associated earth sciences incorporated

Subsurface Exploration, Geologic Hazard, and Geotechnical Engineering Report

The report needs to identify the measured and design infiltration rates. Also identify the test method for determining the rates

UPS FACILITY

Redmond, Washington

Prepared For:

541 ARCHITECTURE, INC.

Project No. 180539E001
March 19, 2019

Associated Earth Sciences, Inc.
911 5th Avenue
Kirkland, WA 98033
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March 19, 2019
Project No. 180539E001

541 Architecture, Inc.
1414 NE 17th Avenue
Portland, Oregon 97232

Attention: Mr. Tony Brizendine

Subject: Subsurface Exploration, Geologic Hazard, and Geotechnical Engineering Report
UPS Facility
18001 NE Union Hill Road
Redmond, Washington

Dear Mr. Brizendine:

We are pleased to present our geotechnical engineering report for the referenced project. This report summarizes the results of our subsurface exploration, geologic hazard, and geotechnical engineering study, and offers recommendations for the design and development of the proposed project. We recommend that we be allowed to review the recommendations contained in this report, and modify them, as project plans develop and are finalized.

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.
Kirkland, Washington

Matthew A. Miller, P.E.
Principal Engineer

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SUBSURFACE EXPLORATION, GEOLOGIC HAZARD, AND GEOTECHNICAL ENGINEERING REPORT

UPS FACILITY

Redmond, Washington

Prepared for:
541 Architecture, Inc.
1414 NE 17th Avenue
Portland, Oregon 97232

Prepared by:
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March 19, 2019
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I. PROJECT AND SITE CONDITIONS (ITEMS 1–3)

1.0 INTRODUCTION

This report presents the results of our subsurface exploration, geologic hazard, and geotechnical engineering study for the proposed improvements to the existing United Parcel Service (UPS) facility in Redmond, Washington. The location of the site is shown on the "Vicinity Map," Figure 1. The approximate locations of explorations completed for this study are shown on the "Existing Site and Exploration Plan," Figure 2. Interpretive exploration logs are included in the Appendix. The conclusions and recommendations contained in this report should be reviewed and modified, or verified, if project plans change substantially.

Prior to our start of work, Associated Earth Sciences, Inc. (AESI) was supplied with a document titled "Consultant Services and Responsibility Scope of Work for Site Investigation." The previously referenced document dictates items to be completed for the project, with Item 8 requesting two separate reports for Items 1–4 and Items 5–7. The two requested reports included in our report have been separated as sections titled, "Project and Site Conditions (Items 1–3)" and "Design Recommendations (Items 5–7)". Item 4 is not included in this report, as no septic systems are currently proposed.

1.1 Purpose and Scope

The purpose of this study was to provide subsurface data to be used in the design and development of the subject project. This study included reviewing selected available geologic literature, advancing nine exploration borings, installing nine groundwater monitoring wells, and performing geologic studies to assess the type, thickness, distribution, and physical properties of the subsurface sediments and shallow groundwater. Geotechnical engineering studies were completed to establish recommendations for the type of suitable foundations, floor support, lateral earth pressures, and drainage considerations. This report summarizes our fieldwork and offers geotechnical engineering recommendations based on our present understanding of the property and potential future development. We recommend that we be allowed to review the recommendations presented in this report and revise them, if needed, as the project develops, and a design is finalized.

1.2 Authorization

Our work was completed in general accordance with our proposal, dated October 23, 2018. This report has been prepared for the exclusive use of 541 Architecture, Inc. and its 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 practices in effect in this area at the time our report was prepared. No other warranty, express or implied, is made.

2.0 SITE AND PROJECT DESCRIPTION

The project is located at 18001 NE Union Hill Road in Redmond, Washington (King County Parcel Nos. 0625069012 and 0625069141). The subject site is a total of 36.31 acres in size, and includes existing buildings, warehouse structures and parking areas, currently utilized by UPS.

For preparation of this report, we were provided with a site plan prepared by UPS Corporate Plant Engineering, dated June 15, 2018. Based on review of the provided plan and our discussions with you, we understand that the project includes a new warehouse building addition in the eastern portion of Parcel No. 0625069012. Parcel No. 0625069141 is currently undeveloped and is being considered for a new employee parking lot.

Based on the soils encountered in our exploration borings and their susceptibility to earthquake-induced liquefaction, this report recommends the use of aggregate piers to support foundation loads for the new warehouse building addition. Ancillary structures, including a customer service building and shop building, will use other methods to support foundation loads and are not planned to use aggregate piers.

3.0 SUBSURFACE EXPLORATION

Our field study included advancing nine exploration borings and completing each boring as a groundwater monitoring well. 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 budgetary constraints.

3.1 Exploration Borings

The exploration borings were completed by advancing hollow-stem auger tools with a track-mounted drill rig. During the drilling process, samples were obtained at the surface elevation, 2 feet below ground surface, and at subsequent 5-foot-depth intervals. The exploration borings were continuously observed and logged by a representative from our firm. The exploration logs presented in the Appendix are based on the field logs, drilling action, and observation of the samples secured.

Disturbed, but representative samples were obtained by using the Standard Penetration Test (SPT) procedure in accordance with *American Society for Testing and Materials* (ASTM) D-1586. This test and sampling method consists of driving a standard 2-inch, outside-diameter, split-barrel sampler a distance of 18 inches into the soil with a 140-pound hammer free-falling a distance of 30 inches. The number of blows for each 6-inch interval is recorded, and the number of blows required to drive the sampler the final 12 inches is known as the Standard Penetration Resistance ("N") or blow count. If a total of 50 is recorded within one 6-inch interval, the blow count is recorded as the number of blows for the corresponding number of inches of penetration. The resistance, or N-value, provides a measure of the relative density of granular soils or the relative consistency of cohesive soils; these values are plotted on the attached exploration boring logs.

The samples obtained from the split-barrel sampler were classified in the field and representative portions placed in watertight containers. The samples were then transported to our laboratory for further visual classification and laboratory testing, as summarized in this report.

3.2 Monitoring Wells

Following drilling, groundwater monitoring wells were installed in each exploration boring to allow for observation of groundwater levels below the site. The wells consisted of a 2-inch-diameter polyvinyl chloride (PVC) Schedule-40 well casing with threaded connections. The lower 10 feet of the well consists of a finely slotted (0.010-inch machine slot) well screen to permit water inflow. The annular space around the well screen was backfilled with silica sand, and the upper portion of annulus was sealed with bentonite chips. A steel flush-mount monument was placed over the top of each wellhead for protection. The as-built configurations of the wells are illustrated on the boring logs in the Appendix. On December 11th and 12th, 2018, a representative from our firm developed the wells and documented groundwater levels.

4.0 SUBSURFACE CONDITIONS

Subsurface conditions at the project site were inferred from the field explorations accomplished for this study, visual reconnaissance of the site, and review of selected applicable geologic literature. 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. The general distribution of geologic units is shown on the exploration logs.

As shown on the exploration logs included in the Appendix, natural sediments encountered at the site consist of topsoil overlying alluvial native materials consisting of loose to dense sand and gravel sediments with variable silt content. Surficial fill soils overlying the native alluvial sediments were encountered in exploration borings EB-1W, EB-5W, EB-6W, EB-7W, and EB-8W. The following section presents more detailed subsurface information organized from the youngest to the oldest sediment types.

4.1 Stratigraphy

Topsoil

A surficial layer of grass and organic topsoil was encountered at the surface of exploration borings EB-2W, EB-3W, EB-4W, EB-5W, EB-6W, and EB-9W. This organic layer ranged from approximately 3 to 6 inches in thickness. Observed topsoil thickness is shown on the attached subsurface exploration logs. Due to their high organic content, these materials are not considered suitable for foundation, roadway, slab-on-grade floor support, or for use in a structural fill.

Fill

Fill soils (those not naturally placed) were encountered in exploration borings EB-1W, EB-5W, EB-6W, EB-7W, and EB-8W. The fill consisted of loose to dense, light brown and gray fine to medium sand with variable silt content, trace gravel, and minor organics. Where existing fill was observed, it extended to a depth ranging from approximately 1.5 to 4 feet. Fill is also expected in unexplored areas of the site, such as in existing utility trench areas and at previously graded landscaped areas. Existing fill soils are likely variable in density and composition, not suitable for foundation support, and may require mitigation for pavement or slab-on-grade floor support. Excavated existing fill material may be suitable for reuse in structural fill applications if such reuse is specifically allowed by project plans and specifications, if excessively organic and any other deleterious materials are removed, and if moisture content is adjusted to allow compaction to the specified level and to a firm and unyielding condition.

Holocene Alluvium

Sediments interpreted as Holocene alluvium were encountered below the surficial fill or topsoil, and generally consisted of loose to medium dense, stratified, fine to coarse sand, with variable gravel and silt quantities, ranging to sandy gravel with variable silt quantities. The alluvial sediments extended beyond the maximum depths explored in our explorations. Holocene alluvium was deposited in streambeds and alluvial fans subsequent to the full recession (melting) of the Vashon-age glacier in the area of the site approximately 12,500 years ago. These sediments are interpreted to have been deposited within higher energy stream channels of Evans Creek, Bear Creek, and the Sammamish River floodplain. The alluvium is suitable for pavement and utility support provided it is compacted to a firm non-yielding condition during subgrade preparation. Medium dense alluvium is generally suitable for support of light to moderately loaded foundations when properly prepared. The granular (sand and gravel) portion of the Holocene alluvium may be used in structural fill applications if it can be properly moisture-conditioned and compacted, all particles over 6 inches in diameter are removed, and such use is specifically allowed by project specifications.

Review of Selected Available Geologic Data

Review of the regional geologic map titled *Geologic Map of the Redmond Quadrangle* (Derek B. Booth and J.P. Minard, 1988) indicates that the site is underlain by Holocene-age alluvium. This is consistent with our interpretation of the sediments encountered in the exploration borings completed for this project.

4.2 Hydrology

The site and surrounding vicinity are underlain by a regional unconfined aquifer located within the Holocene alluvium found throughout the Sammamish River Valley. We encountered groundwater seepage at the time of drilling in several of our exploration borings and interpret this groundwater seepage to be representative of the regional unconfined aquifer. Table 1 below contains the well installation details and static water levels measured at the time of drilling and after 24 hours.

It should be noted that fluctuations in the level of the groundwater can occur due to the time of the year, variations in rainfall, on- and off-site land uses, and other factors. Locally perched groundwater can sometimes be present above finer-grained (silt, fine sand) interbeds within the alluvium during and following extended periods of precipitation.

Table 1
Well Installation Details

Exploration Location	Groundwater Level (ATD) (feet)	Groundwater Level (AB) (feet)	Screened Interval (feet)	Surface Elevation (feet)*	Groundwater Elevation (AB)(feet)
EB-1W	19	17.67	30-40	~55	~37
EB-2W	18.5	16.37	10-20	~55	~39
EB-3W	20	Dry	10-20	~62	N/A
EB-4W	19	17.48	10-20	~60	~43
EB-5W	19.5	Dry	10-20	~60	N/A
EB-6W	Dry	Dry	10-20	~85	N/A
EB-7W	Dry	Dry	10-20	~80	N/A
EB-8W	Dry	Dry	10-20	~68	N/A
EB-9W	Dry	Dry	10-20	~80	N/A

ATD = At time of drilling, December 10 and 11, 2018.
AB = After Boring, December 11 and 12, 2018.
Dry = No groundwater present
*Surface elevations estimated from the Aerial Topography of Figure 2. We recommend a surveyed elevation for design purposes.

4.3 Laboratory Testing

California Bearing Ratio Testing (CBR)

One representative soil sample was submitted to Mayes Testing Engineers for CBR Testing. The test results are included in the Appendix of this report. The test results are summarized below in Table 2.

Table 2
CBR Testing

Soil Type	Maximum Dry Density (lbs/ft^3)	Moisture (%)	Surcharge Weight (lbs)	CBR @ .1" Penetration (Maximum Density) (ASTM D-1883)	CBR @ .1" Penetration (95% Compaction) (ASTM D-1883)	Swell (%)
Brown, Silty SAND with Gravel	140.4	6.8	10	84	49	0

Test conducted according to *American Society for Testing and Materials* (ASTM) D-1883.
% = percent
lbs/ft^3 = pounds per cubic feet
lbs = pounds
CBR = California Bearing Ratio

II. GEOLOGIC HAZARDS AND MITIGATIONS

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

5.0 LANDSLIDE HAZARDS AND MITIGATIONS

It is our opinion that the risk of damage to the proposed structures by landsliding is low due to lack of steep slopes at the project site and vicinity. No detailed slope stability analyses were completed as part of this study, and none are warranted, in our opinion. Based on our review of the *City of Redmond Municipal Code*, the site vicinity does not contain areas that are considered to be governed by regulations associated with Landslide Hazard Areas.

6.0 SEISMIC HAZARDS AND MITIGATIONS

Earthquakes occur regularly in the Puget Lowland. Most of these events are small and are not felt by people. However, large earthquakes do occur, as evidenced by the 2001, 6.8-magnitude event; the 1965, 6.5-magnitude event; and the 1949, 7.2-magnitude event. The 1949 earthquake appears to have been the largest in this region during recorded history and was centered in the Olympia area. Evaluation of earthquake return rates indicates that an earthquake of the magnitude between 5.5 and 6.0 is likely within a given 20-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

Generally, the largest earthquakes that have occurred in the Puget Sound area are sub-crustal events with epicenters ranging from 50 to 70 kilometers in depth. Earthquakes that are generated at such depths usually do not result in fault rupture at the ground surface. Current research indicates that surficial ground rupture is possible in areas close to the Seattle and South Whidbey Island Fault Zones. Although our current understanding of these fault zones is limited and it is an active area of research, the site lies north of the currently mapped limits of the Seattle Fault Zone and south of the mapped limits of the South Whidbey Island Fault Zone. Therefore, based on current information, the risk of damage to planned improvements as a result of surface rupture due to faulting is low, in our opinion.

6.2 Seismically Induced Landslides

It is our opinion that the risk of damage to the proposed structures by seismically induced landsliding is low due to the lack of significant slopes at the subject site and vicinity.

6.3 Liquefaction

Liquefaction is a process through which unconsolidated soil loses strength as a result of vibrations, such as those which occur during a seismic event. During normal conditions, the weight of the soil is supported by both grain-to-grain contacts and by the fluid pressure within the pore spaces of the soil below the water table. Extreme vibratory shaking can disrupt the grain-to-grain contact, increase the pore pressure, and result in a temporary decrease in soil shear strength. The soil is said to be liquefied when nearly all of the weight of the soil is supported by pore pressure alone. Liquefaction can result in deformation of the sediment and settlement of overlying structures. Areas most susceptible to liquefaction include those areas underlain by non-cohesive silt and sand with low relative densities, accompanied by a shallow water table.

The computer program LiquefyPro (copyright CivilTech software) has been used to evaluate the liquefaction hazards on the site. The method within the program that was selected uses the exploration boring data that can be input into the database for the analysis using the Tokimatsu/Seed methodology. This methodology relies on direct input of data that includes fines content and blow count (Standard Penetration Test [SPT]) data. We have conducted our analysis in the area using the original site grades and soil conditions encountered in the deepest exploration, boring EB-1W. A peak ground acceleration (PGA) of 0.54g for a 2,475-year return period seismic event (2 percent exceedance in 50 years) was used for our analysis in accordance with the current *International Building Code* (IBC).

The results of our analysis indicated that approximately 6 inches of potential settlement during a significant (assumed to be at least magnitude 7 on the Richter scale) seismic event can be expected. For a smaller, likely similar to the original design (475-year return period [10 percent exceedance in 50 years]), seismic event with a PGA of 0.27g, the analysis indicated approximately 4 inches of potential settlement. This settlement largely occurs within the upper 15 feet of the saturated soil zone (i.e., below the groundwater table) starting at a depth of about 20 feet.

We understand that the existing building designed in the late 1980s is supported by conventional shallow foundations, presumably under the current building codes at the time. There appears to be no consideration given to remediation of the potential for liquefaction due to a seismic event. Provided that the risk of liquefaction-induced settlement indicated by the LiquefyPro analysis under the current code is acceptable, then conventional foundations supported on a structural fill pad or the natural alluvial sand and gravel may be used for the proposed building addition. Foundation support in this manner would be similar to the existing building.

In the event that the amount of settlement indicated by the LiquefyPro analysis is not acceptable, it is recommended that alternatives, such as a deep foundation, ground improvement, or a thickened mat foundation should be considered in design of the proposed new building foundation to mitigate these anticipated settlements. Also, with these mitigations, the design should consider the effects of liquefaction-induced differential settlement between the existing portion of the building and the proposed addition, which may include similar support of the existing foundation. Design recommendations concerning use of deep foundations or ground improvement to mitigate liquefaction-induced settlement hazards are presented below in the "Foundations" section of this report.

6.4 Seismic Site Class (2015 *International Building Code*)

In our opinion, the subsurface conditions at the site are consistent with seismic Site Class "E" in accordance with the 2015 IBC, and the publication *American Society of Civil Engineers* (ASCE) 7 referenced therein, the most recent version of which is ASCE 7-10.

7.0 EROSION HAZARDS AND MITIGATION

Based on review of the City of Redmond's map titled *Erosion Hazard Areas Critical Areas Map*, the site does not lie within an erosion hazard area. However, the sediments underlying the site generally contain silt and sand that can be sensitive to erosion. In order to reduce the amount of sediment transport off the site during construction, the following recommendations should be followed:

1. Construction activity should be scheduled or phased as much as possible to reduce the amount of earthwork activity that is performed during the winter months.

2. The winter performance of a site is dependent on a well-conceived plan for control of site erosion and stormwater runoff. The project temporary erosion and sediment control (TESC) should include ground-cover measures, access roads, and staging areas. The contractor must implement and maintain the required measures. A site maintenance plan should be in place in the event stormwater turbidity measurements are greater than Washington State Department of Ecology (Ecology) standards.

3. 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.

4. 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 precipitation occurs, 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 unworked. During the winter months, areas that are to be left unworked 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 stormwater conveyance channels through work areas to route runoff to the approved treatment facilities.

5. 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.

6. Surface runoff and discharge should be controlled during and following development. Uncontrolled discharge may promote erosion and sediment transport.

7. 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 1st and March 31st, these measures are required.

8. On-site erosion control inspections and turbidity monitoring (when required) It is our opinion that with the proper implementation of the TESC plans and by field-adjusting appropriate mitigation elements (BMPs) throughout construction, as recommended by the erosion control inspector, the potential adverse impacts from erosion hazards on the project may be mitigated.

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

III. DESIGN RECOMMENDATIONS (ITEMS 5-7)

8.0 INTRODUCTION

Our explorations indicate that, from a geotechnical engineering standpoint, the proposed project is feasible provided the recommendations contained herein are properly followed. We understand that the project owner has selected to mitigate the risk of liquefaction-induced settlement hazards posed to the proposed warehouse building addition through the use of aggregate piers as a ground improvement technique. For accessory structures, such as the customer service building and shop building, we understand that the owner has selected to accept the risk of liquefaction-induced settlement hazards and place the structures on conventional shallow foundations. The bearing stratum is generally shallow and conventional shallow foundations should be suitable with proper subgrade preparation. Existing fill in our explorations ranges in thickness from 1.5 feet to 4 feet where encountered. Existing fill encountered under proposed building footprints or concrete apron areas should be removed and replaced with compacted structural fill. For other paved areas, we recommend the topmost 2 feet of existing fill be recompacted to structural fill standards. Recommendations for foundation or pavement subgrade mitigation, if needed, will be based on conditions observed at the time of construction. Fill soils are also likely to be present around existing structures and buried utilities may require removal and recompaction at the time of construction.

9.0 SITE PREPARATION

Site preparation should include removal of all trees, brush, debris, and any other deleterious materials. If any existing subsurface structures and/or pavement are encountered during grading, the structures should be demolished and any remaining foundation elements or buried utilities that are not to remain operational should be removed and backfilled with structural fill as discussed in the report. All disturbed soils resulting from demolition activities should be removed to expose underlying undisturbed native sediments and replaced with structural fill, as needed. All excavations below final grade made for demolition activities should be backfilled, as needed, with structural fill. Erosion and surface water control should be established around the clearing limits to satisfy local requirements. If any underground storage tanks or other similar structures are discovered onsite, they should be decommissioned and removed in accordance with applicable Ecology regulations.

9.1 Proof-Rolling and Subgrade Compaction

Following site stripping and potential excavation, the stripped subgrade within the building pads and any new paving areas should be proof-rolled with heavy, rubber-tired construction equipment, such as a fully loaded tandem-axle dump truck. Proof-rolling should be performed prior to structural fill placement. The proof-roll should be monitored by the geotechnical engineer so that any soft or yielding subgrade soils can be identified. Any soft/loose, yielding soils should be removed to a stable subgrade. The subgrade should then be scarified, adjusted in moisture content, and recompacted to the required density. Proof-rolling should only be attempted if soil moisture contents are at or near optimum moisture content. Proof-rolling of wet subgrades could result in further degradation. Low areas and excavations may then be raised to the planned finished grade with compacted structural fill.

9.2 Site Disturbance

The alluvial sediments generally contain less than 10 percent fine-grained material, though intervals of sand with greater than 10 percent silt were encountered in some of our explorations. The sediments are moisture-sensitive and subject to disturbance when wet. The contractor must use care during site preparation and excavation operations so that the underlying soils are not softened. If disturbance occurs, the softened soils should be removed and the area brought to grade with structural fill. If crushed rock is considered for the access and staging areas, it should be underlain by stabilization fabric (such as Mirafi 500X or approved equivalent) to reduce the potential of fine-grained materials pumping up through the rock and turning the area to mud. The fabric will also aid in supporting construction equipment, thus reducing the amount of crushed rock required. We recommend that at least 10 inches of rock be placed over the fabric; however, due to the variable nature of the near-surface soils and differences in wheel loads, this thickness may have to be adjusted by the contractor in the field.

9.3 Temporary Cut Slopes

In our opinion, stable construction slopes should be the responsibility of the contractor and should be determined during construction. For estimating purposes, however, we anticipate that temporary, unsupported cut slopes in the native alluvial soils can be made at a maximum slope of 1.5H:1V (Horizontal:Vertical) or flatter. As is typical with earthwork operations, some sloughing and raveling may occur, and cut slopes may have to be adjusted in the field. If groundwater seepage is encountered in cut slopes, or if surface water is not routed away from temporary cut slope faces, flatter slopes will be required. In addition, WISHA/OSHA regulations should be followed at all times.

10.0 STRUCTURAL FILL

All references to structural fill in this report refer to subgrade preparation, fill type and 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, the upper 12 inches of exposed ground in areas to receive fill should be recompacted to 95 percent of the modified Proctor maximum density using ASTM D-1557 as the standard. If the subgrade contains silty soils and too much moisture, adequate recompaction may be difficult or impossible to obtain and should probably not be attempted. In lieu of recompaction, the area to receive fill should be blanketed with washed rock or quarry spalls to act as a capillary break between the new fill and the wet subgrade. Where the exposed ground remains soft and further overexcavation is impractical, placement of an engineering stabilization fabric may be necessary to prevent contamination of the free-draining layer by silt migration from below.

After recompaction of the exposed ground is tested and approved, or a free-draining rock course is laid, 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 8-inch loose lifts, with each lift being compacted to 95 percent of the modified Proctor maximum density using ASTM D-1557 as the standard. In the case of roadway and utility trench filling, structural fill should be placed and compacted in accordance with current City of Redmond codes and standards. The top of the compacted fill should extend horizontally outward a minimum distance of 3 feet beyond the locations of the roadway edges before sloping down at an angle of 2H:1V.

The contractor should note that any proposed fill soils must be evaluated by 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. Use of moisture-sensitive soil in structural fills should be limited to favorable dry weather conditions, and is only permitted if specifically allowed by project plans and specifications. The native soils present onsite contained variable amounts of silt. The contractor should anticipate isolated beds of material with relatively high silt content. We therefore consider the on-site soils to be moisture-sensitive. If fill is placed during wet weather or if proper compaction cannot be obtained, a select import material consisting of a clean, free-draining gravel and/or sand should be used. 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.

11.0 FOUNDATIONS

Shallow foundations for this project will include the warehouse building addition supported by foundations underlain by aggregate piers, and ancillary structures, such as the customer service center and the shop building, supported by foundations placed on medium dense alluvial sand

and gravel sediments, or on structural fill placed over these materials. Geotechnical recommendations for each of these situations are presented below.

11.1 Recommendations Applicable to All Shallow Foundations

Spread footings may be used for building support when founded directly on subgrades that receive situation-specific remedial preparation as recommended in this report.

Perimeter footings should be buried at least 18 inches into the surrounding soil for frost protection. However, all footings must penetrate to the prescribed bearing stratum, and no footing should be founded in or above organic or loose soils. All footings should have a minimum width of 18 inches.

It should be noted that the area bound 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 ASTM D-1557. In addition, a 1.5H:1V line extending down from any footing must not daylight 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.

Disturbed soil not removed from footing excavations prior to footing placement could result in settlement that is greater than the anticipated settlement estimates presented below. All footing areas should be inspected by AESI prior to placing concrete to verify that the design bearing capacity of the soils has been attained and that construction conforms to the recommendations contained in this report. Such inspections may be required by the governing municipality. Perimeter footing drains should be provided as discussed under the “Drainage Considerations” section of this report.

11.2 Building Addition Footings Supported by Aggregate Piers

Aggregate piers are an effective method of reducing settlement potential under both static and seismic conditions, and are often attractive from a cost and schedule standpoint when compared to other possible settlement mitigation approaches such as augercast piles. Another benefit of using aggregate piers is that the building foundation and structure use a conventional shallow foundation approach. A deep foundation system that relies on augercast piles would require a more complex foundation system including pile caps and grade beams that connect the deep foundation elements. We are available to provide more detailed geotechnical engineering recommendations related to augercast piles on request.

Our recommended approach to foundation design for the new warehouse building addition is to install aggregate piers. Aggregate piers consist of columns of compacted crushed rock below the building pad. Installation of aggregate piers results in significant densification of the surrounding soils, as well as a network of compacted aggregate piers that transmit loads directly to more competent soils at depths. There is little consistency between different contractors who install aggregate piers with respect to their installation equipment and methods. The diameters, depth capability, compactive energy, and other critical factors of each contractor's equipment must be considered when designing an aggregate pier foundation system, and therefore, such systems are typically designed by the contractor who installs them. Once aggregate piers are installed, the building is constructed with a conventional shallow foundation system above a subgrade that has been improved through installation of aggregate piers. Air or water jetting is not permitted as a means to advance aggregate pier installation tools or to clear cuttings.

The aggregate piers should be installed after the site is excavated and the building pad working surface is placed and compacted. The purpose of aggregate piers is to both improve existing loose soils and to transmit loads directly to more competent bearing materials at depth. Aggregate piers are formed by advancing a hollow mandrel to a pre-determined depth. Crushed rock is then installed through the hollow mandrel in thin lifts and compacted by vibration and downward pressure. The result is a column of compacted aggregate and compaction of soils surrounding the aggregate piers. Aggregate piers are proprietary systems and are designed by the contractor who installs them. The contractor will determine the depth and diameter of the aggregate pier holes and the appropriate spacing. Conventional shallow foundations are then constructed above the subgrade after aggregate piers have been installed. The aggregate piers contractor should review exploration logs contained in this report carefully. Some of our explorations encountered existing fill. Existing fill was observed to contain wood debris in some locations. Other obstacles such as roots, stumps, and rocks are possible. Where drilling obstacles are encountered, the contractor should be prepared to relocate aggregate piers, or remove obstacles, as needed. The contractor should expect perched seepage zones within existing fill and groundwater at depth within native soils when drilling aggregate pier borings. We recommend that the aggregate pier design prepared by the contractor be specified to provide an allowable foundation soil bearing pressure of 5,000 pounds per square foot (psf), with up to 1 inch of allowable settlement and up to ½ inch of allowable differential settlement under static and design seismic conditions.

11.3 Shallow Foundations for Ancillary Structures

We understand that the owner has selected to accept the risk of liquefaction-induced settlement hazards and place accessory structures, such as the customer service building and shop building, on conventional shallow foundations. Due to the fill and loose shallow alluvium encountered in our explorations, we anticipate that remedial preparation will be needed to provide a consistent building pad subgrade suitable for placement of conventional shallow foundations. Foundations for these structures should be started by excavating to a depth of 2 feet below planned foundation subgrade elevation. The resulting surface should be observed by AESI and proof-rolled if field conditions allow. Any areas that are excessively organic or yielding should receive further remedial preparation. Once a suitable surface has been reached, the planned foundation grade can be restored by placement of structural fill or crushed rock (Washington State Department of Transportation [WSDOT] Crushed Surfacing Base Course 9-03.9(3) or approved equal), placed and compacted per the "Structural Fill" section of this report. With foundation areas prepared as recommended, an allowable foundation soil bearing pressure of 2,000 psf may be used for design. Anticipated foundation settlement is up to 1 inch, with differential settlement of up to ½ inch.

11.4 Drainage Considerations

Foundations should be provided with foundation drains. Drains should consist of rigid, perforated PVC pipe surrounded by washed pea gravel. The drains should be constructed with sufficient gradient to allow gravity discharge away from the proposed buildings. 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 walls should be sloped downward away from the proposed structures to achieve surface drainage.

12.0 FOUNDATION WALLS

The following recommendations may be applied to conventional walls up to 8 feet tall. We should be allowed to offer situation-specific input for taller walls. All backfill behind foundation walls or around foundation units should be placed as per our recommendations for structural fill and as described in this section of the report. Horizontally backfilled walls, which are free to yield laterally at least 0.1 percent of their height, may be designed to resist lateral earth pressure represented by 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 with sloping backfill up to a maximum gradient of 2H:1V should be designed using an equivalent fluid of 55 pcf for yielding conditions or 75 pcf for fully restrained conditions. If parking areas are adjacent to walls, a surcharge equivalent to 2 feet of soil should be added to the wall height in determining lateral design forces.

As required by the 2015 IBC, retaining wall design should include a seismic surcharge pressure in addition to the equivalent fluid pressures presented above. Considering the site soils and the recommended wall backfill materials, we recommend a seismic surcharge pressure of 8H and 10H psf, where H is the wall height in feet for the "active" and "at-rest" loading conditions, respectively. The seismic surcharge should be modeled as a rectangular distribution with the resultant applied at the midpoint of the walls.

The lateral pressures presented above are based on the conditions of a uniform backfill consisting of excavated on-site soils, or imported structural fill 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. A lower compaction may result in settlement of the slab-on-grade or other structures supported above the walls. Thus, the compaction level is critical and must be tested by our firm during placement. Surcharges from adjacent footings or heavy construction equipment must be added to the above values. Perimeter footing drains should be provided for all retaining 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 1 foot of finish grade for the full wall height using imported, washed gravel against the walls.

12.1 Passive Resistance and Friction Factors

Lateral loads can be resisted by friction between the foundation and the natural soils or supporting structural fill soils, and by passive earth pressure acting on the buried portions of the foundations. The foundations must be backfilled with structural fill and compacted to at least 95 percent of the maximum dry density to achieve the passive resistance provided below. We recommend the following allowable design parameters, which include a factor of safety of 1.5:

- Passive equivalent fluid = 250 pcf
- Coefficient of friction = 0.35

13.0 FLOOR SUPPORT

Slab-on-grade floors may be constructed on medium dense native alluvial soils or structural fill placed over the alluvial sand and gravel sediments. We recommend that the alluvial sediments be recompacted to a firm and unyielding condition prior to placement of the structural fill. All fill placed beneath the slab must be compacted to at least 95 percent of ASTM D-1557.

Floor slabs should be cast atop a minimum of 4 inches of clean, washed, crushed rock or pea gravel to act as a capillary break. Floor slabs should also be protected from dampness by a plastic moisture vapor retarder at least 10 mils thick. The moisture vapor retarder should be placed between the capillary break material and the concrete slab.

14.0 PAVEMENT RECOMMENDATIONS

The pavement sections included in this report section are for driveway and parking areas onsite, and are not applicable to right-of-way improvements. At this time, we are not aware of any planned right-of-way improvements; however, if any new paving of public streets is required, we should be allowed to offer situation-specific recommendations.

Due to the fill and loose shallow alluvium encountered in our explorations, we anticipate that remedial preparation will be needed to provide a firm and nonyielding subgrade suitable for placement of pavements. Pavement areas should be prepared in accordance with the “Site Preparation” section of this report. If the stripped native soil or existing fill pavement subgrade can be compacted to 95 percent of ASTM D-1557 and is firm and unyielding, no additional overexcavation is required. Soft or yielding areas should be overexcavated to provide a suitable subgrade and backfilled with structural fill. The upper 2 feet of pavement subgrade should be recompacted to 95 percent of ASTM D-1557. If required, structural fill may then be placed to achieve desired subbase grades. Structural fill should consist of granular, non-organic soil free of debris and acceptable to the geotechnical engineer compacted in 8-inch lifts to a firm and unyielding condition and at least 95 percent of the modified Proctor maximum dry density.

We anticipate the proposed parking lot and aisles will be subject to light traffic loads from passenger vehicles driving and parking. In these light traffic load areas, we recommend a pavement section consisting of 2½ inches of asphalt concrete pavement (ACP) underlain by a 4-inch compacted layer of crushed surfacing top course (Washington State Department of Transportation [WSDOT] 9-03.9(3)).

We also anticipate that some areas will encounter heavier loading from trucks along with passenger vehicles. In these heavy traffic load areas, we recommend a pavement section consisting of 4 inches of ACP underlain by 2 inches of crushed surfacing top course (WSDOT 9-03.9(3)) and 4 inches of crushed surfacing base course (WSDOT 9-03.9(3)).

14.1 Concrete Paving

We understand that the proposed project may include concrete paving that will support heavy truck loading. Upon completion of the subgrade preparation as described above, the recommended rigid pavement section for the heavy truck loading areas would be as follows:

5 inches - Portland Cement Concrete (PCC)

6 inches - Compacted, 1¼-inch minus crushed surfacing base course (minimum 95 percent compaction as defined by ASTM D-1557)

The concrete should have a minimum 28-day compressive strength of 4,000 pounds per square inch (psi). The concrete should be properly cured a minimum of 7 days immediately after placement. All concrete should contain 5 percent entrained air for freeze-thaw protection and be placed at a maximum 2.5-inch slump. The wear surface should be textured with a coarse metal broom or rake finish to provide skid resistance.

To allow for an orderly arrangement of the cracking that concrete naturally undergoes during curing, we recommend placement of control joints in accordance with Portland Cement Association guidelines.

15.0 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. If significant changes in grading are made, 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 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 this current scope of work. If these services are desired, please let us know, and we will prepare a cost proposal.

16.0 CLOSING

We have enjoyed working with you on this study and are confident 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.
Kirkland, Washington

Tyler Gilsdorf, G.I.T., CESCL
Senior Staff Geologist

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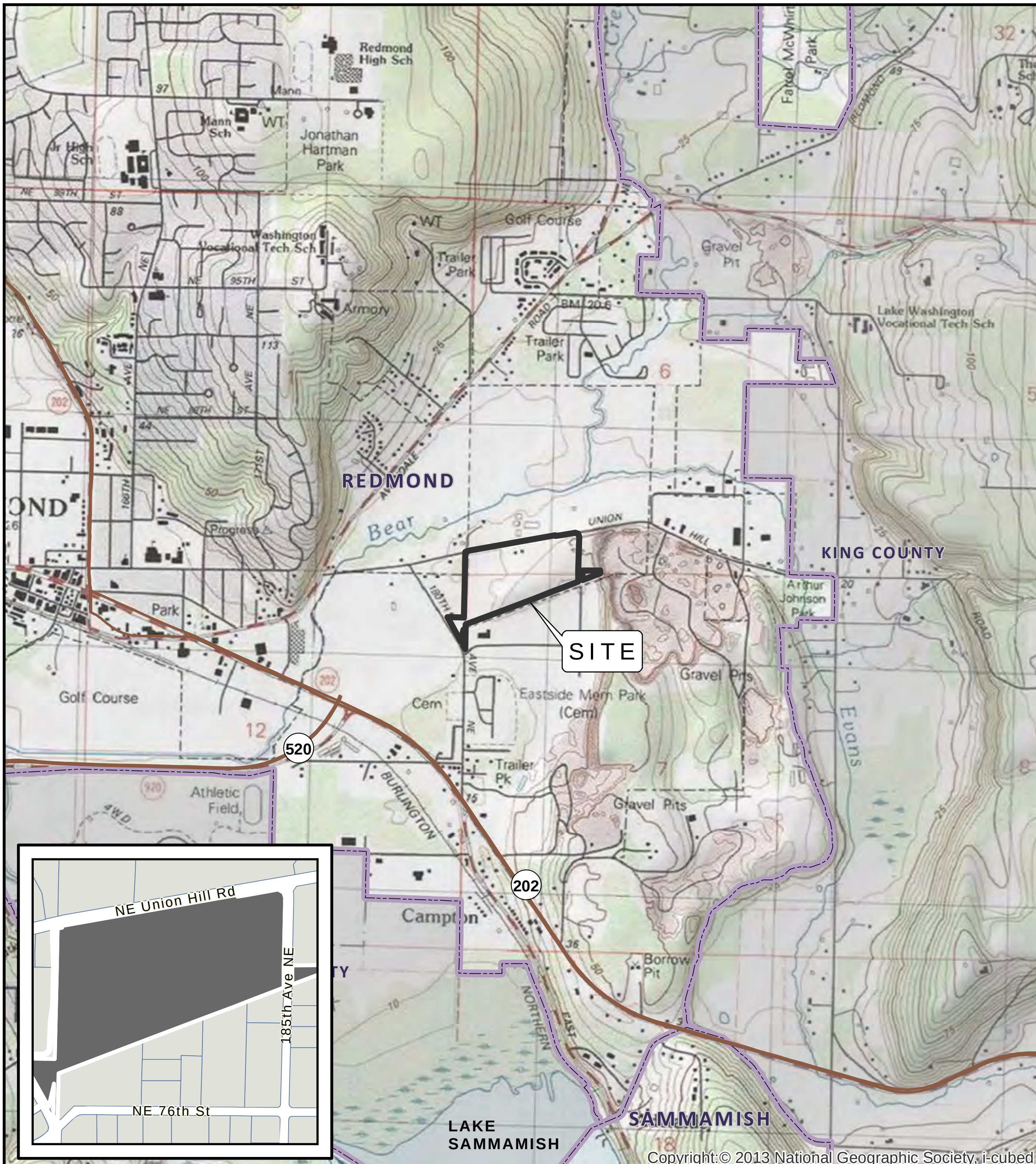
Senior Engineering Geologist

Matthew A. Miller, P.E.
Principal Engineer

Attachments:	Figure 1:	Vicinity Map
	Figure 2:	Existing Site and Exploration Plan
	Appendix:	Exploration Logs
		Laboratory Testing



DATA SOURCES / REFERENCES:
USGS: 7.5' SERIES TOPOGRAPHIC MAPS, ESRI/I-CUBED/NGS 2013
KING CO: STREETS, CITY LIMITS 1/18, PARCELS 8/18

LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE

N

0 1000 2000

FEET

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

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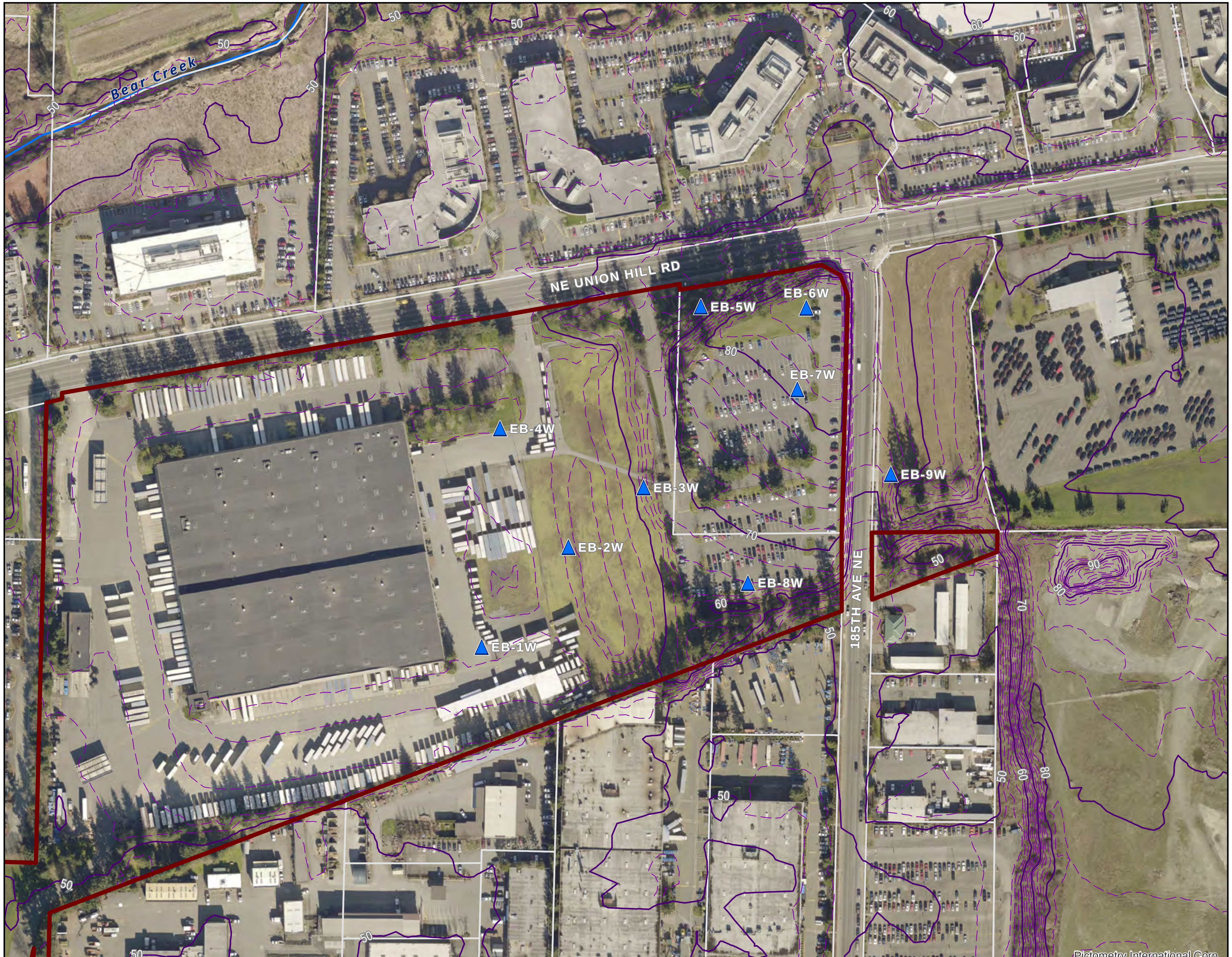
VICINITY MAP

UPS FACILITIES
REDMOND, WASHINGTON

PROJ NO.	DATE:	FIGURE:
180539E001	1/19	1

Document Path: G:\GIS_Projects\aaY2018\180539 UPS CARA 2018\mxd\E001\180539E001 F1 VM_UPS.mxd



LEGEND

- SITE
- MONITORING WELL
- PARCEL

DATA SOURCES / REFERENCES:
PSLC: REDMOND 2014. GRID CELL SIZE IS 3'.
WA STATE PLANE NORTH (FIPS 4601), NAD83(HARN)
NAVD88 GEOID03 (GEOID03), US SURVEY FEET.
FLOWN APRIL 2014, CONTOURS FROM LIDAR
KING CO: STREETS 1/18, PARCELS 9/18, AERIAL PICTOMETRY INT. 2015

LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE

N

0 100 200
FEET

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

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EXISTING SITE AND EXPLORATION PLAN

UPS FACILITIES
REDMOND, WASHINGTON

PROJ NO.	DATE:	FIGURE:
180539E001	1/19	2

Document Path: G:\GIS_Projects\aaY2018\180539 UPS CARA 2018\mxd\E001\180539E001 F2 SM_UPS.mxd

APPENDIX

Exploration Logs
and
Laboratory Testing

Major Division		Fines	Symbol	Description
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)

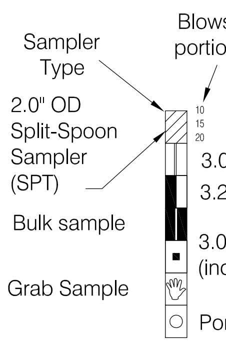
[3] Estimated Percentage

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

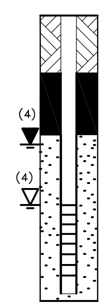
Dry - Absence of moisture, dusty, dry to the touch
Slightly Moist - Perceptible moisture
Moist - Damp but no visible water
Very Moist - Water visible but not free draining
Wet - Visible free water, usually from below water table

Symbols



Sampler Type Description

3.0" OD Split-Spoon Sampler
3.25" OD Split-Spoon Ring Sampler
3.0" OD Thin-Wall Tube Sampler (including Shelby tube)
Portion not recovered



(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

Geologic & Monitoring Well Construction Log

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Project Number	Well Number	Sheet
180539E001	EB-1W	1 of 1

Project Name: UPS Facility
Elevation (Top of Well Casing):
Water Level Elevation:
Drilling/Equipment: Boretec / Mini-Truck Rig
Hammer Weight/Drop: 140# / 30"

Location: Redmond, WA
Surface Elevation (ft): ~55
Date Start/Finish: 12/10/18,12/10/18
Hole Diameter (in): 8 inches

Depth (ft)	Water Level	WELL CONSTRUCTION	ST	Blows/ 6"	Graphic Symbol	DESCRIPTION
0		Flush mount monument with locking well cap Concrete 0 to 1 foot		14 18 12		**Crushed Rock - ~4 inches** **Fill** Moist, light brown and gray, fine to medium SAND, some silt, some gravel; no apparent structure (SP-SM).
				10 10 8		**Older Alluvium** Moist, light brownish gray, fine to medium SAND, trace silt, trace gravel; massive to faintly stratified (SP).
5				12 7 6		Moist, light brown and gray, fine to medium SAND, trace silt, some gravel; faintly stratified (SP). Gravelly drilling at 7 feet. Easier drilling at 8 feet.
10		3/8-inch bentonite chips 1 to 27 feet		7 8 7		Moist, light brown, fine SAND, trace silt; massive (SP).
15		2-inch I.D. PVC casing with threaded connections and O-rings 0 to 30 feet		7 10 11		Slightly harder drilling 14 to 14.5 feet. Moist, light brown to light brownish gray, fine to medium SAND, trace silt, trace gravel; massive (SP).
20	▽ (~17.67) ▼ (~19)			6 5 4		Rods are wet at 19 feet. Wet, light brownish gray, fine to medium SAND, some silt, some gravel; moderate stratification (SP-SM).
25				5 6 5		Wet, light brownish gray to gray, gravelly, fine to coarse SAND, trace silt; faintly stratified (SP).
30		10/20 Colorado silica sand 27 to 40 feet		5 6 6		Wet, gray to brownish gray, fine to medium SAND, some gravel, trace to some silt; faintly stratified (SP-SM).
35		2-inch I.D. PVC well screen 0.010-inch slot width 30 to 40 feet		7 10 11		Wet, gray to brownish gray, fine to coarse SAND, some gravel, trace silt; moderately stratified (SP).
40		Threaded end cap with O-ring Native slough 40 to 41.5 feet		5 9 15		Wet, gray to brownish gray, fine to coarse SAND, some gravel, trace silt, trace gravel; moderately stratified (SP).
		Well tag # BJG-116				Boring terminated at 41.5 feet. Well completed at 40 feet on 12/10/18. Groundwater encountered at 19 feet ATD and at 17.67 feet on 12/11/18.

Sampler Type (ST):
- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample

M - Moisture
▽ Water Level (12/11/18)
▼ Water Level at time of drilling (ATD)

Logged by: TG
Approved by: JHS

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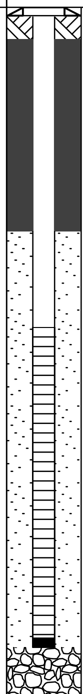
Geologic & Monitoring Well Construction Log

Project Number	Well Number	Sheet
180539E001	EB-2W	1 of 1

Project Name	UPS Facility	Location	Redmond, WA
Elevation (Top of Well Casing)		Surface Elevation (ft)	~55
Water Level Elevation		Date Start/Finish	12/10/18,12/10/18
Drilling/Equipment	Boretec / Mini-Truck Rig	Hole Diameter (in)	8 inches
Hammer Weight/Drop	140# / 30"		



Depth (ft)	Water Level	WELL CONSTRUCTION	Blows/ 6"	DESCRIPTION
0–1		Flush mount monument with locking well cap Concrete 0 to 1 foot	4 7 7	**Grass Sod / Topsoil - ~4 inches** **Older Alluvium** Moist, light brown and gray, fine SAND, trace silt, trace gravel; massive (SP).
2–4		3/8-inch bentonite chips 1 to 7 feet	9 10 9	Moist, light brownish gray to light brown, fine to medium SAND, trace to some silt, trace gravel; massive (SP-SM).
5		2-inch I.D. PVC casing with threaded connections and O-rings 0 to 10 feet	4 4 4	Moist, light brown to light brownish gray, fine to medium SAND, trace silt, some gravel; faint stratification (SP).
8		10/20 Colorado silica sand 7 to 20 feet		Gravelly drilling at 8 feet. Grinding on large rock at 8.5 feet.
10			9 4 4	Sample not representative of depth, low recovery due to pushing on rock. Harder/gravelly drilling 12 to 14 feet.
15	▽ (16.37)	2-inch I.D. PVC well screen 0.010-inch slot width 10 to 20 feet	15 15 12	Moist, light brownish gray, gravelly, fine to coarse SAND, trace sit; no apparent structure; low recovery, broken gravel in sampler (SP).
18	▼ (18.5)			Hard/gravelly drilling 15 to 20 feet.
20		Threaded end cap with O-ring Native slough 20 to 21.5 feet	3 4 7	Wet, brown and gray, sandy, GRAVEL, trace silt; faint stratification; sand is primarily fine to medium (GW).
22		Well tag # BJG-117		Boring terminated at 21.5 feet. Well completed at 20 feet on 12/10/18. Groundwater encountered at 18.5 feet ATD and at 16.37 feet on 12/11/18.

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40

Sampler Type (ST):

- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- ▽ Water Level (12/11/18)
- ▼ Water Level at time of drilling (ATD)

Logged by: TG
Approved by: JHS

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Geologic & Monitoring Well Construction Log

Project Number	Well Number	Sheet
180539E001	EB-3W	1 of 1

Project Name: UPS Facility
Elevation (Top of Well Casing):
Water Level Elevation:
Drilling/Equipment: Boretec / Mini-Truck Rig
Hammer Weight/Drop: 140# / 30"

Location: Redmond, WA
Surface Elevation (ft): ~62
Date Start/Finish: 12/10/18,12/10/18
Hole Diameter (in): 8 inches

Depth (ft)	Water Level	WELL CONSTRUCTION	S T	Blows/ 6"	Graphic Symbol	DESCRIPTION
0		Flush mount monument with locking well cap Concrete 0 to 1 foot		7 7 9		**Grass Sod / Topsoil - ~3 inches** **Older Alluvium** Moist, light brown to light brownish gray, fine to medium SAND, trace to some silt, trace gravel; massive (SP-SM).
		3/8-inch bentonite chips 1 to 7 feet		4 6 5		Moist, light brownish gray to light brown with bands of light oxidation, fine SAND, some silt; layer (~2 inches thick) of silty, fine sand (SM); moderately stratified (SP-SM).
5		2-inch I.D. PVC casing with threaded connections and O-rings 0 to 10 feet		4 5 5		Moist, light brownish gray, fine SAND, trace to some silt; occasional layers (1/4 inch thick) of silty, fine sand; faint stratification (SP-SM).
		10/20 Colorado silica sand 7 to 20 feet				
10				7 11 12		Moist to very moist, light brown and gray, fine to medium SAND, some silt, trace gravel; faint stratification (SP-SM). Gravelly drilling at 12 feet.
15		2-inch I.D. PVC well screen 0.010-inch slot width 10 to 20 feet		10 11 11		Moist, brownish gray to gray, fine to medium SAND, some silt, some gravel; massive; blowcounts may be overstated, broken rock in sampler (SP-SM). Less gravelly drilling at 18 feet.
20	▼	Threaded end cap with O-ring Native slough 20 to 21.5 feet		7 8 9		Wet, light brown to light brownish gray, fine to medium SAND, some gravel, some silt; massive; sampler is wet with one foot of water (SP-SM). Boring terminated at 21.5 feet. Well completed at 20 feet on 12/10/18. Groundwater encountered at 20 feet ATD.
		Well tag # BJG-118				
25						
30						
35						
40						

Sampler Type (ST):

- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- ▽ Water Level ()
- ▼ Water Level at time of drilling (ATD)

Logged by: TG
Approved by: JHS

Geologic & Monitoring Well Construction Log

associated earth sciences incorporated

Project Number	Well Number	Sheet
180539E001	EB-4W	1 of 1

Project Name: UPS Facility
Elevation (Top of Well Casing):
Water Level Elevation:
Drilling/Equipment: Boretec / Mini-Truck Rig
Hammer Weight/Drop: 140# / 30"

Location: Redmond, WA
Surface Elevation (ft): ~60
Date Start/Finish: 12/10/18,12/10/18
Hole Diameter (in): 8 inches

Depth (ft)	Water Level	WELL CONSTRUCTION	ST	Blows/ 6"	DESCRIPTION
0		Flush mount monument with locking well cap Concrete 0 to 1 foot		4 3 4	**Grass Sod / Topsoil - ~4 inches** **Older Alluvium** Moist, light reddish brown to dark reddish brown, fine to medium SAND, some silt, trace gravel; minor organics; massive (SP-SM).
		3/8-inch bentonite chips 1 to 7 feet		4 4 5	Moist, light brown to light brownish gray, fine SAND, trace silt, trace gravel; massive (SP).
5		2-inch I.D. PVC casing with threaded connections and O-rings 0 to 10 feet		6 7 7	Moist, light brown to light brownish gray, fine to medium SAND, trace silt, trace gravel; massive (SP). Gravelly drilling 7 to 9 feet.
		10/20 Colorado silica sand 7 to 20 feet			
10				7 9 16	Moist, light brownish gray, gravelly, fine to coarse SAND, trace to some silt; moderately stratified (SP-SM).
15	▽ (17.48 ft) ▼ (19 ft)	2-inch I.D. PVC well screen 0.010-inch slot width 10 to 20 feet		9 11 15	Moist, light brown and gray, fine SAND, trace silt; massive (SP). Gravelly drilling 18 to 20 feet.
20		Threaded end cap with O-ring Native slough 20 to 21.5 feet		7 8 11	Wet, reddish brown to brown, gravelly, fine to coarse SAND, trace to some silt; moderately stratified (SP-SM).
		Well tag # BJG-119			Boring terminated at 21.5 feet. Well completed at 20 feet on 12/10/18. Groundwater encountered at 19 feet ATD and at 17.48 feet on 12/11/18.
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Sampler Type (ST):

- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- ▽ Water Level (12/11/18)
- ▼ Water Level at time of drilling (ATD)

Logged by: TG
Approved by: JHS

Geologic & Monitoring Well Construction Log

associated earth sciences incorporated

Project Number	Well Number	Sheet
180539E001	EB-5W	1 of 1

Project Name: UPS Facility
Elevation (Top of Well Casing):
Water Level Elevation:
Drilling/Equipment: Boretec / Mini-Truck Rig
Hammer Weight/Drop: 140# / 30"

Location: Redmond, WA
Surface Elevation (ft): ~60
Date Start/Finish: 12/11/18,12/11/18
Hole Diameter (in): 8 inches

Depth (ft)	Water Level	WELL CONSTRUCTION	Blows/6"	DESCRIPTION
0		Flush mount monument with locking well cap Concrete 0 to 1 foot	4 3 5	**Grass Sod / Topsoil - ~4 inches** **Fill** Moist, dark brown, very silty, fine SAND, trace gravel; minor organics and wood debris (SM). Gravelly drilling at ~1.5 feet.
		3/8-inch bentonite chips 1 to 7 feet	8 9 9	Upper ~9 inches: as above. **Older Alluvium** Lower ~9 inches: moist, light brownish gray, fine to medium SAND, trace gravel, trace silt; moderately stratified (SP).
5		2-inch I.D. PVC casing with threaded connections and O-rings 0 to 10 feet	7 9 12	Moist, light brownish gray, fine to coarse SAND, some gravel, trace silt; massive (SP).
		10/20 Colorado silica sand 7 to 20 feet		
10			44 26 36	Moist, light brownish gray to light gray, gravelly, silty, fine to medium SAND; massive; broken gravel in sampler, blowcounts likely overstated (SM).
15		2-inch I.D. PVC well screen 0.010-inch slot width 10 to 20 feet	20 17 9	Low recovery, resampled with a 3-inch Cal-Mod sampler. Moist, light brownish gray, gravelly, fine to coarse SAND, some silt; faint stratification (SP-SM). Gravelly drilling 15 to 17 feet.
	▼ (19.5)			
20		Threaded end cap with O-ring Native slough 20 to 21.5 feet	7 7 9	Wet, light brownish gray, fine to medium SAND, trace gravel, trace silt; moderately stratified (SP).
		Well tag # BJG-123		Boring terminated at 21.5 feet. Well completed at 20 feet on 12/11/18. Groundwater encountered at 19.5 feet ATD.
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Sampler Type (ST):

- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

Logged by: TG
Approved by: JHS

NWWELL- B 180539.GPJ BORING.GDT 1/23/19

Geologic & Monitoring Well Construction Log

associated earth sciences incorporated

Project Number	Well Number	Sheet
180539E001	EB-6W	1 of 1

Project Name: UPS Facility
Elevation (Top of Well Casing):
Water Level Elevation:
Drilling/Equipment: Boretec / Mini-Truck Rig
Hammer Weight/Drop: 140# / 30"

Location: Redmond, WA
Surface Elevation (ft): ~85
Date Start/Finish: 12/11/18,12/11/18
Hole Diameter (in): 8 inches

Depth (ft)	Water Level	WELL CONSTRUCTION	S T	Blows/ 6"	Graphic Symbol	DESCRIPTION
		Flush mount monument with locking well cap Concrete 0 to 1 foot		6 28 10		**Topsoil - ~3 inches** **Fill** Moist, dark brown, silty, fine to medium SAND, trace gravel; minor organics; pounding rock in second 6 inches of sample (SM).
		3/8-inch bentonite chips 1 to 7 feet		10 9 6		Upper ~9 inches: As above. Lower ~9 inches: moist, light brown and gray with minor oxidation, fine to medium SAND, some silt, some gravel (SP-SM).
5		2-inch I.D. PVC casing with threaded connections and O-rings 0 to 10 feet		8 8 10		**Older Alluvium** Gravelly drilling at 4 feet. Sampler pushing rock, sample not representative of depth.
		10/20 Colorado silica sand 7 to 20 feet		12 6 6		Moist, light brown and gray, fine to coarse SAND, some silt, some gravel; faint stratification; low recovery? (SP-SM).
10				4 7 8		Low recovery, sample not representative, sampler pushing on rock. Resampled with Cal-Mod sampler. Moist, light brown and gray, sandy, GRAVEL, trace silt; sand is primarily fine to medium; faint stratification (GW).
15		2-inch I.D. PVC well screen 0.010-inch slot width 10 to 20 feet		13 14 15		Low recovery, sample not representative, sampler pushing on rock. Resampled with Cal-Mod sampler. Moist, light brownish gray to gray, fine to coarse SAND, trace silt; moderately stratified (SP).
20		Threaded end cap with O-ring Native slough 20 to 21.5 feet		12 11 7		Moist, light brownish gray, fine to medium SAND, some gravel, some silt; moderately stratified (SP-SM).
		Well tag # BJG-120				Boring terminated at 21.5 feet. Well completed at 20 feet on 12/11/18. No groundwater encountered.
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Sampler Type (ST):

- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample

M - Moisture
Water Level ()
Water Level at time of drilling (ATD)

Logged by: TG
Approved by: JHS

Geologic & Monitoring Well Construction Log

associated earth sciences incorporated

Project Number	Well Number	Sheet
180539E001	EB-7W	1 of 1

Project Name: UPS Facility
Elevation (Top of Well Casing):
Water Level Elevation:
Drilling/Equipment: Boretec / Mini-Truck Rig
Hammer Weight/Drop: 140# / 30"

Location: Redmond, WA
Surface Elevation (ft): ~80
Date Start/Finish: 12/11/18,12/11/18
Hole Diameter (in): 8 inches

Depth (ft)	Water Level	WELL CONSTRUCTION	ST	Blows/6"	Graphic Symbol	DESCRIPTION
0		Flush mount monument with locking well cap Concrete 0 to 1 foot 3/8-inch bentonite chips 1 to 7 feet		22 29 23 44 12 8		**Asphalt - ~2 inches** **Fill** Moist, brown and gray with minor oxidation, silty, fine to coarse SAND, some gravel; no apparent structure (SM). Gravelly drilling at 1.5 feet. **Older Alluvium** Moist, light brownish gray, fine to coarse SAND, some silt, some gravel; massive; low recovery, pounding on rock (SP-SM).
5		2-inch I.D. PVC casing with threaded connections and O-rings 0 to 10 feet 10/20 Colorado silica sand 7 to 20 feet		5 5 8		Moist, light brown to light brownish gray, fine to coarse SAND, some gravel, trace to some silt; faint stratification (SP-SM). Very gravelly drilling observed from 5 to 10 feet with occasional cobbles in drill cuttings.
10				9 9 13		Low recovery, sampler pushing rock. Resampled with 3-inch Cal-Mod sampler. Moist, light brownish gray and gray, sandy, GRAVEL, trace silt; sand is primarily fine to medium with minor coarse sand; massive (GW).
15		2-inch I.D. PVC well screen 0.010-inch slot width 10 to 20 feet		9 7 8		Moist, light brownish gray, fine to medium SAND, trace gravel, some silt; contains lens (1 inch thick) of silty, fine sand (SM); moderately stratified (SP-SM).
20		Threaded end cap with O-ring Native slough 20 to 21.5 feet Well tag # BJG-121		7 5 3		Moist, light brownish gray to brownish gray, fine to coarse SAND, some gravel, some silt; broken rock in sampler; massive (SP-SM). Boring terminated at 21.5 feet. Well completed at 20 feet on 12/11/18. No groundwater encountered.
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Sampler Type (ST):
- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample

M - Moisture
Water Level ()
Water Level at time of drilling (ATD)

Logged by: TG
Approved by: JHS

Geologic & Monitoring Well Construction Log

associated earth sciences incorporated

Project Number	Well Number	Sheet
180539E001	EB-8W	1 of 1

Project Name: UPS Facility
Elevation (Top of Well Casing):
Water Level Elevation:
Drilling/Equipment: Boretec / Mini-Truck Rig
Hammer Weight/Drop: 140# / 30"

Location: Redmond, WA
Surface Elevation (ft): ~68
Date Start/Finish: 12/11/18,12/11/18
Hole Diameter (in): 8 inches

Depth (ft)	WELL CONSTRUCTION	Blows/ 6"	DESCRIPTION
0	Flush mount monument with locking well cap Concrete 0 to 1 foot	20 13 7	**Asphalt - ~2 inches** **Fill** Moist to very moist, reddish brown to light brownish gray, very silty, fine to medium SAND, trace gravel; disturbed texture; minor fine organics (SM).
	3/8-inch bentonite chips 1 to 7 feet	15 14 12	**Fill ?** No recovery, sample not representative of depth.
5	2-inch I.D. PVC casing with threaded connections and O-rings 0 to 10 feet	4 7 7	**Older Alluvium** Moist, gray to light brownish gray, sandy, GRAVEL, trace silt; massive; sand is primarily fine to medium with minor coarse sand (GW).
	10/20 Colorado silica sand 7 to 20 feet		Occasional cobbles in drill cuttings 5 to 10 feet.
10		16 18 18	No recovery, resampled with 3-inch Cal-Mod sampler. Moist, light brownish gray, gravelly, fine to coarse SAND, trace silt; faint stratification (SP).
15	2-inch I.D. PVC well screen 0.010-inch slot width 10 to 20 feet	7 10 10	Moist, light brown and gray, fine t medium SAND, some gravel, trace silt; faint stratification (SP).
20	Threaded end cap with O-ring Native slough 20 to 21.5 feet	13 12 11	As above; moderately stratified.
	Well tag # BJG-122		Boring terminated at 21.5 feet. Well completed at 20 feet on 12/11/18. No groundwater encountered.

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40

Sampler Type (ST):
- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample

M - Moisture
Water Level ()
Water Level at time of drilling (ATD)

Logged by: TG
Approved by: JHS

Geologic & Monitoring Well Construction Log

associated earth sciences incorporated

Project Number	Well Number	Sheet
180539E001	EB-9W	1 of 1

Project Name	UPS Facility	Location	Redmond, WA
Elevation (Top of Well Casing)		Surface Elevation (ft)	~80
Water Level Elevation		Date Start/Finish	12/11/18,12/11/18
Drilling/Equipment	Boretec / Mini-Truck Rig	Hole Diameter (in)	8 inches
Hammer Weight/Drop	140# / 30"		

Depth (ft)	Water Level	WELL CONSTRUCTION	S T	Blows/ 6"	Graphic Symbol	DESCRIPTION
		Flush mount monument with locking well cap Concrete 0 to 1 foot		14 15 10		**Topsoil - ~6 inches** **Older Alluvium** Moist, light brown, fine to medium SAND, some gravel, some silt; no apparent structure (SP-SM).
		3/8-inch bentonite chips 1 to 7 feet		7 12 10		Moist, light brown and gray, fine to medium SAND, trace gravel, trace silt; faint stratification (SP).
5		2-inch I.D. PVC casing with threaded connections and O-rings 0 to 10 feet		7 10 10		Moist, light brown and gray, fine to coarse SAND, some silt, some gravel; faint stratification (SP-SM).
		10/20 Colorado silica sand 7 to 20 feet				
10				12 14 14		Moist, light brownish gray, fine SAND, trace to some silt; massive (SP-SM).
15		2-inch I.D. PVC well screen 0.010-inch slot width 10 to 20 feet		15 22 19		Moist, light brownish gray to gray, fine to coarse SAND, some gravel, some silt; moderately stratified (SP-SM).
20		Threaded end cap with O-ring Native slough 20 to 21.5 feet		30 30 16		Moist, light brownish gray to gray, gravelly, fine to medium SAND, some silt; broken rock in sampler, blowcounts likely overstated; moderately stratified (SP-SM). Boring terminated at 21.5 feet. Well completed at 20 feet on 12/11/18. No groundwater encountered.
		Well tag # BJG-124				
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Sampler Type (ST):

- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

Logged by: TG
Approved by: JHS

NWWELL- B 180539.GPJ BORING.GDT 1/23/19

MAYES TESTING ENGINEERS
A Terracon COMPANY
20225 Cedar Valley Rd Ste 110
Lynnwood, WA 98036-6365
425-742-9360

CALIFORNIA BEARING RATIO REPORT

Report Number: M7191019.0001
Service Date: 01/14/19
Report Date: 01/16/19
Task:

Client
Associated Earth Sciences
Attn: Tyler Gilsdorf
911 5th Ave Ste 100
Kirkland, WA 98033-6041

Project
QC AESI UPS Facility Laboratory Testing
20225 Cedar Valley Rd
Lynnwood, WA

Project No. M7191019

TEST RESULTS:

BEARING RATIO TEST (ASTM D-1883)

Please see attached test result sheet

Tested By: Kinsey Burke

Report Distribution
(1) Associated Earth Sciences, Tyler Gilsdorf
(1) Mayes Testing Engineers, Inc, Zen Revilla

Reviewed By Zenaida S. A. Revilla
Zenaida Revilla
Laboratory Manager

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