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Our File: 1930

Attention: Chinna Reddy Katireddy, M.Com, MBA, MSc(IT);

Re: Geotechnical Assessment for Proposed New Condominium Development Located at 262 2nd Street, Duncan, B.C.

1.0 INTRODUCTION

As requested, Phillips & Associates Engineering Consultants Ltd. (Phillips & Associates) has completed a preliminary geotechnical assessment of the above referenced property. This report is in addition to the geotechnical report by Brimmell Engineering Ltd., dated January 24/17. Based on drawings provided by Christopher Fryling Architect (dated 06/27/21), we understand that the proposed development will consist of three-storey, six-unit building with surface parking within the southerly third of the property.

The purpose of this report is to provide subsoil information and recommendations pertaining to site preparation, foundation design, sub-drainage, shoring & excavation, and backfill for the construction of the proposed new residence.

This geotechnical assessment is based on our site investigation, and knowledge of local subsurface conditions in the area. This report was prepared exclusively for Chinna Reddy Katireddy and for the use of their design and construction team. We understand the report may be used for permitting purposes by the City of Duncan.

2.0 SITE DESCRIPTION

2.1 Site Description

The property is located on the south side of 2nd Street, Duncan. The property fronts along 2nd Street and is bound to the east and west by neighbouring residencies and a laneway to the south. The existing bungalow house was located centrally within the lot. The existing dwelling has been demolished and the site is vacant. The proposed setback distance for the proposed new residence, from the north property line, is approximately 3.1 m.

The total length of the lot is approximately 36.6 m north to south and 18.3 m in width east to west.
No elevation data was present at the time of writing this report. The site appears level, with minimal elevation change across the site.

2.2 Surficial Geology

The surficial geology of the project was reviewed. Surficial geology mapping by E. C. Halstead[1] indicates the site is underlain by Salish Sediments – shore, deltaic and fluvial deposits: gravel, sand, silt, clay; on average less than 5 ft in thickness. Salish Sediments are underlain with Capilano Sediments – fluvial deposits: deltaic deposits, gravel and sand, commonly terraced. The subject site is located along the boundary of a disused gravel pit.

Similarly, surficial geology mapping by H. E. Blyth and N. W. Rutter[2] indicates the site is underlain by fluvial materials, consisting of gravel, sand or silt deposited by streams and rivers, including floodplains, river terrace, delta and alluvial fan sediments.

3.0 SUBSURFACE INVESTIGATION

3.1 Field Program

Borehole drilling, overseen by Brimmell Engineering Ltd, was conducted on September 23, 2016 to conduct a geotechnical investigation of the subsurface conditions at the property. The investigation consisted of a general visual review of the site and two boreholes designated Borehole 1 (BH 1) and Borehole 2 (BH 2), drilled to a maximum depth of 6.1 m (20 ft) below existing grade. The boreholes were drilled using a track-mounted drill; see photos following text of report by Brimmell Engineering Ltd, dated January 24/17. A borehole location plan, produced by Brimmell Engineering Ltd, is provided, following the text of this report.
During drilling, Dynamic Cone Penetration Testing (DCPT) was conducted at both borehole locations to assess the relative density/consistency of subsurface soils. Soil conditions were logged by Brimmell Engineering Ltd in accordance with the Unified Soil Classification System (USCS).

3.2 Soil Conditions

The following tables are a summarized description of the soil profile based upon the borehole logs provided in the report by Brimmell Engineering Ltd, dated January 24/17. Detailed descriptions of the soil strata encountered are provided on the borehole log in the report by Brimmell Engineering Ltd. It should be noted that the transitions between the classified soil units are gradual rather than the distinct unit boundaries as shown on the borehole log.

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[1] Halstead, E.C., 1966. *Surficial Geology, Duncan, British Columbia.* Geological Survey of Canada, Map 14-1965, 1:63,360 scale.

[2] Blyth, H.E., and Rutter, N.W., 1993. *Surficial geology of the Duncan area (NTS 92B/13).* British Columbia Ministry of Energy, Mines and Petroleum Resources, British Columbia Geological Survey Open File 1993-27, 1:50,000 scale.

Table 1 – Borehole 1 Soil Profile

Depth (m)	Layer	Density/Consistency	Description
0 – 0.4	Fill	Compact	SAND, gravelly, brown (driveway fill).
0.4 – 1.4	Sand	Loose to Compact	SAND, silty, grey.
1.4 – 1.9	Silt	Loose	SILT, sandy, grey, moist.
1.9 – 3.3	Peat	Soft	PEAT, fibrous, dark brown.
3.3 – 5.5	Silt	Loose to Stiff	SILT, sandy, some organics, grey, saturated.
5.5 – 6.1	Gravel	Dense to V. Dense	GRAVEL, sandy, brown, saturated.

Table 2 - Borehole 2 Soil Profile

Depth (m)	Layer	Density/Consistency	Description
0 – 0.3	Topsoil	NA	Sandy, dark brown.
0.3 – 1.0	Sand	Loose	SAND, fine grained, silty, mottled brown.
1.0 – 1.5	Silt	Loose	SILT, grey, moist.
1.5 – 2.0	Sand	Loose	SAND, coarse grained, some gravel, grey, saturated
2.0 – 3.0	Peat	Soft	PEAT, fibrous, black.
3.0 – 5.2	Silt	Loose to Stiff	SILT, sandy, some organics, grey, saturated.
5.2 – 6.1	Gravel	Dense to V. Dense	GRAVEL, sandy, brown, saturated.

At both borehole locations, DCPT yielded very low blow counts from 1.5 m to 4 m below existing grade. High blow counts were recorded in the gravel stratum, indicative of dense ground conditions.

It is important to note that the soil and groundwater conditions described above and encountered at the specific borehole location are representative of the conditions in the immediate vicinity of the borehole. Extrapolation and interpretation of the subsurface conditions is formulated based on an assumed horizontal continuity of the subsurface conditions across the site. Therefore, the geology described in our report is generalized and based on specific borehole information only. Variation in the stratigraphic conditions should always be expected. Where fill soils or organic rich topsoils are encountered and described, little to not lateral continuity should be assumed. It should also be expected that the thickness and condition of fill soils may differ substantially from conditions encountered at the borehole locations.

3.3 Ground Water

Groundwater levels, gradients and flow rates can be difficult to assess due to the variability of the soil conditions throughout the site, challenges with isolating underground layers for measurement, and changes in level in response to climatic conditions. The drilled borehole provides a pathway for groundwater flows to infiltrate and fill the void of the borehole. During drilling, seepage was noted in both boreholes. Groundwater stabilized to approximately 1.5 m (5 ft) below grade after drilling.

Generally, at the site, groundwater layers can be expected within the permeable stratum (peat) preceding a relatively impermeable stratum (sandy silt). Groundwater levels and seepage flows are expected to fluctuate seasonally and in response to climatic conditions. We expect that the groundwater levels measured represent the stabilized water level during the autumnal season.

4.0 DISCUSSION & RECOMMENDATIONS

4.1 General

Based on our review of the architectural plans provided, we understand that the proposed development is expected to consist of the construction of a single structure, split up into six individual units, with surface parking at the south side of the main structure. The new construction is expected to consist of conventional wood framing and pre-engineered wood products. No elevation data was provided for the proposed new residence at the time of writing this report.

The bearing soils underlying the site, at approximately 1.5 m to 4 m below existing grade, do not provide suitable soil bearing resistance. Peat deposits are highly compressible. Any foundations constructed on peat would be susceptible to both primary consolidation settlement and secondary compression settlement which would exceed the serviceable limit state of the structures. Based on the ground conditions observed at the borehole locations, we recommend the proposed development be supported on piled foundations.

To avoid post-construction differential settlements, we recommend supporting any exterior stairs and landings, if applicable, with piles unless they are cantilever from the main structure(s).

As noted in the geotechnical report by Brimmell Engineering Ltd, dated January 24/17, it is most likely that the site conditions will provide adequate support for pavements, sidewalks, patios and driveways/parking areas, provided grades are not raised more than 0.3 m above existing grades.

4.2 Site Preparation

Site preparation for the pile caps and grade beams (spanning between piles/pile caps) will require the removal of the existing structures on the site. We expect the site to be underlain by soft peat soils. We recommend excavation 0.3 m (1 ft) below the design grade beam/pile cap elevation. Following excavation, we recommend placing a geotextile filter fabric to provide a separating barrier. Following geotextile placement, we recommend placing imported 19 mm (3/4") clear crushed gravel fill or an approved alternative. We recommend a total fill thickness of 0.6 m (2 ft) to bring the grade up to approximately 0.3 m (1 ft) above the design bottom of grade beam/pile cap elevation. We expect the fill along with the surcharge of helical pile installation equipment to provide initial consolidation of the peat. The preload fill should remain in place for at least four weeks before pile installation. Following pile installation, we recommend the 'neat trenches' be excavated to the design elevations, within the fill, for pile caps and grade beams.

For any groundwater control that may be required, we recommend installing a shallow well point near the centre of the excavation. The well could consist of a 200 mm (8") outside diameter pipe installed to a depth of 0.9 m (3 ft), with perforations in its below grade section. When dewatering is necessary, the well point would be evacuated using a conventional pump, effectively drawing excess water from the clear crush gravel fill. It may be prudent to plan water outfall prior to construction. If sediment control is required, provisions should be made prior to beginning excavation.

4.3 Pile Supported Foundations

4.3.1 Helical Piles

We recommend using helical for cost savings in lieu of driven steel piles/timber piles or drilled cast-in-place concrete piles. Helical piles are installed using torque head mounted excavators which enables small site access. Helical piles consist of a helical bearing plate or multiple plates attached to a central shaft.

When installed to the proper depth and torque, the helical plates act as individual bearing elements to support a load. The helical pile is therefore a deep, end bearing foundation that can be used to resist both compressive and tensile loads.

The piles should be set in the dense to very dense gravel, which begins at about 5.5 m below grade. A minimum of 1.5 m embedment into the dense to very dense gravel results in expected pile lengths of 7 m. We would expect helical piles of shafts of 3.5" to 4.5" outside diameter to be adequate. Phillips & Associates can provide pile capacities for a range of pile sizes for selection based on structural design requirements, cost and availability.

Should the client choose to support the residences on deep foundations consisting of helical piles, Phillips & Associates can provide the detailed pile design. Detailed pile design is expected to consist of providing design and recommendations for:

- Factored Geotechnical Axial Resistance
- Buckling
- Uplift Resistance
- Lateral Load Resistance
- Pile caps & Spacing
- Load Testing
- Monitoring Requirements

4.3.2 Timber Piles

Alternatively, new, or good quality used, treated Douglas fir piles may be opted for. Timber piles are generally driven with a crane-mounted drop hammer. Adequate seating may be anticipated at about 6 m (20 ft) depth based upon borehole findings.

Should the client choose to support the residences on deep foundations consisting of timber piles, Phillips & Associates can provide the detailed pile design. Detailed pile design is expected to consist of providing design and recommendations for:

- Factored Geotechnical Axial Resistance
- Buckling
- Uplift Resistance
- Lateral Load Resistance
- Pile caps & Spacing
- Load Testing
- Monitoring Requirements

4.4 Shoring

Based on our understanding of the proposed development, we expect an excavation depth of approximately 1.2 m is necessary for preparation of the site for pile caps and grade beams, as per Section 4.2. To support this excavation depth, we anticipate that conventional cut slopes around all sides of the proposed development at 1.5H:1V will be sufficient.

Cut slopes to be covered with 6 mil poly sheeting to protect from erosion. Poly sheeting to be secured in place to resist wind action. No stockpiles/heavy equipment to be within a distance equal to the depth of excavation.