GEOTECHNICAL ENGINEERING STUDY
PROPOSED RESIDENTIAL BUILDING
3803 NE 155TH STREET
LAKE FOREST PARK, WASHINGTON

Project No. G-2239-1

Prepared for

Mr. Adam Lundberg
AML Construction & Development, LLC
12055 Lakeside Pl. NE
Seattle, Washington 98125

July 9, 2015

GEO GROUP NORTHWEST, INC.
13240 NE 20TH STREET, SUITE 10
BELLEVUE, WASHINGTON 98005
PHONE (425) 649-8757 / FAX (425) 649-8758

2015-SAMJ-0008

GEO Group Northwest, Inc.

Geotechnical Engineers, Geologists
& Environmental Scientists

July 9, 2015

G-2239-1

Mr. Adam Lundberg
AML Construction & Development, LLC
12055 Lakeside Pl. NE
Seattle, Washington 98125

Subject: Geotechnical Engineering Study
Proposed Residential Building
3803 NE 155th Street
Lake Forest Park, Washington

Dear Mr. Lundberg:

GEO Group Northwest, Inc. is pleased to present its geotechnical engineering study report for the above-subject property in Lake Forest Park, Washington. This geotechnical engineering report summarizes our activities and presents our findings and conclusions regarding the site conditions and geotechnical aspects of the proposed redevelopment of the site with a multi-story residential building.

Due to the presence of loose fills and soils to depths of up to approximately 27 feet below existing grades the site, we recommend that the proposed building be supported on a system of augered concrete piles with interconnected grade beams and structurally supported floors. Building support and other geotechnical issues are discussed in the enclosed report.

We appreciate this opportunity to provide you with geotechnical engineering services. Should you have any questions regarding this report or need additional consultation during the design and construction phases, please feel welcome to contact us.

13240 NE 20th Street, Suite 10 • Bellevue, Washington 98005
Phone 425/649-8757 • Fax 425/649-8758

Sincerely,

GEO Group Northwest, Inc.

William Chang, P.E.
Principal

TABLE OF CONTENTS
Project No. G-2239-1

TABLE OF CONTENTS (cont.)
Project No. G-2239-1

GEOTECHNICAL ENGINEERING STUDY
PROPOSED RESIDENTIAL BUILDING
3803 NE 155TH STREET
LAKE FOREST PARK, WASHINGTON

Project No. G-2239-1

1 INTRODUCTION

GEO Group Northwest, Inc. has completed a geotechnical engineering study of the property located at 3803 NE 155th Street in Lake Forest Park, Washington, and prepared this report of findings, conclusions, and recommendations. This study was completed for Mr. Adam Lundberg of AML Construction & Development, LLC, for a proposed redevelopment of the property with a multi-unit residential building having 5 or 6 stories.

2 SCOPE OF SERVICES

The scope of the work for this geotechnical engineering study consisted of the following tasks, as outlined in our proposal dated April 28, 2015:

- Performing a subsurface exploration of the site, consisting of drilling three soil borings in the proposed building location to supplement three borings that were drilled in 2006 for a previously proposed development of the site;

- Performing engineering evaluation and analysis regarding foundation design parameters, site grading (including structural fill specifications), soil liquefaction potential, and subgrade preparation of the site prior to construction; and

- Preparing this report of our findings, conclusions, and recommendations regarding geotechnical aspects of the proposed development of the site.

3 SITE CONDITIONS

3.1 SITE DESCRIPTION

The site is located on the south side of the 3800 block of NE 155th Street in a mixed small commercial and residential area of Lake Forest Park, Washington, as illustrated in Plate 1 - Site

Location Map. The site property consists of an irregular-shaped lot that comprises 0.7 acres of land. The north part of the site is occupied by a two-story residence that has been converted to an office and a by a detached garage west of the residence. An asphalt paved parking area is located east of the existing building. The area behind (south of) the existing buildings and parking lot is vacant land that is mostly covered with heavy-gauge black plastic sheeting. Vegetation mostly consisting of blackberry vines and knotweed has penetrated though the sheeting in several locations.

The site has a steep slope along its south and east sides. The slope faces toward the south and southeast and has a height typically ranging between approximately 40 and 50 feet. The slope has inclinations typically ranging up to approximately 80 percent grade. The site topography and existing features are illustrated in Plate 2 - Site Plan.

3.2 Adjacent Properties

The adjacent property to the east (3829 NE 155th Street) is occupied by a single-family residence. This residence is located approximately 5 feet from the site boundary and has a floor elevation of approximately 139 feet.

A two-story apartment building is located on the adjacent property to the west. This building is located approximately 5 feet away from the site boundary and appears to have a floor elevation of about 152 or 154 feet.

3.3 Proposed Development

We understand that the proposed development of the site is generally envisioned to involve the construction of a multi-unit residential building. The building is proposed to be located on the northern part of the site, as illustrated in Plate 2 – Site Plan. The building is proposed to have two floors of parking below five floors of residences. The bottom floor of the building will have an elevation of 140 feet. An exterior parking lot is proposed along the south side of the building.

3.4 Geologic Overview

According to the geologic literature for the vicinity of the project site, surficial soils at the site consist of Quaternary-age glacial deposits associated with the Vashon Stade of the Fraser

Glaciation and older non-glacial deposits[1]. In order of relative age, youngest to oldest, these deposits are identified as 1) Vashon glacial till, 2) Upper Clay, and 3) Unnamed Gravel. Mapped surface exposure of these units in the site vicinity is illustrated in Plate 3 - Geologic Map.

Vashon glacial till deposits (Qvt in the geologic map) typically consist of very dense, unsorted mixtures of silt, sand, gravel, and occasional cobbles which were deposited by and then overridden by the Puget Lobe glacier approximately 12,000 years ago. The silt and clay deposits of the Upper Clay unit (Qcu in the geologic map) typically consist of very dense layers of lacustrine (lake environment) sediments that were deposited before or during the early stages of the Vashon glacial advance. The Unnamed Gravel unit (Qg in the geologic map) consists of oxidized gravel and sand interpreted to have been deposited in an older non-glacial environment.

3.5 Environmentally Sensitive Areas Review

A review of the Environmentally Sensitive Areas map on the City of Lake Forest Park internet site indicates that the middle and southern portion of the site is located within an environmentally sensitive area. This area includes the steep slope on the southern part of the site. The sensitive area types which are present on the site include soil erosion (due to the presence of slopes with loose fills), and steep slope and landslide hazard areas (due to the presence of slopes steeper than 40 percent and higher than 10 feet).

4 SITE INVESTIGATION

4.1 Subsurface Exploration by GEO Group Northwest

A GEO Group Northwest, Inc. geologist supervised the drilling of three exploratory soil borings (B-1, B-2, and B-3) at the site on April 25, 2006, and an additional three borings (B-4, B-5, and B-6) on June 10, 2015. The boring locations are illustrated in Plate 2 – Site Plan. The boring locations were estimated by using a measuring tape and by visually estimating property line locations relative to existing features. The borings were terminated in dense, native soils at depths ranging between approximately 20 and 55 feet below the ground surface. Soil samples

[1] B.A. Liesch, et al., 1963, Geology and Ground-Water Resources of Northwestern King County, Washington. U.S. Geological Survey Water Supply Bulletin No. 20.

were collected from the borings and were tested for moisture content. Copies of the logs for the boring are provided in Appendix A.

Soil samples were collected during drilling by using a 2-inch outside-diameter split-spoon sampler. Standard Penetration Test (SPT) data was recorded while sampling by driving the sampling tube using a 140-pound hammer with a 30-inch drop. The soil samples were reviewed in our office to verify the field classifications, and moisture content testing of the samples was performed. The moisture content data are included on the boring logs.

The soils encountered in the borings typically consisted of a layer of loose fills underlain with a relatively thin layer of loose to medium dense soils (apparent old topsoil or alluvium), all underlain with medium dense to dense native soils. Boring B-6 was the only boring where the fills were limited to a thin layer of pavement base course. The fills typically consisted of heterogeneous mixtures of silty sand, sandy silt, and silt, commonly with trace or minor amounts of wood fragments and lesser fine organics. Substantial amounts of wood were encountered at a depth of about 12 feet in boring B-3 and at 27 to 30 feet in boring B-4. Fill thicknesses ranged between approximately 7 and 27 feet, with the greatest thicknesses (over 20 feet) found in borings B-1, B-3, and B-4.

The fills were observed to typically be underlain with relatively thin layer of loose to medium dense, wet, grayish brown sand, dark gray silty sand, and black sandy silt, commonly containing organics and mottling. These soils are interpreted to be variety of old topsoil, colluvium, and stream alluvium and muck.

Dense native soils that were encountered in the borings typically consisted of layers of fine-grained sand, silty sand, and silt. Depths to these soils ranged between approximately 27 and 40 feet, except at boring B-2 where the depth to dense soils was found to be approximately 15 feet. Occasional medium dense layers of fine sand were found within these soils in borings B-4, B-5, and B-6.

Groundwater was encountered in each of the borings except for B-2 at depths ranging between approximately 17 and 22 feet. No groundwater was encountered in boring B-2, but the soils at the bottom of the boring (at approximately 20 feet deep) were rather moist. The groundwater elevations typically ranged between approximately 122 and 126 feet, except in boring B-6 where is it was encountered at approximately 132 feet. The top of the groundwater commonly was encountered a few feet above the base of the fills, but groundwater also was noted within many of the native soil layers.

4.2 Previous Geotechnical Investigation by Others

Cascade Geotechnical, Inc., in Kirkland, Washington, completed a preliminary subsurface soils investigation of the site in 1990. GEO Group Northwest, Inc., reviewed a copy of the report from this investigation, dated July 20, 1990, which was prepared for Norbrook Construction. A copy of the report is provided in Appendix B.

According to the report, four exploratory test pits were excavated on the site by using a backhoe. The test pits were completed to depths ranging between 11.5 and 17 feet below the ground surface. Approximate locations of these test pits, identified as TP1-1 through TP1-4, are illustrated in Plate 2 – Site Plan. The locations of these test pits are based solely on the information provided in the 1990 geotechnical report and have not been field-verified.

Subsurface soil conditions in the test pits were reported to consist of fills composed of loose silty sand and sandy silt with trace amounts of debris. The thicknesses of the fills were reported to range from 2.5 to 15 feet. Native soils under the fills consisted of medium dense or dense silty sand and silt in test pits TP1-2 and TP1-4. In test pit TP1-1, the encountered native soils consisted of very stiff silty clay and very dense sandy silt. In test pit TP1-3, the encountered native soils consisted of soft to medium stiff clay and silt to the bottom of the test pit at 17 feet.

A site sketch and a written log that documented the excavation of an additional four test pits on the northeast part of the site in 1996 was appended to the 1990 report. These four test pits were excavated to depths ranging between 4.5 and 21 feet below the ground surface, and the approximate locations of these test pits, identified as TP2-1 through TP2-4, as indicated in the sketch are noted in Plate 2 – Site Plan. The locations of these test pits have not been field-verified.

The fills encountered in these test pits were reported to have thicknesses ranging between 2.5 and 18 feet and to have consisted of loose mixtures of silt, sand, and gravel, occasionally with organic matter and pea gravel. Relatively dense native soils reportedly encountered in test pits TP2-2, TP2-3, and TP2-4 at depths of about 2.5, 18, and 5 feet, respectively, consisted of silty gravelly sand (TP2-2) or sand and silty sand(TP2-3 and TP2-4). Dense native soils were not reported to be encountered in test pit TP2-1 which was terminated at a depth of 16.5 feet.

Groundwater seepage was reported encountered at a depth of 16 feet (two feet above the base of the fill) in test pit TP2-3. Groundwater is not noted in the logs for the other test pits.

4.3 Summary of Exploration Findings

Based on the findings from the test pits and soil borings, the thickness of the fills and loose to medium dense native soils varies by up to 23 feet across the northern part of the site (i.e., from 4 feet at test pit TP1-1 to 27 feet at boring B-4).

A summary of the exploration elevations, fill thickness and dense soil elevations for the test pits and borings is presented in the table below. This information was used to create two cross sections to interpret and illustrate the subsurface conditions of the site. These cross sections are presented in Plate 4A – Profile A-A' and Plate 4B – Profile B-B'. Soil and groundwater conditions depicted beyond the exploration locations in the sections are inferred and may vary from those shown.

SUMMARY OF SUBSURFACE EXPLORATION DATA

Exploration ID	Surface Elevation	Fill Thickness	Depth to Dense Soil	Elevation of Top of Dense Soil	Elevation of Bottom of Boring/ Test Pit	Depth to Groundwater	Groundwater Elevation
Borings							
B-1	143	20	30	113	106.5	17	126
B-2	147	7	15	132	125.5	NE	NE
B-3	145	22	27	118	108.5	20	125
B-4	141	27	40	101	84.5	19	122
B-5	142	8	30	2	95.5	18	124
B-6	154	< 2.5	30	124	112.5	22	132

Notes: All data are in units of feet. NE = Not encountered.

SUMMARY OF SUBSURFACE EXPLORATION DATA (CONT'D)

Exploration ID	Surface Elevation	Fill Thickness	Depth to Dense Soil	Elevation of Top of Dense Soil	Elevation of Bottom of Boring/ Test Pit	Depth to Groundwater	Groundwater Elevation
Test Pits							
TP1-1	149.5	2.5	4	140	138	NE	NE
TP1-2	149	8	10.5	137.5	136.5	NE	NE
TP1-3	143	15	NE (>17)	NE (<126)	126	NE	NE
TP1-4	143	8.5	NE (>14)	NE (<129)	129	NE	NE
TP2-1	136	16.5	NE (>16.5)	NE (<119.5)	119.5	NE	NE
TP2-2	142	2.5	4.5	137.5	137.5	NE	NE
TP2-3	138	18	18	120	117	16	122
TP2-4	142	5	6.5	135.5	135.5	NE	NE

Notes: All data are in units of feet. NE = Not encountered.

The native soils encountered in borings B-1, B-2, B-3, B-4, and B-5 are generally similar to the Upper Clay deposits described in the referenced geologic literature, but also commonly contain some fine-grained sandy layers. The soils encountered in boring B-6 at the northwest corner (and highest portion) of the site are interpreted to be similar to weathered glacial till soils to a depth of about 10 feet overlying other older Vashon-age glacial deposits that are generally sandy but contain appreciable silty layers. Soils with the characteristics described for the Unnamed Gravel deposit do not appear to have been encountered in the borings.

5 SITE SEISMICITY AND SOIL LIQUEFACTION EVALUATION

5.1 SEISMICITY HISTORY

The greater Puget Sound region has experienced a number of small to moderate earthquakes and occasionally strong shocks during the period of historical record in the Pacific Northwest.

Historical records for the region indicate that the Olympia earthquake of April 13, 1949, with a Richter magnitude of 7.1, produced ground-shaking of intensity VIII on the Modified Mercalli Scale near its epicenter; and the Seattle-Tacoma earthquake of April 29, 1965, with a Richter magnitude of 6.5, produced a ground-shaking of intensity IV to VIII near its epicenter. More recently, the Nisqually earthquake of February 28, 2001, with a Richter magnitude of 6.8, produced ground shaking at intensities up to VIII near its epicenter and at scattered locations in King County, including the Duwamish River valley area of Kent. These levels of ground-shaking are estimated to be the maximum that have occurred in the local region during the period of historic record keeping that goes back to approximately the 1850s.

5.2 SITE SEISMIC DESIGN CLASSIFICATION

Per the 2012 edition of the International Building Code (IBC), the project site meets Site Class E (Soft Soil Profile), as outlined in Section 1613 in the code. This site class determination is based on the observed presence of a thickness of more than 10 feet of loose or soft soils and fills that have apparent shear strengths of less than 500 pounds per square foot (psf).

5.3 SOIL LIQUEFACTION POTENTIAL

Liquefaction is a phenomenon where soil below the water table temporarily loses strength and behaves as a liquid due to strong shaking, such as from earthquakes. The results of soil liquefaction can include ground settlement, sand boils, and lateral soil spreading. Loose, saturated, medium- to fine-grained sands are the soil types which typically are most susceptible to liquefaction.

Soils encountered in boring B-1 at depths of approximately 20 to 25 feet and in boring B-4 at a depth of approximately 30 feet consisted of saturated, loose to medium dense, fine-grained sand and slightly silty sand. The thicknesses of these layers were found to be less than 5 feet. Other loose, saturated soils encountered in the borings typically consisted of silty sand with appreciable proportions of fines and are expected to have low susceptibility to liquefaction.

Based on the soil conditions found in the borings drilled for this study, we conclude that the site has a low susceptibility to liquefaction from seismic shaking of the intensity, duration, and location which have characterized past events in the region. If future events of greater severity at the site occur, however, the susceptibility of these soils to liquefaction may be higher. The risk of potential damage to the proposed redevelopment due to soil liquefaction can be mitigated by supporting the building on a deep foundation system that is embedded into dense, native soils which are not susceptible to seismically-induced liquefaction.

6 SITE STABILITY EVALUATION

6.1 Record of Previous Landsliding

During our subsurface investigation work in 2006, we were told by the occupant of the existing buildings that a landslide had occurred on the steep slope on the site about 15 years ago. The black plastic sheeting that covers much of the southern part of the site was placed following the landslide, and the sheeting also covered part of the steep slope. The landslide apparently was located on or in proximity to the eastern edge of the project site, and abutted the adjacent residence to the east. During our subsurface investigation work on site in 2015, neighboring residents told us that a landslide had occurred on the steep slope many years ago. The extent of the landslide reportedly reached the south side of the house on the adjacent property to the east. Details about the date, extent, or cause of the landslide have not been provided to us.

During our visits to the site we have observed no evidence of recent, fresh landslides. However, much of the eastern and southern portions of the site have been obscured by thick overgrown vegetation, and much of the ground surface has been covered with black plastic sheeting. Some apparent cracks were observed on the ground surface between the locations of borings B-4 and B-5 during our exploration work in 2015.

6.2 Evaluation of Soil Stability

Based on 1) the findings from our subsurface investigation, 2) the local geologic conditions reported in the literature we reviewed, 3) the findings reported in the previous soil investigation report for the site by Cascade Geotechnical, 4) the surface conditions as depicted in the topographic survey for the site, and 5) the anecdotal information we received about a past landslide on site, we have developed the following comments and conclusions.

- The eastern and southern portions of the site are marginally stable in their present condition, in our opinion. This is due to multiple factors, chiefly that 1) the fills are loose and are thick in proximity to the slope, the slope inclination approaches the typical angle of repose for relatively loose soils (independent of the effects of rooted vegetation, surface hardening/compacting, and the like), and the base of the fills and underlying loose soil zone are wet.

- The northern portion of the site in the vicinity of the existing buildings appears to be relatively stable, in our opinion. These soils have higher densities, the extent of the loose fills is less, and slope conditions are much gentler.

- In our opinion, the proposed building can be constructed in a manner that will not adversely affect the stability of the site or of the adjacent property to the east provided that it is supported on a pile and structural beam foundation system. Resistance of lateral forces against pile caps and grade beams can be provided by compacting the existing subgrade soils to a firm condition.

- In addition to compacting the subgrade below the proposed building, we also recommend that the fills beyond the south and east limits of the proposed building be improved by compacting them to a firm condition. This improvement to the exterior fills will supplement the building's resistance against lateral forces and will improve the stability of the fills and slope.

- It should be understood that post-construction settlement of the fills can be expected. Compaction of the surficial portion of the fills likely will reduce the magnitude of such settlement but will not eliminate it. This settlement may result in visible settlement of structures and pavements which are supported on these materials.

- We understand that the proposed office building will be located at least 40 feet away from the top of the steep slope (25 feet steep slope buffer plus 15 feet building setback). In our opinion, this proposed distance of the proposed building from the top of the steep slope is sufficient to avoid adverse impact to the slope and the proposed building, provided that the development is designed and constructed in conformance with the recommendations in this report.

- We understand that a parking lot may be planned next to the south side of the proposed building and may abut the top of the steep slope. We understand that the parking lot will not extend into the 25 feet wide steep slope buffer. In our opinion, the proposed parking lot will be susceptible to gradual settlement if it will rely on the underlying subgrade for support, due to the presence of loose fills across much of the area. The degree of potential settlement can be reduced by compacting the subgrade below the parking lot, or by constructing it as a structurally supported concrete slab on augered concrete piles that are embedded in the deeper dense native soils, or both.

- The site has a potential for significant soil erosion due to the loose condition of the fills and steepness of the slope area. Stormwater generated during construction should be controlled so that it does not accumulate in proximity to the steep slope or flow onto the steep slope. Post-construction stormwater also should be controlled to avoid its accumulation near the steep slope or flow onto the slope, and preferably should be tightlined to the local stormwater utility system.

7 CONCLUSIONS AND RECOMMENDATIONS

Based on the results from our subsurface investigation, it is our opinion that the main geotechnical issues to be considered for the proposed development include building support, site stability, excavations and slopes, excavation support, basement and retaining walls, and subsurface drainage.

The presence of loose fills with thicknesses of up to about 27 feet and the saturated condition of the lower portion of these fills and of the underlying soils lead us to recommend that a pile foundation system be used to support the proposed building. In our opinion, the preferred piling alternative for the project is auger-cast concrete piles that are embedded into the dense native soils. We anticipate that installing piles by using 'open-hole' methods may encounter difficulties at maintaining open boreholes and with groundwater accumulation in the boreholes. We anticipate that similar difficulties would be encountered with installing aggregate piers at the site.

In our opinion, the steep slope on site appears to be marginally stable based on the loose condition of the fills, the steepness of the slope, and the presence of saturated soils and fills at the bottom of the fill section. Improvement to the stability of the site can be achieved by compacting the surface of the loose fills below the proposed building location and beyond the building toward the top of the steep slope.

Our recommendations regarding these and other geotechnically-related aspects of the proposed site development are presented in the following sections of this report.

7.1 GRADING AND EARTHWORK

7.1.1 Site Clearing and Grubbing

The construction area should be cleared and grubbed of vegetation, organics, debris, and other deleterious materials if present. Silt fencing should be installed around areas to be disturbed by construction activity to prevent sediment being carried off site.

7.1.2 Excavations and Slopes

We recommend that temporary excavation slopes not exceed the limits specified in local, state and federal government safety regulations. We recommend that temporary cuts greater than 4 feet in height be sloped at an inclination no steeper than 1.5H:1V (Horizontal:Vertical) in the fills due to their variable and uncontrolled composition, and to no steeper than 1H:1V in the native soils. If groundwater seepage is encountered during excavation, the excavation work should be halted, and the stability of the excavation and issues regarding slope stability and potential need for engineered support should be evaluated on site by the geotechnical engineer. We recommend that permanent slopes be graded to no steeper than 3H:1V.

7.1.3 Subgrade Preparation

Loose fills were encountered during the exploration work we performed on the site. These fills typically consisted of loose silty sand and silt with occasional wood debris. These soils are susceptible to deep rutting and pumping from construction traffic during wet weather conditions. Therefore, we recommend that the subgrade be stabilized by compacting it to a firm condition by using a full-size vibratory roller at the start of construction. A layer of clean crushed rock also can be placed over the subgrade for additional protection to the subgrade due to construction activity.

7.1.4 Structural Fill

Fills placed to achieve design site elevations below building, pavement, patio, or sidewalk areas should meet the requirements for structural fill in situations where the fills will provide support to these improvements.

The on-site soils have moisture contents and in some instances also have relatively high silt contents. For these reasons, these soils are unlikely to be suitable for use as structural fill. We recommend that an imported granular soil or aggregate material be used as structural fill; this material should have a moisture content that is at or near its optimum value for attaining compaction density requirements. This material should be free of organic or other deleterious substances and should contain no particles larger than three inches in diameter. During wet weather, however, we recommend that this material not contain more than 5 percent fines (silt and clay-size particles passing the No. 200 mesh sieve), so that it can more readily be compacted to the required standards.

Structural fill material should be placed at or near its optimum moisture content. The optimum moisture content is the water content in soil that enables the soil to be compacted to the highest dry density for a given compaction effort.

Structural fill should be placed in horizontal lifts no greater than 10 inches in loose thickness. Structural fill under parking lots, driveways, patios and sidewalks should be compacted to at least 90 percent of maximum density, with the exception of the upper 12 inches. The top 12 inches should be compacted to at least 95 percent maximum dry density, as determined by ASTM Test Designation D-1557-91 (Modified Proctor).

We recommend that GEO Group Northwest, Inc. be retained to 1) evaluate the suitability of material that is proposed for use as structural fill, and 2) to monitor the placement and compaction of structural fill for quality assurance of the earthwork.

7.2 BUILDING SUPPORT

The proposed building can be supported on auger-cast concrete piles that penetrate through the fills and loose to medium dense soils and are embedded into the underlying native, dense soils. We recommend that the piles have a minimum diameter of 18 inches and a minimum embedment of 20 feet into the native, dense soils. Allowable bearing capacities for a selection of pile sizes and embedment lengths are presented in the table

Allowable Axial Pile Capacities

Pile Diameter (inches)	Pile Embedment (feet)	Allowable Capacity (tons)	Uplift Capacity (tons)
18	20	45	22
18	25	58	29
18	30	73	36
24	20	75	37
24	25	98	49
24	30	121	60
30	20	115	57
30	25	148	74
30	30	182	91
36	20	163	81
36	25	208	104
36	30	256	128

A safety factor of 3.0 is included in the tabulated capacities. The capacities were calculated based on the soil conditions encountered in the soil borings completed for this study. These capacities are based on skin friction and end bearing resistance in the medium dense to dense soils that were found below depths of approximately 30 to 40 feet. Negative skin friction resistance (also referred to as "down-drag") associated with potential settlement of the upper loose fills and soils are not anticipated to significantly affect the pile capacities, as these materials have low relative densities and minimal cohesiveness that would generate down-drag.

No reduction in pile capacity is required if the pile spacing is at least three times the pile diameter. A one-third increase in the above allowable pile capacities can be used when considering short-term transitory wind or seismic loads. We estimate that the maximum total post-construction settlement should be one-quarter (1/4) inch or less, and the differential settlement across building width should be one-quarter (1/4) inch or less.

Lateral forces against the foundation system can be resisted by passive earth pressure and friction of an improved subgrade against the pile caps and grade beams. The subgrade should be improved by thoroughly compacting it to a firm condition. The improved subgrade can be assigned a passive soil pressure of 250 pcf (pounds per cubic foot) equivalent fluid weight. A coefficient of friction of 0.35 may be used between the improved subgrade and the foundation elements. Alternatively, lateral forces can be resisted by using battered augered piles or inclined helical anchors.

The performance of piles depends on how and into what bearing stratum the piles are installed. It is critical that judgment and experience be used as a basis for determining the embedment length and acceptability of a pile. Therefore, we recommend that GEO Group Northwest, Inc. be retained to monitor the pile installation operation, collect and interpret installation data, and verify suitable bearing stratum. We also suggest that the contractor's equipment and installation procedure be reviewed by GEO Group Northwest, Inc. prior to pile installation to help mitigate problems which may delay work progress.

7.3 EXCAVATION SUPPORT

We understand that construction of the proposed building will require temporary excavation reaching depths of up to approximately 9 to 15 feet in depth in proximity to the north and west property lines, and will therefore require shoring. Cantilever soldier pile shoring with timber lagging can be used to support portions of the excavation where open cut slopes are not feasible.

Active Earth Pressures

We recommend that the cantilever soldier pile and lagging shoring for level backslope conditions be designed to resist an active pressure distribution of 35 pounds per cubic foot (pcf). The active soil pressure should be considered to act on a width of one pile-spacing above the excavation line and of one pile-diameter below the excavation line.

Backslope Considerations

Backslopes which extend a height approximately equal to or greater than the excavation height should be considered as "infinite" slopes for purposes of engineering design. For "infinite" backslopes of approximately 1H:1V, an active pressure of 50 pcf should be used for design.

Smaller backslopes that have inclinations of approximately 1H:1V, however, can be considered as surcharge loads having a value equivalent to the soil weight of one-half the height of the backslope using a unit weight of 125 pounds per square foot (psf). For example, a 4-feet high backslope can be considered equivalent to a surcharge load of 250 psf.

Other Surcharge Pressure

We recommend that surcharge pressure associated with construction equipment operating in proximity to the shoring be accounted for in the shoring design as equivalent to an additional 2 feet of soil height against the shoring.

Seismic Earth Pressure

If the shoring is to provide permanent support, a rectangular pressure of 8H pounds per square foot (psf), where H is the wall height in feet, should be added to active pressure distribution account for seismic pressure on the wall.

Passive Earth Pressure

The shoring can be designed using a passive soil pressure of 350 pcf, equivalent fluid weight. The passive pressure zone should start at one foot below the lowest level of excavation or soil disturbance. The passive pressure can be considered to act on a width of one pile-spacing or two pile-diameters, whichever is less. Mobilization of the full passive pressure assumes that the grade in front of the wall relatively level for a distance of four times the pile embedment. These recommended pressures apply to drained soil conditions.

The distribution of the above-described earth pressures acting on the shoring wall is schematically illustrated in Plate 5 - Lateral Earth Pressure Diagram.

Wall Lagging

Due to soil arching effects in the soil, timber lagging for the shoring system can consist of either pressure-treated or untreated lumber designed to resist 50 percent of the apparent lateral soil pressure for pile spacing up to four times the pile diameter. In order for this soil arching effect to occur, the pile holes should be backfilled with grout approximately to soil grade behind the wall.

Excavation work to install the lagging should be performed in lifts approximately 4 to 5 feet in depth, or to less depth as appropriate to avoid significant sloughing of soils from beyond the property line. Void areas behind the lagging should be backfilled with a granular material that contains no more than five percent fines (i.e., material passing a U.S. #200 sieve).

Performance Monitoring

Select points on off-site structures, driveways, or sidewalks located in proximity to the shoring should be surveyed or documented before the start of construction to record their baseline conditions. Existing cracks, sags, or other damage to the adjacent buildings, retaining walls, pavements, and sidewalks also should be documented prior to the start of construction.

The off-site points and selected points along the top of the shoring should then be monitored for movement (vertical and horizontal) following construction. We recommend that every other pile along the shoring wall be monitored. The points should be surveyed on a weekly basis and the information provided to the geotechnical engineer and the structural engineer for review until the shoring has been structurally restrained or has been backfilled.

7.4 Conventional Basement Walls and Retaining Walls

The following recommendations regarding conventional concrete basement walls and non-basement retaining walls are provided for use if these features are planned to be included in development of the site. These recommendations apply only to fully-drained wall systems. If hydrostatic pressures may be exerted on such walls, due to groundwater or other periodic or occasional un-drained conditions, these recommendations should be re-evaluated to incorporate the added hydrostatic pressures. Similarly, if other nearby structures may impose surcharge loads against such walls, these recommendations should be re-evaluated to address those factors.

Retaining walls which are restrained horizontally on top (such as basement walls) are considered unyielding and should be designed for a lateral soil pressure under the at-rest condition. Retaining walls which are free to rotate on top by 0.002 times their height or more should be designed for a lateral soil pressure under the active condition.

Active Earth Pressure: 35pcf (equivalent fluid pressure), for level ground behind the wall;

At-Rest Earth Pressure: 45pcf (equivalent fluid pressure), for level ground behind the wall;

Passive Earth Pressure: 175 pcf (as equivalent fluid pressure) for unimproved soil; 350 pcf for compacted granular fill having a depth of at least 3 feet below and horizontal distance of 10 feet beyond the edge of the wall footing;

Seismic Loading Pressure: 8H psf, where H is the height of the wall in feet;

Base Coefficient of Friction: 0.35 for compacted granular fill or competent soil

To prevent buildup of hydrostatic pressure behind conventional concrete basement or retaining walls, we recommend that a vertical drain mat be used to facilitate drainage behind the walls. The drain mat core should be placed against the wall with the filter fabric side of the mat facing toward the backfill. The drain mat should extend from near the finished surface grade down to the base of the wall, where it should be directed to discharge to a drainage system to be conveyed to an appropriate discharge facility. For long-term drainage ability, a prism at least 18 inches wide of free draining backfill material also should be placed against the wall after the drain mat has been installed. The free-draining backfill should extend downward to the base of the drain mat. We also recommend that a waterproofing layer be applied to basement and retaining walls to prevent moisture intrusion through the wall.

The top 12 inches of backfill behind retaining or basement walls should consist of compacted and relatively impermeable soil. This cap material can be separated from the underlying more granular drainage material by a geotextile fabric, if desired. Alternatively, the surface can be sealed with asphalt or concrete paving. The ground surface should be sloped to drain away from the wall.

GEO Group Northwest, Inc. recommends that backfill material which will support structures or improvements (such as patios, sidewalks, driveways, etc.) behind permanent concrete retaining walls and basement walls be placed and compacted consistent with the structural fill recommendations presented in this report.

7.5 UNDERGROUND UTILITIES

Underground utilities that are installed in the loose fills at the site should be supported on a layer of at least 6 to 12 inches of granular bedding material to provide support to rigid conduits. It may be necessary to line the bottom portion of the utility trench with geotextile fabric to confine the bedding material if conditions are particularly soft. We recommend that a granular material that requires minimal compaction effort to achieve a supporting condition be used for backfill.

7.6 Site Drainage

7.6.1 Surface Water Drainage during and after Construction

Water should not be allowed to stand in areas where foundations, slabs or pavements are to be constructed. During wet weather, these areas should be protected when idle by compacting the surface or covering the surface with plastic sheeting and directing the water away from the areas. Final site grades should direct drainage away from the building.

7.6.2 Subsurface and Roof Drain Lines

Roof downspout drain lines should be tightlined separately from subsurface drainage systems (such as retaining wall, basement wall, or foundation drainage systems) to their point of discharge into a storm water handling system. We recommend that sufficient cleanouts be installed at strategic locations to allow for periodic maintenance of the roof downspout drainage system.

7.7 Pavement Section Support and Design

We recommend that parking and driveway areas on site be supported on a layer of structural fill that is at least 12 inches in thickness. We recommend that fill be underlain with a layer of durable woven geotextile fabric, such as Mirafi 500X or similar so that separation of the fill from the underlying soils is maintained. The acceptability of the structural fill layer should be checked by performing a proof-rolling of the surface by using a fully loaded dump truck or other heavy construction vehicle. If areas of soft or unstable subgrade soils are discovered during proof-rolling, they should be excavated and replaced with structural fill or crushed rock.

We recommend that parking and driveway areas on site have a pavement section that consists of at least 3 inches of asphalt over 6 inches of crushed rock base course above the structural fill layer.

8 LIMITATIONS

This report has been prepared for the specific application to this site for the exclusive use of Mr. Adam Lundberg, AML Construction & Development, LLC, and his authorized representatives or agents. We recommend that this report be included in its entirety in the project contract documents for the information of project designers and contractors.

Our findings and recommendations stated herein are based on the field observations, our experience and judgment. The recommendations are our professional opinion derived in a manner consistent with the level of care and skill ordinarily exercised by other members of the profession currently practicing under similar conditions in this area and within the budget constraints. No warranty is expressed or implied. In the event soil conditions vary from those described herein, during site excavation or construction, GEO Group Northwest, Inc. should be notified, and the above recommendations should be reviewed and, where appropriate, be revised.

9 ADDITIONAL SERVICES

We recommend the GEO Group Northwest, Inc. be retained to perform a general review of the final design and specifications of the proposed development to verify that the earthwork and foundation recommendations have been properly interpreted and implemented in the project documents. We also recommend that GEO Group Northwest, Inc. be retained to provide monitoring and testing service for geotechnically-related work during construction. Work that should be monitored or verified by the geotechnical engineer typically includes the following:

- Preparation of soil subgrade in building and pavement areas;
- Structural fill selection, placement, and compaction;
- Placement and compaction of utility trench backfill

The purposes of this monitoring are to comply with construction permit requirements, where applicable, and to provide independent quality control engineering services. Construction monitoring services also can involve reviewing unanticipated conditions and providing consultation and recommendations that may involve changes to project design or methods.

10 CLOSING

We appreciate this opportunity to provide you with geotechnical engineering services. Please feel welcome to contact us if you have any questions regarding this report or need additional consultation.

Sincerely,

GEO GROUP NORTHWEST, INC.

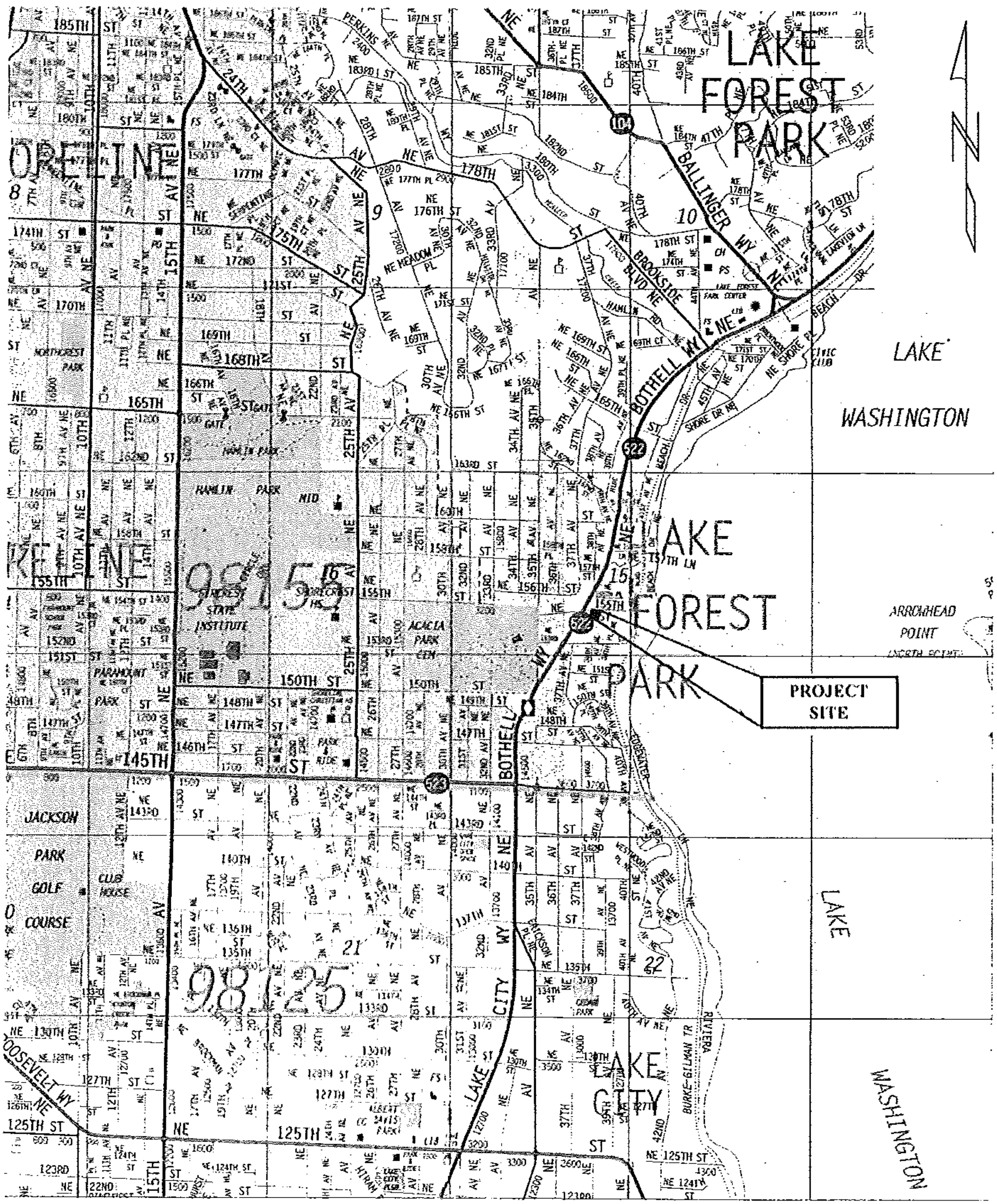
Keith Johnson
Project Geologist

William Chang, P.E.
Principal

PLATES

G-2239-1

GEO Group Northwest, Inc.



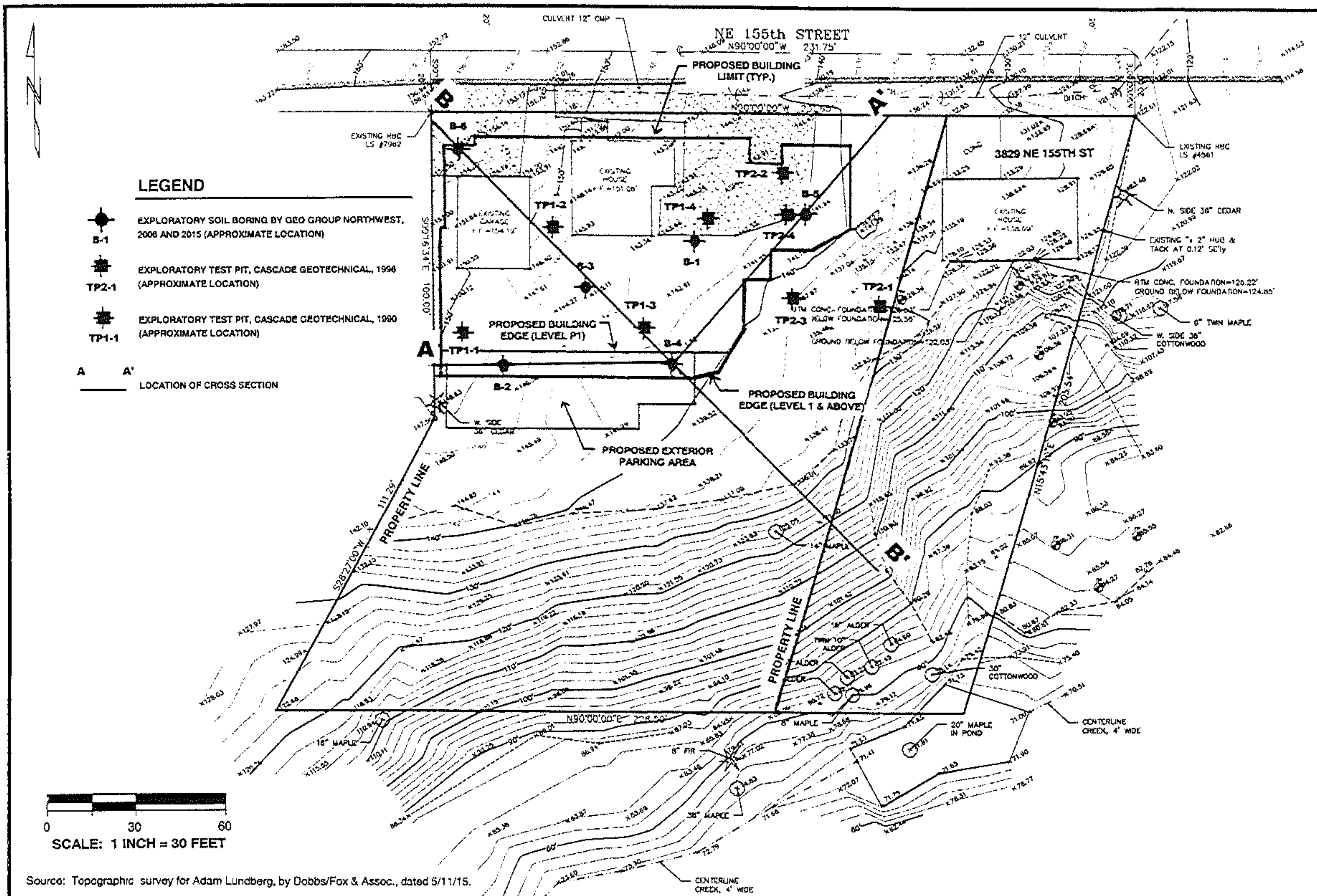
GEO Group Northwest, Inc.

Geotechnical Engineers, Geologists, & Environmental Scientists

SITE LOCATION MAP

PROPOSED RESIDENTIAL BUILDING
3803 NE 155TH STREET
LAKE FOREST PARK, WASHINGTON

SCALE:	1" = 2000'	DATE:	5/1/06	MADE:	KJ	CHKD:	WC	JOB NO:	G-2239	PLATE	1

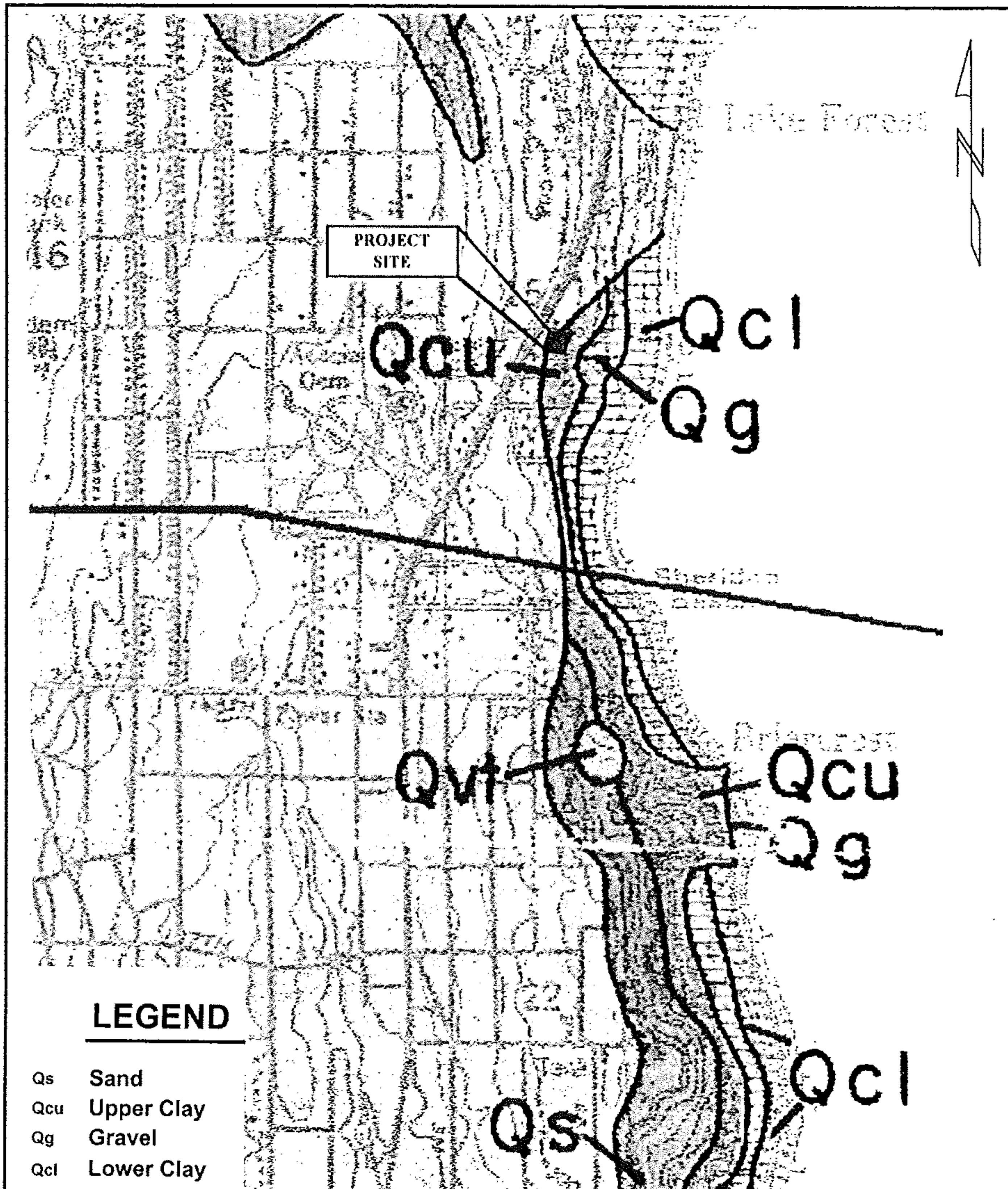


SITE PLAN

PROPOSED RESIDENTIAL BUILDING
3803 NE 155TH STREET
LAKE FOREST PARK, WASHINGTON

GEO Group Northwest, Inc.
Geotechnical Engineers, Geologists, & Environmental Scientists

SCALE	1" = 30'	DRAWN BY	KJ	CHECKED BY	WC	DATE	6/12/2015	PROJECT NO.	G-2239-1	PLATE	2



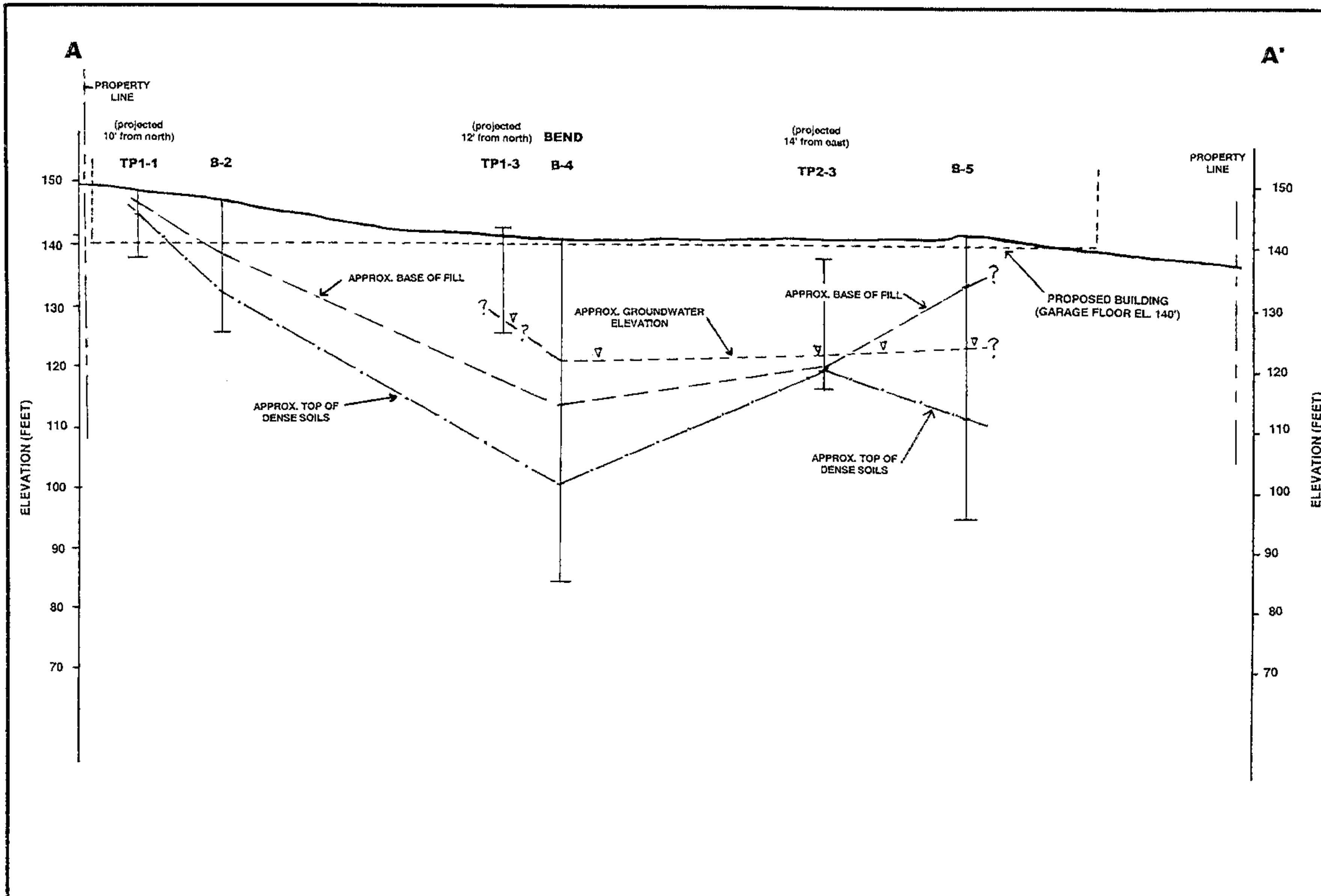
Reference: B.A. Liesch, et al., 1963.

GEO Group Northwest, Inc.
Geotechnical Engineers, Geologists, & Environmental Scientists

GEOLOGIC MAP

PROPOSED RESIDENTIAL BUILDING
3803 NE 155TH STREET
LAKE FOREST PARK, WASHINGTON

SCALE: 1" = 1000'	DATE: 5/1/06	MADE: KJ	CHKD: WC	JOB NO: G-2239	PLATE 3

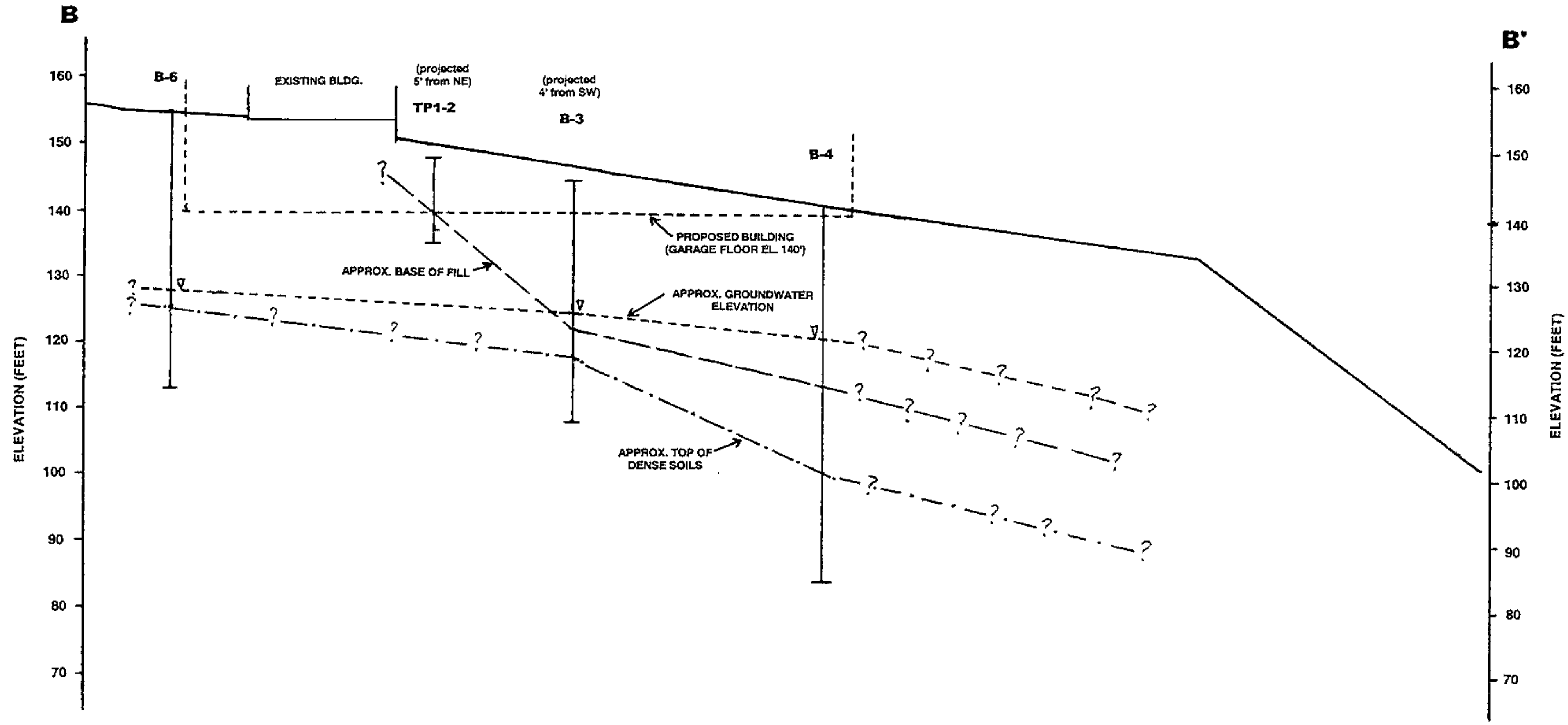


PROFILE A - A'

PROPOSED RESIDENTIAL BUILDING
3803 NE 155TH STREET
LAKE FOREST PARK, WASHINGTON

GEO Group Northwest, Inc.
Geotechnical Engineers, Geologists, & Environmental Scientists

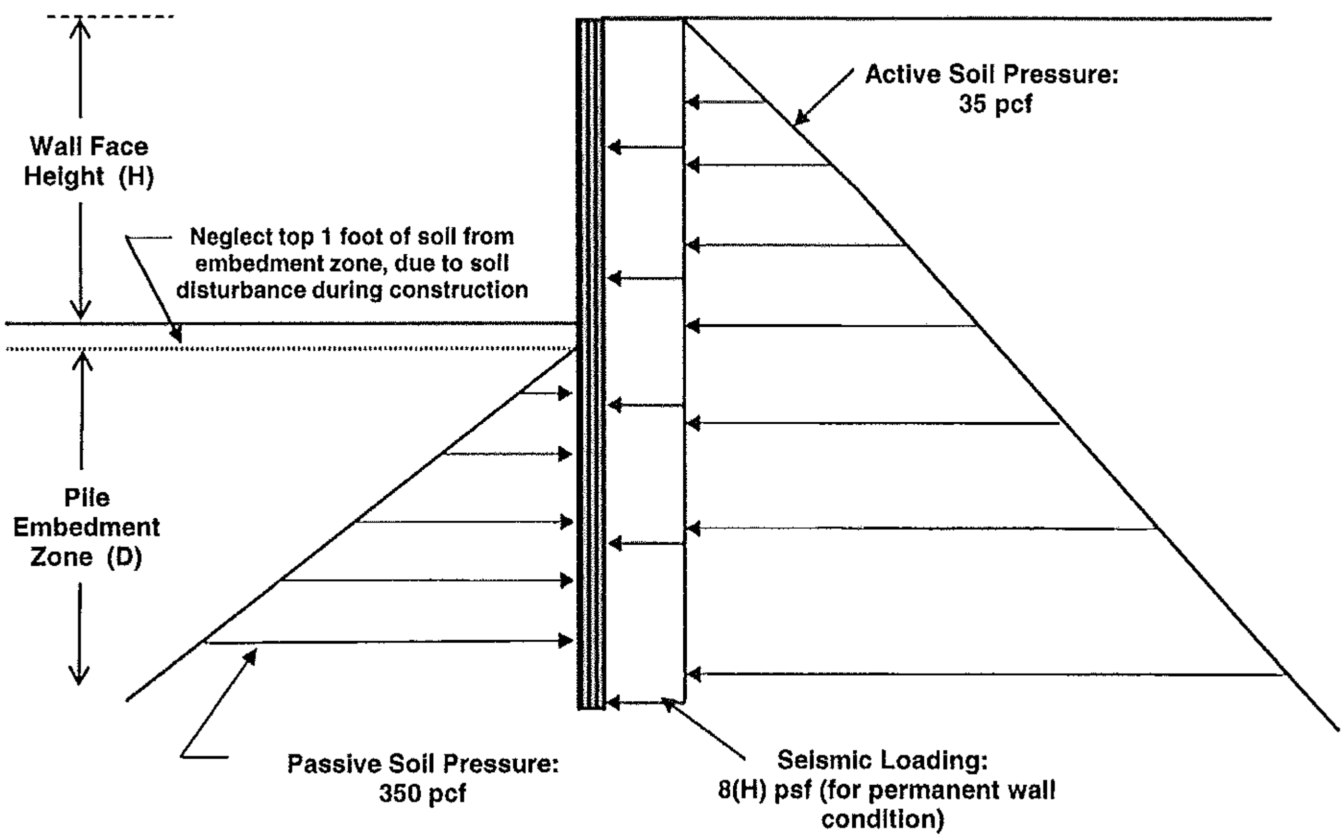
SCALE	1" = 15'	DRAWN BY	KJ	CHECKED BY	WC	DATE	6/17/2015	PROJECT NO.	G-2239-1	PLATE	4A



GEO Group Northwest, Inc. Geotechnical Engineers, Geologists, & Environmental Scientists				PROFILE B-B' PROPOSED RESIDENTIAL BUILDING 3803 NE 155TH STREET LAKE FOREST PARK, WASHINGTON					
SCALE	1" = 15'	DRAWN BY	KJ	CHECKED BY	WC	DATE	6/29/2015	PROJECT NO. G-2239-1	PLATE 4B

LATERAL EARTH PRESSURE DIAGRAM

CANTILEVER SOLDIER PILE AND LAGGING SHORING



NOT TO SCALE

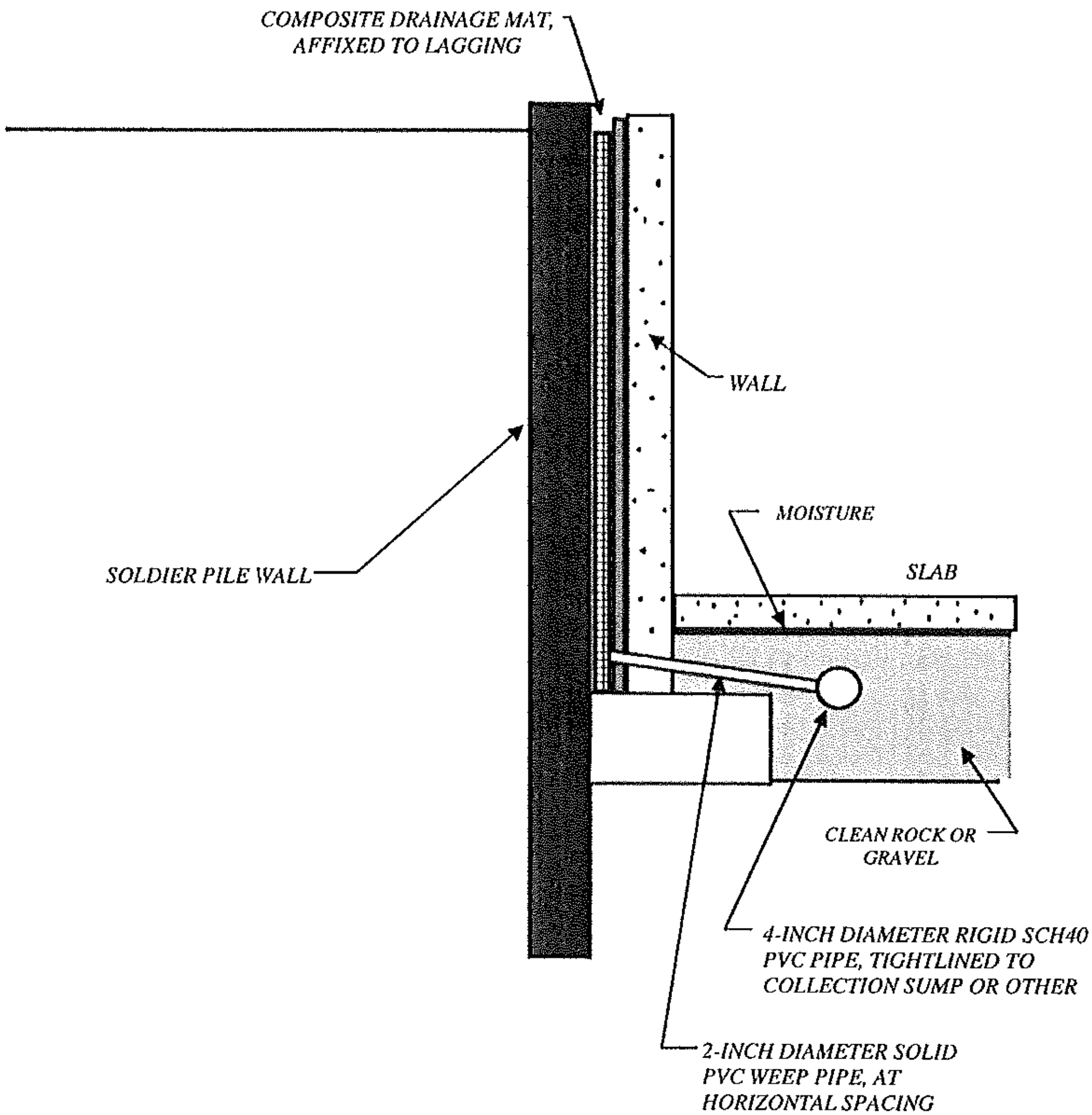
NOTES:

1. Active and passive soil pressures noted above are fluid-equivalent pressures.
2. The active soil pressures act on one pile spacing behind the wall and on the pile width below the wall.
3. The passive soil pressure acts on two pile diameters or one pile spacing, whichever is smaller.
4. The wall is assumed to be fully drained; no hydrostatic pressures act on the wall.
5. Surcharge loads from nearby traffic, buildings, or backslopes are not considered in this diagram, but should be evaluated and included in the design of the shoring.

GEO Group Northwest, Inc.
Geotechnical Engineers, Geologists, & Environmental Scientists

LATERAL EARTH PRESSURE DIAGRAM
PROPOSED RESIDENTIAL BUILDING
3803 NE 155TH STREET
LAKE FOREST PARK, WASHINGTON

SCALE NONE	DATE 6/24/2015	MADE KJ	CHKD WC	JOB NO. G-2239-1	PLATE 5



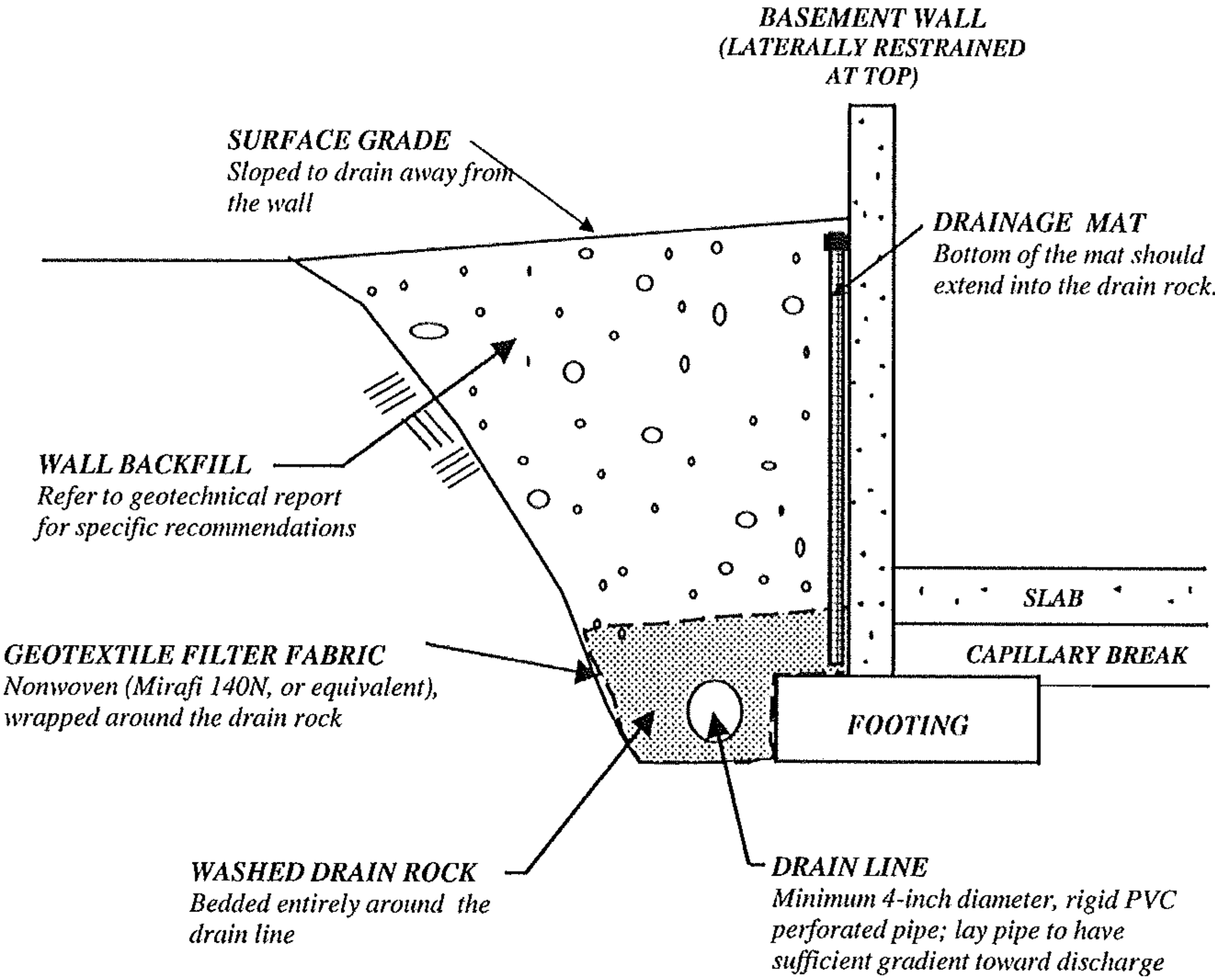
NOT TO SCALE

GEO Group Northwest, Inc.
Geotechnical Engineers, Geologists, & Environmental Scientists

TYPICAL SHORING WALL DRAINAGE

PROPOSED RESIDENTIAL BUILDING
3803 NE 155TH STREET
LAKE FOREST PARK, WASHINGTON

SCALE NONE	DATE 6/15/2015	MADE KJ	CHKD WC	JOB NO. G-2239-1	PLATE 6



NOT TO SCALE

NOTES:

1.) Do not replace rigid PVC pipe with flexible corrugated plastic pipe.

2.) Perforated PVC pipe should be tight jointed, laid with perforations facing downward, and sloped toward discharge location(s).

3.) The geotextile filter fabric should be wrapped around the drain rock that surrounds the pipe, not wrapped directly around the pipe.

4.) Wall backfill should meet structural fill specifications if it will support pavements, slabs, or structures. Refer to the geotechnical report for structural fill recommendations and specifications.

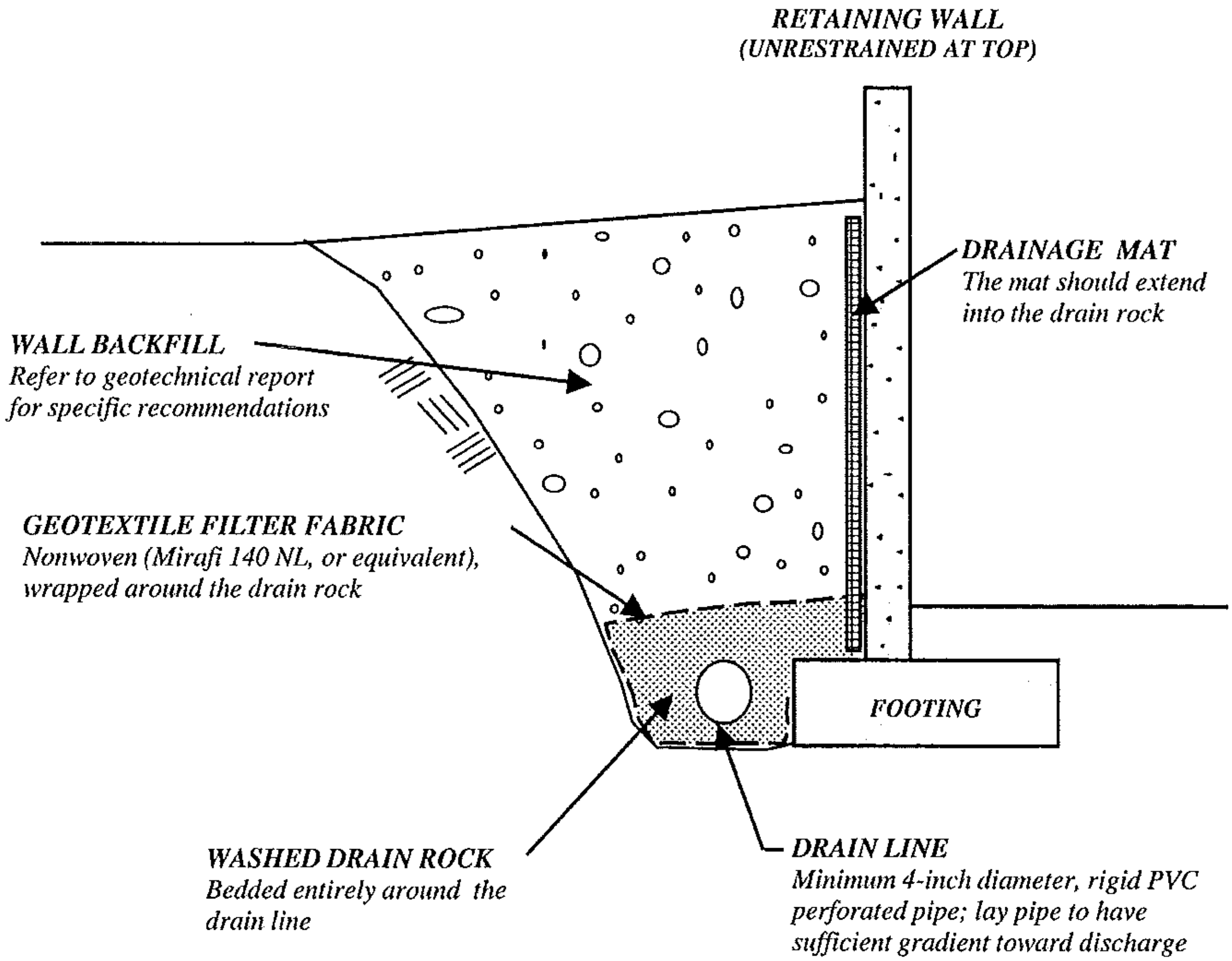
5.) Surface grade above the backfill can be covered with a layer of relatively impermeable topsoil or pavement or slab to reduce infiltration of surface water into the backfill and drainage system.

GEO Group Northwest, Inc.
Geotechnical Engineers, Geologists, & Environmental Scientists

TYPICAL BASEMENT WALL DRAINAGE

PROPOSED RESIDENTIAL BUILDING
3803 NE 155TH STREET
LAKE FOREST PARK, WASHINGTON

SCALE: NONE	DATE: 6/12/2015	MADE: KJ	CHKD: WC	JOB NO. G-2239-1	PLATE 7



NOT TO SCALE

NOTES:

1.) These recommendations are intended for walls 4 feet or greater in height, but can also be used for walls of lesser height, where desired.

2.) Do not replace rigid PVC pipe with flexible corrugated plastic pipe.

3.) Perforated PVC pipe should be tight jointed and laid with perforations oriented downward. The pipe should be gently sloped to provide flow toward the tightline or discharge location.

4.) Do not connect other drain lines into the footing drain system.

5.) Backfill should meet structural fill specifications if it will support driveways, sidewalks, patios, or other structures. Refer to the geotechnical engineering report for structural fill recommendations.

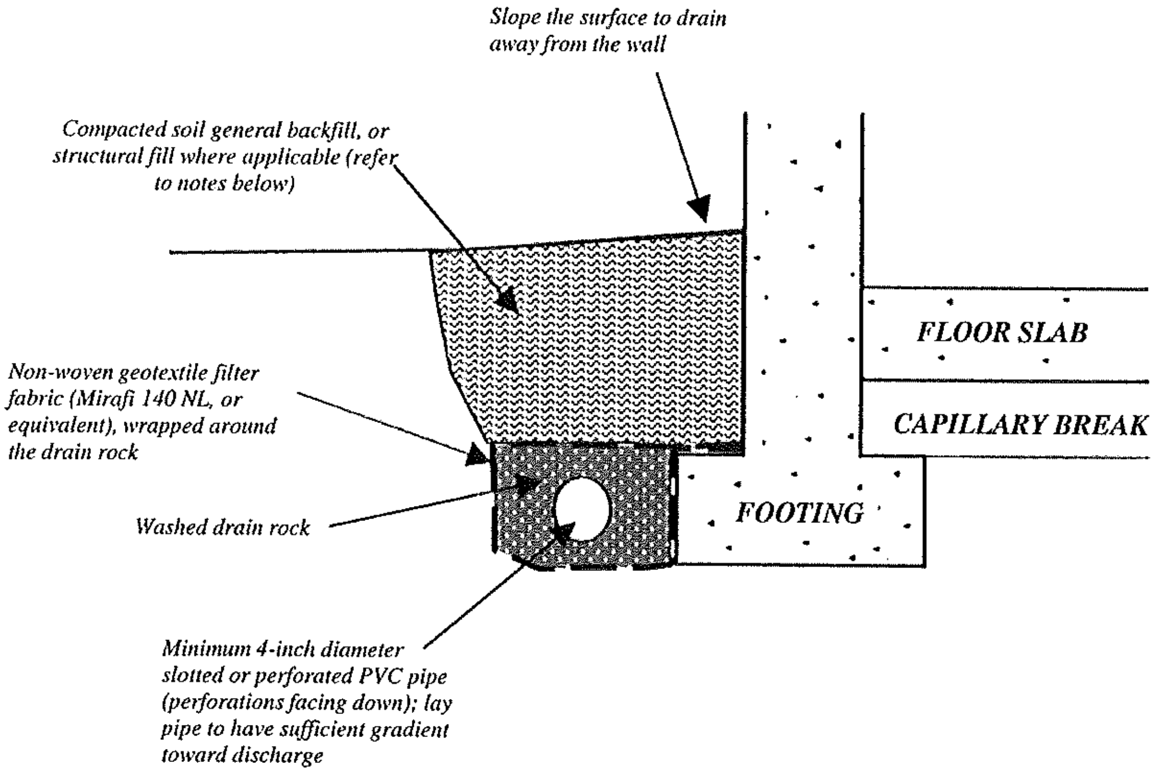
GEO Group Northwest, Inc.
Geotechnical Engineers, Geologists, & Environmental Scientists

TYPICAL RETAINING WALL DRAINAGE

PROPOSED RESIDENTIAL BUILDING
3803 NE 155TH STREET
LAKE FOREST PARK, WASHINGTON

SCALE	DATE	MADE	CHKD	JOB NO.	PLATE
NONE	6/12/2015	KJ	WC	G-2239-1	8

TYPICAL FOOTING DRAIN



NOT TO SCALE

NOTES:

1.) Perforated or slotted rigid PVC pipe should be tight jointed and laid with perforations or slots down, and with positive gradient toward discharge location(s). The pipe should be placed at or slightly above the elevation of the bottom of the footing. Do not replace rigid PVC pipe with flexible corrugated plastic pipe.

2.) Do not connect other drainage lines to the footing drain lines. Drain line cleanouts should be installed at appropriate locations to allow periodic inspection and maintenance of the lines after construction.

3.) If the backfill will support sidewalks, driveways, patios, or other structures, it should meet the recommendations for structural fill provided in the geotechnical report.

4.) The geotextile filter fabric should be placed around the drain rock as shown, and not wrapped directly around the pipe.

GEO Group Northwest, Inc. Geotechnical Engineers, Geologists, & Environmental Scientists			TYPICAL FOOTING DRAIN PROPOSED RESIDENTIAL BUILDING 3803 NE 155TH STREET LAKE FOREST PARK, WASHINGTON		
SCALE: NONE	DATE: 3/12/2015	MADE: KJ	CHKD: WC	JOB NO. G-2239-1	PLATE 9

APPENDIX A

G-2239-1

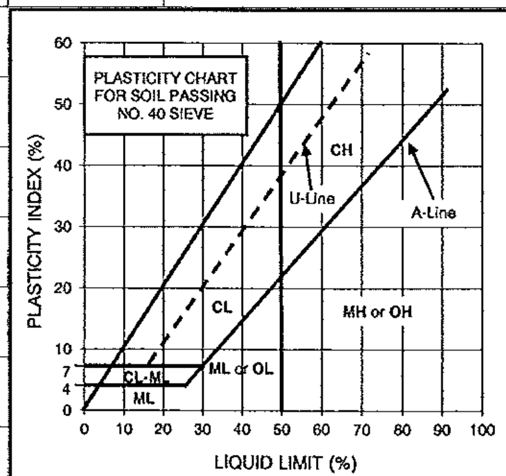
BORING LOGS

GEO Group Northwest, Inc.

SOIL CLASSIFICATION & PENETRATION TEST DATA EXPLANATION

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

MAJOR DIVISION			GROUP SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA	
COARSE-GRAINED SOILS More Than Half by Weight Larger Than No. 200 Sieve	GRAVELS (More Than Half Coarse Fraction is Larger Than No. 4 Sieve)	CLEAN GRAVELS (little or no fines)	GW	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURE, LITTLE OR NO FINES	CONTENT OF FINES BELOW 5%	Cu = (D60 / D10) greater than 4 Cc = $(D30)^2$ / (D10 * D60) between 1 and 3
			GP	POORLY GRADED GRAVELS, AND GRAVEL-SAND MIXTURES LITTLE OR NO FINES		CLEAN GRAVELS NOT MEETING ABOVE REQUIREMENTS
		DIRTY GRAVELS (with some fines)	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12%	GM: ATTERBERG LIMITS BELOW "A" LINE, or P.I. LESS THAN 4
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES		GC: ATTERBERG LIMITS ABOVE "A" LINE, or P.I. MORE THAN 7
	SANDS (More Than Half Coarse Fraction is Smaller Than No. 4 Sieve)	CLEAN SANDS (little or no fines)	SW	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	CONTENT OF FINES BELOW 5%	Cu = (D60 / D10) greater than 6 Cc = $(D30)^2$ / (D10 * D60) between 1 and 3
			SP	POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES		CLEAN SANDS NOT MEETING ABOVE REQUIREMENTS
		DIRTY SANDS (with some fines)	SM	SILTY SANDS, SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12%	ATTERBERG LIMITS BELOW "A" LINE with P.I. LESS THAN 4
			SC	CLAYEY SANDS, SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE with P.I. MORE THAN 7
FINE-GRAINED SOILS Less Than Half by Weight Larger Than No. 200 Sieve	SILTS (Below A-Line on Plasticity Chart, Negligible Organics)	Liquid Limit < 50%	ML	INORGANIC SILTS, ROCK FLOUR, SANDY SILTS OF SLIGHT PLASTICITY		
		Liquid Limit > 50%	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOIL		
	CLAYS (Above A-Line on Plasticity Chart, Negligible Organics)	Liquid Limit < 50%	CL	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAYS, CLEAN CLAYS		
		Liquid Limit > 50%	CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS		
	ORGANIC SILTS & CLAYS (Below A-Line on Plasticity Chart)	Liquid Limit < 50%	OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY		
		Liquid Limit > 50%	OH	ORGANIC CLAYS OF HIGH PLASTICITY		
HIGHLY ORGANIC SOILS			Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS		



SOIL PARTICLE SIZE

FRACTION	U.S. STANDARD SIEVE: Passing Sieve	Passing Size (mm)	Retained Sieve	Retained Size (mm)
SILT / CLAY	#200	0.075		
SAND				
FINE	#40	0.425	#200	0.075
MEDIUM	#10	2.00	#40	0.425
COARSE	#4	4.75	#10	2.00
GRAVEL				
FINE	0.75"	19	#4	4.75
COARSE	3"	76	0.75"	19
COBBLES	76 mm to 203 mm			
BOULDERS	> 203 mm			
ROCK FRAGMENTS	> 76 mm			
ROCK	>0.76 cubic meter in volume			

GENERAL GUIDANCE FOR ENGINEERING PROPERTIES OF SOILS, BASED ON STANDARD PENETRATION TEST (SPT) DATA

SANDY SOILS: Blow Counts N	Relative Density, %	Friction Angle φ, degrees	Description	SILTY & CLAYEY SOILS: Blow Counts N	Unconfined Strength q_u, tsf	Description
0 - 4	0 - 15		Very Loose	< 2	< 0.25	Very soft
4 - 10	15 - 35	26 - 30	Loose	2 - 4	0.25 - 0.50	Soft
10 - 30	35 - 65	28 - 35	Medium Dense	4 - 8	0.50 - 1.00	Medium Stiff
30 - 50	65 - 85	35 - 42	Dense	8 - 15	1.00 - 2.00	Stiff
> 50	85 - 100	38 - 46	Very Dense	15 - 30	2.00 - 4.00	Very Stiff
				> 30	> 4.00	Hard

GEO Group Northwest, Inc.
Geotechnical Engineers, Geologists, & Environmental Scientists
13240 NE 20th Street, Suite 10 Bellevue, WA 98005
Phone (425) 649-8757 Fax (425) 649-8758

PLATE A1

BORING NO. B-1

Logged By: KJ Date Drilled: 4/25/2006 Surface Elev. 143 feet +/-

Depth ft.	USCS Code	Description	Sample Type	Sample No.	Blow Count per 6 inches	Water Content %	Other Tests & Comments
	SM-ML	Brown SILTY SAND to SANDY SILT, damp, loose, mottled (FILL).	I	S1	2,2,3 (N=5)	14.4	
	SM-ML	As above.	I	S2	2,2,2 (N=4)	21.6	
5	SM-	As above.	I	S3	2,3,4 (N=7)	18.6	
	SM	Gray SILTY SAND, moist, loose, has visible voids (FILL).	I	S4	2,2,2 (N=4)	12.9	
10	SM	As above, some brownish blotches.	I	S5	2,2,3 (N=5)	22.1	
	SM/OL	Gray SILTY SAND and dark brown SILTY MUCK, heterogeneous, moist, loose, silty sand is as above.	I	S6	5,3,2 (N=5)	16.0	
15	SM	Brown-gray SILTY SAND and WOOD, moist to wet, loose.	I	S7	4,3,5 (N=8)	51.8	
	SM-	Gray SANDY SILT to SILTY SAND, moist, loose.	I	S8	4,3,3 (N=6)	17.9	
20	SP	Gray SAND, wet, loose, some fine black organics, speckled with brown medium sand grains (SUSPECT NATIVE SOIL).	I	S9	1,2,2 (N=4)	11.8	
	SP-SM	Grayish brown SAND, wet, medium dense, damp brown silt lens at bottom of sample (NATIVE SOIL).	I	S10	1,4,8 (N=12)	28.9	
25	SP/	Brownish gray SAND and olive SILTY SAND and SILT, wet, medium dense, gradationally becomes finer toward bottom of sample, silt is damp.	I	S11	9,9,14 (N=23)	36.4	
30	ML	Brown SILT, damp, medium dense to dense, grades to gray very fine sandy silt toward bottom of sample.	I	S12	5,15,14 (N=29)	36.1	
35	ML	Gray SILT, damp, dense.	I	S13	7,11,20 (N=31)	37.5	
40		Bottom of boring: 36.5 feet. Drilling Method: Hollow-stem auger. Sampling Method: 2-inch-O.D. sampler and 140 lb. hammer. Groundwater encountered at 20 feet during drilling, measured at 17 feet after drilling was completed.					

LEGEND:
- 2" O.D. Split-Spoon Sampler
- 3" O.D. Shelby Tube Sampler
- 3" O.D. Dames & Moore Sampler

GROUNDWATER OBSERVATION WELL: seal; measured water level; well tip (screen)

GEO Group Northwest, Inc.

Geotechnical Engineers, Geologists, & Environmental Scientists

BORING LOG

PROPOSED OFFICE BUILDING
3803 NE 155TH STREET
LAKE FOREST PARK, WASHINGTON

JOB NO. G-2239 DATE 5/4/2006 PLATE A2

BORING NO. B-2

Logged By: KJ   Date Drilled: 4/25/2006   Surface Elev. 147 feet +/-

Depth ft.	USCS Code	Description	Sample Type	Sample No.	Blow Count per 6 inches	Water Content %	Other Tests & Comments
	SM	Brown SILTY SAND, dry to damp, loose, mostly fine and medium grained with minor gravel (FILL).	I	S1	3,2,3 (N=5)	11.5	
	SM	As above, with mottling, medium dense, no gravel.	I	S2	7,8,9 (N=17)	19.9	
5	SM	As above, dry, with much wood and sawdust.	I	S3	3,2,7 (N=9)	- -	
	ML	Pale gray-brown SANDY SILT, dry to damp, medium dense, with wood waste as above (DISTURBED NATIVE SOIL).	I	S4	5,5,7 (N=12)	20.8	
10	ML	Grayish brown SANDY SILT, damp, medium dense, some very fine grained sand, deep red oxidation (NATIVE SOIL).	I	S5	4,10,12 (N=22)	16.2	
	ML-SM	Brown and gray SILTY SAND to SANDY SILT, damp, medium dense, deep red oxidation blotches and bands.	I	S6	6,10,13 (N=23)	22.6	
15	ML/SM	Gray SILT and brown GRAVELLY SILTY SAND, interbedded, damp, dense, strong red oxidation in sandy layers.	I	S7	7,20,25 (N=45)	13.4	
20	ML/SM	As above, gravelly sand in bottom of sample is moist.	I	S8	5,22,22 (N=44)	20.9	
25		Bottom of boring: 21.5 feet. Drilling Method: Hollow-stem auger. Sampling Method: 2-inch-O.D. sampler and 140 lb. hammer. Groundwater not encountered.					
30							
35							
40							

LEGEND:
- I 2" O.D. Split-Spoon Sampler
- II 3" O.D. Shelby Tube Sampler
- III 3" O.D. Dames & Moore Sampler

GROUNDWATER OBSERVATION WELL: seal; measured water level; well tip (screen)

GEO Group Northwest, Inc.

Geotechnical Engineers, Geologists, & Environmental Scientists

BORING LOG

PROPOSED OFFICE BUILDING
3803 NE 155TH STREET
LAKE FOREST PARK, WASHINGTON

JOB NO. G-2239   DATE 5/4/2006   PLATE A3

BORING NO. B-3

Logged By: KJ   Date Drilled: 4/25/2006   Surface Elev. 145 feet +/-

Depth ft.	USCS Code	Description	Sample Type	Sample No.	Blow Count per 6 inches	Water Content %	Other Tests & Comments
	SM	Brown SILTY SAND, damp, medium dense, trace gravel (FILL).	I	S1	5,7,9 (N=16)	11.1	
	SM	As above, loose.	I	S2	4,5,5 (N=10)	13.8	Some rock or concrete below surface.
5	SM	Brown SILTY SAND, damp, loose, some red oxidation staining, brown/black silty sand with fine organics at bottom of sample, moist.	I	S3	3,4,5 (N=9)	21.3	
	SM	Dark gray and brown SILTY SAND, damp, loose, trace charcoal.	I	S4	2,1,2 (N=3)	15.3	
10	SM	As above.	I	S5	1,2,2 (N=4)	21.7	
	SM	As above, with wood as most of sample, moist to wet.	I	S6	1,45,11 (N=56)	19.9	Blow count affected by wood waste.
15	SM	As above, very loose, damp to moist.	I	S7	2,1,1 (N=2)	22.8	
▼	SM	As above, very mottled, loose, moist.	I	S8	2,1,3 (N=4)	17.1	
20 ▽	SM	Gray SILTY SAND, wet, loose, minor gravel, brown at bottom.	I	S9	1,2,2 (N=4)	16.7	
	ML/ SM/ SP	Gray SAND and SILTY SAND and black SANDY SILT to SILTY SAND, wet, very loose, fine organics in black soil.	I	S10	0,1,2 (N=3)	23.7	
25	SM-	Dark gray SAND to SILTY SAND, wet, loose, trace rootlets, some brownish lenses (SUSPECT NATIVE SOIL).	I	S11	0,2,5 (N=7)	25.8	
	ML	Dark olive SILT to SANDY SILT, wet to damp, dense, sand is very fine, grades finer and damp and brown toward bottom of sample (NATIVE SOIL).	I	S12	10,15,20 (N=35)	24.1	
30	ML	Brown and gray SILT and SANDY SILT, damp to moist, dense, wet gray sand at bottom of sample.	I	S13	8,18,24 (N=42)	27.7	
35	ML	Gray SILT, damp, dense to very dense.	I	S14	14,17,33 (N=50)	33.5	
40		Bottom of boring: 36.5 feet. Drilling Method: Hollow-stem auger. Sampling Method: 2-inch-O.D. sampler and 140 lb. hammer. Groundwater encountered at 20 feet during drilling, measured at 17 feet after drilling was completed.					

LEGEND:
- 2" O.D. Split-Spoon Sampler
- 3" O.D. Shelby Tube Sampler
- 3" O.D. Dames & Moore Sampler

GROUNDWATER OBSERVATION WELL: seal; measured water level; well tip (screen)

▽ = at time of drilling
▼ = later measurement

GEO Group Northwest, Inc.
Geotechnical Engineers, Geologists, & Environmental Scientists

BORING LOG

PROPOSED OFFICE BUILDING
3803 NE 155TH STREET
LAKE FOREST PARK, WASHINGTON

JOB NO. G-2239 **DATE** 5/4/2006 **PLATE** A4

BORING NO. B - 4

Logged By: KJ   Date Drilled: 6/10/2015   Surface Elev. 141' (±)

Drilled By: Geologic Drill

Depth ft.	Elevation	USCS Code	Description	Sample Loc.	Sample No.	SPT Blow Counts	Water Content %	Other Tests/ Comments
			Cut back blackberry vines and knotweed on bare ground.					
		SM	SILTY SAND, dark grayish brown, dry, loose, sand is mostly fine grained, some organics mixed in (FILL).	I		2,3,3 (N=6)	8.1	
5		SM/ML	SILTY SAND and SILT, dark grayish brown and olive gray, damp, loose, mixed/hetergenous texture (FILL).	I		2,2,1 (N=3)	33.1	
		ML	SILT, olive gray, moist, loose, lesser very dark gray sand, mottled, heterogeneous texture (FILL).	I		3,2,3 (N=5)	20.6	
10		ML/SM	SILT and SILTY SAND, very dark grayish brown and dark gray, moist, loose, mixed/heterogeneous texture, occasional wood and finer organics (FILL).	I		2,3,3 (N=6)	32.5	
		ML	SANDY SILT and SILT, dark brown and dark gray, moist, very loose, hetergenous/mixed texture, some wood and other fibrous organics, mottled (FILL).	I		2,1,2 (N=3)	24.0	
15		ML	As above, moist to wet, loose, mottled coloring.	I		1,3,3 (N=6)	29.6	
		ML	As above, damp to moist, loose to medium dense.	I		2,4,6 (N=10)	26.0	
▽ 20		SM	SILTY SAND, gray with some brown, wet, loose to medium dense, sand is mostly fine grained, trace gravel,	I		8,7,3 (N=10)	12.1	poor sample recovery (may include slough)
		SM	SILTY SAND, dark brown, wet, loose, contains wood, very silty (APPARENT FILL).	I		2,1,5 (N=6)	35.9	
25								

LEGEND: I 2" O.D. SPT Sampler; II 3" O.D. California Sampler; ▽ Water Level noted during drilling; ▼ Water Level measured at later time, as noted

GEO Group Northwest, Inc.
Geotechnical Engineers, Geologists, & Environmental Scientists

BORING LOG

PROPOSED RESIDENTIAL BUILDING
3803 NE 155TH STREET
LAKE FOREST PARK, WASHINGTON

JOB NO. G-2239-1   DATE 3/4/2015   PLATE A5

BORING NO. B - 4

Logged By: KJ   Date Drilled: 6/10/2015   Surface Elev. 141' (±)
Drilled By: Geologic Drill

Depth ft.	Elevation	USCS Code	Description	Sample Loc.	Sample No.	SPT Blow Counts	Water Content %	Other Tests/ Comments
		SP-SM SM-ML	SAND to SILTY SAND, gray, wet, loose, sand is fine grained, trace gravel. Occasional SANDY SILT to SILTY SAND strata that are brown and contain wood	I		3,3,4 (N=7)	24.3	
		SM	SILTY SAND, greenish gray, wet, loose in sampler, sand is fine grained (APPARENT NATIVE SOIL).	I		2,16,50-5" (N=50+)*	13.9	* Note: Blow counts affected by log encountered in boring.
30		SP-SM	SAND to SILTY SAND, dark gray, wet, medium dense, fine grained, some wood in sample (APPARENT NATIVE SOIL).	I		13,7,5 (N=12)	32.7	
		SM/ML	SILTY SAND and SILT, interlayered, dark gray and dark brownish gray, moist, medium dense, some fine blackish organics, sand is fine grained (NATIVE SOIL).	I		13,6,6 (N=12)	21.6	
35		SM/ML	SILTY SAND and SILT, dark gray and bluish gray, moist (ML) to wet (SM), sand is fine grained, minor fine gravel in SM.	I		4,8,5 (N=13)	23.8	
40		SP-SM	SAND to SILTY SAND, dark gray, moist to wet, dense, sand is very fine grained, coarsens downward (but remains fine), occasional rootlets/organics, finely stratified.	I		40,17,23 (N=40)	26.8	
45		SP-SM	As above, gray.	I		5,13,23 (N=36)	30.7	
50								

LEGEND: I 2" O.D. SPT Sampler; II 3" O.D. California Sampler; ▽ Water Level noted during drilling; ▼ Water Level measured at later time, as noted

GEO Group Northwest, Inc.
Geotechnical Engineers, Geologists, & Environmental Scientists

BORING LOG

PROPOSED RESIDENTIAL BUILDING
3803 NE 155TH STREET
LAKE FOREST PARK, WASHINGTON

JOB NO. G-2239-1   DATE 3/4/2015   PLATE A6

BORING NO. B - 4

Logged By: KJ Date Drilled: 6/10/2015 Surface Elev. 141' (±)
Drilled By: Geologic Drill

Depth ft.	Elevation	USCS Code	Description	Sample Loc.	Sample No.	SPT Blow Counts	Water Content %	Other Tests/ Comments
		SP	SAND, dark gray, wet, medium dense, fine grained, no fines.	I		1,4,9 (N=13)	26.1	
55		SM-ML	SILTY SAND to SILT, gray, damp to moist, dense, sand is very fine grained, finely stratified.	I		10,15,20 (N=35)	28.4	
60			Depth of boring: 56.5 feet. Drilling Method: Hollow-stem auger. Sampling Method: 2-inch-O.D. standard penetration sampler driven using a 140 lb. hammer with a 30-inch drop. Groundwater seepage encountered at approximately 19 feet below ground surface during drilling.					
65								
70								
75								

LEGEND: 2" O.D. SPT Sampler; 3" O.D. California Sampler; ▽ Water Level noted during drilling; ▼ Water Level measured at later time, as noted

GEO Group Northwest, Inc.
Geotechnical Engineers, Geologists, & Environmental Scientists

BORING LOG

PROPOSED RESIDENTIAL BUILDING
3803 NE 155TH STREET
LAKE FOREST PARK, WASHINGTON

JOB NO. G-2239-1 DATE 3/4/2015 PLATE A7

BORING NO. B - 5

Logged By: KJ
Drilled By: Geologic Drill
Date Drilled: 6/10/2015
Surface Elev. 142' (±)

Depth ft.	Elevation	USCS Code	Description	Sample Loc.	Sample No.	SPT Blow Counts	Water Content %	Other Tests/ Comments
			Asphalt pavement over thin layer of base course.					
		SM	SILTY SAND, dark brown-gray, dry to damp, loose, sand is mostly fine to medium grained, little gravel (FILL).	SPT		5,4,4 (N=8)	9.9	
5		SM	SILTY SAND with gravel, brown, damp, loose, sand is mostly fine to medium grained, mottled (FILL).	SPT		4,3,4 (N=7)	16.8	
		SM	As above, moist, oxidized.	SPT		9,13,15 (N=28)	9.9	
		SM	SILTY SAND, olive brown, damp, medium dense, some oxide staining, sand is fine grained, minor gravel (APPARENT NATIVE SOIL).					
10		SM	SILTY SAND with gravel, brown, damp to moist, medium dense, some oxide staining, sand is mostly fine to medium grained (NATIVE SOIL).	SPT		8,11,14 (N=25)	10.4	
15		SM	As above, but poor sample recovery, moist to very moist, mottled.	SPT		11,8,8 (N=16)	14.6	poor sample recovery
▽ (approx. 18)								
20		SP-SM	SAND, brown, wet, medium dense, fine grained, 5-10% fines (NATIVE SOIL).	SPT		9,10,10 (N=20)	28.8	
25								

LEGEND:
- 2" O.D. SPT Sampler
- 3" O.D. California Sampler
- ▽ Water Level noted during drilling
- ▼ Water Level measured at later time, as noted

GEO Group Northwest, Inc.
Geotechnical Engineers, Geologists, & Environmental Scientists

BORING LOG

PROPOSED RESIDENTIAL BUILDING
3803 NE 155TH STREET
LAKE FOREST PARK, WASHINGTON

JOB NO. G-2239-1 | DATE 3/4/2015 | PLATE A8

BORING NO. B - 5

Logged By: KJ
Drilled By: Geologic Drill
Date Drilled: 6/10/2015
Surface Elev. 142' (±)

Depth ft.	Elevation	USCS Code	Description	Sample Loc.	Sample No.	SPT Blow Counts	Water Content %	Other Tests/ Comments
		SP-SM						
		ML	SILT to SANDY SILT, brown, damp to moist, medium dense, weakly stratified, some oxide staining near top.	I		9,10,14 (N=24)	26.0	
30		SP/ML	SAND and SILT, interbedded, brown to olive brown, damp (ML) to moist (SM), medium dense to dense, sand is fine grained.	I		9,15,15 (N=30)	20.3 28.0	sand silt
▽								
35		SP/SM	SAND and SILTY SAND, interbedded, olive brown to light olive gray, moist (SM) to wet (SP), dense, has some strongly oxidized bands, sand is fine grained	I		10,15,20 (N=35)	25.5	
40		SM	SILTY SAND, olive brown, wet, medium dense, 10-15% fines, sand is fine grained.	I		6,13,13 (N=26)	19.1	
45		SM-ML	SILTY SAND to SILT, bluish gray, damp, dense, sand is very fine grained, weakly stratified to massive texture.	I		11,13,30 (N=43)	32.9	
50			Depth of boring: 46.5 feet. Drilling Method: Hollow-stem auger. Sampling Method: 2-inch-O.D. standard penetration sampler driven using a 140 lb. hammer with a 30-inch drop. Groundwater encountered at approximately 18 feet below ground surface during drilling.					

LEGEND: I 2" O.D. SPT Sampler; Ï 3" O.D. California Sampler; ▽ Water Level noted during drilling; ▼ Water Level measured at later time, as noted

GEO Group Northwest, Inc.
Geotechnical Engineers, Geologists, & Environmental Scientists

BORING LOG

PROPOSED RESIDENTIAL BUILDING
3803 NE 155TH STREET
LAKE FOREST PARK, WASHINGTON

JOB NO. G-2239-1 | DATE 3/4/2015 | PLATE A9

BORING NO. B - 6

Logged By: KJ   Date Drilled: 6/10/2015   Surface Elev. 154' (±)
Drilled By: Geologic Drill

Depth ft.	Elevation	USCS Code	Description	Sample Loc.	Sample No.	SPT Blow Counts	Water Content %	Other Tests/ Comments
			Parking area asphalt pavement over base course.					
		SM	SILTY SAND with gravel, brown, damp to moist, mottled, some blackish organics and oxide staining, massive texture (APPARENT NATIVE SOIL).	I		7,10,15 (N=25)	10.2	
5		SP/SM	SAND and SILTY SAND, brown and grayish brown, damp to moist, medium dense, little gravel, some oxide stain, sand is mostly fine to medium grained (NATIVE SOIL).	I		5,6,6 (N=12)	14.6	
		SP/SM	As above, moist.	I		4,5,7 (N=12)	15.2	
10		SM	SILTY SAND, brown, moist, loose to medium dense, sand is somewhat graded, minor gravel.	I		3,5,5 (N=10)	13.2	
		SM	SILTY SAND, brown and gray, moist, medium dense, sand is mostly fine grained, mottled, very silty.	I		7,8,10 (N=18)	15.1	
15		SM	SILTY SAND, olive brown, moist medium dense, sand is fine to medium grained, little gravel, some oxide staining.	I		5,7,11 (N=18)	23.1	
20		ML	SANDY SILT and SILT, olive brown / olive gray, moist, medium dense, trace gravel, contains occasional wet lenses of clean fine sand	I		4,4,8 (N=12)	19.6	
▽ (approx. 22)								
25								

LEGEND: I 2" O.D. SPT Sampler; II 3" O.D. California Sampler; ▽ Water Level noted during drilling; ▼ Water Level measured at later time, as noted

GEO Group Northwest, Inc.
Geotechnical Engineers, Geologists, & Environmental Scientists

BORING LOG

PROPOSED RESIDENTIAL BUILDING
3803 NE 155TH STREET
LAKE FOREST PARK, WASHINGTON

JOB NO. G-2239-1 | DATE 3/4/2015 | PLATE A10

BORING NO. B - 6

Logged By: KJ
Drilled By: Geologic Drill
Date Drilled: 6/10/2015
Surface Elev. 154' (±)

Depth ft.	Elevation	USCS Code	Description	Sample Loc.	Sample No.	SPT Blow Counts	Water Content %	Other Tests/ Comments
		ML-SM	SANDY SILT to SILTY SAND, dark gray, moist, medium dense, sand is fine to medium grained.	I		7,11,12 (N=23)	22.1	
		SP	SAND, dark gray, wet, medium dense, fine grained.					
30		SM	SILTY SAND, olive brown, moist, dense, occasional lenses of wet clean fine sand.	I		10,17,25 (N=42)	20.1	
35		SP	SAND, olive brown, wet, medium dense, fine grained, 5% fines.	I		8,9,12 (N=21)	25.4	
40		SP-SM	SAND to SILTY SAND, olive gray, wet, dense, fine grained, 5-10% fines.	I		14,23,20 (N=43)	26.0	
45								
50								

Depth of boring: 41.5 feet.
Drilling Method: Hollow-stem auger.
Sampling Method: 2-inch-O.D. standard penetration sampler driven using a 140 lb. hammer with a 30-inch drop.

Groundwater encountered at approximately 22 feet during drilling.

LEGEND:
- 2" O.D. SPT Sampler
- 3" O.D. California Sampler
- ▽ Water Level noted during drilling
- ▼ Water Level measured at later time, as noted

GEO Group Northwest, Inc.
Geotechnical Engineers, Geologists, & Environmental Scientists

BORING LOG

PROPOSED RESIDENTIAL BUILDING
3803 NE 155TH STREET
LAKE FOREST PARK, WASHINGTON

JOB NO. G-2239-1 | DATE 3/4/2015 | PLATE A11

APPENDIX B

G-2239-1

PREVIOUS GEOTECHNICAL INVESTIGATION AND TEST PIT LOGS

Copy

NORBROOK OFFICE SITE

3803 N.E. 155th STREET

KING COUNTY, WASHINGTOn

JOB NO. 9006-26G

TABLE OF CONTENTS

CASCADE GEOTECHNICAL, INC.
12919 N.E. 126TH PLACE (206) 821-5080
KIRKLAND, WASHINGTON 98034 FAX: (206) 823-2203

July 20, 1990
Job No. 9006-26G

Norbrook Construction
P.O. Box 27205
Seattle, Washington 98125

Attention: Mike Sorenson

Reference: Norbrook Office Site
3803 N.E. 155th Street
King County, Washington

Dear Mr. Sorenson:

At your request, we have completed our preliminary subsurface soils investigation for the above site. The following report presents the results of our findings and offers preliminary conclusions and recommendations for the proposed office building in King County, Washington.

SCOPE

The scope of our study was to investigate the subsurface soil and ground water conditions in order to formulate preliminary conclusions and recommendations for construction and development of the site. A Cascade Geotechnical representative visited the above site on July 2, 1990 to view the site and to investigate the subsurface soil and ground water conditions.

The site investigation was based on a surface reconnaissance of the site, a review of available the geologic maps and four (4) backhoe test pits. This report offers conclusions and recommendations for site preparation, foundation design parameters, drainage and slope stability.

PROJECT DESCRIPTION

We understand that the proposed project is to consist of the short platting of an existing lot, removing the existing buildings and constructing a two (2) story office building on the northwest corner of the proposed western lot. No topographic or building plans have been provided to us. A previously completed soil survey of the ground near the slope break was not provided to us for review. We should be engaged to review the site and building plans to see that our recommendations are properly interpreted.

A plat map prepared by Reid, Middleton and Associates, Inc. and dated August 8, 1986 has been provided to us.

SITE DESCRIPTION

The site is an irregular, 42,846 square foot property which is located at the top of a south and southeastern sloping hillside approximately 1000 feet east of Lake Washington in northwestern King County, Washington. The property is bounded by office and residential buildings to the west, N.E. 155th Street to the north and a residence to the south.

Two (2) older, wood-framed buildings are located on the proposed building site, located on the northwest corner of the property. The buildings have slab-on-grade basement floors which were observed to have cracks with one (1) to two (2) inches of vertical displacement.

As determined from our visual observations on July 2, 1990, the ground is relatively flat on a one-hundred (100) foot wide terrace directly adjacent to N.E. 155th Street. The ground slopes down towards the south and east on the southern half and eastern end at approximately twenty-five (25) to thirty (30) degrees, respectively.

The property was relatively clear in the areas adjacent to the existing buildings. The remaining portions of the property were covered with dense blackberry bushes and grasses.

SUBSURFACE SOIL CONDITIONS

Site subsurface conditions were determined by excavating four (4) backhoe test pits on July 2, 1990. The test pit locations were selected by an engineering geologist from our office and located in or near the proposed building site by pacing relative to property lines and other identifiable landmarks.

The Test Pit Location Map is presented in Appendix A. Depths referred to in this report are relative to the existing ground surface at the time of our investigation. For detailed test pit logs and soil descriptions see Appendix B. All soils were classified according to the Unified Soils Classification System. A copy of this classification is contained in Appendix C.

Up to eight (8) and one-half (8 1/2) feet of uncontrolled fill was observed in the south and northwest sections of the proposed building area. Under the southwest section, approximately two and one-half (2 1/2) feet of uncontrolled fill was observed in Test Pit #1. The uncontrolled fill was observed to thicken towards the south and approximately thirty (30) feet south of the southeast corner of the existing east building, fifteen (15) feet of uncontrolled fill material was observed in Test Pit #3. The uncontrolled fill was observed to consist of gray and brown loose silty sand and sandy silt.

A soft to medium stiff sandy silt was encountered under the uncontrolled fill in Test Pit #3. Test Pit #3 was terminated within this soil at seventeen (17) feet below the surface.

Underlying the uncontrolled fill in Test Pit #1, a loose sand approximately one and one-half (1 1/2) feet thick was observed overlying a dense silty sand. A one (1) foot thick layer of a blue-gray to grayish brown, very stiff clayey silt was found underlying the silty sand at nine and one-half (9 1/2) feet below the surface. This soil was observed to grade into a mottled, grayish-brown, very dense sandy silt. Test Pit #1 was terminated in the very dense sandy silt at a depth of eleven and one-half (11 1/2) feet.

Below the uncontrolled fill in Test Pit #2, a gray, loose to medium silty sand was found at a depth of eight (8) feet. This soil was found to overlie a dense silty sand which was encountered at ten and one-half (10 1/2) feet. The dense silty sand was found to the termination depth of twelve and one-half (12 1/2) feet.

In Test Pit #4, a medium dense gravelly sand with some cobbles and very thin silt layers was found to underlie the uncontrolled fill below eight and one-half (8 1/2) feet. The contact between the uncontrolled fill and the gravelly sand was observed to slope towards the south at approximately twenty-five (25) degrees. A two (2) inch metal pipe was found to slope down with the gravelly sand contact. Test Pit #4 was terminated within the gravelly sand at fourteen (14) feet.

The property lies within an area that has been geologically mapped as the contact between the Vashon glacial till and the older clay as shown on the "Preliminary Geologic Map of Seattle and Vicinity" (USGS Map I-354, Waldron et al, 1962). The property has been extensively filled, especially towards the south. Overconsolidated material was observed in Test Pits #1 and #2 on the relatively higher sections of the property but no glacially consolidated soils were encountered in Test Pits #3 and #4. The gravelly sand found at depth in Test Pit #4 may be a recessional outwash which had previously been deposited in a gully eroded into the older glacial materials then covered with the fill material.

GROUND WATER

No ground water seepage was observed in the test pits. Wet silty sand was encountered immediately below uncontrolled fill in Test Pit #2 and mottling was observed in the native silty sand and sandy silt in Test Pits #1 and #2. We would expect ground water seepage above the relatively impermeable, dense soils in the wetter, winter months.

CONCLUSIONS AND RECOMMENDATIONS

The building site is located in an area where up to eight and one-half (8 1/2) feet of uncontrolled fill has been placed on a pre-existing slope. However, no evidence of slope movement was noted on the property. Due the considerable set-back from the existing fill slope, we expect that the construction of the proposed office building will not decrease the stability of the site, if our recommendations are closely followed. The owner should be aware that the potential for slope movement on the southern portion of the property will continue to exist.

Based upon the test pit data, development and use of the building site will require that the proposed building foundation bear on the underlying medium dense to dense silty sand and medium dense gravelly sand. A spread and strip footing foundation may bear on adequately placed and compacted structural fill placed on horizontal surfaces cut well into the native soil. The fill should be limited to a thickness no greater than four (4) feet. Specific and detailed recommendations regarding structural fill placement in the eastern half of the proposed building area are provided below. The amounts of uncontrolled fill to be excavated and structural fill to be placed in the eastern section of the proposed building area will be large for such a constricted site, so a relatively long term earthwork construction schedule should be anticipated.

If the proposed floor elevations on the eastern half of the proposed building area are situated where a spread footing foundation cannot be economically used, an alternate option would be to use a deep foundation to limit settlement. The deep foundation may consist of drilled piers. If you decide to proceed with this option, we can provide the specific design parameters.

If the proposed building utilizes a slab-on-grade floor in conjunction with spread footings, structural fill which is placed and adequately compacted according to our recommendations should be placed under the slab area to prevent excessive settlement. If a deep foundation is placed and structural support for the slab-on-grade is not provided, some differential settlement can be expected in. If no significant settlement can be tolerated, pier support for the slab will be necessary.

Site Preparation

The native soils on the site are moisture sensitive due to the high amount of fine grained material. We therefore recommend performing site preparation and excavation work during an extended period of dry weather to avoid excess costs and construction problems associated with soil deterioration.

We recommend adjusting site grades to provide proper drainage throughout the site. All excess soil should be removed from the site. During construction, the site slopes should be disturbed as little as possible to avoid erosion and soil saturation. Care should be taken so that no excavated soil is placed on the southern slope. We recommend that any excavation cuts deeper than four (4) feet should be no steeper than a 1.5(H):1(V) slope for temporary construction purposes.

Foundation Design (Spread Footings)

In the western portion of the proposed building area, conventional spread or strip footings which bear on a horizontal, firm, undisturbed surface of the native medium dense to dense silty sand or medium dense gravelly sand are suitable for design loads up to 2000 psf maximum safe bearing value. This native bearing soil should be free of organic material, water or loose soils and should not become wet prior to concrete placement. A one-third ($^1/_3$) increase of the bearing value may be used for the calculation of wind and seismic loading. The bearing surface should be cut at least eighteen (18) inches into the suitable soil. Spread footings should have a minimum width as determined by local building codes and be placed at least eighteen (18) inches below final grade for frost protection.

Since the uncontrolled fill is of unknown stability, building and foundation design should take the possibility of downhill movement of the fill into account.

Structural Fill

Structural fill should be used to support the eastern portion of the foundation where grades require it. Fill should be placed directly on a firm, horizontal subgrade of native bearing soil. The structural fill may consist of an imported free-draining material which meets the following gradation:

Sieve Size	Percent Passing
4 inch	100
#4	25-75
#200	5 maximum, based on the fraction passing the #4 sieve.

Fill should be placed in twelve (12) inch, loose lifts and compacted to at least 95 percent of the ASTM D-1557 maximum dry density. The fill should be limited to a thickness no greater than four (4) feet and should extend out from the outside edge of the footing a distance at least equal to the fill thickness. Fill should be placed under dry conditions.

Drainage

Strict control of all drainage will be necessary. All drainage should be designed so as not to direct surface and subsurface water flows onto the slope.

Footing drains should be placed at the base of all footings and tightlined to the storm sewer system. We suggest using a four (4) inch diameter, rigid, perforated pipe bedded and backfilled with at least twelve (12) inches of pea gravel.

Roof drains should be tightlined to the storm sewer system. These drains should be separate from the footing drains.

Parking areas should be tightlined to the storm sewer system with the surface graded to direct the water away from the slope and the edges curbed to avoid ponding of water. These drains should be separate from the footing drains.

General

We recommend that we be engaged to review the final grades and building plans as they become available. If you decide to proceed with a deep foundation in the eastern half of the building area, we should be engaged to provide additional recommendations. We should be retained to observe the excavation of all uncontrolled fill and the placement and compaction of any structural fill.

We expect the on site soil conditions to reflect our findings; however, some variations may occur. Should soil conditions be encountered that cause concern and/or are not discussed herein, Cascade Geotechnical should be contacted immediately to determine if additional or alternate recommendations are required.

This report has been prepared for the exclusive use of Norbrook Construction for specific application to the proposed office building at 3803 N.E. 155th Street, King County, Washington, in accordance with generally accepted soils engineering practices. No other warranty, expressed or implied, is made.

Thank you for this opportunity to assist you with this project. Should you have any questions, please feel free to contact us at any time.

Sincerely,

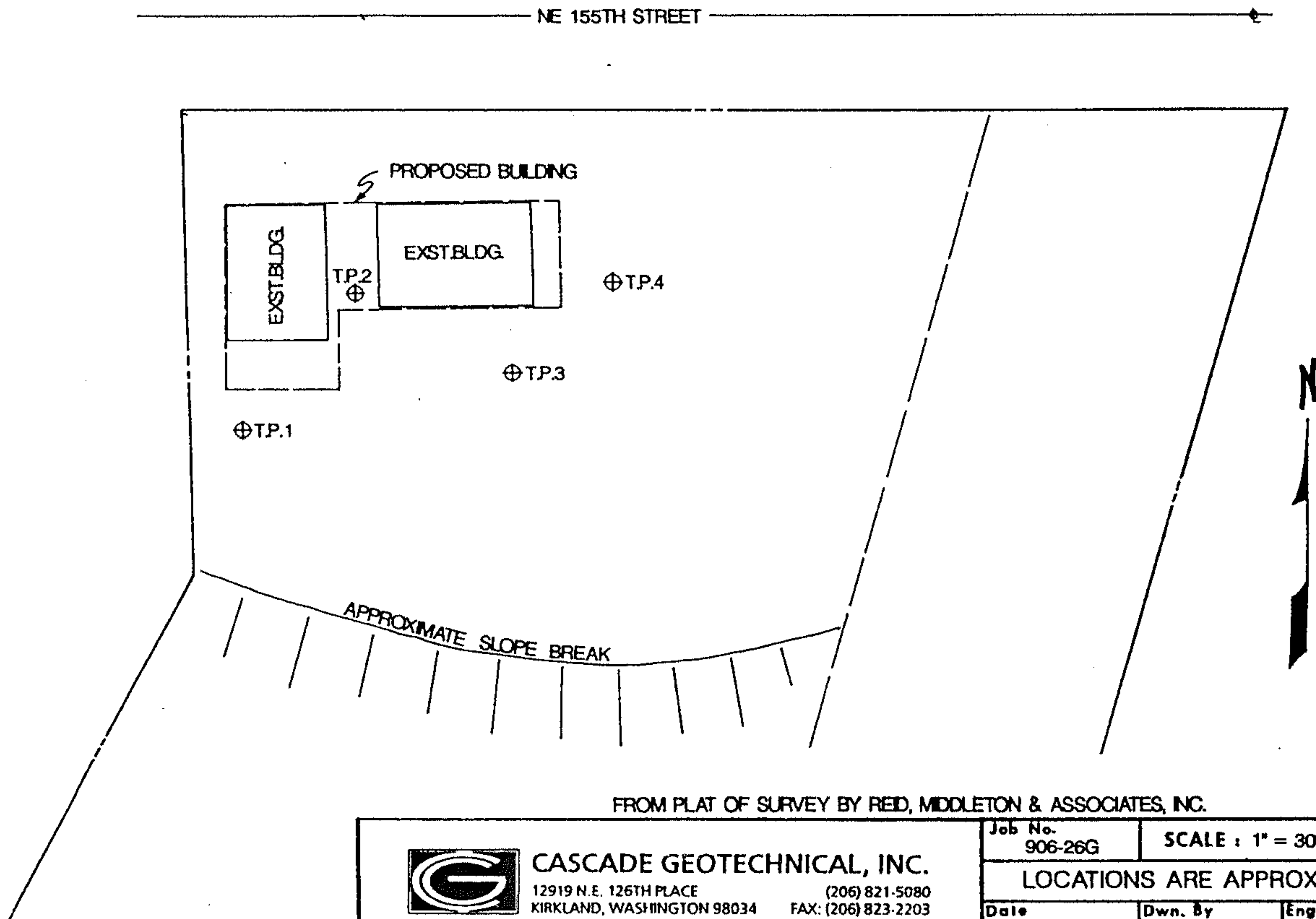
CASCADE GEOTECHNICAL

George E. Lamb P.E.
Principal Engineer

Jason Olsson
Engineering Geologist

JO:pg

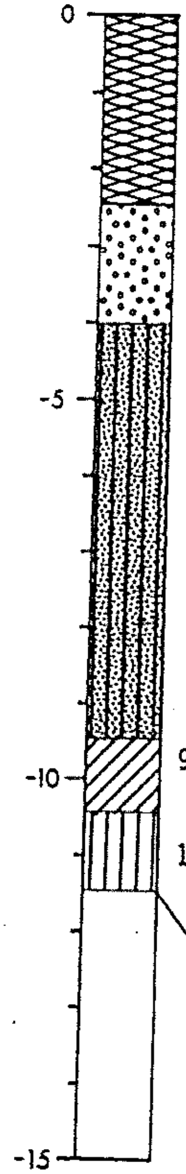
NORBROOK - NE 155TH ST. OFFICE SITE
TEST PIT LOCATION MAP



FROM PLAT OF SURVEY BY REID, MIDDLETON & ASSOCIATES, INC.

CASCADE GEOTECHNICAL, INC. 12919 N.E. 126TH PLACE KIRKLAND, WASHINGTON 98034 (206) 821-5080 FAX: (206) 823-2203	Job No. 906-26G	SCALE : 1" = 30'	
	LOCATIONS ARE APPROXIMATE		
	Date 07/06/90	Dwn. By HLA	Eng - Geol

T.P.- 1	Soil Description & Classification



0 -2.5' UNCONTROLLED FILL; DEBRIS AND LOOSE SILTY SAND.

2.5'-4' SAND; TAN-BROWN, WITH PLANT DEBRIS, LOOSE, MOIST. (SW)

4'-9.5' SILTY SAND; MOTTLED LIGHT GRAY, WITH SOME GRAVEL, DENSE, MOIST, BECOMING SILTIER WITH DEPTH (SM)

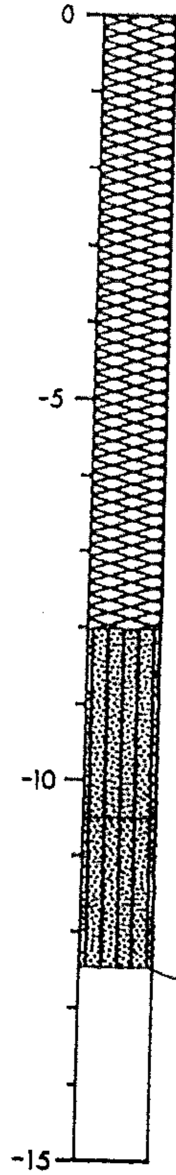
9.5'-10.5' SILTY CLAY; BLUE-GRAY TO GRAYISH BROWN, VERY STIFF, MOIST. (CL)

10.5'-11.5' SANDY SILT; MOTTLED GRAYISH-BROWN, VERY DENSE, MOIST. (ML)

T.D. = 11.5'

Notes: NO GROUND WATER SEEPAGE.

T.P.- 2	Soil Description & Classification



0 -8' UNCONTROLLED FILL; BROWN, LOOSE, SILTY SAND WITH BURIED TREES AND A LARGE ROOT SYSTEM BETWEEN 3.5' AND 7.5'; LOOSE, BROWNISH-GRAY SILTY SAND AT BASE.

8'-10.5' SILTY SAND; GRAY, WITH TRACE ORGANICS AND ROOTS THROUGHOUT, MEDIUM DENSE, WET. (SM)

10.5'-12.5' SILTY SAND; LIGHT GRAY WITH SOME OXIDATION STAINING, TRACE ROOTLETS, DENSE, MOIST. (SM)

T.D. = 12.5'

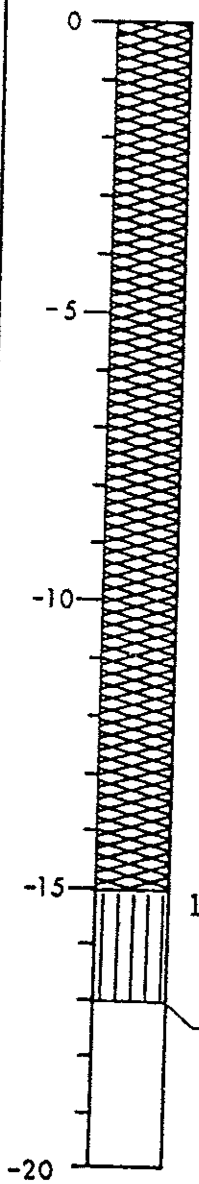
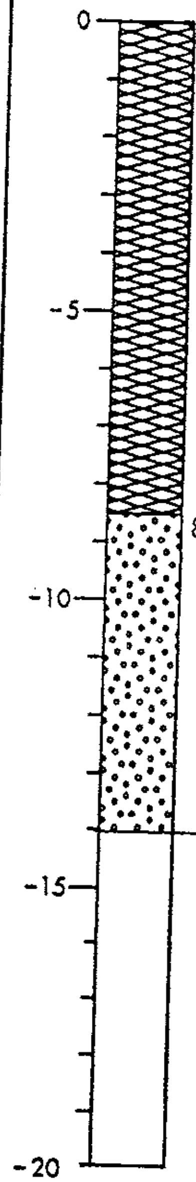
Notes: NO GROUND WATER SEEPAGE.

TEST PIT LOG

CASCADE GEOTECHNICAL
A DIVISION OF
CASCADE TESTING LABORATORY, INC

NORBROOK
NE 155TH ST. OFFICE SITE

Date 07/02/90	Job No. 9006-26G	Dwn. By AEM	Geo/Eng.

T.P. - 3	Soil Description & Classification	T.P. - 4	Soil Description & Classification
	0 -15' UNCONTROLLED FILL; GRAY, MOIST TO WET SANDY SILT AND SILTY SAND WITH TRACE DEBRIS. 15'-17' SANDY SILT; GRAY, WITH MINOR GRAVEL AND CLAY, SOFT TO MEDIUM STIFF, WET. (ML ; uncontrolled fill?) T.D. = 17'		0 -8.5' UNCONTROLLED FILL; GRAY AND BROWNISH-GRAY SILTY SAND AND SANDY SILT. 8.5'-14' GRAVELLY SAND; LIGHT BROWN, WITH SOME COBBLES AND VERY THIN SILT LAYERS, MEDIUM DENSE, MEDIUM GRAINED, MOIST. (SW) T.D. = 14'
Notes: CAVING THROUGHOUT TEST PIT.		Notes: 2" METAL PIPE SLOPING DOWN AT 2H:1V ANGLE AT CONTACT, BETWEEN FILL AND NATIVE SOIL.	

TEST PIT LOG

CASCADE GEOTECHNICAL
A DIVISION OF
CASCADE TESTING LABORATORY, INC.

NORBROOK
NE 155TH ST. OFFICE SITE

Date	Job No.	Dwn. By	Geo/Eng.
07/02/90	9006-26G	AEM	[signature]

UNIFIED SOILS CLASSIFICATION SYSTEM

MAJOR DIVISIONS			SYMBOL	LETTER	DESCRIPTION
COARSE GRAINED SOILS	GRAVEL & GRAVELLY SOILS	CLEAN GRAVELS		GW	Well-graded gravels or gravel-sand mixtures, little or no fines
				GP	Poorly graded gravels or gravel-sand mixtures, little or no fines
		GRAVELS WITH FINES		GM	Silty gravels or gravel-sand-silt mixtures
				GC	Clayey gravels or gravel-sand-clay mixtures
	SAND & SANDY SOILS	CLEAN SANDS		SW	Well-graded sands or gravelly sands, little or no fines
				SP	Poorly graded sands or gravelly sands, little or no fines
		SANDS WITH FINES		SM	Silty sands or sand-silt mixtures
				SC	Clayey sands or sand-clay mixtures
FINE GRAINED SOILS	SILTS & CLAYS Liquid Limit Less Than 50			ML	Inorganic silts & very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity
				CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays or lean clays
				OL	Organic silts & organic silty clays of low plasticity
	SILTS & CLAYS Liquid Limit Greater Than 50			MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
				CH	Inorganic clays of high plasticity, fat clays
				OH	Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS				PT	Peat or other highly organic soils

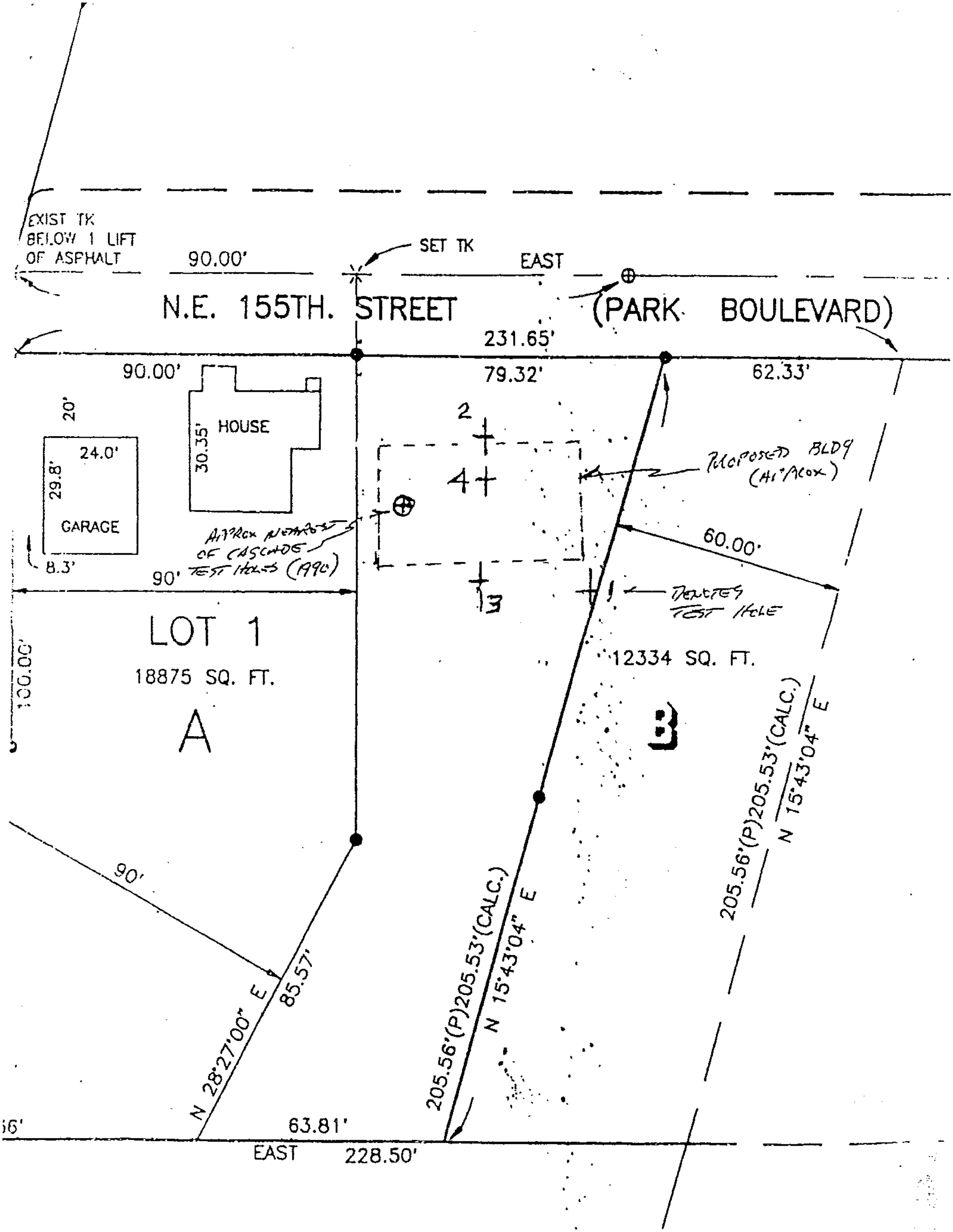
TOPSOIL		Humus & duff layer
FILL		Uncontrolled, with highly variable constituents

SYMBOL	DATUM	NOTE
I	2" O.D. Split Spoon Sampler	Sample Interval
II	Ring or Shelby Sampler	Sample Interval
P	Sampler Pushed	Sample Interval
*	Other Sample Type	Sample Interval

SYMBOL	DATUM	NOTE
∇	Water Level	Date Recorded
Ts	Torvane Reading	
qu	Penetrometer Reading	
	Water Observation Well	Tip Elevation

CASCADE GEOTECHNICAL
A DIVISION OF
CASCADE TESTING LABORATORY, INC.

KEY CHART



EXIST TK
BELOW 1 LIFT
OF ASPHALT
90.00'
SET TK
EAST
N.E. 155TH. STREET
(PARK BOULEVARD)
231.65'
90.00'
79.32'
62.33'
20'
HOUSE
30.35'
24.0'
29.8'
GARAGE
8.3'
2
4
PROPOSED BLDG
(APPROX)
APPROX NEAREST
OF CASCADE
TEST HOLES (1990)
60.00'
90'
3
1
DENOTES
TEST HOLE
LOT 1
18875 SQ. FT.
A
12334 SQ. FT.
B
100.00'
205.56'(P)205.53'(CALC.)
N 15°43'04" E
90'
85.57'
N 28°27'00" E
63.81'
EAST
228.50'

TEST PIT LOGS

#1

0'	--	Highly variable gray and brown fill consisting of sand and silt with gravel (loose, soft)
16.5'	--	Completed 1-26-96; no groundwater encountered

#2

0'	--	Brown variable fill consisting of silt and sand (generally compacted as a result of surface traffic)
2.5'	--	Rusty brown silty gravelly sand (weathered glacial till, grades increasingly dense with depth)
4.5'	--	Completed 1-26-96; no groundwater encountered

#3

0'	--	Highly variable gray and brown fill consisting of sand, silt, and gravel with organic matter throughout (loose, soft)
18'	--	Brown silty sand (dense to very dense)
21'	--	Completed 1-26-96; groundwater seepage from 16' and below

#4

0'	--	Variable brown silty sand fill including pea gravel pipe bedding (generally compacted in upper 1 to 2 feet)
5'	--	Brown to gray F-M sand and silty sand (increasingly dense with depth)
6½'	--	Completed 1-26-96; no groundwater encountered