It should be appreciated that temporary cut slopes are only available when located a safe distance away from existing structures, tree protection zones, roads, neighbouring lots, and utilities. We recommend all supporting soils within the load path of existing structures or foundations remain undisturbed (1.5H:1V down & away).

Temporary cut slopes more than 1.2 meters (4 ft) in height require inspection by a professional engineer prior to worker entry in accordance with the Work Safe BC guidelines. Upon site review the engineer will assess the excavation slope stability based on actual site conditions and may provide revised or additional recommendations

4.5 Slab-On-Grade Floors & Suspended Slab Floors

Slab-on-grade floors are not appropriate when placed directly onto peat. Suspended slabs should be used to span between the grade beams, which are then supported on piles.

Alternatively, we recommend that any fill placed under the slab be 19 mm clear crush gravel, well compacted in 300 mm loose lifts. We recommend this layer be a minimum of 300 mm thickness to provide capillary break and act as a drainage layer. We further recommend that the prepared subgrade be overlain by a polyethylene moisture barrier to inhibit any upward migration of moisture beneath the concrete suspend.

4.6 Methane

Decomposition of the peat and deleterious matters at the site in anaerobic conditions would result in generation of methane gas. Methane gas is non-toxic, colourless, odourless, and is lighter than air. It can build up below the slab. Although it is non-toxic, it is considered an asphyxiant because it displaces oxygen. Also, if confined, it can be a potentially explosive. Thus, installation of a methane gas collection system below the slab is recommended. This system should consist of 3 lines of 3" perforated pipes running the length of each building and spaced evenly apart. These pipes should be connected to a perforated header pipe at one end. From the header pipe, the subslab system should be connected to positive outlet through roof ventilation pipe extended above the roof.

In addition, we recommend placing a vapour barrier below the slab. The vapour barrier should consist of at least 15 mil polyethylene sheeting that is continuous without rips. Where necessary, joints between sheets, and around pile penetration or plumbing pipes, should be overlapped at least 18" and be securely glued and taped.

Natural and/or mechanical ventilation should be provided within each residence for the purpose of preventing methane gas accumulation. Methane gas detection system should also be installed.

4.7 Backfill

Post-construction settlement is difficult to predict due to variations in rate of decomposition of the peat, frequency of rise and fall of the water table, and neighbouring construction influences. It can be possible for up to 4" – 8" of total post-construction settlement to occur within the first year of construction completion in the areas of the site that are not pile supported. At minimum we recommend supporting critical accessory structures such as staircases on piles. For any cast-in-place concrete finishing we recommend use of generous amounts of reinforcement to control slab cracking. It may also be prudent to consider having walkways, or patios structurally tied-in to the building foundation, however such decisions should be made in consultation with the structural consultant.

For accessory structures such as walkways, landings, patios, and pavers, we recommend that a flexible finishing be used such as brick pavers, concrete tiles, or asphalt paving, for ease of future repair. For adequate support, we recommend placing engineered fill underlain by a geotextile filter fabric to provide layer separation. Engineered fill is defined as sand and gravel with less than 5% passing the #200 sieve. Engineered fill should be compacted to a minimum 95% of Modified Proctor Maximum Dry Density (MPMDD), as per ASTM D1557, at a moisture content that is within 2% of optimum for compaction. All fill materials should be placed in lift thicknesses compatible with the compaction equipment being used, to a maximum lift thickness of 300 mm. For critical accessory structures it may be prudent to consider placing a bi-axial geogrid, such as Nilex BX-1400, within mid-layer of the engineered fill to evenly distribute loads and reduce settlements.

Alternatively, provided grades are not raised more than 0.3 m above existing grades, the site conditions should be adequate for support of pavements, sidewalks, patios, driveways and parking areas without use of flexible finishing products.

Proposed grades should slope away from the building to promote flow of surface water runoff away from the building. This grading should extend beyond the backfill zone.

The placement of backfill to be monitored by a representative of Phillips & Associates to confirm that the placed fill is suitable for the intended purpose. All backfill should be placed in a manner that avoids damaging the foundation wall, drainage tile, and damp-proofing or waterproofing on the wall.

Phillips & Associates should be contacted for review of backfill materials and procedures.

4.8 Perimeter Drainage & Underground Services

A perimeter drain should be installed at the base of footing elevation consisting of a 4-inch (100 mm) diameter perforated PVC pipe surrounded by 6 inches (150mm) of ¾ inch (19mm) clear crushed gravel or drain rock wrapped with ARMTEC 150 or equivalent filter fabric. The perimeter drain should be installed such that the top of the perforated pipe is beneath the underside of the adjacent slab or crawl space skim coat. The perimeter drain should be connected to a pumped sump or a suitable gravity outlet. Normal damp proofing should be sufficient for control of moisture ingress provided the excavation is backfilled with free draining sand or sand and gravel, however we suggest that a synthetic drainage board should be placed against the foundation wall to separate the backfill soils from the foundation wall, thereby creating a secondary barrier against moisture penetration. All other aspects of construction should meet the requirements of the British Columbia Building Code 2018.

For underground services, flexible connections should be provided to accommodate differential settlements (estimated in the order of 4 in) between the yard area and the non-settling building. Plumbing pipes below the ground floor slab should be adequately supported with approved hangers tied to the slab reinforcement or as designed by the structural consultant. Perimeter rainwater leaders and drain tile, where used, should also be tied to the perimeter of the building foundation. Treated cedar planks (3 in by 12 in) may be required to be placed below the pipes where strapping is not possible, as well as at the base of the concrete sumps to reduce potential future settlement.

As noted in the geotechnical report by Brimmell Engineering Ltd. dated January 24/17, based upon the soil conditions and the high-water table present at the site, the site is not well-suited to on-site infiltration of stormwater. To limit the post-development runoff to the City's storm sewers, to pre-development conditions, a below grade detention tank is most likely required.

4.9 Seismic Assessment

Based on the current level of geotechnical data, we recommend that the structure be designed based on a Class D design spectrum in accordance with Table 4.1.8.4.A of the British Columbia Building Code 2018.

Primarily the upper peat and loose sand/silt are not susceptible to liquefaction, however, they may be susceptible to softening as peat deposits are expected to have little to no lateral strength. The very dense sandy gravel soils encountered would not be expected to liquefy. Based on this assessment, a pile foundation embedded into very dense sandy gravel layers is favourable for the proposed construction.

4.10 Lateral Earth Pressures on Basement Walls/Retaining Walls

Below grade foundation walls may be designed for a static earth pressure of 5.0 x H kPa (where H is the wall height in m) with a triangular pressure distribution. The walls should also be designed to withstand an additional seismic earth pressure of 5.0 x H kPa with an inverted triangular pressure distribution. Allowances for pressure due to compaction operations should be included in the earth pressure determinations and a value of 12 kPa is applicable for a vibratory compactor and granular material.

Foundation walls retaining 3 meters or less of soil can be simplified by assuming a uniform (rectangular) lateral pressure of 20 kPa for both static and static plus seismic conditions. All earth pressures provided herein are unfactored. Phillips & Associates can provide specific lateral earth pressures associated with actual dimensions of retaining walls upon request.

The earth pressure given assumes that the wall will be backfilled with clean, free draining sand or sand and gravel, the backfill is level behind the wall, the wall is frictionless and backfill is hydraulically connected to a perimeter drainage system to collect and dispel water from behind wall. All backfill should be placed in a manner that avoids damaging the foundation wall, drainage tile, and damp-proofing or waterproofing on the wall. Proposed grades should slope away from the building to promote flow of surface water runoff away from the building.

Phillips & Associates should be contacted for review of backfill materials and procedures.

5.0 GEOTECHNICAL REVIEW DURING CONSTRUCTION

Geotechnical field reviews will be required to satisfy Letters of Assurance requirements and confirm that the recommendations of the geotechnical report are followed. It is expected that geotechnical field reviews will be needed to address the following issues:

- Review of stability of excavation slopes in accordance with Work Safe BC regulations.
- Review of geotextile and fill placement.
- Full-time review during pile installation to confirm acceptability of piles.
- Review of any engineered fill, placement, and compaction.
- Review of perimeter backfill materials, placement, and compaction.

Recommendations may not be valid if an adequate level of inspection is not provided during construction, or if relevant building code requirements are not met. It is the responsibility of the developer to notify Phillips & Associates when conditions or situations not outlined within this document are encountered. Contractors working on site should review this document in advance of any work being carried out so that they become familiar with the sensitive aspects of the works proposed.

Contractor to contact Phillips & Associates a minimum of 48 hours before a site review is required.

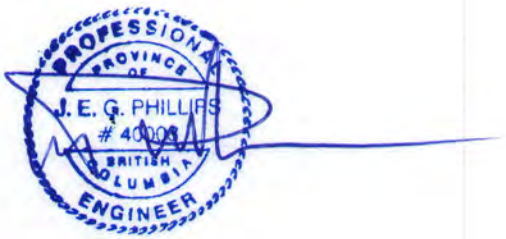
6.0 CLOSURE

Phillips & Associates has completed this preliminary report based on the information provided and our understanding of the project as described in this report. If during construction, the subsurface conditions are noted to differ from those described herein, we should be notified immediately and recommendations regarding the geotechnical aspects of the development should be reviewed and modified, as appropriate.

We are pleased to be of assistance to you on this project and we trust that our comments and recommendations are both helpful and sufficient for your current purposes. If you would like further details or require clarification of the above, please do not hesitate to call. For further details on the field investigation and borehole information, please refer to the report by Brimmell Engineering Ltd. dated January 24/17.

For:
Phillips & Associates

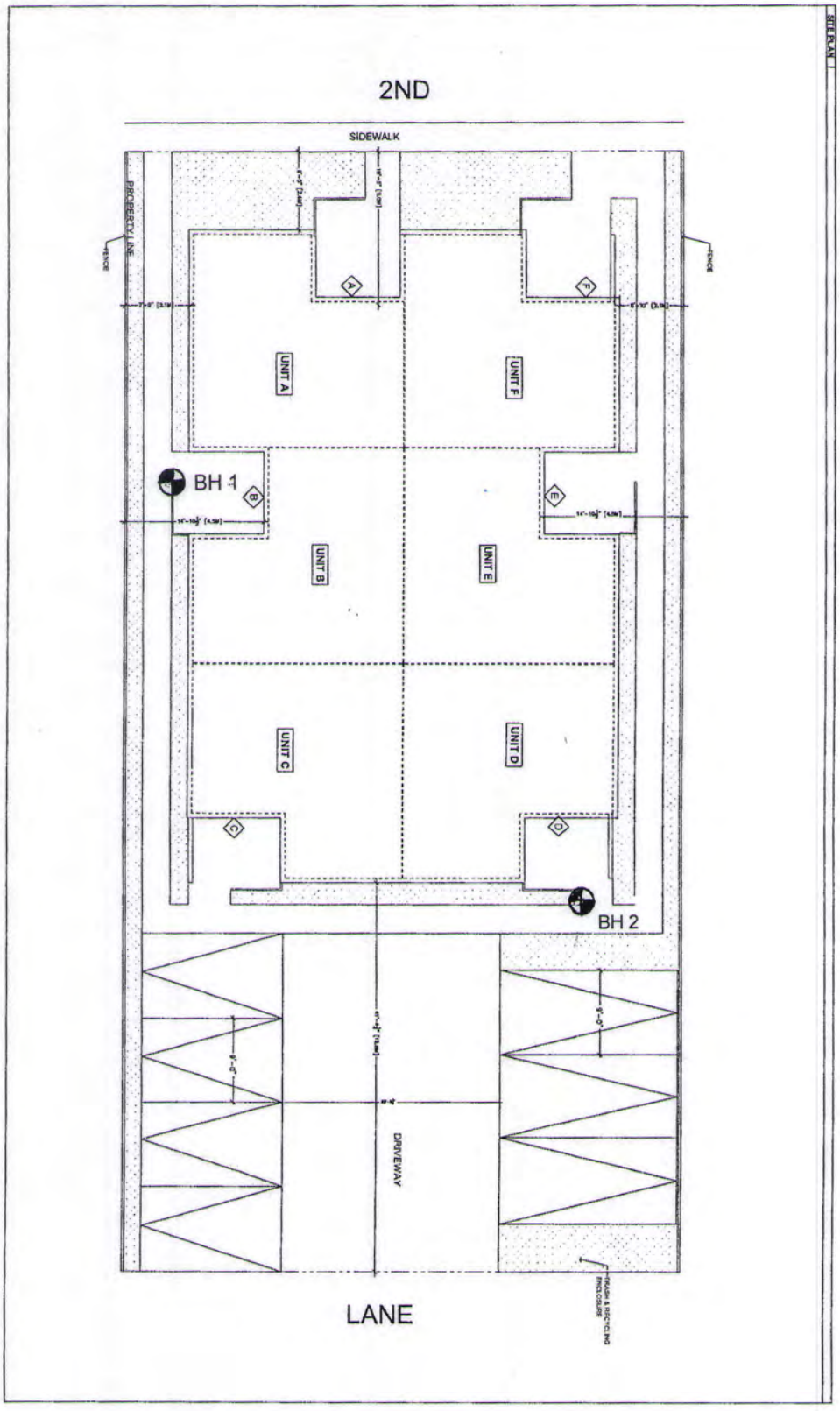
Reviewed by:



Cathal Donnelly, E.I.T.
Project Engineer

Ward Phillips, P. Eng.
Principal

Attachments: Borehole Locations – Brimmell Engineering Ltd.



Project: 262 2nd Ave. Duncan	**DRAWING 1 Oct 5/16**	**Name: Borehole Locations**
Client: Macropus Global Ltd.	**Job No. 16-161**	**Brimmell Engineering Ltd.**