ground improvement and foundation options is further limited by relatively high fines contents in the underlying soils, environmental considerations, lateral space constraints, and a depth to firm ground greater than 30 m. Based on the assessment described herein, ground improvement coupled with a raft slab appears to be the most viable foundation alternative. Subject to the ground improvement technique selected, piles may also need to be incorporated into the foundation to address other potential hazards such as tsunami erosion and/or post-seismic secondary lagoon berm failures.

Geotechnical recommendations are provided based on the understanding that relatively large seismically induced movements of the buildings and zone of improved ground in relation to berms and civil infrastructure and potentially tilting of structures and/or severed pipe connections are acceptable outcomes. The differential performance of facilities within the areas of improved ground in relation to adjacent elements will need to be considered in overall facility emergency management plans. For example, civil/mechanical details will be needed in the pipe layout to control the location of pipe rupture to protect the buildings.

From a static design perspective, foundation design will need to consider potential impacts of settlement generated by a new lagoon berm, widening of the existing berm and raising of the existing berm height. Settlement will be generated by the new berm construction and recommendations are provided for a staged construction process that will reduce the potential impacts of differential settlement on the overflow apron and pipes.

Geotechnical discussion regarding building siting, construction sequencing, ground improvement, foundation design for the UV/Aeration Building and the Screening Building, and construction of a new division berm are provided below.

We note that ground conditions at the new Screening Building location have been inferred based on test hole information at the UV/Aeration Building and original Screening Building location. Further assessment of the ground conditions at the new building site should be completed to verify that deep ground conditions are similar to those assumed and whether unsuitable fill material for building support is present (i.e. organic silt is shown on the outer edge of the berm on the as-built drawings in this area). The results of this supplementary assessment could affect site preparation in this area (i.e. localized excavation and replacement) and the recommended spacing for densification points.

5.2 BUILDING SITING

Geotechnical recommendations were provided during design in relation to the facility layout. In summary,

- We support the relocation of the Screening Building to its current location due to significant differential settlement in relation to variable new fill thicknesses required below the structure and constructability considerations in relation to in-filling of an active sewage lagoon at its originally contemplated location;
- Buildings should be set-back from the lagoon berm crest to reduce complications related to construction equipment access for ground improvement, differential settlement related to grade increases and seismic ground movements related to post seismic lagoon berm failure. While we recognize there are physical limitations, the set-back should be as large as possible;
- Buildings should not be located in the vicinity of grade changes greater than 0.3 m due to the high potential for settlements to be generated that could affect structure performance; and,
- New structure loads imposed on the ground should be kept to a minimum (i.e. a geotechnical preference towards one storey versus two storey’s) to reduce the potential for settlement.

5.3 CONSTRUCTION SEQUENCING

Construction of the various facilities for this project is expected to include a scheduling sequence that accommodates the ground conditions. For example, the proposed new division berm and raising of grade in the vicinity of the new buildings and along the outfall pipe alignment will need to be completed first with preload to generate as much settlement as possible prior to construction of settlement sensitive elements such as buildings, overflow apron and/or pipes. This will necessitate early drainage and dredging of the existing lagoon (at least in the area of the new berm). Similar preload recommendations are provided under separate cover for the land based component of the proposed outfall pipe, particularly in the area of the proposed berm raising and new manhole/vent chamber.

Ground improvement would follow and potentially overlap with the preload. Building construction, pipe installation and overflow apron surfacing would commence based on the ground response to the preload and densification activities.

Supplementary assessment work at the new Screening Building should be completed prior to tendering for ground improvement. Subject to project scheduling, this work could be completed concurrent with or prior to construction of the new division berm.

5.4 GROUND IMPROVEMENT

Ground improvement is recommended to mitigate the seismic displacements to meet the seismic performance criteria described in Section 2.2 above for the two buildings. Several ground improvement alternatives are geotechnically viable including: Compaction Piles (a series of tightly spaced, concrete or treated timber piles), Geopier Grouted Impact® Pier System (Geopier GIS), or similar, and/or a soil-cement mixing technique (Deep Soil-Cement Mixing (DSM)). Comparatively, the DSM method is more robust, stiffer, and will have greater resistance to impacts from local berm slope movements, flow failures and/or tsunami forces. As such, DSM is geotechnically preferred as it is expected to provide the best performance out of the three methods reviewed.

A conventional, permeable form of ground improvement such as stone columns, vibro-densification, etc. is not recommended due to potential negative effects on the containment function of the existing lagoons. Based on the analyses, ground improvement should extend to 15 m below the top of the berm (i.e. to the silty sand/sandy silt zone).

An overview of each option and design details based on the FLAC analyses are presented below. Technical merits and constructability of each method are compared in Table 5.3.1. It should be noted that densification of soils with significant fines content is complex and the final pier/pile spacing will be subject to verification through field trials early in the ground improvement program. Field verification typically requires time between installation and testing to allow for dissipation of pore pressures. While results tend to improve with time, a minimum of 72 hours is often recommended for practical construction considerations. A longer duration is preferred if it can be accommodated in the construction schedule.

Compaction Piles:

- A group of piles, driven in a pattern, to compact a surface layer of loose granular soil through displacement;
- Minimum 0.3 m diameter, treated timber or concrete piles installed on a triangular pattern;
- Minimum SPT $(N_1)_{60,cs}$ value of 22 blows per 300 mm within the ground improvement zone;
- Maximum 1.4 m center to center spacing (Minimum 20% area replacement ratio); and,
- Extending a minimum of 6 m laterally beyond the perimeter of the buildings;

Geopier Grouted Impact® Pier System:

- A patented displacement mandrel is advanced into the ground, filled with cement grout to a prescribed depth, followed by aggregate that is vertically rammed into placed by a series of up and down motions;
- Average 0.6 m diameter grout filled stone columns installed on a triangular pattern with a dry-bottom, displacement method;
- Minimum SPT $(N_1)_{60,cs}$ value of 22 blows per 300 mm within the ground improvement zone;
- Maximum 1.6 m center to center spacing (Minimum 15 % area replacement ratio); and,

- Extending a minimum of 6 m laterally beyond the perimeter of the buildings.

With respect to the spacing of Geopier elements, WSP has experience with ground improvement projects at sites with similar soil type. Although results are expected to vary from site to site, our previous experience has shown that subject to verification through in-situ testing at the time of construction, the spacing of the Geopier elements could potentially increase (i.e. to a maximum of in the order of 1.8 m). Improvements in ground conditions would need to be verified at several test areas prior to endorsement of a wider spacing. In-situ testing is anticipated to include cross-hole shear wave velocity testing and verification that the average diameter of the piers increases due to the ramming action associated with the installation method.

Deep Soil Mixing (DSM):

- A powerful drill advances a mixing tool as binder slurry is pumped through the connecting drill steel, mixing the soil to the target depth. Additional mixing of the soil is completed as the tool is withdrawn to the surface. The process employs the effects of both hydration and the bonding of soil particles to increase the shear strength. DSM structures are typically installed in the form of relatively closely spaced single columns to form walls, blocks or interlocking grids.
- Equivalent average shear strength 250 kPa;
- The contractor will be responsible for selecting the target Unconfined Compression Strength (UCS) and area replacement ratio (i.e., width and spacing of DSM panels) to achieve this equivalent shear strength. At this site, we would anticipate a UCS of treated soil in the order of 0.5 MPa to 1 MPa, a panel width of approximately 0.7 m to 1 m and an area replacement ratio in the order of 0.4 to 0.5; and,
- Extending to a minimum 4 m laterally beyond the perimeter of the buildings.

General Ground Improvement Considerations

In general, the improved soil zone is predicted to behave as a block and differential movements within the improved soil zone associated with deep ground movements are anticipated to be relatively small. Differential movements within the improved soil zone would be least with the DSM alternative.

For the compaction pile and Geopier alternatives the proximity of the existing lagoons introduces some construction challenges (i.e., piles/piers would need to be installed beyond the crest of the existing berm). There is also potential for the structures to be affected by differential movements at the edges of the buildings associated with berm slope failure. Additional ground improvement in the form of tighter densification points, extension of the improved ground area, full depth berm widening, and/or addition of rip rap facing is recommended where new buildings are within 6 m of the crest of the existing berm.

The existing berm may need to be locally upgraded to support the crane for ground improvement.

Ground improvement will generate vibrations that could induce settlement of adjacent ground, initiate local failures in the lower strength portions of the existing berm (i.e. organic silt zones) and/or introduce a breach in the containment aspects. Pre-construction survey of the existing berm and on-going monitoring during construction is recommended (i.e. regular visual reviews, survey hubs readings, in-ground pressure monitoring, and/or vibration measurements).

5.5 RAFT SLAB

Ground improvement coupled with a raft slab appears to be the most viable foundation alternative for support of the UV/Aeration Building and Screening Building in consideration of all design conditions. In the areas of ground improvement, structure design may be based on a Site Class D in accordance with the 2012 BC Building Code for seismic design purposes based on the understanding that the fundamental period of the buildings is less than 0.5 seconds. It is anticipated that a raft slab supported on improved ground can accommodate the settlement described in Section 4.4 above.

For the initial assessment, a modulus of subgrade reaction (MSR) of 25 MPa/m is recommended. It should be noted that, while it is simple in its definition, the MSR is a very difficult parameter to evaluate properly because it is not a unique fundamental property of the soil that is easily measured. Accordingly, design is expected to be an iterative process with the Structural Engineer. Due to local variations in the soil, subgrade disturbance during construction excavation, placement of reinforcing steel, and limitations of the theory itself, only an approximate indication of the magnitude of the MSR can be given based on the subsurface information available at this point. This value is applicable to a 0.3 x 0.3 m area, and for a slab with a width of "B", the equivalent subgrade modulus (k) should be determined using the following equation (CFEM 2016):

$$k = k_{(0.3)} \left(\frac{B + 0.3}{2B}\right)^2$$

A geogrid reinforced soil zone is recommended to facilitate transfer of foundation loads onto compaction piles or rigid ground improvement elements. Reinforcement should consist of biaxial geogrid (BX1200 or approved equivalent) installed in accordance with the manufacturer's instructions to a minimum of 2 m beyond the perimeter of the building at 0.5 m and 0.2 m below underside of concrete. Site preparation is anticipated to consist of:

- Excavation to 0.5 m below raft slab (potential cutting off of densification timber piles);
- Compaction in the presence of the geotechnical engineer;
- Remediation of soft, poor soils locally as needed;
- Placement of geogrid on geotechnical approved subgrade (subject to conditions encountered a medium weight, non-woven geotextile such as Nilex 4553 (or approved equivalent) may need to be installed prior to the geogrid);
- Placement and compaction of 19 mm minus, crushed sand and gravel to a minimum 95% MPMDD to 0.2 m below slab, another layer of geogrid, followed by compacted crushed sand and gravel to underside of slab.

At the Screening Building it is recommended that the geogrid reinforced layer be installed at a common elevation. Engineered fill as described in Section 5.8 below may be used to raise grade below the shallower portion of the building. This will facilitate reworking of the existing fill and/or replacement of poor soils and promote uniform building performance. The upper raft slab should be underlain by a minimum 150 mm thick layer of 19 mm minus crushed sand and gravel compacted to 95% MPMDD.

For sliding resistance, a friction factor of 0.55 may be used.

We understand that final floor slab elevation at both structures is above existing grade and about 0.5 to 1 m above the top of raft slab. To reduce the total new building load, final floor slab elevation is to be achieved through the use of light-weight fill placed on the raft slab surface. We recommend that the surface of the light weight fill be covered with light to medium weight, non-woven geotextile (such as Nilex 4553, or approved equivalent) separator and an approximate 100 mm thick layer of 19 mm minus, crushed sand and gravel compacted to 95% MPMDD to provide a stiff transition layer. The designer should consider the potential for buoyancy and compressibility of the light weight fill.

5.6 SHALLOW FOOTINGS

We understand that a number of shallow footings may be needed to support non-critical structural elements such as stairs. Based on the understanding that these will be located within the area of improved ground design may be based on a serviceability limit states (SLS) bearing pressure of 100 kPa. These areas should be directly underlain by a minimum of 0.3 m thickness of engineered fill placed on geotechnically approved subgrade (i.e. generally expected to be existing granular berm fill) and compacted to a minimum 95% Modified Proctor Maximum Dry Density.

5.7 LATERAL EARTH STRESS

Lateral earth pressures on below grade walls for the concrete channels below the screening building will include both static and seismic components – along with live loading associated with other site activities. It has been assumed that the wall backfill (typically composed of clean, well-graded, sand and gravel) will be maintained in a fully drained condition to avoid hydrostatic pressure. We have also anticipated in our discussion of earth pressures that the surface of the backfill would be approximately horizontal.

The selection of earth pressure parameters for use in lateral load calculations is influenced by the structural design of the wall – in particular, whether the wall is able to yield or whether it should be considered as non-yielding. The following discussion assumes that, in this case, the wall will be non-yielding in the static sense, but that the entire structure will have sufficient capacity to move dynamically to develop active lateral pressures (K_a).

For static design, therefore, a non-yielding (rigid) case is assumed and ‘at-rest’ (K_o) lateral loading should be applied. Dynamic soil pressures would be calculated using the Mononobe-Okabe (M-O) equation with the full peak ground acceleration (PGA) due to the relatively rigidity/stiffness of the structure (K_{ae}).

The proposed pressure distributions for both static and dynamic lateral loadings are attached (Figures 4&5)

Table 5.7.1 – Preliminary Lateral Earth Pressures – Geotechnical Parameters

ESTIMATED BACKFILL PARAMETERS		EARTH PRESSURE COEFFICIENTS		
SOIL FRICTION (Ø)	UNIT WEIGHT (kN/m³)	ACTIVE (Ka)	AT REST (Ko)	DYNAMIC* (Kae)
35°	20	0.27	0.43	0.78

* based on M-O equation – includes both static (active) and dynamic components, based on 100% of PGA (2012).

Site specific live loads and traffic loads (if any) – along with potential hydrostatic and hydro-dynamic loads - would also have to be included in the calculation of lateral pressures.

5.8 DIVISION BERM

The proposed granular fill berm with 2H:1V side slopes is geotechnically feasible provided the following recommendations are implemented. Berm fill is to be placed on a subgrade of non-organic, silt and sand. This will require removal of accumulated sewage sediment and natural, organic rich silt and sand through excavation or dredging to expose the underlying interbedded silt and sand.

Construction of the new berm is anticipated to generate settlement. Based on historical information, settlements could be relatively large (i.e. +/- 0.5 m) and would be expected to be differential. A preload created by an over-build is recommended to reduce the potential magnitude of future settlement and related negative impacts on the performance of the proposed overflow apron and new intake pipes. Preloading will also help to reduce the differential performance between new and existing berms. This may affect construction schedule. For planning purposes we recommend an approximate 2 m high preload over top of the design finished berm height. The duration of the preload is difficult to predict based on the variation in soil conditions observed at the test hole locations. Initial planning may be based on a minimum of six months subject to the results of settlement monitoring during the preload. We recommend that the preload remain in place during the ground improvement program. We also recommend that the lagoon be maintained in a dewatered condition to reduce pore pressures and facilitate a greater rate of settlement. Provided the preload is left in place for sufficient time to complete primary consolidation, the long-term post construction settlements are estimated to be less than 50 mm. A larger and/or longer preload would be required to reduce estimated long term settlements further.

Conceptual plans indicate that the overflow apron is to be surfaced with concrete. We recommend that a more settlement tolerant surface be considered for the overflow apron. If hard surfacing is used, the City should be aware that there is potential for a higher than normal level of maintenance. With this approach, consideration could be given to incorporating replacement of the apron surface into the operational plans/budget in the event that settlements cause operational issues.

Alternatively, if the order of magnitude of settlement described herein is too large and/or if the preload cannot be left in place a sufficient length of time and the monitor/maintenance approach described above is not acceptable, it is recommended that ground improvement be implemented below the overflow apron and splitter box to mitigate settlements. Ground improvement, if required, should extend laterally a minimum of 2 m horizontally beyond the perimeter of the rigid structures. The level of ground improvement would be less than proposed at the buildings (i.e. smaller area replacement ratio / wider spacing).

Seepage into the lagoon is expected to be tidally influenced and construction of the deeper portions of the berm should be co-ordinated with low tide events. Notwithstanding this, it is expected that there will be limitations on practical dewatering that can be achieved in the existing lagoon and that specialized dewatering methods would be required to lower the water level to the base of the berm. Accordingly, the following general wet construction methodology is proposed for consideration potentially in conjunction with basic dewatering efforts if practical:

- Dredge to non-organic subgrade (inferred at 4 to 5 m below the top of the existing berm);
- Place well graded, 0.3 m diameter minus, durable, angular rock fill with an excavator or clam-shell bucket in lifts to waterline elevation. The proposed use of “Class 10 Rip Rap” (i.e. 0.3 m minus diameter) as a specification for material placed in wet conditions is geotechnically suitable;
- Install a heavy weight, non-woven geotextile separator such as Nilex 4510, or approved equivalent;
- Place and compact a well graded, 150 mm minus crushed rock fill capped with a minimum 200 mm thick layer of 25 mm minus crushed rock. Subject to further discussion, consideration could also be given to use of a well graded, 75 mm minus sand and gravel fill placed and compacted in lifts to a minimum 95% Modified Proctor Maximum Dry Density (MPMDD) above the waterline. The preferred berm material may be affected by erosion due to seismically induced sloshing forces (and to a lesser degree, regular lagoon flow).

A geotextile separator at the interface between the natural soil and the 300 mm minus rock fill would reduce the volume of rock fill that is required (i.e. less material “lost” into the soft subgrade) and reduce the potential for settlement as fines would not tend to migrate into the voids of the rock fill. However, there will be some practical limitations to being able to install geotextile below the water table in a controlled manner. Accordingly, consideration could be given to specifying a geotextile at that interface, subject to geotechnical review in relation to depth of water and actual subgrade conditions. We recommend Nilex 4510, or approved equivalent, for this application (i.e. same product as for above the 300 mm rock fill).

Some settlement additional to that of a well compacted granular fill that is placed in dry conditions could occur with placement of crushed rock below water as full compaction cannot be achieved and finer grained sediments could work their way into the rock fill voids.

We recommend that flexible connections be considered for pipes installed in this area, particularly near the transition zones between existing and new berms.

Erosion protection is recommended at the face of the slopes, particularly if a smaller diameter fill such as 75 mm minus material is used, or if flow between berms is expected to be consistently in one direction. Conceptually this protection would include a layer of non-woven geotextile (i.e. Nilex 4551, or approved equivalent), suitably secured at the top and toe and overlain with a 150 mm thick surface layer of rock fill.

Temporary culvert installations are proposed prior to overflow apron construction (i.e. during the preload) to provide a conduit for fluids to pass through to the other side of the berm. Consideration should be given to a low permeability head wall at each end of the culverts to reduce the potential for preferential flows along the outside of the culvert pipes and related erosion. Temporary culvert installations should be sealed with grout once the overflow apron is in place to minimize potential for problems in the future.

5.9 PIPES

In general, new pipes not within the new berm or buried in the vicinity of a new structure are to be installed on the inside edge of the existing lagoon berms at or near to the slope surface. It is anticipated that some localized excavation and replacement of poor soils at the ground surface will be required to provide suitable support.

The berms have been constructed of variable soils including an organic silt core in the SW/SE portions of the lagoon and organic silt on the exterior berm in the NW/NE portions of the lagoon. The new pipe should not be installed directly above the compressible organic silt core. This may require giving consideration to burial of the segment of pipe in the southwest part of the site that connects the new facilities to the outfall pipe. Cut-off walls should be installed where pipes enter and exit the berm and at each end of the pipe to reduce the potential of soil erosion adjacent to the pipes.

5.10 EXCAVATIONS/DEWATERING

In general, excavations for the buildings and pipes are anticipated to be advanced through variable fill ranging from organic silt core material to sand and gravel with variable fines. Accordingly, stability of temporary excavations is anticipated to be variable. For preliminary planning purposes, temporary excavation angles of 1H:1V and 2H:1V may be used for areas of granular and variable fill, respectively. Gentler slopes may be required in areas of very poor soil such as organic silts, loose silt and sand, or wet ground conditions. The lateral extent of excavations may affect equipment access and careful planning/sequencing of construction activities will be necessary.

We recommend that the interior lagoons be maintained in a drained condition as much as practical during construction to facilitate monitoring of berm response to construction activities and to reduce the potential for berm instability. As noted above, it may not be possible to fully drain the area of the new division berm, but this is anticipated to be a unique condition.

5.11 ENGINEERED FILL

Engineered fill required to raise subgrade for the buildings or to raise berms should consist of 75 mm minus well graded sand and gravel with less than 5% by weight smaller than 0.075 mm. Sand and gravel portions of the existing berms are anticipated to be suitable for this purpose, subject to confirmation by WSP. Engineered fill should be placed in evenly placed lifts and compacted to a minimum 95% MPMDD. In place lift thickness should not be more than 300 mm to achieve this compaction requirement. In-place density testing should be carried out to verify compacted densities.

5.12 FUTURE GEOTECHNICAL

Further geotechnical review is anticipated to be required in support of final design, tendering and construction. Scope is anticipated to include:

- Completion of supplementary assessment at the new Screening Building location;
- Geotechnical input for preparation of special provisions components of the specifications and drawings (as needed) (i.e. ground improvement, preload, etc.);
- Review of tender documents for general compliance with the intent of geotechnical recommendations;
- Assistance with design of construction erosion and sediment control (if requested);
- Geotechnical support during tendering (as needed); and
- Field reviews and testing during construction.

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TABLE 5.3.1 – GROUND IMPROVEMENT ALTERNATIVES SUMMARY TABLE

ALTERNATIVE	PRO	CON
Deep Soil Mixing (DSM)	- Effective at improving fine grained soils - Smaller footprint - Robust, uniform performance, least differential movements - Low potential for being affected by local berm instabilities/flow failures - Relatively low vibrations/noise level - Reasonably high production if cobbles/boulders/obstacles not present	- Higher mobilization and per unit costs compared to other ground improvement options (offset by smaller footprint) - Specialized contractor – reduced number of contractors - Large working space - On-site cement/grout mixing - Comprehensive QA/QC program required - Chemicals in lagoon potentially affect hydration

Compaction Piles	- Conventional installation technique
	    - Broader range of contractors
	    - Reduced mobilization costs
	- No cement mixing
	- Moderately effective at improving fine grained soils
	- Straight forward QA/QC program
	- Reasonably high production if cobbles/boulders/obstacles not present
		- Less effective than DSM in fine grained soils soils (comparable to Geopier GIS)
		- Equivalent shear strength of improved ground less than DSM (comparable to Geopier GIS)
		    - Less resistance to local berm instabilities/flow failures
		    - Larger footprint
		    - More differential movements
		- Relatively high noise and vibration levels
		- Timber piles need to be treated above water table
		- Potential buoyancy challenges

Geopier Grouted Impact® System (Geopier GIS)	- Reduced mobilization costs (comparable to Compaction Piles)
	- Moderately effective at improving fine grained soils
	- Reasonably high production if cobbles/boulders/obstacles not present
	- Moderate noise and vibration levels
		- Less effective than DSM in fine grained soils (comparable to Compaction Piles)
		- Equivalent shear strength of improved ground less than DSM (comparable to Compaction Piles)
		    - Less resistance to local berm instabilities/flow failures
		    - Larger footprint
		    - More differential movements
		- Moderate working space
		- On-site cement/grout mixing
		- Moderate QA/QC program required
		- Chemicals in lagoon potentially affect hydration
		- Moderate noise and vibration levels

PROJECT:

PORT ALBERNI WWTP
GEOTECHNICAL DESIGN REPORT

TITLE:

SITE LOCATION PLAN

CLIENT:

ASSOCIATED ENGINEERING LTD.

FIGURE NO.:	DATE:	FILE NO.:	SCALE:	DRAWN BY:	REV NO.:
1	JAN 2018	171-04753-00	NTS	LM	1

PROJECT:

PORT ALBERNI WWTP
GEOTECHNICAL DESIGN REPORT

TITLE:

TEST HOLE LOCATION PLAN

CLIENT:

ASSOCIATED ENGINEERING LTD.

FIGURE NO.:	DATE:	FILE NO.:	SCALE:	DRAWN BY:	REV NO.:
2	JAN 2018	171-04753-00	NTS	LM	1

2010 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836
Western Canada English (250) 363-6500 Facsimile (250) 363-6565

Requested by: Lalinda Weerasekara, WSP Group Inc May 15, 2017

Site Coordinates: 49.2479 North 124.8214 West

User File Reference: Port Alberni

National Building Code ground motions:
2% probability of exceedance in 50 years (0.000404 per annum)

Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA (g)
0.758	**0.564**	**0.303**	**0.161**	**0.354**

Notes. Spectral and peak hazard values are determined for firm ground (NBCC 2010 soil class C - average shear wave velocity 360-750 m/s). Median (50th percentile) values are given in units of g. 5% damped spectral acceleration (Sa(T), where T is the period in seconds) and peak ground acceleration (PGA) values are tabulated. Only 2 significant figures are to be used. ***These values have been interpolated from a 10 km spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the calculated values.*** Warning: You are in a region which considers the hazard from a deterministic Cascadia subduction event for the National Building Code. Values determined for high probabilities (0.01 per annum) in this region do not consider the hazard from this type of earthquake.

Ground motions for other probabilities:

Probability of exceedance per annum	0.010	0.0021	0.001
Probability of exceedance in 50 years	40%	10%	5%
Sa(0.2)	0.184	0.395	0.535
Sa(0.5)	0.126	0.294	0.381
Sa(1.0)	0.066	0.153	0.208
Sa(2.0)	0.035	0.079	0.110
PGA	0.093	0.192	0.257

References

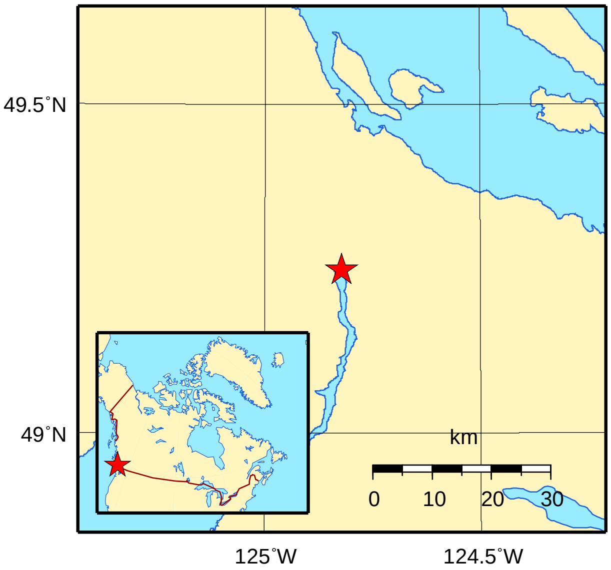
National Building Code of Canada 2010 NRCC no. 53301; sections 4.1.8, 9.20.1.2, 9.23.10.2, 9.31.6.2, and 6.2.1.3
Appendix C: Climatic Information for Building Design in Canada - table in Appendix C starting on page C-11 of Division B, volume 2

User's Guide - NBC 2010, Structural Commentaries NRCC no. 53543 (in preparation)
Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File xxxx
Fourth generation seismic hazard maps of Canada: Maps and grid values to be used with the 2010 National Building Code of Canada (in preparation)

See the websites *www.EarthquakesCanada.ca* and *www.nationalcodes.ca* for more information

Aussi disponible en français



Natural Resources Canada Ressources naturelles Canada

Canada

FIGURE 4 SOIL STRESS DISTRIBUTION - STATIC

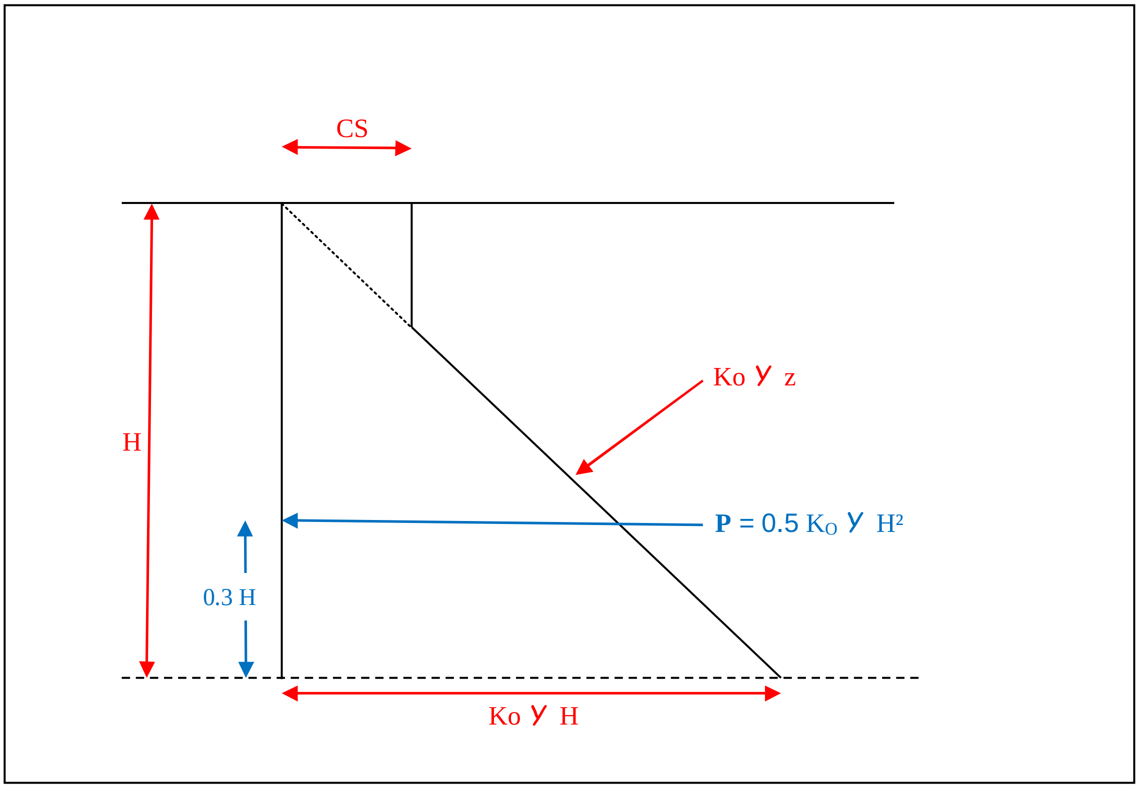
CS = Compaction stress, uniform locked in lateral stress associated with backfill compaction (15 to 20 kPa).

K_o = Coefficient of earth stress at rest.

γ = Unit bulk density of the wall backfill (kN/m^3).

H = Total embedded height of wall (m).

z = Depth of embedded wall from surface (m).



NOTE : The above lateral stress design recommendations are based on the assumption that the back of the wall is fully drained (no hydrostatic pressures acting on the wall). As outlined in the text of the report, if sufficient drainage is not provided behind the walls, hydrostatic and hydrodynamic loads need to be included in the design.

FIGURE 5 SOIL STRESS DISTRIBUTIONS – DYNAMIC

K_{AE} = Seismic active earth coefficient (Mononobe-Okabe).

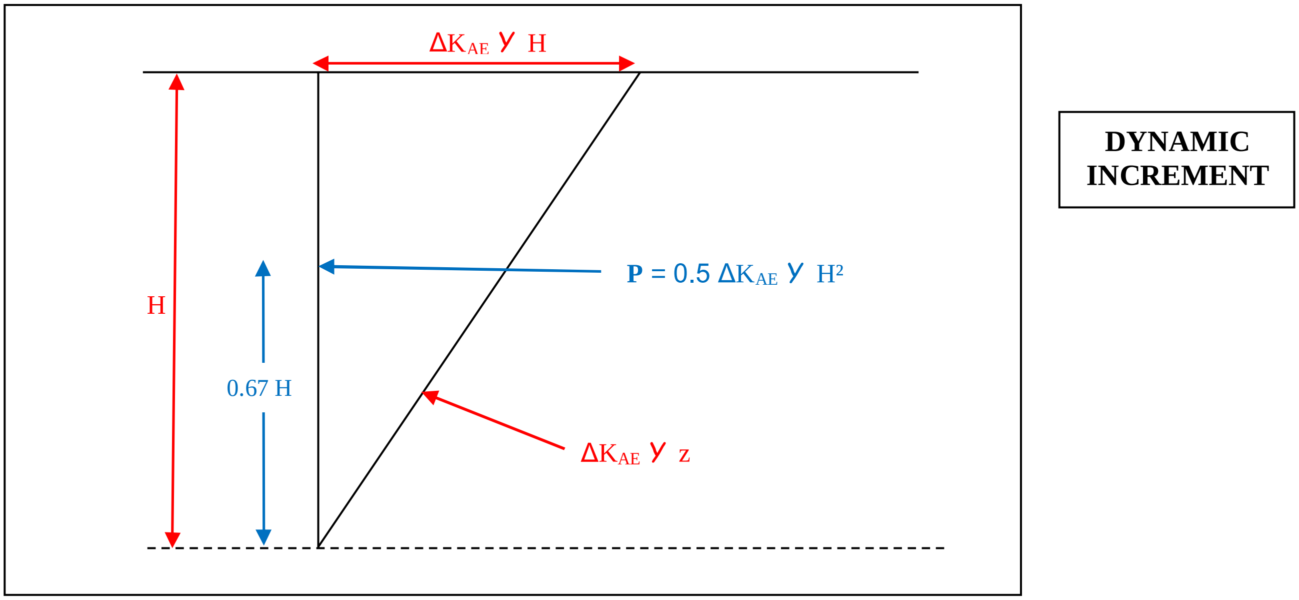
ΔK_{AE} = Differential seismic active earth coefficient ($K_{AE} - K_A$).

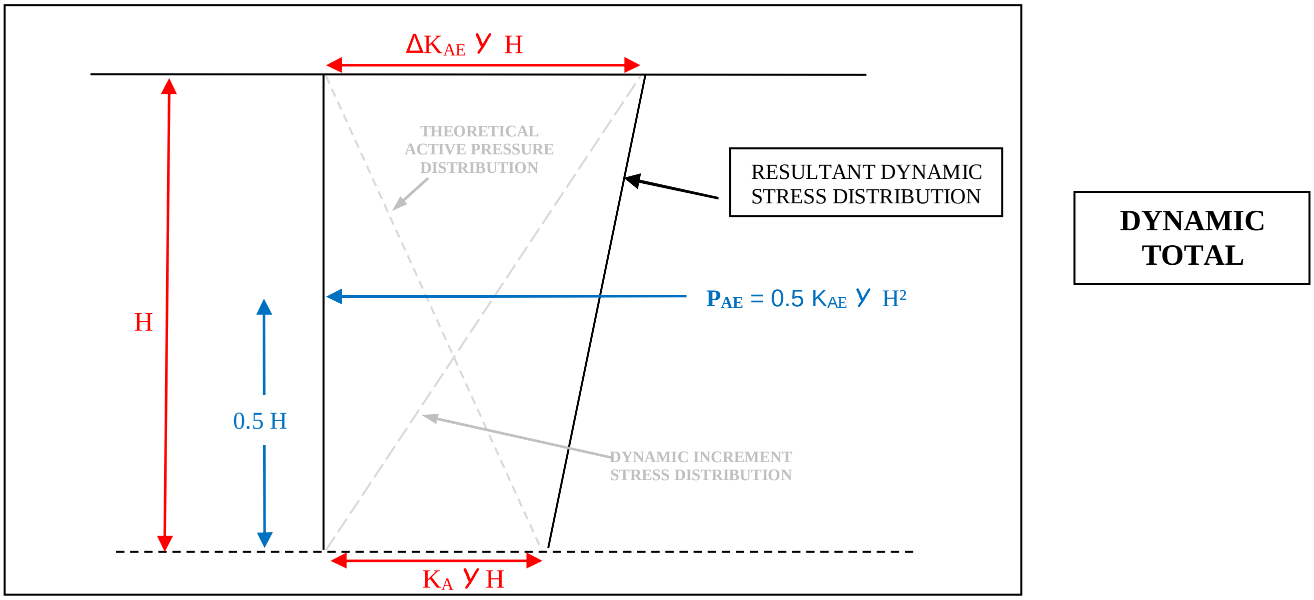
γ = Unit bulk density of the wall backfill (kN/m^3).

K_A = Coefficient of active earth pressure.

H = Total embedded height of wall (m).

z = Height of embedded wall from base (m).





NOTE : The above lateral stress design recommendations are based on the assumption that the back of the wall is fully drained (no hydrostatic pressures acting on the wall). As outlined in the text of the report, if sufficient drainage is not provided behind the walls, hydrostatic and hydrodynamic loads need to be included in the design.

NOTE : The dynamic earth stress is additive to the static triangular (self weight) earth stress distribution (active state), and any hydrostatic pressures. It is believed that the "locked in" compaction stresses are relieved in the first few cycles of seismic motion, and thus are not included in the total dynamic loading. The total dynamic loading under dry conditions acts at approximately the mid-height of the embedded height of the wall.

PHOTOGRAPHS

Photo	Description
	**Photo 1:** General view of sand at 5 m depth in BH17-02 (lower half of photo). Note the organic silt/peat at about 3 m depth in upper half of photo.
	**Photo 2:** Sandy gravel at 8.5 m depth in BH17-02 (lower half of photo)

PHOTOGRAPHS

Photo	Description
	**Photo 3:** Typical sand with some fines from BH17-02 at about 14.5 m depth
	**Photo 4:** Typical CLAY/SILT from BH17-02 at about 26 m depth.

PHOTOGRAPHS

Photo	Description
	**Photo 5:** General view of conditions in TP17-01 with the existing berm. Note significant sloughing below water level.
	**Photo 6:** Inferred natural silty sand below 3 m depth at TP17-01

PHOTOGRAPHS

<table>
<tr><th>Photo</th><th>Description</th></tr>
<tr><td></td><td>Photo 7:
View of granular fill over interior silty sand core at TP17-02. The core material is at the base of the excavation in the photo.</td></tr>
<tr><td></td><td>Photo 8:
View to northwest from proposed UV/Aerator Building along the approximate alignment of the proposed in-fill division berm.</td></tr>
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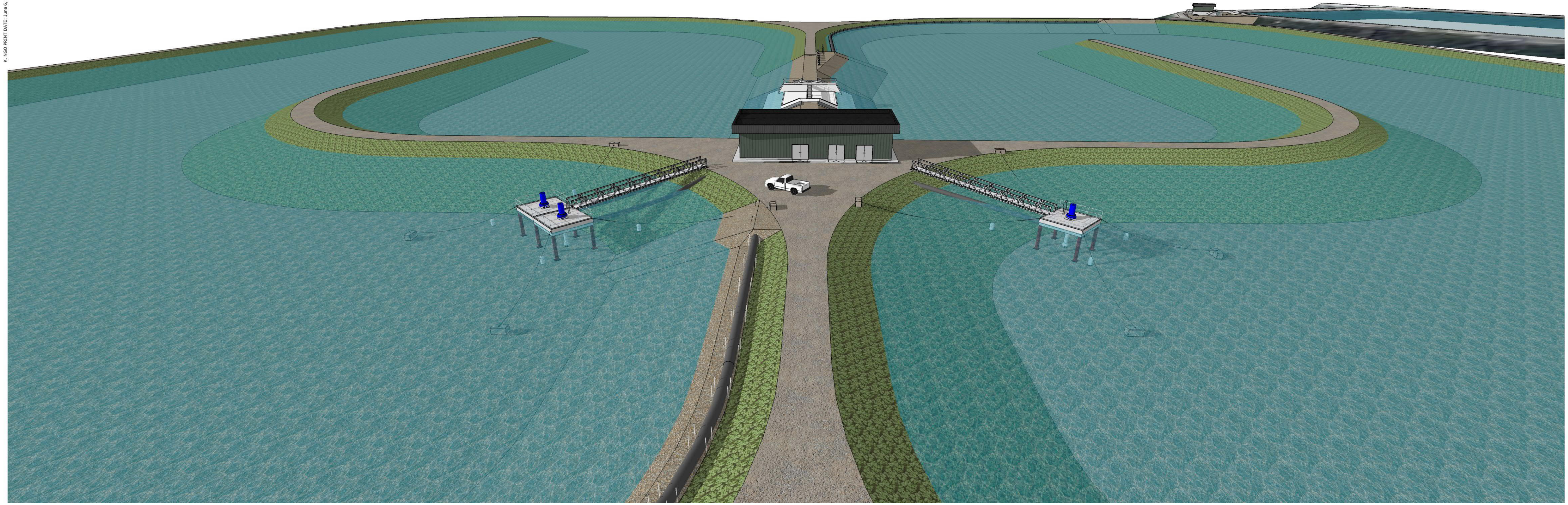
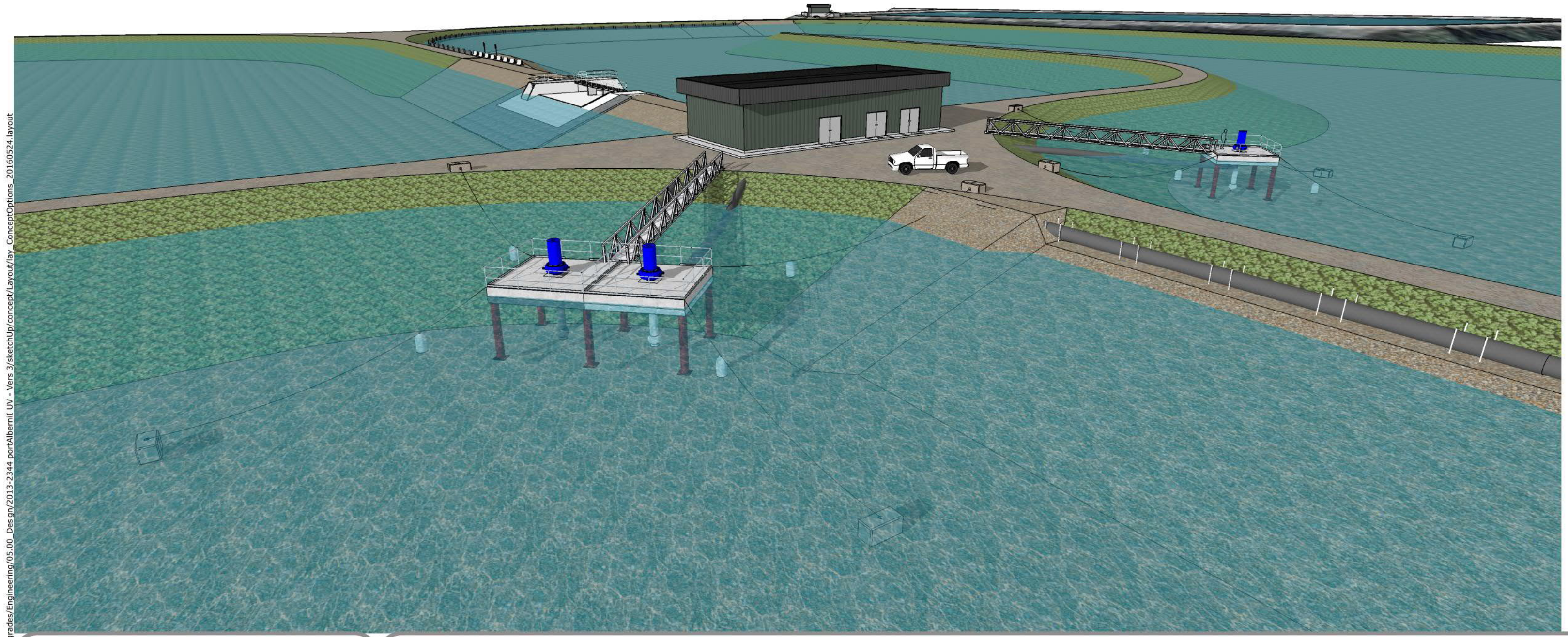
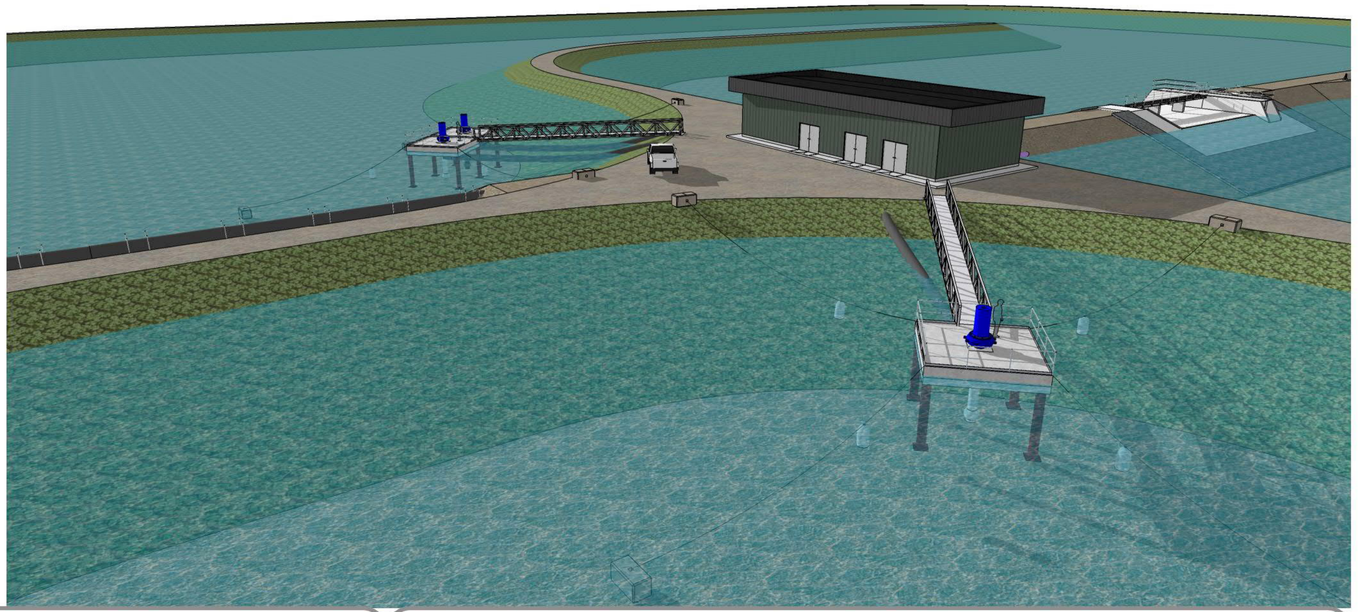
APPENDIX

1. CONCEPT DESIGN DRAWINGS – NOV 2017

K. NGO PRINT DATE: June 6, 2016







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Associated Engineering
GLOBAL PERSPECTIVE.
LOCAL FOCUS.

CONCEPT DESIGN

DESIGN T. ROBINSON
M. SIMHON
K. NGO
DRAWN K. NGO
DATE 2016JUN06

City of
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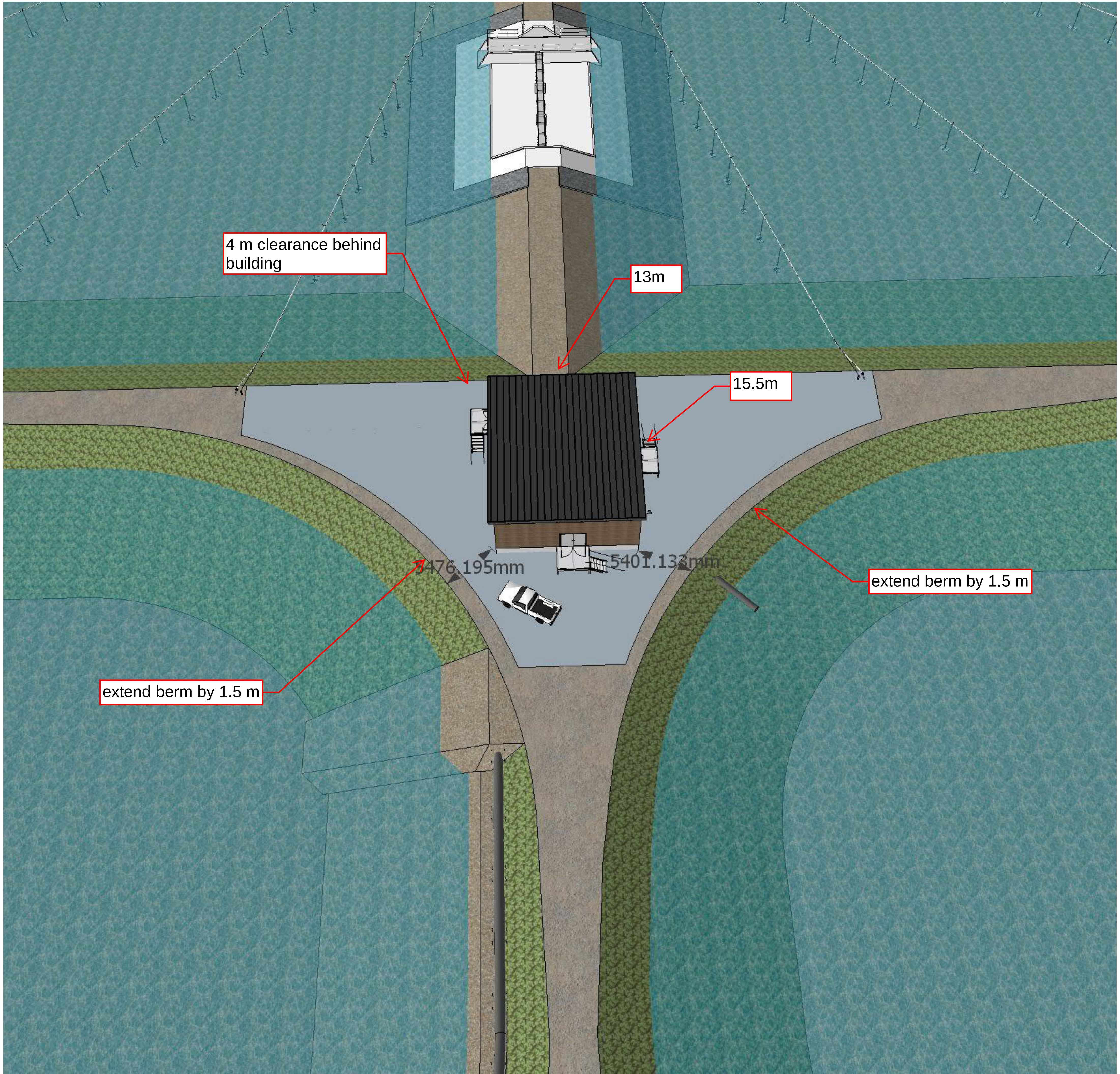
LAGOON UPGRADES

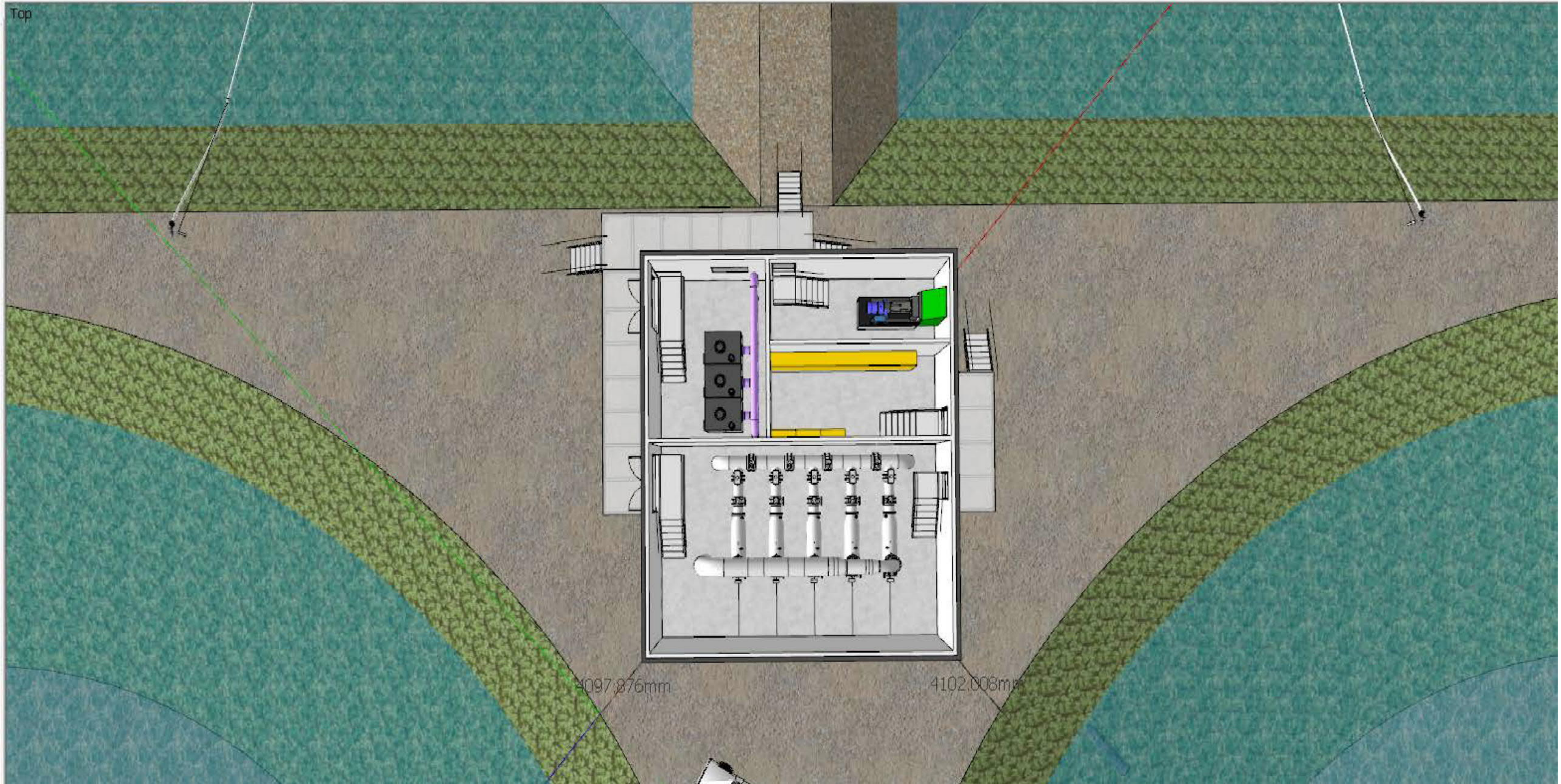
SCALE: AS SHOWN

2013-2344

SPACE PLANNING
UV & AERATION BUILDING
ISOMETRIC

DRAWING No.:	REVISION	SHEET
2344-00-A-008	A	6 / 10


4 m clearance behind building
13m
15.5m
5476.195mm
5401.132mm
extend berm by 1.5 m
extend berm by 1.5 m



Top
4097.876mm
4102.008mm

IF NOT 50 mm ADJUST SCALES
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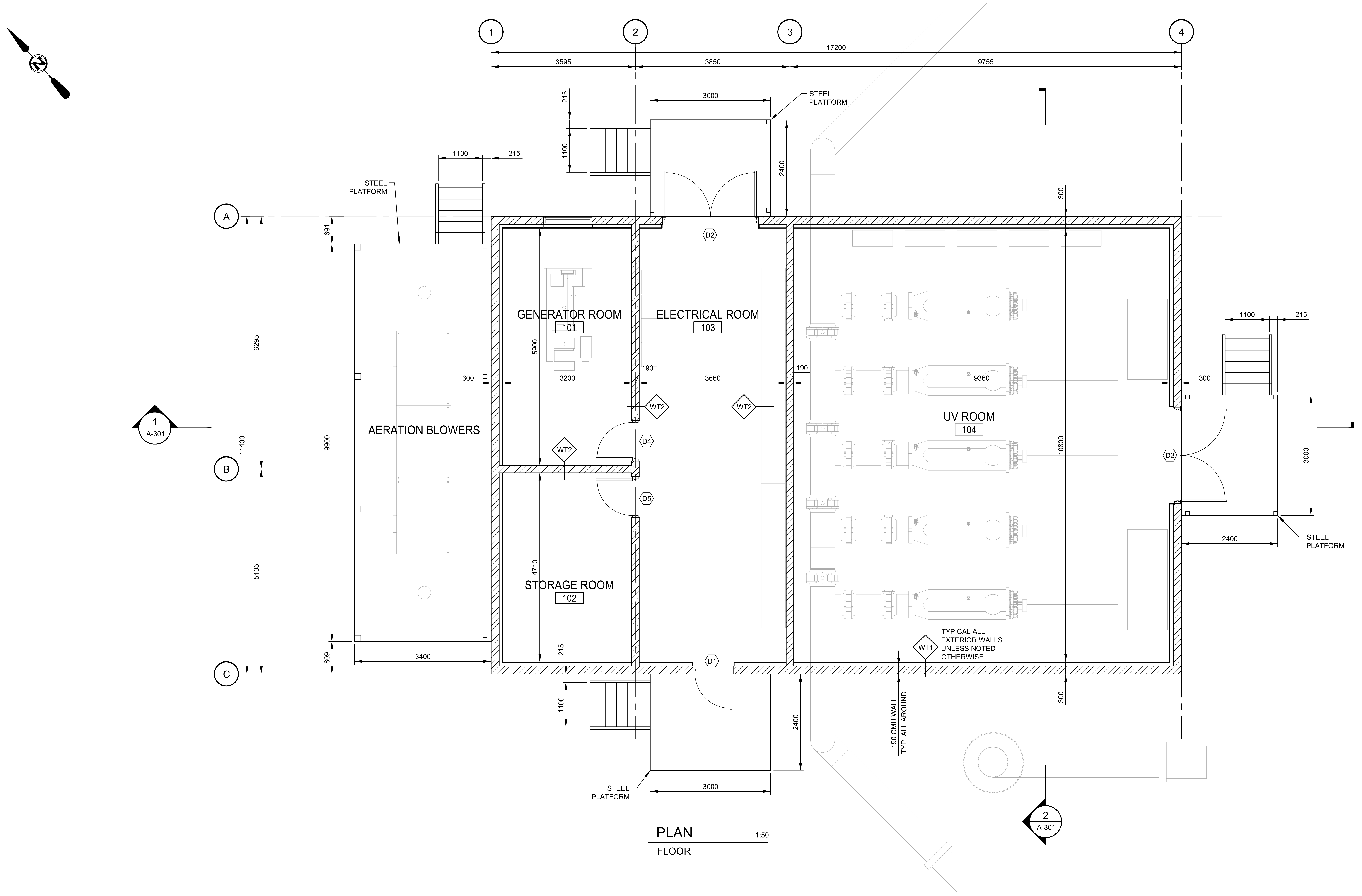
SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS, TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE



PLAN
1:50
FLOOR

WALL TYPES LEGEND

WT1
EXTERIOR WALL
-190 CONCRETE MASONRY UNIT
-METAL Z-GIRTS (20 Ga.)
-50 RIGID INSULATION (R12)
-VAPOR BARRIER (BLUESKIN PEEL & STICK)
-19 PLY SHEATHING & 12 GYPSUM

WT2
INTERIOR WALL
-190 CONCRETE MASONRY UNIT, SMOOTH FACE

FLOOR TYPES LEGEND

FT1
-CONCRETE FLOOR STRUCTURE

ROOF TYPES LEGEND

RT1
-SBS CAP SHEET AND BASE SHEET
BY SOPREMA OR APPROVED EQUAL
-12mm OVERLAY BOARD
-100 RIGID INSULATION (R20)
-VAPOR BARRIER
-300 CONCRETE ROOF SLAB

PARAPET TYPES LEGEND

PT1
-PRE-FINISHED METAL CLADDING FASCIA
-51 RIGID INSULATION (R12)
-VAPOR BARRIER
-190 MASONRY BLOCK
(SMOOTH FACE)
-51 RIGID INSULATION (R12)
-VAPOR BARRIER
-16 PRESSURE TREATED PLYWOOD
-SBS ROOFING SYSTEM

PT2
-SBS ROOFING SYSTEM
-16 PRESSURE TREATED PLYWOOD
-51 RIGID INSULATION (R12)
-VAPOR BARRIER
-190 MASONRY BLOCK (SMOOTH FACE)
-100 RIGID INSULATION (PLUG)
-190 MASONRY BLOCK (SMOOTH FACE)
-VAPOR BARRIER
-51 RIGID INSULATION (R12)
-16 PRESSURE TREATED PLYWOOD
-SBS ROOFING SYSTEM

NOTE:
ALL SBS ROOFING TO BE INSTALLED TO RCABC SPECIFICATION FOR A 5 YEAR WARRANTY.

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A	2017NOVXX	J. COPE	H. DUALAN JR	ISSUED FOR XXXXXX

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WASTEWATER LAGOON
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20172972-00

SCALE: AS SHOWN

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FLOOR PLAN

DRAWING	REVISION	SHEET
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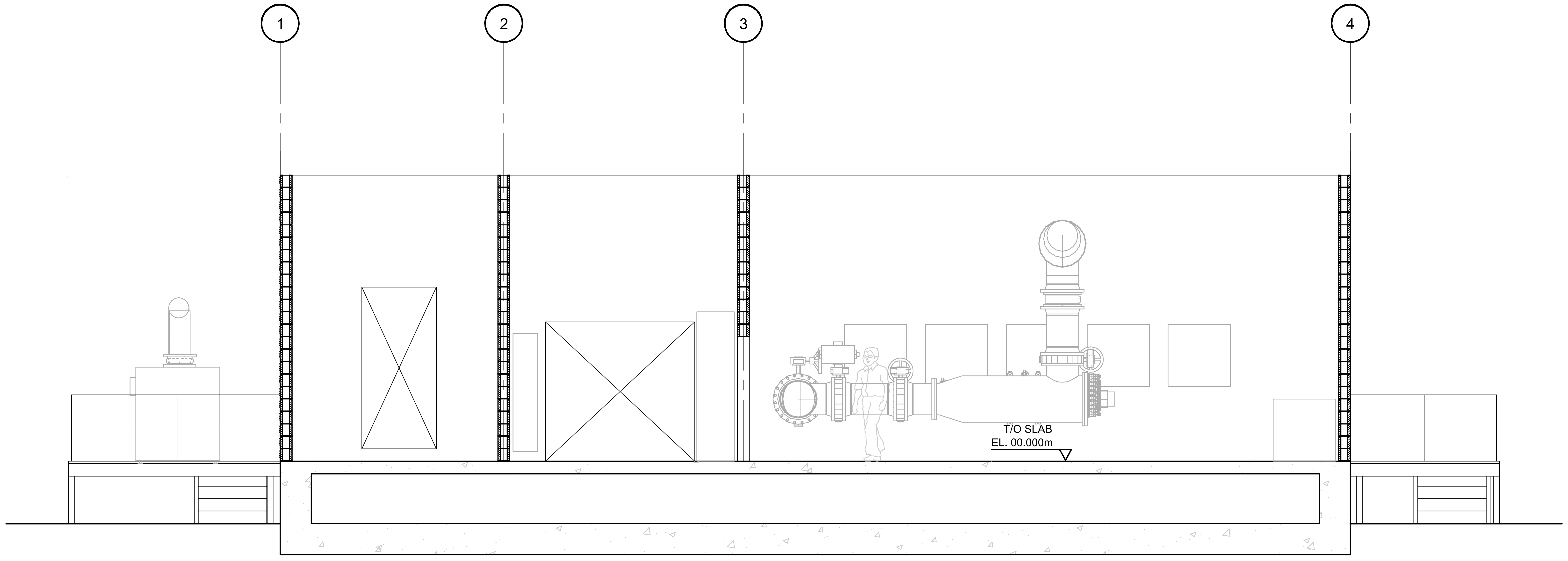

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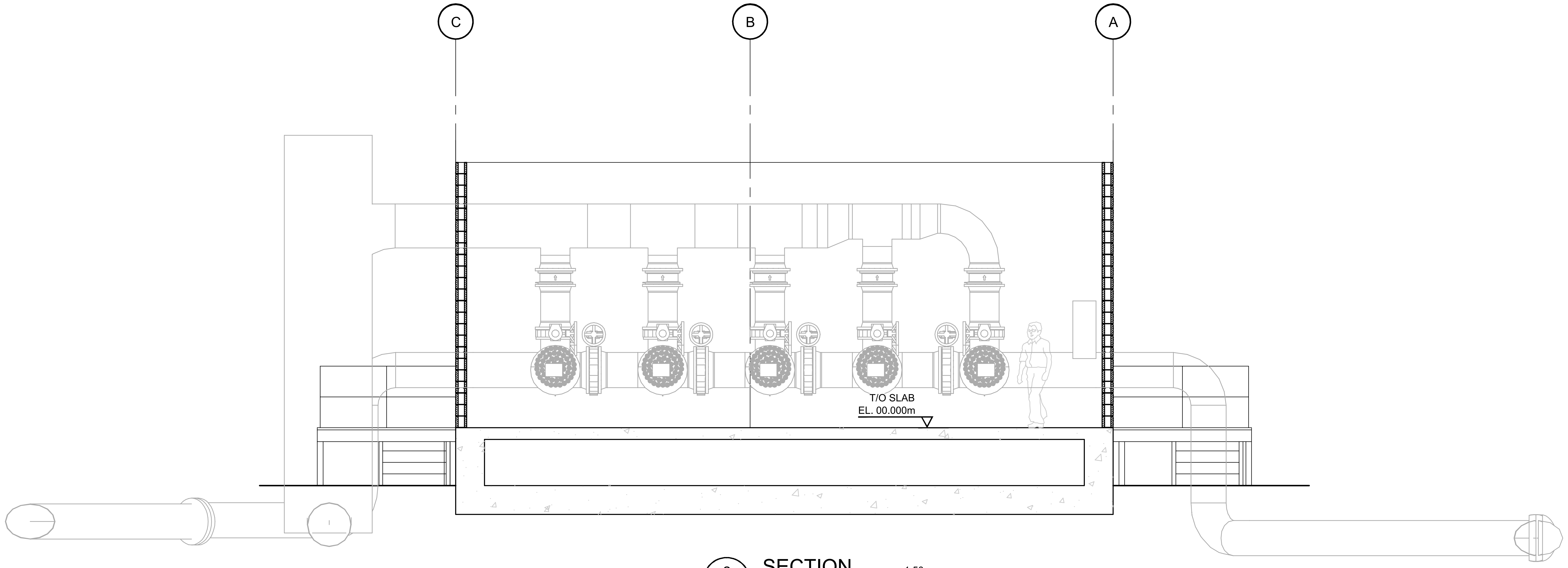

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EXPANSION UPGRADES

20172972-00

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Port Alberni

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SECTIONS SHEET 1

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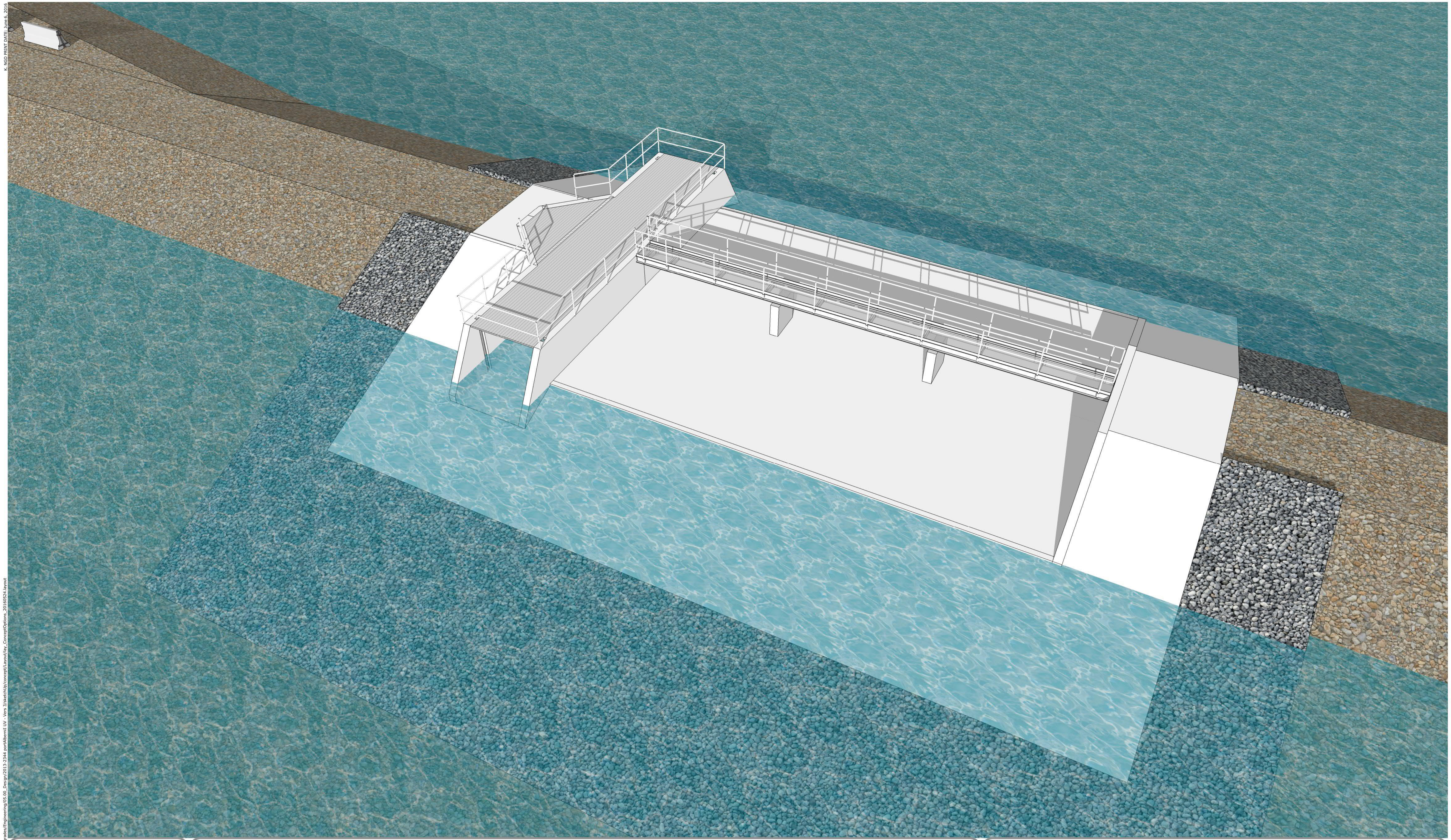

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CONCEPT DESIGN

DESIGN	T. ROBINSON
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	K. NGO
DRAWN	K. NGO
DATE	2016JUN06

City of
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LAGOON UPGRADES

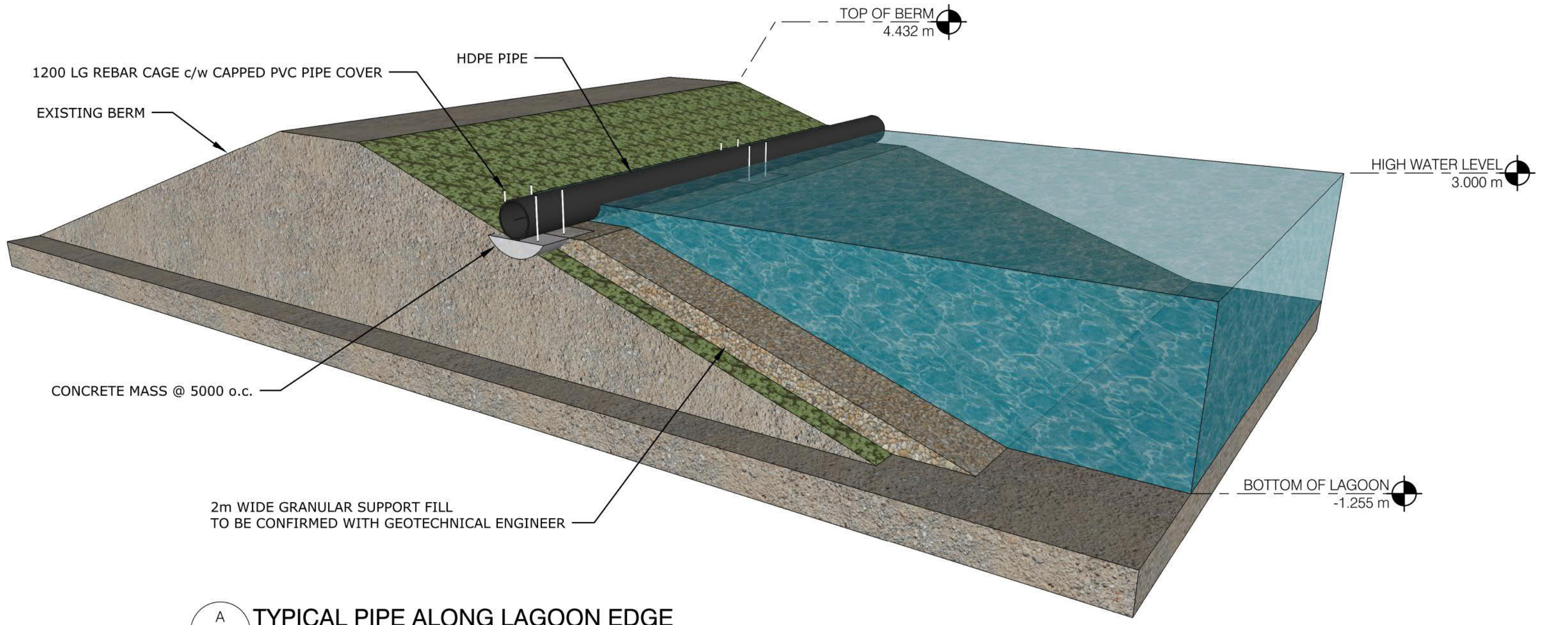
SCALE: AS SHOWN

2013-2344

SPACE PLANNING
OVERFLOW

DRAWING No.:	REVISION	SHEET
2344-00-A-007	A	5 /10

K. NGO PRINT DATE: June 6, 2016



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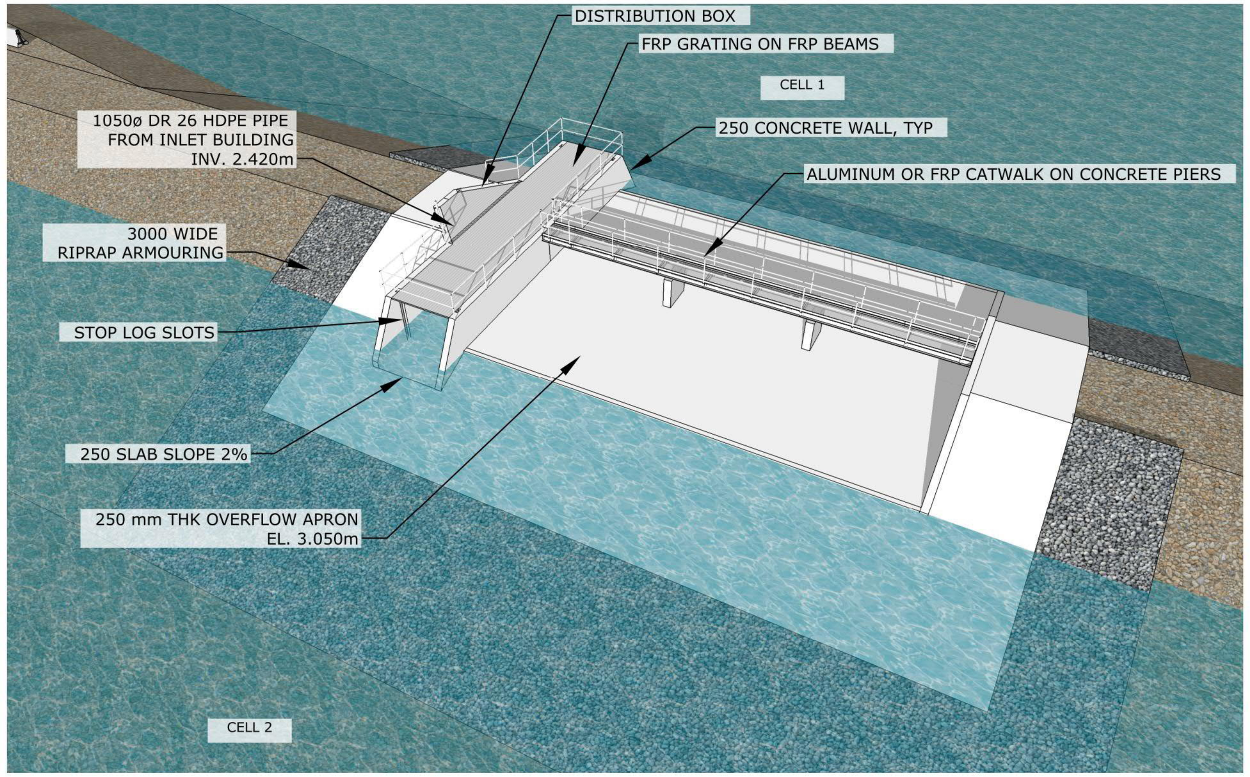
TYPICAL PIPE ALONG LAGOON EDGE



C
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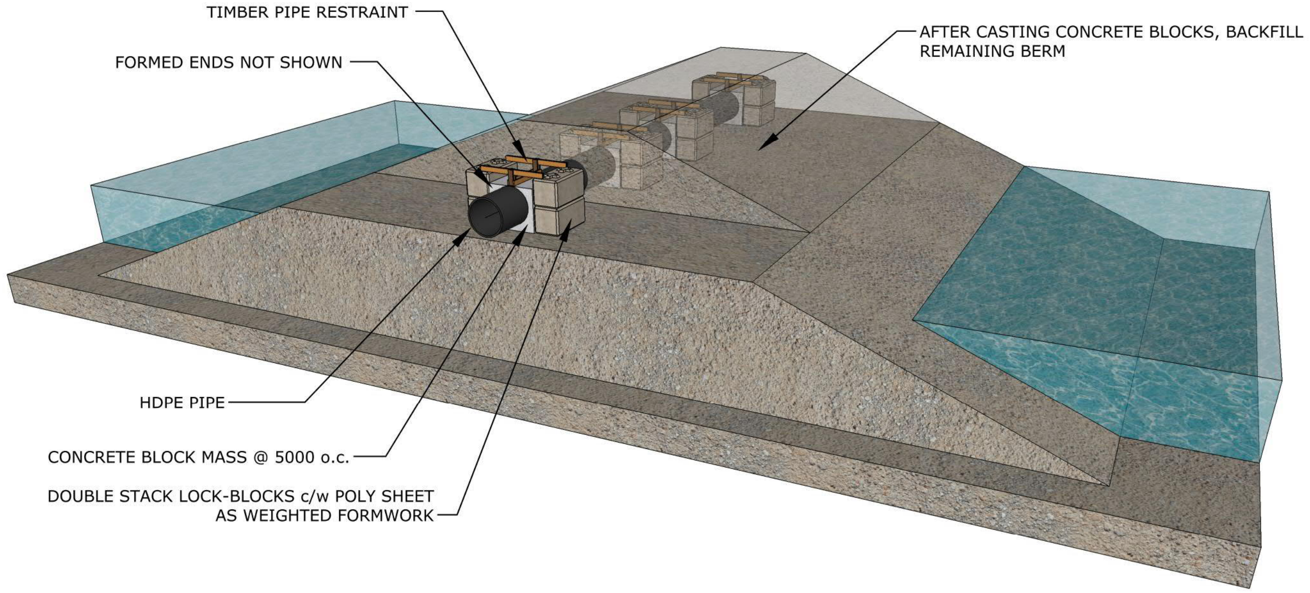
LAGOON INLET STRUCTURE



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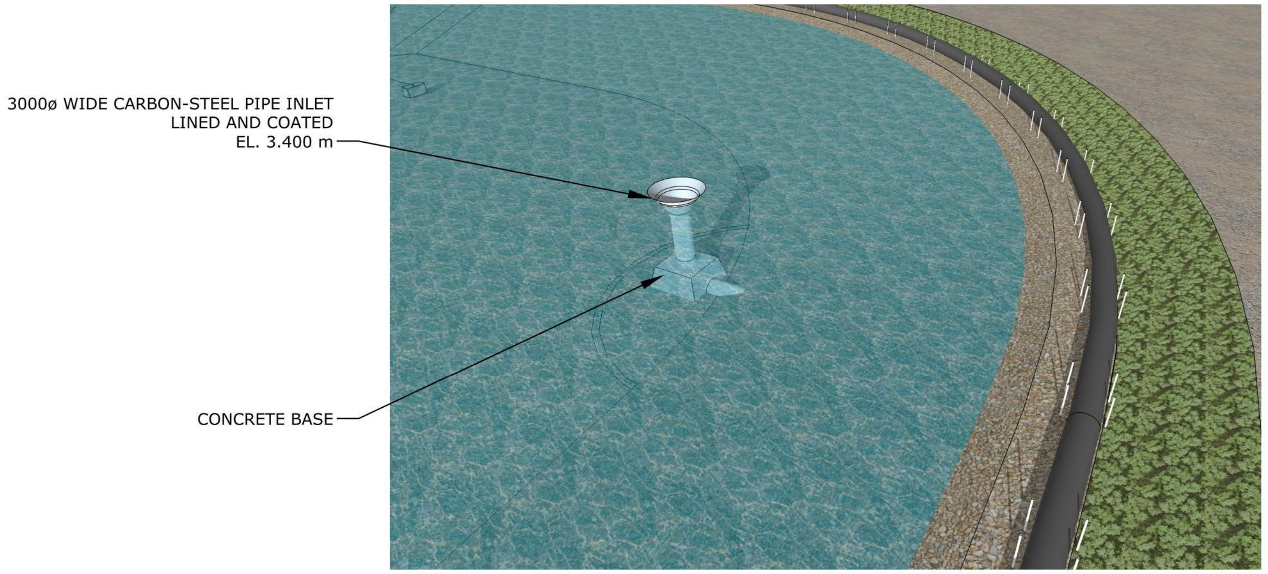
CONSTRUCTION SECTION FOR PIPE IN NEW BERM



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LAGOON OVERFLOW

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CONCEPT DESIGN

DESIGN
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K. NGO
DRAWN
K. NGO
DATE
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SCALE: AS SHOWN

2013-2344
SPACE PLANNING
DETAILS

DRAWING No.:	REVISION	SHEET
2344-00-A-109	A	9 / 10

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9	5121.223	2858.398	4.650
2	5133.317	2848.424	4.200
3	5131.971	2847.240	4.273
4	5128.593	2857.585	4.650
5	5126.716	2855.935	4.700
6	5124.838	2854.284	4.650
7	5124.978	2861.698	4.650
8	5123.100	2860.048	4.700
10	5118.376	2869.209	4.650

PNT#	NORTHING	EASTING	ELEV
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12	5114.621	2865.909	4.650
13	5105.173	2884.231	4.650
14	5103.295	2882.581	4.700
15	5101.417	2880.931	4.650
16	5091.969	2899.253	4.650
17	5090.091	2897.603	4.700
18	5088.213	2895.953	4.650
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20	5076.887	2912.625	4.700

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23	5065.820	2925.216	4.700
24	5063.943	2923.565	4.650
25	5062.551	2932.723	4.260
26	5060.673	2931.072	4.310
27	5058.795	2929.422	4.260
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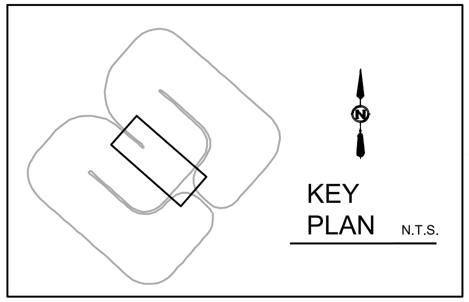

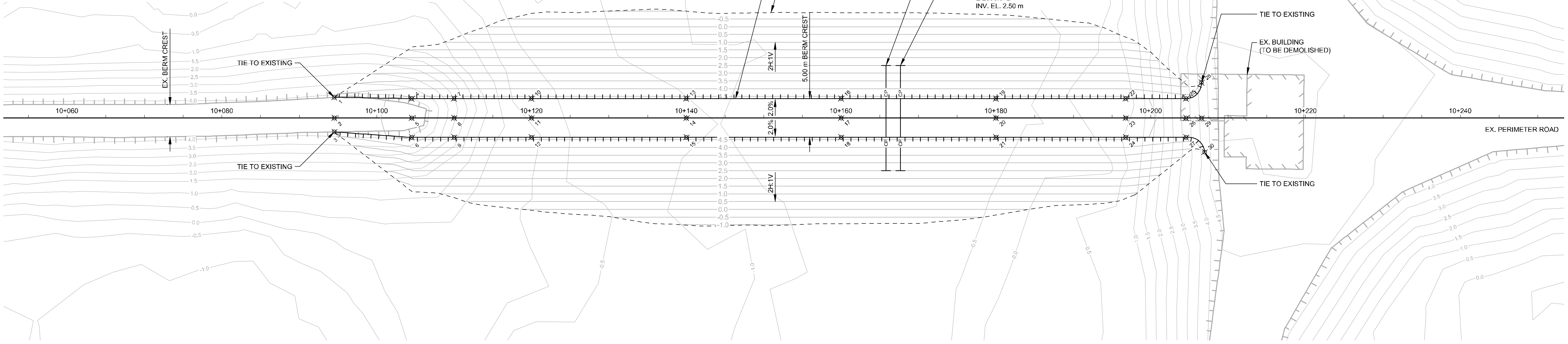

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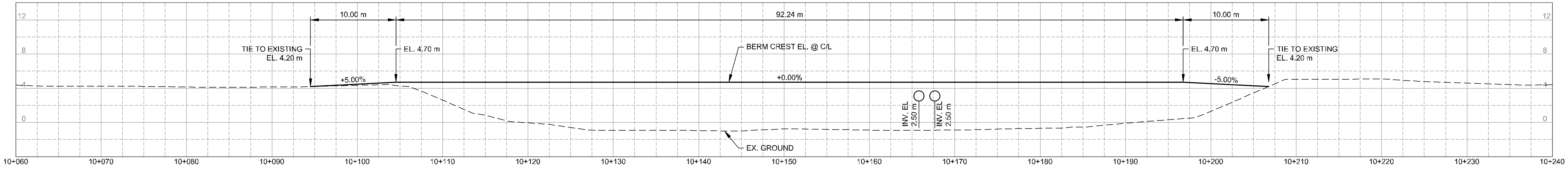

PROFILE
1:250

SURVEY NOTES:

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2. COORDINATES SHOWN IN LOCAL, GROUND COORDINATE SYSTEM. TO CONVERT TO UTM ZONE 10 NAD83: SHIFT N 5452594.841, E 364495.260, SCALE FROM 0,0,0 BY 0.99981766.
3. ELEVATIONS ARE GEODETIC DATUM DERIVED FROM ICM 87H341.

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DATE: 2017-08-16, Jason White

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CITY OF PORT ALBERNI

WASTEWATER LAGOON
EXPANSION UPGRADES

20172972-00

SCALE: AS SHOWN

THE CITY OF Port Alberni

CIVIL
LAGOON BERM
GENERAL ARRANGEMENT

DRAWING	REVISION	SHEET
2792-00-C-101	X	---/

IF NOT 50 mm ADJUST SCALES
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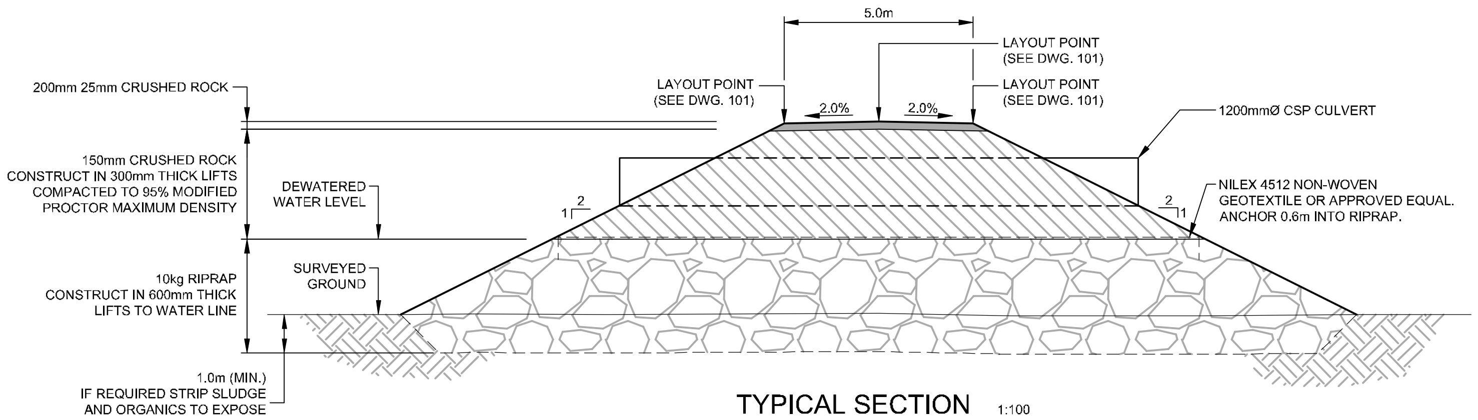

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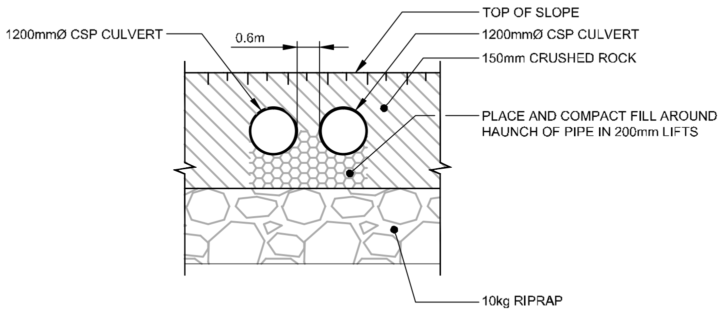

DETAIL 1:100

CULVERTS

NOTES:

1. SUBGRADE TO BE INSPECTED BY GEOTECHNICAL ENGINEERING PRIOR TO COMMENCEMENT OF FILL PLACEMENT. PROVIDE 72 HOURS NOTICE TO ENGINEER PRIOR TO INSPECTION.

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DATE: 2017-08-16, Jason White

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NOT FOR CONSTRUCTION
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CITY OF PORT ALBERNI

WASTEWATER LAGOON
EXPANSION UPGRADES

20172972-00

SCALE: AS SHOWN

THE CITY OF
Port Alberni

CIVIL
LAGOON BERM
DETAILS

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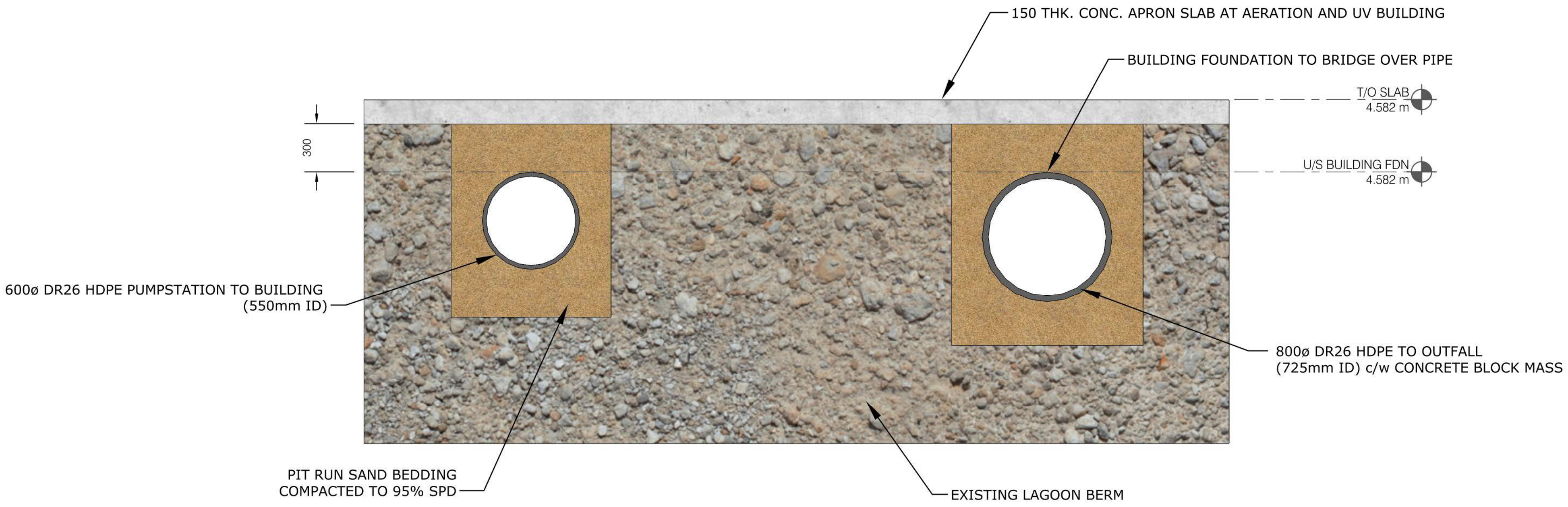
K. NGO PRINT DATE: June 6, 2016



A
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TYPICAL PIPE TRENCH DETAIL
1:20

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CONCEPT DESIGN

DESIGN	T. ROBINSON
	M. SIMHON
	K. NGO
DRAWN	K. NGO
DATE	2016JUN06

City of
Port Alberni
LAGOON UPGRADES

SCALE: AS SHOWN

2013-2344

SPACE PLANNING
DETAILS 2

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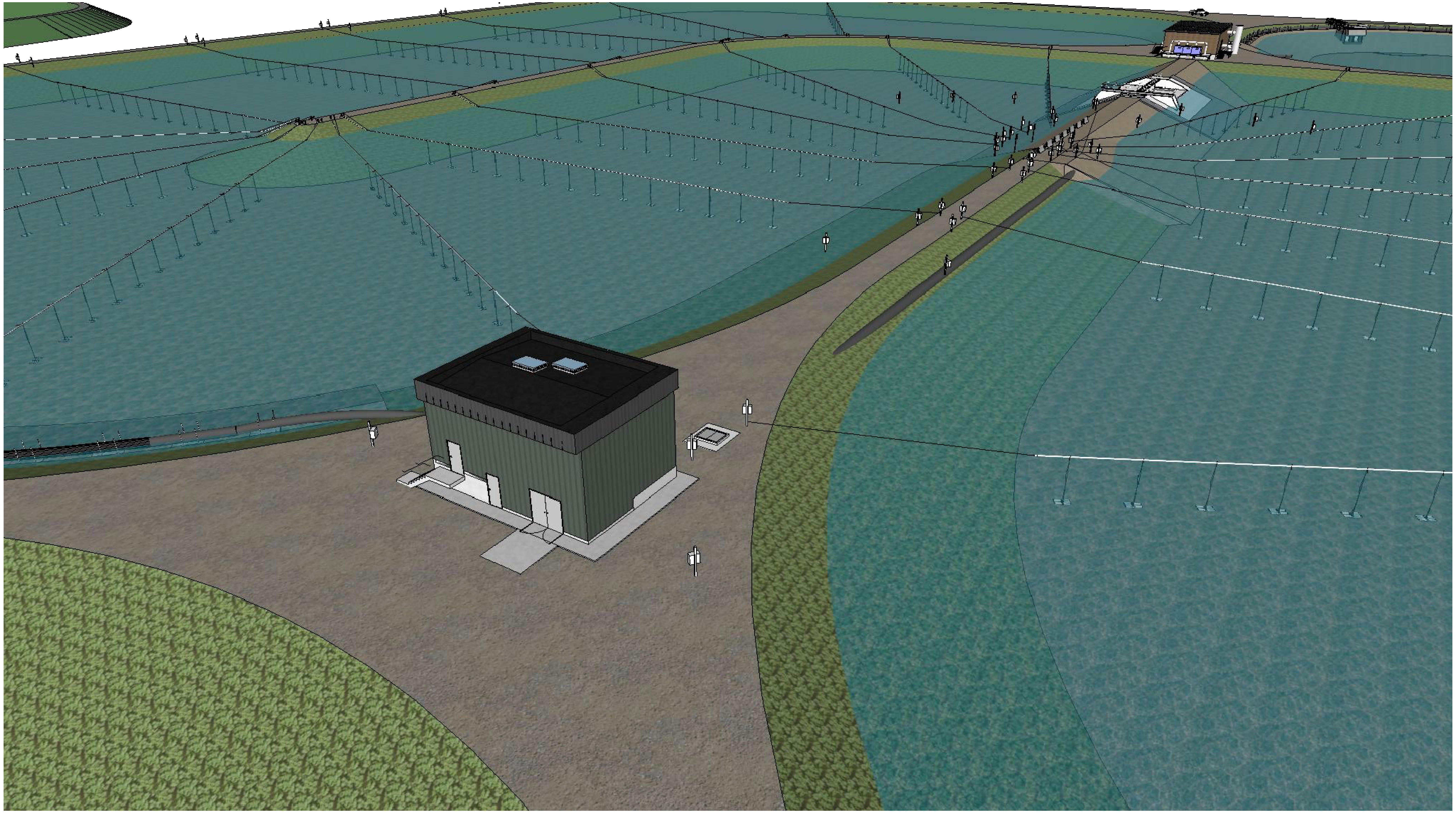

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DESIGN	<Design>
REVIEW	<Review>
DRAWN	<Drawn>
DATE	November 27, 2017

City of
Port Alberni

Wastewater Upgrades
Screen Building

SCALE 1:100

2017-2972

Page 1

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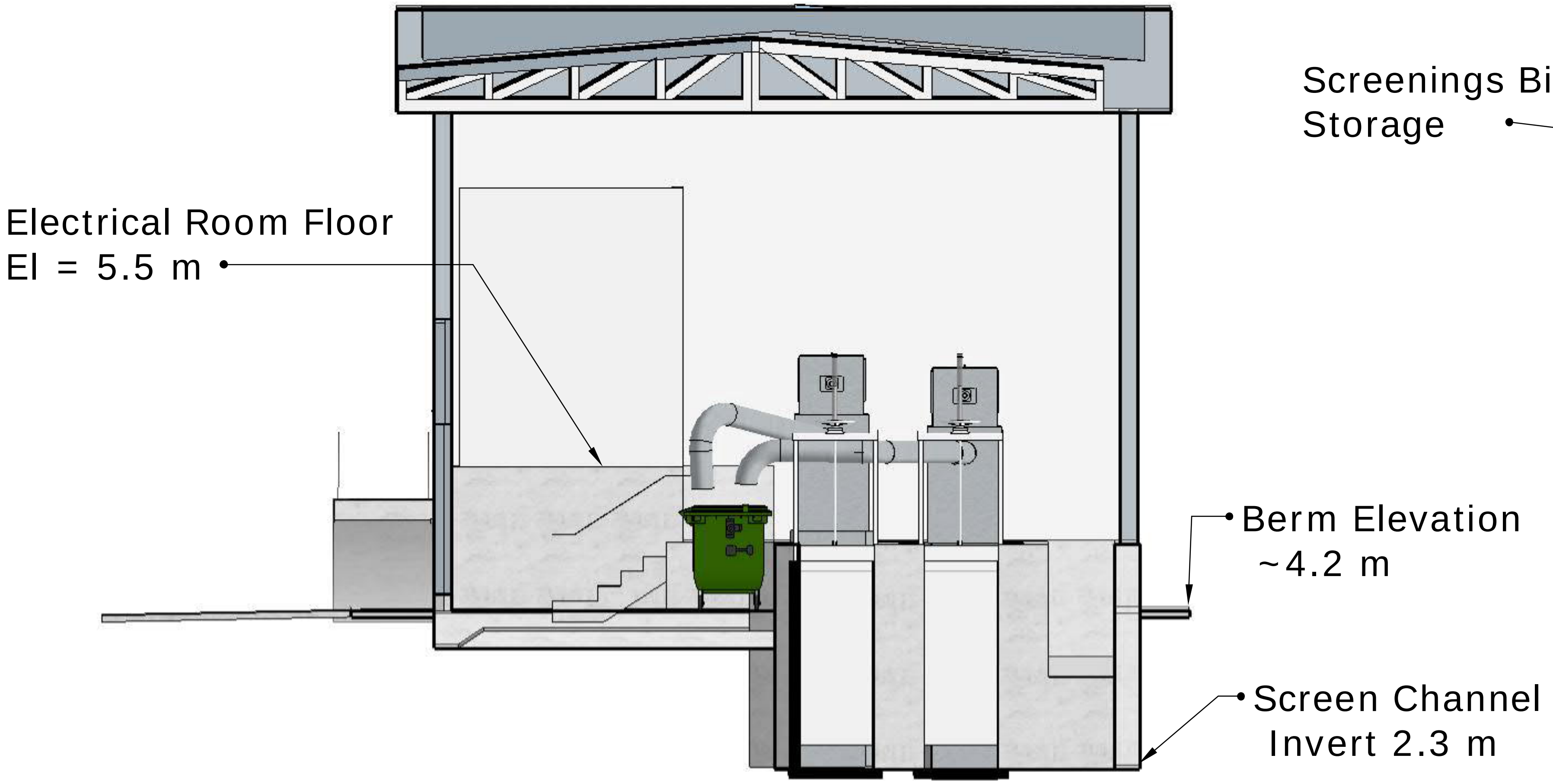

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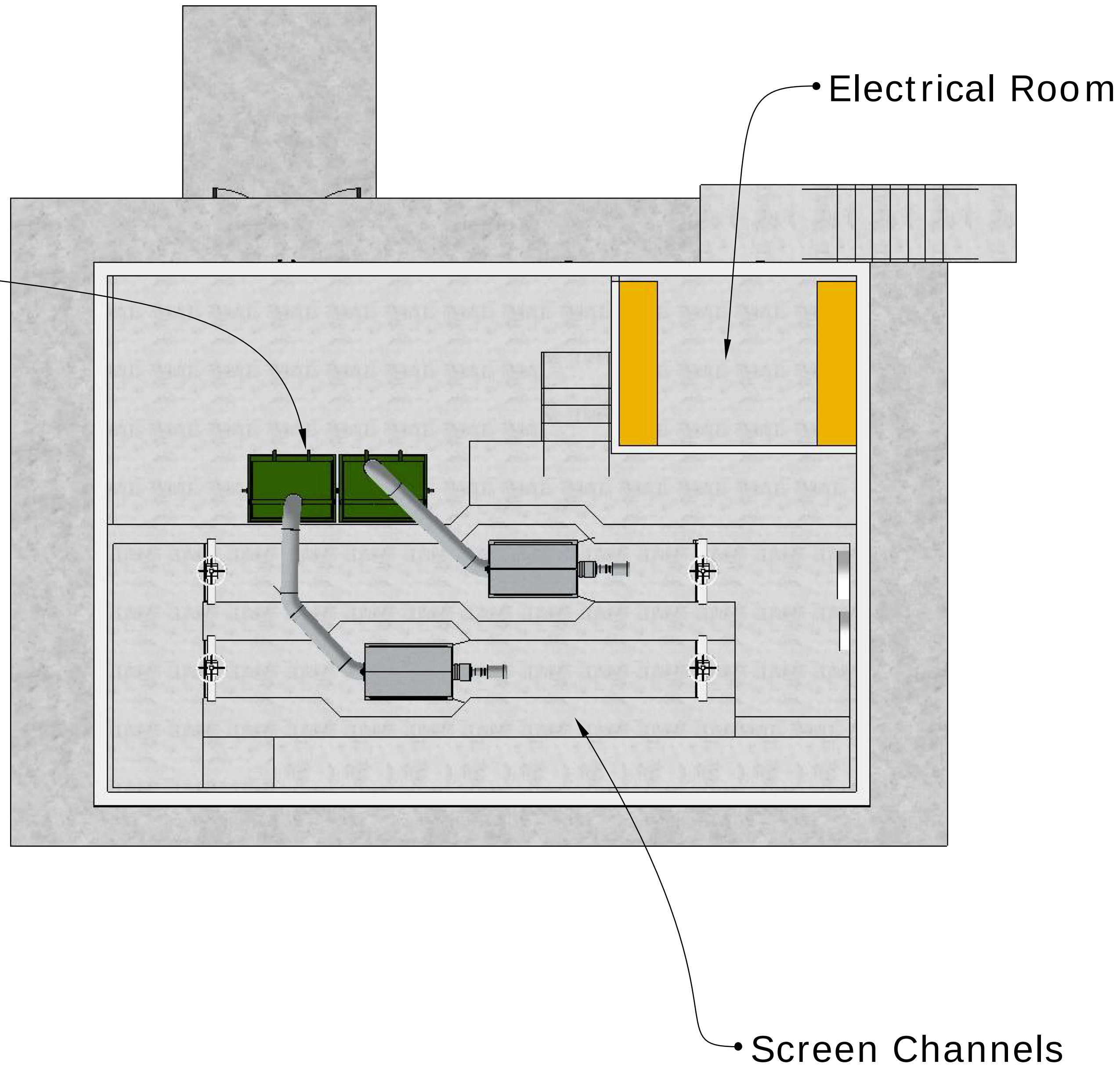

Plan

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GLOBAL PERSPECTIVE.
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DESIGN <Design>
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DATE November 27, 2017

City of
Port Alberni
Wastewater Upgrades
Screen Building
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Page 2

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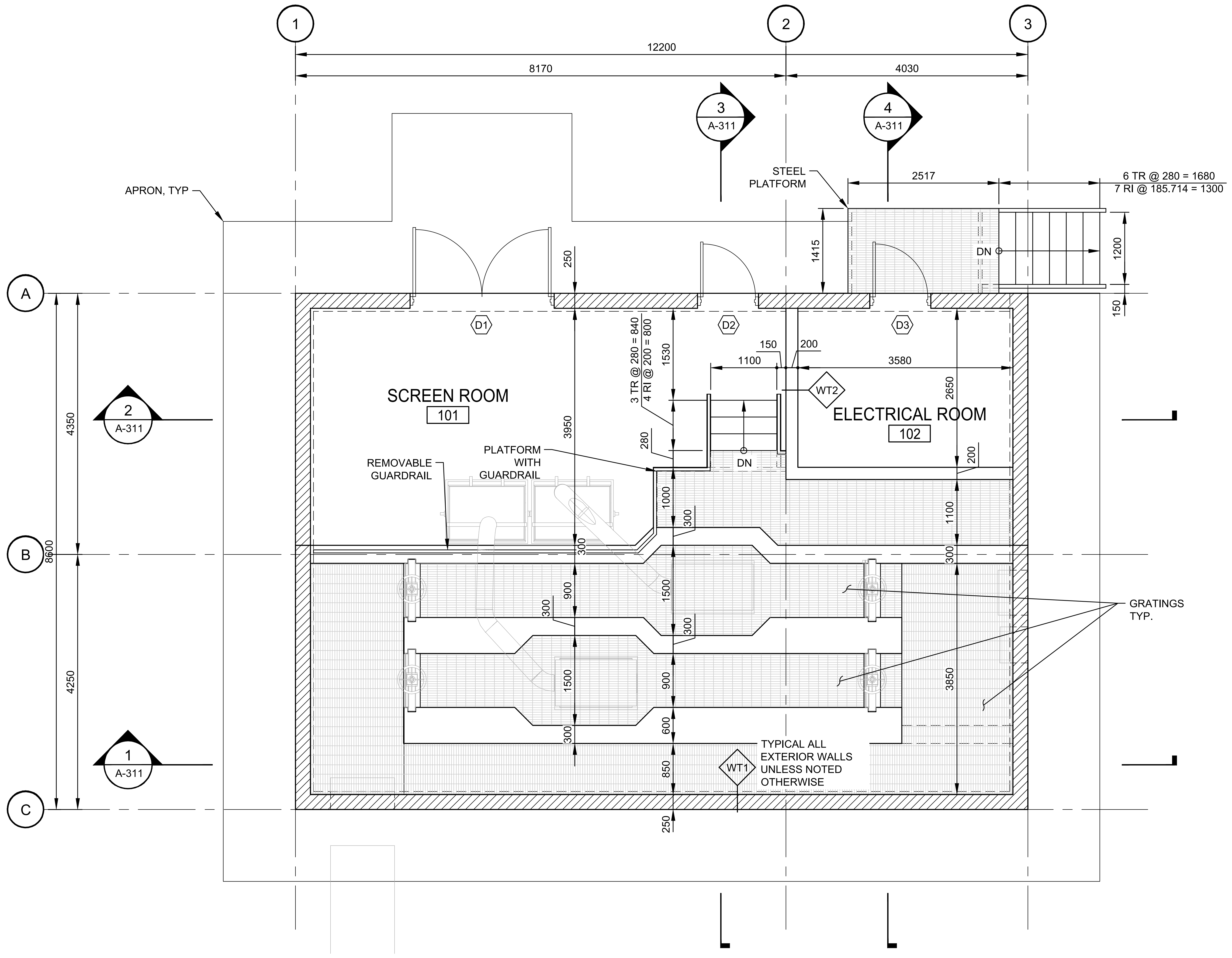

PLAN 1:50
FLOOR

WALL TYPES LEGEND

WT1
EXTERIOR WALL
-240 CONCRETE MASONRY UNIT
-METAL Z-GIRTS (20 Ga.)
-50 RIGID INSULATION (R12)
-VAPOR BARRIER (BLUESKIN PEEL & STICK)
-19 PLY SHEATHING & 12 GYPSUM

WT2
INTERIOR WALL
-190 CONCRETE MASONRY UNIT, SMOOTH FACE

FLOOR TYPES LEGEND

FT1
-CONCRETE FLOOR STRUCTURE

ROOF TYPES LEGEND

RT1
-SBS CAP SHEET AND BASE SHEET
BY SOPREMA OR APPROVED EQUAL
-12mm OVERLAY BOARD
-100 RIGID INSULATION (R20)
-VAPOR BARRIER
-300 CONCRETE ROOF SLAB

PARAPET TYPES LEGEND

PT1
-PRE-FINISHED METAL CLADDING FASCIA
-51 RIGID INSULATION (R12)
-VAPOR BARRIER
-190 MASONRY BLOCK
(SMOOTH FACE)
-51 RIGID INSULATION (R12)
-VAPOR BARRIER
-16 PRESSURE TREATED PLYWOOD
-SBS ROOFING SYSTEM

PT2
-SBS ROOFING SYSTEM
-16 PRESSURE TREATED PLYWOOD
-51 RIGID INSULATION (R12)
-VAPOR BARRIER
-190 MASONRY BLOCK (SMOOTH FACE)
-100 RIGID INSULATION (PLUG)
-190 MASONRY BLOCK (SMOOTH FACE)
-VAPOR BARRIER
-51 RIGID INSULATION (R12)
-16 PRESSURE TREATED PLYWOOD
-SBS ROOFING SYSTEM

NOTE:
ALL SBS ROOFING TO BE INSTALLED TO RCABC SPECIFICATION FOR A 5 YEAR WARRANTY.

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DATE: 2017-12-06, Jhunn Dualan

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NOT FOR CONSTRUCTION
DRAFT

REV	DATE	DESIGN	DRAWN	DESCRIPTION
A	2017DECXX	J. COPE	H. DUALAN JR	ISSUED FOR XXXXXX

CITY OF PORT ALBERNI

WASTEWATER LAGOON
EXPANSION UPGRADES

20172972-00

SCALE: AS SHOWN

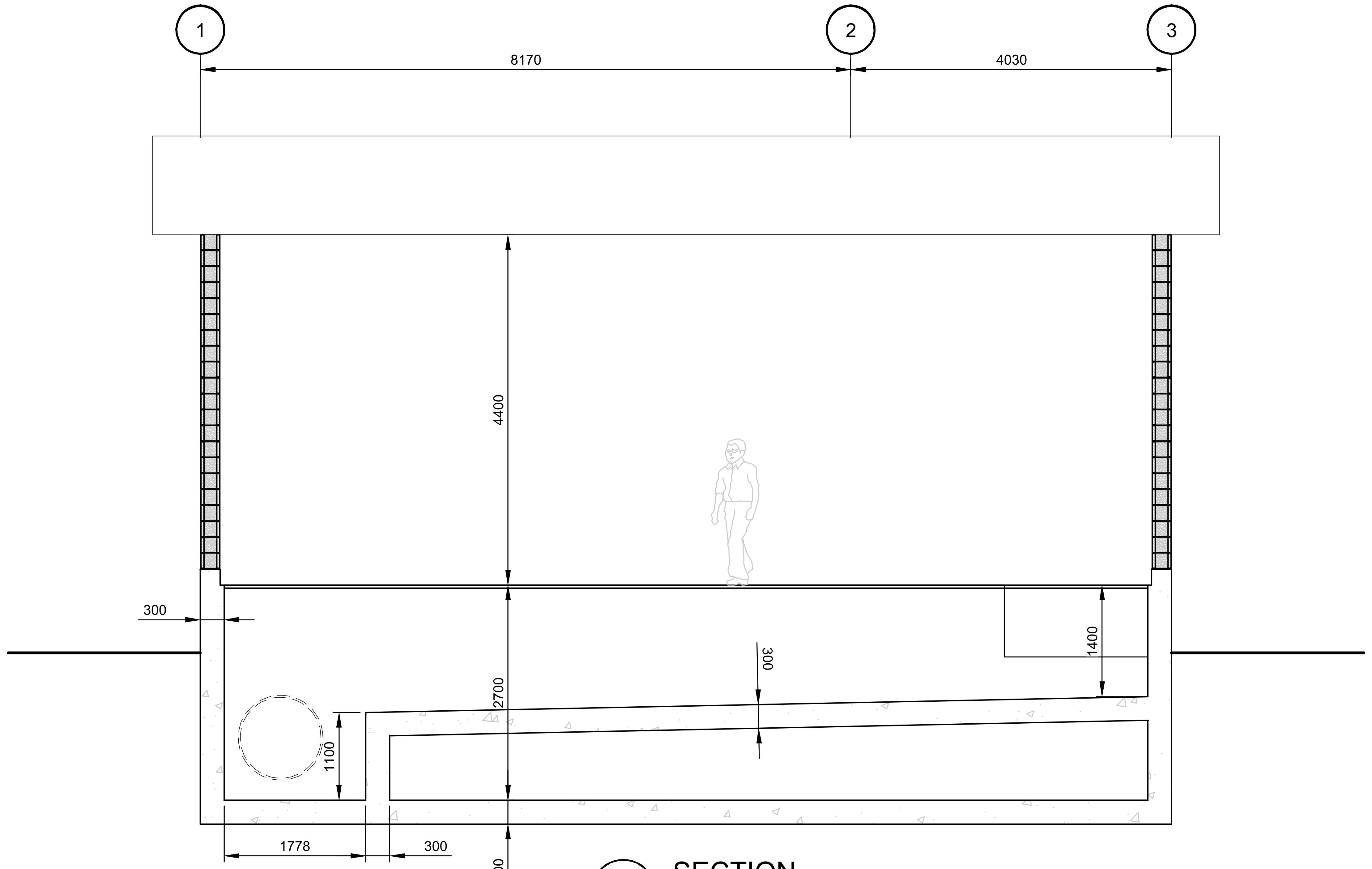
THE CITY OF
Port Alberni
ARCHITECTURAL

SCREEN BUILDING - FLOOR PLAN

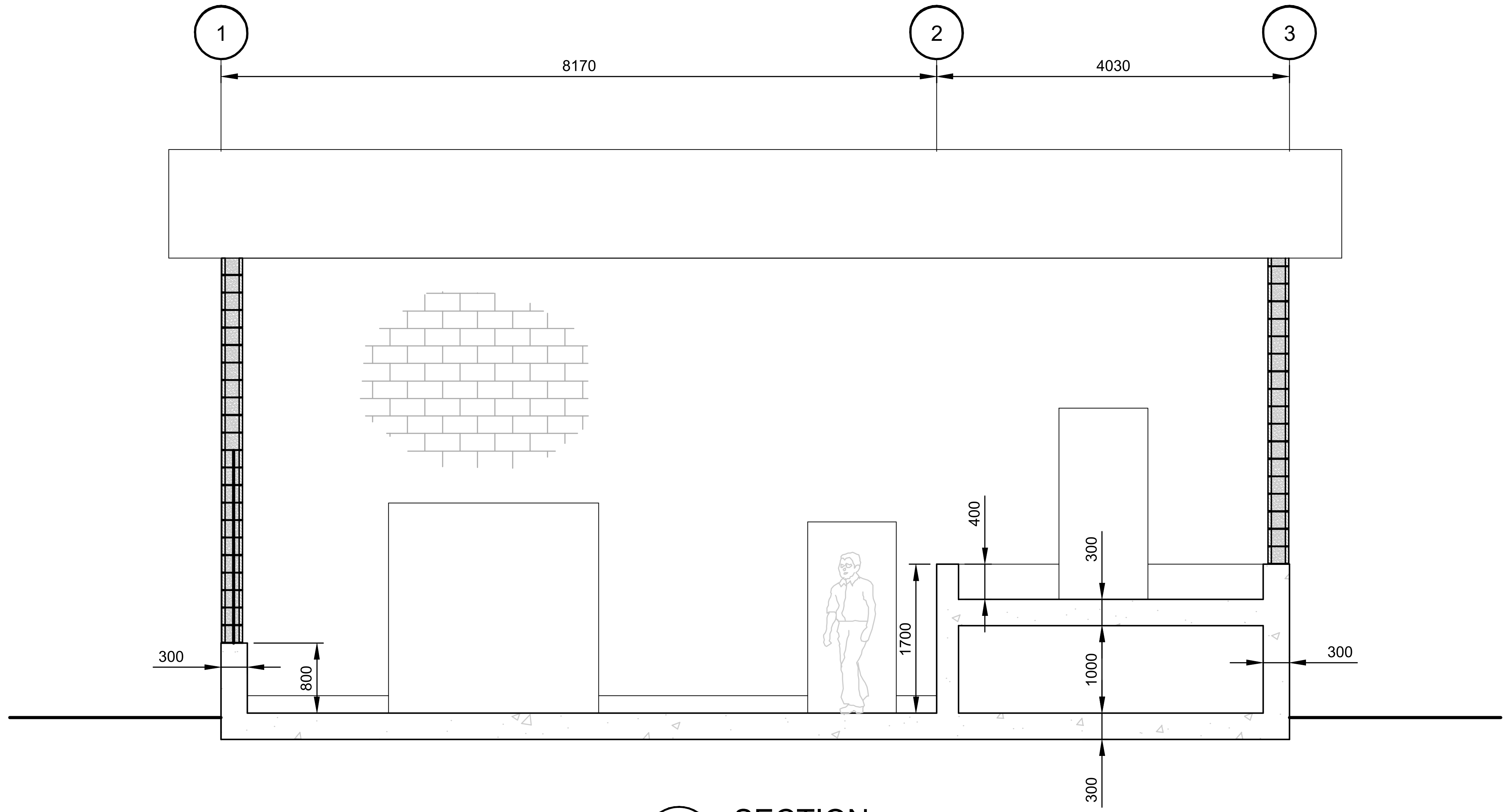
DRAWING	REVISION	SHEET
2972-00-A-111	A	----/

IF NOT 50 mm ADJUST SCALES
50 mm

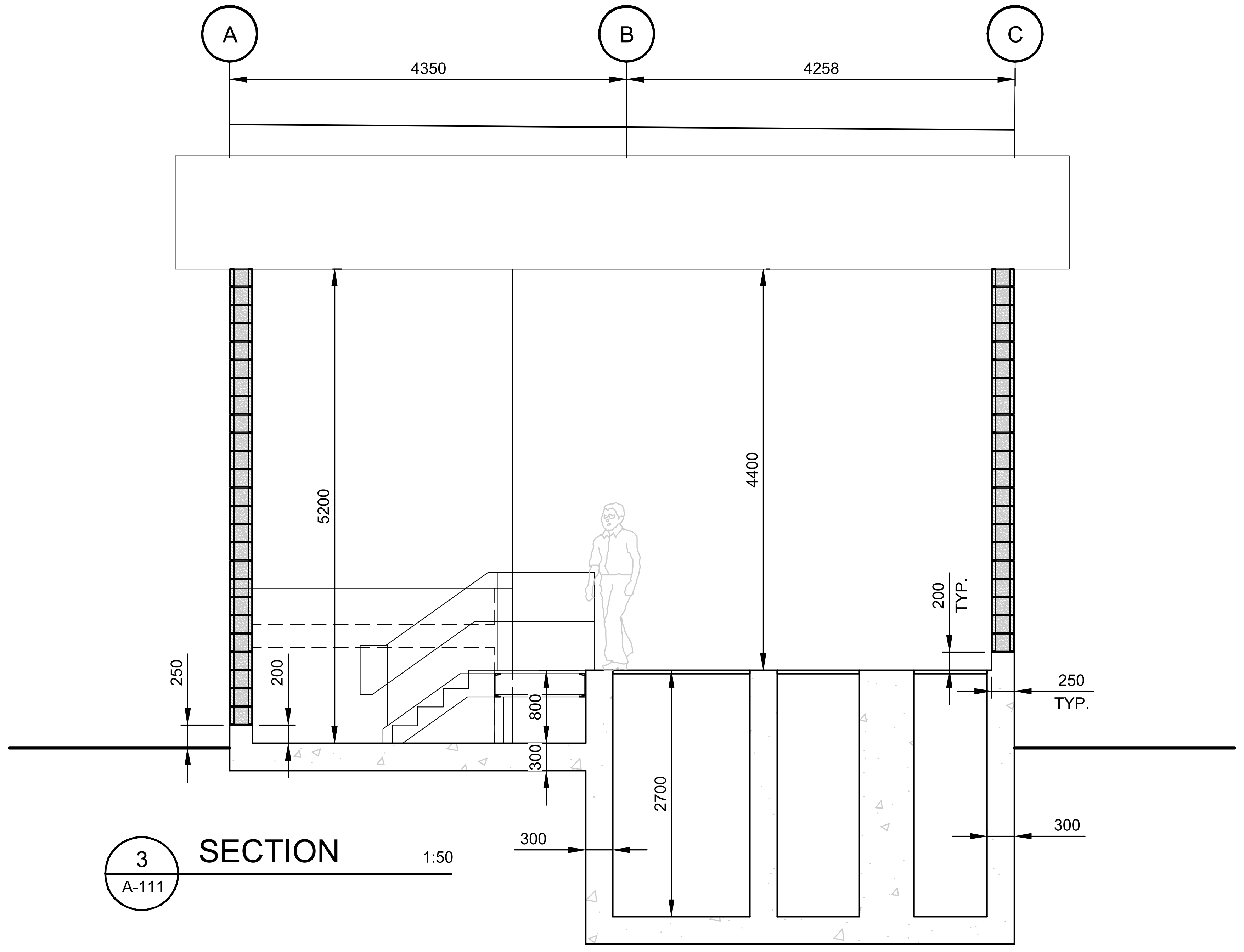
SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS, TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE



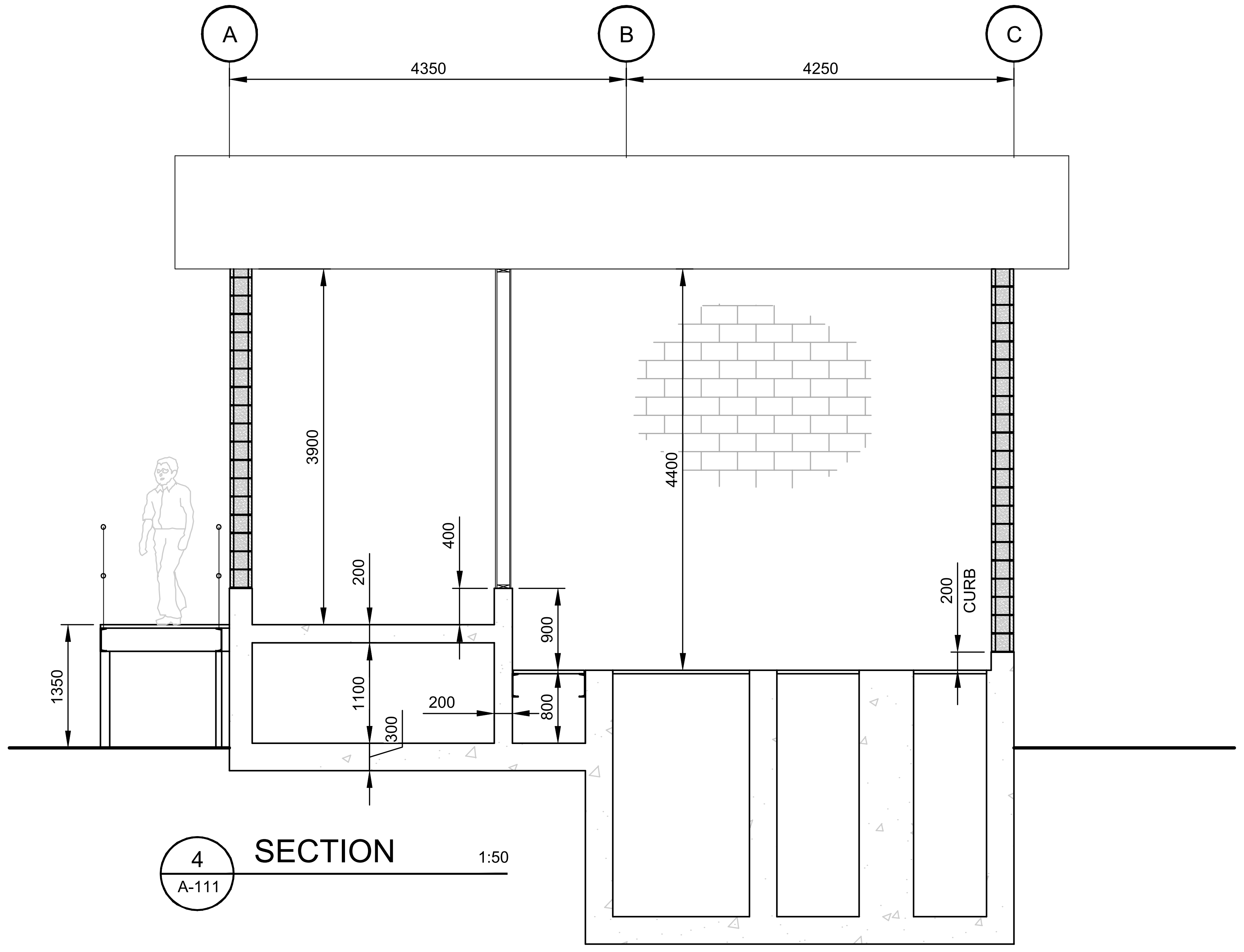
1 A-111 SECTION 1:50



2 A-111 SECTION 1:50



3 A-111 SECTION 1:50



4 A-111 SECTION 1:50

P:\20172972\00_WstWtr_Trtmnt_Upg\Working_Dwgs\200_Architectural\2972-00-a-311.dwg
DATE: 2017-12-06, Jhunn Dualan

Associated Engineering
CANADA'S BEST MANAGED COMPANIES Platinum member

PRELIMINARY/
FOR DISCUSSION
NOT FOR CONSTRUCTION
DRAFT

REV	DATE	DESIGN	DRAWN	DESCRIPTION
X	YYYYMMMDD	E. ENGINEER	D. DRAFTER	ISSUED FOR XXXXXX

CITY OF PORT ALBERNI

WASTEWATER LAGOON
EXPANSION UPGRADES

20172972-00

SCALE: AS SHOWN

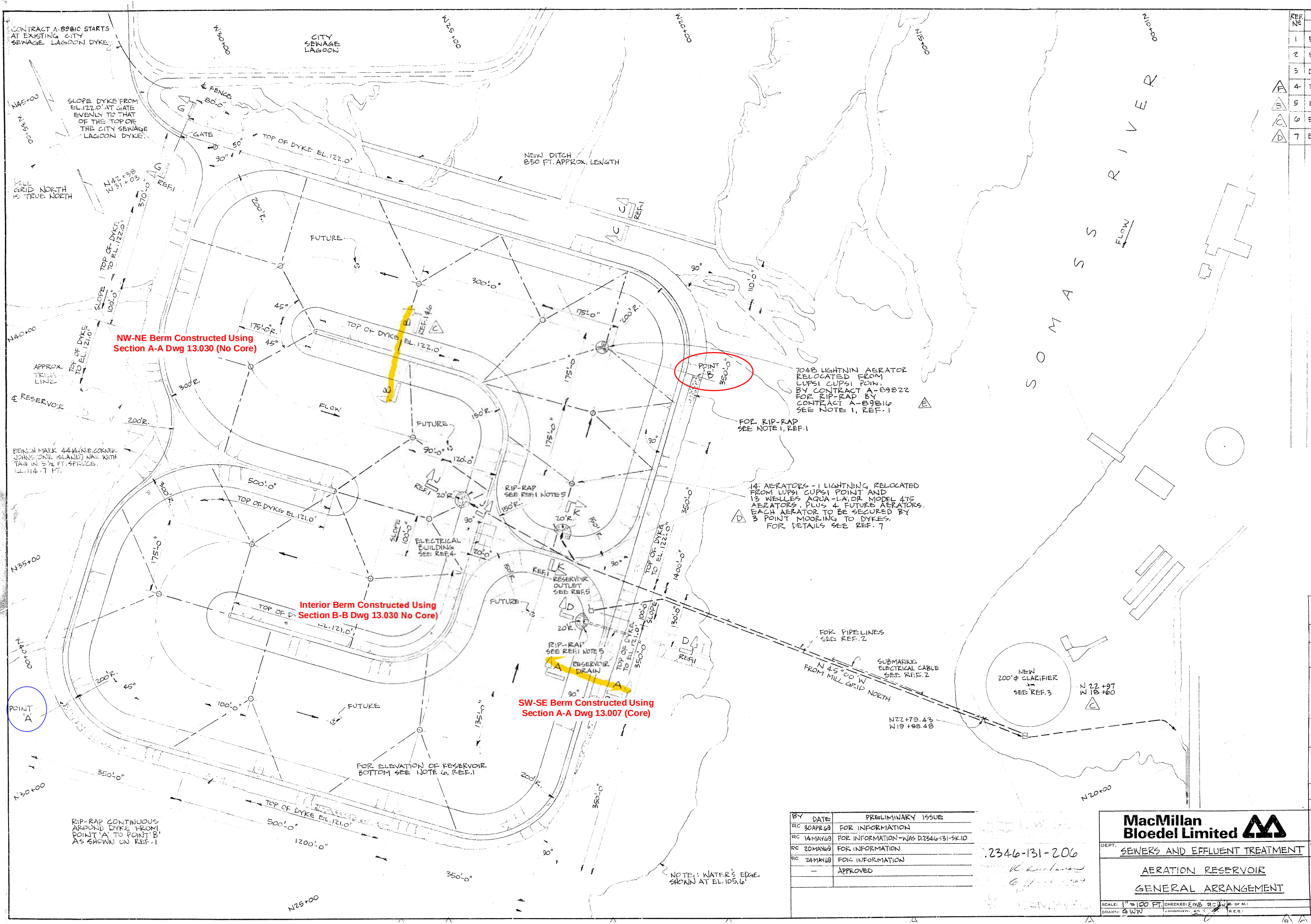
THE CITY OF
Port Alberni
ARCHITECTURAL

SCREEN BUILDING - SECTIONS

DRAWING	REVISION	SHEET
2972-00-A-311	X	---- /

APPENDIX

2. AS-BUILT SECTIONS OF EXISTING BERM



	REF. №	REFERENCES NO.	DESCRIPTION
	1	E-13,007	AERATION RESERVOIR SECTIONS AND DETAILS
	2	E-13,025	EFFLUENT RIVER CROSSING PIPELINE PROFILE & DETAILS
	3	E-13,021	200' ⌀ CLARIFIER LAYOUT AND DETAILS
F	4	E-13,032	AERATOR ELECT BLDG. ARRANGEMENT & DETAILS
B	5	E-13,031	AERATION RESERVOIR OUTFALL [illegible] & DETAILS
C	6	E-13,030	AERATION RESERVOIR ALTERNATE SECTIONS
D	7	E-13,033	AERATION RESERVOIR AERATOR ANCHOR & ELECT. DUCTS

NO.	BY DATE	REVISION	APP'D
F	GWW 17FEB70	CORRECTED REF. 4 ISSUED FOR CONTRACT A-89822	
E	GWW 4DEC.69	AERATOR MOORINGS ADDED.	
D	GKW 6NOV.69	LOCATED AERATORS ADDED SECTION K-K AND REF.7	RC
C	W.E.J 6OCT'69	ISSUED FOR REF. ONLY FOR CONTRACT A-89817. CLARIFIER CO-ORDINATES REVISED. REF. 6 ADDED.	
B	U. [illegible] 18.9-69	ISSUED AS REF-ERENCE FOR TENDER 89817. REF 5 CORRECTED.	RC
A	GWW 4JULY69	ISSUED FOR CONTRACT A89816 AND FOR REFERENCE ONLY CONTRACT A89810	RO
–	4JUNE'69	ISSUED FOR TENDER A-89810	

BY	DATE	PRELIMINARY ISSUE
RC	30APR69	FOR INFORMATION
RC	14MAY69	FOR INFORMATION - WAS D.2346-131-SK.10
RC	20MAY69	FOR INFORMATION
RC	24MAY69	FOR INFORMATION
	–	APPROVED

.2346-131-206

R. Buchanan
6 June 1969

MacMillan Bloedel Limited

ALBERNI PULP AND PAPER DIVISION

DEPT. SEWERS AND EFFLUENT TREATMENT

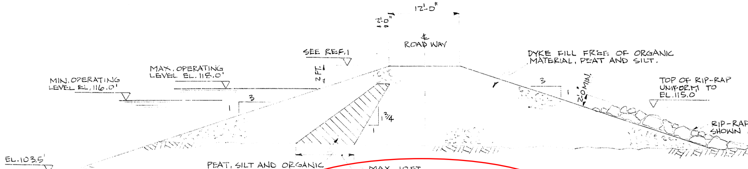
AERATION RESERVOIR
GENERAL ARRANGEMENT

DATE:

FILE: 7003 7082 7085

SCALE: 1" = 100 FT.
CHECKED: EmB RC
B. OF M.:
DRAWN: GWW
APPROVED:
P.E.S.:

DWG.: E-13,006
REV. F



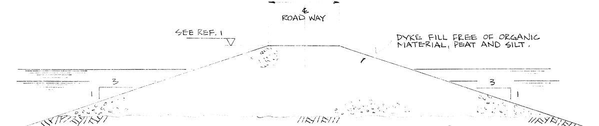
THIS SECTION USED FOR SW & SE DYKES (H)

A - A REF.1

TYPICAL ENCLOSING DYKE

SCALE: 1/8"=1'-0"

(FOR ALTERNATES TO THIS SECTION SEE REF.5) (C)



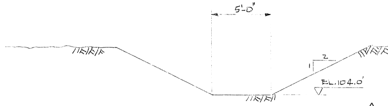
THIS SECTION NOT USED SEE REF.5 (H)

B - B REF.1

TYPICAL INNER DYKE

SCALE: 1/8"=1'-0"

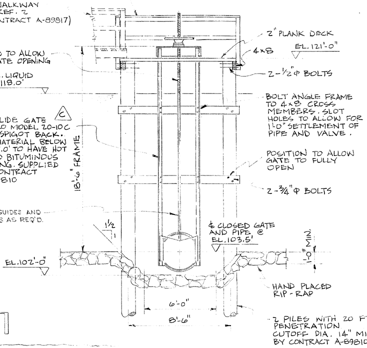
(FOR ALTERNATE TO THIS SECTION SEE REF.5) (C)



C - C

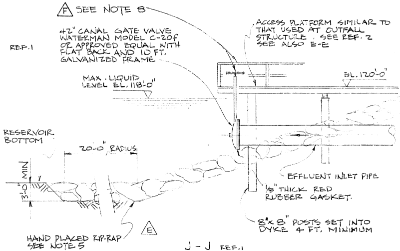
DRAINAGE DITCH REF.1

SCALE: 1/4"=1'-0"



E E REF.1

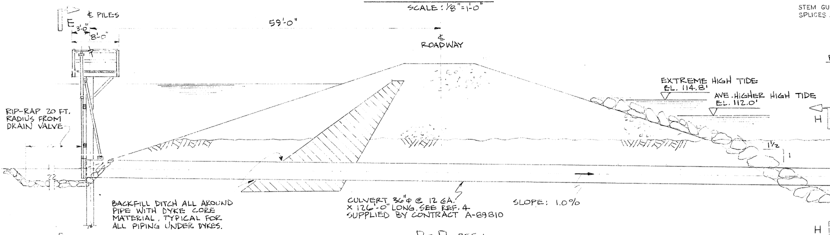
SCALE: 1/4"=1'-0"



J - J REF.1

SCALE: 1/8"=1'-0"

K - K (SIMILAR EXCEPT WITHOUT VALVE AND ACCESS PLATFORM)



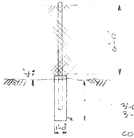
D - D REF.1

RESERVOIR DRAIN

SCALE: 1/8"=1'-0"

H - H

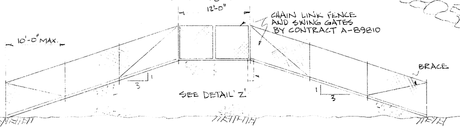
END OF CULVERT TO HAVE 4-¾"Φ RODS WELDED TO END BEFORE COATING, TO PREVENT ENTRY OF DRIFT LOGS.



3'-6" FOR GATE AND TERMINAL POSTS
3'-0" FOR OTHER POSTS

CONCRETE FOOTINGS SQUARE OR ROUND BY CONTRACT A-89810

DETAIL 'Z'



G - G REF.1

ACCESS GATE AND FENCE

{ THIS GATE NOT INSTALLED SIMILAR GATE INSTALLED AT ENTRANCE TO PIPELINE ROAD } (H)

REF. Nº	REFERENCES NO.	DESCRIPTION
1	E-13,006	AERATION RESERVOIR GENERAL ARRANGEMENT
(B) 2	E-13,031	AERATION RESERVOIR OUTFALL ARRGT & DETAILS
3	A-13,086	STRUCT. STDS FIXED HANDRAILS
4	E-13,025	EFFLUENT RIVER CROSSING PIPELINE PROFILE & DETAILS
(C) 5	E-13,030	AERATION RESERVOIR ALTERNATE SECTIONS

NOTES

1. (F) PLACE A 60 FT. DIA. CIRCLE OF RIP-RAP WITH 1 FT. MIN. THK'NESS, UNDER THE LIGHTNIN AERATOR 7048 WITH A SURFACE TO WITHIN PLUS OR MINUS SIX INCHES OF THE RESERVOIR BOTTOM.
2. PILES TO BE CREOSOTED FIR, 16 LB/CU.FT. FULL CELL TREATMENT. ALL OTHER TIMBER BELOW EL. 120' TO BE GIVEN 2 BRUSH COATS CREOSOTE OIL.
3. ALL FASTENINGS TO BE GALVANIZED STEEL.
4. ASBESTOS BONDED AND COATED ARMCO CORRUGATED STEEL PIPE WITH WATER TIGHT COUPLERS, BY CONTRACT A-89816.
5. FOR RESERVOIR INLETS AND OUTLETS RIP-RAP SHALL BE HAND PLACED WITH FLAT SURFACES FORMING THE SIDES AND BOTTOM TO WITHIN PLUS OR MINUS TWO INCHES OF THE SURFACES SPECIFIED ON THE DRAWING AND WITH ALL JOINTS KEYED WITH SMALL STONES.
6. ENTIRE RESERVOIR BOTTOM TO BE EXCAVATED TO EL. 103.5'
7. PLATFORM AND HANDRAILS TO BE FROM CONSTRUCTION GRADE FIR.
8. (F) CONTRACT A.89822 TO INSTALL OWNER'S 42" VALVE SHOWN IN SECTION J-J. PLATFORM BY OTHERS.

NO.	BY. DATE	REVISION	APP'D.
H	MID 14 JAN.71	GENERAL REVISION AS BUILT	
G	GWW 17FEB70	ISSUED FOR CONTRACT A-89822	HR
F	GWW 4DEC69	NOTE 8 ADDED NOTE 1 REVISED WAS 18 AERATORS	
E	GWW 7NOV69	VALVE & PLATFORM ADDED TO SECTION J-J	RC
D	W.E.J 6OCT'69	ISSUED FOR REF. ONLY FOR CONTRACT A-89817	HR
C	GWW 19-9-69	DRAIN VALVE WAS MODEL 101C. REF. 5 ADDED	RC
B	U. S-BO 18.8-69	ISSUED AS REFERENCE FOR TENDER A-89817 REF 2 ADDED	RC
A	GWW 4JULY69	ISSUED FOR CONTRACT A-89816	RB HR
	4JUNE'69	ISSUED FOR TENDER A-89810	

BY	DATE	PRELIMINARY ISSUE
RC	20MAY69	FOR INFORMATION
RC	24-MAY69	FOR INFORMATION
	—	APPROVED

T. W. BEAK

.2346-131-207
K. Buchanan
6 June 1969

BANDWELL

MacMillan Bloedel Limited

ALBERNI PULP AND PAPER DIVISION

DEPT. SEWERS AND EFFLUENT TREATMENT

DATE:

AERATION RESERVOIR
SECTIONS AND DETAILS

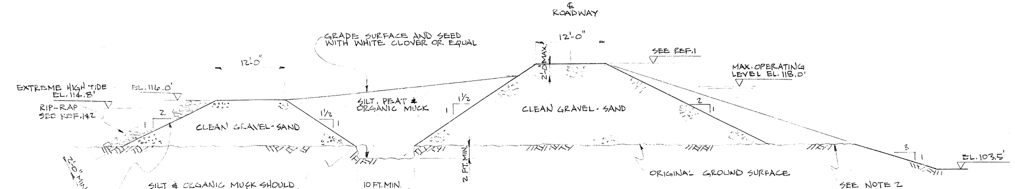
FILE: 7003 7082 7085

SCALE: AS NOTED
DRAWN: GWW
CHECKED: EMB. RC
APPROVED:
B. OF M.:
R.E.S.:

DWG.: E-13,007

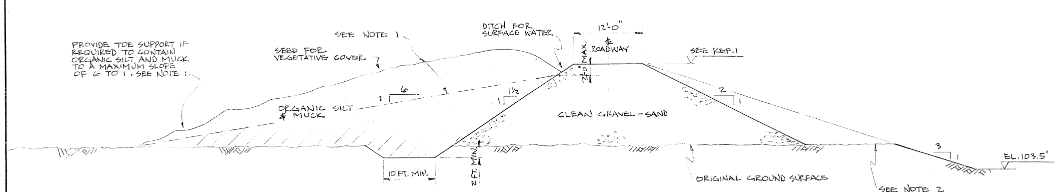
REV. H

REF. NO.	DWG.NO.	DESCRIPTION
1	E-13,006	AERATION RESERVOIR GEN. ARRANGEMENT
2	E-13,007	AERATION RESERVOIR SECTIONS & DETAILS

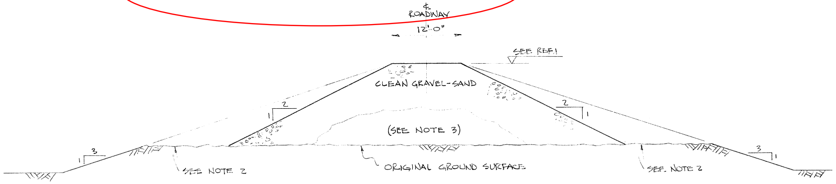


THIS SECTION NOT USED

ALTERNATE № I TO SECTION A-A REF.2
FOR S.W. AND S.E. OUTSIDE DYKES



ALTERNATE № II TO SECTION A-A REF.2
FOR N.W. AND N.E. OUTSIDE DYKES



ALTERNATE TO SECTION B-B REFS. 1&2
TYPICAL INNER DYKE

NOTES:

1. FOR THE N.W. AND N.E. OUTSIDE DYKES THE GRAVEL TOE SUPPORT IS NOT REQUIRED IF SUFFICIENT ORGANIC MUCK IS PLACED SUCH THAT THE VOLUME OF MUCK IS GREATER THAN THAT UNDER A LINE PROJECTED DOWN FROM A POINT TWO FEET BELOW THE TOP OF THE DYKE AT 1 VERTICAL ON 6 HORIZONTAL. IF THE VOLUME IS LESS THAN THE ABOVE MINIMUM LIMIT THEN A TOE SUPPORT WILL BE REQUIRED TO CONTAIN THE ORGANIC MUCK AT A SLOPE NO STEEPER THAN 1:6.

2. THE UNDISTURBED ORIGINAL GROUND SURFACE SHALL BE LEFT AS SHOWN IN SECTIONS AT EACH INSIDE DYKE TOE. ALL VEGETATION SHALL BE REMOVED BUT SOD SHALL BE UNDISTURBED.

3. SOME SILTY GRAVEL-SAND MAY BE USED IN CONSTRUCTION OF THE INNER DYKES PROVIDED THAT THESE DYKES WILL WITHSTAND THE TRAFFIC OF CONSTRUCTION EQUIPMENT WITHOUT DAMAGE.

4. WHERE DYKE SECTION CHANGES FROM "SECTION A-A" ON REF.1 TO "ALTERNATE SECTION A-A" SHOWN ON THIS DRAWING, THE IMPERVIOUS CORES MUST CONTACT EACH OTHER AND FORM A CONTINUOUS WATER STOP AROUND THE PERIMETER OF THE RESERVOIR. WHERE THIS IMPERVIOUS CORE PASSES UNDER THE ROADWAY, IT SHALL BE MADE OF SELECT SILTY SAND AND GRAVEL WITH CROSS SECTION AS SHOWN BY "SECTION A-A" REF. 1.

NO.	DATE	REVISION	BY
–	GWW 19SEPT69	ISSUED FOR CONTRACT A-83816	RC

BY	DATE	PRELIMINARY ISSUE
RC	12·9·69	FOR COMMENTS AND APPROVAL
	–	APPROVED FOR CONSTRUCTION

T. W. BEAK
D.2346-131-230
R. Buchanan
19 September 1969
SANDWELL

MacMillan Bloedel Limited

ALBERNI PULP AND PAPER DIVISION

DEPT. SEWERS AND EFFLUENT TREATMENT

AERATION RESERVOIR
ALTERNATE SECTIONS

DATE:
FILE: 7003 7013 7082

SCALE: 1/8" = 1'-0"
DRAWN: GWW
CHECKED: RKC
APPROVED:
B. OF M.:
R.E.S.:
DWG.: E-13,030
REV.:

APPENDIX

3. BOREHOLE LOGS & GRADATION ANALYSES REPORTS

WSP Canada Inc.
1935 Bollinger Road
Nanaimo, B.C. V9S 5W9
Tel: +1 250-753-1077
Fax: +1 250-753-1203
www.wsp.com

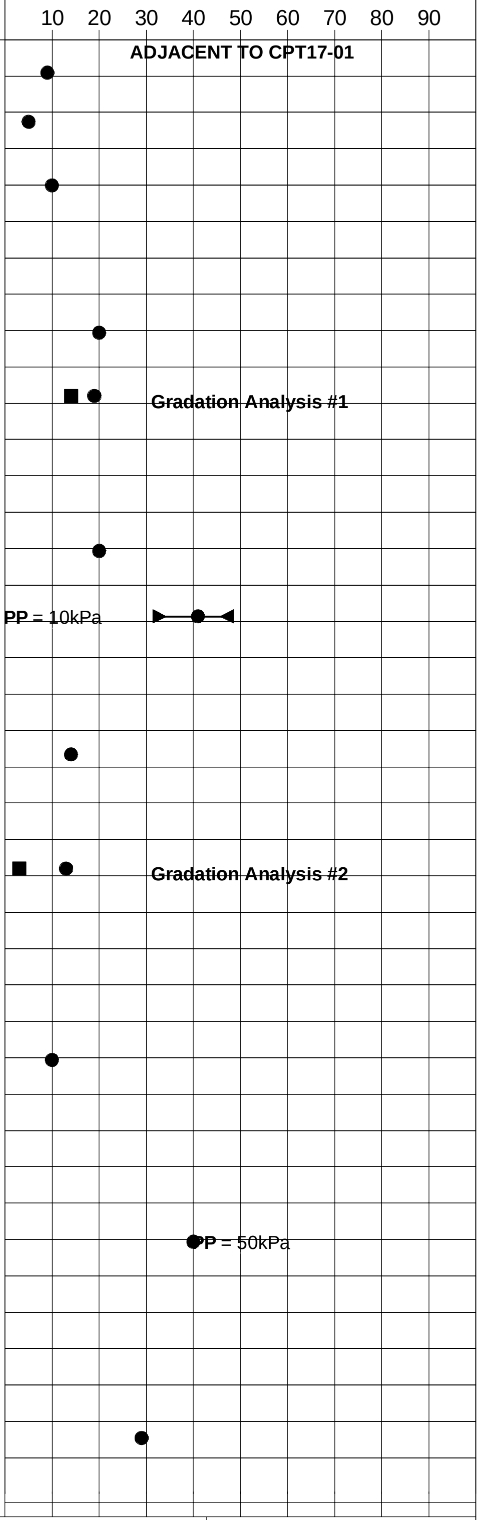
Port Alberni WWTP Upgrade
Geotechnical Assessment

BH17-01

Pg 1 of 2
Project No: 171-04753-00

Depth (m): 2, 4, 6, 8, 10, 12, 14, 16, 18
Depth (ft): 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65

Description	N	Type/ Sample #	Water Level
compact, brown SAND AND GRAVEL (FILL), some fines, poorly graded, max particle size observed = 80 mm, moist, cobbles.	25	SPT1	
		G1	
	10	SPT2	P1 Apr 20 2017
		RS1	
loose to compact, grey SAND, some gravel, some fines, poorly graded, max particle = 20 mm, moist. - interbedded with silt layers lenses to 5.8 m depth		G2	
		RS2	
- below 5.8 m trace to some fines		G3	
very soft to soft, grey SILT, some sand, low plasticity, moist, shells.		G4	
		RS3	
loose to compact, grey, gravelly SAND, trace fines, coarse grained sand, poorly graded, max particle size observed = 10 mm, wet, heaving.		G5	
		RS4	
		G6	
loose/soft, silty SAND/sandy SILT, trace gravel, low plasticity, moist to wet, shells, wood debris, organics, poorly graded, fine grained sand.		G7	
loose to compact, grey SAND, trace fines, trace gravel, poorly graded, coarse grained sand, wet.			
loose, grey, SAND AND SILT, trace gravel, poorly graded, trace organics, shells.		G8	



Continued on Pg 2 of 2

C: Condition of Sample
- Good ▇
- Disturbed ▥
- No Recovery ☐

Type: Type of Sampler
- SPT : 2 in. standard
- ST : Shelby
- G : Grab
- CORE

N: Number of Blows
- WH : Weight of Hammer
- WR : Weight of Rod
- Standard Penetration Test : ASTM D1586
- Hammer Type:

DCPT Blow/300 mm

Plastic Limit (%) ▶—●—◀ Liquid Limit (%)
Moisture Content (%)
- ▼ Ground Water Level
- (X) Shear strength in kPa (Torvane)
- PP Pocket Penetrometer (compressive strength in kPa)
- X Shear strength in kPa (Unconfined)
- ⊗ Shear strength in kPa (Field vane)
- ⊠ Remolded strength in kPa
- ■ Percent Passing # 200 sieve

Bentonite/Grout Plug
Solid Pipe
Cuttings
Slotted Pipe
Sand/Pea-Gravel

Drill Method: Sonic
Date Drilled: 18/04/2017
Logged by: LM
Checked by: DF

SOIL CLASSIFICATION IN ACCORDANCE WITH THE CANADIAN FOUNDATION ENGINEERING MANUAL 4TH EDITION 2006.

THIS LOG IS FOR GEOTECHNICAL PURPOSES ONLY
THIS LOG IS THE SOLE PROPERTY OF WSP CANADA INC. AND CANNOT BE USED OR DUPLICATED IN ANY WAY WITHOUT EXPRESS WRITTEN PERMISSION.

WSP Canada Inc.
1935 Bollinger Road
Nanaimo, B.C. V9S 5W9
Tel: +1 250-753-1077
Fax: +1 250-753-1203
www.wsp.com

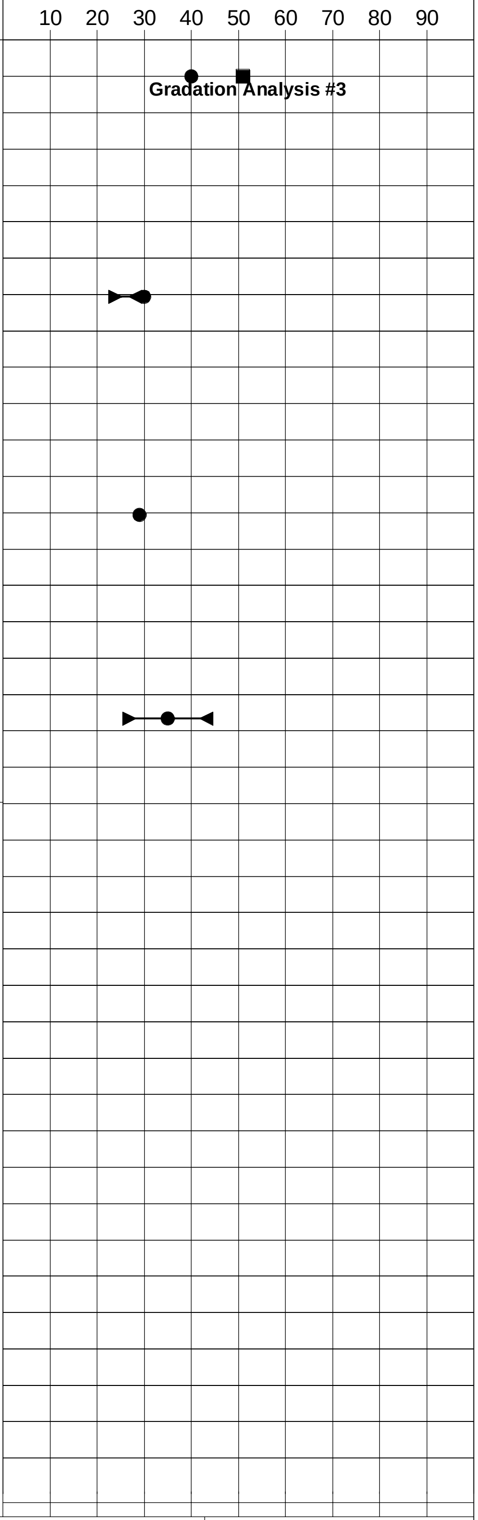
Port Alberni WWTP Upgrade
Geotechnical Assessment

BH17-01

Pg 2 of 2
Project No: 171-04753-00

Depth (m)	Depth (ft)	Description	Well 1	C	N	Type/ Sample #	Water Level
		loose, grey, SAND AND SILT, trace gravel, poorly graded, trace organics, shells. *(continued)*					
22		sandy SILT, intermediate plasticity below 22 m.					
						G9	
						G10	
		CLAY and SILT, some sand below 29 m				G11	
30.5	100	Free water in hole at 1.8 m depth at end of drilling. Hole sloughing upon completion. Bottom of hole at 30.5 meters					

Depth scale (m): 22, 24, 26, 28, 30, 32, 34, 36, 38
Depth scale (ft): 70, 75, 80, 85, 90, 95, 100, 105, 110, 115, 120, 125, 130



C: Condition of Sample
Good ▬
Disturbed ▥
No Recovery ☐

Type: Type of Sampler
SPT : 2 in. standard
ST : Shelby
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

DCPT Blow/300 mm

SOIL CLASSIFICATION IN ACCORDANCE WITH THE CANADIAN FOUNDATION ENGINEERING MANUAL 4TH EDITION 2006.

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Plastic Limit (%) ▶——●——◀ Liquid Limit (%)
Moisture Content (%)
▼ Ground Water Level
(X) Shear strength in kPa (Torvane)
PP Pocket Penetrometer (compressive strength in kPa)
X Shear strength in kPa (Unconfined)
⊗ Shear strength in kPa (Field vane)
⊠ Remolded strength in kPa
■ Percent Passing # 200 sieve

Bentonite/Grout Plug
Solid Pipe
Cuttings
Slotted Pipe
Sand/Pea-Gravel

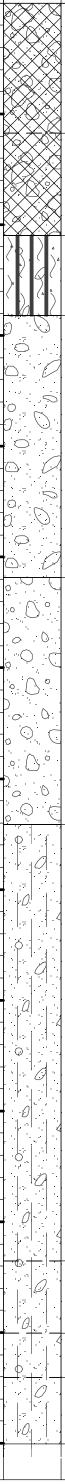
Drill Method: Sonic
Date Drilled: 18/04/2017
Logged by: LM
Checked by: DF

WSP Canada Inc.
1935 Bollinger Road
Nanaimo, B.C. V9S 5W9
Tel: +1 250-753-1077
Fax: +1 250-753-1203
www.wsp.com

Port Alberni WWTP Upgrade
Geotechnical Assessment

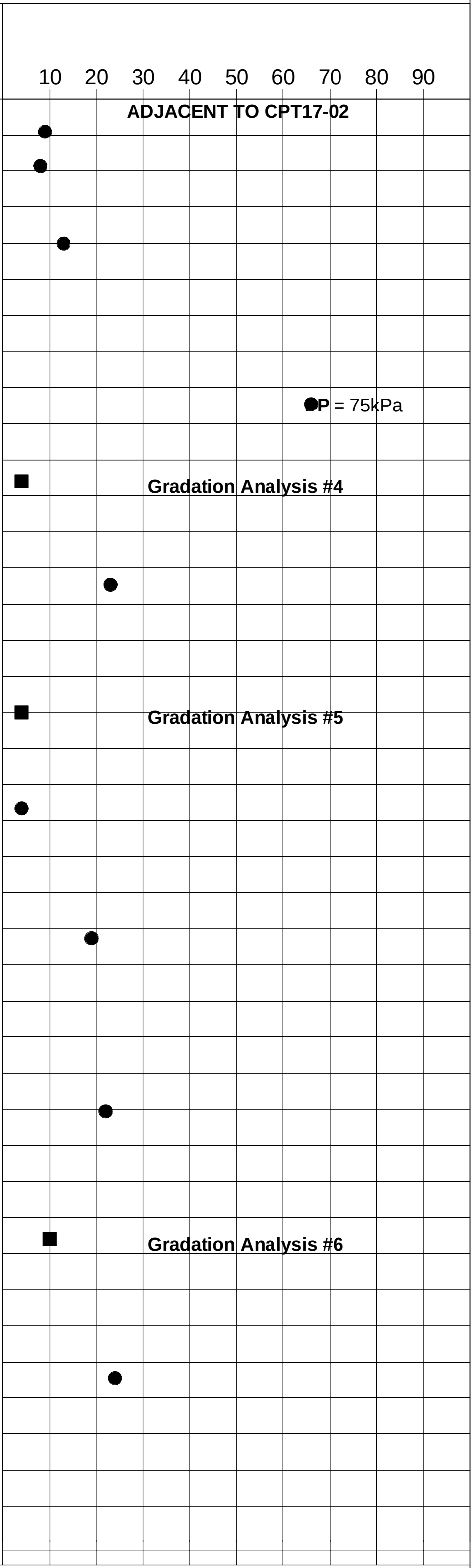
BH17-02

Project No: 171-04753-00



Description	N	Type/ Sample #
compact, brown SAND AND GRAVEL (FILL), some fines, poorly graded, max particle size observed = 80 mm, moist, cobbles.	19	SPT1
		G1
- below 1.8 m wet -below 2.1 m, grey	11	SPT2
		RS1
firm, brown SILT, some sand, trace gravel, low plasticity, moist, organics.		G2
loose, grey, gravelly SAND, trace fines, poorly graded, coarse grained sand, max particle size observed = 30 mm, trace wood debris, wet, heaving.		RS2 G3
loose to compact, grey, sandy GRAVEL, trace fines, poorly graded, rounded, max particle size observed = 60 mm, wet, heaving.		RS3 G4
loose to compact, grey SAND, some fines, trace gravel, poorly graded, max particle size observed = 60 mm, wet, trace shells/wood debris.		G5 G6
- below 17.4 m some silt		G7
- fine grained gravel layer 18.3 to 18.9 m		

Depth (m): 2, 4, 6, 8, 10, 12, 14, 16, 18
Depth (ft): 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65



Continued on Pg 2 of 2

C: Condition of Sample
Good ▆
Disturbed ▥
No Recovery ☐

Type: Type of Sampler
SPT : 2 in. standard
ST : Shelby
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

DCPT Blow/300 mm

SOIL CLASSIFICATION IN ACCORDANCE WITH THE CANADIAN FOUNDATION ENGINEERING MANUAL 4TH EDITION 2006.

THIS LOG IS FOR GEOTECHNICAL PURPOSES ONLY
THIS LOG IS THE SOLE PROPERTY OF WSP CANADA INC. AND CANNOT BE USED OR DUPLICATED IN ANY WAY WITHOUT EXPRESS WRITTEN PERMISSION.

Plastic Limit (%) ▶—●—◀ Liquid Limit (%)
Moisture Content (%)
▼ Ground Water Level
(X) Shear strength in kPa (Torvane)
PP Pocket Penetrometer (compressive strength in kPa)
X Shear strength in kPa (Unconfined)
⊗ Shear strength in kPa (Field vane)
☒ Remolded strength in kPa
■ Percent Passing # 200 sieve

Bentonite/Grout Plug
Solid Pipe
Cuttings
Slotted Pipe
Sand/Pea-Gravel

Drill Method: Sonic
Date Drilled: 19/04/2017
Logged by: LM
Checked by: DF

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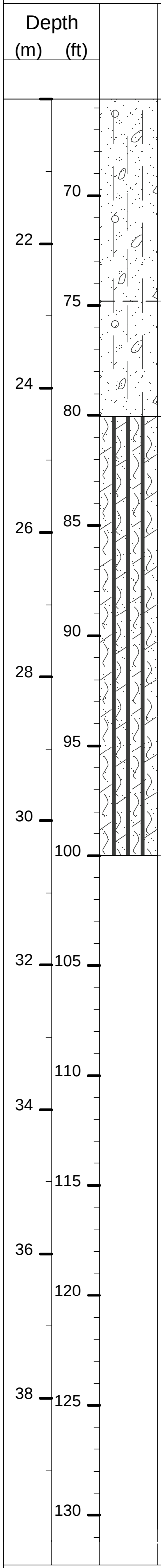
Nanaimo, B.C. V9S 5W9
Tel: +1 250-753-1077
Fax: +1 250-753-1203
www.wsp.com

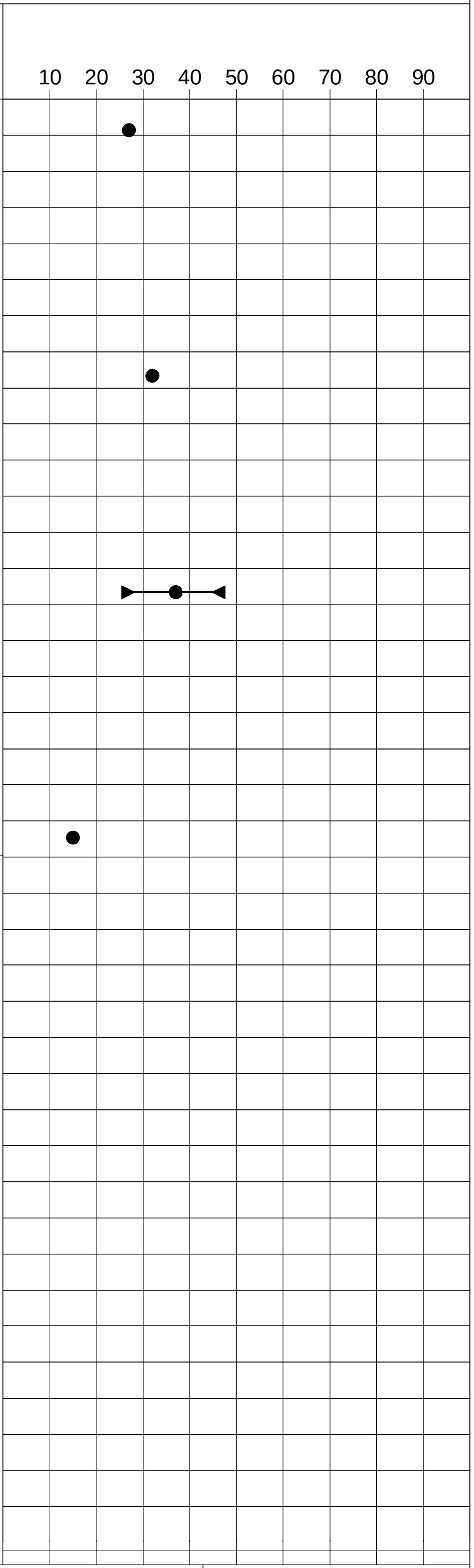
Port Alberni WWTP Upgrade
Geotechnical Assessment

BH17-02

Pg 2 of 2
Project No: 171-04753-00



Description	Closure 1	C	N	Type/ Sample #	Water Level
loose to compact, grey SAND, some fines, trace gravel, poorly graded, max particle size observed = 60 mm, wet, trace shells/wood debris. *(continued)*				G8	
- below 22.9 m silty				G9	
soft, grey CLAY and SILT, some sand to sandy, intermediate plasticity, moist to wet, shells, wood debris.				G10 G11	
Backfilled with grout upon completion. Free water at 1.8 m depth after drilling. Bottom of hole at 30.5 meters					



C: Condition of Sample
Good ▇
Disturbed ▥
No Recovery ☐

Type: Type of Sampler
SPT : 2 in. standard
ST : Shelby
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

DCPT Blow/300 mm

SOIL CLASSIFICATION IN ACCORDANCE WITH THE CANADIAN FOUNDATION ENGINEERING MANUAL 4TH EDITION 2006.

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Plastic Limit (%) Liquid Limit (%)
▶—●—◀
Moisture Content (%)
▼ Ground Water Level
(X) Shear strength in kPa (Torvane)
PP Pocket Penetrometer (compressive strength in kPa)
X Shear strength in kPa (Unconfined)
⊗ Shear strength in kPa (Field vane)
☒ Remolded strength in kPa
■ Percent Passing # 200 sieve

Bentonite/Grout Plug
Solid Pipe
Cuttings
Slotted Pipe
Sand/Pea-Gravel

Drill Method: Sonic
Date Drilled: 19/04/2017
Logged by: LM
Checked by: DF

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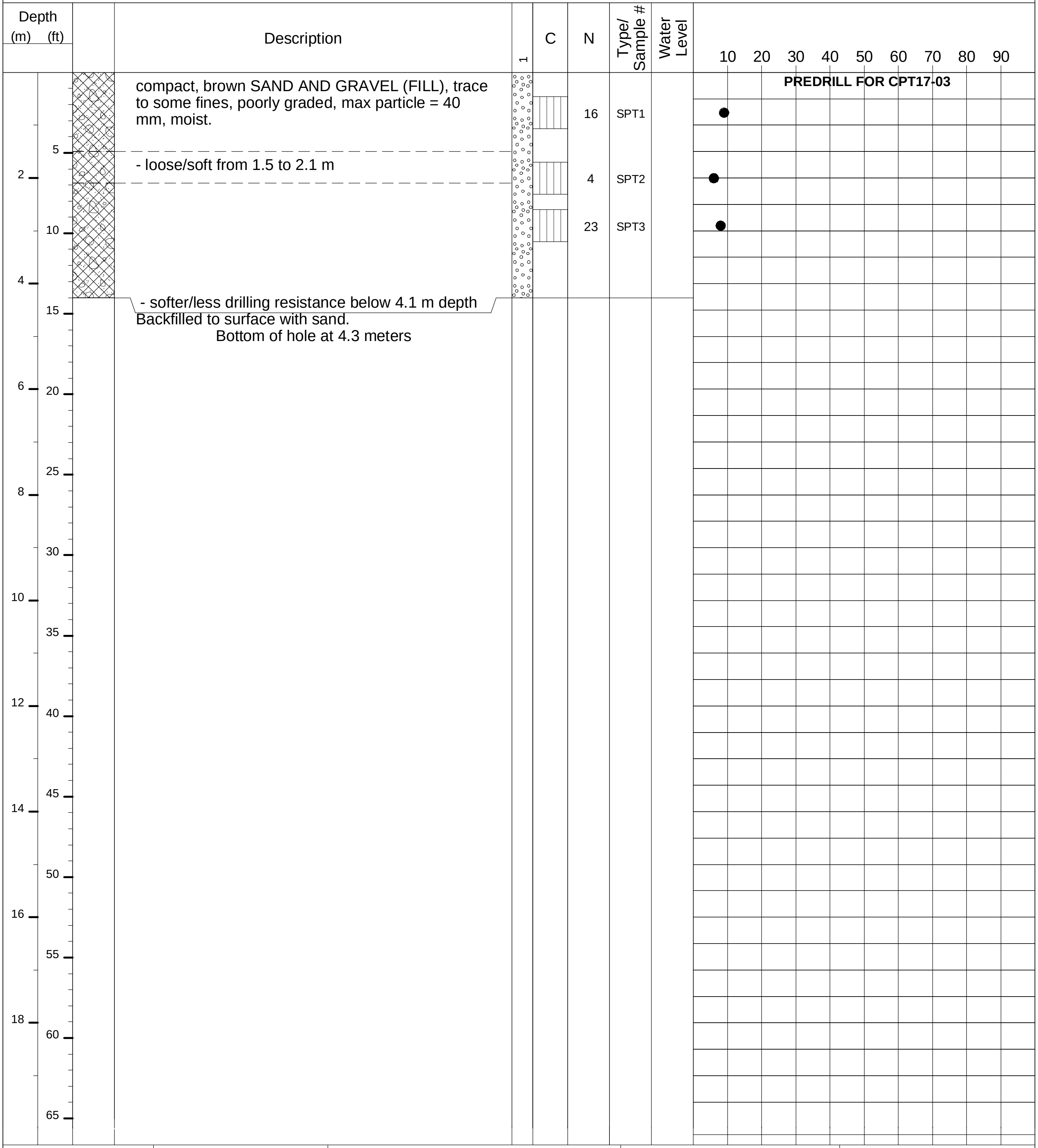
Port Alberni WWTP Upgrade
Geotechnical Assessment

BH17-03

Pg 1 of 1
Project No: 171-04753-00



compact, brown SAND AND GRAVEL (FILL), trace to some fines, poorly graded, max particle = 40 mm, moist.

- loose/soft from 1.5 to 2.1 m

- softer/less drilling resistance below 4.1 m depth

Backfilled to surface with sand.

Bottom of hole at 4.3 meters

C	N	Type/ Sample #
▥	16	SPT1
▥	4	SPT2
▥	23	SPT3

C: Condition of Sample
Good ■
Disturbed ▥
No Recovery ☐

Type: Type of Sampler
SPT : 2 in. standard
ST : Shelby
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

DCPT Blow/300 mm

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Plastic Limit (%) ▶—●—◀ Liquid Limit (%)
Moisture Content (%)
▼ Ground Water Level
(X) Shear strength in kPa (Torvane)
PP Pocket Penetrometer (compressive strength in kPa)
X Shear strength in kPa (Unconfined)
⊗ Shear strength in kPa (Field vane)
☒ Remolded strength in kPa
■ Percent Passing # 200 sieve

Bentonite/Grout Plug
Solid Pipe
Cuttings
Slotted Pipe
Sand/Pea-Gravel

Drill Method: Sonic
Date Drilled: 19/04/2017
Logged by: LM
Checked by: DF

1 LOG PER PAGE 2/6/17

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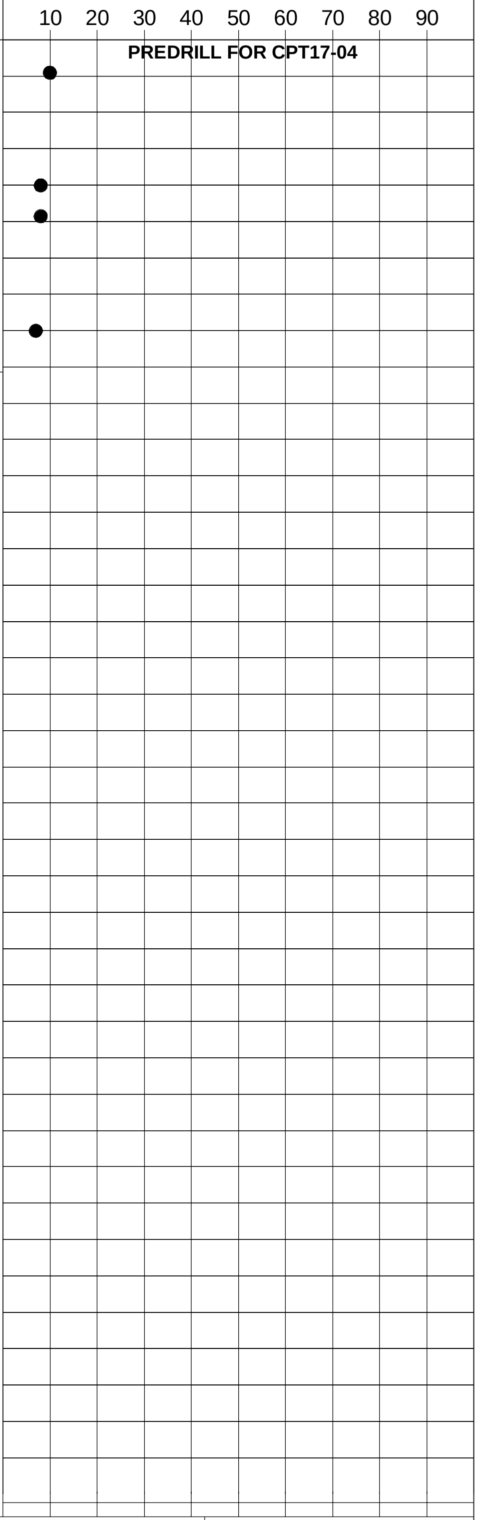
Port Alberni WWTP Upgrade
Geotechnical Assessment

BH17-04

Pg 1 of 1
Project No: 171-04753-00

Depth (m)	Depth (ft)	Description	C	N	Type/ Sample #	Water Level
		compact, brown SAND AND GRAVEL (FILL), some fines, poorly graded, max particles size observed = 80 mm, moist, cobbles.	Disturbed	12	SPT1	
		- compact to dense, grey, 0.9 to 0.1 m depth				
2		- silty below 2.1 m	Disturbed	46	SPT2	
			Disturbed		G1	
	10	- some fines below 3.0 m				
4			Disturbed	38	SPT3	
	15	Backfilled to surface with sand. Bottom of hole at 4.6 meters				



C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
ST : Shelby
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

DCPT Blow/300 mm

Plastic Limit (%) ▶—●—◀ Liquid Limit (%)
Moisture Content (%)
▼ Ground Water Level
(X) Shear strength in kPa (Torvane)
PP Pocket Penetrometer (compressive strength in kPa)
X Shear strength in kPa (Unconfined)
⊗ Shear strength in kPa (Field vane)
☒ Remolded strength in kPa
■ Percent Passing # 200 sieve

Bentonite/Grout Plug
Solid Pipe
Cuttings
Slotted Pipe
Sand/Pea-Gravel

Drill Method: Sonic
Date Drilled: 19/04/2017
Logged by: LM
Checked by: DF

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Port Alberni WWTP Upgrade Geotechnical Assessment

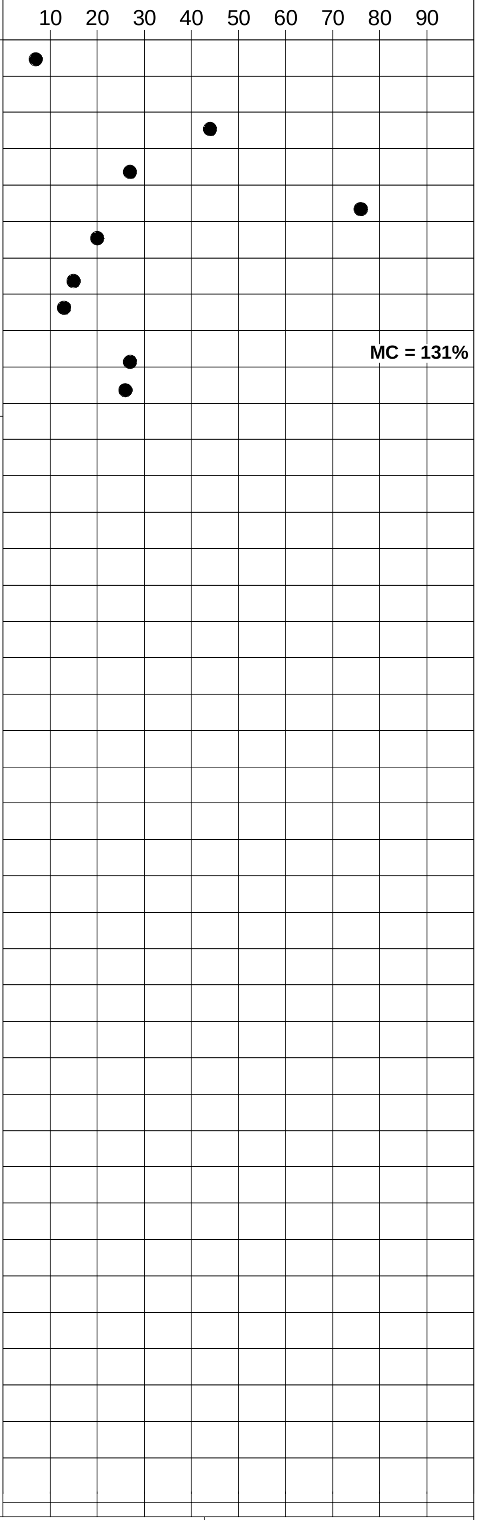
BH17-05

Pg 1 of 1
Project No: 171-04753-00

Description	Closure 1	C	N	Type/ Sample #	Water Level
compact, brown, SAND AND GRAVEL (FILL), some fines, poorly graded, max particle size observed = 50 mm, moist.	▨	▥	17	SPT1	
		▥		G1	
firm to stiff, brown, sandy SILT, trace gravel, low plastic, moist, wood debris		▥	1	SPT2	
interbedded, gravelly SAND and sandy SILT, very loose/very soft, organics/wood debris, max particle size observed = 40 mm, poorly graded.		▥		G2	
		▥		G3	
loose, grey GRAVEL, some sand, trace fines, poorly graded, rounded, max particle size observed = 60 mm, wet		▥	4	SPT3	
		▥		G4	
soft, dark brown, ORGANIC SILT, non plastic, wood debris, moist.		▥		G5	
		▥		G6	
very loose, grey/brown SAND, some fines, trace gravel, poorly graded, max particle size observed = 20 mm, wet		▥	3	SPT4	

Free water at 3.4 m below ground surface at end of drilling.
Hole sloughing.
Bottom of hole at 5.2 meters

Depth (m) (ft)



C: Condition of Sample
Good ▨
Disturbed ▥
No Recovery ☐

Type: Type of Sampler
SPT : 2 in. standard
ST : Shelby
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

DCPT Blow/300 mm

SOIL CLASSIFICATION IN ACCORDANCE WITH THE CANADIAN FOUNDATION ENGINEERING MANUAL 4TH EDITION 2006.

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Plastic Limit (%) Liquid Limit (%)
Moisture Content (%)
Ground Water Level
(X) Shear strength in kPa (Torvane)
PP Pocket Penetrometer (compressive strength in kPa)
X Shear strength in kPa (Unconfined)
⊗ Shear strength in kPa (Field vane)
⊠ Remolded strength in kPa
■ Percent Passing # 200 sieve

Bentonite/Grout Plug
Solid Pipe
Cuttings
Slotted Pipe
Sand/Pea-Gravel

Drill Method: Sonic
Date Drilled: 20/04/2017
Logged by: LM
Checked by: DF

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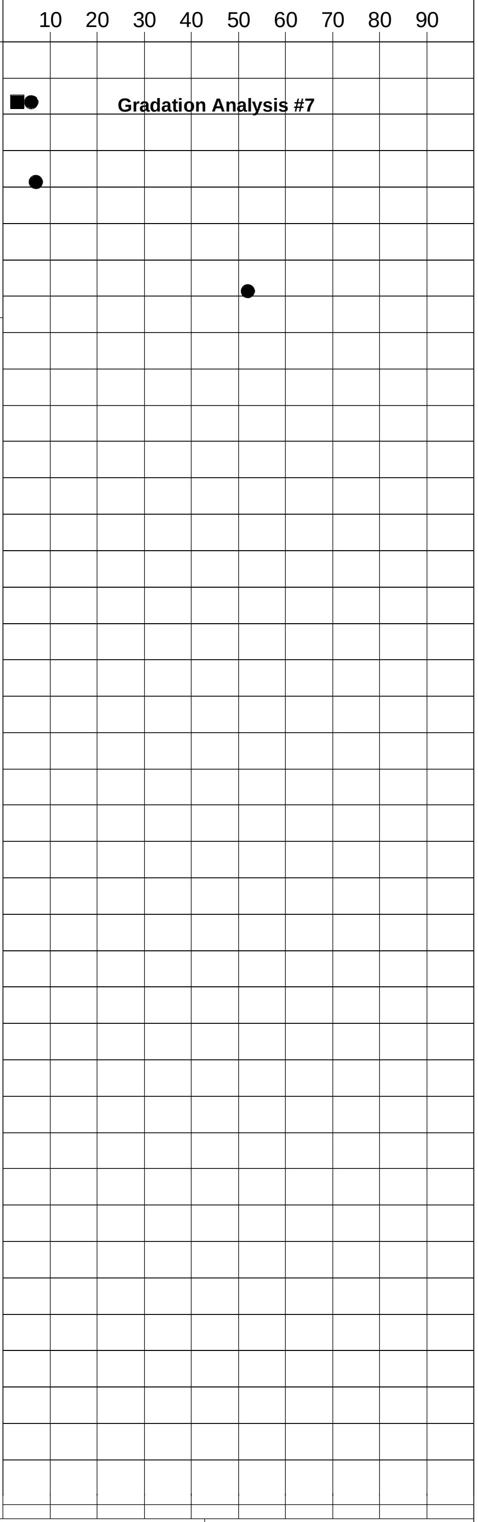
Port Alberni WWTP Upgrade
Geotechnical Assessment

TP17-01

Pg 1 of 1
Project No: 171-04753-00

Depth (m)	Depth (ft)	Description	C	N	Type/ Sample #	Water Level
0 – 2	0 – 10	compact, brown SAND AND GRAVEL (FILL), trace fines, poorly graded, moist to wet, max particle size observed = 100 mm, cobbles. - backfill			B1 G1	
	10 – 12.5	loose, grey/brown silty SAND, some gravel, poorly graded, max particle size observed = 60 mm, moist to wet, organics/shells, wood debris, sloughing - wet below 3.5 m			G2	

Free water at 3.5 m.
Backfilled with bucket packed excavated material.
Bottom of test pit at 3.8 meters



C: Condition of Sample
Good ▆
Disturbed ▥
No Recovery ☐

Type: Type of Sampler
SPT : 2 in. standard
ST : Shelby
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

DCPT Blow/300 mm

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Plastic Limit (%) ▶—●—◀ Liquid Limit (%)
Moisture Content (%)
▼ Ground Water Level
(X) Shear strength in kPa (Torvane)
PP Pocket Penetrometer (compressive strength in kPa)
X Shear strength in kPa (Unconfined)
⊗ Shear strength in kPa (Field vane)
⊠ Remolded strength in kPa
■ Percent Passing # 200 sieve

Drill Method: Test Pit
Date Drilled: 21/04/2017
Logged by: LM
Checked by: DF

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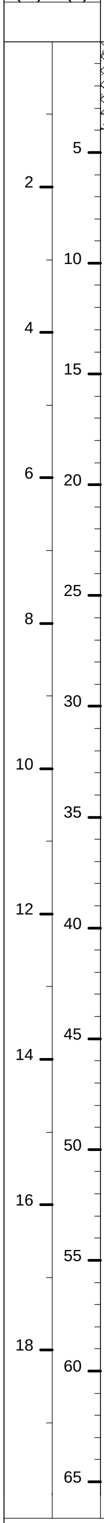
Port Alberni WWTP Upgrade
Geotechnical Assessment

TP17-02

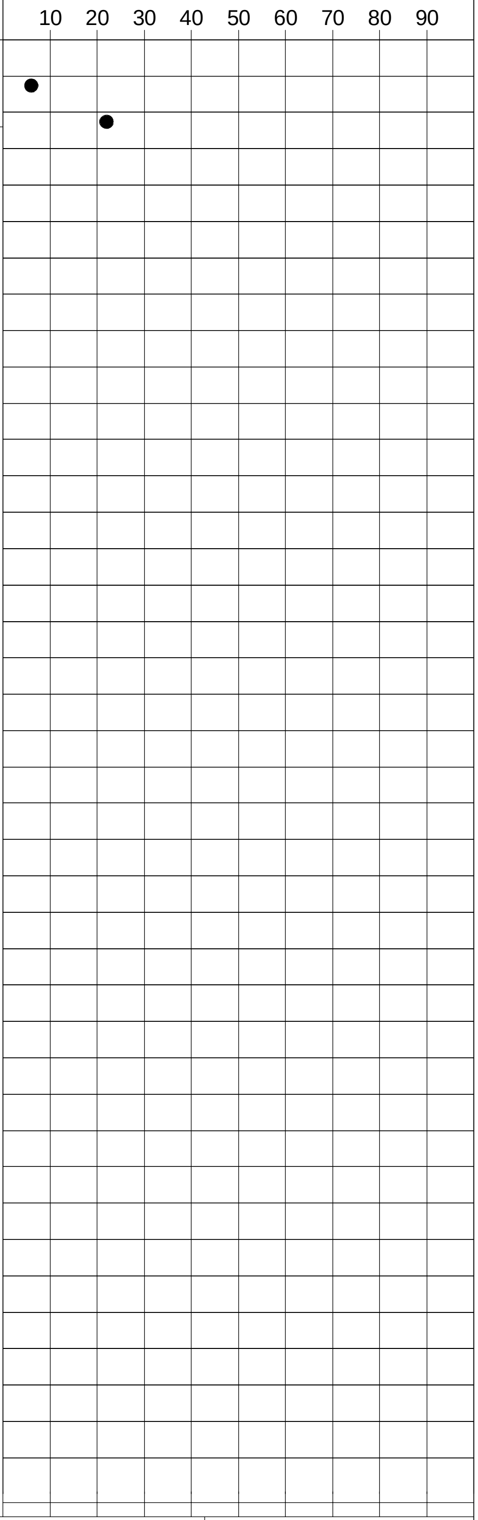
Pg 1 of 1
Project No: 171-04753-00



Description	C	N	Type/ Sample #	Water Level
compact, brown SAND AND GRAVEL (FILL), trace fines, poorly graded, max particle size observed = 60 mm, moist.			B1	
loose, brown silty SAND, (FILL - INFERRED BERM CORE ZONE) some gravel, poorly graded, max particle size observed = 30 mm, moist, organics.			G1	

Backfilled with bucket packed excavated material.
- no seepage or sloughing observed

Bottom of test pit at 1.2 meters



C: Condition of Sample
Good ▨
Disturbed ▥
No Recovery ☐

Type: Type of Sampler
SPT : 2 in. standard
ST : Shelby
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

DCPT Blow/300 mm

SOIL CLASSIFICATION IN ACCORDANCE WITH THE CANADIAN FOUNDATION ENGINEERING MANUAL 4TH EDITION 2006.

THIS LOG IS FOR GEOTECHNICAL PURPOSES ONLY

Plastic Limit (%) ▶—●—◀ Liquid Limit (%)
Moisture Content (%)
▼ Ground Water Level
(X) Shear strength in kPa (Torvane)
PP Pocket Penetrometer (compressive strength in kPa)
X Shear strength in kPa (Unconfined)
⊗ Shear strength in kPa (Field vane)
☒ Remolded strength in kPa
■ Percent Passing # 200 sieve

Drill Method: Test Pit
Date Drilled: 21/04/2017
Logged by: LM
Checked by: DF

WSP Canada Inc.

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Victoria, BC
Canada V8Z 6R4
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E-mail: victoria@wsp.com

AGGREGATE GRADATION CHART

IDENTIFICATION:

Client Associated Engineering Ltd
Project Industrial WWTP Upgrade - Port Alberni

File No.: 171-04753-00
Report No.: 1

Sample Location In-situ
BH17-01, Box 2, 4.7m-5.0m

Date: 08-May-17

SAMPLING INFORMATION:

Material: Sand, some gravel, some fines
Specification: n/a

Date Sampled	18-Apr-17
Date Tested	08-May-17
Sample No:	1
Fracture by mass	n/a
Supplier:	In Situ
Sampled by:	LM
Tested by:	GG

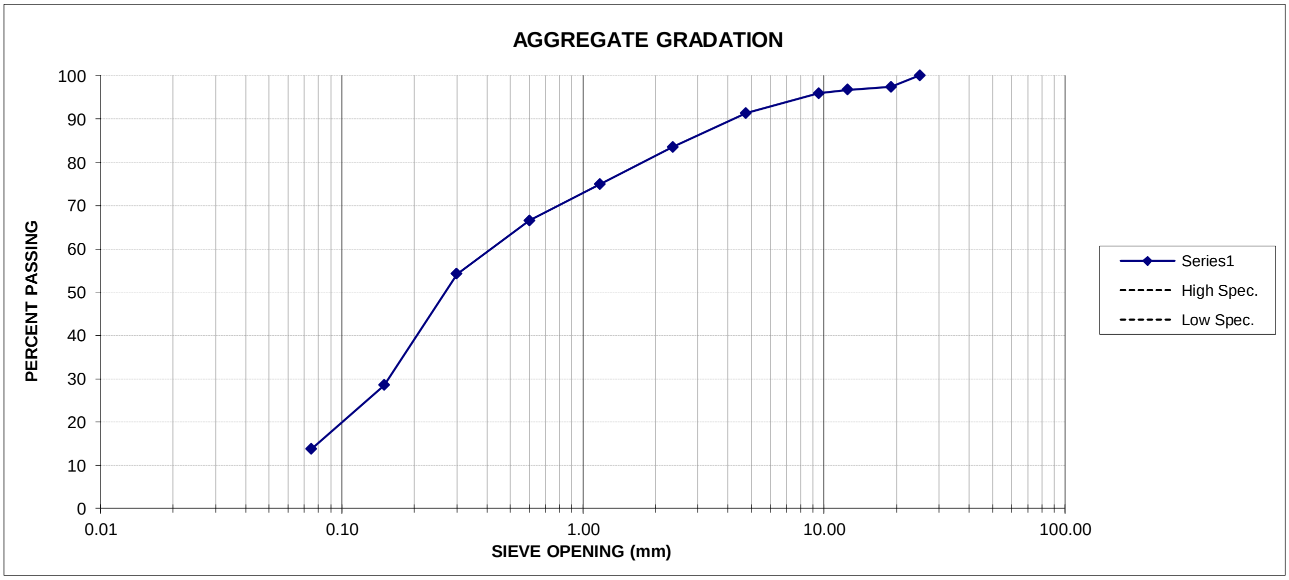
Material Specification

Sieve	High Spec.	Low Spec.

Sieve Analysis

Sieve	% Passing
75.0	
63.0	
50.0	
37.5	
25.0	100.0
19.0	97.4
12.5	96.8
9.5	95.9
4.75	91.4
2.36	83.5
1.18	75.0
0.600	66.6
0.300	54.2
0.150	28.5
0.075	13.8

AGGREGATE GRADATION:



REMARKS: Tested according to ASTM C-: 136 and C-117

REPORTS TO:

WSP CANADA INC.

per:

WSP Canada Inc.

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Canada V8Z 6R4
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Fax.: 250-475-2211
E-mail: victoria@wsp.com

AGGREGATE GRADATION CHART

IDENTIFICATION:

Client: Associated Engineering Ltd
Project: Industrial WWTP Upgrade - Port Alberni

File No.: 171-04753-00
Report No.: 2

Sample Location: In-situ
BH17-01, Box 4, 10.7m-12.2m

Date: 08-May-17

SAMPLING INFORMATION:

Material: Sand, gravelly, trace fines
Specification: n/a

Date Sampled 18-Apr-17
Date Tested 08-May-17
Sample No: 2
Fracture by mass n/a
Supplier: In Situ
Sampled by: LM
Tested by: GG

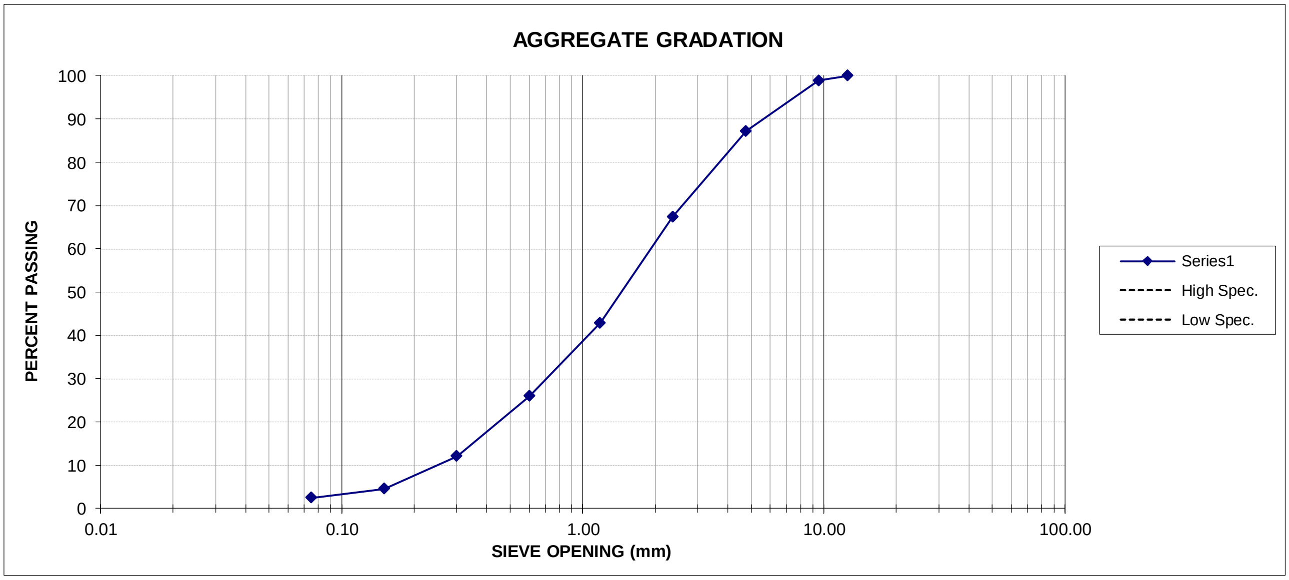
Material Specification

Sieve	High Spec.	Low Spec.

Sieve Analysis

Sieve	% Passing
75.0	
63.0	
50.0	
37.5	
25.0	
19.0	
12.5	100.0
9.5	98.9
4.75	87.2
2.36	67.4
1.18	43.0
0.600	26.0
0.300	12.1
0.150	4.6
0.075	2.5

AGGREGATE GRADATION:



REMARKS: Tested according to ASTM C-:   136 and C-117

REPORTS TO:

WSP CANADA INC.

per:

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AGGREGATE GRADATION ANALYSIS

IDENTIFICATION:

Client: Associated Engineering Ltd

Project: Industrial WWTP Upgrade - Port Alberni

File No.: 171-04753-00

Report No.: 3

Sample Location: In-situ
BH17-01, Box 7, 20.4m-20.7m

Date: 11-May-17

SAMPLING INFORMATION:

Material: Sand and SILT, trace gravel, trace organics, shells

Specification: n/a

Date Sampled	18-Apr-17
Date Tested	08-May-17
Sample No:	3
Fracture by mass	N/A
Supplier:	In Situ
Sampled by:	LM
Tested by:	GG

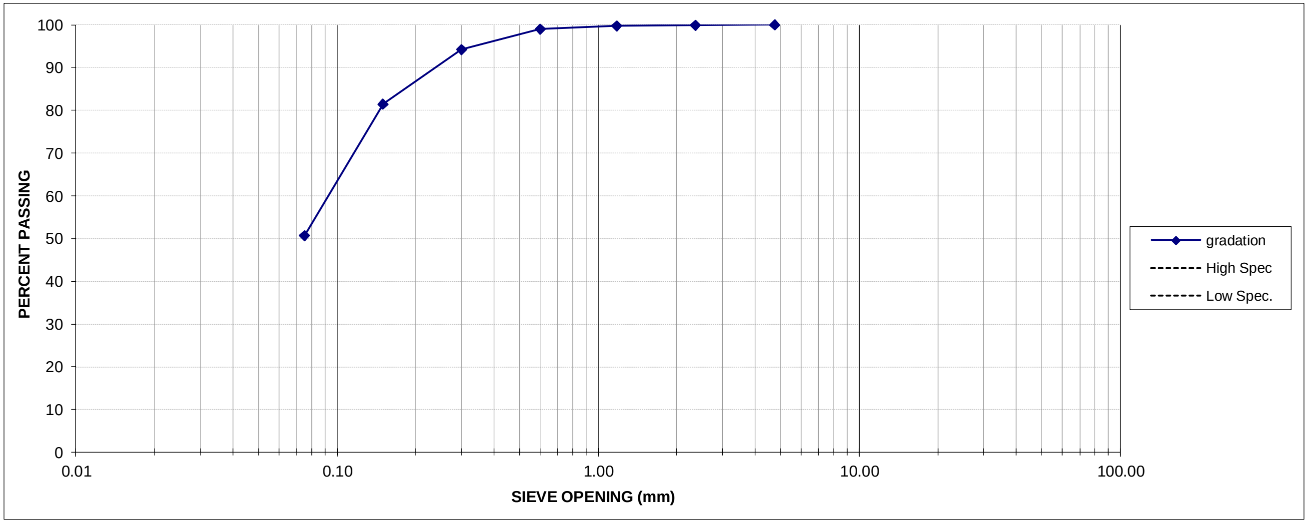
Material Specification

Sieve	High Spec.	Low Spec.

Sieve Analysis

Sieve	% Passing
75	
63	
50	
37.5	
25	
19.0	
12.5	
9.5	
4.75	100.0
2.36	99.9
1.18	99.8
0.600	99.0
0.300	94.2
0.150	81.4
0.075	50.7

AGGREGATE GRADATION:



REMARKS: Tested according to ASTM C- 136 and C-117

REPORTS TO:

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per:

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AGGREGATE GRADATION CHART

IDENTIFICATION:

Client: Associated Engineering Ltd
Project: Industrial WWTP Upgrade - Port Alberni

File No.: 171-04753-00
Report No.: 4

Sample Location: In-situ
BH17-02, Box 2, 4.6m-6.1m

Date: 08-May-17

SAMPLING INFORMATION:

Material: Gravelly sand, trace fines
Specification: n/a

Date Sampled 19-Apr-17
Date Tested 08-May-17
Sample No: 4
Fracture by mass n/a
Supplier: In Situ
Sampled by: LM
Tested by: GG

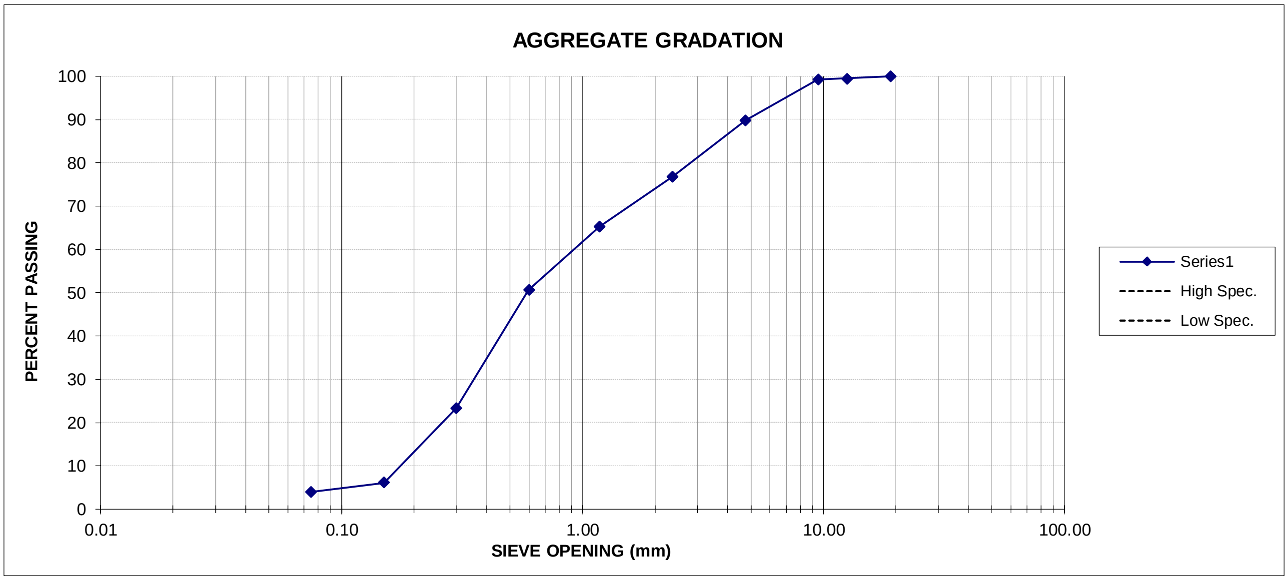
Material Specification

Sieve	High Spec.	Low Spec.

Sieve Analysis

Sieve	% Passing
75.0	
63.0	
50.0	
37.5	
25.0	
19.0	100.0
12.5	99.5
9.5	99.2
4.75	89.8
2.36	76.8
1.18	65.2
0.600	50.6
0.300	23.2
0.150	6.1
0.075	4.0

AGGREGATE GRADATION:



REMARKS: Tested according to ASTM C-: 136 and C-117

REPORTS TO:

WSP CANADA INC.

per:

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E-mail: victoria@wsp.com

AGGREGATE GRADATION CHART

IDENTIFICATION:

Client: Associated Engineering Ltd
Project: Industrial WWTP Upgrade - Port Alberni

File No.: 171-04753-00
Report No.: 5

Sample Location: In-situ
BH17-02, Box 3, 7.9m-9.1m

Date: 08-May-17

SAMPLING INFORMATION:

Material: Sandy gravel, trace fines
Specification: n/a

Date Sampled 19-Apr-17
Date Tested 08-May-17
Sample No: 5
Fracture by mass n/a
Supplier: In Situ
Sampled by: LM
Tested by: GG

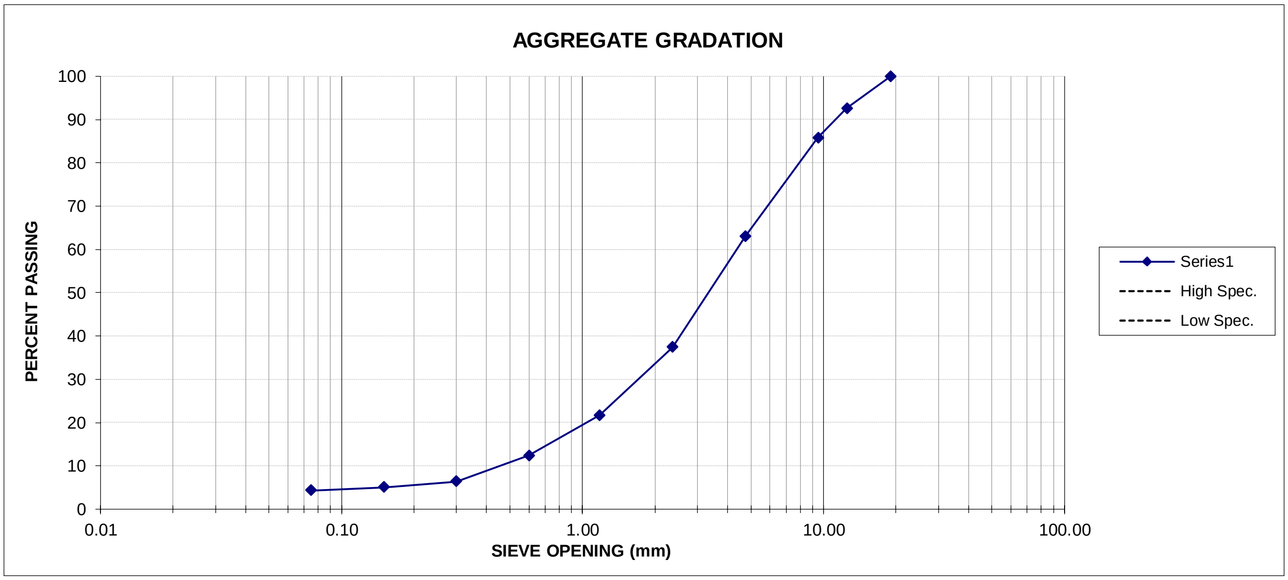
Material Specification

Sieve	High Spec.	Low Spec.

Sieve Analysis

Sieve	% Passing
75.0	
63.0	
50.0	
37.5	
25.0	
19.0	100.0
12.5	92.6
9.5	85.8
4.75	63.0
2.36	37.4
1.18	21.7
0.600	12.3
0.300	6.4
0.150	5.0
0.075	4.3

AGGREGATE GRADATION:



REMARKS: Tested according to ASTM C-: 136 and C-117

REPORTS TO:

WSP CANADA INC.

per:

WSP Canada Inc.

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Victoria, BC
Canada V8Z 6R4
Tel.: 250-475-1000
Fax.: 250-475-2211
E-mail: victoria@wsp.com

AGGREGATE GRADATION CHART

IDENTIFICATION:

Client: Associated Engineering Ltd
Project: Industrial WWTP Upgrade - Port Alberni
Sample Location: In-situ
BH17-02, Box 3, 15.5m-16.2m

File No.: 171-04753-00
Report No.: 6
Date: 08-May-17

SAMPLING INFORMATION:

Material: Sand, some fines, trace gravel
Specification: n/a

Date Sampled 19-Apr-17
Date Tested 08-May-17
Sample No: 6
Fracture by mass n/a
Supplier: In Situ
Sampled by: LM
Tested by: GG

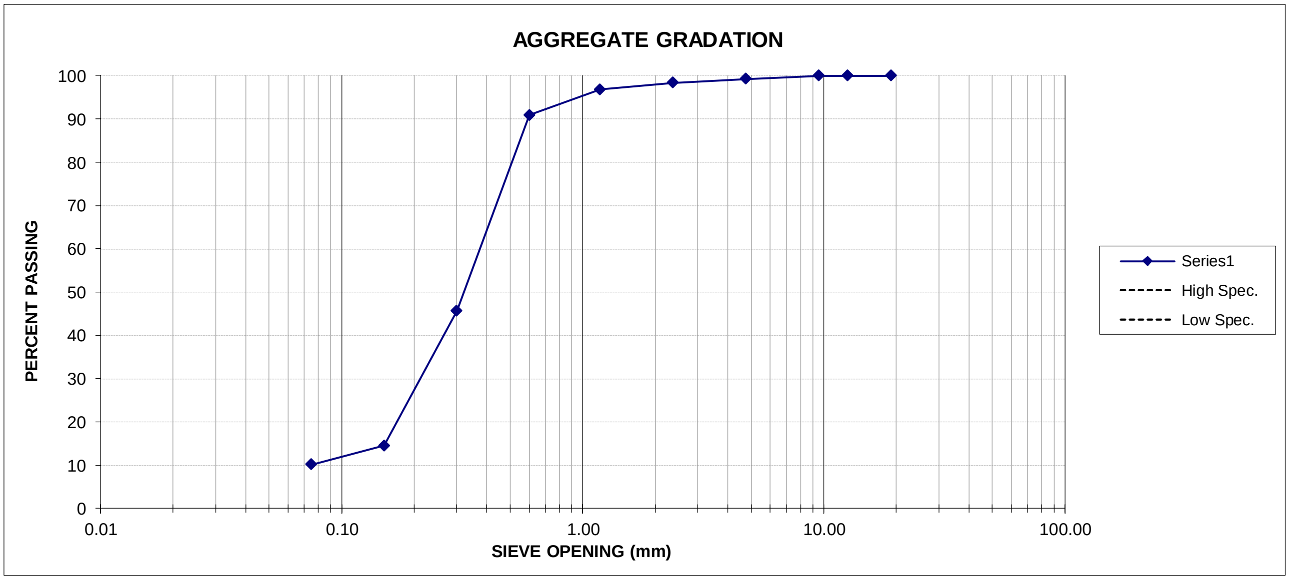
Material Specification

Sieve	High Spec.	Low Spec.

Sieve Analysis

Sieve	% Passing
75.0	
63.0	
50.0	
37.5	
25.0	
19.0	100.0
12.5	100.0
9.5	100.0
4.75	99.3
2.36	98.4
1.18	96.8
0.600	91.0
0.300	45.7
0.150	14.5
0.075	10.2

AGGREGATE GRADATION:



REMARKS: Tested according to ASTM C-: 136 and C-117

REPORTS TO:

WSP CANADA INC.

per:

WSP Canada Inc.

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Canada V9S 5W9
Tel.: 250-753-1077
Fax.: 250-753-1203
E-mail: nanaimo@wsp.com

AGGREGATE GRADATION ANALYSIS

IDENTIFICATION:

Client: Associated Engineering (BC) Ltd.
Project: Port Alberni WWTP
File No.: 171-04753-00
Report No.: 7
Sample Location: In-situ
TP17-01 Bulk 1, 0.8 m
Date: 8-May-17

SAMPLING INFORMATION:

Material: Sand and Gravel, trace fines
Specification: N/A

Date Sampled 21-Apr-17
Date Tested 06-May-17
Sample No: 4583
Fracture by mass N/A
Supplier: N/A
Sampled by: LM
Tested by: TR

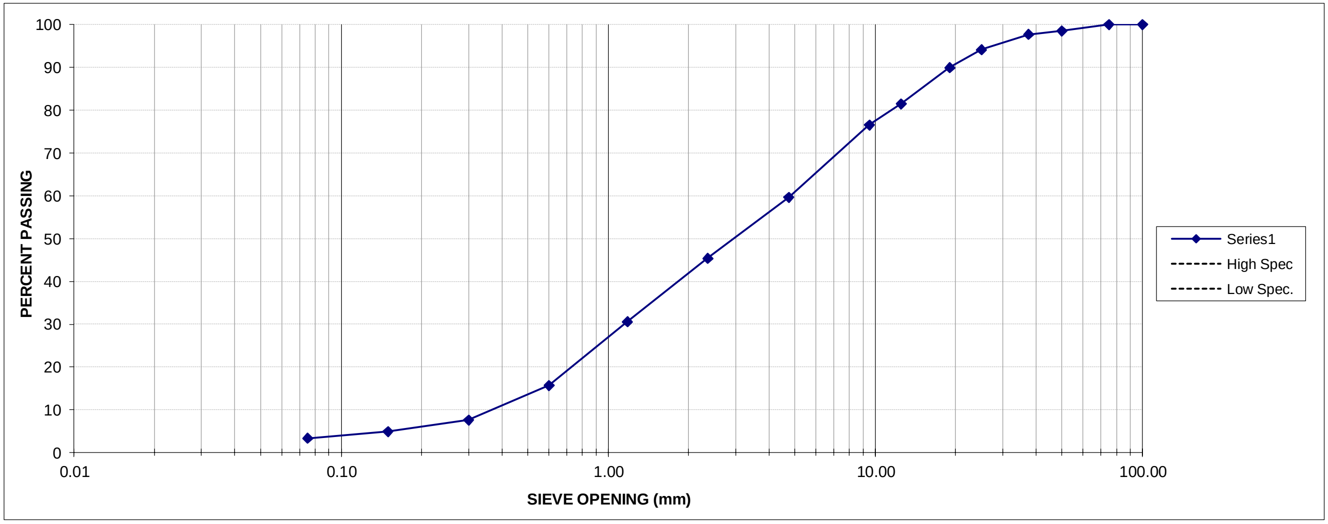
Material Specification

Sieve	High Spec.	Low Spec.

Sieve Analysis

Sieve	% Passing
150	100.0
100	100.0
75	100.0
50	98.5
37.5	97.7
25	94.1
19	89.9
12.5	81.5
9.5	76.6
4.75	59.7
2.36	45.4
1.18	30.6
0.600	15.6
0.300	7.5
0.150	4.9
0.075	3.3

AGGREGATE GRADATION:



REMARKS: Tested in accordance with ASTM C- 136 and C-117

REPORTS TO:

WSP CANADA INC.

per:

APPENDIX

4. CONE PENETRATION TESTING RESULTS

Site Investigation Summary

Cone Penetration Testing Report

GREGG DRILLING CANADA LTD.

2017
Authored by: Kelly Cabal & Dr. Peter K. Robertson
Prepared for: WSP
Site: Port Alberni Waste Water Treatment, Port Alberni, B.C.

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April 24, 2017

WSP
Attn: Darryl Furey

Subject:CPT Site Investigation
Port Alberni Waste Water Treatment
Port Alberni, British Columbia
GREGG Project Number: 17-025CA

Dear Mr. Furey:

The following report presents the results of GREGG Drilling & Testing's Cone Penetration Test investigation for the above referenced site. The following testing services were performed:

1	Cone Penetration Tests	(CPTU)	☒
2	Pore Pressure Dissipation Tests	(PPD)	☒
3	Seismic Cone Penetration Tests	(SCPTU)	☒
4	UVOST Laser Induced Fluorescence	(UVOST)	☐
5	Groundwater Sampling	(GWS)	☐
6	Soil Sampling	(SS)	☐
7	Vapor Sampling	(VS)	☐
8	Pressuremeter Testing	(PMT)	☐
9	Vane Shear Testing	(VST)	☐
10	Dilatometer Testing	(DMT)	☐

A list of reference papers providing additional background on the specific tests conducted is provided in the bibliography following the text of the report. If you would like a copy of any of these publications or should you have any questions or comments regarding the contents of this report, please do not hesitate to contact our office at (562) 427-6899.

Sincerely,
GREGG Drilling & Testing, Inc.

Peter Robertson
Technical Director, Gregg Drilling & Testing, Inc.

Cone Penetration Testing Description

Gregg Drilling carries out all Cone Penetration Tests (CPT) using an integrated electronic cone system, *Figure CPT*.

The cone takes measurements of tip resistance (q_c), sleeve resistance (f_s), and penetration pore water pressure (u_2). Measurements are taken at either 2.5 or 5 cm intervals during penetration to provide a nearly continuous profile. CPT data reduction and basic interpretation is performed in real time facilitating on-site decision making. The above mentioned parameters are stored electronically for further analysis and reference. All CPT soundings are performed in accordance with revised ASTM standards (D 5778-12).

The 5mm thick porous plastic filter element is located directly behind the cone tip in the u_2 location. A new saturated filter element is used on each sounding to measure both penetration pore pressures as well as measurements during a dissipation test (*PPDT*). Prior to each test, the filter element is fully saturated with oil under vacuum pressure to improve accuracy.

When the sounding is completed, the test hole is backfilled according to client specifications. If grouting is used, the procedure generally consists of pushing a hollow tremie pipe with a "knock out" plug to the termination depth of the CPT hole. Grout is then pumped under pressure as the tremie pipe is pulled from the hole. Disruption or further contamination to the site is therefore minimized.

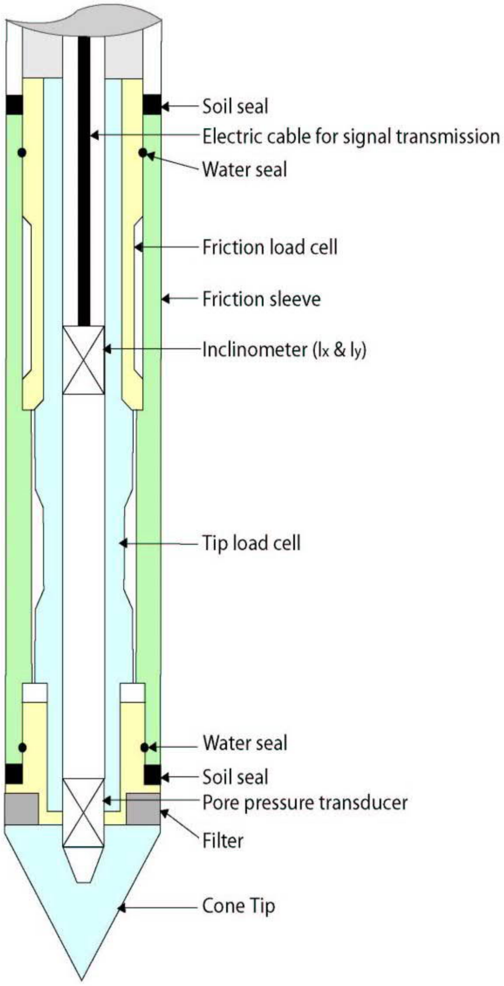


Figure CPT

Gregg 15cm^2 Standard Cone Specifications

Dimensions	
Cone base area	15 cm^2
Sleeve surface area	225 cm^2
Cone net area ratio	0.80
Specifications	
Cone load cell	
Full scale range	180 kN (20 tons)
Overload capacity	150%
Full scale tip stress	120 MPa (1,200 tsf)
Repeatability	120 kPa (1.2 tsf)
Sleeve load cell	
Full scale range	31 kN (3.5 tons)
Overload capacity	150%
Full scale sleeve stress	1,400 kPa (15 tsf)
Repeatability	1.4 kPa (0.015 tsf)
Pore pressure transducer	
Full scale range	7,000 kPa (1,000 psi)
Overload capacity	150%
Repeatability	7 kPa (1 psi)

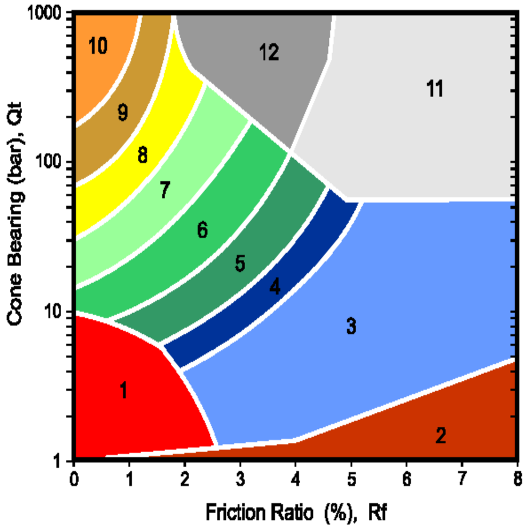
Note: The repeatability during field use will depend somewhat on ground conditions, abrasion, maintenance and zero load stability.

CPT Data & Interpretation

The Cone Penetration Test (CPT) data collected are presented in graphical and electronic form in the report. The plots include interpreted Soil Behavior Type (SBT) based on the charts described by Robertson (1990). Typical plots display SBT based on the non-normalized charts of Robertson et al (1986). For CPT soundings deeper than 30m, we recommend the use of the normalized charts of Robertson (1990) which can be displayed as SBTn, upon request. The report also includes spreadsheet output of computer calculations of basic interpretation in terms of SBT and SBTn and various geotechnical parameters using current published correlations based on the comprehensive review by Lunne, Robertson and Powell (1997), as well as recent updates by Professor Robertson (Guide to Cone Penetration Testing, 2015). The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed. Gregg Drilling & Testing Inc. does not warranty the correctness or the applicability of any of the geotechnical parameters interpreted by the software and does not assume any liability for use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used in the software. Some interpretation methods require input of the groundwater level to calculate vertical effective stress. An estimate of the in-situ groundwater level has been made based on field observations and/or CPT results, but should be verified by the user.

A summary of locations and depths is available in Table 1. Note that all penetration depths referenced in the data are with respect to the existing ground surface.

Note that it is not always possible to clearly identify a soil type based solely on q_t, f_s, and u_2. In these situations, experience, judgment, and an assessment of the pore pressure dissipation data should be used to infer the correct soil behavior type.



ZONE	SBT	
1	🟥	Sensitive, fine grained
2	🟫	Organic materials
3	🟦	Clay
4	🟦	Silty clay to clay
5	🟩	Clayey silt to silty clay
6	🟩	Sandy silt to clayey silt
7	🟩	Silty sand to sandy silt
8	🟨	Sand to silty sand
9	🟫	Sand
10	🟧	Gravely sand to sand
11	⬜	Very stiff fine grained*
12	⬛	Sand to clayey sand*

*over consolidated or cemented

Figure SBT (After Robertson et al., 1986) – Note: Colors may vary slightly compared to plots

Pore Pressure Dissipation Tests

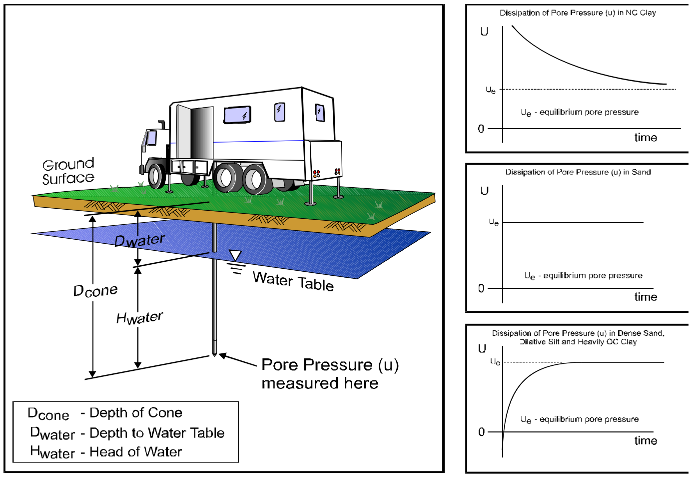
Pore Pressure Dissipation Tests (PPDT's) conducted at various intervals can be used to measure equilibrium water pressure (at the time of the CPT). If conditions are hydrostatic, the equilibrium water pressure can be used to determine the approximate depth of the ground water table. A PPDT is conducted when penetration is halted at specific intervals determined by the field representative. The variation of the penetration pore pressure (*u)* with time is measured behind the tip of the cone and recorded.

Pore pressure dissipation data can be interpreted to provide estimates of:

- Equilibrium piezometric pressure
- Phreatic Surface
- In situ horizontal coefficient of consolidation (c_h)
- In situ horizontal coefficient of permeability (k_h)

In order to correctly interpret the equilibrium piezometric pressure and/or the phreatic surface, the pore pressure must be monitored until it reaches equilibrium, *Figure PPDT*. This time is commonly referred to as t_{100}, the point at which 100% of the excess pore pressure has dissipated.

A complete reference on pore pressure dissipation tests is presented by Robertson et al. 1992 and Lunne et al. 1997.



Water Table Calculation

$$D_{water} = D_{cone} - H_{water}$$

where $H_{water} = U_e$ (depth units)

Useful Conversion Factors:
1psi = 0.704m = 2.31 feet (water)
1tsf = 0.958 bar = 13.9 psi
1m = 3.28 feet

Figure PPDT

A summary of the pore pressure dissipation tests are summarized in Table 1.

Groundwater Sampling

Gregg Drilling & Testing, Inc. conducts groundwater sampling using a sampler as shown in *Figure GWS*. The groundwater sampler has a retrievable stainless steel or disposable PVC screen with steel drop off tip. This allows for samples to be taken at multiple depth intervals within the same sounding location. In areas of slower water recharge, provisions may be made to set temporary PVC well screens during sampling to allow the pushing equipment to advance to the next sample location while the groundwater is allowed to infiltrate.

The groundwater sampler operates by advancing 44.5mm (1¾ inch) hollow push rods with the filter tip in a closed configuration to the base of the desired sampling interval. Once at the desired sample depth, the push rods are retracted; exposing the encased filter screen and allowing groundwater to infiltrate hydrostatically from the formation into the inlet screen. A small diameter bailer (approximately ½ or ¾ inch) is lowered through the push rods into the screen section for sample collection. The number of downhole trips with the bailer and time necessary to complete the sample collection at each depth interval is a function of sampling protocols, volume requirements, and the yield characteristics and storage capacity of the formation. Upon completion of sample collection, the push rods and sampler, with the exception of the PVC screen and steel drop off tip are retrieved to the ground surface, decontaminated and prepared for the next sampling event.

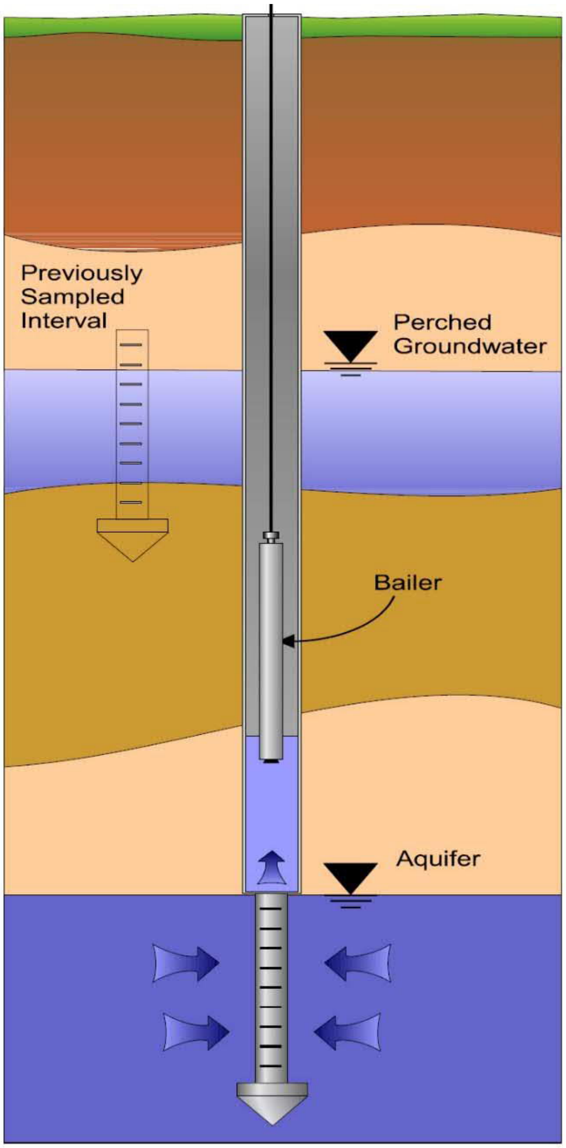


Figure GWS

For a detailed reference on direct push groundwater sampling, refer to Zemo et. al., 1992.

Soil Sampling

Gregg Drilling & Testing, Inc. uses a piston-type push-in sampler to obtain small soil samples without generating any soil cuttings, *Figure SS*. Two different types of samplers (12 and 18 inch) are used depending on the soil type and density. The soil sampler is initially pushed in a "closed" position to the desired sampling interval using the CPT pushing equipment. Keeping the sampler closed minimizes the potential of cross contamination. The inner tip of the sampler is then retracted leaving a hollow soil sampler with inner 1¼" diameter sample tubes. The hollow sampler is then pushed in a locked "open" position to collect a soil sample. The filled sampler and push rods are then retrieved to the ground surface. Because the soil enters the sampler at a constant rate, the opportunity for 100% recovery is increased. For environmental analysis, the soil sample tube ends are sealed with Teflon and plastic caps. Often, a longer "split tube" can be used for geotechnical sampling.

For a detailed reference on direct push soil sampling, refer to Robertson et al, 1998.

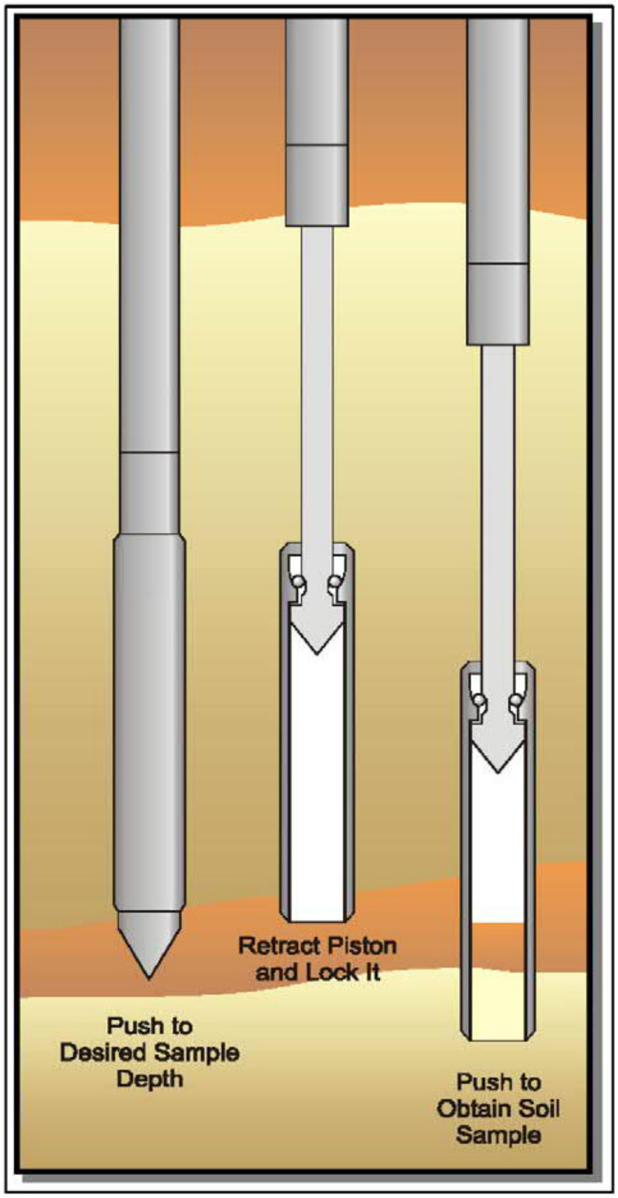


Figure SS

Seismic Cone Penetration Testing (SCPT)

Seismic Cone Penetration Testing (SCPT) can be conducted at various intervals during the Cone Penetration Test. Shear wave velocity (Vs) can then be calculated over a specified interval with depth. A small interval for seismic testing, such as 1-1.5m (3-5ft) allows for a detailed look at the shear wave profile with depth. Conversely, a larger interval such as 3-6m (10-20ft) allows for a more average shear wave velocity to be calculated. Gregg's cones have a horizontally active geophone located 0.2m (0.66ft) behind the tip.

To conduct the seismic shear wave test, the penetration of the cone is stopped and the rods are decoupled from the rig. An automatic hammer is triggered to send a shear wave into the soil. The distance from the source to the cone is calculated knowing the total depth of the cone and the horizontal offset distance between the source and the cone. To calculate an interval velocity, a minimum of two tests must be performed at two different depths. The arrival times between the two wave traces are compared to obtain the difference in time (Δt). The difference in depth is calculated (Δd) and velocity can be determined using the simple equation: v = Δd/Δt

Multiple wave traces can be recorded at the same depth to improve quality of the data.

A complete reference on seismic cone penetration tests is presented by Robertson et al. 1986 and Lunne et al. 1997.

A summary the shear wave velocities, arrival times and wave traces are provided with the report.

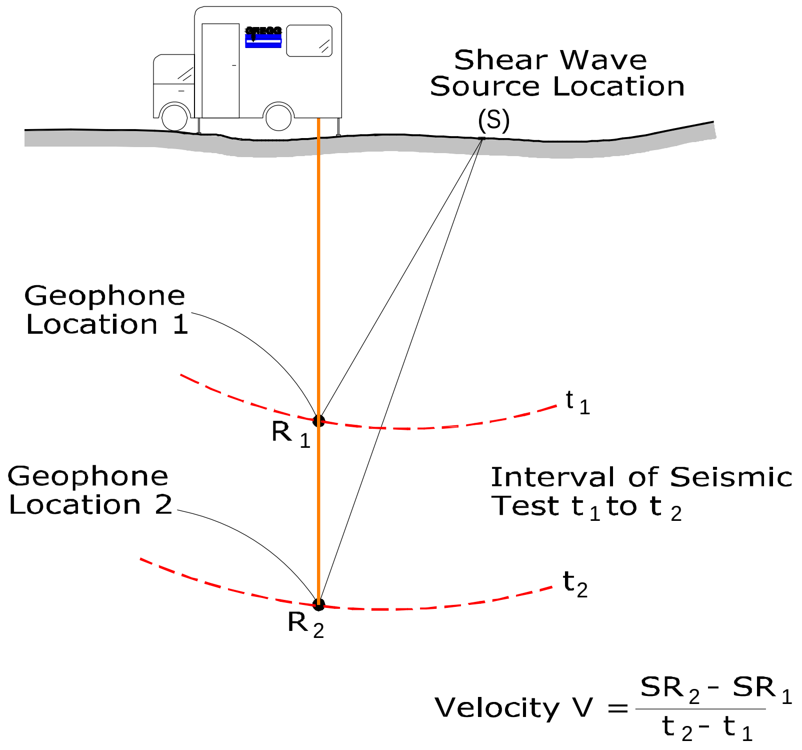


Figure SCPT

References

Lunne, T., Robertson, P.K. and Powell, J.J.M., "Cone Penetration Testing in Geotechnical Practice" E & FN Spon. ISBN 0 419 23750, 1997

Mayne, P.W., "NHI (2002) Manual on Subsurface Investigations: Geotechnical Site Characterization", available through www.ce.gatech.edu/~geosys/Faculty/Mayne/papers/index.html, Section 5.3, pp. 107-112.

Roberston, P.K., "Soil Classification using the Cone Penetration Test", Canadian Geotechnical Journal, Vol. 27, 1990 pp. 151-158.

Robertson, P.K., and K.L. Cabal, "Guide to Cone Penetration Testing, 6th Edition" 2015. http://www.greggdrilling.com/technical-guides

Robertson, P.K., R.G. Campanella, D. Gillespie and A. Rice, "Seismic CPT to Measure In-Situ Shear Wave Velocity", Journal of Geotechnical Engineering ASCE, Vol. 112, No. 8, 1986 pp. 791-803.

Robertson, P.K., Sully, J., Woeller, D.J., Lunne, T., Powell, J.J.M., and Gillespie, D.J., "Guidelines for Estimating Consolidation Parameters in Soils from Piezocone Tests", Canadian Geotechnical Journal, Vol. 29, No. 4, August 1992, pp. 539-550.

Robertson, P.K., T. Lunne and J.J.M. Powell, "Geo-Environmental Application of Penetration Testing", Geotechnical Site Characterization, Robertson & Mayne (editors), 1998 Balkema, Rotterdam, ISBN 90 5410 939 4 pp 35-47.

Copies of ASTM Standards are available through www.astm.org

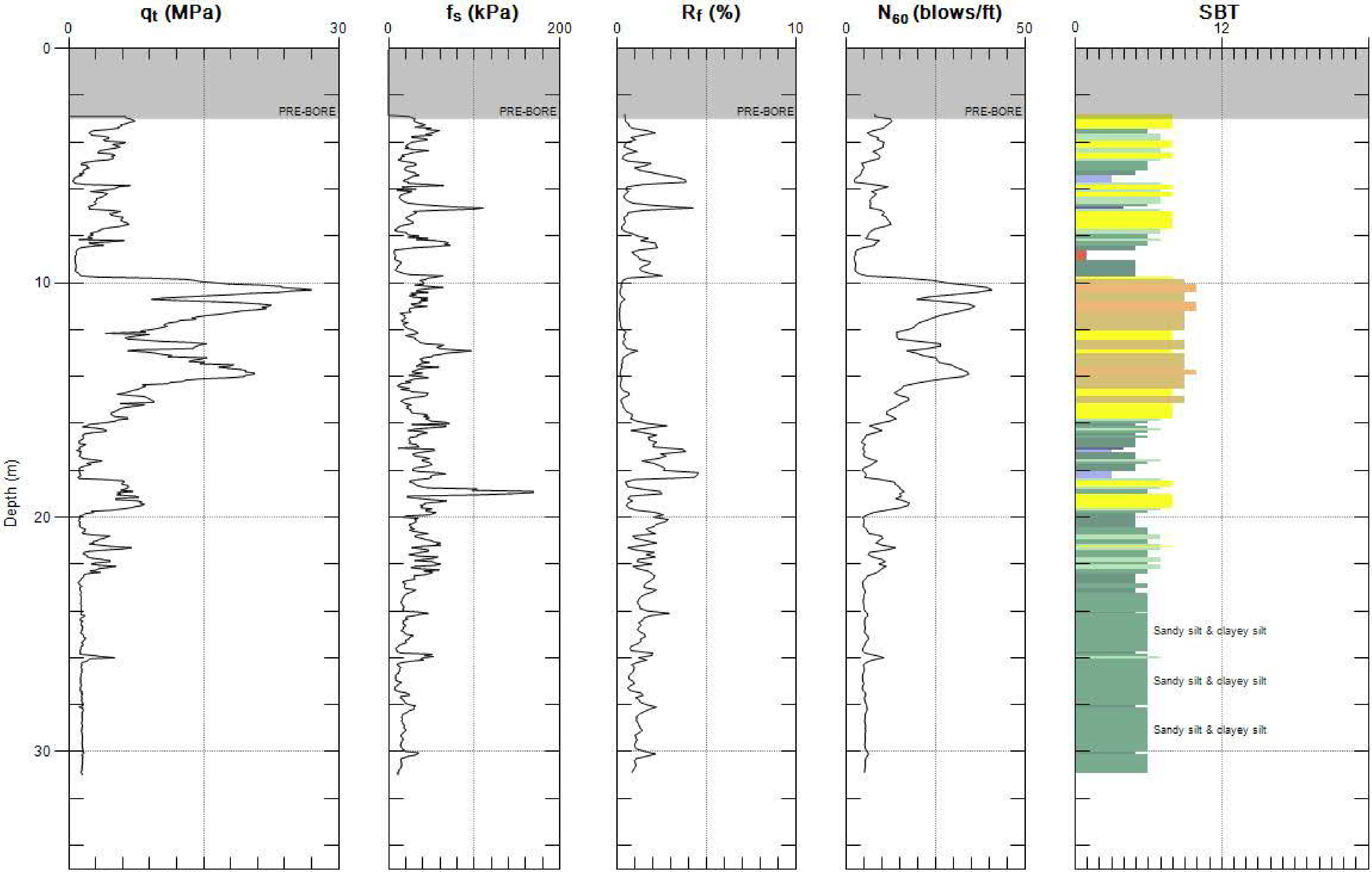
TABLE 1: Summary of CPTs

CPT Sounding Identification	Date	Termination Depth (m)	Depth of Groundwater Samples (m)	Depth of Soil Samples (m)	Depth of Pore Pressure Dissipation Tests (m)
CPT17-01	4/19/17	31.00	-	-	6.1, 8.1, 13.7, 15.1, 19.8, 25.9
CPT17-02	4/20/17	5.80	-	-	-
CPT17-02b	4/20/17	32.75	-	-	-
CPT17-03	4/20/17	20.05	-	-	7.85, 8.85, 12.25, 17.85, 20.0
CPT17-04	4/19/17	20.00	-	-	7.7, 16.0, 20.0

WSP

Site: PORT ALBERNI
Sounding: CPT17-01

Engineer: LUKE
Date: 4/19/17 09:31



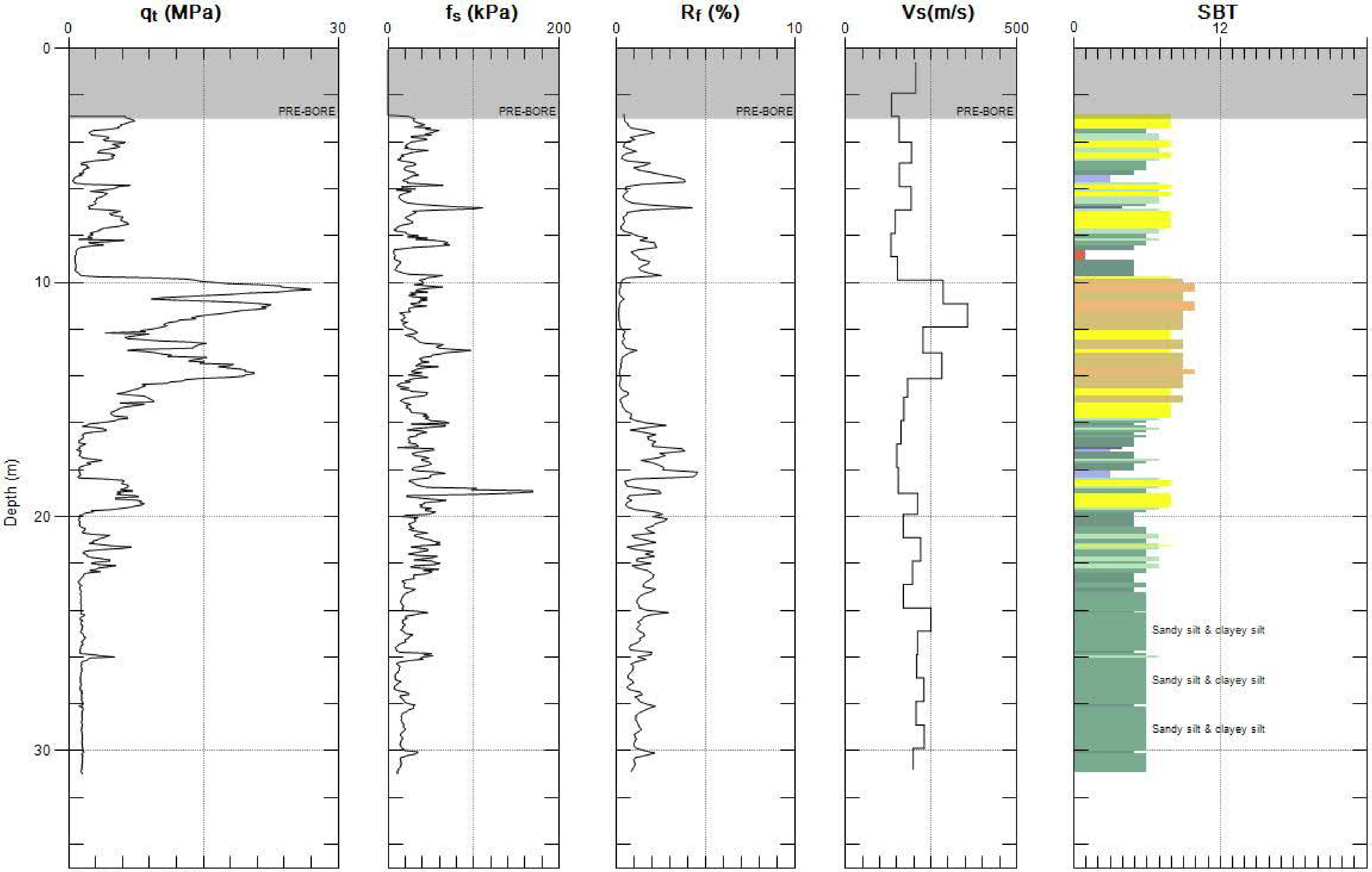
Max. Depth: 31.00 (m)
Avg. Interval: 0.10 (m)

SBT: Soil Behavior Type (Robertson 1990)

WSP

Site: PORT ALBERNI
Sounding: CPT17-01

Engineer: LUKE
Date: 4/19/17 09:31



Max. Depth: 31.00 (m)
Avg. Interval: 0.10 (m)

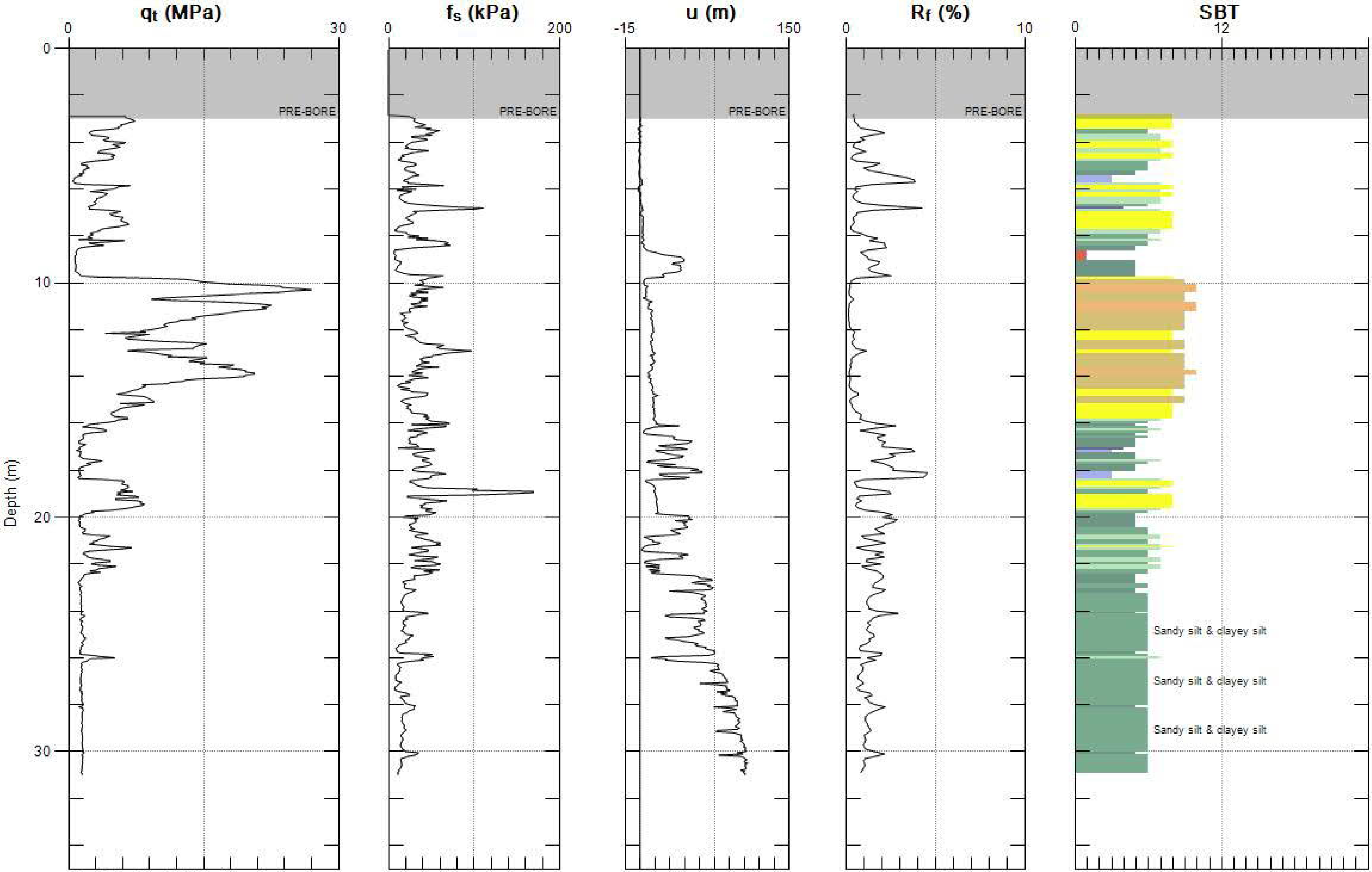
SBT: Soil Behavior Type (Robertson 1990)

GREGG

WSP

Site: PORT ALBERNI
Sounding: CPT17-01

Engineer: LUKE
Date: 4/19/17 09:31



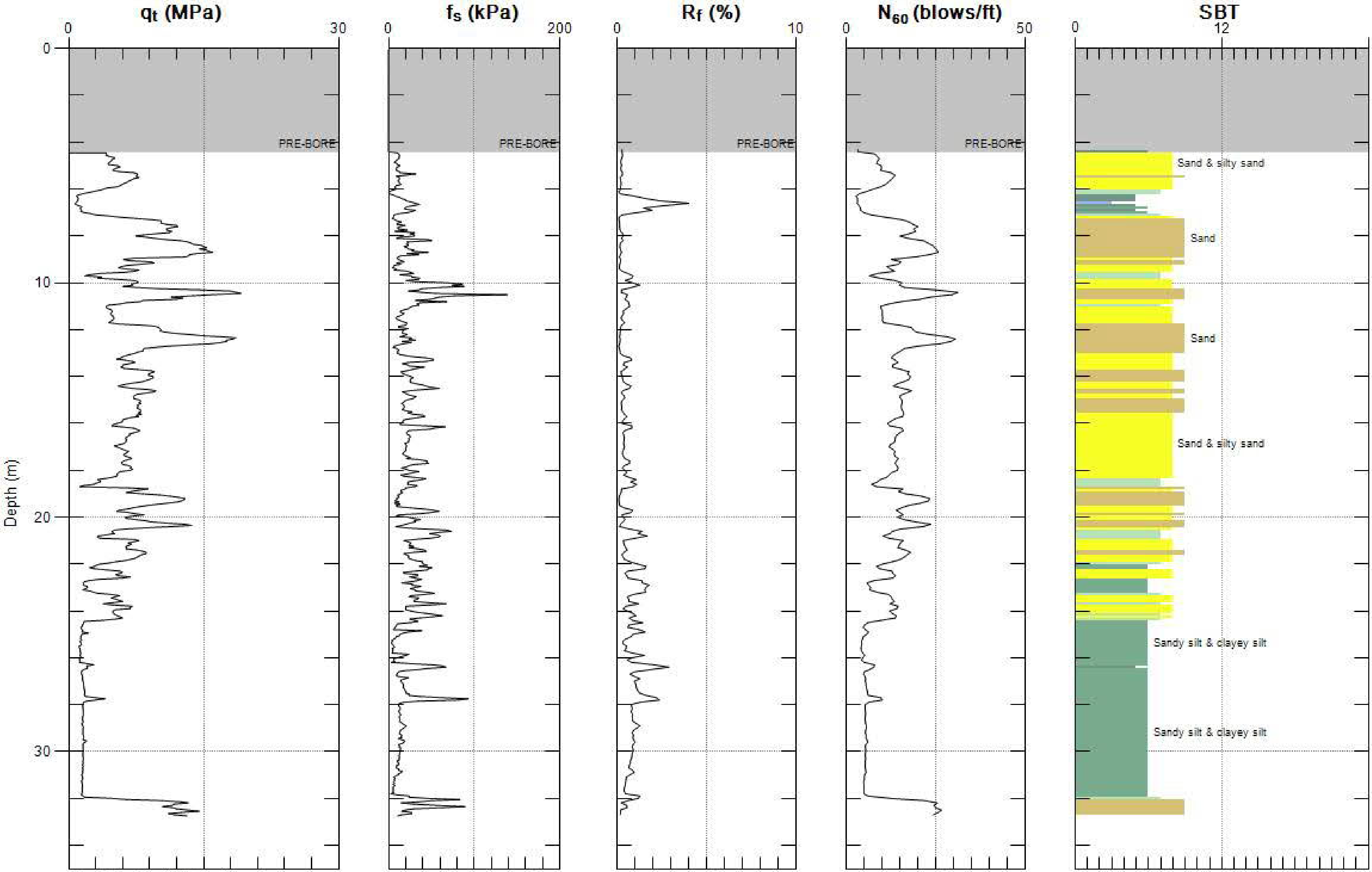
Max. Depth: 31.00 (m)
Avg. Interval: 0.10 (m)

SBT: Soil Behavior Type (Robertson 1990)

WSP

Site: PORT ALBERNI
Sounding: CPT17-02b

Engineer: LUKE
Date: 4/20/17 02:58



Max. Depth: 32.75 (m)
Avg. Interval: 0.10 (m)

SBT: Soil Behavior Type (Robertson 1990)

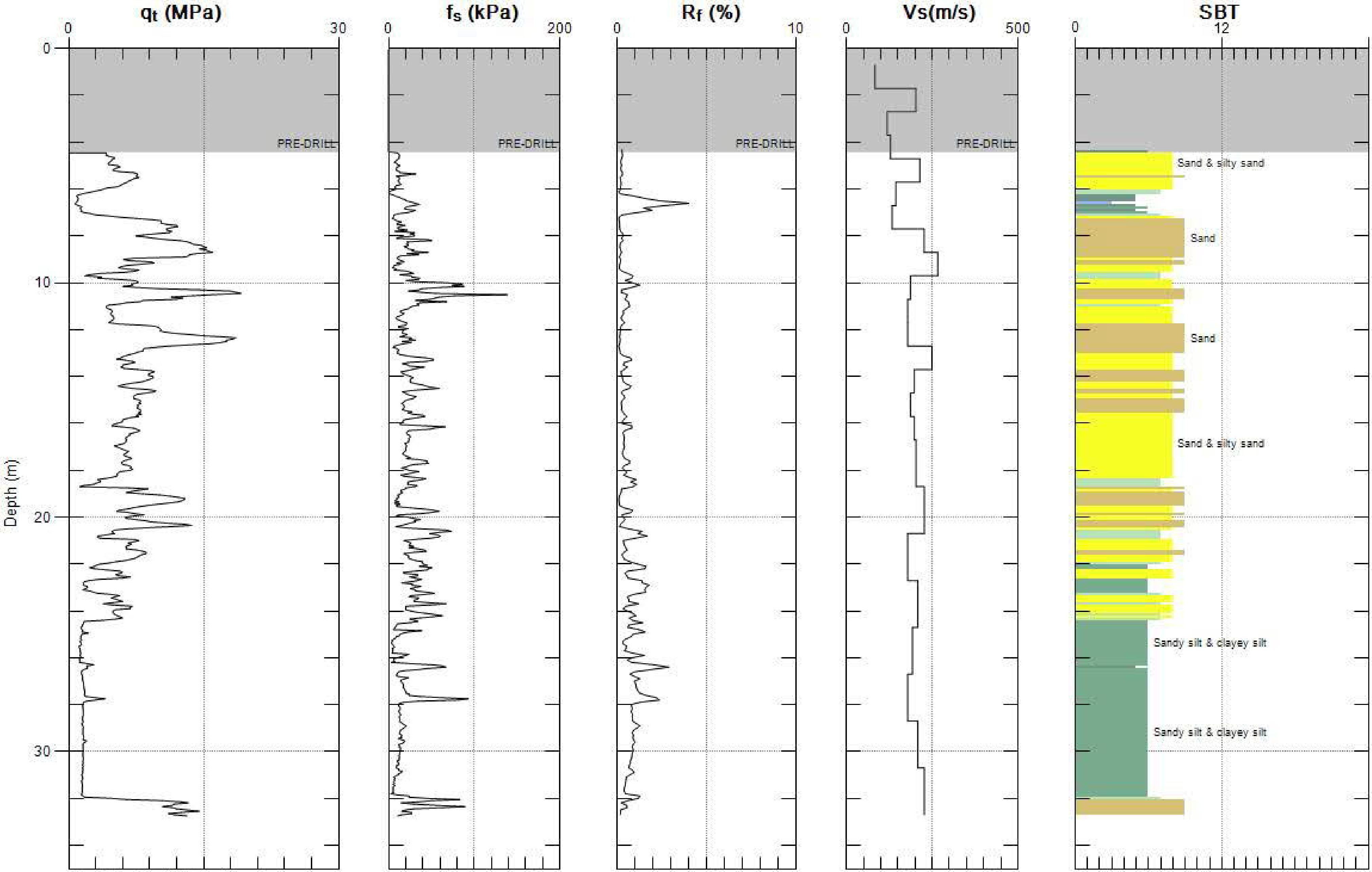
WSP

Site: PORT ALBERNI

Sounding: CPT17-02b

Engineer: LUKE

Date: 4/20/17 02:58



Max. Depth: 32.75 (m)
Avg. Interval: 0.10 (m)

SBT: Soil Behavior Type (Robertson 1990)

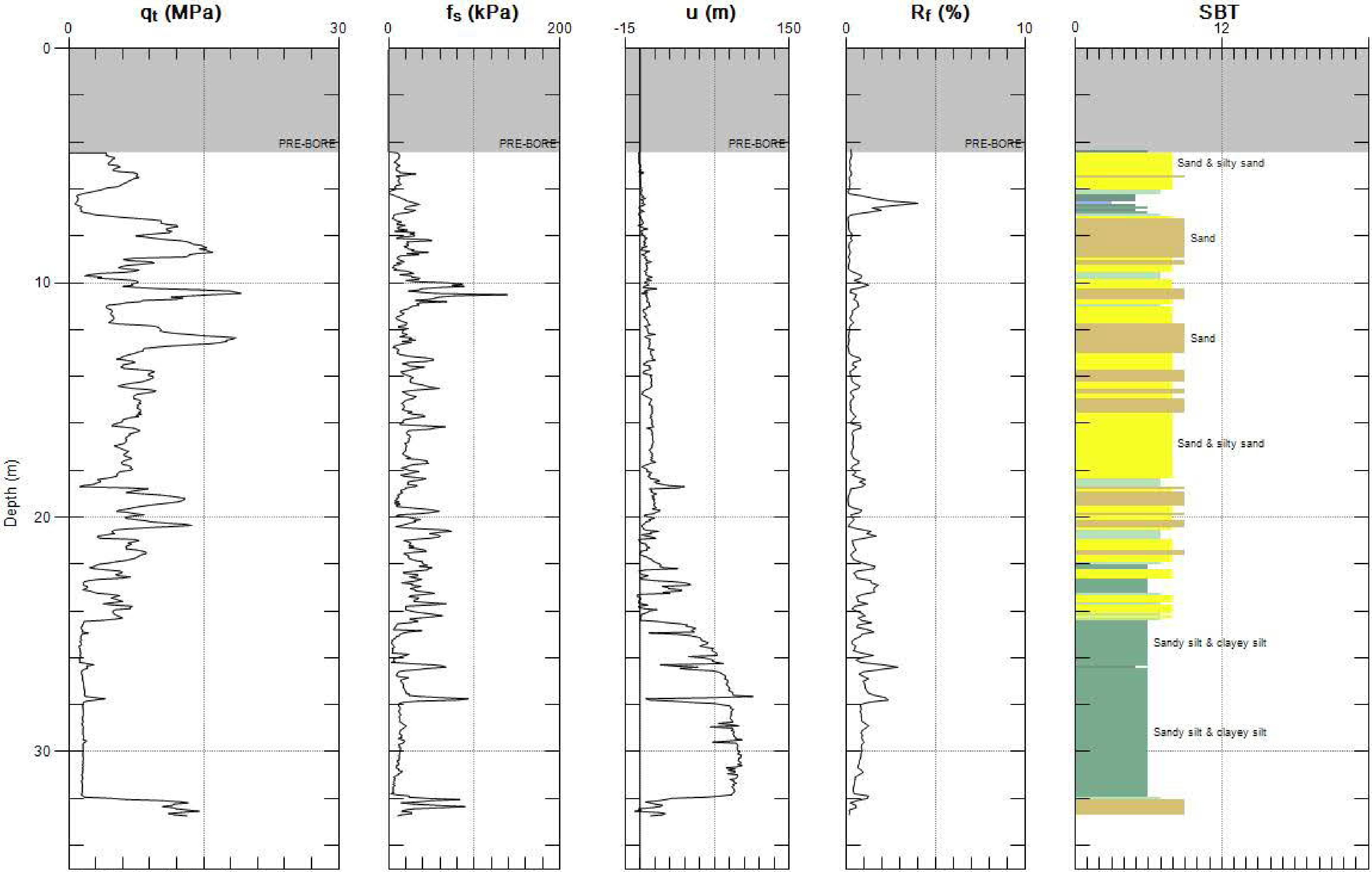
WSP

Site: PORT ALBERNI

Sounding: CPT17-02b

Engineer: LUKE

Date: 4/20/17 02:58



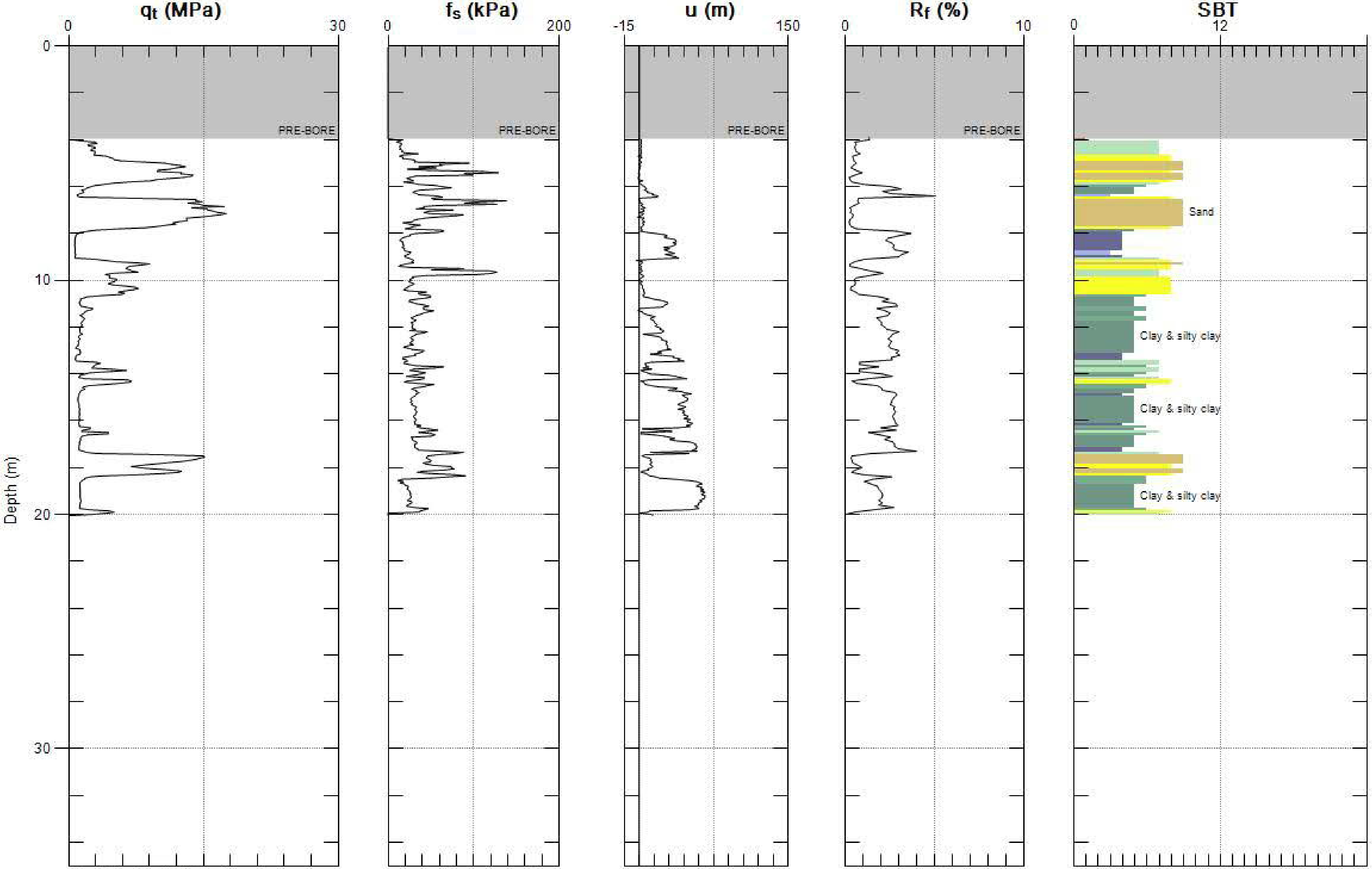
Max. Depth: 32.75 (m)
Avg. Interval: 0.10 (m)

SBT: Soil Behavior Type (Robertson 1990)

WSP

Site: PORT ALBERNI
Sounding: CPT17-03

Engineer: L.MARQUIS
Date: 4/20/17 08:20



Max. Depth: 20.05 (m)
Avg. Interval: 0.10 (m)

SBT: Soil Behavior Type (Robertson 1990)

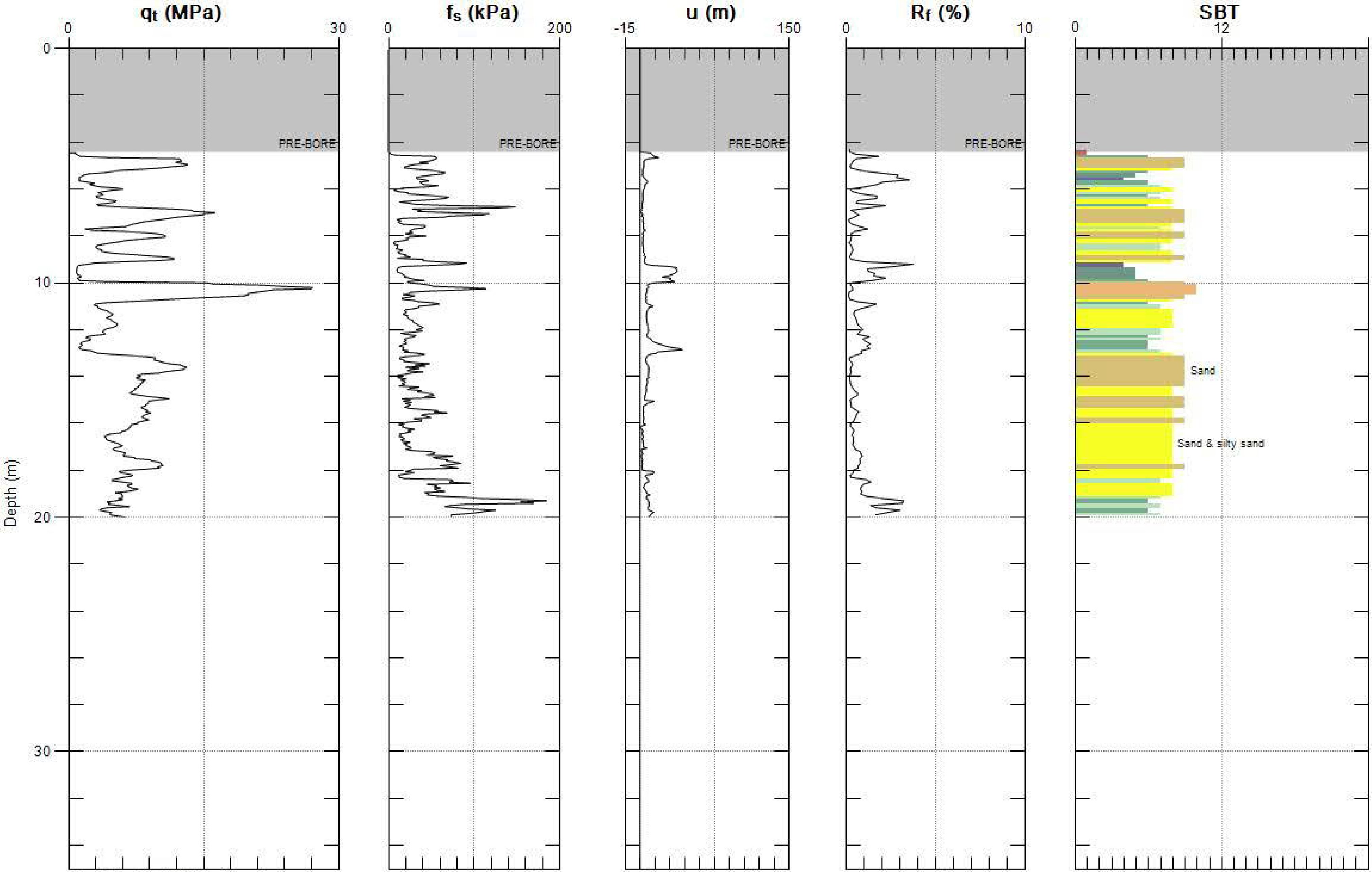
WSP

Site: PORT ALBERNI

Sounding: CPT17-04

Engineer: LUKE

Date: 4/19/17 03:55



Max. Depth: 20.00 (m)
Avg. Interval: 0.10 (m)

SBT: Soil Behavior Type (Robertson 1990)

Shear Wave Velocity Calculations

PORT ALBERNI WASTE WATER FACILITY
CPT 17-01

Geophone Offset: 0.20 Meters
Source Offset: 0.51 Meters

04/19/17

Test Depth (Meter)	Geophone Depth (Meter)	Waveform Ray Path (Meter)	Incremental Distance (Meter)	Characteristic Arrival Time (ms)	Incremental Time Interval (ms)	Interval Velocity (M/Sec)	Interval Depth (Meter)
0.80	0.60	0.79	0.79	5.8000			
2.10	1.90	1.97	1.18	11.5500	5.7500	205.2	1.25
3.10	2.90	2.94	0.98	18.8000	7.2500	134.8	2.40
4.15	3.95	3.98	1.04	25.4000	6.6000	157.3	3.43
5.10	4.90	4.93	0.94	30.3000	4.9000	192.6	4.43
6.10	5.90	5.92	1.00	36.6000	6.3000	158.0	5.40
7.10	6.90	6.92	1.00	41.8000	5.2000	191.7	6.40
8.10	7.90	7.92	1.00	48.6500	6.8500	145.6	7.40
9.10	8.90	8.91	1.00	56.1500	7.5000	133.1	8.40
10.10	9.90	9.91	1.00	62.7000	6.5500	152.4	9.40
11.10	10.90	10.91	1.00	66.2000	3.5000	285.4	10.40
12.10	11.90	11.91	1.00	69.0000	2.8000	356.8	11.40
13.20	13.00	13.01	1.10	73.8500	4.8500	226.6	12.45
14.30	14.10	14.11	1.10	77.7500	3.9000	281.9	13.55
15.10	14.90	14.91	0.80	82.1500	4.4000	181.7	14.50
16.10	15.90	15.91	1.00	88.0000	5.8500	170.8	15.40
17.10	16.90	16.91	1.00	94.1500	6.1500	162.5	16.40
18.10	17.90	17.91	1.00	100.8000	6.6500	150.3	17.40
19.15	18.95	18.96	1.05	107.6000	6.8000	154.4	18.43
20.10	19.90	19.91	0.95	112.1000	4.5000	211.0	19.43
21.10	20.90	20.91	1.00	118.0000	5.9000	169.4	20.40
22.10	21.90	21.91	1.00	122.5500	4.5500	219.7	21.40
23.10	22.90	22.91	1.00	127.6500	5.1000	196.0	22.40
24.10	23.90	23.91	1.00	133.5500	5.9000	169.5	23.40
25.10	24.90	24.91	1.00	137.5500	4.0000	249.9	24.40
26.05	25.85	25.86	0.95	142.0500	4.5000	211.1	25.38
27.05	26.85	26.85	1.00	146.8500	4.8000	208.3	26.35
28.05	27.85	27.85	1.00	151.2000	4.3500	229.8	27.35
29.05	28.85	28.85	1.00	156.0500	4.8500	206.2	28.35
30.10	29.90	29.90	1.05	160.6000	4.5500	230.7	29.38
31.00	30.80	30.80	0.90	165.1500	4.5500	197.8	30.35

Shear Wave Velocity Calculations

PORT ALBERNI WASTE WATER FACILITY
PORT ALBERNI

Geophone Offset: 0.20 Meters
Source Offset: 0.51 Meters

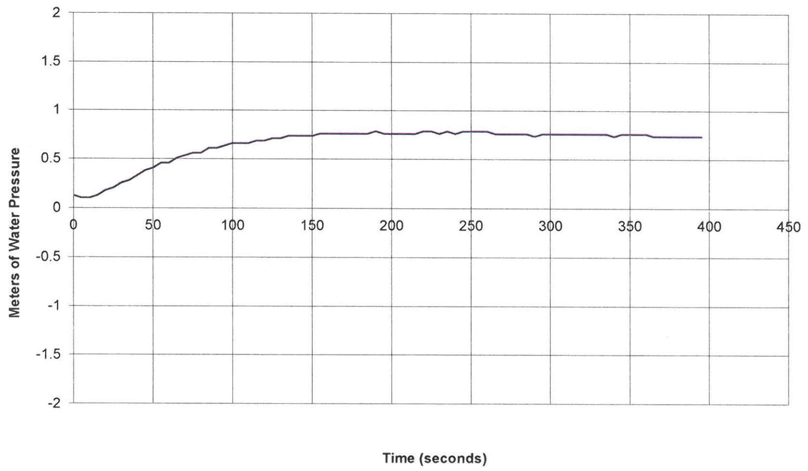
04/20/17

Test Depth (Meter)	Geophone Depth (Meter)	Waveform Ray Path (Meter)	Incremental Distance (Meter)	Characteristic Arrival Time (ms)	Incremental Time Interval (ms)	Interval Velocity (M/Sec)	Interval Depth (Meter)
0.90	0.70	0.87	0.87	17.5000			
1.90	1.70	1.77	0.91	28.4000	10.9000	83.4	1.20
2.90	2.70	2.75	0.97	33.2000	4.8000	202.7	2.20
3.90	3.70	3.73	0.99	41.5000	8.3000	118.9	3.20
4.90	4.70	4.73	0.99	49.2000	7.7000	128.9	4.20
5.90	5.70	5.72	1.00	53.8500	4.6500	214.0	5.20
6.90	6.70	6.72	1.00	60.7500	6.9000	144.4	6.20
7.90	7.70	7.72	1.00	68.2500	7.5000	133.0	7.20
8.90	8.70	8.71	1.00	72.6500	4.4000	226.8	8.20
9.90	9.70	9.71	1.00	76.4000	3.7500	266.3	9.20
10.90	10.70	10.71	1.00	81.7500	5.3500	186.7	10.20
11.90	11.70	11.71	1.00	87.3500	5.6000	178.4	11.20
12.90	12.70	12.71	1.00	92.9500	5.6000	178.4	12.20
13.90	13.70	13.71	1.00	96.9500	4.0000	249.8	13.20
14.90	14.70	14.71	1.00	102.0000	5.0500	197.9	14.20
15.90	15.70	15.71	1.00	107.3500	5.3500	186.8	15.20
16.90	16.70	16.71	1.00	112.4000	5.0500	197.9	16.20
18.90	18.70	18.71	2.00	122.2500	9.8500	203.0	17.70
20.90	20.70	20.71	2.00	131.0500	8.8000	227.2	19.70
22.90	22.70	22.71	2.00	142.2500	11.2000	178.5	21.70
24.90	24.70	24.71	2.00	151.8500	9.6000	208.3	23.70
26.90	26.70	26.70	2.00	162.2500	10.4000	192.3	25.70
28.90	28.70	28.70	2.00	173.4500	11.2000	178.5	27.70
30.90	30.70	30.70	2.00	183.0500	9.6000	208.3	29.70
32.90	32.70	32.70	2.00	191.8500	8.8000	227.2	31.70

GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

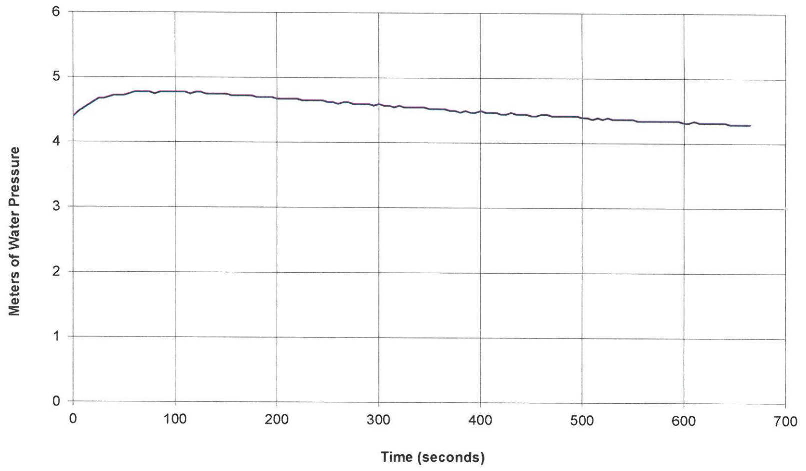
Sounding: CPT17-01
Depth: 6.1
Site: PORT ALBERNI
Engineer: LUKE



GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

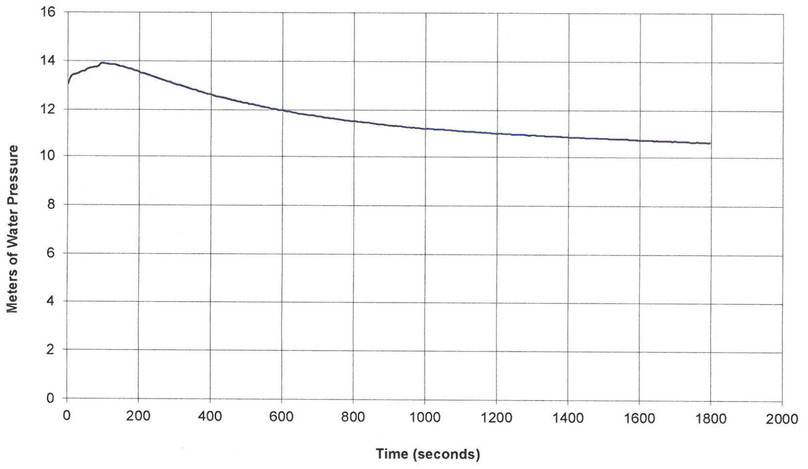
Sounding: CPT17-01
Depth: 8.1
Site: PORT ALBERNI
Engineer: LUKE



GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

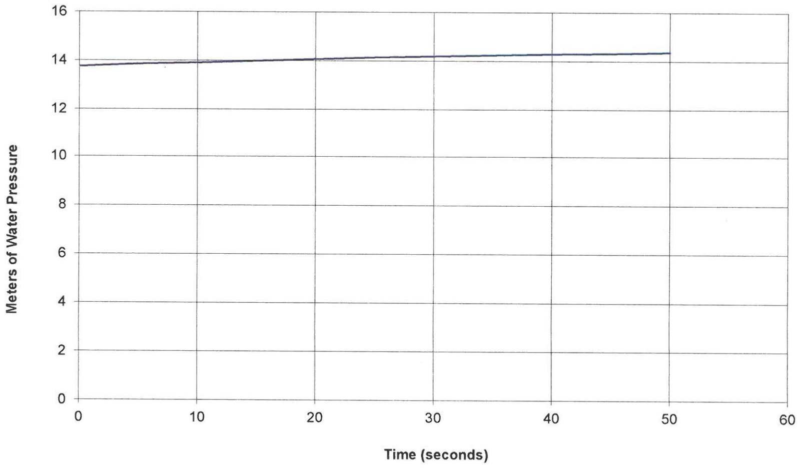
Sounding: CPT17-01
Depth: 13.7
Site: PORT ALBERNI
Engineer: LUKE



GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

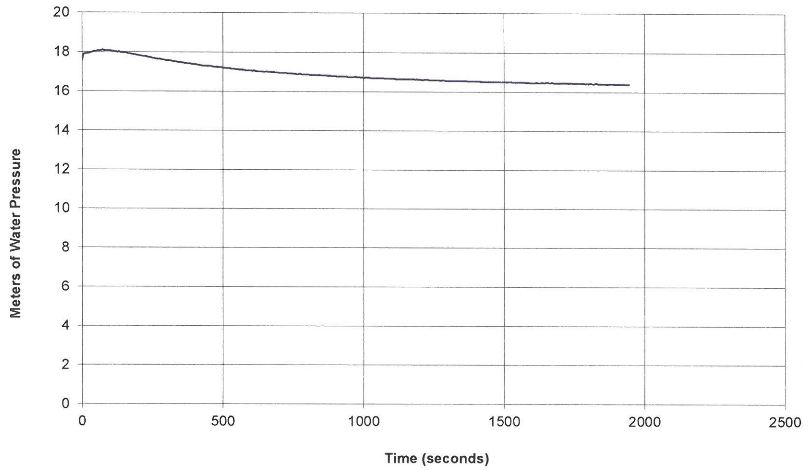
Sounding: CPT17-01
Depth: 15.1
Site: PORT ALBERNI
Engineer: LUKE



GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

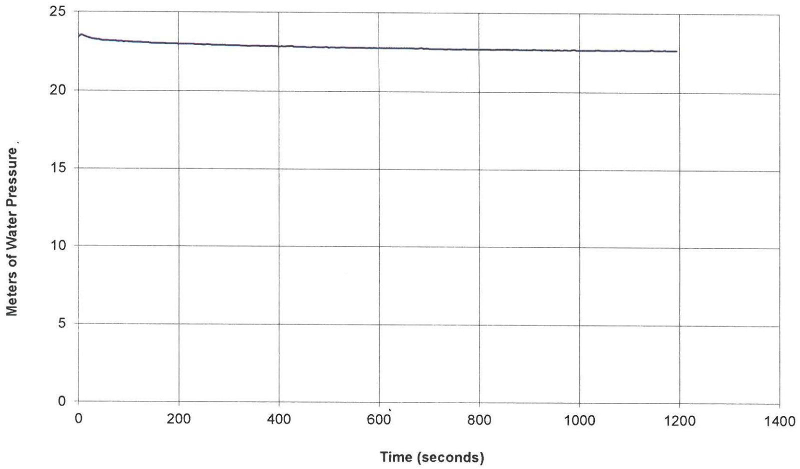
Sounding: CPT17-01
Depth: 19.8
Site: PORT ALBERNI
Engineer: LUKE



GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

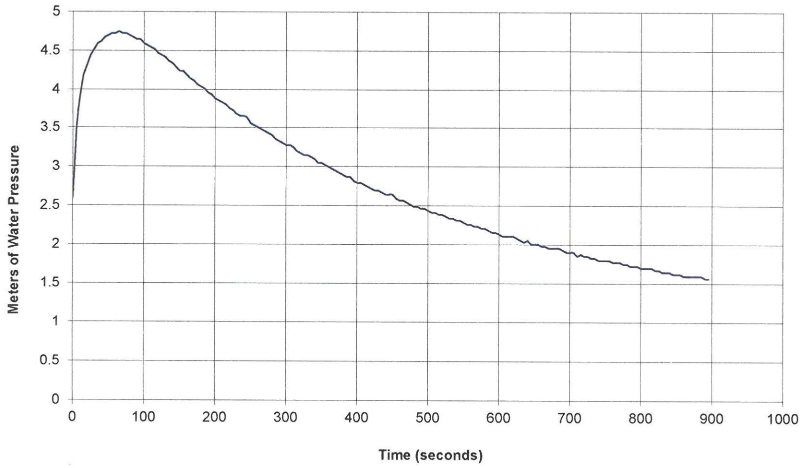
Sounding: CPT17-01
Depth: 25.9
Site: PORT ALBERNI
Engineer: LUKE



GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

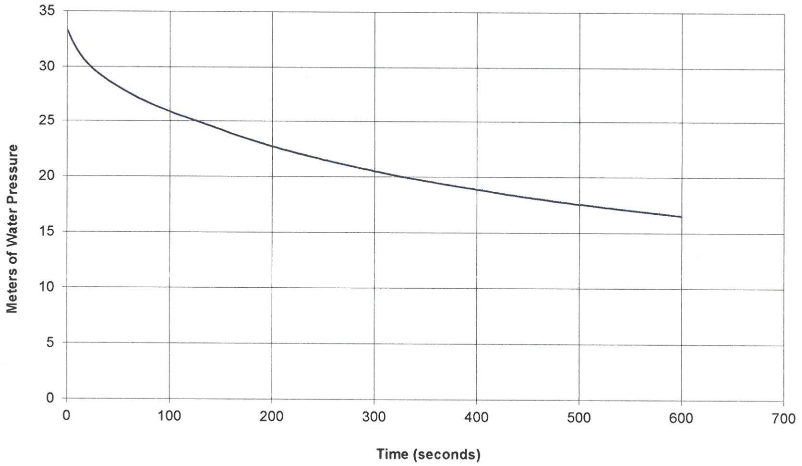
Sounding: CPT 17-03
Depth: 7.85
Site: PORT ALBERNI
Engineer: L.MARQUIS



GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

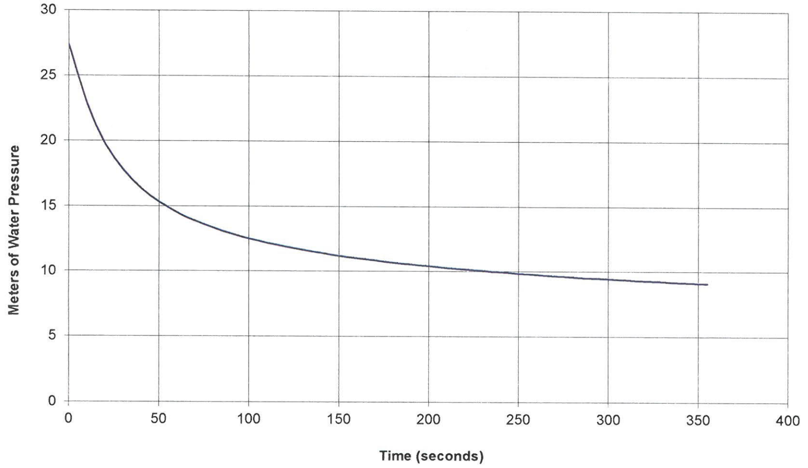
Sounding: CPT 17-03
Depth: 8.85
Site: PORT ALBERNI
Engineer: L.MARQUIS



GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

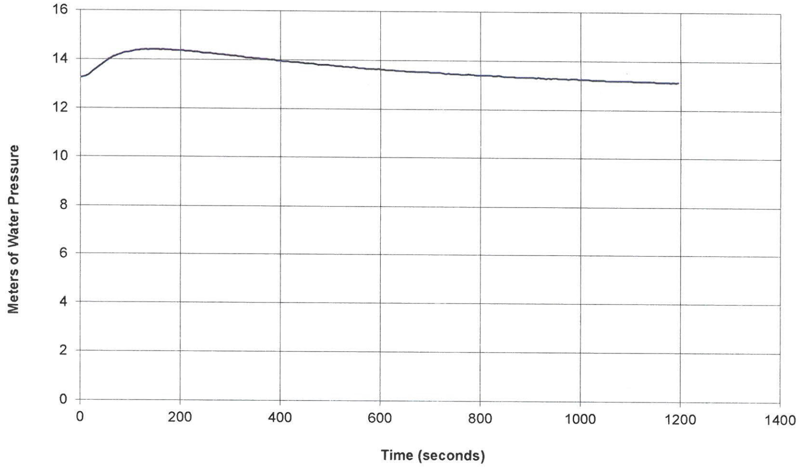
Sounding: CPT 17-03
Depth: 12.25
Site: PORT ALBERNI
Engineer: L.MARQUIS



GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

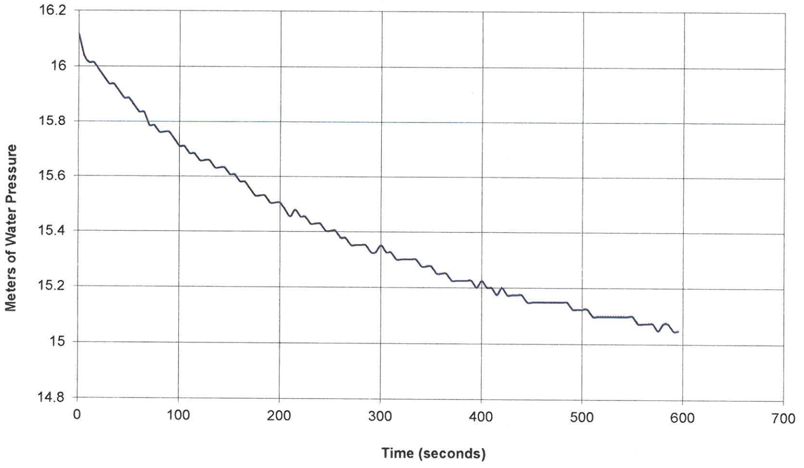
Sounding: CPT 17-03
Depth: 17.85
Site: PORT ALBERNI
Engineer: L.MARQUIS



GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

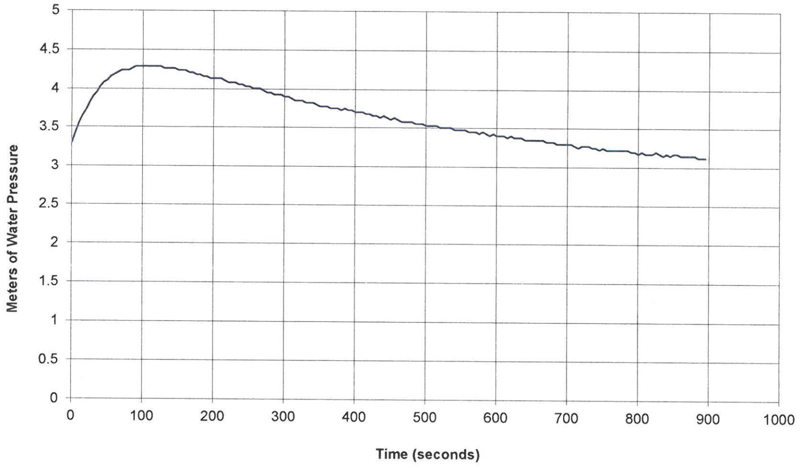
Sounding: CPT 17-03
Depth: 20
Site: PORT ALBERNI
Engineer: L.MARQUIS



GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

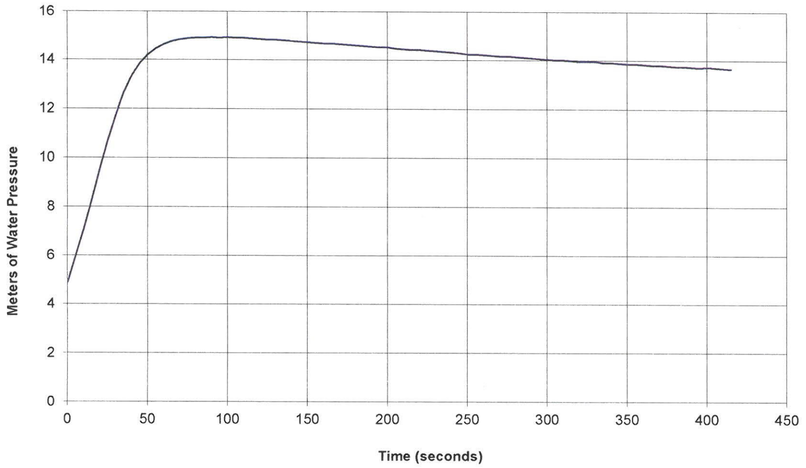
Sounding: CPT17-04
Depth: 7.7
Site: PORT ALBERNI
Engineer: LUKE



GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

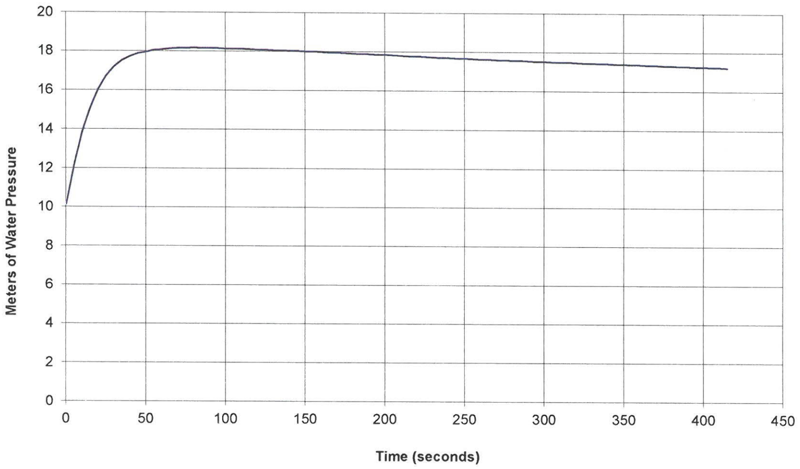
Sounding: CPT17-04
Depth: 16
Site: PORT ALBERNI
Engineer: LUKE



GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

Sounding: CPT17-04
Depth: 20
Site: PORT ALBERNI
Engineer: LUKE



APPENDIX

5. SUMMARY OF SEISMIC ANALYSES

APPENDIX 5 – SUMMARY OF SEISMIC ANALYSES

A5.1 INTRODUCTION

This technical memorandum outlines the details of the seismic analyses performed for the Port Alberni Wastewater Treatment Plant. This memorandum is intended to be read in conjunction with WSP's Geotechnical Assessment Report dated January 2018, which contains the details of subsurface conditions, foundation options and other relevant geotechnical recommendations.

This memorandum provides the details of the model development and calibration, analysis methodology, and results of the seismic ground deformation analysis performed using the FLAC (Fast Lagrangian Analysis of Continua, version 8.0) computer program. Details of input ground motions and supplementary comparative analyses performed using simplified approaches are also included.

A5.2 GEOTECHNICAL DESIGN PARAMETERS

This section provides the details of site characterization that were used to determine input geotechnical design parameters. Soil characterization is based on CPT data, observations of soil samples, and laboratory test results.

A5.2.1 SOIL BEHAVIOUR CLASSIFICATION

MICROSTRUCTURE

Most of the existing empirical correlations developed for the interpretation of CPT data are predominately based on calibrations conducted on young and uncemented soils with little or no microstructure (Robertson 2009; Mayne 2014). Robertson (2016) highlighted the limitations in using such CPT-based correlations for soils with microstructure.

To confirm the applicability of conventional CPT-based correlations for this site, Robertson (2016) suggested using a K_G^* parameter estimated using cone penetration resistances and shear wave velocities. According to Robertson (2016), most young and uncemented soils will exhibit K_G^* values between 100 and 300. The estimated K_G^* values are shown in Figure A5-1 for the two deep CPTs and also for coarse and fine-grained soils separately. This method of classification identifies the soils as young and uncemented, which is consistent with the geological interpretation. Therefore, the conventional CPT-based correlations are applicable to this site to determine geotechnical design parameters from penetration resistances.

SOIL BEHAVIOR TYPE

To characterize in situ soils with respect to their seismic response, soils were differentiated between sand-like and clay-like responses. Sand-like soils are susceptible to cyclic liquefaction while clay-like soils are not susceptible to cyclic liquefaction although cyclic softening could occur. Clay-like soils can also develop pore pressures during undrained cyclic loading but generally do not reach zero effective stress; hence retain some level of stiffness and strength during cyclic loading and generally deform less than sand-like soils. The transition from sand-like to clay-like occurs in a fairly narrow range of Plasticity Index (PI), as such sand-like soils tend to have PI < 10% and clay-like soils tend to have PI > 18% (Bray and Sancio 2006).

Using CPT resistances, a similar classification can be performed by using the Soil Behaviour Index (I_c) defined by Robertson (1990). Robertson and Wride (1998) suggested I_c of 2.6 as the approximate boundary between sand-like and clay-like soils, although intermediate soils can exhibit I_c values between 2.4 and 2.6. More recently, Robertson (2016) published an updated approach where a modified Soil Behaviour Index (I_B) was proposed to demarcate sand-like and clay-like soils. In this method, I_B of 32 represent the lower bound for most sand-like soils and I_B of 22 represent the upper boundary of most clay-like soils. The soil behaviours estimated using Robertson (1990) and Robertson (2016) methods are shown in Figure A5-2 and A5-3 for the two deep SCPT holes.

Robertson (2016) extended the modified classification system by incorporating the dilative and contractive potentials of the soil. A soil identified as “contractive” will develop positive porewater pressures during undrained shear loading therefore tends to be more susceptible to liquefaction and associated strength loss. In contrast, “dilative” soils will generate negative porewater pressure, thereby increases the shear strength and resistance to liquefaction. The soil profiles developed based on the modified method with dilative/contractive potentials are shown in Figure A5-4.

A5.2.2 SAND-LIKE SOILS

The equivalent SPT blow counts (N_{60}) in sand layers generally range from 10 to 20, therefore classified as “compact” (Figure A5-5). The equivalent blow counts estimated using the approach proposed by Jefferies and Davies (1993). Relatively thin dense sand layers with blow counts exceeding 20 were also noticed at some locations, although those appear to be discontinuous. Loose layers with SPT blow counts less than 10 are estimated for the transition layer encountered near the base of the sand layer.

For this site, fines content is an important factor in view of its impact on the liquefaction resistance and deciding the feasibility of certain ground improvement options. Traditionally, the CPT-based fines estimates are considered less reliable, therefore several methods were considered in estimating the fines content. The fines contents estimated using the methods proposed by Suzuki et al (1998) and Robinson et al. (2013) are shown in Figures A5-6 and A5-7, respectively. The variation in fines content was considered in the sensitivity analyses in relation to liquefaction susceptibility and feasibility review of ground improvement alternatives.

Post-seismic shear strengths were estimated using the approach proposed by Idriss and Boulanger (2008). Based on the soil profile, the void ratio distribution is judged to be negligible. The estimated post-seismic shear strengths for the two deep CPTs are shown in Figure A5-8. For the subsequent analyses, a post-seismic shear strength ratio of 0.06 was selected.

A5.2.3 CLAY-LIKE SOILS

The degree of cyclic softening of fine-grained soils is an important consideration given its potential to trigger deep-seated failures that could extend to the building footprint. In such situations, near-surface ground improvements may not entirely mitigate the movement towards Somass River, and will have a significant impact on the project cost if such movements are to be mitigation.

Figure A5-9 shows the peak undrained shear strength estimated using a N_{kt} of 14 as per the method proposed by Lunne et al (1997). According to this plot, the peak undrained shear strength of deep fine-grained soil layers ranges from about 50 kPa to 70 kPa. Figure A5-10 shows the peak undrained shear strength ratios estimated using CPTs for the two deep soil profiles. The shear strength ratio appear to be decreasing with depth and approaches about 0.2, which corresponds to a shear strength ratio of a typical normally consolidated soil. This observation is consistent with the geological history, compressibility and strength characteristics interpreted from CPTs and laboratory tests. As noted above and shown on Figure A5-4, the clay-like soils at this site are identified as contractive according to the modified soil classification presented by Robertson (2016).

Figure A5-11 shows soil sensitivity estimated from CPTs using the method proposed by Robertson (2009). Fine-grained soils are classified as medium to high-sensitive (Canadian Foundation Engineering Manual 2006), with sensitivities mostly ranging from 3 to 6. Generally, the soil sensitivity at this site appears to increase with depth. Figure A5-12 shows soil sensitivities estimated using index tests according to the method proposed by Mitchell and Soga (2005). Four Atterberg Limit Determination tests were available to estimate sensitivity using this method. Except for the test performed at a depth of 23.5 m in BH17-01, the estimated soil sensitivity of the remaining three samples ranged from 4 to 7, which is consistent with the CPT-based interpretations for those samples.

A5.2.4 SOIL BEHAVIOR CLASSIFICATION SUMMARY

In summary, the coarse-grained soils encountered at this site are classified as contractive under undrained shear loading, and are therefore highly susceptible to cyclic liquefaction.

The fine-grained soils at this site are compressible with a light over-consolidation. With estimated moderate to high sensitivities, these soils are susceptible to significant strength loss from disturbances caused by cyclic loading.

The estimated soil behaviours are consistent with the geological interpretations. Design implications of these soil behaviours are discussed in the following sections.

A5.3 GROUND MOTIONS

A5.3.1 SEISMIC HAZARD

The site is located in a high seismic zone due to its close proximity to the Cascadia Subduction Zone located off the west coast of Canada. As a result, the seismic hazard at this site is influenced by the following three types of earthquake sources (Adams and Halchuk, 2003):

- **Shallow Crustal Earthquakes (Crustal):** These earthquakes occur in the overriding North American plate at depths of about 10 to 20 km. The earthquake magnitude generally ranges from about M6.5 to M7.5 with strong shaking lasting for about 10 to 15 seconds. An example of this earthquake is the 1943 M7.3 Central Vancouver Island earthquake. Hodgson (1946) reported the details of an undersea power line that was destroyed in the Alberni Inlet, amongst various other damages occurred in the Port Alberni area.
- **Deep In-Slab Earthquakes (In-Slab):** These earthquakes occur at a depth of about 40 to 60 km, at or below the subducting slab between southern Puget Sound and southern Gulf Islands. The earthquake magnitude generally varying from M6.5 to M7.5 with 15 to 30 seconds of strong shaking. Examples of this type of earthquakes include the 1949 and 1965 Puget Sound Earthquakes and 2001 Nisqually Earthquake.

- **Cascadia Megathrust Earthquakes (Interface):** These earthquakes occur at the interface of Juan de Fuca and North American plates. The earthquake magnitude is expected to be range M8.0 to M9.0 with 1 to 2 minutes of strong shaking. The Cascadia interface has been seismically quiescent in the recent history, preventing the use of recent seismicity data to estimate the recurrence rate for these events. As a result, recurrence rates have been estimated using paleoseismic evidence, such as coastal subsidence and tsunami deposition.

Seismic hazard values corresponding to the 2475-year return period design event were obtained from the interactive website http://www.earthquakescanada.nrcan.gc.ca/index-eng.php maintained by the Geological Survey of Canada (GSC). At the time of preparing this report, the 2015 National Building Code of Canada (NBCC) seismic hazard values were available. However, as the British Columbia Building Code (BCBC) has not been updated to adopt the 2015 NBCC seismic hazard values, WSP was informed to undertake the seismic analysis using the 2010 NBCC values as per the 2012 BCBC requirements.

Table A5-1 Spectral Response Accelerations for Site Class C for 5% Damping (as per 2010 NBCC)

PGA	SA(0.2)	SA(0.5)	SA(1.0)	SA(2.0)
0.354	0.758	0.564	0.303	0.161

Source : Geological Survey of Canada

For the liquefaction triggering analyses discussed in the following section, an earthquake magnitude (M_w) of 7.0 was selected for the Crustal and In-Slab events and an M_w of 8.5 was selected for the Interface event.

A5.3.2 GROUND MOTION DEVELOPMENT

The following factors were considered in the selection of ground motion suite:

- Both Crustal and In-Slab ground motions were matched to periods less than 1 seconds and Interface motions were matched to periods between 1 second and 10 seconds.
- Scaling was undertaken such that the average response spectrum of each suite of time histories was not more than 10% below the target spectrum over the period range of interest.
- For each seismic source, a suite of five earthquake time histories were developed. Seismic design parameters (e.g., cyclic shear stresses) were selected by computing the average response of the five motions for each seismic source, followed by selecting the maximum response of the three average responses.

CRUSTAL MOTIONS

The seed motions for Crustal earthquake sources were obtained using the Pacific Earthquake Engineering Research Center (PEER) web-tool that can be accessed through http://ngawest2.berkeley.edu. This interactive database is a repository of shallow crustal ground motions records obtained from various parts of the world. The web-tool also allows users to select and download seed motions that have the best spectral match to a target spectrum. The goodness of fit is measured by computing the Mean Squared Error (MSE) between the target spectrum and response spectrum of the scaled ground motion.

The candidate motions were selected subject to the following conditions:

- Scaling factors – between 0.25 and 4.0
- Earthquake magnitude, Mw – between M6.0 and M7.5
- Closest distance/horizontal distances to rupture plane (i.e., R_jb and R_rup) – between 10 km and 30 km
- For the purpose of matching the target spectrum, the period range of interest was selected between 0.1 and 1 seconds.

From this database, five candidate motions were selected by ranking them with respect to MSE, scaling factors and fault mechanisms. No more than two seed motions were selected from a given historical event.

IN-SLAB MOTIONS

For the In-Slab seismic source, the seed motions were obtained from the COSMOS Strong-motion Virtual Data Centre (http://strongmotioncenter.org/vdc/scripts/earthquakes.plx). The candidate motions were scaled and spectrally matched to the target response spectrum for periods less than 1 second. If necessary, the motions were baseline corrected using the SeismoSignal (SeismoSoft 2016) program.

SUBDUCTION (INTERFACE) MOTIONS

The uniform hazard response spectrum given in the 2010 NBCC does not include contributions from the Cascadia subduction event, as such, the seismic hazard from such events were estimated using a deterministic approach. However, in the 2015 NBCC, the Cascadia subduction earthquake zone was considered as a separate zone model and combined probabilistically with other models. The 2015 NBCC provides spectral accelerations compatible with the 2,475-year hazard, which was selected for developing ground motions for the Interface event.

The seed motions for the Interface seismic sources were obtained from the recent Japanese earthquakes which have recorded earthquake magnitudes that ranged from M8.0 to M9.0. This range of earthquake magnitudes are expected from a partial to full-length rupture of the Cascadia fault line (e.g., Hyndman and Rogers, 2010; Goldfinger et al., 2012). The records were scaled to match the spectral shapes of periods greater than 1 second.

A5.3.3 SUMMARY OF DESIGN SEISMIC MOTIONS

The details of 15 seed motions are given in Table A5-2. The acceleration time histories of these ground motions are shown in Figures A5-13(a) through (c). The response spectra of the scaled motions with respect to the target spectrum are shown in Figure A5-14.

Table A5-2: Details of Seed Motions Selected for Each Seismic Source

	ID	Earthquake	Year	Recording Station	M_w	R_{rup} (km)
Crustal	CR1	Loma Prieta	1989	Capitola Fire Station	7.0	20
	CR2	San Fernando	1971	DOT highway department sta.	6.6	36
	CR3	San Fernando	1971	LA - Hollywood Stor FF	6.6	25
	CR4	Imperial Valley	1979	Calipatria Fire Station	6.53	25
	CR5	Imperial Valley	1979	Cerro Prieto	6.53	15
In-Slab	IS1	Nisqually, WA	2001	USGS 7032	6.8	75
	IS2	Nisqually, WA	2001	USGS 7032	6.8	75
	IS3	El Salvador	2001	R110_DB-7175 (180)	7.6	60
	IS4	El Salvador	2001	R110_DB-7175 (270)	7.6	60
	IS5	Tarapaca, Chile	2005	R0_IQUIQUE IDIEM-Ln	7.8	115
Subduction (Interface)	IF1	Tohoku, Japan	2011	R209_YMT008	9.0	~210
	IF2	Tohoku, Japan	2011	R209_YMT008	9.0	~210
	IF3	Tokachi-oki Japan	2003	Noya, R152 HKD107-EW	8.0	~130
	IF4	Tokachi-oki Japan	2003	Noya, R152 HKD107-NS	8.0	~130
	IF5	Tokachi-oki Japan	2003	Ebetsu, R245 HKD181-EW	8.0	~230
	IF5	Tokachi-oki, Japan	2003	Ebetsu, R245 HKD181-NS	8.0	~230

Notes: Mw – Moment magnitude, Rrup – the shortest distance to the rupture plane and ID – assigned identification number for the earthquake.

Besides spectral accelerations, other characteristics of the input ground motion are recognized to have a significant impact on the seismic displacements (Bray and Travasarou 2007, Yegian et al. 1991; Kim and Sitar 2004; Athanasopoulos-Zekkos 2008). According to previous studies, these parameters include, but not limited to, Peak Ground Acceleration (PGA), Peak Ground Velocity (PGV), mean period (T_m), Arias Intensity (I_a), significant duration ($D_{5\text{-}95}$), elastic spectral acceleration at the degraded fundamental period ($Sa(1.5^*T_s)$), Root Mean Square Acceleration (a_{rms}), Characteristic Intensity (I_c). A summary of these ground motion parameters are given in Table A5-3 for each input motion and also some select parameters are plotted in Figure A5-15.

A5.4 SITE-SPECIFIC SIMPLIFIED LIQUEFACTION ASSESSMENT

A5.4.1 GROUND RESPONSE ANALYSES

To estimate the near-surface seismic ground response and seismic demands for liquefaction triggering, one-dimensional (1D) site-specific ground response analyses were undertaken at the two initially proposed building locations. This analysis was performed using SHAKE2000 (Ordonez, 2013), which employs an equivalent-linear total-stress approach.

SOIL INPUT PARAMETERS

The modulus degradation and damping curves selected for each soil type are summarized in Table A5-4 and also shown in Figure A5-16 and A5-17 for the two generalized soil profiles.

Table A5-4: Modulus degradation and damping curves selected for each soil type

SOIL TYPE	MODULUS DEGRADATION AND DAMPING CURVES
Clay and Silt	Vucetic and Dobry (1991) curves
Sand, Sand and Gravel Mixtures	Seed et al. (1986) upper bound curve for modulus degradation and lower bound curve for damping.
Till-like	EPRI (1993)

The shear wave velocity profiles were primarily developed from SCPTs and are shown in these plots. As stated previously, the available information is not sufficient to confirm the depth to firm ground (i.e., till or bedrock). SCPT17-01 was terminated at a depth of 31 m, which was the maximum targeted depth of investigation, while SCPT17-02b was terminated at a depth of 32 m due to effective refusal related to instrument inclination and the potential for instrument damage. For the ground response analyses, the elastic-half space was considered at a depth 40 m.

A5.4.2 LIQUEFACTION SUSCEPTIBILITY

A simplified liquefaction triggering assessment was conducted in accordance with the procedure outlined by Idriss and Boulanger (2008). The intent of this simplified analysis was to supplement and confirm the results obtained from advance numerical modeling performed using FLAC. The seismic demand in the form of Cyclic Stress Ratio (CSR) was estimated from the SHAKE analysis. As stated previously, the design CSR was selected as the maximum of three averages computed for the three seismic sources.

LIQUEFACTION SUSCEPTIBILITY OF SAND-LIKE SOILS

A soil exhibiting sand-like behaviour is considered susceptible to liquefaction if the Factor of Safety computed from the above approach is less than 1.1. Under such conditions, the excess porewater pressure ratio (R_u) in soil is expected to be greater than 0.75. R_u is expected to be small for soils with Factor of Safety greater than 1.4, as such strength and stiffness degradation under seismic loading can be disregarded. In soil layers with a Factor of Safety between 1.1 and 1.4, the generation of excess porewater pressure may still result in considerable degradation of strength and stiffness, although it is less severe than that for fully liquefied soils.

For the liquefaction triggering assessment, the resistance to liquefaction (i.e., Cyclic Resistance Ratio, CRR) of sand-like soil was primarily determined using CPTs. CRR of sand-like soils was calculated according to the method outlined by Idriss and Boulanger (2008). In this assessment, the fines content was estimated using the correlation proposed by Suzuki et al., (1998), as this method provide a lower-bound estimate for fines content (i.e., conservative in terms of liquefaction resistance).

CYCLIC FAILURE POTENTIAL OF CLAY-LIKE SOIL

Clay-like soils can also develop porewater pressures during undrained cyclic loading, but generally do not reach zero effective stress. As a result, the degree of strength and stiffness degradation is not significant as in sand-like soil. Nevertheless, soft normally or lightly overconsolidated clay-like soils can develop large positive porewater pressures that can trigger potentially large ground deformations depending on the ground geometry, sensitivity and external building loads.

For clay-like soils, the potential for cyclic softening was estimated based on CPTs using the approach proposed by Idriss and Boulanger (2008). In this approach, $\mathrm{CRR}_{\mathrm{M}=7.5}$ of clay-like soils was estimated using the following:

$$CRR_{M=7.5} = 0.8 \ \times S \times (OCR)^{m}$$

Where, *S* is the peak undrained shear strength ratio at normally consolidated state and *m* is an exponent determined from the SHANSEP method (Ladd and Foott 1974). The shear strength ratio (S) and OCR were estimate from CPTs, while the exponent, *m* was taken as 0.8.

The susceptibility of these soils to liquefaction or cyclic softening was also assessed using the empirical methods proposed by Bray and Sancio (2006) and Seed et al. (2003), and the results are plotted in Figure A5-18. With the exception of an index test completed at a depth 23.7 m, the remaining four index tests indicate that fine-grained materials as moderate to low susceptible to liquefaction and cyclic softening. The soil sample collected at a depth of 23.7 m is classified as potentially liquefiable (or cyclic softening), and may have been sourced from a relatively low plastic silt layer. These index-based approaches do not directly consider the intensity, duration of seismic loading and shear strength of the soil, therefore prominence was given to the CPT-based assessment.

A5.4.3 SUMMARY OF LIQUEFACTION ASSESSMENT

The CSR, CRR and Factor of Safety plots for the two building sites are shown in Figures A5-19(a) and (b). The key observations of the liquefaction triggering assessment are as follows:

- Loose to compact sand-like soils encountered in the upper 20 to 24 m are identified as potentially liquefiable. The total thickness of soil layers identified as liquefiable is 9 m at SCPT17-01 and 12.5 m at SCPT17-02b. The liquefiable layers are highlighted in yellow in Figures A5-19(a) and (b).
- The clay-like soils encountered at depths greater than 20 to 24 m are at low risk of cyclic softening with a Factor of Safety exceeding 1.1.

A5.5 TWO-DIMENSIONAL NUMERICAL (FLAC) MODELING

A5.5.1 GENERAL

Considering the limitations in the simplified liquefaction assessment in sites that are prone to liquefaction and large ground displacements, two-dimensional (2D) ground deformation analysis was completed using FLAC. This finite-difference program utilizes an explicit solution scheme which is suited for conducting liquefaction-induced ground deformation analyses for sites likely to undergo significant geometry changes. For this project, the main intent of performing FLAC analysis was to identify the ground deformation mechanism and risks of deep-seated failures.

This 2D modeling approach overcomes many limitations in the 1D simplified analysis and generally perceived to provide a more realistic indication of the displacement pattern and magnitude. It is important to note that strong shaking would generate significant excess porewater pressures and lead to highly nonlinear soil response and liquefaction, which are not explicitly captured using an equivalent-linear approach. Based on our review of the data, it is our opinion that the SHAKE analysis is sufficient to estimate liquefaction triggering while the FLAC analysis identifies the displacement mechanism and order of magnitude displacement.

A5.5.2 MODEL DETAILS

The 2D model established using a ground profile provided by Associated aligned in the northwest/southeast direction was selected for FLAC modeling. Soil profile in the model was based on the conditions encountered at the boreholes and assumptions that these conditions extended laterally beyond the test hole locations.

The layering and mesh used in the FLAC model are shown in Figure A5-20. The model is about 40 m deep and 450 m wide, and includes about 17000 elements of approximately 1 m x 1 m soil elements. The primary focus of this analyses was the Aeration/UV building which is closest to the river and has the highest risk of failure caused by ground movements. With sharp topographical changes towards the river near ground surface, this ground profile in general is considered to represent the most critical condition for a seismic ground deformation assessment.

Average ground displacements associated with In-Slab and Interface ground motions suites were found to be similar to the following individual ground motions: 2001 Nisqually (IS2) and 2003 Tokachi-oki (IF3) respectively. Accordingly, results for analyses conducted with these ground motions are presented on the attached Figures.

For modeling the seismic wave propagation, Kuhlemeyer and Lysmer (1973) recommended an element size smaller than 1/10th to 1/8th of the wave length associated with the highest frequency component of the input wave. Based on this recommendation, for a 1 m thick soil element with a minimum near-surface shear wave velocity of about 100 m/s, the maximum frequency that is transmitted through the soil column is estimated to be about 20 Hz. This is considered acceptable as the power spectrum obtained by filtering the frequency contents greater than 20 Hz is not significantly different to that of the unfiltered motion.

Compliant (absorbing) boundary conditions were used at the base of the model, in which the seismic input motion was applied as a shear stress time history. The model was extended at least 5 m into the lower boundary zone in order to reduce base rotations and beam-like deflections that may occur when compliant boundary conditions are imposed to the model base.

Free-field boundary conditions were applied to the sides of the model and boundary zones were introduced between the lateral boundary and potentially liquefiable soils. These zones tend to eliminate numerical issues that sometimes arise by having free-field conditions near to liquefiable soils zones. The general slope failure mechanism is not impacted by these boundary layers as these layers are located sufficiently far away from the location of interest (i.e., two buildings).

Flow mode was on during shaking.

A5.5.3 CONSTITUTIVE MODELS AND SOIL INPUT PARAMETERS

The granular soil layers were modeled using the user-defined UBCSAND constitutive model developed by Professor Peter Byrne and his co-workers (e.g. Byrne et al., 2004, Beaty and Byrne, 2011). UBCSAND is an effective stress plasticity model developed primarily for sand-like soils likely to experience variations in effective stress due to porewater pressure build-up and degradation of stiffness due to seismic loading. As a result, the UBCSAND model is used extensively in advanced seismic assessment that involve modeling of dynamic response of soils with potential for liquefaction, cyclic mobility or softening. The model adopts a hyperbolic relationship between shear stress ratio and plastic shear strain, and estimates the plastic volumetric response using a flow rule that is a function of the stress ratio. The model is also capable of simulating the “banana-shaped” loops in the stress versus strain plots, resulting from shear-induced dilation as it repeatedly crosses the phase transformation line during undrained cyclic shearing.

The 904aR version of the UBCSAND model (Beaty and Byrne 2011) was used in this analysis. The model was calibrated by simulating the cyclic response of a single soil element under simple shear loading, and matching the empirical liquefaction triggering relationship recommended by Idriss and Boulanger (2008). The 904aR version was also calibrated to capture the static bias ($K_{\square}$) and overburden stress ($K_{\square}$) effects of sand-like soils (Beaty and Byrne 2011). Further details relating to the UBCSAND formulation can be found in Beaty and Byrne (2011). The cyclic resistance of each layer was determined based on the equivalent corrected, clean sand SPT blow count, $(N_1)_{60,cs}$ estimated from CPTs.

Material located above the groundwater table and other non-liquefiable materials were modeled using the Mohr-Coulomb constitutive model. The hysteresis damping of these materials was modeled using the built-in “sig-4” model. As the constitutive models and hysteresis damping are insufficient to produce sufficient damping at small strain levels, a small amount of full Rayleigh damping (both mass-proportional and stiffness-proportional), equal to 0.5% of critical damping at a frequency of 0.5 Hz, was applied.

A5.5.4 MODELLING APPROACH

The general steps involved in the FLAC analyses are summarized below:

- **Static equilibrium:** The model was brought to mechanical and groundwater flow equilibrium in several steps by switching off the dynamic mode. During this process, the initial static equilibrium was achieved by using the linear elastic model, followed by the Mohr-Coulomb model. The in-plane and out-of-plane horizontal stresses ($\square_{xx}$ and $\square_{zz}$) were adjusted by specifying a lateral earth pressure coefficient of 0.45. After achieving the static equilibrium using the Mohr-Coulomb model, the model was again brought to static equilibrium by assigning the UBCSAND constitutive model to the potentially liquefiable soils.
- **Dynamic analysis:** Prior to initiating the dynamic analyses, Rayleigh damping, compliant and free-field boundary conditions were activated. Groundwater flow was allowed during the dynamic analyses. Remeshing algorithms were utilized to allow the model to run without causing numerical instabilities caused by large mesh distortions. Several other subroutines were used to track the maximum stresses in ground improved zones, excess porewater pressures, displacements, etc.
- **Post-Seismic Static Equilibrium:** The post-seismic residual shear strengths were assigned for elements exceeding R_u of 0.75. Once modelling of shaking was complete, the model was allowed to run until excess porewater pressures dissipated and displacements became stable.

A5.5.5 LIQUEFACTION POTENTIAL

Figure A5-21 shows R_u estimated at the end of shaking for the two ground motions. As stated previously, the layers with $R_u > 0.75$ were considered liquefiable. These plots indicate that most soils in the upper 20 to 25 m are susceptible to liquefaction. In general, the results from FLAC analyses are consistent with the results obtained from the simplified liquefaction triggering assessment discussed previously.

Notwithstanding, soil layers that were identified as at low risk of liquefaction in the SHAKE analyses will also be subject to some degree of softening due to migration of excess porewater pressures from liquefiable layers. As a result, the extent of liquefaction is more severe in the FLAC analyses. Figure A5-22 shows the buildup of R_u for the IS2 (In-Slab) event at different time intervals. For this seismic event, most liquefaction susceptible soils are predicted to liquefy after 15 seconds of strong shaking.

According to the FLAC analyses, the estimated R_u in clay-like layers is less than 0.3 at the two building locations. In clay-like soils, the strength and stiffness loss become significant if R_u exceeds about 0.5 (Wijewickreme and Sanin 2010). At or near the Somass river, clay-like soils may develop R_u values greater than 0.5, which may contribute to the significantly large ground displacements (i.e., flow slide like) predicted at this location.

Seismically induced movements (vertical and lateral) are estimated for unimproved ground conditions in Sections A5.5.6, 7 and 8 below and are summarized in Table A5-5 in Section A5.5.9.

A5.5.6 POST-SEISMIC SETTLEMENT

- **2D FLAC Analyses:** At present, post-seismic volumetric strains due to reconsolidation of liquefied soils cannot be accurately modelled using constitutive models such as UBCSAND. This is mainly because majority of the post-seismic reconsolidation strains are associated with the sedimentation process, which cannot be easily incorporated into a constitutive model (Boulanger and Ziotopoulou 2015). As a result, the post-seismic volumetric strains for this project were estimated separately using the approach outlined by Ishihara and Yoshimine (1992), in which the maximum shear strains estimated using FLAC was used along with the initial relative density of the soil layers.
- **Simplified Methods:** The post-seismic settlements were also estimated using several simplified approaches. As such, the “free-field” post-seismic settlement was estimated using the approaches proposed by Wu (2001), Zhang et al. (2002), Ishihara and Yoshimine (1992) for sand-like soils. The methods are mainly based on the laboratory test results conducted on clean-sand or sands with small amounts of fines. The post-seismic volumetric strains of potentially liquefiable silt layers were estimated using the approach proposed by Wijewickreme and Sanin (2004).

  For shallow foundations, additional “shear-induced” settlements will contribute to the total settlement. The estimation of this shear-induced settlement is complex and depends on the foundation type and ground improvement option. Furthermore, additional vertical displacements will occur due to lateral movements. As per Seed et al (2003), the vertical displacement associated with this lateral movement is expected to range from about 10 to 20% of the lateral displacement.

A5.5.7 LATERAL SPREAD

- **2D FLAC Analyses:** Figure A5-23 shows the horizontal displacement contours estimated at the end of shaking, and Figure A5-24 shows the displacement time histories at the building locations for the average in-slab and interface seismic events. Without any ground improvement, the horizontal ground displacements for the In-Slab input motion is estimated to result in movements of 0.3 m at the Screening building and 0.6 m at the Aeration/UV building. The estimated movements for the Interface event is about 1.5 m at the Screening building and 2 m for the Aeration/UV building. These results are in general agreement with the displacements independently obtained from the simplified methods (discussed below).
- In general, considerably larger displacements were predicted for the Interface motions (i.e. IF3). It is interpreted that the long duration of the Interface motion contributes to the greater accumulation of displacements since liquefaction is predicted to occur within a few seconds of shaking. The larger ground displacements may also be explained using the indicators such as Arias and Characteristic Intensities, which generally correlate well with the ground displacement. As indicated in Figure A5-15, these indices are significantly higher for the Interface motions than those estimated for the In-Slab and Crustal motions.
- **Simplified Methods:** For comparison and validation purposes, lateral spread displacements were also estimated using simplified approaches that are commonly used in practice including empirical approaches such as Youd et al. (2002, 2009), and semi-empirical approaches such as Zhang et al (2004) and Faris (2004). Lateral spread was estimated using general ground slopes of 2% to 7% (i.e. ignoring the potential influence of the berms) and liquefiable layers identified from the simplified liquefaction triggering analyses. Without ground improvement, lateral displacements in the order of 1 m and 3 m were estimated using these simplified methods for the Screening and Aeration/UV building locations, respectively. The lateral displacement profiles estimated using the simplified approaches are shown in Figure A5-24.

A5.5.8 FLOW SLIDE POTENTIAL

FLAC analyses indicate very large displacements (flow slide like conditions) occurring proximity to the Somass River. It is important to note that Hodgson (1946) and Rogers (1980) reported a failure of a cable line in the Alberni inlet, likely caused by submarine slope failure occurred during the 1946 earthquake. This is indicative of the potential ground failure risks at this site. However, the FLAC analyses indicate that the risk of such movements extending to the building site is small if ground improvement is undertaken. The Aeration/UV building is at a higher risk compared to the Screening building given its proximity to the River and steeper topographical conditions.

Notwithstanding this, the containment berms are not designed to the same seismic performance levels as the buildings and seismically induced failure of the berms is possible (although explicit review of existing berm stability was beyond the scope of this assignment). This could lead to localized flow failures that could regress into the building footprint area. Considering the indirect impact of berm failure on the building, ground improvement may need to be extended further away from the building perimeter. This potential for flow failure should be considered in the selection of a preferred ground improvement technique.

A5.5.9 SUMMARY OF FLAC ANAYLSES - DEFORMATIONS

Post-seismic displacements obtained from FLAC and simplified methods for the building site without ground improvement are summarized in Table A5-5. In summary:

- Without ground improvement, the simplified methods and FLAC analyses estimate a total post-seismic settlement in the range of 400 mm to 800 mm.
- Without ground improvement, lateral displacements is estimated to be in the order of 1 m for the Screening Building and 3 m for the Aeration/UV building.

Considering the inherent limitations in estimating in post-seismic displacements, the actual displacements are generally considered to range from 50% to 200% of the estimated values.

Table A5-5 Post-Seismic Displacements (Without Ground Improvement)

	Method		Aeration and UV building	Screening building
Post-Seismic Settlement	Simplified methods		0.4 to 0.8 m	0.4 to 0.8 m
	FLAC		0.4 to 0.8 m	0.4 to 0.8 m
Lateral Spreading	Simplified method		1 to 3 mm	1 to 2 m
	FLAC	In-Slab	0.6 m	0.3 m
		Interface	3 m	2 m

5.5.10 GROUND IMPROVEMENT MODEL

The predicted ground displacements are relatively large for a site that is required to support post-disaster structures. Therefore, the following ground improvement options were considered in the FLAC analyses to meet the seismic performance objectives of these two structures.

- Deep Soil-Cement Mixing Method (DMM)
- Compaction Piles:
- Geopier Grouted Impact® Pier System:

The depth and lateral extent of ground improvement was varied and analyses indicated that ground improvement should extend a minimum of 15 m below the foundation. The lateral extent of improvement was dependent upon the ground improvement method. Translational displacement of the ground improved zone may occur through a slip surface that develops below the ground improved zone.

DEEP SOIL-CEMENT MIXING

For the Deep Soil Cement Mixing (DSM) option, an equivalent shear strength of 250 kPa was selected for the DSM zone which extends. The FLAC model with the proposed DSM zone at Aeration/UV building is shown in Figure A5-26. The model indicated that ground improvement should extend a minimum of 5 m laterally beyond the foundation perimeter.

The estimated displacement time histories and displacement contours are shown in Figures A5-27 (a) and (b) for in-slab and interface ground motions. The maximum shear strains and excess porewater pressure ratios at the end of shaking are shown in Figure A5-28 for the interface ground motion. The FLAC analyses indicated that stresses within the improved ground zone are within than the design equivalent shear strength of 250 kPa.

As shown in Figures 27 and 28, the failure surface is expected to extend up to the DSM zone. However, within the ground improved zone below the buildings, ground movements are predicted to be relatively uniform due to the rigidity and high shear strength of the DSM zone.

Similar to the analyses conducted for the existing ground conditions, the largest ground deformations were obtained for the Interface event. For this event, the estimated lateral displacement at the Aeration/UV building and Screening buildings is about 1.0 m, and 0.8 m, respectively. These displacements are about five times larger than the displacements estimated for the In-Slab event. The estimated post-seismic settlement is 200 mm for the two buildings.

COMPACTION PILES AND GEOPIERS

For the compaction pile and Geopier options, FLAC analyses were performed assuming an equivalent clean-sand penetration resistance, $(N_1)_{60,cs}$ of 22 for the densified zone. The FLAC analyses indicated that the improved zone should extend laterally a minimum of 6 m from the building foundation perimeter.

For the Aeration/UV building, FLAC analysis indicate lateral displacements in the order of 1 m for the IF3 (interface) motion, and about 0.2 m movement for IS2 (inslab) motion. Similar to the DMM option, the failure plane extends to the building footprint (e.g., Figure A5-29). The estimated post-seismic settlement is 250 mm for the two buildings.

It should be noted that ground movement within the ground improved zone is possible with the compaction pile/geopier alternative.

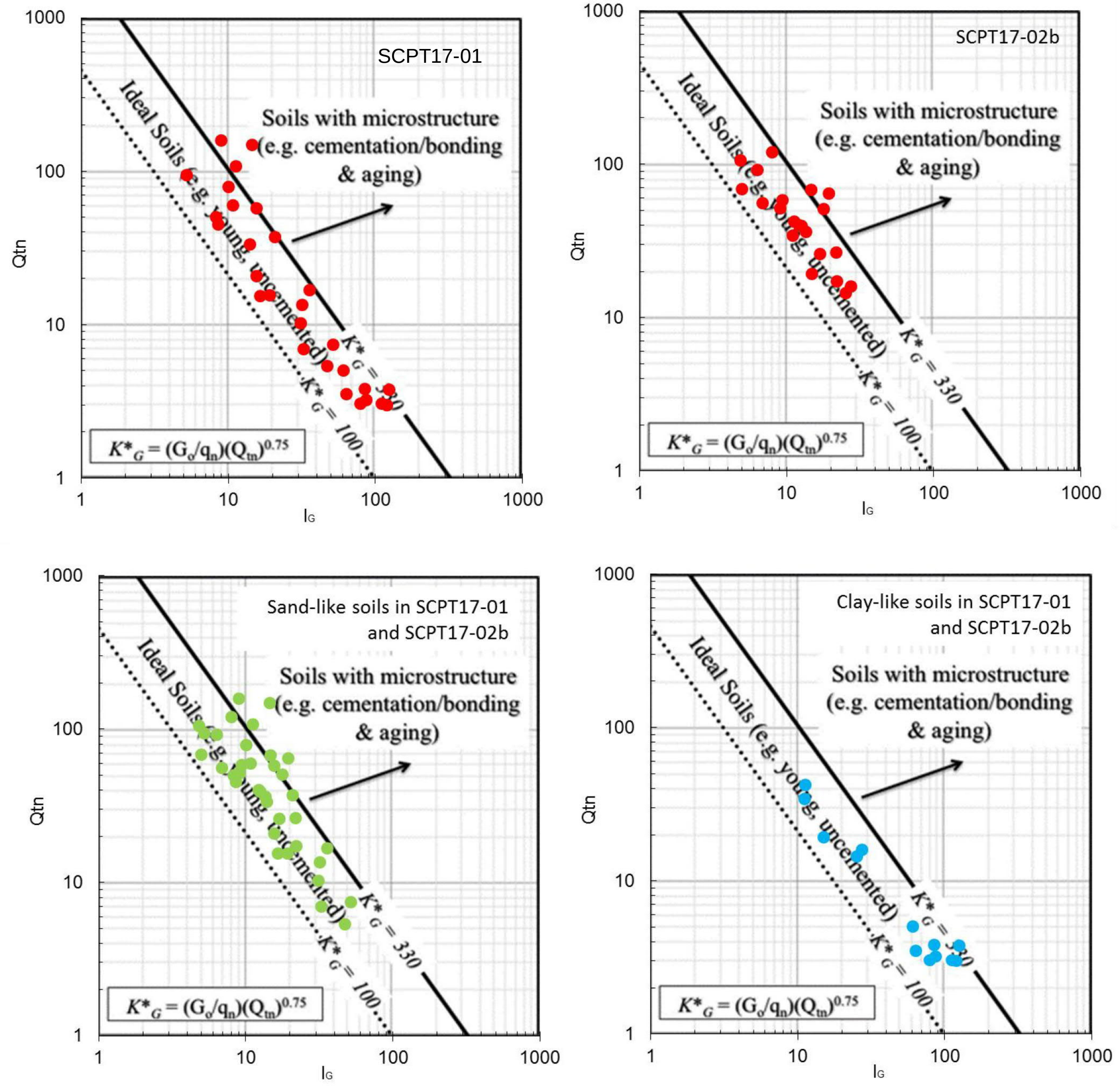
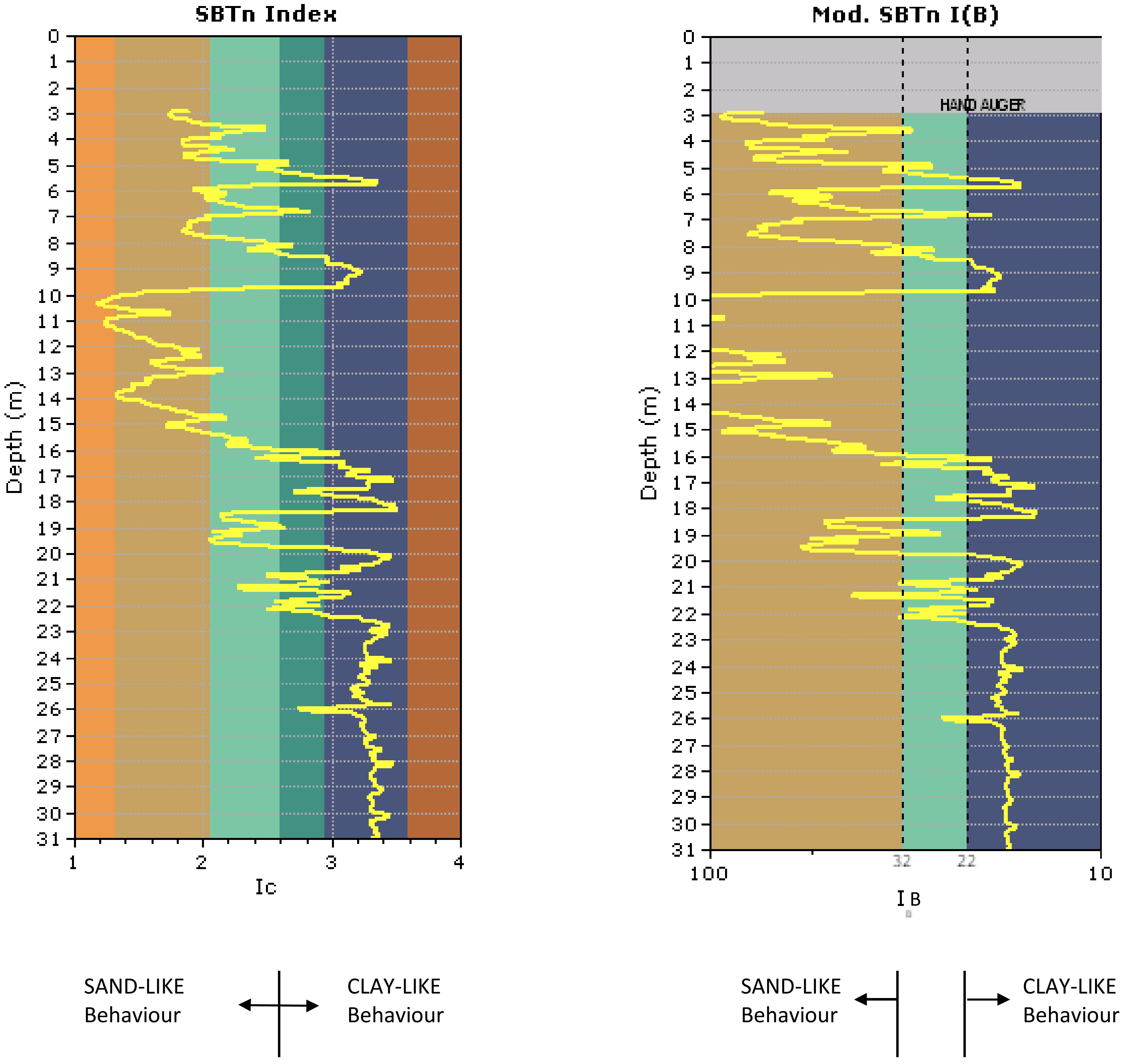


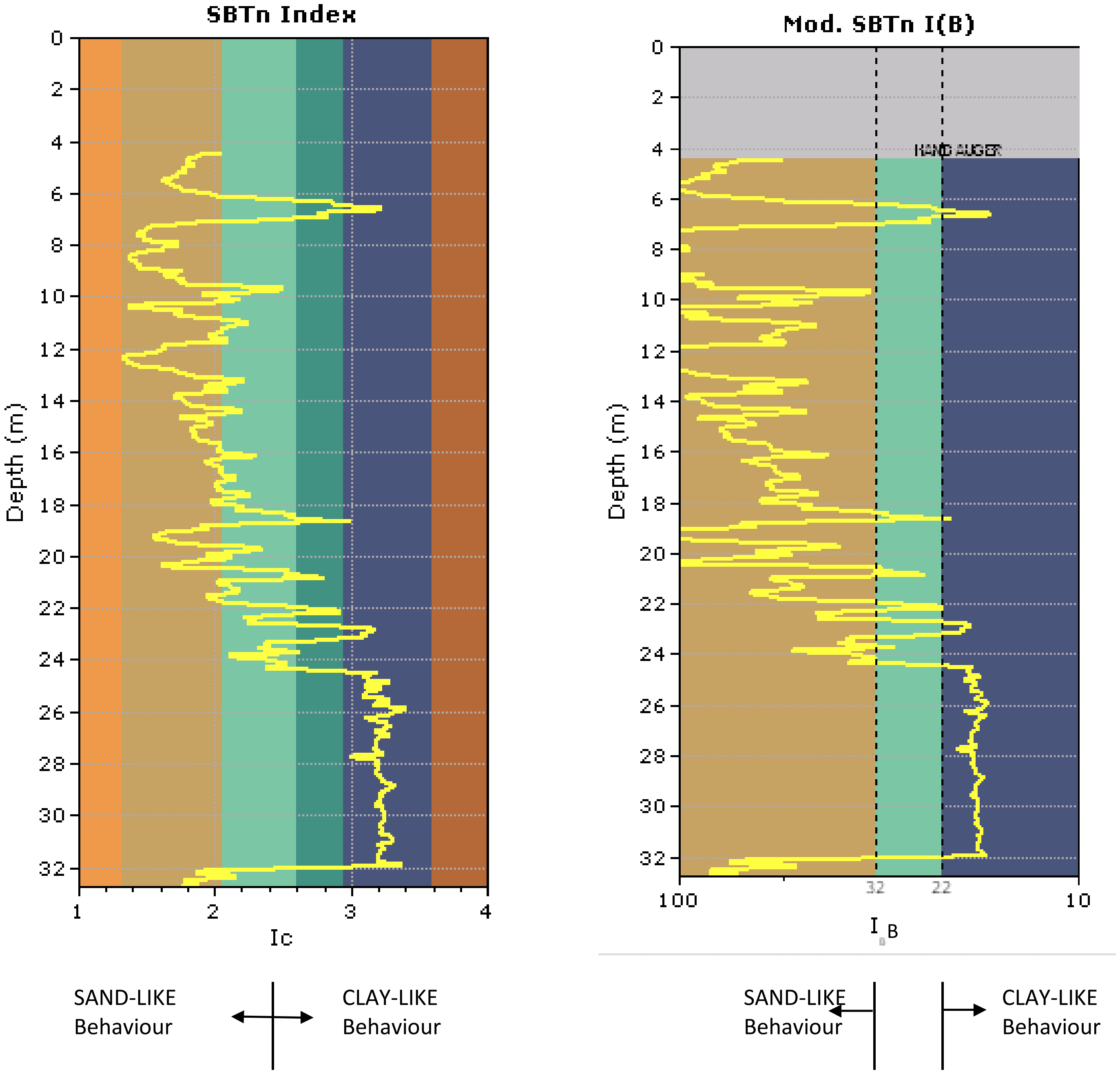
Figure A5-1 - Q_{tn} and I_G Plots for (a) SCPT17-01, (b) SCPT17-02b (c) Sand-Like and (d) Clay-Like Soils



(a)

(b)

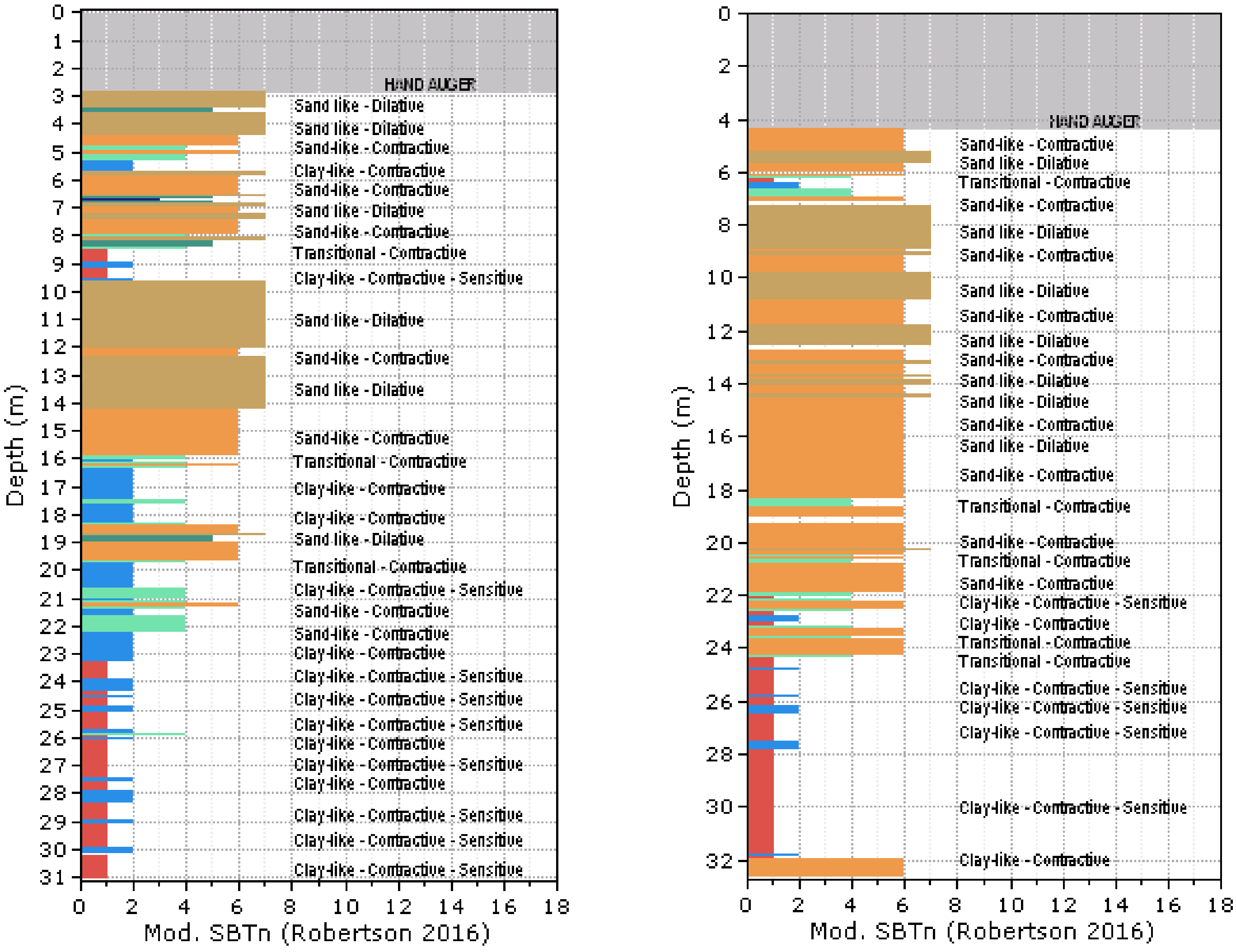
Figure A5-2 Soil Behavior Classifications as per the (a) Robertson (2009) and Robertson (2016) methods for SCPT17-01



(a)

(b)

Figure A5-3. Soil Behavior Classifications as per the (a) Robertson (2009) and Robertson (2016) methods for SCPT17-2b



(a)

(b)

Figure A5-4 Dilative and contractive potentials estimated based on the method proposed by Robertson (2016) methods for (a) SCPT17-01 and (b) SCPT17-02b. Contracine = soils are more likely to develop pore water pressure and therefore more susceptible to liquification and/or strength loss.

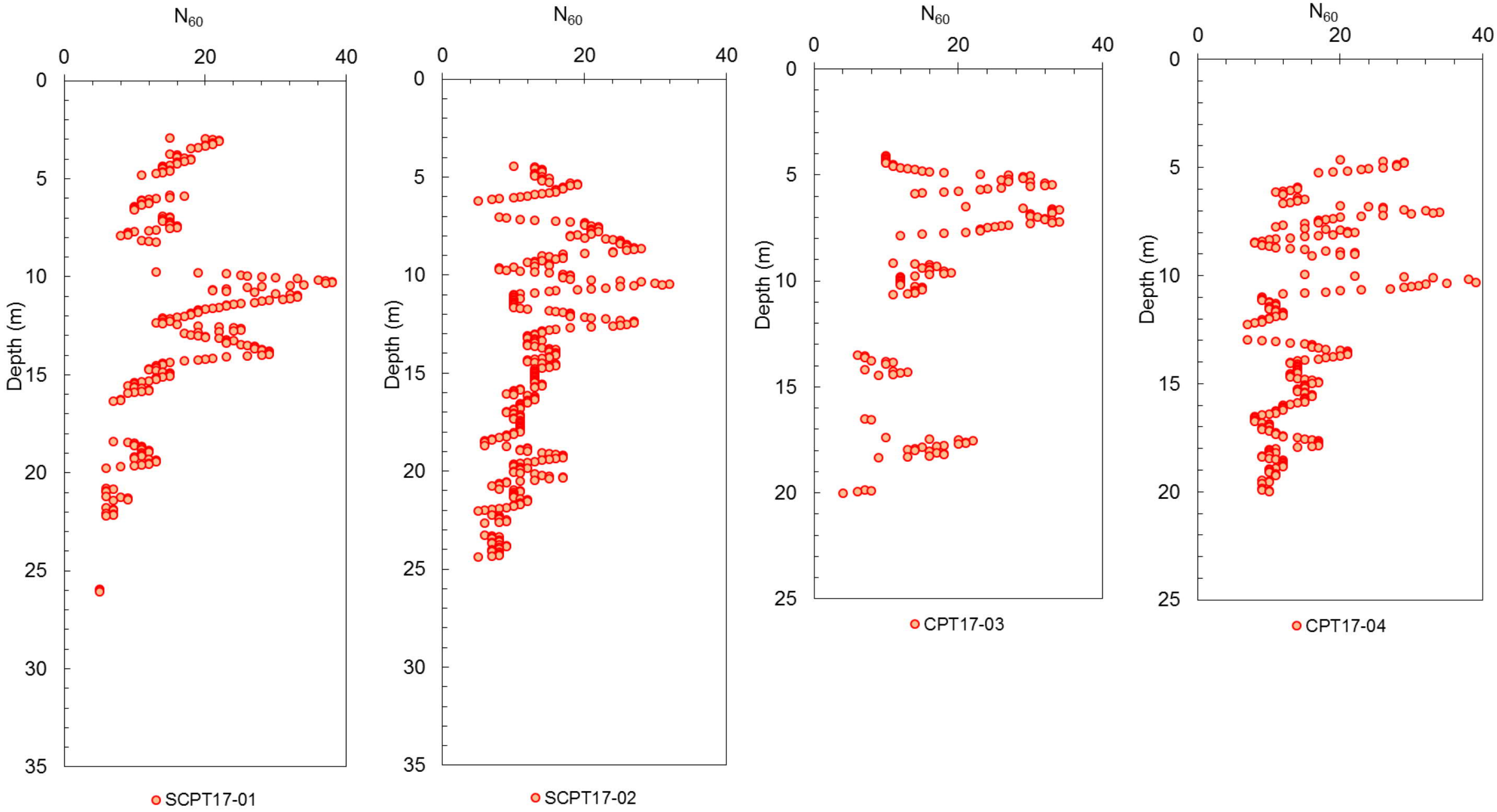


Figure A5-5. SPT N_{60} values estimated from CPTs using Jeffries and Davies (1993)

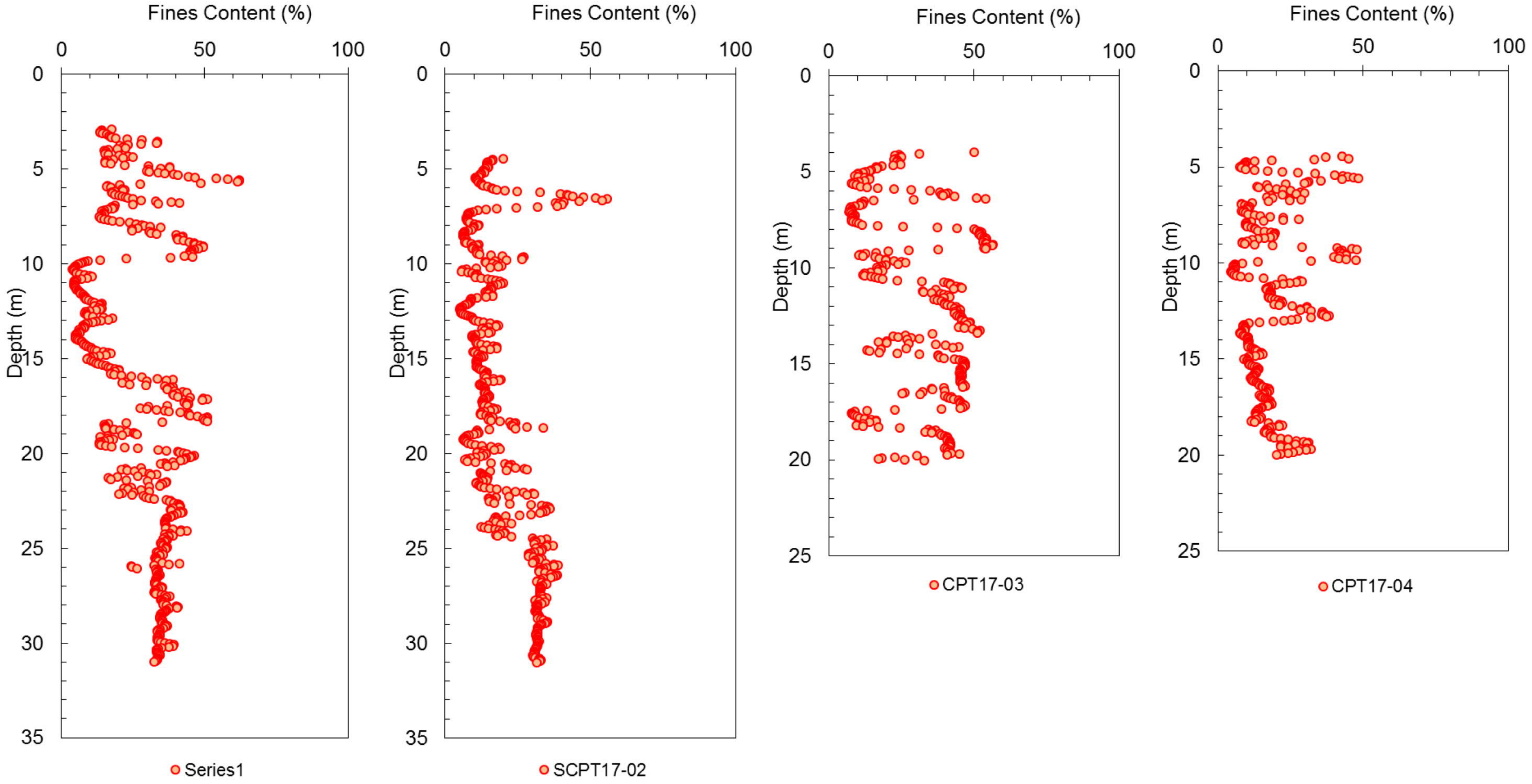


Figure A5-6 Fines contents estimated using the method proposed by Suzuki et al (1998)

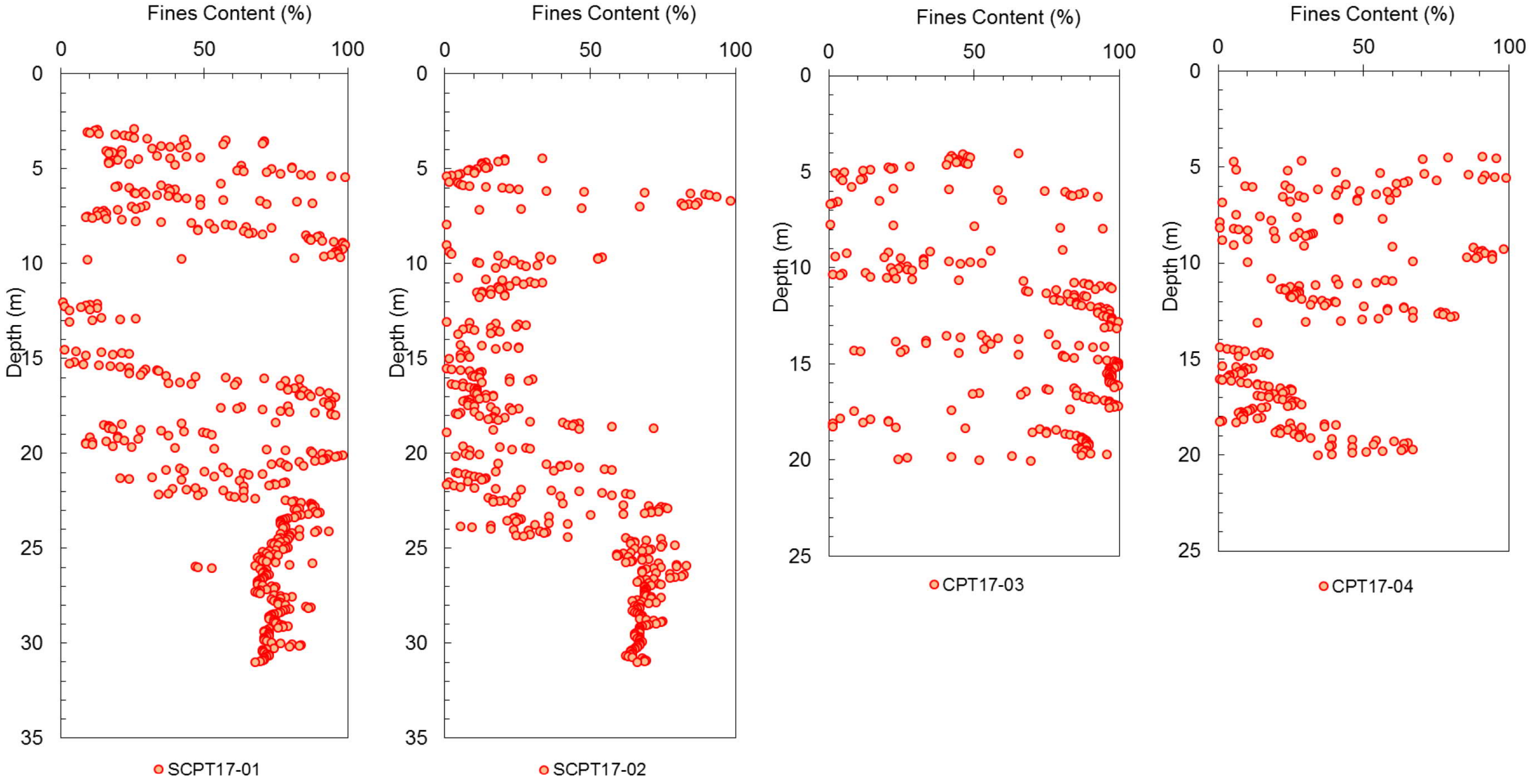


Figure A5-7 Fines contents estimated using the method proposed by Robinson et al (2013)

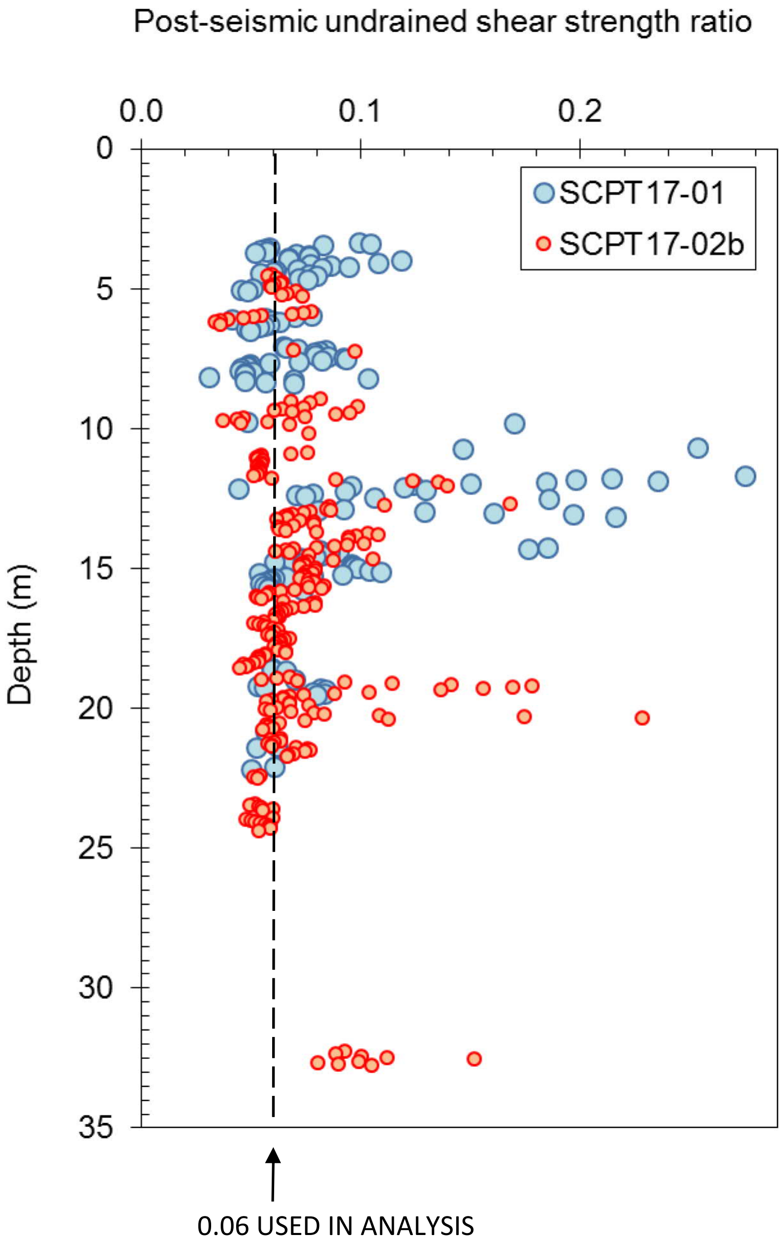


Figure A5-8 Post-seismic shear strengths estimated for sand-like soil layers using the Idriss and Boulanger (2008) method.

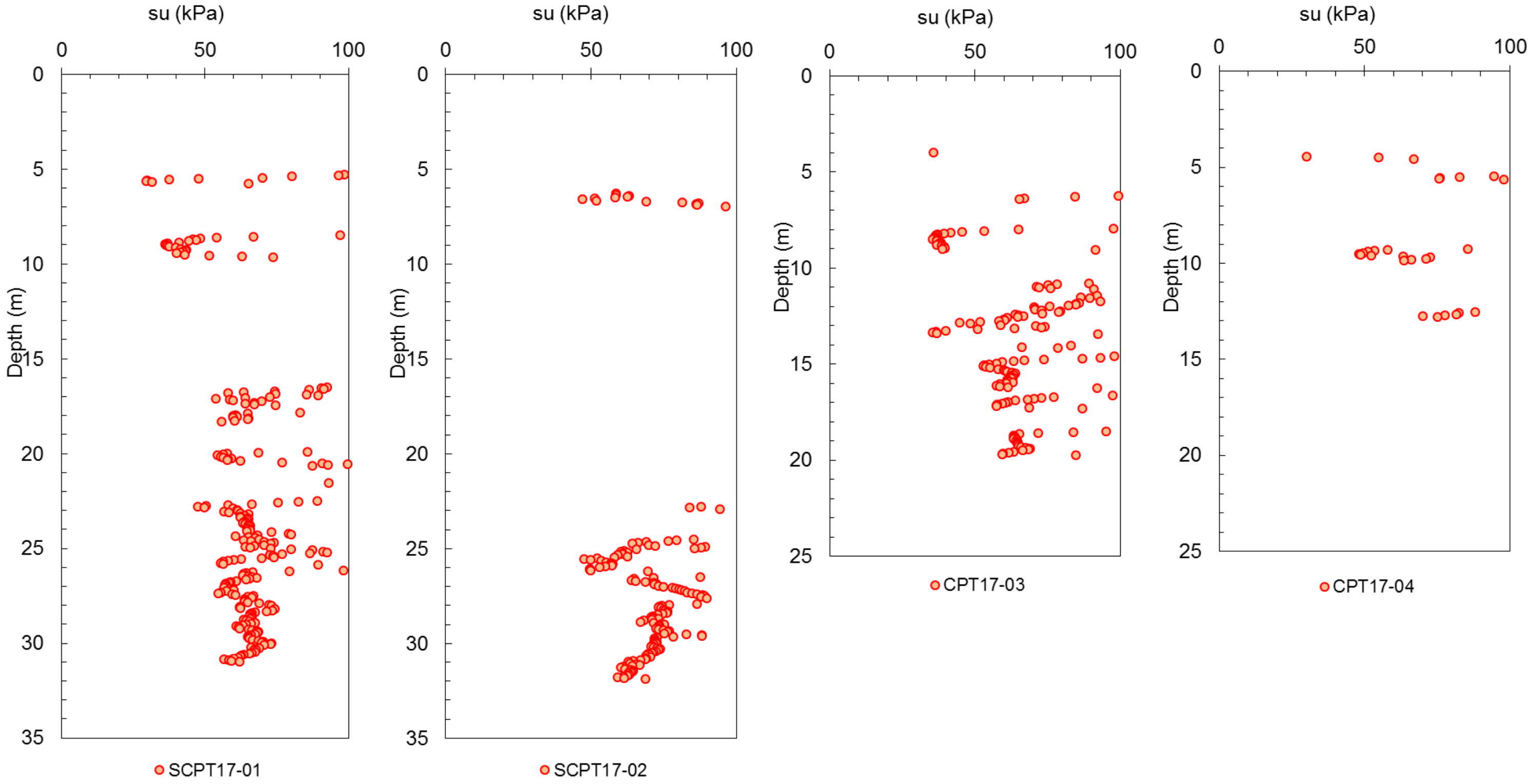


Figure A5-9 Peak undrained shear strength estimated using an N_{kt} of 14 as per Lunne et al (1997)

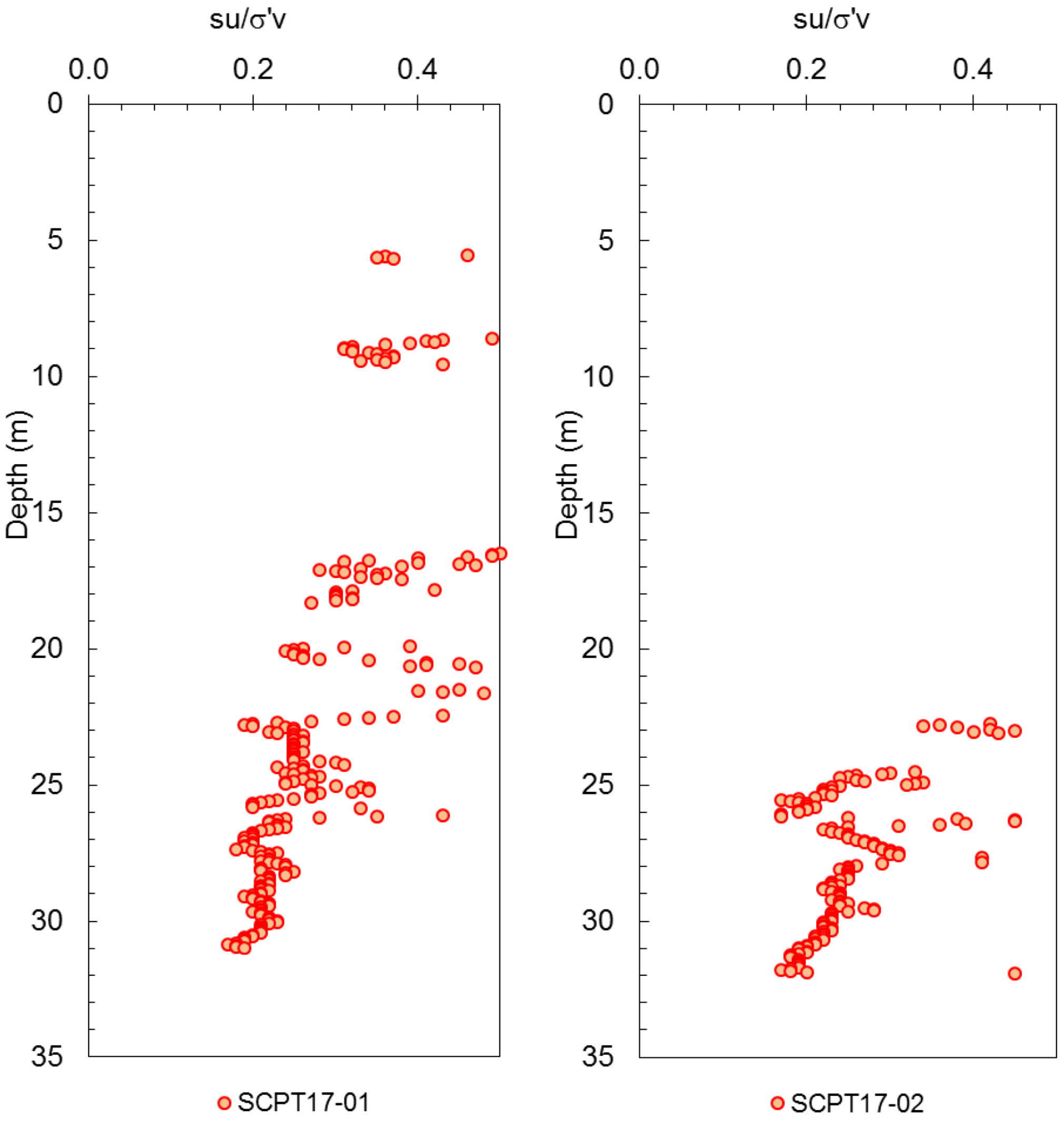


Figure A5-10 Peak undrained shear strength ratio estimated using an N_{kt} of 14 as per Lunne et al (1997)

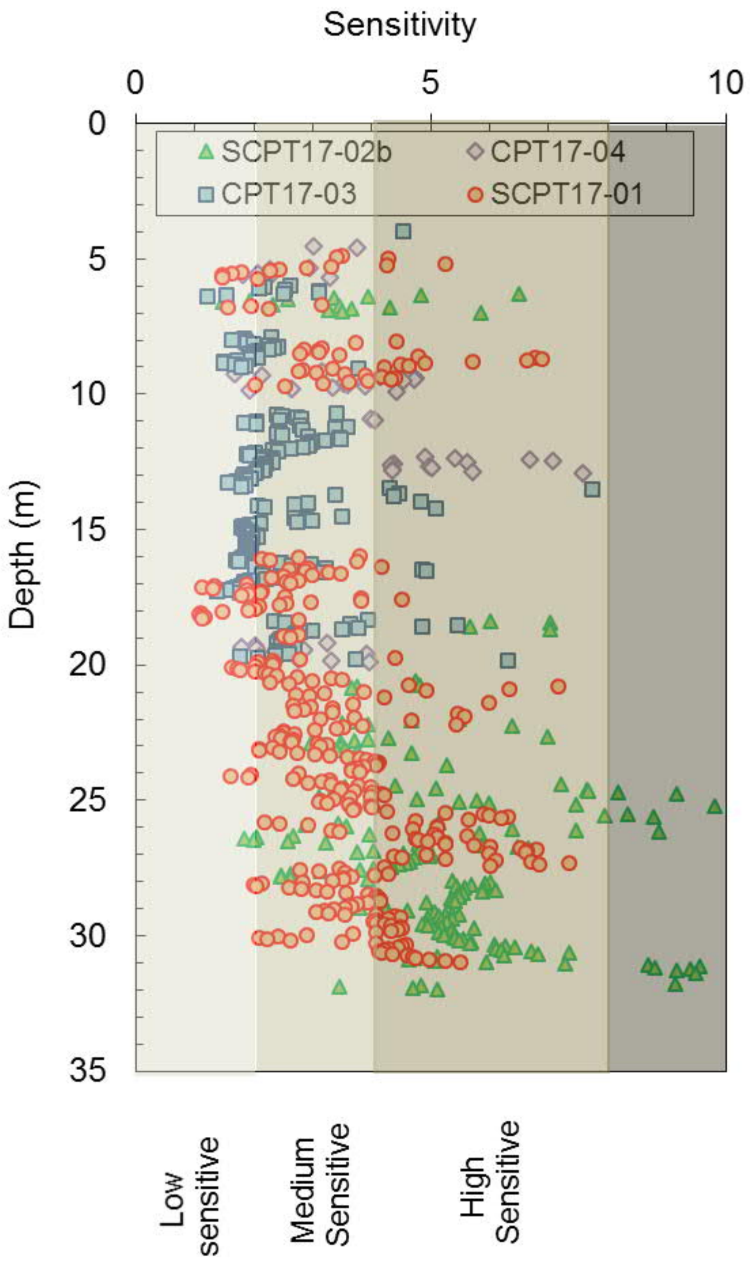


Figure A5-11 Sensitivity estimated from CPTs using the approach proposed by Robertson (2009)

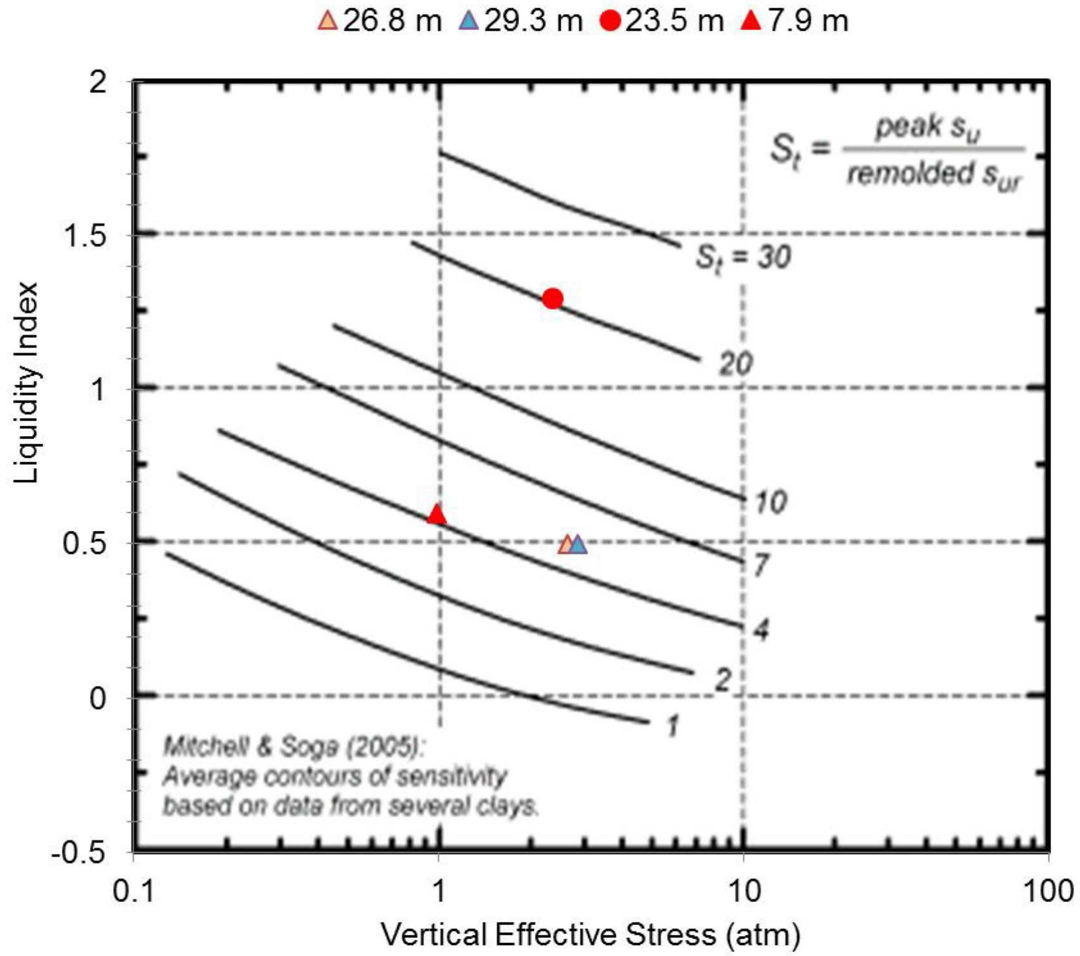


Figure A5-12 Soil sensitivities estimated using lab test results as per Mitchell and Soga (2005)

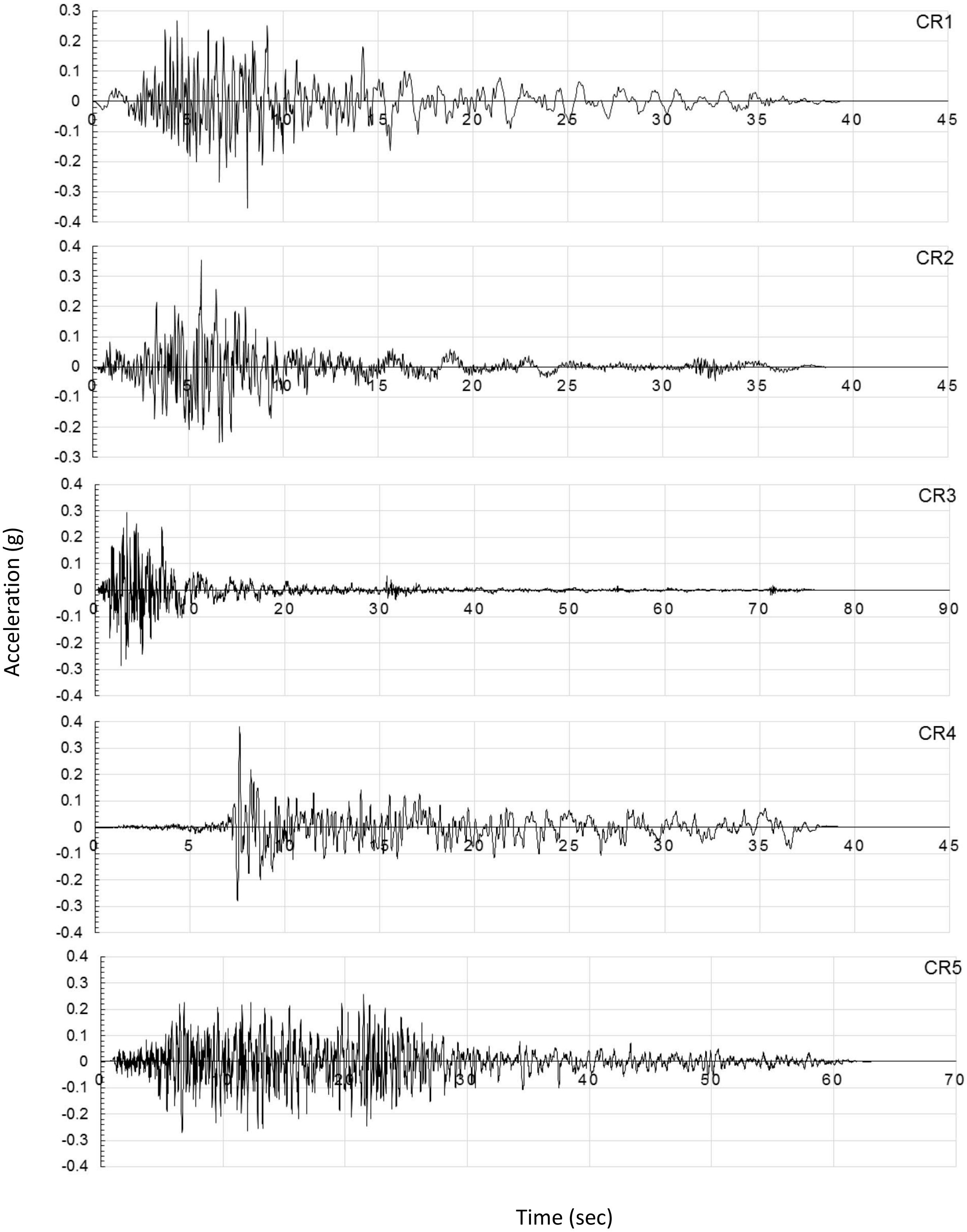


Figure A5-13(a) Scaled time histories for the Crustal seismic source.

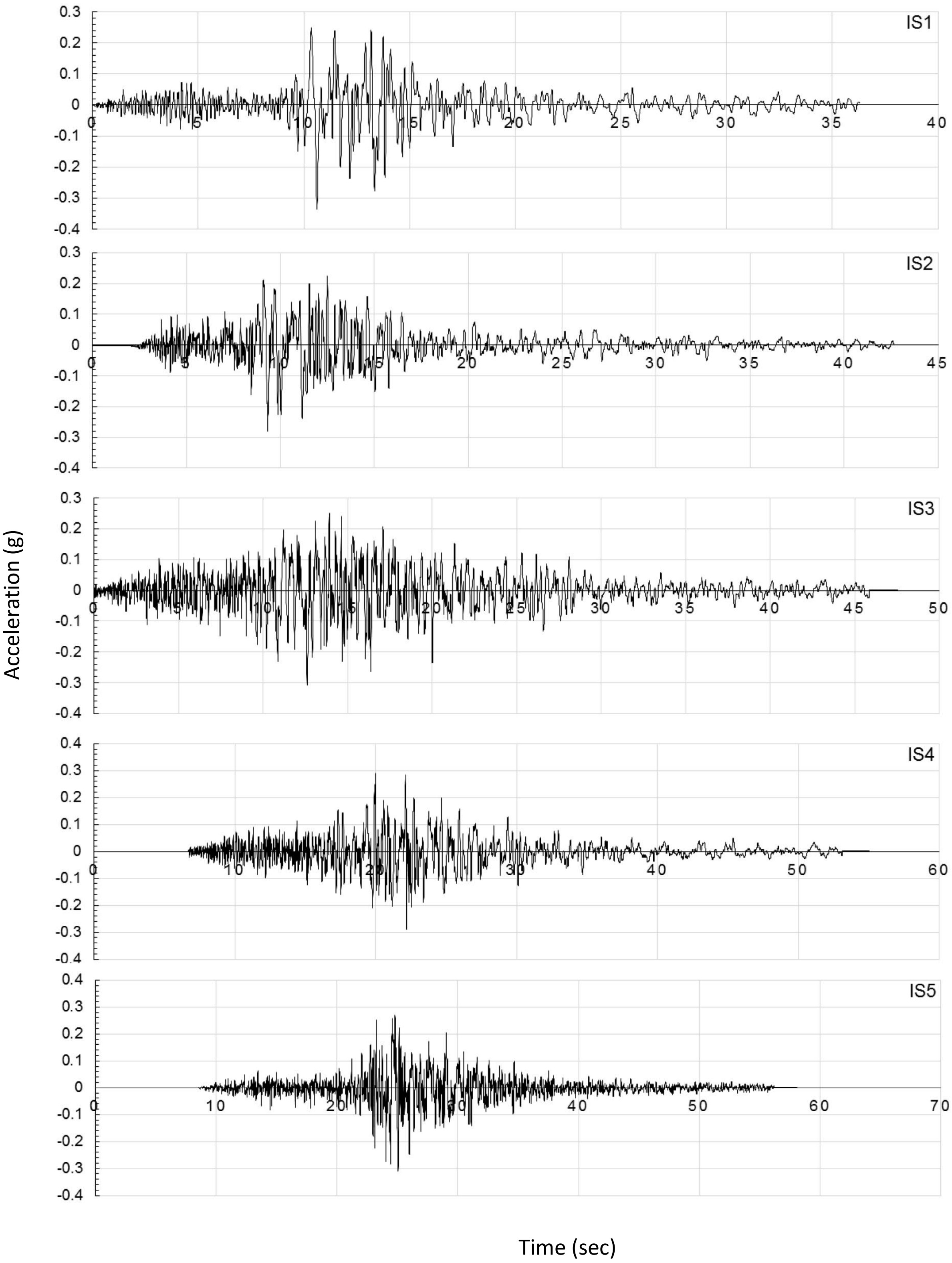


Figure A5-13(b) Scaled time histories for the Inslab seismic source.

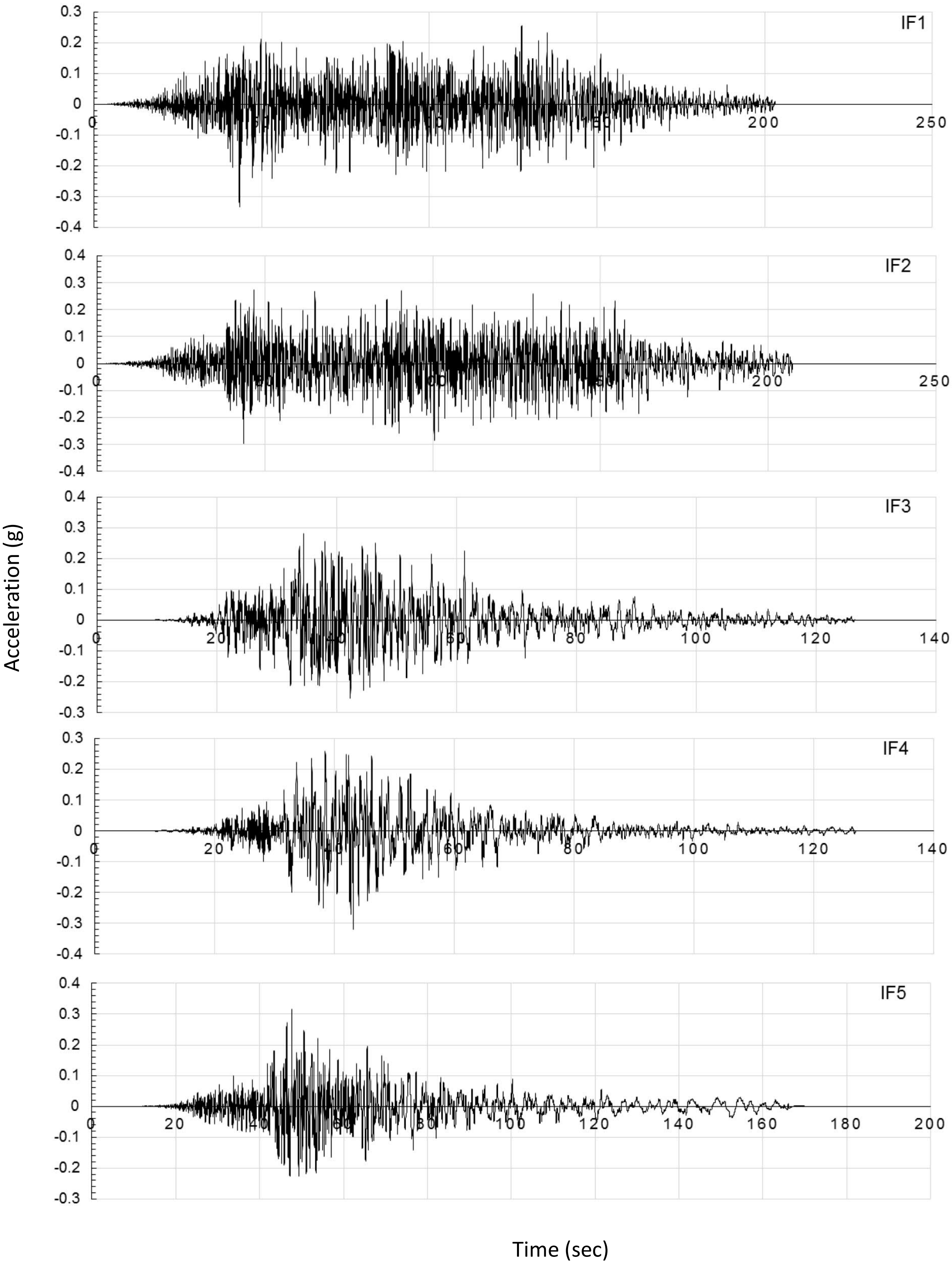
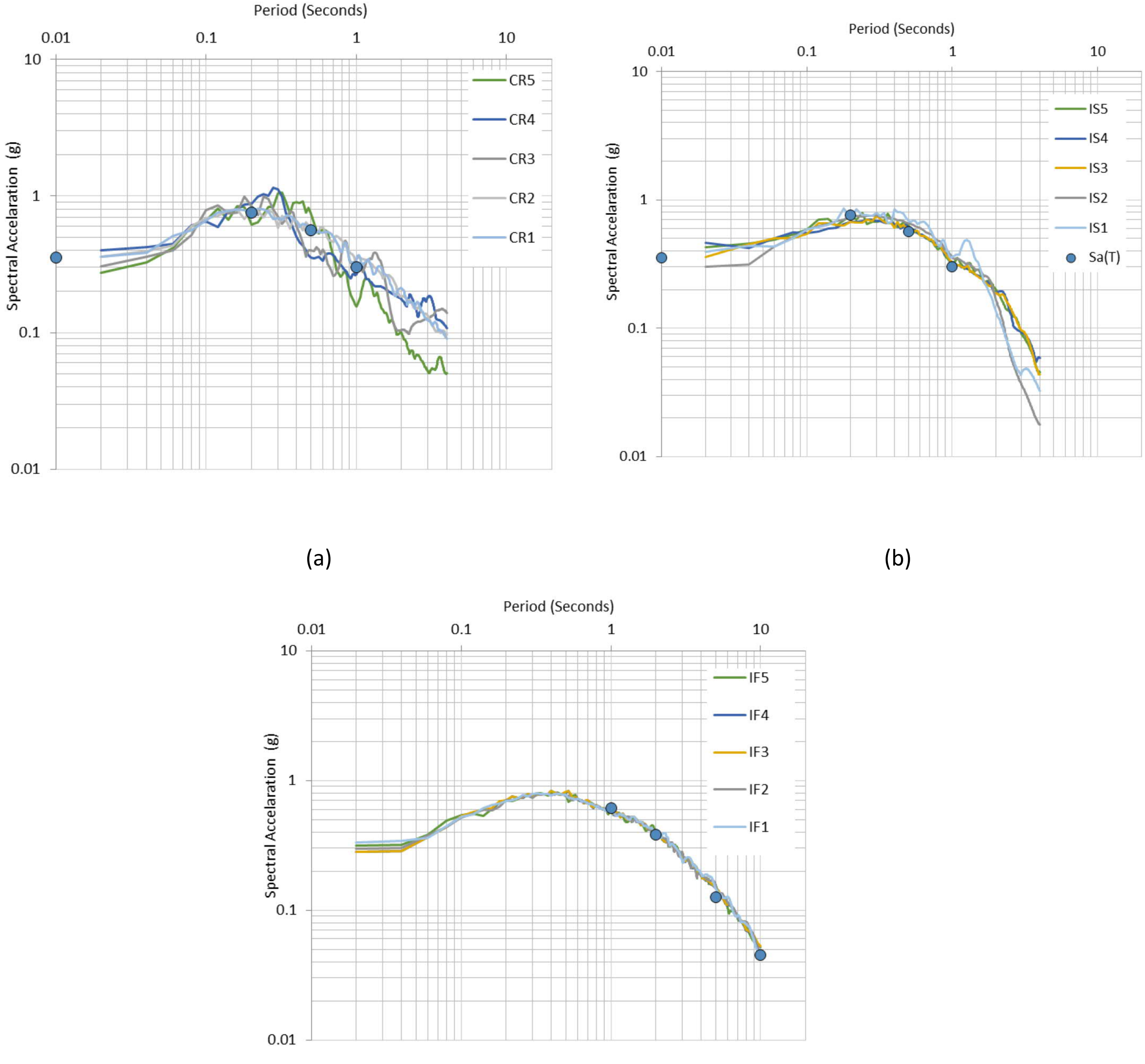


Figure A513(c) Scaled time histories for the Interface seismic source.



(a)

(b)

(c)

Figure A5-14. Target and matched response spectrum of candidate motions for (a) Crustal, (b) Inslab and (c) Interface design earthquake events.

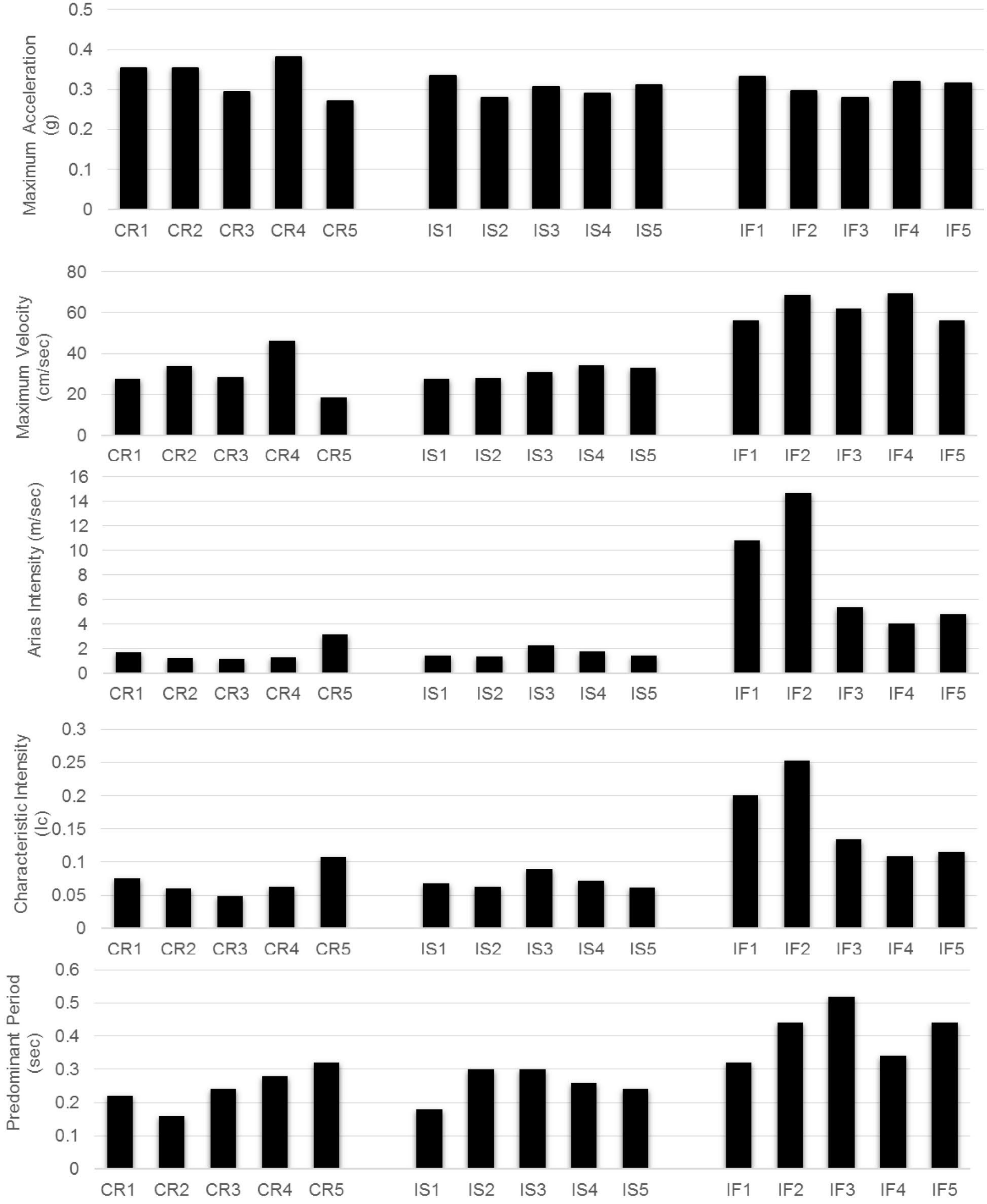


Figure A5-15. Select ground motion parameters of each input ground motion.

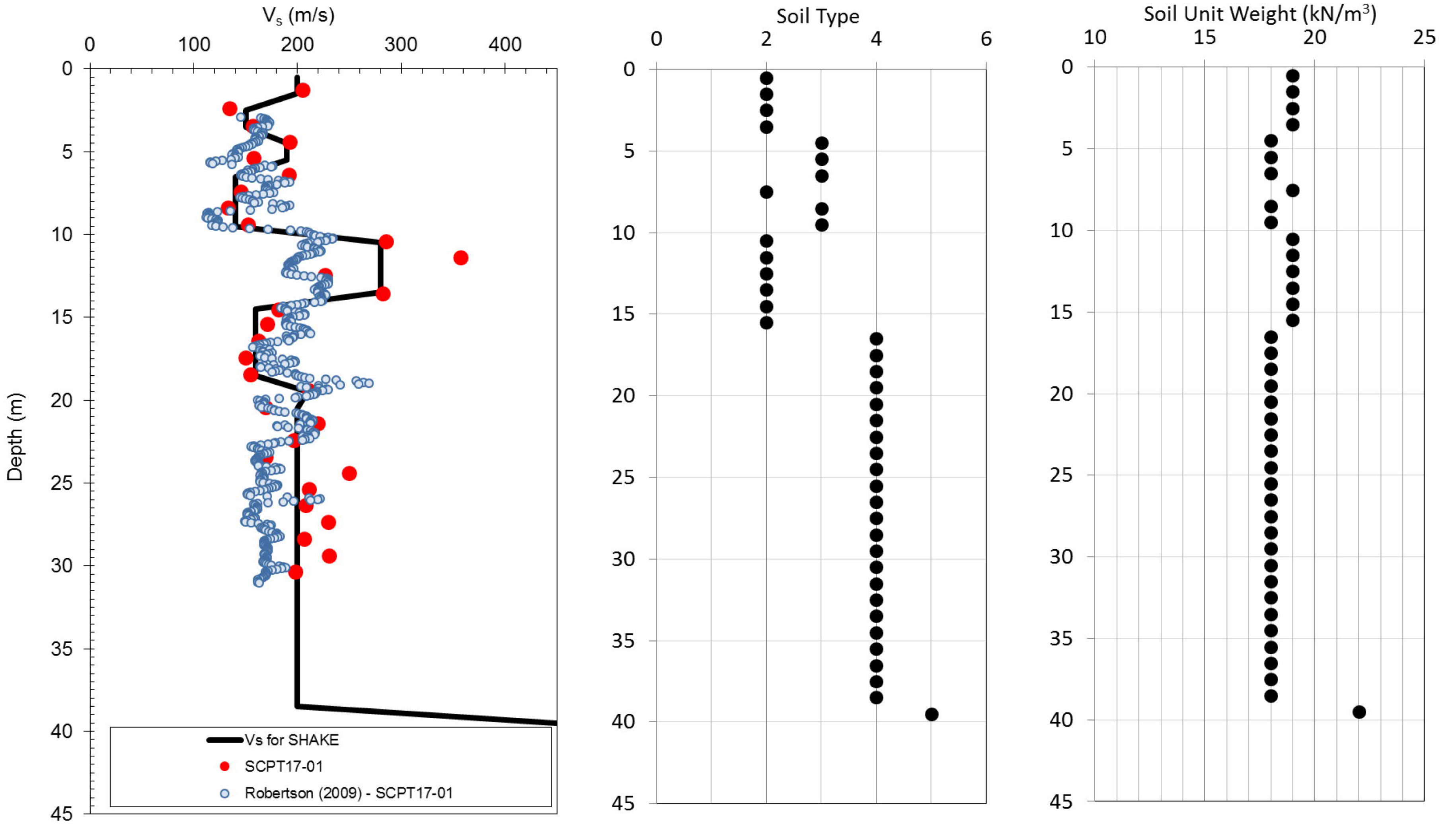


Figure A5-16: SHAKE input parameters for Soil Profile 1 (Aeration and UV Building)

- **Soil Type 2:** Seed et al. (1986)
- **Soil Type 3:** Vucetic and Dobry (1991) curves for PI of 5
- **Soil Type 4:** Vucetic and Dobry (1991) curves for PI of 15
- **Soil Type 5:** EPRI (1993) Soft rock

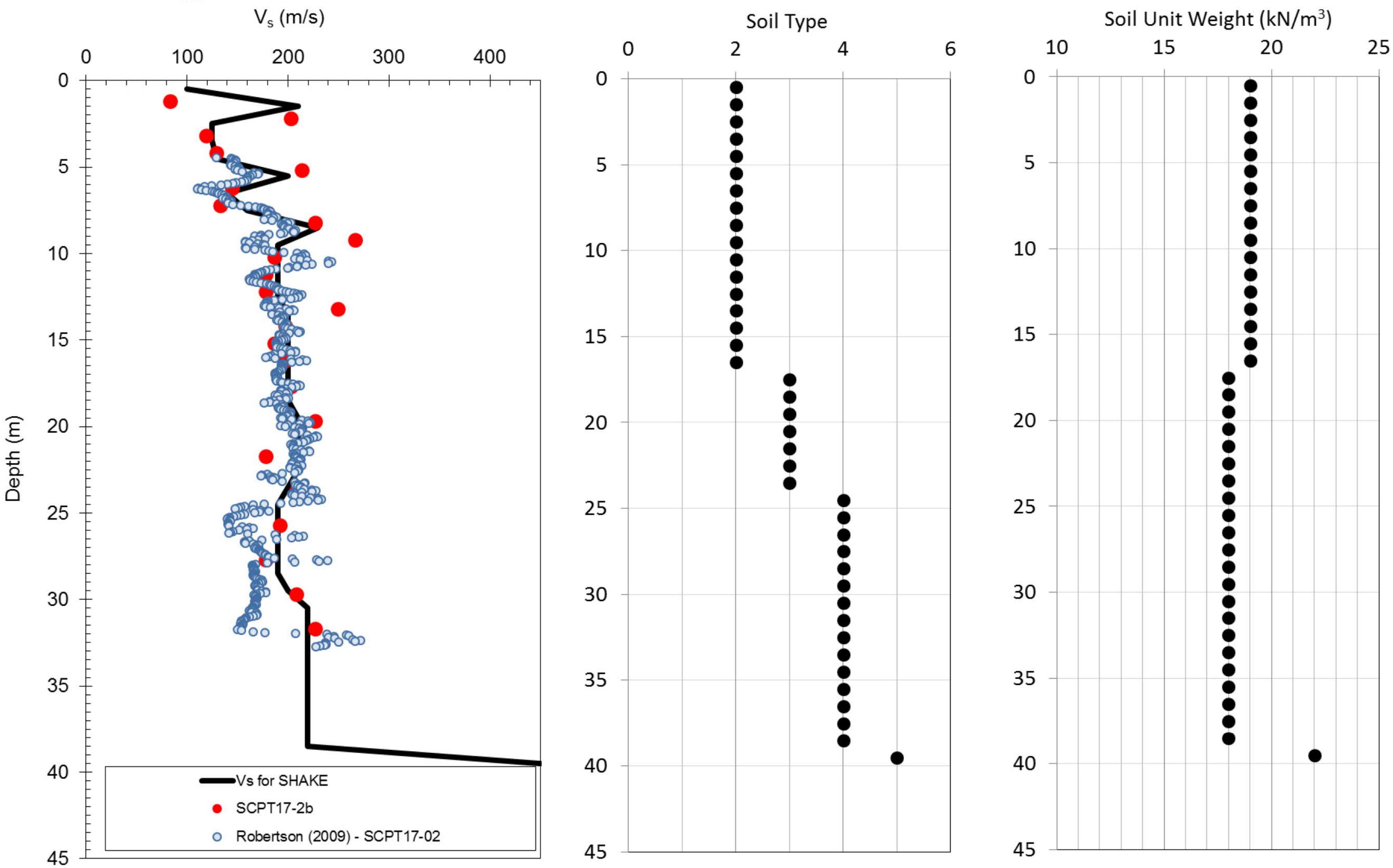


Figure A15-17: SHAKE input parameters for Soil Profile 2 (Screening Building)

- **Soil Type 2:** Seed et al. (1986)
- **Soil Type 3:** Vucetic and Dobry (1991) curves for PI of 5
- **Soil Type 4:** Vucetic and Dobry (1991) curves for PI of 15
- **Soil Type 5:** EPRI (1993) Soft rock

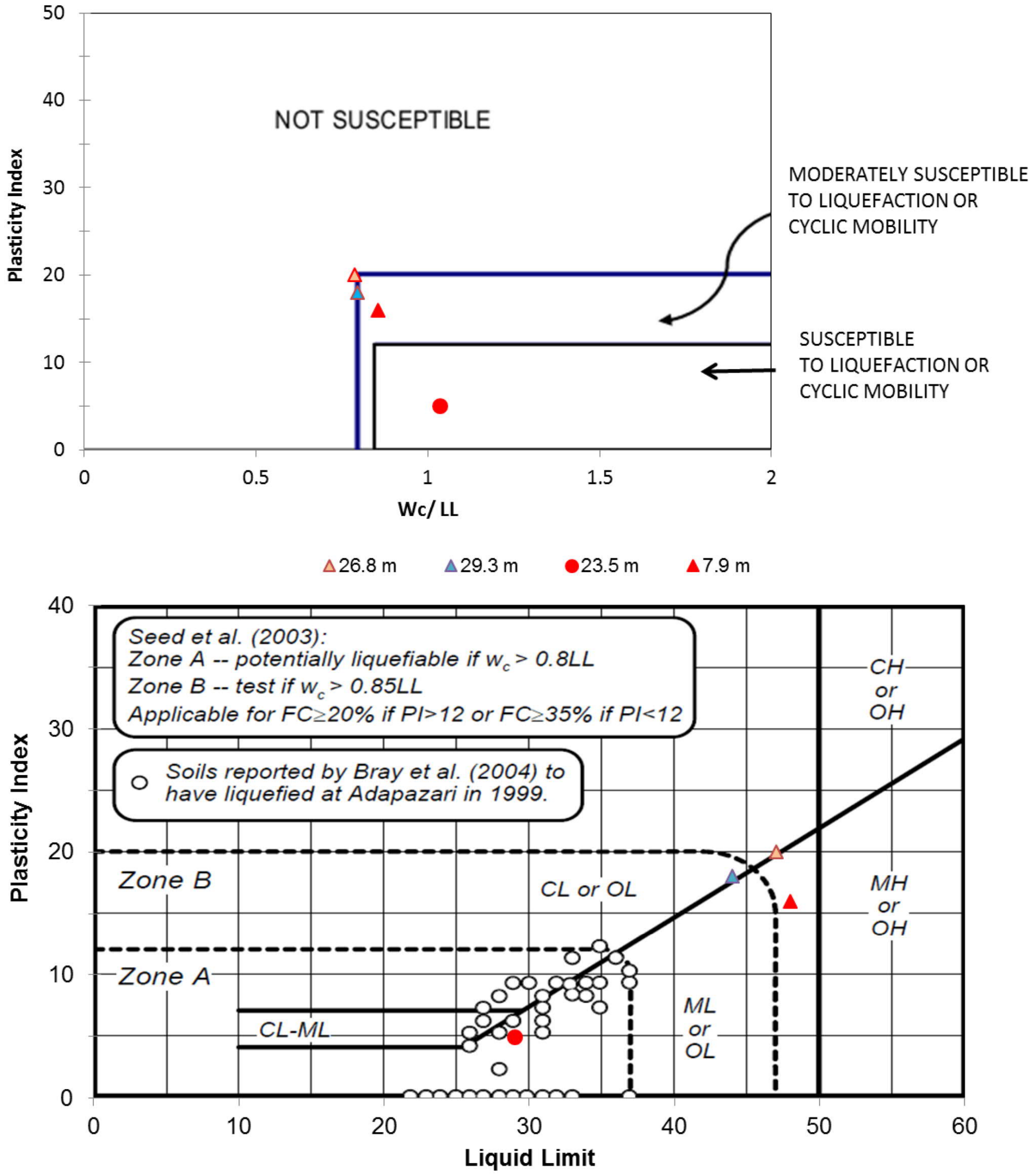
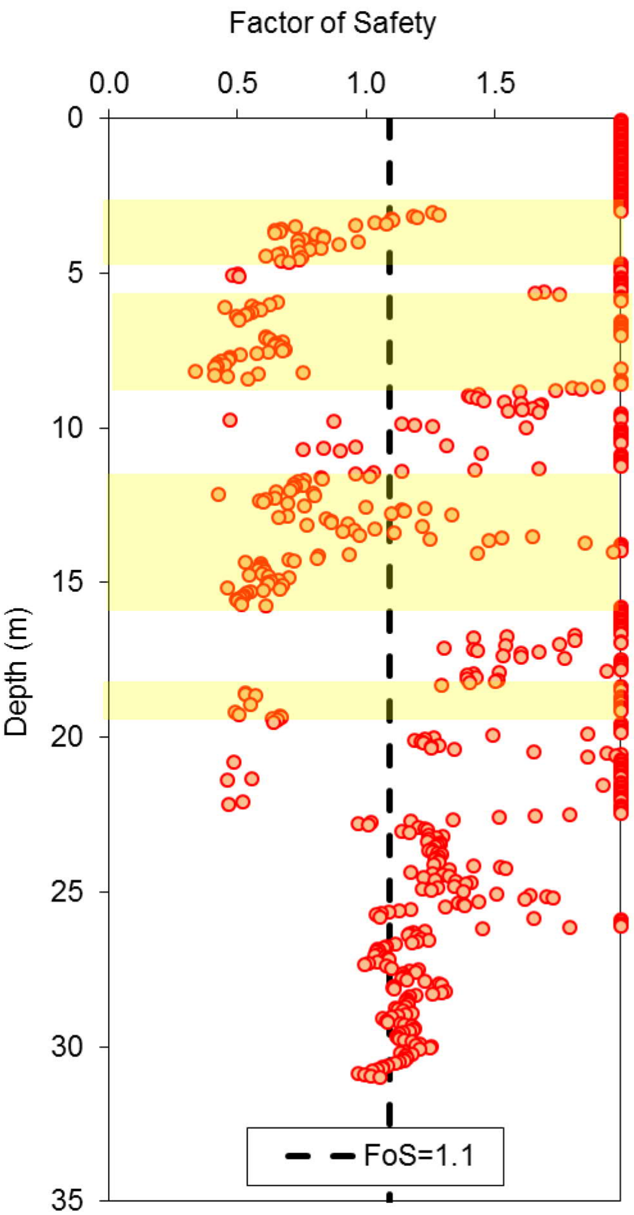


Figure A5-18 Liquefaction Susceptibility of fine-grained materials based on the approaches proposed by Bray and Sancio (2006) and Seed et al. (2003).



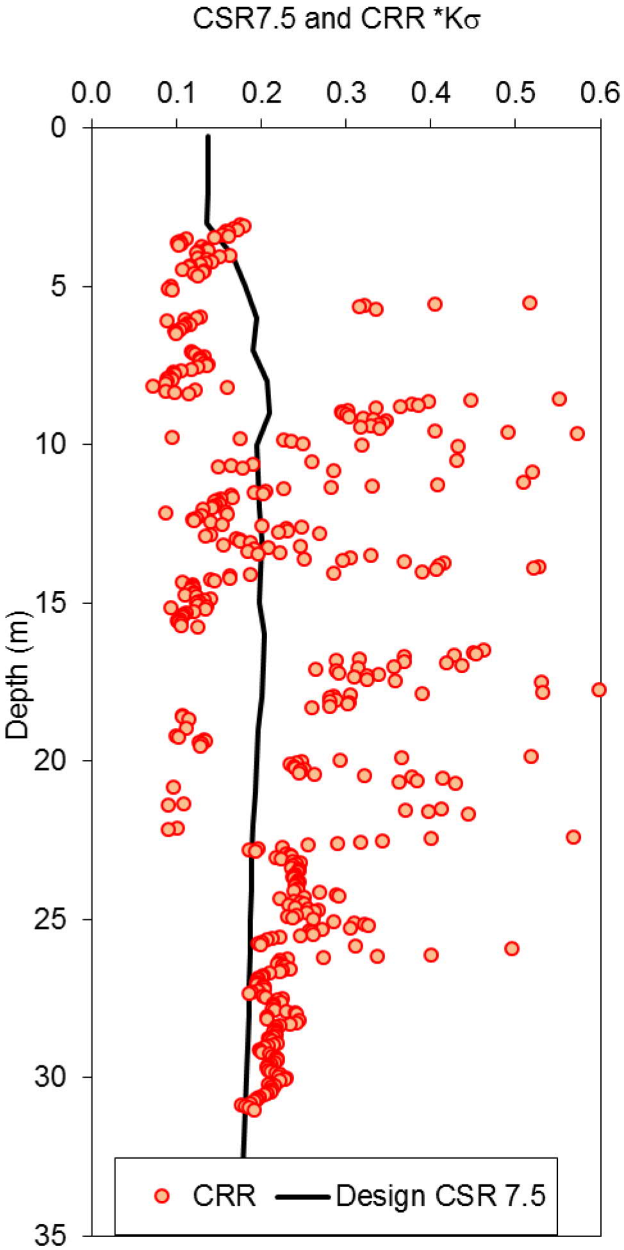


Figure A5-19(a) CSR, CRR and Factor of Safety against liquefaction (Soil Profile 1)

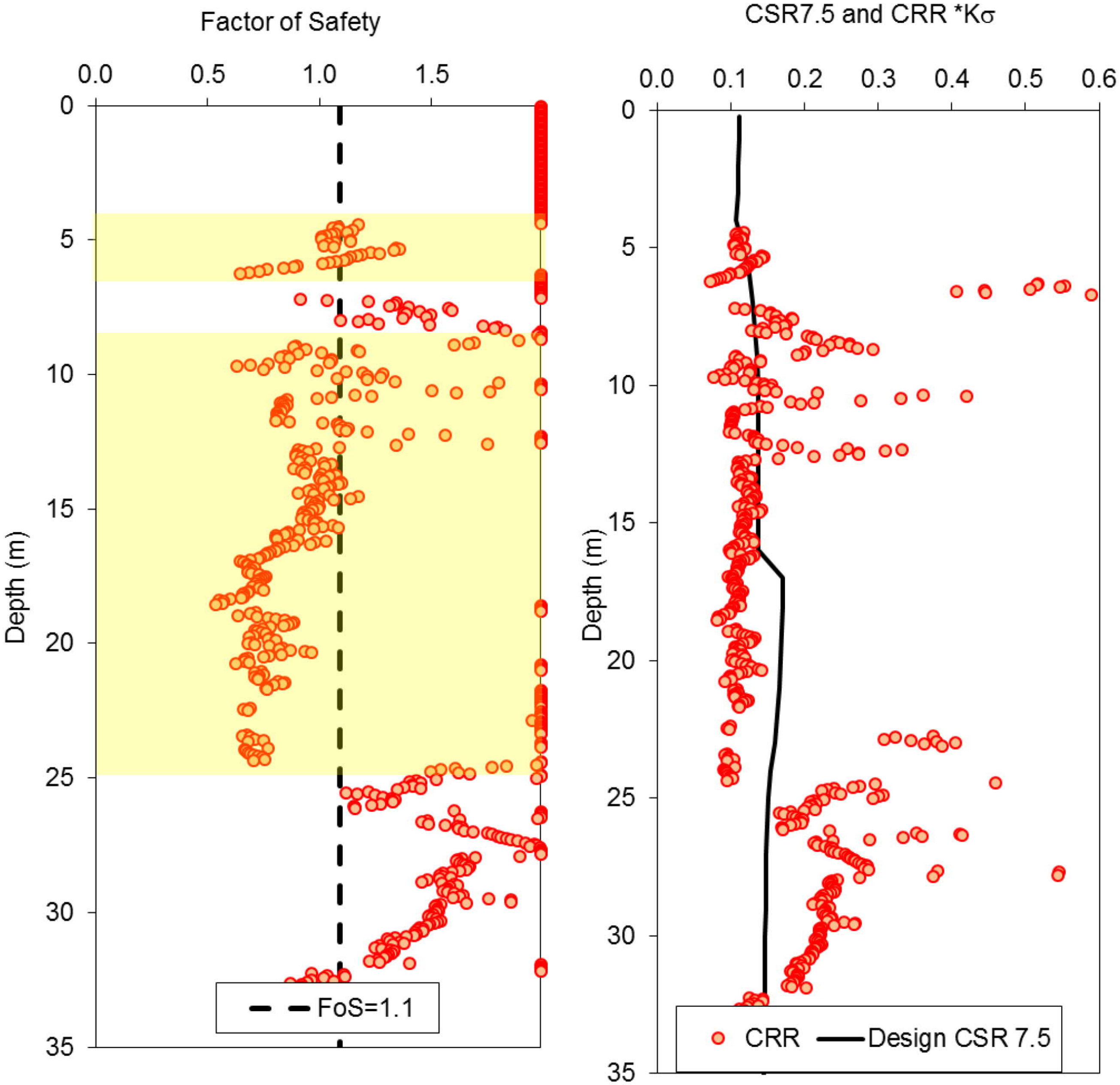


Figure A5-19 (b) CSR, CRR and Factor of Safety against liquefaction (Soil Profile 2)

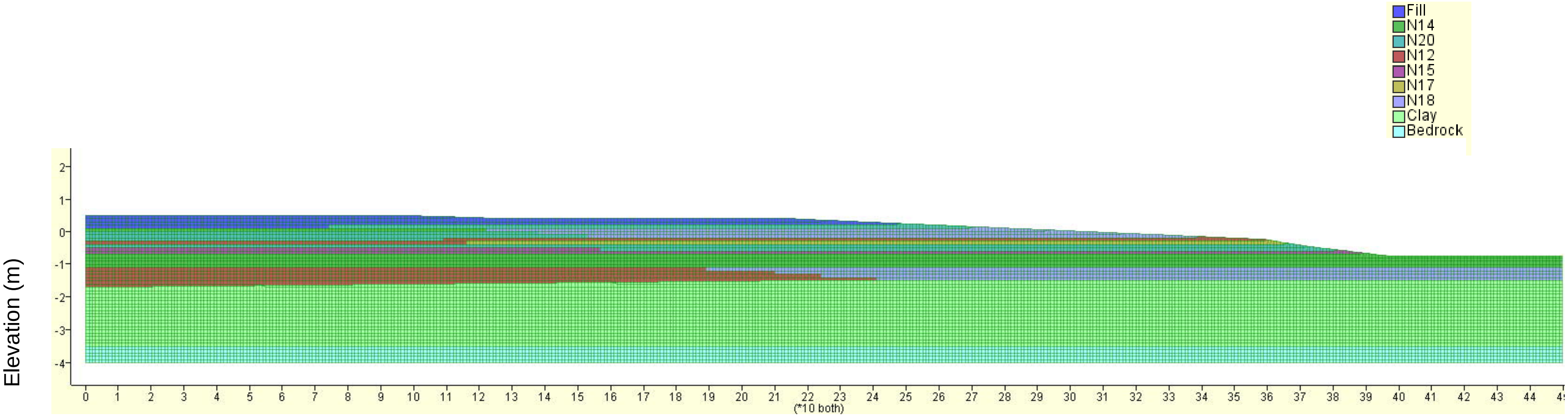
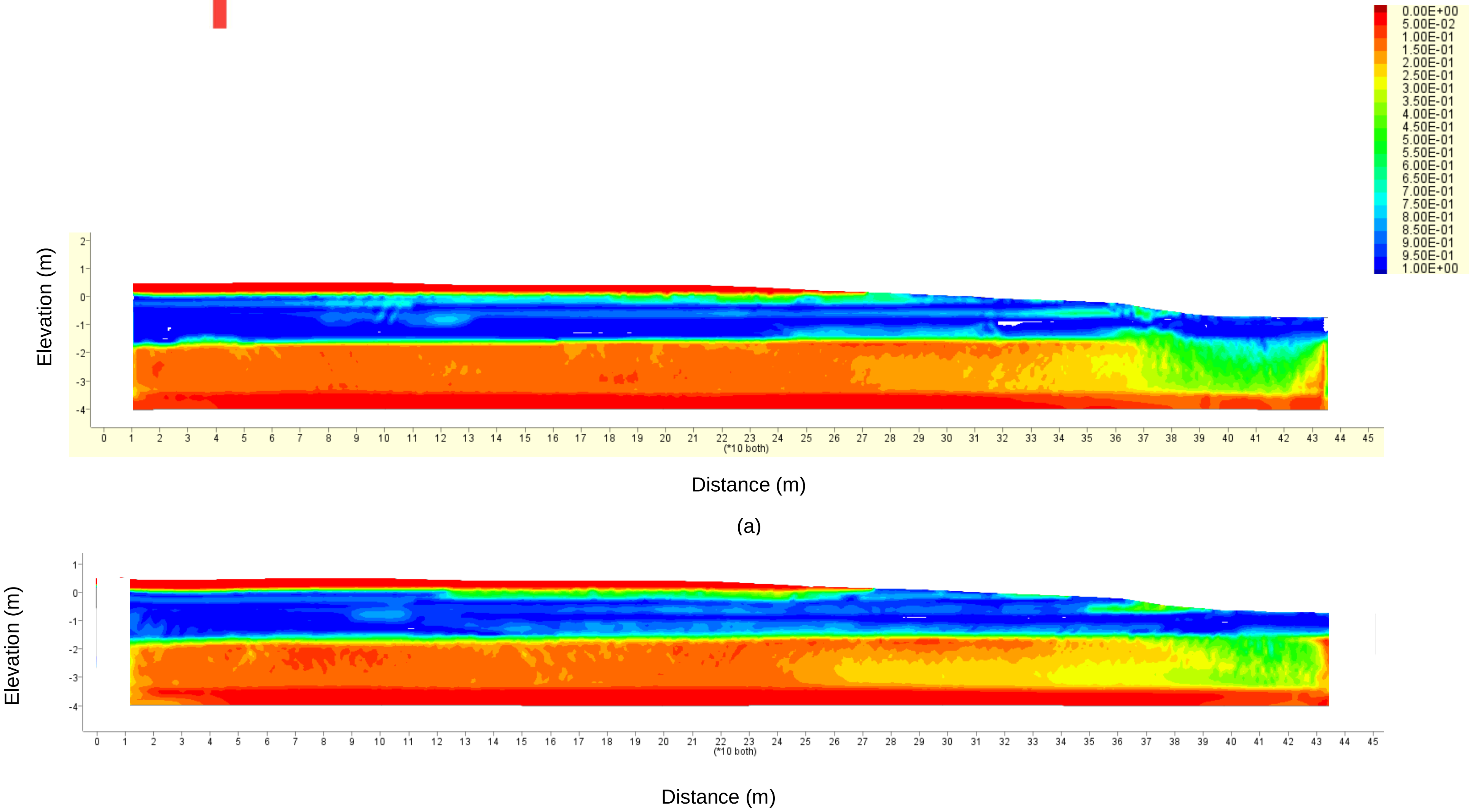


Figure A5-20: FLAC model for existing ground conditions



(a)

(b)

Figure A5-21: Maximum excess porewater pressure ratios estimated for (a) IS2 (in slab EQ) (at the end of shaking) and (b) IF3 (Interface EQ) (after 80 seconds)

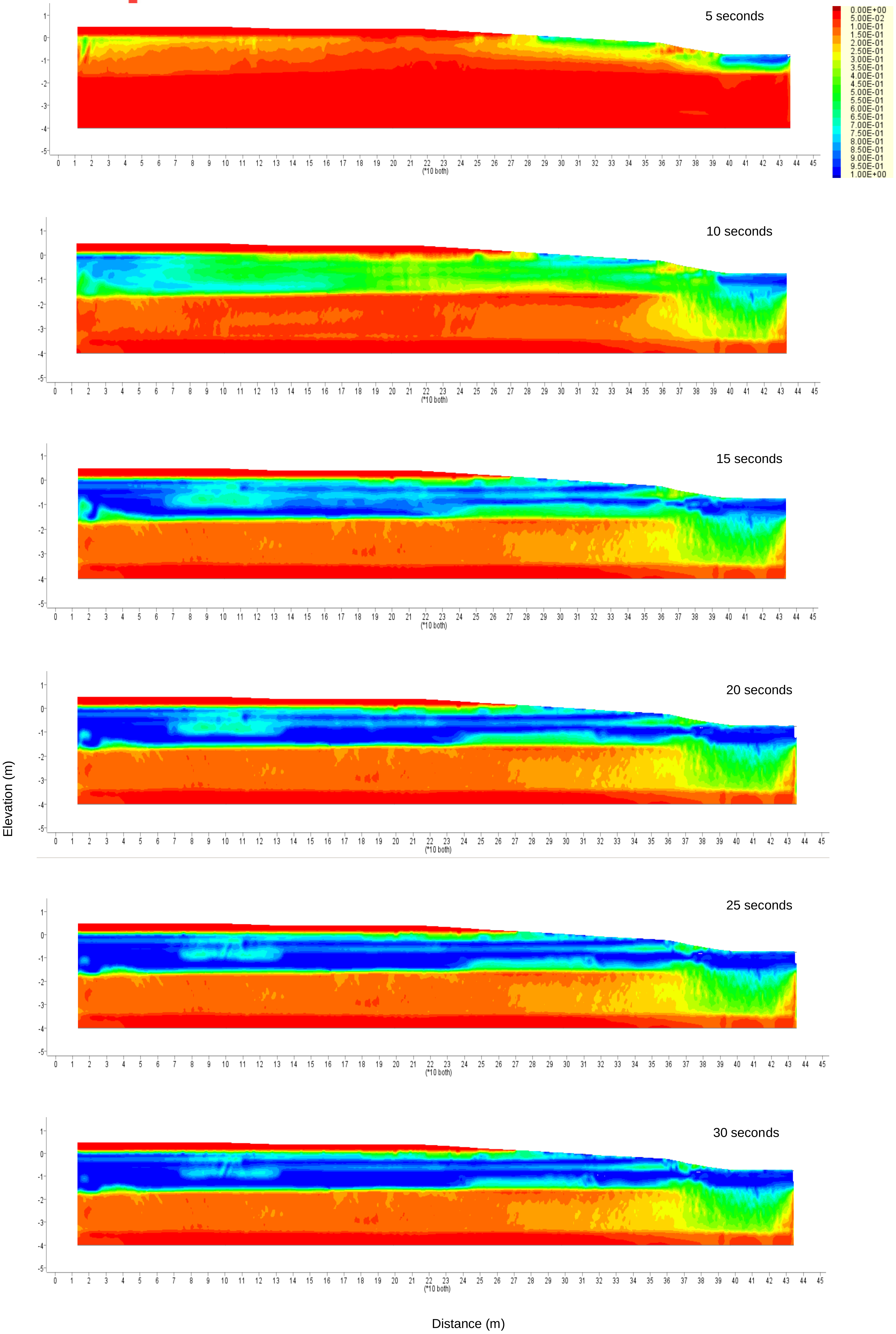


Figure A5-22: Maximum excess porewater pressure ratios estimated for the IS2 (In-slab EQ ground) motion

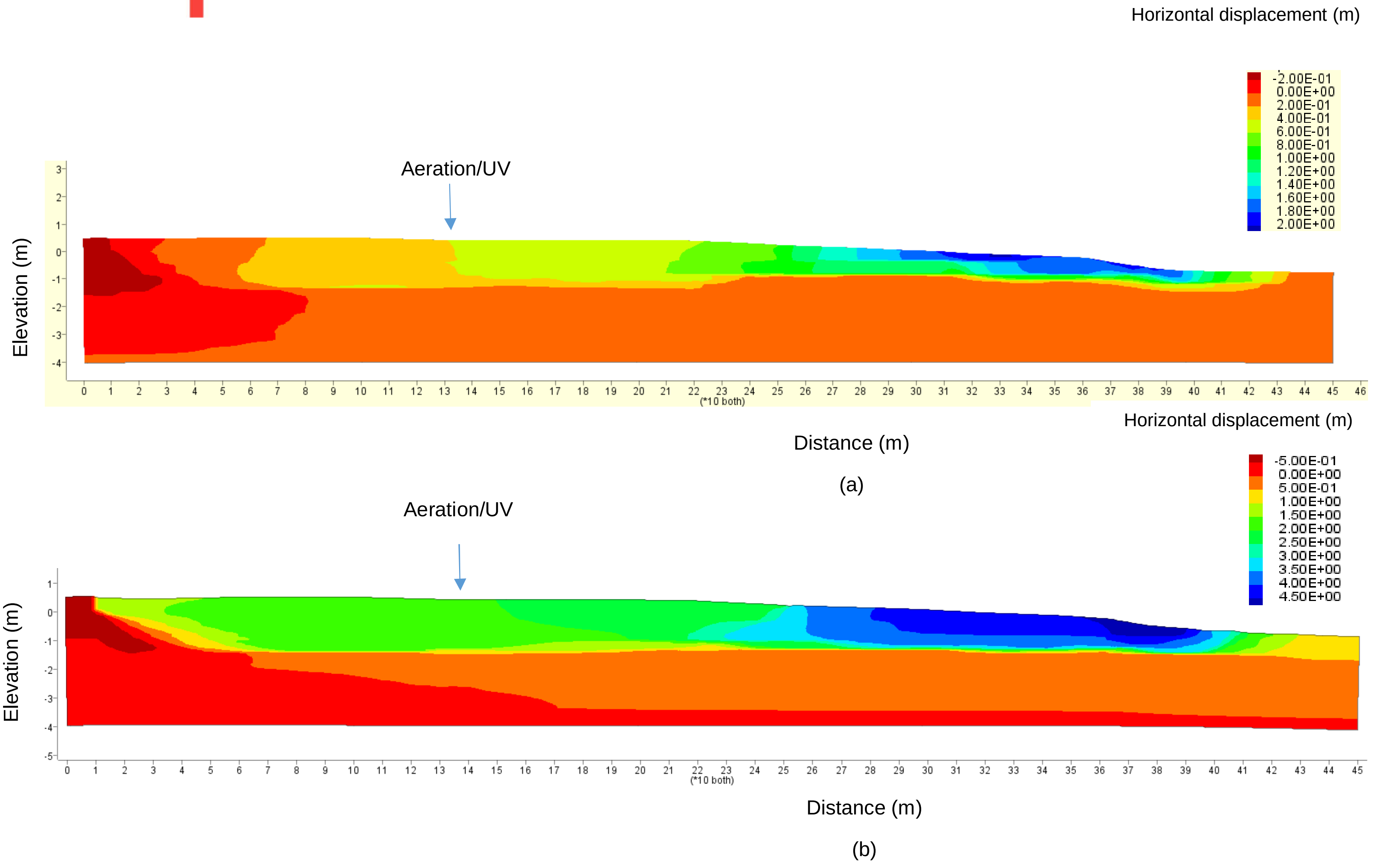
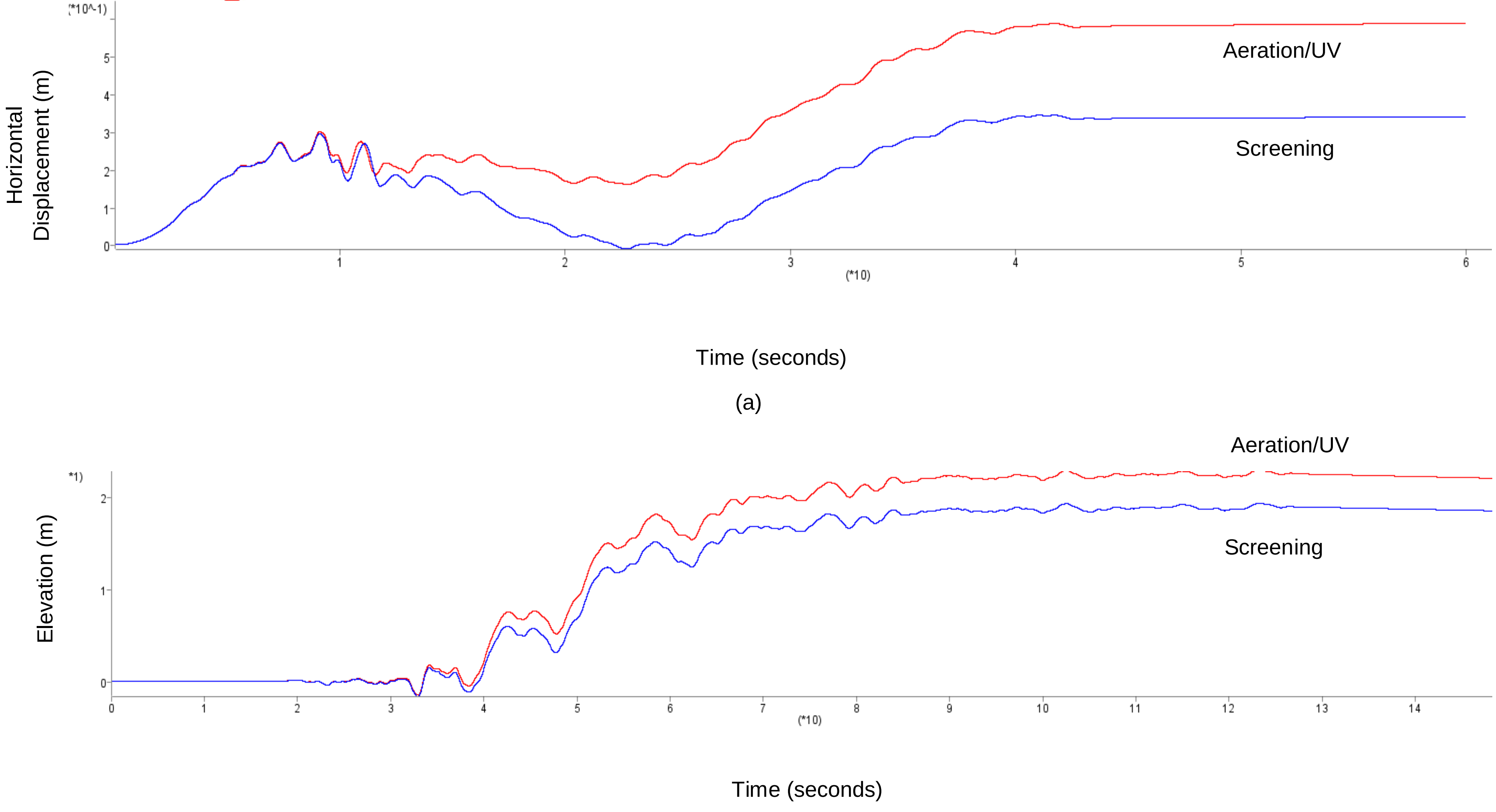


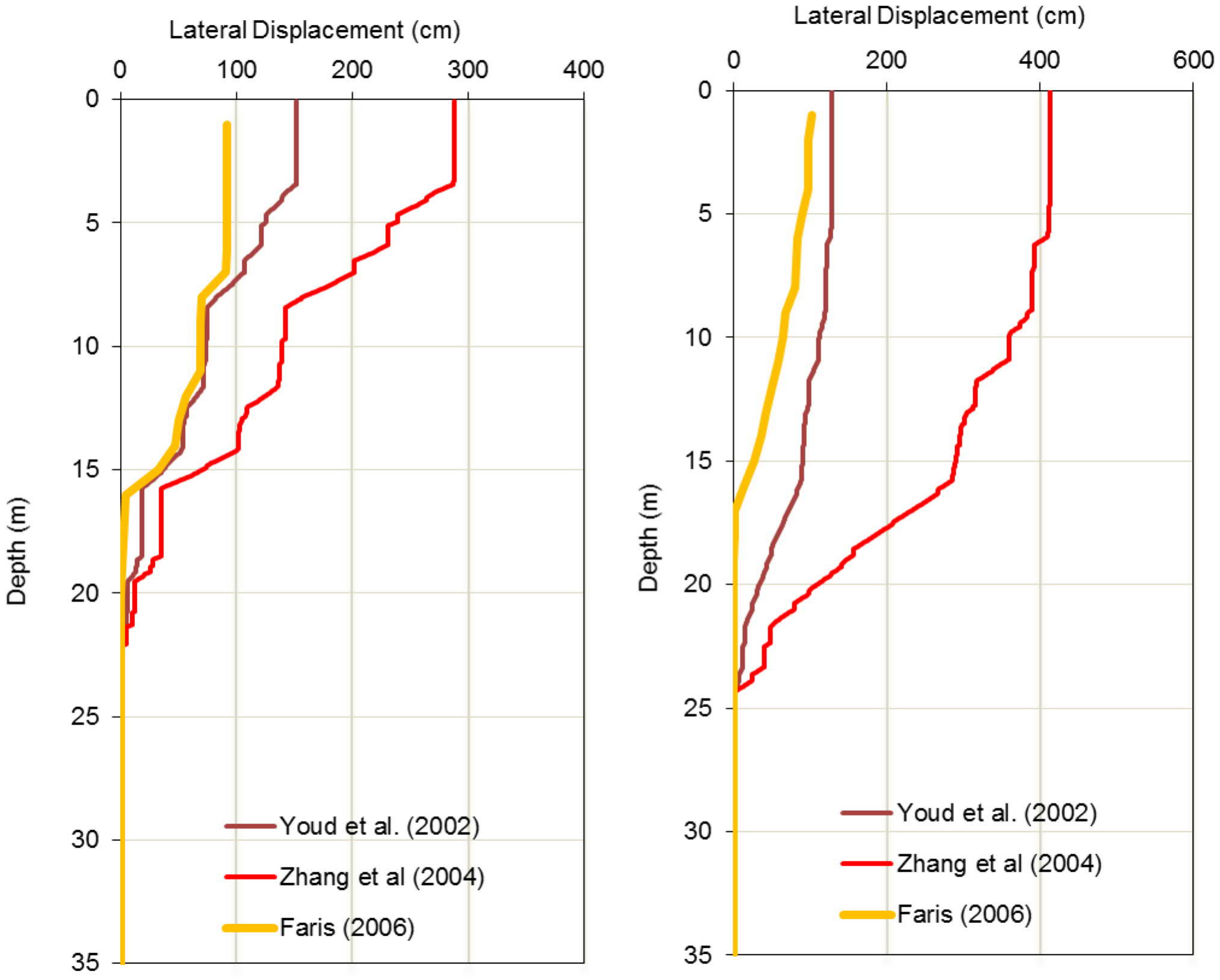
Figure A5-23. Horizontal displacements estimated at the end of shaking for (a) IS2 motion (In-slab EQ) and (b) IF3 motion (Interface EQ).



(a)

(b)

Figure A5-24: Displacement time histories recorded at two building locations (a) for IS2 (In-slab EQ) motion and (b) IF3 motion (Interface EQ)



Aeration/UV
Building

Screening
Building

Figure A5-25- Post-seismic lateral spreading displacements estimated using Faris et al. (2006), Zhang et al (2002), Youd et al. (2002) methods.

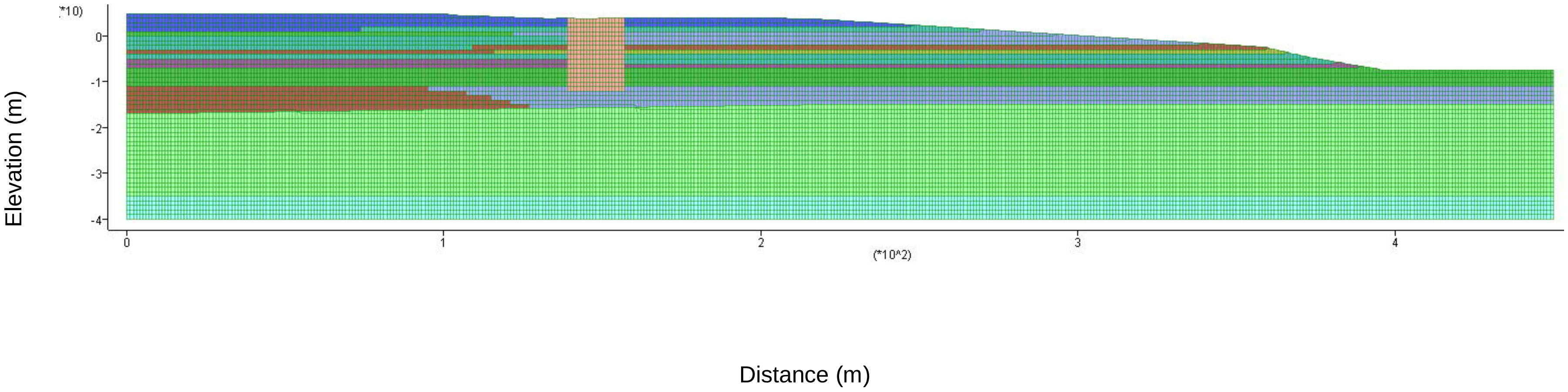


Figure A5-26: FLAC model with Deep Soil-Cement Mixing Method (DMM) of ground improvement (DMM) zone at the Aeration/UV building location.

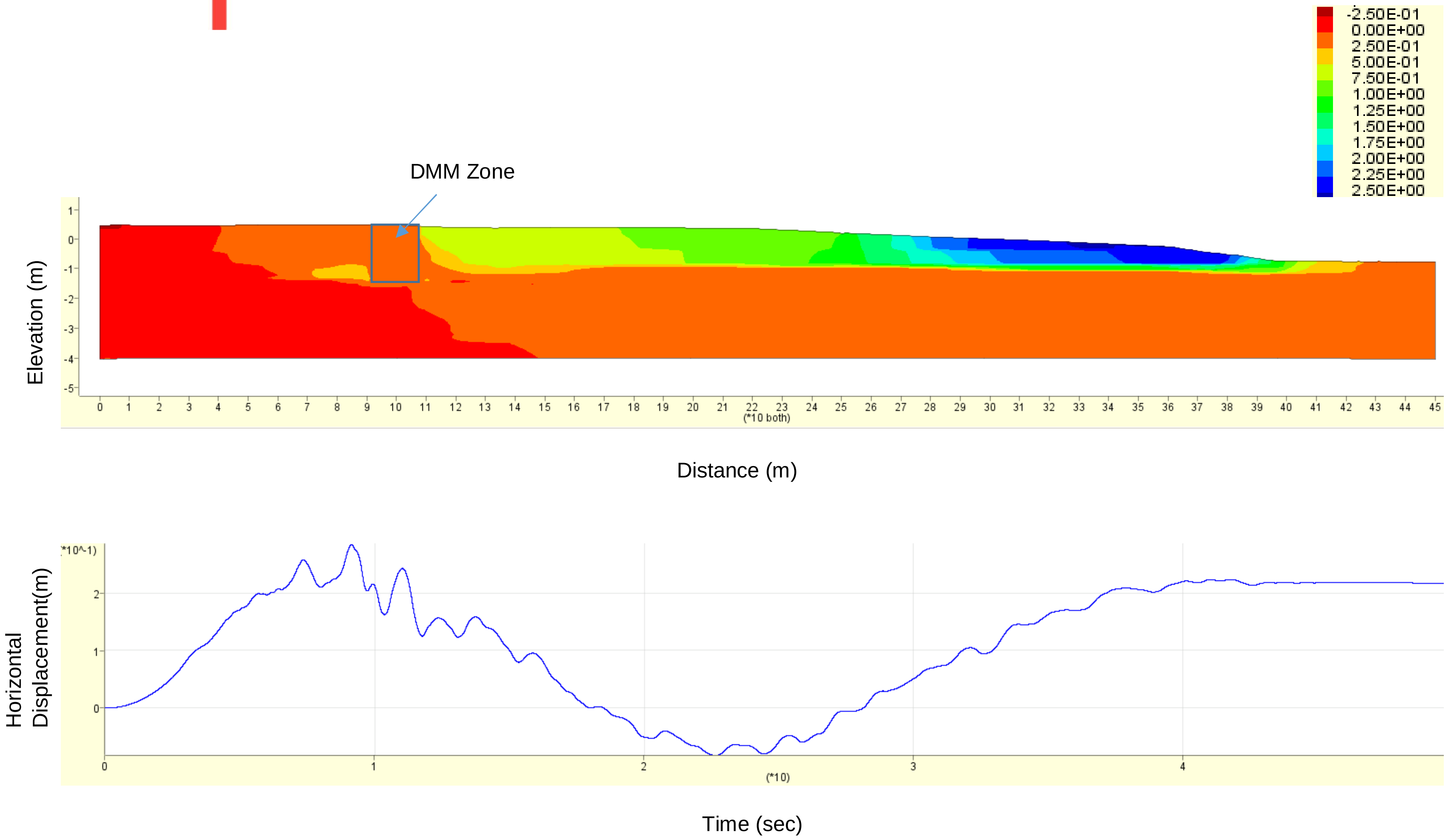


Figure A5-27 (a): After ground improvement: (a) Horizontal displacement profile at the end of shaking and (b) displacement time history at the Aeration/UV building (IS2 Motion) (In-slab EQ)

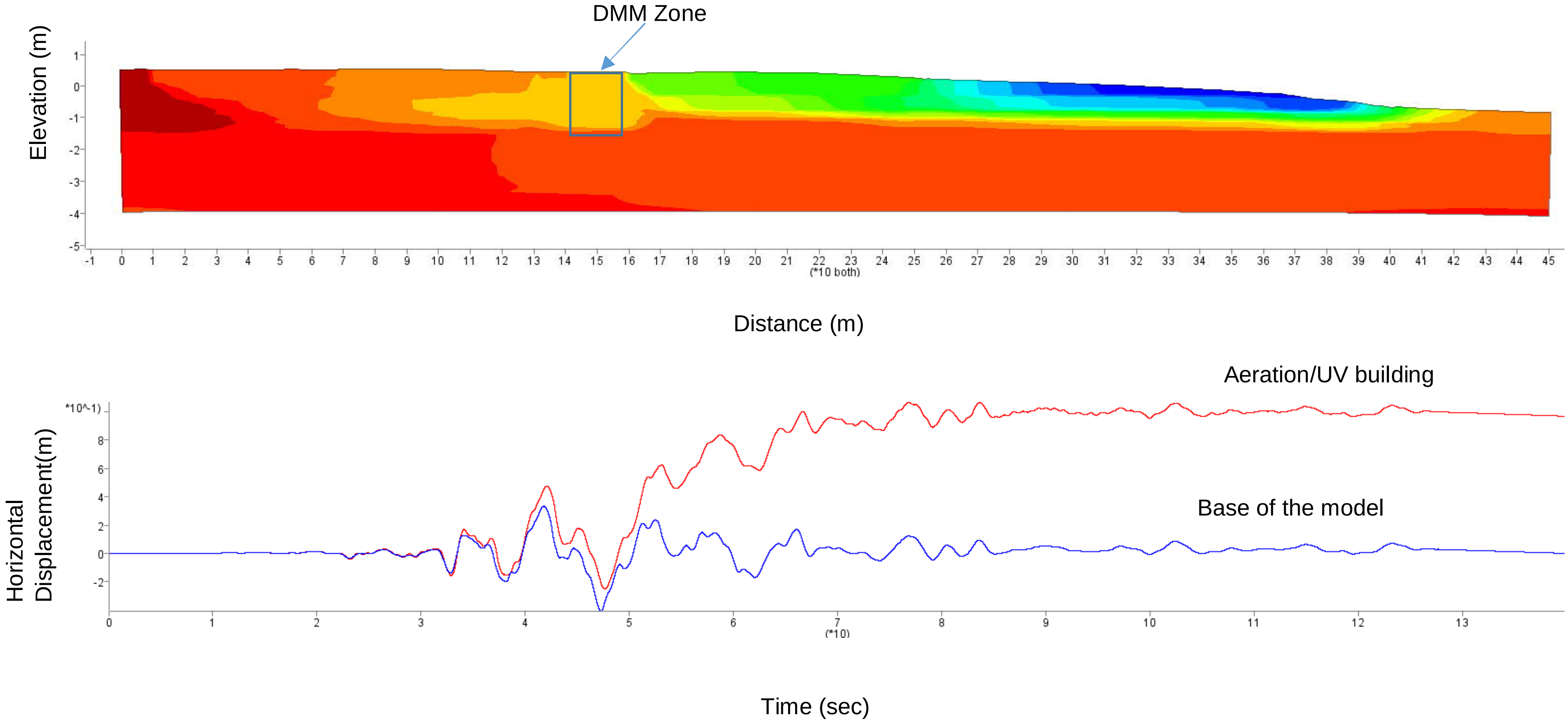


Figure A5-27 (b): After ground improvement: (a) Horizontal displacement profile at the end of shaking and (b) displacement time history at the Aeration/UV building location (IF3 Motion) (Interface EQ)

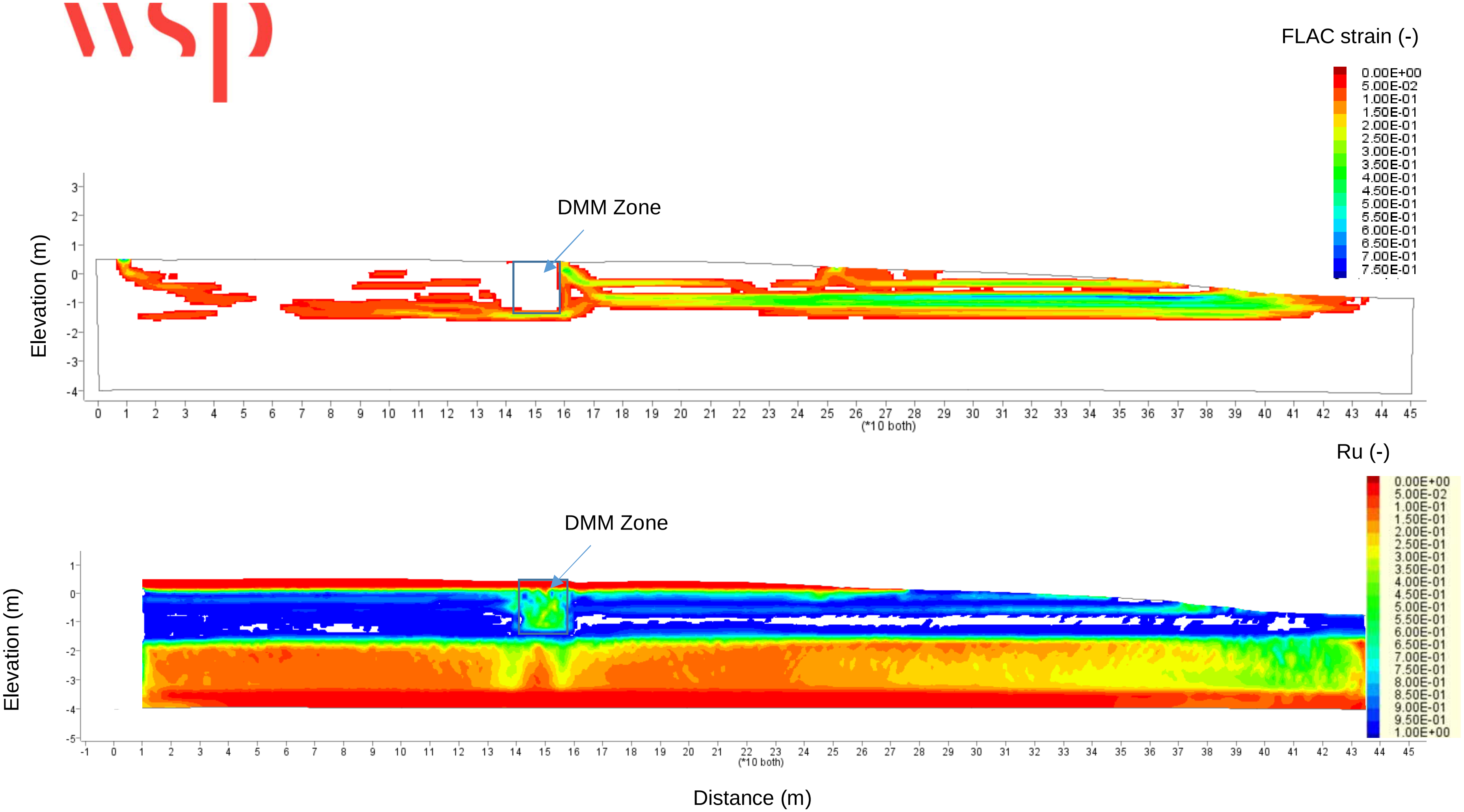


Figure A5-28: After ground improvement (a) Maximum shear strain and (b) excess pore water pressure contour at the end of shaking (for the Aeration/UV building – IF3 Motion) (Interface EQ)

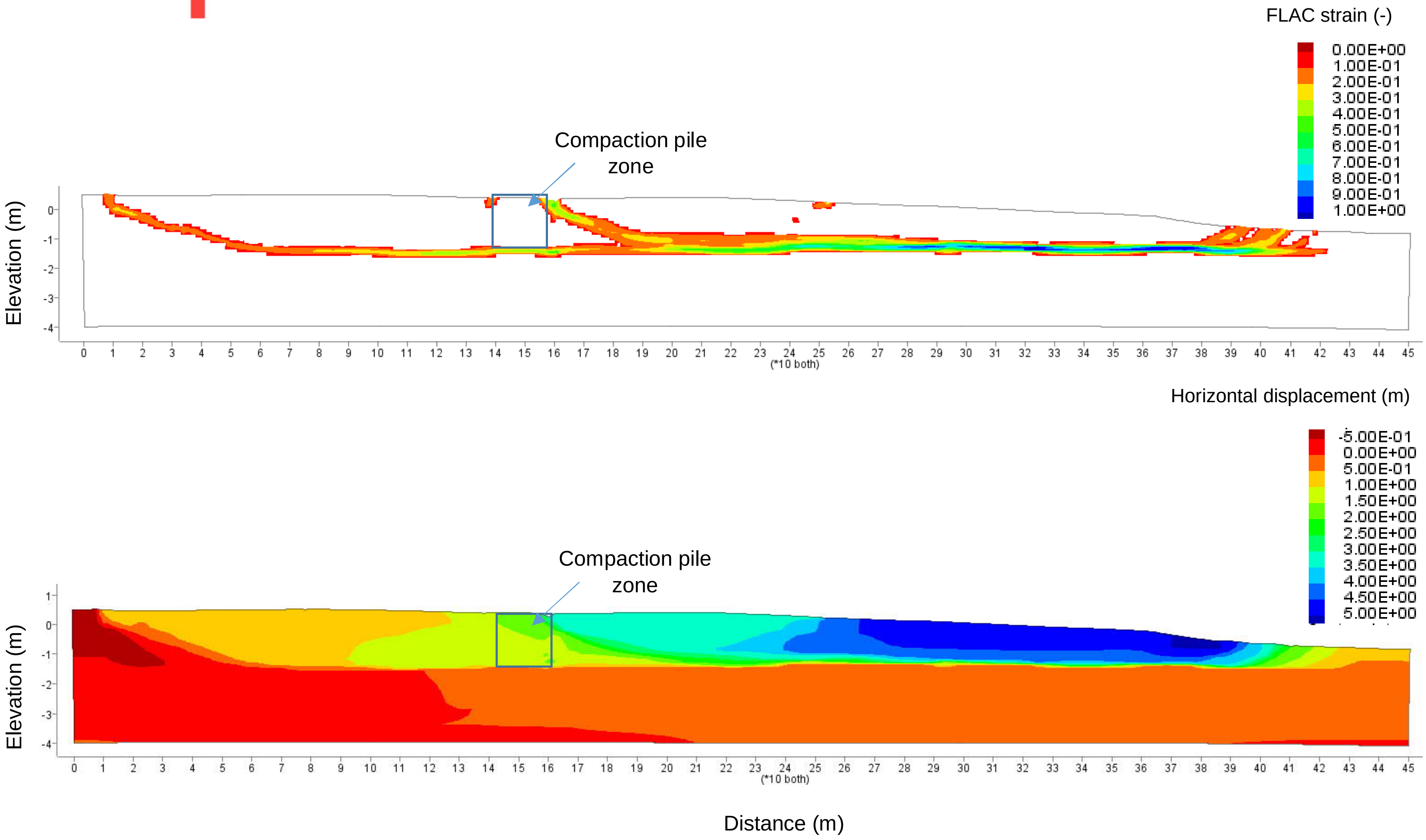


Figure A5-29: (a) Maximum shear strains and (b) horizontal displacements estimated at the end of shaking for the IF3 (Interface EQ) motion (Compaction pile option).

Table A5-3. Important Ground Motion Parameters

	Crustal					In-Slab					Interface				
	CR1	**CR2**	**CR3**	**CR4**	**CR5**	**IS1**	**IS2**	**IS3**	**IS4**	**IS5**	**IF1**	**IF2**	**IF3**	**IF4**	**IF5**
Max. Aceleration (g)	0.353	0.354	0.295	0.382	0.270	0.335	0.281	0.308	0.291	0.311	0.333	0.296	0.280	0.321	0.316
Time of Max. Aceleration (sec)	8.12	5.68	3.36	7.62	6.68	10.63	9.33	12.61	19.99	25.08	43.43	43.70	34.43	43.15	47.67
Max. Velocity (cm/sec)	27.7	34.0	28.5	46.2	18.6	27.8	28.2	31.0	34.3	33.1	56.2	68.6	62.0	69.4	56.1
Time of Max. Velocity (sec)	7.70	5.54	8.50	8.66	6.57	10.52	11.09	17.84	20.68	24.52	89.78	90.07	32.36	42.44	43.56
Max. Displacement (cm)	15.382	13.307	20.900	39.260	8.421	19.214	29.606	28.621	72.978	47.824	58.021	51.557	59.434	51.537	44.705
Time of Max. Displacement (sec)	8.40	9.36	7.08	16.87	10.15	11.47	9.07	8.84	13.04	22.77	88.40	88.04	36.81	47.14	53.44
Vmax / Amax: (sec)	0.080	0.098	0.099	0.123	0.070	0.085	0.102	0.103	0.120	0.109	0.172	0.236	0.226	0.221	0.181
Acceleration RMS: (g)	0.052	0.045	0.031	0.046	0.056	0.050	0.045	0.055	0.045	0.040	0.058	0.067	0.052	0.045	0.043
Velocity RMS: (cm/sec)	8.176	7.418	5.424	13.183	5.079	5.906	5.468	6.642	8.113	5.549	10.667	12.825	12.776	11.446	12.188
Displacement RMS: (cm)	4.541	4.382	3.873	13.851	2.361	9.663	14.967	16.103	45.575	21.598	8.183	8.292	13.804	9.759	10.439
Arias Intensity: (m/sec)	1.683	1.257	1.167	1.314	3.134	1.425	1.333	2.231	1.746	1.466	10.824	14.710	5.387	4.053	4.794
Characteristic Intensity (Ic)	0.076	0.061	0.048	0.063	0.107	0.068	0.062	0.089	0.072	0.062	0.201	0.254	0.135	0.109	0.115
Specific Energy Density (cm2/sec)	2674	2201	2337	6887	1646	1266	1275	2097	3622	1790	23923	34580	20963	16826	25476
Cumulative Absolute Velocity (cm/sec)	1344	982	1009	1178	2275	1117	1163	1757	1476	1260	8172	9944	3952	3151	4311
Acceleration Spectrum Intensity (g*sec)	0.282	0.275	0.284	0.298	0.329	0.298	0.283	0.263	0.259	0.273	0.292	0.289	0.295	0.296	0.292
Velocity Spectrum Intensity (cm)	129.0	137.1	106.0	103.7	96.3	143.0	136.8	135.8	138.8	142.5	235.5	233.8	229.6	224.3	232.1
Housner Intensity (cm)	128.8	130.3	104.1	110.4	83.3	128.8	124.0	126.4	127.3	127.4	227.5	223.5	224.4	220.3	223.4
Sustained Maximum Acceleration (g)	0.267	0.216	0.251	0.198	0.257	0.248	0.227	0.252	0.211	0.273	0.241	0.273	0.254	0.260	0.247
Sustained Maximum Velocity (cm/sec)	24.1	23.8	25.4	36.2	17.2	22.8	25.9	26.4	31.8	23.3	50.2	48.0	60.3	46.8	51.0
Effective Design Acceleration (g)	0.284	0.299	0.274	0.384	0.262	0.333	0.267	0.279	0.276	0.284	0.328	0.295	0.278	0.320	0.317
A95 parameter (g)	0.345	0.347	0.288	0.379	0.260	0.331	0.273	0.296	0.286	0.304	0.312	0.273	0.262	0.310	0.304
Predominant Period (sec)	0.220	0.160	0.240	0.280	0.320	0.180	0.300	0.300	0.260	0.240	0.320	0.440	0.520	0.340	0.440
Mean Period (sec)	0.601	0.564	0.576	0.657	0.392	0.550	0.509	0.477	0.527	0.477	0.779	0.847	0.904	0.989	0.910

APPENDIX

6. TERMS OF REFERENCE FOR GEOTECHNICAL REPORTS

TERMS OF REFERENCE FOR GEOTECHNICAL REPORTS ISSUED BY WSP CANADA INC.

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TERMS OF REFERENCE FOR GEOTECHNICAL REPORTS ISSUED BY WSP CANADA INC. (continued)

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August 21, 2019

WSP File Ref: 171-04753-02

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Burnaby, BC V5G 4M5

Attention: Christian Brumption, M.Eng., P.Eng.

**Subject: Port Alberni WWTP – Piled Pump Platform
Geotechnical Design Summary**

1.0 GENERAL

As requested, WSP Canada Inc. (WSP) provides the following geotechnical summary for design and construction of a piled platform alternative to the floating barge for the intake pumps for the UV Building for the Port Alberni WWTP Upgrade project. This report provides a summary of the platform configuration, an overview of seismic design criteria applied to this component of the upgrade project, a summary of key geotechnical parameters that were provided throughout the design process and geotechnical recommendations for construction.

A draft version was submitted on 19 August 2019 and review comments have been incorporated herein.

2.0 PLATFORM DESCRIPTION

Preliminary design plans provided by Associated Engineering Ltd. (AEL) dated July 30, 2019 (Select plans included in Appendix A) indicate that a 7 m x 8.1 m pile supported platform is proposed in each lagoon approximately 25 m southeast of the UV Building. The platforms are to be located approximately 9 m away from the crest of the existing interior lagoon berm. Each platform is to be supported on four – 762 x 16 mm diameter steel pipe piles partially filled with concrete to approximately 2 m below mudline (i.e. approximately 7.5 m below the top of berm and Elevation -3 m). Preliminary plans indicate a pipe grade of ASTM A252 Grade 3 Spiral Steel Pipe Piles (240 MPa) with 35 MPa concrete and vertical reinforcing infill. At the time of preparation of this report the final wall thickness of the piles was under review in relation to corrosion potential and possible coating alternatives. Top of pile elevation is to be approximately 3.1 m (Geodetic) with a top of platform elevation of 3.6 m (Geodetic). Table 1 below summarizes pile loading conditions provided by AEL (email dated July 17, 2019).

Table 1: Summary of Pile Loads Provided by AEL

LOADING CONDITION	VERTICAL COMPRESSION LOAD (KN)	FACTORED LATERAL LOAD AT PILE HEAD (KN)
Static	580 kN	N/A
1/100 year return period earthquake	420 kN	63 kN
1/475 year return period earthquake	450 kN	143 KN

A 750 mm diameter HDPE pipe will extend from the UV Building to the platform along the alignment shown on the plans. Proposed pipe invert elevation is 1.5 m +/-0.5 m. The pipe will be supported on a granular fill bench approximately 4.5 m wide (i.e. an extension of the recent berm widening). Concrete collars will be installed at regular intervals to resist uplift forces.

3.0 SUMMARY OF GROUND CONDITIONS

As an overview of ground conditions, the site is relatively complex from a geotechnical perspective. Based on test holes advanced nearby within the existing berm during work at the UV Building the general soil profile consists of (in order of increasing depth):

Table 2: Inferred Soil Conditions at the Proposed Platform

DEPTH INTERVAL (m)	ELEVATION INTERVAL (m)	DESCRIPTION
TOP OF EXISTING LAGOON BERM		
0 to 4 m	4.5 to 0.5m	Loose to compact **SAND AND GRAVEL (FILL)** with variable fines
4.5 to 6 m	0.5 to -1 m	Gravelly **SAND (FILL?)** with some silt
INFERRED MUDLINE		
6 to 7 m	-1 to -2 m	Soft **SILT** with wood debris (i.e. Mudline at platform location)
7 to 9 m	-2 to -4 m	Loose **SAND** with some gravel
9 to 10.5 m	-4 to -5.5 m	**SILT** some sand, shells
10.5 to 17 m	-5.5 to -12 m	Compact **SAND** with some gravel
17 m +	Below -12 m	**SILT**

4.0 SEISMIC DESIGN APPROACH

4.1 Seismic Setting

The project site is located in a high seismic zone due to its close proximity to the Cascadia Subduction Zone located off the west coast of Vancouver Island. Simplified liquefaction triggering analyses performed for the site indicate that coarse-grained soils encountered at the test hole locations are potentially liquefiable under 1/475 or higher return period event. The risk of liquefaction is lower for a more frequent but smaller intensity earthquake, such as the 1/100 return period event.

Seismic slope stability analyses indicate that the post-seismic Factor of Safety is less than unity for the 1/475 year return period event indicating potential for large ground displacements. Estimated Factors of Safety are considerably lower than unity for rare and high intensity seismic events such as the 975 and 2475 year return period events, indicting a high potential for flow slide type failures (i.e., ground displacements exceeding several meters).

4.2 Seismic Performance Criteria for Pump Platform Foundations:

We understand that the following two-level seismic performance target has been adopted by the City for the pump platform foundations. These seismic performance criteria are an extension of the design philosophy adopted by the City at the outset of the project (summarized in AEL's Technical Memorandum dated 10 March 2017) and are considered a balance of seismic resiliency and cost (i.e. cost implications of more stringent performance criteria are expected to be significant and prohibitive). There would be no intent to upgrade the existing lagoon berms in the vicinity of the proposed structures.

Seismic Event	Minimum Performance Level	Performance Targets
1/100 year return period event having a 40% probability of being exceeded in 50 years	Minimal damage/immediate use	• Steel piles shall remain within the elastic range and concrete compressive strain shall not exceed 0.004; • Pile displacement shall be limited to slight misalignment of the spans or settlement of some piles. Damage should be visually observable and accessible for repairs; • Any minor damage or repair that may be required shall not interrupt the operation of the pump station. • Permanent deformations of the fill embankments shall be limited, and shall not compromise the operation of the facility.
1/475 year return period event having a 10% probability of being exceeded in 50 years	No collapse/ life-safety	• Collapse of the structure is to be prevented and life-safety must be maintained. • The structure may become unusable or require extensive repairs to restore it to its full functionality. • Lateral and vertical movements of foundations are not restricted, but those movements shall not lead to the collapse of the structure.

5.0 ANALYSES

5.1 Seismic Site Classification

The site is classified as Site Class F as per Section 4.4.3.2 of CAN/CSA S6-14, due to the potentially liquefiable soils. As per the BC Supplement to the CAN/CSA S6-14, the seismic inertial load can be established based on the Geological Survey of Canada response spectrum adjusted for site conditions using generic site coefficients (i.e., not site-specific). Based on the measured shear wave velocities, Site Class E can be considered for the design response spectrum, and the applicable site coefficients can be obtained from Tables 4.2 through 4.8 in the code.

5.2 Axial Loading

The maximum factored load is 580kN under static (non-seismic conditions). With a resistance factor of 0.4, the required axial capacity is 1450 kN which can be achieved with a tip embedded within the granular deposit near approximate Elevation -9 m.

A considerable loss of axial pile resistance is expected after a 1/475 year return period event. As a result, piles may experience large settlements depending on the level of excess porewater pressure generated around the pile (Kanppett and Madabhushi, 2008). This is extremely difficult to predict with confidence. After some displacement, piles are expected to regain all or some of their capacity due to dilation of liquefied soil from continued shearing and dissipation of excess porewater pressures.

5.3 Lateral Loading

Lateral loads were provided by AEL for the 1/100 year and 1/475 year events which were used in the analyses. Lateral pile response analysis was performed using the LPILE (Ensoft 2012) computer program based on seismic "inertial loads" provided by AEL and "kinematic" (i.e., lateral spreading loads) computed by WSP. In accordance with CALTRANS (2012) and the BC Supplement to CAN/CSA S6-14 the proposed pile foundation was analyzed for the following load combinations: (1) 100% Inertial Loading and (2) 50% Inertial Loading + 100% Kinematic Loading

5.3.1 Load Combination 1: 100 % Inertial Loading (Figures 1 and 2)

A 762 mm x 16 mm pipe pile with an allowance of 3 mm of corrosion (i.e., effective thickness of 13 mm) was considered in the analyses. Our calculations indicate that the yield moment of the pile is approximately 1400 kN*m and 1800 kN*m, without and with concrete infill, respectively. As shown below, the maximum bending moment associated with inertial loading in both the 1/100 year and 1/475 year earthquakes is smaller than that value (i.e., pile hinging is acceptable for a no-collapse criteria).

Soil conditions are loose/soft (i.e. low resistance) and piles are expected to deform nearly as a rigid body (i.e. tilting rather than bending) which indicates that "pile strength" may be less critical than pile head deflections. Under inertial loading, analysis completed for a single pile (i.e. no consideration of group effects) indicates that pile head deflections could be in the order of 20 mm for the 1/100 year earthquake and 65 mm for the 1/475 year earthquake. The differential movement between two adjacent piles would be expected to be in the similar order of magnitude. Deck connections should be designed to accommodate such displacements. As per AEL recommendations, free-pile head conditions were assumed in the analyses, however, the actual deflections are likely to be less due to the deck connection and influence of the platform itself. Significant tilting of the platform could also occur due to massive soil movements.

5.3.2 Load Combination 2: 50% Inertial Loading + 100% Kinematic Loading (Figure 3)

Due to extensive liquefaction and relatively large ground displacements, we expect this to be a critical load combination for the 1/475 year seismic event. In comparison, lateral spreading loading is not a concern for the 1/100 year seismic event since liquefaction and lateral spreading are not predicted.

As shown in Figure 3 for the 1/475 year seismic event, pile head displacements in the order of 0.15 m are estimated. Bending moments and shear forces are smaller than the structural capacity of the pile. As noted in Section 5.3.1 above, actual pile head displacement is expected to be smaller due to the framing action of the deck. If connections between pile and deck are designed to accommodate these movements, we expect that the no-collapse/life-safety requirement will be satisfied.

6.0 GEOTECHNICAL RECOMMENDATIONS

6.1 Piles

The design static pile compression and lateral loads described in Section 2 above are considered geotechnically achievable with sufficient penetration below the mud-line and into the underlying compact sand deposit to achieve fixity. Due to the presence of compressible soils at depth, piles should not be advanced deeper than Elevation -10 m without input from the Geotechnical Engineer. Pile design is governed by lateral loading and the need to achieve minimum embedment below mud line (i.e. tip elevation of Elevation -8.5 m or deeper). Pile capacity is expected to be generated through skin friction (i.e. no substantial soil plug is expected to form). Under static loading conditions, settlement is expected to be within typical allowances of maximum 25 mm total and less than 15 mm differential.

Accordingly, it will be feasible from a geotechnical perspective to advance piles with vibratory method to within 3 m of the design tip elevation (i.e. near the top of the sand deposit) subject to confirmation of vertical load carrying capacity through dynamic formulae (with suitable factor of safety) during driving of the final 3 m and, if necessary, restrikes after pore pressure dissipation.

Some challenges may be encountered during construction. Logs were randomly encountered in the upper 5 m during ground improvement works in the nearby UV Building area. Some coarse rockfill has been placed nearby, and will be used during construction of the pipe support berm and there is potential that cobble or boulder sized particles have or could roll into the piled platform footprint area.

We advise against replacement of soil with concrete to the full depth of the pile due to a high risk of adverse impacts of removing soil due to pore pressure imbalance and ground heave. We understand that concrete infill design extends to a maximum of 2 m below mudline (i.e. no deeper than Elevation -3 m).

6.2 Pipe Support Berm

From a geotechnical perspective, the pipe may be supported on a berm that is constructed with a methodology similar to that used for construction of the main berm widening and central division berm. This procedure is summarized in Field Review Report 10 dated 2019-01-09 (Appendix B) and shown conceptually on the attached Figures 4 and 5. A critical assumption for this approach is that sufficient time is provided for a preload to generate the bulk of settlement associated with loads from the new berm and future pipe. Further discussion regarding settlements, preloading and the berm construction procedure are provided below.

The proposed center of the berm will range in height from approximately 2 to 3 m at the south end reducing in thickness to the north where they tie into the recent (January 2019) berm widenings near the UV Building. This will apply a new load which will generate relatively significant long-term settlement. Settlement will vary as the berm height varies and will be differential to settlement at the proposed pile supported platform and new UV Building. Preliminary estimates indicate that long-term settlement in the area of highest fill could be in the order of 100 to 200 mm, which may exceed the differential movement that the pipe or/and pipe connection at the pump platform can accommodate.

To reduce future settlement to a level that can be accommodated by the pipe and its connections, it is recommended that a preload be applied to the new berms. An approximate configuration for the preload is shown on Figure 5. The preload may be constructed with sand and gravel fill (i.e. Type A fill), concrete blocks, or 10 kg rock fill that is designated for use as erosion protection on the berm slopes. Two settlement gauges should be installed on each pipe bench and monitored using procedures described on Drawing Preload-1 of the main contract. Similar scale preload at the existing site has taken about 4 to 6 months. Further geotechnical discussion is recommended if less time is available for a preload. A shorter preload will still have significant benefits in relation to management of settlement, but consideration may also need to be given to flexible joints and/or a monitor/maintenance approach provided that the latter is acceptable to the City.

In general, the successfully implemented berm construction procedure involves the following steps:

1. Removal of surficial zone of organic silt to expose the underlying loose to very loose sand with occasional gravel and pockets of silt and/or silty sand;
2. Removal of localized pockets of soft silt which are larger than 0.5 m diameter;
3. Pumping to remove accumulated seepage;
4. Placement of heavy weight, non-woven geotextile on geotechnically approved subgrade perpendicular to the slope alignment with a minimum 1 m overlap between adjacent pieces of geotextile;
5. Placement of coarse rock fill (i.e. 50 kg Rip Rap) and compaction with a hoe pack to lock particles together and reduce voids;
6. Placement and compaction of a maximum 300 mm thick 75 to 100 mm minus angular rock fill (i.e. 10 kg Rip Rap) with a hoe-pack;
7. Benching into the existing slope/berm (i.e. at the north end of the proposed pipe sections) approximately 0.5 to 1 m laterally at existing/new fill interface above the existing 10kg rock fill elevation (i.e. approximately Elevation 0.5 to 1.0) in accordance with the procedures applied previously on the

project and shown on Figure GI-7 of the main contract. Refer to WSP Field Review Reports 10 and 12 (January 2019) in Appendix 2 for information about the recent berm widening work on the east and west sides of the existing berm, respectively; and,

8. Placement of 75 to 100 mm minus angular rock fill in 300 mm in thickness and compacting to the equivalent of a minimum 95% Modified Proctor Maximum Dry Density with either a hoe-pac or heavy drum roller compactor; and,
9. We understand that a finer grained material (such as 25 mm clear crush) may be used for bedding the pipe. Type A fill will be susceptible to erosion and will need to be suitably protected. We understand that erosion protection will be designed by the Civil Engineer. A conceptual illustration of this is shown on the attached

Pipe berm construction should be conducted when the lagoon water levels are low (i.e. rock fill placement in relatively dry conditions or limited thickness of standing water). We note that at the time of widening of the existing berms, the contractor discarded some of the organic materials into the existing lagoon beyond the toe of the new berms. This caused the existing organic materials to be less stable and flow into the previous excavation. Some additional challenges in relation to temporary excavation stability may be encountered in relation to this disturbed soil during excavation for the proposed pipe support berms described herein. There is high potential that conditions may necessitate implementation of procedures similar to those used for construction of the central division berm (i.e. isolation of the work area and removal of fluidized sludge/mud with a vac truck).

The side slopes of a pipe berm constructed primarily with 10 kg Rip Rap may be built to a slope gradient of 1.5H:1V. To reduce the lateral extent of excavation (and subgrade preparation), the lower portion of the berm (i.e. constructed with 50 kg Rip Rap) may be designed based on a 1H:1V side slope. We note that berm construction conditions are expected to be challenging on the west side of the lagoon due to the deeper mudline in this area.

To further reduce the potential for construction challenges, consideration was given to relocating the proposed pipe to the east approximately 3.5 m to provide a berm height similar to that proposed on the east side of the existing berm (shown as a dashed line on Figure 5). However, we understand this large adjustment of the alignment is not considered feasible at this time and a direct connection from the recently installed pipe to the connection point at the platform is preferred.

Subject to seepage and moisture conditions, consideration could also be given to using Type A fill to construct the upper portion of this berm, but a more gentle side slope (i.e. maximum 2H:1V finished slope angle) would be required resulting in a wider excavation. Type A fill is highly susceptible to erosion and would need to be suitably protected as indicated above. For these reasons, use of Type A fill for this berm is not recommended geotechnically.

Care must be taken during construction of this berm to avoid placing rockfill in the zone of future piles.

We understand that the toe of the pipe berm is to extend no closer than 1 m away from the pile supported platform. We understand that in this area, the new pipe will follow the sloped ground before it connects at the platform. In this area, the slope of the berm should be reduced to 2H:1V along the pipe centerline for long-term and seismic stability considerations.

7.0 FUTURE GEOTECHNICAL

Further geotechnical engineering is anticipated as the project develops. At this time, we envisage the following scope could be needed:

1. Geotechnical review of tender documents in the context of geotechnical recommendations;
2. Preparation of specialized components of the construction specifications, if required (e.g., pile installation);
3. Geotechnical engineering support during tender, as needed;
4. Construction review services during pipe berm construction and pile installation; and
5. Geotechnical engineering support in relation to unforeseen conditions, as needed.

8.0 CLOSURE

The work outlined above was carried out in accordance with our current contract with Associated Engineering Ltd. and the attached Terms of Reference for Geotechnical Reports. The City of Port Alberni is an approved user of this report subject to the terms under which it was prepared.

We trust that this information meets your current requirements. Please contact the undersigned if you have any questions or need further details.

Yours truly,

WSP Canada Inc.

2019-08-21

D.W. FUREY
29783
2019-08-21

Reviewed by:

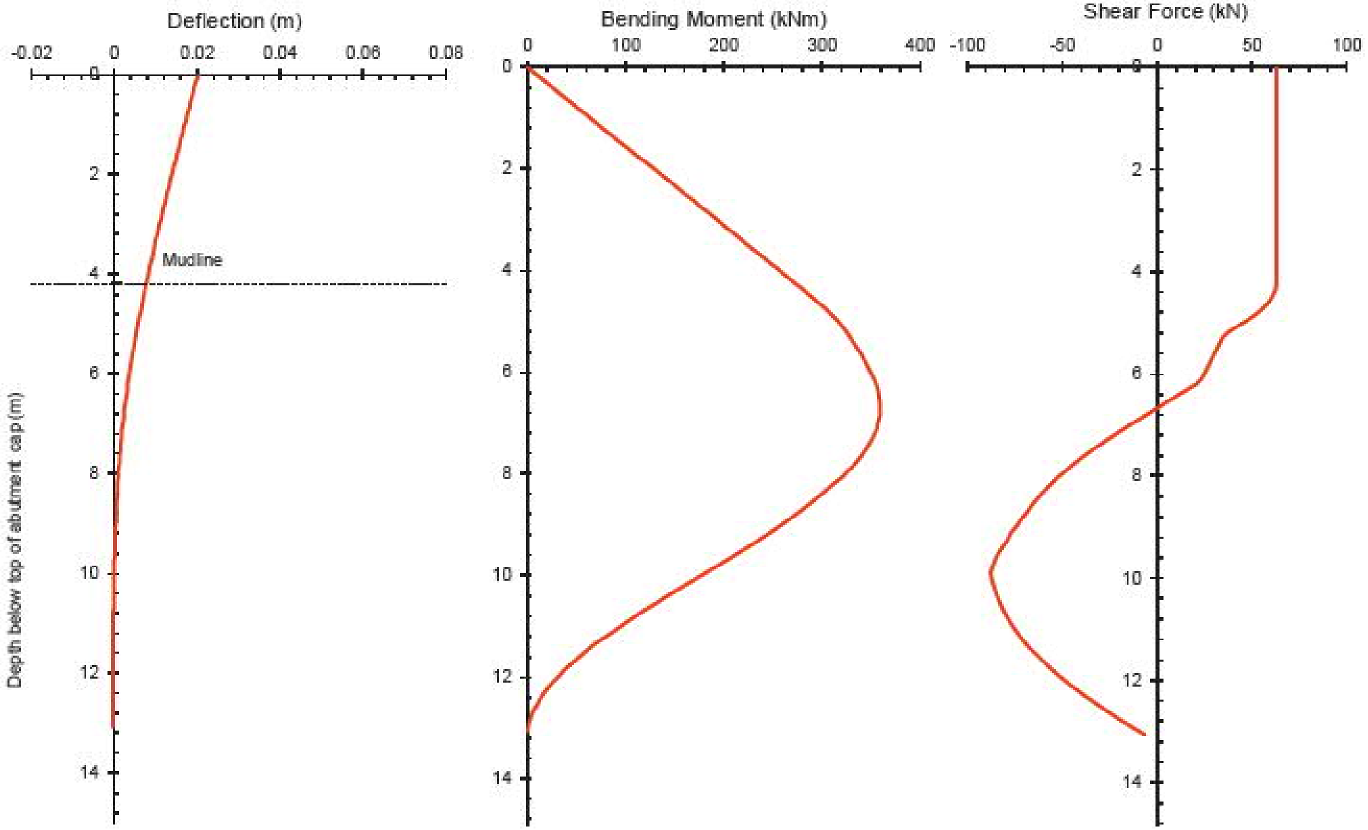
Darryl Furey, M.Eng., P.Eng.
Senior Geotechnical Engineer

Lalinda Weerasekara, Ph.D., P.Eng.
Senior Geotechnical Engineer

Encl:	Figure 1:	Lateral Pile Analysis Results – 100 yr EQ (100% Intertial Loading)
	Figure 2:	Lateral Pile Analysis Results – 475 yr EQ (100% Intertial Loading)
	Figure 3:	Lateral Pile Analysis Results – 475 yr EQ (50% Inertial + 100% Kinematic Loading)
	Figure 4:	Plan View – Conceptual Pipe Support Berm
	Figure 5:	Profile - Conceptual Pipe Support Berm
	Appendix A	Preliminary Pile Platform Plan and Section Views
	Appendix B	WSP Field Review Reports 10 and 12
	Appendix C	Terms of Reference for Geotechnical Reports

Pile Details	
Pile Diameter (mm)	762
Pile Wall Thickness (mm)	13.0
Pile reinforcements	12 x 25M
Concrete strength (Mpa)	35

Loads (per pile)	
Axial load on pile(s) (kN)	450
Shear Force at pile top (kN)	63
Seismic Event	1/100



PROJECT:
PORT ALBERNI WWTP

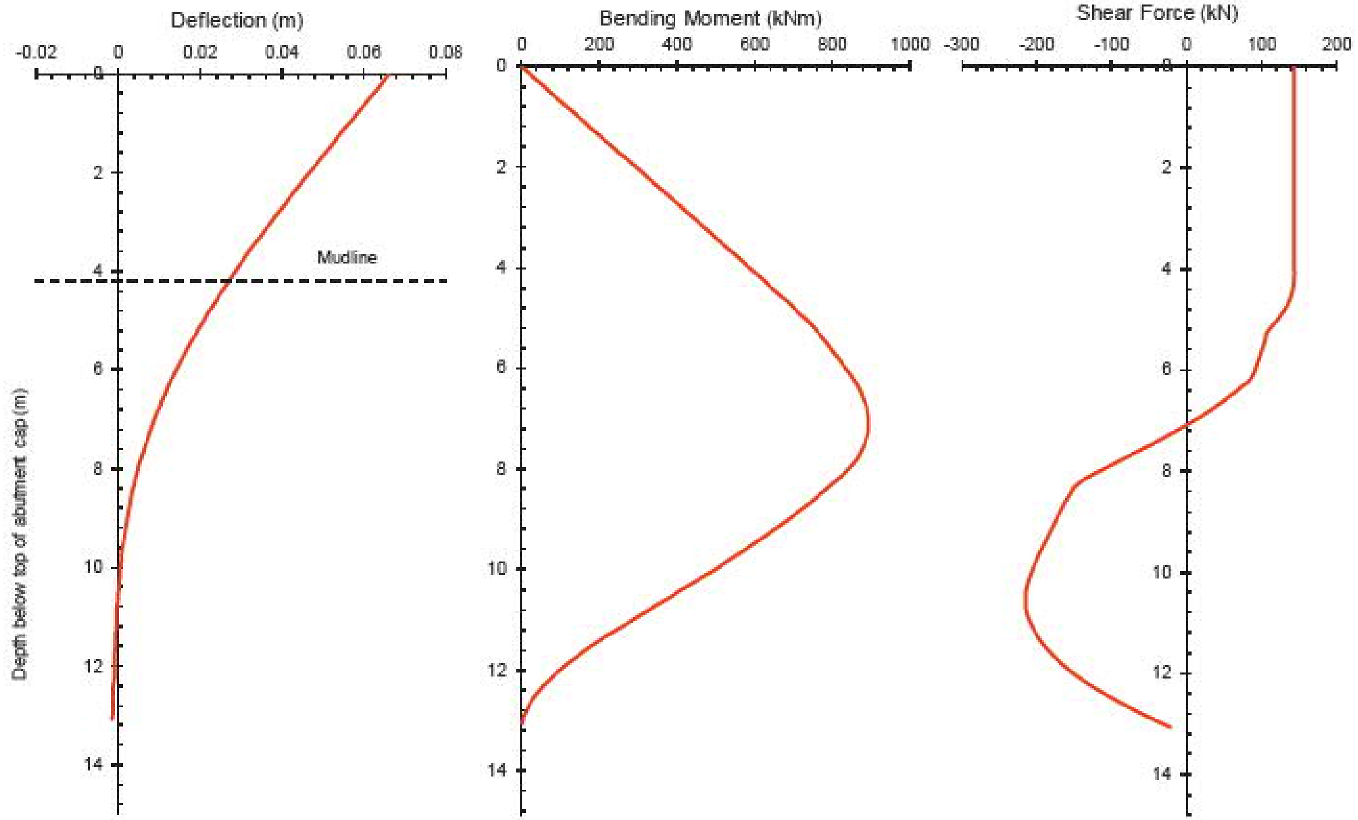
TITLE:
LATERAL PILE ANALYSIS RESULTS FOR 1/100 YEAR EARTHQUAKE (100% INERTIAL LOADING CASE)
GEOTECHNICAL DESIGN SUMMARY
PILED PUMP BARGE PLATFORM ALTERNATIVE

CLIENT:
ASSOCIATED ENGINEERING (BC) LTD.

FIGURE NO.:	DATE:	FILE NO.:	SCALE:	DRAWN BY:	REV NO.:
1	AUG 2019	171-04753-02	NTS	LW	-

Pile Details	
Pile Diameter (mm)	762
Pile Wall Thickness (mm)	13.0
Pile reinforcements	12 x 25M
Concrete strength (Mpa)	35

Loads (per pile)	
Axial load on pile(s) (kN)	450
Shear Force at pile top (kN)	143
Seismic Event	1/475



PROJECT:
PORT ALBERNI WWTP

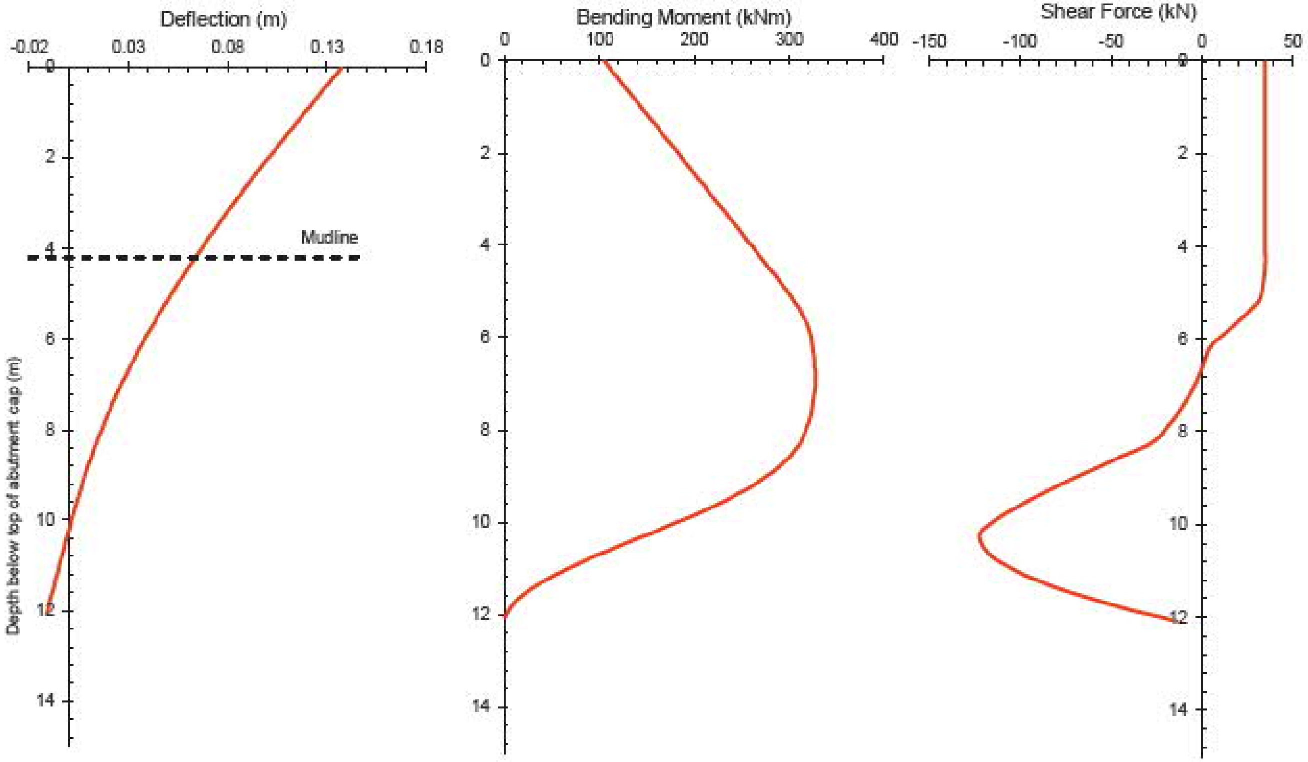
TITLE:
LATERAL PILE ANALYSIS RESULTS FOR 1/475 YEAR EARTHQUAKE (100% INERTIAL LOADING CASE)
GEOTECHNICAL DESIGN SUMMARY
PILED PUMP BARGE PLATFORM ALTERNATIVE

CLIENT:
ASSOCIATED ENGINEERING (BC) LTD.

FIGURE NO.:	DATE:	FILE NO.:	SCALE:	DRAWN BY:	REV NO.:
2	AUG 2019	171-04753-02	NTS	LW	-

Pile Details	
Pile Diameter (mm)	762
Pile Wall Thickness (mm)	13.0
Pile reinforcements	12 x 25M
Concrete strength (Mpa)	35

Loads (per pile)	
Axial load on pile(s) (kN)	450
Shear Force at pile top (kN)	71
Seismic Event	1/475



PROJECT:

PORT ALBERNI WWTP

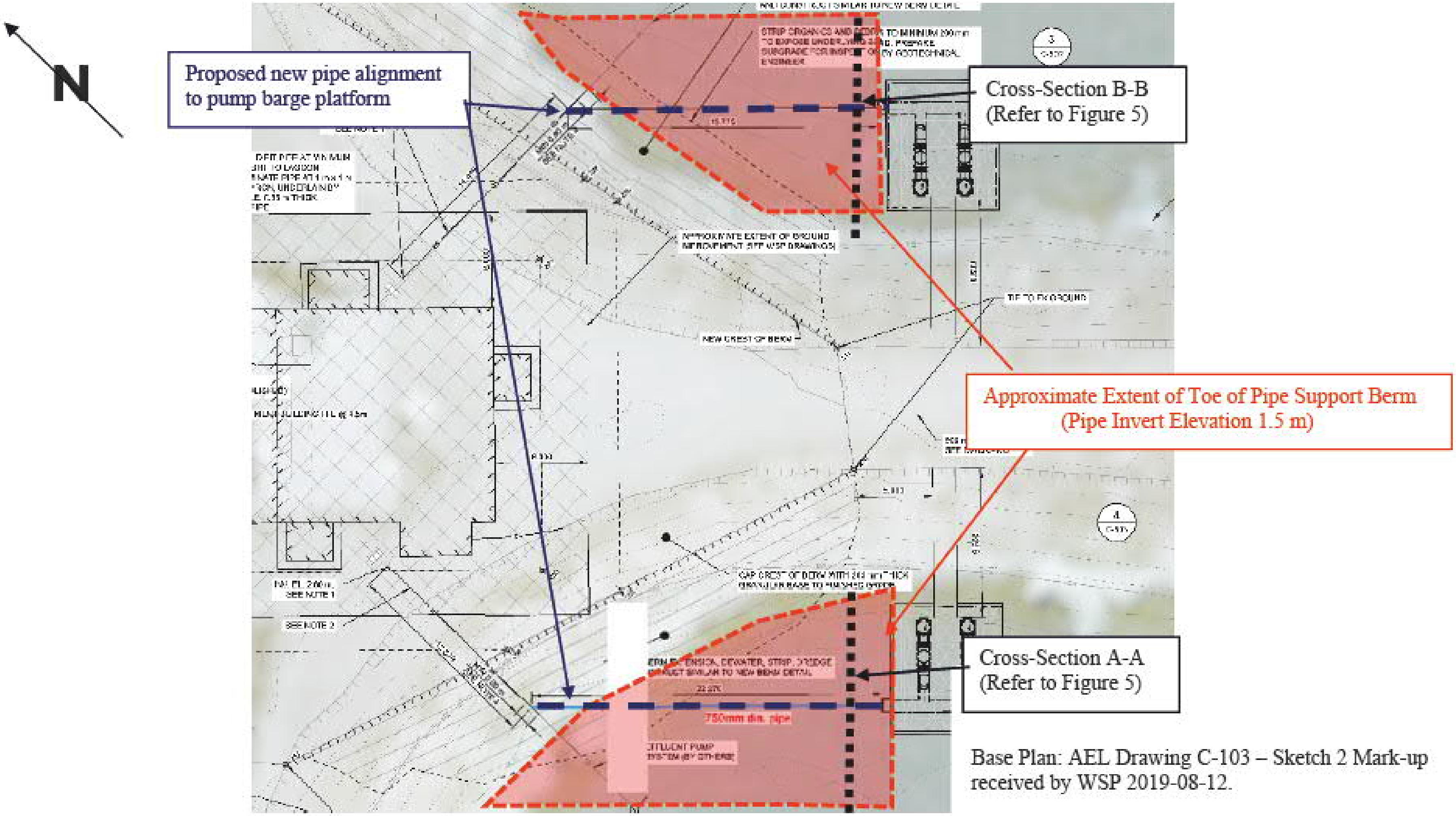
TITLE:

LATERAL PILE ANALYSIS RESULTS FOR 1/475 YEAR EARTHQUAKE (50% INERTIAL + 100% KINEMATIC LOADING CASE)
GEOTECHNICAL DESIGN SUMMARY
PILED PUMP BARGE PLATFORM ALTERNATIVE

CLIENT:

ASSOCIATED ENGINEERING (BC) LTD.

FIGURE NO.:	DATE:	FILE NO.:	SCALE:	DRAWN BY:	REV NO.:
3	AUG 2019	171-04753-02	NTS	LW	-



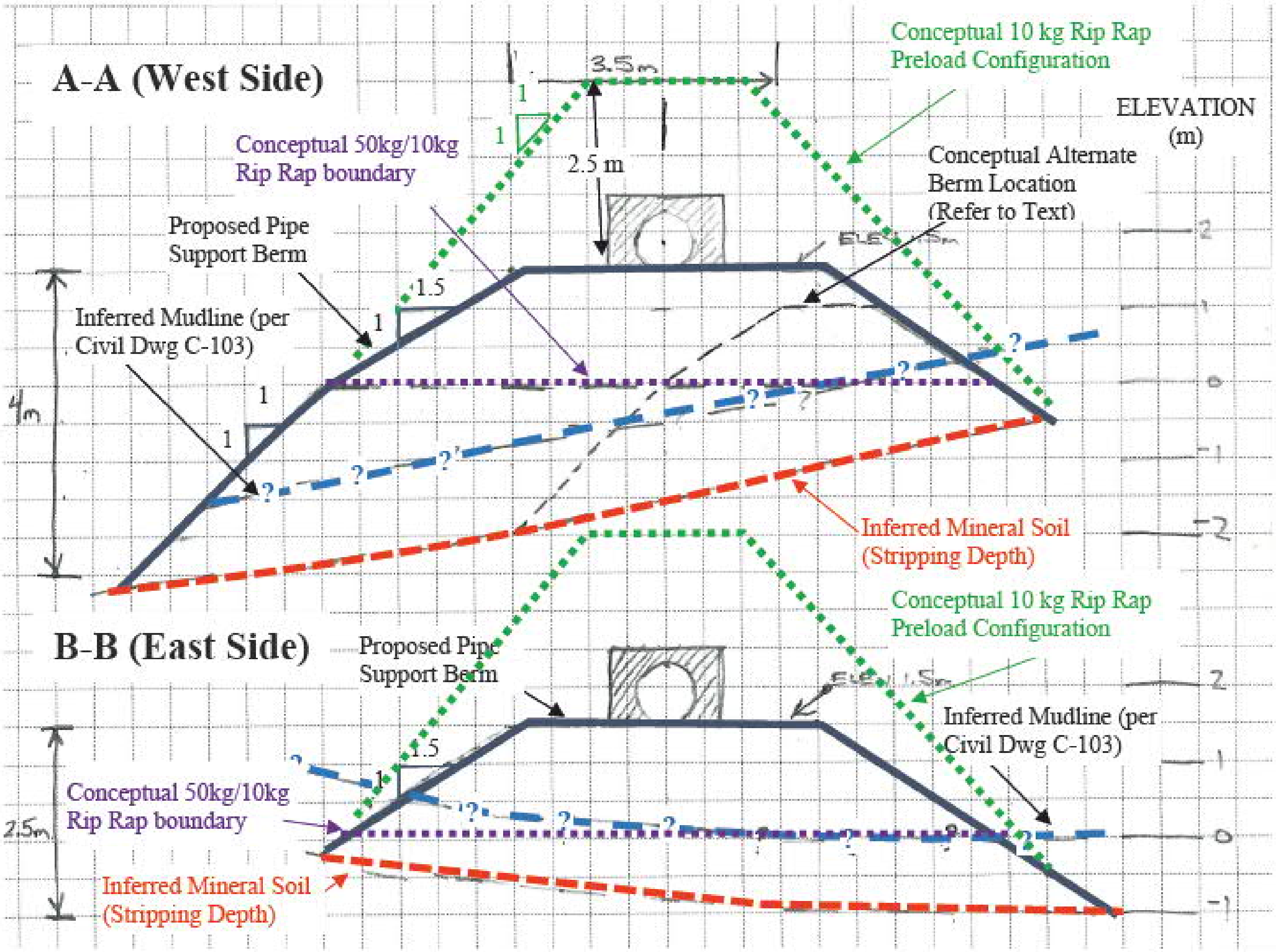
Base Plan: AEL Drawing C-103 – Sketch 2 Mark-up received by WSP 2019-08-12.

PROJECT:
PORT ALBERNI WWTP

TITLE:
PLAN VIEW – CONCEPTUAL PIPE SUPPORT BERM
GEOTECHNICAL DESIGN SUMMARY
PILED PUMP BARGE PLATFORM ALTERNATIVE

CLIENT:
ASSOCIATED ENGINEERING (BC) LTD.

FIGURE NO.:	DATE:	FILE NO.:	SCALE:	DRAWN BY:	REV NO.:
4	AUG 2019	171-04753-02	NTS	DF	-



PROJECT:
PORT ALBERNI WWTP

TITLE:
PROFILE – CONCEPTUAL PIPE SUPPORT BERM
GEOTECHNICAL DESIGN SUMMARY
PILED PUMP BARGE PLATFORM ALTERNATIVE

CLIENT:
ASSOCIATED ENGINEERING (BC) LTD.

FIGURE NO.:	DATE:	FILE NO.:	SCALE:	DRAWN BY:	REV NO.:
5	AUG 2019	171-04753-02	NTS	LW	-

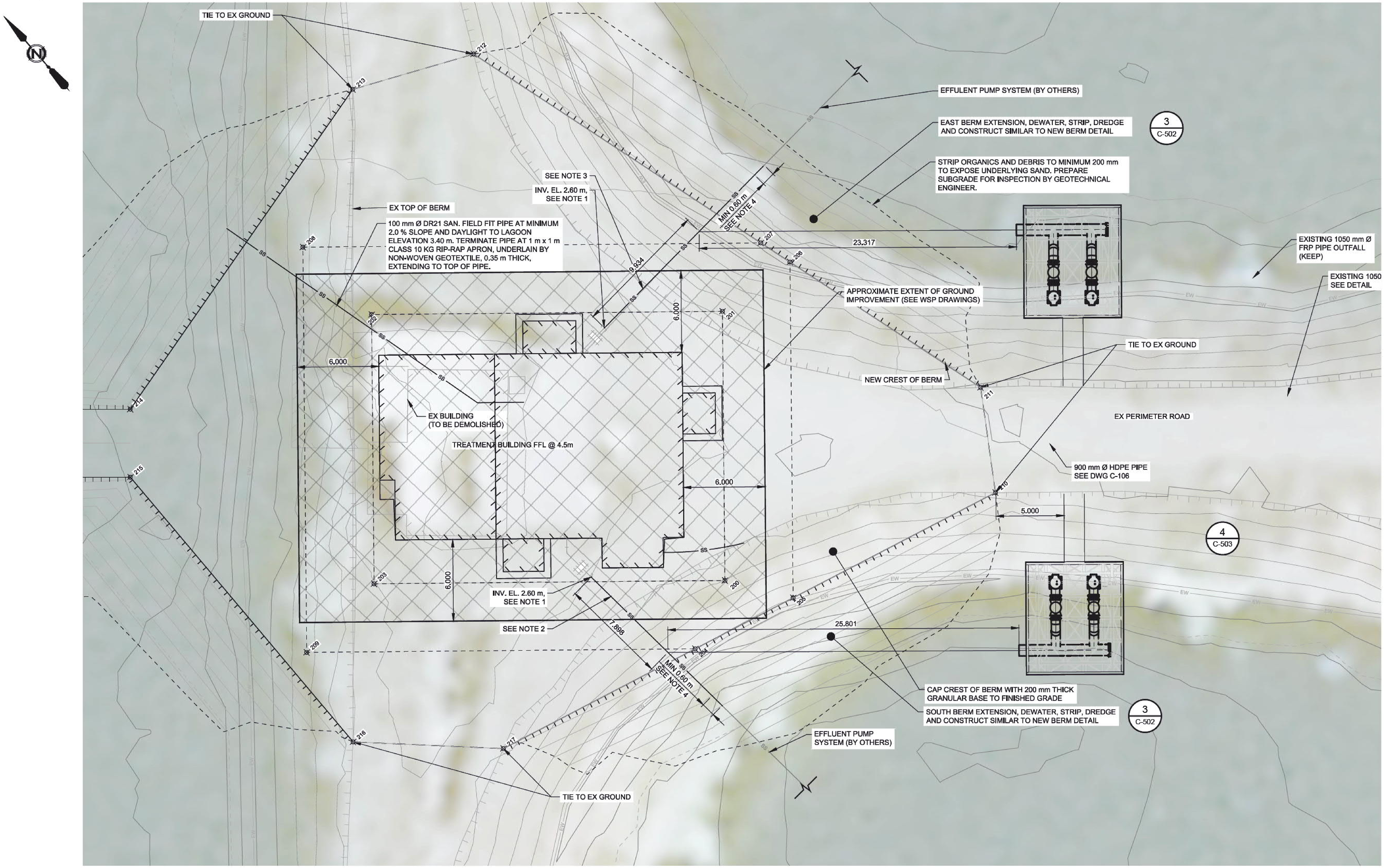
APPENDIX

A

PRELIMINARY PILE PLATFORM PLAN AND SECTION VIEWS

IF NOT 50 mm ADJUST SCALES
50 mm

SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS, TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE



1 PLAN 1:150

POINT TABLE				
PNT#	NORTHING	EASTING	PR ELEV	EX ELEV
200	5032.538	2947.797	4.50	3.48
201	5047.520	2960.719	4.50	3.89
202	5064.361	2941.194	4.50	4.90
203	5049.380	2928.271	4.50	4.48
204	5030.210	2942.840	4.40	2.18
205	5028.271	2950.719	4.40	2.05
206	5046.956	2966.836	4.40	1.92
207	5049.433	2966.156	4.40	1.91
208	5071.413	2940.674	4.40	3.35
209	5048.859	2921.220	4.40	3.32
210	5024.266	2966.995	4.41	4.07
211	5030.787	2971.277	4.58	4.58
212	5073.789	2959.468	4.84	4.84
213	5077.707	2951.079	4.60	4.60
214	5070.843	2923.289	4.15	0.15
215	5067.087	2919.988	4.15	0.02
216	5041.668	2919.444	4.38	4.14
217	5034.007	2927.412	4.09	4.09

SOUTH AND EAST BERM BERM EXTENSIONS

- REMOVAL/DREDGED VOLUME (1.0 m DEPTH) = 403 m^3
- 10 KG RIP-RAP BELOW WATER (ELEV: 0.0 m) = 0 m
- IMPORTED FILL ABOVE WATER (INCLUDE REPLACEMENT OF DREDGED VOLUME) = 1,323 m^3

NOTES:

1. TIE INTO 750 mm CARBON STEEL EFFLUENT PIPE, REFER TO DWG 2972-00-D-151, C/W HDPE FLANGE ADAPTER AND BACKING RING, AT INV ELEV 2.60 m.
2. 13.60 m - 750 mm HDPE DR26 SAN @ 1.0%.
3. 16.70 m - 750 mm HDPE DR26 SAN @ 1.0%.
4. EXTEND 750 mm HDPE PIPE MIN 0.60 m BEYOND DAYLIGHT LOCATION AT EDGE OF BERM. TIE INTO EFFLUENT PUMP SYSTEM FLOATING PUMP STATION AND FLEXIBLE JOINT (BY OTHERS). COORDINATE WITH EFFLUENT PUMP STATION SYSTEM SUPPLIER.

\\S-VAN-FS-01\projects\20172972\00_WstWtr_Trtmnt_Upg\Working_Dwgs\400_Process_Mech\OBS_2972-00-c-103.dwg
DATE: 2019-07-30, Robin Wang

Associated Engineering
Suite 300 - 4940 Canada Way, Burnaby, British Columbia, V5G 4M5
Ph: 604 293 1411 Fax: 604 291 6163
www.ae.ca

CANADA'S BEST MANAGED COMPANIES Platinum member

REV	DATE	DESIGN	DRAWN	DESCRIPTION
3	2018AUG02	Z. SALLY	A. MOLYNEAUX	ISSUED FOR ADDENDUM 5
2	2018JUL24	Z. SALLY	A. MOLYNEAUX	ISSUED FOR ADDENDUM 4
1	2018JUL11	Z. SALLY	A. MOLYNEAUX	ISSUED FOR ADDENDUM 2
0	2018JUNE27	Z. SALLY	A. MOLYNEAUX	ISSUED FOR TENDER

CITY OF PORT ALBERNI

WASTEWATER LAGOON
EXPANSION UPGRADES

20172972-00

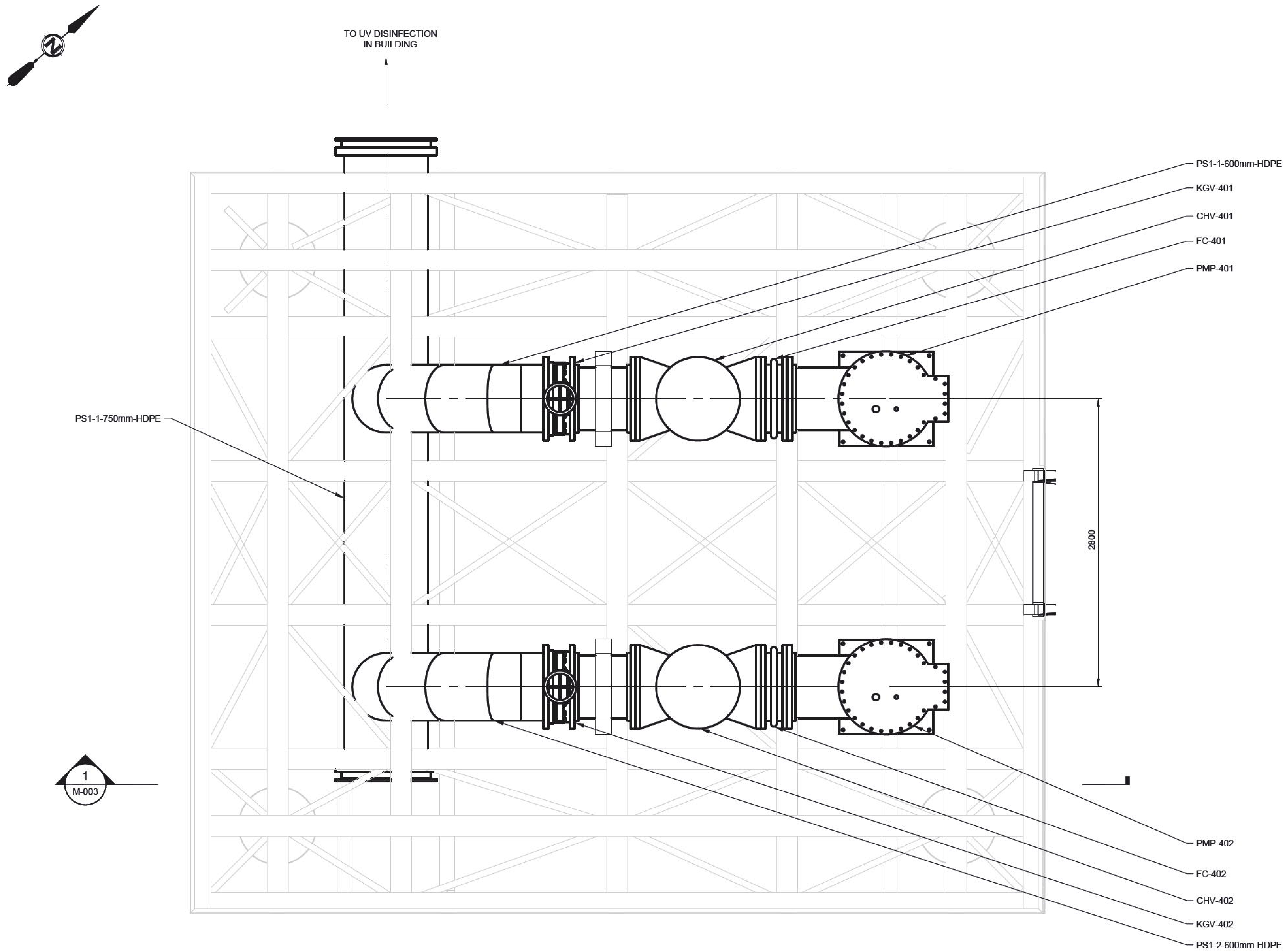
SCALE: AS SHOWN

THE CITY OF
Port Alberni

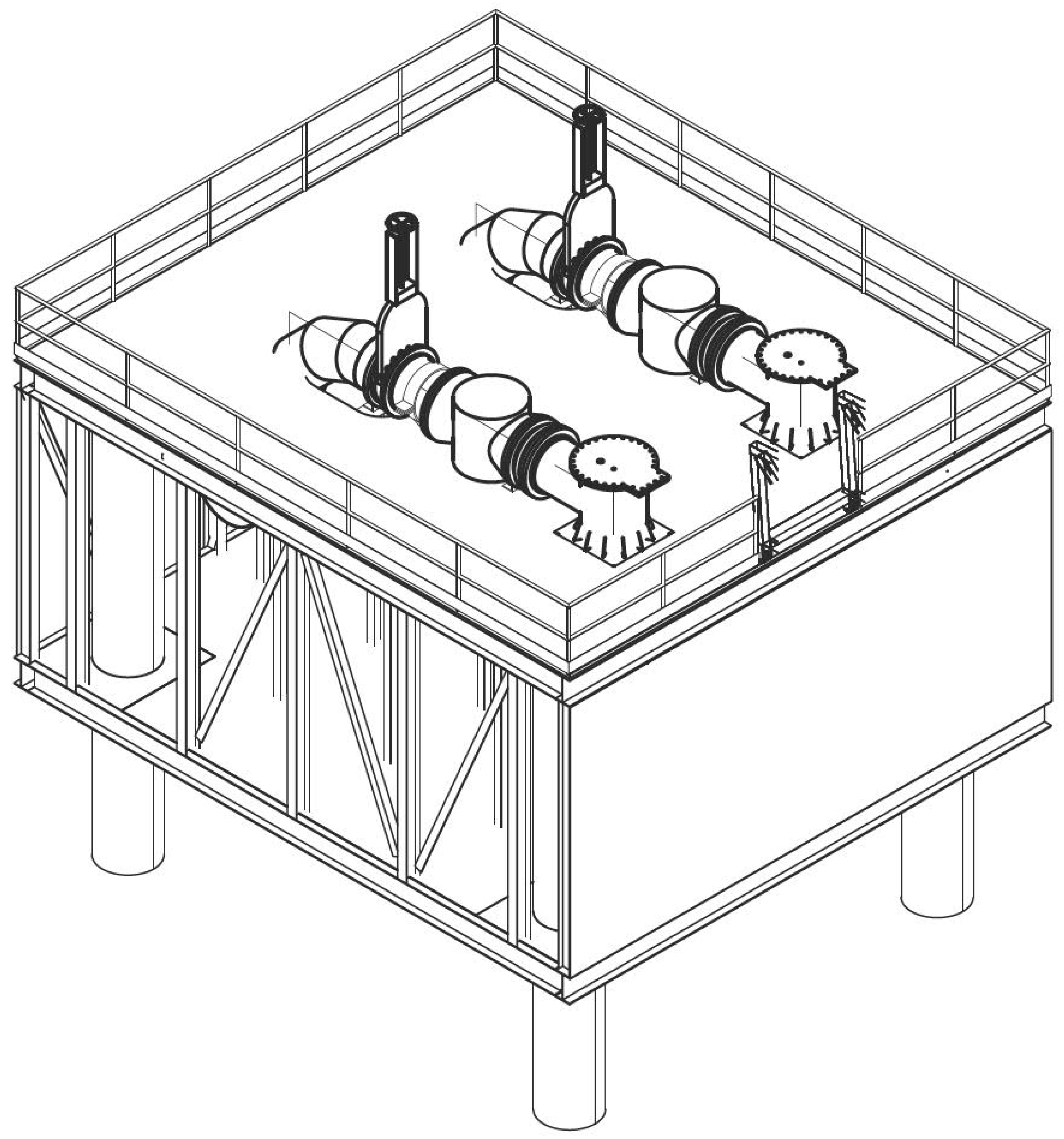
CIVIL
SITE GRADING
UV BUILDING

DRAWING	REVISION	SHEET
2972-00-C-103	3	8 / 111

IF NOT 50 mm ADJUST SCALES
50 mm
SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS, TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE



PLAN 1:25
PUMP STATION #1



NOTES:
1. PUMPS (AND DRAFT TUBES) PRE-PURCHASED BY THE CITY. TOTAL OF FOUR.
2. PUMP STATION #2 IS A MIRROR IMAGE OF PUMP STATION #1.

Associated Engineering
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Ph: 604 293 1411 Fax: 604 291 6163
www.ae.ca

CANADA'S BEST MANAGED COMPANIES
Platinum member

A	2019JUL23	M.SIMHON	R.WANG	ISSUED FOR REVIEW
REV	DATE	DESIGN	DRAWN	DESCRIPTION

CITY OF PORT ALBERNI

WASTEWATER LAGOON
EXPANSION UPGRADES

20172972-00

SCALE: AS SHOWN

THE CITY OF
Port Alberni

PROCESS MECHANICAL
PUMP STATION #1
PLAN

DRAWING	REVISION	SHEET
2072-00-M-002	A	---- / 111

IF NOT 50 mm ADJUST SCALES
50 mm
SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS, TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE

1 SECTION 1:25
-
PUMP STATION #1

NOTES:
1. PUMPS (AND DRAFT TUBES) PRE-PURCHASED BY THE CITY. TOTAL OF FOUR. INSTALLATION BY CONTRACTOR.
2. PUMP STATION #2 IS A MIRROR IMAGE OF PUMP STATION #1.
3. 750mm HDPE DISCHARGE PIPING TO BE KEPT SUBMERGED AT VARYING LAGOON WATER LEVELS.

\\S-VAN-FS-01\projects\20172972\00_WstWtr_Trtmnt_Upg\Working_Dwgs\400_Process_Mech\TEMP_P3D\2072-00-m-003.dwg
DATE: 2019-08-02, Robin Wang

Associated Engineering
Suite 300 - 4940 Canada Way, Burnaby, British Columbia, V5G 4M5
Ph: 604 293 1411 Fax: 604 291 6163
www.ae.ca

CANADA'S BEST MANAGED COMPANIES
Platinum member

REV	DATE	DESIGN	DRAWN	DESCRIPTION
A	20171011	Z.SALLY	J.WHITE	ISSUED FOR REVIEW

CITY OF PORT ALBERNI

WASTEWATER LAGOON
EXPANSION UPGRADES

20172972-00

SCALE: AS SHOWN

THE CITY OF
Port Alberni

PROCESS MECHANICAL
PUMP STATION #1
SECTION

DRAWING	REVISION	SHEET
2072-00-M-003	A	---- / 111

APPENDIX

B

WSP FIELD REVIEW REPORTS 10 AND 12

WSP Canada Inc.
1935 Bollinger Road
Nanaimo, BC V9S 5W9
Tel. +1 250-753-1077
WSP.com

Field Review Report

Project:	**Port Alberni WWTP**	**Project Number:**	171-04753-02
Location:	Port Alberni, BC	**Report Number:**	10
Contractor:	Tritech	**Date:**	7 to 9 January 2019
Owner:	City of Port Alberni c/o Associated Engineering (BC) Ltd.	**Time:**	08:30 to 17:30 (7th) 08:00 to 15:30 (8th) 08:30 to 16:00 (9th)
		Weather:	Moderate to Heavy Rain & Snow
In Attendance:	Oscar Urriola (WSP) (7 to 9 Jan) Darryl Furey (WSP) (7 Jan Only) Roger Larose & Erik Frankson (Tritech) Greg Brouwer (Associated) (8/9 Jan)		

As requested, WSP Canada Inc. (WSP) visited the site from 7 to 9 January 2019 to observe subgrade preparation and placement of engineered fill for the widening of the east berm near the future UV Treatment Building (E UV Berm Widening). Site work included subgrade preparation, construction of the toe of the new berm from Field. Station 0 to 35, and commencement of placement of Type A fill. Several construction procedures were attempted to determine a suitable methodology for construction in the toe area of the new berms.

Photographs of site conditions at the time of the field reviews are attached. A site plan (Figure 1) illustrating the approximate stationing and attached as-built cross-sections (Figures 2 and 3) are also attached.

Station 29 to 35

At the time of WSP's arrival on 7 January, the contractor had constructed the next section of new berm toe fill from approximately Station 29 to 35. The contractor reports having used the same construction procedure as was applied on 4 January (Friday) as described in Field Review Report 9 and modified by using coarse, angular rock fill in the lower 0.5 m (i.e. 50 kg rip rap, typical size range from 150 to 450 mm diameter). The contractor noted that subgrade conditions seemed softer/looser than those observed on Friday.

Station 25 to 29

As built conditions at Station 28 are shown in cross-section on Figure 3. Coarse, angular rock fill was placed directly on a geotechnically approved subgrade of the underlying inferred natural, loose sand (i.e. prior to geotextile arrival on site). An approximately 1 m wide bench was left in place near the toe of the existing berm. A hoe-pack was used to compact the angular rock fill and several lifts of angular rock fill were required to achieve a relatively stable base condition. Based on this observation, a geotextile separator was recommended. Also, the bench on the inside edge of the coarse rock fill did not perform well under compaction effort and some remedial work was required.

Station 0 to 25

The construction procedure applied to this section generally consisted of:

1. Removal of soft, organic silt to expose the underlying loose to very loose sand with occasional gravel and pockets of silt and/or silty sand;
2. Removal of localized pockets of soft silt which were larger than 0.5 m diameter;
3. Pumping to remove accumulated seepage;
4. Placement of Armtec 250 non-woven geotextile on geotechnically approved subgrade perpendicular to the slope with a minimum 1 m overlap between adjacent pieces of geotextile;
5. Placement of coarse rock fill and compaction with a hoe pack and dewatering with a sump pump;
6. Placement and compaction of a maximum 300 mm thick 100 mm minus angular rock fill (10 kg Rip Rap) with multiple, overlapping passes with a heavy drum roller compactor;
7. Placement (wrapping) with a geotextile separator parallel to the slope with a minimum 0.5 m overlap;
8. Benching into the existing slope/berm approximately 0.5 to 1 m laterally at existing/new fill interface; and,
9. Placement of Type A fill in lifts not exceeding 300 mm in thickness and compacting to a minimum 95% Modified Proctor Maximum Dry Density. In Place Density (IPD) test results will be reported under separate cover.

The lateral extent of rock fill varied as summarized in Table 1 below:

Table 1 Summary of Lateral Extent of Rock Fill At Base of Excavation

STATION	Width of Rock Fill (m)	Approximate Maximum Thickness of Rock Fill at Outside Edge (m)
35	3	0.8 to 1
28	4	1
17	6.5 to 7.5	1.2 to 1.4
10	5	1
5	3	0.6

We understand that the top of rock fill ranged from approximately Elevation 1.2 (outside edge) to Elevation 1 m (inside edge) (per survey information from Associated/Tritech).

We note that the moisture content of the Type A granular fill was less than that previously observed (i.e. Field Review Report 9) but was still relatively high. Notwithstanding, the specified compaction was being achieved. The contractor will need to monitor the moisture content of material that is delivered to site to make sure that the moisture content does not become excessive again.

In summary, the observed conditions and construction progress described herein meet the intent of geotechnical recommendations.

WSP is scheduled to be on site Thursday and Friday (10/11 January) to install Vibrating Wire Piezometers and conduct in place density testing at regular intervals during placement of the Type A fill in the berm widening area.

Closure

This document was completed in accordance with the terms of our contract with Associated Engineering Ltd. for the project and the Terms of Reference for Geotechnical Reports appended to the geotechnical assessment report. The City of Port Alberni is an approved user subject to the terms under which it was prepared.

Distribution:
Christian Brumpton (Associated Engineering)

Attachments:
Figures 1 to 3
Photos (8 pages)

WSP CANADA INC.

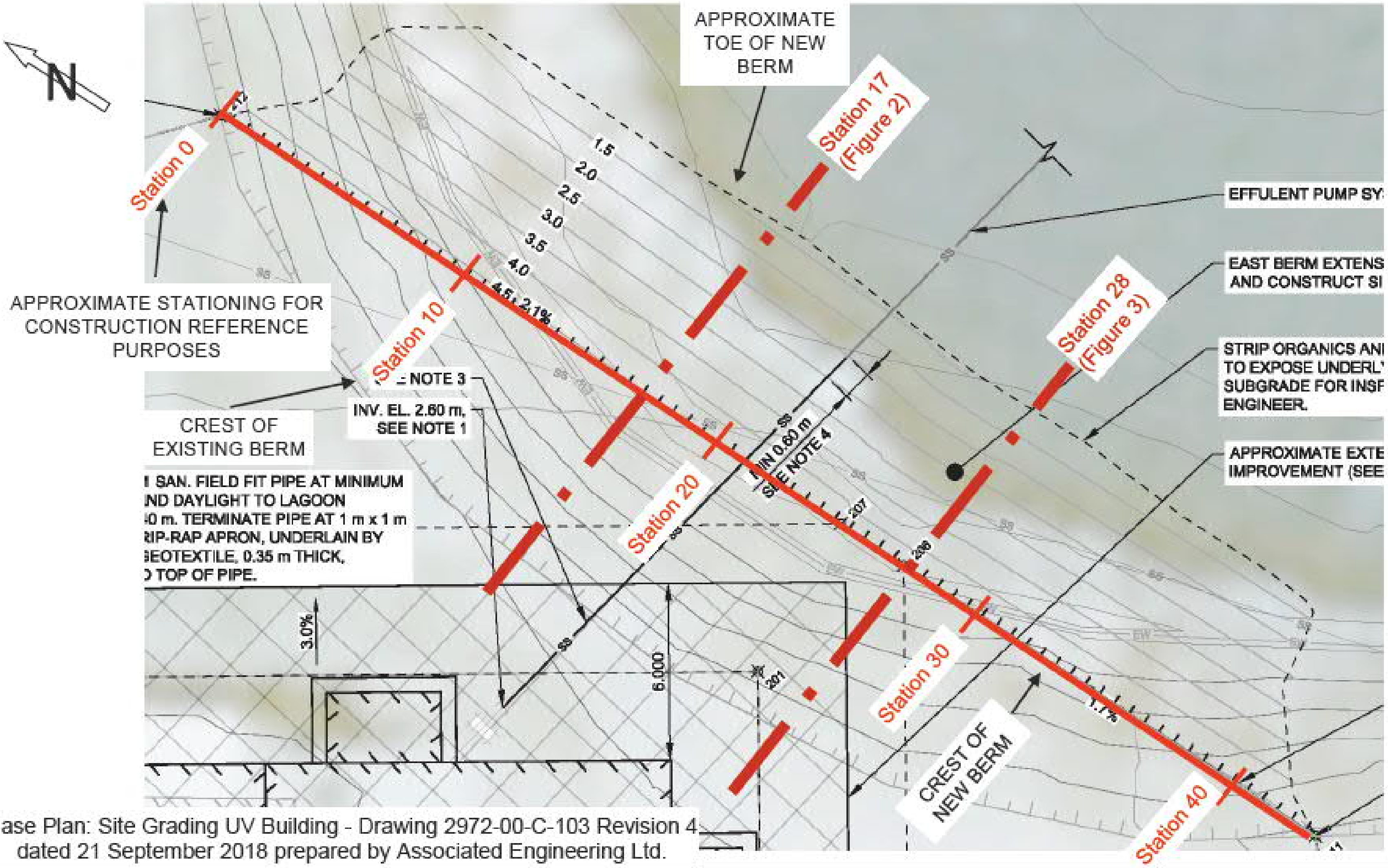
Per: Darryl Furey, M.Eng., P.Eng.
Senior Geotechnical Engineer

D.W. FUREY
29783

Reviewed by: Tom Oxland, P.Eng.
Senior Geotechnical Engineer

2019-01-11

This document represents an electronic version of the original hard copy document, sealed, signed and dated by Darryl Furey, M.Eng., P. Eng. and retained on file. The content of the electronically transmitted document can be confirmed by referring to the original hard copy on file.



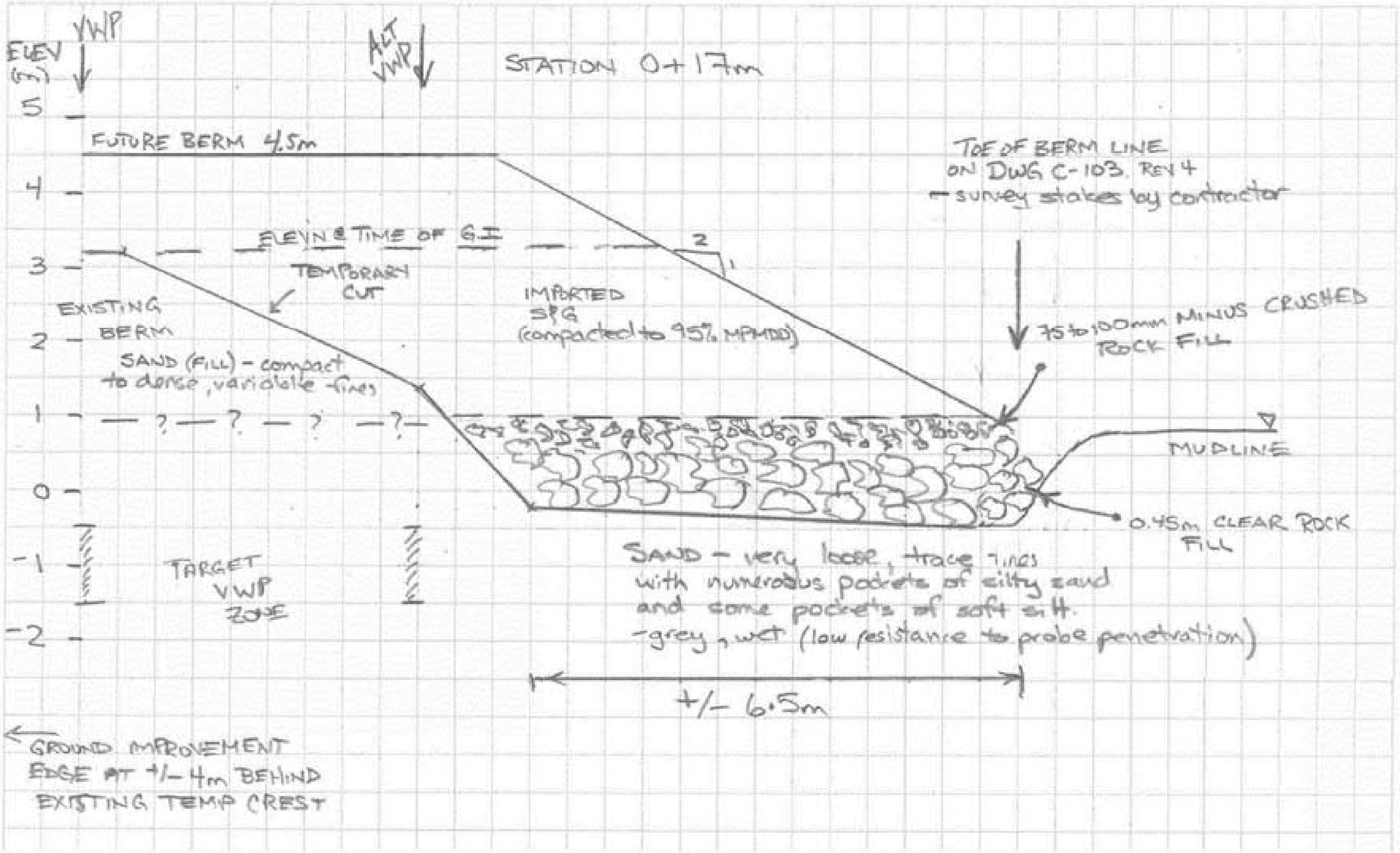
Base Plan: Site Grading UV Building - Drawing 2972-00-C-103 Revision 4 dated 21 September 2018 prepared by Associated Engineering Ltd.

PROJECT:
PORT ALBERNI WWTP
REVIEW REPORT 10

TITLE:
SITE PLAN
EAST UV BERM WIDENING

CLIENT:
ASSOCIATED ENGINEERING (BC) LTD.

FIGURE NO.:	DATE:	FILE NO.:	SCALE:	DRAWN BY:	REV NO.:
1	JAN 2019	171-04753-02	NTS	DF	-



PROJECT:

PORT ALBERNI WWTP
FIELD REVIEW REPORT 10

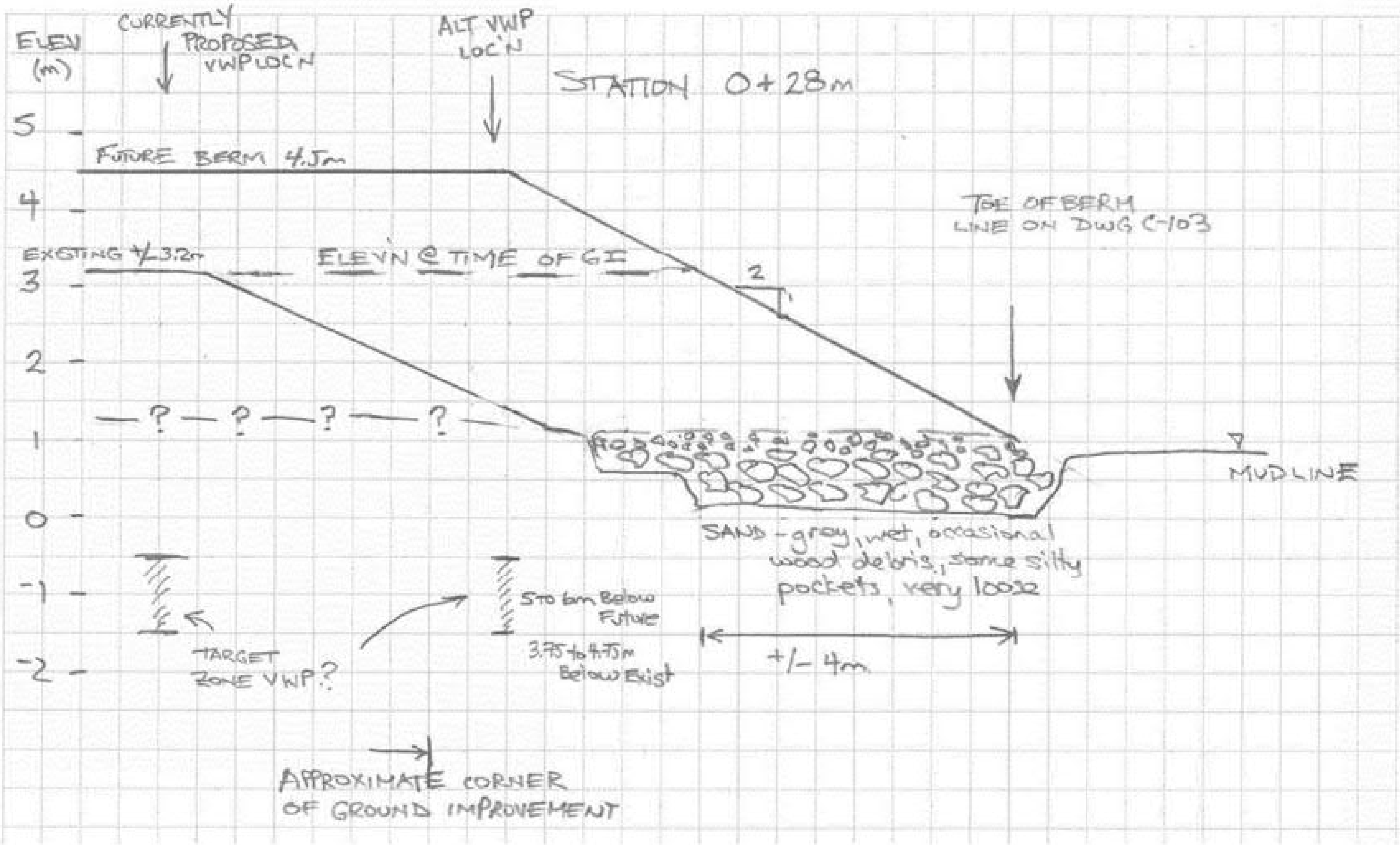
TITLE:

AS-BUILT CROSS-SECTION AT +/- STATION 17 m
EAST UV BERM WIDENING

CLIENT:

ASSOCIATED ENGINEERING (BC) LTD.

FIGURE NO.:	DATE:	FILE NO.:	SCALE:	DRAWN BY:	REV NO.:
2	JAN 2019	171-04753-02	NTS	DF	-



PROJECT:	PORT ALBERNI WWTP FIELD REVIEW REPORT 10
TITLE:	AS-BUILT CROSS-SECTION AT +/- STATION 28 m EAST UV BERM WIDENING
CLIENT:	ASSOCIATED ENGINEERING (BC) LTD.

FIGURE NO.:	DATE:	FILE NO.:	SCALE:	DRAWN BY:	REV NO.:
3	JAN 2019	171-04753-02	NTS	DF	-

PHOTO TABLE

Photo	Description
	**Photo 1:** **07 Jan 2019** **Station 29 to 35** Conditions at time of WSP arrival on site in morning of 7 Jan 2019. Contractor reports having constructed this section using the same procedure applied on 4 Jan 2019 (Refer to Field Review Report 9). New 100 mm minus crushed rock fill is in place over coarse rock from Station 31 to 35 in the photograph.
	**Photo 2:** **07 Jan 2019** **Station 25 to 29** General view of conditions after placement and compaction of coarse rock fill over geotechnically approved subgrade prior to geotextile on site. Note the significant amount of water and fines present and that multiple lifts of coarse rock were required to achieve stable base conditions.

Photo 3:
07 Jan 2019

Station 25 to 29

Conditions after placement and compaction of 300mm thick layer of 100 mm minus crushed rock fill.

Photo 4:
07 Jan 2019

Station 20 to 25

General view of subgrade conditions prior to geotextile placement.

Photo 5:
07 Jan 2019

Station 20 to 25

General view of coarse rock fill over geotextile.

Photo 6:
07 Jan 2019

Station 20 to 25

General view of placement of 100 mm minius angular rock fill over coarse rock fill.

Photo 7:
07 Jan 2019

Station 13 to 20

General view of conditions during subgrade preparation. Note the approximate alignment of the future toe of slope per drawings as indicated by stakes in the background..

Photo 8:
07 Jan 2019

Station 13 to 20

General view of existing berm and underlying sand.

Photo 9:
07 Jan 2019

Station 13 to 20

Geotextile in place. Note the pond water level in the background..

Photo 10
07 Jan 2019

Station 13 to 20

Spreading coarse rock fill prior to compaction.

Photo 11:
08 Jan 2019

Station 8 to 13

Subgrade preparation. Note the reduction in thickness of mud/silt at about Station 10.

Photo 12
08 Jan 2019

View looking north of berm toe fill conditions at the end of day.

Photo 13:
09 Jan 2019

Station 3 to 5

General view of subgrade conditions and site preparation.

Photo 14:
09 Jan 2019

Station 3 to 5

Compaction of coarse rock fill.

Photo 15:
09 Jan 2019

Station 3 to 8

Compaction of 100mm minus rock fill.

Photo 16:
09 Jan 2019

General view of geotextile in place over 100 mm minus rock fill. Note the placement of the first layer of Type A material in the background.

WSP Canada Inc.
1935 Bollinger Road
Nanaimo, BC V9S 5W9
Tel. +1 250-753-1077
WSP.com

Field Review Report

Project:	**Port Alberni WWTP**	**Project Number:**	171-04753-02
Location:	Port Alberni, BC	**Report Number:**	12
Contractor:	Tritech	**Date:**	14-18 January 2019
Owner:	City of Port Alberni c/o Associated Engineering (BC) Ltd.	**Time:**	08:00 to 16:30 Daily
		Weather:	Partly overcast to light rain
In Attendance:	Oscar Urriola (WSP) (D Furey – 16th) Roger Larose & Erik Frankson (Tritech) Greg Brouwer (Associated)		

As requested, WSP Canada Inc. (WSP) visited the site from 14 to 18 January 2019 to review subgrade, geotextile and rock fill placement and compaction and conduct in place density testing on the overlying Type A fill during construction of the berm widening on the south side of the UV building (SW UV Berm Widening). In place density testing was also conducted on Type A fill at approximately 2.5 to 3.2 m Elevation on the E UV Berm Widening. Settlement gauges were installed in both berm areas to assist Associated with determining Type A fill volumes. A stationing system was established for general reference during construction and is shown on the attached Figure 1. Photographs of site conditions at the time of the field reviews are attached.

In summary, the observed conditions and construction progress described herein meets the intent of geotechnical recommendations.

Discussions were also had with Tritech and Vancouver Island Survey on 16 January 2019 regarding the need to resolve variable bench mark data, settlement gauge readings and bridge monitoring points. Discussion included plans to establish as soon as possible a more reliable method of surveying moving forward. Elevation data was requested for the recently installed vibrating wire piezometers.

Southwest UV Berm Widening

Generally, berm widening followed the geotechnically approved procedure described in Field Review Report 10. Natural subgrade generally consisted of loose, wet, grey sand. Some challenges were encountered in the widest part of the new berm in relation to seepage/sloughing of mud. A temporary "dam" was created using on site granular soils to facilitate construction of this part of the berm.

Benches approximately 0.6 m wide were cut at the new fill/old fill interface. In general, subgrade at the bench locations consisted of natural, grey loose to compact sand in the lower part of the new berm and compact sand fill with some gravel and variable fines content in the existing lagoon berms. In place density testing was conducted on the Type A fill being placed and all final results met or exceeded the specified minimum 95% Modified Proctor Maximum Dry Density. In place density test results will be reported under separate cover.

The exterior face of the slope was compacted with a hoe-pac.

The berm widening was constructed to approximate elevation 2.5 to 2.7 m at the time WSP left the site on 18 January 2019.

Future Geotechnical Reviews – Near Term

WSP is scheduled to be on site Monday 21 January at 8 AM to review subgrade at the toe of the North UV Berm Widening, and conduct in place density testing at regular intervals during placement of Type A fill in the SW berm.

Closure

This document was completed in accordance with the terms of our contract with Associated Engineering Ltd. for the project and the Terms of Reference for Geotechnical Reports appended to the geotechnical assessment report. The City of Port Alberni is an approved user subject to the terms under which it was prepared.

Distribution:
Christian Brumpton (Associated Engineering)

Attachments:

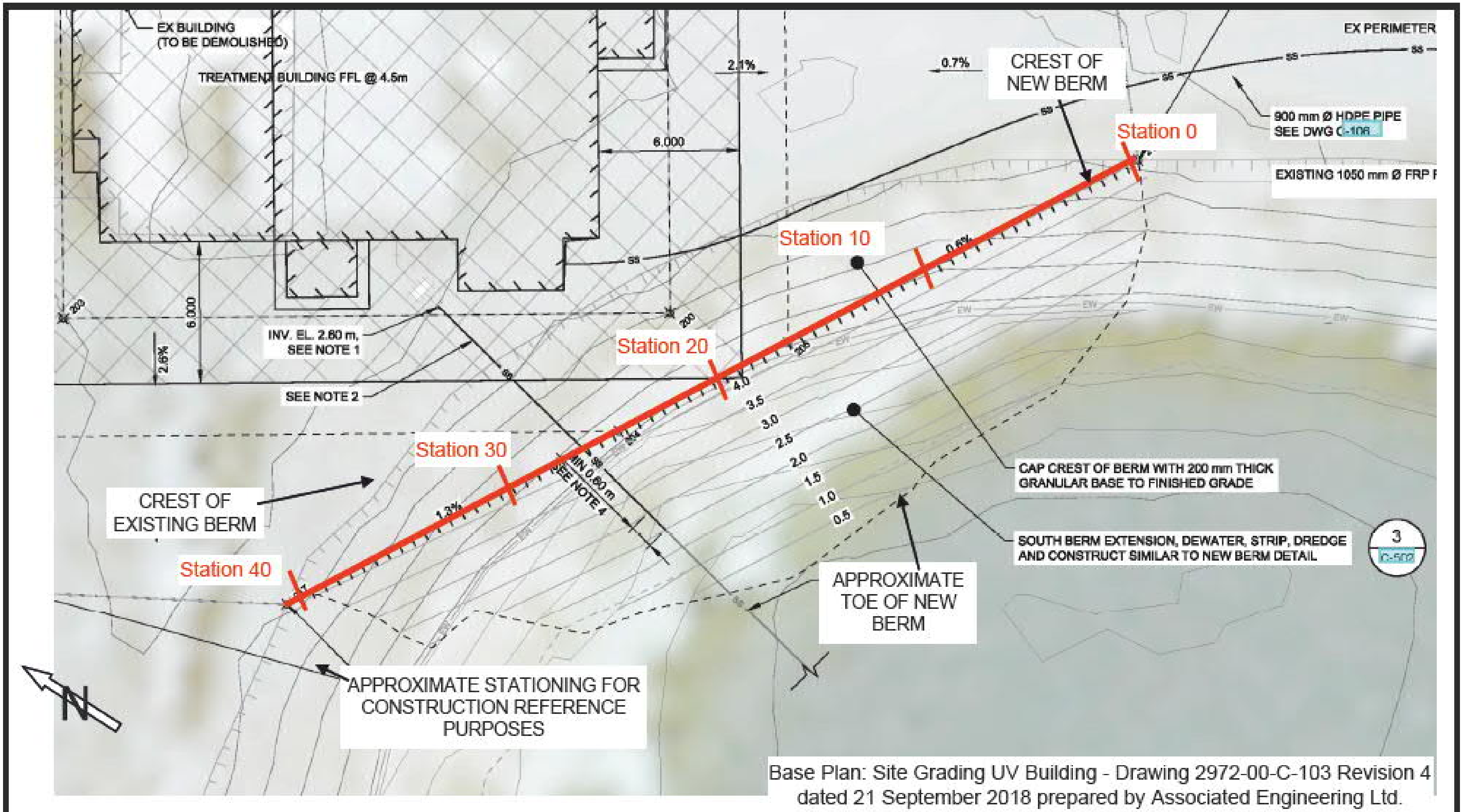
Figure 1 (SW UV Berm Widening – Stationing)
Photos (7 pages)

WSP CANADA INC.

Per: Darryl Furey, M.Eng., P.Eng.
Senior Geotechnical Engineer

Reviewed by: Tom Oxland, P.Eng.
Geotechnical Engineer

This document represents an electronic version of the original hard copy document, sealed, signed and dated by Darryl Furey, M.Eng., P. Eng. and retained on file. The content of the electronically transmitted document can be confirmed by referring to the original hard copy on file.



Base Plan: Site Grading UV Building - Drawing 2972-00-C-103 Revision 4
dated 21 September 2018 prepared by Associated Engineering Ltd.

PROJECT:	PORT ALBERNI WWTP REVIEW REPORT 12				
TITLE:	SITE PLAN SOUTHWEST UV BERM WIDENING				
CLIENT:	ASSOCIATED ENGINEERING (BC) LTD.				
FIGURE NO.: 1	DATE: JAN 2019	FILE NO.: 171-04753-02	SCALE: NTS	DRAWN BY: DF	REV NO.: -

PHOTO TABLE – SOUTHWEST UV BERM WIDENING

Photo	Description
	**Photo 1:** **14 Jan 2019** General view of SW berm area looking west prior to berm widening. Note that the pink stakes on right side are approximate future crest of berm.
	**Photo 2:** **14 Jan 2019** View of typical construction procedure. From right to left: 1. Excavate to remove mud/organic soils and expose underlying sand; 2. Pump water out; 3. Place geotextile; 4. Placve and compact coarse rock fill.

Photo 3:
14 Jan 2019

Close up view of typical sand subgrade at toe of existing berm.

Photo 4:
15 Jan 2019

General view of conditions on 15 Jan 2019 (excavation near excavator is at about Station 8 – 12).

Note proximity of lagoon water to excavation.

Photo 5:
15 Jan 2019

View of temporary "dam" near Station 12 to 17 placed in lagoon to reduce flow of water into excavation. Photo is taken prior to completion of pumping down of water in excavation area, final removal of soft, wet subgrade, and geotextile placement.

Photo 6:
15 Jan 2019

View of geotextile placed near Station 12 to 17.

Photo 7:
15 Jan 2019

View of typical placement and compaction of 10 kg rock after compaction of 50 kg rock (at Station 12 to 17).

Photo 8:
16 Jan 2019

View of subgrade preparation near Station 23 to 27.

Note the lower poind water level in background relative to the previous day's work. The paint line in the middle of the photo is the approximate location of the toe of the widened berm as marked by surveyor.

Photo 9:
17 Jan 2019

View of settlement gauges installed on SW berm.

Photo 10
17 Jan 2019

View of geotextile cover and settlement gauges on SW berm.

Photo 11
18 Jan 2019

Placement and compaction of Type A materialon SW berm.

Photo 12
18 Jan 2019

General view of conditions on SW UV berm at end of day on 18 January 2019

PHOTO TABLE – EAST UV BERM WIDENING

	**Photo 13** **16 Jan 2019** General view of E berm at appromate 2.5 to 3.2 m elevation. Note: settlement gauges installed by contractor.
	**Photo 14** **16 Jan 2019** General view of E UV berm conditions looking west.

APPENDIX

C

TERMS OF REFERENCE FOR GEOTECHNICAL REPORTS

TERMS OF REFERENCE FOR GEOTECHNICAL REPORTS ISSUED BY WSP CANADA INC.

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The terms of reference for geotechnical reports issued by WSP (the "Terms of Reference") contained in the present document provide additional information and caution related to standard of care and the use of the Report. The Client should read and familiarize itself with these Terms of Reference.

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All documents, records, drawings, correspondence, data, files and deliverables, whether hard copy, electronic or otherwise, generated as part of the services for the Client are inherent components of the Report and, collectively, form the instruments of professional services (the "Instruments of Professional Services"). The Report is of a summary nature and is not intended to stand alone without reference to the instructions given to WSP by the Client, the communications between WSP and the Client, and to any other reports, writings, proposals or documents prepared by WSP for the Client relative to the specific site described in the Report, all of which constitute the Report.

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The information, observations, findings, suggestions, recommendations and opinions contained in the Report, or any component forming the Report, are for the sole use and benefit of the Client and the team of consultants selected by the Client for the specific project that the Report was provided. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION OR COMPONENT WITHOUT THE WRITTEN CONSENT OF WSP. WSP will consent to any reasonable request by the Client to approve the use of this Report by other parties designated by the Client as the "Approved Users". As a condition for the consent of WSP to approve the use of the Report by an Approved User, the Client must provide a copy of these Terms of Reference to that Approved User and the Client must obtain written confirmation from that Approved User that the Approved User will comply with these Terms of Reference, such written confirmation to be provided separately by each Approved User prior to beginning use of the Report. The Client will provide WSP with a copy of the written confirmation from an Approved User when it becomes available to the Client, and in any case, within two weeks of the Client receiving such written confirmation.

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TERMS OF REFERENCE FOR GEOTECHNICAL REPORTS ISSUED BY WSP CANADA INC. (continued)

5. INTERPRETATION OF THE REPORT

a. **Nature and Exactness of Descriptions**: The classification and identification of soils, rocks and geological units, as well as engineering assessments and estimates have been based on investigations performed in accordance with the standards set out in Paragraph 1 above. The classification and identification of these items are judgmental in nature and even comprehensive sampling and testing programs, implemented with the appropriate equipment by experienced personnel, may fail to locate some conditions. All investigations or assessments utilizing the standards of Paragraph 1 involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and all persons making use of such documents or records should be aware of, and accept, this risk. Some conditions are subject to changes over time and the parties making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. Where special concerns exist, or when the Client has special considerations or requirements, the Client must disclose them to WSP so that additional or special investigations may be undertaken, which would not otherwise be within the scope of investigations made by WSP or the purposes of the Report.

b. **Reliance on information**: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site investigation and field review and on the basis of information provided to WSP. WSP has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, WSP cannot accept responsibility for any deficiency, misstatement or inaccuracy contained in the report as a result of misstatements, omissions, misrepresentations or fraudulent acts of persons providing information.

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APPENDIX C - EIS

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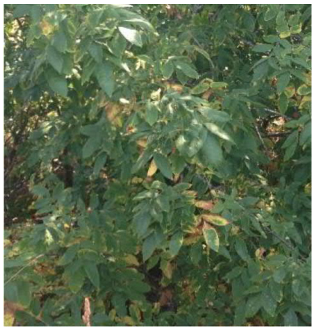
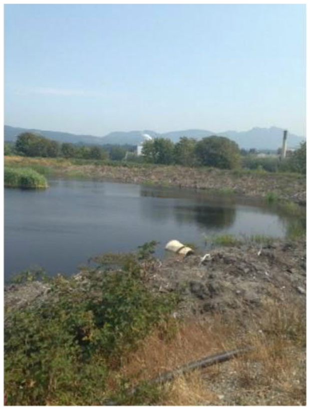
REPORT

City of Port Alberni

Wastewater Treatment Plant Expansion Construction and Operations Environmental Impact Study





February 2018

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1 Introduction

1.1 PROJECT BACKGROUND AND UNDERSTANDING

The City of Port Alberni (City) has developed a Liquid Waste Management Plan (LWMP) to meet requirements of the BC *Municipal Wastewater Regulation* (MWR) under the *Environmental Management Act*. The LWMP is intended to improve wastewater treatment and stormwater management in the City. A key part of the LWMP is replacement of the City's existing lagoon with an improved treatment system that has been designed to meet current provincial and federal regulations[1], and a new outfall offshore in Alberni Inlet ("the Project"). To facilitate the Project, the City has acquired the adjacent inactive lagoon from Catalyst Paper, which will be designed to meet the MWR and federal *Wastewater Systems Effluent Regulation* (WSER) under the *Fisheries Act*.

Currently, the City discharges treated municipal effluent from its lagoon system to the Somass River through a side channel. The LWMP identifies this method of releasing treated effluent as not adhering to best practices and having unacceptable potential environmental effects. As part of the Project, the City will decommission the existing lagoon and restore most of the site to natural habitat to increase the total area of tidal marsh and enhance biodiversity and ecosystem function.

The Project will be completed in three phases:

- **Phase 1**: Upgrade the former Catalyst lagoon including the following:
    - Construction of a new berm within the lagoon to split the existing single cell lagoon into two cells; the berm will include a splitter structure for incoming wastewater from the screening building and provision to overflow between the two cells;
    - Demolition of the existing electrical building;
    - Modifications to the existing outfall structure to improve lagoon level control and provide emergency overflow for Catalyst;
    - Construction of a new screening building to screen incoming sewage prior to treatment in the lagoon;
    - Construction of a new electrical building with UV disinfection and blowers for aeration;
    - Installation of floating pump stations within the new lagoon;
- **Phase 2**: Installation of a new outfall to the Somass Estuary. Excess material from outfall construction will be temporarily stockpiled at a suitable location on site. Suitable material will be used to increase existing berm height where settlement has occurred, while the remaining material will either be reused for other purposes or removed from site.
- **Phase 3**: Decommission the old lagoon, including desludging of the lagoon, removal of portions of two berms and restoration of the area; top up berms on new lagoon. Extent of berm removal around existing City lagoon to be confirmed during site restoration design.

---

[1] The lagoon will meet requirements of the provincial MWR and the federal Wastewater Systems Effluent Regulation (WSER) under the *Fisheries Act*.

1.2 CONSTRUCTION AND OPERATION ENVIRONMENTAL IMPACT STUDY

Associated Engineering was retained by the City to conduct a Construction and Operation Environmental Impact Study (COEIS) for the Project in accordance with the MWR subsection 19(1), specifically:

> *A qualified environmental professional must conduct for a wastewater facility an environmental impact study that includes provisions for controlling environmental impacts during construction and operation of the wastewater facility or site.*

This COEIS report is a separate document from the receiving environment (i.e. effluent discharge) Environmental Impact Study (EIS) report that is required under MWR subsection 19(2), and should be used as a companion document to the EIS report (Associated Engineering 2014, 2017).

The scope of work of the COEIS included the following tasks:

- Field assessment by Stacy Boczulak, M.Sc., R.P.Bio., of Associated on August 11, 2017 with Rick and Libby Avis who are local stakeholders and members of the Somass Estuary Management Committee;
- Review existing information on the Somass Estuary;
- Review concept drawings and description of the new lagoon upgrading and old lagoon decommissioning and restoration project;
- Describe the existing conditions and Project upgrades;
- Describe the environmental characteristics of the Project site and nearby areas;
- Identify potential environmental effects related to construction and operation;
- Develop measures to avoid or minimize the potential for environmental effects during construction; and
- Develop measures to avoid or minimize the potential for environmental effects during operations, including environmental emergency response.

Select photographs from the site visit are included in Appendix A.

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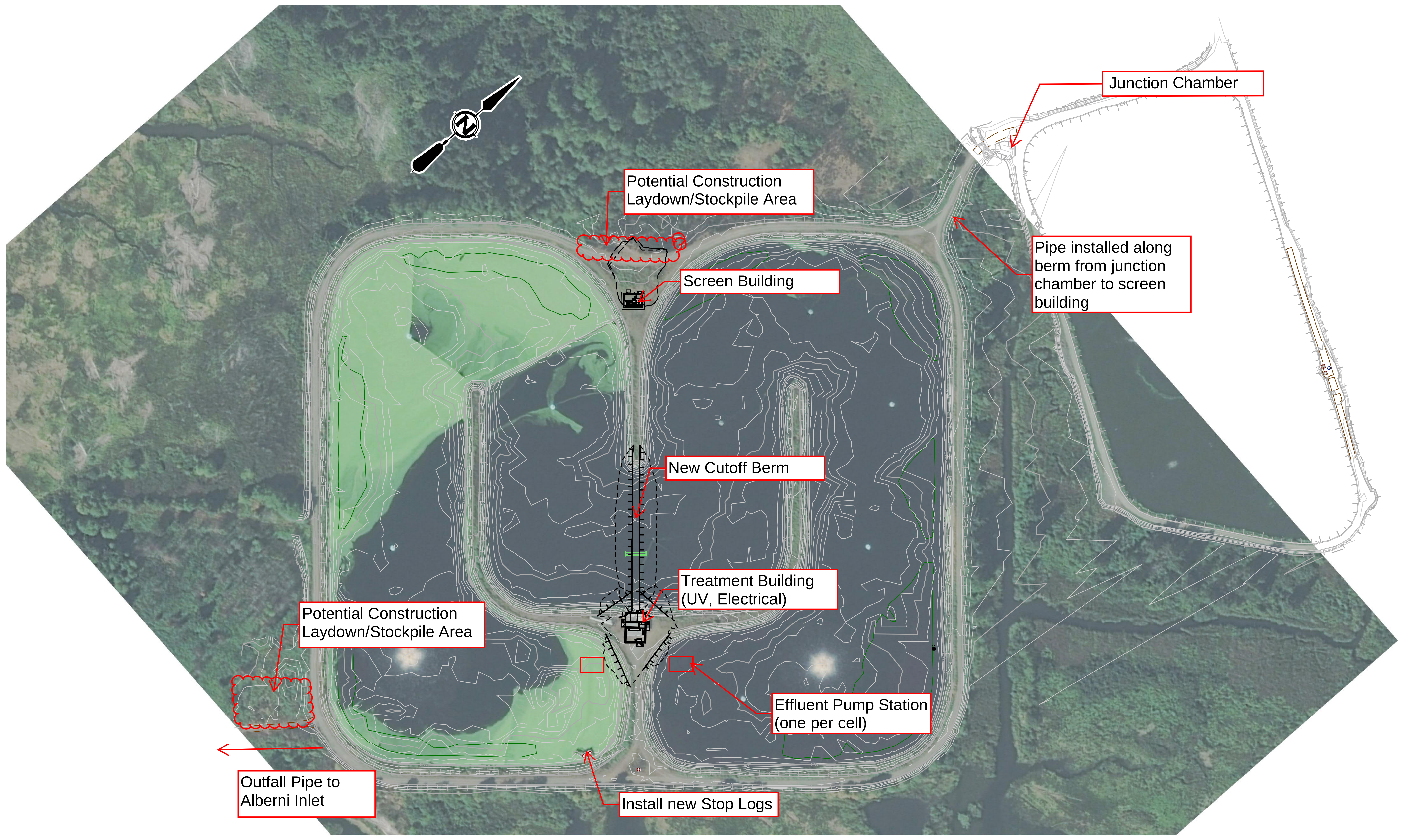

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FOR DISCUSSION
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CITY OF PORT ALBERNI

Figure 1-1
Project Site and Works
20172972-00
SCALE: AS SHOWN

THE CITY OF Port Alberni
CIVIL

SITE PLAN

DRAWING	REVISION	SHEET
2972-00-C-103	A	----/

2 Project Description

2.1 PROJECT SITE

The City's current aerated wastewater lagoon covers an area of approximately 5 ha, contained by earthen dykes and located in the tidal flats on the east side of the Somass Estuary. The lagoon was constructed in 1958 to provide biological wastewater treatment for the City. Influent reaches the lagoon via pipelines beneath the Somas River, and the treated effluent discharges into the Somass River through an open channel on the south side of the lagoon. The access road is from the west on a dyke through the estuary.

The new lagoon is approximately 12 ha and was previously used by Catalyst Paper to treat mill wastewater. It has been replaced by a mechanical treatment plant. In Phase 1 of the Project, a berm will be constructed in the new lagoon to divide the new lagoon into two separate cells. Each cell will have an effluent pumping system so the cells can be operated independently. There will be an overflow structure placed across the berm that divides the two cells in the event that the effluent pumping system in one cell is not operating properly. Figure 1-1 provides an overview of the proposed upgrades and Figure 2-1 outlines the environmental attributes identified in this COEIS.

2.2 BASELINE ENVIRONMENT

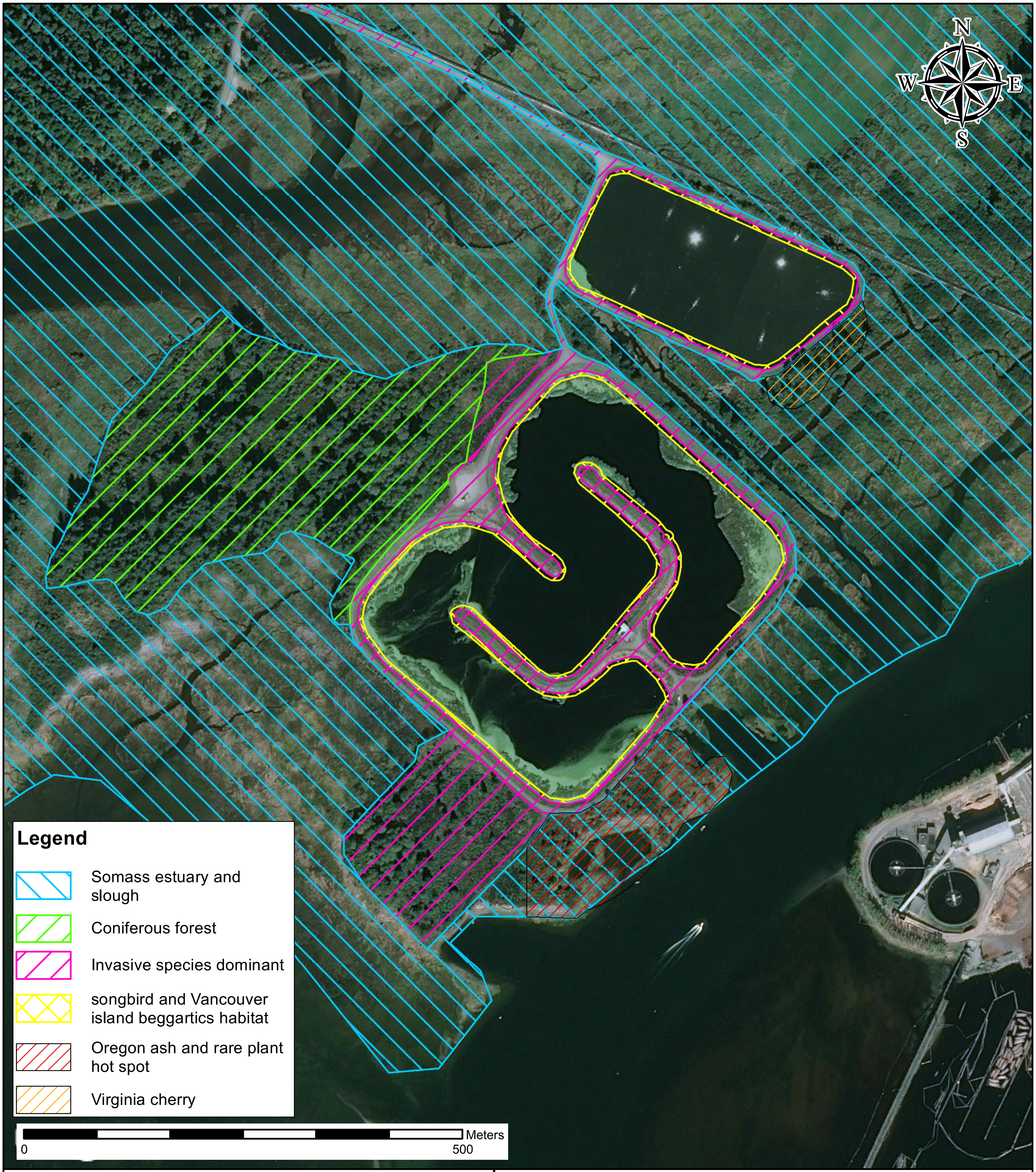
2.2.1 Biophysical

The lagoons are located at the head of the Alberni Inlet, and part of the Somass Estuary (Figure 2-1), an area that is of considerable importance for fisheries, waterfowl and vegetation values. The lagoons are within the tidal marsh habitat of the estuary, which is rated as "Very High Value" habitat based in part on historic loss of this habitat type from development and on its biodiversity (Catherine Berris Associates Inc. 2006).

2.2.2 Fish and Wildlife

Although there are no fish reported in the lagoons, juvenile salmonids and other estuarine fish can access tidal channels and sloughs at high tide to feed. The Somass Estuary is habitat for many fish species including six species of salmonid: chinook salmon (*Oncorhynchus tshawytscha*), chum salmon (*O. keta*), pink salmon (*O. gorbuscha*), coho salmon (*O. kisutch*), cutthroat trout (*O. clarkii*), and rainbow trout (*O. mykiss*).

During the field assessment, songbirds (e.g., marsh wrens) were observed in the lagoons. Several other bird species such as ducks, geese, grebes, sandpipers, hawks and kingfishers are known to frequent the area (Berris Associates Inc. 2006). In the surrounding tidal channels and marshes, common fish species include three-spine stickleback (*Gasterosteus aculeatus*) and herring (*Clupea pallasii*), and common bird species include American widgeon (*Anas americana*), greater scaup (*Aythya marila*), bufflehead (*Bucephala albeola*), green-winged teal (*Anas carolinensis*), mallard (*Anas platyrhynchos*), and the



Associated Engineering

GLOBAL PERSPECTIVE. LOCAL FOCUS.

PREPARED FOR:

City of Port Alberni

PROJECT:

CITY OF PORT ALBERNI
WASTEWATER TREATMENT SYSTEM UPGRADES

PROJECT NO.: **2017-2972.003.380**

FILE: **Figure 2-1: EA Attributes.mxd**

DATE: **Aug. 2017**

DRAWN BY: **DA**

Figure 2-2 Port Alberni Lagoons and Environmental Attributes

provincially Blue-listed[2] trumpeter swan (*Cygnus buccinator*) and great blue heron (*Ardea herodias*) (CDC 2018). The conifer forest on the northwest side of the lagoons is rated as "Very High Value" habitat based on its biodiversity, its limited extent within the estuary, and its provision of nesting and perching locations for birds of prey (e.g., bald eagles and hawks) (Berris Associates Inc. 2006). The Somass River contains all five species of Pacific salmon, the provincially Red-listed[3] white sturgeon, and Blue-listed cutthroat trout (CDC 2018). These fish are important prey for river otter, mink, great blue heron, and belted kingfisher.

2.2.3 Vegetation

Plant species diversity is high in both the tidal marsh and forest habitats, including Blue- and Red-listed species (Catherine Berris Associates Inc. 2006). Aquatic vegetation within both lagoons is dominated by grasses (e.g., invasive reed canary grass [*Phalaris arundinacea*]), invasive yellow iris (*Iris pseudoacorus*), bulrush (*Schoenoplectus acutus*), and common cattail (*Typha latifolia*). Vegetation on the berms of the lagoons is mainly non-native and invasive species such as Himalayan blackberry (*Rubus armeniacus*), Scotch broom (*Cytisus scoparius*), field rose (*Rosa arvenis*), morning glory (*Calystegia sepium*), purple loosestrife (*Lythrum salicaria*), and English ivy (*Hedera helix*). Virginia cherry (*Prunus virginiana*) is present on the southeast side of the old lagoon (Figure 2-1). Although this cherry species is not a listed species, it is considered rare in the Alberni Valley and provides food for local black bears (Avis, R. personal communication, 2017). Vancouver Island beggarticks (*Bidens amplissima*), a provincially Blue-listed species and federally designated species at risk, has been recorded along the berm around both lagoons (CDC 2018), but populations have been impacted through lagoon maintenance (Avis, R. personal communication, 2017). A management plan has been developed for this species (Environment Canada 2015). Vegetation on the berms is limited due to vegetation maintenance along the access roads; however, there is one large arbutus tree (*Arbutus menziesii*) located on the internal berm of the new lagoon. Oregon ash (*Fraxinus latifolia*), a Red-listed species, is limited to swamps and estuaries in lowland areas (CDC 2018) and occurs at the southeast edge of the new lagoon along with bigleaf maples (*Acer macrophyllum*) and willows (*Salix* spp.). The estuary supports 13 listed plant species that have been observed in the area (Appendix B). Most of these species are found in the sloughs and tidal marshes adjacent to the lagoons.

Adjacent conifer forest comprises predominantly Sitka spruce (*Picea sitchensis*) along with lodgepole pine (*Pinus contorta*), western redcedar (*Thua plicata*), Douglas-fir (*Pseudostuga menziesii*), red alder (*Alnus rubra*), and balsam poplar (*Populus balsamifera*). Sword fern (*Polystichum munitum*) dominates the understorey. The forest is well established with high structural diversity and a valued habitat component within the broader estuarine landscape (Appendix A).

2.2.4 Neighbouring Land Use

Ducks Unlimited Canada owns property to the north of the lagoons and access road. This area is leased for haying by a local agricultural producer (Avis L, personal communication, 2017). Sea water does not appear to reach this area.

---

[2] Blue-listed species are any species or ecosystems that are of special concern (CDC 2018).

[3] Red-listed species are any species or ecosystems that are at risk of being lost (i.e., extirpated, endangered or threatened) (CDC 2018).

The closest residential area to the Project site is located approximately 2 km to the west on lands of the Tseshaht [Ts'ishaa7ath] First Nation (IR #1). Access to the Project site for both construction and future operations is from a road that runs from Highway 4 through Tseshaht land. A locked gate controls access.

2.3 PROJECT CONSTRUCTION

Most of the construction for Phase 1 will occur within the existing footprint of the berms/roads, with a small portion of the Project (e.g., incoming sewer force mains and junction chamber) within 50 m of the existing berms/roads. Phase 1 is anticipated to begin in spring 2018. Phase 1 construction will involve:

- Demolition of the existing electrical building, including removal of all electrical equipment remaining inside.
- Construction of a new berm to divide the former Catalyst lagoon into two equal cells, which will operate in parallel, including overflow weir and splitter structure on the new berm.
- Construction of a new screening building to screen incoming sewage prior to treatment in the lagoon.
- Construction of a new treatment building at the northeast end of the new lagoon with UV disinfection and blowers for aeration.
- Consolidation of six inflows into two pipes that will connect to the screening building.
- Installation of floating effluent pump stations within the new lagoon.

Phase 2 is anticipated to begin in late summer 2018. Phase 2 construction will involve:

- Installation of a new outfall to the Somass estuary (not part of this COEIS).
- Stockpiling excess material from outfall construction on site just south of the new lagoon for use in Phase 3.

Construction for Phase 3 will occur within 50 m the existing footprint of the berms/roads and is anticipated to take place in spring 2019. Phase 3 construction will involve:

- Removal of sludge from the area of the lagoon being infilled and disposal of sludge material elsewhere. Method for desludging is still to be determined. If geotubes are used, they will be stored on site adjacent to or on the existing berm of the new lagoon.
- Deconstruction of two berms on the old lagoon.
- Use of old berm material to build up berms on new lagoons. Extra berm material to be stockpiled south of the new lagoon.

2.4 PROJECT OPERATION

The new treatment facility will include the following components:

- Screening facility to remove solids larger than 6 mm (size of screen opening) from the wastewater;
- Biological treatment via extended aeration in the two lagoon cells, to operate in parallel;
- Effluent pumping system;
- UV Disinfection; and
- Standby power generation.

Solids handling at the facility will include:

- Compaction of screenings removed by the screens in a washer/compactor unit, followed by temporary storage on site prior to final disposal off site.
- Removal of accumulated solids by periodic desludging of the lagoon cells. The expected frequency of desludging is every 15 to 20 years.

3 Environmental Assessment – Construction

3.1 POTENTIAL ENVIRONMENTAL EFFECTS

3.1.1 Vegetation, Ecosystems and Wildlife

Within the footprint, Vancouver Island beggarticks (Blue-listed) are found along the banks of the berms of the lagoons. Potential effects on this species during Phases 1 and 3 (i.e., infilling of the old lagoon and raising of the berm on the new lagoon) include temporary habitat loss.

Virginia cherry is found on the southeast side of the old lagoon and some areas along the new lagoon. Potential effects on this species during Phase 3 (i.e., decommissioning of the berms on the old lagoon or raising the berms of the new lagoon) include disturbance of the area where this rare species grows.

Oregon ash (Red-listed) is found along the south side of the new lagoon. This area may be affected during Phase 3 (i.e., raising and widening berms).

Efforts will be made to limit direct effects on rare and listed species (Section 3.2.1), although some disturbance is possible. With mitigation after construction, as described in Section 3.2.1, the effects on rare or listed species are expected to be negligible. As works are primarily limited to previously disturbed areas, there is minimized potential to affect listed species in the area or the overall health of the estuary or forested ecosystems.

There is the potential to introduce or spread invasive species during construction. Invasive species (e.g., Himalayan blackberry and English ivy) have already been established within the estuary, and care should be taken to preserve the native vegetation of the estuary while minimizing the presence and spread of undesirable invasive or non-native species.

The surrounding forest and estuary areas provide habitat for various mammals (e.g., black bear, deer, small mammals), birds (e.g., waterfowl, shorebirds, raptors, songbirds), and amphibians. Wildlife habitat within the site (within lagoons) is limited to marginal habitat for amphibians, foraging habitat for mammals, and nesting and foraging habitat for birds. There is potential to affect breeding birds during construction. The *Migratory Birds Convention Act* protects various species of migratory birds (S.C. 1994, c. 22). The Act provides protection for breeding birds and their nests by requiring that works be conducted in a fashion that prevents disturbance to bird nests. Specific steps to comply with the Act are described in Section 3.2.1.

3.1.2 Fish and Fish Habitat

All construction will occur on or directly adjacent to the existing lagoons and disturbed areas; thus, there is no expected loss of fish habitat or direct effects on fish. The potential for indirect effects related to changes in water quality are discussed below.

3.1.3 Water Quality

Potential effects on surface water quality could occur during construction from soil erosion and sedimentation, from spills of vehicle fluids and other construction-related fluids, and from concrete wash water reaching a fish-bearing waterbody (i.e., Somass River). These effects would occur if rainwater flows from construction areas over the ground surface into the waters of the Somass Estuary. Water management during construction is a critical component for avoiding potential effects on waterbodies.

The soil erosion hazard is high due to steeply sloped berms. Care must be taken during construction that runoff not be allowed to flow off the site since it would enter an area with very high environmental value (i.e., the estuary or forest). Potential effects on groundwater quality from construction activity relate primarily to spills or leaks from construction vehicles where contamination, if not addressed, may leach through soils to groundwater.

Providing effective containment of water and runoff can be achieved, and spills and leaks are avoided, there is negligible potential for effects on either surface or groundwater quality resulting from construction.

3.1.4 Air Quality

Potential effects on air quality are limited to fugitive dust generation and emissions from construction vehicles. Access to the Project site is through Tseshaht Lands and specific attention must be directed to controlling dust generation and emissions from traffic on the road. Dust generation and emissions from construction vehicles can be controlled through standard construction environmental management practices (Section 3.2.3).

3.1.5 Noise

The adjacent land use is predominately industrial (i.e. Catalyst Paper) and generally noisy. Thus, the potential for noise levels during construction to reach nuisance levels is low unless construction activity extends outside normal daytime working hours. As mentioned, access to the Project site is through Tseshaht Lands, including residential properties within 2 km of the Project site. The Project site is largely screened by tall trees that will help buffer construction noise; however, specific attention should be paid to noise during transport.

3.2 RECOMMENDED ENVIRONMENTAL PROTECTION AND MITIGATION STRATEGIES

3.2.1 Vegetation, Ecosystems and Wildlife

The following mitigation strategies are intended to avoid or limit potential effects on vegetation and wildlife:

- Avoid removing individual Oregon ash specimens (i.e., limit berm widening to the outside of the new lagoon where possible). If individuals will potentially be buried during berm raising, efforts should be made to transplant individual trees or, at minimum, cut and plant stakes from affected specimens for re-planting. Re-establish Vancouver Island beggarticks along any disturbed perimeter berms of the lagoons. This can be accomplished by seed harvesting on existing plants in September and October (if possible with Project timing), or by obtaining seeds from a native plant nursery[4].

- Avoid and flag areas that contain rare plants, if possible. If not possible, have a Qualified Environmental Professional determine the mitigation measures (e.g., propagation, transplantation).
- Carry out an inventory of rare plants within the site just prior to the start of construction. This should include documentation of the numbers of plants and/or the areas that could be disturbed, as well as a photography and video log. Use this information to prepare a Species at Risk Management and Restoration Plan to focus on invasive control, existing population protection and translocation (of identified individuals or groups) to other areas identified as suitable within the site, and a follow up monitoring program.
- Ensure that all equipment arrives on site clean and free of soil or vegetative debris.
- Post signs at areas identified as having noxious weed infestations prior to start of construction.
- Restrict herbicide use in areas with abundance of traditional use plants.
- Monitor topsoil piles for weed growth during construction and implement corrective measures to avoid infestation when warranted.
- If seed mixes are used, use Certified No. 1 seed, unless for a chosen reclamation seed species.
- Where possible re-vegetate disturbed areas with plants of cultural, economic or social importance.
- Install temporary fencing or equivalent around the construction area to minimize the area that will be disturbed. Sensitive areas should be marked with special tape (e.g., marked “rare plant area”), and construction crews instructed on avoidance.
- The *Migratory Birds Convention Act* prohibits the disturbance, injury, or destruction of a migratory bird, its nest, or eggs. Thus, complete any vegetation removal outside of the bird nesting period (i.e., conduct clearing activities between mid-August and mid-March) (Government of Canada 2018). If clearing within the breeding bird window is necessary, pre-clearing nest surveys by a qualified professional are recommended in order to demonstrate due diligence in adhering to guidance under the Act. If active nests of species named in the BC *Wildlife Act* (i.e., great blue heron or various raptors including eagles, peregrine falcon and osprey) are identified in the vicinity of the site prior to construction, these must be protected year-round and cannot be disturbed. A QEP will identify and mark any active nests for protection. Note that in-stream vegetation could be mowed in the fall or winter to prevent nesting the following year.
- Remove invasive plants with root structures intact and dispose of off-site (incineration is preferred). Soil in these identified areas may be contaminated (seeds, roots) and should not be transported to another location, to prevent spread.
- Re-establish Virginia cherry by means of transplanting individuals or cutting and planting stakes in the area. Planting should occur in similar ecological conditions and proximate as possible to where the loss occurred; thus, any affects on this species should be temporary.
- Re-vegetate cleared areas with native plant species adapted to local climate conditions as soon as feasible to assist in preventing the spread of invasive plant species. If seed mixes are used during re-vegetation, confirm they do not contain weeds or invasive species.

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[4] Sannich Native Plants, http://www.saanichnativeplants.com/ or Nats Nursery in Langley http://natsnursery.com/

The City should consider working with local stakeholders and/or Tseshaht Nation members in the pre-construction inventory and post-construction revegetation efforts.

3.2.2 Water Quality

Prevention of water quality effects will be accomplished in two ways:

- Drainage and erosion control; and
- Spill prevention and prompt mitigation if a spill does occur.

Drainage and Erosion Control

Procedures will be put in place during construction by the Contractor to prevent runoff from flowing off site. The following drainage and erosion control measures are intended to prevent potential effects on water quality:

- Develop formal water management and erosion and sedimentation control (ESC) plans including drawings prior to the start of construction.
- During construction, minimize the area of soil that is exposed to rain or wind at any one time.
- Provide a sufficient quantity of sedimentation fence (silt fence) or other suitable erosion and sedimentation control product on site and install as necessary around all disturbed areas to prevent sediment laden runoff from leaving the site.
- Stockpile soil on previously disturbed sites (i.e., raised area of previous fill at south corner of new lagoon or northwest side of new lagoon but not encroaching on the forested area) (Figure 2-1).
- Cover and monitor soil stockpiles to ensure that sediment is not washed away.
- Provide containment around the stockpile if there is a risk of erosion, especially of the stockpile is placed on a hard surface.
- Prevent vehicles from tracking through muddy areas.
- Wash construction vehicles of excess mud prior to leaving the site. If vehicles are washed of mud on site, it should be done in a location where the runoff from washing will infiltrate to ground, or discharged back into the former Catalyst lagoon. It must not be done where the water will run off to a wetland, watercourse, or ditch. Vehicles should be reasonably clear of mud when leaving the site.
- After construction is complete, re-seed areas of disturbed soil with a native species seed mixture.

Spill and Leak Prevention and Management

The construction spill prevention and management plan will be consistent with the goals of the operational plan for Phase 1. In general, the focus during both construction and operations will be on the prevention of spills and leaks rather than clean-up, since it is difficult to completely contain spilled material and the surrounding area is of such high environmental value. The key components of the construction plan are as follows:

- Properly maintain and inspect construction vehicles regularly. Promptly address any loose fittings, drips or leaks.
- Prohibit contractors from changing oil or other fluids on site or on City roads.
- Train all on-site contractor employees on spill procedures including the content and use of spill kits, and sign off to verify understanding of material that is presented.

- Provide spill kits throughout the job site on all mobile equipment, in work vehicles, in site offices, and in the back of the mechanic's trucks. As noted above, all construction personnel will be trained in the use of spill containment and clean-up kits. Spill kits will be replenished immediately after use. The Contractor will periodically check that there are adequate spill kits on-site, and replenish the supply if need be.
- Develop spill response procedures, including containment, notification, clean-up, and reporting.
- Contain spills by:
    - Stopping the flow by shutting down the equipment, closing valves and pumps, or plugging hoses;
    - Containing spilling or dripping materials by means of placing spill pans under areas where equipment is parked, if possible;
    - Diking the material around a spill to prevent the spill from entering the estuary, water bodies, or other earth materials;
    - Recovering pooled liquids and placing in drums for temporary storage and disposal by approved agencies;
    - Collecting residual liquids with absorbent pads;
    - Proper temporary storage and disposal of contaminated soils and absorbent materials;
    - Skimming and soaking up of any spill in a water body;
    - Removing all ignition sources from the affected area;
    - Notifying appropriate project management (see below);
    - Completing documentation; and
    - Reviewing procedures, and formulating corrective actions to be promptly administered to reduce the chance of future reoccurrence.
- Report spills (Table 3-1) to the Provincial Emergency Program (PEP) of the Ministry of Attorney General by telephoning 1-800-663-3456 as provided in subsection 2(1) of the *Environmental Management Act*. Notify the Ministry of Environment Regional Environmental Management Manager and the Island Health Authority of the situation and the intended plan of action.
- Notify the City of any smaller spill where the product infiltrates into surface soils.
- Provide clean up of the spill and disposal of any contamination releases into the environment. The Contractor will be responsible for ensuring that a qualified person takes on responsibility for the containment, clean up and disposal. The responsible person will photograph and otherwise document the containment and clean-up activities.
- Document the spill event and submit the spill report to the City. The City will review the report and determine if enhancements to the procedure are required and implement any required changes

Table 3-1
Reportable levels for certain substances: BC Spill Reporting Regulation

Item	Substance Spilled	Specified Amount
1	Class 1, Explosives as defined in section 2.9 of the federal Regulations	Any quantity that could pose a danger to public safety or 50 kg
2	Class 2.1, Flammable Gases, other than natural gas, as defined in section 2.14 (a) of the federal Regulations	10 kg
3	Class 2.2 Non-Flammable and Non-Toxic Gases as defined in section 2.14 (b) of the federal Regulations	10 kg
4	Class 2.3, Toxic Gases as defined in section 2.14 (c) of the federal Regulations	5 kg
5	Class 3, Flammable Liquids as defined in section 2.18 of the federal Regulations	100 L
6	Class 4, Flammable Solids as defined in section 2.20 of the federal Regulations	25 kg
7	Class 5.1, Oxidizing Substances as defined in section 2.24 (a) of the Federal Regulations	50 kg or 50 L
8	Class 5.2, Organic Peroxides as defined in section 2.24 (b) of the federal Regulations	1 kg or 1 L
9	Class 6.1, Toxic Substances as defined in section 2.27 (a) of the federal Regulations	5 kg or 5 L
10	Class 6.2, Infectious Substances as defined in section 2.27 (b) of the federal Regulations	1 kg or 1 L, or less if the waste poses a danger to public safety or the environment
11	Class 7, Radioactive Materials as defined in section 2.37 of the federal Regulations	Any quantity that could pose a danger to public safety and an emission level greater than the emission level established in section 20 of the "Packaging and Transport of Nuclear Substances Regulations"
12	Class 8, Corrosives as defined in section 2.40 of the federal Regulations	5 kg or 5 L

Item	Substance Spilled	Specified Amount
13	Class 9, Miscellaneous Products, Substances or Organisms as defined in section 2.43 of the federal Regulations	25 kg or 25 L
14	Waste containing dioxin as defined in section 1 of the *Hazardous Waste Regulation*	1 kg or 1 L, or less if the waste poses a danger to public safety or the environment
15	Leachable toxic waste as defined in section 1 of the *Hazardous Waste Regulation*	25 kg or 25 L
16	Waste containing polycyclic aromatic hydrocarbons as defined in section 1 of the *Hazardous Waste Regulation*	5 kg or 5 L
17	Waste asbestos as defined in section 1 of the *Hazardous Waste Regulation*	50 kg
18	Waste oil as defined in section 1 of the *Hazardous Waste Regulation*	100 L
19	Waste containing a pest control product as defined in section 1 of the *Hazardous Waste Regulation*	5 kg or 5 L
20	PCB Wastes as defined in section 1 of the *Hazardous Waste Regulation*	25 kg or 25 L
21	Waste containing tetrachloroethylene as defined in section 1 of the *Hazardous Waste Regulation*	50 kg or 50 L
22	Biomedical waste as defined in section 1 of the *Hazardous Waste Regulation*	1 kg or 1 L, or less if the waste poses a danger to public safety or the environment
23	A hazardous waste as defined in section 1 of the *Hazardous Waste Regulation* and not covered under items 1 – 22	25 kg or 25 L
24	A substance, not covered by items 1 to 23, that can cause pollution	200 kg or 200 L
25	Natural Gas	10 kg, if there is a breakage in a pipeline or fitting operated above 100

Item	Substance Spilled	Specified Amount
		psi that results in a sudden and uncontrolled release of natural gas

*Table downloaded from Spill Reporting Regulation on August 18, 2017. Contractors are responsible for having the most recent version of the regulation and this table.

Note: "Federal Regulations" means the Transportation of Dangerous Goods Regulations made under the Transportation of Dangerous Goods Act (Canada); "Hazardous Waste Regulation" means B.C. Reg. 63/88.

3.2.3 Air Quality

Fugitive Dust

Fugitive dust will be controlled to prevent effects on air quality outside the site. Work crews will monitor dust generation on dry days and take action if dust is observed to be migrating away from the site. Specific attention must be directed to controlling dust generation from traffic on the road through Tseshaht lands. If excessive dust is being generated, steps should be taken to control fugitive dust immediately. Sprinkling the ground surface with water until it is moist is an effective dust control method for haul roads and other traffic routes, and is the preferred control technique. In extreme dusty conditions it may be necessary to cease the work that is causing the dust until the wind velocity decreases.

If excessive dust generation occurs frequently, and if sprinkling with water is ineffective, spray-on chemical soil treatments (palliatives) may be considered. Use of chemical palliatives must be first approved by the City and the Tseshaht First Nation on their lands. Examples of chemical palliatives include anionic asphalt emulsion, latex emulsion, resin-water emulsions, and calcium chloride.

Equipment and Vehicles

Vehicles and moving equipment will be kept in good working order to minimize air emissions. No off-highway equipment is to idle longer than five (5) consecutive minutes. This includes rental equipment under contractors’ control. The idling limit does not apply to:

- Idling when queuing;
- Idling to verify that the vehicle is in safe operating condition;
- Idling for testing, servicing, repairing or diagnostic purposes;
- Idling that is necessary to accomplish work for which the vehicle was designed (such as operating a crane);
- Idling that is required to bring the machine system to operating temperature; and
- Inclement weather conditions (for operator safety).

Vehicles with smoky exhausts (visible emissions for more than ten seconds) must be repaired.

3.2.4 Noise

Noise will be managed to avoid or minimize effects on nearby residential properties (within approximately 2 km). In general, measures taken to minimize noise hazards to humans will also minimize effects on local wildlife. The following general noise control procedures are intended to mitigate construction noise:

- Minimize the duration of noisy construction activity and plan for it to occur, if feasible, between 9:00 am and 5:00 pm, Monday to Friday and not before 7:00 am or after 9:00 pm.
- Avoid or minimize vehicle use along roads through Tseshaht IR#1 and other residential neighbourhoods during the night (i.e. 7:00 p.m. to 7:00 a.m.)
- Ensure that construction equipment driven or operated by internal combustion engines (e.g. generators, loaders, etc.) are fitted with appropriate mufflers or silencers. Maintain the engines and muffler systems on construction equipment in good working condition. Do not idle a vehicle with a low restriction muffler for more than 15 minutes in a general area.
- Operate equipment at and within load tolerances and ratings.
- Focus maintenance efforts on lubrication and replacement of worn parts, and correction of deficient exhaust systems.
- When practical, shut down heavy equipment that is not in active use rather than letting it idle for long periods.
- Avoid unnecessary engine revving, use of engine retarding system, and use of airbrakes.
- Avoid banging tailgates and front-end loader buckets.
- Orient stationary equipment (e.g., generators and compressors) so that noise screening/dampening features (i.e., buildings, topography and vegetation) prevent noise from traveling directly from the sources(s) to adjacent noise sensitive areas (i.e., Tseshaht IR#1 and downtown Port Alberni across the Somass River).

4 Environmental Assessment – Operations

4.1 POTENTIAL ENVIRONMENTAL EFFECTS

The old lagoon will be in operation until Phase 3. Most of the Project works will be replacing/updating the current system. Furthermore, changes to the system (i.e., consolidating intakes, adding a UV disinfection system) will not significantly impact operation of the new lagoon system. Thus, we do not expect significant changes to lagoon operation as a result of the Project.

At the completion of Phases 1 and 2, the new lagoon will be put into operation and the existing City lagoon removed from service. The new treatment facility is designed to operate in accordance with all provincial government requirements for such facilities, including the MWR and other applicable regulations.

Potential environmental effects from accidents or malfunctions include:
- Unpleasant odours;
- Unintentional releases of partially treated municipal wastewater via the emergency overflow; and
- Minor spills of hydrocarbons or other chemicals.

Under normal operation conditions, the risks to the environment from operations are low (and not higher than current operations) since equipment and procedures are in place to avoid or minimize the probability of their occurrence, and to limit the duration of such releases if they do happen. An overall reduction in environmental effects is anticipated once the new lagoon begins operation, as the existing lagoon included a surface discharge to the Somass River without effluent disinfection.

The potential environmental effects of the lagoon operations on the Alberni Inlet receiving environment are addressed in the Project Receiving Environment EIS report (Associated Engineering 2014, 2017).

4.2 RECOMMENDED ENVIRONMENTAL PROTECTION AND MITIGATION STRATEGIES

4.2.1 Operating Plan

Most elements of the Port Alberni WWTF Operating Plan are intended to ensure that the lagoon meets the environmental obligations. A new Operations Manual will be prepared as part of the Project. This manual will include but not be limited to:
- Built-in redundancy to offset effects of system malfunctions;
- Preventative maintenance procedures;
- Equipment testing and certification;
- Staffing and remote SCADA system monitoring;
- Emergency procedures;
- Spill response and reporting procedures;
- Environmental monitoring – final effluent and periodic receiving environment monitoring; and
- Staff competency and training.

If these procedures are followed, there is negligible potential for environmental effects from Project operations.

5 Summary and Recommendations

The City of Port Alberni is upgrading its municipal Wastewater Treatment Facility to provide the long-term secondary treatment capacity that is required to service the current and future population and comply with the provincial MWR and federal WSER. A key part of planned upgrade is replacement of the existing City's lagoon with an upgraded system that meets current treatment standards, which is facilitated by the purchase of the neighbouring Catalyst lagoon. The upgrades will be completed in three phases.

This Construction and Operation Environmental Impact Study (COEIS) has been prepared in accordance with MWR subsection 19(1) and addresses the construction and operation of the Project. All the planned upgrades will be conducted within 50 m of the existing lagoons. Potential effects during Project **construction** are limited to:

- Effects from the direct disturbance of native vegetation (including rare plants), ecosystems, and wildlife habitat within the construction site;
- Water quality from spills or runoff leaving the property;
- Temporary fugitive dust; and
- Temporary noise.

The mitigation measures to avoid or limited potential effects on vegetation include:

- Pre-construction rare plant inventory to document existing conditions;
- Species at Risk Management and Restoration Plan to outline translocations, seeding, restoration site plan, and follow up monitoring; and
- Avoidance measures including fencing or flagging off “do not disturb” areas, replacement of any rare plants that are disturbed, and invasive species control.

Mitigation for wildlife includes pre-clearance nest surveys (depending on timing).

All other effects (i.e. water quality, air quality, and noise) can be prevented or minimized using standard best management practices for construction, as described in this COEIS. With implementation of these mitigation measures, there is negligible risk of environmental effects during construction of the planned upgrades.

No effects from Project **operations** on the surrounding environment are expected, assuming that operations continue to follow MWR requirements and industry best management practices. This includes development and implementation of an updated environmental emergency response plan.

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Certification Page

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If you have any questions or comments, please feel free to contact the undersigned.

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Appendix A - Site Photographs

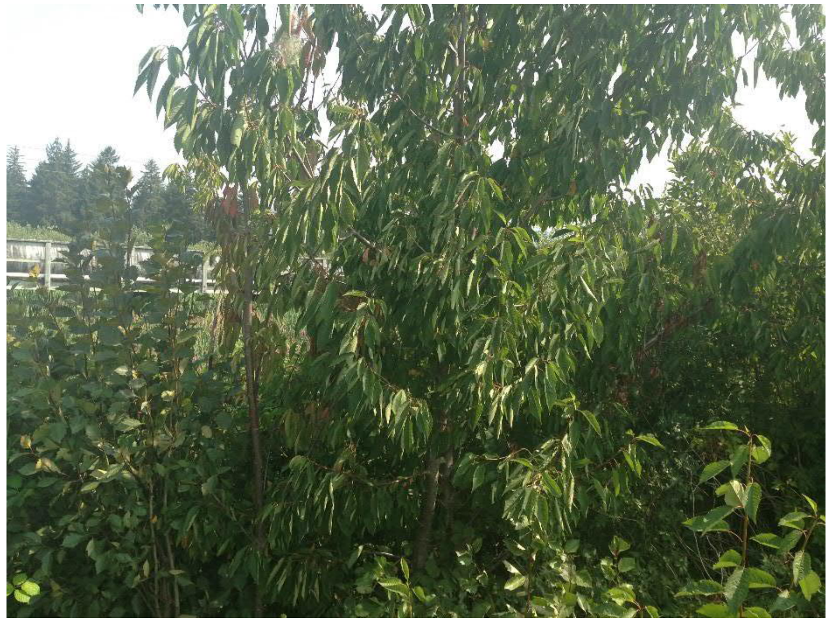


Photo 1: Virginia Cherry along berm of old lagoon (facing west)

Photo 2: Bubblers in old lagoon (facing south)

Photo 3:.Typical vegetation of the mixed forest (facing west)

Photo 4: Berm of new lagoon with invasive blackberry and mixed forest (facing southwest)

Project Number: 2017-2972	Date: Jan 20 2018	**Wastewater Treatment Plant Expansion**	
Prepared For: THE CITY OF Port Alberni	Drawn by SB Data Sources: Field Photos Aug 18 2017	Associated Environmental	Site Visit photos

Photo 5: Cattail and weedy species along berm of new lagoon (facing southeast)

Photo 6: Tidal channel with Oregon ash along south east side of new lagoon

Photo 7: Estuary south of new lagoon.

Photo 8: Tidal Channel North of the old lagoon

	Project Number: 2017-2972	Date: Jan 20 2018	**Wastewater Treatment Plant Expansion**	
	Prepared For: THE CITY OF Port Alberni	Drawn by SB Data Sources: Field Photos Aug 18 2017	Associated Environmental	Site Visit photos

Appendix B - Species Inventory of Somass Estuary and Species at Risk

Vegetation Inventory
BC Listed Species

Scientific Name	Common name	BC status[1]	COSEWIC[2]
Allium geyeri var tenerum	Geyer's onion	blue	
Bidens amplissima	Vancouver Island beggar ticks	blue	1 -SC (Nov 2001)
Castilleja ambigua ssp. ambigua	paintbrush owl-clover	blue	
Cuscuta cephalanti	five-angled dodder	red	
Elatine rubella	three-flowered waterwort	blue	
Eleocharis pravula	small spike-rush	yellow	
Eleocharis rostellata	beaked spike-rush	yellow	
Fraxinus latifolia	Oregon ash	red	
Juncus oxymeris	pointed rush	blue	
Lilaea scilloides	flowering quillwort	blue	
Limosella acaulis	Owyhee mudwort	red	
Sidalacea hendersonii	Henderson's checker-mallow	blue	

1: BC Status

Red-listed – Any indigenous species, subspecies or community that is extirpated, endangered, or threatened in BC.

Blue-listed – Any indigenous species, subspecies or community considered to be of special concern in BC.

Blue-listed elements are at risk, but are not extirpated, endangered or threatened.

2: COSEWIC (Committee on the Status of Endangered Wildlife in Canada):

SC – Special Concern: A species that is particularly sensitive to human activities or natural events, but is not endangered or threatened.

Vegetation Inventory

Scientific Name	Common name
GYMNOSPERMS	
CUPRESSACEAE	
Thua plicata Donn ex D. Don	western redcedar
PINACEAE	
Picea sitchensis (Bong.) Car	Sitka spruce
Pinus contorta Dougl. ex Loud.	lodgepole pine
Pseudostuga menziesii (Mirb.) Franco	Douglas-fir
DICOTYLEDONS	
ACERACEAE	
Acer macrophyllum Pursh	bigleaf maple
ALISMATACEAE	
Alisma plantago-aqluatica L	American Water-plantain
AMARANTHACEAE	
Amarthus reflectus	pigweed
APIACEAE	
Angelica genuflexa Nutt	kneeling angelica
Anglecia lucida L	seacoast anglica
Cicuta douglasi i (DC.) Coult. & Rose	Douglas' water-hemlock
Conioselinum gmelinii (Cham. & Schlecht	Pacific hemlock-parsely
Daucus carota L	wild carrot
Foeniculum vulgare P. Mill	sweet fennel
Heraceum maximum Bartr.	cow-parsnip
Lilaeopsis occidentalis Coult & Rose	western lilaeopsis
Oenanthe sarmentosa Presl ex DC.	Pacific water-parseley
Sanicula crassicaulis Poepp. ex DC. var	Pacific sanicle
AQUIFOLIACEAE	
Ilex aquifolium L.	English holly
ARALIACEAE	
Hedera helix L.	English Ivy
ASTERACEAE	
Achillea millefolium L.	yarrow
Anaphalis margaritaceae (L.) Benth. & H	pearly everlasting
Antennaria neglecta	field pussytoes
Arctium minus L.	common burdock
Aster eatonii (A. Gray) T.J. Howell	Eaton's aster
Aster subspicatus Nees *var subspicatus*	Douglas' aster
Bidens amplissima Green	Vancouver Island beggarticks
Cirsium arvense (L.) Scop. *var horridum*	Canada thistle
Cirsium vulgare (Savi) Tenore	bull thistle
Conyza candadensis (L.) Crongq. *var gla*	horseweed
Erigeron philadelphicus L.	Philadelphia fleabane
Gnaphaliium palustre Nutt.	lowland cudweed
Grindelia integrifolia DC.	Puget Sound gumweed
Hypochaeris glabra L	smooth cat's-ear
Hypochaeris radicata L.	hairy cat's-ear
Lactuca muralis (L.) Fresn.	wall lettce
Leontodon taraxacoides (Vill.) Merat	hairy hawkbit

Leucanthemum vulgre Lam	oxeye daisy
Matricaria discoidea DC.	pineapple weed
Prenathes alata (Hook.) D. Diertr.	western rattlesnake-root
Senecio vulgaris L.	common groundsel
Solidago canadensis L.	Canadad goldenrod
Sonchus arvensis L.	perennial sow-thistle
Sonchus asper (L.) Hill	prickly sow-thistle
Tanacetum parthenium (L.) Schultz-Bip	feverfew
Taraxaxum officinale G.H. Weber ex Wig	common dandelion
Tripleurospermum inodorum	scentless mayweed
BERBERIDACEAE	
Achlys triphylla (J.E. Smith) DC.	vanilla-leaf
Mahonia aquifolium (Pursh) Nutt.	tall Oregon-grape
Mahonia nervosa (Pursh) Nutt.	dull Oregon-grape
BETULACEAE	
Alnus ruba Bong.	red alder
Betula pendula Roth	European birch
BORAGINACEAE	
Myosotis laxa Lehm.	small-flowered forget-me-not
Plagiobothrys scouleri (H. & A.) I.M. John	Scouler's popcornflower
BRASSICACEAE	
Arabis eschscholtziana Andrz	Eschscholtz's rockcress
Barbarea orthoceras Ledeb.	American winter cress
Brassica campestris L.	field mustard
Capsella bursa-pastoris (L.) Medic.	shepherd's purse
Cardamine oligosperma Nutt *var oligospe*	little western bitter cress
Draba verna L.	common draba
Lepidium campestre (L.) R. Br.	field pepper-grass
Raphanus raphanistrum L.	wild raddish
Rorippa curvisiliqua (Hook) Bess. ex Britt	western yellow cress
Sisybrium officinale (L.) Scop	hedge mustard
Teesdalia mudicaulis	Shepherd's cress
CALLITRICHACEAE	
Callitriche palustris L.	spring water-starwort
CAPRIFOLIACEAE	
Linnaea borealis L.	twinflower
Lonicera ciliosa (Pursh) Poir. ex DC	western trumpet
Lonicera involucrata (Richards) Banks e	black twinberry
Sambucus cerulea Raf. var cerulea	blue elderberry
Sambucus racemosa L. *ssp. pubens var*	coastal red elderberry
Symphoricarpos albus (L.) Blake *var laev*	common snowberry
CARYOPHYLLACEAE	
Cerastium fontanum Baumg. *ssp. trivale*	mouse-ear chickweed
Sagina maxima A. Gray ssp. crassicaulis	coastal pearwort
Sagina procumbens L.	bird's-eye pearlwort
Silene gallica L.	small-flowered catchfly
Spergula arvensis L.	corn-spurry
Spergularia macrotheca (Hornem.) Heyn	beach sand-spurry
Spergularia ruba (L.) J.&K. Presl	red sand-spurry
Stellaria crispa Cham. & Schlecht.	crisp starwort
Stellaria media (L.) Vill.	common chickweed
CHENOPODIACEAE	

Atriplex rosea L.	red orache
Chenopodium alba L.	lamb's-quarters
CLUSIACEAE	
Hypericum perforatum L.	common St. John's-wort
Hypericum scouleri Hook *ssp scouleri*	wester St. John's-wort
CORNACEAE	
Cornus nuttallii Aud ex T.&G.	western flowering dogwood
Cornus stolonifera Mich	red-osier dogwood
CRASSULACEAE	
Crassula aquatica (L.) Schoeni	pigmyweed
Sedum oreganum Nutt	Oregon stonecrop
CUSCUTACEAE	
Cuscuta cephalanthi Engelm	button-bush dodder
ELATINACEAE	
Elatine rubella Rydb.	three-flowered waterwort
Elatine brachysperma	
ERICACEAE	
Arctostaphylos uva-ursi (L.) Spreng	kinnikinnick
Arbutus menziesii Pursh	*arbutus*
Gaultheria shallon Pursh	salal
Vaccinium ovatum Pursh	evergreen huckleberry
Vaccinium parvifloium Sm	red huckleberry
FABACEAE	
Cytisus scoparius (L.) Link	Scotch broom
Lathyrus nevadensis S. Wats. *var pilosel*	purple peavine
Lathyrus palustris L.	marsh peavine
Lathyrus sylvestris L	narrow-leaved everlasting peavine
Lotus corniculatus L.	birds-foot trefoil
Lotus dendiculatus (Drew) Greene	meadow birds-foot trefoil
Lotus micranthus Benth	small-flowered birds-foot trefoil
Lupinus polyphyllus Lindl. *ssp. polyphyllu*	large-leaved lupine
Medicago lupulina L.	black medic
Medicago sativa L.	alfalfa
Melilotus alba Desr.	white sweet-clover
Melilotus officinalis (L.) Lam	yellow sweet-clover
Robinia pseudoacacia L.	black locust
Trifolium arvense L.	hare's-foot clover
Trifolium campestre Schreb.	low hop-clover
Trifolium dubium Sibth.	small hop-clover
Trifolium pratense L.	red clover
Trifolium repens L.	white clover
Trifolium wormskioldii Lehm.	springbank clover
Vicia americana Muhl. ex Willd.	American vetch
Vicia cracca L. *ssp. cracca*	tufted vetch
Vicia hirsuta (L.) S. F. Gray	tiny vetch
Vicia nigricans Hook & Arn *ssp. giantea* (	giant vetch
Vicia sativa L *var sativa*	common vetch
Vicia tetrasperma (L.) Schreb.	slender vetch
Vicia villosa Roth *ssp. villosa*	hairy vetch
FAGACEAE	
Quercus robu r L.	English Oak
FUMARIACEAE	

Dicentra formosa (Haw.) Walp.	Pacific bleeding heart
GENTIANACEAE	
Centaurium erythraea Raf.	common centaury
GERANIACEAE	
Geranium bicknellii Britt	Bicknell's geranium
Geranium dissectum L.	cut-leaved geranium
GROSSULARIACEAE	
Ribes divaricatum Dougl. *ssp divaricatum*	wild black gooseberry
Ribes sanguineum Pursh *var sanguineun*	red-flowering currant
HALORAGACEAE	
Myriophyllum sibiricum Kom.	Siberian water-milfoil
Myriophyllum verticillatlum L.	verticillate water-milfoil
HYDROPHYLLACEAE	
Nemophila parviflora Dougl. ex Benth. *va*	small-flowered nemophila
LAMIACEAE	
Lamium purpureum	Purple dead-nettle
Lycopus europaeus L..	European horehound
Mentha arvensis L	field mint
Prunella vulgaris L	self-heal
Scutellaria lateriflora L.	blue skullcap
Stchys chamissonis Benth. var cooleyae (	Cooley's hedge-nettle
LYTHRACEAE	
Lythrum salicaria L	Purple loosestrife
MALVACEAE	
Malva parviflora L.	small-flowered mallow
Sidalcea hendersonii S. Wats	Henderson's checker-mallow
MYRICAEAE	
Myrica gale L.	Sweet gale
OLEACEAE	
Fraxinus latifolia Benth	Oregon Ash
ONAGRACEAE	
Epilobium angustifolium	
Epilobium cliatum	
Ludwigia palustris (L.) Elliot	water-pursalane
PLANTAGINACEAE	
Plantago lanceolata L.	ribwort plantain
Plantago macrocarpa Cham. & Schlecht.	Alaska plantain
Plantago major L.	common plantain
Plantago maritima L *ssp juncoides*	sea plantain
POLYGONACEAE	
Polygonum aviculare L.	common knotweed
Polygonum hydropipe r L.	marshpepper smartweed
Polygonum persicaria L.	Lady's-thumb
Rumex acetosella L.	sheep sorrel
Rumex aquaticus L. *var fenestratus* (Greene) Dorn	
Rumex conglomeratus Murr.	clustered dock
Rumex crispus L	curled dock
Rumex maritimus L	golden dock
Rumex salicifolius Weinm.	willow dock
PORTULACACEAE	
Claytonia sibirica L.	Siberian miner's-lettce
Montia fontana L.	blinks

Montia linearis	Narrow-leaved Montia
PRIMULACEAE	
Anagallis minima (L.) Krause	chaffweed
Dodecatheon pulchellum (Raf.) Merrill	pretty shootingstar
Glaux maritima L.	sea-milkwort
Trientalis borealis Raf. *ssp. latifolia*	broad-leaved starflower
RANUNCULACEAE	
Aquilegia formosa Fisch. ex DC. *ssp form*	Sitka columbine
Ranunculus orthorhynchus Hook.	straight-beaked buttercup
Ranunculus repens L	creeping buttercup
Thalictrum occidentale A. Gray	western meadowrue
Trautvetteria caroliniensis (Walt.) Vail	false bugbane
RHAMNACEAE	
Rhamnus purshiana DC.	cascara
ROSACEAE	
Amelanchier alnifolia Nutt *var semiintegri*	saskatoon
Aruncus dioicus (Walt.) Fern.	goat's-beard
Crataegus douglasii Lindl.	black hawthorn
Crataegus monogyna Jacq.	common hawthorn
Fragaria virginiana Duchesne	wild strawberry
Malus fusca (Raf.) Schneid.	Pacific crab apple
Physocarpus capitatus (Pursh) Kuntze	Pacific ninebark
Potentilla egedii Wormskj.	coastal silverweed
Prunus emarginata (Dougl.) Walp.	bitter cherry
Prunus virginiana L.	choke cherry
Rosa canina L.	dog rose
Rosa nutkana Presl *var nutkana*	Nootka rose
Rubus discolo r Weihe & Nees	Himalayan blackberry
Rubus laciniatus Willd.	cutleaf evergreen blackberry
Rubus praviflorus Nutt. *var parviflorus*	thimbleberry
Rubus spectabilis Pursh	salmonberry
Rubus ursinus Cham. & Schlecht. *ssp ma*	trailing blackberry
Sanguisorba officinalis L.	great burnet
Sorbus aucuparia L.	European mountain ash
Spirea douglasii Hook	hardhack
RUBIACEAE	
Galium aperine L.	cleavers
Galium boreale L.	northern bedstraw
Galium trifidum L.	small bedstraw
Sherardia arvensis L.	field madder
SALICACEAE	
Populus balsamifera L	balsam poplar
Salix hookeriana J Barratt ex Hook.	Hooker's willow
Salix scoleriana J. Barratt ex Hook.	Scouler's willow
SAXIFRAGACEAE	
Heuchera micrantha Dougl. ex Lindl *var*	small-flowered alumroot
Saxifraga rufidula (Small) Macoun	rusty-haired saxifrage
SCROPHULARIACEAE	
Castilleja ambigua (Benth.) Chuang & He	paintbrush owl-clover
Castilleja unalaschcensis (Cham. & Schle	Unalaska paintbrush
Collinsia parviflora Dougl. ex Lindl	small-flowered blue-eyed Mary
Eluphrasia memorosa (Pers.) Wallr.	eastern eyebright

Limosella aquatica L.	water mudwort
Mimulus guttatus DC.	yellow monkey-flower
Rhinanthus minor L.	yellow rattle
URTICACEAE	
Urtica dioica	stinging nettle
VALERIANACEAE	
Plectritis congesta (Lindl.) DC.	sea blush
VIOLACEAE	
Viola langsdorfii Fisch ex Gingins	Alaska violet
MONOCOTYLEDONS	
ALISMATACEAE	
Alisma triviale Pursh.	American water-plantain
ARACEAE	
Lysichiton americanus	skunk cabbage
CYPERACEAE	
Bolboschoenus maritimus (L.) Palla *var p*	seacoast bulrush
Carex languginosa Michx.	wooly sedge
Carex lenticularis Michs. *var lenticularis*	lakeshore sedge
Carex lyngbyei Hornem.	Lyngbye's sedge
Carex obnupta Bailey	slough sedge
Carex sitchnesis Prescott	Sitka sedge
Carex stipata Muhl.	sawbeak sedge
Carex virdula Michx. *ssp. virdula*	green sedge
Dulichium arundinaceum (L.) Britt.	three-way sedge
Eleocharis palustris (L.) Roem. & J.A. Sch	common spike-rush
Eleocharis parvula (Roem. & Schult.) link	small spike-rush
Eleocharis rostellata (Torr.) Torr.	beaked spike-rush
Isolepis cernua (Vahl) Roem. & J.A. Schu	low clubrush
Schoenoplecutus acutus (Muhl. ex Bigelo	hard-stemmed bulrush
Schoenoplectus pungens (Vahl) Palla *var*	American bulrush
Schoenoplectus tmabernaiemontani (K.C	soft-stemmed bulrush
Scirpus microcarpus J. & K. Presl	small-flowered bulrush
Trichophorum cespitosum (L.) Hartm	tufted clubrush
IRIDACEAE	
Iris pseudoacorus L.	yellow iris
Iris sp.	
Sisyrinchium californicum (Ker-Gawl. ex S	golden-eyed grass
Sisyrinchium littorale Greene	shore blue-eyed grass
JUNACEAE	
Juncus arcticus Willd. *ssp. sitchensis* En	arctic rush
Juncus articulatus L.	jointed rush
Juncus bufonius L.	toad rush
Juncus effsus L.	common rush
Juncus oxymeris Engelm.	pointed rush
Luzula multiflora (Ehrh.) Lej.	many-flowered wood-rush
JUNCAGINACEAE	
Lilaea scilloide s (Poir) Haum.	flowering quillwort
Triglochin maritima L.	seaside arrow-grass
LEMNACEAE	
Lemna minor L.	common duckweed
LILIACEAE	

Allium geyeri S. Wats. var tenerum M.E.	Geyer's onion
Camassia quamash (Pursh) Greene	common camas
Erytronium oregonum Appleg. *ssp orego*	white fawn lily
Fitillaria camschatcensis (L.) Ker-Gawl	northern riceroot
Maianthemum dilatatum (A. Wood) Nels.	false lily-of-the-valley
Proartes hookeri Torr. *var oregana* (S. W	Hooker's fairybells
Trillium ovatum Pursh	western trillium
Triteleia hyacinthina (Lindl.) Greene	white triteleia
ORCHIDACEAE	
Calypso bulbosa (L.) Oakes	fairy-slipper
Platanther dilatata (Pursh) Lindl. ex Beck	fragrant white rein orchid
POACEAE	
Agrostis exarata Trin.	spike bentgrass
Agrostis scabra Willd.	hair bentgrass
Agrostis stolonifera L.	creeping bentgrass
Aira caryophyllea L.	silver hairgrass
Aira praecox L.	early hairgrass
Bromus carinatus Hook. & Arnott	California brome
Bromus sitchensis Trin.	Alaska brome
Calamagrostis candensis (Mich.) Beauv.	bluejoint reedgrass
Dactylis glomerata L	orchard-grass
Danthonia california Boland	California oatgrass
Deschampsia cespitosa (L.) Beauv.	tufted hairgrass
Dichanthelium acuminatum (Swartz) Gou	western witchgrass
Elymus repens (L.) Gould	quackgrass
Festcua ruba L. *ssp ruba* sens. lat.	red fescue
Hierochloe hirta (Schrank) Borbass *ssp. a*	common sweetgrass
Holcus lantus L.	common velvet-grass
Leymus mollis (Trin.) Pilger *ssp. mollis*	dune wildrye
Lolium arundinaceum (Schreb.) Darbshire	tall fescue
Melic subulata (Griseb.) Scribn.	Alaska oniongrass
Phalaris arundinaceae L.	Canarygrass
Poa palustris L.	fowl bluegrass
Poa prartensis L.	Kentucky bluegrass
Trisetum cernum Trin.	tall trisetum
POTAMOGETONACEAE	
Potamogeton crispus L.	curled pondweed
RUPPIACEAE	
Ruppia maritima L.	beaked ditch-grass
TYPHACEAE	
Typha latifolia L.	common cattail
ZANNICHELLIACEAE	
Zannichellia palustris L.	horned pondweed
EQUISETACEAE	
Equisetum arvense L	common horesetail
Equisetum varegatum Schleich *ssp. alaskanum* (A. A. Eat.) Hult.	
ISOETACEAE	
Isoetes maritima Underw.	coastal quillwort
SELAGINELLACEAE	
Selaginella wallacei Hieron	Wallace's selaginella
BLECHNACEAE	
Blechnum spican t (L.) Roth	deer fern

DENNSTAEDTIACEAE	
Pteridium aquilinum (L.) Kuhn	bracken fern
DRYOPTERIDACEAE	
Athyrium filix-femina (L.) Roth *ssp. cyclos*	lady fern
Polystichum munitum (Kaulf.) K. B. Bresl	sword fern
POLYPODIACEAE	
Polypodium glycyrrhiza D. C .Eaton	licorice fern

APPENDIX D – PUMP INFORMATION

No: M-10.2116 - 06	2
Dat/Nam.: 24.05.2016 / S. Demir	
Cad Code: M_102116	
Technical changes reserved Änderungen vorbehalten Sous réserve de modifications	

AFLX 0701

Dimension sheet PE5

Maßblatt PE5

Plan d'encombrement PE5

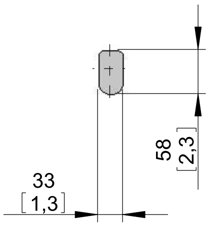
SULZER

Type Typ Type 50Hz	Type Typ Type 60Hz	Weight Gewicht Poids (~kg)	Weight Gewicht Poids (~lb)	H (mm)	H (inch)	Size
PE 450/6	PE 520/6-60	1170	2580	2093	82.4	A
PE 550/6	PE 630/6-60	1260	2778	2213	87.1	B
PE 750/6	PE 860/6-60	1350	2977			
PE 900/6	PE 1040/6-60	1395	3076			
	PE 430/8-60	1195	2635	2093	82.4	A
	PE 520/8-60	1295	2855	2213	87.1	B
	PE 630/8-60	1340	2955			
	PE 860/8-60	1385	3054			

Weight: Includes pump and 10m cable
Gewicht : Beinhaltet Pumpe und 10m Kabel
Poids: Pompe et 10m de câble

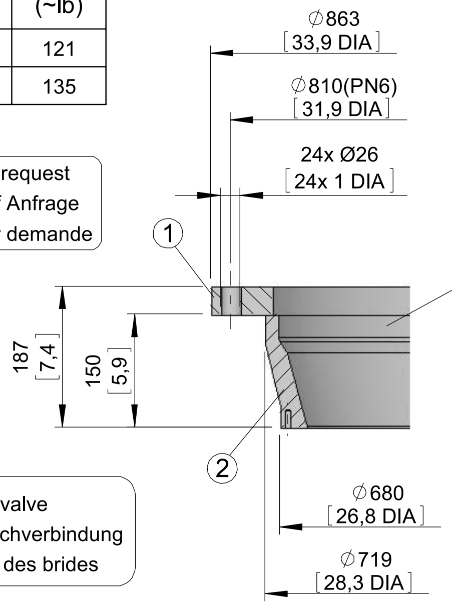
For different cable length see IOM chapter 1.5
Für abweichende Kabellänge siehe EBA, Kapitel 1.5
Pour des longeurs supérieures, voir la section 1.5 du manuel

Lifting hoop cross section
Fangbügel-Querschnitt
Section d'anse de levage

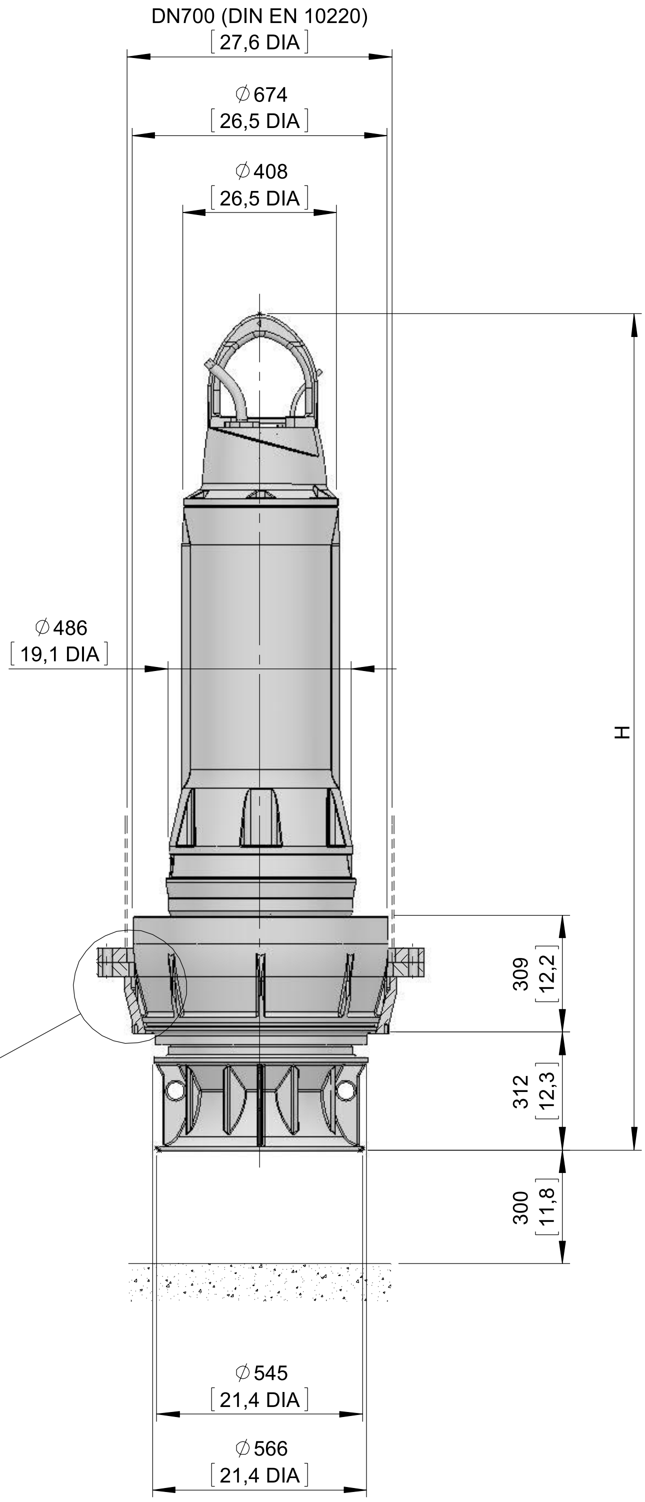


	Weight Gewicht Poids (~kg)	Weight Gewicht Poids (~lb)
1	55	121
2	61	135

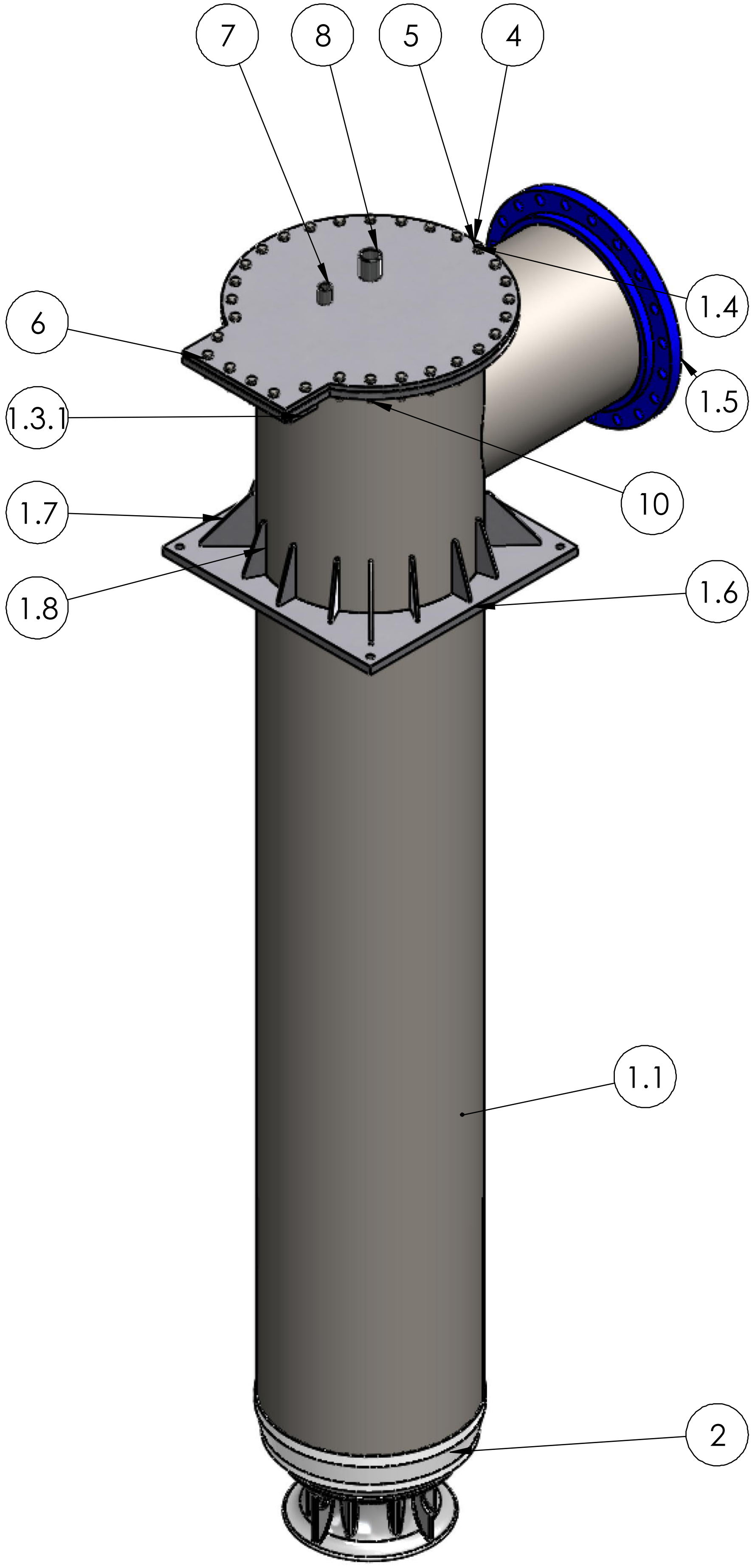
① on request
auf Anfrage
sur demande



Dim. flange valve
Maße Flanschverbindung
Dimensions des brides



[mm / inch]



BILL OF MATERIALS

ITEM NO.	ITEM	DESCRIPTION	MATERIAL	QTY.
1	WELDMENT	700 MM PUMP TUBE WITH 600 MM DISCHARGE		1
1.1	PIPE	700MM PIPE	ASTM A36 Steel	1
1.2	PLATE	1/4" THK	CSA G40.21-44W	2
1.2.1		Sheet	CSA G40.21-44W	-
1.3	PLATE	1/4" THK	CSA G40.21-44W	1
1.3.1		Sheet	CSA G40.21-44W	-
1.4	PLATE	1" THK	CSA G40.21-44W	1
1.5	FLANGE	24" (600MM) slip on weld flange	ASTM A36 Steel	1
1.6	PLATE	1 1/4" THK	CSA G40.21-44W	1
1.7	PLATE	3/8" THK	CSA G40.21-44W	4
1.8	PLATE	3/8" THK	CSA G40.21-44W	9
1.9	PLATE	3/8" THK	CSA G40.21-44W	3
2	PUMP	SULZER AFLX 0701, PE860/6-60	Cast Carbon Steel	1
3	SUPPORT FRAME	SUPPORT FRAME , CABLING		1
3.1	HSS TUBE	HSS, RECTANGULAR, 50 X 100 X 6.35 X 760 LG	AISI 304	1
3.2	HSS TUBE	HSS, RECTANGULAR, 50 X 100 X 6.35 X 2262 LG	AISI 304	1
3.3	FLAT BAR	FLAT BAR, 9.5 X 76 X 9.2520 LG	AISI 304	2
3.4	FLAT BAR	FLAT BAR, 6 X 50 X 7.8740 LG	AISI 304	1
3.5	FLAT BAR	FLAT BAR, 6 X 50 X 7.8740 LG	AISI 304	1
4	COVER	3/4" PLATE	CSA G40.21-44W	1
5	LID GASKET	1/8" NEOPRENE GASKET	Rubber	1
6	FASTENER	3/4" X 2-1/2" HHCS	SS 18-8	28
7	COUPLER	25MM(1") MIP STEEL	Plain Carbon Steel	1
8	COUPLER	50MM(2") STEEL FIPS	Plain Carbon Steel	1
9	FASTENER	3/4" HEX NUT	SS 18-8	2
10	FASTENER	3/4" HEX NUT	SS 18-8	30

PRECISION
SERVICE & PUMPS INC: EST.1992
Ph. 604.850.7010 Fx. 604.850.9666
www.precision-pumps.com
1334 Riverside, Abbotsford B.C. V2S 8J2

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MATERIAL

UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN MILLIMETERS
TOLERANCES:
ANGULAR: MACH± .5 BEND ±1.0
±1MM
ONE PLACE DECIMAL ±0.1MM
THREE PLACE DECIMAL ±0.05MM

	NAME	DATE
DRAWN	KAA	12/14/2018
CHECKED		
CHECKED		

PSP WO #:

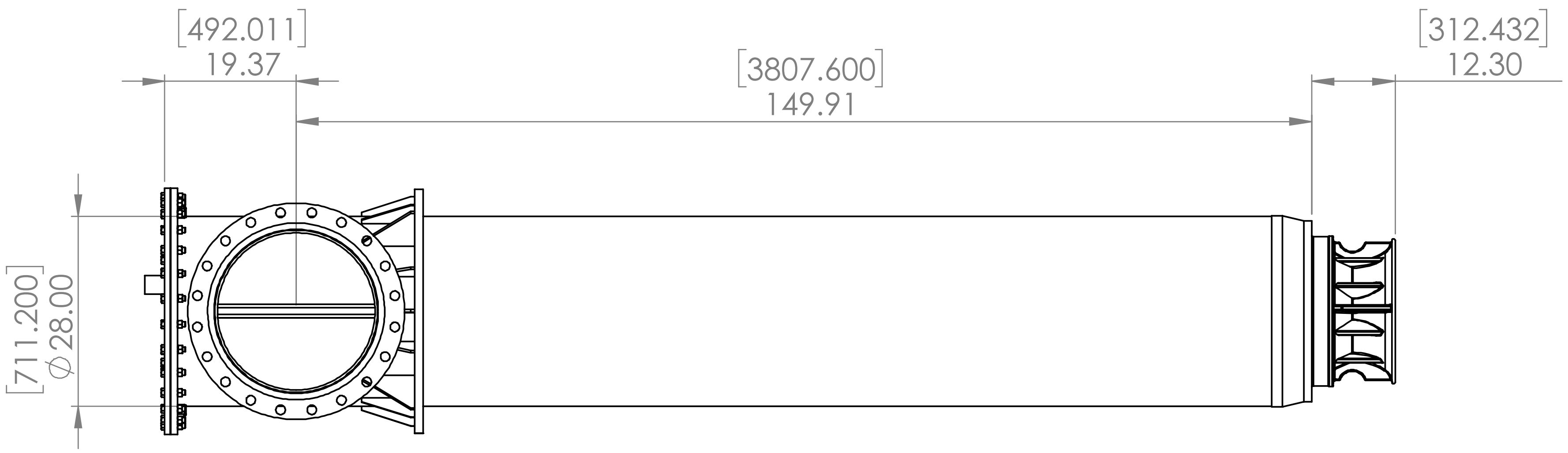
PORT ALBERNI WWTP
BARGE CONCEPT

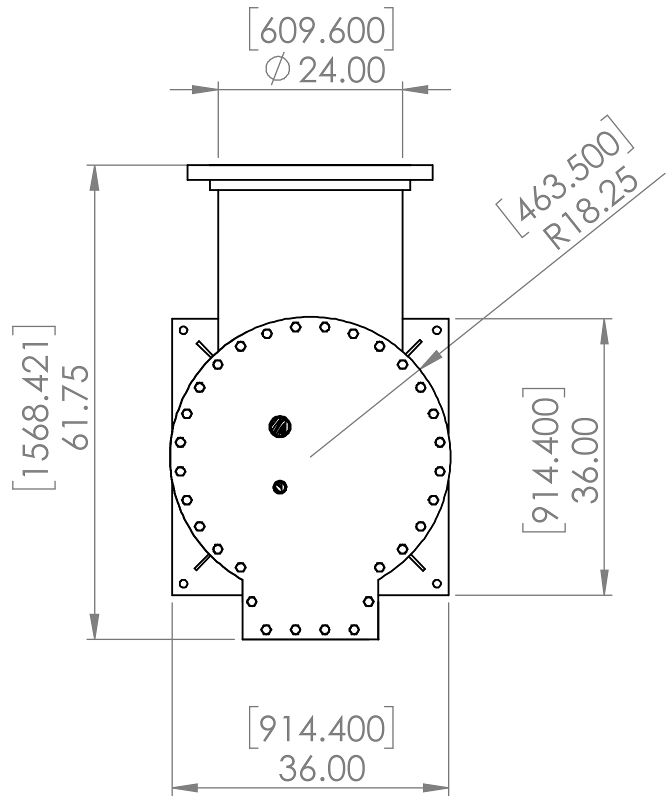
PUMP AND TUBE DRAWING

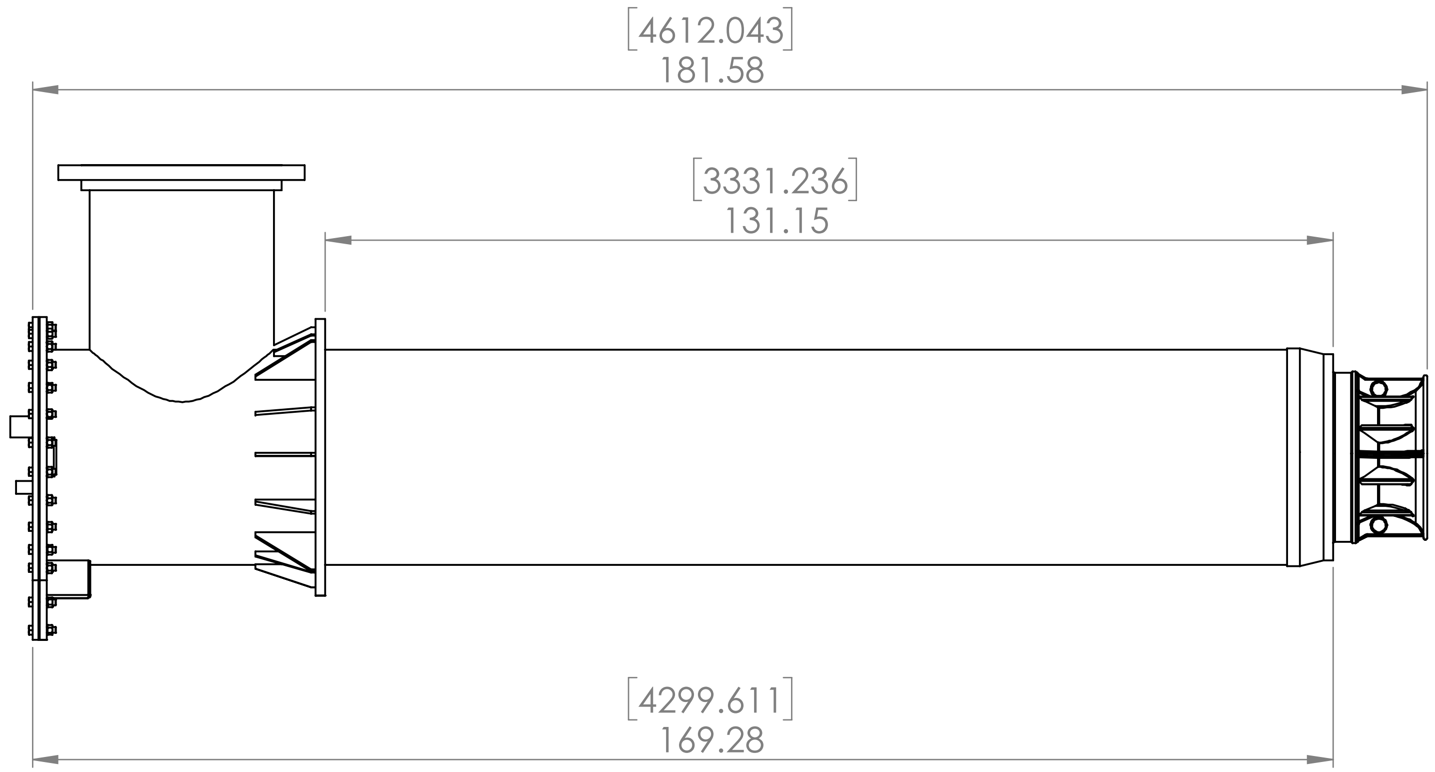
SIZE **B**
REV

SHEET TITLE: Sheet1

SHEET 1 OF 4







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MATERIAL

UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN MILLIMETERS
TOLERANCES:
ANGULAR: MACH± .5 BEND ±1.0
±1MM
ONE PLACE DECIMAL ±0.1MM
THREE PLACE DECIMAL ±0.05MM

	NAME	DATE
DRAWN	KAA	12/14/2018
CHECKED		
CHECKED		

PSP WO #:

PORT ALBERNI WWTP
BARGE CONCEPT

ASSEMBLY DIMENSIONS

SIZE **B**
REV

SHEET TITLE: Sheet4

SHEET 4 OF 4