GEOPACIFIC
VANCOUVER KAMLOOPS CALGARY

1779 West 75 Avenue
Vancouver, BC
V6P 6P2
604-439-0922

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

January 17, 2018
File: 15716

Attention: Nathan Ma

Re: Geotechnical Investigation Report, Proposed Residential Development
Lot 4, UBC South Campus, Vancouver, B.C.

1.0 INTRODUCTION

We understand that a residential development is proposed for Lot 4 on the UBC South Campus. Design drawings are not yet available, however we understand that the proposed development will include a 6 storey wood framed residential building over 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 on Birney Avenue, southeast of the intersection of Birney Avenue and Webber Lane on the UBC south campus. The site is bounded by Birney Avenue to the north, mid-rise developments to the east and south and a vacant lot to the west. Mundell Park is located along to the southwest of the site.

The site is undeveloped and is currently covered with grass and bushes. The site is of irregular shape with dimension of about 50 m in the north to south direction and 95 m in the east to west direction. The site slopes gently from north to south with an elevation differential of about 2 m.

The location of the site relative to the surrounding improvements is shown on our Drawing No. 15716-01 included with this report.

3.0 FIELD INVESTIGATION

3.1 Site Investigation

GeoPacific completed a geotechnical site investigation for this project on December 21, 2017. 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 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 by a geotechnical technician from our office and backfilled after logging and sampling.

Five test holes were advanced using the subcontracted drilling services of Uniwide Drilling. The test holes were advanced to depths of 9.1 to 12.2 m below 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. 15716-1 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.

Topsoil

Topsoil was identified in all our test holes and found to be about 0.3 m thick, however the thickness of the topsoil could vary greatly between test holes.

Sand and Gravel/Silty Sand (Fill)

In general, the topsoil is underlain by fill comprised of sand and gravel and silty sand which was found to extend to depths ranging from 0.6 m to 0.9 m below grade. The fill material at test hole TH17-03 extended to a depth of 4.3 m and contained some organics. Based on our observations and DCPT soundings the fill materials are compact.

Silty Sand/Silty Sand (Glacial Till)

The fill materials are underlain by glacial till comprised of sand and gravel and silty sand. The sand and gravel contained trace to some silt. Some cobbles and occasional boulders are expected. 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

Groundwater was encountered at test holes TH17-01 to TH17-03 at depths of 4.8 to 5.1 m below site grades which is assumed to be perched within more permeable layers of the soil profile. Perched groundwater is likely to develop during the wetter months of the year within the surficial fills and the more permeable zones within the glacial till. Groundwater seepage during excavation, from within the glacial till, is expected to be moderate.

5.0 DISCUSSION

5.1 General

The proposed development is to consist of 6 storeys wood frame construction over up to 2 levels of below grade parking. We expect that the loading induced by the new development will be moderate with loads of up to 1,200 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 6.5.

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.

We confirm, from a geotechnical stand point, that the proposed building 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 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 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 concrete or 19 mm clear crush gravel for protection.

6.2 Foundations and Bearing Capacity

Foundations placed on very dense glacial till may be designed on the basis of a serviceability limit state (SLS) bearing pressure of 500 kPa and a factored ultimate limit state (ULS) bearing pressure of 750 kPa.

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. All footings should also be buried a minimum of 450 mm below the surface for frost protection.

Post construction settlement of foundations designed as recommended should be less than 25 mm total and 20 mm over 10 m span.

6.3 Seismic Design of Foundations

In accordance with the 2012 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 soils at this site are not considered susceptible to liquefaction triggering or strain softening in consideration of the seismic hazard defined in the 2012 British Columbia Building Code (BCBC).

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 2012 BC Building Code.

6.4 Grade Supported Concrete Slabs

Any reinstatement beneath grade supported slabs should be completed with 19 mm clear crush gravel compacted in 300 mm loose lifts under the review of GeoPacific. We recommend a minimum of 150 mm of 19 mm clear crush gravel below the slab.

6.5 Excavation and Shoring

We expect that temporary excavations would be sloped where possible. Slopes within the topsoil and fill and loose materials should be 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 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 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.

6.6 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 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.

6.7 Utility Installation

Site utilities 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 Worker Compensation Board (WCB) of British Columbia. Any excavation in excess of 1.2 m in depth requiring worker-entry must be reviewed by a professional geotechnical engineer.

6.8 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 50 liters/minute for the entire excavation for preliminary design purposes to be confirmed following excavation.

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:

January 17, 2018

Arye Lipshitz
Engineering Technician

Steven Fofonoff, M. Eng. P.Eng.
Principal

LEGEND:

TH17-# - TEST HOLE (TH) LOCATION

SITE PLAN

SCALE = NTS

N
W
E
S

REFERENCE:

GEOPACIFIC
VANCOUVER KAMLOOPS CALGARY

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

P 604.439.0922
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DATE: December 21, 2017		
DRAWN BY: AL	APPROVED BY: SMF	REVIEWED BY:
SCALE: SEE ABOVE		

Residential Development

Birney Avenue and Shrum Lane, UBC

Test Hole Locations

FILE NO.: 15716

DWG. NO.: 01

REVISIONS:
A.
B.
C.

ORIGINAL PAPER SIZE 8.5"x11"

Test Hole Log: TH17-01

File: 15716
Project: Residential Development
Client: UBC Properties Trust
Site Location: Birney Avenue and Shrum Lane, UBC

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	0.3
		Sand and gravel (Fill) Compact, trace silt, sub-rounded gravel, brown, moist	0.9
1 / 2		***Silty sand (Till)*** Compact to very stiff, trace to some fine gravel, moist to wet	
3 / 4		3' to 6' mottled, grey-brown	3.7
5 / 6		8' to 12' very stiff, grey	
		Sand (Till) Dense to very dense, trace to some silt, fine to medium grained sand, grey, moist to wet	
7 / 8		30' to 40' pockets of silt	
9 / 10			
11 / 12			12.2
		End of Borehole	
13 / 14			
15 / 16			
17 / 18			
19 / 20			

Moisture Content (%)

DCPT (blows per foot) 10 20 30 40

Groundwater / Well: ▼ Groundwater at 17'

Remarks

Logged: AL
Method: Soild stem auger
Date: December 21, 2017

Datum: Ground surface
Figure Number: A.1.

Test Hole Log: TH17-02

File: 15716
Project: Residential Development
Client: UBC Properties Trust
Site Location: Birney Avenue and Shrum Lane, UBC

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INFERRED PROFILE

Depth (ft / m)	Symbol	SOIL DESCRIPTION	Depth (m)/Elev (m)
0 / 0		Ground Surface	
0 / 0		***Topsoil*** Grass on top, sand, roots, dark brown	0.3
1 / 0		***Sand and gravel (Fill)*** Compact, trace silt, sub-rounded gravel, brown, moist	0.6
2 / 1		***Sand (Till)*** Dense to very dense, trace to some silt, fine to medium grained sand, grey, moist to wet	
3 / 1			
4 / 2			
5 / 2			
6 / 2			
7 / 2			
8 / 3			
9 / 3			
10 / 3			
11 / 4			
12 / 4			
13 / 4			
14 / 4			
15 / 5			
16 / 5			
17 / 5			
18 / 5			
19 / 6			
20 / 6			
21 / 6			
22 / 6			
23 / 7			
24 / 7			
25 / 7			
26 / 8			
27 / 8			
28 / 8			
29 / 8			
30 / 9			
31 / 9			
32 / 9			
33 / 10			
34 / 10			
35 / 10			
36 / 11			
37 / 11			
38 / 11			
39 / 12			12.2
40 / 12		End of Borehole	
41 / 12			
42 / 13			
43 / 13			
44 / 13			
45 / 13			
46 / 14			
47 / 14			
48 / 14			
49 / 15			
50 / 15			

Moisture Content (%)

DCPT (blows per foot)
10 20 30 40
25
45
>50

Groundwater / Well

Groundwater at 16'

Remarks

DCPT refusal at 3'

Logged: AL
Method: Soild stem auger
Date: December 21, 2017

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

Test Hole Log: TH17-03

File: 15716
Project: Residential Development
Client: UBC Properties Trust
Site Location: Birney Avenue and Shrum Lane, UBC

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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					
1 / 0		***Topsoil*** Grass on top, sand, roots, dark brown	0.3				
2 / 0			0.6				
3 / 1		***Silty sand (Till Fill)*** Compact, some gravel, fine grained sand, grey, moist					
4 / 1							
5 / 2		***Sand and gravel (Fill)*** Compact, trace to some organics, trace to some silt, roots, branches, dark brown, moist to wet					
6 / 2							
7 / 2							
8 / 3							
9 / 3							
10 / 3							
11 / 3							
12 / 4							
13 / 4			4.3				
14 / 4		***Sand (Till)*** Dense to very dense, some gravel, trace to some silt, fine to medium grained sand, grey, moist to wet					
15 / 5						▼	Groundwater at 16'
16 / 5							
17 / 5							
18 / 5							
19 / 6							
20 / 6							
21 / 6							
22 / 6							
23 / 7							
24 / 7							
25 / 7							
26 / 8							
27 / 8							
28 / 8							
29 / 8							
30 / 9			9.1				
31 / 9		End of Borehole					
32 / 9							
33 / 10							
34 / 10							
35 / 10							
36 / 11							
37 / 11							
38 / 11							
39 / 12							
40 / 12							
41 / 12							
42 / 13							
43 / 13							
44 / 13							
45 / 13							
46 / 14							
47 / 14							
48 / 14							
49 / 14							
50 / 15							

Logged: AL
Method: Soild stem auger
Date: December 21, 2017

Datum: Ground surface
Figure Number: A.3.

Test Hole Log: TH17-04

File: 15716
Project: Residential Development
Client: UBC Properties Trust
Site Location: Birney Avenue and Shrum Lane, UBC

GEOPACIFIC CONSULTANTS
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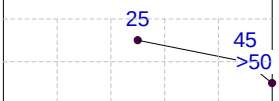
INFERRED PROFILE

Depth (ft / m)	Symbol	SOIL DESCRIPTION	Depth (m)/Elev (m)
0 / 0		Ground Surface	
0 / 0		***Topsoil*** Grass on top, sand, roots, dark brown	0.3
1 / 0		***Sand and gravel (Fill)*** Compact, trace silt, sub-rounded gravel, brown, moist	0.6
2 / 1		***Sand (Till)*** Dense to very dense, trace to some silt, fine to medium grained sand, grey, moist to wet	
3 / 1			
4 / 1			
5 / 1			
6 / 2			
7 / 2			
8 / 2			
9 / 3			
10 / 3			
11 / 3			
12 / 4			
13 / 4			
14 / 4			
15 / 5			
16 / 5			
17 / 5			
18 / 6			
19 / 6			
20 / 6			
21 / 7			
22 / 7			
23 / 7			
24 / 8			
25 / 8			
26 / 8			
27 / 9			
28 / 9			
29 / 9			
30 / 10			
31 / 10			
32 / 10			
33 / 11			
34 / 11			
35 / 11			
36 / 11			
37 / 12			
38 / 12			
39 / 12			12.2
40 / 12		End of Borehole	
41 / 13			
42 / 13			
43 / 13			
44 / 13			
45 / 14			
46 / 14			
47 / 14			
48 / 14			
49 / 15			
50 / 15			

Moisture Content (%)

DCPT (blows per foot) 10 20 30 40



Groundwater / Well

Remarks

DCPT refusal at 3'

Logged: AL
Method: Soild stem auger
Date: December 21, 2017

Datum: Ground surface
Figure Number: A.4.

Test Hole Log: TH17-05

File: 15716
Project: Residential Development
Client: UBC Properties Trust
Site Location: Birney Avenue and Shrum Lane, UBC

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	
0 / 0		***Topsoil*** Grass on top, sand, roots, dark brown	0.3
2 / 0.6		***Sand and gravel (Fill)*** Compact, trace silt, sub-rounded gravel, brown, moist	0.6
2 / 3		***Sand (Till)*** Dense to very dense, trace to some silt, fine to medium grained sand, grey, moist to wet	
29 / 9		End of Borehole	9.1

Moisture Content (%)

DCPT (blows per foot) 10 20 30 40

Groundwater / Well

Remarks

Logged: AL
Method: Soild stem auger
Date: December 21, 2017

Datum: Ground surface
Figure Number: A.5.