GEOPACIFIC
VANCOUVER KAMLOOPS CALGARY

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Buffalo-Gentai Development Ltd.
205 - 8877 Odlin Crescent
Richmond, BC
V6X 3Z7

June 25, 2020
File: 16523

Attention: Gerald Chiang

Re: Geotechnical Investigation Report - Mixed Use Development
3104, 3108 and 3112 St George Street, 123, 125, 127 and 129 Buller Street,
and 3101 and 3103 St Johns Street Port Moody, BC

1.0 INTRODUCTION

We understand that a new low-rise mixed use development is proposed for the above referenced site. Based on preliminary drawings provided by WA Architects, dated May 11, 2020, the proposed development will consist of 6 levels of wood frame construction all two and a half levels of below grade reinforced concrete parking. It is anticipated that the underground parking will extend to, or close to, the property line on all sides of the development.

This report provides the results of our field investigation and makes geotechnical recommendations for the design and construction of the proposed development. This report was prepared exclusively for Buffalo-Gentai Development Ltd. for their use and for the use of others on their development team. We expect that the City of Port Moody will use the report in the development permitting process.

2.0 SITE DESCRIPTION

The development is located south-west of the intersection of St Johns Street and Buller Street. The development site is pan-handled in shape and is bound by St John Street to the north, Buller Street to the east, St George Street to the south and a municipal lane to the west. The site is currently improved with residential at grade homes. The site has a grade differential of about 5 to 6 metres, sloping down from south-east to north-west according to the Topographic survey completed by Target Land Surveying, dated November 8, 2018. The location of the site and existing improvements are shown on the attached site plan Drawing No. 16523-01, presented following this report.

3.0 FIELD INVESTIGATION

GeoPacific Consultants Ltd. conducted a field investigation at 3101 and 3103 St.Johns Street on August 23, 2017. At that time, three suger test holes were drilled to depths ranging between 10.7 and 18.3 m below existing site grades. A subsequent investigation was completed on October 12, 2018 and encompassed 3104, 3108 and 3112 St George Street, 123, 125, 127 and 129 Buller Street . At that time four auger holes were drilled to depths ranging between 6.1 and 9.1 m below existing site grades.

Both drilling program was completed using a track mounted solid stem auger drilling rig, supplied and operated by Uniwide Drilling Co. Ltd., of Richmond, B.C. Disturbed samples were collected from the auger flights for logging and routine lab index testing. The test holes were backfilled in accordance to provincial requirements.

Approximate location of the test holes are shown in the drawings no. 16523-01, and the test hole logs are presented in Appendix A following the text of this report.

4.0 SUBSURFACE CONDITIONS

4.1 Soil Conditions

The general geology of the region under investigation is described as raised marine shore deposits and fluvial sand according to the Geological Survey of Canada Map 1484A. A general description of the soils encountered in our test holes is given below.

Topsoil/Fill

Up to 1.5 metres of fills are noted in our test holes. The fills range from brown sand fill to silty sand fill. Organics such as rootlets were noted within the topsoil. Topsoil to organic silt below the site fills were noted at TH18-01 at a depth of 0.9 metres below existing site grades.

Sand and Gravel

Dense to very dense sand and gravel is noted below the site fills across the entire site. The sand is generally observed to be medium to coarse grained, with varying amounts of fine to coarse gravel. The sand and gravel deposits are observed to be brown grading to grey with depth. Furthermore, silty seams are noted in TH17-02, TH17-03, TH18-02, TH18-03 and TH18-04 at a depths of approximately 5.2 m to 6.7 m below existing site grades. The sand and gravel stratum was noted to extend to the maximum depth of exploration at all test hole locations.

For a more detailed description of the subsurface conditions, refer to the test hole logs in Appendix A following the text of this report.

4.2 Groundwater Conditions

Ground water was noted between 1.5 and 2.1 m below existing site grades. Based on our observations, this is inferred to be the static groundwater table that is contained in the granular deposits. The groundwater table is expected to fluctuate seasonally, being at a higher elevation during the wetter months of the year.

5.0 DISCUSSION

5.1 General Comments

Based on available drawings provided by WA Architects, the proposed development is expected to consist of a 6 level woodframe structure all over 2.5 levels below grade of reinfoced concrete construction. As such we anticipate that the building will be founded on the dense sand and gravel as described in Section 4.1.

Based on site constraints, we expect that shoring will be required for vertical excavations. For the proposed 2.5 level below grade parkade, secant pile shoring will be the most economical solution based on soil and groundwater conditions. The secant pile shoring would extend below the final excavation grade to create a longer flow path and reduce the amount of groundwater inflows. Further investigation may be required to determine the optimal depth for the cutoff wall. We expect that the building would be tanked to mitigate lowering of the static groundwater table due to long term groundwater pumping.

We confirm, from a geotechnical standpoint, that the proposed low rise development is feasible and may be safely used for the use intended provided the recommendations outlined in Section 6.0 of this report are incorporated into the overall design.

5.2 Seismic Considerations

We understand that based on "City of Port Moody Official Community Plan Hazardous Lands Map 13" the proposed development is within a flood and soil liquefaction area. The soils encountered on-site are compact to dense at the founding level. Therefore, the soils on-site are not considered liquefiable during the design earthquake under the 2018 British Columbia Building Code.

5.3 Groundwater Analysis

We anticipate that temporary dewatering will be required during the installation of the proposed underground portion of the development. We have completed a seepage analysis using a finite element computer program SEEP/W (GeoStudio 2018) to provide an initial estimate for the groundwater inflows into the excavation areas for the site based on available geotechnical information. We have assumed a cutoff embedment depth between 5 and 10 m below the proposed excavation level.

The results of our seepage analysis indicate the temporary groundwater dewatering rates will range from approximately 480L/min to 650 L/min. As a result of the temporary excavation and dewatering at this site, we expect that groundwater levels may be lowered by up to 1 m at the face of the wall, reducing to 0.1 to 0.2 m at approximately 30 m away from the shoring wall. Based on City of Port Moody GIS, Dallas Creek trends from south-east to northwest and is offset a minimum distance of approximately 50 to 55 m from the site. Based on our analysis, we expect that Dallas Creek is outside of the temporary groundwater drawdown zone of influence.

Dewatering values and the dewatering zone of influence can be influenced by a number of factors including soil type, soil deposition, soil stratification, and seasonal variations in the groundwater level. Therefore, seepage rates can vary from those estimated from our model. Our seepage analysis has been undertaken based on some hydraulic conductivity assumptions and in conjunction with the limitations of the software which include analysis in two-dimensional space with a simplified soil stratigraphy. Thus, we recommend that for design purposes, dewatering rates in the range of 400 L/min to 1500 L/min are considered. Should refined estimates be required further investigation and groundwater specific testing can be completed to refine our estimates.

6.0 RECOMMENDATIONS

6.1 Site Preparation

Site preparation associated with foundations and grade supported slabs include removing any organic topsoil, variable fill materials and any other material considered to compromise the design recommendations stated

herin. However, as the development will be constructed with a below grade component, we expect that the foundation depth of excavation will be driven by the architectural design rather that the soils encountered.

Suitable bearing soils are expected at the proposed foundation elevations. Any open excavations should be sloped away from the subgrade to inhibit the ponding of water. Any loosened/softened or otherwise disturbed portions of the subgrade should be removed and replaced with lean mix concrete. Once approved by the geotechnical engineer, all foundation subgrades should be protected using 50 mm of lean mix concrete (Minimum 5 Mpa 28 day compressive strength). Grade reinstatment beneath floor slabs and any non-structural wall can be done using engineered fill.

"Engineered Fill" is generally defined as clean sand to sand and gravel containing 5 percent fines or less, by weight, compacted in 300 mm loose lifts to a minimum standard of 95% of it's Modified Proctor Maximum Dry Density (ASTM D1557) at a moisture content that is within 2% of its optimum for compaction.

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

6.2 Building Foundations

Footings which are founded on undisturbed compact to dense sand and gravel, described in Section 4.1, may be designed on the basis of a Seviceability Limit State (SLS) bearing pressure of 250 kPa and a Factored Ultimate Limit State (ULS) bearing pressure of 375 kPa for a tanked raft foundation. A subgrade reaction modulus of 10 MPa/m can be used for design.

We expect that the settlement of footings designed as recommended should be within the normally acceptable limits of 25 mm maximum and up to 20 mm differential over a 10 metre span.

The foundation subgrade must be reviewed by the geotechnical engineer.

6.3 Seismic Classification

Based on the anticipated subsurface conditions we recommend that the building be designed in accordance with Site Class D spectral parameters as defined in Table 4.1.8.4.A of the 2018 British Columbia Building Code. Peak ground acceleration for firm ground for the approximate site location is 0.32g (Natural Resources Canada, Site Coordinates: 49.2760° north, -122.8413° west).

6.4 Foundation Drainage

For 2.5 levels below grade we recommend that a tanked foundation is implemented which will mitigate the concerns of offsite settlements due to long-term groundwater drawdown.

For a tanked below grade structure, with a temporary cutoff wall, a perimeter drainage system is not required. A drainage system within the parkade may be considered to keep the floor dry from incidental water accumulation.

6.5 Earth Pressures and Water Pressures

We understand that the proposed development will have 2.5 levels of below grade construction. Earth pressure on below grade walls depends upon a number of factors including the backfill material, surcharge

loads, backfill slope, drainage, rigidity of the basesment or retaining wall, presence of shoring, and method of construction including sequence and degree of compaction.

We expect that the basement walls would be constructed directly against the shoring/cut off wall constructed as part of the development.

Earth pressures can be assumed to be 4.5H (kPa) triangular to the groundwater level which should be assumed to be 1 m below current site grades during wetter months of the year, after which combined soil and water pressures can be assumed to increase linearly with depth at a rate of 12.5H (kPa) to the base of the structure. Assuming the cut off wall can be constructed on private property, the stiffness of this wall can be used to transfer the majortiy of these pressures to the floors and foundation elements.

Dynamic loading induced by an earthquake should be added to the static loads should be taken as 3H (kPa) inverted triangular.

The underside of the raft should be designed to resist uplift pressures due to buoyancy, considering a water level of 1m below current site grades.

The backfill and procedures proposed must be reviewed by the Geotechnical Engineer.

6.6 Temporary Excavations

For 2.5 levels of below grade development a secant pile wall would be required to provide a groundwater cut-off. The vertical members would be reinforced with tie back soil anchors to resist lateral earth pressures. Anchor holes should be sealed to reduce amount of water infiltration into the site and backflow preventers may be necessary. The secant pile wall will extend below final excavation grades to increase the flow path of the groundwater. This reduces temporary de-watering during construction and would be left in place to provide transfer of lateral loads into the slab and foundation systems.

For 2.5 levels of below grade construction with a cutoff wall, temporary dewatering during construction is expected as noted in Section 5.3. Groundwater inflows could either be controlled utilizing well-point dewatering systems or conventional sumps and sump pumps. We expect that conventional sumps and sump pumps would require increased maintenance to keep the excavation dry. Furthermore, some excavation induced ground movements are unavoidable, irrespective of the shoring method used. We expect movements at the perimeter of the excavation to be in the order of 20 to 30 mm at the face, decreasing to 10 to 15 mm at 3 m away from the excavation face.

GeoPacific can provide shorign and excavation drawings upon request.

7.0 FIELD REVIEWS

As required for Municipal "Letters of Assurance", GeoPacific Consultants Ltd. will carry out sufficient field reviews during construction to ensure that the Geotechnical Design recommendations contained within this report have been adequately communicated to the design team and to the contractors implementing the design. These field reviews are not carried out for the benefit of the contractors and therefore do not in any way effect the contractors obligations to perform under the terms of his/her contract.

It is the contractors' responsibility to advise GeoPacific Consultants Ltd. (a minimum of 48 hours in advance) that a field review is required. Geotechnical field reviews are normally required at the time of the following:

1.	Stripping:	Review of stripping depth.
2.	Excavation:	Review of temporary slopes and soil conditions.
3.	Shoring:	Review of shoring installation and tests.
4.	Engineered Fill:	Review of materials and compaction degree.
5.	Foundation:	Review of foundation subgrade.
6.	Slab on Grade:	Review of under slab fill materials and compaction.
7.	Backfill:	Review of placement of backfill along foundation walls.

It is critical that these reviews are carried out to ensure that our intentions have been adequately communicated. It is also critical that contractors working on the site view this document in advance of any work being carried out so that they become familiarized with the sensitive aspects of the works proposed. It is the responsibility of the developer and/or contractor to notify GeoPacific when conditions differ from those described in this report.

8.0 CLOSURE

This report is prepared solely for use by our client's design team for this project as described to the general standards of similar work for similar projects in this area and no other warranty of any kind is expressed or implied. GeoPacific Consultants Ltd. accepts no responsibility for any other use of this report.

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 the undersigned if you require any clarification or additional information.

For:
GeoPacific Consultants Ltd.

Reviewed by:

Zakhar Okunev, B.Eng., E.I.T.
Project Engineer

Kevin Bodnar, M.Eng., P.Eng.
Principal

LEGEND:

- TH18-# – TEST HOLE (TH) LOCATION (2018)
- TH17-# – TEST HOLE (TH) LOCATION (2017)

*TEST HOLE LOCATIONS ARE APPROXIMATE

SITE PLAN

SCALE = 1:750

REFERENCE:

GEOPACIFIC
VANCOUVER KAMLOOPS CALGARY

1779 W. 75th Avenue
Vancouver, B.C. V6P 6P2

P 604.439.0922
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DATE:		
OCTOBER 9, 2018		
DRAWN BY:	APPROVED BY:	REVIEWED BY:
N.P.	K.B.	Z.O.
SCALE:		
AS SHOWN		

MIXED USE DEVELOPMENT

3104, 3108 & 3112 ST. GEORGE ST AND
123, 125, 127 & 129 BULLER ST, PORT MOODY, BC
TEST HOLE LOCATION PLAN

FILE NO.: 16523

DWG. NO.: 16523-01

REVISIONS:
A. June 25, 2020
B.
C.

ORIGINAL PAPER SIZE: 8.5"x11"

APPENDIX A - TEST HOLE LOGS

Test Hole Log: TH17-01

File: 15301
Project: Mixed Use Development
Client: Buffalo Investments Ltd.
Site Location: 3101 and 3103 St.Johns 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	
		Sand and Gravel (Fill) Fine to medium sand and coarse gravel fill, brown, compact, moist	0.0
3 / 1		***Sandy Silt (Fill)*** Fine sandy silt, brown, firm, moist	1.2
7 / 2		***Sand (Fill)*** Medium sand, brown, compact, moist	
9 / 3		***Sand and Gravel*** Fine sand and fine gravel grading to medium to coarse sand and gravel with depth, brown, compact to dense, moist	2.7
13 / 4		***Sand and Gravel*** Medium to coarse sand and fine to coarse gravel, some fine to medium seams interbedded, some silt with siltier seams interbedded, grey, compact to dense, saturated	
17 / 5			5.2
19 / 6		***Sandy Silt*** Sandy silt, grey, stiff, moist	
21 / 7		***Sand and Gravel*** Medium to coarse sand and fine to coarse gravel, some fine to medium seams interbedded, some silt with siltier seams interbedded, grey, compact to dense, saturated	
33 / 10			
39 / 12		End of Borehole	12.2

Fines content (%): 13.4%

DCPT (blows per foot) 10 20 30 40: 6, 6, 20, 27, 17, 11, 23, 27, 29, 27, 21, 21, 31, 33, 30, 30, 26, 28, 26, 28, 28, 26, 20, 23, 25, 29, 24, 43, 49

Groundwater / Well: 7' Estimated Static Water Table

Remarks

Logged: ZO
Method: SS Auger
Date: August 23, 2017

Datum: Existing Ground
Figure Number: A.01
Page: 1 of 1

Test Hole Log: TH17-02

File: 15301
Project: Mixed Use Development
Client: Buffalo Investments
Site Location: 3101 and 3103 St.Johns Street, Port Moody, BC

GEOPACIFIC CONSULTANTS
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Tel: 604-439-0922 Fax:604-439-9189

INFERRED PROFILE

Depth (ft / m)	Symbol	SOIL DESCRIPTION	Depth (m)/Elev (m)
0 / 0		Ground Surface	
		8" Concrete	0.0
		Sandy Silt (Fill) Fine sandy silt, brown, firm, moist	0.6
2 / 1		**Sand** Medium to coarse sand, some fine to coarse gravel, brown grading to grey with depth, compact to dense, moist grading to saturated with depth	
3 / 2		**Sand and Gravel** Medium to coarse sand and fine to coarse gravel, grey, compact, saturated	2.7
4 / 3		**Silt** Silt, grey, firm, moist	4.6
5 / 4		**Gravelly Sand** Fine to medium sand, gravelly, grey, compact to dense, saturated	
7 / 6		**Sandy Gravelly Silt** Fine sandy gravelly silt, fine to coarse gravel, grey, dense, moist	7.0
8 / 7		**Sand and Gravel** Fine to medium sand and fine to coarse gravel, some silt, grey, compact to dense, saturated	7.9
10 / 9		End of Borehole	10.7

Moisture Content (%): 11.4% (at ~14 ft); 10.4% (at ~24 ft)

Fines Content (%)

DCPT (blows per foot) 10 30: 32, 30, 29, 24, 21, 10, 28, 30, 27, 32, 25, 22, 31, >50, >50, 48, 35, 34, 21, 21, 22, 36, 32, 32

Groundwater / Well

Remarks

Logged: ZO
Method: SS Auger
Date: August 23, 2017

Datum: Existing Ground
Figure Number: A.02
Page: 1 of 1

Test Hole Log: TH17-03

File: 15301
Project: Mixed Use Develeopment
Client: Buffalo Investments Ltd.
Site Location: 3101 and 3103 St.Johns Street, Port Moody, BC

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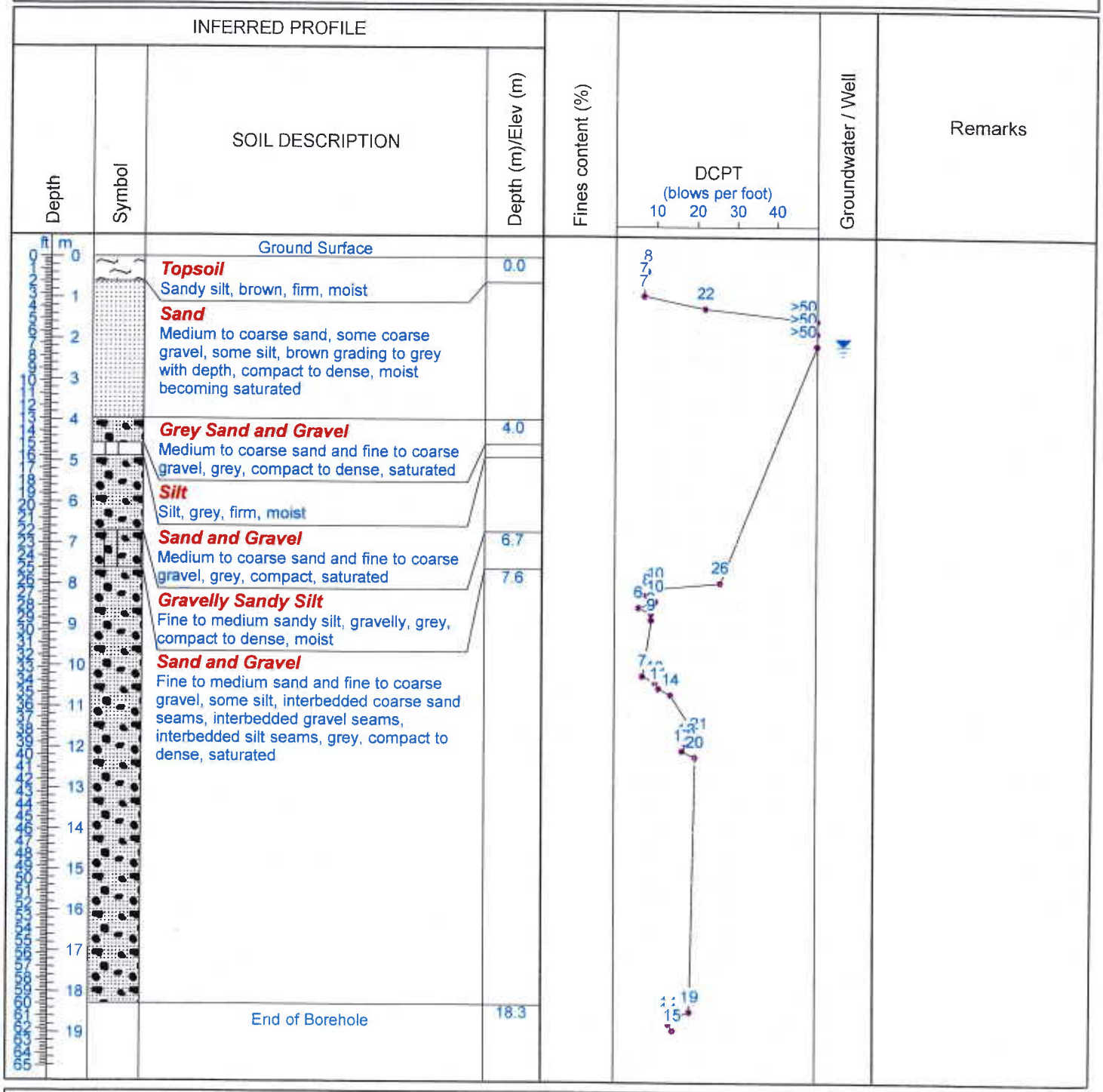

Logged: ZO
Method: SS Auger
Date: August 23, 2017

Datum: Existing Ground
Figure Number: A.03
Page: 1 of 1

Test Hole Log: TH18-01

File: 16523
Project: Proposed Residential Development
Client: Buffalo Investments
Site Location: St.George Street and Buller Street, Port Moody, BC

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Depth (ft / m)	Symbol	INFERRED PROFILE: SOIL DESCRIPTION	Depth (m)/Elev (m)	Moisture Content (%)	Fines Content (%)	DCPT (blows per foot) 10 30	Groundwater / Well	Remarks
0 / 0		Ground Surface						
0 / 0		***Sand (Fill)*** Sand to sand and gravel, fine sand, brown, loose, moist	0.0					
3 / 1		***Topsoil/Organic Silt*** Organic silt to topsoil, soft, brown, moist	0.9					
5 / 2		***Sandy Gravel*** Sandy gravel, medium to coarse sand, fine to coarse gravel, brown, dense to very dense, wet	1.5				▼	Inferred groundwater
8 / 2		***Sand and Gravel*** Sand and gravel to sand with some gravel, trace silt, medium sand, fine to coarse gravel, grey, dense to very dense, wet	2.4					
20 / 6		End of Borehole	6.1					

Logged: ZO
Method: SS Auger
Date: October 12, 2018

Datum: Existing Ground
Figure Number: A.01
Page: 1 of 1

Test Hole Log: TH18-02

File: 16523
Project: Proposed Residential Development
Client: Buffalo Investments
Site Location: St.George Street and Buller Street, Port Moody, BC

GEOPACIFIC CONSULTANTS
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Depth (ft / m)	Symbol	SOIL DESCRIPTION (INFERRED PROFILE)	Depth (m)/Elev (m)	Moisture Content (%)	Fines Content (%)	DCPT (blows per foot) 10 30	Groundwater / Well	Remarks
0 / 0		Ground Surface						
0–1 / 0		***3" Ashphalt***	0.0			6		
1–2		***Sand and Gravel (Fill)***				3		
2–3 / 1		***Silty Sand(Fill)*** Silty sand to sand, fine to medium sand, brown, loose, moist				2		
4–5						6		
5–6		***Sand and Gravel*** Sand and gravel, medium to coarse sand, fine to coarse gravel, trace to some silt, brown, dense to very dense, wet at 7'	1.5			>50		
6–7 / 2						>50	▼	Inferred groundwater
8–9		***Sand and Gravel*** Sand and gravel to sand with some gravel, trace silt, medium sand, fine to coarse gravel, grey, dense to very dense, wet	2.4					
10 / 3								
12–13 / 4								
15–16 / 5		Silty seam with fine to medium sand at 17'						
18–20 / 6								
21–23 / 7		Silty Seam at 23'						
24–26 / 8								
27–29 / 9								
30		End of Borehole	9.1					
31–32								

Logged: ZO
Method: SS Auger
Date: October 12, 2018

Datum: Existing Ground
Figure Number: A.02

Test Hole Log: TH18-03

File: 16523
Project: Proposed Residential Development
Client: Buffalo Investments
Site Location: St.George Street and Buller Street, Port Moody, BC

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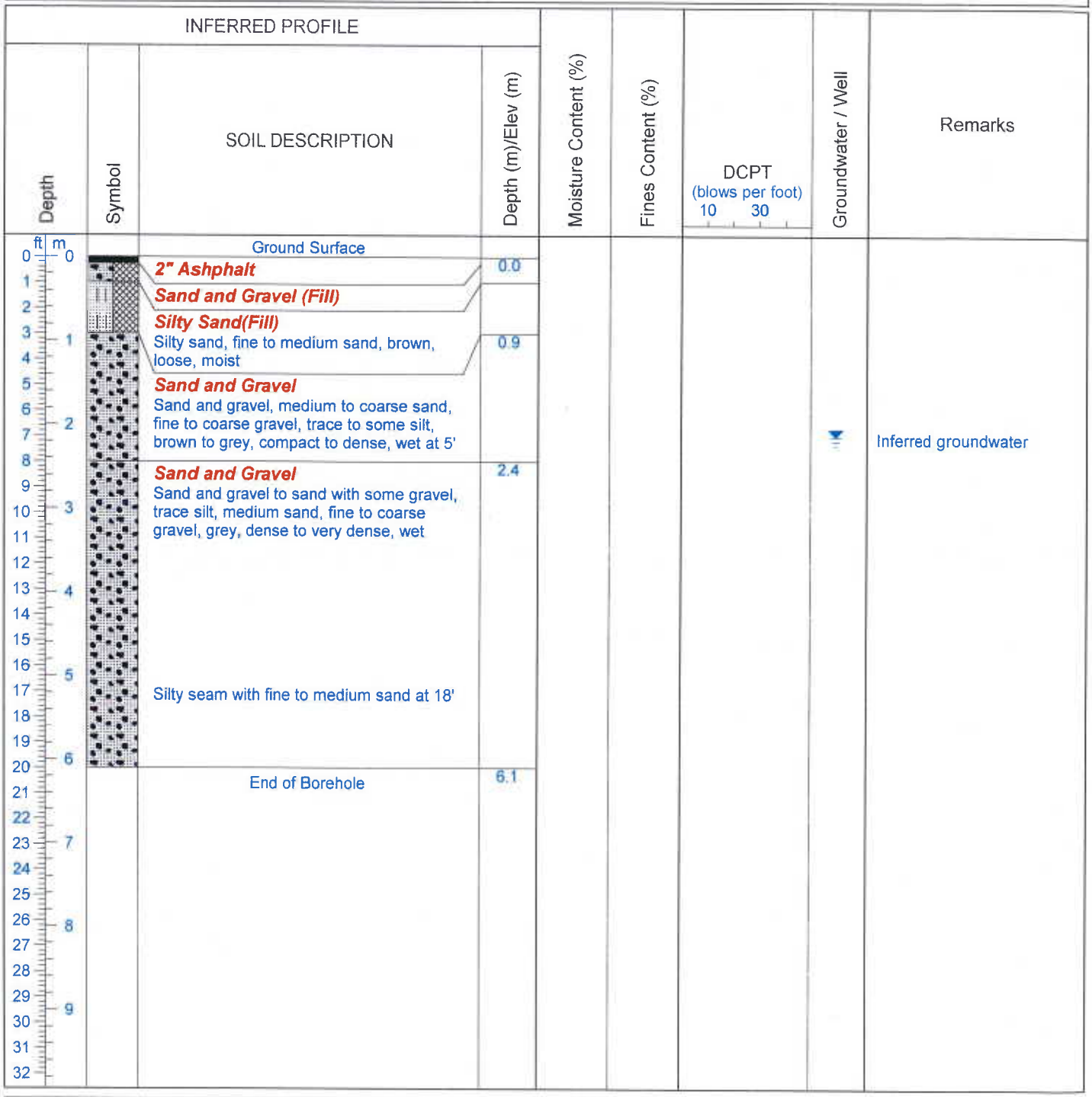

Logged: ZO
Method: SS Auger
Date: October 12, 2018

Datum: Existing Ground
Figure Number: A.03
Page: 1 of 1

Test Hole Log: TH18-04

File: 16523
Project: Proposed Residential Development
Client: Buffalo Investments
Site Location: St.George Street and Buller Street, Port Moody, BC

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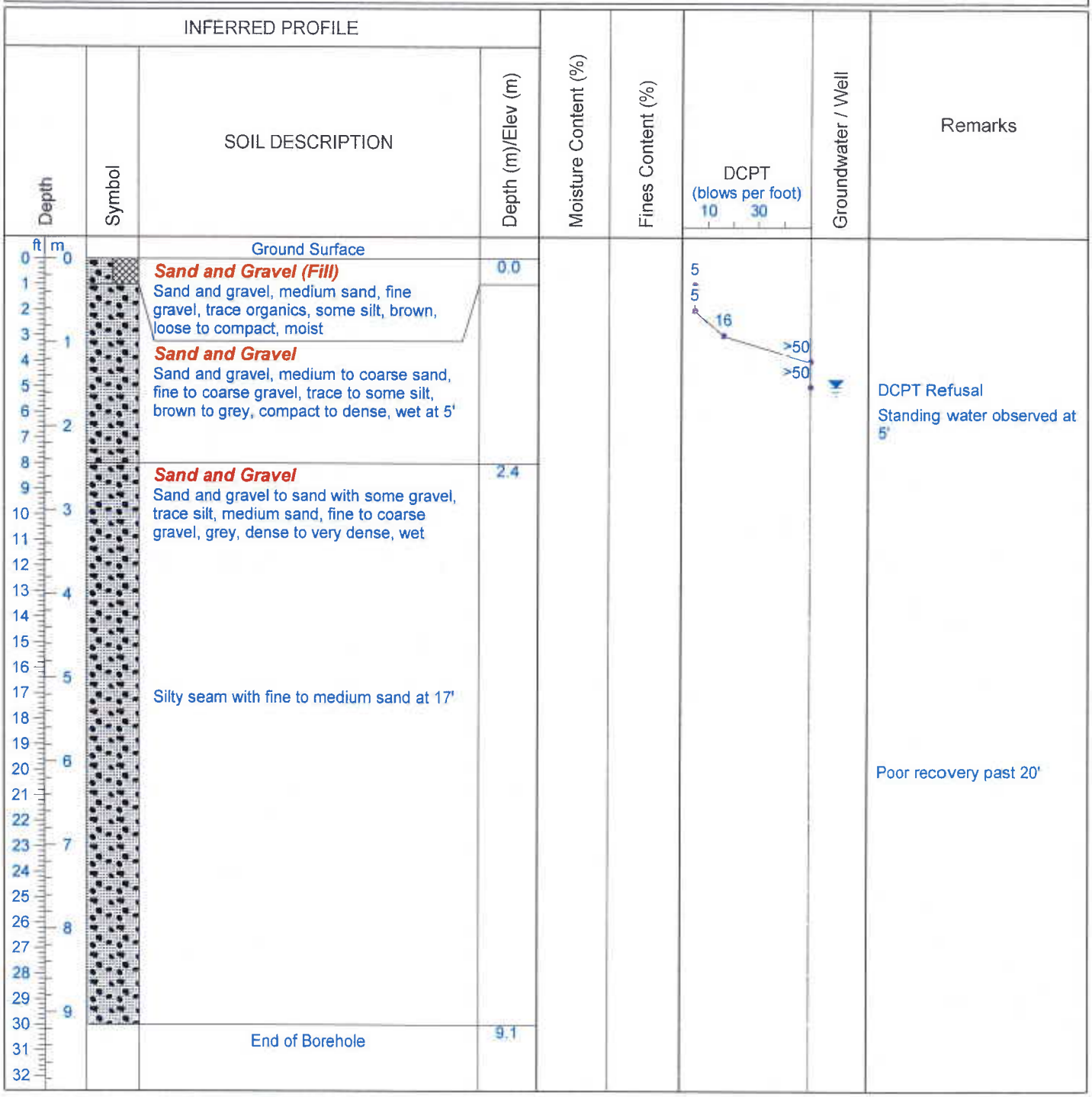

Logged: ZO
Method: SS Auger
Date: October 12, 2018

Datum: Existing Ground
Figure Number: A.04
Page: 1 of 1