THURBER ENGINEERING LTD.

September 10, 2018 File: 22523

Jacobs
Metrotower II, Suite 2100
4720 Kingsway
Burnaby, BC V5H 4N2

Attention: Jessie Gerwien

REGIONAL DISTRICT OF NANAIMO
CHASE RIVER FORCEMAIN NO.1 REPLACEMENT AND PUMP STATION UPGRADES
GEOTECHNICAL & ENVIRONMENTAL INVESTIGATION REPORT

Dear Jessie:

This letter presents the results of a geotechnical and environmental investigation conducted for the Chase River Forcemain Replacement and Pump Station Upgrades Project. The scope of our work was outlined in our proposal letter dated April 13, 2018. Authorization to proceed was given by you in an email sent on July 20, 2018.

It is a condition of this letter that Thurber's performance of its professional services is subject to the attached Statement of Limitations and Conditions.

1. PROJECT BACKGROUND

We understand the project involves the following system upgrades:

- Replacing the existing 1.1 km long No.1 Forcemain (450 mm diameter ductile iron) with a larger diameter HDPE or PVC line capable of handling the entire peak design flow for the pump station. The new Forcemain will generally follow the existing alignment except at the Chase River crossing, where the new Forcemain will be attached to the existing Island Highway Bridge.

- Various upgrades to the existing pump station including expansion of the Forcemain valve chamber, addition of flow meters and isolation valves and improvements to pump station inlets to screen grit and rocks. This will require excavation to about 10 m depth.

2. SITE DESCRIPTION

The existing pump station is located on a generally flat site, with the Chase River down slope to the north, the Chase River Estuary Park to the east, a CN Rail bridge up slope to the south, and the Trans-Canada Highway upslope to the west. The existing forcemain is located within the roadway of Haliburton Street, which undulates along the 1.1 km alignment.

The mapped bedrock geology in the area is undifferentiated Nanaimo Group, described as: *boulder, cobble and pebble conglomerate, coarse to fine sandstone, siltstone, shale and coal.*

(Massey, N.W.D., Desjardins, P.J. and Grunsky, E.C., 1994. Vancouver Island (92B, C, E, F, G, K, L; 102I). British Columbia Ministry of Energy, Mines and Petroleum Resources, British Columbia Geological Survey Open File 1994-6).

3. INVESTIGATION

Prior to conducting the field investigation BC One Call was notified to identify utilities in the vicinity of the investigation area. In addition, Kellys 1st Call Locators of Lantzville, BC. was used to scan for underground utilities at the proposed test hole locations. A large number of close proximity buried and overhead services were identified along Haliburton Street, which greatly limited the ability to drill along the alignment without using a hydroexcavator (HydroVac).

The field investigation consisted of drilling four test holes (TH18-1 to TH18-4) at accessible locations along the alignment. TH18-1, -2 and -3 were drilled on August 16, 2018 using a truck mounted solid stem auger drill rig operated by Drillwell Enterprises Ltd. of Duncan, BC.

TH18-1 was located just outside the existing Pump Station, and met shallow refusal at 2.4m depth on large cobbles in the fill. Additional test holes were attempted adjacent to the original location, but the auger was unable to penetrate through the material. To ensure that enough geotechnical information was available for design, a sonic borehole, TH18-4, was drilled at this location on September 4th, 2018 by Drillwell, and reached a depth of 7.3 m.

Dynamic cone penetration tests (DCPT's) were conducted at TH18-1, TH18-2 and TH18-3. The DCPT involves driving a 60 mm diameter cone attached to AW drill rod with a 185 mm sleeve. The rod is driven under the energy of a 63.5 kg weight falling from a height of 760 mm and the number of blows required to advance the cone 305 mm into the ground is recorded and included on the test hole logs.

Standard penetration tests (SPT's) were conducted at TH18-4. The SPT involves driving a 50 mm diameter thick-walled sampler 600 mm into the soil under the energy of a 63.5k kg weight falling 760 mm. The number of blows required to drive the sampler between 150 mm and 450 mm interval is known as the standard penetration blow count (N-value).

The soils were logged in the field by a Thurber representative and disturbed samples were obtained at selected depths from the augers for visual identification and moisture content determination. The test holes were backfilled with cuttings, sealed with bentonite and capped with cold-mix asphalt.

The results of the field and laboratory testing were used to compile test hole logs that are provided in Appendix A. The approximate locations of the test holes are shown on the attached Drawing No. 22523-1 also provided in Appendix A.

In addition to the drilling investigation, Thurber also observed bedrock outcrops at the north end of the project alignment, and this is shown on the drawing in Appendix A.

The Regional District of Nanaimo (RDN) also undertook maintenance of a section of the Forcemain near 1061 Haliburton Street (approximate location shown on Drawing 22523-1). A Jacobs engineer was on site during the trench excavation and was able to observe the trench materials and geometry, and sent two samples of the of the trench materials to Thurber's Victoria Lab for visual assessment. The approximate location of the trench is shown on the drawing in Appendix A.

4. SUBSURFACE CONDITIONS

Soil conditions encountered during the investigation were highly variable and are summarised below, moving from north to south along the alignment:

Bedrock Outcrop

At the northern end of the alignment, bedrock was observed on both the high and low side of the road. The rock comprises *Slightly to moderately weathered, light grey, "weak", SANDSTONE, with bedding planes at 2 mm – 20 mm spacings, and cross cutting joints on 10 mm – 30 mm spacings.* Rock strength is inferred, no testing was conducted.

TH18-2

TH18-2 was drilled across the street from 997 Haliburton Street, near the bedrock exposure observed at the northern extent of the alignment. Below the asphalt and 200 mm of road base fill, loose silty SAND was encountered down to 2.4 m, where both the auger and DCPT met refusal on inferred rock. Groundwater seepage was not encountered.

TH18-3

TH18-3 was drilled outside 1081 Haliburton Street, near to the intersection of Haliburton Street and Chase River Road. Below the asphalt surface was SAND and GRAVEL road base fill was encountered to 0.5 m depth. This was underlain by orange brown silty CLAY to 1.5 m depth where both the auger and DCPT met refusal. Groundwater was not encountered.

RDN Trench Repairs

The notes and samples received from Ryan James from Jacobs indicate that trench materials encountered during the excavation consist of road base fill comprising brown, moist, SAND and GRAVEL (up to 40 mm) to 1.2 m depth. This is underlain by compacted gravelly SAND down to 2.6 m. Groundwater seepage was not encountered. The crew working on this repair noted that this is the deepest section of the alignment, and the invert is generally at a shallower depth closer to 1.5 m.

TH18-1 and TH18-4

TH18-1 and TH18-4 were drilled in the pavement adjacent to the western wall of the existing pump station. The upper 2.4m comprises dense to very dense SAND and GRAVEL FILL, with

some cobbles and boulders up to 150 mm diameter. This is underlain by loose to compact wet SAND and GRAVEL down to 5.4 m depth and is underlain by very dense Sand, Gravel and Clay Till-like material.

Bedrock was encountered at 6.1 m depth, and the borehole was terminated at 7.3 m depth. The bedrock comprises: *Unweathered to slightly weathered, dark grey, "moderately strong", BASALT.* Rock strength is inferred, no testing was conducted. This rock is not part of the Nanaimo Group, but instead from the underlying Karmutsen Formation, the most common bedrock found on Vancouver Island.

Groundwater seepage was encountered in TH18-4, at a depth of approximately 3 m.

5. GEOTECHNICAL ASSESSMENT & RECOMMENDATIONS

Our assessment of the onsite soils and engineering recommendations are discussed below:

5.1 Site Seismicity

Assuming the pump station is founded on bedrock or on the dense sand and gravel and clay till above bedrock, Seismic Site Class B may be used for the design.

The 2012 British Columbia Building Code specifies a design level earthquake with a 2% probability of exceedance in 50 years (corresponds to an average return period of 2,475 years). In accordance with the seismic hazard values for the 2015 National Building Code of Canada (NBC), the peak ground acceleration (PGA) at the site for the 2,475-year event is 0.46 g. The 2015 NBC Seismic Hazard Calculation output is attached in Appendix B for reference.

5.2 Forcemain Trench Base Preparation and Backfill

We understand that the proposed new forcemain will mostly be founded in the existing trench, and therefore we consider that the trench materials are likely suitable to be reused. Prior to laying the new forcemain, the soil at the base of the trench should be compacted to at least 95% of the Modified Proctor Maximum Dry Density (MPMDD), in accordance with Section 4.14 of the City of Nanaimo Engineering Standards and Specifications Document.

In the event that cohesive materials such as silty CLAY (observed in TH18-3) are encountered, or if the new trench deviates from the current alignment, we recommend excavating an additional 300 mm below pipe invert and backfilled using 19 mm or 75 mm minus clean sandy gravel, compacted to at least 95% of the Modified Proctor Maximum Dry Density (MPMDD), in accordance with Section 4.17 of the City of Nanaimo Engineering Standards and Specifications Document.

A maximum lift thickness of 300 mm is recommended, although thinner lifts may be required if small plate tampers or jumping jack units are employed, particularly around the pipe zone. Heavy compactive equipment such as hoe-paks should not be utilized around the pipe zone. Backfill

should consist of 19 mm or 75 mm minus clean sandy gravel compacted to at least 95% of the Modified Proctor Maximum Dry Density (MPMDD).

If bedrock is encountered, it should be removed by blasting, ripping or chipping methods to a depth of at least 300 mm below pipe invert and backfilled with sandy gravel engineered fill.

All bearing surfaces should be inspected by a qualified geotechnical engineer to confirm that the subgrade has been adequately prepared and is acceptable prior to placing engineered backfill.

5.3 Temporary Excavations

Due to the granular nature of the soils, the existing fill materials should be sloped no steeper than 1H:1V. Alternatively a trench box may be used to maintain trench stability during construction. All temporary excavations should conform to Part 20 of the Occupational Health and Safety (OHS) Regulation of BC, as well as Section 4 of the City of Nanaimo Engineering Standards and Specifications

Based on the observations during the geotechnical investigation and forcemain repairs, significant groundwater is not likely to be encountered during the forcemain replacement. It should be noted that groundwater depth can vary seasonally, and that dewatering may be required if groundwater is encountered.

5.4 Lift Station Recommendations

We understand that the base of the proposed lift station at the pump station will be about 10 m below ground level. As bedrock is anticipated to be encountered at approximately 6 m depth, blasting will likely be required to remove the bedrock economically. Basalt can usually be blasted near vertical with minimal amount of stabilization. Control of vibrations will be important to prevent damage to the existing structures in the area. The blasting subcontractor should retain a qualified blasting consultant to design the blasts and monitor the vibrations.

Bearing capacity of bedrock is a function of rock strength, weathering and fracturing. Provided the foundations are founded only on bedrock as described above, a typical ultimate limit states (ULS) bearing resistance of 1,000 kPa can be used for the design. Higher capacities can be obtained if the bedrock surface is prepared to a higher standard (loose rock removal). The serviceability limit state (SLS) is not a design issue for foundations on bedrock. Settlement due to the building loads is anticipated to be less than a few millimeters. If the foundations are supported partially on bedrock, further assessment will be required to provide an acceptable bearing capacity (ULS and SLS).

Where the rock is sloping at more than 6:1 (6 horizontal to 1 vertical) and not naturally keyed, it should be benched by chipping and blasting. The bedrock surface should be hosed and brushed clean prior to pouring footings so that the concrete will bond to the rock.

All foundation bearing surfaces must be inspected by a qualified geotechnical engineer to confirm that the surfaces have been adequately prepared and is acceptable for the design bearing pressure.

5.5 Pavement Structure Recommendations

Where the forcemain is to be replaced within Haliburton Street, the pavement structure will need to be reconstructed. As noted in Section 5.2, the trench backfill around and on top of the pipe will consist of either the existing or imported, free draining granular material.

Based on the Sections 4.27 - 4.28 and Standard Drawing T-4A of the City of Nanaimo Engineering Standards and Specifications Document, the following pavement structure should be used:

- Asphalt 75 mm
- Well graded base course 100 mm
- Sub-base 250 mm

The restoration of traveled surfaces should conform to the standard above or to the existing road structure, whichever is greater. All pavement restorations where asphalt cutting around a manhole is required, should be done in accordance with Standard Drawing No. T-4B in the City of Nanaimo Engineering Standards and Specifications Document.

6. ENVIRONMENTAL ASSESSMENT & RECOMMENDATIONS

Environmental soil samples were collected from soil layers encountered in TH18-1, TH18-2 and TH18-3 using industry-standard soil sampling techniques. A total of three of the soil samples collected were submitted to AGAT Labs in Burnaby, BC in a chilled cooler under chain-of-custody documentation for analysis of potential contaminants of concern including Contaminated Sites Regulation (CSR) - regulated metals, light and heavy extractable petroleum hydrocarbons (LEPH/HEPH) and polycyclic aromatic hydrocarbons (PAH). The samples submitted for analysis were selected based on their appearance as suspected fill. No visual or olfactory evidence of contamination was observed within any of the soil samples collected.

The analytical data has been presented on the attached Table 1 with comparisons to the lowest of the following CSR environmental standards:

- CSR Schedule 3.1 Part 1 Matrix Numerical Soil Standards based on Commercial Land use (CL) including the lowest available standard for “intake of contaminated soil”, “toxicity to soil invertebrates and plants”, “groundwater used for drinking water” and “groundwater flow to fresh surface water used by aquatic life”

- CSR Schedule 3.1 Parts 2 and 3 Generic Numerical Soil Standards to Protect Human and Ecological Health based on CL land use.

A copy of the environmental laboratory report is included in Appendix C.

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Initial results identified an exceedance of CSR standards for Commercial Land Use for nickel from TH18-1 at 1.8 m depth with a detected concentration of 73.1 ug/g which marginally exceeded the applicable CSR standard of 70 ug/g. As a result of this finding, the sample was reanalysed twice by the laboratory to ascertain the validity of the initial nickel result. Neither of the reanalysed results exceeded the CSR standard (i.e. 62.3 ug/g and 66.8 ug/g), and therefore the initial exceedance for nickel can be discounted as being unrepresentative of the sample collected. The mean concentration of the three nickel results in the TH17-1, 1.8 m sample is 67.4 ug/g. The origin of the elevated nickel in the sampled soil is unknown.

No other metals, hydrocarbons or PAH were detected in concentrations that exceed the applicable CSR standards.

Excavated soils should be visually inspected for indications of potential soil contamination, and any suspect soil should be set aside for analytical testing.

7. CLOSURE

We trust the above provides the information you require at this time. If you have any questions regarding this letter, please contact either of the undersigned.

Yours truly,
Thurber Engineering Ltd.
Stephen Bean, M.Eng., P.Eng.
Review Principal

Sebastian Suckling, BSc., GIT.
Geologist

Attachments:

Statement of limitations and conditions

Appendix A

Drawing 22523 -1

Symbols and Terms Used on the Test Hole Logs

Thurber 2018 Test Hole Logs

Appendix B

NBC Seismic Hazard Calculation

Appendix C

Environmental Data Summary Table

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STATEMENT OF LIMITATIONS AND CONDITIONS

1. STANDARD OF CARE

This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report, which is of a summary nature and is not intended to stand alone without reference to the instructions given to Thurber by the Client, communications between Thurber and the Client, and any other reports, proposals or documents prepared by Thurber for the Client relative to the specific site described herein, all of which together constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. THURBER IS NOT RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT THURBER'S WRITTEN CONSENT AND SUCH USE SHALL BE ON SUCH TERMS AND CONDITIONS AS THURBER MAY EXPRESSLY APPROVE. Ownership in and copyright for the contents of the Report belong to Thurber. Any use which a third party makes of the Report, is the sole responsibility of such third party. Thurber accepts no responsibility whatsoever for damages suffered by any third party resulting from use of the Report without Thurber's express written permission.

5. INTERPRETATION OF THE REPORT

a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will 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 the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those 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. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.

b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.

c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.

d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, release or dispersal of pollutants or hazardous substances, unless such pollutants or hazardous substances have been specifically and accurately identified to Thurber by the Client prior to the commencement of Thurber's professional services.

7. INDEPENDENT JUDGEMENTS OF CLIENT

The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.

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NOTES:

1. Test Holes were located by hand-held GPS unit; locations are approximate only.
2. 2016 aerial images from the City of Nanaimo.

0 25 50 75 100 150 200 m
SCALE 1:3000

TH18-1 Auger Borehole
TH18-4 Sonic Borehole

THURBER ENGINEERING LTD.

REGIONAL DISTRICT OF NANAIMO c/o JACOBS

TEST HOLE LOCATION PLAN

CHASE RIVER FORCEMAIN REPLACEMENT / PUMP STATION UPGRADES
GEOTECHNICAL INVESTIGATION
NANAIMO, B.C.

DESIGNED	DRAWN	APPROVED	DATE	SCALE	PROJECT No.	DWG. NO.	REV.
SWS	RRS	SMB	SEPTEMBER 10, 2018	1:3000	22523 - 1		-

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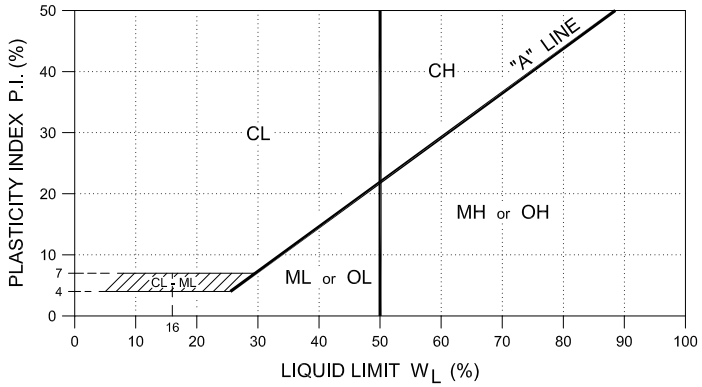
UNIFIED CLASSIFICATION SYSTEM FOR SOILS (ASTM D2487)

MAJOR DIVISION			SYMBOLS GROUP	SYMBOLS GRAPH	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA
COARSE-GRAINED SOILS (MORE THAN 50% BY WEIGHT RETAINED ON No. 200 SIEVE)	GRAVELS MORE THAN 50% COARSE FRACTION RETAINED ON No. 4 SIEVE	CLEAN GRAVELS (< 5% FINES)	GW		WELL GRADED GRAVEL and WELL GRADED GRAVEL with SAND.	$C_U = \frac{D_{60}}{D_{10}} \geq 4 \quad C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$
			GP		POORLY GRADED GRAVEL and POORLY GRADED GRAVEL with SAND.	NOT MEETING ABOVE REQUIREMENTS
		GRAVELS WITH FINES (> 12% FINES)	GM		SILTY GRAVEL, GRAVEL - SAND - SILT MIXTURES.	FINES CLASSIFY AS ML or MH (3)
			GC		CLAYEY GRAVEL, GRAVEL - SAND - CLAY MIXTURES.	FINES CLASSIFY AS CL or CH (3)
	SANDS MORE THAN 50% COARSE FRACTION PASSES No. 4 SIEVE	CLEAN SANDS (< 5% FINES)	SW		WELL GRADED SAND and WELL GRADED SAND with GRAVEL	$C_U = \frac{D_{60}}{D_{10}} \geq 6 \quad C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$
			SP		POORLY GRADED SAND and POORLY GRADED SAND with GRAVEL.	NOT MEETING ABOVE REQUIREMENTS
		SANDS WITH FINES (> 12% FINES)	SM		SILTY SAND, SAND - SILT MIXTURES.	FINES CLASSIFY AS ML or MH (3)
			SC		CLAYEY SAND, SAND - CLAY MIXTURES.	FINES CLASSIFY AS CL or CH (3)
FINE-GRAINED SOILS (MORE THAN 50% BY WEIGHT PASSES No. 200 SIEVE)	SILTS BELOW "A" LINE NEGLIGIBLE ORGANIC CONTENT	W_L < 50%	ML		INORGANIC SILTS, SILTS with SAND and SILTS with GRAVEL and SANDY or GRAVELLY SILTS.	P.I. < 4 or PLOTS BELOW THE "A" LINE
		W_L > 50%	MH		INORGANIC SILTS, SILTS with SAND & SILTS with GRAVEL & SANDY or GRAVELLY SILTS, FINE SANDY or SILTY SOILS.	P.I. PLOTS BELOW THE "A" LINE
	CLAYS ABOVE "A" LINE ON PLASTICITY CHART NEGLIGIBLE ORGANIC CONTENT	W_L < 50%	CL		INORGANIC CLAYS of LOW PLASTICITY, GRAVELLY, SANDY, or SILTY CLAYS, LEAN CLAYS.	P.I. > 7 and PLOTS ON OR ABOVE THE "A" LINE
		W_L near 50%	CL-CH		BORDERLINE INORGANIC CLAYS and SILTY CLAYS with LIQUID LIMITS NEAR 50%.	(only used for visual identification)
		W_L > 50%	CH		INORGANIC CLAYS of HIGH PLASTICITY, FAT CLAYS.	P.I. PLOTS ON OR ABOVE THE "A" LINE
	ORGANIC SILTS and CLAYS	W_L < 50%	OL		ORGANIC SILTS and ORGANIC SILTY CLAYS of LOW PLASTICITY.	$\frac{W_L \text{ (oven dried)}}{W_L \text{ (not dried)}} < 0.75$
		W_L > 50%	OH		ORGANIC CLAYS OF HIGH PLASTICITY.	$\frac{W_L \text{ (oven dried)}}{W_L \text{ (not dried)}} < 0.75$
HIGHLY ORGANIC SOILS			PT		PEAT and other HIGHLY ORGANIC SOILS.	STRONG COLOR OR ODOR, AND OFTEN FIBROUS TEXTURE.

PLASTICITY CHART FOR SOILS PASSING No. 40 SIEVE



NOTES:

1. ALL SIEVE SIZES ARE U.S. STANDARD, A.S.T.M. E11-04.
2. COARSE GRAINED SOILS WITH 5 TO 12% FINES REQUIRE DUAL SYMBOLS (GW-GM, GW-GC, GP-GM, GP-GC, SW-SM, SW-SC, SP-SM, SP-SC).
3. IF FINES CLASSIFY CL-ML USE DUAL SYMBOL (GC-GM or SC-SM).
4. WHERE TESTING IS NOT CARRIED OUT, THE IDENTIFICATIONS ARE DETERMINED BY VISUAL-MANUAL PROCEDURES DESCRIBED IN ASTM D2488-06.

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SYMBOLS AND TERMS USED ON TEST LOGS

1. PARTICLE SIZE CLASSIFICATION OF MINERAL SOILS

DESCRIPTION		APPARENT PARTICLE SIZE
BOULDERS		> 200 mm
COBBLES		75 mm to 200 mm
GRAVEL	coarse	19 mm to 75 mm
	fine	4.75 mm to 19 mm
SAND	coarse	2 mm to 4.75 mm
	medium	0.475 mm to 2 mm
	fine	0.075 mm to 0.475 mm
SILT		Non-plastic particles, not visible to the naked eye
CLAY		Plastic particles, not visible to the naked eye

NOTE: Metric Conversion is approximate only

2. TERMS DESCRIBING CONSISTENCY (Cohesive Soils Only)

DESCRIPTION	APPROXIMATE UNDRAINED SHEAR STRENGTH
Very Soft	Less than 10 kPa (250 psf)
Soft	10 to 25 kPa (250 - 500 psf)
Firm	25 to 50 kPa (500 - 1000 psf)
Stiff	50 to 100 kPa (1000 - 2000 psf)
Very Stiff	100 to 200 kPa (2000 - 4000 psf)
Hard	Greater than 200 kPa (4000 psf)

NOTE: Metric Conversion is approximate only

3. TERMS DESCRIBING DENSITY (Cohesionless Soils Only)

DESCRIPTION	STANDARD PENETRATION TEST Number of blows per foot (300 mm) *
Very Loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	over 50

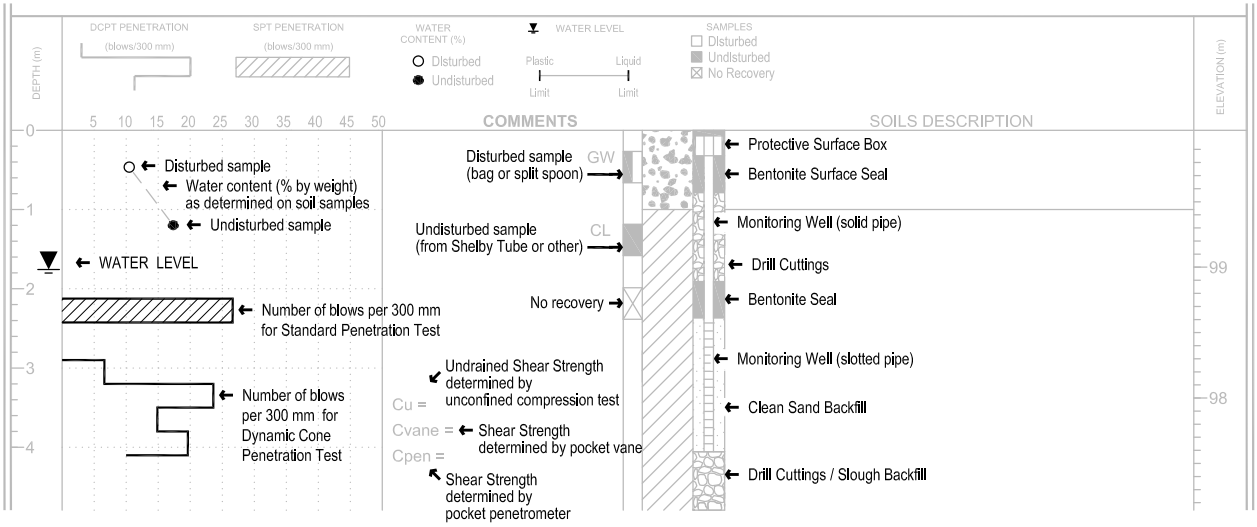
** Directly applicable to sands and, with interpretation, to gravels*

4. PROPORTION OF MINOR COMPONENTS BY WEIGHT

DESCRIPTION	PERCENT BY WEIGHT
and	35 to 50 %
y / ey	20 to 35 %
some	10 to 20 %
trace	less than 10 %

EXAMPLE: Silty SAND, trace of gravel = Sand with 20 to 35% silt and up to 10% gravel, by dry weight. (Percentages of secondary materials are estimates based on visual and tactile assessment of samples).

5. LEGEND FOR TEST HOLE LOGS *(Typical only showing commonly included elements)*



Sheet 1 of 1

LOG OF TEST HOLE

TEST HOLE NO. **TH18-1**

LOCATION: See Drawing 22523-1
N 5442665 E 432805 (Approx.)

TOP OF HOLE ELEV:

METHOD: Solid Stem Auger

DRILLING CO.: Drillwell Enterprises Ltd.

INSPECTOR: SWS

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CLIENT: Regional District of Nanaimo

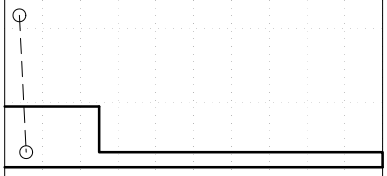
PROJECT: Chase River Forcemain No. 1 Replacement and Pump Station Upgrades; Geotechnical Investigation

DATE: 16-Aug-2018

FILE NO.: 22523

DCPT PENETRATION (blows/300 mm) | SPT PENETRATION (blows/300 mm) | WATER CONTENT (%): ○ Disturbed ● Undisturbed | WATER LEVEL: Plastic Limit — Liquid Limit | SAMPLES: ◧ Disturbed ■ Undisturbed ☒ No Recovery | GRAIN SIZE (%): ▲ Passing #200 sieve △ Passing #4 sieve | SOIL HEADSPACE READING (ppm): ✱ GASTECH reading ⊠ PID reading

DEPTH (m) | 10 20 30 40 50 60 70 80 90 100 | **COMMENTS** | SOILS DESCRIPTION | DEPTH (m)



DEPTH (m)	COMMENTS	SOILS DESCRIPTION
0	Solid Stem Auger Refusal was encountered during 3 attempts to complete this test hole.	75 mm ASPHALT
1	GP/SP	Moist, grey-brown SAND and GRAVEL (FILL); trace silt; contains cobbles to 150 mm diameter
2	SP-SM 50 blows / 100 mm penetration. DCPT Refusal at 1.9 m depth.	Moist, grey, silty SAND and GRAVEL (FILL); contains cobbles to 150 mm diameter
3		Auger Refusal at 2.4 m depth. No water encountered while drilling. Upon completion of drilling: Hole was backfilled with cuttings to near surface. Asphalt cold patch installed at surface.
4		
5		
6		
7		
8		
9		
10		

LOG OF TEST HOLE (NO EST.) R RRS_22523_CHASE RIVER FORCEMAIN_2018 TEST HOLE LOGS.GPJ THURBER BC.GDT 10/9/18- THURBER VICTORIA FEBRUARY 2012 REVERSE.GLB

Sheet 1 of 1

LOG OF TEST HOLE

TEST HOLE NO. **TH18-2**

LOCATION: See Drawing 22523-1
N 5443508 E 432641 (Approx.)

TOP OF HOLE ELEV:

METHOD: Solid Stem Auger

DRILLING CO.: Drillwell Enterprises Ltd.

INSPECTOR: SWS

THURBER

CLIENT: Regional District of Nanaimo

PROJECT: Chase River Forcemain No. 1 Replacement and Pump Station Upgrades; Geotechnical Investigation

DATE: 16-Aug-2018

FILE NO.: 22523

DEPTH (m) | DCPT PENETRATION (blows/300 mm) | SPT PENETRATION (blows/300 mm) | WATER CONTENT (%): ○ Disturbed ● Undisturbed | WATER LEVEL: Plastic Limit — Liquid Limit | SAMPLES: Disturbed, Undisturbed, No Recovery | GRAIN SIZE (%): ▲ Passing #200 sieve, △ Passing #4 sieve | SOIL HEADSPACE READING (ppm): ✱ GASTECH reading, ⊠ PID reading | DEPTH (m)

10 20 30 40 50 60 70 80 90 100

DEPTH (m)	COMMENTS	SOILS DESCRIPTION
0		100 mm ASPHALT
		Moist, grey, sandy GRAVEL (Road-base FILL)
1		Dry to moist, light brown, silty, fine grained SAND (FILL); trace angular gravel to 20 mm diameter
	SM	
2	SM	
	50 blows / 200 mm penetration. DCPT Refusal at 2.3 m depth.	
3		Auger Refusal at 2.4 m depth. No water encountered while drilling.
		Upon completion of drilling: Hole was backfilled with cuttings to near surface. Asphalt cold patch installed at surface.
4		
5		
6		
7		
8		
9		
10		

LOG OF TEST HOLE (NO EST.) R RRS_22523_CHASE RIVER FORCEMAIN_2018 TEST HOLE LOGS.GPJ THURBER BC.GDT 10/9/18- THURBER VICTORIA FEBRUARY 2012 REVERSE.GLB

Sheet 1 of 1

LOG OF TEST HOLE

TEST HOLE NO. **TH18-3**

LOCATION: See Drawing 22523-1
N 5443038 E 432802 (Approx.)

TOP OF HOLE ELEV:

METHOD: Solid Stem Auger

DRILLING CO.: Drillwell Enterprises Ltd.

INSPECTOR: SWS

THURBER

CLIENT: Regional District of Nanaimo

PROJECT: Chase River Forcemain No. 1 Replacement and Pump Station Upgrades; Geotechnical Investigation

DATE: 16-Aug-2018

FILE NO.: 22523

DCPT PENETRATION (blows/300 mm) | SPT PENETRATION (blows/300 mm) | WATER CONTENT (%): ○ Disturbed ● Undisturbed | WATER LEVEL: Plastic Limit — Liquid Limit | SAMPLES: ◧ Disturbed ■ Undisturbed ☒ No Recovery | GRAIN SIZE (%): ▲ Passing #200 sieve △ Passing #4 sieve | SOIL HEADSPACE READING (ppm): ✱ GASTECH reading ⊠ PID reading

DEPTH (m)	10 20 30 40 50 60 70 80 90 100	COMMENTS		SOILS DESCRIPTION
0				150 mm ASPHALT
				Dry, grey, sandy GRAVEL (Road-base FILL)
				Dry to moist, orange-brown SAND (FILL); trace silt
1	○		CL	Moist, mottled orange and grey, silty CLAY (possible FILL); trace gravel; trace sand
2		30 blows / 150 mm penetration; SPT bouncing.		Auger Refusal at 1.5 m depth. No water encountered while drilling. Upon completion of drilling: Hole was backfilled with cuttings to near surface. Asphalt cold patch installed at surface.
3				
4				
5				
6				
7				
8				
9				
10				

Sheet 1 of 1

LOG OF TEST HOLE

TEST HOLE NO. **TH18-4**

LOCATION: See Drawing 22523-1
N 5442664 E 432804 (Approx.)

TOP OF HOLE ELEV:

METHOD: Geoprobe Sonic

DRILLING CO.: Drillwell Enterprises Ltd.

INSPECTOR: SWS

THURBER

CLIENT: Regional District of Nanaimo

PROJECT: Chase River Forcemain No. 1 Replacement and Pump Station Upgrades; Geotechnical Investigation

DATE: 4-Sep-2018

FILE NO.: 22523

DCPT PENETRATION (blows/300 mm) | SPT PENETRATION (blows/300 mm) | WATER CONTENT (%): ○ Disturbed ● Undisturbed | WATER LEVEL: Plastic Limit — Liquid Limit | SAMPLES: Disturbed, Undisturbed, No Recovery | GRAIN SIZE (%): ▲ Passing #200 sieve, △ Passing #4 sieve | SOIL HEADSPACE READING (ppm): ✱ GASTECH reading, ⊠ PID reading

DEPTH (m) | 10 20 30 40 50 60 70 80 90 100 | **COMMENTS** | SOILS DESCRIPTION

DEPTH (m)		COMMENTS		SOILS DESCRIPTION
0				150 mm ASPHALT
1	GP			Moist, brown SAND and GRAVEL (FILL); trace silt; contains cobbles to 100 mm diameter
2				
3 ▼	SM	Water Level (4-Sep-2018)		Moist, brown SAND and GRAVEL; trace silt; trace clay; gravel to 25 mm diameter
4	GM			Moist becoming wet, grey, sandy GRAVEL; trace to some silt; gravel to 40 mm diameter
5	GM SP			Wet, brown SAND; trace silt
6	GM/SM SM	60 blows / 125 mm penetration		Very dense, wet, grey, sandy GRAVEL (till-like); trace to some silt; trace to some clay; gravel to 50 mm diameter
7	ROCK			BEDROCK; dark grey, fine grained BASALT; slightly to moderately weathered (Karmutsen Formation)
8				End of Hole at 7.3 m depth. Water encountered at 3.0 m depth while drilling. Upon completion of drilling: Hole was backfilled with bentonite to 2.7 m depth. Backfilled with cuttings to near surface. Asphalt cold patch installed at surface.
9				
10				

LOG OF TEST HOLE (NO EST.) R RRS_22523_CHASE RIVER FORCEMAIN_2018 TEST HOLE LOGS.GPJ THURBER BC.GDT 10/9/18- THURBER VICTORIA FEBRUARY 2012 REVERSE.GLB

THURBER

2015 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

September 06, 2018

Site: 49.133 N, 123.9212 W User File Reference: Chase River Pump Station

Requested by: Sebastian Suckling, Thurber

National Building Code ground motions: 2% probability of exceedance in 50 years (0.000404 per annum)

Sa(0.05)	Sa(0.1)	**Sa(0.2)**	Sa(0.3)	**Sa(0.5)**	**Sa(1.0)**	**Sa(2.0)**	**Sa(5.0)**	**Sa(10.0)**	**PGA (g)**	**PGV (m/s)**
0.546	0.838	**1.041**	1.069	**0.962**	**0.555**	**0.335**	**0.106**	**0.037**	**0.456**	**0.703**

Notes. Spectral (Sa(T), where T is the period in seconds) and peak ground acceleration (PGA) values are given in units of g (9.81 m/s^2). Peak ground velocity is given in m/s. Values are for "firm ground" (NBCC 2015 Site Class C, average shear wave velocity 450 m/s). NBCC2015 and CSAS6-14 values are specified in **bold** font. Three additional periods are provided - their use is discussed in the NBCC2015 Commentary. 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 directly calculated values.***

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(0.05)	0.123	0.284	0.390
Sa(0.1)	0.189	0.437	0.601
Sa(0.2)	0.233	0.542	0.748
Sa(0.3)	0.234	0.556	0.769
Sa(0.5)	0.192	0.484	0.681
Sa(1.0)	0.093	0.256	0.374
Sa(2.0)	0.049	0.143	0.218
Sa(5.0)	0.011	0.033	0.061
Sa(10.0)	0.0038	0.011	0.021
PGA	0.101	0.238	0.327
PGV	0.118	0.327	0.476

References

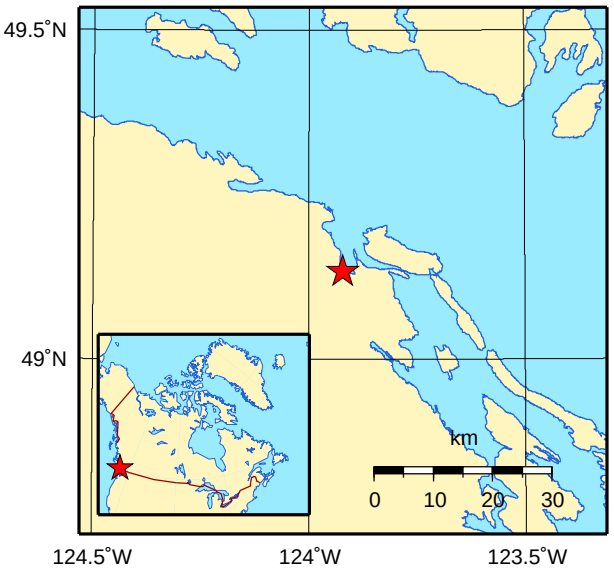
National Building Code of Canada 2015 NRCC no. 56190;
Appendix C: Table C-3, Seismic Design Data for Selected Locations in Canada

User's Guide - NBC 2015, Structural Commentaries NRCC no. xxxxxx (in preparation)
Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File 7893 Fifth Generation Seismic Hazard Model for Canada: Grid values of mean hazard to be used with the 2015 National Building Code of Canada

See the websites *www.EarthquakesCanada.ca* and *www.nationalcodes.ca* for more information

Aussi disponible en français



Natural Resources Canada Ressources naturelles Canada

Canada

THURBER

THURBER

REGIONAL DISTRICT OF NANAIMO
TABLE 1: SOIL METALS AND HYDROCARBON DATA
CHASE RIVER FORCEMAIN & PUMP STATION UPGRADES

	Investigation Data							BC CSR Standards (see notes * **)
SAMPLE	**TH18-1**	**TH18-1**			**TH18-2**	**TH18-2**	**TH18-3**	
DEPTH (m)	**0.9**	**1.8**			**0.9**	**2.1**	**0.6**	
Description	Grab	Grab	Re-Analysis #1	Re-Analysis #2	Grab	Grab	Grab	
Sample Date	2018-08-16	2018-08-16	2018-08-16	2018-08-16	2018-08-16	2018-08-16	2018-08-16	
LAB SAMPLE ID	9489060	9489062	9503839	9503840	9489063	9489064	9489065	**Commercial (CL)**
pH	7.34	7.54	7.52	7.39	6.05	6.26	6.85	
Metals								
Aluminum	17200	31900	22500	21400	19200	23700	16500	**250000**
Antimony	0.3	0.3	0.3	0.3	0.3	0.3	0.1	**40**
Arsenic	2.1	5.4	5.5	4.1	3.5	6.5	3.1	**10**
Barium	67.2	53.8	53.2	58.6	72.4	110	34.6	**350**
Beryllium	0.3	0.3	0.3	0.3	0.4	0.5	0.2	**4+**
Boron	3	6.9	5.5	5.4	3.5	4.8	2.3	**50000**
Cadmium	0.18	0.31	0.24	0.24	0.3	0.26	0.21	**1+**
Chromium (total)	39	95	88	86	37	61	41	**250++**
Cobalt	9.8	18.7	17.7	17.0	11.5	18.9	8.4	**25**
Copper	48.2	50.7	56.3	54.2	35	52.1	19.5	**300+**
Iron	27400	58300	37300	37000	30500	43400	28400	**150000**
Lead	21.6	4.5	4.5	5.8	18.4	5.6	1.6	**150**
Lithium	8.6	21.7	21.3	21.4	10.1	18.8	9.4	**450**
Manganese	330	450	350	424	475	570	179	**2000**
Mercury	0.02	0.03	0.02	0.03	0.04	0.03	0.02	**75**
Molybdenum	0.3	1.1	1.1	1.3	0.3	0.2	0.6	**15**
Nickel	16.4	**73.1**	62.3	66.8	35	49.1	22	**70+**
Selenium	0.2	0.4	0.6	0.2	0.4	0.3	0.3	**1**
Silver	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	**40**
Strontium	45	42	39	40	24	44	29	**150000**
Thallium	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	**25**
Tin	2.8	0.5	0.5	0.5	1.0	0.6	0.4	**300**
Tungsten	0.3	0.1	<0.05	<0.05	0.1	0.1	0.3	**200**
Uranium	0.3	0.7	0.8	0.8	0.3	0.3	0.2	**30**
Vanadium	82	104***	106***	102***	90	102***	102***	**100**
Zinc	31	53	48	49	56	60	21	**450+**
Hydrocarbons								
LEPH	<20	<20			<20	<20	<20	**2000**
HEPH	<20	53			29	<20	<20	**5000**
PAH								
Acenaphthene	<0.01	<0.01			<0.01	<0.01	<0.01	**15000**
Anthracene	<0.02	<0.02			<0.02	<0.02	<0.02	**30**
Benzo(a)anthracene	<0.02	<0.02			0.02	<0.02	<0.02	**10**
Benzo(a)pyrene	<0.05	<0.05			<0.05	<0.05	<0.05	**30**
Benzo(b)fluoranthene	<0.02	<0.02			0.03	<0.02	<0.02	**10**
Benzo(k)fluoranthene	<0.02	<0.02			<0.02	<0.02	<0.02	**10**
Chrysene	<0.05	<0.05			<0.05	<0.05	<0.05	**4500**
Dibenzo(a,h)anthracene	<0.02	<0.02			<0.02	<0.02	<0.02	**10**
Fluoranthene	<0.05	<0.05			0.05	<0.05	<0.05	**200**
Fluorene	<0.02	<0.02			<0.02	<0.02	<0.02	**9500**
Indeno(1,2,3-c,d)pyrene	<0.02	<0.02			0.02	<0.02	<0.02	**10**
1-Methylnaphthalene	<0.01	0.12			0.03	<0.01	<0.01	**200**
2-Methylnaphthalene	<0.01	0.14			0.04	<0.01	<0.01	**950**
Naphthalene	<0.01	0.1			0.03	<0.01	<0.01	**20**
Phenanthrene	<0.02	0.05			0.03	<0.02	<0.02	**50**
Pyrene	<0.02	0.02			0.05	<0.02	<0.02	**100**

NOTES: All results expressed as micrograms per gram (µg/g)(ppm) on a dry weight basis unless otherwise noted.
* The standards shown are the lower of Schedule 3.1 Standards for "intake of contaminated soil", "toxicity to soil invertebrates and plants" and "groundwater used for drinking water".
** Schedule 3 matrix standards for "groundwater flow to fresh surface water used by aquatic life" also apply and are shown.
*** Sample has a concentration of less than the Vancouver Island Regional Background concentration of vanadium - 200 ug/g.
\+ The standards are variable based on pH. The standard shown is based on the lowest pH detected (6.0 - 6.5).
++ Standard shown is based on the presence of chromium III (trivalent) which was confirmed to be present by analysis.
< Less than detection limit.
7.32 Bold orange indicates the concentration exceeds the applicable BC CSR standards based on Commercial Land Use.

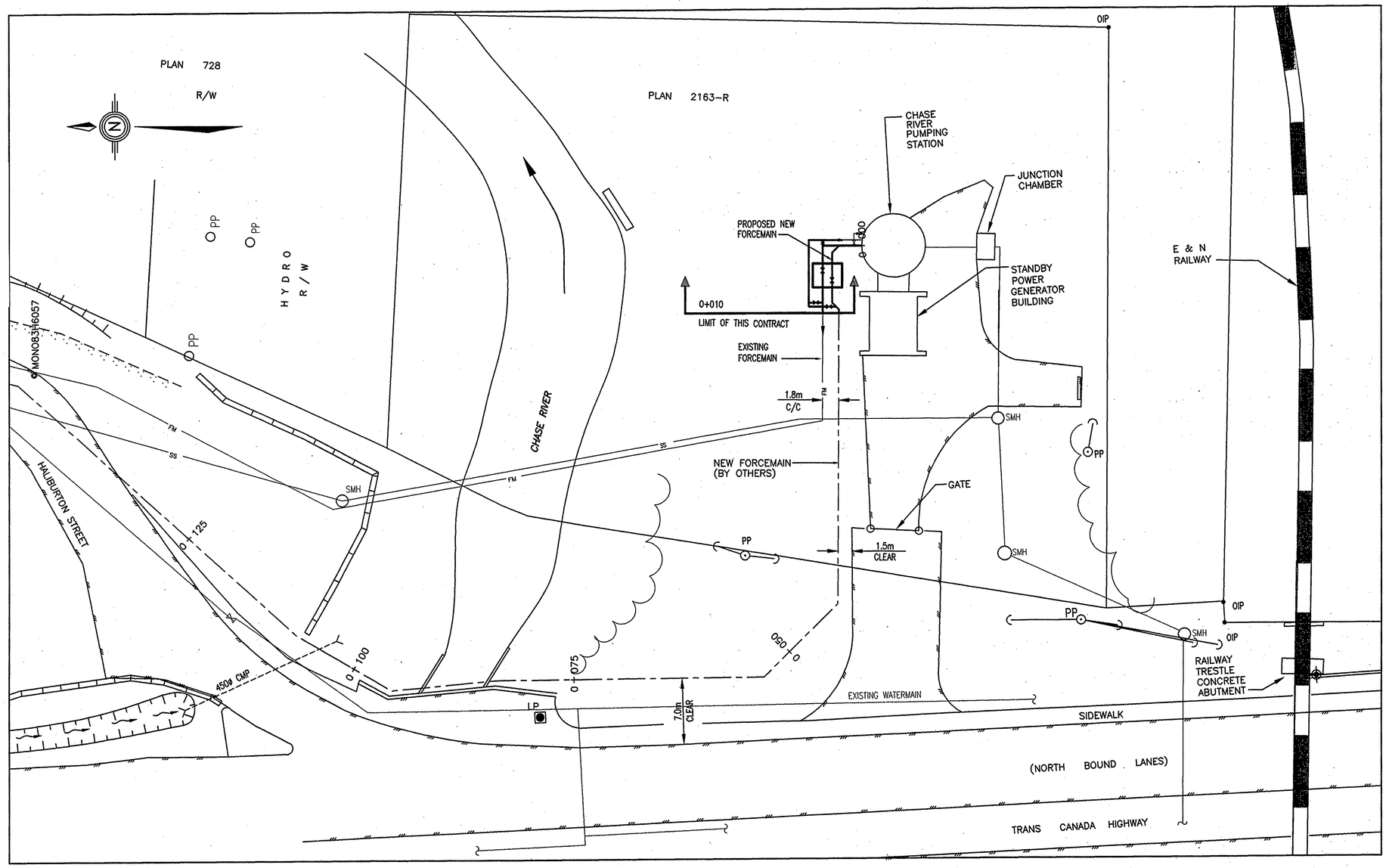
PROJECT: Haliburton Meter Surveys

ADDRESS	TOUCH READ ALREADY		UPGRADE TO TOUCH READ		SERVICE SIZE AND TYPE	CONCRETE BOX		PLASTIC BOX		ADJUST DEPTH		METER DEPTH	REPLACE BOX		RELOCATE BOX		COMMENTS
Haliburton	Y	N	Y	N		Y	N	Y	N	Y	N		Y	N	Y	N	
# 995	✓		✓		20mm C/U	✓			✓	✓		30"	✓			✓	
# 997		✓	✓		20mm C/U		✓	✓		✓		28"	✓			✓	
# 999	✓		✓		" "		✓	✓		✓		12"	✓			✓	
# 1001	✓		✓		" "		✓	✓		✓		12"	✓			✓	
# 1003	✓			✓	" "		✓	✓		✓		30"	✓			✓	
# 1007 1009		✓	✓		" "		✓	✓		✓		26"	✓			✓	
# 1011 1013		✓	✓		" "	✓			✓		✓	18"	✓			✓	
# 1015		✓	✓		" "	✓			✓	✓		24"	✓			✓	
# 1019		✓	✓		" "		✓	✓		✓		12"	✓			✓	
# 1021		✓	✓		" "		✓	✓		✓		12"	✓			✓	
# 1025		✓	✓		" "		✓	✓		✓		12"	✓			✓	
# 1031	✓			✓	" "		✓	✓			✓	18"	✓			✓	Re ajust boxes.
# 1037		✓	✓		" "		✓	✓			✓	18"	✓			✓	Re ajust boxes.
# 60 Centennial		✓	✓		" "		✓	✓			✓	18"	✓			✓	
# 61 Centennial		✓	✓		" "	✓			✓	✓		12"	✓			✓	Meter is off Haliburton
# 1045 Estuary Lane		✓	✓		" "	✓			✓	✓		12"	✓			✓	
# 1055 # 1065 # 1061																	Meter is off Haliburton
# 1067 Haliburton		✓	✓		" "		✓	✓			✓	18"	✓			✓	These meters are on Estuary Lane.
TOTALS																	

PROJECT: Haliburton ST Meter Survey

ADDRESS	TOUCH READ ALREADY		UPGRADE TO TOUCH READ		SERVICE SIZE AND TYPE	CONCRETE BOX		PLASTIC BOX		ADJUST DEPTH		METER DEPTH	REPLACE BOX		RELOCATE BOX		COMMENTS
Haliburton st	Y	N	Y	N		Y	N	Y	N	Y	N		Y	N	Y	N	
#1069																	
#1071		✓	✓		20mm c/u	✓			✓		✓	18"	✓			✓	Meter is on Estuary Ln
#1073		✓	✓		" "		✓	✓			✓	18"	✓		?		owners service is right under cedar tree
#1107		✓	✓		" "		✓	✓		✓		40"	✓		✓		Raise service and move to other side of side walk
#1109		✓	✓		" "	✓			✓		✓	18"	✓			✓	
#1115		✓	✓		" "		✓	✓			✓	18"	✓		✓		move out from under retaing wall
#1119		✓	✓		" "		✓	✓			✓	18"	✓			✓	
#1123		✓	✓		" "	✓			✓	✓		26"	✓			✓	
#1127		✓	✓		" "		✓	✓		✓		24"	✓			✓	
#1131	✓		✓		" "		✓	✓		✓		24"	✓			✓	
#1141		✓	✓		" "	✓			✓		✓	18"	✓			✓	
#1145	✓	✓			" "		✓	✓		✓		24"	✓			✓	
#1140 Island Hwy		✓	✓		" "	✓			✓	✓		24"	✓			✓	Meter is on Haliburton
#1110 Haliburton st	✓			✓	" "	✓			✓		✓	18"		✓		✓	
#1100	✓			✓	" "	✓			✓	✓		28"	✓			✓	Remove Meter Setter
#1082	✓			✓	" "	✓			✓	✓		28"	✓			✓	Remove Meter Setter
#1078	✓		✓		" "		✓	✓		✓		24"	✓			✓	Hedge needs to be cut.
#1074	✓			✓	" "		✓	✓		✓		24"	✓			✓	
#1072		✓	✓		" "		✓	✓		✓		24"	✓			✓	
TOTALS																	

N-INT-148



SITE PLAN
1:250

LEGEND

PROPOSED

- NEW FORCEMAIN (THIS CONTRACT)
- NEW FORCEMAIN (UNDER CONST. BY OTHERS)
- NEW PIPES
- NEW STRUCTURE/MECHANICAL

EXISTING

- PIPES
- STRUCTURE/MECHANICAL
- STRUCTURE/MECHANICAL TO BE ABANDONED IN PLACE (IF SO DETAILED) OR REMOVED
- EDGE OF PAVEMENT
- P.P. POWER POLE
- L.P. LIGHT POLE
- RAILROAD TRACKS
- W WATERMAIN
- FM FORCEMAIN
- ST STORM SEWER
- SS SANITARY SEWER
- CULVERT
- DITCH
- SMH SANITARY MANHOLE
- DMH STORM MANHOLE
- VALVE
- FIRE HYDRANT
- CATCH BASIN
- TOP OF BANK
- SURVEY MONUMENT
- OIP OLD IRON PIN

DRAWING INDEX

REGIONAL DISTRICT OF NANAIMO

TWINNING OF THE CHASE RIVER SANITARY FORCEMAIN, STAGE III - VALVE CHAMBER

CONTRACT No. 122.46.7.2

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
J. P. ZHOU
April 1, 1999

N-INT-148

ACAD DWG. 1224672A 4:1 99-03-31

AutoCAD DRAWING	ISSUE	DATE	DRAWN	CHK'D	APP'D	DESCRIPTION	ISSUE	DATE	DRAWN	CHK'D	APP'D	DESCRIPTION
REVISIONS	A	JULY/98	KS	JPZ	JPZ	ISSUED FOR TENDER						
	B	DEC/98	DKAJ	JWCB	JWCB	RECORD DRAWING						

DESIGNED JPZ
DRAWN KRC/LW
CHECKED B.C.

DAYTON & KNIGHT LTD.
Consulting Engineers
July 27 1998

REGIONAL DISTRICT OF NANAIMO
TWINNING OF THE CHASE RIVER SANITARY FORCEMAIN
STAGE III – VALVE CHAMBER
SITE PLAN – DRAWING INDEX – LEGEND

SCALE: AS NOTED
DRAWING No. 122.46.7.2
SHEET 1 OF 3 ISSUE B

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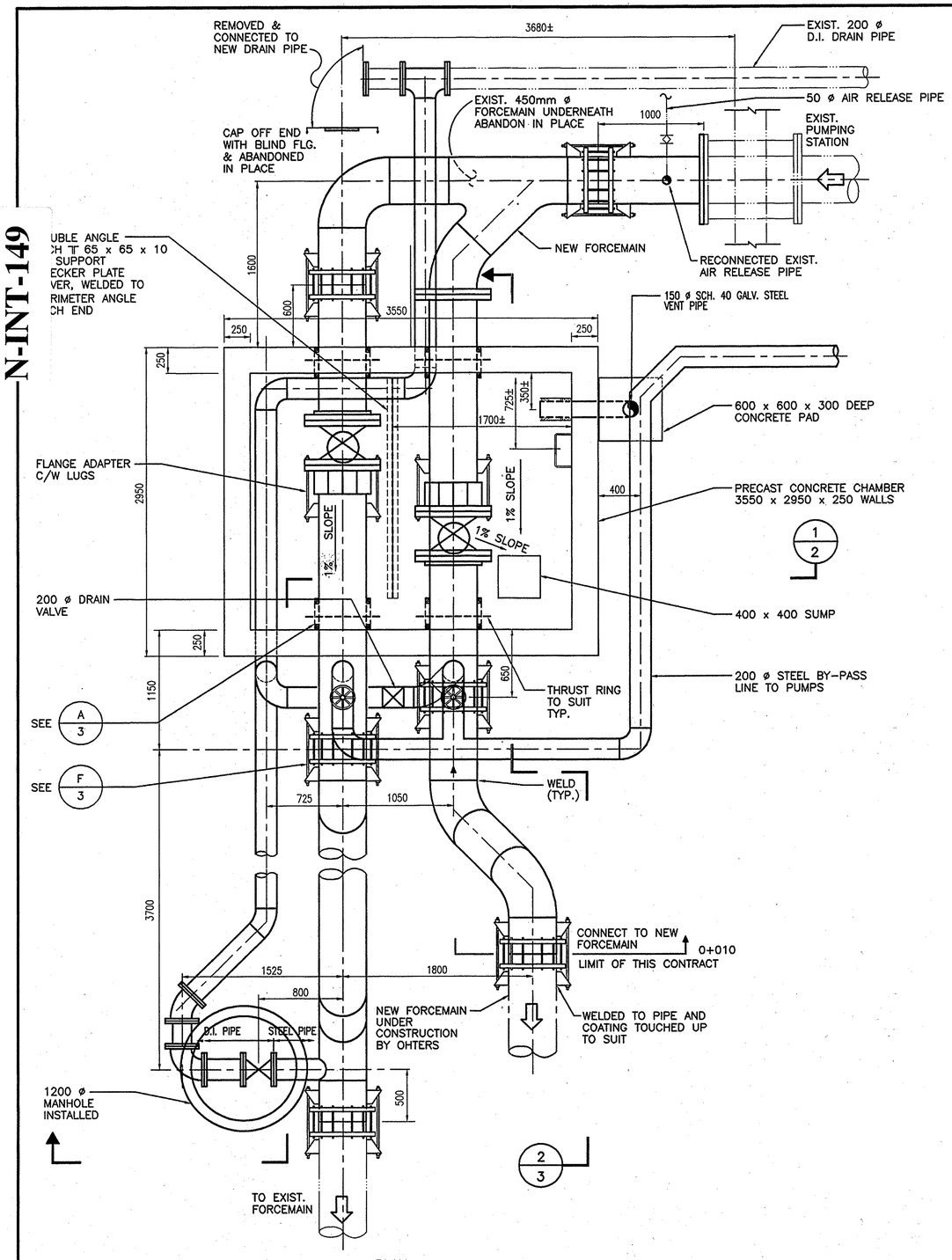
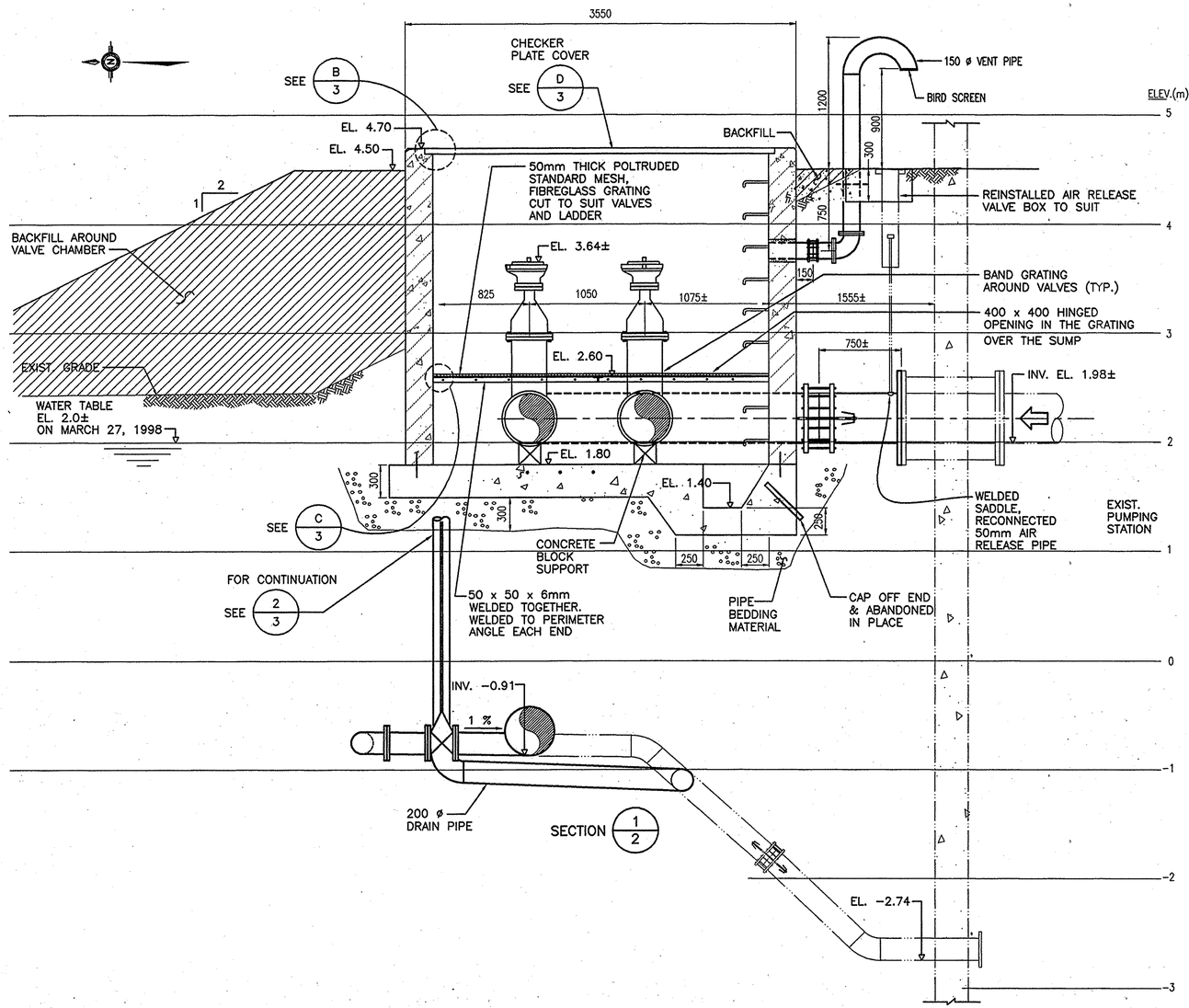
N-INT-149





PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
J. P. ZHOU
April 1, 1999

N-INT-149

ACAD DWG. 1224672B 1:25 99-03-31

AutoCAD DRAWING

REVISIONS	ISSUE	DATE	DRAWN	CHK'D	APP'D	DESCRIPTION
	A	JULY/98	KS			ISSUED FOR TENDER
	B	DEC/98	DKAJ	JWCB	JWCB	RECORD DRAWING

DESIGNED JPZ/SO
DRAWN KRC/LW/KS
CHECKED B.C.

DAYTON & KNIGHT LTD.
Consulting Engineers
July 27 1998

REGIONAL DISTRICT OF NANAIMO
TWINNING OF THE CHASE RIVER SANITARY FORCEMAIN
STAGE III – VALVE CHAMBER
PLAN AND SECTION

SCALE: 1:25
DRAWING No. 122.46.7.2
SHEET 2 OF 3 ISSUE B

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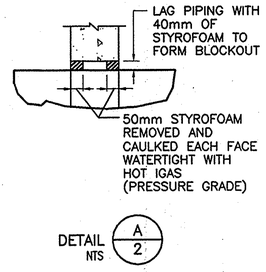
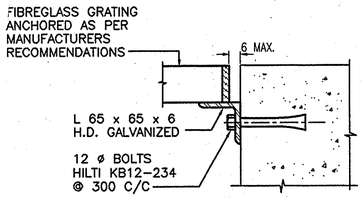
N-INT-150

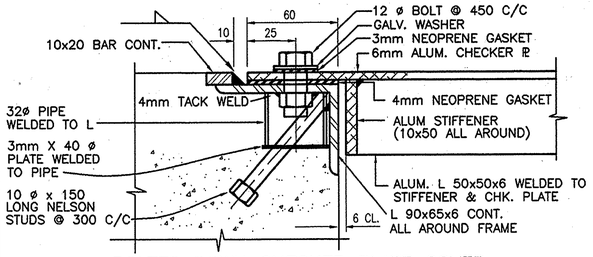


DETAIL A/2 NTS



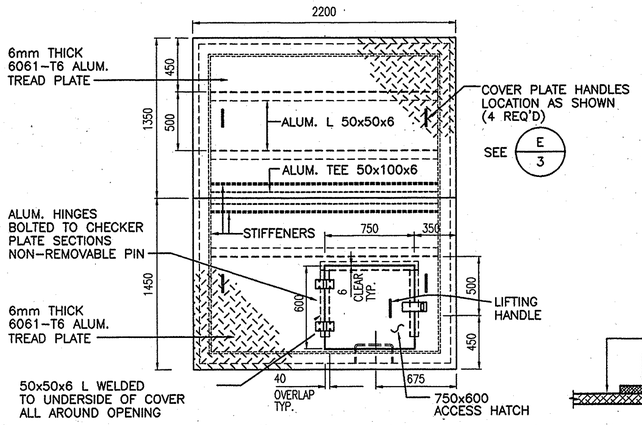
FIBREGLASS GRATING FRAME

DETAIL C/2 N.T.S.



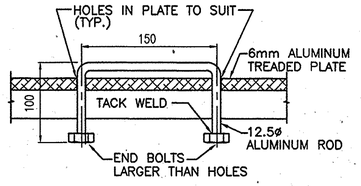
BOLTED DOWN CHECKER PLATE COVER

DETAIL B/2 N.T.S.



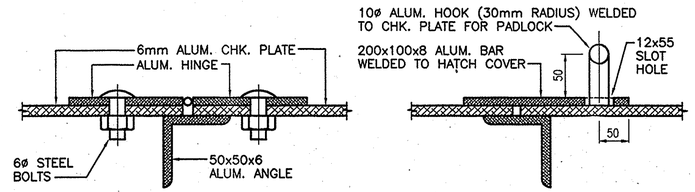
CHECKER PLATE COVER

DETAIL D/2 NTS



COVER PLATE HANDLE

DETAIL E/3 N.T.S.

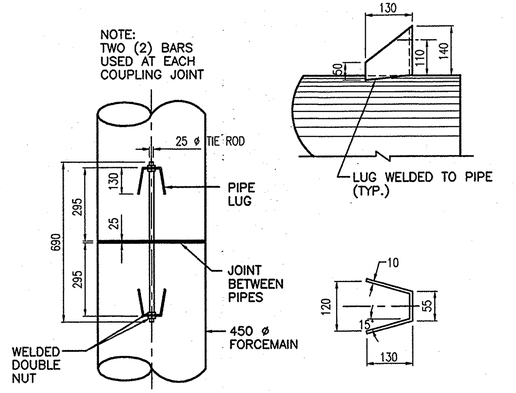


SECTION – ACCESS HATCH

N.T.S.

NOTES:

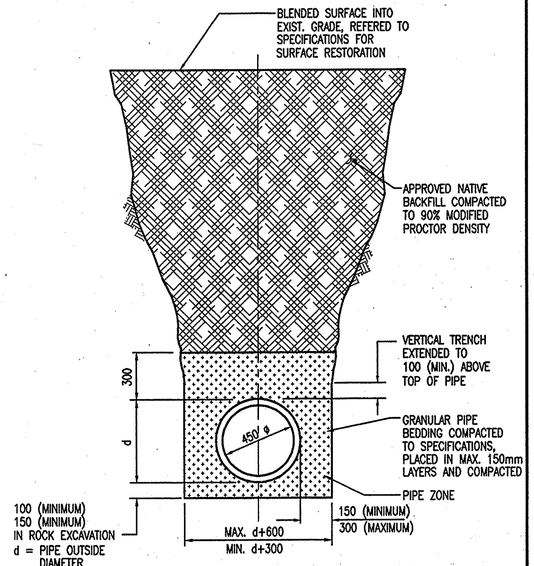
1. ALL ELEVATIONS ARE TO GEODETIC DATUM AND ARE IN METRES.
2. MAXIMUM DEFLECTION PER JOINT IS 2 1/2°



JOINT HARNESS **PIPE LUG**

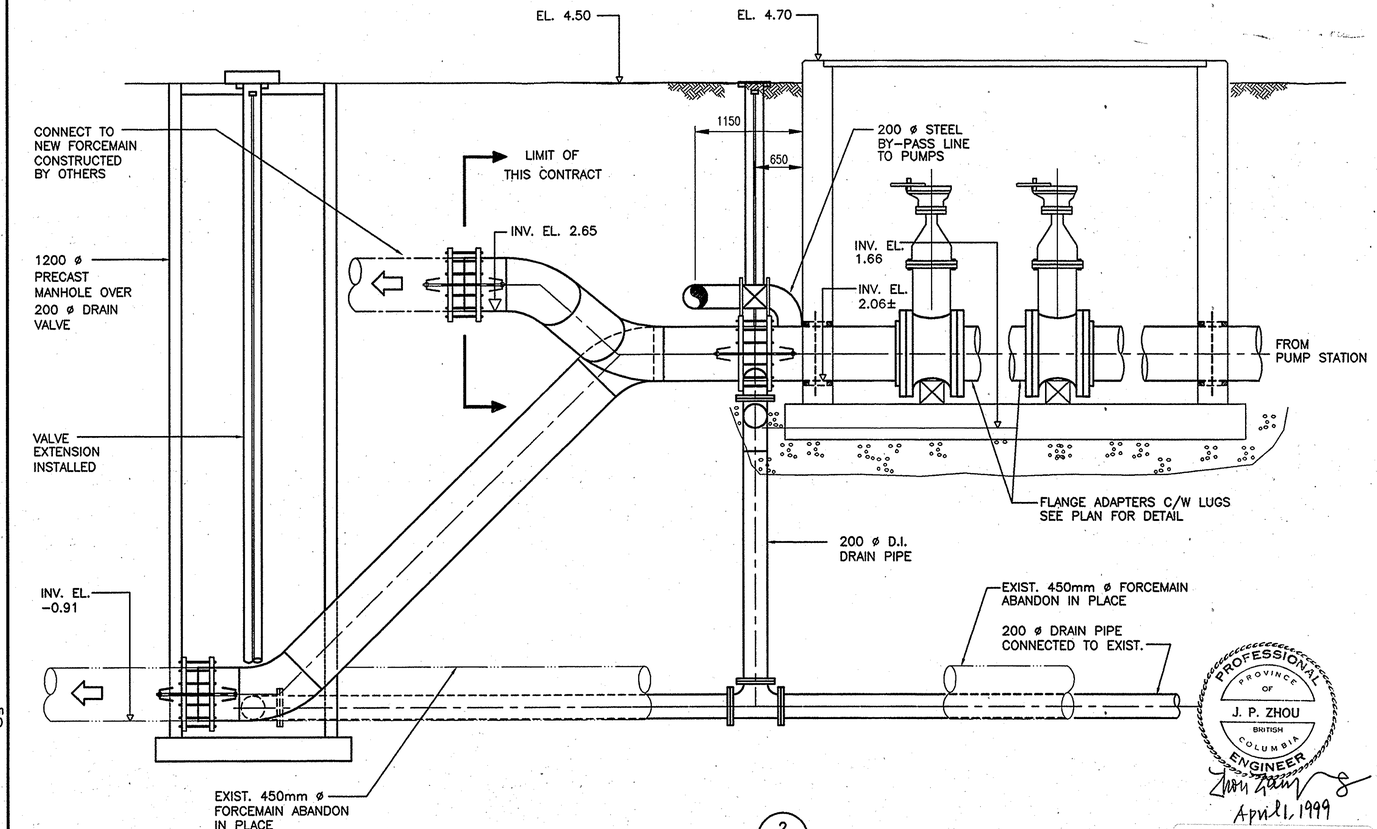
TIE BAR DETAILS (TYP.)

DETAIL F/2 N.T.S.



STANDARD TRENCH DETAILS FOR UNTRAVELLED AREAS

N.T.S.



SECTION 2/2 1:25

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA J. P. ZHOU April 1, 1999

N-INT-150

ACAD DWG. 1224672C 1:25 99-03-31

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REVISIONS	ISSUE	DATE	DRAWN	CHK'D	APP'D	DESCRIPTION	ISSUE	DATE	DRAWN	CHK'D	APP'D	DESCRIPTION
	A	JULY/98	KS			ISSUED FOR TENDER						
	B	SEP25/98	DBC	JWCB	JWCB	REVISIONS TO HATCH COVER						
	C	DEC/98	DKAJ	JWCB	JWCB	RECORD DRAWING						

AutoCAD DRAWING

DESIGNED JPZ
DRAWN KRC/LW/KS
CHECKED J.C.

DAYTON & KNIGHT LTD.
Consulting Engineers
July 28 1998

REGIONAL DISTRICT OF NANAIMO
TWINNING OF THE CHASE RIVER SANITARY FORCEMAIN
STAGE III – VALVE CHAMBER
SECTION AND DETAILS

SCALE: AS SHOWN
DRAWING No. 122.46.7.2
SHEET 3 OF 3 ISSUE C

jTable 2. Potential Regulatory Permitting and Approvals

Project component	Approval	Agency	Legislation/ Registration	Review and Approval Timeframe	Responsible Party	Application Considerations
Federal						
Forcemain and Watermain	Self-assessment	DFO	*Fisheries Act*	2-4 weeks	Jacobs	A self-assessment will be conducted to determine whether a Request for Review or Authorization is required.
Forcemain and Watermain	Request for Review and *Fisheries Act* Authorization for Paragraph 35(2)(b)	DFO	*Fisheries Act*	8 weeks 150 days	Jacobs (if required)	Request for Review is potentially required for this Project. A Request for Review is required for watercourse crossings and other activities requiring clearing of riparian vegetation or instream disturbance which may result in serious harm to fish that are part of a commercial, recreational, or Aboriginal fishery, or to fish that support such a fishery. A *Fisheries Act* authorization is unlikely for this Project. An authorization is required for watercourse crossings and other activities requiring clearing of riparian vegetation or instream disturbance which will result in serious harm to fish that are part of a commercial, recreational or Aboriginal fishery, or to fish that support such a fishery.
Provincial						
Forcemain and Watermain	Notification or Approval	BC MFLNRORD	*Water Sustainability Act*	45 days	Jacobs	As the activities are anticipated to impact the slopes of a ravine (a “stream” under the *WSA*), a notification is required. Construction methods are expected to satisfy criteria for aerial pipeline crossings in the *Water Sustainability Regulation*, qualifying works as an “authorized” change (requiring notification for low risk works instead of change approval). For a notification, comply with the terms and conditions in the Project region, as well as any terms and conditions specified by the habitat officer.
Forcemain	General Wildlife Permit (Amphibian Salvage)	BC MFLNRORD	*Wildlife Act*	6 to 8 weeks	Jacobs	Required for amphibian salvage during construction.
Forcemain and Watermain	Heritage Inspection Permit	Archaeology Branch, BC MFLNRORD (on public and private lands in BC)	*Heritage Conservation Act* (Section 14) *EAA*	2-3 months	RDN	The RDN has applied for this Permit.
Forcemain and Watermain	Road and Highway Crossing Permit	BC MoTI	*Transportation Act*	To be determined	RDN	Required to conduct works within road right-of-way.

jTable 2. Potential Regulatory Permitting and Approvals

Project component	Approval	Agency	Legislation/ Registration	Review and Approval Timeframe	Responsible Party	Application Considerations
Forcemain and Watermain	Temporary Closure/ Right-Of-Way use	BC MoTI	*Transportation Act*	To be determined	RDN	Required if BC MoTI roads are used and impacted by construction activities. Engagement with BC MoTI should be conducted when construction plans are finalized.
Municipal						
Forcemain and Watermain	Development Permit	City of Nanaimo	*Local Government Act* *Riparian Areas Regulation*	8-12 weeks	RDN	When a new development is proposed in any of the City or Nanaimo DPAs a Development Permit is required prior to any construction. The Development Permit ensures the new Project is consistent with DPA criteria outlined in the Official Community Plan (City of Nanaimo, 2017). This Project currently crosses four DPAs: DPA1 (watercourses), DPA2 (environmentally sensitive areas), DPA3 (natural hazard lands), and DPA5 (steep slopes development). Under Section 7.4 of the OCP, the RDN may be exempt from DPA1, DPA2, and DPA5 requirements, provided they comply with the Guidelines for Municipal Works and Services within ESAs. DPA3 may require geotechnical reporting that conforms with the Guidelines for the Preparation of Geotechnical Reports. Further consultation with the City of Nanaimo is recommended to confirm specific requirements once detailed Project design is available. Recommended approach is a short memo to the City detailing the project activities and proposed mitigation.
Forcemain	Building Permit	City of Nanaimo	*Local Government Act*	3-5 weeks, although the City of Nanaimo website indicates that target application processing times are currently not being met due to volume	RDN	Consultation with the City has confirmed that a building permit is required for the aboveground building associated with the valve chamber.

jTable 2. Potential Regulatory Permitting and Approvals

Project component	Approval	Agency	Legislation/ Registration	Review and Approval Timeframe	Responsible Party	Application Considerations
Forcemain and Watermain	Permit for Removing and Depositing Soil on Your Property	City of Nanaimo	*Soil Removal and Depositing Regulation Bylaw 1976, No. 1747*	6-8 weeks	Contractor	A permit is required for removing or depositing soil when the soil volume exceeds 383 m^3 (500 cubic yards). Follow the Guidelines for Soil Removal and Depositing (Fill).
Other						
Forcemain and Watermain	Approval for works near Right-of-Way	BC Hydro	*None*	--	RDN	The proposed route is adjacent to BC Hydro's existing right-of-way. Consultation and a possible approval may be required.
Watermain	Construction Permit	Island Health	*Drinking Water Protection Regulation*	60 days	City of Nanaimo	A Construction Permit must be obtained from a Drinking Water Officer before construction, installation, alteration or extension of a water supply system is commenced

Notes:

Migratory bird nesting period is from late March to mid-August. Where clearing or construction activities are scheduled during the migratory bird nesting period or sensitive time periods for raptors, conduct low intensity nest searches. If an active nest is discovered during clearing or construction activities, the nest will be subject to site-specific mitigation measures (such as protective buffering around the nest or unobtrusive monitoring.

DFO = Fisheries and Oceans Canada
DPA = Development Permit Area
ESA = Environmental and Socio-Economic Assessment
m^3 = cubic metre(s)
RDN = Regional District of Nanaimo

GENERAL

1.1. Summary

1.1.1. Pre-fabricated Valve and Metering Enclosure to be designed and constructed as outlined on the Drawings. The enclosure shall be removable in one piece and include lifting lugs and a visible weight tag. A spreader bar shall not be required for the safe removal of the enclosure.

1.1.2. Section Includes:

a) Structural framing for the building including structural steel door frames for equipment doors.

b) Lugs on structural steel members for installation and removal.

c) Secondary framing for metal roofing, mechanical equipment and piping, electrical equipment and controls, lighting fixtures as required.

d) Sheet metal roofing, wall panels, doors, louvers, complete with coping flashings, fascias, eaves troughs, downpipes and splash guards.

e) Anchor bolts, as shown on the Drawings.

1.2. References

a) CAN/CSA A660 Certification of Manufacturers of Steel Building Systems.

b) CSA G40.20/G40/21 General Requirements for Rolled or Welded Structural Quality Steel.

c) CSA S16 Design of Steel Structures.

d) CSA S136 North American Specification for the Design of Cold Formed Steel Structural Members.

e) CSA W47.1 Certification of Companies for Fusion Welding of Steel.

f) CSA W55.2 Certification of Companies for Resistance Welding of Steel and Aluminum

g) CSA W59 Welded Steel Construction (Metal Arc Welding).

h) Specifications for Commercial Steel Doors and Frames published by the Canadian Steel Door and Frame Manufacturers' Association (CSDFMA).

1.3. System Description

1.3.1. Design Requirements:

a) Design buildings for applicable dead and live loads established by the NBC for the locality, hourly wind pressures one in 50.

b) Design building frame assuming column bases to be pinned connections. The foundation cannot resist moments forces from column base. Base shear forced from columns and bracings are to transfer to foundation through anchor bolts.

c) Design column base plates to allow 40 mm out of plumb anchor bolt installation.

d) Allow for loads imposed by attached mechanical and electrical equipment and services including fans, as required.

e) Deflection of roof panels and wall panels: Maximum 1/180 of span when supporting applicable loads.

f) Design panels to span from foundation to eave line to support loads imposed with a maximum deflection of 1/180.

1.4. Submittals

1.4.1. Shop drawings:

a) Submit shop drawings indicating shape and thickness, finishes, dimensions of components of building including details of appurtenances, spacing and location of supports, connections, type and location of fastenings, metal finishes and other pertinent information.

b) Indicate provision for structural and thermal movement between building components.

c) Indicate details of attaching mechanical and electrical equipment and services, as required.

d) Submit anchor bolt as shown on the Drawings and levelling plate plan.

1.4.2. Certificates: Submit three copies of certificates for design loads and design standards used in design of building.

1.4.3. Submit certificate for prefabricated building indicating the design loadings, including drift snow loads for which the structure has been designed are in compliance with the National Building Code. Submit shop drawings and certification signed and sealed by professional engineer licensed in the Province of British Columbia.

a) Submit certificate for building frame, roof, enclosure on Canadian Sheet Steel Building Institute form - Certificate of Design and Manufacturing Performance.

b) Submit shop drawings and certification for the building frame signed and sealed by a professional engineer registered in the Province of British Columbia.

1.4.4. Manufacturer's specifications: Submit three copies of manufacturer's specifications.

1.4.5. Submit color selection chart and two samples 300 mm long of finish and colors for:

a) wall panel (Stone Grey)

b) roof panel (Stone Grey)

1.4.6. Submit accepted drawings and calculations certified by a Professional Engineer licensed to design structures and registered in the Province of British Columbia and to the municipality to assist with approval as required for building permit. Base design on design loads.

1.5. Quality Assurance

1.5.1. Qualifications of installer:

a) Approval and authorization by building manufacturer.

b) Evidence of acceptable experience in all phases of work involved on projects of comparable size and scope.

2. PRODUCTS

2.1. Manufacturers

2.1.1. Pre-Engineered Building acceptable manufacturers

a) Steelway Building Systems.

b) Butler Manufacturing Co. Ltd.

c) Steelox Building Systems.

d) Robertson Building Systems Ltd.

2.2. Self Framed System

2.2.1. Design: Building to be self framing design utilizing roof and wall panels as primary structural supporting components. Transmission of horizontal wind loads to be made through interlocking panel roof system and no roof or wall diagonal bracing will be permitted. Provide contour gable trim at each end wall and eave trim at high side. Provide contour gutter at low side eave. Provide downspouts and concrete splash pads as shown on the drawings.

2.3. Framed Building System

2.3.1. Base Plates and Leveling Plates:

a) Ship leveling plates to site in a timely manner for installation before casting foundation.

b) Field measure leveling plate locations before fabrication of column base plates.

c) Fabricate bolt holes in column base plates to match anchor bolt locations as shown on the Drawings.

2.3.2. Secondary Structural Members:

a) Frames for equipment openings shall be hot rolled steel section C310x31 minimum.

2.4. Finish for Sheet Metal Components

2.4.1. Secondary framing: Purlins and girts of zinc wipe coated steel.

2.4.2. Auxiliary framing members: Hot-dip galvanized Z275 coating.

3. EXECUTION

3.1. Examination

3.1.1. Examine concrete base after construction and report conditions which would adversely affect erection of building.

3.1.2. Comply with details of attaching mechanical and electrical equipment and services to building.

3.1.3. Commencing erection will imply acceptance of substrate conditions.

3.2. Erection

3.2.1. Erect building in accordance with manufacturer's specifications and instructions.

3.2.2. Provide galvanized steel channel framing for door frame and sidelight. Provide support angles at building corners base and eave.

3.2.3. Accurately fit assemblies to provide airtight and watertight installation and provide clearance required due to expansion, contraction and deflection of building structures and frames. Anchor units securely to concrete foundation.

3.2.4. Seal hairline joints at junction of frame members.

3.2.5. Installation tolerances:

a) Vertical position: plus/minus 3 mm.

b) Horizontal position: plus/minus 3 mm.

c) Deviation from plumb: 3 mm maximum each plane.

d) Racking of face: 6 mm maximum.

e) Racking in elevation: nil.

3.2.6. Secure roof deck to purlins. Over roof deck apply continuous roof membrane. Lap joints 75 mm. Provide for drainage to exterior above roof membrane at eaves.

3.2.7. Install roof panels with lapped joints.

3.2.8. Provide manufacturer's standard rubber closure, 19 mm thick minimum, at top of panels and at eave of roof deck and panels.

3.2.9. Cut and trim panels to receive frames, louvres, mechanical and electrical protrusions, as required.

3.2.10. Provide prefinished galvanized steel flashings at corner, jamb, sill, roof curbs, cut-outs and protrusions, as required.

3.3. Application - Sealants

3.3.1. Provide air and watertight installation.

3.3.2. Seal joints on exterior and interior between door frames and wall and between louvre frames and wall.

3.3.3. Seal joints between building and concrete slab-on-grade.

3.3.4. Seal all other locations where indicated or required for an air and watertight enclosure.

3.3.5. Before application of sealant, clean and dry joints to be sealed. Ensure that surfaces to receive sealant are free from extraneous matter or other treatments which may affect bond.

3.3.6. Apply sealant in accordance with sealant manufacturer's printed instructions.

3.3.7. Quality of exposed sealant: Smooth bead, free from ridges, wrinkles, air pockets and imbedded foreign materials.

3.3.8. Remove as work progresses, excess sealant or droppings which would set up or become difficult to remove from finished surfaces.

3.4. Installation – Door Hardware

3.4.1. Install and adjust hardware on doors and frames.

3.4.2. Provide lubricants required and use in manner to ensure smooth function of hardware consistent with manufacturer's recommendations.

3.4.3. Adjust weatherstripping as required.

END OF SECTION

1. GENERAL

1.1. Summary

1.1.1. This Supplemental Specification Section specifies general requirements for the supply and installation of process piping, valves, fittings and related appurtenances associated with the Work. More detailed requirements are contained in other Sections. This Section must be referenced to and interpreted simultaneously with all other Sections pertinent to the Work describe herein.

1.1.2. Design, select, locate and provide expansion joints, pipe guides and anchors required for final piping layout. Typical details, anchors, and thermal expansion allowance shown on the drawings are provided only for general guidance.

1.1.3. All materials not specifically listed or specified but required to complete the installation are the responsibility of the Contractor.

1.2. References

1.2.1. Definitions

a) Maximum working pressure: The greatest continual pressure at which the piping system operates.

b) Test pressure: The hydrostatic pressure used to determine system compliance.

c) Interior: Within an environmentally controlled enclosure where the temperature is maintained above 5°C.

d) Submerged: Regularly or occasionally immersed in liquid; or within 3.0 m above maximum water level within a structure or lagoon/pond.

e) Outdoor: Exposed, above ground, outside or within an enclosure that is not environmentally controlled.

f) Buried: Placed directly in soil and/or granular fill.

g) Contractor's Engineer: A professional engineer registered in the Province of British Columbia qualified to do detailed piping thermal expansion design at the Contractor's cost.

1.2.2. Reference Standards

a) Conform with the most recent version of all standards referenced in this Section.

b) ANSI B1 .1: Unified Inch Screw Threads, UN and UNR Thread Form

c) ANSI/AWWA C606: Grooved and Shouldered Joints

d) ASME B31.3: Power Piping

e) ASTM B16.21: Nonmetallic Flat Gaskets for Pipe Flanges

f) ASTM A193: Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications

g) ASTM A194: Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both

h) ASTM A307: Carbon Steel Bolts, Studs, and Threaded Rod 60000 PSI Tensile Strength

i) ASTM A354: Quenched and Tempered Alloy Steel Bolts, Studs and Other Externally Threaded Fasteners

j) ASTM A563: Carbon and Alloy Steel Nuts

k) ASTM B32: Solder Metal

l) ASTM B633: Electrodeposited Coatings of Zinc on Iron and Steel (m) ASTM B766: Electrodeposited Coatings of Cadmium

1.3. Coordination

1.3.1. Prior to construction, coordinate with other divisions to locate openings and place sleeves in cast in place concrete and/or masonry.

1.3.2. Prior to demolition, coordinate with other divisions to locate pipe, sleeve and duct penetrations through existing structures.

1.4. Submittals - For Review

1.4.1. Before fabrication, provide manufacturer data for each type of pipe material and for each fitting, valve, coupling, and all specified appurtenances used to complete the work covered in this section.

1.4.2. For all piping systems greater than 25 mm in diameter provide isometric drawings to indicate assembly details; pipe size, welds, flanges, couplings, valve placement, valve operating wheels, vents and drains, cathodic protection, seismic restraint system, expansion joints, guides, anchors, supports and provisions for thrust restraint, wall penetrations, as well as any other pertinent details.

1.4.3. Provide details of any shop fabricated pipe and fittings.

1.4.4. Where directed by the Consultant, provide mill test results or product samples.

1.4.5. For restrained, mechanical, and expansion joints provide manufacturer's catalogue data, shop drawings and assembly drawings confirming general arrangement, dimensions, tolerances, materials of construction, weights and installation details.

1.4.6. If requested, the piping fabricator shall submit a demonstrated fillet and butt weld on a test sample of pipe to be examined and approved by a certified inspection company. The test specimens will be submitted to the Consultant's inspection company at the Owner's expense. Any retesting required by the Owner shall be completed at the Contractor's expense.

1.4.7. Catalogue cuts and/or shop drawings for each type of valve indicating the valve data and pressure rating, materials of construction, dimensions, head loss characteristics through the valve, operating torque and valve end configuration.

1.4.8. An amended Detailed Valve Specification Sheet for all valves. Indicate with check marks where the valve supplied meets the requirements specified and with written amendments where the product differs from the specification.

1.5. Submittals – For Information

1.5.1. Submit radiographic weld test and other shop inspection and test results.

1.5.2. Provide current and complete documentation of welder's qualifications prior to the commencement of any welding. All welders who work on this project must provide the correct documentation, including but not limited to Welding Certifications.

1.5.3. Prior to commencing any welding of stainless-steel pipe, submit a Welding Procedure Specification (WPS) including a written description of welding techniques including but not limited to materials, methods, and quality control. Certify that the technique is acceptable for the intended service condition. Written procedures to be signed and sealed at the Contractor's cost by a professional engineer registered in BC qualified for welding design.

1.5.4. Provide hanger, joint restraint, 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.

1.5.5. Submit manufacturer’s catalogue data and assembly drawings for mechanical, restraint and expansion joints confirming general arrangement, dimensions, tolerances, materials of construction, weights and installation details.

1.5.6. Submit Operating and Maintenance data for valves. Include complete description of operation together with detailed drawings, a complete list of replacement and repair parts, and parts manufacturer’s identifying numbers.

1.6. Quality Assurance

1.6.1. Review the drawings prior to installation of piping, conduit services, and fixtures by this or any other division. Identify any conflicts and cooperate with Consultant to determine the adjustments necessary to resolve these conflicts.

1.6.2. Provide complete, fully tested and operational process piping systems.

1.6.3. Comply with all laws, ordinances, rules, regulations, codes and orders of all authorities having jurisdiction relating to this work.

1.6.4. All welding of pipe and fittings shall be undertaken by welders certified for pipe welding for each applicable pipe welding procedure through the Industry Training Authority (ITA) and holding a Level A or Level B interprovincial Red Seal Ticket. For stainless steel welding, a Level A Red Seal Ticket is required.

1.6.5. The fabricator shall be fully approved by the Canadian Welding Bureau under the requirements of CSA W47.

1.6.6. All pipe fabrication and welding shall be in accordance with ASME B31.3 Process Piping for normal fluid service code for pressure piping or where applicable Section IX of the Boiler and Pressure Vessel Code.

1.6.7. Perform visual examinations of all welding to reveal any surface or root defects, unacceptable weld fit-ups, arc strikes, weld spatter, or insufficient heat tint removal.

1.6.8. Perform visual examination of shop welding before shipping.

1.6.9. Provide radiographic inspections required to meet the welding standards cited in this Section. At the discretion of the Consultant, 5% of welds may be subject to radiographic inspection in the shop, the cost of which will be borne by the Owner

unless tests prove the weld defective, then the cost to correct the defective work plus the cost of additional radiographic inspection shall be borne by the Contractor.

1.6.10. Spot-radiographic inspection of welds, or alternative method, may be conducted at the option and at the expense of the Owner. The Consultant will designate such company to carry out inspection of welds at the site of erection, and the Contractor shall fully co-operate with the Consultant and representatives in supply such labour and working space as may be required. Welding judged unacceptable shall be repaired using a method satisfactory to the Consultant at no additional cost to the Owner. The Contractor shall pay for the spot-radiographic inspection of all welds which are judged unacceptable.

1.6.11. For each defective weld, two additional radiographic inspections at locations identified by the Consultant will be required, plus a radiograph of the repair. Costs for such additional radiographic inspections including the radiograph of the repair shall be borne by the Contractor.

1.6.12. The Consultant may use any method of inspection necessary to establish quality control and ensure adherence to welding procedures. Any weld test specimen coupons submitted shall clearly identify the welder(s).

1.7. Delivery, Storage and Handling

1.7.1. Store on site as recommended by materials manufacturer to prevent damage, undue stresses, or weathering. Store materials a minimum of 200 mm above ground with sufficient supports to prevent bending.

1.7.2. Protect non-UV light inhibited plastic materials from sunlight.

1.7.3. Provide shipping devices to maintain the face-to face dimension of each expansion joint during shipment, storage and installation.

2. PRODUCTS

2.1. Bolts and Studs

2.1.1. Provide hex head bolts and studs, threads to ANSI B1.1, standard coarse thread series.

2.1.2. Connecting stainless: Grade B8 ASTM A193, C1.1.

2.1.3. Connecting stainless steel to steel or cast/ductile iron: Provide carbon steel bolts and studs, Grade B to ASTM A307, heavy hex, cadmium plated to ASTM B766. Bolt sizes to AWWA C110.

2.1.4. Connecting steel, or unless otherwise specified:

a) Provide carbon steel bolts and studs, Grade B to ASTM A307, heavy hex, zinc plated to ASTM B633 or cadmium plated to ASTM B766.

b) Bolt sizes to AWWA C110.

2.1.5. Axial stress in bolts shall not exceed 40% or material yield strength based on unthreaded body area.

2.2. Nuts and Washers

2.2.1. Provide hex head nuts, threads to ANSI B1.1, standard coarse thread series. Greater than 25 mm, provide heavy hex.

2.2.2. Connecting stainless steel: Provide nuts to ASTM A194 Grade 8.

2.2.3. Connecting stainless steel to steel or cast/ductile iron: Provide carbon steel nuts, Grade A to ASTM A563. Provide flat hardened steel washers to ASTM F436. Nuts and washers to be cadmium plated to ASTM B766. Always include washers.

2.2.4. Connecting steel, or unless otherwise specified: Provide carbon steel nuts, Grade A to ASTM A563. Provide flat hardened steel washers to ASTM F436. Nuts and washers to be zinc plated to ASTM B633 or cadmium plated to ASTM B766.

2.2.5. Tie-rods

a) Provide tie-rods continuously threaded to ASTM A354 and fabricated in accordance with 81.1 (screw threads, coarse thread series). Tie rods to be steel cadmium plated in accordance with ASTM B766.

2.3. Fittings

2.3.1. Provide fittings with wall thickness equal to or greater than the pipe, of the same, material, coating, lining and pressure rating as pipe or better.

2.3.2. Provide eccentric reducers in horizontal lines with the flat side on top, unless shown otherwise.

2.3.3. Provide concentric reducers in vertical lines unless indicated otherwise.

2.3.4. Provide short radius elbows unless otherwise specified on the drawings of liquid service.

2.3.5. Provide smooth flow standard radius elbows for process air service unless otherwise specified.

2.4. Joints — Flanges

2.4.1. Flanges for mating to equipment or valves must be compatible with those items. In all situations similar faced flanges only shall be mated. Companion flanges for connection to cast iron or ductile iron or PVC equipment or valve flanges shall be flat faced and flush with the equipment or valve flange.

2.4.2. Class 150 — flat faced with full face gaskets, unless mating to raised face valves, lap joint flanges or equipment.

2.4.3. Class 300 — Not used.

2.4.4. If not specified or shown otherwise use slip-on flanges.

2.4.5. On piping operating at less than gauge pressure, provide flat faced slip on flanges only. This applies to blower inlet piping.

2.4.6. Where dissimilar metals are to be connected, furnish dielectric fittings and/or isolating flanges, including major bolt sleeves and washers.

2.4.7. Gaskets

a) Conform to ASTM B1621 and AWWA C228 Table 1.

b) Minimum gasket thickness 3.175 mm.

c) Provide full face gaskets for flat faced flanges

d) Provide ring type gaskets for raised face flanges.

e) Provide gasket materials suitable for the temperature, pressure and corrosivity of the fluid conveyed in the pipeline.

i. Provide liquid service gaskets of EPDM or neoprene.

ii. Provide air service gaskets of compressed Kevlar with neoprene binder, suitable for service conditions.

2.5. Joints — Threaded Couplings

2.5.1. Provide screwed joints with American Standard threads.

2.5.2. Provide Teflon tape suitable for pipe material and service.

2.6. Joints — Grooved Joint Coupling

2.6.1. Provide pipe grooving, couplings and gaskets conforming to ANSI/AWWA C606. Victaulic or approved equal.

2.6.2. Provide for liquid service Victaulic Grade “E” EPDM flush seal gasket or approved equal.

2.6.3. Provide cut grooves on schedule 40, standard wall or thicker pipe, roll grooves for Sch 10 and Sch 5 stainless steel.

2.6.4. Grooved joint flange adapters shall be used only where specifically indicated.

2.7. Joints — Flexible and Restrained Joint Couplings

2.7.1. Provide cylindrical centre ring, two follower rings, two resilient gaskets, and connecting bolts. Robar, Dresser or equal.

2.7.2. If joint restrained add restraining rods and gussets welded to the pipe. Provide sufficient restraint to resist pressure equal to twice the system test pressure, as recommended by the manufacturer.

2.7.3. Provide gasket suitable for service conditions.

2.8. Joints - Welding

2.8.1. Use welding materials conforming to CSA W48.

2.8.2. Provide electrodes compatible with the material welded and which deposit metal with strength and corrosion resistance properties at least equivalent to the base metal.

2.9. Lining and Coating

2.9.1. Do not paint or line stainless steel pipe.

3. EXECUTION

3.1. Preparation

3.1.1. Prior to installation, inspect and field measure to ensure that previous work is not prejudicial to the proper installation of piping.

3.1.2. Make all minor modification to suit equipment and structural element locations and elevations, at no expense to the Owner.

3.1.3. Advise the Consultant of all modifications. Indicate all piping modifications on the shop drawings submitted prior to fabrication or installation. Do not commence work on related piping until the Consultant's approval has been received.

3.1.4. Prior to valve and pipe appurtenance installation, field measure and check all equipment locations, pipe alignments, and structural installation. Ensure that valve location and orientation provides suitable access to all valve operators. Ensure that sufficient easily disassembled joints are provided to allow for removal and replacement of all valves and pipe appurtenances.

3.2. Pipe Handling

3.2.1. Inspect each pipe, fitting and piping appurtenance prior to installation. Do not install damaged material or materials with damaged linings or coatings.

3.2.2. Repair pipe with damaged protective coatings in accordance with coating manufacturer's directions and to the satisfaction of the Consultant.

3.2.3. Remove all foreign matter from inside of piping and piping appurtenances prior to installation.

3.2.4. Use proper implements, slings, tools and facilities for the proper protection of the Exercise care in the installation so as to avoid damage to pipe or coatings.

3.3. Conflicts

3.3.1. Confirm the pipework routing with Consultant prior to commencement of fabrication and installation. Advise Consultant of any conflicts with existing services, structures, or services yet to be installed. Where necessary, amend the routing of pipework to avoid conflict, as instructed by Consultant.

3.4. Buried Pipe Installation

3.4.1. For buried pipes refer to Section 6 – Sanitary Sewer System of Engineering Standards and Specifications from the City of Nanaimo.

3.4.2. For buried stainless steel pipe apply tape to buried pipe and welded joints. Use Polyken, Tec-Tape or Denso tape consisting of primer and tape applied to minimum thickness of 0.90 mm in accordance with AWWA C209.

3.4.3. For flanged or coupled joints and for fittings use petrolatum primer, mastic and tape; Polyken, Tec-Tape or Denso, in accordance with AWWA C217.

3.5. Interior and Outdoor Pipe Installation

3.5.1. Piping installed in interior building spaces shall be fabricated and installed in accordance with the ASME Pressure Vessel Code.

3.5.2. Make adequate provision in piping runs for expansion, contraction, slope and anchorage.

3.5.3. Install pipe support system to adequately secure the pipe and to prevent undue vibration, sag and stress.

3.5.4. Provide temporary supports as necessary during construction to prevent overstressing equipment, valves or pipe.

3.5.5. Accurately cut all piping for fabrication to field measurements.

3.5.6. Install pipes in straight alignment. Variance from the true alignment shall not exceed 10 mm in any direction or as required in ASME B31.3 whichever is less.

3.5.7. Fabricate and assemble pipe runs to ensure that pipework is not stressed to achieve the designed alignment and that no stresses are transferred to equipment or equipment flanges. “Springing” of pipework to ensure alignment is not permitted.

3.5.8. The Contractor shall undo and subsequently remake all pipework connections where so instructed by the Consultant to ensure that springing does not occur.

3.5.9. Take care not to damage equipment, piping appurtenances, valves, flanges, or other joints.

3.6. Connections to Equipment and Existing Piping

3.6.1. Verify fit and materials at each connection prior to making the connection. Where joining piping to existing equipment, confirm flange type on the equipment and install matching pipe flanges to suit.

3.6.2. Modifications to either new or existing materials required to make connections shall be approved by Consultant in writing prior to the connections being made.

3.7. Pipe Joints

3.7.1. General

a) Provide joints that can be readily disassembled at the minimum within 1.0 m of any connection to equipment, on both sides of structural penetrations, and within 0.6 m of all threaded end valves.

b) Allow a minimum of 150 mm to face or 75 mm to edge of flanges or grooved joint couplings from wall, floor or ceiling unless otherwise shown.

3.7.2. Threaded

a) Unless specifically noted on the Drawings, threaded couplings shall only be used on piping with nominal diameters less than 65 mm.

b) Ream the ends of all pipes to remove all burrs and cuttings when fabricating threaded joints.

c) Clean out pipe prior to joining.

d) Apply Teflon tape to male threads and join pipe. Do not use extra tape to make up for slack in the joint.

e) Install threaded pipe with as few joints as possible. Short lengths of pipe coupled tighter shall not be used, except where a union is specifically shown on the drawings.

f) If it is necessary to back off a screwed joint after it is made, the thread shall be cleaned, and new compound applied.

g) Threads shall not be caulked.

h) Bushings shall not be used.

i) Nipples in threaded piping shall be shoulder nipples. Close nipples shall not be used unless specifically indicated.

3.7.3. Flanged

a) Clean flanges and gaskets prior to connection.

b) Lubricate gaskets with soapy water and apply anti-seize compound to stainless steel bolts.

c) Bring flanges into close parallel and lateral alignment.

d) Tighten bolts progressively, proceeding from side to side of the flange. Wrenches used for tightening bolts shall be in good condition and properly sized to prevent rounding of nut and bolt heads. Apply manufacturer's torque recommendations when connecting to valves and equipment. Do not over torque bolts.

e) Do not use washers to take up excess bolt length.

f) Bolt projection beyond nuts shall be approximately two full threads.

g) Align flanges which connect piping to mechanical equipment to close parallel and lateral alignment prior to tightening bolts. Do not place strain on equipment.

h) Install flange adapters in accordance with manufacturer's recommendations.

i) Install lap joint flanges in vibration free service only. Do not install in buried or submerged environments.

3.7.4. Grooved Joint Couplings

a) Install grooved joints and grooved joint flange adapters as recommended by manufacturer using manufacturer's recommended lubricants on gaskets.

b) All grooving tools and accessories to be manufactured by grooved product supplier.

3.8. Welding – General

3.8.1. All piping is to be shop welded.

3.8.2. Metal surfaces in and adjacent to the welding groove shall be dry before welding commences and kept dry and free from dirt, loose scale, slag, grease or any other foreign contaminant.

3.8.3. All welds after welding is complete must be cleaned and surface prepared as required for the final coating, finish or passivation method to be applied.

3.8.4. The end of each pipe shall be carefully fitted to butt accurately with proper gap to the preceding pipe or fitting. Before placing the pipe in position, the ends of the pipe shall be made truly circular by an approved method and, if necessary, for large pipes "spiders" shall be placed in each to keep them truly circular.

3.9. Field Welding

3.9.1. In general field welding is not acceptable. Field welding may be performed only under exceptional circumstances and with the prior written consent of the Consultant.

3.9.2. Field welding shall conform to the general requirements of AWWA C206 "Field Welding of Steel Water Pipe Joints", and the quality requirements under "Welding-General" in this specification.

3.9.3. Field welding shall not be done under conditions that would impair the completed weld including but not limited to: moisture; blowing sands or dust; high winds; low temperatures. If in the Consultant's opinion, protection from prevailing weather conditions is necessary, then all welding shall cease until this protection is provided at the Contractor's cost, and welds done under poor conditions shall be re-made. The Contractor shall be prepared for such events and will not be compensated for downtime associated with delays of this nature

3.9.4. When the ambient temperature is below 0°C all welding operations shall cease unless an appropriate welding procedure has been submitted. Written procedures to be signed and sealed at the Contractor's cost by a professional engineer registered in BC qualified for welding design.

3.9.5. In general, field welds shall be butt type, suitably bevelled to the satisfaction of the Consultant.

3.9.6. Pipes cut in the field for closing pieces and other field joints shall be cut to a smooth uniform level. Edges shall be smooth and not serrated and shall be ground smooth if they are rough after cutting.

3.10. Pipe Structural Penetrations

3.10.1. Refer to Structural Drawings and Specifications.

3.10.2. Coordinate with other divisions to locate and place sleeves or cast-in-place pipe sections prior to the construction of concrete and masonry building elements.

3.11. Drains, Vents, Flushing Connections, Sample Points

3.11.1. Provide manual air vents at the high points of each reach of pipeline.

3.11.2. Provide manual drains at the low points of each reach of pipeline. Pipe drains to a sump, gutter floor drain, or other approved collection point.

3.11.3. Manufacturer's recommendations and as specified.

3.12. Testing

3.12.1. All piping shall be pressure tested and witnessed by the Consultant.

3.12.2. Review pipe pressure testing procedures with Consultant at least 1 week prior to commencement of pressure testing.

3.12.3. Give Consultant 24 hours notice of testing.

3.12.4. Thoroughly clean all piping prior to pressure testing.

3.12.5. Prior to pressure testing ensure piping is adequately restrained.

3.12.6. Do not insulate, bury, concrete surround or otherwise conceal work until piping systems are tested and accepted.

3.12.7. Supply all equipment, gauges and materials including fluids for pressure testing.

3.12.8. Install fittings for air relief, gauges and drainage as needed to complete testing. After testing remove and plug fittings.

3.12.9. Cap and plug all lines that are normally open ended. Remove on completion of testing.

3.12.10. Isolate all low pressure equipment or pipeline appurtenances during testing to

3.12.11. protect the equipment or pipeline appurtenances from damage.

3.12.12. Repair and replace any defective work using new material.

3.12.13. Testing Piping Carrying Liquid Commodities

a) There shall be no loss of pressure during testing, and no visual evidence of leakage.

b) Test duration: 2 hours.

c) Test pressure: 1.5 times the maximum working pressure. Confirm system working pressure with Consultant prior to pipe testing.

3.13. Cleaning and Flushing

3.13.1. After installation and prior to testing, perform initial cleaning of process and utility pipelines.

3.13.2. Clean piping greater than 150 mm and less than 600 mm by passing a tightly fitting cleaning ball or swab through the pipeline. Remove instrumentation or piping appurtenances that may be damaged by this procedure and replace after cleaning.

3.13.3. Give lines smaller or equal to 150 mm an initial flush with clean water for piping normally conveying liquid commodities, or purge with air or inert gas for piping normally conveying air or gas.

3.13.4. Flush with clean water and drain pipes conveying liquid commodities after testing. Dispose of testing and flushing water in a manner which causes no damage to buildings or siteworks in a manner approved by the Consultant.

3.13.5. For piping conveying air or gas less than or equal to 150 mm diameter, purge with air and/or inert gas before testing. Upon completion of testing and cleaning, drain and dry the piping with a dry air stream.

3.14. Operations and Maintenance Manual

3.14.1. Include copies of all manufacturer’s information provided in shop drawing submittals for all piping appurtenances in the operations and maintenance manuals.

3.14.2. Include name and contact information of supplier for each piping appurtenance in the operations and maintenance manuals.

END OF SECTION

1. GENERAL

1.1. Summary

1.1.1. This Supplementary Specification section applies to supply, fabrication, and installation of 316 Stainless Steel process piping for the sanitary sewer piping.

1.1.2. This section must be referenced to and interpreted simultaneously with all other Sections pertinent to the Work described herein.

1.1.3. Related Requirements

a) Process Piping General SS 40 20 10

b) Process Valves General SS 40 50 10

1.2. Reference Standards

1.2.1. Conform with the most recent version of all standards referenced in this Section.

a) ANSI/ASME B16.5: Pipe Flanges and Flanged Fittings: NPS ½ through NPS 24 Metric/Inch Standard

b) ANSI/ASME B16.9: Factory Made Wrought Buttwelding Fittings

c) ANSI/ASME B16.11: Forged Fittings, Socket-Welding and Threaded

d) ANSI/ASME B16.21: Nonmetallic Flat Gaskets for Pipe Flanges

e) ANSI/ASME B36.19: Stainless Steel Pipe

f) ASTM A182: Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings and Valves and parts for High Temperature Service

g) ASTM A240: Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels and for General Applications

h) ASTM A312: Seamless, Welded and Heavily Cold Worked Austenitic Stainless Steel Pipes

i) ASTM A380: Standard Practice for Cleaning, Descaling and Passivation of Stainless Steel Parts, Equipment and Systems

j) ASTM A403: Wrought AustenitIc Stainless Steel Piping Fittings

k) ASTM A480: General Requirements for Flat-Rolled Stainless and Heat –Resisting Steel Plate, Sheet and Strip

l) ASTM A778: Welded, Unannealed Austenitic Stainless Steel Tubular Products

m) ASTM A967: Chemical Passivation Treatments for Stainless Steel Parts

n) AWWA C220: Stainless Steel Pipe ½" (13 mm) and Larger

o) AWWA C226: Stainless-Steel Fittings for Waterworks Service, Sizes ½". through 72" (13 mm through 1,800 mm)

p) AWWA C227: Bolted, Split-Sleeve Restraind and Nonrestrained Couplings for Plain-End Pipe

q) AWWA C606: Grooved and Shouldered Joints

1.3. Delivery, Storage and Handling

1.3.1. Protect materials from contamination from dirt or road salt by shrink wrap or other suitable packaging, and end caps, prior to shipment.

1.3.2. Store materials in such a way to prevent scratching and scoring of the surface and to avoid contact with dirt or carbon steel.

1.4. Design Conditions

1.4.1. Use the following design conditions:

a) Normal commodity temperature range: 2 to 25°C.

b) Normal ambient temperature range: Indoor 0 to 40°C. Outdoor -20 to 40°C.

c) Normal service operating pressure range: 0 to 400 kPa

2. PRODUCTS

2.1. Provide piping systems as detailed below with components suitable for the operating:

Item	Size	Description
Pipe	50 mm & smaller 60 mm & larger	Schedule 40S: ASTM A312/A312M, Type 316 seamless, pickled and passivated. Schedule 10S: ASTM A778, “as-welded” grade, Type 316L.
Joints	50 mm & smaller 60 mm & larger	Threaded or flanged at equipment as required or shown. Butt-welded or flanged at valves and equipment.
Fittings	50 mm & smaller 60 mm & larger	Threaded Forged: 1,000 CWP, ASTM A182/A182M, Grade F316L. Butt-Welded: ASTM A774/A774M Grade 316L conforming to MSS SP 43, “as-welded” grade, pickled and passivated; fitting wall thickness to match adjoining pipe; long radius elbows unless shown otherwise.
Branch Connections	50 mm & smaller 60 mm & larger	Tee or reducing tee in conformance with Fittings above. Butt-welding tee or reducing tee in accordance with Fittings above.
Flanges	All	Forged Stainless Steel: ASTM A182/A182M, Grade F316L, ASME B16.5 or B16.47 Class 150 or Class 300, slip-on or weld neck . Raise face for Class 150 and Class 300. Flat face for flange connecting to ductile/cast iron Class 125 flanges.
Unions	50 mm & smaller	Threaded Forged: ASTM A182/A182M, Grade F316, 13800 or 20700 kPag WOG, integral ground seats, AAR design meeting the requirements of ANSI B16.11, bore to match pipe.
Bolting	All	Forged Flanges: Type 316 stainless steel, ASTM A320/A320M Grade B8M hex head bolts and ASTM A194/A194M Grade 8M hex head nuts.
Gaskets	All Flanges	Flanged 5 mm thick, unless otherwise specified, red rubber (SBR), hardness 80 (Shore A), rated to 93 degrees C, conforming to ANSI B16.21, AWWA C207, and ASTM D1330, Grades 1 and 2. Blind flanges shall be gasketed covering entire inside face with gasket cemented to blind flange.
Thread Lubricant	50 mm & smaller	Teflon tape.

3. EXECUTION

3.1. Stainless Steel Pipe Welding and Fabrication

3.1.1. Stainless steel fabrication shall be done in an approved fabrication shop set up to handle, fabricate and weld stainless steel using handling procedures designed to eliminate carbon contamination of the stainless steel including but not limited to: the use of stainless steel tools including wire brushes, chisels, files and hammers, welding gloves and grinding wheels. Only 300 series stainless steel brushes or wheels shall be used on austenitic and nickel alloys.

3.1.2. Areas used for fabrication of austenitic and nickel alloys shall be separated from carbon steel areas by methods suitable to prevent contamination by dirt, carbon steel shavings, grinding dust and sparks, and zinc dust from painting operations. Welding gloves and tools used during the fabrication of stainless steel shall not have been used on previous carbon steel work.

3.1.3. Where tape is used for backing purge gas the tape shall use an adhesive backing such that when no longer required it can be completely removed with residual adhesive removed by a suitable solvent or abrasive.

3.1.4. Clean piping to a pre-weld zone extending 50 mm on either side of the weld with alcohol or acetone.

3.1.5. All welding of the root pass of austenic stainless steel pipe shall be done using the Gas Tungsten Arc Weld (GTAW) process with shielding gas protection of the backside of the weld sufficient to reduce oxygen content to a level that can avoid granulation and ensure a high quality corrosion resistant weld. Large bore piping may be internally back welded to achieve the same result.

3.1.6. The Shield Metal Arc Weld (SMAW) process may only be used for fill passes or fillet welds.

3.1.7. Solar Flux is not acceptable.

3.1.8. Clean welds after fabrication in accordance with ASTM A380.

3.1.9. Pickle and passivate welds after fabrication in accordance with AWWA C220, ASTM A380 and ASMT A967 by immersing in a liquid bath of pickling solution. Large bore piping shall be cleaned with a pickling paste.

3.1.10. Any noticeable discolouration on the piping after welding shall be removed by pickling.

3.1.11. Once sufficient pickling time has elapsed to re-passivate the stainless steel surface, clean the piping of all acids by thoroughly rinsing the pipe with water.

3.1.12. Thread stainless steel pipe in accordance with threading machine manufacturer’s

3.2. Pipe Grooving

3.2.1. Groove stainless steel pipe in accordance with grooving machine manufacturer’s instructions.

3.2.2. Contamination from iron particles by pressure contact with rollers or tooling should, if at all possible, be avoided. Where stainless steel rollers or tools are unavailable, adhesive plastic films or tape can be used to prevent direct contact. They shall removed after fabrication.

3.3. Fabricated Fittings

3.3.1. Shop fabricated fittings made from rolled stock in accordance with ASTM A240 shall be in a solution annealed condition. Shop fabricated fittings made from pipe shall be in accordance with AWWA C220, ASTM A312, ASTM A778. Design standard shall be in accordance with AWWA C226 and thickness of all reinforcement collars and pads shall be determined by the appropriate formula in the latest edition of AWWA M11.

3.4. Pipe Coating: Do not paint stainless steel piping.

END OF SECTION

1. GENERAL

1.1. Summary

1.1.1. This section is intended for use in specifying pipe for conveyance projects that are 300 mm in diameter or larger. For plant piping and pipe less than 300 mm in diameter, refer to data sheet that is available in Section 40 20 10, Process Piping General.

1.2. Related Requirements

1.2.1. Process Piping General SS 40 20 10

1.2.2. Process Valves General SS 40 50 10

1.3. Shop Drawings:

1.3.1. Marking plan and details of standard pipe section showing dimensions, pipe joints, fittings and special fittings, jointing systems, pressure rating and thickness, size, coating and lining data and other pertinent information.

1.3.2. Hydraulic Thrust Restraint for Restrained Joints: Details including materials, sizes, assembly rating and pipe attachment methods.

1.4. Submittals for Information:

1.4.1. Manufacturer's Certificate of Compliance stating that inspections and specified tests have been made and that results thereby comply with requirements of Article Source Quality Control.

1.4.2. Field Hydrostatic Testing Plan: Submit at least 15 days prior to testing and at minimum, include the following:

a) Testing dates.

b) Piping systems and section(s) to be tested.

c) Method of isolation.

d) Method of conveying water from source to system being tested.

e) Calculation of maximum allowable leakage for piping section(s) to be tested.

f) Method for safe disposal of tested water.

1.5. Certifications of Calibration: Approved testing laboratory certificate of pressure gauges for hydrostatic test.

1.6. Delivery, Storage and Handling

1.6.1. Flanges: Securely attach metal, hardboard or wood protectors over entire gasket surface.

1.6.2. Threaded Ends: Fit with metal, wood, or plastic plugs or caps.

1.6.3. Cold Weather Storage: Locate products to prevent coating from freezing ground.

1.6.4. Handling: Use heavy canvas or nylon slings to lift pipes, fittings and special fittings. Cables or chains shall not be used. If pipe material is damaged during handling it shall be replaced.

1.6.5. Delivery, storage and handling shall be in accordance with manufacturer's recommendations. Pipes, fittings and special fittings shall not be stored on rock or other hard material that may damage the pipes, fittings and special fittings.

1.6.6. Pipes fittings and special fittings shall be marked indicating manufacturer's name, pipe type and class.

1.6.7. Damaged pipes, fittings and specials will not be accepted.

2. PRODUCTS

2.1. Pipe:

2.1.1. General:

a) Centrifugally cast, grade 60 42 10 iron, minimum 1,035 kPa working pressure.

b) Meet requirements of AWWA C150, C153 and C111.

c) Lined and coated as specified.

2.1.2. Pressure class of pipe shall be 1,035 kPa.

2.1.3. Pipe wall thickness of threaded pipe for a flanged pipe end shall be minimum special thickness Class 53 from 300 mm to 1,350 mm diameter pipe in accordance with AWWA C115.

2.1.4. Grooved end pipe, for all pipe diameters, shall be minimum Special Class 53.

2.1.5. Pipe shall be new and recently manufactured. Refurbished pipe shall not be provided.

2.2. Joints:

2.2.1. Push-On Joint: Rated at minimum working pressure equal to pipe material design.

2.2.2. Restrained Joint:

a) Manufactured proprietary joint that mechanically restrains pipe to adjoining pipe.

b) Manufacturers and Products:

i. U.S. Pipe; TR Flex and Restrained Tyton.

ii. American Ductile Iron Pipe; Flex Ring and Lok Ring.

iii. Canada Pipe Company Limited; Thrust Lock, Super Locl, MJ/TJ Lock.

2.2.3. Use of set screws for restraint or field lock gaskets shall not be allowed.

2.2.4. Flanged Joints: Threaded 1,725 kPa working pressure ductile iron flanges conforming to AWWA C115.

2.3. Fittings:

2.3.1. Ductile Iron, Push On, Flanged or Restrained Joint: In accordance with AWWA C110, at 1,725 kPa minimum working pressure for 75 to 600 mm fittings and 1,035 kPa minimum working pressure for 750 to 1,200 mm fittings

2.3.2. Mechanical Joint Fittings: In accordance with AWWA C111.

2.3.3. Grooved End Fittings:

a) Radius cut grooved, fixed type conforming to AWWA C110 and AWWA C153.

b) Flanges: When required, furnish with grooved type flange adaptors of same manufacturer as grooved end coupling.

c) Manufacturers:

i. Victaulic, Gustin Bacon, or approved alternative.

2.3.4. Fittings shall be new and recently manufactured. Refurbished fittings will not be accepted.

2.4. Lining: shall be with 40-mil (1.1 mm) ceramic epoxy, as manufactured by Induron.

2.5. Coating: Asphaltic coating, 1 mil (25 micron) thick, in accordance with AWWA C151, C115, C110 and C153.

2.6. Bolting:

2.6.1. Bolts for flanged connections shall be carbon steel, ASTM A307, Grade A hex bolts and ASTM A563, Grade A hex head nuts.

2.6.2. Bolts for grooved end connections shall be manufacturer's standard.

2.7. Gaskets:

2.7.1. Gaskets for flat faced 1,035 and 1,725 kPa working pressure flanges shall be 3 mm thick, red rubber (SBR), hardness 80 (Shore A), rated to 200 degrees F, conforming to ANSI B16.21, AWWA C207, and ASTM D1330, Grades 1 and 2.

2.7.2. Gaskets for grooved end joints shall be Halogenated butyl, conforming to ASTM D2000 and AWWA C606.

3. EXECUTION

3.1. Inspect pipe and fittings to ensure no cracked, broken, or otherwise defective materials are being used.

3.2. Provide and use proper implements, tools, and facilities for safe and proper execution of Work.

3.3. Lower pipe, fittings, and appurtenances into trench, piece by piece, by means of a crane, slings, or other suitable tools and equipment, in such a manner as to prevent damage to pipe materials, protective coatings and linings.

3.4. Do not drop or dump pipe materials into trench.

3.5. Handle pipe with special care during temperature below freezing.

3.6. Follow manufacturer's instructions for handling of pipes.

3.7. Cleaning Pipe and Fittings:

3.7.1. Remove lumps, blisters, and excess coal tar coating from bell and spigot ends of each pipe. Wire brush outside of spigot and inside of bell and wipe clean, dry, and free from oil and grease before pipe is laid.

3.7.2. Wipe ends of mechanical joint pipe and fittings and of rubber gasket joint pipe and fittings clean of dirt, grease, and foreign matter.

3.7.3. Maintain pipe clean as work progresses. Do not allow water to flow through pipe during construction.

3.7.4. Do not use solvents to clean joints.

3.8. Lay pipes on prepared trench grade, bed, true to line and grade as shown in Drawings.

3.9. Direction of Laying: Lay pipe with bell end facing in direction of laying. For lines on an appreciable slope, face bells upgrade at discretion of the Consultant.

3.10. Mechanical Joint, Push On Joint, and Restrained Joint Pipe: After first length of pipe is installed in trench, secure pipe in place with approved embedment material tamped under and along sides to prevent movement. Keep ends clear of embedment material. After each section is jointed, place embedment material as specified to prevent movement.

3.11. Take precautions necessary to prevent floating of pipe prior to completion of backfill operation.

3.12. When using a movable trench shield, take necessary precautions to prevent pipe joints from pulling apart when moving shield ahead.

3.13. Do not allow foreign material to enter pipe while it is being placed in trench.

3.14. Close and block open end of last laid section of pipe to prevent entry of foreign material or creep of gasketed joints when laying operations are not in progress, at close of day's work, or whenever workers are absent from the job.

3.15. Ensure that the barrel of each pipe is in contact with the bedding throughout its full length.

3.16. Ensure that the ends of pipes butt against each other so that there is no unevenness along the inside.

3.17. Maintain trench dry and do not lay pipe in water.

3.18. If the temperature of air is below 0 degrees C, provide all necessary heating equipment, tarpaulins, etc. to prevent the trench from freezing.

3.19. Lay no pipe when the air temperature is below –4 degrees C, unless permission has been granted by the Consultant.

3.20. Joining Push On Joint Pipe and Mechanical Joint Fittings:

3.20.1. Join pipe with push on joints and mechanical joint fittings in strict accordance with manufacturer's recommendations.

3.20.2. Provide special tools and devices, such as, special jacks, chokers, and similar items required for installation.

3.20.3. Do not use backhoe for pushing pipes.

3.20.4. Lubricate pipe gaskets using lubricant furnished by pipe manufacturer. No substitutes will be permitted.

3.20.5. Clean ends of fittings of dirt, mud, and foreign matter by washing with water and scrubbing with a wire brush, after which, slip gland and gasket on plain end of pipe. If necessary, lubricate end of pipe to facilitate sliding gasket in place, then guide fitting onto spigot of pipe previously laid.

3.20.6. Check position of rubber rings by using approved feeler gauge all around the pipe. If ring has been displaced, remove and correct rubber ring. Replace all damaged rubber rings.

3.21. Cutting Pipe:

3.21.1. General: Cut pipe for inserting valves, fittings, or closure pieces in a neat and workmanlike manner without damaging pipe or lining and so as to leave a smooth end, at right angles to the axis of the pipe.

3.21.2. Pipe: Cut pipe with milling type cutter or saw. Do not flame cut.

3.21.3. Dressing Cut Ends: Dress cut end of mechanical joint pipe to remove sharp edges or projections, which may damage rubber gasket. Dress cut ends of push on joint pipe by beveling, as recommended by manufacturer.

END OF SECTION

1. GENERAL

1.1. Summary

1.1.1. This section applies to supply, and installation of PVC piping for non-chemical related general process, potable, drainage and waste applications within the Valve & Metering Enclosure scope: Commodities include:

a) Air Valve Release Piping

b) Drainage

1.1.2. This section must be referenced to and interpreted simultaneously with all other Sections pertinent to the Work described herein.

1.1.3. Related Requirements

a) Process Piping General SS 40 20 10

b) Process Valves General SS 40 50 10

1.2. References

1.2.1. Reference Standards

a) Conform with the most recent version of all standards referenced in this Section.

ASTM	NSF	Other
D1784	NSF 14	CSA B137.3
D1785	NSF 61	
D2466		
D2467		
D2564		

1.3. Delivery, Storage and Handling

1.3.1. Store and handle in accordance with manufacturer recommendations.

1.3.2. Protect materials from contamination from dirt or road salt by shrink wrap or other suitable packaging, and end caps, prior to and during shipment.

1.3.3. Store materials in such a way to prevent scratching and scoring of the surface. Keep stored materials out of hot areas

1.3.4. Protect from direct exposure to sunlight.

1.3.5. Support pipe while in storage to prevent sagging or bending.

1.4. Design Conditions

1.4.1. Applies to all commodities where Schedule 80 PVC pipe is identified:

a) Normal commodity temperature range: 0.5 to 25 °C.

b) Normal service operating pressure range: 0 to 700 kPa

c) Maximum (intermittent short term) operating pressure: 900 kPa

d) Test pressure: 1036 kPa

1.4.2. Applies to Drainage and where Schedule 40 PVC pipe is identified:

a) Normal commodity temperature range: 0.5 to 25 °C.

b) Normal service operating pressure range: 0 to 100 kPa

c) Maximum (intermittent short term) operating pressure: 200 kPa

d) Test pressure: 300 kPa

1.5. Submittals

1.5.1. Contractor shall submit shop drawings with the proposed primer and solvent glue intended each type of commodity.

2. PRODUCTS

2.1. Provide piping systems as detailed below with components suitable for the operating:

Item	Size	Description
Pipe	All	Schedule 80 PVC, Type I, Grade I, or Class 12454-B conforming to ASTM D1784 and ASTM D1785. Threaded Nipples: Schedule 80 PVC.
Fittings	All	Schedule to match pipe above, Schedule 80 ASTM D2467 for socket weld type and Schedule 80 ASTM D2464 for threaded type.
Joints	All	Solvent socket weld except where connection to threaded valves and equipment may require future disassembly.
Flanges	All	One piece, molded hub type PVC flat face flange in accordance with Fittings above, ANSI B16.1 Class 125 drilling.
Bolting	All	Type 316 stainless steel, ASTM A193/A193M Grade B8M hex head bolts and ASTM A194/A194M Grade 8M hex nuts.
Gaskets	All	Flat Face Mating Flange: Full faced 3 mm thick ethylene propylene (EPR) rubber. Raised Face Mating Flange: Flat ring 3 mm thick ethylene propylene (EPR) rubber, with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment.
Solvent Cement	All	As recommended by the pipe and fitting manufacturer conforming to ASTM D2564.
Thread Lubricant	All	Teflon Tape.

3. EXECUTION

3.1. Install piping and fittings in accordance with manufacturer recommendations.

3.2. Use suitable tools specifically designed for use with thermoplastic piping and fittings.

3.3. Joining

3.3.1. Piping shall be joined with solvent cementing or butt fusion.

3.3.2. Solvent Cementing:

a) Inspect and clean all components prior to joining

b) Primer shall be used to soften areas prior to joining with cement.

c) Apply sufficient cement to fill gaps in joining area.

d) Assemble joints while surfaces are wet and soft.

e) Allow adequate time for surfaces to bond and fuse in order to achieve required strength for operating and test conditions.

i. Take into account ambient temperature for cure times.

3.3.3. Flange Joints

a) Bolt torque in accordance with manufacturer recommendations.

b) Flange faces shall be flush for installation. Gap between flanges shall not exceed 3 mm.

3.3.4. Where connecting plastic to metal pipes use flanges or flexible grooved joint couplings.

3.4. Provide adequate spacing at elbows and direction changes as well as expansion loops on straight runs to allow for thermal expansions and contraction based on commodity temperature ranges and manufacturer recommendations.

3.5. Pressure test in accordance with Section 40 20 10 Process Piping General.

END OF SECTION

1. GENERAL

1.1. Summary

1.1.1. This section applies to supply and installation of High Density Polyethylene (HDPE) Piping (HDPE) for pressure piping in the forcemain.

1.1.2. This section must be referenced to and interpreted simultaneously with all other Sections pertinent to the Work described herein.

1.1.3. Related Requirements

a) Process Piping General SS 40 20 10

b) Process Valves General SS 40 50 10

1.2. References

1.2.1. Comply with:

a) City of Nanaimo Engineering Standards & Specifications ,

b) Canadian General Standards Board: 41-GP-25M-77 – Pipe, Polyethylene for the Transport of Liquids.

c) ASTM International (ASTM):

i. D638, Standard Test Method for Tensile Properties of Plastics.

ii. D2657, Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings

iii. D2774, Standard Practice for Underground Installation of Thermoplastic Pressure Piping.

iv. D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.

v. F714, Standard Specification for Polyethylene (PE) Plastic Pipe (SDR PR) Based on Outside Diameter.

1.3. Submittals

1.3.1. Shop Drawings:

a) Catalog information confirming pipe, fittings, pressure rating, thickness, size and other materials conform to requirements of this Section.

b) Drawings of specific connection details.

1.3.2. Informational Submittals:

a) Certification from pipe manufacturer that Contractor is qualified to join, lay, and handle pipe.

b) Field Hydrostatic Testing Plan: Submit at least 15 days prior to testing and at minimum, include the following:

i. Testing dates.

ii. Piping systems and section(s) to be tested.

iii. Method of isolation.

iv. Method of conveying water from source to system being tested.

v. Calculation of maximum allowable leakage for piping section(s) to be tested.

vi. Method for safe disposal of tested water.

c) Certifications of Calibration: Approved testing laboratory certificate if pressure gauge for hydrostatic test has been previously used. If pressure gauge is new, no certificate is required.

d) Test report documentation.

1.4. Qualifications

1.4.1. Pipe Manufacturer: Listed with Plastic Pipe Institute as meeting recipe and mixing requirements of resin manufacturer for resin used to manufacture pipe for this Project.

1.4.2. Persons fusing HDPE pipe shall have minimum of 10 year of experience with fusing HDPE pipe and shall have received training for fusing HDPE pipe in accordance with recommendations of pipe supplier or fusing equipment supplier.

1.5. Delivery, Storage and Handling

1.5.1. Delivery, storage and handling shall be in accordance with manufacturer's recommendations.

1.5.2. Pipes, fittings, and specials shall be marked indicating manufacturer's name, pipe type, size and class.

1.5.3. Shipping: Do not scrape, cut, kink, or otherwise damage pipe during transportation.

1.5.4. Storage:

a) Limit stacking of pipe to a height that will not cause excessive deformation of bottom layers of pipes under anticipated temperature conditions.

b) Where necessary due to ground conditions that may damage the pipes and fittings, store pipe on wooden sleepers, spaced suitably and of such widths as not to allow deformation of pipe at point of contact with sleeper or between supports.

c) Following manufacturer's recommendations for cold weather storage.

1.5.5. Damaged pipes, fittings and specials will not be accepted.

1.6. Environmental Conditions

1.6.1. Fusing Conditions:

a) Allow for expansion and contraction due to temperature change.

2. PRODUCTS

2.1. Pipe and fittings materials

2.1.1. Pipe lengths, fittings, and flanged connections to be joined by thermal butt fusion shall be of same type, grade, and class as specified in the Drawing Notes for entire polyethylene compound and supplied from same raw material supplier.

2.1.2. Fittings shall be molded for sizes 150 mm and smaller and shall be fabricated from polyethylene pipe; for sizes 200 mm and larger, by means of thermal butt fusion or molded. Ends of fabricated fittings shall not be trimmed to match pipe section to which they are going to be joined. Polyethylene fittings shall have same or higher pressure rating as pipe when installed.

2.1.3. Flanges: ASTM A240, Type 316 stainless steel, ANSI B16.1 Standard drilling. Flanges shall be complete with one piece, molded polyethylene stub ends. Flanged connections shall have same or greater pressure rating as pipe.

2.1.4. Gaskets: Gasket material, size, and thickness shall be as recommended by pipe or flange manufacturer.

2.1.5. Joints: Thermal butt fusion, except where connecting to unions, valves, and equipment with flanged connections that may require future disassembly.

2.1.6. Bolts, Nuts, Washers: Type 316 stainless steel, ASTM A193, Grade B8 hex head bolts; and ASTM A194, Grade 8 hex head nuts. Bolts shall be fabricated in accordance with ANSI B18.2.2 and provided with washers of same material as bolts.

2.1.7. Gaskets: Flat ring, 3 mm ethylene propylene rubber (EPR).

3. EXECUTION

3.1. Examination

3.1.1. Verify Conditions Prior to Installation.

3.1.2. Inspect pipe and fittings to ensure no cracked, broken or otherwise defective materials are being used.

3.2. Installation

3.2.1. Fabricate and install polyethylene pipe in strict conformance with pipe manufacturer’s recommendations.

3.2.2. Joining: Butt fuse pipes and fittings in accordance with pipe manufacturer’s recommendations. Depending on site conditions, perform butt fusion joining in or outside of excavation.

3.2.3. Mechanical Connections: Connect HDPE pipe to auxiliary equipment such as valves, pumps, tanks, and other piping systems with flanged connections as follows:

a) Polyethylene “stub end”, thermally butt fused to ends of pipe.

b) Backing flange, as specified.

c) Bolt and nut of sufficient length to show a minimum of three complete threads when joint is made and tightened to manufacturer's standard. Retorque nuts after 4 hours.

d) Gaskets as specified.

3.2.4. Special Precautions at Flanges: Support polyethylene pipe connected to heavy fittings, manholes, and rigid structures in such a manner that no subsequent relative movement between polyethylene pipe at flanged joint and rigid structures is possible.

3.3. Placement in Trench:

3.3.1. Handle joined pipeline in such a manner that pipe is not damaged by dragging it over sharp and cutting objects.

3.3.2. Position slings for handling pipeline away from butt fused joints.

3.3.3. Remove sections of damaged pipe and replace it with undamaged pipe. Damaged pipe is defined as pipe with visible kinks or gouges exceeding.

3.3.4. Exercise care when lowering pipe into trench to prevent damage or twisting of pipe.

3.3.5. Snake pipe from one side of trench to other to allow for thermal and settling movements.

3.3.6. At flanges, valves, and connections, excavate trench bottom out sufficiently to ensure clearance between undisturbed trench bottom and flange, valve, or connection.

3.3.7. Handle pipe with special care during temperature below freezing.

3.3.8. Maintain trench dry and do not lay pipe in water.

3.3.9. If the temperature of air is below 0 degrees C, provide all necessary heating equipment, tarpaulins, etc. to prevent trench from freezing.

3.3.10. Lay no pipe when air temperature is below –4 degrees C, unless permission has been granted by the Engineer.

END OF SECTION

1. GENERAL

1.1. Summary

1.1.1. This Supplemental Specification Section specifies supply and installation of all valves and related appurtenances installed on process piping systems. This section must be referenced to and interpreted simultaneously with all other Sections pertinent to the Work described herein.

1.2. Related Requirements:

1.2.1. 40 20 10 - Process Piping General

1.2.2. 40 51 13 – Eccentric Plug Valves

1.2.3. 40 52 15 – Knife Gate Valves

1.2.4. 40 53 19 - Ball Valves

1.3. References

1.3.1. Reference Standards

a) Conform with the most recent version of all standards referenced in this Section.

i. ANSI Bl.20.1: Pipe Threads, General Purpose, Inch

ii. ANSI B16.l: Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250

iii. ANSI B16.5: Pipe Flanges and Flanged Fittings: NPS ½ through NPS 24 Metric/Inch Standard

iv. MSS SP-25: Marking System for Valves, Fittings, Flanges and Unions

1.4. Submittals - Review

1.4.1. Provide catalogue cuts and/or shop drawings for each type of valve and actuator indicating the valve number, materials of construction, dimensions, head loss characteristics through the valve, operating torque and maximum pull on actuator, and valve end configuration.

1.4.2. Provide valve pressure/temperature rating. For bidirectional valves provide rating for both sealing directions.

1.4.3. For butterfly and plug valves provide headloss vs. percent open curves.

1.4.4. Canadian Registry Number (CRN) designated by the Province of British Columbia. Where applicable.

1.4.5. A copy of the specific valve specification sections marked to indicate with check marks where the valve supplied meets the specification and with written amendments with explanation where the product differs from the

specification.

1.4.6. On piping submittals, indicate direction of sealing.

1.5. Submittals - For Operations and Maintenance Manuals

1.5.1. Submit operation and maintenance data for incorporation into operation and Maintenance manual, including detailed exploded views, a complete numbered list of replacement and repair parts, and supplier and parts manufacturer's contact information.

1.6. Quality Assurance

1.6.1. If a CRN is not available, provide a letter notarized in Canada and stating:

a) The standard or code under which the valve was manufactured (ANSI, MSS, AWWA, etc.)

b) If not stated under the code in Item (a), state the pressure/temperature rating of the valve body, seat, and all seals.

c) The quality control program under which the valve was manufactured.

1.6.2. Provide valves marked in accordance with MSS SP-25 for type, size, rating, and where applicable, direction of flow.

1.7. Delivery, Storage and Handling

1.7.1. Deliver valves and unload at site using methods which do not damage casings, coatings or any valve or actuator parts.

1.7.2. Clearly tag each valve stating size, type, coatings and mating parts.

1.7.3. Store on site using methods recommended by the manufacturer to prevent damage, stress, weathering or corrosion.

2. PRODUCTS

2.1. General

2.1.1. Provide valves of the same type, size range and service from a single manufacturer.

2.1.2. All valves to have true alignment or bores.

2.1.3. Unless otherwise indicated on the Process and Instrumentation drawings valves shall be the same size as the pipe run in which they are to be installed.

2.1.4. Valves to open counter-clockwise.

2.1.5. The process drawings indicate major process valves required for the process to operate as intended. Where a valve may be required for the process to function correctly or is required to satisfy fire and safety codes but is not shown in the drawings, inform the *Consultant* and provide details and suggest ions for remedial action. Do not commence piping in the related pipe run until obtaining the *Consultant's* approval.

2.2. Valve Ends

2.2.1. Unless shown on the Drawings otherwise, valves less than 75 mm diameter shall have female threaded connections conforming to ANSI B1.20.1. Valve sizes greater or equal to 75 mm shall have flanged connections to ANSI B16.1 or ANSI B16.5. Valves with grooved joint ends are not to be used without the written approval of the Consultant.

2.2.2. Lug style water body valves shall have tapped holes.

2.3. Manual Lever or Handwheel Actuators

2.3.1. Provide operator and actuator types as specified on the Drawings.

2.3.2. Provide lever actuators for small diameter quarter turn valves. Operator to be perpendicular to the pipe run when the valve is closed.

2.3.3. Unless noted otherwise on the *Drawings,* provide lever operator for ball and butterfly valves less than 150 mm diameter, and plug valves less than 100 mm diameter, unless noted otherwise on drawings.

2.3.4. Maximum pull on the end of the lever arm or at the rim of a handwheel not to exceed 300 N when one side of the valve is at test pressure and one side is at atmospheric pressure. If greater force is required, provide suitable gear operator.

2.3.5. Provide padlockable lockout feature on all control valves and manual isolation and shut-off valves.

2.3.6. Provide valve stem extensions where noted on the Drawings or where additional clearance is required for pipe insulation or where operation without the extension is difficult.

2.3.7. Minimum hand wheel diameter:

a) 38 mm valve: 75 mm handwheel

b) 50 mm valve: 85 mm handwheel

c) 250 mm valves and larger: 400 mm handwheel

2.3.8. Minimum lever operator length:

a) 25 mm valve: 125 mm lever

b) 38 mm valve: 150 mm lever

c) 50 mm valve: 150 mm lever

d) 75 mm valve: 175 mm lever

e) 100 mm valve: 225 mm lever

f) 150 mm valve: 250 mm lever

2.4. Manual Gear Actuators

2.4.1. Provide manual gear actuators for valves not specified to have a manual lever operator.

2.4.2. Worm gear operator to be equipped with a non-rising stem handwheel and an integrated visual indicator of the valve position.

2.4.3. Gear operators shall be grease lubricated. Where gear operators are intended for direct bury or submergence, seal units with long life lubricant recommended by the gear operator manufacturer for the specific application. Gear operators for direct bury or submergence to be manufactured in accordance with AWWA C504.

2.4.4. Equip operators with mechanical stop-limiting devices to prevent over travel of the disc, ball or plug in the open and closed positions, self-locking to hold the valve in any intermediate position between full open and full closed. Actuator components between the input and the stop limiting device shall be designed to withstand, without damage, a rim pull of 890 N for a handwheel or chainwheel and an input torque of 400 N m for wrench nuts.

2.4.5. Actuator shall provide 1.25 times required operating torque under full rated line pressure for direct bury or submergence applications, or for commodities with 2% or greater solids content; 1.0 times required operating torque under full rated line pressure in other applications.

2.4.6. Maximum pull at rim of hand wheel with gear operator - 300 N.

2.4.7. Manual operators for buried service valves to include an AWWA operating nut and be gasketed and grease packed for submerged operation at water pressures up to 700 kPa. Where angle valve stem extensions are employed, they shall be angle geared. Provide valve stem extension to surface with cast iron valve box, lid and rock plate.

2.4.8. Operators intended for submerged applications shall rated as such and be grease packed and fully sealed for full submergence up to depths of 7m. Use stainless steel or epoxy coated cast or ductile iron enclosures. All stem extensions shall be manufacturerd from a suitable grade of stainless steel.

2.4.9. Actuator body to be exterior epoxy coated.

2.4.10. Orientation of valve as per mechanical drawings or to allow for the greatest degree of hand wheel access.

2.4.11. For manual valves on pipes 75 mm and greater mounted over 2 m above the operating floor, provide chain wheel gear operators, sized so that a force of 150 N is sufficient to open the valve when one side of valve is at test pressure and the other side is at atmospheric pressure. Chain pulley to mesh positively with the chain. Extend chain from valve operator to 1.2 m above the operating floor or as directed by the *Consultant,* with exact dimensions field determined. Provide approved chain hooks where required to prevent chain from hanging within traffic paths.

2.5. Valve Identification

2.5.1. Tag all values using AISI 304 stianless steel tags with 12 mm high engraved letters and numbers. Fill numbers and letters with black paint. Attach tag to valve using a 304 stainless steel chain or braided wire. Inscription to include valve size in mm, manufacturer and model number.

2.6. Coating

2.6.1. Coat all carbon steel, ductile iron and cast iron valves and actuators for corrosion protection. Use liquid or fusion bonded epoxy or approved equal.

2.6.2. All valves and actuators to be provided with factory applied coatings rated warrantied for the intended service application.

3. EXECUTION

3.1. Preparation

3.1.1. The valve and piping arrangement indicated on the drawings is based on typical dimensions for valves of the specified type. Make all necessary modifications in the *Work* to allow for discrepancies between the valve dimensions shown and those supplied for the *Work,* at no extra cost.

3.1.2. Ensure that valve location and orientation provides suitable access to manual operators and that sufficient space and accessibility is available for automatic actuators.

3.1.3. Ensure that valve location and orientation provides sufficient space for tightening of flange and valve nuts with a standard wrench.

3.1.4. Ensure that valve actuators can operate without conflicting with other piping, equipment, structures or insulation. Do not cut insulation to allow valve actuators to operate. Where conflicts are identified, inform the *Consultant* and propose modifications. Do not commence work on the affected piping run until modifications are approved.

3.2. Installation

3.2.1. Install all valves in accordance with manufacturer's instructions.

3.2.2. In horizontal pipe runs other than in locations where space does not permit, mount all valves except for butterfly valves and trunnion ball and plug valves with a vertical operating shaft with the actuator at the top. In no case install a valve with the operator shaft pointing down.

3.2.3. Mount butterfly valves and trunnion ball and plug valves with the shaft in a horizontal orientation. Plugs to rotate to top of pipe to open. Disks to swing up in direction of flow to open.

3.2.4. Provide spool pieces between butterfly valves, swing check valves and fittings as required to allow for free disc movement.

3.2.5. Do not over torque bolts to correct for misalignment.

3.2.6. Support valves in position using temporary supports until valves are fixed in place.

3.2.7. Unless otherwise specified, install single seated ball valves and knife gate valves with the seat downstream. Install at tank connections with seat away from tank. Install on pump discharge and suction lines with seat adjacent to the pump.

3.3. Coating

3.3.1. Repair and damage to shop coating as recommended by valve manufacturer, including and not limited to:

a) Steel brushing for removal of any rust

b) Solvent cleaning of repair and surrounding area

c) Priming coat

d) Two coats of top coat

3.4. Testing

3.4.1. **All** valves to be shop tested according to current applicable ANSI or AWWA Standards and the standards under which the valves were manufactured.

3.4.2. Operate valves under simulated and/or real process conditions to ensure valves operate as intended.

3.4.3. Pressure test valves in conjunction with the pipes in which the valves are installed.

END OF SECTION

1. GENERAL

1.1. Summary

1.1.1. This section covers supply, install and testing of 400 mm to 500 mm 100% Eccentric Plug Valves of rectangular port construction with resilient faced cylindrical plugs eccentrically offset from the seat for sanitary sewage application in the valve building as indicated on the drawings.

1.2. Related Requirements:

1.2.1. 40 20 10 - Process Piping General

1.2.2. 40 50 10 – Process Valves General

1.3. References

1.3.1. ASTM A126 Class B "Gray Iron Castings for Valves, Flanges and Pipe Fittings"

1.3.2. ASME B16.1 "Pipe Flanges and Flanged Fittings"

1.3.3. AWWA C517 “Resilient-Seated Cast-Iron Eccentric Plug Valves”

1.3.4. AWWA C111 "Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings"

1.3.5. NSF/ANSI 372 “Drinking Water System Components - Lead Content”

1.4. Submittals

1.4.1. Submit detailed product data and descriptive literature to include dimensions and materials of construction.

1.4.2. Provide shop drawings to show installation arrangement of major component assemblies.

1.5. Quality Assurance

1.5.1. Supplier shall have been manufacturing eccentric plug valves for a period of at least ten years. At the Consultant’s request, supplier shall provide a list of installations involving equipment of similar size and application.

1.5.2. Valves and Actuators shall be warranted by the manufacturer for defects in materials and workmanship for a period of two years (24 months) from date of shipment.

1.5.3. Each valve and actuator shall be assembled, adjusted and tested as a unit by the valve manufacturer.

2. PRODUCTS

2.1. Valves shall be quarter-turn, non-lubricated with resilient encapsulated plug.

2.2. Valve components:

2.2.1. Connections:

a) Flanged valves shall have flanges with drilling to ANSIB16.1, Class 125.

b) Mechanical Joint valves shall fully comply with ANSI/AWWA C111/A21.11.

2.2.2. Body Material - Cast Iron, ASTM A126, Class B

2.2.3. One-piece construction fully encapsulated with resilient facing per ASTM D2000-BG and ANSI/AWWA C517 requirements.

2.2.4. Type 316 Stainless Steel Bearings -ASTM A743 Grade CF8M, Welded-In Nickel Seat

2.2.5. Totally enclosed, geared, manual operator with handwheel, 50 mm nut, or chain wheel. Size operator for 1.5 times the maximum operating shutoff pressure differential for direct and reverse pressure, whichever is higher. For buried service, provide completely sealed operator filled with heavy lubricant.

2.2.6. Totally enclosed and sealed worm gear actuator with position indicator (above ground service only) and externally adjustable open and closed stops.

2.2.7. Size operator for 1.5 times the maximum operating shutoff pressure differential for direct and reverse pressure, whichever is higher. For buried service, provide completely sealed operator filled with heavy lubricant.

2.2.8. Provide internal and external epoxy coating.

2.3. Manufacturers and Products:

2.3.1. Val-Matic; Cam-Centric 5800

2.3.2. DeZurik; Style PEC

3. EXECUTION

3.1. Not used.

END OF SECTION

1. GENERAL

1.1. Summary

1.1.1. This section applies to bi-directional drip-tight knife gate valves sizing from 100 mm to 200 mm installed in valve chambers as indicated in the Drawings.

1.1.2. This section must be referenced to and interpreted simultaneously with all other Sections pertinent to the Work described herein. All materials not specifically listed or specified but required to complete the installation are the responsibility of the Contractor.

1.1.3. Related Requirements:

a) 40 20 10 - Process Piping General

b) 40 50 10 – Process Valves General

1.2. Working pressure:

1.2.1. 1,035 kPa (150 psi)

2. PRODUCTS

2.1.1. Materials:

a) Bonnetless, full lug body, rated 1035 kPa CWP, bi-directional drip-tight differential pressure rating of 1035 kPa up to 350 mm, drilled and tapped to ASME B16.5 Class 150 dimensions, round port, resilient seat/seals of EPDM or PTFE, drip-tight shutoff.
b) The resilient seat shall be field replaceable and not be pressure dependent at low pressures. All resilient seated valves shall provide zero leakage through the full range of the pressure rating of the valve.
c) Type 316 stainless steel body, gate and stem; aluminum bronze or brass stem nut; braided graphite- or Teflon-impregnated packing with resilient core; stainless steel packing gland; low friction gate with rounded or chamfered edges.
d) Packing system to provide zero leakage seal at all pressures, around the gate; valve superstructure and yoke designed for full peripheral access to gland bolts when valve is equipped with manual bevel gear handwheel or power actuator.
e) Direct mount handwheel.
f) In compliance with MSS SP 81 and AWWA C520.

2.1.2. Manufacturers and Products: PMP Mono Series, Bray Series 740, or approved alternative.

3. EXECUTION

3.1. Not used.

END OF SECTION

1. GENERAL

1.1. Summary

1.1.1. This section applies to metallic ball valves 6 mm to 50 mm diameter provided for all commodities as identified on the drawings.

1.1.2. This section must be referenced to and interpreted simultaneously with all other Sections pertinent to the Work described herein

1.1.3. Related Requirements:

a) 40 20 10 - Process Piping General

b) 40 50 10 – Process Valves General

1.1.4. Valves to be rated to 1,035 kPa working pressure at 100°C

2. PRODUCTS

2.1.1. Material:

a) Body: 304 or 316 stainless steel, full port, two-piece, ASTM A351 CF8M

b) Valve Ends: NPT Female threaded ANSI B1.20.1

c) Coating: Not applicable

d) Lining: Not applicable

e) Ball: 304 or 316 floating ball, ASTM A351 CF8M

f) Seats: Reinforced PTFE

g) Stem: 316 SS, blow-out proof.

h) Packing: Reinforced PTFE

i) Actuator: 304 or 316 SS locking lever handle, vinyl coated

2.1.2. Manufacturers and Products: KITS Type 600 or approved alternative.

3. EXECUTION

3.1. Not used.

END OF SECTION

1. GENERAL

1.1. Summary

1.1.1. This section applies to sewage combination air release and vacuum valves, 100 mm connection diameter, provided for the valve chambers indicated in Drawings.

1.1.2. The valve shall be suitable for sewage service; combines the operating functions of both an air and vacuum valve and an air release valve. The air and vacuum portion shall automatically exhaust air during filling of a system and allow air to re-enter during draining or when a vacuum occurs. Air release portion to automatically exhaust entrained air that accumulates in system.

1.1.3. Single body unit with air and vacuum valve and an air release valve in a single housing.

1.1.4. This section must be referenced to and interpreted simultaneously with all other Sections pertinent to the Work described herein.

1.1.5. Related Requirements:

a) 40 20 10 - Process Piping General

b) 40 50 10 – Process Valves General

1.1.6. Rated Pressure: 1,600 kPa (232 psi).

2. PRODUCTS

2.1.1. Materials:

a) The valve shall consist of a single chamber stainless steel body, stainless steel direct acting float, solid small orifice top float and “Anti-Surge” float in HDPE, stainless steel nozzle, stainless steel top cap and EPDM rubber seals and seat.

b) The valve shall have an integral "Anti-Surge" Orifice mechanism which shall limit transient pressure rise or shock induced by closure to less than 1.5 x valve rated working pressure, however, must open to the full diameter of the valve size during a negative pressure.

c) Connection to the valve inlet shall be facilitated by flanged ends conforming to ANSI B16.5 Class 150 and Screwed NPT flush port.

2.1.2. Manufacturers and Products:

a) Vent-O-Mat Series RGXII model 1631 or approved equivalent

3. EXECUTION

3.1. Not used.

END OF SECTION

1. GENERAL

1.1. Summary

1.1.1. This Supplemental Specification specifies the supply and installation of piping supports, anchors, thrust restraints and seismic bracing. This section must be referenced to and interpreted simultaneously with all other Sections pertinent to the Work described herein.

1.1.2. Design, select, locate and provide pipe hangers, supports, anchors, thrust restraints and seismic bracing.

1.1.3. No attempt has been made to indicate all necessary pipe supports, anchors, thrust restraints and seismic bracing in the drawings. Details provided are intended as a general guide for quality only. The intent has been to indicate general arrangements and typical spacing but does not relieve the Contractor of the responsibility of designing and supplying a complete support system.

1.1.4. Related Requirements:

a) Section 40 10 10: Process Piping General

b) Section 40 50 10: Process Valve General

1.2. References

1.2.1. Definitions

a) Contractor's Engineer: A professional engineer registered in the Province of British Columbia qualified to do detailed piping structural design at the Contractor's cost.

b) Service loads: All static and dynamic loads which must be resisted by pipe hangers and supports including but not limited to:

i. Weights of pipes, valves, fittings, insulating materials, suspended hanger components, normal fluid contents.

ii. Weight of hydrostatic test fluid or cleaning fluid

iii. Reaction forces due to operation of all valves

iv. Wind, snow or ice loadings on outdoor piping

v. Loads from future piping shown on drawings

vi. Vibration

vii. Thrust forces caused by moving liquids and internal pressure

viii. Forces resulting from thermal expansion/contraction due to commodity and ambient temperature fluctuations

c) Design Loads: That combination of service loads producing the maximum load effects to be resisted by the pipe hangers and supports in accordance to the BC Building Code.

d) Seismic Loads: In accordance to the BC Building Code.

e) Allowable Load: the maximum design load as recommended by the manufacturers.

1.2.2. Reference Standards

a) Conform with the most recent version of all standards referenced in this Section.

i. BC Building Code

ii. BC Plumbing Code

iii. ANSI/ASME B31.3 Process Piping

iv. MSS SP-89 – Pipe Hangers and Supports: Fabrication and Installation Practices

v. MSS SP 58, Pipe Hangers and Supports – Materials, Design and Manufacture

vi. MSS SP-60 – Pipe Hangers and Supports – Selection and Application

vii. SMACNA – Guidelines for Seismic Restraints

1.3. Submittals - For Review

1.3.1. Details including precise location and factored design loads where piping is supported by any proposed supplementary structural members. Review by Consultant will be for support by the existing structure. Sizing of proposed supplementary structural members will remain the responsibility of the Contractor's Engineer.

1.3.2. Manufacturer's pipe hanger and support cut sheets.

1.3.3. Details of pipe thrust restraints and harnesses. Sizing of proposed thrust restraints and harnesses remain the responsibility of the Contractor's Engineer.

1.4. Submittals – For Information Only

1.4.1. Before commencement of installation, provide hanger, support, anchor and seismic restraint system design details including dimensions, dimensioned locations, load information, design calculations and illustrative drawings, stamped and signed by the Contractor's Engineer.

1.5. Delivery, Storage and Handling

1.5.1. Deliver materials and unload at site using methods which do not damage coatings or any parts.

1.5.2. Store on site using methods recommended by the manufacturer to prevent damage, stress, weathering or corrosion.

1.6. Site Conditions

1.6.1. Seismic design as per the most current edition of the British Columbia Building Code.

2. PRODUCTS

2.1. General

2.1.1. Design pipe support systems to support Design Loads with a factor of safety of 4.0 or as required for seismic bracing, whichever is greater.

2.1.2. Provide seismic restraints to resist pipe movements and loads occurring as a result of seismic events.

2.1.3. Where structural bearings are not in suitable locations, provide supplementary structural members.

2.1.4. Support plastic piping with at least 50 mm measured around the pipe perimeter and 50 mm longitudinal smooth bearing surface in contact with the pipe.

2.2. Maximum support spacing for horizontal straight runs of pipe is as tabulated, unless indicated otherwise on the Drawings. Provide additional supports as required to support the design loads.

Nominal Pipe Size	SS SCH 10 (m)	PVC SCH 80 (m)
25 mm		1.8
38 mm		2.0
50 mm		2.1
65 mm		2.3
75 mm		2.4
100 mm	3.7	2.7
150 mm	4.2	3.0
200 mm	4.6	3.4
250mm	4.9	
300mm	5.2	
350mm	5.4	
400mm	5.5	
450mm	5.6	
900mm	7.3	

2.2.1. Support copper tubing up to 15 mm in diameter every 1.8 m on centre. Tubing larger than 15 mm in diameter shall be supported every 2.4 m on centre.

2.2.2. Space plastic pipe supports to allow for expansion and contraction as recommended by manufacturers at elbows and changes in direction.

a) Where spacing for thermal expansion and contraction cannot be achieved provide expansions loops in accordance with manufacturer recommendations on straight pipe runs.

2.3. Materials

2.3.1. Steel hot dip galvanized after fabrication.

2.3.2. Cadmium plated steel nuts, bolts, washers and threaded rods.

2.3.3. 304 stainless steel: In dry interior conditions where clamping directly to or welding to stainless steel pipe, in wet interior conditions with open tanks or channels, in outdoor conditions and in submerged conditions.

2.3.4. Type 304 Stainless steel nuts, bolts, washers and threaded rods for corrosive, outdoor and submerged conditions.

2.3.5. 304 stainless steel: In interior spaces with open tankage or channels.

2.3.6. Reinforced cast in place concrete.

2.3.7. Provide isolation to prevent contact between dissimilar metals.

2.3.8. Isolate copper tubing from supports with a double thickness of Plycoflex 310 on Greenline accessory tape between the copper pipe and the supports.

2.3.9. Provide plastic or rubber end caps at the exposed ends of all framing channels that are located less than 2300 mm above the floor.

2.4. Manufactured Pipe Hangers and Supports

2.4.1. Acceptable Manufacturers:

a) Unistrut or approved equal

b) B-Line, Myatt, Standon or approved equal

2.4.2. Acceptable Types:

a) Pipe stanchion with saddle and yoke

b) Pipe stanchion with adjustable roller hanger

c) Riser Clamp

d) Offset Pipe Clamp

e) Framing Channel Pipe Strap

f) Framing Channels and Connection Fittings

g) Framing Channel Post Base

2.5. Thrust restraints

2.5.1. Prevent transmission of pipe movement and thrust forces onto equipment flanges or connections.

2.5.2. Where thrust restraints are used to prevent pipe movement and the transmission of thrust forces onto equipment flanges or connections:

a) Design pipe thrust restraints for thrust loads developed by 1.5 times the maximum pipe test pressure.

b) Provide compression coupling joints with rod type thrust harnesses anchored in accordance with AWWA M11.

c) Minimum tie-rod diameter – 19 mm.

2.6. Anchors

2.6.1. Provide number and location of anchors as determined by Contractor’s Engineer.

2.6.2. Reinforce piping as required at anchor locations to withstand applied forces.

2.7. Seismic Restraints

2.7.1. Unless otherwise required by local building codes, seismic restraints may be omitted from:

a) Compressed air piping less than 25 mm diameter.

b) All piping suspended by individual hangers 300 mm or less in length from the top of the pipe to the bottom of the support for the hanger.

2.7.2. Do not brace piping systems to dissimilar points of a building or to dissimilar building systems that may respond in a different mode during an earthquake.

2.7.3. Size restraints to fit the outside diameter of insulation, where insulation is specified.

2.7.4. Do not use branch lines to brace main lines.

2.7.5. Do not limit thermal expansion and contraction of the piping system by seismic bracing.

2.7.6. Provide a means to reduce noise and vibration transmission between linked fitting parts.

3. EXECUTION

3.1. Provide pipe support system to adequately secure the pipe and prevent undue vibration, and stress, and to prevent the transmission of forces to equipment and tanks.

3.2. Support piping in accordance with the pipe manufacturer's recommendations.

3.3. Support piping so that no pockets will be formed in the span due to sagging of the piping between supports.

3.4. Support piping so that temporary supports will not be required when removing parts of the piping system for equipment maintenance.

3.5. Provide temporary supports as necessary during construction to prevent overstressing of equipment, valves or pipe.

3.6. Do not support piping from equipment or other pipes.

3.7. Do not drill or burn holes in the building structural steel without prior written permission from the Consultant.

3.8. Do not use hanger components for rigging and erection purposes.

3.9. When fabricating products under this specification, use welding procedures to minimize distortion and avoid damage to finished work or bonded materials. Finished products to be true to line, free from twists, bends, open joints, sharp corners and sharp edges.

3.10. Recoat cut ends of galvanized framing channel with zinc dust-zinc oxide coating.

3.11. Hanger and support components in contact with plastic pipe to be free of burrs and sharp edges.

3.12. Rollers to roll freely without binding.

3.13. Locate any cast in place concrete supports to prevent encasement in concrete of valves, pipe appurtenances or easily disassembled pipe joints.

3.14. Finished floor beneath base plates and framing channel post bases to be roughed prior to grouting. Grout between base plate and floor to be free of voids and foreign material. Adjust stanchions to obtain required pipe slope and elevation prior to grouting of baseplates.

3.15. Cut and drill baseplates to specified dimensions prior to welding stanchions or other attachments and prior to setting anchor bolts.

3.16. Locate the first seismic restraint on a piping system not more than 3.0 m from the main riser, entrance to a building or piece of equipment.

3.17. Install seismic bracing within 45 degrees above and 45 degrees below horizontal relative to the horizontal centreline of the pipe.

END OF SECTION