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Subsurface Exploration, Geologic Hazards, and Geotechnical Engineering Report

ROSE HILL PROPERTY

Redmond, Washington

Prepared For:
BMC ROSE HILL, LLC

Project No. EE150375A
January 29, 2016
Revised May 27, 2016

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January 29, 2016
Revised May 27, 2016
Project No. EE150375A

BMC Rose Hill, LLC
Ridgewood Corporate Center, Building F
150 120th Avenue NE, Suite 200
Bellevue, Washington 98005

Attention: Ms. Barbara Rodgers

Subject: Subsurface Exploration, Geologic Hazards,
and Geotechnical Engineering Report
Rose Hill Property
Redmond, Washington

Dear Ms. Rodgers:

We are pleased to present your copy of the referenced report. This report summarizes the results of our subsurface exploration, geologic hazard, and geotechnical engineering studies and offers recommendations for the design and development of the proposed project.

We have enjoyed working with you on this study and are confident that the recommendations presented in this report will aid in the successful completion of your project. If you should have any questions or if we can be of additional help to you, please do not hesitate to call.

Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Everett, Washington

Matthew A. Miller, P.E
Principal Engineering

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SUBSURFACE EXPLORATION, GEOLOGIC HAZARDS, AND GEOTECHNICAL ENGINEERING REPORT

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I. PROJECT AND SITE CONDITIONS

1.0 INTRODUCTION

This report presents the results of our subsurface exploration, geologic hazards, and geotechnical engineering study for the proposed new residential development at the above-referenced property located on the east side of 138th Avenue NE near the intersection with NE 97th Street in Redmond, Washington (Figure 1). The proposed development is located within the southwestern portion of King County Parcel No. 0352059103 (northern parcel) and the western two-thirds of Parcel No. 0352059071 (southern parcel). The existing site topography, provided by KPFF Consulting Engineers (KPFF), and approximate locations of the explorations accomplished for this study, are presented on the "Site and Exploration Plan," Figure 2. This plan also includes proposed road and lot layout, and the location of the planned recreation and storm water tracts. In the event that any changes in the nature, design, or locations of the proposed improvements are planned, the conclusions and recommendations contained in this report should be reviewed and modified, or verified, as necessary.

1.1 Purpose and Scope

The purpose of this study was to provide subsurface data and preliminary geotechnical engineering recommendations to be utilized in the design of the project. As noted above, our recommendations are considered preliminary in that plans for the proposed development have not yet been finalized. Our current study included a review of the "Rose Hill Subdivision Site Plan") by KPFF dated April 28, 2016, available geologic literature, excavating 10 exploration pits, and performing geologic studies to assess the type, thickness, distribution, and physical properties of the subsurface sediments and shallow ground water. Geotechnical engineering studies were completed to formulate our preliminary recommendations for site preparation, excavation, and structural fill placement, shallow foundation support, floor support, drainage considerations, and storm drainage facility (concrete vault) considerations. This report summarizes our current fieldwork and offers preliminary development recommendations based on our present understanding of the project. We recommend that we be allowed to review the final project plans prior to construction to verify that our geotechnical recommendations have been correctly interpreted and incorporated into the design.

1.2 Authorization

This report has been prepared for the exclusive use of BMC Rose Hill, LLC and their agents for specific application to this project. Within the limitations of scope, schedule, and budget, our services have been performed in accordance with generally accepted geotechnical engineering and engineering geology practices in effect in this area at the time our report was prepared. No other warranty, express or implied, is made.

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2.0 PROJECT AND SITE DESCRIPTION

This report was completed with an understanding of the project based on the above-referenced site development plan provided to us by KPFF on January 27, 2016. The preliminary plan for development depicts 28 new home sites with one recreation tract (Tract A) along the north side of the proposed development and one recreation and storm water tract (Tract B) located along the eastern side of the property. Grade separation between the individual lots will be provided by segmental block retaining walls anticipated to range up to approximately 4 feet. A segmental block retaining wall is also planned along the eastern (down slope) side of Tract B. Tract B will contain a concrete storm water detention vault that will outlet via a 40-foot-wide access and utility easement extending northeast from the northeastern corner of the development to an existing storm drainage in the NE 100th Street easement. There will also be a segmental block retaining wall located on the north side of Tract A and the "hammerhead" east of Tract A. Access to the new residential development will be via two new roads extending east from 138th Avenue NE. Frontage improvement will include the widening of 138th Avenue NE. The widening will include a retaining wall on the east side of the right-of-way (ROW) about 125 feet north of the north entrance on to the plat. The wall will be built on the slope and benched into the native soils.

The total area of the two parcels is approximately 12 acres. The parcels are currently undeveloped and forested. The area of the proposed development will encompass approximately 5 acres.

The overall topography across the two parcels generally slopes down toward the east. A large drainage is present within the majority of the northern parcel generally north of the proposed development. The existing site topography consists of a topographic high of approximately 265 feet along the east side of 138th Avenue SE and a topographic low of generally 140 feet along the eastern property line downslope directly to the east of the area of the proposed development. The east-facing slope continues east off the properties to an existing development located along the west side of Willows Road NE. The topographically lowest portion of the limits of the proposed development ranges from approximately 195 to 205 feet along the eastern side of Tract B. Slope gradients in the area of the proposed development ranges from approximately 10 to 15 percent. Slope gradients immediately adjacent to the proposed development to the east and north range from approximately 27 percent to 37 percent. There are scattered areas with slope gradients exceeding 40 percent that are greater than 10 feet in height north and east of the limits of the proposed development shown as shaded areas on the site plan developed by KPFF.

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3.0 SUBSURFACE EXPLORATION

Our field study included completing 10 exploration pits with a tracked excavator to gain shallow subsurface information about the site.

The various types of sediments, as well as the depths where characteristics of the sediments changed, are indicated on the exploration logs presented in Appendix A. The depths indicated on the logs where conditions changed may represent gradational variations between sediment types. If changes occurred between sample intervals in our explorations, they were interpreted. The exploration locations are noted on the "Site and Exploration Plan," Figure 2, attached with this report.

The conclusions and recommendations presented in this report are based on the explorations completed for this study. The number, locations, and depths of the explorations were completed within site and budget constraints. Because of the nature of exploratory work below ground, extrapolation of subsurface conditions between field explorations is necessary. It should be noted that differing subsurface conditions may sometimes be present due to the random nature of deposition and the alteration of topography by past grading and/or filling. The nature and extent of any variations between the field explorations may not become fully evident until construction. If variations are observed at that time, it may be necessary to re-evaluate specific recommendations in this report and make appropriate changes.

3.1 Exploration Pits

Ten exploration pits were excavated using a track-mounted excavator at the site on July 17, 2015. The approximate locations of the pits are shown on the "Site and Exploration Plan," Figure 2. The pits permitted direct, visual observation of subsurface conditions. Materials encountered in the exploration pits were studied and classified in the field by an engineering geologist from our firm. All exploration pits were backfilled immediately after examination and logging. Exploration pit backfill was tamped with the excavator bucket, but was otherwise uncompacted. Where exploration pits are present under areas that will be prepared for future structures, the backfill should be removed and replaced as structural fill prior to construction. Selected samples were then transported to our laboratory for further visual classification and laboratory testing.

4.0 SUBSURFACE CONDITIONS

Subsurface conditions at the project site were inferred from the field explorations, visual reconnaissance of the site, and review of published geologic literature for the vicinity of the property. As shown on the field logs, the exploration pits encountered two main native soil types. The majority of the explorations encountered dense, grading to very dense sand with variable amounts of silt and gravel interpreted as lodgement till. These sediments were weathered at shallow depths and became progressively less weathered and more dense with increasing depth below the ground surface. These sediments are overlain across the site by topsoil. These sediment types are discussed in greater detail below from shallowest (youngest) to deepest (oldest).

4.1 Topsoil

A very loose, organic-rich layer of silt, sand, and gravel mimicking the underlying soils was encountered in each of our exploration pits. The thickness of the topsoil layer ranged from approximately 6 to 12 inches. Topsoil is not suitable to support structural loads or for use as structural fill and should be completely removed during construction.

4.2 Vashon Lodgement Till

Vashon lodgement till sediments were observed in all the exploration pits underlying the topsoil described above. Vashon lodgement till typically consists of a dense, poorly sorted mixture of clay, silt, sand, and gravel. The lodgement till encountered in our exploration pits at depth commonly consists of dense to very dense, moist, olive to gray, silty fine- to medium-grained sand with variable gravel content and occasional cobbles and boulders. Typically, the lodgement till has a very low permeability, and water tends to perch atop the till and flow laterally as interflow, although some water very slowly infiltrates down into the underlying sediments. The moisture content of the lodgement till throughout much of the year is a few percent over the optimum moisture content for maximum compaction. The medium dense to very dense lodgement till is suitable for support of building foundations, walls, and other settlement-sensitive structures; however, they will deteriorate rapidly if disturbed while in a wet condition. The upper 2 to 5 feet of the till was observed to be in a medium dense weathered condition. Some areas of the weathered portion of the till may be in a loose condition requiring additional over-excavation to achieve a subgrade suitable for placement of structural fill and/or for support of structural loads. The lodgement till sediments can be used in structural fills, and the ability to achieve suitable compaction and performance of the fill will depend mostly on the moisture content at the time of placement. Some moisture-conditioning may be required. It should be noted, as mentioned above, that boulders can occur within this unit at the site. Though boulders may not be abundant, it is likely that more will be encountered.

4.3 Published Geologic Map

Review of the regional geologic maps titled *Geologic Map of the Kirkland Quadrangle, Washington*, by James P. Minard (1983), and the *Geologic Map of King County*, compiled by Derek B. Booth, Kathy A. Troost, and Aaron P. Wisher (2006), indicate that the area of the subject site is underlain by Vashon-age advance outwash. Vashon-age lodgement till is

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mapped in the vicinity directly west of the property. Our interpretation of the lodgement till sediments encountered in our explorations is in general agreement with the regional geologic mapping. Advance outwash sediments consist generally of a dense, variable mixture of sand and gravel with low silt contents that were deposited in rivers and streams ahead of the advancing glacier and subsequently overridden by the glacial ice. The presence and lateral distribution of geologic units contained in regional geologic maps such as those referenced above can differ from that observed during site-specific subsurface investigations based on the sometimes limited amount of surface soil exposures during regional geologic mapping. It is likely that the Vashon advance outwash is present underlying the Vashon lodgement till at depths greater than that explored at the site during this investigation. However further exploration would be needed to determine the extent and the potential presence of ground water at depth.

4.4 Hydrology

Ground water seepage was not observed in any of our exploration pits at the time of our subsurface exploration in July 2015. Shallow ground water is commonly absent in sloping upland areas underlain by lodgement till during seasonally drier periods of the year (generally June through September). However, shallow ground water is typically present during seasonally wetter periods of the year as a condition known as interflow. Interflow occurs atop lodgement till or other relatively impermeable sediments. Interflow generally occurs during the months of October through June when surface water infiltrates down through the topsoil and relatively permeable weathered parent sediments and becomes trapped atop a very low-permeability parent sediment. Potential interflow would follow the topography and flow in primarily an easterly direction across the site. Perched, interflow ground water should be expected during and after extended periods of increased precipitation. Ground water may occur during other times of the year due to variations in the amount of rainfall, and/or changes in site usage.

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II. GEOLOGIC HAZARDS AND MITIGATIONS

The following discussion of potential geologic hazards is based on the geologic, slope, and ground water conditions as observed and discussed herein.

5.0 SLOPE HAZARDS AND MITIGATIONS

Slope gradients at the site within the area of the proposed development are moderate (generally less than approximately 20 percent). The sediments underlying the slope generally consist of glacially consolidated glacial sediments as described above with relatively thin, surficial deposits of loose to medium dense, topsoil, and weathered glacial sediments. Ground water was not encountered within the shallow subsurface at the site.

We understand that the project is regulated under the City of *Redmond Zoning Code* (RZC). Section 21.064.060 of the RZC defines landslide hazard areas as any area with a slope 40 percent or steeper with a vertical relief of 10 feet or more. The RZC prohibits most development within a landslide hazard area buffer, which is defined as 50 feet from the top or toe of the slope. However, the buffer may be reduced to a minimum of 15 feet upon approval of a geotechnical engineer.

The sediments underlying the slope generally consist of glacially consolidated glacial sediments as described previously. Adverse ground water conditions were not observed in the explorations accomplished for our study. Based on the subsurface conditions encountered, it is our opinion that a minimum buffer of 15 feet from areas in excess of 40 percent grade that exceeds 10 feet in vertical height is sufficient to adequately protect the proposed and surrounding developments from the critical landslide hazard.

We recommend that structures constructed bordering the 15-feet buffer be founded upon the underlying, undisturbed, dense glacial sediments. Specific recommendations for building support are provided in the "Foundations" section of this report.

5.1 Slope Stability Assessment

In response to the peer review by Golder Associates, as the geotechnical reviewer for the City of Redmond, a detailed slope stability analysis was performed. Information from our current site explorations and past explorations on another site in the area was used to create the model for the analysis. In general, the cross-section used for the analysis was generated east to west past the boundaries of the site.

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Slope stability analyses were conducted using the computer program Slope/W, Version 2007, by Geo-Slope International. The program used the Morgenstern-Price method for evaluating a rotational failure. Input parameters for the analysis included slope geometry, geology and ground water conditions, soil strength parameters, and dynamic (i.e., seismic) conditions. For evaluation of slope stability under dynamic conditions, a horizontal ground acceleration of 0.26g was used in our analysis. This seismic coefficient is equal to 0.5 times that determined by the 2012 *International Building Code* (IBC) peak ground acceleration. Soil strength parameters used for our analysis were assumed based on direct shear testing on a nearby project, typical published values, and our prior experience. The values assumed were conservatively selected to fall within the lower range of typical values and are shown below in Table 1.

Table 1
Summary of Assumed Soil Strength Parameters

Sediment Type	Unit Weight (lbs/ft^3)	Internal Friction Angle (degrees)	Cohesion (lbs/ft^2)
Advance Outwash (silty sand/sandy silt)	130	37	300

lbs/ft^3 = pounds per cubic foot
lbs/ft^2 = pounds per square foot

We analyzed the static and seismic stability of the slopes adjacent to the proposed storm water vault, before and after the vault was constructed. Slope Profile A-A' was located through the vault area.

The stability of a slope can be expressed in terms of its factor of safety. The factor of safety is the ratio between the forces that resist sliding to the forces that drive sliding. For example, a factor of safety of 1.0 would indicate a slope where the driving forces and the resisting forces are exactly equal. Increasing factor of safety values greater than 1.0 indicate increased stability. Factors of safety below 1.0 indicate conditions where driving forces exceed resisting forces and landsliding is imminent. Factors of safety of 1.5 and 1.1 are typically considered to be the minimum acceptable values for slope stability under static and seismic conditions, respectively. The slope stability analyses indicate that minimum factors of safety exceed these values for both static and seismic conditions for the profile evaluated. The critical failure surface shown on Slope Profile A-A' have the lowest factors of safety. All other failure surfaces had factors of safety greater than the values shown. The results of the slope stability analyses are summarized below in Table 2. Copies of the Slope/W profiles, the design horizontal acceleration, the soil strength parameters used for our analysis, and the calculated minimum factors of safety are provided in Appendix B.

Table 2
Summary of Slope Stability Analysis Results

Profile	Minimum Factor of Safety	
	Static	**Seismic**
A-A' (Pre development)	3.9	1.7
A-A' (Post Development)	3.2	1.6
Minimum Per Common Standard of Practice	1.5	1.1

5.2 138th Avenue NE Widening

As part of the frontage improvements widening will occur in the 138th Avenue ROW. The widening will include an area where a wall will be constructed to avoid excessive impacts to the steep slope. It is our understanding that the wall will be a cast-in-place concrete wall. If the wall is placed directly upon the native glacial till sediments, it is our opinion that this will not affect the stability pf the slope above the critical area where the wall is located.

6.0 SEISMIC HAZARDS AND MITIGATIONS

Earthquakes occur in the Puget Lowland with great regularity. The vast majority of these events are small and are usually not felt by people. However, large earthquakes do occur, as evidenced by the 1949, 7.2-magnitude event; the 1965, 6.5-magnitude event; and the 2001, 6.8-magnitude event. The 1949 earthquake appears to have been the largest in this area during recorded history. Evaluation of return rates indicates that an earthquake of a magnitude between 6.0 and 7.0 is likely within a given 25- to 40-year period.

Generally, there are four types of potential geologic hazards associated with large seismic events: 1) surficial ground rupture, 2) seismically induced landslides, 3) liquefaction, and 4) ground motion. The potential for each of these hazards to adversely impact the proposed project is discussed below.

6.1 Surficial Ground Rupture

The project site is located approximately 8 miles north of the Seattle Fault Zone and 4 miles southwest of the Southern Whidbey Island-Lake Alice Fault Zone (SWIFZ).

Recent studies of the Seattle Fault Zone by the United States Geological Survey (USGS; e.g., Johnson et al., 1994, *Origin and Evolution of the Seattle Fault and Seattle Basin, Washington*, Geology, v. 22, p.71-74; and Johnson et al., 1999, *Active Tectonics of the Seattle Fault and Central Puget Sound Washington - Implications for Earthquake Hazards,* Geological Society of

America Bulletin, July 1999, v. 111, n. 7, p. 1042-1053) have provided evidence of surficial ground rupture along a northern splay of the Seattle Fault. The recognition of this fault is relatively new, and data pertaining to it are limited, with the studies still ongoing. According to the USGS studies, the latest movement of this fault was about 1,100 years ago when about 20 feet of surficial displacement took place.

A recent study of the SWIFZ by the USGS (Sherrod et al., 2005, *Holocene Fault Scarps and Shallow Magnetic Anomalies Along the Southern Whidbey Island Fault Zone near Woodinville, Washington*, Open-File Report 2005-1136, March 2005) indicates that "strong" evidence of prehistoric earthquake activity has been observed along two fault strands thought to be part of the southeastward extension of the SWIFZ located about 8 miles southeast of the site. The study suggests as many as nine earthquake events along the SWIFZ may have occurred within the last 16,400 years. The recognition of this fault splay is relatively new, and data pertaining to it are limited with the studies still ongoing. The recurrence interval of movement along this fault system is still unknown, although it is hypothesized to be in excess of one thousand years.

The recurrence interval for movement along these fault systems is still unknown, although it is hypothesized to be in excess of several thousand years. Due to the suspected long recurrence interval and distance from the fault zone, the potential for surficial ground rupture at the site is considered to be low during the expected life of the structures and no mitigation efforts beyond complying with the 2012 IBC are recommended.

6.2 Seismically Induced Landslides

The on-site, natural sediments found during the explorations are glacially consolidated lodgement till sediments and are not sensitive to landsliding given the topographic conditions at the site. No current evidence of landslide activity was observed. Given the subsurface and topographic conditions within and adjacent to the proposed development area, it is our opinion that the risk of damage to the proposed project by landsliding is low. This opinion is dependent upon site grading and construction practices being completed in accordance with the geotechnical recommendations presented in this report.

6.3 Liquefaction

Liquefaction is a condition where loose, saturated, typically fine-grained soils lose shear strength when subjected to high-intensity cyclic loads, such as occur during earthquakes. The resulting reduction in strength can cause differential foundation settlements and slope failures. Loose, saturated, fine-grained soils that cannot dissipate the buildup of pore water pressure are the predominant type of sediments subject to liquefaction.

The observed site soils were dense and no ground water was observed. These soils are not expected to be prone to liquefaction. A detailed liquefaction hazard analysis was not performed as part of this study, and none is warranted, in our opinion.

6.4 Seismic Site Class (2012 IBC)

In our opinion, the subsurface conditions at the site are consistent with seismic Site Class "D" in accordance with the 2012 IBC, and the publication ASCE 7 referenced therein, the most recent version of which is ASCE 7-10.

7.0 EROSION HAZARDS AND MITIGATION

As of October 1, 2008, the Washington State Department of Ecology (Ecology) Construction Storm Water General Permit (also known as the National Pollutant Discharge Elimination System [NPDES] permit) requires weekly Temporary Erosion and Sedimentation Control (TESC) inspections and turbidity monitoring for all sites 1 or more acres in size that discharge storm water to surface waters of the state. Because we anticipate that the proposed project will require disturbance of more than 1 acre, we anticipate that these inspection and reporting requirements will be triggered. The following recommendations are related to general erosion potential and mitigation.

The erosion potential of the site soils is moderate, but may be high if steep slopes remain unvegetated during construction. The most effective erosion control measure is the maintenance of adequate ground cover. Maintaining cover measures atop disturbed ground provides the greatest reduction to the potential generation of turbid runoff and sediment transport. During the local wet season (October 1 through March 31), exposed soil should not remain uncovered for more than 2 days unless it is actively being worked. Ground-cover measures can include erosion control matting, plastic sheeting, straw mulch, crushed rock or recycled concrete, or mature hydroseed.

7.1 Erosion Hazard Mitigation

To mitigate the erosion hazards and potential for off-site sediment transport, we recommend the following:

1. The winter performance of a site is dependent on a well-conceived plan for control of site erosion and storm water runoff. It is easier to keep the soil on the ground than to remove it from storm water. The owner and the design team should include adequate ground-cover measures, access roads, and staging areas in the project bid to give the selected contractor a workable site. The selected contractor needs to be prepared to implement and maintain the required measures to reduce the amount of exposed

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ground. A site maintenance plan should be in place in the event storm water turbidity measurements are greater than the Ecology standards.

2. All TESC measures for a given area to be graded or otherwise worked should be installed prior to any activity within that area. The recommended sequence of construction within a given area would be to install sediment traps and/or ponds and establish perimeter flow control prior to starting mass grading.

3. During the wetter months of the year, or when large storm events are predicted during the summer months, each work area should be stabilized so that if showers occur, the work area can receive the rainfall without excessive erosion or sediment transport. The required measures for an area to be "buttoned-up" will depend on the time of year and the duration the area will be left un-worked. During the winter months, areas that are to be left un-worked for more than 2 days should be mulched or covered with plastic. During the summer months, stabilization will usually consist of seal-rolling the subgrade. Such measures will aid in the contractor's ability to get back into a work area after a storm event. The stabilization process also includes establishing temporary storm water conveyance channels through work areas to route runoff to the approved treatment facilities.

4. All disturbed areas should be revegetated as soon as possible. If it is outside of the growing season, the disturbed areas should be covered with mulch, as recommended in the erosion control plan. Straw mulch provides the most cost-effective cover measure and can be made wind-resistant with the application of a tackifier after it is placed.

5. Surface runoff and discharge should be controlled during and following development. Uncontrolled discharge may promote erosion and sediment transport. Under no circumstances should concentrated discharges be allowed to flow over significant slopes.

6. Soils that are to be reused around the site should be stored in such a manner as to reduce erosion from the stockpile. Protective measures may include, but are not limited to, covering with plastic sheeting, the use of low stockpiles in flat areas, or the use of straw bales/silt fences around pile perimeters. During the period between October 1 and March 31, these measures are required.

7. On-site erosion control inspections and turbidity monitoring should be performed in accordance with Ecology requirements. Weekly and monthly reporting to Ecology should be performed on a regularly scheduled basis. TESC monitoring should be part of the weekly construction team meetings. Temporary and permanent erosion control and drainage measures should be adjusted and maintained, as necessary, at the time of construction.

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8. It is our opinion that with the proper implementation of the TESC plans and by field-adjusting appropriate mitigation elements (best management practices) during construction, as recommended by the erosion control inspector, the potential adverse impacts from erosion hazards on the project may be mitigated.

8.0 CRITIAL AQUIFER RECHARGE AREA (CARA)

The site is located within wellhead protection Zone 4 of the City of Redmond's CARA program. As per the City of Redmond a detailed ground water study is not required for sites within Zone 4. No mitigation measures outside of erosion control BMP's (best management practices) will be incorporated into the construction of final design of the project.

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III. DESIGN RECOMMENDATIONS

9.0 INTRODUCTION

Our exploration indicates that, from a geotechnical standpoint, the proposed project is feasible provided the recommendations contained herein are properly followed. The bearing stratum is relatively shallow, and conventional shallow foundations should perform well with proper subgrade preparation. Important geotechnical considerations for the project will include adequate keying and benching of structural fills that will be placed on slopes, and management of moisture-sensitive subgrade soils and excavated soils that will be used in structural fill applications. The following report sections provide specific geotechnical site development recommendations.

10.0 SITE PREPARATION

Existing vegetation and topsoil should be removed from areas where new buildings, paving, or other structures are planned. The observed in-place depth of topsoil at the exploration locations is presented on the exploration logs in Appendix A, and typically ranged from 6 to 18 inches. After the upper 6 to 18 inches is stripped, the surface should be evaluated in the specific area by proof-rolling to verify a firm and unyielding condition. Topsoil should be expected to increase in volume by a factor of approximately 1.3 from in-place volume to loose stockpile volume. After topsoil stripping, remaining roots and stumps should be removed from structural areas. All soils below finished grade disturbed by stripping and grubbing operations should be recompacted as described below for structural fill.

Based on our explorations completed for this study, any deep excavations that are planned for the project should be expected to encounter dense to very dense soil conditions. The lodgement till sediments are very dense at depth, and excavation progress was slow during our subsurface exploration program. The lodgement till will be used as structural fill for the planned grading on the site. Due to the density of these materials in place, a swell factor of 1.0 to 1.1 may be used for compacted, in-place material throughout the site. Due to the variability of the fines content and the density across the site, this is a best estimate of the potential conditions.

Once excavation to subgrade elevation is complete, the resulting surface should be proof-rolled with a loaded dump truck or other suitable equipment. Soft, loose, or yielding areas should be excavated to expose suitable bearing soils. The subgrades should then be compacted to a firm and unyielding condition as determined by the geotechnical engineer or their representative. Structural fill can then be placed to achieve desired grades, if needed.

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In our opinion, stable, temporary construction slopes should be the responsibility of the contractor and should be determined during construction. For estimating purposes, we anticipate that temporary, unsupported cut slopes in the unsaturated lodgement till less than 12 feet in height can be excavated at angles of ¾H:1V (Horizontal: Vertical) or flatter. Temporary excavations in medium dense weathered soils should be planned at angles of 1H:1V. If steeper slopes are needed, shoring and/or trench boxes should be used. All permanent cut or fill slopes should be sloped back at no steeper than 2H:1V unless protected with the use of rockeries or other stabilization methods. These slope angles assume that ground water seepage is not encountered and that surface water is not allowed to flow across the temporary slope faces. If ground or surface water is present when the temporary excavation slopes are exposed, flatter slope angles will be required. As is typical with earthwork operations, some sloughing and raveling may occur, and cut slopes may have to be adjusted in the field. In addition, WISHA/OSHA regulations should be followed at all times.

The on-site soils contain high amounts of fine-grained material. The high percentage of fine-grained material makes them moisture-sensitive and subject to disturbance when wet. Overall, the soils found on-site are suitable for structural fill, but should be closely monitored to allow for placement at the optimum moisture content. The contractor must use care during site preparation and excavation operations so that moisture-sensitive subgrade soils are not softened. If disturbance occurs, the softened soils should be removed and the area brought to grade with structural fill.

11.0 STRUCTURAL FILL

Structural fill will be necessary to establish desired grades in some areas. All references to structural fill in this report refer to subgrade preparation, fill type, placement, and compaction of materials, as discussed in this section. If a percentage of compaction is specified under another section of this report, the value given in that section should be used.

After stripping, planned excavation, and any required overexcavation have been performed to the satisfaction of the geotechnical engineer/engineering geologist, the surface should be proof-rolled to verify a firm and unyielding condition. After the exposed ground is tested and approved, structural fill may be placed to attain desired grades. Structural fill is defined as non-organic soil, acceptable to the geotechnical engineer, placed in maximum 12-inch loose lifts, with each lift being compacted to at least 95 percent of the maximum dry density (MDD) as the standard. In non-structural areas outside of building pads, roadways, and utilities, this standard may be reduced to at least 90 percent of MDD. In the case of roadway and utility trench filling, the backfill should be placed and compacted in accordance with current local codes and standards. The top of the compacted fill should extend horizontally outward a minimum distance of 3 feet beyond the locations of the perimeter footings or roadway edge before sloping down at an angle of 2H:1V.

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Where new structural fill will be placed on slopes steeper than 5H:1V, the fill should be keyed and benched into suitable underlying native soils. The key trench should be at least 8 feet wide and 3 feet deep, and hillside benches should be cut horizontally as the fill progresses. Hillside benches should be at least 2 feet wide and typically are less than 8 feet wide.

The contractor should note that any proposed fill soils must be evaluated by Associated Earth Sciences, Inc. (AESI) prior to their use in fills. This would require that we have a sample of the material 72 hours in advance to perform a Proctor test and determine its field compaction standard. Soils in which the amount of fine-grained material (smaller than the No. 200 sieve) is greater than approximately 5 percent (measured on the minus No. 4 sieve size) should be considered moisture-sensitive. The native soils present on-site consisted primarily of silt and are considered highly moisture-sensitive. Use of excavated native silts in structural fills is not recommended due to their very high content of fine-grained material. In addition, construction equipment traversing the site when the soils are wet can cause considerable disturbance. We recommend that a select import material consisting of a clean, free-draining gravel and/or sand be used in structural fill applications. Free-draining fill consists of non-organic soil with the amount of fine-grained material limited to 5 percent by weight when measured on the minus No. 4 sieve fraction with at least 25 percent retained on the No. 4 sieve.

A representative from our firm should observe the stripped subgrade and be present during placement of structural fill to document the work and perform a representative number of in-place density tests. In this way, the adequacy of the earthwork may be evaluated as filling progresses, and any problem areas may be corrected at that time. It is important to understand that taking random compaction tests on a part-time basis will not assure uniformity or acceptable performance of a fill. As such, we are available to aid the owner in developing a suitable monitoring and testing program.

12.0 FOUNDATIONS

Spread footings may be used for building support when they are constructed above new structural fill placed as described above, or by medium dense to very dense native soils. The foundation bearing stratum, consisting of either medium dense to very dense Vashon sediments or structural fill placed over these sediments, is relatively shallow and spread footings may be used for foundation support. The depth to foundation bearing soils ranged from 1½ to 2½ feet in all exploration pits. For residential structures, footings may be designed for an allowable foundation soil bearing pressure of 2,500 pounds per square foot (psf), including both dead and live loads. With the site soils, higher foundation soil bearing pressures are possible, but are not expected to be needed for the project. An increase of one-third may be used for short-term wind or seismic loading. All foundations must penetrate to the prescribed bearing stratum, and no foundations should be constructed in or above loose, organic, or existing fill soils.

Anticipated settlement of footings founded as recommended should be on the order of ¾ inch or less, with differential settlement of ½ inch or less. However, disturbed material not removed from footing trenches prior to footing placement could result in increased settlements. All footing areas should be observed by AESI prior to placing concrete to verify that the foundation subgrades are undisturbed and construction conforms to the recommendations contained in this report. Perimeter footing drains should be provided, as discussed under the "Drainage Considerations" section of this report.

It should be noted that the area bounded by lines extending downward at 1H:1V from any footing must not intersect another footing or intersect a filled area that has not been compacted to at least 95 percent of *American Society for Testing and Materials* (ASTM):D 1557. In addition, a 1½H:1V line extending down and away from any footing must not daylight onto a slope or cut because sloughing or raveling may eventually undermine the footing. Thus, footings should not be placed near the edge of steps or cuts in the bearing soils.

13.0 LATERAL WALL PRESSURES

All backfill behind walls or around foundations should be placed as per our recommendations for structural fill and as described in this section of the report. Horizontally backfilled walls that are free to yield laterally at least 0.1 percent of their height may be designed using an equivalent fluid equal to 35 pounds per cubic foot (pcf). Fully restrained, horizontally backfilled, rigid walls that cannot yield should be designed for an equivalent fluid of 50 pcf. Walls that retain sloping backfill at a maximum angle of 2H:1V should be designed using an equivalent fluid pressure of 45 pcf for yielding conditions.

The lateral pressures presented above are based on the conditions of a uniform backfill consisting of the on-site, natural glacial sediments or imported sand and gravel compacted to 90 percent of ASTM:D 1557. A higher degree of compaction is not recommended, as this will increase the pressure acting on the walls.

Footing drains must be provided for all retaining and foundation walls, as discussed under the "Drainage Considerations" section of this report. It is imperative that proper drainage be provided so that hydrostatic pressures do not develop against the walls. This would involve installation of a minimum 1-foot-wide blanket drain to within 2 feet of the ground surface using imported, washed gravel against the walls placed to be continuous with the footing drain.

ATTACHMENT 17

13.1 Passive Resistance and Friction Factors

Footings cast directly against undisturbed, dense soils in a trench may be designed for passive resistance against lateral translation using an equivalent fluid equal to 350 pcf. The passive equivalent fluid pressure diagram begins at the top of the footing; however, total lateral resistance should be summed only over the depth of the actual key. This value applies only to footings/keyways where concrete is placed directly against the trench sidewalls without the use of forms. If footings are placed on grade and then backfilled, the top of the compacted backfill must be horizontal and extend outward from the footing for a minimum lateral distance equal to three times the height of the backfill before tapering down to grade. With backfill placed as discussed, footings may be designed for passive resistance against lateral translation using an equivalent fluid equal to 250 pcf and the truncated pressure diagram discussed above.

The allowable friction coefficient for footings cast directly on undisturbed, dense soils may be taken as 0.36. Since it will be difficult to excavate these soils without disturbance, the soil under the footings must be recompacted to at least 95 percent of the above-mentioned standard for this value to apply.

14.0 FLOOR SUPPORT

Crawl space floors could be used if supported on spread foundations. If crawl space floors are used, an impervious moisture barrier should be provided above the soil surface within the crawl space. Slab-on-grade floors may be used over medium dense to very dense native soils or structural fill, as recommended in the "Site Preparation" section of this report. The floor should be cast atop a minimum of 4 inches of washed pea gravel or washed crushed rock to act as a capillary break. It should also be protected from dampness by an impervious moisture barrier or otherwise sealed. Floor slabs that are supported by medium dense to very dense soils and structural fill should experience ½ inch or less of settlement.

15.0 DRAINAGE CONSIDERATIONS

Ground water was not observed in any of our exploration pits. However, ground water could occur seasonally where loose, weathered soils are underlain by dense, unweathered soils. Ground water could also be present in granular layers within a less-weathered soil unit. Due to the potential variability of the site soils in terms of composition and density across short distances, it is difficult to predict where these conditions will occur. Therefore, prior to site work and construction, the contractor should be prepared to provide subgrade protection and drainage, as necessary.

ATTACHMENT 17

All footing walls should be provided with a drain at the footing elevation. Drains should consist of rigid, perforated, polyvinyl chloride (PVC) pipe surrounded by washed pea gravel. The level of the perforations in the pipe should be set at the bottom of the footing at all locations, and the drain collectors should be constructed with sufficient gradient to allow gravity discharge away from the buildings. In addition, all foundation walls taller than 3 feet should be lined with a minimum 12-inch-thick washed gravel blanket provided over the full height of the wall to within 12 inches of final grade, and which ties into the footing drain. Roof and surface runoff should not discharge into the footing drain system, but should be handled by a separate, rigid, tightline drain. In planning, exterior grades adjacent to foundations should be sloped downward away from the structures to achieve surface drainage. No surface water discharges should be planned on or above steep slopes.

16.0 PROJECT DESIGN AND CONSTRUCTION MONITORING

We are available to provide additional geotechnical consultation as the project design develops and possibly changes from that upon which this report is based. We recommend that AESI perform a geotechnical review of the plans prior to final design completion. In this way, our earthwork and foundation recommendations may be properly interpreted and implemented in the design.

We are also available to provide geotechnical engineering and monitoring services during construction. The integrity of the foundations for buildings and of new pavement depends on proper site preparation and construction procedures. In addition, engineering decisions may have to be made in the field in the event that variations in subsurface conditions become apparent. Construction monitoring services are not part of the current scope of work. If these services are desired, please let us know, and we will prepare a cost proposal.

We have enjoyed working with you on this study and are confident that these recommendations will aid in the successful completion of your project. If you should have any questions or require further assistance, please do not hesitate to call.

Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Everett, Washington

Engineering Geologist
1387
Frank S. Mocker
6/2/16

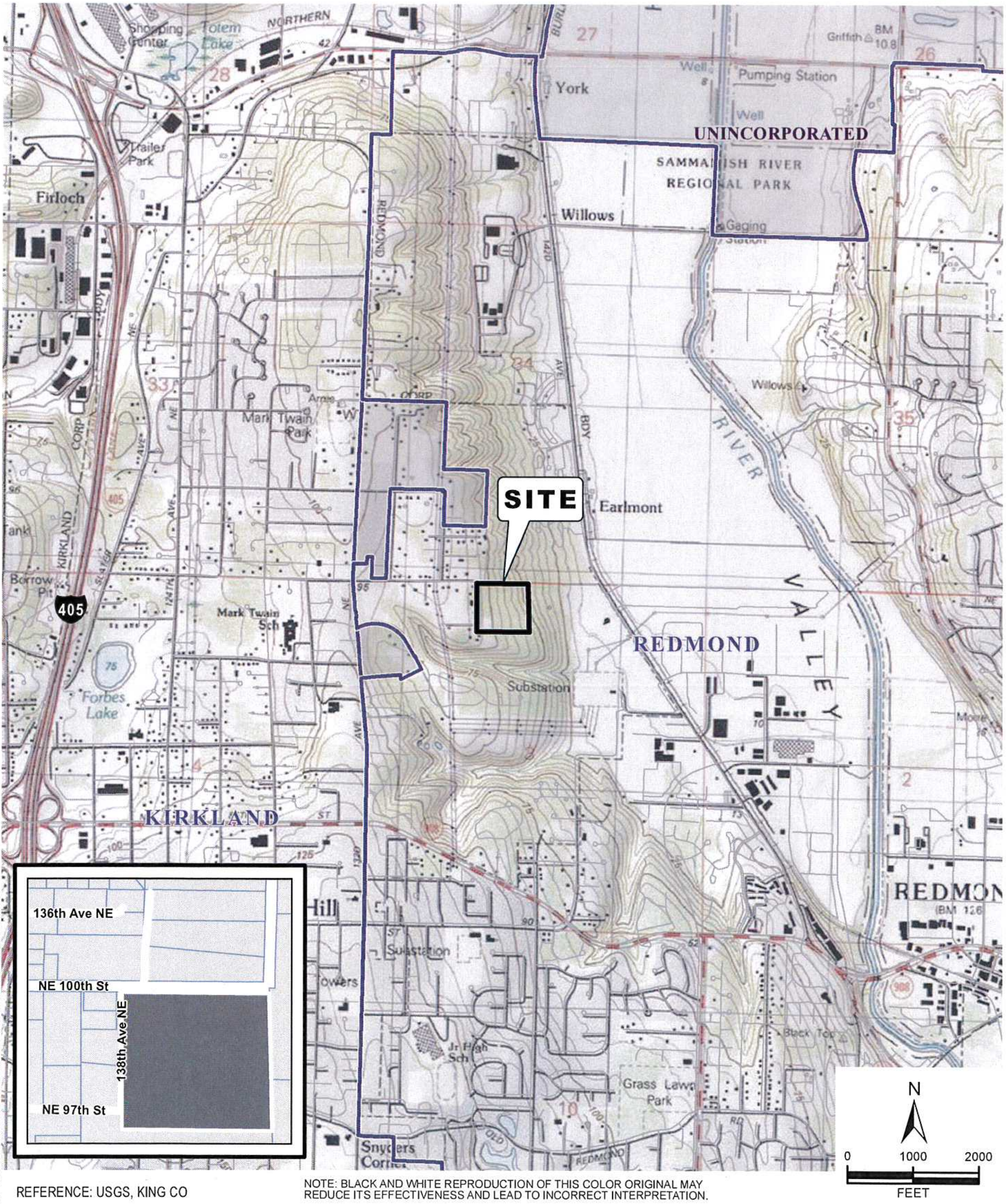
MATTHEW A. MILLER
38284
6-2-16

Frank S. Mocker, L.G., L.E.G.
Project Geologist

Matthew A. Miller, P.E.
Principal Engineer

Attachments:	Figure 1:	Vicinity Map
	Figure 2:	Site and Exploration Plan
	Appendix A:	Exploration Logs
	Appendix B:	Slope Stability Analysis

ATTACHMENT 17



REFERENCE: USGS, KING CO

NOTE: BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION.

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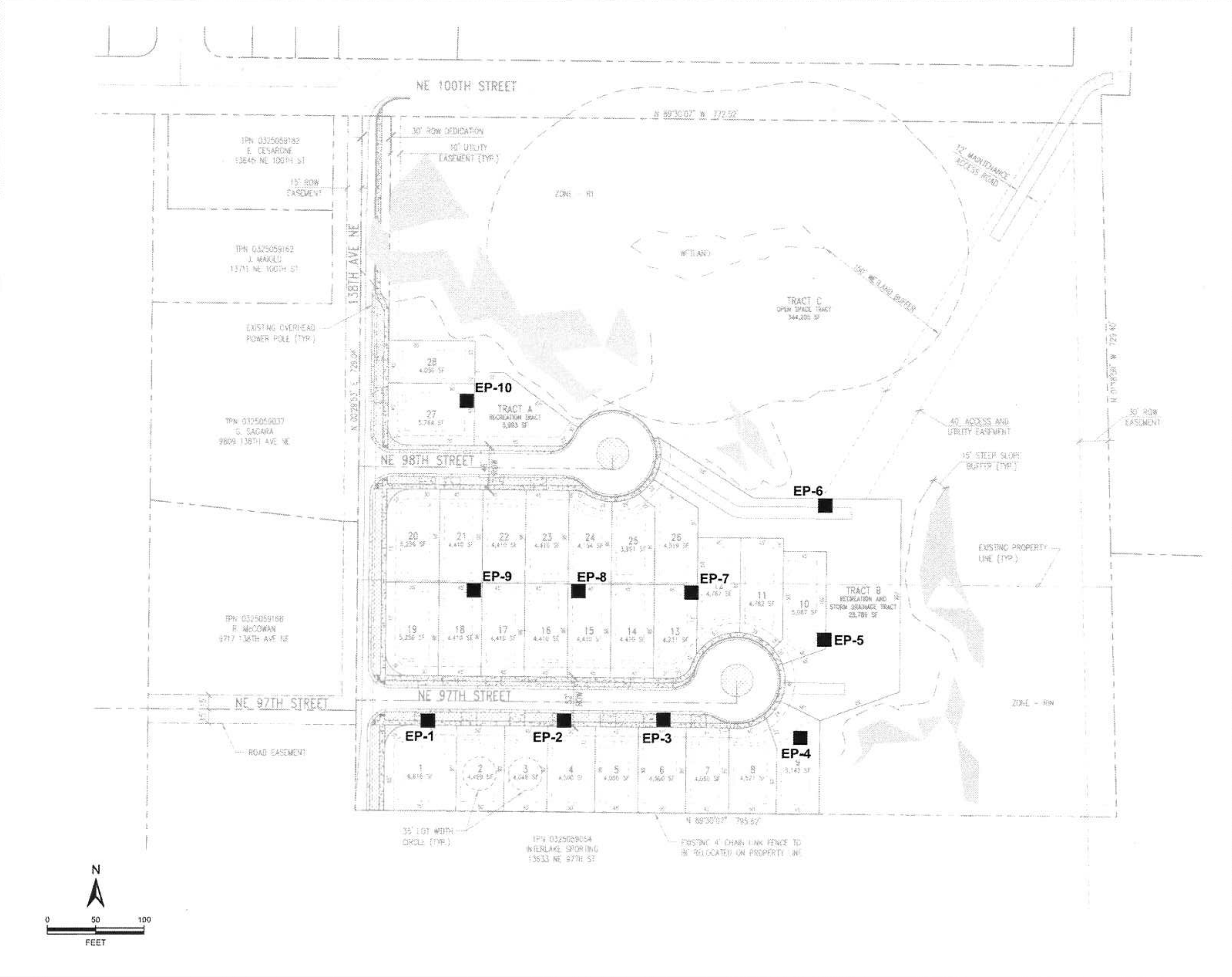
VICINITY MAP
ROSE HILL PROPERTY
REDMOND, WASHINGTON

FIGURE 1

DATE 7/15

PROJ. NO. EE150375A

ATTACHMENT 17



LEGEND:

■ **EP** EXPLORATION PIT

— — — EXISTING LOT LINE

——— PROPOSED LOT LINE

– – – – EASEMENT LINE

- - - - BUILDING SETBACK LINE

— — CRITICAL AREA BUFFER

▨ STEEP SLOPE

NOTE: LOCATION AND DISTANCES SHOWN ARE APPROXIMATE.

NOTES:
1. BASE MAP REFERENCE: KPFF, ROSE HILL SUBDIVISION SITE PLAN, SHEET C-1.0 REVISED DATED 1-25-2016

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SITE AND EXPLORATION PLAN

ROSE HILL PROPERTY
REDMOND, WASHINGTON

PROJ NO.	DATE:	FIGURE:
EE150375A	1/16	2

ATTACHMENT 17

APPENDIX A

Exploration Logs

ATTACHMENT 17

Coarse-Grained Soils - More than 50%(1) Retained on No. 200 Sieve	Gravels - More than 50%(1) of Coarse Fraction Retained on No. 4 Sieve	≤5% Fines(5)	**GW**	Well-graded gravel and gravel with sand, little to no fines
			GP	Poorly-graded gravel and gravel with sand, little to no fines
		≥12% Fines(5)	**GM**	Silty gravel and silty gravel with sand
			GC	Clayey gravel and clayey gravel with sand
	Sands - 50%(1) or More of Coarse Fraction Passes No. 4 Sieve	≤5% Fines(5)	**SW**	Well-graded sand and sand with gravel, little to no fines
			SP	Poorly-graded sand and sand with gravel, little to no fines
		≥12% Fines(5)	**SM**	Silty sand and silty sand with gravel
			SC	Clayey sand and clayey sand with gravel
Fine-Grained Soils - 50%(1) or More Passes No. 200 Sieve	Silts and Clays Liquid Limit Less than 50		**ML**	Silt, sandy silt, gravelly silt, silt with sand or gravel
			CL	Clay of low to medium plasticity; silty, sandy, or gravelly clay, lean clay
			OL	Organic clay or silt of low plasticity
	Silts and Clays Liquid Limit 50 or More		**MH**	Elastic silt, clayey silt, silt with micaceous or diatomaceous fine sand or silt
			CH	Clay of high plasticity, sandy or gravelly clay, fat clay with sand or gravel
			OH	Organic clay or silt of medium to high plasticity
Highly Organic Soils			**PT**	Peat, muck and other highly organic soils

Terms Describing Relative Density and Consistency

	Density	SPT(2) blows/foot
Coarse-Grained Soils	Very Loose	0 to 4
	Loose	4 to 10
	Medium Dense	10 to 30
	Dense	30 to 50
	Very Dense	>50
	Consistency	**SPT(2) blows/foot**
Fine-Grained Soils	Very Soft	0 to 2
	Soft	2 to 4
	Medium Stiff	4 to 8
	Stiff	8 to 15
	Very Stiff	15 to 30
	Hard	>30

Test Symbols

G = Grain Size
M = Moisture Content
A = Atterberg Limits
C = Chemical
DD = Dry Density
K = Permeability

Component Definitions

Descriptive Term	Size Range and Sieve Number
Boulders	Larger than 12"
Cobbles	3" to 12"
Gravel	3" to No. 4 (4.75 mm)
Coarse Gravel	3" to 3/4"
Fine Gravel	3/4" to No. 4 (4.75 mm)
Sand	No. 4 (4.75 mm) to No. 200 (0.075 mm)
Coarse Sand	No. 4 (4.75 mm) to No. 10 (2.00 mm)
Medium Sand	No. 10 (2.00 mm) to No. 40 (0.425 mm)
Fine Sand	No. 40 (0.425 mm) to No. 200 (0.075 mm)
Silt and Clay	Smaller than No. 200 (0.075 mm)

(3) Estimated Percentage

Component	Percentage by Weight
Trace	<5
Some	5 to <12
Modifier (silty, sandy, gravelly)	12 to <30
Very *modifier* (silty, sandy, gravelly)	30 to <50

Moisture Content

Dry - Absence of moisture, dusty, dry to the touch

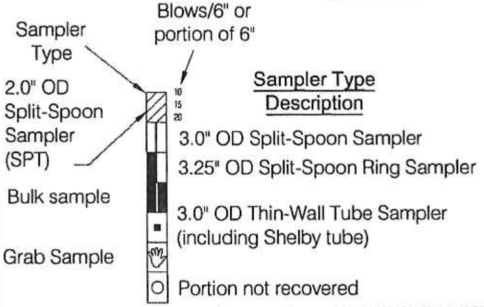
Slightly Moist - Perceptible moisture

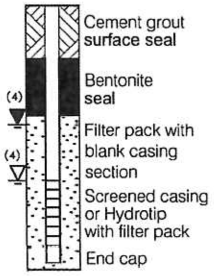
Moist - Damp but no visible water

Very Moist - Water visible but not free draining

Wet - Visible free water, usually from below water table

Symbols





(1) Percentage by dry weight

(2) (SPT) Standard Penetration Test (ASTM D-1586)

(3) In General Accordance with Standard Practice for Description and Identification of Soils (ASTM D-2488)

(4) Depth of ground water

▼ ATD = At time of drilling

▽ Static water level (date)

(5) Combined USCS symbols used for fines between 5% and 12%

Classifications of soils in this report are based on visual field and/or laboratory observations, which include density/consistency, moisture condition, grain size, and plasticity estimates and should not be construed to imply field or laboratory testing unless presented herein. Visual-manual and/or laboratory classification methods of ASTM D-2487 and D-2488 were used as an identification guide for the Unified Soil Classification System.

blocks \ dwg \ log_key.dwg LAYOUT: Layout 4 -2014 Qty Chng

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EXPLORATION LOG KEY

FIGURE A1

ATTACHMENT 17

LOG OF EXPLORATION PIT NO. EP-1

Depth (ft)

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

DESCRIPTION

Elev: ~257

Topsoil

1 Very loose, dry, brown, silty SAND, trace gravel; abundant organics (SM).

Weathered Vashon Lodgement Till

2 Medium dense, moist, light brown, silty SAND, some fine to coarse rounded gravel, trace organics (roots); nonstratified (SM).

3

Vashon Lodgement Till

4 Dense, moist, light olive, silty fine to coarse SAND, trace to some fine to coarse rounded gravel, trace rounded cobbles; slightly less silty with depth; less gravel with depth; sand grades to fine to medium grained; nonstratified to faintly bedded (SM).

5

6

7

8

9

10

11 Bottom of exploration pit at depth 10 feet
No seepage. No caving.

12

13

14

15

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LOG OF EXPLORATION PIT NO. EP-2

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION** Elev: ~247
	Topsoil Very loose, dry, brown, silty SAND, trace gravel; abundant organics (SM).
1	**Weathered Vashon Lodgement Till**
2	Medium dense, moist, light brown, fine to medium SAND, some silt to silty, trace to some gravel, trace organics (rootlets) (SP/SM).
3	
4	**Vashon Lodgement Till**
5	Dense, moist, light olive, silty fine to medium SAND, some fine to coarse gravel, trace cobbles; nonstratified; varies to very silty (SM).
6	
7	
8	
9	
10	
11	Bottom of exploration pit at depth 10 feet No seepage. No caving.
12	
13	
14	
15	
16	
17	
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20	

KCTP3 150375.GPJ January 28, 2016

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7/17/15

LOG OF EXPLORATION PIT NO. EP-3

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	**DESCRIPTION** Elev: ~232
	Topsoil Very loose, dry, brown, silty SAND, trace gravel; abundant organics (SM).
1	**Weathered Vashon Lodgement Till**
2	Loose to medium dense, moist, light brown, very silty fine to coarse SAND, trace fine to coarse gravel, trace organics (roots) (SM). Becomes medium dense at ~2.5 feet.
3	
4	
5	
6	**Vashon Lodgement Till**
7	Dense, moist, light olive, silty fine to medium SAND, trace coarse sand, trace fine to coarse rounded gravel, trace rounded cobbles; (SM).
8	Varies to some fine to coarse rounded gravel at 7.5 feet.
9	
10	
11	
12	Dense, moist light olive, fine to coarse SAND, some silt, trace to some fine to coarse gravel, trace cobbles from 12 to 13 feet (SW/SM).
13	Becomes silty at 13 feet.
14	
15	Bottom of exploration pit at depth 14 feet No seepage. No caving.
16	
17	
18	
19	
20	

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ATTACHMENT 17

LOG OF EXPLORATION PIT NO. EP-4

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION Elev: ~208
	Topsoil Very loose, dry, brown, silty SAND, trace gravel; abundant organics (SM).
1	**Weathered Vashon Lodgement Till**
2	Medium dense, slightly moist, light brown, very silty fine to coarse SAND, trace gravel, trace cobbles, trace organics (rootlets); nonstratified (SM).
3	
4	At 4.5 feet, strongly iron oxide staining in fine to medium SAND, trace to some silt seams, trace organics (rootlets); stratified (SP).
5	**Vashon Lodgement Till**
6	Very dense, moist, olive gray, fine to coarse SAND, some silt to silty, trace to some fine to coarse rounded gravel; nonstratified (SM).
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	Bottom of exploration pit at depth 15 feet No seepage. No caving.
17	
18	
19	
20	

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ATTACHMENT 17

LOG OF EXPLORATION PIT NO. EP-5

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION** Elev: ~203
	Topsoil Very loose, dry, brown, silty SAND, trace gravel; abundant organics (SM).
1	**Weathered Vashon Lodgement Till**
2	Medium dense, slightly moist, light brown, silty SAND, trace gravel, trace cobbles, trace organics (rootlets); sand is fine to medium grained, trace coarse sand (SM).
3	**Vashon Lodgement Till**
4	Dense to very dense, moist, light olive, silty fine to coarse SAND, trace to some gravel, trace cobbles; nonstratified (SM).
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	Bottom of exploration pit at depth 15 feet No seepage. No caving.
17	
18	
19	
20	

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LOG OF EXPLORATION PIT NO. EP-6

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION Elev: ~203
	Topsoil Very loose, dry, brown, silty SAND, trace gravel; abundant organics (SM).
1	**Weathered Vashon Lodgement Till** Medium dense, slightly moist, light brown, silty fine to coarse SAND, trace to some gravel, trace cobbles, trace organics (roots) (SM).
2	
3	
4	**Vashon Lodgement Till** Dense to very dense, moist, light olive, fine to coarse SAND, some silt to silty, trace to some fine to coarse rounded gravel, trace cobbles; nonstratified; ranges to some silt with depth (SW/SM).
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	Bottom of exploration pit at depth 14.5 feet No seepage. No caving.
16	
17	
18	
19	
20	

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ATTACHMENT 17

LOG OF EXPLORATION PIT NO. EP-7

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Elev: ~226

Depth (ft)	DESCRIPTION
	Topsoil
1	Very loose, dry, brown, silty SAND, trace gravel; abundant organics (SM).
	Weathered Vashon Lodgement Till
2	Medium dense, slightly moist, light brown, silty fine to coarse SAND, trace gravel, trace cobbles, trace organics (roots) (SM).
3	
4	
5	
6	More pronounced iron oxide staining at 6 feet. Becomes dense below 6 feet.
7	**Vashon Lodgement Till**
8	Dense to very dense, moist, light olive, silty fine to coarse SAND, trace to some gravel, trace cobbles (SM).
9	
10	
11	Bottom of exploration pit at depth 10 feet No seepage. No caving.
12	
13	
14	
15	
16	
17	
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19	
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7/17/15

LOG OF EXPLORATION PIT NO. EP-8

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION Elev: ~242
	Topsoil
1	Very loose, dry, brown, silty SAND, trace gravel; abundant organics (SM).
	Weathered Vashon Lodgement Till
2	Medium dense, slightly moist to moist, light brown, silty fine to coarse SAND, trace to some fine to coarse rounded gravel, trace cobbles, trace organics (SM).
3	
4	
	Vashon Lodgement Till
5	Dense to very dense, moist, olive gray, silty fine to coarse SAND, trace to some fine to coarse rounded gravel, trace cobbles (SM).
6	
7	
8	
9	Color varies to greenish olive.
10	
11	Bottom of exploration pit at depth 10 feet No seepage. No caving.
12	
13	
14	
15	
16	
17	
18	
19	
20	

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ATTACHMENT 17

LOG OF EXPLORATION PIT NO. EP-9

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Elev: ~254

Depth (ft)	DESCRIPTION
	Topsoil Very loose, dry, brown, silty SAND, trace gravel; abundant organics (SM).
1	**Weathered Vashon Lodgement Till**
2	Medium dense, slightly moist to moist, light brown, silty fine to coarse SAND, trace to some fine to coarse rounded gravel, trace cobbles, trace organics (SM).
3	
4	
5	
6	**Vashon Lodgement Till**
7	Dense to very dense, moist, light olive, fine to coarse SAND, some silt to silty, some fine to coarse gravel, trace cobbles; nonstratified; faintly cross stratified? (defined by faint parting planes) (SW/SM).
8	
9	
10	
11	
12	
13	
14	
15	
16	Bottom of exploration pit at depth 15 feet No seepage. No caving.
17	
18	
19	
20	

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ATTACHMENT 17

LOG OF EXPLORATION PIT NO. EP-10

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION** Elev: ~251
	Topsoil
1	Very loose, dry, brown, silty SAND, trace gravel; abundant organics (SM).
2	**Weathered Vashon Lodgement Till** Medium dense, slightly moist to moist, light brown, silty fine to coarse SAND, trace to some fine to coarse rounded gravel, trace cobbles, trace organics (SM).
3	
4	**Vashon Lodgement Till**
5	Dense to very dense, moist, olive, silty SAND, trace to some gravel, trace cobbles; occasional seam of fine to coarse SAND, some gravel, some silt (SM).
6	
7	
8	
9	
10	
11	Bottom of exploration pit at depth 10 feet No seepage. No caving.
12	
13	
14	
15	
16	
17	
18	
19	
20	

Rose Hill Property
Redmond, WA

Logged by: FSM
Approved by: JHS

associated
earth sciences
incorporated

Project No. EE150375A
7/17/15

ATTACHMENT 17

APPENDIX B

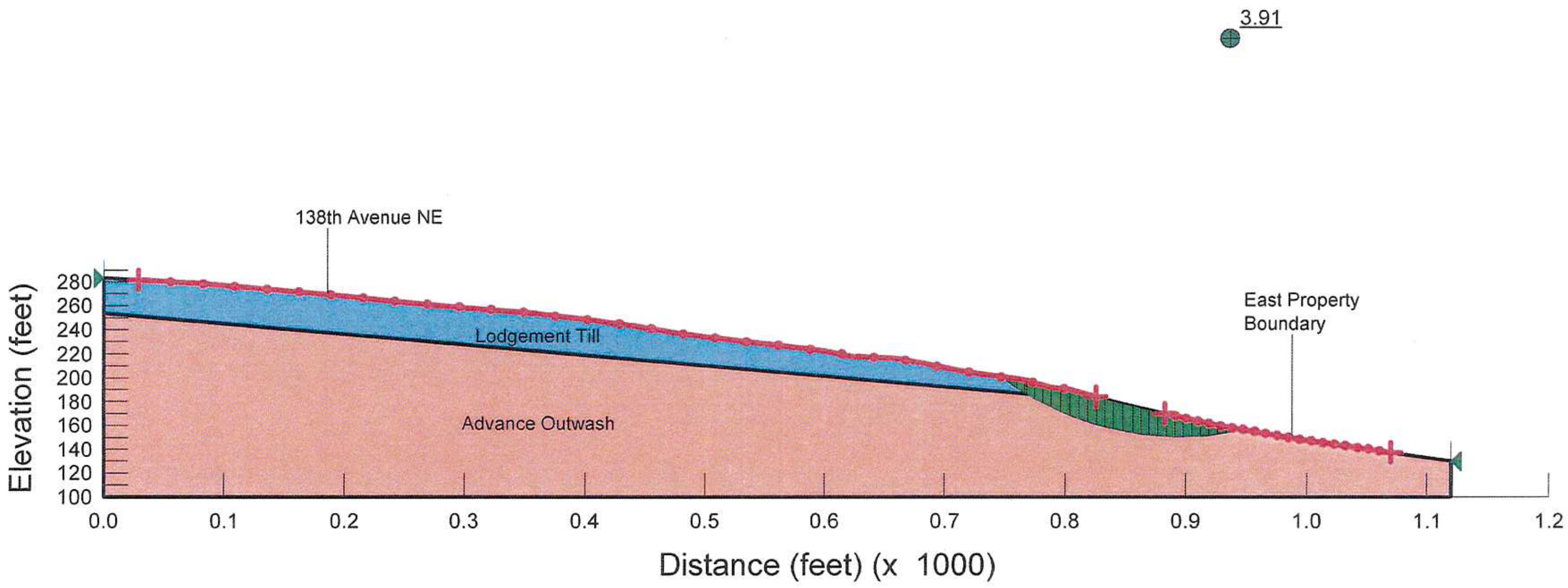
Slope Stability Analysis

ATTACHMENT 17

EE150375A - Section A-A'
Existing Natural Slope
Static

Name: Lodgement Till
Unit Weight: 140 pcf
Cohesion: 300 psf
Phi: 37 °

Name: Advance Outwash
Unit Weight: 130 pcf
Cohesion: 300 psf
Phi: 35 °

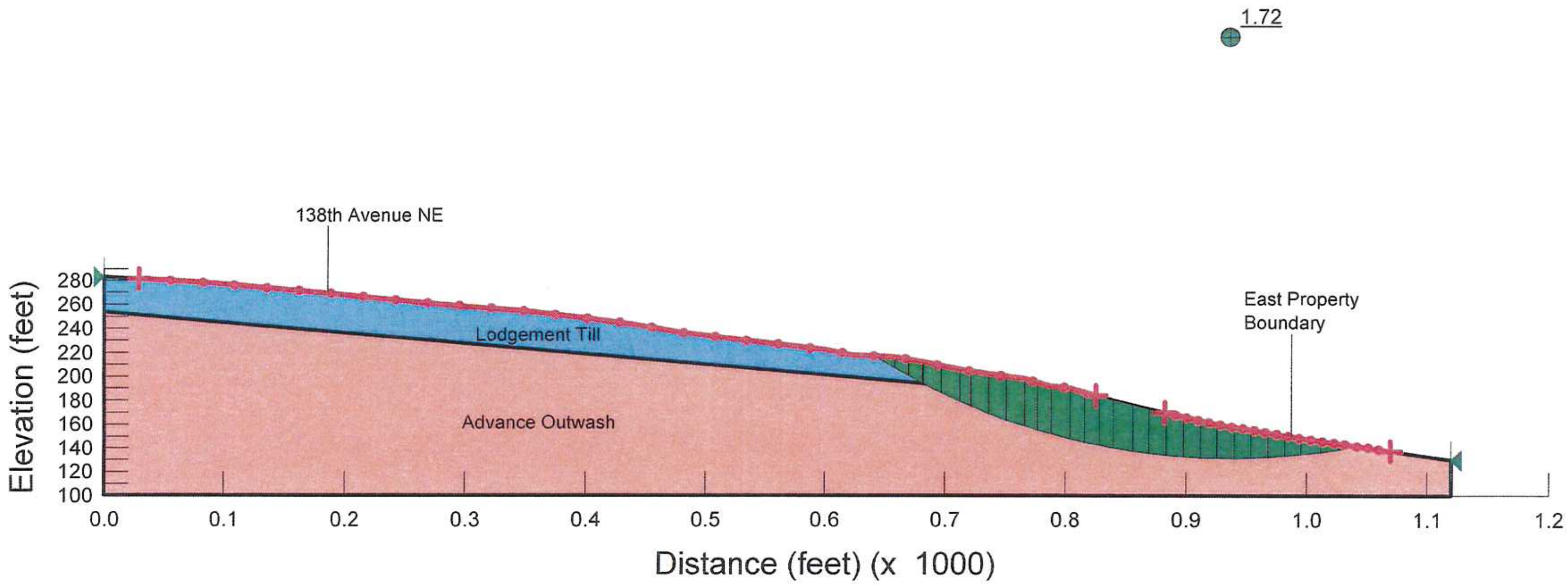


ATTACHMENT 17

EE150375A - Section A-A'
Existing Natural Slope
Seismic - 0.26g

Name: Lodgement Till
Unit Weight: 140 pcf
Cohesion: 300 psf
Phi: 37 °

Name: Advance Outwash
Unit Weight: 130 pcf
Cohesion: 300 psf
Phi: 35 °



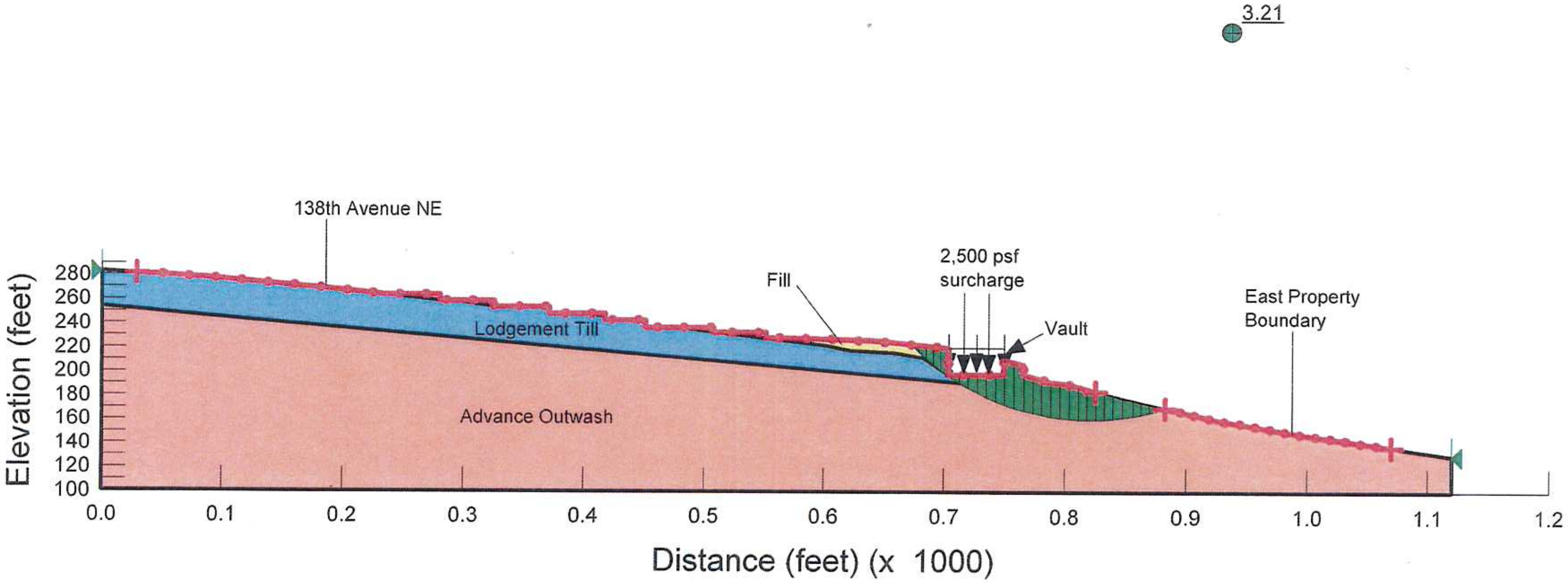
ATTACHMENT 17

EE150375A - Section A-A'
Post-Construction Slope
Static

Name: Lodgement Till
Unit Weight: 140 pcf
Cohesion: 300 psf
Phi: 37 °

Name: Advance Outwash
Unit Weight: 130 pcf
Cohesion: 300 psf
Phi: 35 °

Name: Fill
Unit Weight: 130 pcf
Cohesion: 50 psf
Phi: 34 °



ATTACHMENT 17

EE150375A - Section A-A'
Post-Construction Slope
Seismic - 0.26g

Name: Lodgement Till
Unit Weight: 140 pcf
Cohesion: 300 psf
Phi: 37 °

Name: Advance Outwash
Unit Weight: 130 pcf
Cohesion: 300 psf
Phi: 35 °

Name: Fill
Unit Weight: 130 pcf
Cohesion: 50 psf
Phi: 34 °