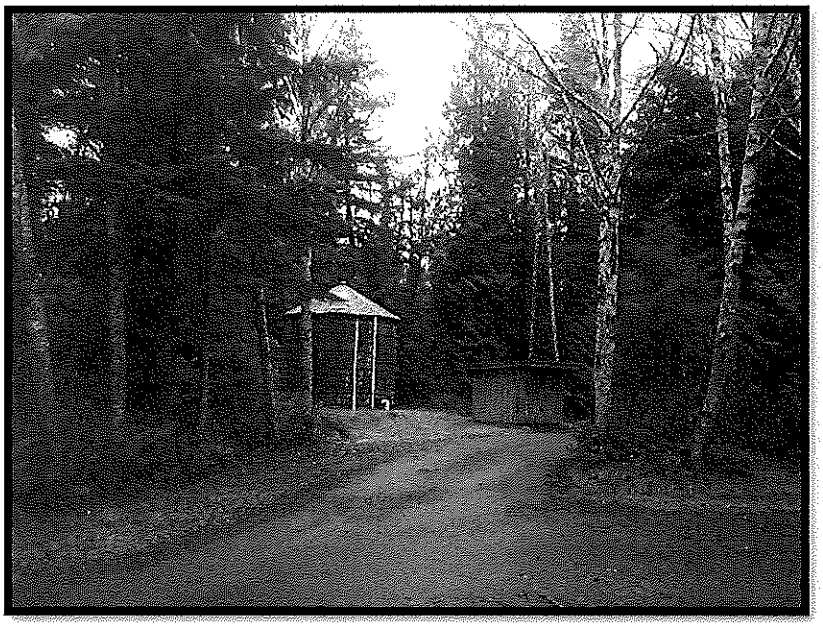
LEVELTON

The Tla-O-Qui-Aht First Nation

Tofino Water Supply Upgrades – Phase 3

Geotechnical Assessment



Submitted by:
LEVELTON CONSULTANTS LTD.

July 10, 2015
Levelton File # R715-0161-00

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EXECUTIVE SUMMARY

Levelton Consultants Ltd. (Levelton) has completed a geotechnical assessment in support of civil design being prepared by ISL Engineering & Surveying (ISL) for the third phase of proposed water supply upgrades in Pacific Rim National Park south of Tofino, BC. The project is a joint effort between Tla-o-qui-aht First Nation (TFN) and Parks Canada and involves the installation of three sections of watermain (cumulative 10 km), a pump station, two new above ground steel reservoirs and a water treatment building. The reservoirs and chlorination building are to be designed in general accordance with the National Building Code of Canada. No specific seismic design criteria were provided for the waterline. Design in relation to a potential tsunami was beyond the scope of Levelton's assignment.

Ground conditions in the area are complex and variable. In general, subsoil conditions transition from primarily marine drift deposits toward the west to an area to the east that has granular deposits above the marine soils. At the reservoir and chlorination building sites soil conditions are adverse and range from thick organic deposits and liquefiable sand at Lost Shoe Creek and normally consolidated, compressible clay upwards of 50 m thick at Wick Road and High Point. As a result, the design process has been iterative and has included several interim geotechnical memos and emails to facilitate discussions. This report consolidates subsurface information from previous phases and the early design interaction for the current project into one document and provides geotechnical discussion and recommendations for design and construction of the waterline, reservoirs and chlorination building.

A new pipe is to be installed within the ditch centerline adjacent to Highway 4 (Pacific Rim Highway) with horizontal directional drilling. Subsoil conditions are generally considered to be suitable. In some areas, geotechnical guidance has been provided with respect to a preferred side of the road or minimum depth to avoid poor soil conditions. In several localized areas, different installation techniques may need to be considered such as excavation and replacement to remove poor soils or avoid drilling into coarse (cobbley) embankment fill material at existing ravine crossings. Long term monitoring and maintenance is recommended for a section of pipe near Lost Shoe Creek underlain by organic deposits.

Wet conditions were observed at about 1.5 to 2 m below ground surface. Construction during and / or after an extended dry period is recommended.

Foundation design for the reservoir and chlorination building has required consideration of relatively large calculated settlements (beyond normally acceptable tolerances) under static loading, relatively large ground movements associated with potential lateral spread towards slopes, and modest settlement related to liquefaction. While static movements are expected to be gradual and relatively uniform, seismic movements could be more abrupt and differential across the structure footprints. A number of different concepts to mitigate the impacts of these movements were considered and discussed during the design process. Recommendations herein focus on a client preferred foundation alternative of a robust shallow, rigid raft incorporating partial buoyancy through the use of light weight foam-concrete replacement below the reservoirs at Wick Road and High Point and a piled foundation with a rigid raft slab. If the calculated seismic movements cannot be accommodated in the design and structures are required to remain functional after the design earthquake, some form of ground improvement (an involved undertaking in terms of both design and construction) would be required to reduce the magnitude of potential movements.

The partial buoyancy concept for the reservoirs has been selected in part based on the presence of a crust of dessicated clay and historical serviceable behavior of the existing reservoir at Wick Road that is similar in size to that proposed. With this approach there will be a need for on-going monitoring and maintenance to manage the anticipated settlements such as through incremental, controlled reservoir filling coupled with settlement monitoring. The purpose of a staged filling program would be to gradually consolidate the underlying clay to increase strength and avoid faster loading that could generate large settlements and potentially weaken the clay. To facilitate a staged reservoir filling program, the existing reservoir(s) should remain in service for an overlapping period. Site preparation for the reservoirs is to include the replacement of 2.5 m thickness of clay from the reservoir footprint plus a buffer zone of 1 m with a light weight, foam concrete (i.e., Cematrix Cellular Concrete). Foam concrete is lighter than water and proper drainage and groundwater management will be critical both during construction and during unloading of the reservoir to avoid uplift.

The load imposed by the reservoirs is too large to be completely offset by lightweight fill and relatively large long term settlements could still be generated. Civil and structural design will need to accommodate potential total settlements below the reservoirs / treatment building in combination with a structure-pipe connection design to accommodate differential movements between the structures and buried pipework.

For the treatment building at Lost Shoe Creek is a deep pile system incorporating a structural floor. Driven, closed ended steel pipe piles bearing in the underlying granular deposit (i.e., below 8 m depth) are recommended. Pile design should include the potential for down drag forces. Geotechnical resistances are provided for 305 mm diameter piles installed to about 11 m depth. Flexible connections are recommended for this structure as well.

Further geotechnical input is expected in support of final design, tendering and construction.

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July 10, 2015
Levelton File # R715-0161-00

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Project: Tofino Water Supply Upgrades – Phase 3
Subject: Geotechnical Assessment

1 INTRODUCTION

As requested, Levelton Consultants Ltd. (Levelton) has completed a geotechnical assessment in support of civil design being prepared by ISL Engineering & Surveying (ISL) for the third phase of proposed water supply upgrades in Pacific Rim National Park in Tofino, BC. The project is a joint effort between Tla-o-qui-aht First Nation (TFN) and Parks Canada. Work was complete in general accordance with our proposal dated 29 August 2014 (Levelton File Ref: P714-1194) (authorized on 16 January 2015) and supplementary scope letter dated 14 April 2015 (authorized 20 April 2015).

In summary of our experience and the recent field work, ground conditions in the area are complex and variable. At the reservoir and chlorination building sites soil conditions are adverse and range from thick organic deposits and liquefiable sand at Lost Shoe Creek and slightly over-consolidated, compressible clay at Wick Road and High Point. An initially contemplated reservoir at Lost Shoe Creek was abandoned to reduce complications in relation to the organic soil deposits. To address relatively large calculated settlements imposed by the reservoirs at Wick Road and High Point, alternate foundation and site preparation alternatives (i.e., preload, net no load increase, piles, impact piers, etc.) have been considered and discussed with ISL. During the design process preliminary geotechnical feedback was provided through discussions with ISL and summarized in an overview of initial findings on 12 March 2015 and geotechnical discussion regarding seismic design and reservoir / building foundations on 8 June 2015.

This report incorporates feedback from ISL, TFN and Parks Canada and supercedes the previous interim documents. Geotechnical discussion and recommendations are presented for design and construction of the reservoirs, treatment building and general water line herein. In terms of structure foundations,

recommendations focus on a client preferred foundation alternative of a robust shallow foundation system incorporating partial buoyancy through the use light weight foam-concrete replacement below the reservoirs at Wick Road and High Point and a piled foundation with a rigid raft slab that can accommodate relatively large seismic displacements for the water treatment building at Lost Shoe Creek.

Appended to this report are a general site location plan, test hole location plans, a borehole station and elevation summary table, site photographs, borehole and CPT logs, relevant background borehole logs from previous work, and groundwater well logs.

2 PROJECT UNDERSTANDING

2.1 GENERAL

The project includes the installation of three sections of watermain (cumulative 10.1 km), a pump station, two new reservoirs, and a water treatment building:

- Waterline Segment A – Esowista to Airport Road – Station 1+920 to 3+850 (1930 m);
- Waterline Segment B – Warden's Office – Station 9+520 to 10+015 (495 m);
- Waterline Segment C – Combers Beach to Lost Shoe Creek – Station 11+950 to 19+665 (7715m);
- New "High Point" Reservoir (at Station 10+945);
- Replacement Wick Road Reservoir (+/- Station 17+500); and
- New Lost Shoe Creek Pump Station and Water Treatment Building (+/- Station 19+665).

The approximate location of these various project elements is shown on the attached Figure 1.

In general the waterline is proposed to be installed at about 1.5 to 2 m depth within the ditch centerline on the west / south (ocean) side of Highway 4 (Pacific Rim Highway). The westernmost kilometer of Segment A is proposed on the north (land) side of the road based on geotechnical recommendations to avoid the area of poor road performance and thick variable fill and organics on the south side of the road. Proposed installation methodology is directional drilling. The approximate stationing and proposed waterline alignment are shown on Figures 2 through 7.

The two reservoirs are to be the same: above grade 7 m high x 9.15 m diameter steel with about 400 m^3 to 450 m^3 capacity supported on a shallow concrete foundation. Structural loads provided by Western Tank and Lining Ltd. on 26 June 2015 indicate that the reservoir and contents dead load is approximately 67 kPa. Approximate layout for the reservoirs are shown on Figures 8 and 9.

The chlorination building at Lost Shoe creek is to be nominally 4m by 6 m in size with an unfactored load of about 42 kPa (per email correspondence from ISL 1 May 2015). The approximate location of the building is shown on Figure 10.

2.2 SEISMIC DESIGN PHILOSOPHY

We understand that there is no specific seismic or resilience performance criteria for the project other than the client's indicated preference that the structures (i.e. reservoirs and water treatment building) be designed in accordance with the National Building Code of Canada (NBCC). The NBCC indicates that such structures have a post-disaster importance designation for determining specified loads. Final design will depend on the Owner's specific expectations in terms of functionality after the design earthquake. Further discussion in this regard is provided in Section 5 below.

A site specific seismic hazard risk calculation (2005 National Building Code) was obtained from the NRC website (attached) from which it was determined that the "firm ground" (Site Class C) Peak Ground Acceleration (PGA) for a 2 per cent in 50 year (1 in 2475 year return period) was 0.52 g (Figure 11).

We further note that large portions of the Pacific Rim National Park, including the Wick Road Reservoir site and much of the proposed watermain alignment, are located within a Tsunami Hazard Zone. Design in relation to a potential tsunami was beyond the scope of Levelton's assignment and no further comments are provided in this regard.

3 SITE DESCRIPTION

The project area is located within the Pacific Rim National Park on the Estowista Peninsula on the west side of Vancouver Island, south of Tofino, as shown on the attached Figure 1. The Estevan Lowland physiographic region occupies a narrow band that stretches some 300 km along the southwest coast of Vancouver Island. It is dissected by numerous inlets and fiords and is commonly less than 3 km in width. In general, the *Estevan Lowland* may be described as flat and featureless with elevations being commonly less than 50 m above sea level. Based upon our experience within the project and surrounding areas, the coastline of the region is very rocky except where infilled with beaches, marine silts and clays, and / or more recent organic swamp deposits. Our experience indicates that natural soils along much of the alignment will consist of sand underlain by soft blue clay with occasional bedrock highs. Photographs of conditions at various locations in the project area are presented in Appendix 1.

The project area is gently to moderately undulating. Subsoil conditions transition between the Tofino Terrain System toward the west which is characterized by marine drift (bluish gray stony clay containing occasional sand lenses, small marine shells and angular gravel) and the Ucluelet Terrain System toward the east which is characterized by a surface of coarse sand and gravels[1].

Water wells registered in the BC Government database indicate that clay at the Wick Road and High Point reservoir sites extend to depths ranging from approximately 50 to 100 m below ground surface. At Lost Shoe Creek, the surface of the clay was encountered at about 20 m depth and was overlain by granular

[1] Soils of the Tofino-Ucluelet Lowland of British Columbia. Report No. 11 British Columbia Soil Survey. Research Branch, Canada Department of Agriculture, 1971.

deposits, consistent with the general description of soils in the Ucluelet Terrain System. The thickness of clay at Lost Shoe Creek is not known. Water well logs are presented in Appendix 3

3.1 WATERMAIN ALIGNMENT

Highway No. 4 (Pacific Rim Highway) was generally higher in elevation than the natural ground elevation and had ditches on each side of the road. The invert of the ditches ranged from about 0.6 m to about 1.2 m below road grade and ditch side slope grades ranged from gently sloping (about 5H:1V) to slightly steeper than 2H:1V in some areas. The shoulders of the road were generally narrow and, in some cases, less than 1 m in width.

West of Incinerator Rock (Waterline Segment A), the south (ocean) side of the road appeared to be performing poorly, with signs of settlement, alligator cracking, patching, and longitudinal cracking. The worst area appeared at the westernmost part of this section near the Esowista Reserve. This area was a curved and sloped section of road where the terrain sloped down towards the ocean with a drop of about 6 m.

The proposed alignment includes several crossings of deep ravines including: Station 12+870 (Devil's Dip) and 16+570 (Sandhill Creek). Background information provided by Parks Canada indicates that upgrades at Devil's Dip circa 1997 included removal of organic and wood debris from the base of the channel, installation of two large culverts and reconstruction of the road embankment with compacted granular fills. Refer to the attached Photos 5 to7.

Levelton has previously carried out subsurface exploration along the proposed alignment in Segments A and B and the findings of those assessments are used in this report with relevant logs included in Appendix 4.

3.2 HIGH POINT RESERVOIR

The proposed High Point reservoir is located about 75 m west and upslope of Highway 4 and approximately 900 m south of Greenpoint Campground. The site area consisted of a cleared area approximately 35 m across with stockpiles of variable fill soil (including organics and clay) and logs from construction sites in the area. Ground surface sloped down gently to the west. A gravel surfaced road provided access to the site from the highway. The surrounding area consisted of dense trees and underbrush.

3.3 WICK ROAD RESERVOIR

The proposed reservoir is located approximately 240 m north of Wick Road and 120 m west of Wickaninnish Beach. A new reservoir is proposed in a heavily treed area on the northwest side of the access road. Ground surface at the reservoir site is relatively flat. An approximately 20 m high slope down to the beach area is present approximately 40 m west of the proposed reservoir.

An existing wood stave cylinder reservoir similar in size to that proposed is located approximately 60 m south west of the proposed reservoir. No signs of distress were observed at the time of our review and we understand that in general, the reservoir has performed as intended during its 30 plus years of service.

3.4 LOST SHOE CREEK WATER TREATMENT BUILDING

A new water treatment building is proposed at the south end of the proposed waterline near Lost Shoe Creek approximately 80 m northeast of the Pacific Rim Highway on the south side of an asphalt surfaced access road. A new water well installed by others as part of the current system upgrade project was present about 20 m east of the proposed treatment building. At the time of the review the proposed building area was relatively flat and covered with broom, blackberries and small shrubs. It is understood through conversation with a Park employee that the cleared area had been used as a parking lot previously.

Lost Shoe Creek was approximately 60 m south east of the proposed treatment building site. The creek bank was approximately 10 m high and an existing well and pump house were present near the crest of this slope. We understand the existing well and pump house are being replaced as part of this project.

An existing wood stave cylinder shaped reservoir was present upslope and approximately 60 m north of the proposed treatment building. We understand that water from this reservoir currently is trucked to other locations.

4 SUBSURFACE CONDITIONS

Field work was divided into phases: a site reconnaissance on 26 and 27 January 2015, conventional auger drilling with a track mounted machine from 2 to 6 February 2015 (Drillwell Enterprises) and specialty electric Cone Penetration Test (CPT) program conducted 29 April to 2 May 2015. Prior to drilling, underground utility conflicts were cleared at the proposed drill sites by Kelly's One Call Locating.

A total of 29 new boreholes and four CPT holes were advanced near the proposed reservoirs and sections of new alignment where previous test hole information was not available. Test holes along the alignment were generally advanced to 3 to 4.5 m below ground surface (typically the asphalt surface). A deeper hole was advanced near the Sandhill Creek ravine crossing (BH15-16). At the Wick Road and High Point reservoir sites boreholes were advanced to depths ranging from 12 and 20 m, respectively, and CPT holes were advanced to effective refusal at 19 and 43.6 m depths, respectively. At Lost Shoe Creek boreholes and CPT holes were advanced to 12 and 14 m below ground surface, respectively.

Borehole logs, laboratory test results (gradation analyses and consolidation testing) and CPT logs are presented in Appendices 5, 6 and 7. A summary table of the approximate stationing of the boreholes and anticipated soil conditions at proposed pipe invert elevation is attached (Table 1 in Appendix 2).

In summary, ground conditions were in general agreement with published surficial geology mapping and generally consisted of a variable thickness of granular road embankment fills overlying natural fine grained soils towards the north (Tofino Terrain System, Wick Road and High Point Reservoirs) and / or granular deposits over fine grained soils towards the east (Ucluelet Terrain System, Lost Shoe Creek). Thick (>45 m), normally consolidated clay was encountered at the proposed reservoir sites. Variations from these general conditions included:

- Organic silt encountered in the upper 7m near Lost Shoe Creek, in the upper 3 m at BH15-11 (Station 16+945) and in the upper 2 m in some locations on the downslope (ocean) side of the road west of Incinerator Rock; and,
- Granular fill (inferred imported sand and gravel) encountered in the road embankment fills at two deep creek/ravine crossings along Highway 4 (BH15-16 at 16+600); and BH15-24 at Station 12+880).

4.1 WATERMAIN ALIGNMENT

4.1.1 Watermain Segment A

Soil conditions in this segment are based on a review of background information from previous geotechnical assessment work completed in this area. In general, variable fill over organics and wood debris were encountered below about 150 to 180 mm thickness of asphalt at borehole locations on both sides of the road (BH10-07, 08 and 09, and BH14-01, 02 and 03). The organics in general extended to about 2 m below ground surface in holes advanced near the road. Pavement distress was observed in the eastbound lane west of the Incinerator Rock Parking Lot (Station 2+000 to 3+045). At the east end of this section (nearer to Airport Road) subsurface conditions did not include organics and general consisted of variable granular FILL (600 mm to 750 mm thick); overlying compact SAND (3.2 m thick); underlain by soft to firm SILTY CLAY. Groundwater was typically in the order of about 1.5 m below grade.

Levelton understands that it was common to use logs to spread the load over these compressible soils during early road construction. There was evidence of wood pieces at the interface of fill and underlying natural soils that may be the remains of this type of road construction. There was also an attempt to use geotextile to improve road conditions in the area of BH14-04. Levelton observed the placement of this geotextile material in the 1980's as part of a pavement resurfacing program. Road repairs in the past have also consisted of placing additional layers of asphalt, which is also evidence that the road has continued to settle over a significant period of time.

4.1.2 Watermain Segment B

Soil conditions in this segment are based on a review of background information from previous geotechnical assessment work completed in this area. Borehole BH10-24, 25 and 36 were advanced near to the road. In general, the encountered subsurface conditions consisted of: variable granular fill in the order of 0.5 to 1.2 m thick overlying about 0.3 m thickness of organic silt underlain by soft to firm silty clay. At the time of that work in 2010, groundwater was measured at about 0.9 m depth.

4.1.3 Watermain Segment C

Along the proposed watermain Segment C, conditions below the road fill general consisted of firm to soft clay from Comber's Beach to Wick Road (+/-5.7 km) transitioning to natural sand from Wick Road to Lost Shoe Creek (+/- 2km). Conditions were variable within a transition zone extending between boreholes BH15-12 to 15 (i.e., approximately Station 16+945 to 17+675).

Start of Alignment (Comber's Beach) to Transition (Station 11+950 to 16+945) (BH15-15 to 27)

Subsurface conditions generally consisted of sand and gravel fill overlying natural clay. A 1.4 m thick layer of sand was encountered overlying the clay in borehole BH15-17 and a veneer of organic silt was encountered underlying the sand and gravel fill and overlying the clay in borehole BH15-20. The clay was generally stiff near the surface becoming soft with depth. Moisture content in the clay soil ranged from 19 to 54%.

Transition Zone (Station 16+945 to 17+765) (BH15-12 to BH15-14)

In general, the transition consisted of sand and gravel fill overlying sand or clay and varying depths. Sand and gravel fill thickness ranged from 0.5 to 0.9 m.

Transition to Lost Shoe Creek (Station 17+765 to 19+665) to (BH15-05 to 11)

This portion of the alignment generally consisted of sand and gravel fill up to 1.8 m thick overlying natural sand. All but BH15-05 were drilled within the asphalt pavement consisting of 50 to 110 mm thickness. Peat was encountered in boreholes BH15-05 and 11 consisting of less than 150mm thickness interbedded layers within the sand in BH15-05 and a 1.0m thickness at 1.8 m depth overlying the sand in BH15-11.

Boreholes BH15-16 and 24 were located in an area of an in-filled valley with a culvert running approximately perpendicular to the road to allow water to pass through the infill. The boreholes consisted of 6.4 m thick sand and gravel fill overlying a veneer of organic soil overlying clay in BH15-16 and a minimum of 3.7 m in BH15-24. Refusal in cobbley material limited the depth of borehole BH15-24. In general, the findings are consistent with construction photos of these areas provided to Levelton.

4.2 High Point and Wick Road Reservoirs

Ground conditions at the proposed reservoir sites were similar. In general, the encountered subsurface conditions consisted of a veneer of sand and gravel fill and / or organic silt overlying marine clays that were stiff near the ground surface and became soft below 1.5 m depth. The thickness of the clay deposit was proven to be at least 19 m and 43 m thick at High Point and Wick Road, respectively. Water well logs indicate that it could extend to more than 100 m below ground surface.

Numerous tests were conducted to characterize the clay including: field vane tests, Atterberg Limit determinations, moisture content testing, consolidation testing and CPT pore pressure dissipation testing and shear wave velocity measurements. Test results are present on the attached borehole logs (Appendix 1), CPT tables and logs (Appendix 3), and consolidation test plots (Appendix 6) and summarized as follows:

- Field vane testing ranges from about 20 to 60 kPa (typical about 30 to 40 kPa) peak strength to 4 to 25 kPa (typical about 10 to 15) remoulded strength with a sensitivity typically in the order of 2 to 3 at depths ranging from about 3 to 11 m below ground surface;
- Consolidation testing at about 5 and 10 m below ground surface indicated a pre-consolidation pressure of about 10 to 20 kPa;
- Atterberg Limits: Liquid Limit – 42 to 68%; Plastic Limit - 14 to 24%; Plasticity Index – 27 to 46%; Classification – Intermediate Plastic (CI) to High Plastic (CH); and,
- Moisture Content: 35 to 51%

In summary, the deposit is considered to be a medium to high plastic clay that is slightly over consolidated to about 15 m depth. The upper approximate 5 m is somewhat desiccated and form a crust at the surface.

4.3 Lost Shoe Creek Water Treatment Building

Four boreholes were advanced in this area of the project including borehole BH15-01, 02, 05, and 28 and one seismic CPT (SCPT15-32) to depths below ground surface that ranged from 3.1 m for pipe installation and up to 14 m for the chlorination building. In general, the encountered subsurface conditions consisted of 0.5 to 1.5 m of sand and gravel fill overlying natural, fine to medium grained sand, interbedded with peat of varying thickness. The maximum depth of peat was encountered in borehole BH15-01 to a depth of 7.6 m below ground surface. Underlying the upper sand and peat layers was a dense, medium grained, natural sand that provided effective refusal to the CPT. The water well log for this site indicates that clay is present below 20 m depth.

Moisture content testing was carried out on the sand and peat soils. Moisture content within the peat ranged from 200% to 380%. Moisture content in the sand was generally 20 to 22%.

5 SEISMIC ANALYSES

The supplementary assessment that was completed at the reservoir sites incorporated an in situ testing program using the CPT equipment that allows for the assessment of seismic ground response. To assist in reviewing seismic ground response, geotechnical discussion is presented below with a focus on the reservoirs and chlorination building.

5.1 Reservoirs

Based on a review of the logs and laboratory testing, the fine grained deposits that underlie the Wick Road and High Point reservoir sites are resistant to widespread liquefaction due to their plasticity index. Due to the presence of more than 30 m thickness of intermediate plastic soft to medium stiff clays at the Wick Road and High Point reservoir sites, the subsurface conditions at these sites are designated as Site Class F as per the

2010 National Building Code for seismic design. For Site Class F, seismic site coefficients Fa and Fv are evaluated on a site by site basis.

To better characterize seismic response for the Wick Road and High Point reservoir sites, a 1-Dimensional equivalent linear effective stress analysis was completed using the software program, SHAKE2000. Based on these analyses, a Fa of 2.3 may be used for structural design. It is our understanding that Fa controls design as the fundamental period of the reservoirs is expected to be in the order of 0.1 to 0.2 seconds. If Fv is critical to the analysis further interaction with Levelton will be required to assist in the interpretation of the spectral curve, which is spiked in the vicinity of Fv.

While significant vertical settlement related movements associated with the design earthquake are not expected we note that the proposed reservoir at the Wick Road site is located about 40 m away from an approximate 20 m vertical change in grade (slope down toward the ocean). Preliminary pseudostatic analyses based on undrained shear strengths measured with the field vane indicate that there is potential for relatively large seismically induced vertical and lateral movements (i.e., in the order of 0.5 m or more) that could be abrupt and differential across the reservoir footprint.

At the High Point Reservoir site, ground surface slopes down gently to the west. The potential for lateral spread is significantly reduced at this location relative to the Wick Road reservoir site and related movements are estimated to be in the range of 0.15 m. These movements would be differential across the reservoir footprint.

5.2 WATER TREATMENT BUILDING

At Lost Shoe Creek, granular deposits in the upper 3 to 5 m depth range are potentially susceptible to liquefaction indicating a Site Class F designation for seismic design for the proposed chlorination building. In addition, there is potential for lateral spread in relation to a 10 m high river embankment that is located some 60 m from the proposed structure. Based on preliminary liquefaction potential analyses vertical liquefaction related settlement of the granular deposits is estimated to be in the order of 50 to 100 mm. Order of magnitude estimates of lateral spread based on empirical relationships indicated that lateral / vertical movements could be relatively large (i.e., in the order of 1 m or more laterally and 0.5 m or more vertically). We note that there is a degree of uncertainty in these estimates as the seismic performance of the interbedded organic deposits at this site is complex and unknown. In particular, seismically induced movements could be larger than indicated.

Detailed, site specific analyses at Lost Shoe Creek to determine Fa and Fv was beyond the scope of this assignment. Notwithstanding, as outlined in the Building Code, for structures with a fundamental period of vibration equal to or less than 0.5 seconds (which we understand applies to the one storey building) that are built on liquefiable soils, Site Class and the corresponding values of Fa and Fv may be determined by assuming that the soils are not liquefiable provided that the potential for liquefaction and related movements is considered in the design.

Accordingly, seismic design of the relatively small and lightly loaded structure may be based on a Site Class E and the assumption that relatively large lateral and vertical ground movements could occur (i.e., design for life safety not post-disaster performance). In the absence of some form of ground improvement or an adaptation by the structural engineer to accommodate movements, significant damage to the structure may occur and it may be necessary to implement major repairs or rebuild.

6 GEOTECHNICAL RECOMMENDATIONS

6.1 WATERMAIN ALIGNMENT

6.1.1 General

Installation of the sewer and water line along Highway No. 4 offers some significant geotechnical challenges to conventional cut and cover type installations, due to the relatively narrow work space (shoulder and ditch area) and poor subgrade conditions in some areas. Accordingly, the proposed horizontal directional drilling that has successfully overcome these challenges on previous phases of the project is considered generally suitable for the current phase of work. Geotechnical discussion and recommendations are presented below for directional drilling. Specific discussion is provided in Section 6.1.3 where challenges may be encountered for directional drilling.

A summary table of the approximate stationing of the boreholes and anticipated soil conditions at proposed pipe invert elevation is attached (Table 1 in Appendix 2).

6.1.2 Horizontal Directional Drilling (HDD)

Horizontal directional drilling is a form of trenchless technology where a drill string creates a near horizontal or shallow arc pilot hole along the proposed pipeline alignment. The pipeline is installed by drilling the pilot hole on the designed path followed by a second stage that enlarges the hole by passing a larger cutting tool known as the back reamer. The reamer's diameter depends on the size of the pipe. The third stage places the product pipe in the enlarged hole by way of the drill steel and is pulled behind the reamer to allow centering of the pipe in the newly reamed path. The procedure uses fluid jet or mechanical cutting, or both with a low controlled volume of drilling fluid. The drilling fluid helps stabilize the bore hole, remove drill cuttings, and provides a lubricant for the drill string and pipeline installation.

Horizontal directional drilling projects are generally successful in areas of medium to stiff clays and silts and medium to dense sands. They often encounter problems in very loose to dense gravelly sand, very loose to dense gravel, and soils with significant cobbles, boulders, and obstructions. The majority of the conditions encountered along Highway No. 4 are considered to be favourable conditions for horizontal directional drilling.

In terms of the temporary insertion pits which we understand will be in the order of 2 m deep, excavation side walls are not expected to be stable in steep cut conditions and some sloping back should be expected. Soft soil conditions and variable seepage conditions should be expected in the lower parts of the pits, particularly below 1.5 m below the road surface where moist to wet conditions were encountered in most of the borehole logs. A working layer of gravel will likely be required for worker and equipment access. Seepage will likely be perched

on the underlying clay and will likely be greatest for the section of pipe overlain by sands (i.e., between Wick Road and Lost Shoe Creek). Construction during or after extended dry periods is recommended to reduce the potential for excavation instability, seepage management and siltation control at the pits.

Some of the specifics that also need to be considered include the location of dugouts / settling basins to contain drilling mud and the location of lay down areas for the pipelines.

6.1.3 Ravine Crossings and Organic Deposits

Different installation techniques may need to be considered at several deep ravine crossings and localized areas of organics and / or wood debris:

- West of Incinerator Rock (2+000 to 3 +275, Segment A) poor ground conditions (variable fill over organics and wood debris) were encountered and design should be based on a pipe invert elevation deeper than 2 m to avoid these materials. Specific geotechnical review should be requested if localized areas of organics or logs are encountered below this depth during installation. Geotextiles and "corduroy road logs" have been encountered in previous boreholes in this section and the contractor should be made aware of the presence of those materials;

- Station 17+930 (BH15-11, Segment C) peat extended to 3 m depth and is close to proposed invert depth. The pipe should be lowered below 3m through this section or the peat should be replaced with engineered fill with an open cut excavation;

- Station 12+870 (BH15-24, Devil's Dip, Segment C) and Station 16+570 (BH15-16, Sandhill Creek) (Segment C) sand and gravel fill with some cobbles was present to about 6 m depth. The material was quite difficult to drill in some zones and the cobbles would introduce obstacles to a directional drilling operation. Contractors should be advised or consideration given to an open cut installation across these ravines; and

- Near Lost Shoe Creek (Segment C) a portion of the watermain alignment (+/- 250 lineal meters) is likely underlain by thick deposits of peat (cumulative 3+ meters thick) interbedded with fine to medium grained sand extending to 8 m depth (i.e., BH15-01). The transition location is not known but is inferred to occur between BH15-5 and 6 (i.e., 19+668 to 19+410).
    - The peat will continue to decay over long periods of time and generate settlements larger than typically allowed for in design. Some allowance for settlement of the pipe should be included in the design (i.e., via flexible joints), acceptance of the need for maintenance or additional support provided to the pipe (i.e., via piles). Post construction settlement monitoring of the pipe and/or ground in this area is recommended; and,
    - Grade changes (current and future) could negatively affect the watermain (by generating relatively large settlements) and further geotechnical input is recommended if any raising of grades is contemplated. A note to this effect should be added to the road drawings if possible.

6.2 RESERVOIRS AND CHLORINATION BUILDING

6.2.1 General

As described in Section 4 above, our characterization of the proposed reservoir and chlorination building sites has identified geotechnically challenging conditions with respect to foundation design. (i.e., High Point, Wick Road, and Lost Shoe Creek). Our analysis has indicated that the predicted settlements for structures supported on conventional shallow foundations would be large and well beyond normally acceptable tolerances. In the absence of an option to re-locate, our findings indicate that it will be necessary to implement special foundation systems or alternate design concepts to address existing ground conditions. The Owner should be prepared to undertake a greater than normal level of observation and maintenance during the lifetime of the structures.

During design, Levelton has reviewed and discussed with ISL a number of approaches including: excavation and replacement, pre-loading, deep foundations (i.e., piles, GeoPiers, etc.), ground improvement and load reduction (i.e., full or partial buoyancy design through complete / partial burial and / or the use of light weight fill). Geotechnical recommendations for client preferred foundation alternatives is presented in two sections:

1) High Point and Wick Road (Reservoirs)
   a) These sites are underlain by thick (i.e., >45 m), normally consolidated clay deposits that are prone to large long-term consolidation settlements.
   b) Under seismic loading conditions the Wick Road reservoir site is susceptible to relatively large movements related to lateral spread associated with a near-by slope.

   Recommended Foundation System - robust shallow raft foundation system incorporating partial buoyancy through the use light weight foam-concrete replacement.

2) Lost Shoe Creek (Chlorination Building)
   a) This site is underlain by organic deposits with about 3 m of cumulative thickness distributed over a depth of 8 m.
   b) There are considerations of low bearing capacity and long term primary and secondary consolidation settlements, liquefaction and lateral spread.

   Recommended Foundation System - a piled foundation with a rigid raft slab that can accommodate relatively large seismic displacements.

Geotechnical discussion and recommendations are presented below for foundation design based on current information. The design involves complex subgrade-foundation-structure interaction and geotechnical review of the design should be requested prior to finalizing design based on detailed information that becomes available regarding slab thickness, final loads, pile spacing, etc. We anticipate this will involve further interaction between the Geotechnical, Structural, and Civil Engineers.

From the viewpoint of civil design considerations, we note that even small increases in load over a large area can generate settlement (consolidation) in the type of normally consolidated clays and organic deposits present at these sites. In areas of piled foundations, settlement can introduce additional loads on piles. Grade increases in the vicinity of the structures should be avoided where possible. Levelton should be provided opportunity to review any proposed increases in grade within 10 m of the structures in relation to potential foundation settlements prior to finalizing design.

We also note that for the proposed foundations the structures could move differentially relative to the pipes. Civil and structural design will need to accommodate potential total settlements below the reservoirs / treatment building in combination with a structure-pipe connection design to accommodate differential movements between the structures and buried pipework.

6.2.2 Foundation Design High Point and Wick Road Reservoirs

At the High Point and Wick Road reservoir sites, our analyses indicates that the proposed foundation loads will exceed the pre-consolidation pressure of the normally consolidated clays. As a result of the thicknesses of the clay and the breadth and height of the reservoir, long term primary and secondary consolidation calculations indicate that total settlements under conventional shallow foundations could approach 300 mm. This settlement would largely be differential to buried pipework. This magnitude of settlement greatly exceeds normal conventional design requirements. In addition, as noted in the seismic discussion above, relatively large lateral and vertical displacement could occur during seismic shaking and the reservoirs will need to be designed to accommodate these movements. If this is not possible and the reservoirs are to remain functional after the design earthquake, ground improvement (an involved undertaking in terms of both design and construction) would be required to reduce the magnitude of potential movements.

In order to mitigate large long term settlements and seismic movements, a robust shallow rigid raft foundation system incorporating partial buoyancy through the use light weight foam-concrete replacement is recommended. This approach will require an acknowledgement from the Owner that long term settlements are expected (i.e., long term settlements would be reduced but not eliminated). As discussed further below, implicit in the design is a program of observation and maintenance over the design life of the structure.

We recommend a partial compensation foundation design that involves the removal of 2.5 m thickness of clay from the reservoir footprint plus a buffer zone of 1 m around the raft slab (as measured at the base of the excavation), and its replacement with a light weight, foam concrete (Cematrix Cellular Concrete or approved equivalent). Based on an estimated surface saturated weight of about 600 kg/m^3 for the light weight foam concrete, the replacement program would reduce loads by about 30 kPa. This load reduction in combination with consideration of estimated pre-consolidation pressures and the spreading of load through a mass of cellular concrete that is larger in diameter than the raft slab, a net new load of about 15 to 20 kPa will be imposed on the underlying soils. Corresponding long-term settlements are calculated to be in the order of 150 mm. Flexible connections should be provided between the pipe and the reservoirs.

Structural design for a raft slab that will distribute loads and avoid a concentration in the lightweight fill may be based on a modulus of subgrade reaction of 5 MPa/m.

A continuous vertical interface between the perimeter of the foam concrete and the adjacent natural deposits is to be avoided. Subject to input from the contractor the concrete may be placed in a terraced configuration (i.e., with a minimum 1 m wide bench at half depth) or with a 1H:1V excavation slope.

The foam concrete is lighter than water and careful control of groundwater elevations will be required, particularly during construction, prior to loading and at times when the reservoir is emptied for maintenance. Preliminary calculations indicate that groundwater should not be higher than about 1.5 m below ground surface during construction and 1 m below ground surface when the reservoir has less than 1 m of water in it. To facilitate long term management of this condition, a perimeter drainage system should be installed at an invert elevation of 1.5 m. We recommend that this be a gravity system.

As part of the managed approach, future settlements should be monitored through the installation of accurate survey points that could be installed on the new utilities and at the surface at the time of construction. This will provide data that can be used to refine the settlement estimates and help manage future maintenance and planning in the area. The use of settlement tolerant connections is important. We further recommend that the reservoirs be loaded incrementally over time to allow gradual, controlled consolidation of the clay and related strength increases as opposed to sudden, "shock" loading that could weaken the clay and initiate larger movements. Initially, we recommend consideration be given to a 60 to 75% loading accompanied by settlement monitoring for an extended period of time (say 6 to 12 months) prior to bringing the reservoirs on full line. We understand that the existing Wick Road reservoir may be able to remain in operation to facilitate this. Further geotechnical input can be provided in this regard during final design.

At the Wick Road Reservoir site, the existing waterline is near to the proposed excavation. Further review in relation to temporary pipe support and / or rerouting will be required.

Foam concrete is a specialty product, tender documents should be prepared with input from Levelton. A rigorous Quality Assurance mix review, testing and field monitoring program should be implemented during construction.

Where not covered by the reservoir foundation or perimeter backfill, cellular concrete is to be protected from damage by a protective cover of a minimum of 0.3 m of soil, or concrete.

6.2.3 Lost Shoe Creek – Chlorination Building

Subsurface conditions at Lost Shoe Creek include interlayered organic peat deposits extending to 8 m in depth. Settlements generated in the underlying organics by new imposed loads from chlorination building exceed normal tolerances and include considerations to long-term secondary settlement in the peat. Estimates of settlement under a conventional shallow foundation system using an assumed average building floor load of 15 to 20 kPa approached 300 mm for primary consolidation, with a further 50 to 100 mm of secondary consolidation over a 50 year design period.

The geotechnically preferred foundation option is a deep pile system incorporating a structural floor. Driven, closed ended steel pipe piles bearing in the underlying granular deposit (i.e., below 8 m depth) are recommended. Excavation and replacement to remove the organic soils was not considered practical due to the 8 m depth of the organic deposits. Pre-loading had been considered as a pragmatic option but was discounted following discussions with ISL due to project scheduling considerations and the potential for on-going secondary consolidation.

Hard driving is expected in the upper granular soils and specification will need to consider the potential need to pre-bore through the upper granular zone and or a greater pile wall thickness. Preliminary pile analyses were based on an estimated load of 30 kPa and an objective of limiting long term settlement while providing suitable axial pile resistance. To avoid transferring excessive loads to the clay deposit that underlies the bearing deposit at about 20 m depth (thereby generating additional settlement) the tip of the pile should not extend more than 3 to 4 m into the sand and gravel deposit (i.e., about 11 to 12 m below ground surface). Calculated total static settlements under these conditions are in the order of 50 mm.

Pile design and layout is dependent upon a number of factors including long term settlement tolerances, pile spacing, design loading per pile, seismic performance objectives, pile group interaction, and down drag (i.e., forces generated on the piles as the adjacent soil settles). For preliminary design purposes, 305 mm diameter steel pipe piles with 12.5 mm wall thickness were considered. Table 2 provides preliminary Serviceability Limit State (SLS) and factored Ultimate Limit State (ULS) geotechnical pile resistance values for individual steel pipe piles advanced in two configurations. Geotechnical review of the design should be requested once more information is available and prior to finalizing the design.

Table 2: Geotechnical Resistances and Settlements of Pipe Piles Under Axial Loads – Lost Shoe Creek

Outside Diameter (mm)	Penetration Depth (m)	Compression ULS Resistance (kN)	Compression SLS Resistance (kN)		Uplift ULS Resistance kN	Estimated Long Term Settlement (mm)	Unfactored Downdrag (kN)
			4 D-spacing	8 D-spacing			
305	11	80	30	70	25	50-75	30

Note 1: 4D spacing = about 30 piles; 8D spacing = about 12 piles

Settlement of soil around piles generated by compression of the peat as it decays will induce down drag forces along the shaft of a pile foundation. Down drag forces were considered in the SLS capacities provided above. Down drag forces should also be considered when assessing the structural ULS capacity of the pile by combining the down-drag and the long-term sustained structural loads. Maximum drag loads are computed to occur about half way down the pile. To reduce drag loads and related settlements, a low friction bituminous or other viscous coating could be applied to the upper half of the pile surfaces before installation. The estimated preliminary drag load on the piles are provided in Table 2 above.

The use of pile foundations to support the building will create differential settlement potential between the building and the buried pipework. As with the reservoirs, a flexible connection is recommended subject to input from the Civil Engineer. Careful control to avoid raising future grades is recommended to limit settlements outside of the building area and limit additional load added to the piles.

As noted in the seismic discussion above, relatively large lateral and vertical displacement could occur during seismic shaking. These movements could be too large for the piles to accommodate and they may shear off or buckle. Accordingly, seismic design should be based on a raft slab resting on natural ground that may not be level. If a degree of functionality is required for this building after the design earthquake, ground improvement to reduce the magnitude of movements may need to be considered.

7 FUTURE GEOTECHNICAL WORK

Levelton anticipates that future geotechnical work may include the following:

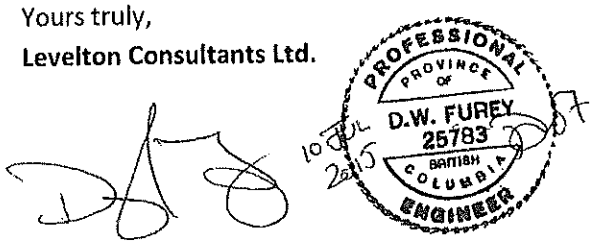
- Review of foundation design and grading plans in relation to geotechnical recommendations and assumptions;
- Assistance with preparation of technical specifications for pile installation at Lost Shoe Creek and site preparation and cellular concrete supply and placement at High Point and Wick Road reservoir sites;
- Review of tender documents for general agreement with the intent of geotechnical recommendations;
- Support during tender as needed; and,
- Site reviews, consultation, and testing during construction.

8 CLOSURE

This report has been prepared by Levelton Consultants Ltd. (Levelton) in accordance with the attached Terms of Reference for Geotechnical Reports exclusively for Tla-O-Qiu-Aht First Nation. ISL Engineering and Land Services Ltd. is considered an approved user subject to the terms under which it was prepared.

We trust this meets your current needs.

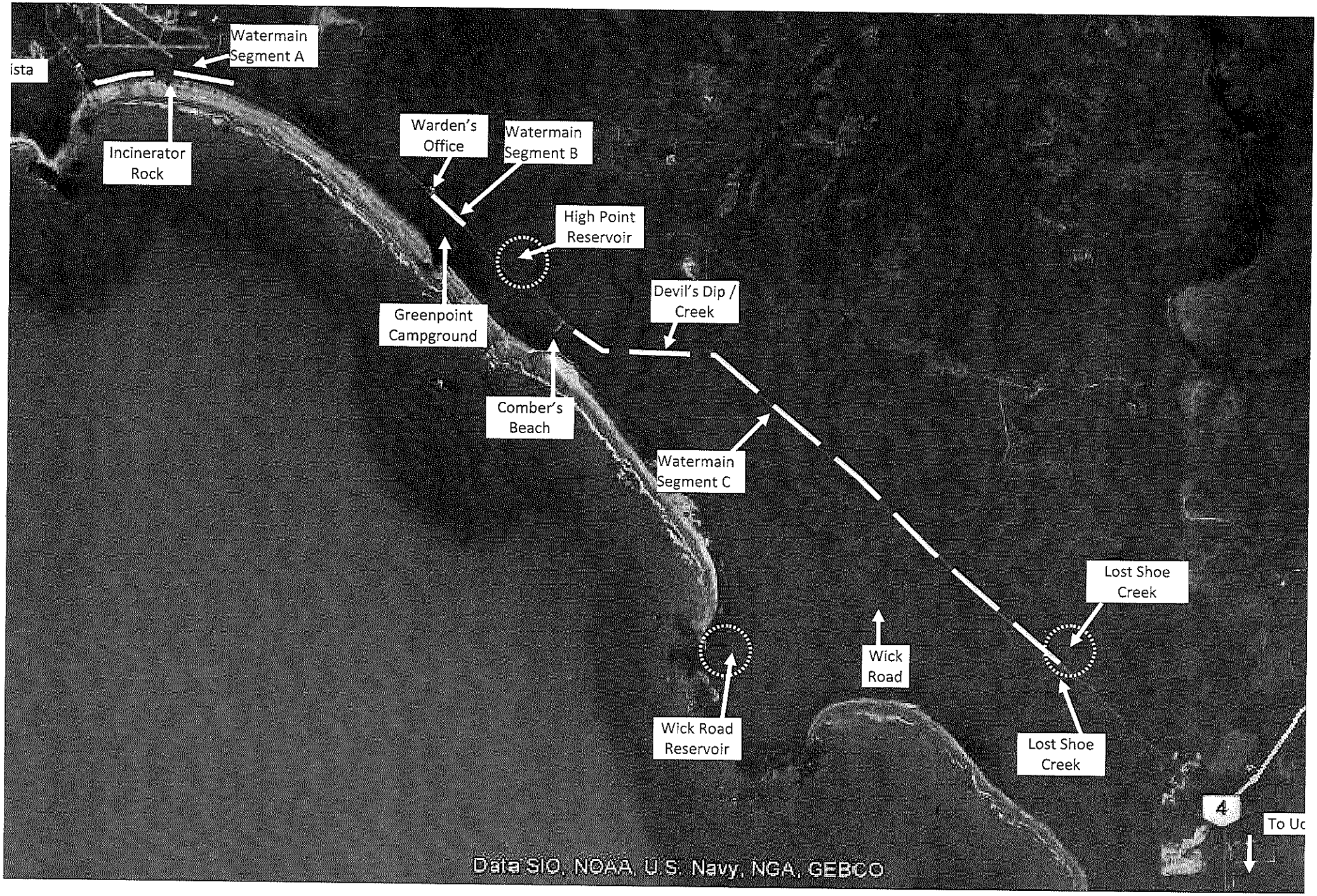
Yours truly,
Levelton Consultants Ltd.



Per: Darryl Furey, M.Eng., P.Eng.
Senior Geotechnical Engineer

Reviewed by:

Don Kaluza, P.Eng.
Senior Geotechnical Engineer

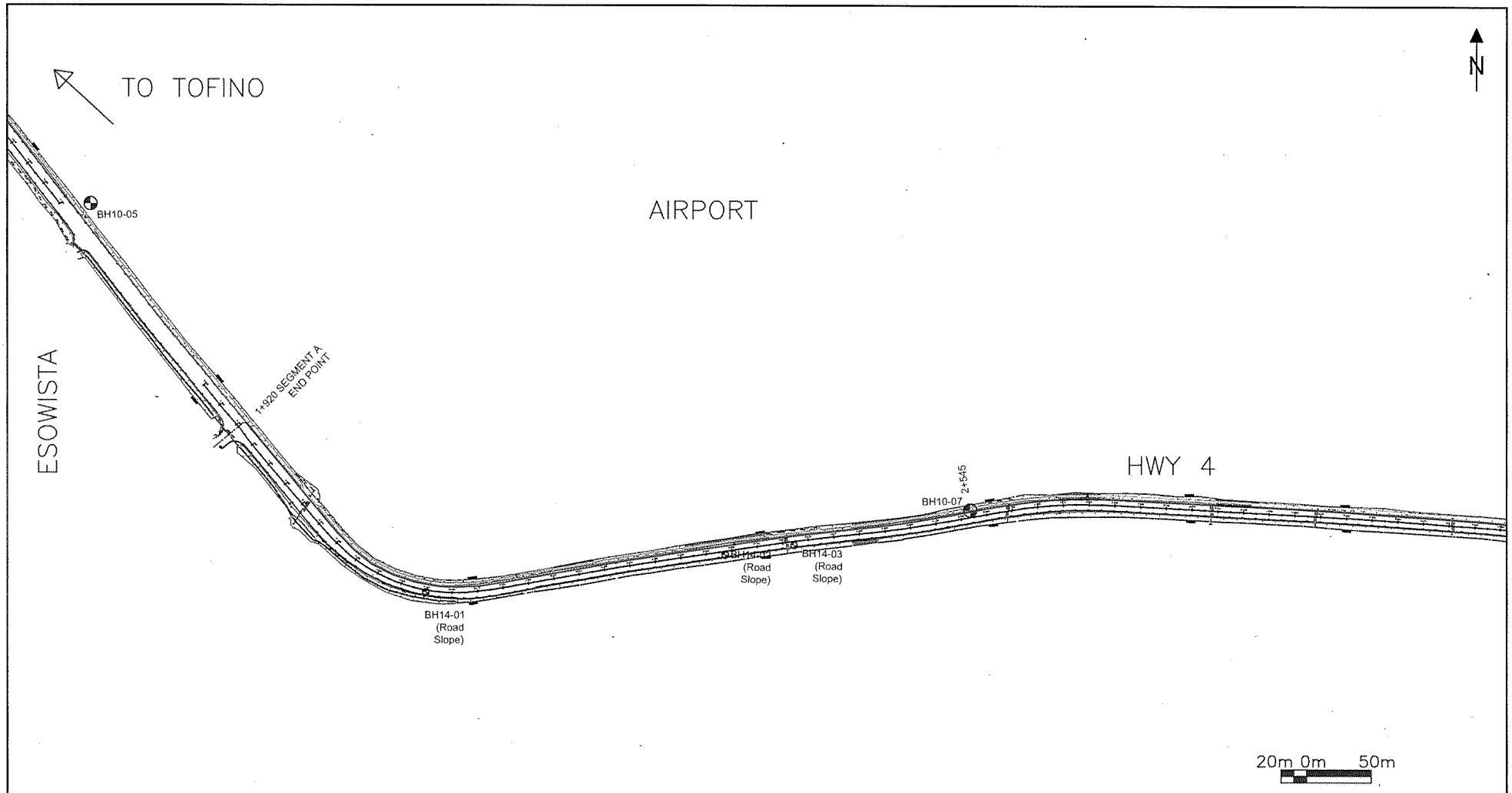


ELTON CONSULTANTS LTD.

BOLLINGER ROAD
IMO, B.C.
DA V9S 5W9

PROJECT: TOFINO WATER SUPPLY UPGRADES – PHASE 3

TITLE: SITE LOCATION PLAN



BASE PLAN PROVIDED BY ISL ENGINEERING AND LAND SERVICES LTD.

LEGEND:

APPROXIMATE LOCATION OF BOREHOLE

REV. :	DESCRIPTION:	DATE (M/D/YR)

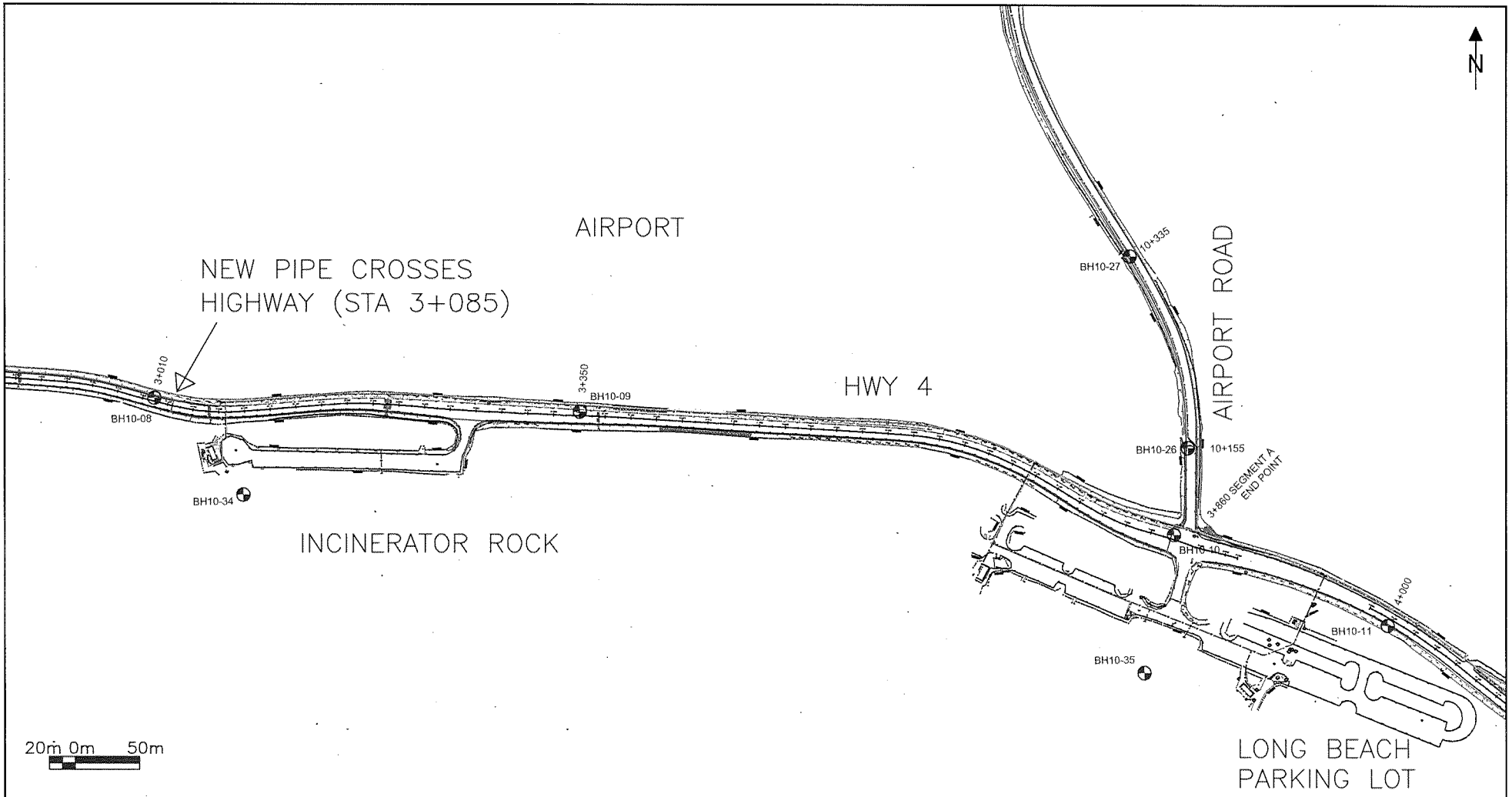
PROJECT: TOFINO WATER SUPPLY UPGRADES GEOTECHNICAL ASSESSMENT

CLIENT: THE TLA-O-QUI-AHT FIRST NATION

TITLE: BOREHOLE LOCATION PLAN – SEGMENT A (1+670 to 3+000)

DATE: JUNE 2015
DESIGN BY: RB
DRAWN BY: RB
CHECKED BY: DF
SCALE: AS SHOWN
PROJECT No.: R715-0161
FIGURE NO.: 2

LEVELTON



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REV.	DESCRIPTION	DATE (M/D/YR)

PROJECT: TOFINO WATER SUPPLY UPGRADES
GEOTECHNICAL ASSESSMENT

CLIENT: THE TLA-O-QUI-AHT FIRST NATION

TITLE: BOREHOLE LOCATION PLAN – SEGMENT A (3+000 to 3+860)

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SCALE: AS SHOWN
PROJECT No.: R715-0161
FIGURE NO.: 3

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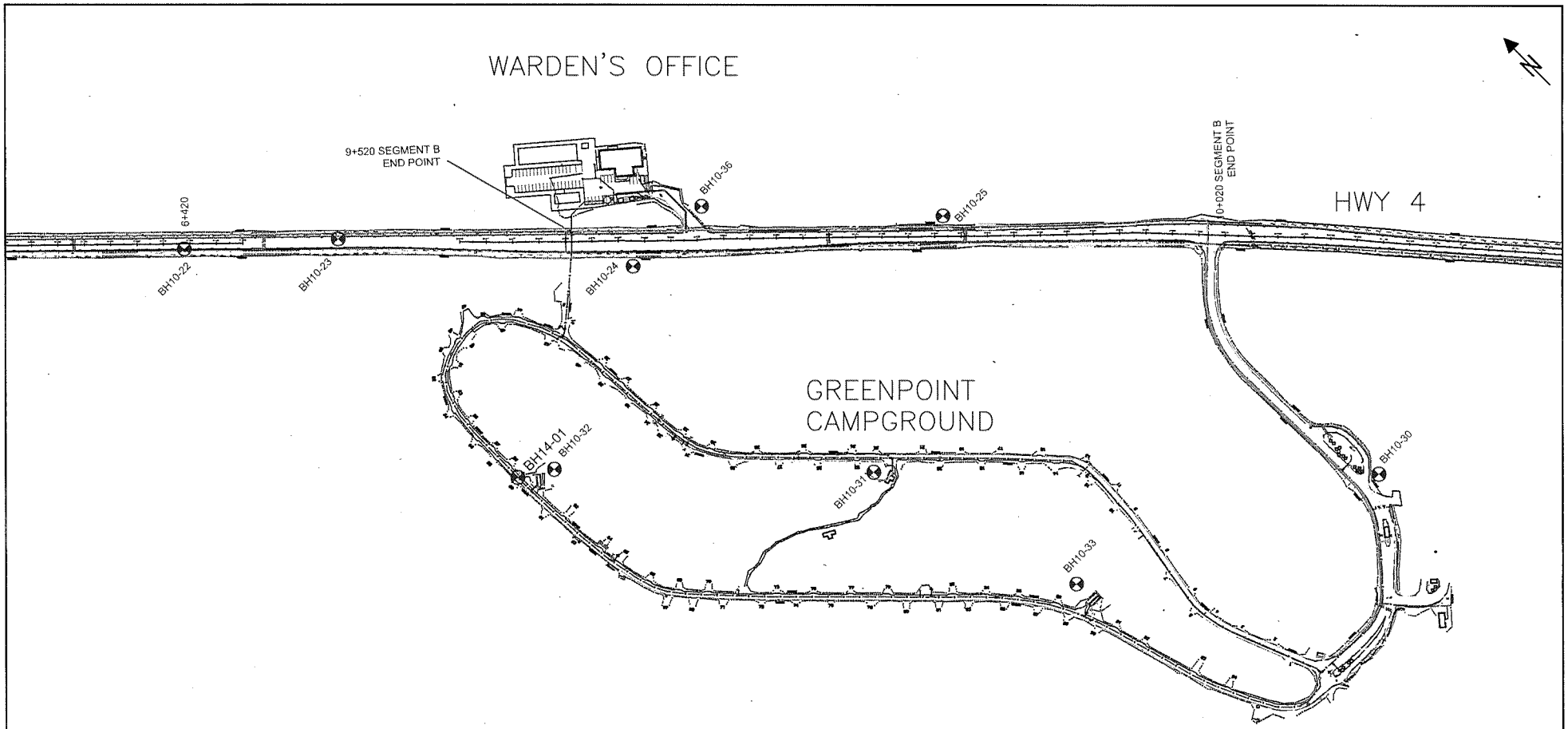

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REV.	DESCRIPTION:	DATE (M/D/YR)

PROJECT: TOFINO WATER SUPPLY UPGRADES
GEOTECHNICAL ASSESSMENT

CLIENT: THE TLA-O-QUI-AHT FIRST NATION

TITLE: BOREHOLE LOCATION PLAN – SEGMENT B (9+520 to 10+020)

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FIGURE NO.: 4

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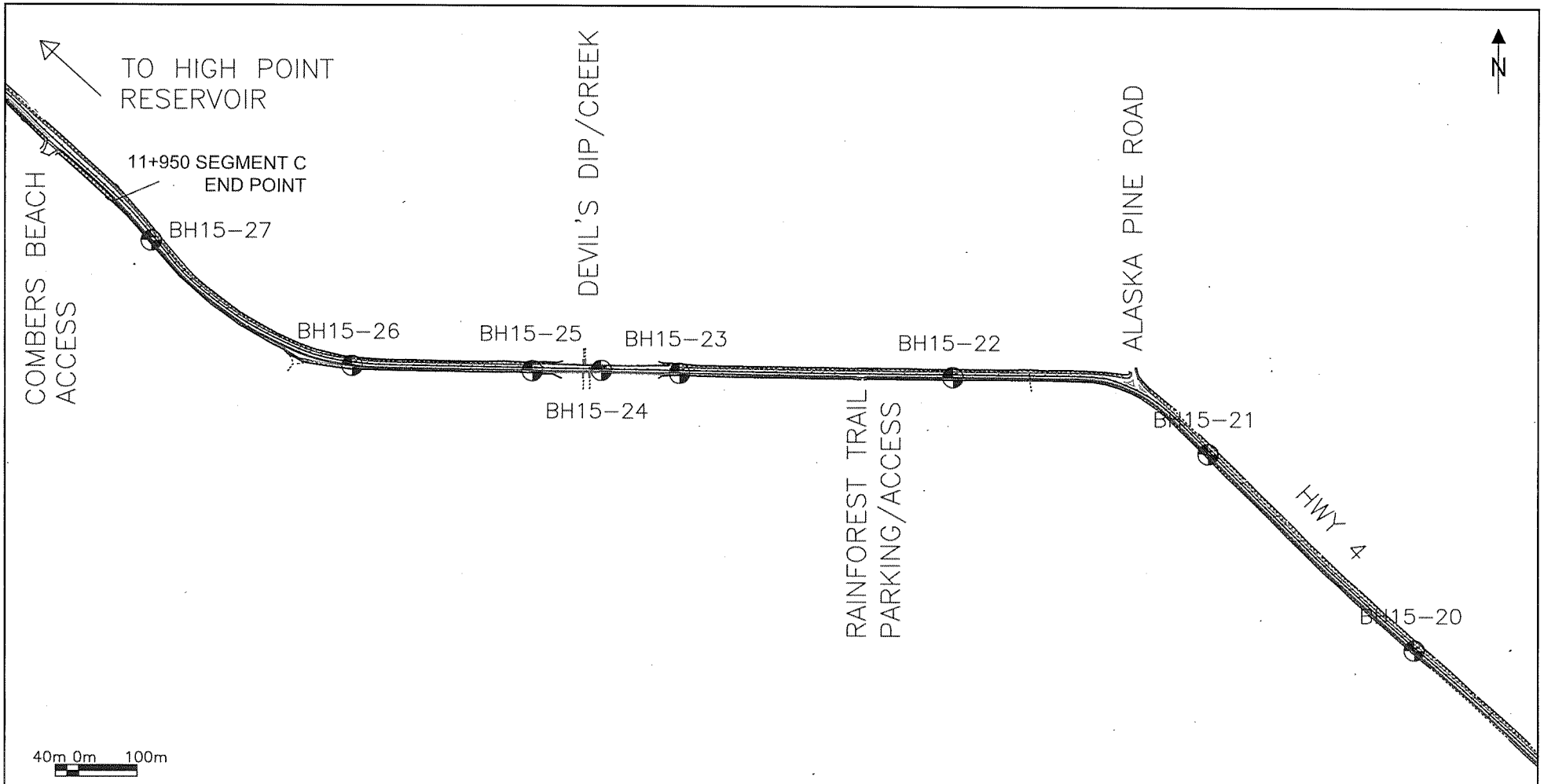

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REV.	DESCRIPTION	DATE (M/D/YR)

PROJECT: TOFINO WATER SUPPLY UPGRADES GEOTECHNICAL ASSESSMENT

CLIENT: THE TLA-O-QUI-AHT FIRST NATION

TITLE: BOREHOLE LOCATION PLAN – SEGMENT C (11+800 + 14+600)

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PROJECT No.: R715-0161
FIGURE NO.: 5

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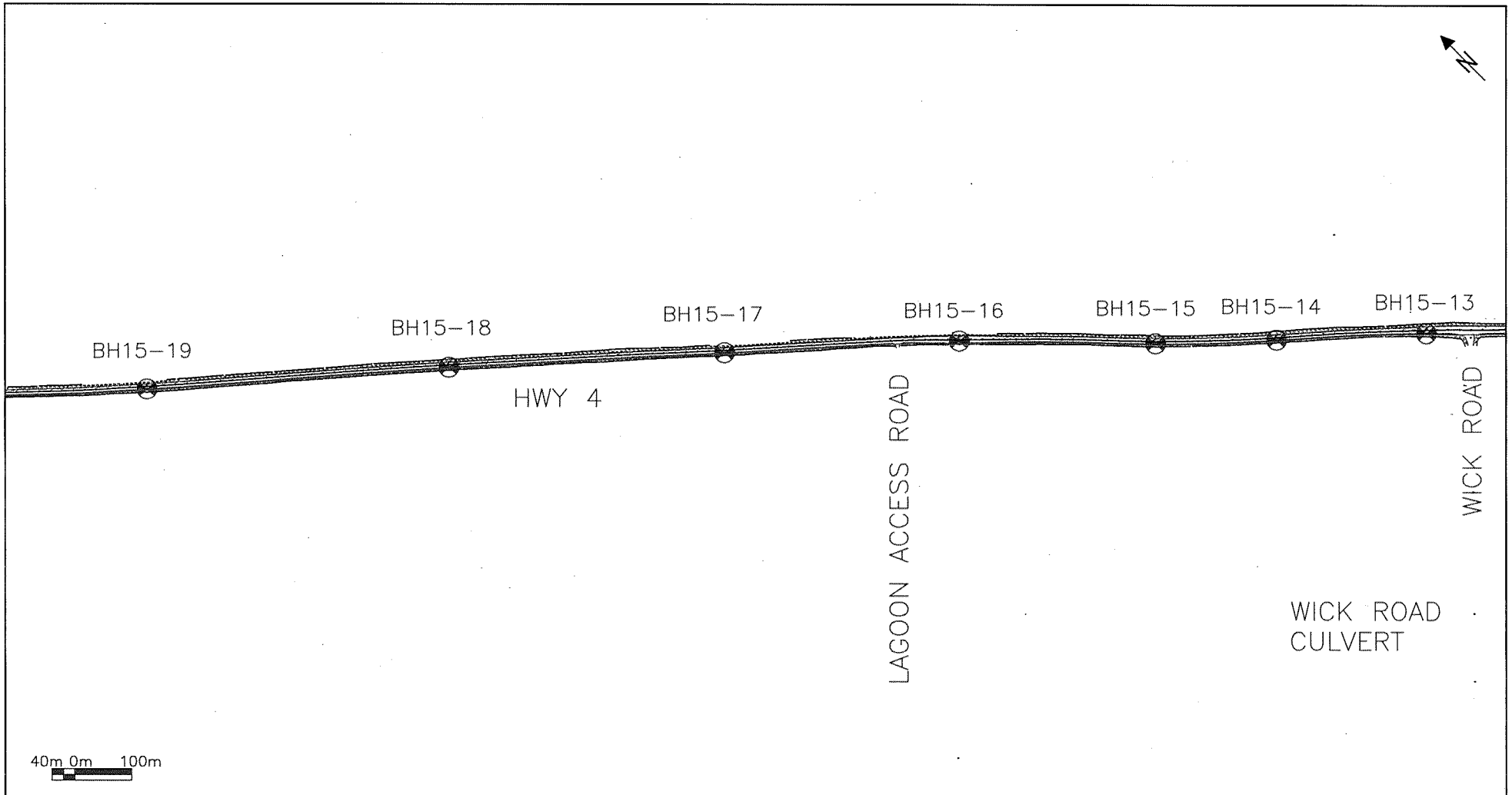

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APPROXIMATE LOCATION OF BOREHOLE

REV.	DESCRIPTION	DATE (M/D/YR)

PROJECT: TOFINO WATER SUPPLY UPGRADES
GEOTECHNICAL ASSESSMENT

CLIENT: THE TLA-O-QUI-AHT FIRST NATION

TITLE: BOREHOLE LOCATION PLAN – SEGMENT C (14+600 to 17+550)

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FIGURE NO.: 6

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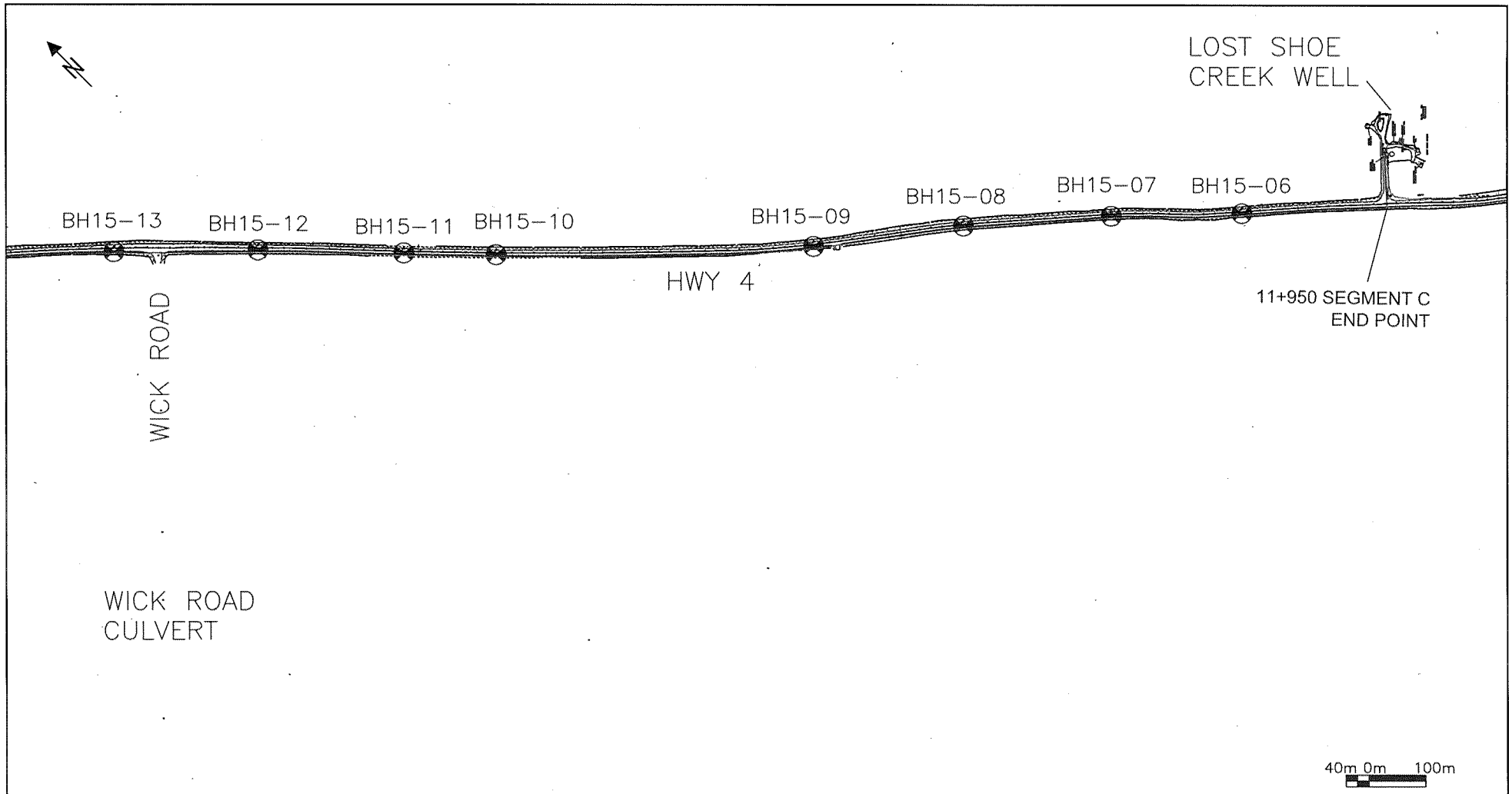

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APPROXIMATE LOCATION OF BOREHOLE

REV.	DESCRIPTION	DATE (M/D/YR)

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PROJECT: TOFINO WATER SUPPLY UPGRADES
GEOTECHNICAL ASSESSMENT

CLIENT: THE TLA-O-QUI-AHT FIRST NATION

TITLE: BOREHOLE LOCATION PLAN – SEGMENT C (17+250 to 19+660)

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PROJECT No.: R715-0161
FIGURE NO.: 7

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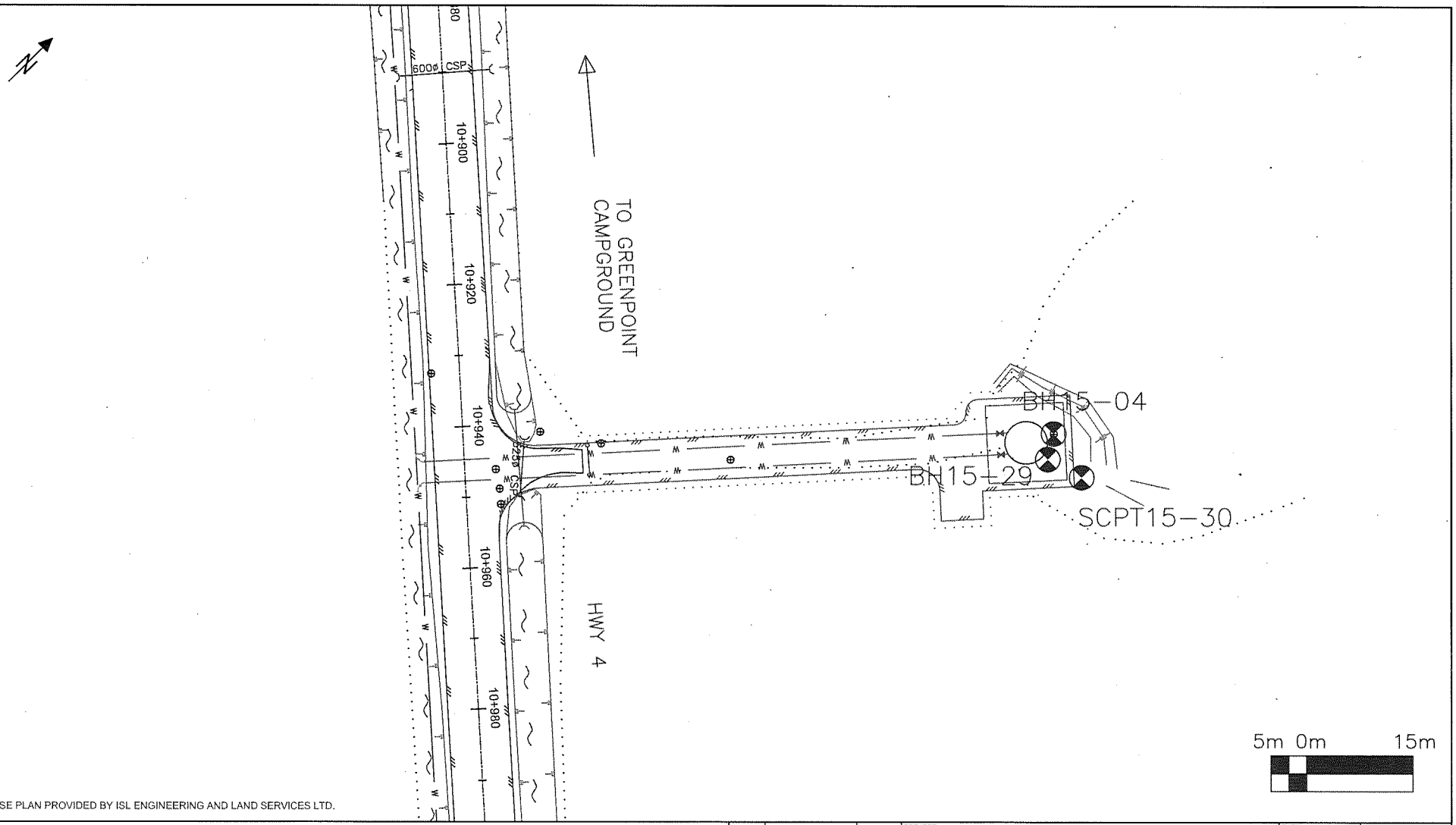

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APPROXIMATE LOCATION OF BOREHOLE

REV.	DESCRIPTION	DATE (M/D/YR)

PROJECT: TOFINO WATER SUPPLY UPGRADES – PHASE 3
GEOTECHNICAL ASSESSMENT

CLIENT: TLA-O-QUI-AHT FIRST NATION c/o ISL

TITLE: BOREHOLE LOCATION PLAN – HIGH POINT RESERVOIR

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FIGURE NO.: B

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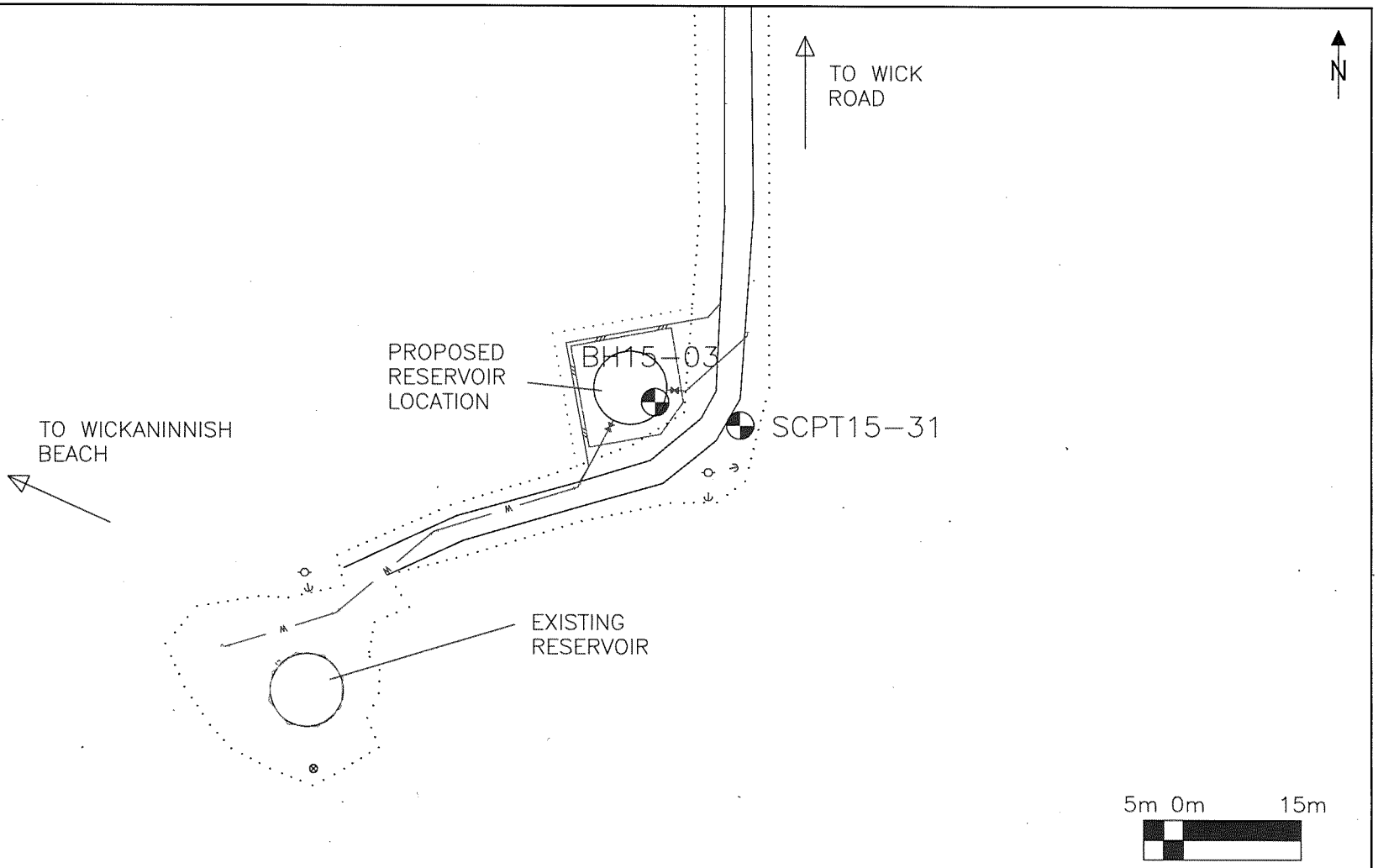

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APPROXIMATE LOCATION OF BOREHOLE

REV.	DESCRIPTION:	DATE (M/D/YR)

PROJECT: TOFINO WATER SUPPLY UPGRADES – PHASE 3
GEOTECHNICAL ASSESSMENT

CLIENT: TLA-O-QUI-AHT FIRST NATION c/o ISL

TITLE: BOREHOLE LOCATION PLAN – WICK ROAD RESERVOIR

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PROJECT No.: R715-0161
FIGURE NO.: 9

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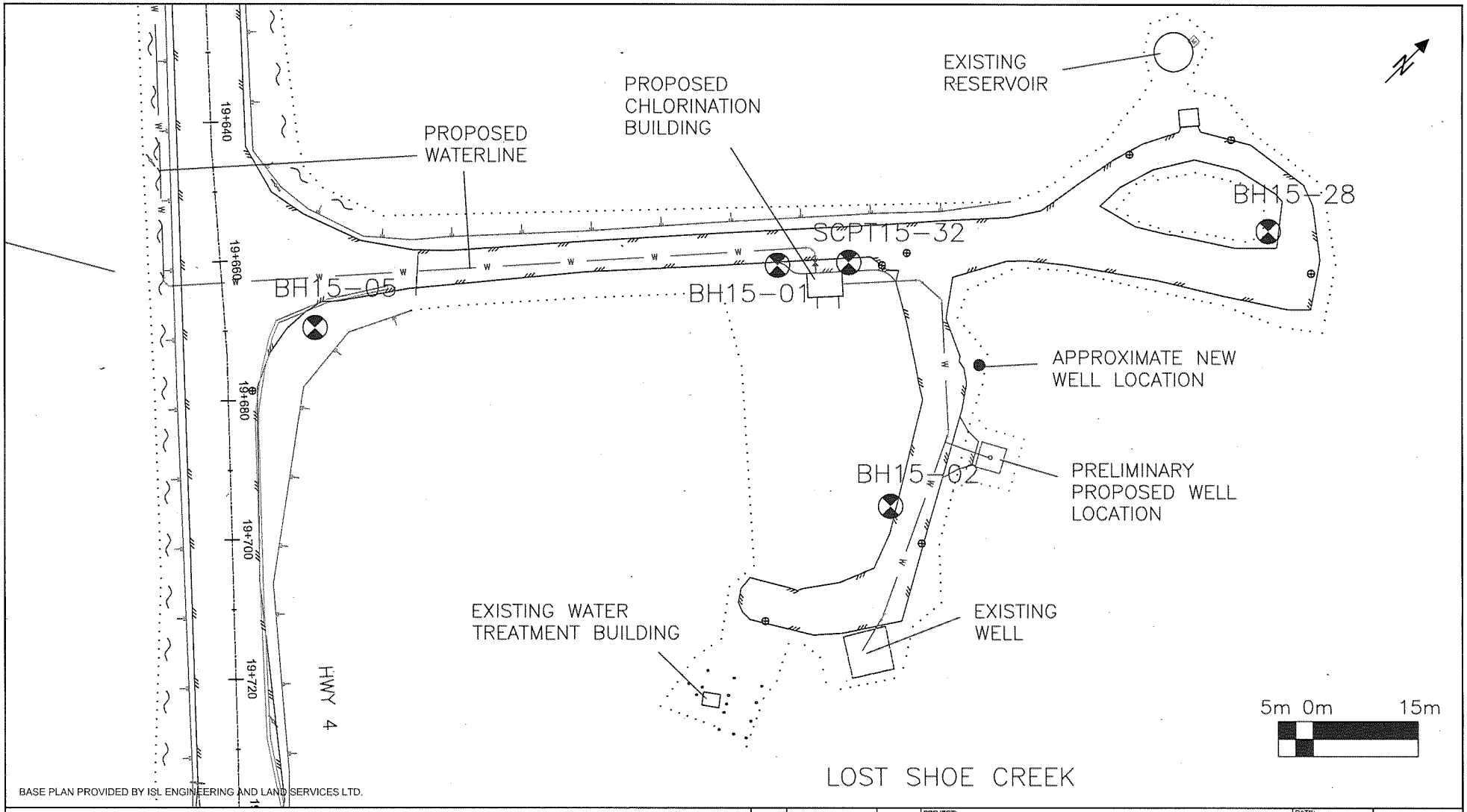

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LEGEND:

APPROXIMATE LOCATION OF BOREHOLE

REV.	DESCRIPTION	DATE (M/D/YR)

PROJECT: TOFINO WATER SUPPLY UPGRADES – PHASE 3
GEOTECHNICAL ASSESSMENT

CLIENT: TLA-O-QUI-AHT FIRST NATION c/o ISL

TITLE: BOREHOLE LOCATION PLAN – LOST SHOE CREEK WELL

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PROJECT No.: R715-0161
FIGURE NO.: 10

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2010 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836
Western Canada English (250) 363-6500 Facsimile (250) 363-6565

Requested by: ,

May 25, 2015

Site Coordinates: 49.0159 North 125.6576 West

User File Reference:

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

Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA (g)
1.202	0.936	0.473	0.206	0.523

Notes. Spectral and peak hazard values are determined for firm ground (NBCC 2010 soil class C - average shear wave velocity 360-750 m/s). Median (50th percentile) values are given in units of g. 5% damped spectral acceleration (Sa(T), where T is the period in seconds) and peak ground acceleration (PGA) values are tabulated. Only 2 significant figures are to be used. ***These values have been interpolated from a 10 km spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the calculated values.*** Warning: You are in a region which considers the hazard from a deterministic Cascadia subduction event for the National Building Code. Values determined for high probabilities (0.01 per annum) in this region do not consider the hazard from this type of earthquake.

Ground motions for other probabilities:

Probability of exceedance per annum	0.010	0.0021	0.001
Probability of exceedance in 50 years	40%	10%	5%
Sa(0.2)	0.157	0.627	0.762
Sa(0.5)	0.109	0.489	0.594
Sa(1.0)	0.060	0.247	0.300
Sa(2.0)	0.034	0.097	0.122
PGA	0.076	0.273	0.332

References

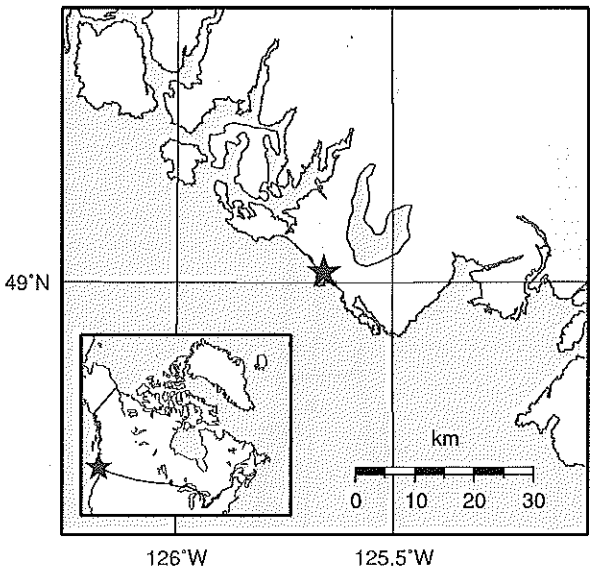
National Building Code of Canada 2010 NRCC no. 53301; sections 4.1.8, 9.20.1.2, 9.23.10.2, 9.31.6.2, and 6.2.1.3
Appendix C: Climatic Information for Building Design in Canada - table in Appendix C starting on page C-11 of Division B, volume 2

User's Guide - NBC 2010, Structural Commentaries NRCC no. 53543 (in preparation)
Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File xxxx
Fourth generation seismic hazard maps of Canada: Maps and grid values to be used with the 2010 National Building Code of Canada (in preparation)

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

Aussi disponible en français



R715-0161-00

FIGURE 11

APPENDIX 1

PHOTOGRAPHS

Photo1: Photo take near Lost Shoe Creek showing typical alignment conditions in Waterline Segment C.

Photo 2: Conditions looking north near ravine/creek crossing near Station 18+000. Note the pylon from Photo 3 in the background.

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Photo 3: Erosion conditions at discharge of culvert at crossing near Station 18+000.

Photo 4: Current conditions at "Devil's Dip" at approximate Station 12+760 in Waterline Segment C.

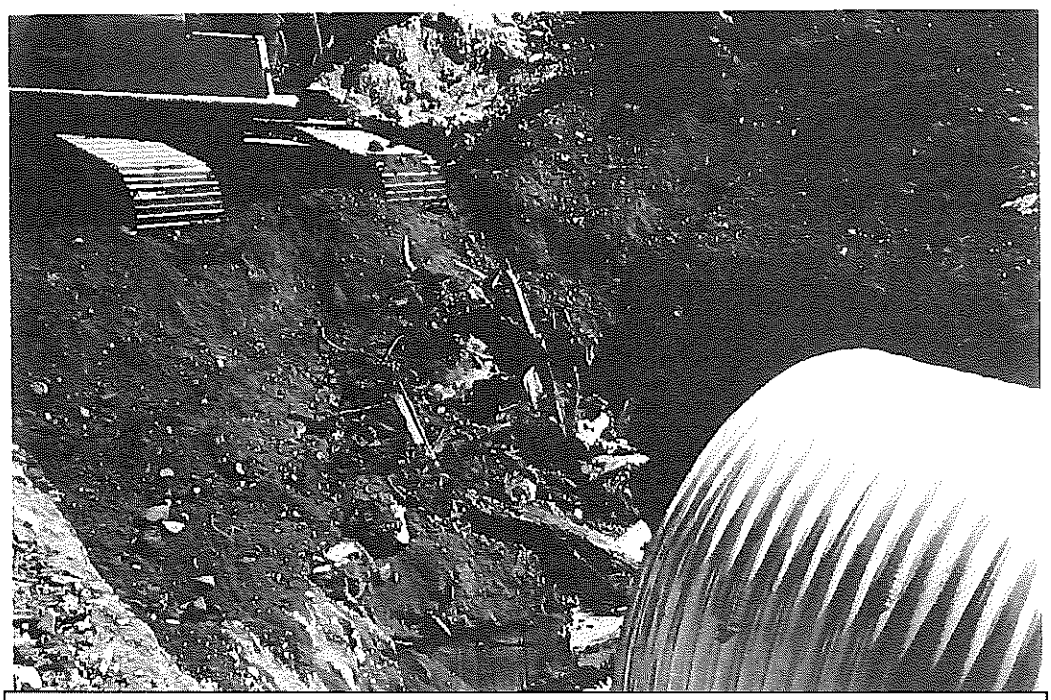


Photo 5: Historical Photo #127 – August 10, 1997 – Excavation conditions at base of Devil's Dip illustrating removal of organics and wood debris to expose underlying clay.

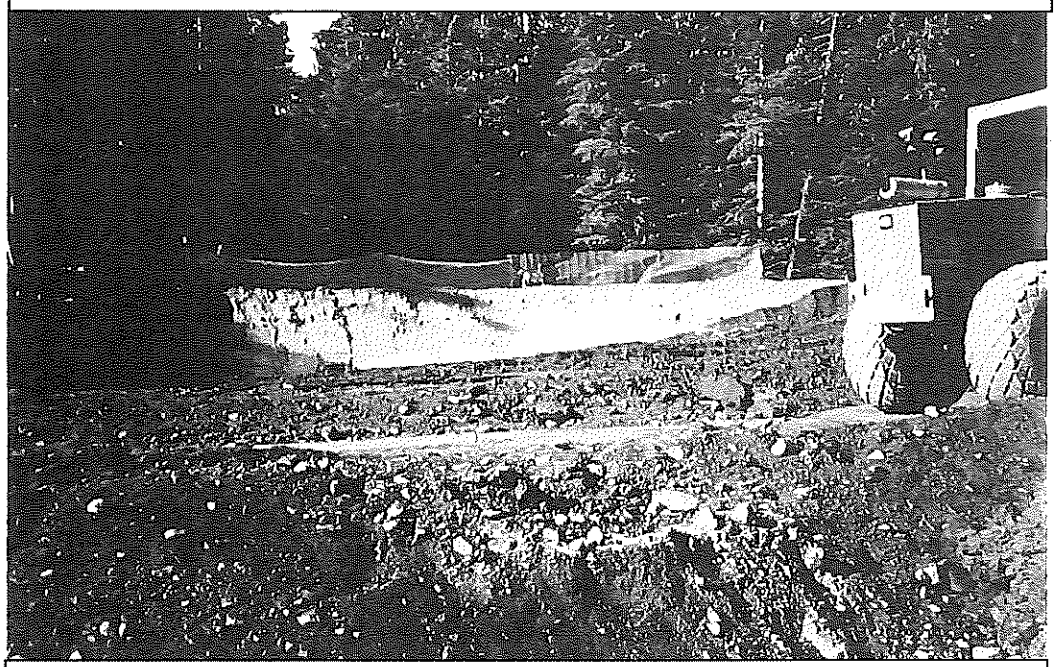


Photo 6: Historical Photo #131 – August 11, 1997 – Placement and compaction of embankment material at Devil's Dip near top of culvert elevation.

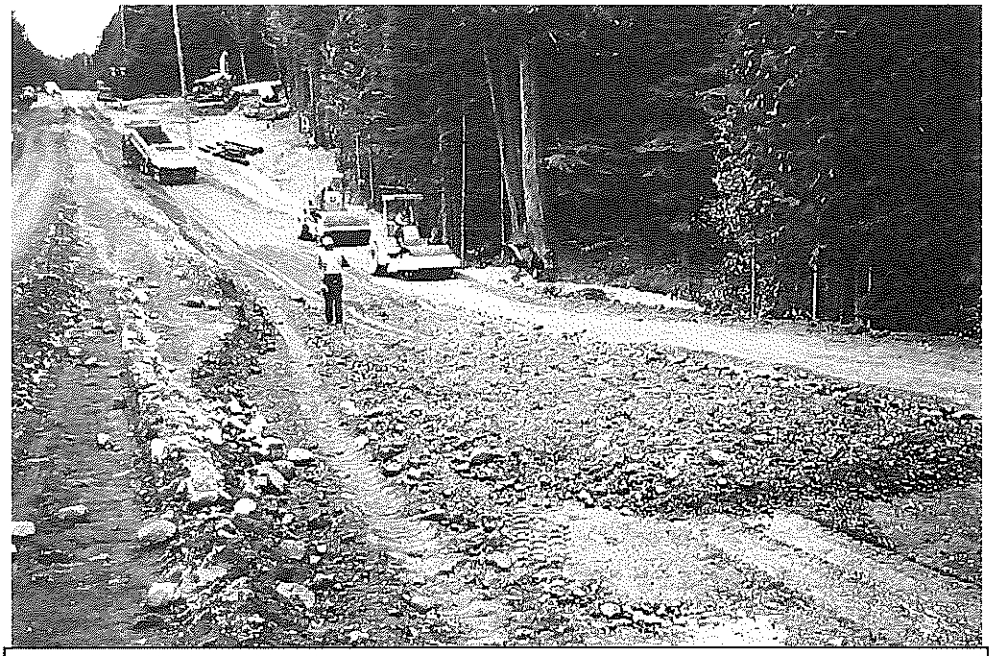


Photo 7: Historical Photo #152 – 18 August 1997 – Placement and compaction of engineered fill at Devil's Dip. Note the relatively coarse nature of material, limited lift thickness and heavy compaction equipment in the background

Photo 8: Conditions at tie-in to previous phase at north end of Waterline Segment C facing southeast.

Photo 9: Conditions on ocean side of road in Waterline Segment A (Esowista).

Photo 10: Conditions at proposed High Point Reservoir.

Photo 11: Conditions at proposed Wick Road Reservoir.

Photo 12: View of typical normally consolidated clay on auger encountered at depth of Wick Road and High Point reservoir sites.

Photo 13: Conditions at proposed chlorination building at Lost Shoe Creek – Note Highway 4 in the background.

Photo 14: Over-steepened slope along Lost Shoe Creek near to existing well.

APPENDIX 2

TABLE 1 – BOREHOLE STATION & ELEVATION SUMMARY

Long Beach Parking Lot (105m SW of road centerline, approx 3+850)					
170 m East of project area (Approx 4+020)		5.9			
e to Greenpoint Entrance (9+520 to 10+015) (495 m)					
Greenpoint Washroom (180m SW of road centerline, approx 9+480)					
Greenpoint Washroom (170m SW of road centerline, approx 9+520)					
9+570	34.4	34.6			
rive Intersection (9+620)					
Warden's Office (25m NW of road centerline, approx 9+625)					
Greenpoint Washroom (180m SW of road centerline, approx 9+760)					
9+805	33.5	33.9			
ground Entrance Intersection (10+010)					
Greenpoint Sanitary Dump (265m SW of road centerline, approx 9+900)					
Greenpoint Sanitary Dump (180m SW of road centerline, approx 10+160)					
main Comber's Beach Parking Lot to Lost Shoe Creek 11+950 to 19+665 (7715 m)					
rking Lot Intersection (11+810)					
atermain (11+950)					
12+045	35.4	36.0	33.6	2.4	Soft, blue grey, CLAY, wet
12+455	35.4	36.0	33.6	2.4	Soft, grey, CLAY, trace gravel, moist to
12+760	31.8	31.8	29.8	2.0	Soft, blue grey, CLAY, trace sand, we
Culvert at "Devil's Dip" (12+870)					
12+880	27.8	28.1	26.5	1.6	Brown, cobbly, SAND AND GRAVEL F
13+015	35.1	35.3	33.4	1.9	Firm, blue grey, CLAY, moist to wet
rking Lot Intersection(13+325)					
13+480	36.9	37.3	35.3	2.0	Soft, blue grey, CLAY, moist
ntersection (13+800)					
13+965	40.2	40.8	38.5	2.3	Very stiff, rust brown mottled grey, CLAY, mois 2.5m depth)
14+450	39.3	39.8	37.9	1.9	Firm, grey, CLAY, moist
15+170	36.5	37.0	34.7	2.3	Soft, grey, CLAY, moist
15+700	32.2	32.8	30.8	2.0	Soft, blue grey, CLAY, trace sand
16+185	26.3	26.7	24.3	2.4	Soft to firm, tan, CLAY, moist to we
cess Road Intersection(16+490)					
+570)					
16+600	18.7	18.8	16.5	2.3	Grey, SAND AND GRAVEL FILL, moist (organic de from 6.4m to 6.7m depth)
16+945	26.2	26.7	24.3	2.4	Stiff, tan, CLAY, moist (soft, blue grey, some sanc 2.8m depth)
17+160	28.3	28.8	26.3	2.5	Firm to stiff, grey becoming tan, CLAY, sand len wet
17+420	27.1	27.9	25.4	2.5	Stiff, CLAY, some sand and sand lenses,
ction (17+500)					
17+675	22.6	23.3	21.0	2.3	Tan, SAND, trace silt, wet
17+930	16.0	16.5	14.0	2.5	Dark brown, PEAT, fibrous, wet (up to 2.9m
18+095	16.5	17.4	14.9	2.5	Grey, SAND, fine to medium grained, trace to s
18+650	25.0	25.7	22.9	2.8	Grey, SAND, some gravel, trace silt, w
tersection (18+695)					
18+920	23.9	24.3	22.4	1.9	Grey, SAND, medium grained, mois
19+180	24.0	24.4	22.5	1.9	Compact, grey, SAND, fine grained, w
19+410	23.5	23.9	21.9	2.0	Compact, grey, SAND, some fine grained and cc lenses, moist
eservoir Access Road Intersection (19+665)					
19+668	21.7	22.1			
9+760)					
Point Reservoir					
ir Access Road Intersection (10+945)					
Proposed High Point Reservoir (90m NE of road centerline, approx 10+945)					
Proposed High Point Reservoir (80m NE of road centerline, approx 10+945)					
Proposed High Point Reservoir (90m NE of road centerline, approx 10+945)					
Road Reservoir					
Wick Road Culvert (625m SW of road centerline, approx 17+500)					
Wick Road Culvert (615m SW of road centerline, approx 17+500)					
Proposed Wick Road Reservoir (2210m SW of road centerline, approx 16+185)					
Proposed Wick Road Reservoir (2210m SW of road centerline, approx 16+185)					
Shoe Creek Reservoir					
Proposed Lost Shoe Creek Reservoir (80m NE of road centerline, approx 19+660)					
Proposed Lost Shoe Creek Reservoir (150m NE of road centerline, approx 19+660)					
Proposed Lost Shoe Creek Pump Station (94m NE of road centerline, approx 19+700)					
Proposed Lost Shoe Creek Reservoir (85m NE of road centerline, approx 19+660)					

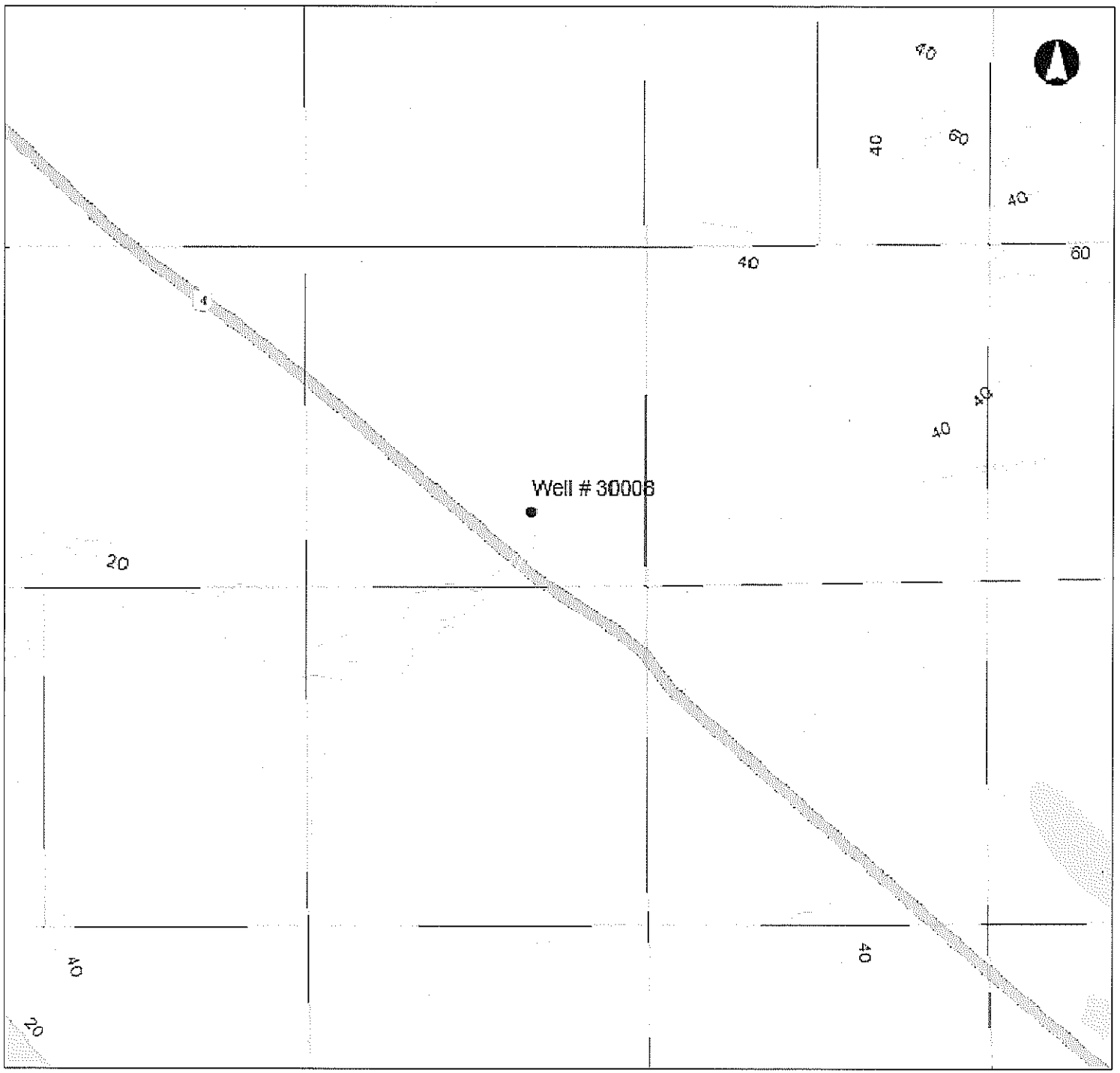
the label "BH14-* or BH10-* are from previous assessment work conducted by Levelton in the project area (logs not included in the preliminary report)

ns are approximate and are based on an overlay of handheld GPS data onto the base drawing.

ationing information based on Interim Plans provided by ISL Engineering 2015-03-03 (Drawing - ACAD-3283_XP_Phase3-HWY4.dwg). Some elevation information was not available at time of report preparation.

APPENDIX 3

WATER WELL LOGS



BRITISH COLUMBIA

Water Resources Atlas

Legend

- Water Wells
- Integrated Cadastral Fabric
- Contours (1:20,000)

FCODE

- Contour - Index
- Contour - Index Indefinite
- Contour - Index Depression
- Contour - Index Depression Ind
- Contour - Intermediate
- Contour - Intermediate Indefinite
- Contour - Intermediate Depressi
- Contour - Intermediate Depressi

TileCache

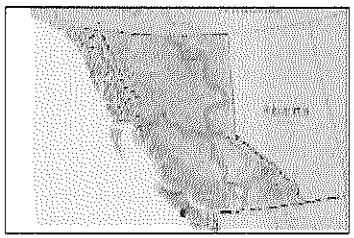
0 0.27 0.55 km

1: 13,411

Copyright/Disclaimer

Datum: NAD83
Projection: NAD_1983_BC_Environment_Albers

Key Map of British Columbia



BRITISH COLUMBIA

Report 1 - Detailed Well Record

Well Tag Number: 30008	Construction Date: 1974-03-27 00:00:00
Owner: PACIFIC RIM PARK	Driller:
	Well Identification Plate Number:
Address: LOST SHOE CREEK	Plate Attached By:
	Where Plate Attached:
Area: LONG BEACH	
	PRODUCTION DATA AT TIME OF DRILLING:
WELL LOCATION:	Well Yield: 40 (Driller's Estimate)
Land District	Development Method:
District Lot: Plan: Lot:	Pump Test Info Flag: Y
Township: Section: Range:	Artesian Flow:
Indian Reserve: Meridian: Block:	Artesian Pressure (ft):
Quarter:	Static Level: 18 feet
Island:	
BCGS Number (NAD 83): Well: 1	WATER QUALITY:
	Character:
Class of Well:	Colour:
Subclass of Well:	Odour:
Orientation of Well:	Well Disinfected: N
Status of Well: New	EMS ID:
Well Use:	Water Chemistry Info Flag: Y
Observation Well Number:	Field Chemistry Info Flag:
Observation Well Status:	Site Info (SEAM):
Construction Method:	
Diameter: 6.0 inches	Water Utility:
Casing drive shoe:	Water Supply System Name:
Well Depth: 88 feet	Water Supply System Well Name:

Elevation: 0 feet (ASL)	
Final Casing Stick Up: inches	SURFACE SEAL:
Well Cap Type:	Flag:
Bedrock Depth: feet	Material:
Lithology Info Flag:	Method:
File Info Flag:	Depth (ft):
Sieve Info Flag:	Thickness (in):
Screen Info Flag:	
	WELL CLOSURE INFORMATION:
Site Info Details:	Reason For Closure:
Other Info Flag:	Method of Closure:
Other Info Details:	Closure Sealant Material:
	Closure Backfill Material:
	Details of Closure:

Screen from	to feet	Type	Slot Size

Casing from	to feet	Diameter	Material	Drive Shoe

GENERAL REMARKS:
40 GPM

LITHOLOGY INFORMATION:

From	0	to	0 Ft.	Hole # 1
From	0	to	2 Ft.	Fill
From	2	to	20 Ft.	Fine silty sand with a trace of
From	0	to	0 Ft.	organics
From	20	to	58 Ft.	Fine to coarse sand and gravel, W.B.
From	58	to	62 Ft.	Fine to coarse silty sand
From	62	to	88 Ft.	Blue clay

- Return to Main
- Return to Search Options
- Return to Search Criteria

PROJECT No.: 1407002 / 2000

CLIENT: ISL Engineering and Land Services
PROJECT: ISL Well Installation
LOCATION: Tofino, BC

RECORD OF BOREHOLE: TPW15-1

DRILLING DATE: February 24 and 25, 2015
DRILLING CONTRACTOR: Drillwell Enterprises Ltd.

SHEET 1 OF 2

DATUM: Ground Surface

INCLINATION: -90°

DEPTH SCALE METRES	DRILLING RIG	DRILLING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY %	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH nat V. + Q - ● rem V. ⊕ U - ○ Pocket Pen - ■ Cu, kPa (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT Wp W Wl NP - Non-Plastic (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
0	Dr-12 Foremost	Dual Rotary (Casing:203 mm;)	Ground Surface										
			(GP) sandy GRAVEL, medium to coarse sand, sub-rounded, maximum 25mm diameter gravel; brown; non-cohesive, moist, loose.		0.00	1	CS						
1													
2			(SM) SILTY SAND, some gravel, fine to coarse sand, trace organics and twigs; rust mottled brown; non-cohesive, moist to wet, loose.		2.44	2	CS						
3													
4			(ML) sandy SILT, trace gravel, fine sand, trace organics; brown; cohesive, w>PL, soft.		3.96	3	CS						
5													
6						4	CS						
7			(SP) SAND, fine to coarse, some non-plastic fines, trace gravel, sub-rounded gravel; brown; wet, loose.		6.86	5	CS						
8													
9						6	CS						
10													
11						7	CS						
12						8	CS						
13													
14			(SP) gravelly SAND, fine to coarse sand, sub-rounded gravel; brown; wet, loose.		13.41	9	CS						
						10	CS						
15			*CONTINUED NEXT PAGE*										

SOIL CLASSIFICATION SYSTEM: GACS

DEPTH SCALE
1 : 75

Golder Associates

LOGGED: CH
CHECKED: DRAFT

PROJECT No.: 1407002 / 2000

CLIENT: ISL Engineering and Land Services
PROJECT: ISL Well Installation
LOCATION: Tofino, BC

RECORD OF BOREHOLE: TPW15-1

SHEET 2 OF 2

DATUM: Ground Surface

DRILLING DATE: February 24 and 25, 2015
DRILLING CONTRACTOR: Drillwell Enterprises Ltd.

INCLINATION: -90°

DEPTH SCALE METRES	DRILLING RIG / DRILLING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	RECOVERY %	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80)	SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Pocket Pen -; Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3})	WATER CONTENT PERCENT (Wp, W, Wl; NP - Non-Plastic) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
15	Dr-12 Foremost / Dual Rotary (Casing:203 mm;)	(SP) sandy GRAVEL, fine to coarse sand, sub-angular to sub-rounded gravel; brown; wet, loose. *(continued)*		14.94	11	CS								
					12	CS								
16					13	CS								
17					14	CS								
18		(SP/GP) SAND and GRAVEL, fine to coarse.		17.98	15	CS								
		(GP) sandy GRAVEL, medium to coarse, sub-rounded gravel; brown; wet, loose.		18.29	16	CS								
19		(SW) SAND, fine to coarse, trace gravel; brown; wet, loose.		19.20	17	CS								
20					18	CS								
		(CH) CLAY; blue-grey.		20.42	19	CS								
21		End of Borehole.		20.73										
22														
23														
24														
25														
26														
27														
28														
29														
30														

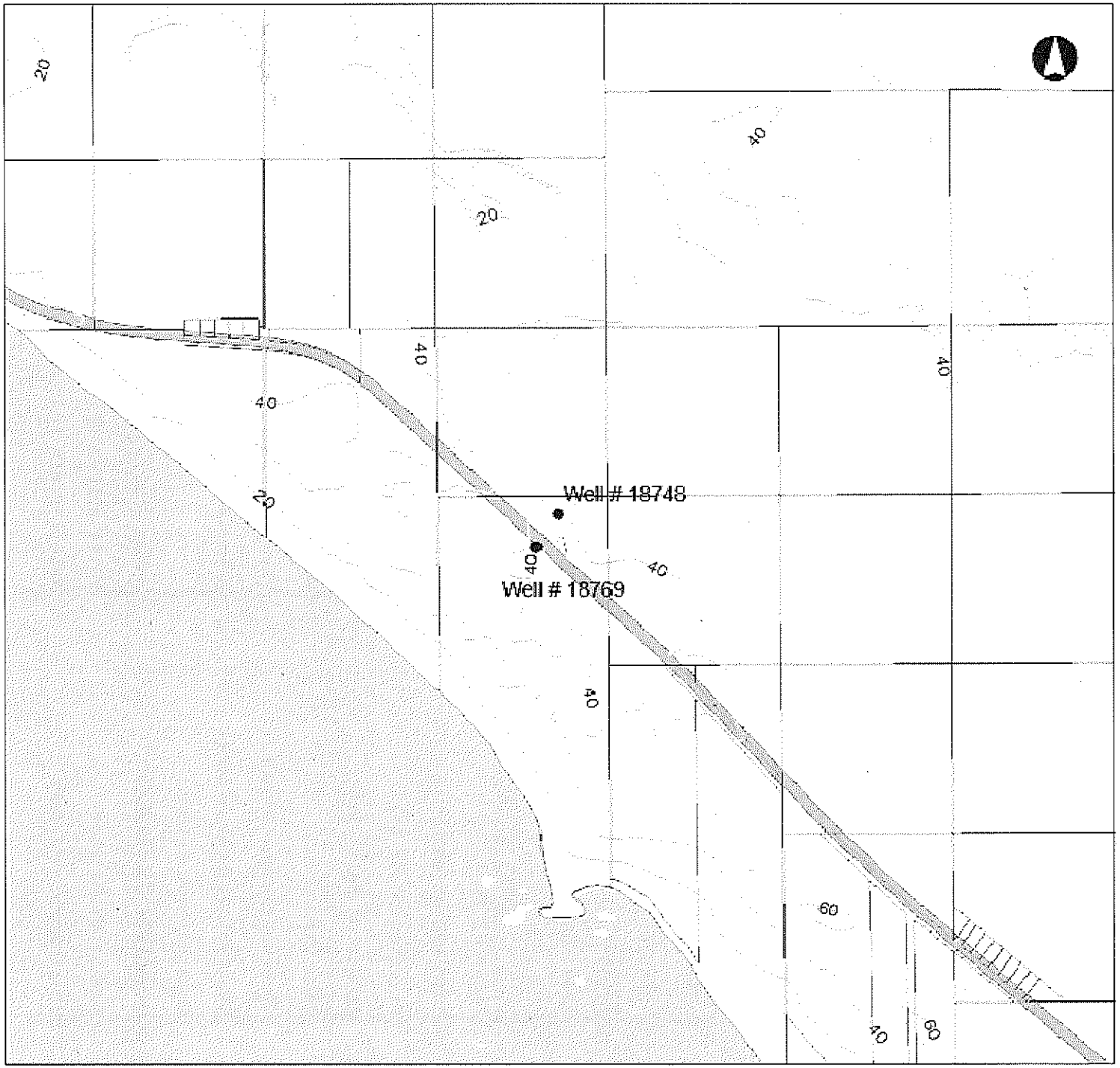
SOIL CLASSIFICATION SYSTEM: GACS

DEPTH SCALE
1 : 75

LOGGED: CH
CHECKED:

DRAFT

Golder Associates



BRITISH COLUMBIA

Water Resources Atlas

Legend

- Water Wells
- Integrated Cadastral Fabric
- Contours (1:20,000)

FCODE

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- Contour - Index Indefinite
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- Contour - Intermediate
- Contour - Intermediate Indefinite
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- Contour - Intermediate Depressi

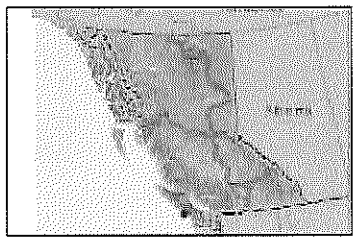
- TileCache

0 0.27 0.55 km

1: 13,411

Datum: NAD83
Projection: NAD_1983_BC_Environment_Albers

Key Map of British Columbia



BRITISH COLUMBIA

Report 1 - Detailed Well Record

Well Tag Number: 18748	Construction Date: 1964-07-01 00:00:00
Owner: PARKS BRANCH	Driller:
	Well Identification Plate Number:
Address:	Plate Attached By:
	Where Plate Attached:
Area:	
	PRODUCTION DATA AT TIME OF DRILLING:
WELL LOCATION:	Well Yield: 0 (Driller's Estimate)
Land District	Development Method:
District Lot: 138 Plan: Lot:	Pump Test Info Flag:
Township: Section: Range:	Artesian Flow:
Indian Reserve: Meridian: Block:	Artesian Pressure (ft):
Quarter:	Static Level:
Island:	
BCGS Number (NAD 83): Well: 1	WATER QUALITY:
	Character:
Class of Well:	Colour:
Subclass of Well:	Odour:
Orientation of Well:	Well Disinfected: N
Status of Well: New	EMS ID:
Well Use:	Water Chemistry Info Flag: Y
Observation Well Number:	Field Chemistry Info Flag:
Observation Well Status:	Site Info (SEAM):
Construction Method:	
Diameter: 8.0 inches	Water Utility:
Casing drive shoe:	Water Supply System Name:
Well Depth: 166 feet	Water Supply System Well Name:

Elevation: 0 feet (ASL)	
Final Casing Stick Up: inches	SURFACE SEAL:
Well Cap Type:	Flag:
Bedrock Depth: 147 feet	Material:
Lithology Info Flag:	Method:
File Info Flag:	Depth (ft):
Sieve Info Flag:	Thickness (in):
Screen Info Flag:	
	WELL CLOSURE INFORMATION:
Site Info Details:	Reason For Closure:
Other Info Flag:	Method of Closure:
Other Info Details:	Closure Sealant Material:
	Closure Backfill Material:
	Details of Closure:

Screen from	to feet	Type	Slot Size

Casing from	to feet	Diameter	Material	Drive Shoe

GENERAL REMARKS:

LITHOLOGY INFORMATION:

From	0	to	1.5 Ft.	Gravel and sand fill
From	1.5	to	3 Ft.	Roots organic clay
From	3	to	12 Ft.	Tan clay
From	12	to	16 Ft.	Blue clay
From	16	to	59 Ft.	Blue clay with few pebs and small inter-
From	0	to	0 Ft.	bedded sand layers - little water in
From	0	to	0 Ft.	sand layers 1-2 GPM S.W.L. 47'+
From	59	to	141.5 Ft.	Silty clay, few pebs with small layer of
From	0	to	0 Ft.	sand
From	141.5	to	143 Ft.	Compact gravelly sand (caves under bit
From	143	to	147 Ft.	Glacial till
From	147	to	166 Ft.	Rock S.W.L. 62-73'
From	0	to	0 Ft.	Hole was tested with bailer at bottom &

From	0 to	0 Ft.	betw. 56-59'. In both cases, recovery
From	0 to	0 Ft.	was very slow.

- Return to Main
- Return to Search Options
- Return to Search Criteria

BRITISH COLUMBIA

Report 1 - Detailed Well Record

Well Tag Number: 18769	Construction Date: 1964-08-01 00:00:00
Owner: PARKS BRANCH	Driller:
	Well Identification Plate Number:
Address:	Plate Attached By:
	Where Plate Attached:
Area:	
	PRODUCTION DATA AT TIME OF DRILLING:
WELL LOCATION:	Well Yield: 0 (Driller's Estimate)
Land District	Development Method:
District Lot: 138 Plan: Lot:	Pump Test Info Flag:
Township: Section: Range:	Artesian Flow:
Indian Reserve: Meridian: Block:	Artesian Pressure (ft):
Quarter:	Static Level: 42 feet
Island:	
BCGS Number (NAD 83): Well: 2	WATER QUALITY:
	Character:
Class of Well:	Colour:
Subclass of Well:	Odour:
Orientation of Well:	Well Disinfected: N
Status of Well: New	EMS ID:
Well Use:	Water Chemistry Info Flag:
Observation Well Number:	Field Chemistry Info Flag:
Observation Well Status:	Site Info (SEAM):
Construction Method:	
Diameter: 8.0 inches	Water Utility:
Casing drive shoe:	Water Supply System Name:
Well Depth: 130 feet	Water Supply System Well Name:

Elevation: 0 feet (ASL)	
Final Casing Stick Up: inches	SURFACE SEAL:
Well Cap Type:	Flag:
Bedrock Depth: feet	Material:
Lithology Info Flag:	Method:
File Info Flag:	Depth (ft):
Sieve Info Flag:	Thickness (in):
Screen Info Flag:	
	WELL CLOSURE INFORMATION:
Site Info Details:	Reason For Closure:
Other Info Flag:	Method of Closure:
Other Info Details:	Closure Sealant Material:
	Closure Backfill Material:
	Details of Closure:

Screen from	to feet	Type	Slot Size

Casing from	to feet	Diameter	Material	Drive Shoe

GENERAL REMARKS:

LITHOLOGY INFORMATION:

From	0	to	2	Ft. Sand and gravel fill
From	2	to	7	Ft. Organics - peat
From	7	to	40	Ft. Silty clay
From	40	to	116	Ft. Stoney clay
From	116	to	118	Ft. Compact stone layer in clay
From	118	to	130	Ft. Clay with layers of sand and gravel
From	0	to	0	Ft.
From	0	to	0	Ft. Well tested by bailer - very slow reco-
From	0	to	0	Ft. very

- Return to Main
- Return to Search Options
- Return to Search Criteria

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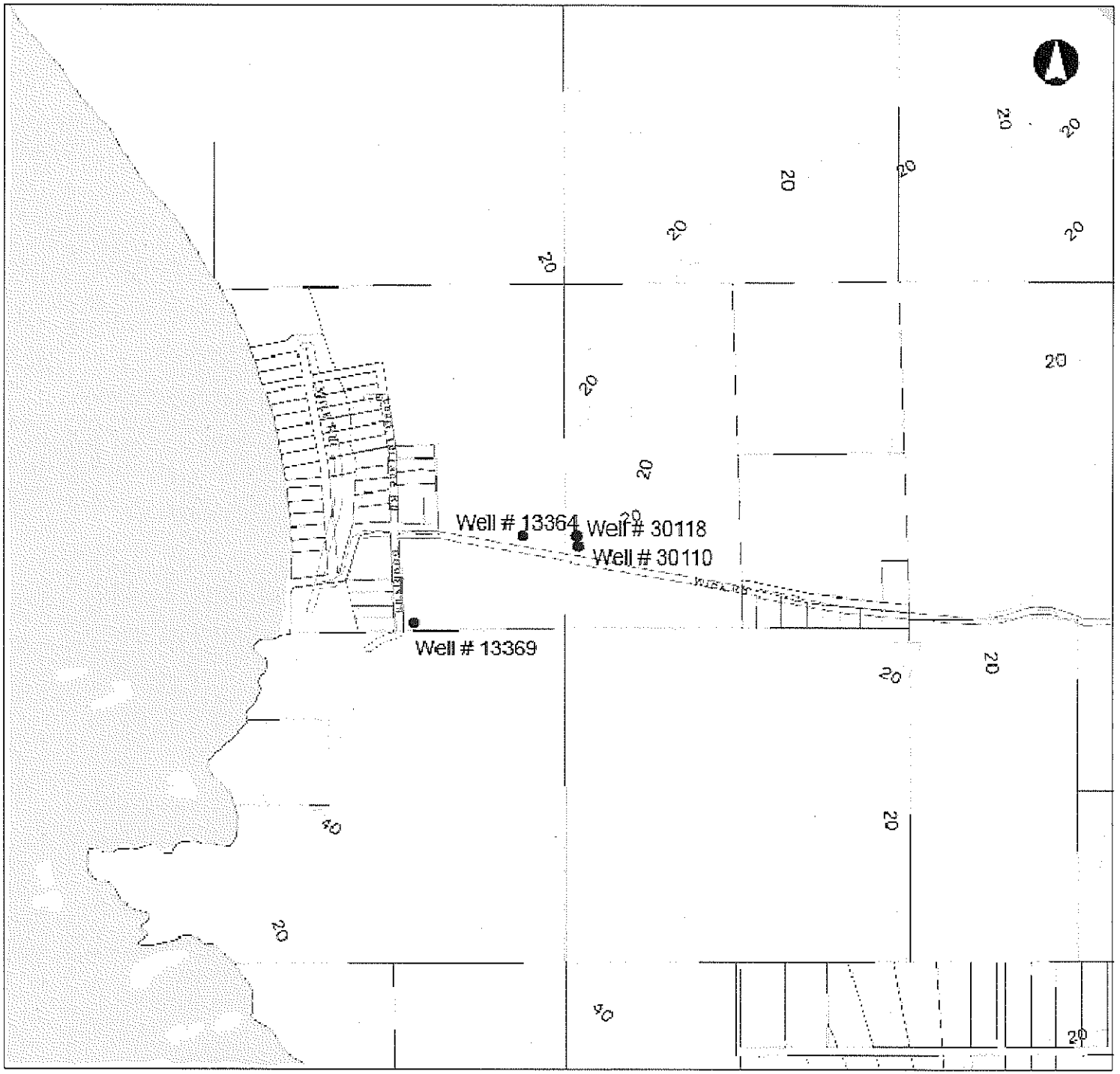

BRITISH COLUMBIA

Water Resources Atlas

Legend

- Water Wells
- Integrated Cadastral Fabric
- Contours (1:20,000)

FCODE

- Contour - Index
- Contour - Index Indefinite
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- Contour - Intermediate
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- Contour - Intermediate Depressi
- Contour - Intermediate Depressi

TileCache

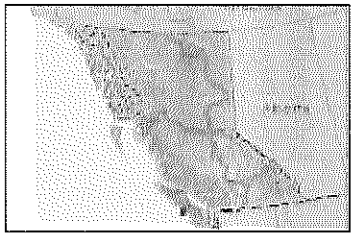
0 0.27 0.55 km

1: 13,411

Copyright/Disclaimer

Datum: NAD83
Projection: NAD_1983_BC_Environment_Albers

Key Map of British Columbia



BRITISH COLUMBIA

Report 1 - Detailed Well Record

Well Tag Number: 13364	Construction Date: 1950-01-01 00:00:00
Owner: DEPT INDIAN AFFAIRS	Driller:
	Well Identification Plate Number:
Address: PACIFIC RIM NATION PARK	Plate Attached By:
	Where Plate Attached:
Area:	
	PRODUCTION DATA AT TIME OF DRILLING:
WELL LOCATION:	Well Yield: 0 (Driller's Estimate)
Land District	Development Method:
District Lot: Plan: Lot:	Pump Test Info Flag:
Township: Section: Range:	Artesian Flow:
Indian Reserve: Meridian: Block:	Artesian Pressure (ft):
Quarter:	Static Level:
Island:	
BCGS Number (NAD 83): Well: 3	WATER QUALITY:
	Character:
Class of Well:	Colour:
Subclass of Well:	Odour:
Orientation of Well:	Well Disinfected: N
Status of Well: New	EMS ID:
Well Use:	Water Chemistry Info Flag:
Observation Well Number:	Field Chemistry Info Flag:
Observation Well Status:	Site Info (SEAM):
Construction Method:	
Diameter: 0.0 inches	Water Utility:
Casing drive shoe:	Water Supply System Name:
Well Depth: 205 feet	Water Supply System Well Name:

Elevation: 0 feet (ASL)	
Final Casing Stick Up: inches	SURFACE SEAL:
Well Cap Type:	Flag:
Bedrock Depth: feet	Material:
Lithology Info Flag:	Method:
File Info Flag:	Depth (ft):
Sieve Info Flag:	Thickness (in):
Screen Info Flag:	
	WELL CLOSURE INFORMATION:
Site Info Details:	Reason For Closure:
Other Info Flag:	Method of Closure:
Other Info Details:	Closure Sealant Material:
	Closure Backfill Material:
	Details of Closure:

Screen from	to feet	Type	Slot Size

Casing from	to feet	Diameter	Material	Drive Shoe

GENERAL REMARKS:

LITHOLOGY INFORMATION:

From	0	to	3 Ft.	Orange sandy clay
From	3	to	8 Ft.	Orange hardpan
From	8	to	17 Ft.	Brown hardpan
From	17	to	28 Ft.	Sand and gravel, some water (red)
From	28	to	41 Ft.	Blue clay
From	41	to	46 Ft.	Fine sand, layers in clay (some water)
From	46	to	100 Ft.	Sand layer in clay (some water)
From	100	to	135 Ft.	Sandy clay, some stones
From	135	to	205 Ft.	Heavy blue clay
From	0	to	0 Ft.	
From	0	to	0 Ft.	Pull casing out, fill in hole, and move
From	0	to	0 Ft.	to site # 3

• Return to Main

- Return to Search Options
- Return to Search Criteria

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BRITISH COLUMBIA

Report 1 - Detailed Well Record

Well Tag Number: 13369	Construction Date: 1950-01-01 00:00:00
Owner: NATIONAL PARKS BRANC	Driller:
	Well Identification Plate Number:
Address: PACIFIC RIM NATIONAL PARK	Plate Attached By:
	Where Plate Attached:
Area:	
	PRODUCTION DATA AT TIME OF DRILLING:
WELL LOCATION:	Well Yield: 0 (Driller's Estimate)
Land District	Development Method:
District Lot: Plan: Lot:	Pump Test Info Flag:
Township: Section: Range:	Artesian Flow:
Indian Reserve: Meridian: Block:	Artesian Pressure (ft):
Quarter:	Static Level:
Island:	
BCGS Number (NAD 83): Well: 4	WATER QUALITY:
	Character:
Class of Well:	Colour:
Subclass of Well:	Odour:
Orientation of Well:	Well Disinfected: N
Status of Well: New	EMS ID:
Well Use:	Water Chemistry Info Flag:
Observation Well Number:	Field Chemistry Info Flag:
Observation Well Status:	Site Info (SEAM):
Construction Method:	
Diameter: 0.0 inches	Water Utility:
Casing drive shoe:	Water Supply System Name:
Well Depth: 200 feet	Water Supply System Well Name:

Elevation: 0 feet (ASL)	
Final Casing Stick Up: inches	SURFACE SEAL:
Well Cap Type:	Flag:
Bedrock Depth: feet	Material:
Lithology Info Flag:	Method:
File Info Flag:	Depth (ft):
Sieve Info Flag:	Thickness (in):
Screen Info Flag:	
	WELL CLOSURE INFORMATION:
Site Info Details:	Reason For Closure:
Other Info Flag:	Method of Closure:
Other Info Details:	Closure Sealant Material:
	Closure Backfill Material:
	Details of Closure:

Screen from	to feet	Type	Slot Size

Casing from	to feet	Diameter	Material	Drive Shoe

GENERAL REMARKS:
DRY HOLE

LITHOLOGY INFORMATION:

From	0	to	3 Ft.	Gravel, stones, clay, logs (fill)
From	3	to	42 Ft.	Gray clay
From	42	to	150 Ft.	Blue clay, some small sharp stones
From	150	to	152 Ft.	Boulders
From	152	to	174 Ft.	Blue clay
From	174	to	178 Ft.	Blue clay
From	178	to	200 Ft.	Bedrock, salt water
From	0	to	0 Ft.	
From	0	to	0 Ft.	Pull casing, fill in hole, and move to
From	0	to	0 Ft.	site # 2

- Return to Main
- Return to Search Options
- Return to Search Criteria

Information Disclaimer

The Province disclaims all responsibility for the accuracy of information provided. Information provided should not be used as a basis for making financial or any other commitments.

BRITISH COLUMBIA

Report 1 - Detailed Well Record

Well Tag Number: 30110	Construction Date: 1974-04-11 00:00:00
Owner: PARKS PACIFIC RIM	Driller:
	Well Identification Plate Number:
Address: WICKINNIINSH INN	Plate Attached By:
	Where Plate Attached:
Area: LONG BEACH	
	PRODUCTION DATA AT TIME OF DRILLING:
WELL LOCATION:	Well Yield: 2 (Driller's Estimate)
Land District	Development Method:
District Lot: Plan: Lot:	Pump Test Info Flag:
Township: Section: Range:	Artesian Flow:
Indian Reserve: Meridian: Block:	Artesian Pressure (ft):
Quarter:	Static Level:
Island:	
BCGS Number (NAD 83): Well: 1	WATER QUALITY:
	Character:
Class of Well:	Colour:
Subclass of Well:	Odour:
Orientation of Well:	Well Disinfected: N
Status of Well: New	EMS ID:
Well Use:	Water Chemistry Info Flag:
Observation Well Number:	Field Chemistry Info Flag:
Observation Well Status:	Site Info (SEAM):
Construction Method:	
Diameter: 6.0 inches	Water Utility:
Casing drive shoe:	Water Supply System Name:
Well Depth: 490 feet	Water Supply System Well Name:

Elevation: 0 feet (ASL)	
Final Casing Stick Up: inches	SURFACE SEAL:
Well Cap Type:	Flag:
Bedrock Depth: 353 feet	Material:
Lithology Info Flag:	Method:
File Info Flag: Y	Depth (ft):
Sieve Info Flag:	Thickness (in):
Screen Info Flag:	
	WELL CLOSURE INFORMATION:
Site Info Details:	Reason For Closure:
Other Info Flag:	Method of Closure:
Other Info Details:	Closure Sealant Material:
	Closure Backfill Material:
	Details of Closure:

Screen from	to feet	Type	Slot Size

Casing from	to feet	Diameter	Material	Drive Shoe

GENERAL REMARKS:
FRACTURES AT 445', 455' AND 470', BUT YIELDED SALTY WATER. 2 GPM.

LITHOLOGY INFORMATION:

From	0	to	15 Ft.	Fine silty brown sand and gravel
From	15	to	25 Ft.	Silty to coarse sand and gravel, W.B.
From	25	to	40 Ft.	
From	40	to	48 Ft.	Blue clay, fine to coarse sand, W.B.
From	48	to	353 Ft.	Blue clay
From	353	to	490 Ft.	Argillite

- Return to Main
- Return to Search Options
- Return to Search Criteria

BRITISH COLUMBIA

Report 1 - Detailed Well Record

Well Tag Number: 30118	Construction Date: 1974-04-16 00:00:00
Owner: PARKS PACIFIC RIM	Driller:
	Well Identification Plate Number:
Address: WICKINNIINSH INN	Plate Attached By:
	Where Plate Attached:
Area: LONG BEACH	
	PRODUCTION DATA AT TIME OF DRILLING:
WELL LOCATION:	Well Yield: 2.2 (Driller's Estimate)
Land District	Development Method:
District Lot: Plan: Lot:	Pump Test Info Flag: Y
Township: Section: Range:	Artesian Flow:
Indian Reserve: Meridian: Block:	Artesian Pressure (ft):
Quarter:	Static Level: 9 feet
Island:	
BCGS Number (NAD 83): Well: 2	WATER QUALITY:
	Character:
Class of Well:	Colour:
Subclass of Well:	Odour:
Orientation of Well:	Well Disinfected: N
Status of Well: New	EMS ID:
Well Use:	Water Chemistry Info Flag: Y
Observation Well Number:	Field Chemistry Info Flag:
Observation Well Status:	Site Info (SEAM):
Construction Method:	
Diameter: 6.0 inches	Water Utility:
Casing drive shoe:	Water Supply System Name:
Well Depth: 80 feet	Water Supply System Well Name:

Elevation: 0 feet (ASL)	
Final Casing Stick Up: inches	SURFACE SEAL:
Well Cap Type:	Flag:
Bedrock Depth: feet	Material:
Lithology Info Flag:	Method:
File Info Flag: Y	Depth (ft):
Sieve Info Flag:	Thickness (in):
Screen Info Flag:	
	WELL CLOSURE INFORMATION:
Site Info Details:	Reason For Closure:
Other Info Flag:	Method of Closure:
Other Info Details:	Closure Sealant Material:
	Closure Backfill Material:
	Details of Closure:

Screen from	to feet	Type	Slot Size

Casing from	to feet	Diameter	Material	Drive Shoe

GENERAL REMARKS:
SAFE PRODUCTIVE CAPACITY 2.25 US GPM HOLE # 4

LITHOLOGY INFORMATION:

From	0 to	15 Ft.	Fine silty brown clay
From	15 to	25 Ft.	Fine to coarse sand and gravel (W.B.)
From	25 to	80 Ft.	Blue clay

- Return to Main
- Return to Search Options
- Return to Search Criteria

APPENDIX 4

BACKGROUND INFORMATION LOGS

WATERMAIN SEGMENTS A & B

WATERMAIN SEGMENT A
(Note – BH10-6 does not exist)

LEVELTON

Sewer and Lift Stations
Tofino, BC
Geotechnical Assessment

BH10-05

Project No: VI10-1223-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		Compact, brown, **SAND AND GRAVEL (FILL)**, roadbase/subbase, moist.				
	2	Loose, orange brown, silty, **SAND**, wet.				
		Loose to compact, grey/orange brown, **SAND**, fine to medium grained, some silt, some gravel, moist.			G	
	4				G	
	6					
2						
	8				G	
		Compact, grey, **SAND**, moist.				
	10					
		Bottom of hole at 3.4 metres				
	12					
4						
	14					
	16					
	18					
6						
	20					
	22					
	24					

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type: Trip Hammer

DYNAMIC CONE PENETRATION TEST:
Blow count no. of blows of a 140 lb (64 kg) hammer dropped 30in. (750mm) to produce 12in (300mm) of a 2in (50mm) diameter cone.

- ● Moisture Content %
- ▶ Plastic Limit
- ◀ Liquid Limit
- ▼ Ground Water Level
- (X) Shear strength in kPa (Torvane or Penetrometer)
- X Shear strength in kPa (Unconfined)
- ⊗ Shear strength in kPa (field vane)
- ⊠ Remolded strength in kPa
- ■ Percent Passing # 200 sieve

Drill Method:
Solid Stem Auger / DCPT
Date Drilled: 7/23/2010
By: RH

LEVELTON

Sewer and Lift Stations
Tofino, BC
Geotechnical Assessment

BH10-07

Project No: VI10-1223-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		ASPHALT				
		Compact, grey, **SAND AND GRAVEL (FILL)**, occasional cobble.				
	2	Loose, **VARIOUS FILL,** some sand and gravel, some silt, moist.				
		ORGANIC SILT, moist. - lots of wood debris observed			G	
	4					
		- some gravel observed below 1.5m - wet below 1.5m depth.				
2	6					
	8				G	
	10	Bottom of hole at 3.1 metres				
	12					
4	14					
	16					
	18					
6	20					
	22					
	24					

10 20 30 40 50 60 70 80 90

- Advancement of 0.15m > 100 Blows

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type: Trip Hammer

DYNAMIC CONE PENETRATION TEST:
Blow count no. of blows of a 140 lb (64 kg) hammer dropped 30in. (750mm) to produce 12in (300mm) of a 2in (50mm) diameter cone.

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method:
Solid Stem Auger / DCPT
Date Drilled: 7/23/2010
By: RH

LEVELTON

Sewer and Lift Stations
Tofino, BC
Geotechnical Assessment

BH10-08

Project No: VI10-1223-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		ASPHALT				
		Compact, brown, **SAND AND GRAVEL (FILL)**, cobbles sizes to 100mm diameter.				
	2					
		Loose, dark brown/black, **SAND AND GRAVEL**, organic, some silt, some wood debris, moist.				
	4				G	
	6					
2		Dark brown, **SAND**, fine to medium grained, wet.				
	8				G	
	10	Bottom of hole at 3.1 metres				
	12					
4						
	14					
	16					
	18					
6						
	20					
	22					
	24					

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type: Trip Hammer

- ● Moisture Content %
- ▶ Plastic Limit
- ◀ Liquid Limit
- ⧩ Ground Water Level
- (X) Shear strength in kPa (Torvane or Penetrometer)
- X Shear strength in kPa (Unconfined)
- ⊗ Shear strength in kPa (field vane)
- ⊠ Remolded strength in kPa
- ■ Percent Passing # 200 sieve

Drill Method:
Solid Stem Auger
Date Drilled: 7/23/2010
By: RH

LEVELTON

Sewer and Lift Stations
Tofino, BC
Geotechnical Assessment

BH10-09

Project No: VI10-1223-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		ASPHALT				
		Compact, brown, **SAND AND GRAVEL (FILL),** road base and subbase.				
0.6	2	Compact, blue grey, **VARIOUS FILL,** some sand and gravel, moist.				
1.2	4	Loose, black, **ORGANIC SAND,** trace to some wood debris, moist.			G	
1.8	6	**SAND,** with wood debris, wet.				
2.4	8	Compact, blue grey, **SAND,** fine to medium grained, wet.			G	
3.0	10	Bottom of hole at 3.1 metres				
3.7	12					
4.3	14					
4.9	16					
5.5	18					
6.1	20					
6.7	22					
7.3	24					

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type: Trip Hammer

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method:
Solid Stem Auger
Date Drilled: 7/23/2010
By: RH

LEVELTON

Sewer and Lift Stations
Tofino, BC
Geotechnical Assessment

BH10-10

Project No: VI10-1223-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
	0	Compact, grey, **SAND AND GRAVEL (FILL),** pitrun, numerous gravel, occasional cobble, moist.				
	2					
		Loose, **VARIOUS FILL,** some sand, some gravel, moist.				
	4				G	
		Loose to compact, grey, **SAND,** moist.				
	6					
2		Compact to dense, blue grey, gravelly, **SAND,** fine to medium grained.				
	8				G	
	10	Soft, blue, **SILT,** trace clay, moist.				
	12				G	
		Bottom of hole at 3.7 metres				
4	14					
	16					
	18					
6	20					
	22					
	24					

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type: Trip Hammer
DYNAMIC CONE PENETRATION TEST:
Blow count no. of blows of a 140 lb (64 kg) hammer dropped 30in. (750mm) to produce 12in (300mm) of a 2in (50mm) diameter cone.

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method:
Solid Stem Auger / DCPT
Date Drilled: 7/23/2010
By: RH

LEVELTON

Sewer and Lift Stations
Tofino, BC
Geotechnical Assessment

BH10-11

Project No: VI10-1223-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		Compact, brown, **SAND AND GRAVEL (FILL),** numerous gravel sizes to 50mm diameter, moist.				
	2	Compact, grey, **SAND (FILL?),** some gravel, numerous gravel sizes to 50mm diameter, trace silt, moist.				
	4	- grinding noise observed possibly due to cobbles.			G	
	6					
2		Loose to compact, brown, **SAND,** trace to some gravel, wet.				
	8				G	
	10					
		Bottom of hole at 3.1 metres				
	12					
4						
	14					
	16					
	18					
6						
	20					
	22					
	24					

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type: Trip Hammer

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method:
Solid Stem Auger
Date Drilled: 7/23/2010
By: RH

LEVELTON

Sewer and Lift Stations
Tofino, BC
Geotechnical Assessment

BH10-26

Project No: VI10-1223-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		Compact, brown, **SAND AND GRAVEL (FILL)**, roadbase/subbase.				
		Loose to compact, **SAND (FILL?)**, mottled, occasional root & rootlets.				
		- trace organic with small lenses to 1.1m				
		- wood debris (large log) observed below 2.8m depth.				
		Bottom of hole at 3.2 metres				

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type: Trip Hammer

- ● Moisture Content %
- ► Plastic Limit
- ◄ Liquid Limit
- ⧩ Ground Water Level
- ⊗ Shear strength in kPa (Torvane or Penetrometer)
- X Shear strength in kPa (Unconfined)
- ⊗ Shear strength in kPa (field vane)
- ⊠ Remolded strength in kPa
- ■ Percent Passing # 200 sieve

Drill Method: Solid Stem Auger
Date Drilled: 7/22/2010
By: RH

LEVELTON

Sewer and Lift Stations
Tofino, BC
Geotechnical Assessment

BH10-34

Project No: VI10-1223-00

Depth (m)	Depth (ft)	Description	Piezo 1	C	N	Type	Water Level
		Loose, brown/black, **SAND AND GRAVEL (FILL)**, trace organics, moist.					
	2	Compact, grey to blue grey, **SAND**, medium to fine grained, moist.				G	
	4						
	6						
2		- wet below 2.0m depth.					Jul/21/10
	8					G	
		Bottom of hole at 2.7 metres					
	10						
	12						
4							
	14						
	16						
	18						
6							
	20						
	22						
	24						

10 20 30 40 50 60 70 80 90

- 35 Blows Advancement of 0.7m

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type: Trip Hammer

DYNAMIC CONE PENETRATION TEST:
Blow count no. of blows of a 140 lb (64 kg) hammer dropped 30in. (750mm) to produce 12in (300mm) of a 2in (50mm) diameter cone.

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Bentonite/Grout Plug
Solid Pipe
Cuttings
Slotted Pipe
Sand/Pea-Gravel

Drill Method:
Solid Stem Auger / DCPT
Date Drilled: 7/21/2010
By: RH

LEVELTON

Sewer and Lift Stations
Tofino, BC
Geotechnical Assessment

BH10-35

Project No: VI10-1223-00

Depth (m)	Depth (ft)	Description	Piezo 1	C	N	Type	Water Level
		Dark brown with some black, **SAND AND GRAVEL (VARIOUS FILL),** trace to some organic.					
	2	- roots and rootlets observed at 0.8m depth.					
		Compact, grey/brown, **SAND,** fine grained, moist.				G	
	4						Jul/22/10
2	6	- dense, some gravel sizes to 50mm diameter, wet					
		- grinding at 2.2m depth.				G	
	8						
	10						
	12						
4		Soft, blue, silty, **CLAY,** wet.					
	14					G	PP @ 4.6m <0.5 tsf
	16						
	18					G	PP @ 5.9m <0.5 tsf
6	20						
						G	PP @ 6.4m <0.5 tsf
	22						
		Bottom of hole at 6.9 metres					
	24						

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type: Trip Hammer

DYNAMIC CONE PENETRATION TEST:
Blow count no. of blows of a 140 lb (64 kg) hammer dropped 30in. (750mm) to produce 12in (300mm) of a 2in (50mm) diameter cone.

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- X Shear strength in kPa (Unconfined)
- ⊗ Shear strength in kPa (field vane)
- ⊠ Remolded strength in kPa
- ■ Percent Passing # 200 sieve

Bentonite/Grout Plug
Solid Pipe
Cuttings
Slotted Pipe
Sand/Pea-Gravel

Drill Method:
Solid Stem Auger / DCPT
Date Drilled: 7/21/2010
By: RH

1 LOG PER PAGE VI10-1223-00.GPJ LEVELTON.GDT 8/19/10

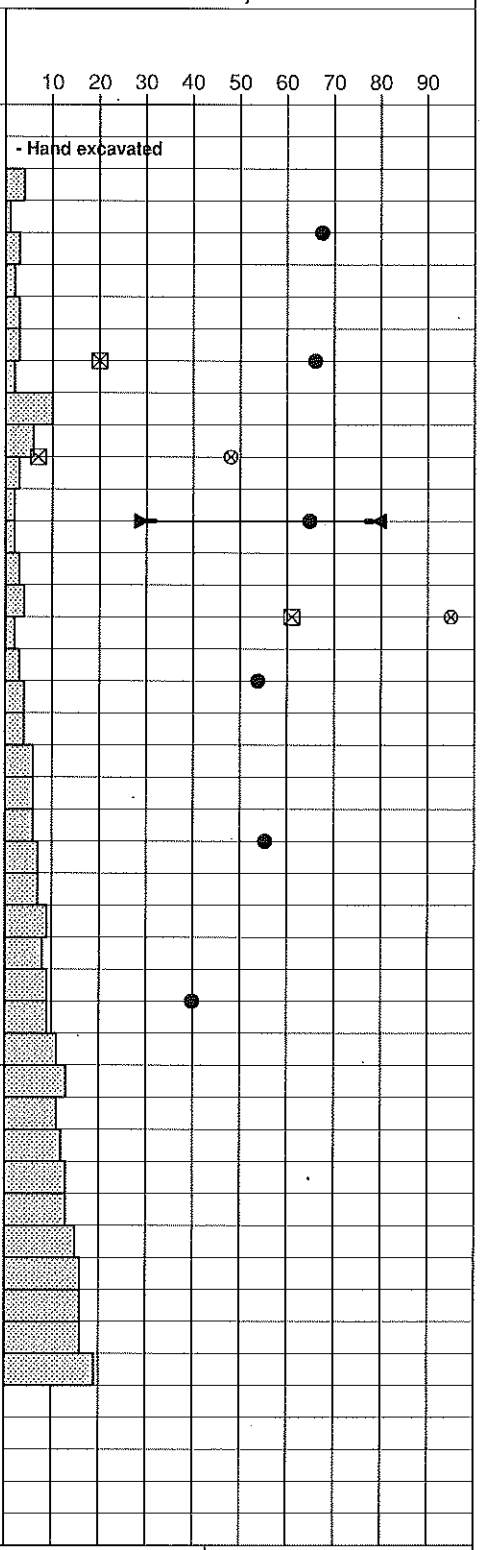
LEVELTON

Geotechnical Assessment
Highway 4 - Pacific Rim National Park
WSP Canada Inc.

BH14-01
Pg 1 of 1

Project No: R714-0308-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		ASPHALT (330mm), ≥ 5 layers.				
		Compact, dark grey, **SAND AND GRAVEL (FILL),** 19mm, crushed, base course.				
		Loose, black and brown, **SAND AND GRAVEL,** organic, moist to wet with depth.			G	
2	5					
		Firm, orange brown, silty, **CLAY,** trace to some sand lenses.			G	
	10	- firm, blue grey, wet				
4					G	
	15	- stiff.				
					G	
6	20					
					G	
	25					
8					G	
	30	Bottom of hole at 9.1 metres				
10						
	35					
12	40					
	45					



C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

DYNAMIC CONE PENETRATION TEST:
Blow count no. of blows of a 140 lb (64 kg) hammer dropped 30in. (750mm) to produce 12in (300mm) of a 2in (50mm) diameter cone.

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method: Solid Stem Auger / DCPT
Date Drilled: 23/01/2014
By: RH

LEVELTON

Geotechnical Assessment
Highway 4 - Pacific Rim National Park
WSP Canada Inc.

BH14-02

Project No: R714-0308-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		ASPHALT (180mm), ≥ 4 layers.				
		Compact, dark grey, **SAND AND GRAVEL (FILL),** crushed, 19mm.				
		Compact, grey, **SAND AND GRAVEL (FILL),** pit run, moist.			G	
	5	Loose, black, **SAND AND GRAVEL,** organic, wet.				
2		Loose, black, **SAND AND GRAVEL,** midden-like, organic, wet.			G	
		Loose, black, **SAND,** some gravel, wet.			G	
	10	- layer of gravel/cobble at 3.7 to 4.0m.				
4		Firm, grey, silty, **CLAY,** trace sand and gravel, moist.			G	
	15					
6	20				G	
		Bottom of hole at 6.1 metres				
	25					
8						
	30					
10						
	35					
12						
	40					
	45					

10 20 30 40 50 60 70 80 90

- Hand excavated

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

DYNAMIC CONE PENETRATION TEST:
Blow count no. of blows of a 140 lb (64 kg) hammer dropped 30in. (750mm) to produce 12in (300mm) of a 2in (50mm) diameter cone.

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method: Solid Stem Auger / DCPT
Date Drilled: 23/01/2014
By: RH

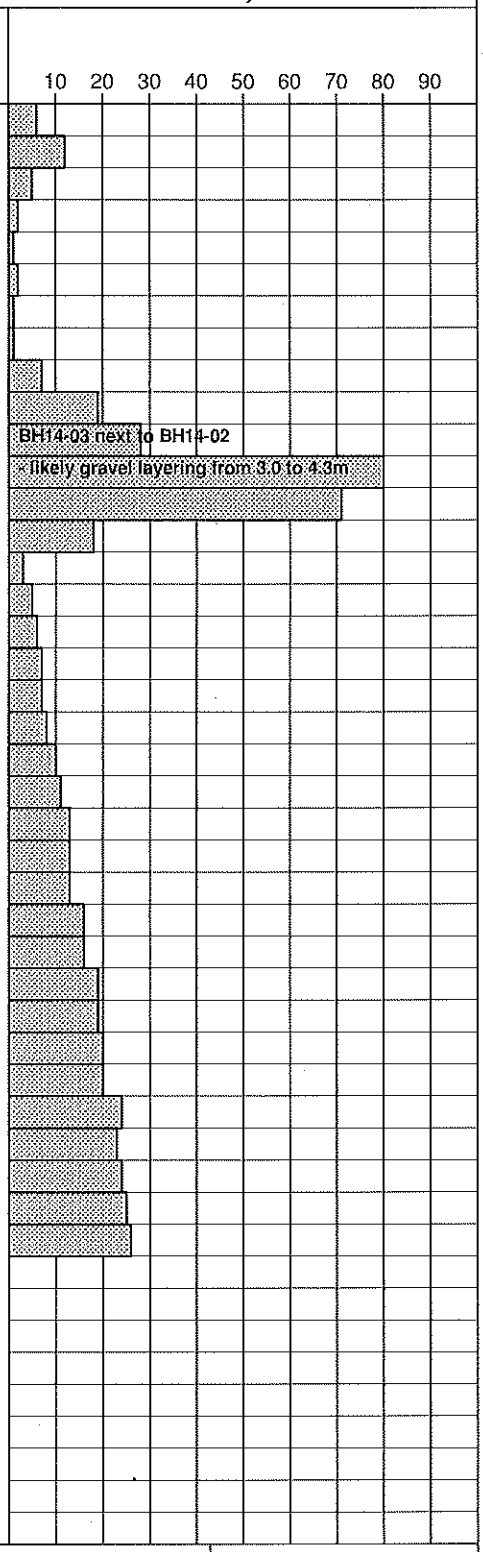
LEVELTON

Geotechnical Assessment
Highway 4 - Pacific Rim National Park
WSP Canada Inc.

BH14-03

Project No: R714-0308-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
				Dynamic Cone Pentration Test		



C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

DYNAMIC CONE PENETRATION TEST:
Blow count no. of blows of a 140 lb (64 kg) hammer dropped 30in. (750mm) to produce 12in (300mm) of a 2in (50mm) diameter cone.

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method: DCPT
Date Drilled: 23/01/2014
By: RH

WATERMAIN SEGMENT B

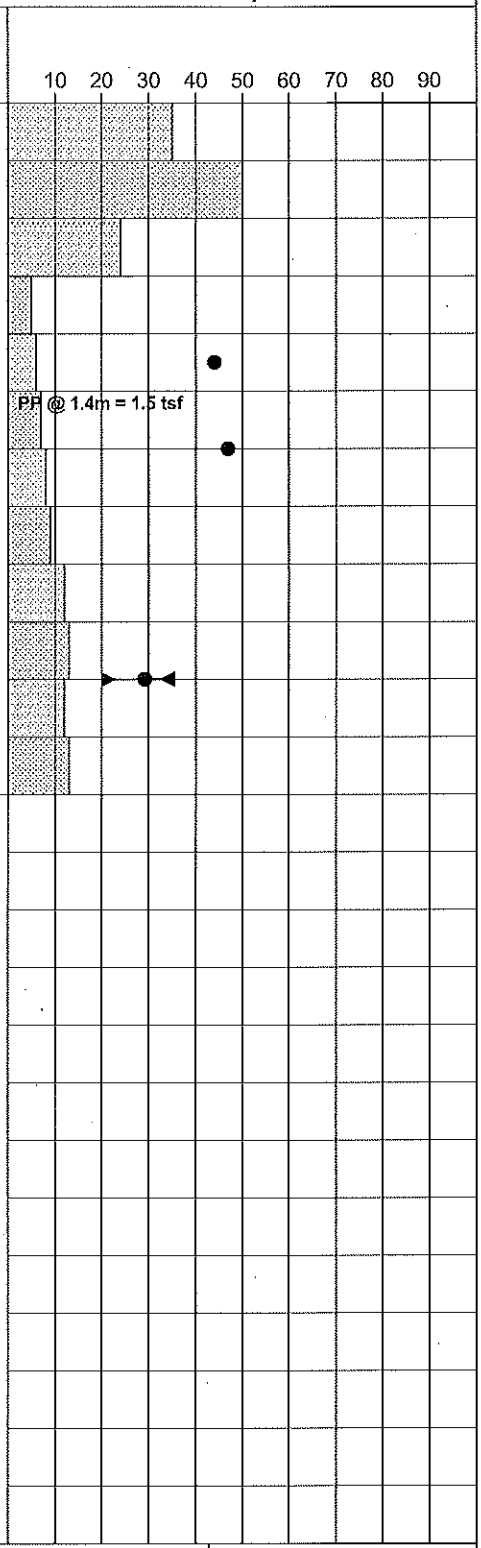
LEVELTON

Sewer and Lift Stations
Tofino, BC
Geotechnical Assessment

BH10-24

Project No: VI10-1223-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
	2	Compact, brown, **SAND AND GRAVEL (FILL)**, roadbase/subbase, moist.				
	4	Firm, mottled orange brown/grey, silty, **CLAY**, trace sand.			G	
	6					
2		- firm, blue, wet - increased plasticity observed with depth			G	
	8					
	10					
		- trace seashell fragments observed at 3.0m depth.			G	
	12					
		Bottom of hole at 3.7 metres				
4	14					
	16					
	18					
6	20					
	22					
	24					



C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type: Trip Hammer

DYNAMIC CONE PENETRATION TEST:
Blow count no. of blows of a 140 lb (64 kg) hammer dropped 30in. (750mm) to produce 12in (300mm) of a 2in (50mm) diameter cone.

- ● Moisture Content %
- ▶ Plastic Limit
- ◀ Liquid Limit
- ▼ Ground Water Level
- (X) Shear strength in kPa (Torvane or Penetrometer)
- X Shear strength in kPa (Unconfined)
- ⊗ Shear strength in kPa (field vane)
- ⊠ Remolded strength in kPa
- ■ Percent Passing # 200 sieve

Drill Method: Solid Stem Auger / DCPT
Date Drilled: 7/22/2010
By: RH

LEVELTON

Sewer and Lift Stations
Tofino, BC
Geotechnical Assessment

BH10-25

Project No: VI10-1223-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		Compact to dense, brown, **SAND AND GRAVEL (FILL),** roadbase/subbase, cobbles to 100mm diameter, moist.				
	2	Loose, black, **SAND AND GRAVEL,** organic, wood debris, wet.				
		Firm, blue grey, gravelly, **SILT,** moist.				
		Firm, brown, silty, **CLAY,** moist.				
	4					
					G	
	6					
2		- soft to firm, blue, trace sand, moist.				
	8				G	
	10					
	12					
4		Bottom of hole at 4.0 metres				
	14					
	16					
	18					
6	20					
	22					
	24					

10 20 30 40 50 60 70 80 90

PP @ 1.5m = 1.5 tsf

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type: Trip Hammer

DYNAMIC CONE PENETRATION TEST:
Blow count no. of blows of a 140 lb (64 kg) hammer dropped 30in. (750mm) to produce 12in (300mm) of a 2in (50mm) diameter cone.

- ● Moisture Content %
- ▶ Plastic Limit
- ◀ Liquid Limit
- ⧩ Ground Water Level
- (X) Shear strength in kPa (Torvane or Penetrometer)
- X Shear strength in kPa (Unconfined)
- ⊗ Shear strength in kPa (field vane)
- ⊠ Remolded strength in kPa
- ■ Percent Passing # 200 sieve

Drill Method: Solid Stem Auger / DCPT
Date Drilled: 7/22/2010
By: RH

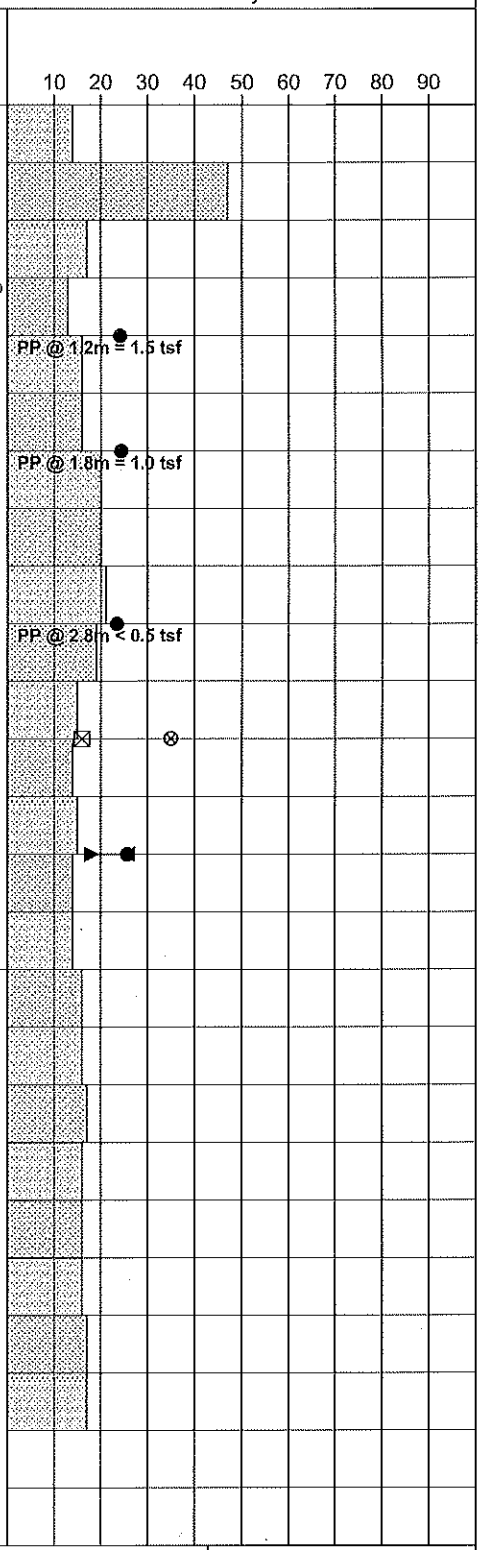
LEVELTON

Sewer and Lift Stations
Tofino, BC
Geotechnical Assessment

BH10-30

Project No: VI10-1223-00

Depth (m)	Depth (ft)	Description	Piezo 1	C	N	Type	Water Level
		Loose to compact, brown/grey, **SAND AND GRAVEL (VARIOUS FILL),** moist.					
	2						
		Stiff, brown, **SILT,** trace gravel, moist.					Jul/21/10
	4					G	
	6					G	
2		Firm to soft, blue grey, silty, **CLAY,** trace gravel, moist. - seashell fragments observed from 2.1 to 2.8m					
	8						
	10					G	
		- increased sand content observed below 3.0m depth.					
	12						
4						G	
	14						
		Bottom of hole at 4.6 metres					
	16						
	18						
6							
	20						
	22						
	24						



C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type: Trip Hammer

DYNAMIC CONE PENETRATION TEST:
Blow count no. of blows of a 140 lb (64 kg) hammer dropped 30in. (750mm) to produce 12in (300mm) of a 2in (50mm) diameter cone.

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Bentonite/Grout Plug
Solid Pipe
Cuttings
Slotted Pipe
Sand/Pea-Gravel

Drill Method:
Solid Stem Auger / DCPT
Date Drilled: 7/20/2010
By: RH

LEVELTON

Sewer and Lift Stations
Tofino, BC
Geotechnical Assessment

BH10-31

Project No: VI10-1223-00

Depth (m)	Depth (ft)	Description	Piezo 1	C	N	Type	Water Level
		Loose, dark orange brown, **SAND AND GRAVEL (FILL),** moist.					
	2	Very loose, **SAND (VARIOUS FILL),** trace to some gravel, moist.					
	4	Loose, black/brown, **SAND AND GRAVEL,** organic, wood debris, wet.				G	
		Firm, brown/orange, **SILT,** trace gravel, moist.					
2	6					G	
	8	Firm, grey, silty, **CLAY,** trace sand, trace gravel.					
	10	- blue below 3.0m - sand content increases with depth.				G	
4	12						
	14					G	
	16						
	18						
6	20					G	
	22	Bottom of hole at 6.7 metres					
	24						

PP @ 1.1m = 2.5 tsf

MC = 104.5%

PP @ 2.8m = 1.5 tsf

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type: Trip Hammer
DYNAMIC CONE PENETRATION TEST:
Blow count no. of blows of a 140 lb (64 kg) hammer dropped 30in. (750mm) to produce 12in (300mm) of a 2in (50mm) diameter cone.

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Bentonite/Grout Plug
Solid Pipe
Cuttings
Slotted Pipe
Sand/Pea-Gravel

Drill Method:
Solid Stem Auger / DCPT
Date Drilled: 7/20/2010
By: RH

1 LOG PER PAGE VI10-1223-00.GPJ LEVELTON.GDT 8/19/10

LEVELTON

Sewer and Lift Stations
Tofino, BC
Geotechnical Assessment

BH10-32

Project No: VI10-1223-00

Depth (m)	Depth (ft)	Description	Piezo 1	C	N	Type	Water Level
		Loose, dark brown, **SAND AND GRAVEL (VARIOUS FILL),** moist.					
	2	Black, **ORGANIC LAYER,** some wood debris, wet.					
		Stiff, mottled grey brown, **SILT,** trace sand, moist.					
	4					G	
	6	Soft, blue, silty, **CLAY,** moist.					
2						G	
	8						
	10						
	12	- stiff					
4							
	14						
						G	
	16						
	18	- some gravel below 5.5m					
		- trace to some sand and gravel.					
6							
	20					G	
	22	Bottom of hole at 6.7 metres					
	24						

10 20 30 40 50 60 70 80 90

PP @ 1.4m = 2.5 tsf

PP @ 2.1m <0.5 tsf

PP @ 4.6m <0.5 tsf

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type: Trip Hammer

DYNAMIC CONE PENETRATION TEST:
Blow count no. of blows of a 140 lb (64 kg) hammer dropped 30in. (750mm) to produce 12in (300mm) of a 2in (50mm) diameter cone.

- ● Moisture Content %
- ▶ Plastic Limit
- ◀ Liquid Limit
- ▼ Ground Water Level
- (X) Shear strength in kPa (Torvane or Penetrometer)
- X Shear strength in kPa (Unconfined)
- ⊗ Shear strength in kPa (field vane)
- ⊠ Remolded strength in kPa
- ■ Percent Passing # 200 sieve

Bentonite/Grout Plug
Solid Pipe
Cuttings
Slotted Pipe
Sand/Pea-Gravel

Drill Method:
Solid Stem Auger / DCPT
Date Drilled: 7/20/2010
By: RH

LEVELTON

Sewer and Lift Stations
Tofino, BC
Geotechnical Assessment

BH10-33

Project No: VI10-1223-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
0	0	Loose, brown, **SAND AND GRAVEL (FILL),** moist.				
0.6	2	Brown/black, **SILT,** organic, wet.			G	
1.2	4	Stiff, mottled orange brown, **SILT,** trace to some gravel, moist.				
2.4	8	Soft to firm, blue grey, silty, **CLAY,** trace sand and gravel, moist.			G	
4.3	14				G	
6.7	22	Bottom of hole at 6.7 metres			G	

MC = 105.7%

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type: Trip Hammer

DYNAMIC CONE PENETRATION TEST:
Blow count no. of blows of a 140 lb (64 kg) hammer dropped 30in. (750mm) to produce 12in (300mm) of a 2in (50mm) diameter cone.

- ● Moisture Content %
- ▶ Plastic Limit
- ◀ Liquid Limit
- ▼ Ground Water Level
- (X) Shear strength in kPa (Torvane or Penetrometer)
- X Shear strength in kPa (Unconfined)
- ⊗ Shear strength in kPa (field vane)
- ⊠ Remolded strength in kPa
- ■ Percent Passing # 200 sieve

Drill Method: Solid Stem Auger / DCPT
Date Drilled: 7/22/2010
By: RH

LEVELTON

Sewer and Lift Stations
Tofino, BC
Geotechnical Assessment

BH10-36

Project No: VI10-1223-00

Depth (m)	Depth (ft)	Description	Piezo 1	C	N	Type	Water Level
		Loose to compact, brown, **SAND AND GRAVEL (FILL),** moist.					
	2						
		Loose, grey/brown, **SAND (FILL),** medium to fine grained, wet.					
	4	Loose, brown/black, **ORGANIC SILT,** wet.					Jul/21/10
		Soft to firm, blue grey, silty, **CLAY,** trace sand, trace gravel, moist.				G	
	6					G	
2							
	8					G	
	10						
	12						
4		- sand and gravel content decreases with depth.				G	
	14						
	16						
	18						
6							
	20					G	
	22	Bottom of hole at 6.7 metres					
	24						

10 20 30 40 50 60 70 80 90

- Water observed at 1.1m depth
MC = 123.5%
PP @ 1.8m = 1.0 tsf
PP @ 2.8m = 1.0 tsf

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type: Trip Hammer

DYNAMIC CONE PENETRATION TEST:
Blow count no. of blows of a 140 lb (64 kg) hammer dropped 30in. (750mm) to produce 12in (300mm) of a 2in (50mm) diameter cone.

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Bentonite/Grout Plug
Solid Pipe
Cuttings
Slotted Pipe
Sand/Pea-Gravel

Drill Method:
Solid Stem Auger / DCPT
Date Drilled: 7/21/2010
By: RH

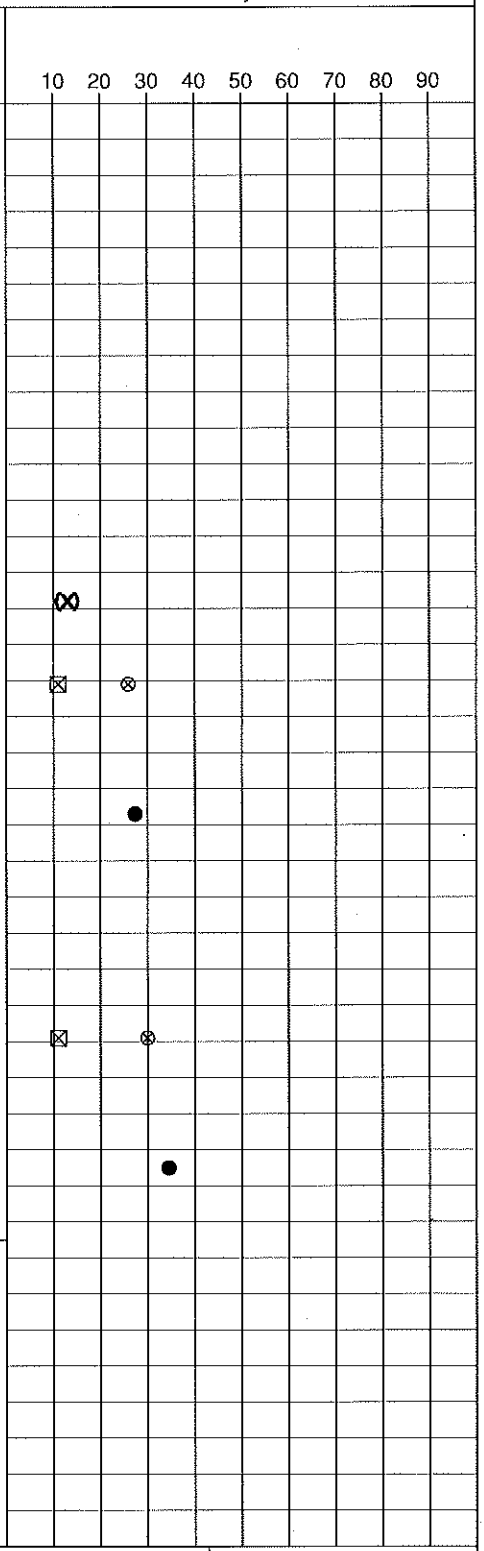
LEVELTON

Greenpoint Campground - Shower Buildings
Tofino, BC
Geotechnical Assessment

BH14-01
Pg 1 of 1

Project No: R714-1999-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		ASPHALT (40mm).				
		Brown, **SAND AND GRAVEL (FILL),** moist.				
		Loose, **SAND (TILL?),** trace gravel and silt, wet.				
		Loose, brown, **ORGANIC SILT,** moist.				
		Firm becoming soft with depth, blue grey mottled orange, **CLAY,** trace sand and gravel, moist.				
1.5	5	- PP @ 1.6m = 2.0 tsf				
3.0	10				G	
4.6	15				G	
6.1	20				ST	
7.6	25					
9.1	30				ST	
9.6		Bottom of hole at 9.6m				
10.7	35					
12.2	40					



C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method: Hollow Stem Auger
Date Drilled: 12/12/2015
By: RB

1 LOG PER PAGE R714-1999-00.GPJ LEVELTON.GDT 29/1/15

APPENDIX 5

BOREHOLE LOGS

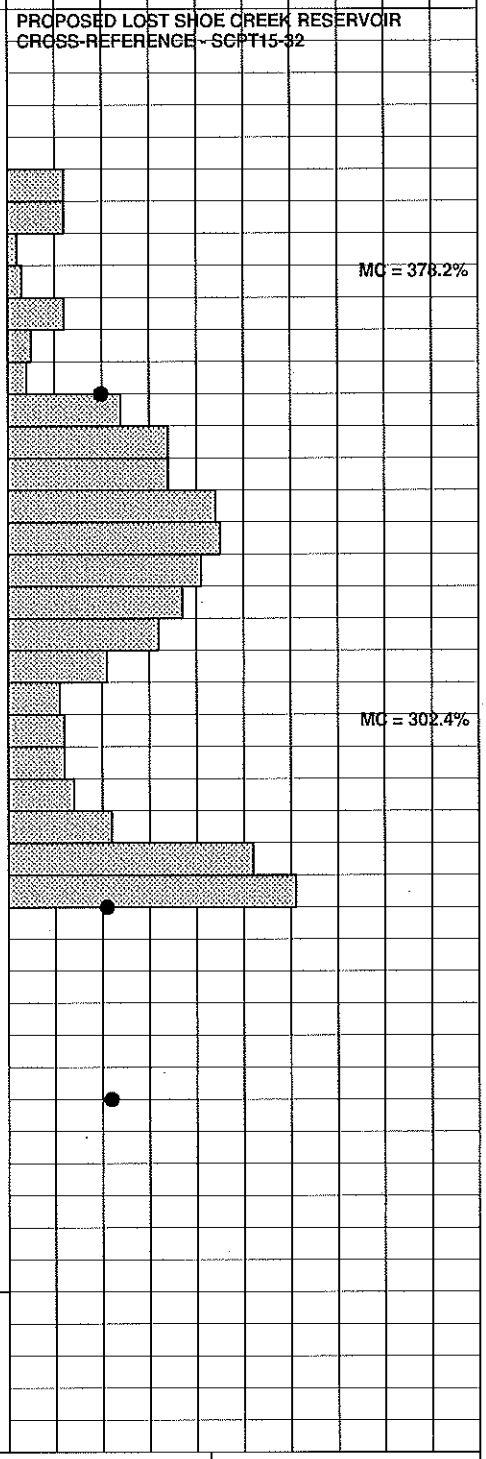
LEVELTON

Pacific Rim Park - Water Supply Upgrades
Tofino, BC
Geotechnical Assessment

BH15-01

Project No: R715-0161-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		Grey, **SAND AND GRAVEL (FILL),** trace silt, subrounded, moist.				
1.5	5	Dark brown, **PEAT,** fibrous, wet.			G	
3	10	Grey with trace white particles, **SAND,** medium grained, wet.			G	
4	15	- peat inclusions observed at 4.0m.				
6	20	Dark brown, **PEAT,** fibrous, woody debris, wet.			G	
7.5	25	Dense, grey, **SAND,** medium grained, wet.			G	
9	30	- becomes tan below 9.2m.				
10.5	35				G	
12	40	Bottom of hole at 12.2 metres				
	45					



C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

DYNAMIC CONE PENETRATION TEST:
Blow count no. of blows of a 140 lb (64 kg) hammer dropped 30in. (750mm) to produce 12in (300mm) of a 2in (50mm) diameter cone.

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method: Solid Stem Auger / DCPT
Date Drilled: 02/02/2015
By: RB

1 LOG PER PAGE R715-0161-00.GPJ LEVELTON.GDT 21/5/15

LEVELTON

Pacific Rim Park - Water Supply Upgrades
Tofino, BC
Geotechnical Assessment

BH15-02
Pg 1 of 1

Project No: R715-0161-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		Grey, **SAND AND GRAVEL (FILL),** moist.				
	5	Dark grey, **SILT** with organic inclusions, trace sand, moist.				
2		Tan, **SAND,** fine grained, trace silt, moist.				
		Dark brown, **PEAT,** fibrous, wet.				
		Tan, **SAND,** fine grained, trace silt, wet.				
	10	Dark brown, **PEAT,** fibrous, wet.				
		Tan, **SAND,** fine grained, trace silt, wet.				
		Bottom of hole at 3.1 metres				
4	15					
6	20					
	25					
8						
	30					
10						
	35					
12	40					
	45					

10 20 30 40 50 60 70 80 90

PROPOSED LOST SHOE CREEK PUMP STATION

- Refusal due to log at 1.5m moved location and resumed drilling

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method:
Solid Stem Auger
Date Drilled: 02/02/2015
By: RB

LEVELTON

Pacific Rim Park - Water Supply Upgrades
Tofino, BC
Geotechnical Assessment

BH15-03

Project No: R715-0161-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		Loose, dark brown, **ORGANIC SILT**, wet.				
		Hard, tan, **CLAY**, moist.			G	
	5	- becoming soft/firm, blue grey below 1.5m depth.				
2					G	
	10					
4						
	15					
					G	
6	20					
	25					
8						
	30					
10					G	
	35	End of augering at 10.7m Bottom of hole at 11.3 metres				
12	40					
	45					

10 20 30 40 50 60 70 80 90

PROPOSED WICK ROAD RESERVOIR
CROSS-REFERENCE - SCPT15-31

Atterberg Limits @ 5.5m
PL: 14.5%; LL: 44.5%; PI: 30.0%
Classification: CI

Atterberg Limits @ 10.3m
PL: 15.7%; LL: 48.2%; PI: 32.5%
Classification: CI

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method:
Solid Stem Auger
Date Drilled: 02/02/2015
By: RB

LEVELTON

Pacific Rim Park - Water Supply Upgrades
Tofino, BC
Geotechnical Assessment

BH15-04

Project No: R715-0161-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		SAND AND GRAVEL (FILL).				
		Stiff, mottled grey rust, **CLAY**, trace sand, moist.			G	
	5					
2		- soft, blue grey below 1.8m			G	
	10					
4						
	15					
6	20	- becoming firm below 6.0m depth.			G	
	25					
8					G	
	30	End of augering at 9.1m Bottom of hole at 12.2 metres				
10						
	35					
12	40					
	45					

10 20 30 40 50 60 70 80 90

PROPOSED HIGH POINT RESERVOIR
(NEAR GREENPOINT CAMPGROUND)
CROSS-REFERENCE - SCPT15-30

Atterberg Limits @ 2.4m
PL: 15.6%; LL: 50.4%; PI: 34.8%
Classification: CH

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

DYNAMIC CONE PENETRATION TEST:
Blow count no. of blows of a 140 lb (64 kg) hammer dropped 30in. (750mm) to produce 12in (300mm) of a 2in (50mm) diameter cone.

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method:
Solid Stem Auger / DCPT
Date Drilled: 02/02/2015
By: RB

LEVELTON

Pacific Rim Park - Water Supply Upgrades
Tofino, BC
Geotechnical Assessment

BH15-05
Pg 1 of 1

Project No: R715-0161-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		Grey, **SAND AND GRAVEL (FILL),** moist.				
	5	**SAND** mixed with organic peaty debris, medium grained, wet. - peat bands observed from 1.5 to 1.8m				
2		- 100mm thick peat band observed at 2.2m - 50mm thick peat band observed at 2.5m				
	10	- 150mm thick peat band observed at 3.1m				
4		- 70mm thick peat band observed at 4.0m depth.				
	15	Bottom of hole at 4.6 metres				
6	20					
	25					
8						
	30					
10						
	35					
12						
	40					
	45					

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method:
Solid Stem Auger
Date Drilled: 03/02/2015
By: RB

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LEVELTON

Pacific Rim Park - Water Supply Upgrades
Tofino, BC
Geotechnical Assessment

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Project No: R715-0161-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		ASPHALT (50mm).				
		Silty, **SAND AND GRAVEL (FILL),** angular, moist.				
		Orange, **SILT,** trace sand and gravel, moist. - organic smear observed at 0.3m depth.				
		Compact, grey, **SAND,** some fine grained and course grained lenses, moist.			G	
		Compact, grey with some rust brown, gravelly, **SAND,** wet.				
		Bottom of hole at 4.6 metres				

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method: Solid Stem Auger
Date Drilled: 03/02/2015
By: RB

LEVELTON

Pacific Rim Park - Water Supply Upgrades
Tofino, BC
Geotechnical Assessment

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Project No: R715-0161-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		ASPHALT (80mm).				
		Grey, **SAND AND GRAVEL (FILL),** moist.				
		White mixed black, **ORGANIC SILT,** moist.				
		Rust orange, **SILT,** trace sand and gravel, moist.				
2	5	Compact, grey, **SAND,** medium to course grained, moist. - wet below 1.5m - fine grained from 1.9 to 2.3m				
4	10	- oxidation observed from 3.4 to 3.7m - gravelly from 3.7 to 4.0m depth.				
	15	Bottom of hole at 4.6 metres				
6	20					
8	25					
10	30					
12	35					
	40					
	45					

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method: Solid Stem Auger
Date Drilled: 03/02/2015
By: RB

LEVELTON

Pacific Rim Park - Water Supply Upgrades
Tofino, BC
Geotechnical Assessment

BH15-08

Project No: R715-0161-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		ASPHALT (60mm).				
		Grey, **SAND AND GRAVEL (FILL),** moist.				
	5	Rust brown, **SILT,** trace gravel, moist.				
2		Grey, **SAND,** medium grained, moist.			G	
	10					
4		- 150mm thick oxidated **SILT** band at 3.8m depth.				
	15	Bottom of hole at 4.6 metres				
6	20					
	25					
8						
	30					
10						
	35					
12						
	40					
	45					

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method:
Solid Stem Auger
Date Drilled: 03/02/2015
By: RB

LEVELTON

Pacific Rim Park - Water Supply Upgrades
Tofino, BC
Geotechnical Assessment

BH15-09

Project No: R715-0161-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		ASPHALT (70mm).				
		Grey, **SAND AND GRAVEL (FILL),** moist.				
		ORGANICS mixed with layer below.				
		Firm, rust brown, **SILT,** trace gravel, moist.				
		Grey, **SAND,** trace silt, moist.				
2	5	- some gravel and becoming wet with depth.			G	
4	15	Bottom of hole at 4.6 metres				
6	20					
8	25					
10	30					
12	35					
	40					
	45					

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:
DYNAMIC CONE PENETRATION TEST:
Blow count no. of blows of a 140 lb (64 kg) hammer dropped 30in. (750mm) to produce 12in (300mm) of a 2in (50mm) diameter cone.

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method: Solid Stem Auger / DCPT
Date Drilled: 03/02/2015
By: RB

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Pacific Rim Park - Water Supply Upgrades
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Project No: R715-0161-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		ASPHALT (110mm).				
		Grey, **SAND AND GRAVEL (FILL),** moist.				
		Stiff, mottled rust brown and grey, sandy, **SILT,** fine grained.				
	5	Grey, **SAND,** fine to medium grained, moist.				
2		- wet below 1.8m			G	
	10	- trace to some **SILT** band from 2.5 to 2.6m depth.				
4	15					
		Bottom of hole at 4.6 metres				
6	20					
	25					
8						
	30					
10						
	35					
12	40					
	45					

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method:
Solid Stem Auger
Date Drilled: 03/02/2015
By: RB

LEVELTON

Pacific Rim Park - Water Supply Upgrades
Tofino, BC
Geotechnical Assessment

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Project No: R715-0161-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		ASPHALT (100mm).				
		Grey, **SAND AND GRAVEL (FILL),** moist.				
1.5	5	- boulders observed at 1.5m depth.				
2		Dark brown, **PEAT,** fibrous, wet.			G	
		MC = 130.3%				
3	10	Blue grey, **SAND,** trace silt and gravel, wet.				
4.1		- tan at 4.1m depth.				
4		Stiff, tan, **SILT AND SAND,** wet.				
4.6	15	Bottom of hole at 4.6 metres				
6	20					
7.5	25					
8						
9	30					
10						
10.5	35					
12						
13	40					
13.5	45					

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- X Shear strength in kPa (Unconfined)
- ⊗ Shear strength in kPa (field vane)
- ⊠ Remolded strength in kPa
- ■ Percent Passing # 200 sieve

Drill Method:
Solid Stem Auger
Date Drilled: 03/02/2015
By: RB

LEVELTON

Pacific Rim Park - Water Supply Upgrades
Tofino, BC
Geotechnical Assessment

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Project No: R715-0161-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		ASPHALT (90mm).				
		Grey, **SAND AND GRAVEL (FILL),** moist.				
		Red brown, **SAND,** trace silt, moist.				
	5	- tan with depth				
2		- wet below 1.8m.				
		Firm, tan, **CLAY,** sand lenses sizes up to 150mm, moist.				
	10					
4						
	15	Bottom of hole at 4.6 metres				
6	20					
	25					
8						
	30					
10						
	35					
12						
	40					
	45					

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method:
Solid Stem Auger
Date Drilled: 03/02/2015
By: RB

LEVELTON

Pacific Rim Park - Water Supply Upgrades
Tofino, BC
Geotechnical Assessment

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Project No: R715-0161-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		Grey, **SAND AND GRAVEL (FILL),** moist.				
		Soft, black, **ORGANIC SILT,** moist.				
		Firm, orange, silty, **SAND,** moist.				
	5	Stiff, **CLAY,** some sand and sand lenses, moist.				
2					G	
	10					
		- 100mm layer of coarse grained sand at 3.7m depth.				
4						
	15	Bottom of hole at 4.6 metres				
6	20					
	25					
8						
	30					
10						
	35					
12						
	40					
	45					

10 20 30 40 50 60 70 80 90

PP @ 1.6m = 2.0 - 3.0 tsf

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:
DYNAMIC CONE PENETRATION TEST:
Blow count no. of blows of a 140 lb (64 kg) hammer dropped 30in. (750mm) to produce 12in (300mm) of a 2in (50mm) diameter cone.

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method:
Solid Stem Auger / DCPT
Date Drilled: 03/02/2015
By: RB

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Pacific Rim Park - Water Supply Upgrades
Tofino, BC
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Project No: R715-0161-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		Loose, black mixed with grey, **SAND AND GRAVEL (FILL)** mixed with **ORGANICS,** moist.				
		Stiff, red mixed with tan, **CLAY (FILL?),** moist.				
	5	Compact, dark grey, **SAND,** medium to coarse grained, moist.				
2		Firm to stiff, grey becoming tan, **CLAY,** sand lenses, moist to wet.				
	10					
		Compact, grey, **SAND,** medium grained, wet. - becoming fine grained with depth.				
4	15					
		Bottom of hole at 4.6 metres				
6	20					
	25					
8						
	30					
10						
	35					
12						
	40					
	45					

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method:
Solid Stem Auger
Date Drilled: 03/02/2015
By: RB

LEVELTON

Pacific Rim Park - Water Supply Upgrades
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Project No: R715-0161-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		Grey, **SAND AND GRAVEL (FILL),** moist.				
		Black, **ORGANIC SILT,** moist.				
		Grey, **SAND,** medium grained, moist.				
	5	Stiff, tan, **CLAY,** moist.				
2						
	10	- soft, blue grey, some sand lenses below 2.8m.				
4					G	
	15	Bottom of hole at 4.6 metres				
6	20					
	25					
8						
	30					
10						
	35					
12						
	40					
	45					

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method: Solid Stem Auger
Date Drilled: 03/02/2015
By: RB

LEVELTON

Pacific Rim Park - Water Supply Upgrades
Tofino, BC
Geotechnical Assessment

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Project No: R715-0161-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		ASPHALT (70mm). - two layers - 40mm and 30mm.				
		Grey, **SAND AND GRAVEL (FILL),** moist.			G	
		Loose, black, **ORGANIC DEBRIS AND SILT,** wet.				
		Firm, grey, **CLAY,** organic inclusions, wet.			G	
		Bottom of hole at 7.6 metres				

10 20 30 40 50 60 70 80 90

5 10 15 20 25 30 35 40 45 (ft)
2 4 6 8 10 12 (m)

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

DYNAMIC CONE PENETRATION TEST:
Blow count no. of blows of a 140 lb (64 kg) hammer dropped 30in. (750mm) to produce 12in (300mm) of a 2in (50mm) diameter cone.

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method:
Solid Stem Auger / DCPT
Date Drilled: 04/02/2015
By: RB

LEVELTON

Pacific Rim Park - Water Supply Upgrades
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Project No: R715-0161-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		Grey, **SAND AND GRAVEL (FILL),** moist.				
		Black, **ORGANIC SILT,** moist.				
		Grey, **SAND,** some gravel, moist.			G	
	5	- wet below 1.5m depth.				
2						
		Soft to firm, tan, **CLAY,** moist to wet.				
	10	- blue grey below 2.6m depth.			G	
4						
	15				G	
		Bottom of hole at 4.6 metres				
6	20					
	25					
8						
	30					
10						
	35					
12						
	40					
	45					

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method:
Solid Stem Auger
Date Drilled: 04/02/2015
By: RB

LEVELTON

Pacific Rim Park - Water Supply Upgrades
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Project No: R715-0161-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		Brown mixed with blue grey, **SAND AND GRAVEL (FILL)** with clay clumps, moist.				
		Firm to stiff, rust brown mottled grey, **CLAY,** trace sand.			G	
2	5	- becomes soft, blue grey below 1.5m depth.				
	10				G	
4	15	Bottom of hole at 4.6 metres				
6	20					
	25					
8	30					
10	35					
12	40					
	45					

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method: Solid Stem Auger
Date Drilled: 04/02/2015
By: RB

LEVELTON

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Project No: R715-0161-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		Brown mixed with grey, **SAND AND GRAVEL (FILL)**, with clay clumps.				
		Stiff, rust brown mottled grey, **CLAY**, moist.				
2	5				G	
		- becoming soft and grey below 2.1m depth.			G	
4	15					
		Bottom of hole at 4.6 metres				
6	20					
	25					
8						
	30					
10						
	35					
12	40					
	45					

Water Level: 10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method: Solid Stem Auger
Date Drilled: 04/02/2015
By: RB

LEVELTON

Pacific Rim Park - Water Supply Upgrades
Tofino, BC
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Project No: R715-0161-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		Brown, **SAND AND GRAVEL (FILL),** moist.				
		Grey mixed with brown, **CLAY (FILL),** mixed with **GRAVEL** and **ORGANICS.**				
	5	Brown, **ORGANIC SILT.**				
2		Firm, grey, **CLAY,** moist.			G	
	10					
4						
	15	Bottom of hole at 4.6 metres				
6	20					
	25					
8						
	30					
10						
	35					
12						
	40					
	45					

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

DYNAMIC CONE PENETRATION TEST:
Blow count no. of blows of a 140 lb (64 kg) hammer dropped 30in. (750mm) to produce 12in (300mm) of a 2in (50mm) diameter cone.

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method: Solid Stem Auger / DCPT
Date Drilled: 04/02/2015
By: RB

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Pacific Rim Park - Water Supply Upgrades
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Project No: R715-0161-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		Grey mixed black, **SAND AND GRAVEL (FILL)** mixed with **ORGANICS** and wood debris.				
		Very stiff, rust brown mottled grey, **CLAY,** moist.			G	
2	5	- soft below 2.5m depth.			G	
	10	Bottom of hole at 3.1 metres				
4	15					
6	20					
	25					
8						
	30					
10						
	35					
12	40					
	45					

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method: Solid Stem Auger
Date Drilled: 04/02/2015
By: RB

LEVELTON

Pacific Rim Park - Water Supply Upgrades
Tofino, BC
Geotechnical Assessment

BH15-22

Project No: R715-0161-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		Grey, **SAND AND GRAVEL (FILL)** mixed with **CLAY,** moist.				
		Very stiff, tan lightly mottled grey, **CLAY,** moist.				
	5	- becoming soft and blue grey below 1.5m depth.				
2					G	
	10					
4						
	15	Bottom of hole at 4.6 metres				
6	20					
	25					
8						
	30					
10						
	35					
12						
	40					
	45					

10 20 30 40 50 60 70 80 90

- PP @ 2.1m = 3.0 tsf

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method: Solid Stem Auger
Date Drilled: 04/02/2015
By: RB

LEVELTON

Pacific Rim Park - Water Supply Upgrades
Tofino, BC
Geotechnical Assessment

BH15-23

Project No: R715-0161-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		Brown, silty, **SAND AND GRAVEL (FILL)**, wet.				
		Stiff, tan, **CLAY**, moist to wet.				
2	5	- firm and blue grey below 1.7m depth.			G	
4	15	Bottom of hole at 4.6 metres				
6	20					
8	25					
10	30					
12	35					
	40					
	45					

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- X Shear strength in kPa (Unconfined)
- ⊗ Shear strength in kPa (field vane)
- ⊠ Remolded strength in kPa
- ■ Percent Passing # 200 sieve

Drill Method:
Solid Stem Auger
Date Drilled: 04/02/2015
By: RB

LEVELTON

Pacific Rim Park - Water Supply Upgrades
Tofino, BC
Geotechnical Assessment

BH15-24

Project No: R715-0161-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		ASPHALT (70mm).				
		Brown, cobbley, **SAND AND GRAVEL (FILL).**				
		Bottom of hole at 3.7 metres due to refusal on cobbles				

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method:
Solid Stem Auger
Date Drilled: 04/02/2015
By: RB

LEVELTON

Pacific Rim Park - Water Supply Upgrades
Tofino, BC
Geotechnical Assessment

BH15-25
Pg 1 of 1

Project No: R715-0161-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		Grey, **SAND AND GRAVEL (FILL),** moist.				
2	5	Soft, blue grey, **CLAY,** trace sand, wet.			G	
	10	Bottom of hole at 3.1 metres				
4	15					
6	20					
8	25					
10	30					
12	35					
	40					
	45					

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method: Solid Stem Auger
Date Drilled: 04/02/2015
By: RB

1 LOG PER PAGE R715-0161-00.GPJ LEVELTON.GDT 21/5/15

LEVELTON

Pacific Rim Park - Water Supply Upgrades
Tofino, BC
Geotechnical Assessment

BH15-26

Project No: R715-0161-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		Brown, **SAND AND GRAVEL (FILL),** moist.				
		Stiff, rust brown mottled grey, **CLAY,** trace gravel, moist to wet.				
	5	- grey below 1.5m				
2		- soft below 2.1m depth.			G	
	10					
4					G	
	15	Bottom of hole at 4.6 metres				
6	20					
	25					
8						
	30					
10						
	35					
12						
	40					
	45					

10 20 30 40 50 60 70 80 90

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method:
Solid Stem Auger
Date Drilled: 04/02/2015
By: RB

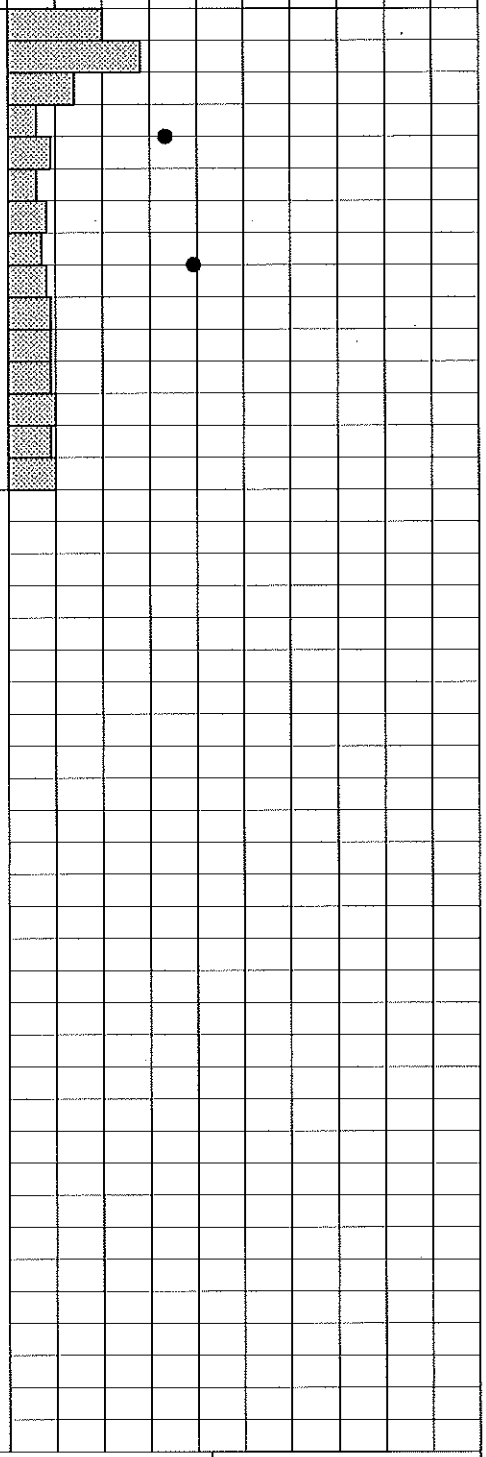
LEVELTON

Pacific Rim Park - Water Supply Upgrades
Tofino, BC
Geotechnical Assessment

BH15-27

Project No: R715-0161-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		Grey, **SAND AND GRAVEL (FILL),** moist.				
		Stiff, tan, **CLAY,** moist.			G	
2	5	- soft, blue grey below 1.5m depth.			G	
4	15	Bottom of hole at 4.6 metres				
6	20					
8	25					
10	30					
12	35					
	40					
	45					



C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

DYNAMIC CONE PENETRATION TEST:
Blow count no. of blows of a 140 lb (64 kg) hammer dropped 30in. (750mm) to produce 12in (300mm) of a 2in (50mm) diameter cone.

- ● Moisture Content %
- ▶ Plastic Limit
- ◀ Liquid Limit
- ⧩ Ground Water Level
- ⊠ Shear strength in kPa (Torvane or Penetrometer)
- × Shear strength in kPa (Unconfined)
- ⊗ Shear strength in kPa (field vane)
- ⊠ Remolded strength in kPa
- ■ Percent Passing # 200 sieve

Drill Method: Solid Stem Auger / DCPT
Date Drilled: 04/02/2015
By: RB

LEVELTON

Pacific Rim Park - Water Supply Upgrades
Tofino, BC
Geotechnical Assessment

BH15-28

Project No: R715-0161-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		Black brown mixed, **SHALE (FILL),** angular, mixed with **SAND AND GRAVEL.**				
		Grey, **SAND,** fine to medium grained, moist to wet.				
		- trace embedded peat layer observed at 0.9m			G	
	5					
2		- peat bands observed at 1.7 to 2.0m			G	
					G	
	10	- peat bands observed at 3.2 to 3.7m.				
4						
		Brown, PEAT, some wood debris, wet.			G	
	15					
					G	
6		Soft, light grey, **CLAY,** organic staining.				
	20					
		Dense, blue grey, **SAND,** medium grained, wet.				
					G	
	25					
8						
	30					
10						
	35	Bottom of hole at 10.7 metres				
12	40					
	45					

10 20 30 40 50 60 70 80 90

CONCEPTUAL ALTERNATE RESERVOIR SITE - LOST SHOE CREEK

- Gradation Analysis #1 @ 2.4m

MC = 201.6%

MC = 369.5%

- Gradation Analysis #2 @ 7m

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method: Solid Stem Auger
Date Drilled: 05/02/2015
By: RB

LEVELTON

Pacific Rim Park - Water Supply Upgrades
Tofino, BC
Geotechnical Assessment

BH15-29
Pg 1 of 2

Project No: R715-0161-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
		SAND AND GRAVEL (FILL).				
		Stiff, mottled grey rust, **CLAY,** trace sand, moist.				
2	5	- soft, blue grey below 1.8m.				
4	10					
6	15				ST	
8	20					
10	25					
12	30				G	
	35					
	40				G	
	45					

10 20 30 40 50 60 70 80 90

PROPOSED HIGH POINT RESERVOIR
(NEAR GREENPOINT CAMPGROUND)
CROSS-REFERENCE - SCPT15-30

- Consolidation Test @ 4.9m - MC = 44%

Atterberg Limits @ 10.4m
PL: 14.8%; LL: 42.6%; PI: 27.8%
Classification: CI

Atterberg Limits @ 12.8m
PL: 14.9%; LL: 51.0%; PI: 36.1%
Classification: CH

C: Condition of Sample
Good
Disturbed
No Recovery

Type: Type of Sampler
SPT : 2 in. standard
S : Shelby
FP : Fixed Piston
G : Grab
CORE

N: Number of Blows
WH : Weight of Hammer
WR : Weight of Rod
Standard Penetration Test : ASTM D1586
Hammer Type:

DYNAMIC CONE PENETRATION TEST:
Blow count no. of blows of a 140 lb (64 kg) hammer dropped 30in. (750mm) to produce 12in (300mm) of a 2in (50mm) diameter cone.

- Moisture Content %
- Plastic Limit
- Liquid Limit
- Ground Water Level
- Shear strength in kPa (Torvane or Penetrometer)
- Shear strength in kPa (Unconfined)
- Shear strength in kPa (field vane)
- Remolded strength in kPa
- Percent Passing # 200 sieve

Drill Method: Hollow Stem Auger / DCPT
Date Drilled: 05/02/2015
By: RB

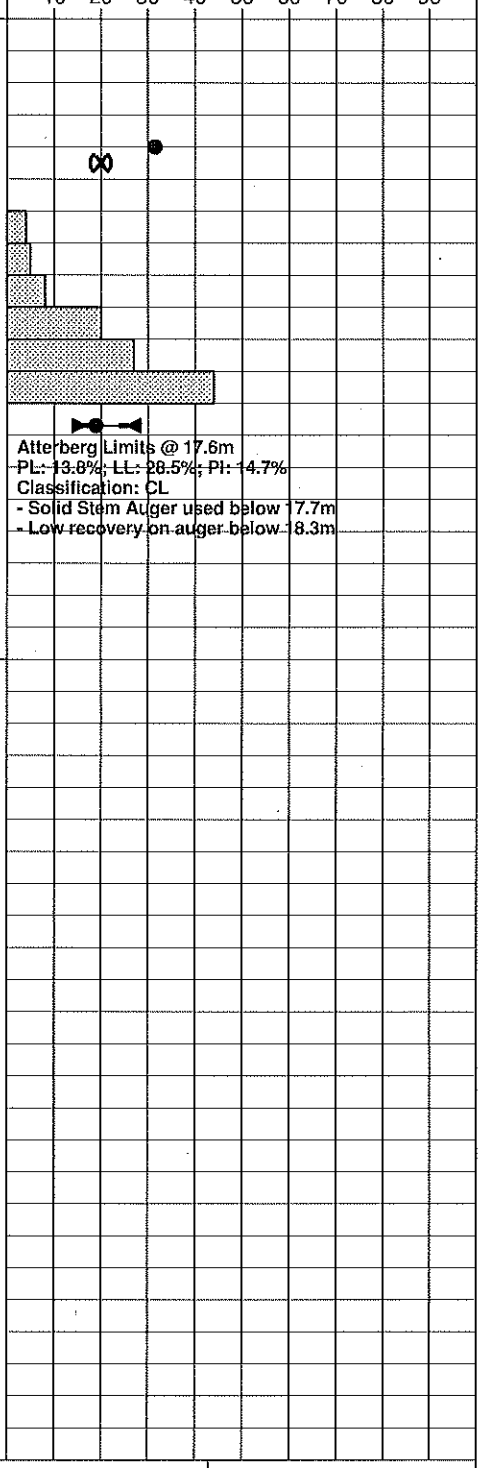
LEVELTON

Pacific Rim Park - Water Supply Upgrades
Tofino, BC
Geotechnical Assessment

BH15-29

Project No: R715-0161-00

Depth (m)	Depth (ft)	Description	C	N	Type	Water Level
14	50	Soft, blue grey, **CLAY**, trace sand, moist.			G	
16	55					
18	60	Stiff, grey, sandy, silty, **CLAY**, trace gravel, wet.			G	
20	65	Bottom of hole at 19.8 metres				
22	70					
24	75					
26	80					
	85					
	90					



C: Condition of Sample
- Good
- Disturbed
- No Recovery

Type: Type of Sampler
- SPT : 2 in. standard
- S : Shelby
- FP : Fixed Piston
- G : Grab
- CORE

N: Number of Blows
- WH : Weight of Hammer
- WR : Weight of Rod
- Standard Penetration Test : ASTM D1586
- Hammer Type:
- DYNAMIC CONE PENETRATION TEST: Blow count no. of blows of a 140 lb (64 kg) hammer dropped 30in. (750mm) to produce 12in (300mm) of a 2in (50mm) diameter cone.

- ● Moisture Content %
- ►Plastic Limit
- ◄ Liquid Limit
- ⧩ Ground Water Level
- ⊠ Shear strength in kPa (Torvane or Penetrometer)
- ✕ Shear strength in kPa (Unconfined)
- ⊗ Shear strength in kPa (field vane)
- ⊠ Remolded strength in kPa
- ■ Percent Passing # 200 sieve

Drill Method: Hollow Stem Auger / DCPT
Date Drilled: 05/02/2015
By: RB

APPENDIX 6

LABORATORY TEST RESULTS
(GRADATION ANALYSES – CONSOLIDATION TEST PLOTS)

LEVELTON

Levelton Consultants Ltd.

1935 Bollinger Road
Nanaimo, BC
Canada V9S 5W9
Tel.: 250-753-1077
Fax.: 250-753-1203
E-mail: nanaimo@levelton.com

AGGREGATE GRADATION ANALYSIS

IDENTIFICATION:

Client: The Tla-o-qui-aht First Nation c/o ISL Engineering
Project: Pacific Rim Park - Water Supply Upgrades - Tofino
Sample Location: BH15-28 at 8' (2.4m)
Obtained grab samples from Solid Stem Auger

File No.: R715-0161-00
Report No.: 1
Date: 18-May-15

SAMPLING INFORMATION:

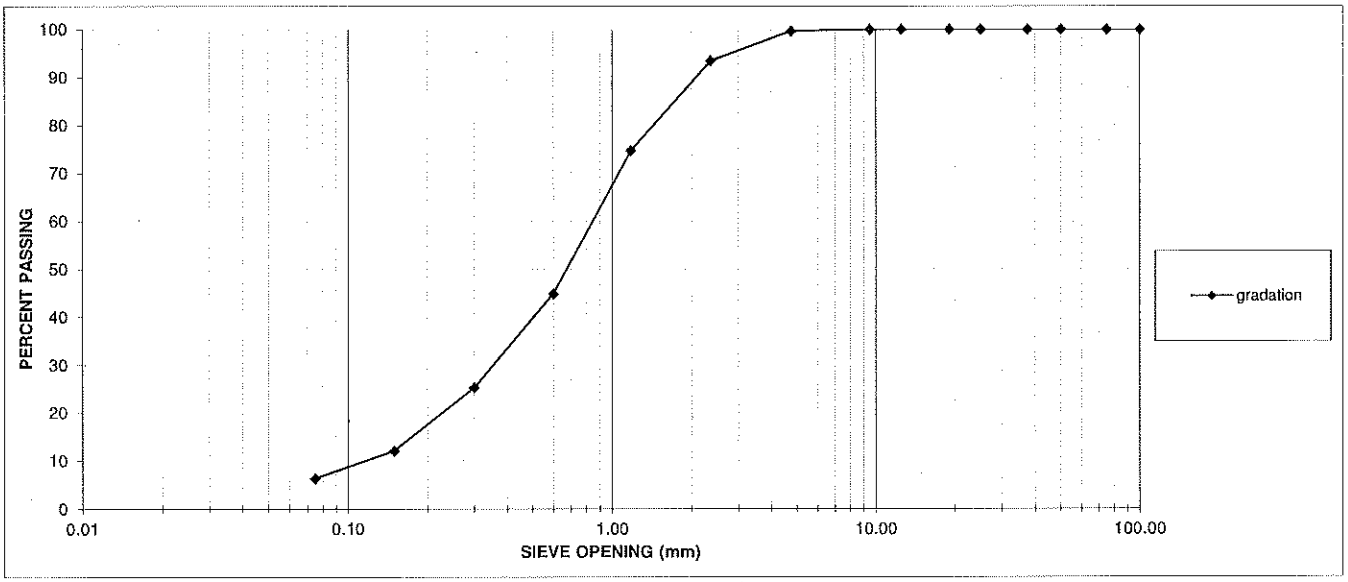
Material: Grey fine to coarse SAND, some gravel, trace fines
Specification: N/A

Date Sampled	05-Feb-15
Date Tested	19-May-15
Sample No:	4018A
Fracture by mass	0.0%
Supplier:	N/A
Sampled by:	RB
Tested by:	CG

Sieve Analysis

Sieve	% Passing
100	100.0
75	100.0
50	100.0
37.5	100.0
25	100.0
19	100.0
12.5	100.0
9.5	100.0
4.75	99.7
2.36	93.5
1.18	74.7
0.600	44.9
0.300	25.3
0.150	12.1
0.075	6.3

AGGREGATE GRADATION:



REMARKS: Tested in accordance with ASTM C- 136 and C-117

REPORTS TO:

LEVELTON CONSULTANTS LTD.

per: _____

Levelton Consultants Ltd.

1935 Bollinger Road
Nanaimo, BC
Canada V9S 5W9
Tel.: 250-753-1077
Fax.: 250-753-1203
E-mail: nanaimo@levelton.com

AGGREGATE GRADATION ANALYSIS

IDENTIFICATION:

Client: The Tla-o-qui-aht First Nation c/o ISL Engineering
Project: Pacific Rim Park - Water Supply Upgrades - Tofino
File No.: R715-0161-00
Report No.: 2

Sample Location: BH15-28 at 23' (7.0m)
Obtained grab samples from Solid Stem Auger
Date: 18-May-15

SAMPLING INFORMATION:

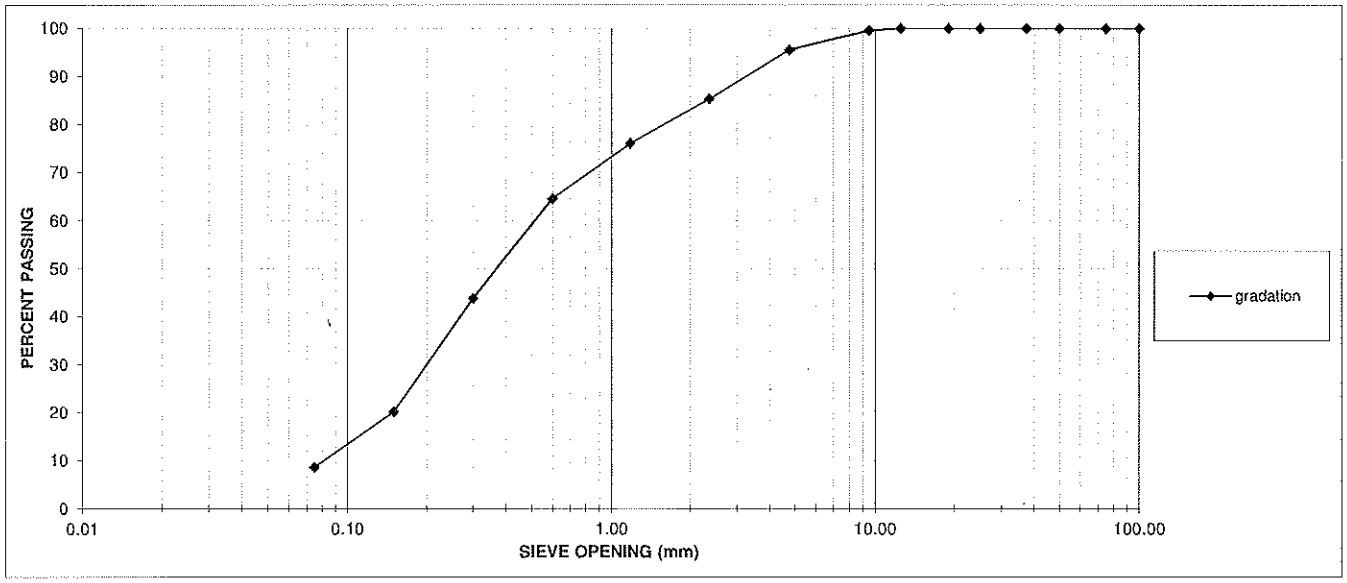
Material: Blue grey fine to coarse SAND, some gravel, trace fines
Specification: N/A

Date Sampled	05-Feb-15
Date Tested	19-May-15
Sample No:	4018B
Fracture by mass	0.0%
Supplier:	N/A
Sampled by:	RB
Tested by:	CG

Sieve Analysis

Sieve	% Passing
100	100.0
75	100.0
50	100.0
37.5	100.0
25	100.0
19	100.0
12.5	100.0
9.5	99.6
4.75	95.6
2.36	85.4
1.18	76.1
0.600	64.6
0.300	43.8
0.150	20.2
0.075	8.6

AGGREGATE GRADATION:



REMARKS: Tested in accordance with ASTM C- 136 and C-117

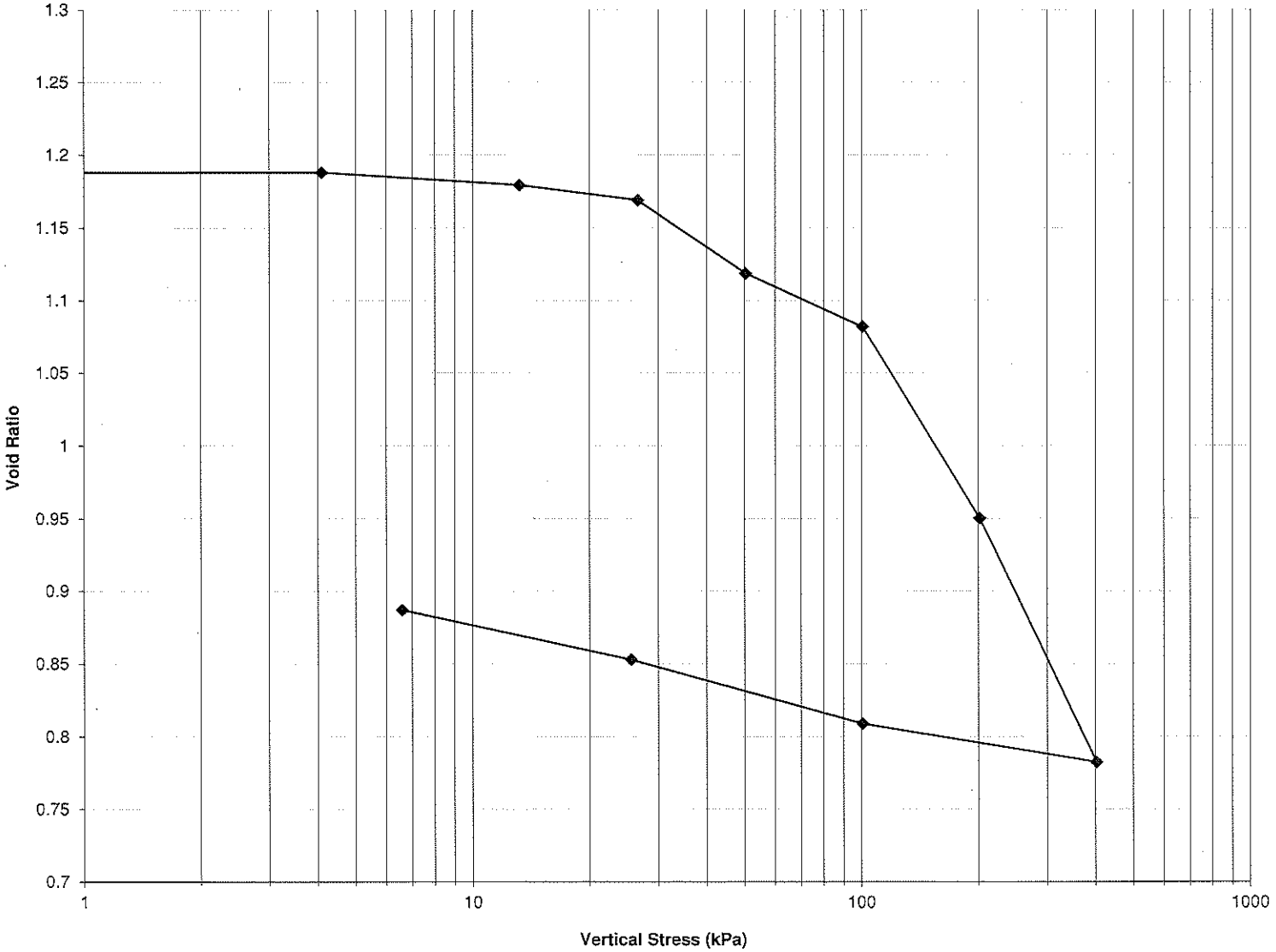
REPORTS TO:

LEVELTON CONSULTANTS LTD.

per:

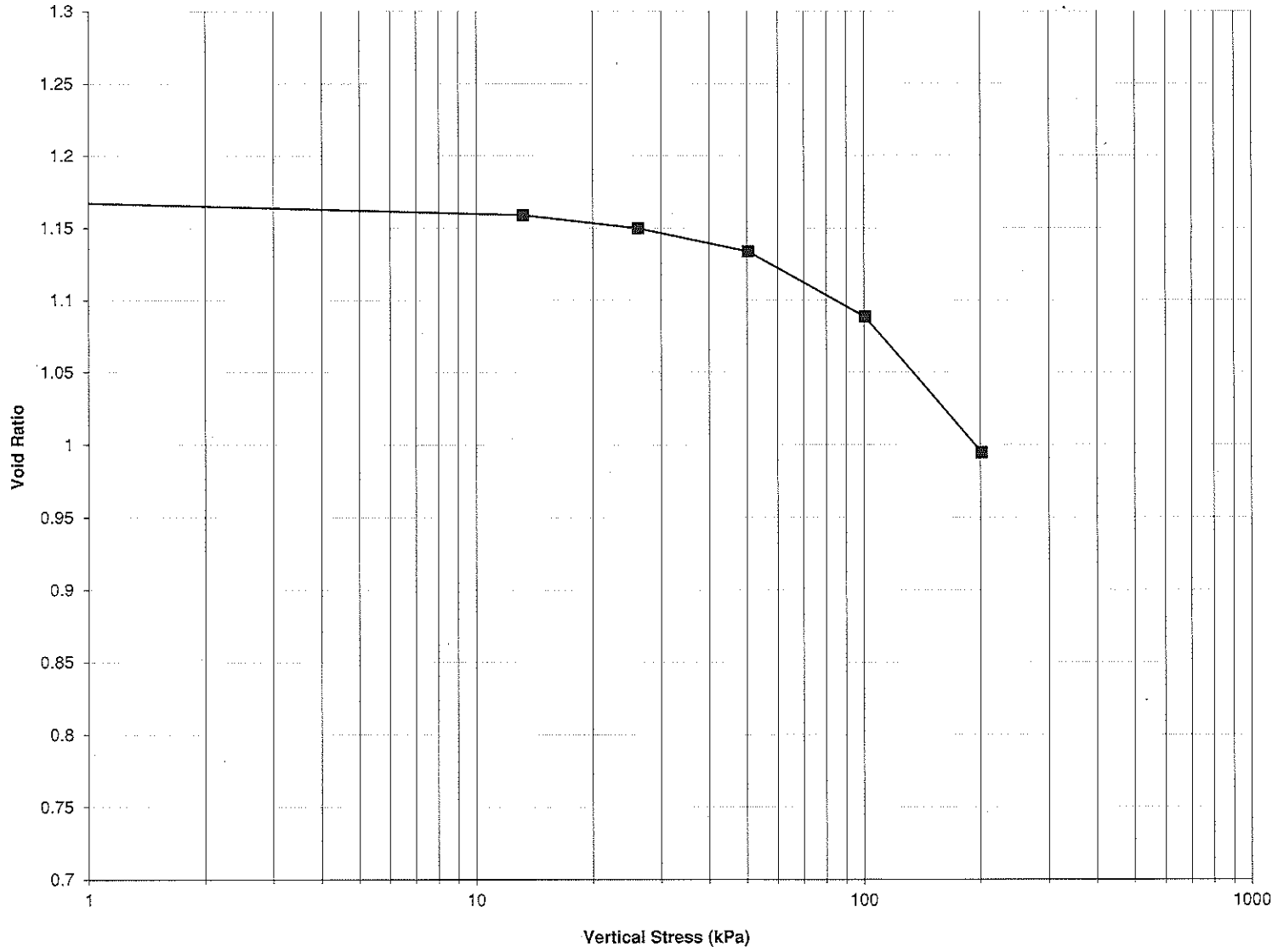
Pacific Rim National Park Water Supply Upgrades
Levelton Project Number: R715-0161
Void Ratio vs. Vertical Stress Curve - BH15-29 @ 4.9m

LEVELTON



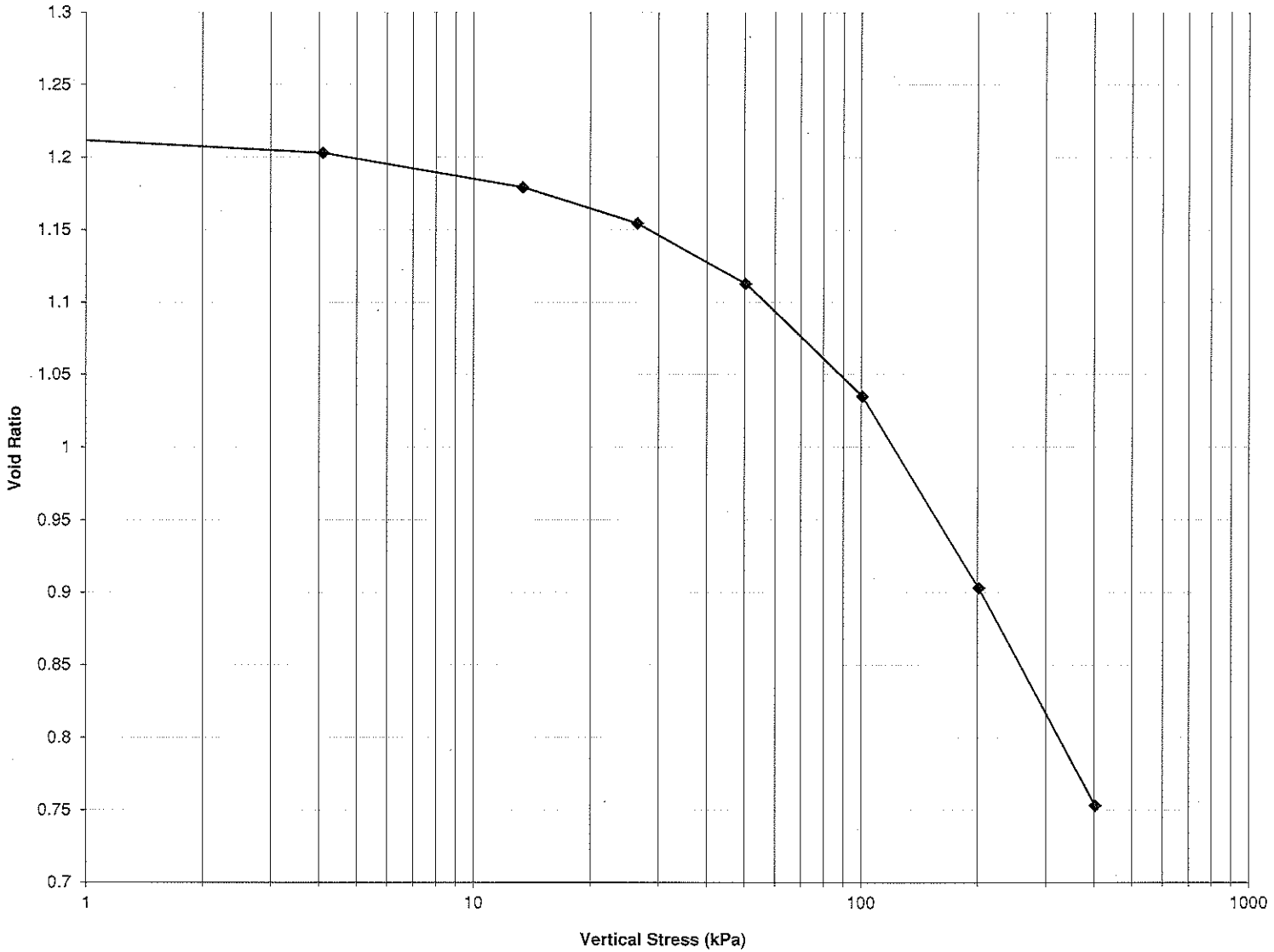
Wick Road Culvert Replacement
Levelton Project Number: R714-1815-00
Void Ratio vs. Vertical Stress Curve - BH14-02 @ 10m

LEVELTON



Wick Road Bridge
Levelton Project Number: R715-0628
Void Ratio vs. Vertical Stress Curve - BH15-0628 6.3 m

LEVELTON



APPENDIX 7

CPT LOGS

CONETEC

Job No: 15-02041
Client: Levelton Consultants Ltd.
Project: Pacific Rim Park - Water Supply Upgrades, Tofino, BC
Start Date: 29-Apr-2015
End Date: 02-May-2015

CONE PENETRATION TEST SUMMARY

Sounding ID	File Name	Date	Cone	Assumed Phreatic Surface[1] (m)	Depth From (m)	Depth To (m)	Northing[2] (m)	Easting (m)	Refer to Notation Number
SCPT15-30	15-02041_SP30	29-Apr-2015	187:T1000F10U500	0.8	0.00	18.90	5436720	302104	
SCPT15-31	15-02041_SP31	30-Apr-2015	187:T1000F10U500	2.0	0.00	37.05	5432399	304741	3
SCPT15-31	15-02041_SP31	30-Apr-2015	408:T1500F15U500	2.0	37.05	43.60	5432399	304739	3
SCPT15-32	15-02041_SP32	02-May-2015	408:T1500F15U500	1.6	0.00	13.65	5431661	308832	4

1. Assumed phreatic surface was based on pore pressure dissipation tests, unless otherwise noted. Hydrostatic conditions were assumed for interpretation tables, unless otherwise noted.
2. Coordinates were acquired from consumer grade GPS equipment. Datum: WGS 84 / UTM Zone 10 North.
3. Assumed phreatic surface was based on dynamic pore pressure response.
4. An equilibrium profile was used for the interpretation table.

CONETEC

Job No: 15-02041
Client: Levelton Consultants Ltd.
Project: Pacific Rim Park - Water Supply Upgrades, Tofino, BC
Start Date: 29-Apr-2015
End Date: 02-May-2015

CPTu PORE PRESSURE DISSIPATION SUMMARY

Sounding ID	File Name	Cone Area (cm^2)	Duration (s)	Test Depth (m)	Estimated Equilibrium Pore Pressure U_{eq} (m)	Calculated Phreatic Surface (m)	Estimated Phreatic Surface (m)	t_{50} [a] (s)	Assumed Rigidity Index (I_r)	c_h [b] (cm^2/min)
SCPT15-30	15-02041_SP30	10	3600	5.00	Not Achieved		0.8	2238	100	0.2
SCPT15-30	15-02041_SP30	10	5405	15.00	Not Achieved					
SCPT15-30	15-02041_SP30	10	250	18.90	18.1	0.8				
SCPT15-31	15-02041_SP31	10	965	0.30	0.0					
SCPT15-31	15-02041_SP31	10	4200	6.00	Not Achieved					
SCPT15-31	15-02041_SP31	10	560	12.35	Not Achieved					
SCPT15-31	15-02041_SP31	10	3600	15.50	Not Achieved					
SCPT15-31	15-02041_SP31	10	465	37.05	Not Achieved					
SCPT15-31	15-02041_SP31	15	535	39.65	Not Achieved					
SCPT15-31	15-02041_SP31	15	430	43.15	Not Achieved					
SCPT15-31	15-02041_SP31	15	245	43.60	Not Achieved					
SCPT15-32	15-02041_SP32	15	250	3.50	1.9	1.6				
SCPT15-32	15-02041_SP32	15	505	6.05	4.5	1.6				
SCPT15-32	15-02041_SP32	15	350	9.50	2.3	7.2				
SCPT15-32	15-02041_SP32	15	435	13.65	6.4	7.3				

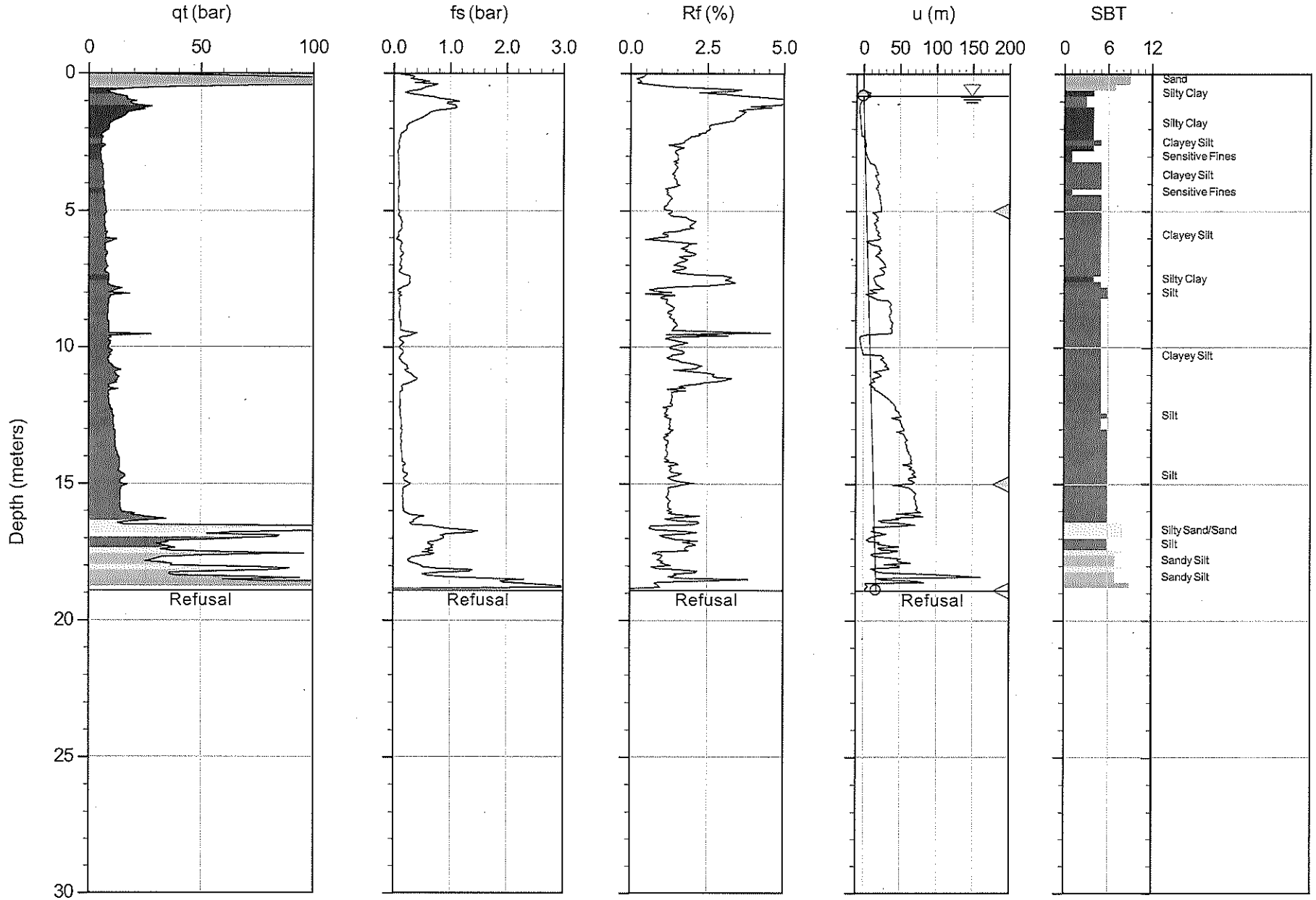
a. Time is relative to where umax occurred
b. Houlsby and Teh, 1991

CONETEC

Levelton

Job No: 15-02041
Date: 04:29:15 12:28
Site: Pacific Rim Park - Water Supply Upgrades, Tofino, BC

Sounding: SCPT15-30
Cone: 187:T1000F10U500



Max Depth: 18.900 m / 62.01 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 15-02041_SP30.COR
Unit Wt: SBT Chart Soil Zones

SBT: Lunne, Robertson and Powell, 1997
Coords: UTM 10N N: 5436720m E: 302104m
Sheet No: 1 of 1

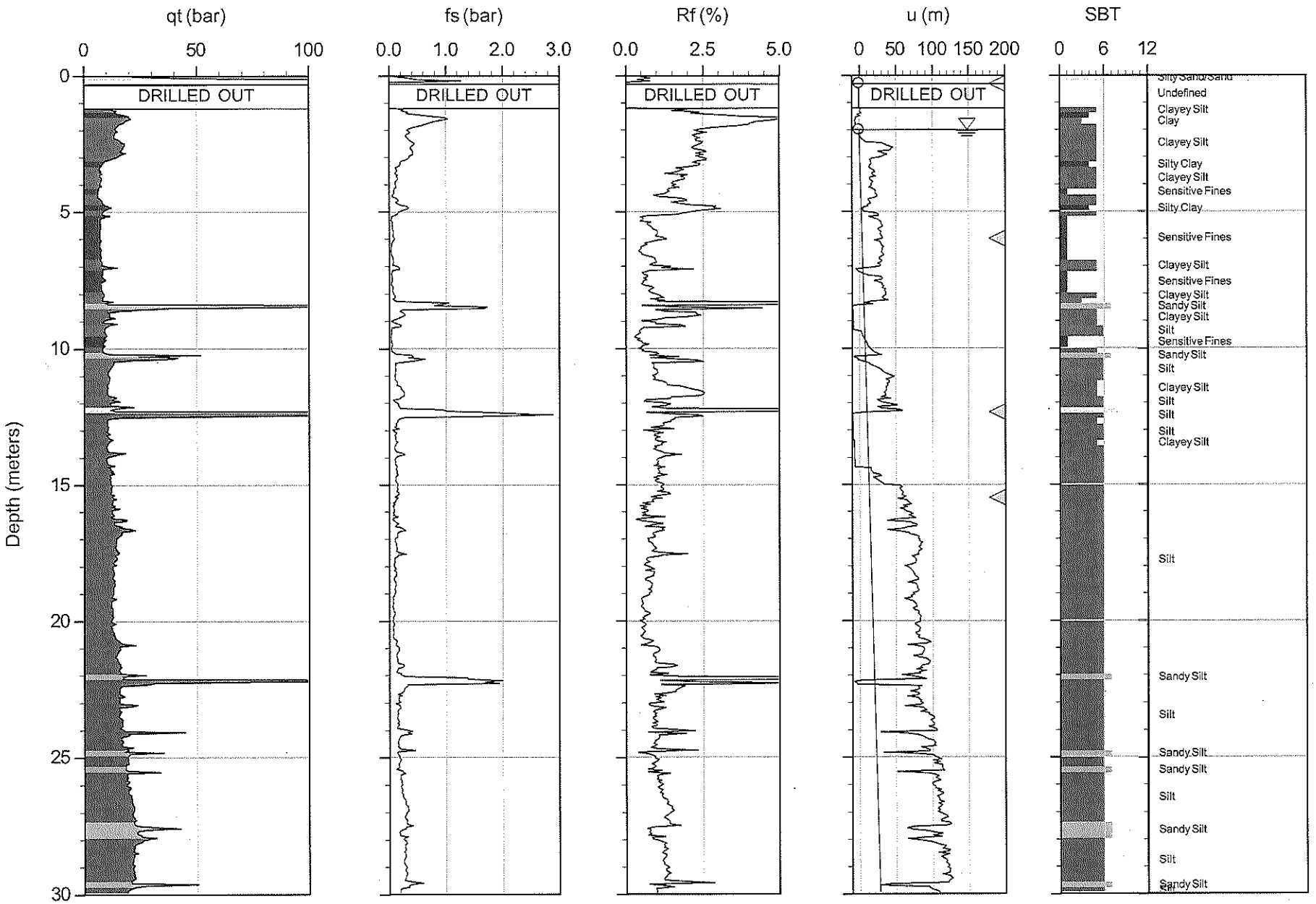
○ Ueq —— Hydrostatic Line ◁ Dissipation, Ueq not achieved ◁ Dissipation, Ueq achieved

CONETEC

Levelton

Job No: 15-02041
Date: 04:30:15 08:22
Site: Pacific Rim Park - Water Supply Upgrades

Sounding: SCPT15-31
Cone: 187:T1000F10U500
408:T1500F15U500



Max Depth: 43.600 m / 143.04 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 15-02041_SP31.COR
Unit Wt: SBT Chart Soil Zones

SBT: Lunne, Robertson and Powell, 1997
Coords: UTM 10N N: 5432399m E: 304741m
Sheet No: 1 of 2

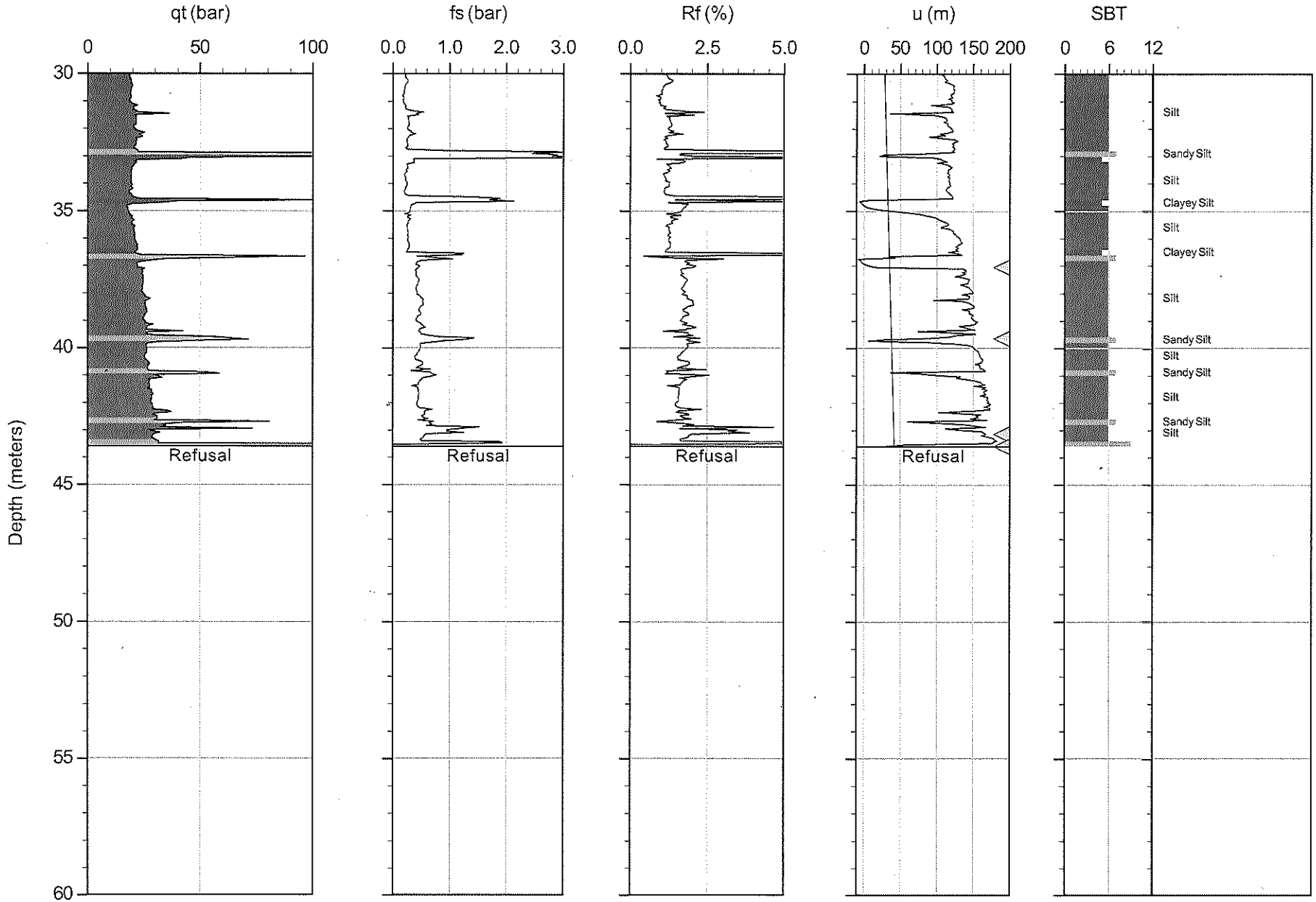
○ Ueq —— Hydrostatic Line ◁ Dissipation, Ueq not achieved ◁ Dissipation, Ueq achieved

CONETEC

Levelton

Job No: 15-02041
Date: 04:30:15 08:22
Site: Pacific Rim Park - Water Supply Upgrades

Sounding: SCPT15-31
Cone: 187:T1000F10U500
408:T1500F15U500



Max Depth: 43.600 m / 143.04 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 15-02041_SP31.COR
Unit Wt: SBT Chart Soil Zones

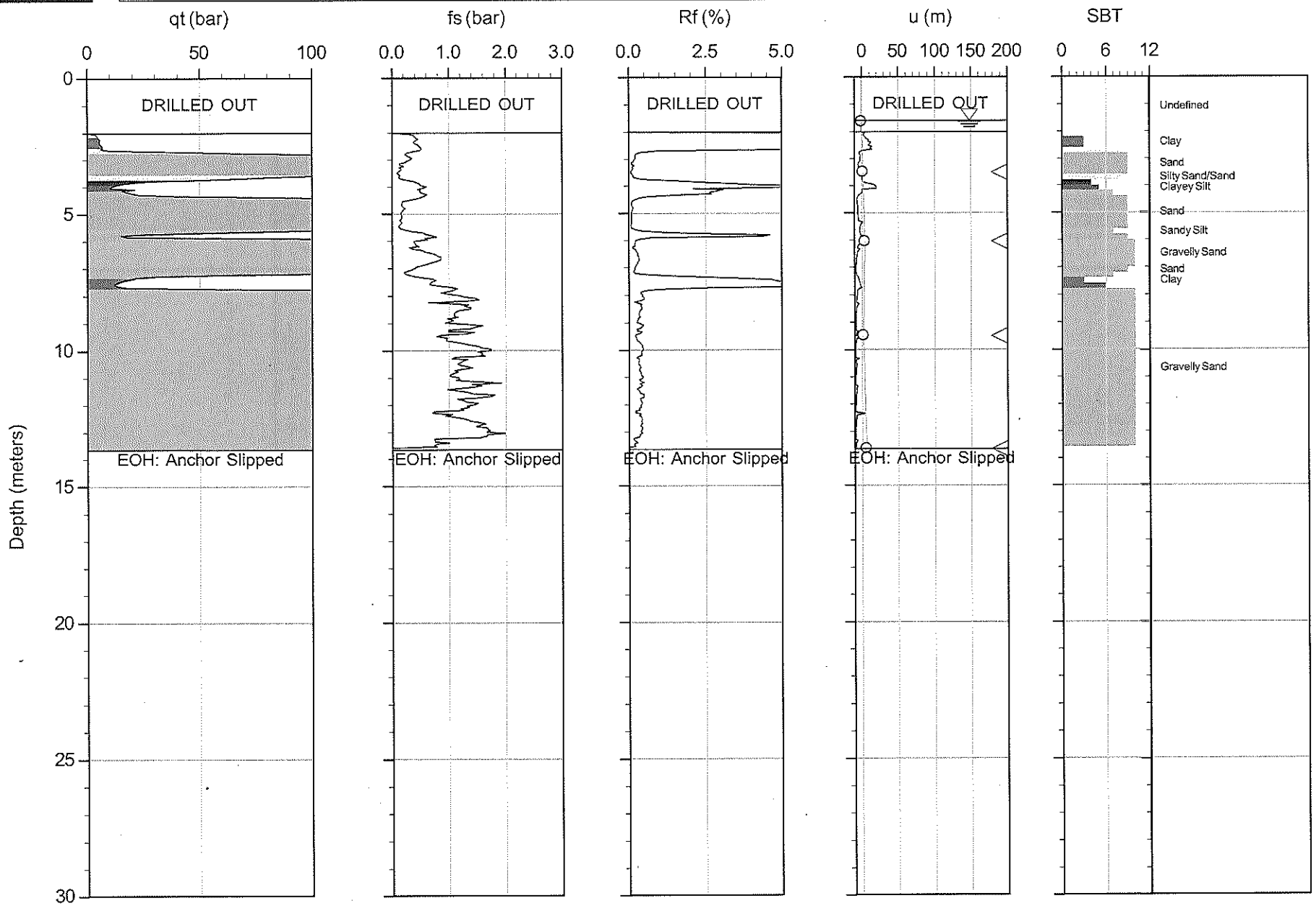
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM 10N N: 5432399m E: 304741m
Sheet No: 2 of 2

○ Ueq —— Hydrostatic Line ◁ Dissipation, Ueq not achieved ◁ Dissipation, Ueq achieved

CONETEC

Levelton

Job No: 15-02041
Date: 05:02:15 08:45
Sounding: SCPT15-32
Cone: 408:T1500F15U500
Site: Pacific Rim Park - Water Supply Upgrades, Tofino, BC



Max Depth: 13.650 m / 44.78 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.200 m

File: 15-02041_SP32.COR
Unit Wt: SBT Chart Soil Zones

SBT: Lunne, Robertson and Powell, 1997
Coords: UTM 10N N: 5431661m E: 308832m
Sheet No: 1 of 1

○ Ueq ····· Ueq Line ◁ Dissipation, Ueq not achieved ◁ Dissipation, Ueq achieved

CONETEC

Job No: 15-02041
Client: Levelton Consultants Ltd.
Project: Pacific Rim Park - Water Supply Upgrades, Tofino, BC
Sounding ID: SCPT15-30
Date: 29-Apr-2015

Seismic Source: Beam
Source Offset (m): 0.40
Source Depth (m): 0.00
Geophone Offset (m): 0.20

SCPTu SHEAR WAVE VELOCITY TEST RESULTS - Vs

Tip Depth (m)	Geophone Depth (m)	Ray Path (m)	Ray Path Difference (m)	Travel Time Interval (ms)	Interval Velocity (m/s)
1.25	1.05	1.12			
2.25	2.05	2.09	0.97	7.54	128
3.25	3.05	3.08	0.99	11.29	87
4.25	4.05	4.07	0.99	10.99	90
5.25	5.05	5.07	1.00	8.89	112
6.25	6.05	6.06	1.00	10.09	99
7.25	7.05	7.06	1.00	9.24	108
8.25	8.05	8.06	1.00	8.64	116
9.25	9.05	9.06	1.00	7.77	129
10.25	10.05	10.06	1.00	8.19	122
11.25	11.05	11.06	1.00	7.49	133
12.25	12.05	12.06	1.00	6.99	143
13.25	13.05	13.06	1.00	6.99	143
14.25	14.05	14.06	1.00	5.84	171
15.25	15.05	15.06	1.00	5.30	189
16.25	16.05	16.05	1.00	5.55	180
17.25	17.05	17.05	1.00	4.35	230
18.25	18.05	18.05	1.00	4.65	215
18.90	18.70	18.70	0.65	1.95	333

CONETEC

Job No: 15-02041
Client: Levelton Consultants Ltd.
Project: Pacific Rim Park - Water Supply Upgrades, Tofino, BC
Sounding ID: SCPT15-31
Date: 30-Apr-2015

Seismic Source: Beam
Source Offset (m): 0.40
Source Depth (m): 0.00
Geophone Offset (m): 0.20

SCPTu SHEAR WAVE VELOCITY TEST RESULTS - Vs

Tip Depth (m)	Geophone Depth (m)	Ray Path (m)	Ray Path Difference (m)	Travel Time Interval (ms)	Interval Velocity (m/s)
1.45	1.25	1.31			
2.45	2.25	2.29	0.97	7.27	134
3.45	3.25	3.27	0.99	6.61	150
4.45	4.25	4.27	0.99	8.09	123
5.45	5.25	5.27	1.00	8.55	116
6.35	6.15	6.16	0.90	7.81	115
7.35	7.15	7.16	1.00	8.31	120
8.35	8.15	8.16	1.00	7.30	137
9.35	9.15	9.16	1.00	6.70	149
10.35	10.15	10.16	1.00	6.00	166
11.35	11.15	11.16	1.00	5.59	179
12.35	12.15	12.16	1.00	4.70	213
13.35	13.15	13.16	1.00	5.07	197
14.35	14.15	14.16	1.00	4.71	212
15.35	15.15	15.16	1.00	4.47	224
16.35	16.15	16.15	1.00	4.28	233
17.35	17.15	17.15	1.00	4.25	235
18.35	18.15	18.15	1.00	4.46	224
19.35	19.15	19.15	1.00	4.62	217
20.35	20.15	20.15	1.00	4.41	227
21.35	21.15	21.15	1.00	4.30	233
22.35	22.15	22.15	1.00	4.36	229
23.35	23.15	23.15	1.00	3.82	262
24.35	24.15	24.15	1.00	3.67	272
25.35	25.15	25.15	1.00	3.78	265
26.35	26.15	26.15	1.00	3.69	271
27.35	27.15	27.15	1.00	3.73	268
28.35	28.15	28.15	1.00	3.57	280
29.35	29.15	29.15	1.00	3.56	281

CONETEC

Job No: 15-02041
Client: Levelton Consultants Ltd.
Project: Pacific Rim Park - Water Supply Upgrades, Tofino, BC
Sounding ID: SCPT15-31
Date: 30-Apr-2015

Seismic Source: Beam
Source Offset (m): 0.40
Source Depth (m): 0.00
Geophone Offset (m): 0.20

SCPTu SHEAR WAVE VELOCITY TEST RESULTS - Vs

Tip Depth (m)	Geophone Depth (m)	Ray Path (m)	Ray Path Difference (m)	Travel Time Interval (ms)	Interval Velocity (m/s)
30.35	30.15	30.15	1.00	3.56	281
31.35	31.15	31.15	1.00	3.70	270
32.35	32.15	32.15	1.00	3.78	265
33.35	33.15	33.15	1.00	3.60	278
34.35	34.15	34.15	1.00	3.19	314
35.35	35.15	35.15	1.00	3.59	278
36.30	36.10	36.10	0.95	3.49	272

CONETEC

Job No: 15-02041
Client: Levelton Consultants Ltd.
Project: Pacific Rim Park - Water Supply Upgrades, Tofino, BC
Sounding ID: SCPT15-32
Date: 02-May-2015

Seismic Source: Beam
Source Offset (m): 0.40
Source Depth (m): 0.00
Geophone Offset (m): 0.20

SCPTu SHEAR WAVE VELOCITY TEST RESULTS - Vs

Tip Depth (m)	Geophone Depth (m)	Ray Path (m)	Ray Path Difference (m)	Travel Time Interval (ms)	Interval Velocity (m/s)
2.30	2.10	2.14			
3.30	3.10	3.13	0.99	15.49	64
4.30	4.10	4.12	0.99	5.63	176
5.30	5.10	5.12	1.00	6.94	144
6.30	6.10	6.11	1.00	5.46	183
7.30	7.10	7.11	1.00	4.53	220
8.30	8.10	8.11	1.00	6.89	145
9.30	9.10	9.11	1.00	3.04	329
10.30	10.10	10.11	1.00	3.00	333
11.30	11.10	11.11	1.00	2.86	349
12.30	12.10	12.11	1.00	2.79	359
13.30	13.10	13.11	1.00	2.72	368

APPENDIX 8

TERMS OF REFERENCE FOR GEOTECHNICAL REPORTS

TERMS OF REFERENCE FOR GEOTECHNICAL REPORTS ISSUED BY LEVELTON CONSULTANTS LTD.

LEVELTON

1. STANDARD OF CARE

Levelton Consultants Ltd. ("Levelton") prepared and issued this geotechnical report (the "Report") for its client (the "Client") in accordance with generally-accepted engineering consulting practices for the geotechnical discipline. No other warranty, expressed or implied, is made. Unless specifically stated in the Report, the Report does not address environmental issues.

The terms of reference for geotechnical reports issued by Levelton (the "Terms of Reference") contained in the present document provide additional information and caution related to standard of care and the use of the Report. The Client should read and familiarize itself with these Terms of Reference.

2. COMPLETENESS OF THE REPORT

All documents, records, drawings, correspondence, data, files and deliverables, whether hard copy, electronic or otherwise, generated as part of the services for the Client are inherent components of the Report and, collectively, form the instruments of professional services (the "Instruments of Professional Services"). The Report is of a summary nature and is not intended to stand alone without reference to the instructions given to Levelton by the Client, the communications between Levelton and the Client, and to any other reports, writings, proposals or documents prepared by Levelton for the Client relative to the specific site described in the Report, all of which constitute the Report.

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Levelton prepared the Report for the Client for the specific site, development, building, design or building assessment objectives and purpose that the Client described to Levelton. The applicability and reliability of any of the information, observations, findings, suggestions, recommendations and opinions contained in the Report are only valid to the extent that there was no material alteration to or variation from any of the said descriptions provided by the Client to Levelton unless the Client specifically requested Levelton to review and revise the Report in light of such alteration or variation.

4. USE OF THE REPORT

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LEVELTON

TERMS OF REFERENCE FOR GEOTECHNICAL REPORTS ISSUED BY LEVELTON CONSULTANTS LTD. (continued)

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a. **Nature and Exactness of Descriptions**: The classification and identification of soils, rocks and geological units, as well as engineering assessments and estimates have been based on investigations performed in accordance with the standards set out in Paragraph 1 above. The classification and identification of these items are judgmental in nature and even comprehensive sampling and testing programs, implemented with the appropriate equipment by experienced personnel, may fail to locate some conditions. All investigations or assessments utilizing the standards of Paragraph 1 involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and all persons making use of such documents or records should be aware of, and accept, this risk. Some conditions are subject to changes over time and the parties making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. Where special concerns exist, or when the Client has special considerations or requirements, the Client must disclose them to Levelton so that additional or special investigations may be undertaken, which would not otherwise be within the scope of investigations made by Levelton or the purposes of the Report.

b. **Reliance on information**: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site investigation and field review and on the basis of information provided to Levelton. Levelton has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Levelton cannot accept responsibility for any deficiency, misstatement or inaccuracy contained in the report as a result of misstatements, omissions, misrepresentations or fraudulent acts of persons providing information.

c. **Additional Involvement by Levelton**: To avoid misunderstandings, Levelton should be retained to assist other professionals to explain relevant engineering findings and to review the geotechnical aspects of the plans, drawings and specifications of other professionals relative to the engineering issues pertaining to the geotechnical consulting services provided by Levelton. To ensure compliance and consistency with the applicable building codes, legislation, regulations, guidelines and generally-accepted practices, Levelton should also be retained to provide field review services during the performance of any related work. Where applicable, it is understood that such field review services must meet or exceed the minimum necessary requirements to ascertain that the work being carried out is in general conformity with the recommendations made by Levelton. Any reduction from the level of services recommended by Levelton will result in Levelton providing qualified opinions regarding adequacy of the work.

6. ALTERNATE REPORT FORMAT

When Levelton submits both electronic and hard copy versions of the Instruments of Professional Services, the Client agrees that only the signed and sealed hard copy versions shall be considered final and legally binding upon Levelton. The hard copy versions submitted by Levelton shall be the original documents for record and working purposes, and, in the event of a dispute or discrepancy, the hard copy versions shall govern over the electronic versions; furthermore, the Client agrees and waives all future right of dispute that the original hard copy signed and sealed versions of the Instruments of Professional Services maintained or retained, or both, by Levelton shall be deemed to be the overall originals for the Project.

The Client agrees that the electronic file and hard copy versions of Instruments of Professional Services shall not, under any circumstances, no matter who owns or uses them, be altered by any party except Levelton. The Client warrants that the Instruments of Professional Services will be used only and exactly as submitted by Levelton.

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July 24, 2015
Levelton File # R715-0161-00

Tla-O-Qiu-Aht First Nation c/o ISL
c/o ISL Engineering and Land Services
#201 8506 200th Street
Langley, BC V2Y 0M1

Attention: Mr. Randolph R. Rosin, M.Eng., P.Eng.

Project: Tofino Water Supply Upgrades – Phase 3
Subject: Reservoir Design Development – Addendum 1 to Geotechnical Assessment

1 INTRODUCTION

This addendum letter summarizes discussions with ISL Engineering and Land Services (ISL) that relate to a potential foundation design alternative for the proposed reservoirs in Pacific Rim National Park in Tofino, BC. A Geotechnical Assessment Report for the project was provided on 10 July 2015[1]. The report described the geotechnically challenging conditions at the reservoir sites and presented recommendations intended to meet the project performance requirements which included a maximum post construction settlement of 150 mm.

Thick deposits of marine sediments at the reservoir sites introduce the potential for long term consolidation settlements under increased imposed loads. The presence of a somewhat desiccated upper crustal zone of soil complicates the analysis in terms of reliance and uncertainty. In addition, the performance of a nearby, similar reservoir at the Wick Road site which we understand has remained functional for many years, presents observational data which appears in conflict with theoretical soil mechanics analysis. To add to the complexity, relatively large settlements have been induced by modest loads on the same sensitive clay deposit on other project sites in the Tofino area (including Wick Road). Based on a review of the data and in consideration of the performance criteria for these important structures the Levelton July report presents site preparation and foundation recommendations geared towards controlling settlements from the imposed new reservoir loads through the use of light weight soil replacements.

[1] Geotechnical Assessment – Tofino Water Supply Upgrades – Phase 3. July 10, 2015. Prepared by Levelton for the Tla-O-Qui Aht First Nation, File Reference: R715-0161-00.

An alternative foundation option has been introduced in which the allowable total settlement criteria has been increased. The intent of this modified criteria is to explore potential cost savings related to abandoning the use of light weight material below the reservoirs. It is acknowledged that there is a degree of uncertainty related to the upper crustal zone in relation to controlling long term settlements. However, given the importance of the structure, Levelton has adopted a controlled imposed load design approach which we consider to be appropriate to the project settlement objectives.

2 SUMMARY GEOTECHNICAL DISCUSSION

The alternative approach under review consists of placing the reservoirs at grade and no replacement of soil with light weight concrete. Our analysis of this scenario indicates that calculated long term static settlements are in the range of 100 mm to 300 mm. These settlements are long term and are expected to occur slowly as the underlying clay consolidates. The settlements are anticipated to be relatively uniform below the reservoirs. Accordingly, there is opportunity to manage the potential impact of these settlements by incorporating a shallow rigid raft foundation system that is designed to accommodate such movements and the differential aspects of buried infrastructure connections. Support for this approach is based, in part, on the observation that the existing reservoir at Wick Road, which is similar in size to that proposed, has been functional during its serviceable lifetime.

We recognize that as long as the differential settlement remains small (less than $\delta/L < 0.004$, where "δ" is the settlement between two points over distance "L")), the effects of relatively large total settlement can generally be accommodated with water reservoirs supported on raft foundations. We further recognize that the soil conditions likely do not vary significantly across the loading footprint of each reservoir and in the general vicinity of each proposed tank. Consequently, it is very possible that the existing reservoir at the Wick Road site could have settled at least 150 mm, without being noticed, particularly if the settlement was relatively uniform.

The alternative design approach outlined herein has an elevated risk of adverse settlement due to the uncertainties related to reliance on the upper stiff zone of soil. We recommend that a settlement monitoring program be established as part of the site maintenance procedures. The settlement data will provide a basis for determining if mitigative maintenance measures are needed in the future.

A number of strategies to reduce uncertainties were discussed, including a preload or operational overlap of the new and existing reservoirs to phase in loads. However, we understand that these are not feasible due to other project constraints.

Provided the Owner is prepared to accept the potential for total settlements exceeding 150 mm and create a suitable monitoring and maintenance program, the alternate concept is considered geotechnically acceptable.

The alternate foundation concept would be as follows:

1. Support the reservoirs on a concentrically loaded circular or square rigid mat foundation. The rigid mat foundation would act to reduce the effect of differential settlement below the reservoirs. Mat foundation design may be based on an SLS bearing resistance of 50 kPa, Modulus of Subgrade Reaction of 5 MPa/m and a factored ULS bearing resistance of 75 kPa.

2. The mat foundation should be constructed on not less than 200 mm of 19 mm minus crushed gravel supported on a subgrade of firm to stiff clay. The crush should be compacted in a single lift to not less than 95 percent Modified Proctor Maximum Dry Density in a single lift over the Geotechnical Engineer approved subgrade. A medium weight non-woven geotextile separator (i.e. Armtec 200, or approved equivalent) should be installed between the clay subgrade and crush in accordance with the manufacturer's instructions.

3. The top of the mat foundation should extend not more than 150 mm above surrounding grade to reduce the increase in loading on the underlying soil.

4. The tank filling is not likely to result in bearing failure of the soil. However, the settlement of the tank should be monitored via accurate survey (+/- 0.002 m) as the tank is filled in stages. Subsequent elevation readings should be conducted at four points on the tank foundation at 7 days, 14 days, 90 days, 180 days and 1 year after filling to confirm the settlements. This data should be provided to the Geotechnical Engineer for review after each reading. The need for future settlement monitoring would be evaluated based on the findings of the initial program.

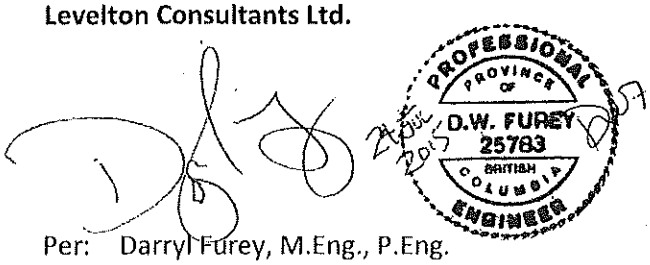
5. Use of connections that allow for settlements in excess of 150 mm is recommended for connecting piping.

3 CLOSURE

This addendum has been prepared by Levelton Consultants Ltd. for the exclusive use of Tla-O-Qiu-Aht First Nation. in general accordance with the Terms of Reference attached to the Reference Report. ISL Engineering and Land Services Ltd. is considered an approved user subject to the terms under which it was prepared.

We trust that the information provided meets your current requirements. If you have any questions, or require additional information, please contact the undersigned.

Yours truly,
Levelton Consultants Ltd.



Per: Darryl Furey, M.Eng., P.Eng.
Senior Geotechnical Engineer

Reviewed by:

Calum Buchan, M.Sc., P.Eng.
Senior Geotechnical Engineer