CITY OF PORT MOODY

DEVELOPMENT PERMIT No. 2019-35-10

TO: MARCON JOHNSTON PROPERTIES LTD.,
5645 199th Street
Langley, BC V3A 1H9
(the "**Developer**")

1. This Development Permit is issued subject to compliance with all applicable City Bylaws, except as specifically varied or supplemented by this Permit.

2. This Permit applies to those lands in Port Moody, British Columbia more particularly described below and including all buildings, structures, and other development thereon:

Lot 14, Block 25, District Lot 201, Group 1, New Westminster District, Plan 72; PID: 011-453-761;

2807 St. George Street and legally described as Lot 13, Block 25, District Lot 201, Group 1, New Westminster District, Plan 72; PID: 011-453-737;

2813 St. George Street and legally described as Lot 12, Block 25, District Lot 201, Group 1, New Westminster District, Plan 72;PID: 011-453-711;

2819 St. George Street and legally described as Lot 11, Block 25, District Lot 201, Group 1, New Westminster District, Plan 72; PID: 011-453-699;

2825 St. George Street and legally described as Lot 10, Block 25, District Lot 201, Group 1, New Westminster District, Plan 72; PID: 011-453-672;

2829 St. George Street and legally described as Lot 9, Block 25, District Lot 201, Group 1, New Westminster District, Plan 72; PID: 003-700-747; and

2831 St. George Street and legally described as Lot 8, Block 25, District Lot 201, Group 1, New Westminster District, Plan 72; PID: 011-453-656;

(the "**Lands**")

1) The following plans and documents are made part of this Permit and, notwithstanding any other provision, no works shall be performed upon the Lands covered by this Permit, nor shall any building or structure be erected, constructed, repaired, renovated, or sited, that is not in substantial accordance with the following and strictly in accordance with all terms and conditions of this Permit.

2) <u>Development Permit: Hazardous Conditions</u>
Prior to the issuance of a building permit, as a condition of issuance of this Development Permit, the development will be in accordance with:

a) the geotechnical report titled “Geotechnical Investigation Report – Proposed Townhouse Development 2801-2831 St. George Street, Port Moody, B.C. ”, dated August 2, 2019, prepared by GeoPacific, attached as Schedule A, and any amendments thereto subsequently approved by the City.

b) The flood hazard assessment report titles “Flood Hazard Assessment for Propose Development – Johnston House Development 2801-2831 St. George Street, Port Moody, B.C.”, dated October 4, 2019, prepared by R.F. Binnie and Associates Ltd., attached as Schedule B, and any amendments thereto subsequently approved by the City.

3) The works contemplated in plans set out in section 2 hereto shall be substantially started within two (2) years of the date of the Council Resolution authorizing issuance of this permit or the Development Permit will lapse.

4) Prior to the issuance of any building permit, as a condition of issuance of this Development Permit, the following plans shall be provided to the City of Port Moody for review and acceptance:

(e) erosion and sediment control plan;

(f) construction impact management plan;

(g) a stormwater management plan;

(h) a construction dust abatement plan;

(i) a construction waste recycling plan;

(j) a completed Engineering Servicing Agreement.

13. The works and services required in accordance with the Engineering Services Agreement are to be completed in compliance with the requirements of the "City of Port Moody Works and Services Bylaw, No. 1789, 1986" and "City of Port Moody Subdivision and Development Servicing Bylaw, No. 2831".

AUTHORIZED BY COUNCIL RESOLUTION passed on the ____of _____, 2019.

CITY OF PORT MOODY, by its authorized signatories:

_____ _____

_____, Mayor D. Shermer, Corporate Officer

GEOPACIFIC
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Marcon Johnston (GP) Ltd.
5645 – 199th Street
Langley, B.C.
V3A 1H9

August 2, 2019
File: 15258

Attention: Tim Schmitt

Re: Geotechnical Investigation Report: Proposed Townhouse Development
2801-2831 St. George Street, Port Moody, BC

1.0 INTRODUCTION

We understand that a new development is proposed for the site referenced above. Design drawings prepared by Shift Architecture Inc. show the development to consist of 43 townhomes constructed in units of 6 to 8, surrounded by at grade paved parking and an internal access road. The design drawings show 3-storey wood framed structures. The project also includes the relocation of a heritage house at the northwest corner of the site.

This report presents the results of a geotechnical investigation of the soil and groundwater conditions at the proposed development site and makes recommendations for the design and construction of the new development. The report has been prepared exclusively for the client, for their use, the use of others on their design and construction team and the City of Port Moody for use in the development and permitting process.

2.0 SITE DESCRIPTION

The proposed development site is a contiguous assembly of 7 lots located south of St. George Street between Moody Street and Hugh Street in Port Moody, B.C. The site is bounded by Moody Street to the west, St. George Street to the north, Hugh Street to the east and Hope Street to the south. Presently the site is improved with 7 at-grade single family homes surrounded by paved parking and landscaping. The site gently slopes down to the northeast with grades of less than 3% on the east end to less than 7% on the west end.

The location of the site relative to the surrounding improvements is shown on our Drawing No. 15258-01, following the text of this report.

3.0 FIELD INVESTIGATION

The subsurface ground conditions were investigated on August 18, 2017 using a track mounted auger drill rig that was supplied by On Track Drilling of Coquitlam, BC. A total of 3 Cone Penetration Test (CPT) soundings and 8 solid stem auger holes were completed at the site. Additionally, shear wave velocity measurements were collected during a CPT sounding. The CPT soundings were advanced to depths of between 3.1 and 7.3 meters below grade, and the auger test holes were drilled to a depth of between 6.1 and 9.1 metres below grade. The investigation was supervised by a geologist from our office who logged and sampled the soils encountered.

Prior to our investigation, a BC one call was placed and a member of our utility locate staff was on site to clear the test locations of buried services. All test holes were backfilled and sealed in accordance with provincial abandonment requirements following classification, sampling and logging.

The CPT is an in-situ testing device which is pushed into the ground employing a hydraulic ram on the drill rig. The cone penetrometer records measurements of tip resistance, sleeve resistance, dynamic pore water pressure, temperature, and inclination in 50 mm increments. Shear wave velocities can also be collected in 1 m intervals when required. The data obtained may be correlated to estimate engineering parameters such as shear strength, relative density, soil behaviour type, and consolidation coefficients. The stratigraphic interpretation was verified with the auger test holes as described above.

The test hole logs are presented on Figure A.01 to A.08 in Appendix A. The CPT sounding data is presented in Figure B.01 to B.03 of Appendix B. Interpreted Soil Parameters are presented in Appendix C, Liquefaction Assessment in Appendix D and Shear Wave Velocity data in Appendix E. The approximate locations of the test hole and CPT soundings are shown on our Drawing 15258-01, following the text of this report.

4.0 SUBSURFACE CONDITIONS

4.1 Soil Conditions

The soil conditions at our test hole locations were considered to consist of topsoil/fill overlying colluvial deposits of sand to sand and gravel. Detailed soil conditions can be found below.

TOPSOIL/FILL

The ground surface is underlain by a thin layer of asphalt and/or topsoil underlain by mineral fill up to 0.9 meters below site grades. The mineral fill was found to consist of loose to compact sandy gravel to sand and gravel.

SAND to SAND and GRAVEL (Colluvium)

The topsoil/fill is underlain by colluvial deposits consisting of compact sand to sand and gravel to the full depth of exploration. The sand was found to be loose to compact on the top 0.1 to 1.5 metres and compact below, fine to medium grained and contain some silt and trace amounts of gravel. The sand and gravel was found to be compact to dense and contain some rounded cobbles. This stratum is expected to be underlain by dense glacial soils.

For a more detailed description of the subsurface conditions refer to the test hole logs in Appendix A, the CPT sounding logs in Appendix B and interpreted soil parameters in Appendix C, following the text of this report.

4.2 Groundwater Conditions

The level of the static groundwater table was estimated at the time of our investigation to be at a depth of between 3.0 and 5.2 metres below current site grades. Note that perched groundwater should be expected to occur in the fill material during wetter periods. Groundwater levels are expected to vary seasonally with generally higher level following sustained precipitation.

5.0 DISCUSSION

5.1 General

As noted, the proposed townhouse development is to consist of relatively light wood framed structures with column and wall loads in the range of 200 kN and 30 kN/m, respectively. However, any below grade construction is expected to be a reinforced concrete construction. Based on the architectural design drawings of the project, the proposed founding elevations of the buildings ranging from less than 0.5 m below existing grade at the north side of the north buildings to up to 3 m below existing grade at the south side of the south buildings.

In general, the site is underlain by a thin layer of asphalt and/or topsoil underlain by loose to compact mineral fill up to 0.9 meters below existing site grades. The topsoil/fill is underlain by sand to sand and gravel to the full depth of exploration of 9.1 metres. The sand/sand and gravel was found to be loose to compact on the top 0.1 to 1.5 metres (0.5 to 1.8 metres below existing grades) and compact to dense below. The sand is expected to be underlain by dense to very dense glacial till.

The parking level is set back from property line along all sides. Thus, we anticipate that the excavation would be sloped, since it is normally more economical to do so. Some shoring will be required if the excavation is in close proximity to the property line.

Based on the OCP of the City of Port Moody (Hazardous Lands – MAP 14), the subject site is within the mapped area for potentially moderate to high risk of earthquake soil liquefaction.

Given the design of the proposed development and proposed grading of the site, we don't believe that the construction of the proposed development and any soil improvement that might be done on the site will affect the level of risk to other nearby properties.

As requested by the city, we can prepare a monitoring plan for the site to monitor any lateral and vertical movements during construction plus two years post construction. However, the monitoring requirements and the duration of the monitoring can be confirmed later once the type of footings/soil improvement has been finalized.

We confirm from a geotechnical point of view that the proposed development is feasible provided the following recommendations are implemented in the design and construction of the development.

We also confirm from a geotechnical point of view that in regards to the soil liquefaction the land, buildings, and structures are safe for the intended use provided the following recommendations are implemented in the design and construction of the development.

5.2 Seismic Analysis

It is generally accepted that loose to compact and saturated non-plastic silts and sands are prone to liquefaction or strain softening during cyclic loading caused by large magnitude long duration earthquakes. The strength reduction caused by soil liquefaction can cause foundations to punch. Furthermore, once liquefaction has been triggered, experience has shown that significant, permanent vertical and horizontal movements may be experienced.

We have conducted a liquefaction assessment based on the 1:2,475 year earthquake, as defined in the 2018 B.C. Building Code (BCBC). In the Port Moody area, this earthquake is expected to measure 7.0 on the Richter Scale and generate a maximum horizontal "firm ground" acceleration of 0.46g (Natural Resources Canada). The results of our analysis are provided in Appendix 'D'. The analysis indicates that the nearest liquefiable layer is at about 4 metres below present site grades. Localized zones of loose to compact sand are predicted to liquefy below this level to depths of up to 7 metres. The significance of ground liquefaction at the depths predicted can be grouped into two principal effects:

1. Reduction in shear strength at depth and thus reduction in bearing capacity - possible punching failure.

2. Post liquefaction vertical and horizontal ground movements - possible structural distress to the building.

Our analyses indicate **post liquefaction permanent ground settlements and horizontal displacements will be in the range of 50 mm and 290 mm, respectively**. The predicted movements are based on empirical observations from other earthquake sites around the world on relatively flat ground away from the influence of surrounding structures and should not be taken as exact calculations of movement but rather order of magnitude estimates. Our calculations of ground movements are based on Tokimatsu & Seed, 1987 and Youd et al., 2002. Differential settlements due to liquefaction should be expected to be in the range of 50% of the total liquefaction settlements.

To mitigate the impacts of soil liquefaction, raft foundation without ground densification or conventional foundations (e.g. pad and/or strip footing) with ground densification can be used to support the new structures. However, the structural engineer should review the estimated post liquefaction movements of the ground without soil liquefaction mentioned above and confirm that they are acceptable.

Additional site Investigation is recommended to be carried out for the site to determine if the mitigative measures mentioned above can be avoided.

6.0 RECOMMENDATIONS

6.1 Site Preparation for Building

Prior to construction of foundations or floor slabs, all vegetation, topsoil, organic material, debris, refuse, and loose or otherwise disturbed soils must be removed from the construction areas to expose a subgrade of compact sand to compact to dense sand and gravel. The subgrade should be proof rolled under the review of the geotechnical engineer. Any loose zones should be re-compacted or over-excavated and replaced with engineered fill.

As mentioned in item 5.2 above and to mitigate the impacts of soil liquefaction, raft foundation without ground densification or conventional foundations with ground densification can be used to support the new structures.

Any grade reinstatement should be done using engineered fill. Engineered Fill is generally defined as clean sand to sand and gravel containing 5 percent fines by weight, compacted in 300 mm loose lifts to a minimum of 95% of the ASTM D1557 (Modified Proctor) maximum dry density at a moisture content that is within 2% of optimum for compaction.

The geotechnical engineer shall be contacted for the review of stripping and engineered fill placement and compaction.

6.2 In-situ Ground Improvement (Densification)

If the conventional foundations (e.g. strip and/or pad footing) is preferred to support the new structures, we expect in-situ ground densification with stone columns to be utilized to mitigate the impacts of soil liquefaction. Stone columns installed using a full displacement method such as Rammed Impact Piers, would be placed beneath foundation elements to improve bearing stresses and reduce liquefaction potential.

6.3 Buildings Foundations

6.3.1 Conventional Foundations

Conventional pad and strip footings can be used to support the proposed development after ground densification. We recommend the foundations to be designed using a Serviceability Limit States (SLS) bearing pressure of 200 kPa. Factored Ultimate Limit States (ULS) may be taken as 1.5 × SLS bearing pressures provided.

6.3.2 Raft Foundation

The new structures can also be supported on a raft foundation on existing soils, without any ground densification. The raft should be designed on the basis of a Serviceability Limit States (SLS) bearing pressures of 100 kPa. Factored Ultimate Limit States (ULS) may be taken as 1.5 × SLS bearing pressures provided.

A subgrade modulus of 10 MPa/m can be used for the design of raft foundations.

6.3.3 General

Based on the assumed building loads and provided that the foundations are designed and constructed as per the recommendations in this report, we estimate the total post-construction settlements of the structures will not exceed 25mm with the expected differential post-construction settlement not to exceed 20mm in 10m horizontal distance.

Irrespective of specified bearing pressures, footings should not be less than 450 mm in width for strip footings and not less than 600 mm in width for square or rectangular footings. Footings should also be buried a minimum of 450 mm below the surface for frost protection.

The geotechnical engineer shall be contacted for the review of all foundation subgrades.

6.4 Seismic Design of Foundations

For structures to be constructed at the above referenced site and on native ground, the Site Classification to be used for estimating the seismic site response as defined in Table 4.1.8.4.A. of the 2018 British Columbia Building Code, should be assumed to be "Site Class F". for buildings with structural period of 0.5 seconds or less, Class E spectrum can be used.

For structures to be constructed on the densified ground, the site could be assumed to be "Site Class C".

6.5 Slab-On-Grade Floors Preparation

In order to provide suitable support for slab-on-grade floors we recommend that any fill placed under the slab should be "engineered fill" as described in Section 6.1 above. In addition, this granular fill must be compacted to a minimum of 98 % Standard Proctor maximum dry density (ASTM D698) with water content within 2% of optimum for compaction.

Floor slab should be directly underlain by a minimum of 150 mm of compacted 19 mm clear crushed gravel fill to inhibit upward migration of moisture beneath the slab. A moisture barrier should underlie the slab directly above the free draining granular material.

The geotechnical engineer shall be contacted for the review of the slab subgrade and underslab materials and compaction.

6.6 Site and Foundation Drainage Systems

A perimeter drainage system will be required for the below grade structure to prevent the development of water pressure on the foundation walls and the lower floor slabs.

For structures without below grade construction, we expect that perimeter drainage would not be required provided the following recommendations are incorporated into the design by the civil and mechanical designers:

1. The top of finished floor slabs are constructed a minimum of 200 mm above finished outside grades.
2. The site is graded such that surface water drains away from the buildings and into the municipal storm water system.
3. The building floors are underlain by a minimum of 300 mm of free draining granular fill.

The areas surrounding the buildings should be sloped away with a minimum gradient of at least 2%. Any structure with below grade construction will require perimeter drainage.

6.7 Temporary Excavation and Shoring

We expect that the perimeter excavation would be sloped where possible and where is a sufficient room to do so since it is more economical to do so. We would expect that slopes cut to 1V to 1H can be constructed within the existing surficial strata. All temporary cut slopes should be covered in poly sheeting to prevent erosion of the slope face. Temporary cut slopes in excess of 1.2 metres in height require inspection by a professional engineer in accordance with Work Safe BC guidelines.

Shoring will be required for excavations where sloped cuts are not possible. Vertical cuts may be supported with the use of a shotcrete membrane tied back with post-tensioned soil anchors. Testing of all soil anchors will be required to ensure that each safely meets its required design capacity. A GeoPacific representative must be on-site for all soil anchor testing.

Light to moderate seepage during the wetter months should be expected due to the formation of perched water tables. We expect that groundwater inflows can be controlled with conventional sumps and sump pumps.

The geotechnical engineer shall be contacted for the review of shoring installation and temporary excavations.

6.8 Earth Pressures on Foundation Walls

Earth pressures against the foundation walls are dependent on factors such as, available lateral restraint along the wall, surcharge loads, backfill materials, compaction of the backfill and drainage conditions.

The foundation wall is expected to be partially yielding and fully restrained between the parking floors and backfilled with a free draining granular soil. The foundation walls will be backfilled with granular soil and compacted in place to a density suitable for support of patios and other settlement sensitive fixtures constructed at grade beyond the parking level limits. We expect backfill to be compacted to at least 95 percent ASTM D698 (Standard Proctor) maximum dry density.

We recommend that the foundation walls be designed to resist the following lateral earth pressures:

Static: Triangular soil pressure distribution of 5.5H kPa, where H is equal to the total wall height in metres.

Seismic: Inverted triangular soil pressure distribution of 4.0H kPa, where H is equal to the total wall height in metres.

The preceding loading recommendations assume that the parkade walls would be backfilled with only free draining backfill materials, ensuring a drained cavity around the perimeter of the parkade. We expect that the perimeter drainage system will be connected to the synthetic drainage material and sufficiently lower the groundwater level such that hydrostatic pressures against the foundation walls are eliminated.

The geotechnical engineer should be contacted for the review of all backfill materials and procedures.

6.9 New On-Site Pavement

Following the recommended site preparation, it is our opinion that our recommended pavement section, given in Table 1, is sufficient to carry the vehicle loads induced by conventional automobile and light truck traffic.

Table 1: Recommended Minimum Pavement Structure

Material	Thickness (mm)
Asphaltic Concrete	75
19 mm minus crushed gravel base course	150
100 mm minus, well graded, clean, sand and gravel subbase course	200

All base and sub-base fills should be compacted to a minimum of 95% Modified Proctor dry density with a moisture content within 2% of optimum for compaction. The base and sub-base materials should meet

municipal requirements for gradation and density. Density testing should be conducted on the base and subbase materials to confirm that they have been compacted to the required standard. The density testing results should be forwarded to the geotechnical engineer for review.

6.10 Utility Installations

We recommend that any trenches be sloped or shored as per the latest Work Safe B.C. regulations. The maximum temporary cut slope angles will depend upon the effectiveness of the contractors de-watering program. We anticipate that typical excavations would be sloped at 1V to 1H, though we expect that the slopes may need to be flattened where groundwater seepage exists.

We recommend that all service trenches be backfilled with clean granular material, which conforms to municipal standards, compacted to 95% "Modified Proctor" dry density (ASTM D1557) with a moisture content within 2% of optimum for compaction.

We assume that any organic soils would be removed beneath the development. However, if any organic and/or weak soils are identified in utility trenches, these may require local over-excavation and replacement with engineered fill as noted in Section 6.1.

In general, we would expect normal post construction settlements of utilities (25 mm total and 20 mm over a 10 metres span differential).

Any excavation in excess of 1.2 metres (4 feet) in depth requiring man-entry must be reviewed by a geotechnical engineer.

6.11 Flooding Assessment

Based on the City of Port Moody hazardous lands map (OCP/Development Permit Area 5 - Map 14), the site may be subject to flooding under extreme conditions. We understand that there is no adopted flood plain level for this area.

Considering the topography of the site and the surrounding areas, the risk of flooding of this site is considered low to insignificant, less than 1:200.

A flood which results in inundation of the structure with water is not expected to have any impact on the foundations of the buildings, and therefore it is our opinion that the land may be used safely for the use intended.

The critical functional areas of the building, such as mechanical and electrical rooms, should be tanked (if located below grade).

7.0 DESIGN REVIEWS AND CONSTRUCTION INSPECTIONS

The preceding sections make recommendations for the design and construction of the proposed development. We have recommended that we be retained for the review of certain aspects of the design and construction. It is important that these reviews are carried out to ensure that our intentions have been adequately communicated. It is also important that any contractors working on the site review this document prior to commencing their work.

It is the responsibility of the contractors working on-site to inform GeoPacific a minimum of 24 hours in advance that a field review is required. In summary, reviews are required by geotechnical engineer for the following portions of the work.

1. Review of site stripping
2. Review of temporary cut slopes
3. Review of shoring installation and anchor testing
4. Review of ground improvement and Quality Control
5. Review of foundation subgrade prior to footing construction
6. Review of slab-on-grade fill compaction prior to slab construction
7. Review of the compaction of engineered fill
8. Review of excavation in excess of 1.2 metres in height requiring man-entry
9. Review of compaction of pavement base and subbase

8.0 CLOSURE

This report has been prepared exclusively for our client for the purpose of providing geotechnical recommendations for the design and construction of the proposed development and related earthworks. The report remains the property of GeoPacific Consultants Ltd. and unauthorized use of, or duplication of, this report is prohibited.

We are pleased to assist you with this project and we trust this information is helpful and sufficient for your purposes at this time. However, please do not hesitate to call if you should require any clarification.

For:
GeoPacific Consultants Ltd.

Reviewed by:

Khidhir Jorj, M.Sc.
Project Manager

Matt Kokan, M.A.Sc., P.Eng.
Principal

LEGEND:

- SCPT#-# – SEISMIC CONE PENETRATION TEST (SCPT) LOCATION
- CPT#-# – CONE PENETRATION TEST (CPT) LOCATION
- TH#-# – TEST HOLE (TH) LOCATION

SITE PLAN

*TEST LOCATIONS ARE APPROXIMATE

GEOPACIFIC
VANCOUVER KAMLOOPS CALGARY

23-Aug-2017		
ZH	MJK	ZH
NTS		

RESIDENTIAL DEVELOPMENT
2801-2831 ST. GEORGE STREET, PORT MOODY, BC
TEST HOLE SITE PLAN

15258

15258-01

APPENDIX A - TEST HOLE LOGS

Test Hole Log: TH17-01

File: 15258
Project: RESIDENTIAL DEVELOPMENT
Client: MARCON JOHNSTON (GP) LTD
Site Location: 2800-2831 ST GEORGE STREET, PORT MOODY, BC

GEOPACIFIC CONSULTANTS
1779 West 75th Avenue, Vancouver, BC, V6P 6P2
Tel: 604-439-0922 Fax:604-439-9189

Depth (ft / m)	Symbol	SOIL DESCRIPTION	Depth (m)/Elev (m)	Moisture Content (%)	DCPT (blows per foot) 20 40 60 80	Groundwater / Well	Remarks
0 / 0		Ground Surface					
1		**Topsoil (150 mm)**	0.0				
2		**Gravel [FILL]** compact sandy GRAVEL fill, some mixed roots and organics, black, dry	0.5				
3 / 1				10.4			
4		**Sand** compact SAND, medium grained, orange-brown, dry fine grained after 1.0 m some silt after 1.0 m	1.5				
5							
6 / 2							
7							
8		**Sand** compact SAND, fine grained, some subrounded gravel, brown, slightly moist		6.8			
9							
10 / 3							
11		**Sand and gravel** dense SAND and GRAVEL, medium grained, brown, slightly moist	3.4				
12							
13 / 4							
14							
15				4.8			
16							
17 / 5						▼	5.2 m estimated water table depth
18							
19		**Sand** compact SAND, medium grained, trace subrounded gravel, brown, slightly moist	5.5				
20 / 6			6.1				
21		End of Borehole					
22							
23 / 7							
24							
25							
26 / 8							
27							
28							
29 / 9							
30							
31							
32							

Logged: ZH
Method: Solid stem auger
Date: 18-Aug-2017

Datum: Ground elevation
Figure Number: A.01

Test Hole Log: TH17-02 (CPT17-01)

File: 15258
Project: RESIDENTIAL DEVELOPMENT
Client: MARCON JOHNSTON (GP) LTD
Site Location: 2800-2831 ST GEORGE STREET, PORT MOODY, BC

GEOPACIFIC CONSULTANTS
1779 West 75th Avenue, Vancouver, BC, V6P 6P2
Tel: 604-439-0922 Fax:604-439-9189

INFERRED PROFILE

Depth (ft / m)	Symbol	SOIL DESCRIPTION	Depth (m)/Elev (m)
0 / 0		Ground Surface	
		Topsoil (100 mm)	0.0
1		***Sand*** loose to compact SAND, fine grained, some silt, brown, dry	
2 / 1			
3			
4			
5			
6 / 2			
7		***Sand and gravel*** compact to dense SAND and GRAVEL, medium grained, brown, slightly moist	2.1
8			
9			
10 / 3			
11		***Sand*** compact SAND, medium grained, some subrounded gravel, brown, slightly moist	3.4
12			
13 / 4			
14			
15			
16 / 5		***Sand*** compact silty SAND, brown, moist	4.9
17			
18			
19			
20 / 6			
21			
22		***Sand and gravel*** dense SAND and GRAVEL, coarse grained, trace rounded cobbles, brown, moist	6.7
23 / 7			
24			
25			7.6
26 / 8		End of Borehole	
27			
28			
29 / 9			
30			
31			
32			

Moisture Content (%): 27.4; 16.9; 28.0

DCPT (blows per foot) 20 40 60 80: 2, 3, 8, 11, 8, 13, 32, 69, 55, 15, 23, 14, 13, 21, 20, 23, 13, 10, 6, 19, 74, 38, 27, 42, 47, 60, >100

Groundwater / Well: 4.9 m estimated water table depth

Remarks: DCPT refusal @ 8.5 m

Logged: ZH
Method: Solid stem auger
Date: 18-Aug-2017

Datum: Ground elevation
Figure Number: A.02

Test Hole Log: TH17-03 (SCPT17-02)

File: 15258
Project: RESIDENTIAL DEVELOPMENT
Client: MARCON JOHNSTON (GP) LTD
Site Location: 2800-2831 ST GEORGE STREET, PORT MOODY, BC

GEOPACIFIC CONSULTANTS
1779 West 75th Avenue, Vancouver, BC, V6P 6P2
Tel: 604-439-0922 Fax:604-439-9189

Depth (ft / m)	Symbol	INFERRED PROFILE: SOIL DESCRIPTION	Depth (m)/Elev (m)	Moisture Content (%)	DCPT (blows per foot) 20 40 60 80	Groundwater / Well	Remarks
0 / 0		Ground Surface					
		Topsoil (200 mm)	0.0				
1 / 0		***Sand*** loose to compact SAND, very fine grained, some silt, brown, dry					
2 / 1		***Sand*** compact gravelly SAND, brown, dry	1.5	10.9			
3 / 2		***Sand and gravel*** compact to dense SAND and GRAVEL, brown, slightly moist some silt after 4.0 m	2.7				
4 / 3		***Sand*** compact SAND, medium grained, trace silt, brown, slightly moist becomes moist @ 5.2 m some subrounded gravel @ 6.1 m	4.9		17 13 18 58 >100	▼	5.2 m estimated water table depth
5 / 4							
6 / 5							
7 / 6		***Sand and gravel*** dense to very dense SAND and GRAVEL, some cobbles, brown, moist	7.0				DCPT refusal @ 7.3 m
8 / 7		End of Borehole	7.6				
9 / 8							
10 / 9							

Logged: ZH
Method: Solid stem auger
Date: 18-Aug-2017

Datum: Ground elevation
Figure Number: A.03

Test Hole Log: TH17-04

File: 15258
Project: RESIDENTIAL DEVELOPMENT
Client: MARCON JOHNSTON (GP) LTD
Site Location: 2800-2831 ST GEORGE STREET, PORT MOODY, BC

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Depth (ft / m)	Symbol	SOIL DESCRIPTION	Depth (m)/Elev (m)	Moisture Content (%)	DCPT (blows per foot) 20 40 60 80	Groundwater / Well	Remarks
0 / 0		Ground Surface					
		Topsoil (300 mm)	0.0				
		Sand compact SAND, fine grained, orange-brown, dry trace subangular gravel @ 0.8 m					
1 / 1							
2 / 2				19.9			
		Sand compact SAND, coarse grained, some subrounded gravel, brown, slightly moist to moist	2.4	31.1			Perched water @ 2.4 m
3 / 3							
4 / 4		***Sand and gravel*** compact to dense SAND and GRAVEL, brown, slightly moist some cobbles @ 4.0 m becomes moist @ 4.3 m	3.7			▼	4.3 m estimated water table depth
5 / 5		***Sand*** compact SAND, medium grained, some silt, brown, moist trace subrounded gravel after 5.5 m	4.9	16.8			
6 / 6							
7 / 7				19.6			
8 / 8		***Sand and gravel*** dense SAND and GRAVEL, some cobbles, brown, moist	7.6				
9 / 9							
		End of Borehole	9.1				

Logged: ZH
Method: Solid stem auger
Date: 18-Aug-2017

Datum: Ground elevation
Figure Number: A.04

Test Hole Log: TH17-05

File: 15258
Project: RESIDENTIAL DEVELOPMENT
Client: MARCON JOHNSTON (GP) LTD
Site Location: 2800-2831 ST GEORGE STREET, PORT MOODY, BC

GEOPACIFIC CONSULTANTS
1779 West 75th Avenue, Vancouver, BC, V6P 6P2
Tel: 604-439-0922 Fax:604-439-9189

INFERRED PROFILE

Depth (ft / m)	Symbol	SOIL DESCRIPTION	Depth (m)/Elev (m)	Moisture Content (%)	DCPT (blows per foot) 20 40 60 80	Groundwater / Well	Remarks
0 / 0		Ground Surface					
		Topsoil (150 mm)	0.0				
		Sand and gravel [FILL] compact SAND and GRAVEL fill, brown, dry					
3 / 1		***Sand and gravel*** compact to dense SAND and GRAVEL, coarse grained, grey-brown, dry trace silt from 1.8 m to 2.4 m		4.4			
10 / 3		cobbles @ 3.0 m		11.6			
		Sand compact SAND, medium grained, brown, slightly moist becomes moist @ 4.0 m trace gravel after 4.4 m	3.4	18.8		▽	4.0 m estimated water table depth
16 / 5		***Sand and gravel*** dense SAND and GRAVEL, trace cobbles, brown, moist	4.9	14.8			
20 / 6		End of Borehole	6.1				

DCPT values: 3, 5, 52, 48, 36, 52, 30, 12, 40, 51, 20, 13, 15, 16, 12, 51, 40, 53, 60

Logged: ZH
Method: Solid stem auger
Date: 18-Aug-2017

Datum: Ground elevation
Figure Number: A.05

Test Hole Log: TH17-06 (CPT17-03)

File: 15258
Project: RESIDENTIAL DEVELOPMENT
Client: MARCON JOHNSTON (GP) LTD
Site Location: 2800-2831 ST GEORGE STREET, PORT MOODY, BC

GEOPACIFIC CONSULTANTS
1779 West 75th Avenue, Vancouver, BC, V6P 6P2
Tel. 604-439-0922 Fax:604-439-9189

INFERRED PROFILE

Depth (ft / m)	Symbol	SOIL DESCRIPTION	Depth (m)/Elev (m)
0 / 0		Ground Surface	
		Concrete (50 mm)	0.0
		Sand and gravel [FILL] compact SAND and GRAVEL fill, brown, dry	0.6
1 / 1		**Silt and sand [FILL]** firm SILT and SAND fill, trace roots, brown, dry	
2 / 2		**Sand** compact SAND, medium grained, some silt, trace gravel, brown, dry	1.8
		Sand and gravel dense SAND and GRAVEL, brown, dry	
3 / 3		**Sand** compact silty SAND, brown, trace silt, slightly moist becomes moist @ 2.9 m	3.0
4 / 4		**Sand and gravel** dense SAND and GRAVEL, trace silt, brown, moist becomes moist to wet @ 3.7 m	4.6
5 / 5		**Sand** compact silty SAND, trace subangular gravel, brown, moist to wet	
6 / 6		**Sand and gravel** dense SAND and GRAVEL, grey-brown, moist to wet	6.1
7 / 7		**Sand** dense SAND, medium grained, trace subround gravel, grey-brown, moist	6.7
8 / 8			
9 / 9			

Moisture Content (%): 38.9, 11.9, 13.3, 17.0

DCPT (blows per foot) 20 40 60 80: >100, >100, 62, 43, 40, 46, 38, 37, 38, 44, 41, 36

Groundwater / Well: ▼

Remarks: 3.0 m estimated water table depth

Logged: ZH
Method: Solid stem auger
Date: 18-Aug-2017

Datum: Ground elevation
Figure Number: A.06

Test Hole Log: TH17-06 (CPT17-03)

File: 15258
Project: RESIDENTIAL DEVELOPMENT
Client: MARCON JOHNSTON (GP) LTD
Site Location: 2800-2831 ST GEORGE STREET, PORT MOODY, BC

GEOPACIFIC CONSULTANTS
1779 West 75th Avenue, Vancouver, BC, V6P 6P2
Tel: 604-439-0922 Fax:604-439-9189

INFERRED PROFILE							
Depth	Symbol	SOIL DESCRIPTION	Depth (m)/Elev (m)	Moisture Content (%)	DCPT (blows per foot) 20 40 60 80	Groundwater / Well	Remarks
33 10					85		
34					48		
35					55		
36 11		End of Borehole	11.0		>100		
37							
38							
39 12							
40							
41							
42							
43 13							
44							
45							
46 14							
47							
48							
49 15							
50							
51							
52 16							
53							
54							
55							
56 17							
57							
58							
59 18							
60							
61							
62 19							
63							
64							

Logged: ZH
Method: Solid stem auger
Date: 18-Aug-2017

Datum: Ground elevation
Figure Number: A.06

Test Hole Log: TH17-07

File: 15258
Project: RESIDENTIAL DEVELOPMENT
Client: MARCON JOHNSTON (GP) LTD
Site Location: 2800-2831 ST GEORGE STREET, PORT MOODY, BC

GEOPACIFIC CONSULTANTS
1779 West 75th Avenue, Vancouver, BC, V6P 6P2
Tel: 604-439-0922 Fax 604-439-9189

Depth (ft / m)	Symbol	SOIL DESCRIPTION	Depth (m)/Elev (m)	Moisture Content (%)	DCPT (blows per foot) 20 40 60 80	Groundwater / Well	Remarks
0 / 0		Ground Surface					
		Concrete (80 mm)	0.0				
		Topsoil and gravel [FILL] loose TOPSOIL and GRAVEL fill, organics, black, dry	0.6				
1				32.0			
		Sand loose to compact SAND, fine grained, trace silt, brown, dry	1.4				
				14.1			
2		**Sand and gravel** dense SAND and GRAVEL, brown, dry cobbley after 2.1 m					
3		**Sand** compact SAND, medium grained, brown, dry	2.7				
		Sand and gravel dense SAND and GRAVEL, brown, slightly moist to moist	3.7			▼	3.7 m estimated water table depth
4		**Sand** compact SAND, medium grained, some gravel, brown, moist					
5				13.8			
		Sand and gravel dense SAND and GRAVEL, brown, moist	5.2				
6		End of Borehole	6.1				
7							
8							
9							

Logged: ZH
Method: Solid stem auger
Date: 18-Aug-2017

Datum: Ground elevation
Figure Number: A.07

Test Hole Log: TH17-08

File: 15258
Project: RESIDENTIAL DEVELOPMENT
Client: MARCON JOHNSTON (GP) LTD
Site Location: 2800-2831 ST GEORGE STREET, PORT MOODY, BC

GEOPACIFIC CONSULTANTS
1779 West 75th Avenue, Vancouver, BC, V6P 6P2
Tel: 604-439-0922 Fax:604-439-9189

Depth (ft / m)	Symbol	SOIL DESCRIPTION	Depth (m)/Elev (m)	Moisture Content (%)	DCPT (blows per foot) 20 40 60 80	Groundwater / Well	Remarks
0 / 0		Ground Surface					
		Topsoil and sandl [FILL] loose TOPSOIL and SAND fill, some gravel, black, dry	0.0		3, 30, 28		
1 / 1		***Sand and gravel*** dense SAND and GRAVEL, brown, trace silt, dry	0.5	21.2	15, 6		
2 / 2		***Sand*** compact SAND, medium grained, trace silt, brown, dry some subrounded gravel @ 2.4 m	1.2		10, 18, 20, 42		
3 / 4		***Sand and gravel*** dense SAND and GRAVEL, brown, slightly moist some cobbles after 3.6 m	3.4	18.4	10, 24, 58		
5 / 6		***Sand*** compact to dense SAND, medium grained, some subangular gravel, brown, moist	4.3	10.5		▼	4.6 m estimated water table depth
6 / 8		End of Borehole	6.1				
7 / 9							

Logged: ZH
Method: Solid stem auger
Date: 18-Aug-2017

Datum: Ground elevation
Figure Number: A.08

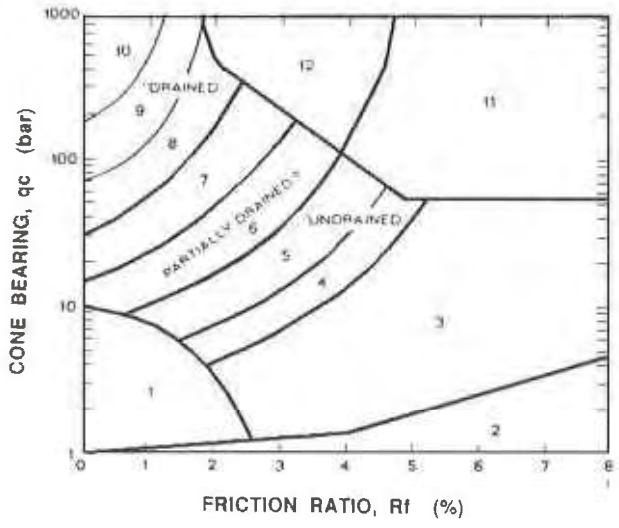
APPENDIX B - ELECTRONIC CONE PENETRATION RESULTS

The system used is owned and operated by GeoPacific and employs a 35.7 mm diameter cone that records tip resistance, sleeve friction, dynamic pore pressure, inclination and temperature at 5 cm intervals on a digital computer system. The system is a Hogentogler electronic cone system and the cone used was a 10 ton cone with pore pressure element located behind the tip and in front of the sleeve as shown on the adjacent figure.

Electronic Cone Penetrometer

In addition to the capabilities described above, the cone can be stopped at specified depths and dissipation tests carried out. These dissipation tests can be used to determine the groundwater pressures at the specified depth. This is very useful for identifying artesian pressures within specific layers below the ground surface.

Interpretation of the cone penetration test results are carried out by computer using the interpretation chart presented below by Robertson[1]. Raw data collected by the field computer includes tip resistance, sleeve friction and pore pressure. The tip resistance is corrected for water pressure and the friction ratio is calculated as the ratio of the sleeve friction on the side of the cone to the corrected tip resistance expressed as a percent. These two parameters are used to determine the soil behaviour type as shown in the chart below. The interpreted soil type may be different from other classification systems such as the Unified Soil Classification that is based upon grain size and plasticity.

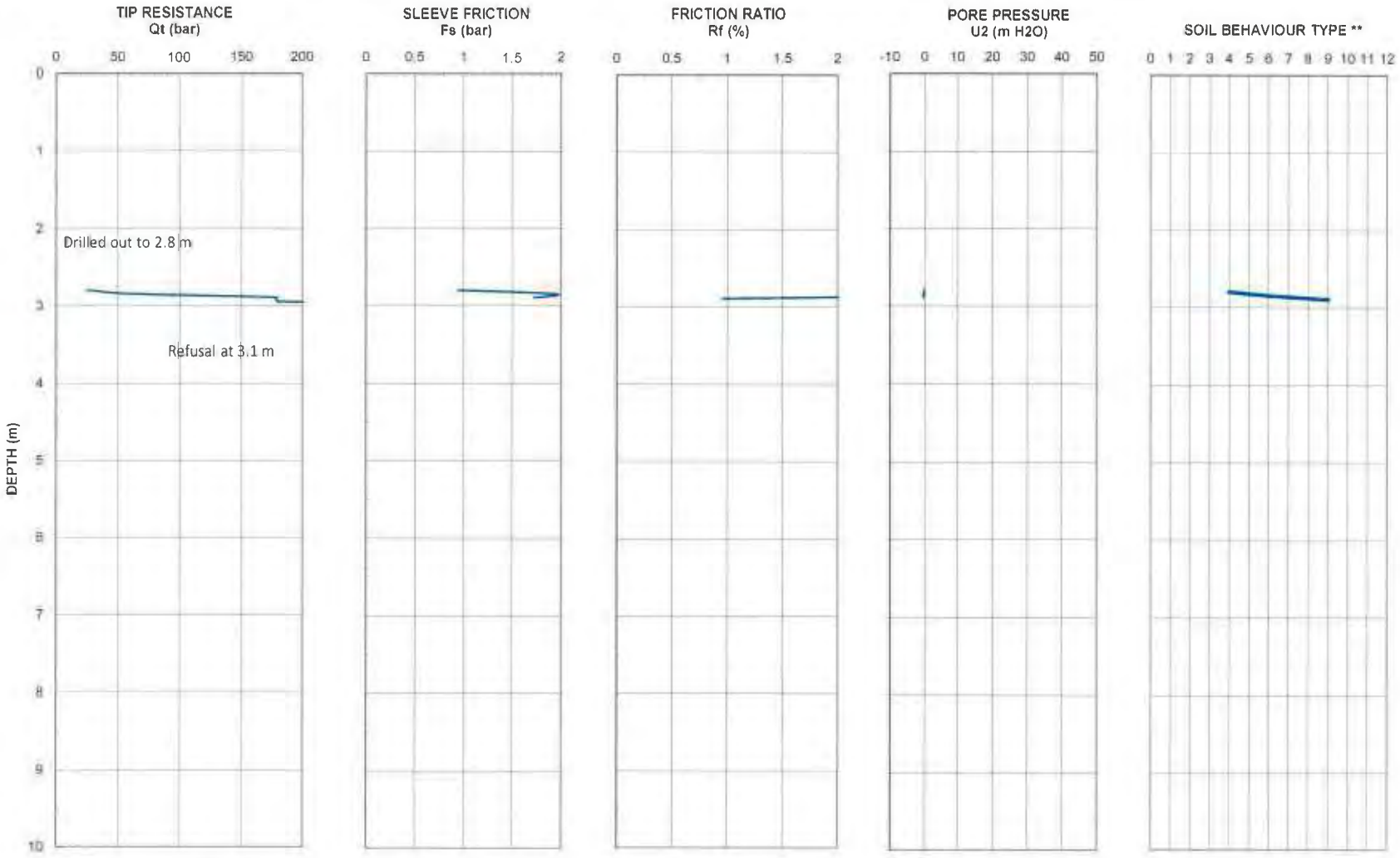


ZONE	SOIL BEHAVIOUR TYPE
1	sensitive fine grained
2	organic material
3	clay
4	silty clay to clay
5	clayey silt to silty clay
6	sandy silt to clayey silt
7	silty sand to sandy silt
8	sand to silty sand
9	sand
10	gravelly sand to sand
11	very stiff fine grained (*)
12	sand to clayey sand (*)

(*) overconsolidated or cemented

[1] Robertson, P.K., 1990, "Soil Classification using the cone penetration test", 1990 Canadian Geotechnical Colloquium, Canadian Geotechnical Journal, Vol. 27, No. 1, 1990

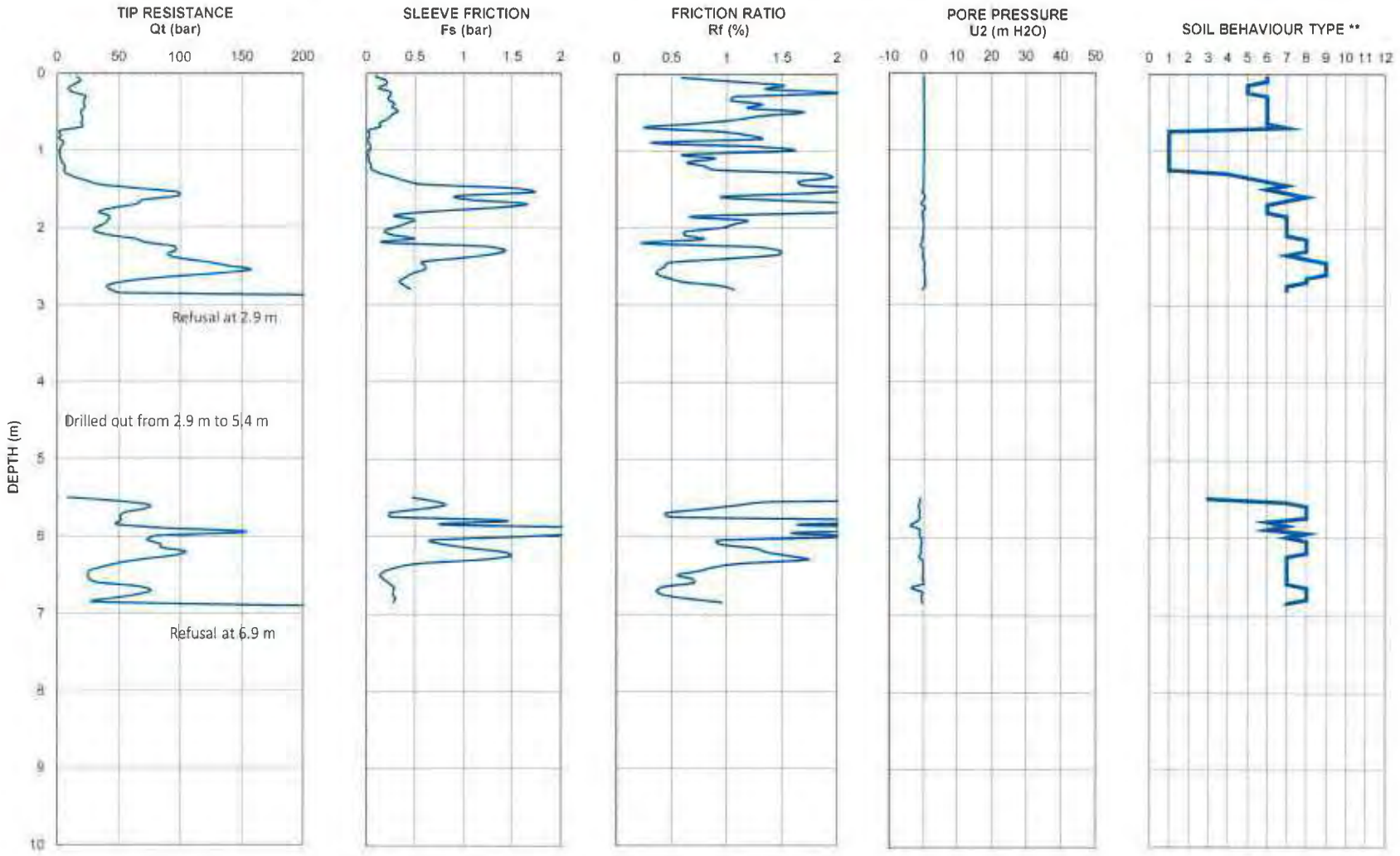
GEOPACIFIC VANCOUVER KAMLOOPS CALGARY	2017-Aug-18	MARCON JOHNSTON (GP) LTD	GeoPacific Project #: 15258
	Sounding: CPT17-01	2800 - 2831 ST. GEORGE STREET, PORT MOODY	Figure: B.01



** Based on Robertson et. al 1986

1 Sensitive Fine Grained
2 Organic Material
3 Clay
4 Silty Clay to Clay
5 Clayey Silt to Silty Clay
6 Sandy Silt to Clayey Silt
7 Silty Sand to Sandy Silt
8 Sand to Silty Sand
9 Sand
10 Gravelly Sand to Sand
11 Very Stiff Fine Grained
12 Sand to Clayey Sand

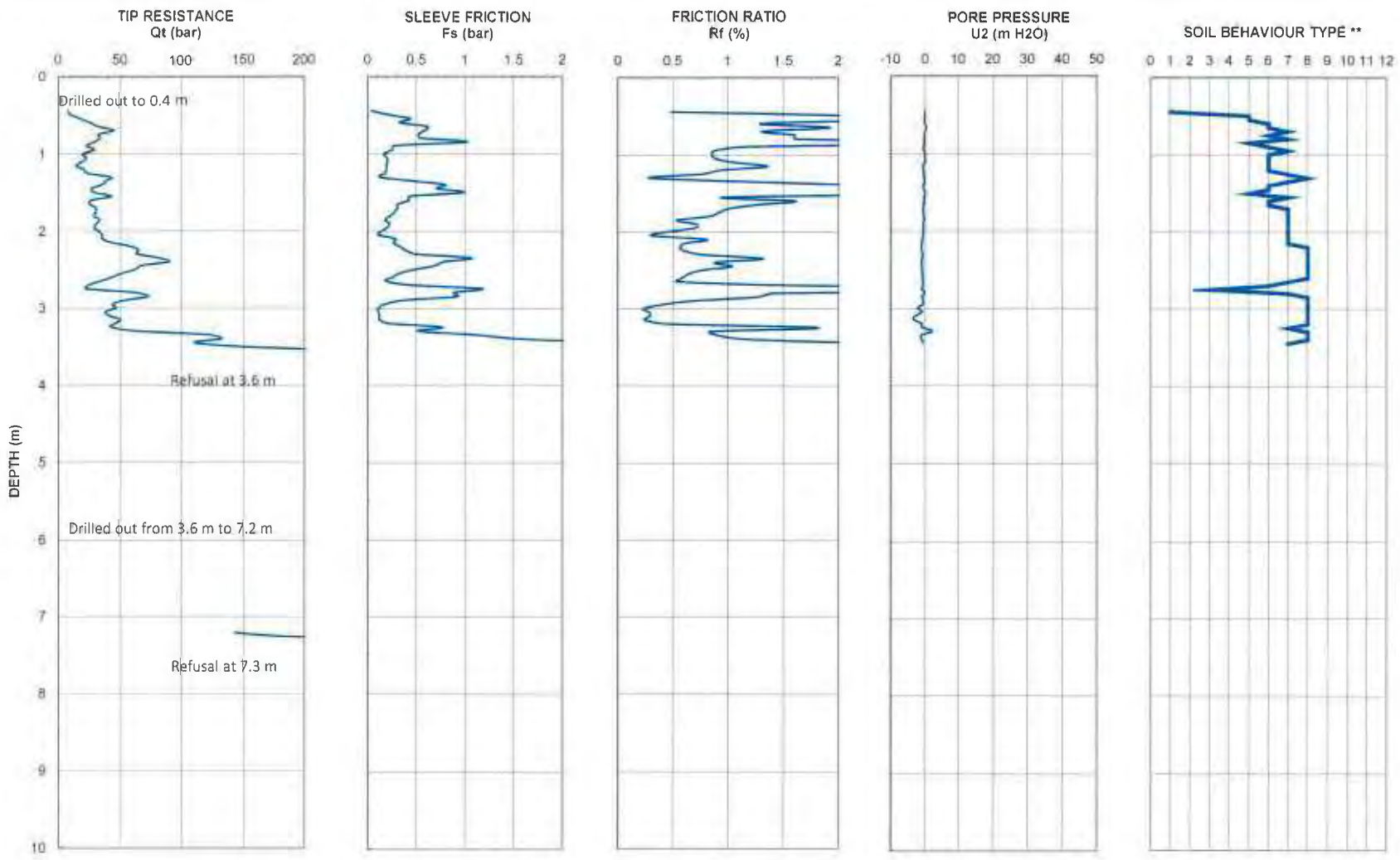
GEOPACIFIC VANCOUVER KAMLOOPS CALGARY	2017-Aug-18	MARCON JOHNSTON (GP) LTD	GeoPacific Project #: 15258
	Sounding: SCPT17-02	2800 - 2831 ST. GEORGE STREET, PORT MOODY	Figure: B.02



** Based on Robertson et. al 1986

1 Sensitive Fine Grained
2 Organic Material
3 Clay
4 Silty Clay to Clay
5 Clayey Silt to Silty Clay
6 Sandy Silt to Clayey Silt
7 Silty Sand to Sandy Silt
8 Sand to Silty Sand
9 Sand
10 Gravelly Sand to Sand
11 Very Stiff Fine Grained
12 Sand to Clayey Sand

GEOPACIFIC VANCOUVER KAMLOOPS CALGARY	2017-Aug-18	MARCON JOHNSTON (GP) LTD	GeoPacific Project #: 15258
	Sounding: CPT17-03	2800 - 2831 ST. GEORGE STREET, PORT MOODY	Figure: B.03



** Based on Robertson et. al 1986

1 Sensitive Fine Grained
2 Organic Material
3 Clay
4 Silty Clay to Clay
5 Clayey Silt to Silty Clay
6 Sandy Silt to Clayey Silt
7 Silty Sand to Sandy Silt
8 Sand to Silty Sand
9 Sand
10 Gravelly Sand to Sand
11 Very Stiff Fine Grained
12 Sand to Clayey Sand

APPENDIX C - INTERPRETED PARAMETERS

The following charts plot the Standard Penetration Test (SPT) values and the undrained strength of fine grained soils based upon generally accepted correlations. The methods of correlation are presented below.

STANDARD PENETRATION TEST CORRELATION

The Standard Penetration Test $N_{1(60)}$ value is related to the cone tip resistance through a Qc/N ratio that depends upon the mean grain size of the soil particles. The soil type is determined from the interpretation described in Appendix B and the data of Table C.1 below is used to calculate the value of $N_{(60)}$.

Table C.1. Tablulated $Qc/N_{1(60)}$ Ratios for Interpreted Soil Types

Soil Type	Qc/N Ratio
Organic soil - Peat	1.0
Sensitive Fine Grained	2.0
Clay	1.0
Silty Clay to Clay	1.5
Clayey Silt to Silty Clay	2.0
Silt	2.5
Silty Sand to Sandy Silt	3.0
Clean Sand to Silty Sand	4.0
Clean Sand	5.0
Gravelly Sand to Sand	6.0
Very Stiff Fine Grained	1.0
Sand to Clayey Sand	2.0

The $Qc/N_{1(60)}$ ratio is based upon the published work of Robertson (1985)[2]. The values of N are corrected for overburden pressure in accordance with the correction suggested by Liao and Whitman using a factor of 0.5. Where the correction is of the form:

$$N_1 = \sigma^{0.5} * N$$

All calculations are carried out by computer using the software program CPTint.exe developed by UBC Civil Engineering Department. The results of the interpretation are presented on the following Figures.

UNDRAINED SHEAR STRENGTH CORRELATION

It is generally accepted that there is a correlation between undrained shear strength of clay and the tip resistance as determined from the cone penetration testing. Generally the correlation is of the form:

$$S_u = \frac{(q_c - \sigma_v)}{N_k}$$

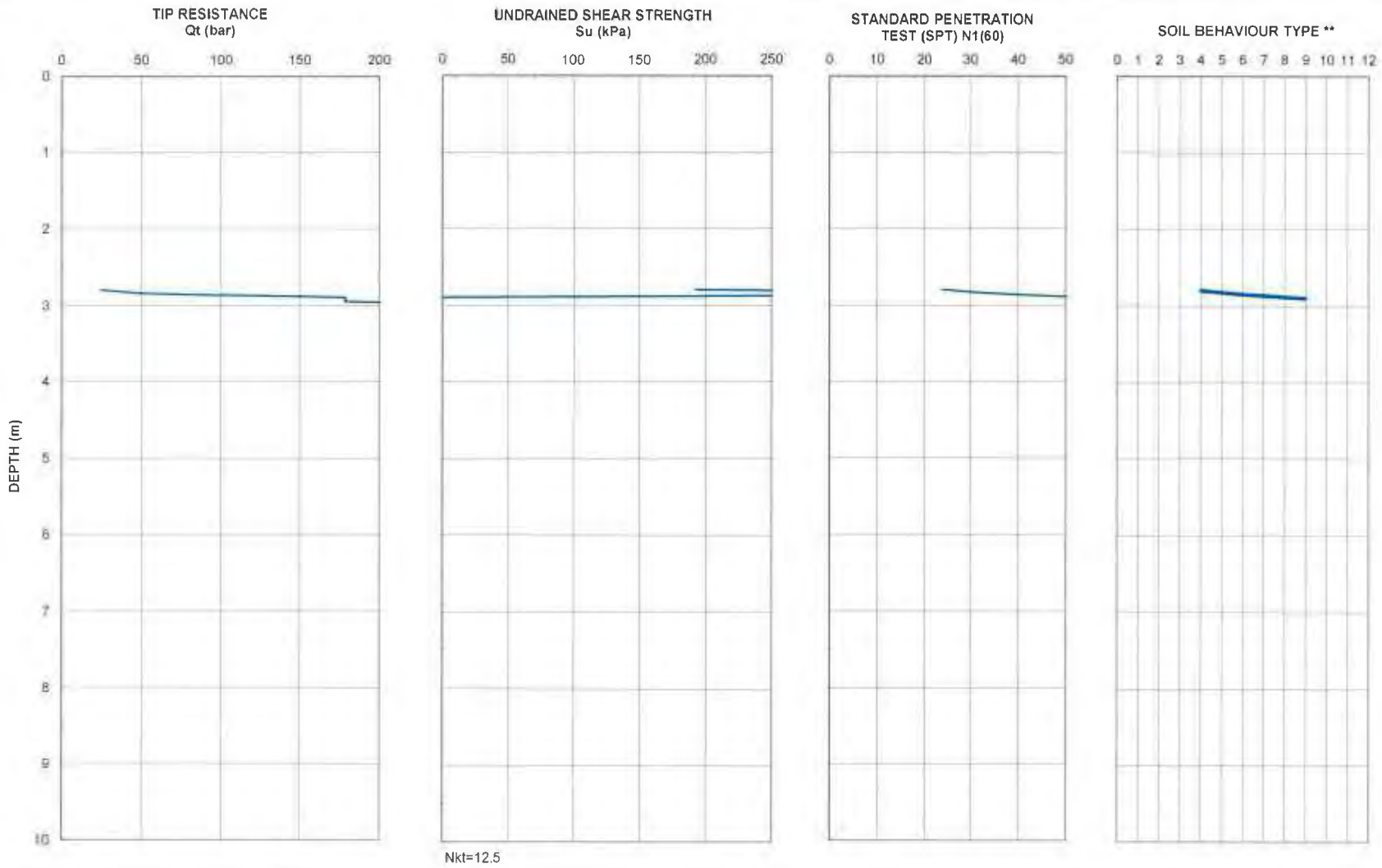
where q_c = cone tip resistance, σ = in situ total stress, N_k = cone constant

The undrained shear strength of the clay has been calculated using the cone tip resistance and an N_k factor of 12.5. All calculations have been carried out automatically using the program CPTint.exe. The results are presented on the Figures following.

---

2 Robertson, P.K., 1985, "In-Situ Testing and Its Application to Foundation Engineering", 1985 Canadian Geotechnical Colloquium, Canadian Geotechnical Journal, Vol. 23, No. 23, 1986

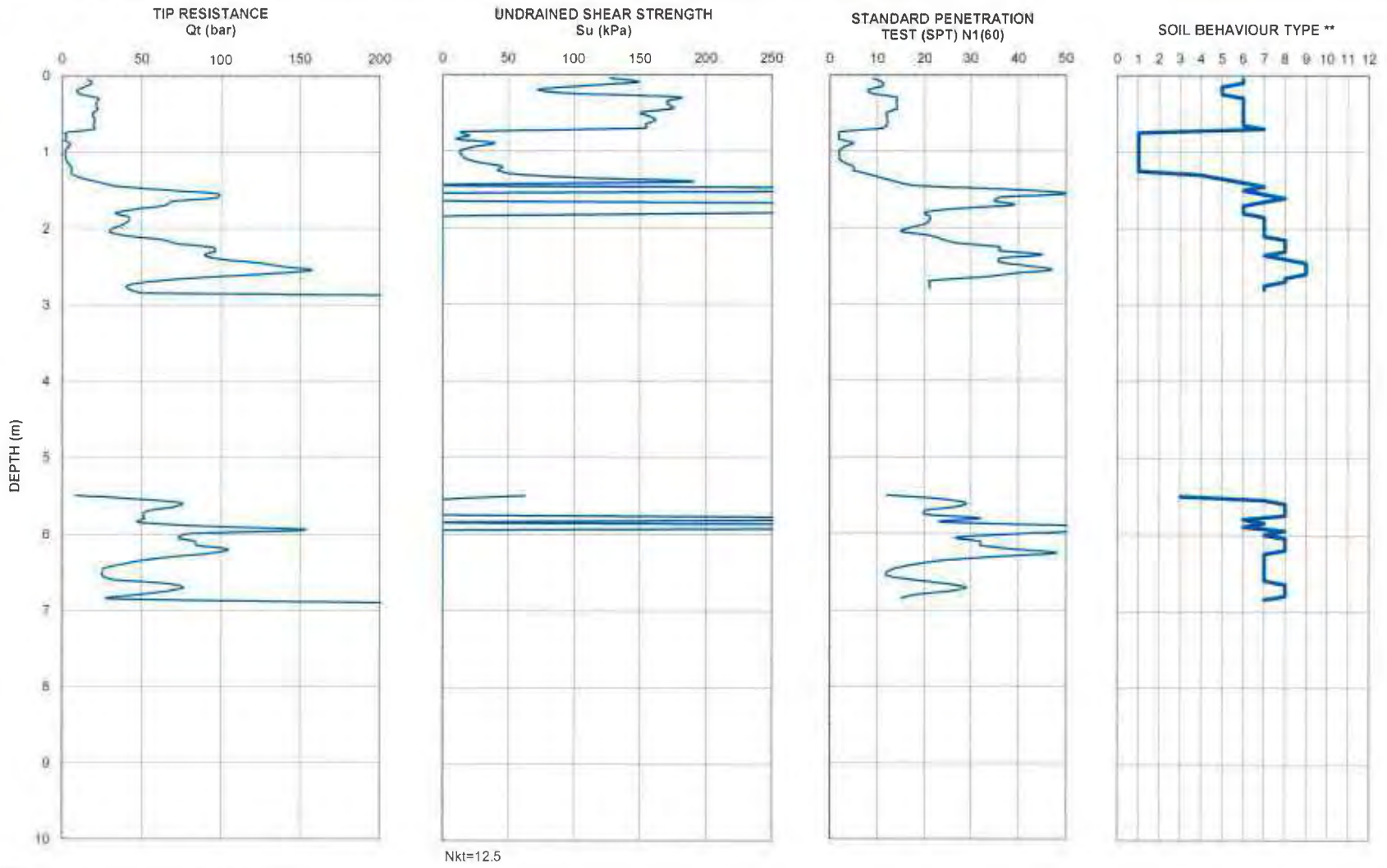
GEOPACIFIC VANCOUVER KAMLOOPS CALGARY	2017-Aug-18	MARCON JOHNSTON (GP) LTD	GeoPacific Project #: 15258
	Sounding: CPT17-01	2800 - 2831 ST. GEORGE STREET, PORT MOODY	Figure: C.01



** Based on Robertson et. al 1986

1 Sensitive Fine Grained
2 Organic Material
3 Clay
4 Silty Clay to Clay
5 Clayey Silt to Silty Clay
6 Sandy Silt to Clayey Silt
7 Silty Sand to Sandy Silt
8 Sand to Silty Sand
9 Sand
10 Gravelly Sand to Sand
11 Very Stiff Fine Grained
12 Sand to Clayey Sand

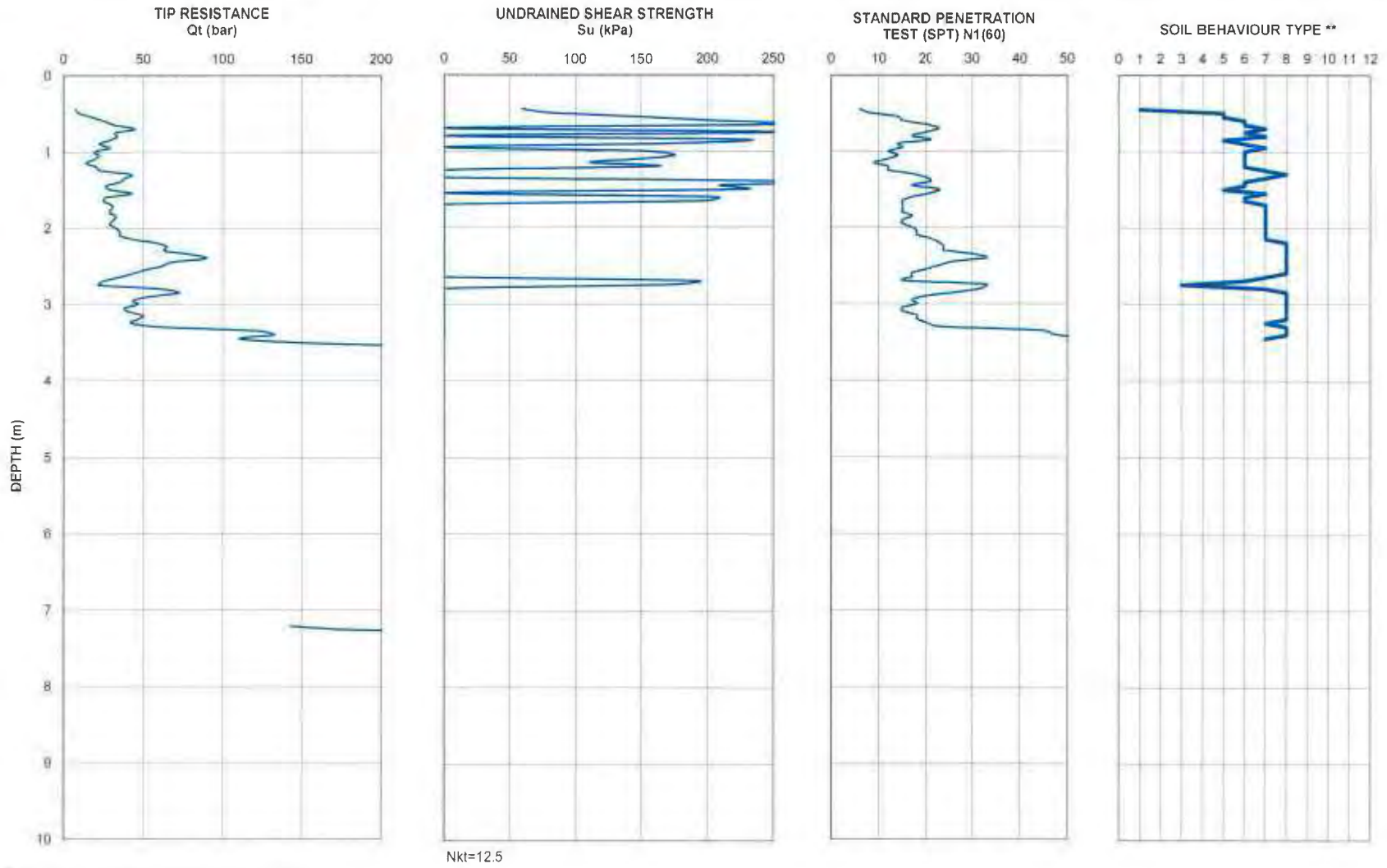
GEOPACIFIC VANCOUVER KAMLOOPS CALGARY	2017-Aug-18	MARCON JOHNSTON (GP) LTD	GeoPacific Project #: 15258
	Sounding: SCPT17-02	2800 - 2831 ST. GEORGE STREET, PORT MOODY	Figure: C.02



** Based on Robertson et. al 1986

1 Sensitive Fine Grained
2 Organic Material
3 Clay
4 Silty Clay to Clay
5 Clayey Silt to Silty Clay
6 Sandy Silt to Clayey Silt
7 Silty Sand to Sandy Silt
8 Sand to Silty Sand
9 Sand
10 Gravelly Sand to Sand
11 Very Stiff Fine Grained
12 Sand to Clayey Sand

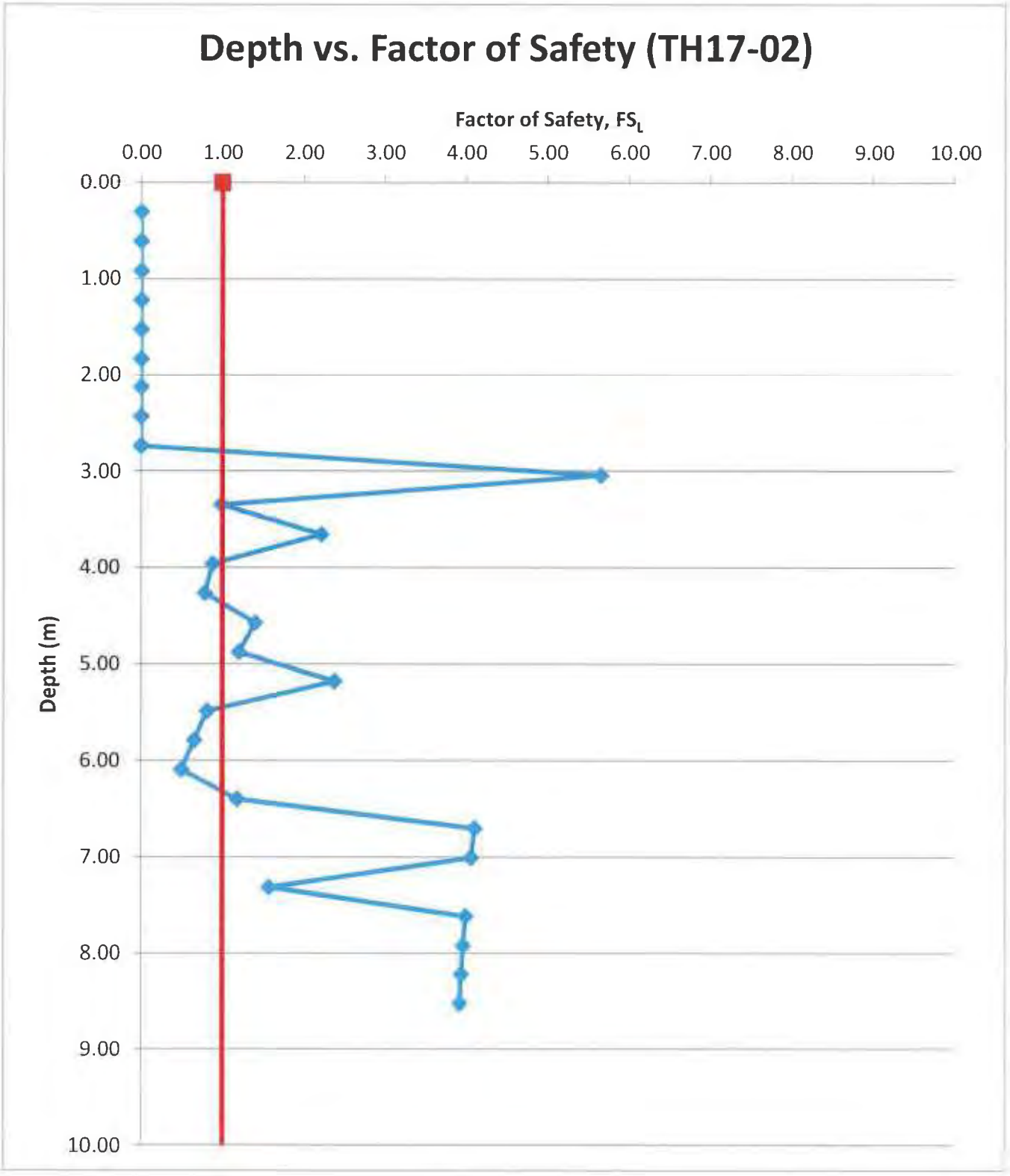
GEOPACIFIC VANCOUVER KAMLOOPS CALGARY	2017-Aug-18	MARCON JOHNSTON (GP) LTD	GeoPacific Project #: 15258
	Sounding: CPT17-03	2800 - 2831 ST. GEORGE STREET, PORT MOODY	Figure: C.03



** Based on Robertson et. al 1986

1 Sensitive Fine Grained
2 Organic Material
3 Clay
4 Silty Clay to Clay
5 Clayey Silt to Silty Clay
6 Sandy Silt to Clayey Silt
7 Silty Sand to Sandy Silt
8 Sand to Silty Sand
9 Sand
10 Gravelly Sand to Sand
11 Very Stiff Fine Grained
12 Sand to Clayey Sand

APPENDIX D- LIQUEFACTION ANALYSIS RESULTS


Depth vs. Factor of Safety (TH17-02)
Factor of Safety, FS$_L$
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
Depth (m)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00

APPENDIX E - SHEAR WAVE VELOCITY DATA (Vs)

GEOPACIFIC
VANCOUVER KAMLOOPS CALGARY

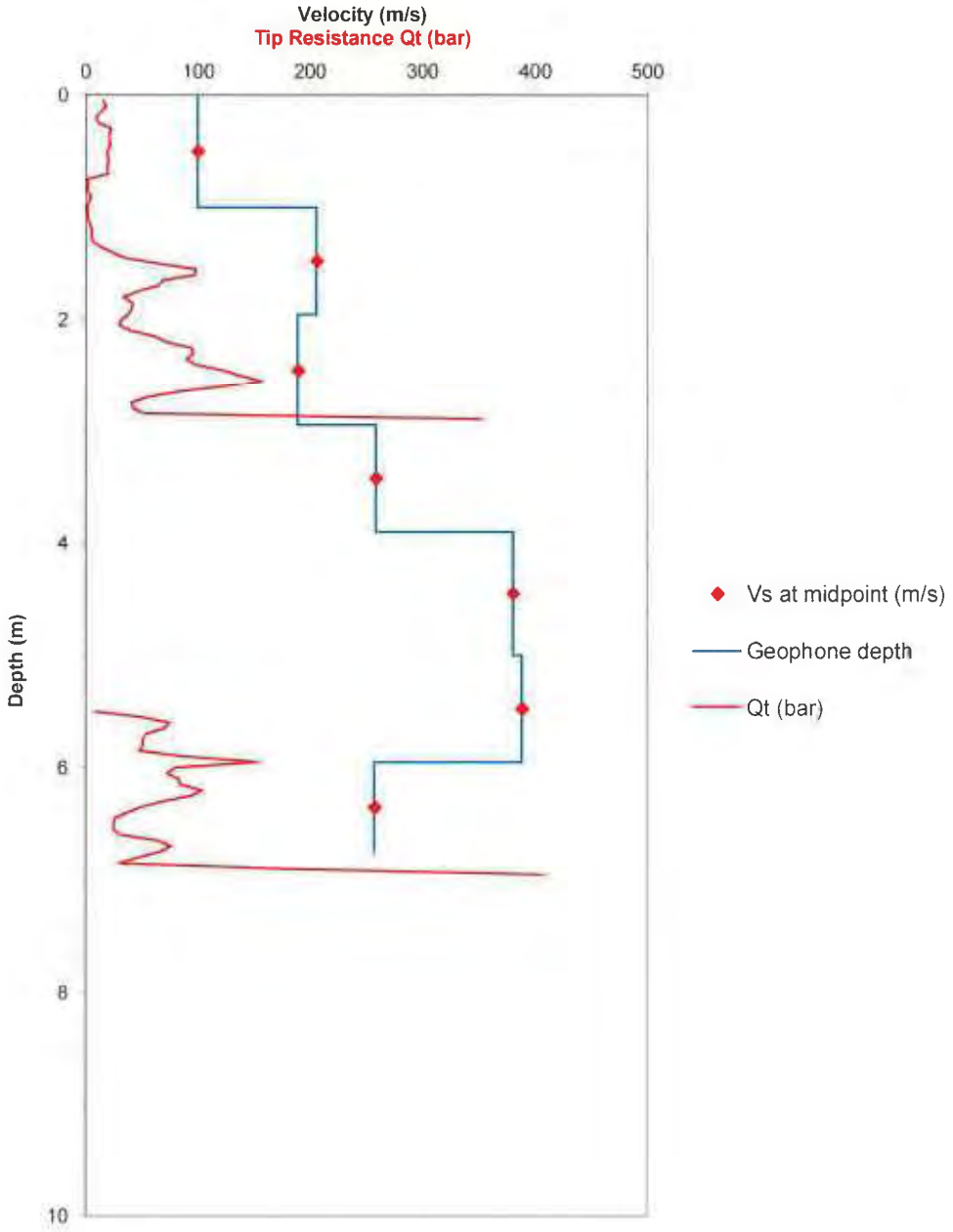
File: 15258
Project: RESIDENTIAL DEVELOPMENT
Client: MARCON JOHNSTON (GP) LTD
Location: 2800-2831 ST. GEORGE STREET, PORT MOODY, BC
Sounding: SCPT17-02
Date: 2017-Aug-18

Seismic Source: Beam
Source to cone (m): 0.4

Shear Wave Velocity Data (Vs)

Depth (m)	Geophone Depth (m)	Ray Path (m)	Ray Path Difference d (m)	Midpoint (m)	Time Difference (ms)	Shear Wave Velocity Vs (m/s)	d/Vs
1.20	1.00	1.08	1.08	0.50	10.79	100	0.0108
2.15	1.95	1.99	0.91	1.48	4.44	206	0.0044
3.15	2.95	2.98	0.99	2.45	5.21	189	0.0052
4.10	3.90	3.92	0.94	3.43	3.64	259	0.0036
5.20	5.00	5.02	1.10	4.45	2.88	381	0.0029
6.15	5.95	5.96	0.95	5.48	2.44	389	0.0024
6.95	6.75	6.76	0.80	6.35	3.10	258	0.0031
						Σ(d/Vs)	0.0325
						average Vs = Σd / Σ(d/Vs)	208

File: 15258
Project: RESIDENTIAL DEVELOPMENT
Client: MARCON JOHNSTON (GP) LTD
Location: 2800-2831 ST. GEORGE STREET, PORT MOODY, BC
Sounding: SCPT17-02
Date: 2017-Aug-18



Binnie File No. 17-0576

FLOOD HAZARD ASSESSEMENT FOR PROPOSED DEVELOPMENT

PREPARED FOR: CITY OF PORT MOODY

Johnston House Development

2801-2831 St. George Street, Port Moody, BC

October 4, 2019 (Rev. 4)

Reviewed by:
Russell Warren, P.Eng, LEED Green Associate
Senior Project Manager, Associate

Prepared by:
Donal Casey, P.Eng
Design Engineer

R.F. BINNIE & ASSOCIATES LTD.

205 - 4946 Canada Way,
Burnaby, BC V5G 4H7
Main: 604-420-1721

OQM | Organizational Quality Management Program

BINNIE

TABLE OF CONTENTS

APPENDICES

1 INTRODUCTION

Marcon Developments Ltd is proposing to redevelop seven properties located at 2801-2831 St. George Street in the City of Port Moody. The proposed project involves consolidating and rezoning the properties to allow for the construction of six 3-storey townhome buildings plus at-grade garages, as well as the relocation of an existing heritage house at the west end of the site.

According to the City of Port Moody's Official Community Plan (OCP), the project site is located on lands identified as being at some hazard from flooding. R.F. Binnie & Associates Ltd., the civil engineering consultant, has prepared the following report and associated appendices to comprise the Flood Hazard Assessment Report as a condition of permit approval. Potential flood hazards from natural events originating outside the property line are assessed.

To meet standards established by the provincial government, Metro Vancouver, the City of Coquitlam and the City Port Moody partnered together to complete the Chines (ISMP) Integrated Stormwater Management Plan (prepared by Associated Engineering, January 2015). The report outlined drainage, stream protection and water management strategies to meet future development objectives. Flood risk and survey of existing drainage infrastructure and channels were identified in the Chines ISMP and used as supporting references in this report.

A desktop review of the available reports and documentation was completed, supplemented by a site visit completed on October 31, 2017 to confirm the existing conditions.

As requested by the City of Port Moody, we reviewed the following documents from the City of Port Moody Engineering Department's Geotechnical Report Library for consideration in our site assessment:

- Kerr Wood Leidal (2015), Lower Mainland Flood Management Strategy - Analysis of Flood Scenarios
- Association of Professional Engineers and Geoscientists of British Columbia (2010), Guidelines for Legislated Landslide Assessments for Proposed Residential Developments in British Columbia
- Associated Engineering (2016), Chines Integrated Stormwater Management Plan
- Dayton & Knight Ltd (1988), Study of Coquitlam / Port Moody Drainage Area
- Hardy Associates (1978) Ltd (1980), Geotechnical Study – North Shore – Port Moody, BC
- BGC Engineering Inc (2009), Climate Change (2050) Adjusted IDF Curves: Metro Vancouver Climate Stations
- BGC Engineering Inc (2009), Regional IDF Curves, Metro Vancouver Climate Stations: Phase 1
- McElhanney Surveying & Engineering Ltd (1982), North Shore Ravine Study
- Associated Engineering (2013), Qualitative Partial Risk Slope Analysis, Chines Escarpment and Corona Crescent Areas
- Northwest Hydraulic Consultants (2016), Lower Mainland Flood Management Strategy - Project 2: Regional Assessment of Flood Vulnerability

2 EXISTING CONDITIONS

The development site is fronted by St. George Street to the north, Hope Street to the south, and Moody Street and Hugh Street to the west and east respectively. The terrain generally slopes toward the northeast corner while a portion of the site at the west end slopes toward the northwest corner, corresponding with the road grades.

An existing drainage diversion system uphill of the site captures flows from existing creek channels and redirects the flows westward. Inlet structures are located at the south end of Moody Street and Hugh Street on Sundial Creek and Goulet Creek respectively. These concrete headwall structures include trash racks at the inlet and upstream debris barriers. Excerpts from the Chines ISMP relevant to these intakes are referenced in **Appendix A**, including an overall catchment map and field reconnaissance photographs. Photographs taken as part of field reconnaissance for this report are included in **Appendix B**.

Currently there are no existing storm sewers fronting the site and there are no curbs along most the roads. It is assumed that the surface drainage follows the existing terrain to the northwest and northeast.

The City of Port Moody Official Community Plan Hazard Zone Map shows that the subject site is within the mapped area fir potentially moderate to high risk of earthquake soil liquefaction. A geotechnical report dated September 10, 2019, as prepared by Geopacific Consultants, completed a soil liquefaction assessment including recommendations for the project. Refer to the geotechnical report prepared by Geopacific Consultants for details.

3 PROPOSED DEVELOPMENT

The proposed development will include roadworks and drainage upgrades at the site frontages. Storm sewers connecting to downstream sewers will be installed to capture stormwater from the site and roads via curbs and catch basins. A stormwater management system will be implemented to reduce runoff volume, detain flows and improve water quality. Refer to the Stormwater Management Plan report for details.

4 FLOOD HAZARD ASSESSMENT

The Chines ISMP includes a hydrologic and hydraulic stormwater analysis of the existing drainage network. The report investigated the 1:10-year and 1:100-year return period events to evaluate the drainage capacities. A potential increase in stormwater flows due to climate change was also considered. There were no deficiencies identified for the diversion pipes at Sundial Creek and Goulet Creek.

During field reconnaissance it was observed that the intake structures appear to be well maintained without signs of debris or sediment build-up, and there were no obvious signs of channel overtopping.

The existing terrain was analyzed through desktop review of topographic contours, available through the City of Port Moody's GIS site, and field reconnaissance. This was completed to develop a high-level understanding of potential overland flood routing and potential impact on the proposed development site. Refer to an area assessment plan provided in **Appendix C**.

The terrain downhill of the Sundial Creek intake appears to slope in a northwest direction. Overland flow from that intake would be expected to follow the terrain or potentially be contained within Hugh Street. The overland flood route from the Goulet Creek intake is expected to follow an old channel alignment in a northwest direction. Overland flow is expected to be intercepted at Henry Street and Hope Street and directed east or west toward Hugh Street and Moody Street.

The east-west frontage roads, St. George Street and Hope Street, contain a high point that would direct overland flow toward Moody Street to the west and Hugh Street to the east. The north-south roads, Hugh Street and Moody Street have a continuous slope northward.

The proposed development and regrading of the subject site is not expected to increase the flood hazard for nearby properties beyond the existing conditions. A flood hazard assessment of the surrounding properties is beyond the scope of this report. It was observed that existing overland flood routing may have an impact on existing properties which would need to be assessed by others when redevelopment occurs.

4.1 Minimum Building Elevations

The City of Port Moody's Subdivision and Servicing Bylaw (BL 2831) provides the following requirements for establishing a minimum building elevation (MBE) to mitigate flood risk:

> *"The MBE shall be established at least 0.6 m above the service connection invert at the building setback from the roadway property line or 0.35 above the 1:100-year hydraulic grade line elevation whichever is greater. In areas that the 1:100 Year runoff is confined within the roadway isolated from the adjacent properties (i.e. no flow via driveway letdowns or storm connections into the adjacent properties), the freeboard between the 1:100-year hydraulic grade line may be reduced to 0.2 m. The MBE for buildings adjacent to major watercourses shall be 0.6 m above the 1:200-year hydraulic grade line."*

The proposed project is not located adjacent to any major watercourses and it is assumed, based on the assessment completed in this report, that the 1:100-year runoff is confined within the roadway. The low point of the site is located at the northeast corner at approximate proposed elevation 24.90m. The proposed MBE's are provided in **Appendix D**. The MBE's are established at a minimum 0.2m above the low point of the site and a minimum 0.6m above the proposed service connection.

5 CONCLUSION

Marcon Developments Ltd is proposing to redevelop seven properties located at 2801-2831 St. George Street in the City of Port Moody. The proposed project involves consolidating the properties to allow for the construction of six 3-storey townhome buildings plus at-grade garages, as well as the relocation of an existing heritage house at the west end of the site.

Based on a desktop review of the existing drainage infrastructure analysis contained within the Chines ISMP, there is sufficient capacity upstream of the development site to convey the 1:100year storm event. Overland flood routes were considered, and the development site is not expected to be impacted as the fronting roads are expected to contain and redirect overland flows. Roadworks and storm infrastructure will need to be upgraded as part of the proposed development works to safely convey overland flow. Proposed MBE's for the development buildings were established and provided in this report.

Based on the findings of this flood hazard assessment, there is no apparent flood hazard associated with the project site that will require additional mitigative measures. This assessment considers that road improvements to current City standards will be completed at all frontages and provided MBE's will be adhered to. In conclusion; the development proposal is not subject to a Flood Hazard.

We trust that you will find the above suitable for your needs. Should you have any questions or comments on the information contained, please do not hesitate to contact the undersigned.

Reviewed by:

Russell Warren, P.Eng, LEED Green Associate
Project Manager

Prepared by:

Donal Casey, P.Eng
Design Engineer

APPENDIX A

INSERTS FROM CHINES ISMP

- Chines ISMP – Figure E-1 - Major Trunk Drainage System in Port Moody
- Chines ISMP – Table E-1 - Pipe Data Collection Table
- Chines ISMP – Figure E-3 - Hydraulic Model Network
- Chines ISMP – Table E-8 - Peak Flow and HGL Assessment Table for 100-year Event
- Chines ISMP – Figure D-1 – Hydraulic Field Reconnaissance
- Chines ISMP – Field Reconnaissance Photo ID 447
- Chines ISMP – Field Reconnaissance Photo ID 449

PROJECT NO:	20112817
SCALE:	1:6,500
DATE:	January 2015
DESIGNED BY:	JL
CHECKED BY:	MM

Associated Engineering

PREPARED FOR: metro vancouver, Port Moody City of the Arts, Coquitlam

CHINES ISMP

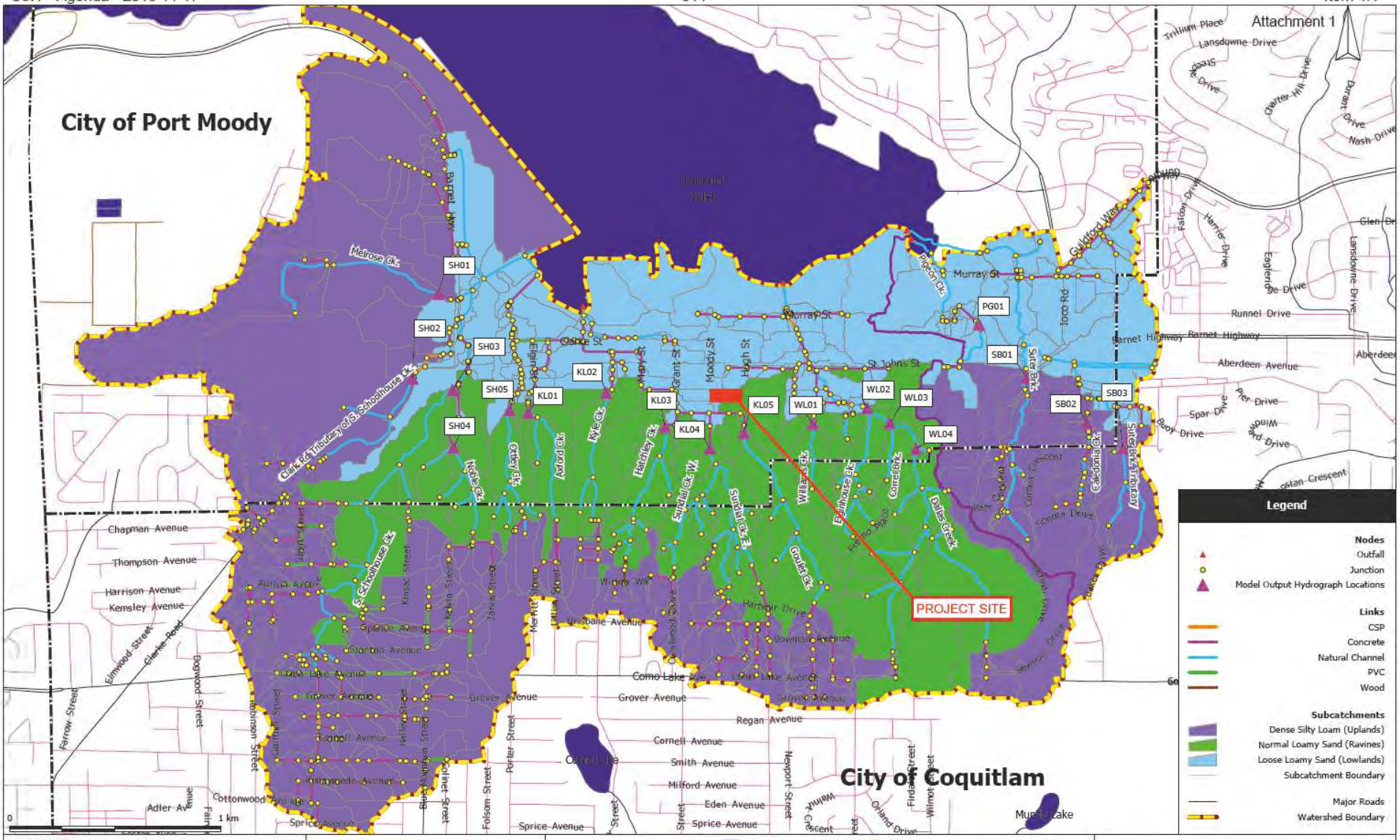
Figure E-1
Major Trunk Drainage System in Port Moody

Inset from Figure E-1 (above)

Culvert ID	Material Type	Diameter (mm)	Slope (%)	Length (m)	Comment	Photo Reference
kyl07	Concrete	600	0	33.9	Storm main north of St. Johns St	n/a
kyl08	Concrete	600	1.3	44.5	Storm main built underneath Kyle St	n/a
kyl09	Concrete	1050	4.1	35.8	Storm main built underneath Kyle St	n/a
kyl10	Concrete	0	3.8	14.4	Storm main built underneath Kyle St	n/a
Hatchley Creek Major Storm Trunks						
hat02	Concrete	600	6.5	66.1	Strom main east of Grant St	n/a
Sundial Creek Major Storm Trunks						
sun02	Concrete	900	9	62.9	Storm main built underneath Moody St	n/a
Goulet Creek Major Storm Trunks						
gou02	Concrete	750	29	27	Storm main across Jane St	n/a
gou03	Concrete	750	5.1	67.6	Storm main built underneath Hugh St and Henry St	n/a
gou04	Concrete	1050	1.1	54	Storm main built underneath Henry St	n/a
gou05	Concrete	1200	0.5	93.7	Storm main built underneath Henry St	n/a
gou06	Concrete	1200	2.4	84.3	Storm main built underneath Henry St	n/a
gou07	Concrete	1200	2.5	66.7	Storm main built underneath Henry St	n/a
gou08	Concrete	1200	6.5	41.4	Storm main built underneath Grant St	n/a

Inset from Table E-1 - Pipe Data Collection

Attachment 1



PROJECT NO:	20112817
SCALE:	1:16,000
DATE:	January 2015
DESIGNED BY:	JL
CHECKED BY:	MM

Associated Engineering

PREPARED FOR: metro vancouver, Port Moody City of the Arts, Coquitlam

CHINES ISMP

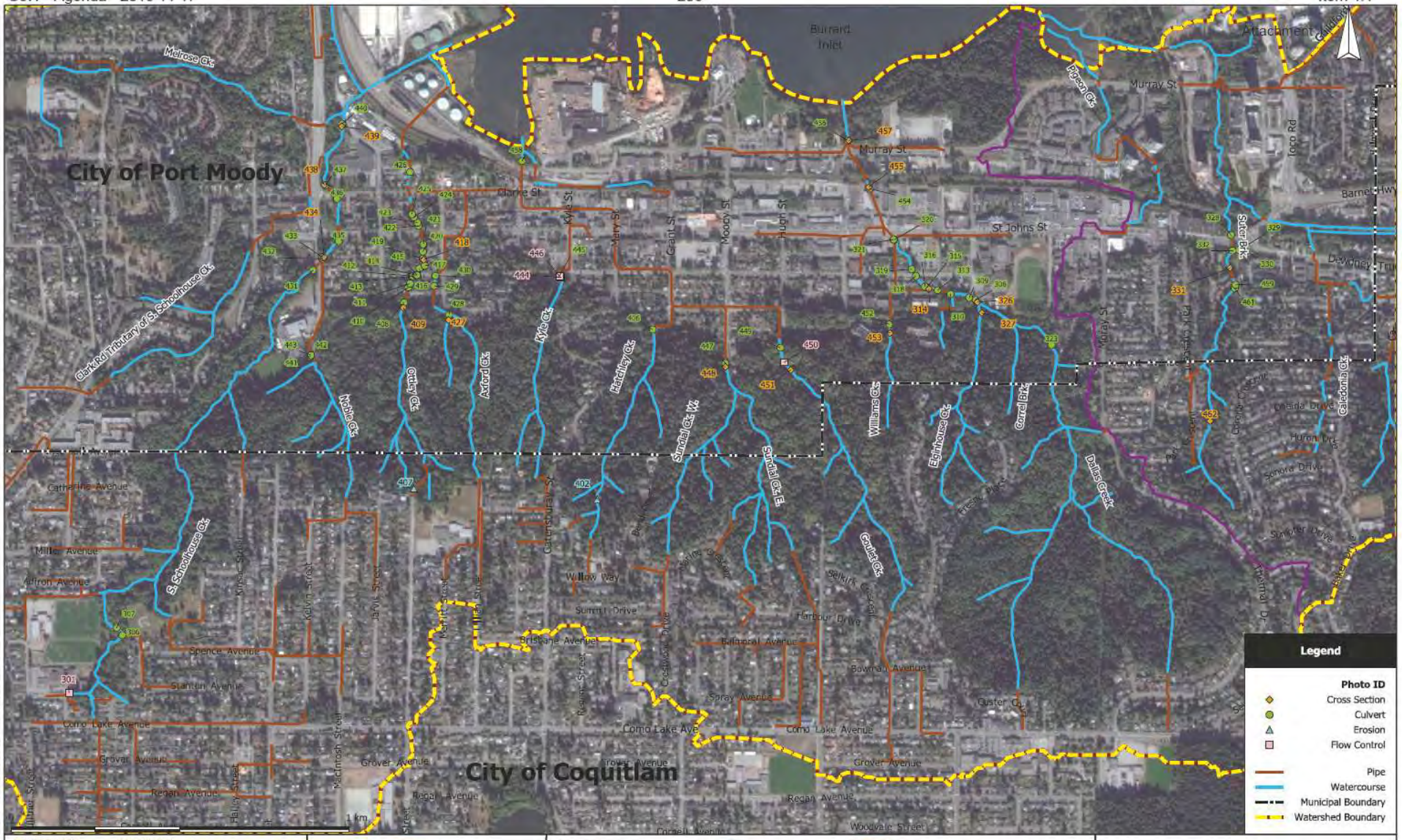
Figure E-3 Hydraulic Model Network

Inset from Figure E-3 (above)

Table E-8
Peak Flow and HGL Assessment for 100-year All Duration Storm Event

Discharge Location	100-year Peak Flow (m^3/s)			100-year HGL (m)			100-year Runoff Volume (m^3)		
	Existing	Future	% Change	Existing	Future	% Change	Existing	Future	% Change
South Schoolhouse Drainage System									
SH01	5.15	5.43	5.1%	23.07	23.09	0.1%	84,196	87,011	3.2%
SH02	5.14	5.62	8.5%	39.11	39.11	0.0%	85,970	90,753	5.3%
SH03	6.26	6.72	6.9%	23.18	23.23	0.2%	144,585	156,444	7.6%
SH04	0.78	0.92	14.6%	47.54	47.59	0.1%	12,356	14,327	13.8%
SH05	0.58	0.62	6.0%	40.79	40.80	0.0%	8,863	9,397	5.7%
Kyle Creek Drainage System									
KL01	0.39	0.40	3.5%	38.64	38.64	0.0%	7,466	7,908	5.6%
KL02	0.58	0.66	11.9%	18.03	18.05	0.1%	11,606	13,236	12.3%
KL03	0.90	1.05	14.9%	33.97	34.01	0.1%	14,150	16,451	14.0%
KL04	2.51	2.78	9.5%	38.95	39.01	0.2%	44,799	50,142	10.7%
KL05	1.54	1.78	13.5%	43.66	43.73	0.2%	24,945	28,807	13.4%

Insert from Table E-8 – Peak Flow and HGL Assessment for 100-year All Duration Storm Event



PROJECT NO:	20112817
SCALE:	1:10,000
DATE:	January 2015
DESIGNED BY:	JL
CHECKED BY:	MM

Associated Engineering

PREPARED FOR: metro vancouver, Port Moody City of the Arts, Coquitlam

CHINES ISMP

Figure D-1 Hydraulic Field Reconnaissance

Time: 1:58:56 PM | Date: 4/15/2015
Map File: P:\20112817\gis\GIS\map_FINAL_figures_20150123_b.mxd - Figure D-1 Hydraulic Field Reconnaissance

Port Moody Coquitlam ISMP – Hydraulic Field Reconnaissance Data Sheet: Culvert

Survey Number:	60	Date:	June 14, 2011
		Weather	Sunny
Inlet or Outlet:	Inlet	Structure:	Headwall
Material:	CONC	Dia or Width (mm):	900
Risk Level:	Low	Road Crown Height (m):	1.8
Type:	Road	Sediment Depth (m):	0.01

Left Bank Height (m):	1.8	Right Bank Height (m):	1.8	Low Channel Width (m):	1.5
Left Bank Slope (H:V):	3:1	Right Bank Slope (H:V):	3:1	Low Channel Depth(m):	0.2
Left Bank Roughness:	0.035	Right Bank Roughness:	0.035	Channel Roughness:	0.035

P:\20112817\00_ISMP\Engineering\01.08_Photos\June_14_2011\P6140047.JPG

Photo ID:	447
GPS Height (m):	40.885
Northing:	5457833.693
Easting:	510894.458
Comment:	Sundials Creek intake with trash rack

Survey Number:	61	Date:	June 14, 2011
		Weather	Sunny
Inlet or Outlet:	Inlet	Structure:	Headwall
Material:	CONC	Dia or Width (mm):	900
Risk Level:	Low	Road Crown Height (m):	1.5
Type:	Road	Sediment Depth (m):	0.01

Left Bank Height (m):	1.5	Right Bank Height (m):	1.5	Low Channel Width (m):	2
Left Bank Slope (H:V):	3:1	Right Bank Slope (H:V):	3:1	Low Channel Depth(m):	0.1
Left Bank Roughness:	0.035	Right Bank Roughness:	0.035	Channel Roughness:	0.035

P:\20112817\00_ISMP\Engineering\01.08_Photos\June_14_2011\P6140049.JPG

Photo ID:	449
GPS Height (m):	43.96
Northing:	5457879.753
Easting:	511057.258
Comment:	Goulet Creek intake with trash rack

APPENDIX B

BINNIE FIELD RECONNAISSANCE PHOTOGRAPHS

BINNIE

Field Reconnaissance Photographs

#1: Sundial Creek intake at south end of Moody Street. Looking south toward creek channel and debris barrier.

#2: Sundial Creek intake at south end of Moody Street. Looking south at intake structure.

#3: Goulet Creek intake at south end of Hugh Street. Looking north at creek channel and intake structure.

#4: Goulet Creek intake at south end of Hugh Street. Looking south toward upstream structure.

#5: St. George Street looking east from intersection at Hugh Street.

#6: St. George Street looking west from intersection at Moody Street.

Field Reconnaissance Photographs

#7: Moody Street looking south from intersection at St. George Street.

#8: Hugh Street looking south from intersection at St. George Street.

#9: Hope Street looking east from intersection at Hugh Street.

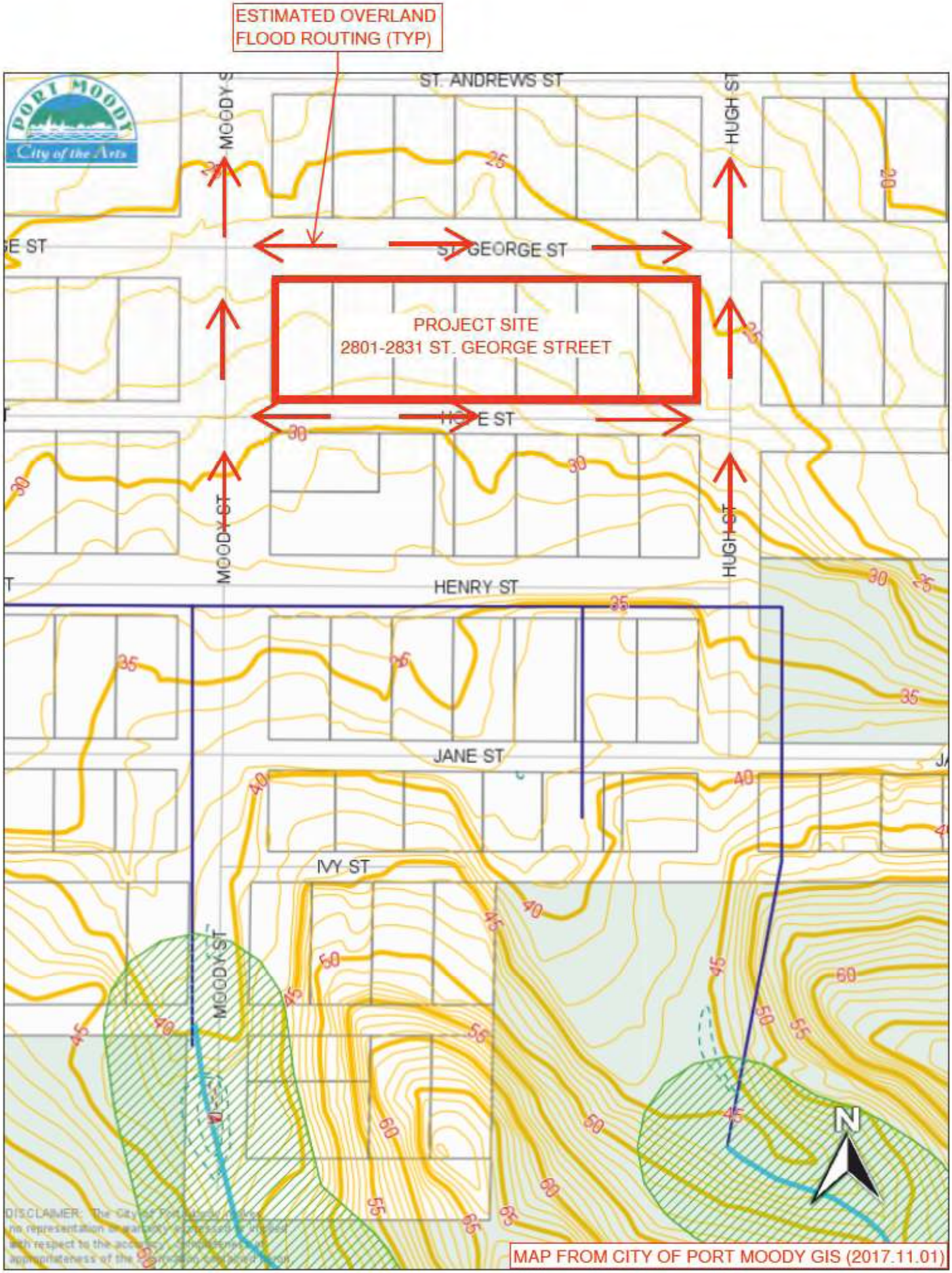
#10: Hugh Street looking north from intersection at Hope Street.

#11: Moody Street looking south from intersection at Jane Street.

APPENDIX C

AREA DRAINAGE ASSESSMENT

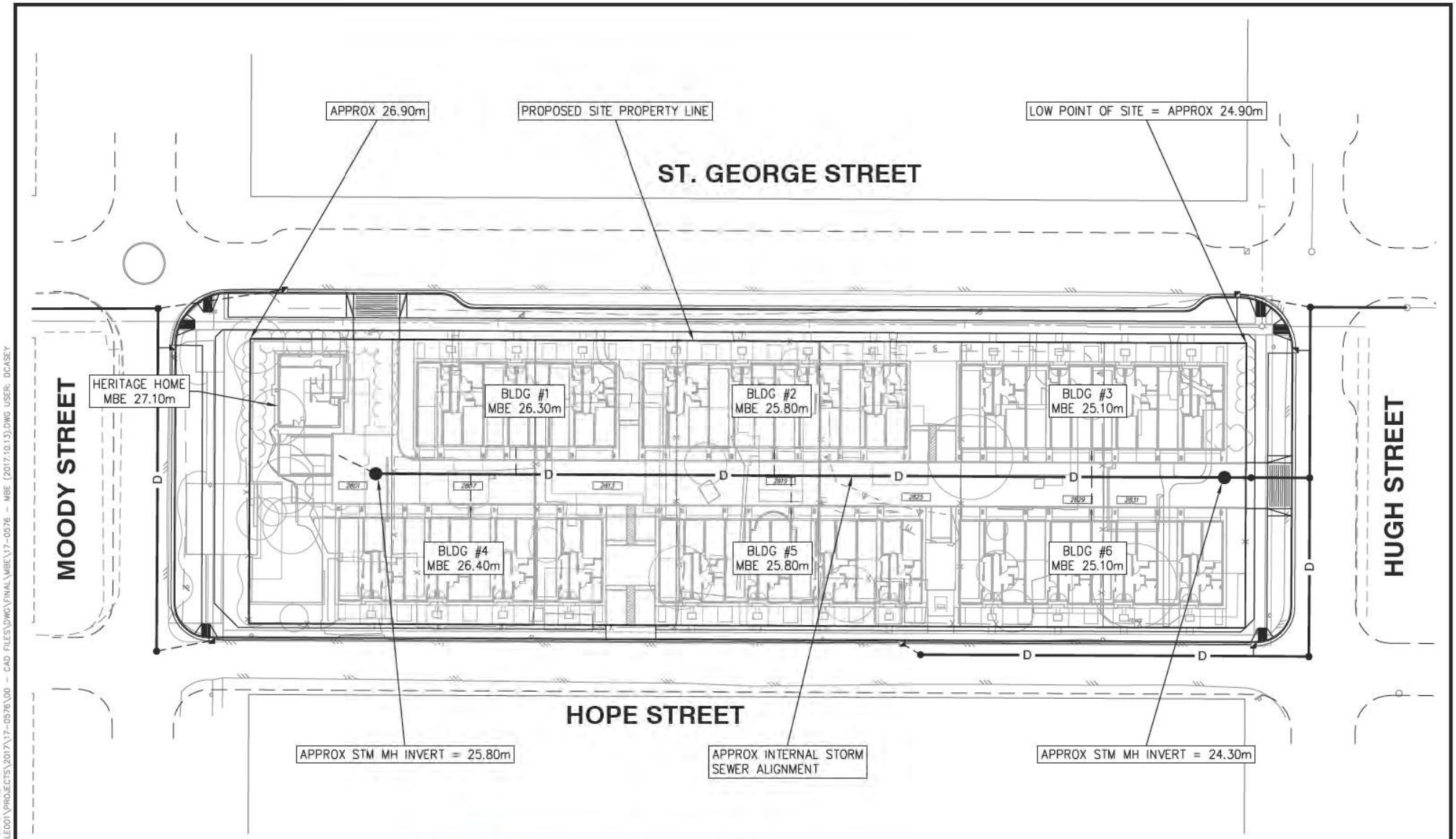
BINNIE


ESTIMATED OVERLAND FLOOD ROUTING (TYP)
ST. ANDREWS ST
MOODY ST
HUGH ST
ST. GEORGE ST
PROJECT SITE
2801-2831 ST. GEORGE STREET
HENRY ST
JANE ST
IVY ST
N
MAP FROM CITY OF PORT MOODY GIS (2017.11.01)

APPENDIX D

MINIMUM BUILDING ELEVATIONS

BINNIE



BINNIE
The people behind your infrastructure.
TEL 604 420 1721 BINNIE.com

DATE	REV.	DESCRIPTION
2017-10-13	1	PRELIMINARY DESIGN

TITLE :
JOHNSTON HOUSE
PRELIMINARY MBE VALUES

DATE : 2017-10-13
DWG. No. : 17-0576-MBE
SCALE : 1:500
REV. 1

PLOTTED: 2017-11-03 3:44:32 PM
FILE: \\BC-BBY-FILE001\PROJECTS\2017\17-0576\00 - CAD FILES\DWG\FINAL\MBE\17-0576 - MBE (2017.10.13).DWG USER: DCASEY

APPENDIX E

FLOOD ASSURANCE STATEMENT

BINNIE

FLOOD ASSURANCE STATEMENT

Note: This statement is to be read and completed in conjunction with the current Engineers and Geoscientists BC *Professional Practice Guidelines – Legislated Flood Assessments in a Changing Climate in BC* ("the guidelines") and is to be provided for flood assessments for the purposes of the *Land Title Act*, Community Charter, or the *Local Government Act*. Defined terms are capitalized; see the Defined Terms section of the guidelines for definitions.

To: The Approving Authority

Date: September 30, 2019

City of Port Moody

100 Newport Dr, Port Moody, BC

Jurisdiction and address

With reference to (CHECK ONE):

- ☐ *Land Title Act* (Section 86) – Subdivision Approval
- ☑ *Local Government Act* (Part 14, Division 7) – Development Permit
- ☐ Community Charter (Section 56) – Building Permit
- ☐ *Local Government Act* (Section 524) – Flood Plain Bylaw Variance
- ☐ *Local Government Act* (Section 524) – Flood Plain Bylaw Exemption

For the following property ("the Property"):

2801-2831 St. George Street, Port Moody, BC

Legal description and civic address of the Property

The undersigned hereby gives assurance that he/she is a Qualified Professional and is a Professional Engineer or Professional Geoscientist who fulfils the education, training, and experience requirements as outlined in the guidelines.

I have signed, sealed, and dated, and thereby certified, the attached Flood Assessment Report on the Property in accordance with the guidelines. That report and this statement must be read in conjunction with each other. In preparing that Flood Assessment Report I have:

[CHECK TO THE LEFT OF APPLICABLE ITEMS]

___ 1. Consulted with representatives of the following government organizations:

_____

✓ 2. Collected and reviewed appropriate background information

___ 3. Reviewed the Proposed Development on the Property

___ 4. Investigated the presence of Covenants on the Property, and reported any relevant information

✓ 5. Conducted field work on and, if required, beyond the Property

✓ 6. Reported on the results of the field work on and, if required, beyond the Property

✓ 7. Considered any changed conditions on and, if required, beyond the Property

8. For a Flood Hazard analysis I have:

- ✓ 8.1 Reviewed and characterized, if appropriate, Flood Hazard that may affect the Property
- ✓ 8.2 Estimated the Flood Hazard on the Property
- ✓ 8.3 Considered (if appropriate) the effects of climate change and land use change
- ___ 8.4 Relied on a previous Flood Hazard Assessment (FHA) by others
- ___ 8.5 Identified any potential hazards that are not addressed by the Flood Assessment Report

9. For a Flood Risk analysis I have:

- ___ 9.1 Estimated the Flood Risk on the Property
- ___ 9.2 Identified existing and anticipated future Elements at Risk on and, if required, beyond the Property
- ___ 9.3 Estimated the Consequences to those Elements at Risk

10. In order to mitigate the estimated Flood Hazard for the Property, the following approach is taken:
- ✓ 10.1 A standard-based approach
- ___ 10.2 A Risk-based approach
- ___ 10.3 The approach outlined in the guidelines, Appendix F: Flood Assessment Considerations for Development Approvals
- ___ 10.4 No mitigation is required because the completed flood assessment determined that the site is not subject to a Flood Hazard

11. Where the Approving Authority has adopted a specific level of Flood Hazard or Flood Risk tolerance, I have:
- ___ 11.1 Made a finding on the level of Flood Hazard or Flood Risk on the Property
- ___ 11.2 Compared the level of Flood Hazard or Flood Risk tolerance adopted by the Approving Authority with my findings
- ___ 11.3 Made recommendations to reduce the Flood Hazard or Flood Risk on the Property

12. Where the Approving Authority has not adopted a level of Flood Hazard or Flood Risk tolerance, I have:
- ✓ 12.1 Described the method of Flood Hazard analysis or Flood Risk analysis used
- ___ 12.2 Referred to an appropriate and identified provincial or national guideline for level of Flood Hazard or Flood Risk
- ✓ 12.3 Made a finding on the level of Flood Hazard of Flood Risk tolerance on the Property
- ___ 12.4 Compared the guidelines with the findings of my flood assessment
- ✓ 12.5 Made recommendations to reduce the Flood Hazard or Flood Risk

✓ 13. Considered the potential for transfer of Flood Risk and the potential impacts to adjacent properties

✓ 14. Reported on the requirements for implementation of the mitigation recommendations, including the need for subsequent professional certifications and future inspections.

Based on my comparison between:

[CHECK ONE]

☐ The findings from the flood assessment and the adopted level of Flood Hazard or Flood Risk tolerance (item 11.2 above)

☐ The findings from the flood assessment and the appropriate and identified provincial or national guideline for level of Flood Hazard or Flood Risk tolerance (item 12.4 above)

I hereby give my assurance that, based on the conditions contained in the attached Flood Assessment Report:

[CHECK ONE]

☐ For subdivision approval, as required by the *Land Title Act* (Section 86), "that the land may be used safely for the use intended":

[CHECK ONE]

- ☐ With one or more recommended registered Covenants.
- ☐ Without any registered Covenant.

☑ For a development permit, as required by the *Local Government Act* (Part 14, Division 7), my Flood Assessment Report will "assist the local government in determining what conditions or requirements it will impose under subsection (2) of this section [Section 491 (4)]".

☐ For a building permit, as required by the Community Charter (Section 56), "the land may be used safely for the use intended":

[CHECK ONE]

- ☐ With one or more recommended registered Covenants.
- ☐ Without any registered Covenant.

☐ For flood plain bylaw variance, as required by the *Flood Hazard Area Land Use Management Guidelines* and the *Amendment Section 3.5 and 3.6* associated with the *Local Government Act* (Section 524), "the development may occur safely".

☐ For flood plain bylaw exemption, as required by the *Local Government Act* (Section 524), "the land may be used safely for the use intended".

I certify that I am a Qualified Professional as defined below.

October 3, 2019
Date

Prepared by

Donal Casey, P.Eng
Name (print)

Signature

300 - 4946 Canada Way
Address

Burnaby, BC

604 420 1721
Telephone

dcasey@binnie.com
Email

Reviewed by

Donal Casey, P.Eng.
Name (print)

Signature

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
D. CASEY
43480
2019.10.03

(Affix PROFESSIONAL SEAL here)

If the Qualified Professional is a member of a firm, complete the following:

I am a member of the firm R.F. Binnie & Associates Ltd.
and I sign this letter on behalf of the firm.

(Name of firm)

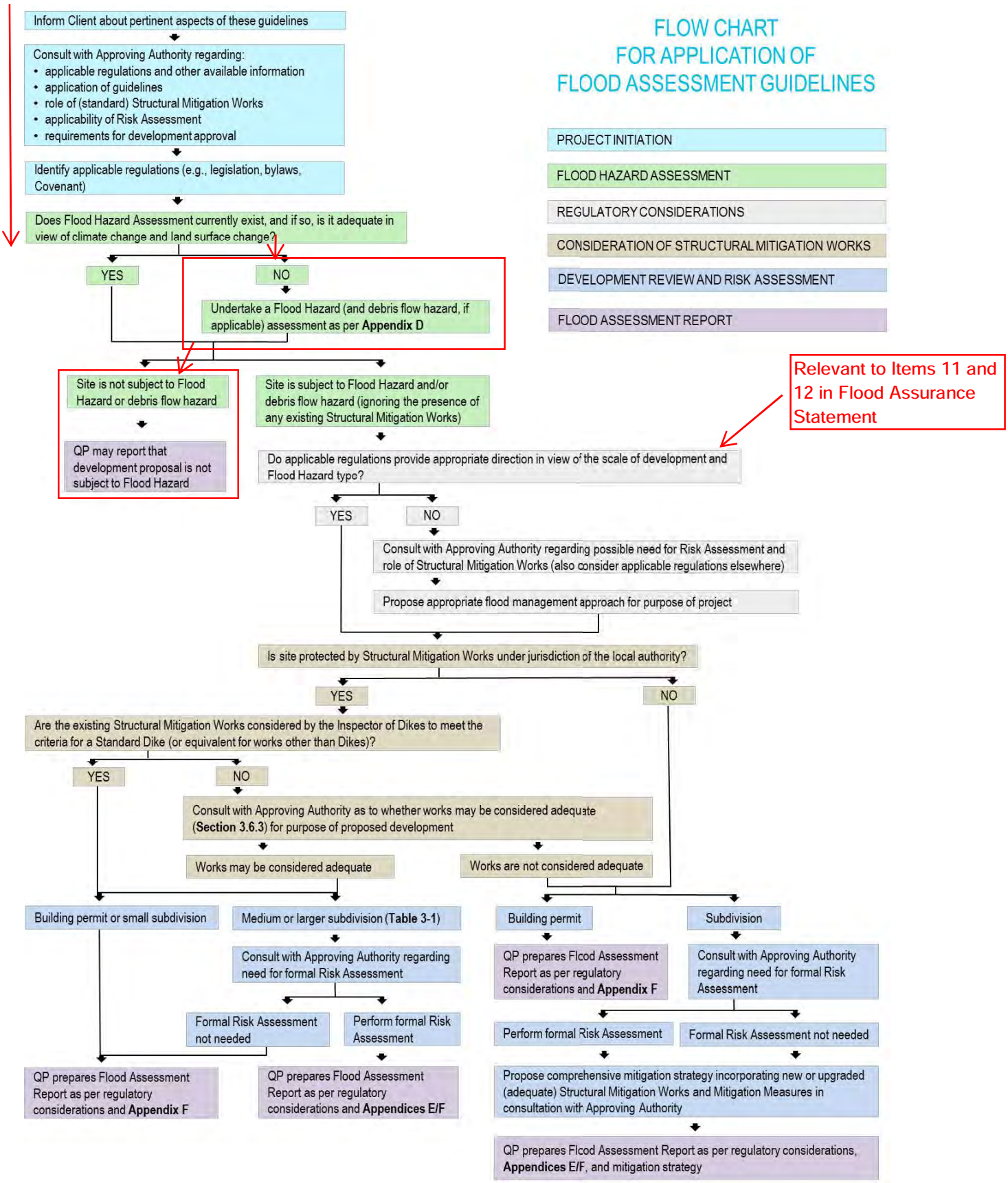


Figure 2: Flow chart for application of flood assessment guidelines