GEOTECHNICAL ENGINEERING INVESTIGATION
PROPOSED COMMERCIAL BUILDINGS
757 & 785 FOREST AVENUE
PORTLAND, MAINE

07-1034 **November 21, 2007**

Prepared for:
Granite Construction
25 Alice Street
Portland, ME 04103

Prepared by:

S.W.COLE ENGINEERING, INC.

286 Portland Road
Gray, ME 04039

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November 21, 2007

Granite Construction
Attention: Jim Messer
25 Alice Street
Portland, ME 04103

Subject: Geotechnical Engineering Investigation – Limited Services
Proposed Commercial Buildings
757 & 785 Forest Avenue
Portland, Maine

Dear Mr. Messer:

In accordance with our Agreement, dated October 10, 2007, we have made a subsurface investigation for the proposed structures at 757 and 785 Forest Avenue in Portland, Maine. This report presents our findings and recommendations and is subject to the limitations presented in Attachment A.

1.0 INTRODUCTION

1.1 Scope of Work

The purpose of our work was to obtain subsurface information at the site of the proposed buildings in order to develop recommendations relative to foundation design and earthwork associated with the proposed construction. The scope of work included test pit explorations, laboratory testing, a geotechnical analysis of the subsurface findings, and preparation of this report.

1.2 Proposed Construction

Based on conversations with Bruce MacLeod (project structural engineer), we understand the proposed construction consists of the following:

757 Forest Avenue: We understand the proposed building at 757 Forest Avenue will be a 2-story, wood-framed, heated structure. Shallow foundations consisting of spread footings and a frost wall are planned around the perimeter with a

thickened slab below interior load bearing walls. The proposed building is on the order of 1,500 square feet in plan area. It is anticipated finished ground floor elevation will be within 1-foot of existing grades.

785 Forest Avenue: We understand the building at 785 Forest Avenue will be a 1-story, wood-framed, heated structure. The proposed building is on the order of 1,000 square feet in plan area. It is anticipated finished floor elevation will be within 1-foot of existing grades.

2.0 EXPLORATION AND TESTING

2.1 Exploration

Two test pit explorations (TP-1 and TP-2) were made at 757 Forest Avenue and two test pits explorations (TP-101 and TP-102) were made at 785 Forest Avenue on November 5, 2007. The test pits were made by Chase Excavating working under subcontract to others. The explorations at 757 Forest Avenue were established in the field based on the building corners as previously staked by the owner. The explorations at 785 Forest Avenue were located on the easterly and westerly side of the existing building. The approximate exploration locations are shown on the "Exploration Location Plans" attached as Sheets 1 and 2. Logs of the test pits are attached as Sheets 3 and 4. A key to the notes and symbols used on the logs is attached as Sheet 5.

2.2 Testing

Laboratory testing was performed on selected samples obtained from the explorations. The results of moisture content testing are shown on the test pit logs. The results of two gradation analyses are attached as Sheets 6 and 7.

3.0 SITE AND SUBSURFACE CONDITIONS

3.1 Site Conditions

757 Forest Avenue: The existing building site is relatively flat and is surrounded by asphalt pavement. An existing single story auto dealership building is located just north of the proposed building location. We understand this structure is to remain. A portion of the proposed building footprint is covered with crushed asphalt. Based on information provided by yourself and the owner, the building

that previously occupied the area had been demolished. We anticipate finished site grades will be within about 1 foot of existing site grades.

785 Forest Avenue: The existing site is occupied by a single story masonry building and surrounding paved parking area. The site is relatively flat, but slopes gently downward toward Forest Avenue on the front portion of the site. We understand the new building will be constructed in the general area of the existing building, which is to be demolished. We anticipate finished site grades will be within 1 foot of existing site grades.

3.2 Subsurface Conditions

The test pits were excavated using a Komatsu excavator. Each test pit was excavated to refusal (probable bedrock). The subsurface conditions at each of the sites are summarized below; refer to the attached logs for a more detailed description of the subsurface findings.

757 Forest Avenue: Test pits TP-1 and TP-2 were excavated in the area of the proposed building at 757 Forest Avenue. These test pits generally encountered 2 to 6 inches of crushed asphalt pavement overlying sandy fill to a depth of about 2 feet. Test pit TP-1 encountered blasted rock that appeared to be overblast rock left in place at a depth of about 2 feet and was dug to refusal in what appears to be intact bedrock at a depth of about 4 feet. Below the fill, test pit TP-2 encountered a relic topsoil layer at about 2 feet below the ground surface and silty sand with some gravel (glacial till) at a depth of about 3 feet. Test pit TP-2 encountered a refusal surface (probable bedrock) at a depth of about 6 feet. Groundwater seepage was not observed in TP-1, but seepage was observed at a depth of about 5 feet in TP-2 at the time of the excavation.

785 Forest Avenue: Test pits TP-101 and TP-102 were excavated adjacent to the existing building at 785 Forest Avenue. These test pits generally encountered 3 to 4 inches of asphalt pavement overlying fill consisting of sandy gravel with some silt to a depth of about 1 foot. Below the fill, the test pits encountered a layer of silty gravelly sand (glacial till) overlying refusal surfaces (probable bedrock) at depths of 2.5 and 1.4 feet in TP-101 and TP-102, respectively. No groundwater seepage was observed in the test pits at the time of the excavation.

In general, it should be anticipated that seasonal groundwater levels will fluctuate and may become perched at or near the top of the bedrock, especially during times of snowmelt and heavy precipitation.

3.3 Seismic Site Class and Frost Conditions

According to the 2006 International Building Code, we interpret the subsurface conditions to correspond to a seismic soil Site Class C. The design freezing index for the Portland, Maine area is about 1,250-Fahrenheit-degree-days, which corresponds to a frost penetration depth on the order of 4.5 feet.

4.0 EVALUATIONS AND RECOMMENDATIONS

4.1 General

Based on the subsurface findings and our understanding of the proposed construction, it appears the proposed buildings can be supported on spread footing foundations. The main geotechnical concerns for the structures are the existing fills and shallow refusals (probable bedrock), as well as subgrade preparation prior to footing and slab placement. The building at 785 Forest Avenue would likely need blasting to remove bedrock to place the building on spread footings with a frost wall. As discussed with Bruce MacLeod (project structural engineer), the building at 785 Forest Avenue could alternatively be supported on a mat foundation.

4.2 Excavation Work

Based on the subsurface findings, we anticipate that excavations will generally encounter fill overlying glacial till and bedrock. We recommend that topsoil, organics, fill soils, and overblast rock be removed from beneath the proposed buildings.

Groundwater seepage may be encountered during excavation work, particularly during precipitation. Ditching, sumping and pumping dewatering techniques should be adequate to control groundwater within foundation excavations.

Some blasting may be required to remove bedrock. We recommend that an experienced drilling and blasting contractor be engaged to provide rock removal and the contractor be required to submit qualifications, references and a blasting plan prior to commencement of excavation. A preblast survey should be

conducted at all structures and wells located within a minimum of 500 feet of the blast area.

4.3 Subgrade Preparation

All loose rock should be removed to expose sound, intact rock. Fractured rock surfaces below footings should be prepared with a densely graded crushed stone, compacted to work the stone into the fractured surface in order to fill voids and to create a level subgrade. Fill and relic topsoil should be removed from below footings. Undisturbed, native soils should be overlain with a non-woven geotextile fabric such as Mirafi 160N prior to placement of crushed stone. The crushed stone should meet the gradation requirements presented in Section 4.8.

4.4 Foundations

4.4.1 757 Forest Avenue

Based on the subsurface findings and our understanding of the proposed construction, the proposed building at 757 Forest Avenue may be supported using spread footings. Footings should be underlain with at least 6 inches of compacted crushed stone overlying sound, intact bedrock or non-woven filter fabric overlying stable native soils. For footings bearing on properly prepared subgrades and backfilled with structural till, we recommend the following geotechnical parameters.

- Net allowable bearing pressure = 3.0 ksf or less
- Base friction factor = 0.4
- Passive lateral earth pressure coeff. (K_p) = 3.0
- Active lateral earth pressure coeff. (K_a) = 0.3
- At-rest lateral earth pressure coeff. (K_o) = 0.5
- Total unit weight of backfill (γ_t) = 130 pcf
- Angle of Internal Friction (ϕ) = 30 degrees

We recommend that wall footings be at least 18 inches wide and column footings at least 24 inches in their least dimension.

4.4.2 785 Forest Avenue

For 785 Forest Avenue, a frost-protected, reinforced concrete mat foundation with a haunched perimeter may be used for foundation support. The perimeter edges should be a minimum of 18 inches thick and the interior of the mat should be thickened below load bearing walls and columns. A minimum of 12 inches of compacted Structural Fill should be placed below the mat foundations. A minimum of 2 inches of rigid insulation, suitable for below grade use, should be placed against the vertical exterior face of the mat. A two inch thickness of perimeter horizontal insulation should also be installed on the exterior side of the mat. The horizontal insulation should extend at least 4 feet from the foundation and be slightly sloped down and away from the building to allow water to drain. The perimeter horizontal insulation should be installed at least 12 inches below finished grade.

For mat foundations founded on properly prepared subgrades, we recommend the following geotechnical parameters for design:

- Modulus of Subgrade Reaction = 175 pci
- Base friction factor = 0.30 (below perimeter haunches only)

4.5 Floor Slabs

We recommend that floor slabs be underlain with at least 12 inches of compacted Structural Fill. Slab-on-grade floors may be designed using a subgrade reaction modulus of 175 pci provided the concrete slab is underlain by 12 inches of compacted structural fill overlying properly prepared subgrades.

For slab-on-grade floors, we recommend that a 15-mil vapor retarder be placed directly below the floor slab concrete. The vapor retarder should have a permeance that is less than the floor covering being applied on the slab and should be installed according to the manufacturer's recommended methods including taping all joints and wall connection. Flooring suppliers should be consulted relative to acceptable vapor retarder systems for use with their products. The vapor retarder must have sufficient durability to withstand direct contact with sub-slab fill and construction activity.

We recommend that control joints be installed within floor slabs to accommodate shrinkage in the concrete as it cures. In general, control joints are usually installed at 10 to 15 foot spacing; however, the actual spacing of control joints should be determined by the structural engineer. We recommend that floor slabs be wet-cured for a minimum of 7 days after casting as a measure to reduce the potential for curling of the concrete and excessive shrinkage. We further recommend that consideration be given to using a curing paper or curing compound after the wet-cure period to improve the quality of the completed floor slab.

4.6 Foundation Drainage

We recommend that perimeter underdrains be provided adjacent to the exterior side of perimeter footings for the building at 757 Forest Avenue. For the building at 785 Forest Avenue, we recommend perimeter underdrains be placed at a depth of at least 6 inches below the perimeter insulation. The perimeter underdrain systems should be enveloped with 6 inches of ¾ inch crushed stone and wrapped with a non-woven geotextile fabric such as Mirafi 140N. Four-inch diameter, rigid perforated drain pipes should be utilized. The foundation drains must have positive gravity outlets. Exterior foundation backfill should be sealed with a surficial layer of clayey or loamy soil in areas that are not to be paved or occupied by entrance slabs. This is to reduce direct surface water infiltration into the backfill. Surface grades should be sloped away from the building to provide positive water drainage. Roof drains must be routed in separate non-perforated drain lines such that roof drainage is not introduced into the foundation drainage system.

4.7 Exterior Slabs and Sidewalks

Entrance approaches, sidewalks and exterior slabs should be designed to reduce the effects of differential frost action between doorways and entrances. We recommend that excavations beneath the entire width of entrances, sidewalks, and exterior slabs continue to at least 4.5 feet below finish grade or bedrock, if shallower. If sound, intact bedrock is encountered within the 4.5 foot excavation depth, excavation should continue to at least 18 inches below the bottom of the slab. Bedrock subgrades should be choked with crushed stone prior to placing Structural Fill. These areas should be backfilled with compacted non-frost susceptible Structural Fill to limit abrupt heave or differential movement. The zone of non-frost susceptible material adjacent to exterior foundations and below

entrance slabs and sidewalks should transition up to any adjacent pavement subbase or sidewalk gravel at a 3H:1V slope or flatter.

4.8 Backfill and Compaction

Structural Fill should be utilized below slab-on-grade floors and mat foundations and for foundation backfill. We recommend that crushed stone be utilized below the footings and as choke stone over bedrock surfaces prior to placing other fills.

The Structural Fill should be a clean, non-frost susceptible soil meeting the following gradation requirements:

Structural Fill	
Sieve Size	**Percent Finer by Weight**
4 inch	100
3 inch	90 to 100
¼ inch	25 to 90
No. 40	0 to 30
No. 200	0 to 5

Crushed stone should be clean, crushed aggregate meeting the following gradation requirements:

Crushed Stone	
Sieve Size	**Percent Finer by Weight**
1 ½ inch	100
1 inch	90 to 100
½ inch	25 to 60
No. 4	0 to 10
No. 8	0 to 5

Fill should be placed in horizontal lifts and be compacted such that desired density is achieved throughout the lift thickness with 3 to 5 passes of the compaction equipment. We recommend that the loose lift thickness for soil fills not exceed 12 inches. Fill used to raise grades within the proposed building area should be compacted to at least 95 percent of its maximum dry density as determined by ASTM D-1557. Foundation backfill located beneath entrance slabs, and adjacent sidewalk areas should be compacted to at least 95 percent of its maximum dry density.

4.9 Re-use of On-site Soils

Based on the results of the grain size analyses, some of the sand fill at 757 Forest Avenue may be suitable for reuse as exterior foundation backfill. Excavated soils should be segregated and stockpiled during construction and additional laboratory tests should be performed to confirm their suitability for re-use. The on-site soils at 785 Forest Avenue are not suitable for re-use due to their silt content and frost susceptibility.

4.10 Soil-Gas Venting

Based on the subsurface findings and our understanding of the proposed construction, the buildings will be underlain by shallow bedrock. Although not in our scope, we recommend that the owner and architect consider a passive sub-slab radon venting system beneath the proposed slab-on-grade floors. Additionally, the ventilation system for the proposed building should be designed to encourage positive air pressurization of the building to help further control intrusion of soil-gas and radon. Design of a sub-slab vent system may require changes to the recommendations in this report. We can assist with design of a sub-slab vent system, if needed.

4.11 Design Review and Construction Testing

S. W. COLE ENGINEERING, INC. should be retained to review the final design and specifications to determine that our earthwork recommendations have been properly interpreted and implemented.

A soils and concrete testing program should also be implemented during construction to observe compliance with the design concepts, plans, and specifications. S. W. COLE ENGINEERING, INC. is available to provide field

and laboratory testing services for soil, concrete, and asphalt construction materials.

5.0 CLOSURE

It has been a pleasure to be of assistance to you with this phase of your project. We look forward to working with you as the design progresses and during the construction phase of this project.

Very truly yours,

S. W. COLE ENGINEERING, INC.

Matthew P. Lilley, P. E.
Geotechnical Engineer

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Attachment A - Limitations

This report has been prepared for the exclusive use of Granite Construction for specific application to the proposed buildings at 757 and 785 Forest Avenue in Portland, Maine. S. W. COLE ENGINEERING, INC. has endeavored to conduct the work in accordance with generally accepted soil and foundation engineering practices. No warranty, expressed or implied, is made.

The soil profiles described in the report are intended to convey general trends in subsurface conditions. The boundaries between strata are approximate and are based upon interpretation of exploration data and samples.

The analyses performed during this investigation and recommendations presented in this report are based in part upon the data obtained from subsurface explorations made at the site. Variations in subsurface conditions may occur between explorations and may not become evident until construction. If variations in subsurface conditions become evident after submission of this report, it will be necessary to evaluate their nature and to review the recommendations of this report.

Observations have been made during exploration work to assess site groundwater levels. Fluctuations in water levels will occur due to variations in rainfall, temperature, and other factors.

S. W. COLE ENGINEERING, INC.'s scope of work has not included the investigation, detection, or prevention of any Biological Pollutants at the project site or in any existing or proposed structure at the site. The term "Biological Pollutants" includes, but is not limited to, molds, fungi, spores, bacteria, and viruses, and the byproducts of any such biological organisms.

Recommendations contained in this report are based substantially upon information provided by others regarding the proposed project. In the event that any changes are made in the design, nature, or location of the proposed project, S. W. COLE ENGINEERING, INC. should review such changes as they relate to analyses associated with this report. Recommendations contained in this report shall not be considered valid unless the changes are reviewed by S. W. COLE ENGINEERING, INC.