ADDENDUM NO. 1 – Contract 2

BID DOCUMENTS FOR

NEW FOR RUPERT RESERVOIR AND REPLACEMENT
WATER TREATMENT RESERVOIR – CONTRACT 2

10/13/2017
FILE: 111720046

TENDER #: 1220-20-519-2017

ISSUED BY: _____

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Addendum issued to active tenderers with documents on record **(33 pages including attachments)**

1. Clarification: Drawing C310 Delete Project Designation: "Watermain Replacement, New Fort Rupert Reservoir and Replacement Water Treatment Reservoir – Contract 1"
   and replace with: "New Fort Rupert Reservoir and Replacement Water Treatment Reservoir – Contract 2".

2. Clarification: Drawing C311 Delete Project Designation: "Watermain Replacement, New Fort Rupert Reservoir and Replacement Water Treatment Reservoir – Contract 1"
   and replace with: "New Fort Rupert Reservoir and Replacement Water Treatment Reservoir – Contract 2".

3. Addition to page TC 1 article 3 add: "Appendix A – Port hardy Reservoirs & Watermain Construction Project Geotechnical Report".

4. Attached Appendix A - Port Hardy Reservoirs & Watermain Construction Project Geotechnical Report. (31 Pages)

5. Add missing page 12 of 12 within specification 33 69 00 Glassed Fused Bolted Steel Reservoir

Distribution:
District of Port Hardy to Post on BC Bid.

Geotechnical Investigation for New Reservoirs

Port Hardy Reservoirs &
Watermain Construction Project

Prepared for:
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September 22, 2017

Rev.	Description	Date	Author	Quality Check	Independent Review
0	Final	092617	W. Quong	W. Quong	J. Pineau
A	Draft	092217	W. Quong	W. Quong	J. Pineau

Stantec

Sign-off Sheet

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Joel Pineau

Stantec

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LIST OF APPENDICES

1.0 INTRODUCTION

The District of Port Hardy (District) owns and operates their municipal water system and have planned to upgrade their water storage and provide a new water main to service additional areas within their existing system. Stantec Consulting Ltd. (Stantec), acting in accordance with the terms of reference provided in our April 28, 2017 proposal in response to the District's Request for Proposal 1220-20-508-2017, has carried out a geotechnical investigation for new water reservoirs that are to be constructed at two sites in Port Hardy, British Columbia, as part of the Port Hardy Reservoirs & Watermain Construction Project (the Project).

The purpose of our geotechnical investigation was to obtain information on soil and groundwater conditions at the two reservoir sites, one of which is located near the existing Water Treatment Plant and the other at an undeveloped site near the intersection of Fort Rupert Road and Byng Road (hereafter referred to as the WTP reservoir site and Fort Rupert reservoir site, respectively). In addition, the results of the geotechnical investigation are used to carry out geotechnical engineering analyses and provide geotechnical recommendations for the design and construction of the new reservoir at the proposed Fort Rupert reservoir site.

The geotechnical engineering scope of work for the Project consisted of the following:

- Review of available project drawings and published geological mapping for the project sites
- A geotechnical subsurface investigation to characterize the soil and groundwater conditions at the two reservoir sites
- Laboratory testing of disturbed soil samples collected during our subsurface investigation
- Geotechnical engineering analyses to develop recommendations for design and construction of the new reservoir at the Fort Rupert reservoir site
- Preparation of this report

In accordance with Stantec's proposal, our geotechnical engineering scope of work for the Project does not include:

- A detailed geotechnical investigation of subsurface conditions within the footprint of the new reservoir at the WTP reservoir site
- Geotechnical recommendations for design and construction of the new reservoir at the WTP reservoir site
- Geotechnical investigation and assessment of soil and groundwater conditions for the watermain portion of the Project

1.1 PROJECT UNDERSTANDING

The Project consists of the replacement of one of the two existing water reservoir at the WTP reservoir site and the construction of a new water reservoir at the undeveloped Fort Rupert reservoir site, located near the intersection of Fort Rupert Road and Byng Road. It is understood that the new reservoir for the WTP reservoir site will be erected in place of the existing east reservoir (Tank No.1), following the disassembly and removal of the existing reservoir. It is understood that the design grade of the new reservoir will roughly match the design grade of the existing west tank (Tank No. 2).

The Fort Rupert reservoir site will be situated in a roughly rectangular shaped, gravel covered area, approximately 17 m x 35 m in size. The Fort Rupert facility also includes a small operations building (5 m x 7 m in size), a genset, and below-ground meter and chlorine analyzer/injection chambers and associated underground piping. The two below-ground chambers will extend up to a maximum 2 m depth. Access to the reservoir will be from the north side of Fort Rupert Road via a new, approximately 100 m long, gravel covered road. Design floor grades of the reservoir and operations building are 72.0 m and 72.5 m, respectively

The Project also includes construction of approximately 3 km of new and replacement watermain pipe throughout south eastern Port Hardy.

We understand that the new water reservoirs for the WTP reservoir and Fort Rupert reservoir sites will be bolted steel tanks supported on shallow concrete foundations and will have volumes of 2.7 ML (2,700 m^3) and 2.0 ML (2,000 m^3), respectively. We understand that the reservoirs will be designed by the manufacturer(s), and that final reservoir dimensions are unknown. However, we understand that water reservoirs are typically constructed to have a height to diameter ratio of one-to-one. Based on this understanding, the new reservoirs for the WTP and Fort Rupert reservoir sites are anticipated to have inside diameters in the order of 15.1 m and 13.7 m, respectively.

As per Stantec's proposal, a detailed geotechnical investigation and assessment of the WTP reservoir site will be necessary following demolition of the existing reservoir to provide geotechnical recommendations for design and construction of the new reservoir at this site.

Geotechnical recommendations for the new reservoir at the WTP Reservoir site are beyond Stantec's scope of work and are not included in this report.

Further, geotechnical investigation and assessment for the 3 km of new and replacement watermain pipe and PRV's was not included in Stantec's scope of work. The contents of this report should not be relied upon for the design and construction of this infrastructure.

2.0 SITE DESCRIPTIONS AND GEOLOGY

2.1 SITE DESCRIPTIONS

2.1.1 WTP Reservoir Site

The existing WTP reservoir site is situated on a hill located approximately 2.4 km to the west of downtown Port Hardy, British Columbia. Two 16.8 m diameter water reservoirs are located side-by-side and 19.8 m apart (centre-to-centre), approximately 430 m southwest of the WTP. We understand that the easternmost (Tank No.1) of these two water reservoirs will be replaced as part of the Project.

Photographs of as-built drawings for the two water reservoirs were taken by Stantec's Civil Engineering group during a meeting with the District. The full drawings are not available, but the images indicate that the drawings were prepared in 1977 and 1978 by Ker, Priestman & Associates Ltd. (KPA).

Photographs of the KPA as-built drawings indicate that the reservoirs were placed in an area that required soil removal and bedrock blasting to construct a level surface at approximate EL. 119 m (Geodetic). The photographs show that "Cl. B mass concrete fill" was used to level the ground beneath the reservoirs.

At the time of our field investigation (see Section 3.1), the area immediately surrounding the two reservoirs was flat and grass-covered. An approximately 80° rock slope, at least 9 m high, was present to the south of the reservoirs and as close as 2.5 m away from the reservoirs. The reservoir area was bounded by a gravel access road to the north and by dense forest to the east and west.

2.1.2 Fort Rupert Reservoir Site

The Fort Rupert reservoir site is situated on top of a hill located approximately 7 km southeast of downtown Port Hardy, British Columbia. The site is situated on a previously undeveloped property located northeast of the intersection between Fort Rupert Road and Byng Road. The reservoir site is located in a relatively flat area at elevation 72 m. South of the reservoir site, the ground slopes down to Fort Rupert Road at an average grade of 7%.

The site was densely forested, but just prior to our field investigation (Section 3.1) the trees were felled by Hecate Integrated Resources Ltd. The proposed reservoir site, gravel access road and the area between Fort Rupert Road, and the reservoir site, were entirely covered by the tree fall.

2.2 GEOLOGICAL MAPPING DATA

Review of surficial geology from Open File 1997-8 (Bobrowsky, 1997) indicates that the native soil deposits at the WTP reservoir site could consist of greater than 1 m of alluvial terrace sediments

(cobble to pebble gravel), or a morainal blanket of glacial diamicton, over bedrock. Glacial diamicton is typically unsorted to poorly-sorted glacial deposits and contains particles that range in size from clay to boulders.

Open File 1997-8 (Bobrowsky, 1997) indicates that native subsurface conditions at the Fort Rupert reservoir site are likely to comprise a morainal blanket, greater than 1 m thick, of glacial diamicton over bedrock.

3.0 INVESTIGATION PROCEDURES

3.1 FIELD INVESTIGATION

Stantec carried out a geotechnical site investigation of the two reservoir sites on August 29 and 30, 2017. On August 29, 2017, one test pit was mechanically excavated at each reservoir site using a backhoe that was provided by the District. The test pit at the WTP reservoir site (TP17-01) was excavated adjacent to the existing reservoir that is to be replaced and advanced to practical refusal on bedrock at a depth of approximately 0.6 m. The test pit at the Fort Rupert reservoir site (TP17-02) was excavated in proximity of the proposed gravel access road and advanced to practical refusal in hard soil at approximately 1.7 m below the existing grade.

On August 30, 2017, three solid stem auger boreholes were advanced at the Fort Rupert reservoir site using a track-mounted, Mobile B47 drill rig that is owned and operated by Blue Max Drilling Inc. The three boreholes (BH17-01 through BH17-03) were located in close proximity of the new reservoir footprint and advanced to practical equipment refusal on suspected bedrock at depths ranging from 3.0 m to 3.7 m below existing grade. Upon completion, all boreholes were backfilled with drill cuttings and reinstated in accordance with the BC *Groundwater Protection Regulation*.

Dynamic Cone Penetration Tests (DCPTs) were carried out adjacent to boreholes BH17-01 and BH17-02 to assess in-situ consistency or compactness of the existing soil layers. The DCPTs were advanced to 2.1 m and 2.7 m depth, at which point practical refusal was encountered (the DCPT cone could not advance below this depth after 43 and 80 blows, respectively).

The geotechnical site investigation was continuously monitored by the Stantec geotechnical engineering representative. The approximate locations of the test pits and auger boreholes at the WTP and Fort Rupert reservoir sites are shown on Figure No. 1 and Figure 2, respectively. (**Appendix B**).

3.2 LABORATORY TESTING

The objectives of the Stantec laboratory testing program were to aid in the visual classification of soil samples and to characterize engineering properties of the soils pertinent to our geotechnical engineering analysis. Geotechnical laboratory testing was performed in general accordance

with applicable standards by ASTM International. Laboratory testing was completed at the Stantec laboratory in Burnaby, British Columbia and consisted of visual classification (ASTM D2487 and D2488), water content measurement (ASTM D2216), and fines content measurement (ASTM D1140 Method A). The results of the laboratory testing program are shown on the Stantec test pit and borehole records in **Appendix C**.

4.0 SUBSURFACE CONDITIONS

4.1 WTP RESERVOIR SITE

Stantec excavated one test pit (TP17-01) to the east of the two existing reservoirs at this site. Approximately 100 mm of root mat was encountered at the surface of this test pit and was underlain by approximately 500 mm of fill. The fill consisted of poorly-graded, coarse sand with cobble and boulder-sized, blast-rock fragments.

The test pit was terminated on intact bedrock at approximately 600 mm below grade. Groundwater was not observed in the open test pit.

4.2 FORT RUPERT RESERVOIR SITE

4.2.1 General

A surficial topsoil layer was encountered in the Stantec boreholes completed near the footprint of the proposed new reservoir and varied in thickness from 250 mm to 450 mm. The topsoil layer was underlain by layers of fine-grained soil (silt and lean clay) that extended to depths ranging between 3.0 m and 3.7 m below current grade. Based on drilling resistance, it was inferred that bedrock underlay the fine-grained soils.

At the location of test pit TP17-02, completed in proximity of the proposed access road to the Fort Rupert reservoir site, a 150-mm thick layer of root mat was encountered at the ground surface and underlain by 450 mm of topsoil. The topsoil layer was underlain by approximately 900 mm of silty sand that, in turn, was underlain by lean clay. The test pit was terminated in the lean clay layer.

The soil conditions encountered in our subsurface investigation for the Project are described in detail on our borehole and test pit records and summarized in this section. The detailed borehole records, along with an explanation of the symbols and terms used for soil descriptions, are included in **Appendix C**. All soil descriptions were made in accordance with ASTM Standard D2487 and D2488.

4.2.2 Overburden Soils

4.2.2.1 Topsoil

Topsoil was encountered in all boreholes and test pits advanced at the Fort Rupert reservoir site. The topsoil layer consisted of silt or sandy silt with clay and contained varying amounts of gravel and organics. Measured moisture content of four samples of topsoil ranged from 33% to 80%.

4.2.2.2 Silt

A layer of brown silt with clay was encountered beneath the topsoil in boreholes BH17-01 and BH17-02. The silt layer was moist, approximately 1.2 m thick, and contained trace amounts of sand and gravel.

DCPT blow counts infer that the silt layer is very stiff from the top of the layer and is hard below approximately 0.9 m depth below grade. The measured moisture contents of two samples of the silt layer were 14% and 16%. Based on Atterberg limits test results from one sample of silt, the plastic limit and liquid limit of the soil were 14% and 23%, respectively (plasticity index of 9%).

4.2.2.3 Silty Sand

Silty sand with gravel was encountered below the topsoil layer in test pit TP17-02 (in proximity to proposed gravel access road). The silty sand layer was approximately 0.9 m thick and inferred to be compact to dense based on bucket resistance during excavation of the test pit.

4.2.2.4 Lean Clay

Lean clay with variable gravel content was encountered near the footprint of the proposed new reservoir beneath the topsoil layer in borehole BH17-03 and beneath the silt layer in boreholes BH17-01 and BH17-02. The lean clay layer was generally moist from the horizon of the layer, and dry below approximately 1.8 m to 2.1 m depth.

DCPT blow counts indicate that the lean clay encountered in the three boreholes is hard. The layer of lean clay was underlain by inferred bedrock between 3.0 m and 3.7 m depth in boreholes completed near the new reservoir.

A layer of lean clay was also encountered beneath the silty sand layer in test pit TP17-02 (in proximity of the proposed site access road). This layer of lean clay was inferred to be hard based on bucket resistance during test pit investigation, and the test pit was terminated approximately 0.2 m into the layer due to practical equipment refusal in this hard soil.

The measured moisture content of eight samples of lean clay ranged from 5% to 18%. Atterberg limits test results from two samples of lean clay indicated plastic limits of 11% and 15% and liquid limits of 25% and 26% (plasticity indexes of 14% and 11%).

4.2.3 Groundwater

The groundwater level was not observed in open boreholes or test pits at the Fort Rupert reservoir site.

5.0 DISCUSSION

5.1 FROST PENETRATION

The 2015 National Building Code of Canada (2015 NBCC) advises that frost penetration depth be assessed based on local experience. In the absence of local experience, frost depth may be estimated based on historic climate data for the area, surface cover and subgrade soil properties.

Frost protection depth for buried structures is estimated based on Freezing Index data (degree-days below 0 °C) and its relationship with frost penetration. The Environment Canada website (Government of Canada, 2017) provides the average climatic conditions for Canadian climate stations. The nearest recording station to the Site that Environment Canada website provides freezing index data for is the Port Hardy Airport station (E 615,432.4 m, N 5,615,545.0 m; Elev. 21.6 m Geodetic), for which a mean annual, I_m, value of 17.5 degree-days below 0 °C is reported for the recording period from 1981 to 2010. The mean annual air temperature for this recording station over this period is 8.6 °C.

The design freezing index, I_d, represents the coldest winter over the last 10-year period, as described in the 2006 Canadian Foundation Engineering Manual (The Canadian Geotechnical Society 2006). The Environment Canada website does not provide freezing index data for the coldest winter over this period. In the absence of historical data, I_d is determined from the following relationship:

$$I_d = 100 + 1.29 I_m$$

Based on this equation, the design freezing index for the Fort Rupert reservoir site was taken to be 123 degree-days below 0 °C.

Using the procedure described in the 2006 Canadian Foundation Engineering Manual (2006 CFEM) and climate data from the Environment Canada website, the design frost penetration depth at the Fort Rupert reservoir site is estimated to be approximately 0.25 m under mean air temperature conditions and 0.65 m under "coldest winter" conditions. These frost depth estimations assume that the sites will remain cleared of trees.

5.2 SEISMIC CONSIDERATIONS

The results of our subsurface investigation infer that it is appropriate to classify the seismic site response at the ground surface of the Fort Rupert reservoir site as Site Class "C", in accordance with the 2010 NBCC criteria, which was adopted in the 2012 British Columbia Building Code (BCBC). However, Site Class B, which corresponds to "rock", can be used if the underside of the new reservoir foundation at the Fort Rupert reservoir site is located 1.0 m or more below existing grade (i.e., if there is less than 3 m of soil between the bedrock and underside of the foundation).

5.3 SETTLEMENT

Three modes of consolidation or compression are associated with settlement: elastic compression, primary consolidation, and secondary compression. Settlement due to elastic compression is an immediate change in soil volume resulting from an increase in vertical stress due to applied loading. In general, settlements due to elastic compression will occur immediately as the load is applied and at the Fort Rupert reservoir site is considered minor in comparison to settlements due to primary and secondary consolidation.

Primary consolidation settlement is typically a concern for cohesive soils having soft to firm consistency and is associated with the dissipation of excess pore water pressure induced by development loads (e.g., increases in overburden pressure) over time. As the native silt and clay deposits which underlie the Fort Rupert reservoir site are heavily overconsolidated (i.e., the past vertical pressures are significantly greater than the present in-situ pressures) or desiccated, we consider there to be negligible risk of post-construction tank settlement due to primary consolidation.

Settlement due to secondary consolidation is a concern for organic-rich soils and/or very thick cohesive deposits and is independent of development loads. As organic-rich and/or thick cohesive deposits were not encountered at the Fort Rupert reservoir site in our site exploration, secondary consolidation is not expected to occur.

6.0 GEOTECHNICAL RECOMMENDATIONS

6.1 GENERAL

Based on the results of our geotechnical investigation and engineering analysis, the main findings of our geotechnical assessment for the Fort Rupert reservoir site are summarized below.

1. The proposed operations building and reservoir and ancillary structures may be supported on conventional shallow footings founded on undisturbed, native, very stiff silt or hard clay soils or founded on structural backfill on undisturbed, native silt or clay soils.

2. Based on the existing site grades, design elevations of the reservoir tank and operations building, and the thickness of topsoil encountered in the Stantec boreholes, it is anticipated that site grading fills of less 0.5 m will be required.

3. The native silt and clay soils are heavily overconsolidated. Therefore, based on the existing grades, the design tank elevation and the expected design tank loads, we consider that post-construction settlement of the reservoir tank will be minor (i.e., less than 25 mm).

Detailed geotechnical recommendations are provided in the following sections for design and construction of the proposed Fort Rupert reservoir site. Geotechnical review by Stantec will be required during construction to ensure that construction is completed in accordance with our recommendations.

Terminology and specifications for aggregates and granular materials used in subsequent sections of this report are in accordance with the Master Municipal Construction Document (MMCD) Volume II, 2009 edition, developed jointly by the Association of Consulting Engineering Companies of British Columbia, the British Columbia Road Builders and Heavy Construction Association, and the Municipal Engineers Division of the Association of Professional Engineers and Geoscientists of British Columbia.

6.2 SITE PREPARATION

Site preparation will include stripping of organics, topsoil and tree removal in the area of the proposed Fort Rupert reservoir site and gravel access road. These development areas were previously densely forested. The root system of these trees will need to be excavated and removed prior to construction of the reservoir tank, operations building and ancillary structure foundations, which may result in over-excavation of native silt or clay soils. In the event of over-excavation, structural fill material, as described in Section 6.4, should be used to bring the elevation up to design subgrade.

Structural fill for the proposed structures or site grading fills required to raise grades at the reservoir site or gravel access road should consist of pre-approved fill as described in Section 6.4.

Excavated native silt and clay soils are not suitable for re-use as building structural or site grading fills.

Since the native silt and clay soils are moisture-sensitive, site preparation should be scheduled for dry weather conditions where possible to reduce the amount of disturbance to any exposed subgrade. The construction subgrade should be provided with sufficient gradient to direct surface water run-off away from construction areas and into collector ditches or drains. If construction and excavation take place in wet weather conditions, all stripped surfaces with exposed silt or clay soils should be covered with at least 150 mm of granular material in order to reduce disturbance to these soils. If any portion of the silt or clay subgrade becomes softened due to moisture and construction activities, it will need to be sub-excavated and replaced with pre-approved fill as described in Section 6.4. For winter construction conditions, frozen soil should not be used as permanent fill, and fill should at no point be placed overtop frozen soil.

6.3 EXCAVATIONS AND DEWATERING

All excavations should be carried out in accordance with WorkSafe BC regulations. Unsupported excavations greater than 1.2 m in depth should be sloped no steeper than 1H:1V (horizontal to vertical). The use of steeper slopes for temporary excavations of greater depth will require certification by a qualified professional engineer or implementation of temporary shoring measures. Excavations should be inspected regularly for signs of instability, and slopes should be flattened if required. All excavations must be kept free of water to facilitate construction and inspection activities. As noted in Section 4.2, groundwater was not encountered in any of the boreholes. Accordingly, we consider that dewatering measures will be required only for removal of surficial run-off from excavations. Stantec anticipates that any required dewatering can likely be handled using conventional sumps and pumps.

6.4 STRUCTURAL FILL AND SITE GRADING FILL

Structural fill beneath the proposed structures and site grading fills for the reservoir site and gravel access road should consist of pit run gravel (MMCD Section 31 05 17, Item 2.3), or other pre-approved mineral soils that are free of organic and deleterious materials. Subgrade fill materials should be placed in loose lifts not greater than 300 mm in thickness and compacted to at least 95% Modified Proctor Maximum Dry Density (MPMDD). Inspection and density testing by a geotechnical engineer is required during construction to ensure that all fill used is suitable and is placed and compacted in accordance with the above-noted recommendations.

6.5 FOUNDATIONS

Based on preliminary drawings provided to us internally and provided that site preparation as described in Section 6.2 is carried out, the proposed reservoir tank, operations building and ancillary structures may be supported on conventional strip and pad footings founded on undisturbed, native very stiff silt or hard clay soils or founded on structural backfill on these undisturbed, native, silt or clay soils.

Strip and pad footings founded on undisturbed, native very stiff silt or hard clay soils or founded on structural fill on undisturbed native very stiff silt or hard clay should be designed for a Serviceability Limit States (SLS) bearing capacity of 200 kPa, which corresponds to estimated post-construction settlement in the order of 25 mm, and a factored Ultimate Limit States (ULS) bearing capacity of 250 kPa. The factored ULS bearing capacity incorporates a geotechnical resistance factor of 0.5, which is applicable for shallow foundations. In all cases, minimum strip and pad footing widths of 450 mm and 900 mm, respectively, should be maintained. The tank perimeter footing, the perimeter footings for the operations building and the pad footings for the ancillary structures should be founded at least 650 mm below finished exterior grade for frost protection.

Alternatively, the proposed reservoir and operations building may be supported on a reinforced raft foundation founded on undisturbed, native very stiff silt or hard clay soils or founded on structural backfill on undisturbed, native, very stiff silt or hard clay soils. Raft foundations can be designed using a modulus of subgrade reaction, k, of 30 MPa/m, which is based on a plate load test over an area of 0.3 m by 0.3 m. Raft foundations should be underlain by a base layer consisting of at least 150 mm of 19 mm minus crushed gravel (MMCD Section 31 05 17, Item 2.10) compacted to a minimum of 95% MPMDD.

Foundation excavations should be reviewed in the field by a geotechnical engineer to confirm that soils encountered on the underside of foundations are consistent with those encountered in the subsurface investigation and are adequate for providing the design bearing capacities noted above. Any soft or disturbed soils within foundation excavations should be evaluated by the field engineer to determine their thicknesses. Upon review by the geotechnical engineer, complete or partial removal of the soft or disturbed soils may be required.

6.6 SLAB-ON-GRADE

Any slab-on-grade for the reservoir tank floor and the operations building may be constructed as a conventional slab-on-grade, provided that site preparation as described in Section 6.2 is carried out throughout the entire footprint of these structures. The slab-on-grade should be underlain by a base layer consisting of at least 150 mm of 19 mm minus crushed gravel (MMCD Section 31 05 17, Item 2.10) compacted to a minimum of 95% MPMDD.

6.7 BUILDING AND SITE DRAINAGE

Stantec does not consider that perimeter or under-slab drainage will be required for the proposed operations building, provided that the finished floor elevation is at least 150 mm higher than the exterior grades. Accordingly, we consider that site drainage measures will need only to address roof and surficial runoff. Stantec recommends that native subgrade in the gravel cover area of the reservoir site and final ground surface be graded to direct runoff towards suitable drainage and away from the reservoir site.

6.8 PERMANENT FILL SLOPES

Permanent granular fill slopes consisting of pit run gravel (MMCD Section 31 05 17, Item 2.3) should be constructed no steeper than 1.5H:1V (horizontal:vertrical).

6.9 UNDERGROUND UTILITIES AND WATER MAINS

Underground utility pipe and water mains should be placed on a bedding layer having a thickness of at least 150 mm. For pipe cushioning, it is recommended that the granular bedding and surround material should extend at least 300 mm beyond both sides of the pipe and up to at least 150 mm above the top of the pipe.

Pipe bedding and surround materials should meet the Master Municipal Construction Document (MMCD) requirements for imported granular pipe bedding (MMCD, Section 31 05 17, Item 2.7-Type 1). Alternatively, imported 25 mm clear crushed gravel (MMCD, Section 31 05 17, Item 2.6 – Coarse) can be used for pipe bedding and surround provided that it is encapsulated in a non-woven geotextile such as NILEX 4551 to prevent the loss of fines from adjacent fill and native soils.

The pipe bedding and surround material should be placed in maximum 150 mm loose lifts if hand-operated compaction equipment is used and 300 mm thick loose lifts if heavy machine-operated equipment is used. The material must be compacted to at least 95%MPMDD. Inspection and testing by a geotechnical engineer or technician will be required during construction to ensure all fill used is suitable, and is placed and compacted to the required specifications.

Fill above the bedding and surround material fill for backfill of utility and water main trenches should consist of pit run gravel (MMCD Section 31 05 17, Item 2.3) and be placed and compacted as described in Section 6.4. All frost-susceptible utilities should be placed a minimum of 650 mm below final grade to prevent freezing.

6.10 GRAVEL ACCESS ROAD AND GRAVEL COVERED RESERVOIR AREA

Following the site preparation presented in Section 6.2, the minimum gravel structure presented in Table 1 is recommended (assuming light vehicle traffic) for the proposed gravel access road and gravel covered area of the reservoir site.

Table 1 Recommended Gravel Structure

Description	Gravel Covered Area
19 mm minus granular base (MMCD, Section 31 05 17, Item 2.10)	150 mm
75 mm minus select granular sub-base (MMCD, Section 31 05 17, Item 2.8)	400 mm

All granular materials should conform to the current Master Municipal Construction Document, and should be tested and approved by a geotechnical engineer prior to their delivery to the site. The crushed gravel base and granular sub-base materials should be compacted to at least 95% MPMDD.

6.11 CONSTRUCTION FIELD REVIEWS

Geotechnical field reviews will be required during construction in order to verify that the soil conditions encountered are consistent with our design assumptions and that work is being carried out in accordance with our recommendations. Geotechnical field reviews should be carried out for the items listed below to fulfill the obligations specified in the BC Building Code Letters of Assurance.

- Stripping of existing unsuitable materials;
- Review of exposed subgrade soil;
- Compaction of structural fill and site grading fill;
- Verification of soil bearing capacity at footing locations;
- Compaction of base fill for slab-on-grade floor and sidewalk areas;
- Compaction of backfill material for foundations and trenches;
- Compaction of sub-base and base fills in gravel covered areas.

7.0 CLOSURE

This report was prepared for the exclusive use of the District of Port Hardy and its agents for specific application to the Port Hardy Reservoirs & Watermain Construction Project. Any use of this report or the material contained herein by third parties, or for other than the intended purpose, should first be approved in writing by Stantec.

Use of this report is subject to the Statement of General Conditions included in **Appendix A**. It is the responsibility of the District of Port Hardy, who is identified as "the Client" within the Statement of General Conditions, and their agents to review the conditions and notify Stantec should any of them not be satisfied. The Statement of General Conditions addresses the following:

- Use of the report
- Basis of the report
- Standard of care
- Interpretation of site conditions
- Varying or unexpected site conditions
- Planning, design, or construction

We trust that this report meets your present requirements. If you have any questions or require additional information, please do not hesitate to contact the undersigned.

Regards,

STANTEC CONSULTING LTD.

Sep 26/17

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8.0 REFERENCES

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Appendix A STATEMENT OF GENERAL CONDITIONS

USE OF THIS REPORT: This report has been prepared for the sole benefit of the Client or its agent and may not be used by any third party without the express written consent of Stantec and the Client. Any use which a third party makes of this report is the responsibility of such third party.

BASIS OF THE REPORT: The information, opinions, and/or recommendations made in this report are in accordance with Stantec's present understanding of the site specific project as described by the Client. The applicability of these is restricted to the site conditions encountered at the time of the investigation or study. If the proposed site specific project differs or is modified from what is described in this report or if the site conditions are altered, this report is no longer valid unless Stantec is requested by the Client to review and revise the report to reflect the differing or modified project specifics and/or the altered site conditions.

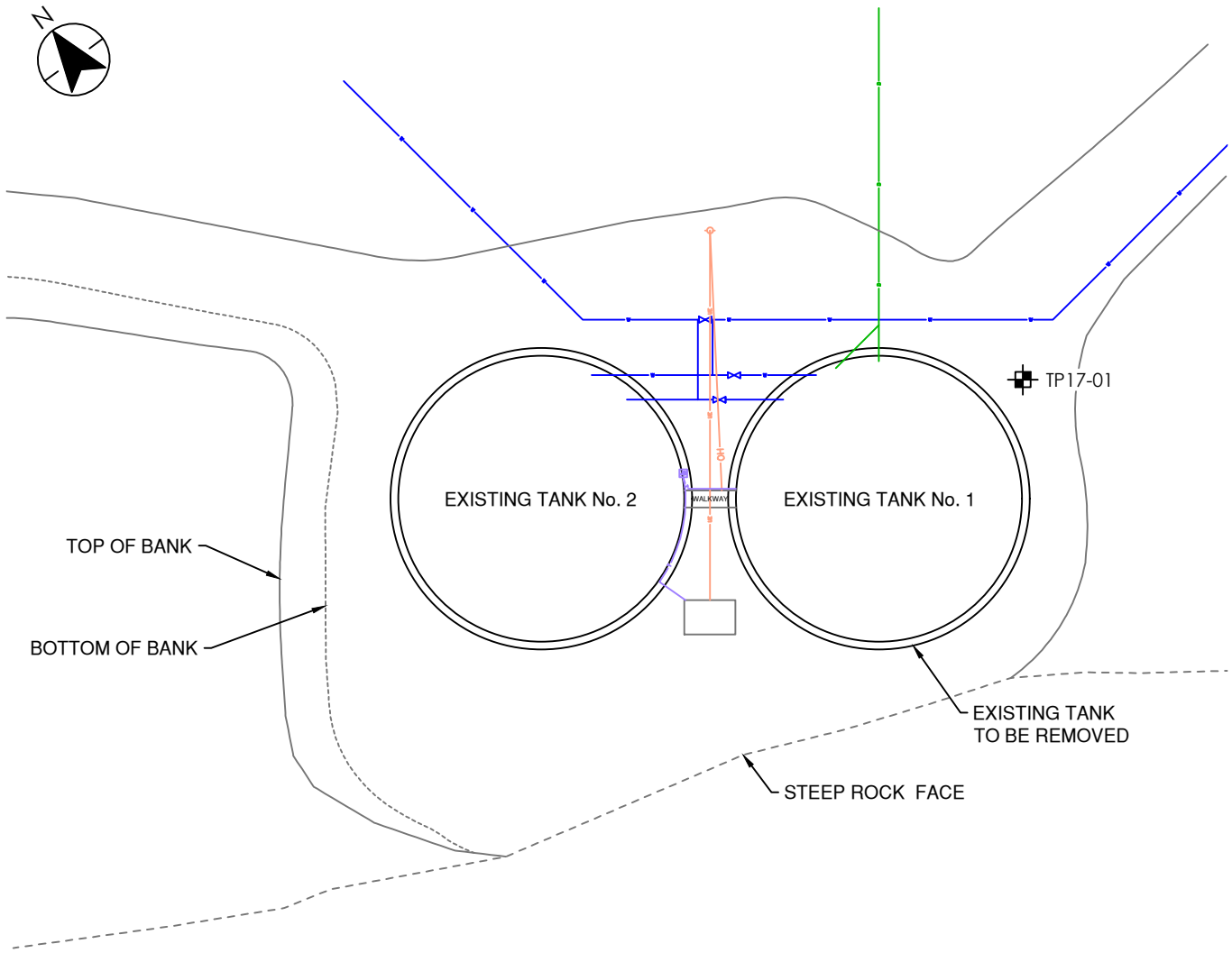
STANDARD OF CARE: Preparation of this report, and all associated work, was carried out in accordance with the normally accepted standard of care in the state or province of execution for the specific professional service provided to the Client. No other warranty is made.

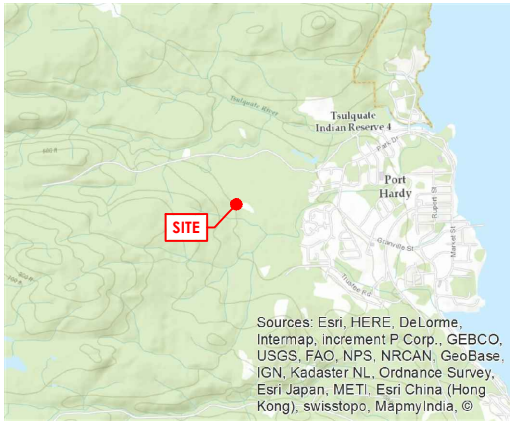
INTERPRETATION OF SITE CONDITIONS: Soil, rock, or other material descriptions, and statements regarding their condition, made in this report are based on site conditions encountered by Stantec at the time of the work and at the specific testing and/or sampling locations. Classifications and statements of condition have been made in accordance with normally accepted practices which are judgmental in nature; no specific description should be considered exact, but rather reflective of the anticipated material behavior. Extrapolation of in situ conditions can only be made to some limited extent beyond the sampling or test points. The extent depends on variability of the soil, rock and groundwater conditions as influenced by geological processes, construction activity, and site use.

VARYING OR UNEXPECTED CONDITIONS: Should any site or subsurface conditions be encountered that are different from those described in this report or encountered at the test locations, Stantec must be notified immediately to assess if the varying or unexpected conditions are substantial and if reassessments of the report conclusions or recommendations are required. Stantec will not be responsible to any party for damages incurred as a result of failing to notify Stantec that differing site or sub-surface conditions are present upon becoming aware of such conditions.

PLANNING, DESIGN, OR CONSTRUCTION: Development or design plans and specifications should be reviewed by Stantec, sufficiently ahead of initiating the next project stage (property acquisition, tender, construction, etc), to confirm that this report completely addresses the elaborated project specifics and that the contents of this report have been properly interpreted. Specialty quality assurance services (field observations and testing) during construction are a necessary part of the evaluation of sub-subsurface conditions and site preparation works. Site work relating to the recommendations included in this report should only be carried out in the presence of a qualified geotechnical engineer; Stantec cannot be responsible for site work carried out without being present.

Appendix B TEST HOLE LOCATION PLANS





Key Plan

Legend

- WATER LINE
- DRAINAGE LINE
- UNDERGROUND ELECTRICAL INE
- TEST PIT LOCATION

SCALE IN METRES

0 5 10 15 20 25

1:400

Stantec

DISCLAIMER: The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing - any error or omissions shall be reported to Stantec without delay. The Copyrights to all designs and drawings are the property of Stantec. Reproduction or use for any purpose other than that authorized by Stantec is forbidden.

Project Information

Project No.:	111720046
Scale:	1:750
Date:	2017-SEPT-22
Drawn by:	G. HUYNH
Checked by:	J. WOO

Project Location

APPROX. 2.4 km WEST OF PORT HARDY, BC

Client/Project

DISTRICT OF PORT HARDY

PORT HARDY RESERVOIRS AND WATER MAIN CONSTRUCTION PROJECT GEOTECHNICAL ASSESSMENT

Title

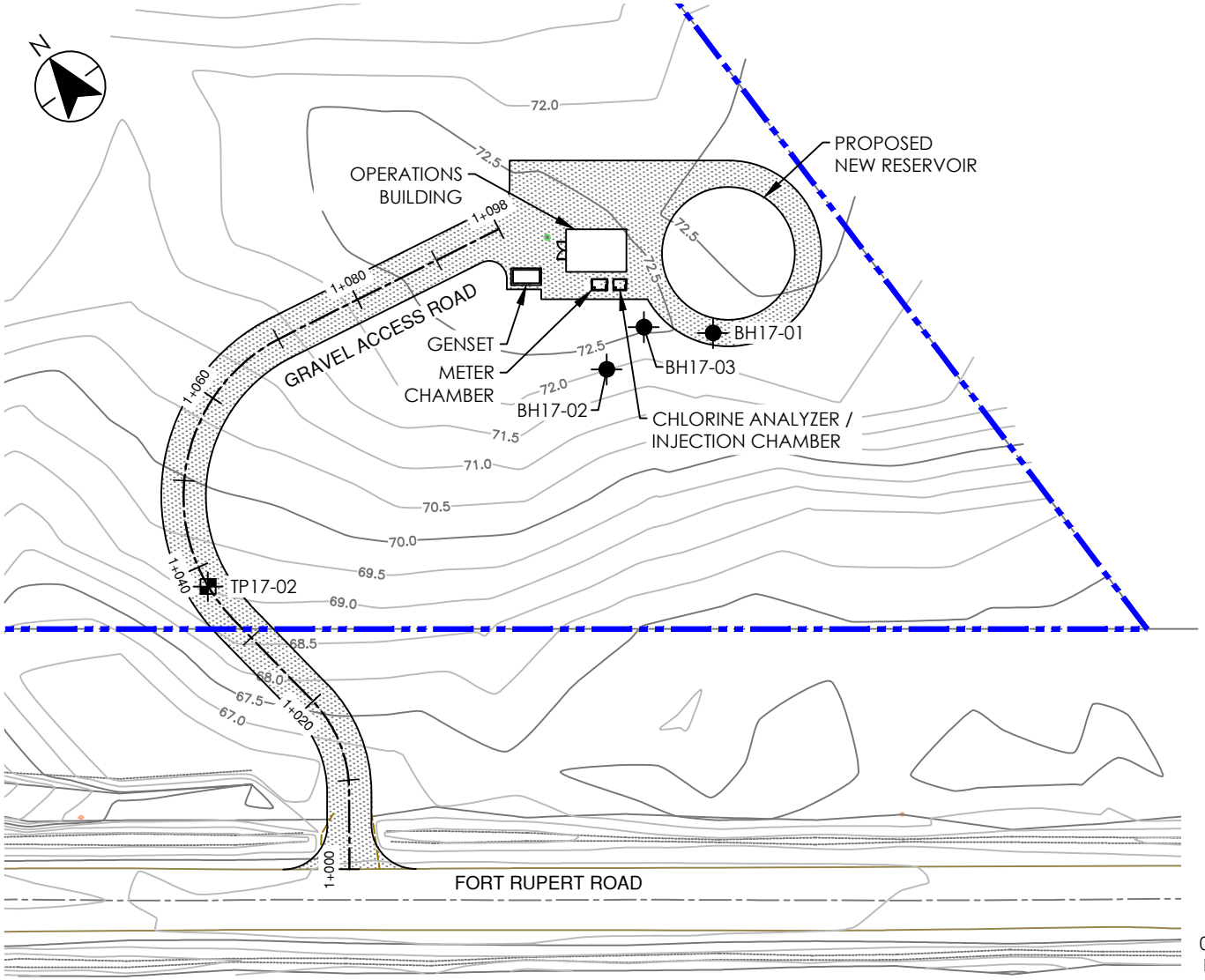
WATER TREATMENT PLANT TEST HOLE LOCATION PLAN

Fig No.

1

S:\1232\projects\111720046\drawings\geotech_assessment\111720046_001.dwg
2017/09/22 12:03 PM By: Huynh, Gordon

ORIGINAL SHEET - ANSI A



Key Plan

Legend

- SITE PROPERTY LINE
- LOTLINE
- BOREHOLE LOCATION
- TEST PIT LOCATION

SCALE IN METRES

0 10 20 30 40 50

1:750

Stantec

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Project Information

Project No.:	111720046
Scale:	1:750
Date:	2017-SEPT-22
Drawn by:	G. HUYNH
Checked by:	J. WOO

Project Location

APPROX. 7 km SOUTHEAST OF PORT HARDY, BC

Client/Project

DISTRICT OF PORT HARDY

PORT HARDY RESERVOIRS AND WATER MAIN CONSTRUCTION PROJECT GEOTECHNICAL ASSESSMENT

Title

FORT RUPERT RESERVOIR SITE TEST HOLE LOCATION PLAN

Fig No.

2

S:\1232\projects\111720046\drawings\geotech_assessment\111720046_001.dwg
2017/09/22 3:14 PM By: Huynh, Gordon

ORIGINAL SHEET - ANSI A

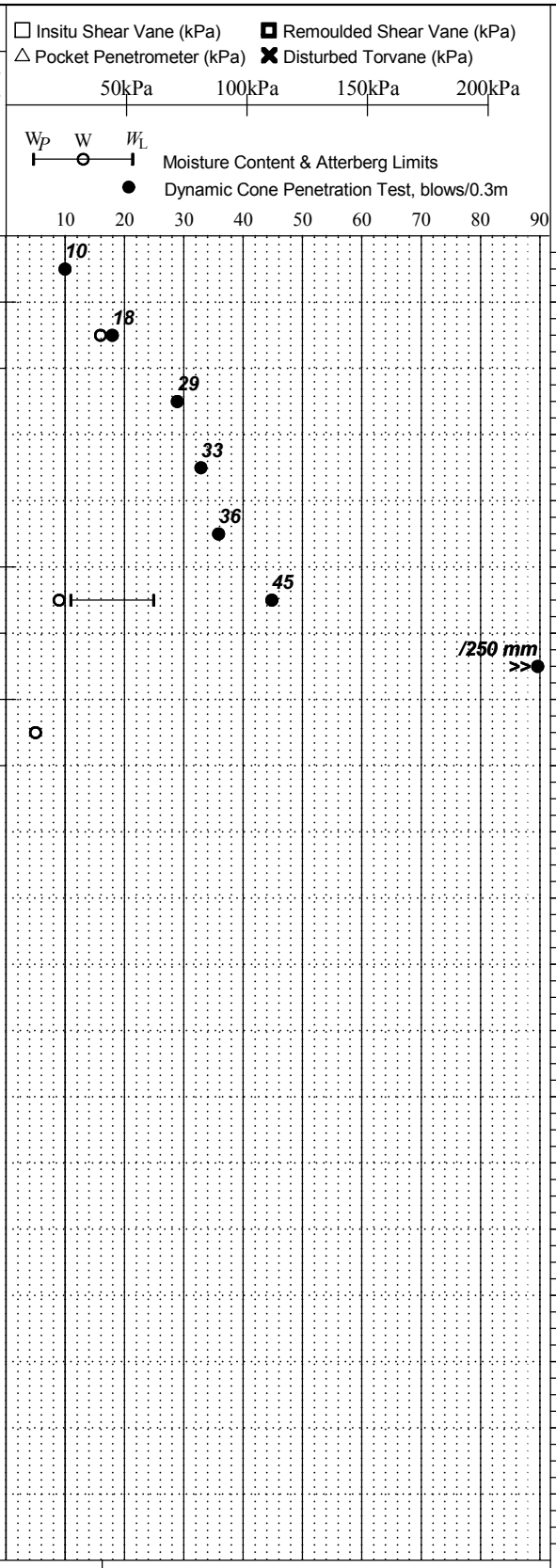
Appendix C TEST HOLE LOGS

BOREHOLE RECORD

BH17-01

CLIENT	District of Port Hardy	DATUM	Geodetic	PROJECT No.	111720046
PROJECT	Rservoir and Watermain Construction Project	ELEVATION		NORTHING	5616068
LOCATION	Fort Rupert Site	DRILL RIG	Mobile B47	EASTING	611891
DRILLING DATE	2017/08/30	DRILLING CO.	Blue Max Drilling Inc.	DRILLING METHOD	Solid Stem Auger

DEPTH (m)	SOIL TYPE	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLES TYPE	SAMPLES NUMBER	MOISTURE CONTENT (%)
0	TP		TOPSOIL: stiff, orange to brown, sandy silt with clay and wood debris, moist			
	ML		Very stiff, brown SILT (ML) with clay - moist, traces of sand, traces of gravel - hard below 0.9 m	GS	01	16
	CL		Hard, grey lean CLAY (CL) with gravel - moist - practical DCPT refusal at 2.1 m, 0 mm after 43 blows - dry below 2.1 m	GS GS	02 03	9 5
4			End of BH17-01 at 3.7 m. Practical refusal on suspected bedrock. No groundwater observed in open borehole. Backfilled with cuttings.			



DEPTH (ft): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20

Sample Type: GS - Grab Sample SPT - Standard Penetration Test
ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: Bentonite Sloughed Drill Cuttings Sand

Logged by: JN
Reviewed by: AM
Date: September 01, 2017

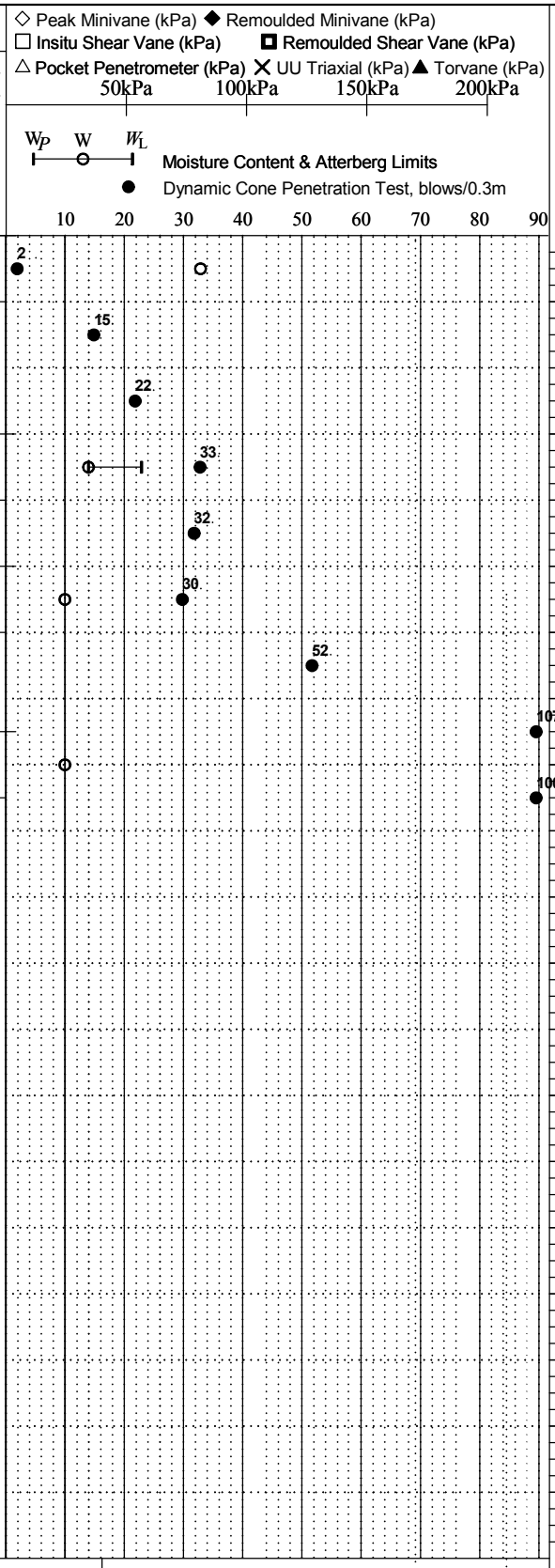
Stantec

BOREHOLE RECORD

BH17-02

CLIENT	District of Port Hardy	DATUM	Geodetic	PROJECT No.	111720046
PROJECT	Rservoir and Watermain Construction Project	ELEVATION		NORTHING	5616068
LOCATION	Fort Rupert Site	DRILL RIG	Mobile B47	EASTING	611874
DRILLING DATE	2017/08/30	DRILLING CO.	Blue Max Drilling Inc.	DRILLING METHOD	Solid Stem Auger

DEPTH (m)	SOIL TYPE	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLES TYPE	SAMPLES NUMBER	MOISTURE CONTENT (%)
0	TP		TOPSOIL: soft, brown silt with wood debris and organics, moist	GS	01	33
1	ML		Very stiff, brown SILT (ML) with clay - moist, traces of gravel - hard below 0.9 m	GS	02	14
2	CL		Hard, grey, lean CLAY (CL) with gravel - moist - dry below 1.8 m - practical DCPT refusal at 2.7 m, 0 mm after 80 blows	GS GS	03 04	10 10
3			End of BH17-02 at 3.4 m. Practical refusal on suspected bedrock. No groundwater observed in open borehole. Backfilled with cuttings.			
4						
5						
6						



DEPTH (ft): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20

Sample Type: GS - Grab Sample SPT - Standard Penetration Test
ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: Bentonite Sloughed Drill Cuttings Sand

Logged by: JN
Reviewed by: AM
Date: September 01, 2017

Stantec

BOREHOLE RECORD

BH17-03

CLIENT	District of Port Hardy	DATUM	Geodetic	PROJECT No.	111720046
PROJECT	Rservoir and Watermain Construction Project	ELEVATION		NORTHING	5616069
LOCATION	Fort Rupert Site	DRILL RIG	Mobile B47	EASTING	611887
DRILLING DATE	2017/08/30	DRILLING CO.	Blue Max Drilling Inc.	DRILLING METHOD	Solid Stem Auger

◇ Peak Minivane (kPa) ◆ Remoulded Minivane (kPa)
□ Insitu Shear Vane (kPa) ■ Remoulded Shear Vane (kPa)
△ Pocket Penetrometer (kPa) ✕ UU Triaxial (kPa) ▲ Torvane (kPa)
50kPa 100kPa 150kPa 200kPa

W_P W W_L Moisture Content & Atterberg Limits
● Dynamic Cone Penetration Test, blows/0.3m

10 20 30 40 50 60 70 80 90

DEPTH (m)	SOIL TYPE	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLES TYPE	NUMBER	MOISTURE CONTENT (%)
0	TP		TOPSOIL: soft brown sandy silt with clay, wood debris and organics, moist - no wood debris or organics below 0.2 m	GS	01	80
				GS	02	54
	CL		Very stiff to hard, brown lean CLAY (CL) - moist, traces of gravel	GS	03	18
1						
			- grey below 1.5 m - with gravel below 1.5 m - dry below 1.8 m	GS	04	15
2				GS	05	6
3			End of BH17-03 at 3.0 m. Practical refusal on suspected bedrock. No groundwater observed in open borehole. Backfilled with cuttings.			
4						
5						
6						

DEPTH (ft): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20

Sample Type: GS - Grab Sample SPT - Standard Penetration Test
ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: Bentonite Sloughed Drill Cuttings Sand

Logged by: JN
Reviewed by: AM
Date: September 01, 2017

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TEST PIT LOG

TP17-01

CLIENT	District of Port Hardy	DATUM	Geodetic	PROJECT No.	111720046
PROJECT	Rservoir and Watermain Construction Project	ELEVATION		NORTHING	5620350
LOCATION	WTP Reservoir Site	DRILL RIG	Backhoe	EASTING	604001
DRILLING DATE	2017/08/29	DRILLING CO.	District of Port Hardy	DRILLING METHOD	Test Pit

◇ Peak Minivane (kPa) ◆ Remoulded Minivane (kPa)
□ Insitu Shear Vane (kPa) ■ Remoulded Shear Vane (kPa)
△ Pocket Penetrometer (kPa) ✕ UU Triaxial (kPa) ▲ Torvane (kPa)
50kPa 100kPa 150kPa 200kPa

W_P W W_L Moisture Content & Atterberg Limits
● Dynamic Cone Penetration Test, blows/0.3m
10 20 30 40 50 60 70 80 90

DEPTH (m)	SOIL TYPE	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLES TYPE	SAMPLES NUMBER	MOISTURE CONTENT (%)
0	TP		ROOTMAT			
	FL		FILL: brown, coarse, poorly-graded sand with blasted rock fragments up to 0.3 m in diameter	GS	01	
			End of TP17-01 at 0.6 m. Practical refusal on bedrock. No groundwater observed in open test pit.			

DEPTH (ft): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20

Sample Type: GS - Grab Sample SPT - Standard Penetration Test
ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: Bentonite Sloughed Drill Cuttings Sand

Logged by: JN
Reviewed by: AM
Date: September 01, 2017

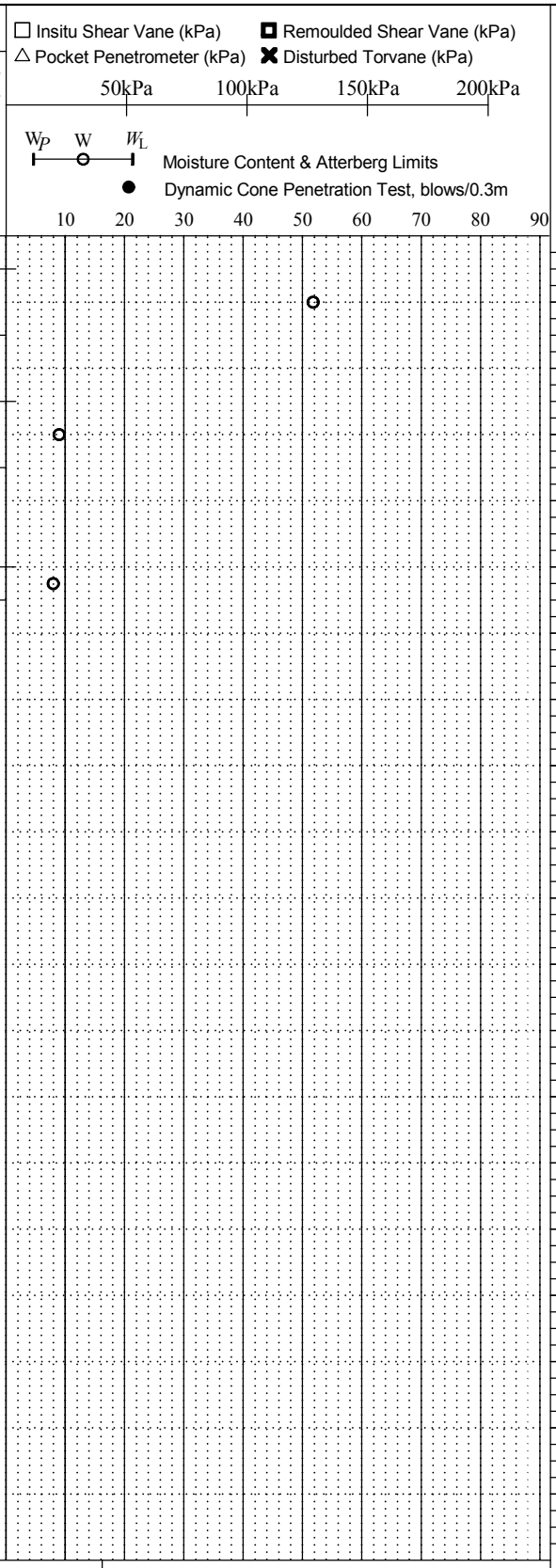
Stantec

TEST PIT LOG

TP17-02

CLIENT District of Port Hardy
PROJECT Rservoir and Watermain Construction Project
LOCATION Fort Rupert Site
DRILLING DATE 2017/08/29
DRILLING CO. Blue Max Drilling Inc.
DATUM Geodetic
ELEVATION
DRILL RIG Backhoe
DRILLING METHOD Solid Stem Auger
PROJECT No. 111720046
NORTHING 5616054
EASTING 611860

DEPTH (m)	SOIL TYPE	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLES TYPE	SAMPLES NUMBER	MOISTURE CONTENT (%)
0	TP		ROOTMAT			
	TP		TOPSOIL: soft, orange to brown, sandy silt with clay - trace gravel	GS	01	52
1	SM		Compact to dense, brown, silty SAND (SM) with gravel - Passing #200 test at 0.8 m: 22% Fines	GS	02	9
	CL		Hard, grey, lean CLAY (CL) with gravel	GS	03	8
2			End of TP17-02 at 1.7 m. Practical refusal on hard lean clay. No groundwater observed in open test pit.			
3						
4						
5						
6						



DEPTH (ft): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20

Sample Type: GS - Grab Sample SPT - Standard Penetration Test
ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: Bentonite Sloughed Drill Cuttings Sand

Logged by: JN
Reviewed by: AM
Date: September 01, 2017

Stantec

.2 The tank shall be purchased with the tank manufacturer's cathodic protection system.

.3 The following tank inspections shall be conducted by a representative of a dealer authorized by the tank manufacturer according to the schedule below (after liquid is first introduced in to the tank):

.1 Year One – Initial tank inspection and cathodic protection validation

.2 Year Three – Periodic cathodic protection inspection

.3 Year Six – Periodic cathodic protection inspection

.4 Year Nine – Periodic cathodic protection inspection