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UBC Properties Trust
200 – 3313 Shrum Lane
Vancouver, BC
V6S 0C8

February 5, 2019
File: 16726

Attention: Nathan Ma

Re: Geotechnical Investigation Report, Proposed Office Development- TEF4
6190 Agronomy Road, Vancouver, B.C.

1.0 INTRODUCTION

We understand that an office development is proposed for the above referenced site on UBC Campus. Design drawings are not yet available, however we understand that the proposed development will include up to 10 storey office building over up to two levels of below grade parking.

This report presents the results of our geotechnical site investigation and makes geotechnical recommendations for the design and construction of the proposed development.

This report has been prepared exclusively for UBC Properties Trust, for their use, and for the use of others within their design and construction team although it remains the property of GeoPacific.

2.0 SITE DESCRIPTION

The site is located to the east of the Technology Enterprise Facility (TEF) and southwest of the intersection of Agronomy Road and Health Science Mall on the UBC campus. The site is bounded by Agronomy Road to the north, the TEF building to the west, Health Science Mall to the east and a parking lot to the south.

The site is undeveloped and is currently occupied by a parking lot. The site is essentially rectangular and is relatively flat. The location of the site relative to the surrounding improvements is shown on our Drawing No. 16726-01 included with this report.

3.0 FIELD INVESTIGATION

GeoPacific completed a geotechnical site investigation for this project on January 24, 2019. The investigation consisted of a review of geological maps, visual inspection, and augered test holes supplemented with dynamic cone penetration test (DCPT) soundings. A drill permit from UBC Campus & Community Planning department was obtained prior to drilling.

Prior to drilling, the test hole locations were cleared of underground services using geophysical methods by GeoPacific's utility locating personnel. The test holes were logged and sampled in the field by a member of our engineering team and backfilled and sealed immediately thereafter, in accordance with provincial groundwater protection regulations.

Four test holes were advanced using the subcontracted drilling services of Uniwide Drilling of Prince George. The test holes were advanced to a depth of 9.1 m below existing site grades. Two of the test holes were supplemented with DCPT soundings to help characterize the in-situ density of the soil.

The test hole locations are shown on our Drawing No. 16726-01 included with this report.

4.0 SUBSURFACE CONDITIONS

4.1 Soil Profile

The general geology of the region under investigation is described as Vashon glacial drift, overlying Quadra fluvial deposits with reference to the Geological Survey of Canada's map 1484A. The glacial drift is characterized as lodgement and minor flow till with lenses and interbeds of substratified glaciofluvial sand and gravel, including lenses and interbeds of glaciolacusterine stony silt. The Quadra fluvial deposits consist of channel fill and floodplain deposits; crossbedded sand with minor silt and gravel lenses.

A general description of the soils encountered at our test hole locations is given below.

Asphalt/Sand and Gravel (Fill)

Asphalt was encountered in all of our test holes and was found to be about 50 mm thick. The asphalt is underlain by compact sand and gravel fill with trace silt. The fill extended to depths of 0.9 to 1.8 m below existing site grades.

Silty Sand (Glacial Till)

The fill is underlain by glacial till deposits comprised of silty sand with some gravel. Some cobbles and occasional boulders are expected to be encountered during construction excavation. In-situ testing and drill observations indicate that this stratum is dense to very dense. These till-like deposits were found to extend to the full depth of our investigation.

Detailed soil descriptions are included on the test hole logs included in Appendix A.

4.2 Groundwater Conditions

We expect the presence of perched ground water to vary seasonally with generally higher perched groundwater levels in the wetter months of the year. The groundwater table was not identified in our investigation and is expected to be well below development grades. Perched groundwater may be encountered in the surficial fills and/or more permeable zones within the glacial till.

5.0 DISCUSSION

The proposed development is to consist of up to 10 storeys of reinforced concrete structure over up to 2 levels of below grade parking. We expect that the loading induced by the new development will be moderate to heavy with loads of up to 2,000 kN on columns and 120 kN per lineal metre on walls.

We expect that the contemplated structures can be supported on conventional spread foundation founded on the dense to very dense glacial till-like soils expected at foundation depth.

We expect that a shored excavation will be required where the below grade portion of the development is in close proximity to property lines, existing structures, roads and utilities. Our design recommendations for temporary excavations are provided in Section 6.6.

Some perched groundwater will likely be encountered while excavating and will need to be controlled. A graded excavation with sumps at low points should be adequate to control the anticipated groundwater inflow.

The soils at this site are not considered susceptible to liquefaction triggering or strain softening in consideration of the seismic hazard defined in the 2018 British Columbia Building Code (BCBC).

We confirm, from a geotechnical stand point, that the proposed office development is feasible provided the recommendations in this report are incorporated into the design and construction.

6.0 DESIGN RECOMMENDATIONS

6.1 Site Preparation

Site preparation associated with foundations and grade supported slabs includes removal of any asphalt, organic soils or topsoil, variable fill materials and any other material considered to compromise the design recommendations stated herein. However, as the development is to be constructed with a below grade component we expect that the depth of excavation will be driven by the architectural design rather than the soils encountered. Suitable bearing soils are expected to be encountered at the proposed foundation elevation.

Any soft, loose or disturbed material should be removed to allow for construction on the proposed subgrade in its natural undisturbed state. Following site preparation, the foundation subgrades should be blinded with lean mix concrete or 19 mm clear crush gravel for protection.

6.2 Foundations and Bearing Capacity

Footings which are founded on competent dense to very dense glacial till of silty sand, as described in Section 4.1, can be designed on the basis of a serviceability limit state (SLS) bearing pressure of 400 kPa for strip or pad footings.

Factored ultimate limit state (ULS) bearing pressures, for transient loads such as those induced by wind and earthquakes, may be taken as 2.0 x the SLS bearing pressures provided above.

We estimate for foundations designed as recommended, settlements will not exceed 25 mm total and 2 mm per metre differential.

Irrespective of the allowable bearing pressures given, pad footings should not be less than 600 mm by 600 mm and strip footings should not be less than 450 mm in width. Footings should also be buried a minimum of 450 mm below the surface for frost protection.

Adjacent footings should achieve a maximum elevation difference equal to half of their horizontal distance to avoid superimposing the upper foundation loading to the lower foundation.

Any foundations near any permanent slope must be reviewed by GeoPacific well in advance of construction.

Foundation subgrades must be inspected by the geotechnical engineer prior to footing construction

6.3 Seismic Design of Foundations

In accordance with the 2018 BC Building Code the buildings are to be designed for a seismic hazard with

2% probability of exceedance over a 50 year period which equates to an earthquake with a return period of 1 in 2,475 years. The design seismic hazard considers ground motions which would have a peak firm ground horizontal acceleration of 0.46 g at this location.

The seismic design parameters for this project should be based on "Site Class C" as defined in Table 4.1.8.4.A of the 2018 BC Building Code.

6.4 Grade Supported Concrete Slabs

In order to provide suitable support for slab-on-grade floors, we recommend that any fill placed under the slab should be "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 98% of the ASTM D698 (Standard Proctor) maximum dry density at a moisture content that is within 2% of optimum for compaction.

The floor slab should be underlain by a minimum of 150 mm of compacted 19 mm minus 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 under slab materials and compaction.

6.5 Foundation Drainage

A perimeter drainage system is considered necessary for the below grade structure to help prevent the development of hydrostatic pressure on the foundation walls or beneath parkade floor slab. We recommend that the mechanical design assume an inflow rate 30 liters/minute for the entire excavation for preliminary design purposes to be confirmed following excavation.

6.6 Excavation and Shoring

We expect that temporary excavations would be sloped where possible. Slopes within the fill and any other loose materials should be at a minimum gradient of 1.5H:1V or flatter. Slopes of 1:1 (H:V) in the native dense to very dense till-like soils are expected to be stable. All temporary excavation slopes should be reviewed by GeoPacific at the time of construction.

It should be appreciated that temporary cut slopes are only suitable when located at a safe distance away from existing structures, roads and utilities. Where the proposed development is near-to existing structures, property lines and utilities, vertical shoring may be required to support the excavations. An anchored reinforced shotcrete shoring system would be well suited for this project. The use of hollow core (IBO) anchors may be required where a drilled anchor hole will not remain open to allow the installation of a conventional anchor bar.

Our experience in this area indicates that cobbles and boulders may be present within the glacial deposits. Cobbles and small boulders can typically be removed with conventional excavation equipment. However, large boulders may require splitting/blasting to facilitate their removal from the site.

Water seepage into the excavation from within the surficial fill and topsoil and in the more permeable zones of the glacial till should be expected. We expect that groundwater inflows could be controlled with conventional sumps and sump pumps.

Temporary cut slopes in excess of 1.2 m in height must be covered in poly sheeting and require inspection

by a professional engineer in accordance with Work Safe B.C. guidelines, prior to man-entry.

6.7 Earth Pressures on Foundation Walls

We expect the foundation walls to be fully restrained at the location of intervening floors and somewhat flexible (capable of some rotation) between the floors. We assume that a vertical excavation cut will be supported using anchored shotcrete with a drained cavity between the shoring and foundation walls. Where a working space is utilized adjacent to a shored vertical wall, we assume pea gravel would be used as backfill.

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

Static: Triangular soil pressure distribution of 5 H (kPa), where H is equal to the total wall height in meters.

Seismic: Inverted triangular soil pressure distribution of 3.5 H (kPa), where H is equal to the total wall height in meters.

The preceding loading recommendations assume that the backfill is level behind the wall, and the wall is frictionless. The free groundwater will be lowered during the excavation and will be maintained lower by the drainage system to be installed so our earth pressures recommended above does not account for any hydraulic pressure.

Any additional surcharge loads located near the foundation walls should be added to the earth pressures given. All earth pressures provided herein are unfactored.

6.8 Utility Installation

Site utilities installation will be required beneath the slabs-on-grade. The design of these systems must consider the locations and elevations of the foundations. The service trenches and excavations required for the installation of the underground pipes, vaults and/or manholes must be located outside of a 1.5H:1V slope measured downward and outward from the edge of foundations.

All excavations and trenches must conform to the latest Occupational Health and Safety Regulation supplied by the Work Safe BC (WSBC). Any excavation in excess of 1.2 m in depth requiring worker-entry must be reviewed by a professional geotechnical engineer.

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. Field reviews are normally required at the time of the following activities:

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 familiarised with the sensitive aspects of the works proposed. It is the responsibility of the developer to notify GeoPacific Consultants Ltd. when conditions or situations not outlined within this document are encountered.

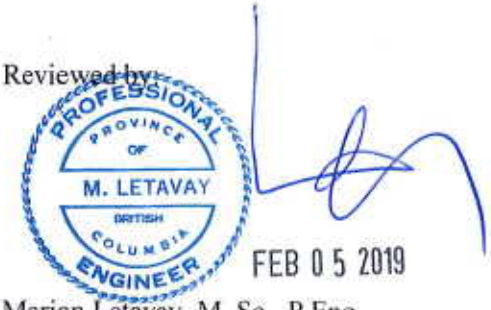
7.0 CLOSURE

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 should require any clarification or additional details.

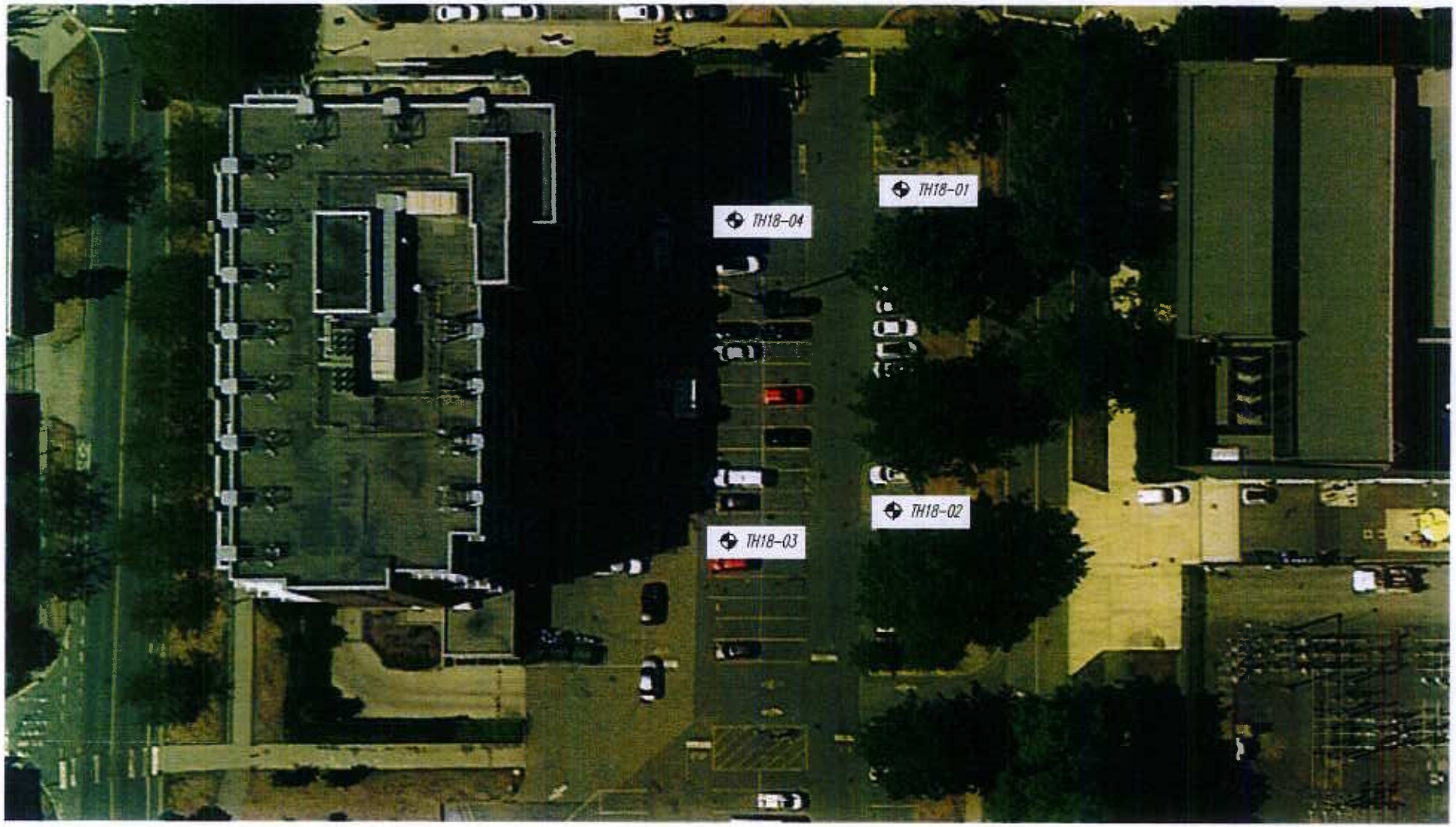
For:
GeoPacific Consultants Ltd.

Reviewed by:



Arye Lipshitz
Project Manager

Marian Letavay, M. Sc., P.Eng.
Senior Geotechnical Engineer



LEGEND:

TH18-# – TEST HOLE (TH) LOCATION

SITE PLAN
SCALE = NTS

REFERENCE:

GEOPACIFIC
VANCOUVER KAMLOOPS CALGARY
1779 W. 75th Avenue
Vancouver, B.C. V6P 6P2
P 604.439.0922
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DATE: January 24, 2019		
DRAWN BY: AL	APPROVED BY: MXL	REVIEWED BY:
SCALE: SEE ABOVE		

OFFICE BUILDING DEVELOPMENT
6190 AGRONOMY ROAD, VANCOUVER, BC
TEST HOLE LOCATIONS

FILE NO.: 16726
DWG. NO.: 16726-01

REVISIONS:
A
B
C

Appendix A

Test Hole Logs

Test Hole Log: TH19-01

File: 16726
Project: Proposed Office Building
Client: UBC Properties Trust
Site Location: 6190 Agronomy Road, Vancouver, BC

GEOPACIFIC CONSULTANTS
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INFERRED PROFILE

Depth (ft / m)	Symbol	SOIL DESCRIPTION	Depth (m)/Elev (m)
0 / 0		Ground Surface	
		Asphalt	
1 / 0		***Sand and gravel (Fill)*** Compact, trace silt, trace fine gravel, grey, moist	
5 / 1.5		***Silty sand (Glacial till)*** Dense to very dense, some fine gravel, fine to medium sand, grey, moist	
30 / 9		End of Borehole	9.1

Moisture Content (%): 10.1; 10.1; 9.5

DCPT (blows per foot): 10 20 30 40
28, 29, 17, 15, 22, 44, >50

Groundwater / Well

Remarks: DCPT refusal at 6'

Logged: AL
Method: Solid stem auger
Date: January 24, 2019

Datum: Ground surface
Figure Number: A.1.
Page: 1 of 1

Test Hole Log: TH19-02

File: 16726
Project: Proposed Office Building
Client: UBC Properties Trust
Site Location: 6190 Agronomy Road, Vancouver, 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) 10 20 30 40	Groundwater / Well	Remarks
0 / 0		Ground Surface					
0 / 0		***Asphalt***					
2 / 1		***Sand and gravel (Fill)*** Compact, trace silt, trace fine gravel, brown-grey, moist	0.9				
3 / 1		***Silty sand (Glacial till)*** Dense to very dense, some fine gravel, fine to medium sand, grey, moist					
29 / 9			9.1				
30 / 9		End of Borehole					

Logged: AL
Method: Solid stem auger
Date: January 24, 2019

Datum: Ground surface
Figure Number: A.2.
Page: 1 of 1

Test Hole Log: TH19-03

File: 16726
Project: Proposed Office Building
Client: UBC Properties Trust
Site Location: 6190 Agronomy Road, Vancouver, 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) 10 20 30 40	Groundwater / Well	Remarks
0 / 0		Ground Surface					
0–3 / 0–1		**Asphalt**					
		Sand and gravel (Fill) Compact, trace silt, trace fine gravel, brown-grey, moist	1.2		25, 22, 44, >50		DCPT refusal at 4'
3–30 / 1–9		**Silty sand (Glacial till)** Dense to very dense, some fine gravel, fine to medium sand, grey, moist		10.8 10.7			
30 / 9		End of Borehole	9.1				

Logged: AL
Method: Solid stem auger
Date: January 24, 2019

Datum: Ground surface
Figure Number: A.3.
Page: 1 of 1

Test Hole Log: TH19-04

File: 16726
Project: Proposed Office Building
Client: UBC Properties Trust
Site Location: 6190 Agronomy Road, Vancouver, BC

GEOPACIFIC CONSULTANTS
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Depth (ft / m)	Symbol	INFERRED PROFILE: SOIL DESCRIPTION	Depth (m)/Elev (m)	Moisture Content (%)	DCPT (blows per foot) 10 20 30 40	Groundwater / Well	Remarks
0 / 0		Ground Surface					
0		***Asphalt***					
1		***Sand and gravel (FIII)*** Compact, trace silt, trace fine gravel, brown-grey, moist					
6			1.8				
2		***Silty sand (Glacial till)*** Dense to very dense, some fine gravel, fine to medium sand, moist					
3		2-6' weathered					
4		6'-30 grey					
5							
6							
7							
8							
9			9.1				
10		End of Borehole					
11							
12							

Logged: AL
Method: Solid stem auger
Date: January 24, 2019

Datum: Ground surface
Figure Number: A.4.
Page: 1 of 1