Geotechnical Engineering Services Report – Final

City of Kirkland Maintenance Center Improvements
Kirkland, Washington

for
KPFF Consulting Engineers

April 3, 2020

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Geotechnical Engineering Services Report – Final
City of Kirkland Maintenance Center Improvements
Kirkland, Washington
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1.0 INTRODUCTION AND PROJECT UNDERSTANDING

The purpose of this report is to summarize the results of our subsurface explorations and geotechnical engineering services for the Kirkland Public Works Maintenance Center Improvements project. The site is approximately 4 acres and located at 904 8th Street in Kirkland, Washington, as shown on Figure 1, Vicinity Map. Our services were performed in accordance with Contract Number SDC-108-0080 and the signed agreement, dated December 18, 2018, and our Request for Additional Services (RAS) No. 1 dated February 10, 2020. Our project understanding is based on discussions with the City of Kirkland (City) and the design civil engineer (KPFF Consulting Engineers), and review of existing site information.

The site is owned by the City and currently serves as a maintenance yard. Much of the yard is paved with asphalt concrete. The site is adjacent to the Cross Kirkland Corridor (CKC) pedestrian path and within a mapped high hazard landslide zone (Kirkland, 2019). The site includes several existing buildings and storage sheds, and several material storage and handling bays, as shown in Figure 2, Site Plan. A plan set showing as-built topography of the maintenance yards (dated April 9, 1985) was provided on March 26, 2020. We understand that the topography in the vicinity of the project improvements has changed very little since that time.

We understand that the project will include improvements to make the site compliant with Washington State Department of Ecology (Ecology) for use in stockpiling construction materials and for storage of decant materials from storm sewer maintenance operations. The improvements include the installation of steel-frame canopies to cover the material storage bays and stockpiles. We understand that the structures will not be occupied and that workers who use the structures will typically be in heavy equipment, such as front-end loaders. The steel-frame canopies are proposed to be supported on shallow foundations. Material storage bays, Bays 1A and 1B, are planned to be located adjacent to the toe of the CKC slope.

The total coverage area is estimated to be approximately 12,000 square feet among four planned steel-frame canopies. A combination of excavation, backfilling and shallow foundations will be required to construct the proposed facility improvements. Additional improvements will include pavement restoration in areas that are disturbed by construction.

We understand the project site and portions of the proposed site improvements are located within 50 feet of mapped high hazard landslide areas. Based on our review of the City of Kirkland Landslide Map (2019), the CKC slope adjacent to Bays 1A and 1B is mapped as a high hazard landslide, as well as the retaining wall centrally located within the maintenance yard. The retaining wall is an engineered wall and should not be considered a geologic hazard. The CKC slope was evaluated as a geologic hazard and we have provided discussion within this report, as well as quantitative slope stability analyses and estimation of slope deformation during a seismic event. The results of our seismic analyses are based on a peak horizontal ground acceleration with a two percent in 50-year probability of exceedance, as defined by the International Building Code (IBC).
2.0 PREVIOUS STUDIES

We reviewed the following previous geotechnical studies completed on the subject property:


3.0 PREVIOUS FIELD EXPLORATIONS AND LABORATORY TESTING

3.1. Previous Field Exploration

As discussed above, GeoEngineers, Inc. (GeoEngineers) reviewed previously completed geotechnical studies at the project site. The field exploration program for the 1987 Report consisted of 24 test pits (Test Pits 1 through 24), each advanced to a depth ranging from about 8 to 12 feet below ground surface (bgs). The approximate test pit locations from the 1987 Report are shown in Appendix B. Appendix B also includes details of the previously completed exploration programs for the City of Kirkland Maintenance Facility and logs of the test pits.

The field exploration program completed for the 2013 Report consisted of advancing three geotechnical soil borings (EB-1, EB-2 and EB-3) to depths ranging from 20 to 21½ feet bgs. Boring EB-3 was completed as a monitoring well. The approximate boring locations of the explorations for the 2013 Report are shown on Figure 2. Logs of borings completed for the 2013 Report are included in Appendix B.

3.2. Previous Laboratory Testing

A laboratory testing program was completed for the soil samples collected in 1987. Laboratory testing consisted of moisture content, sieve analysis and compaction characteristics. The tests were performed in general accordance with test methods of ASTM International (ASTM). Appendix B includes relevant laboratory test results from the previous studies at the Maintenance Center. The 2013 Report indicates that laboratory testing was performed; however, the copy of the report that we reviewed did not include laboratory testing results or a description of the specific tests performed.

4.0 SITE CONDITIONS

4.1. Geology Review

The Geologic Map of the Kirkland Quadrangle, Washington (Minard 1983) indicates the site is underlain by Transitional Beds (Qtb), which is defined as nonglacial and glacial material dated somewhere between the Fraser Glaciation and Pre-Fraser Glaciation. This unit is described as nonglacial and glacial deposits and comprised of mostly massive to bedded medium gray to dark gray clay, silt, and fine to very fine sand with gravel occurring in the lower part. The material underlying the Transitional Beds consists of Pre-Fraser deposits that are typically in a dense to very dense condition.
4.2. Surface Conditions

The project site is located at 904 8th Street in Kirkland, Washington, as shown on Figure 1. The project site is bounded to the east by the CKC, to the south by a Public Storage Facility and the north by light industrial and office space. The subsurface explorations for this project were performed within the fence line of the existing City of Kirkland Maintenance Facility, as shown on Figure 2. The majority of the site is currently surfaced with asphalt pavement. The site can be separated into two areas: a lower area and an upper area. The two areas are separated by an existing concrete retaining wall running north to south in the southeast portion of the site. In the lower area, site grades increase from south to north from an elevation of approximately 125 to 140 feet. In the upper area, site grades range from an elevation of about 145 feet in the north and up to 160 feet in the south. The site is separated from the CKC to the east by an existing slope that ranges from about 12 feet tall in the north, to about 3 to 4 feet tall in the south. Elevations were obtained from Google Earth on January 15, 2019.

4.3. Geologic Hazards and Conclusions

The project site is located within a mapped high hazard landslide zone, as shown on Figure 3, LiDAR Basemap. The slope between the Kirkland Public Works Maintenance Facility site and the CKC, and the existing retaining wall separating the upper and lower portions of the site are identified as areas of high landslide susceptibility, according to the City of Kirkland Landslide Map, 2019. The following discussion is related to the proposed improvements and their impact on the existing slope stability of the CKC, per Kirkland Zoning Code (KZC) 85.15.3.

4.3.1. Impact of Project on CKC Slope

Based on our understanding of the project and our slope stability analyses of the CKC slope (presented in section 5.1.6 of this report); we do not anticipate the existing slope stability to be impacted by the proposed development. Because significant slope modifications are not planned, we do not anticipate an effect on the erosion risk of the CKC slope. The seismic hazards for the subject property are presented in section “4.6. Earthquake Engineering” and in our quantitative slope stability results in section “5.1.6. Slope Stability Analysis of Cross Kirkland Corridor.” Additionally, based on our understanding of the project, project location and size of the proposed maintenance yard improvements, we do not anticipate the proposed improvements impacting any properties other than the City of Kirkland Maintenance Facility.

4.3.2. Consequence of Failure

The structures that are to be constructed near the base of the existing CKC slope will contain/cover soil and other material for the purpose of decanting and storage. We understand that the structures will not be occupied, and that workers who use the structures will typically be in heavy equipment, such as front-end loaders. Also, we understand that the canopy structures will consist of concrete walls with a metal/fabric hybrid canopy structure. Structures of this type are typically able to tolerate significant deformation without collapsing. Therefore, in our opinion, the consequence of failure is relatively low.

4.3.3. Recent Landslide Activity

Based on our site observations and review; we did not observe landslide scarps, tension cracks or features indicating the site to have historical or currently active landslide activity that would present a potential heightened landslide hazard risk. Additionally, we observed the CKC slope to be fully vegetated. According to the Washington State Department of Natural Resources (WA DNR) Geologic Information Portal; the
nearest mapped landslide (pre-historic >150 years) is located approximately 0.3 miles north, near the intersection of NE 98th Street and 110th Avenue NE in Kirkland, Washington.

4.3.4. **Seepage and Water Runoff**

Based on our site reconnaissance and review; we did not observe active seepage or water runoff along the CKC slope. However, we understand that drainage issues and ponding were observed by the City on February 3, 2020 located at the proposed location of Bay 1A, between the existing decanting cell wall and toe of the CKC slope. Based on email correspondence from the City and KPFF, the observed runoff may potentially be the result of a 4-inch-diameter underdrain that was crushed and runs parallel to the existing wall. We understand the City intends to repair that underdrain.

4.3.5. **Stormwater Facilities**

We understand that the City is considering a stormwater line reroute along the toe of the CKC slope. We have not evaluated the temporary slope for this stormwater reroute condition. The contract documents should state the contractor performing the work is responsible for temporary slope stability conditions and stability measures. Based on our slope stability analyses presented in this report, provided the permanent slope is the same grade as existing and proper erosion control measures are taken, the stormwater reroute should not affect the permanent CKC slope stability.

4.3.6. **Legally Permitted Grading Activity**

The mapped areas showing high susceptibility landslides are the result of an engineered retaining wall in the central portion of the site and the slope separating the site from the CKC along the east extent of the site. The eastern slope appears to be a manmade slope, which served as part of the Eastside Railway Corridor and currently serves as the CKC (recreational trail). It is our opinion that the slopes that are identified as landslide hazard areas would not meet the criteria for identification without previous grading activities during construction of previous developments.

4.4. **Subsurface Explorations**

We explored subsurface conditions by advancing a total of three soil borings (Borings A, B and C), each to a depth of approximately 31½ feet, the dates of December 27, 2018 and February 18, 2020. Approximate locations of our explorations are shown on Figure 2. Borings A and B were advanced within the existing City maintenance facility. Boring C was advanced from the top of the CKC slope, on the existing CKC trail. The subsurface explorations for Boring A and B were completed using a subcontracted truck-mounted drill rig and operator. Boring C was completed using a subcontracted track-mounted drill rig and operator. The borings were continuously monitored and logged by a geotechnical engineer from our firm. Additional details of our subsurface exploration program, including summary boring logs, are provided in Appendix A.

4.5. **Subsurface Conditions**

4.5.1. **Soil Conditions**

Based on our review and the explorations completed for this project, we interpret the following subsurface soil units.

- **Fill:** The subsurface explorations (Borings A and B) were advanced through existing asphalt pavement. Boring A encountered about 2 inches of asphalt pavement underlain by fill material generally consisting
of stiff sandy silt in the upper 5 feet. Boring B location consisted of approximately 5 inches of asphalt pavement. The encountered fill material consisted of silty sand and sand with silt with variable gravel content, typically in a loose to medium dense condition. Brick, wood and glass debris was observed within the fill material. The fill material extended to a depth of about 7 ½ feet below existing grade in Boring B.

Boring C encountered a thin layer of gravel surfacing underlain by fill material generally consisting of loose sand with variable silt, gravel and asphalt debris in the upper 15 feet and an approximately 2-foot-thick sandy silt layer from 15 to 17 ½ feet.

- **Transitional Beds (Qtb):** At a depth of approximately 5 feet, below the fill unit, Boring A encountered a thin layer of Transitional Beds, extending to a depth of about 7 ½ feet. In Boring A, this unit generally consists of silty sand with gravel. At a depth of approximately 7 ½ feet, below the fill unit, Boring B encountered Transitional Beds extending to a depth of about 12 feet. In Boring B, this unit consists of sand with variable silt and gravel content with an interbed of sandy silt at 10 ½ feet below existing grade. The Transitional Beds encountered were typically in a medium dense/stiff condition.

Boring C encountered transitional beds underlying the fill unit at a depth of approximately 17 ½ feet. In Boring C, this unit included a thin lens of medium dense sand with silt, transitioning to a medium dense silty sand at a depth of approximately 18 ½ feet, which extended to a depth of approximately 28 feet.

- **Pre-Fraser Deposits:** At a depth of approximately 7 ½ feet, below the Transitional Beds unit, Boring A encountered Pre-Fraser deposits. This unit extends to the boring termination depth of 31 ½ feet below existing grade and generally consists of fine gravel with variable silt and sand content, typically in a dense to very dense condition. At a depth of approximately 11 feet, below the Transitional Beds unit, Boring B encountered Pre-Fraser deposits. This unit extends to the boring termination depth of 31 ½ feet below existing grade and generally consists of silty sand with variable gravel and sand with variable silt with a sandy silt interbed at a depth of approximately 25 feet. The Pre-Fraser deposits encountered within Boring B were in a very dense/hard condition.

In Boring C, we observed Pre-Fraser deposits underlying the Transitional Beds soil unit at a depth of approximately 28 feet below existing grade. This unit extended to the boring termination depth of 31 ½ feet below existing grade and generally consists of coarse gravel with variable silt and sand content in a very dense condition.

**4.5.2. Groundwater Conditions**

While advancing our subsurface explorations, we observed wet soil conditions at approximately 10 feet bgs in Boring A, 20 feet bgs in Boring B (observed on December 27, 2018) and 16 ½ in Boring C (observed on February 18, 2020). We reviewed Ecology’s well logs within the area and the groundwater elevation ranges from 5 to 14 feet bgs. We anticipate that the presence and location of the regional groundwater table varies with season and precipitation events.

Based on previous studies and explorations within the City of Kirkland Maintenance Facility, the encountered groundwater depths are consistent.

**4.6. Earthquake Engineering**

**4.6.1. 2015 IBC Seismic Design Information**

We recommend the parameters in Table 1 for use in seismic design in accordance with 2015 IBC.
### TABLE 1. 2015 IBC SEISMIC PARAMETERS

<table>
<thead>
<tr>
<th>2015 IBC Parameter</th>
<th>Recommended Values</th>
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<tbody>
<tr>
<td>Site Class</td>
<td>C</td>
</tr>
<tr>
<td>Spectral Response Acceleration at Short Periods ($S_0$)</td>
<td>1.26g</td>
</tr>
<tr>
<td>Spectral Response Acceleration at 1-Second Periods ($S_1$)</td>
<td>0.48g</td>
</tr>
<tr>
<td>Design Spectral Response Acceleration at Short Periods ($S_{DS}$)</td>
<td>0.84g</td>
</tr>
<tr>
<td>Design Spectral Response Acceleration at 1-Second Periods ($S_{D1}$)</td>
<td>0.43g</td>
</tr>
</tbody>
</table>

#### 4.6.2. Liquefaction Potential

Liquefaction refers to a condition where vibration or shaking of the ground, usually from earthquake forces, results in development of excess pore pressures in loose to medium dense, saturated soils and subsequent loss of strength in the deposit of the soil affected. In general, soils that are susceptible to liquefaction include loose to medium dense sands to silty sands that are below the water table. Based on the soil type, relative density of the soils encountered and the absence of near-surface groundwater levels observed in our explorations, it is our opinion that the potential for liquefaction at this site is low.

#### 4.6.3. Lateral Spreading

Lateral spreading related to seismic activity typically involves lateral displacement of large, surficial blocks of non-liquefied soil when a layer of underlying soil loses strength during seismic shaking. Lateral spreading usually develops in areas where sloping ground or large grade changes (including retaining walls) are present. Based on our understanding of the subsurface conditions and current site topography, it is our opinion that the risk of lateral spreading is low.

#### 4.6.4. Ground Rupture

The site is located approximately 4 miles south of the Southern Whidbey Island fault zone, which is the nearest mapped fault. Based on our knowledge of regional geology in the vicinity of the site, the substantial thickness of glacial and postglacial deposits beneath the site and the distance to the nearest mapped fault, we conclude the potential for surface fault rupture at the site due to crustal faulting is low.

### 5.0 CONCLUSIONS AND RECOMMENDATIONS

#### 5.1. Site Development and Earthwork

##### 5.1.1. General

We anticipate that site development and earthwork may include demolition and removal of existing pavement and/or structures, excavating for construction of underground structures, and placing and compacting fill.

We anticipate site grading and earthwork can be accomplished with conventional earthmoving equipment. Although we did not observe cobbles or boulders in our explorations, they are common in the soil units observed in our explorations and we recommend the contractor be prepared for such conditions. The following sections provide recommendations for stripping, excavation, erosion control, subgrade development, fill materials, and fill placement and compaction.
5.1.2. Clearing, Stripping and Demolition

Initial site preparation should include demolishing the existing asphalt concrete pavement, excavating to planned foundation grade and removing any loose or otherwise unsuitable soils within the footprint of the planned shallow footings. Care should be taken to reduce disturbance to the exposed subgrade. The excavated material should be stockpiled in an area designated by the City and in accordance with the project plans and specifications.

5.1.3. Erosion and Sedimentation Control

Potential sources or causes of erosion and sedimentation can be influenced by construction methods, slope length and gradient, amount of soil exposed and/or disturbed, soil type, construction sequencing and weather. Implementing an erosion and sedimentation control plan will reduce the project impact on erosion-prone areas. The plan should be designed in accordance with applicable city, county and/or state standards. The plan should incorporate basic planning principles, including:

- Scheduling grading and construction to reduce soil exposure.
- Re-vegetating or mulching denuded areas.
- Directing runoff away from exposed soils.
- Reducing the length and steepness of slopes with exposed soils.
- Decreasing runoff velocities.
- Preparing drainage ways and outlets to handle concentrated or increased runoff.
- Confining sediment to the project site.
- Inspecting and maintaining control measures frequently.

Some sloughing or raveling of exposed or disturbed soil on slopes should be expected. We recommend that disturbed soil be restored promptly so that surface runoff does not become channeled.

Temporary erosion protection should be used and maintained in areas with exposed or disturbed soils to help reduce erosion and reduce transport of sediment to adjacent areas and receiving waters. Permanent erosion protection should be provided by paving, structure construction or landscape planting.

Until the permanent erosion protection is established and the site is stabilized, site monitoring may be required by qualified personnel to evaluate the effectiveness of the erosion control measures and to repair and/or modify them as appropriate. Provision for modifications to the erosion control system, based on monitoring observations, should be included in the erosion and sedimentation control plan.

5.1.4. Temporary Excavations, Shoring and Dewatering

Excavations deeper than 4 feet, such as the Type 2 catch basin being considered near Bay 1A, should be shored or laid back at a stable slope if workers are required to enter. Shoring and temporary slope inclinations must conform to the provisions of Title 296 Washington Administrative Code (WAC), Part N, “Excavation, Trenching and Shoring.” Regardless of the soil type encountered in the excavation, shoring, trench boxes or sloped sidewalls will be required under Washington Industrial Safety and Health Act (WISHA). The contract documents should specify that the contractor is responsible for selecting excavation
and dewatering methods, monitoring the excavations for safety and providing shoring, as required, to protect personnel and structures.

Temporary cut slopes at the site should be inclined no steeper that about 1.5H to 1V (horizontal to vertical). This guideline assumes that all surface loads are kept away from the top of the slope a distance greater than the depth of the cut and that seepage is not present on the slope face. Flatter cut slopes will be necessary where seepage occurs or if surcharge loads are anticipated. Temporary covering with heavy plastic sheeting should be used to protect these slopes during periods of wet weather.

Based on the review of previous information and our explorations, we do not expect groundwater to be a major factor during shallow excavations and earthwork. However, we encountered wet soil at a depth of approximately 5 feet bgs in Boring A, which is consistent with the results reported in the 2013 Report. The test pits completed as part of the 1987 Report indicated groundwater seepage at levels ranging from approximately 4½ to 12 feet bgs. We anticipate that the groundwater levels will vary by season and weather conditions.

We anticipate that shallow groundwater and ponded surface water can be handled adequately with sumps, pumps and/or diversion ditches, as necessary. Ultimately, we recommend that the contractor performing the work be responsible for controlling and collecting any encountered groundwater.

5.1.5. Temporary Excavation Adjacent to Existing Slopes

A relatively shallow excavation is proposed along the toe of the CKC located on the east side of the site, to construct foundations for the proposed canopy structures. In this area, the existing slope of the CKC is on the order of 1.7H:1V to 2H:1V, based on available survey data. As discussed in the Site Geologic Hazards and Conclusions section above, it is our opinion that the risk of slope failure in this area is low. As part of our RAS No. 1, dated February 10, 2020, we completed a slope stability analysis of the existing CKC slope; see below for discussion of approach and analysis and Appendix B for results. Additionally, as an added level of precaution, we recommend the following considerations for excavations that are planned near the bottom of this slope:

■ To limit the risk of destabilizing the existing slope, we recommend the maximum un-shored excavation be such that an “imaginary line” from the base of the excavation to the top of the slope would be no steeper than 1.5H:1V, which is consistent with our recommended maximum temporary slope inclination.

■ Because the top of the slope is a publicly accessible area, the City might consider limiting access to the portion of the slope directly above the planned excavations. Temporary fencing and signage would be one method of limiting access.

The contractor should take care to limit surface disturbance to the existing slope. Equipment, stockpiles and excavation spoils should not be placed on the existing slope.

5.1.6. Slope Stability Analysis of Cross Kirkland Corridor

5.1.6.1. Analysis Method and Results

A slope stability analysis was completed using the computer program SLOPE/W (GEO-SLOPE International, Ltd., 2016). SLOPE/W evaluates the stability of numerous trial shear surfaces using a vertical slice limit-equilibrium method. This method compares the ratio of forces and moments driving slope movement
versus forces and moments resisting slope movement for each trial shear surface and presents the result as the factor of safety. The program then sorts the trial shear surfaces and identifies the surface with the lowest factor of safety, or the “critical” shear surface. We assumed a circular arc failure surface and used the Morgenstern-Price method to calculate the forces. The failure surface was optimized using an algorithm within the SLOPE/W program.

Based on our completed field explorations and laboratory testing, we established three soil units for the CKC slope, which includes: existing fill material, transitional beds and Pre-Fraser deposits. We also included a zone of backfill in the area of the planned excavation to represent the condition after backfilling in areas around the planned foundations. We assumed this material would meet the requirements of the Washington State Department of Transportation (WSDOT) Standard Specification 9-03.14(1) (Gravel Borrow), as recommended in the Structural Fill section of this report. In our opinion, this is a conservative approach, because the majority of the excavation will be filled with concrete for foundation construction.

For our slope stability analyses of the CKC slope, we assigned subsurface soil strengths to each of these soil units using correlations relating blow counts (N-value) to internal friction angle (φ) (Terzaghi, 1996). The WSDOT Geotechnical Design Manual (GDM) presumes that gravel borrow has a friction angle between 36 and 40 degrees and a unit weight between 130 and 145 pounds per cubic foot (pcf). We used a friction angle of 34 degrees and a unit weight of 128 pcf to model the backfilled shallow footing excavation. Additionally, we modeled the existing rock wall along the toe of the CKC slope as a high strength, rip rap wall (unit weight of 125 pcf). The assigned soil properties used for slope stability analysis are provided in Table 2 below.

<table>
<thead>
<tr>
<th>Assigned Soil Unit</th>
<th>Soil Type (USCS Classification)</th>
<th>Unit Weight (pcf)</th>
<th>Cohesion (psf)</th>
<th>Internal Friction Angle φ (°)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fill Material</td>
<td>SP, SP-SM, ML</td>
<td>115</td>
<td>25</td>
<td>30</td>
</tr>
<tr>
<td>Transitional Beds</td>
<td>SP-SM</td>
<td>115</td>
<td>0</td>
<td>34</td>
</tr>
<tr>
<td>Pre-Fraser Deposits</td>
<td>GP, GW-GM</td>
<td>125</td>
<td>0</td>
<td>40</td>
</tr>
<tr>
<td>Structural Fill</td>
<td>GW, GW-GM, SW, SW-SM</td>
<td>128</td>
<td>0</td>
<td>34</td>
</tr>
</tbody>
</table>

Notes:
USCS = Unified Soil Classification System
psf = pounds per square foot

Stability of the CKC slope was evaluated for the following conditions:

1. **Existing Slope Condition:** The existing slope condition is based on the current condition of the slope. The surface profile was developed using as-built topography provided. We used the soil contacts observed and engineering properties obtained in Boring C (top of CKC) and Boring A (approximate toe elevation) to develop the soil profile for the CKC slope.

2. **Temporary Slope Condition:** The existing slope was modeled with the temporary proposed shallow footing excavation adjacent to the CKC toe. The modeled temporary excavation is approximately 8 feet wide and 2 feet deep.
3. **Permanent Slope Condition:** The permanent slope condition was modeled with the proposed excavation backfilled with WSDOT gravel borrow material. This condition represents the post-construction permanent condition in areas adjacent to the planned foundations. In our opinion, this is a conservative approach, because the majority of the excavation will be filled with concrete for foundation construction.

4. **Seismic – Permanent Slope Condition:** The seismic stability of the permanent slope was evaluated based on a 2 percent in 50-year probability of exceedance (2,475-year return period event using a pseudo-static analysis with a horizontal ground acceleration equal to one-half of the peak horizontal ground acceleration [PGA]).

The resulting factors of safety for the CKC slope stability analyses are provided in Table 3 below. Our Slope/W analyses are presented in Figures 4 through 7.

### TABLE 3. SLOPE STABILITY ANALYSIS RESULTS

<table>
<thead>
<tr>
<th>Analyzed Condition</th>
<th>Figure Number</th>
<th>Required Factor of Safety per KZC 85.25</th>
<th>Calculated Factor of Safety</th>
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</thead>
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<tr>
<td>Existing Slope Condition</td>
<td>4</td>
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<td>1.83</td>
</tr>
<tr>
<td>Temporary Slope Condition</td>
<td>5</td>
<td>-</td>
<td>1.47</td>
</tr>
<tr>
<td>Permanent Slope Condition</td>
<td>6</td>
<td>1.5</td>
<td>1.83</td>
</tr>
<tr>
<td>Seismic - Permanent Slope Condition</td>
<td>7</td>
<td>1.1</td>
<td>0.96 ^2</td>
</tr>
</tbody>
</table>

Notes:

1. The PGA (0.564g) for the seismic condition was obtained using the USGS Unified Hazard Tool (return period of 2% in 50 years).
2. The resulting Factor of Safety does not meet City code requirements. Refer to section 5.1.6.2. Seismic Slope Displacement for details.

Based on the results of our analysis, the construction process does not appear to affect the slope stability, except for during the temporary condition, when the excavation is open. We analyzed the temporary slope condition during excavation, the factor of safety for the temporary conditions meets the minimum required factor of safety of 1.25 for temporary slopes per the WSDOT GDM M 46-03.08. The seismic permanent slope condition results indicate that the factor of safety is lower than that required by the City code (FS = 1.1). To further evaluate the risk of seismic slope deformation, we performed a slope deformation analysis using Newmark sliding block analysis, as discussed in the following section.

### 5.1.6.2. Seismic Slope Displacement

A permanent-deformation analysis (Newmark sliding-block analysis) was completed for a section of the CKC near planned storage bays, Bays 1A and 1B, to estimate slope behavior during an earthquake. Permanent seismic deformation of the slope was analyzed using a software program titled Seismic Landslide Movement Modeled using Earthquake Records (SLAMMER) provided by the USGS. The SLAMMER program analyzes a number of historical earthquake records based on a range of earthquake magnitudes, peak accelerations and critical yield acceleration. The critical yield acceleration the horizontal seismic coefficient that results in a factor of safety of 1.0 for the Seismic – Permanent Condition slope stability analysis.

The permanent-deformation analysis estimates approximately 2 inches of movement for the CKC slope during a seismic event, see Figure 8, SLAMMER Results. Based on the results of the slope deformation analysis and the planned separation of the structure from the toe of the slope (minimum 2 feet),
we conclude that the risk of seismic slope deformation impacting the structure is low. The risk of significant impact to life, safety and health is even lower because the structure is not planned to be occupied.

5.1.7. Wet Weather Considerations

The wet weather season generally begins in October and continues through May in western Washington; however, periods of wet weather can occur during any month of the year. The soils encountered in our explorations generally contain a significant amount of fines and will be susceptible to disturbance when wet. If wet weather is unavoidable, we recommend that the following measures be adopted.

- The ground surface in and around the work area should be sloped so that surface water is directed away from the work area. The ground surface should be graded so that areas of ponded water do not develop. Measures should be taken by the contractor to prevent surface water from collecting in excavations and trenches. Measures should be implemented to remove surface water from the work area.

- Earthwork activities should not take place during periods of heavy precipitation.

- Slopes with exposed soils should be covered with plastic sheeting.

- Construction traffic should be restricted to specific areas of the site, preferably areas that are surfaced with working pad materials not susceptible to wet weather disturbance.

- Construction activities should be scheduled so that the length of time that soils are left exposed to moisture is reduced to the extent practical.

- During periods of wet weather, concrete should be placed as soon as practical after preparation of the footing excavations. Foundation bearing surfaces should not be exposed to standing water. If water pools in the base of the excavation, it should be removed before placing structural fill or reinforcing steel. If footing excavations are exposed to extended wet weather conditions, a lean concrete mat can be considered for subgrade protection.

5.2. Structural Fill

All fill that will support foundations, floor slabs, pavement areas, or be placed against retaining walls or in utility trenches should generally meet the criteria for structural fill presented below. The suitability of soil for use as structural fill depends on its gradation and moisture content.

5.2.1. Materials

Materials used to provide foundation support and to construct pavement areas are classified as structural fill for the purpose of this report. Structural fill material quality varies depending upon its use as described below:

5.2.1.1. Structural Fill

The workability of material used as structural fill will depend on the gradation and moisture content of the soil. As the amount of fines increases, soil becomes increasingly sensitive to small changes in moisture content and adequate compaction may become difficult or impossible to achieve. We recommend that structural fill consist of material similar to “Select Borrow” or “Gravel Borrow,” as described in Section 9-03.14 of the WSDOT Standard Specifications. If prolonged dry weather prevails during the earthwork phase of construction, a somewhat higher fines content may be acceptable. If construction is
performed during persistent wet weather, we recommend using imported select granular fill as described below.

5.2.1.2. Select Granular Fill

Select granular fill is well-graded sand and gravel or crushed rock with a maximum particle size of 6 inches and less than 5 percent fines by weight based on -¾-inch fraction. Organic matter, debris or other deleterious material must not be present. In our opinion, material with gradation characteristics similar to WSDOT Specification 9-03.9 (Aggregates for Ballast and Crushed Surfacing), 9-03.10 (Aggregate for Gravel Base) or 9-03.14 (Borrow) is suitable for use as select granular fill, provided that the fines content is less than 5 percent (based on -¾-inch fraction) and the maximum particle size is 6 inches.

5.2.1.3. Re-use of On-site Soils

Based on our subsurface explorations and experience, it is our opinion that the native soil at the site may be considered for use as structural fill and trench backfill, provided that it can be adequately moisture-conditioned, placed and compacted as recommended below. However, care should be taken to separate out any layers of high fines content or fill with unsuitable organic content or construction debris. Because of the limited quantities anticipated, we recommend that imported structural fill be considered for planning and cost estimating purposes. If the contractor wishes to use on-site soils for structural fill, GeoEngineers can further evaluate the on-site soils for suitability as structural fill when excavation operations are underway.

5.2.1.4. Reuse of Existing Asphalt, Base and Concrete Rubble

Existing asphalt pavement and Portland cement concrete (PCC) rubble may be reused as structural fill if properly crushed during demolition. Recycled PCC rubble and base course materials may be reused as structural fill throughout the project, including under the structure footprints. Recycled asphalt may be used under new pavement and in utility trenches but should not be used under foundations.

For use as general structural fill, the asphalt and concrete rubble should be crushed or otherwise ground up and should meet the gradation requirements for gravel borrow as described in Section 9-03.14(1) of the 2018 WSDOT Standard Specifications. If recycled asphalt and/or concrete will be used under pavement areas, we recommend that it meet the gradation requirements for crushed surface base course (CSBC) as described in Section 9-03.9(3) of the 2018 WSDOT Standard Specifications. Recycled asphalt and concrete should not be used in landscape areas.

5.2.2. Fill Placement and Compaction

Structural fill should be placed in uniform, horizontal lifts and uniformly mechanically compacted to a firm, non-yielding condition. Structural fill should be placed in loose lifts not exceeding 12 inches in thickness when using heavy compaction equipment and not more than 6 inches when using hand operated compaction equipment. The actual thickness will be dependent on the structural fill material used and the type and size of compaction equipment. Each lift should be moisture-conditioned to within about 2 percent of the optimum moisture content to achieve proper compaction to the specified density before placing subsequent lifts. The optimum moisture content varies with the soil gradation and should be evaluated during construction. Material containing more than about 5 percent fines can be difficult or impossible to compact when wet.

Structural fill should be compacted to the following criteria:
■ Structural fill placed below structures (supporting foundations or slabs-on-grade) should be compacted to at least 95 percent of the maximum dry density (MDD) estimated in accordance with ASTM D 1557.

■ Structural fill placed less than 2 feet below pavement sections must be compacted to at least 95 percent of the MDD (ASTM D 1557). Fill placed deeper than 2 feet below pavement sections must be compacted to at least 90 percent of the MDD (ASTM D 1557).

■ Backfill behind retaining walls and below-grade structures must be compacted to at least 90 percent of the MDD (ASTM D 1557). Overcompaction of fill placed directly behind retaining walls or below-grade structures should be avoided. We recommend use of hand-operated compaction equipment and maximum 6-inch loose lift thickness when compacting fill behind retaining walls or below-grade structures.

5.3. Utility Trenches

Trench excavation, pipe bedding and trench backfilling, if needed, should be completed using the general procedures described in the WSDOT Standard Specifications or other suitable procedures specified by the project civil engineer. The native and fill soils encountered at the site are generally of low corrosivity, based on our experience in the Puget Sound area. The backfill should be compacted in accordance with the criteria discussed above. A detail of a typical compaction criteria for trench backfill is shown in Figure 9, Compaction Criteria for Trench Backfill.

5.4. Shallow Foundations

5.4.1. General

Proposed structures can be founded on isolated footings supported on bearing surfaces prepared as recommended below.

5.4.2. Footing Bearing Surface Preparation

We anticipate that footings will be planned within 5 feet of existing grade within the existing fill unit. Soils in the existing fill unit were typically observed to be in a loose to medium dense/stiff condition. To limit the risk of foundation settlement, we recommend footings be founded on medium dense or denser native soils or supported on at least 2 feet of compacted structural fill. We do not recommend that footings bear directly on the existing loose/stiff fill soils, unless they can be removed and recompressed.

Footings excavations should be performed using a smooth-edged bucket to limit the disturbance to the bearing surface. The base of the foundation excavation should be compacted as necessary to a firm, unyielding condition. Loose or disturbed materials present at the base of the footing excavations must be compacted or removed and replaced with structural fill. If removal and replacement with structural fill is required, the overexcavation and structural fill zone must extend at least 2 feet beyond the perimeter of the footings.

Foundation bearing surfaces should not be exposed to standing water. If water is present in the excavation, it must be removed before placing structural fill or reinforcing steel. We recommend that a member of our firm observe foundation excavations before placement of reinforcing steel in order to confirm that bearing surfaces have been prepared in accordance with our recommendations, or to provide recommendations for recompack of disturbed soil or removal of unsuitable soil.
5.4.3. Allowable Bearing Pressures

Lightly loaded footings may be designed using an allowable soil bearing value of 2,500 psf, provided they are supported on foundation bearing surfaces prepared as recommended above. The allowable soil bearing values apply to the total of dead and long-term live loads and may be increased by up to one-third for wind or seismic loads.

We recommend that the spread footings be founded a minimum of 18 inches below the lowest adjacent grade.

5.4.4. Settlement

Provided the footings are supported on at least 2 feet of properly compacted structural fill, we estimate the post construction total settlement of the lightly loaded shallow foundations will be on the order of about 1 inch. Loose or disturbed soils not removed from the footing excavation prior to placing concrete will result in additional settlement. We recommend that the footing excavations be cut using a smooth-edged bucket to reduce the amount of disturbed soil exposed at the subgrade, or the disturbed subgrade soil be thoroughly compacted prior to placing structural fill.

5.4.5. Lateral Resistance

Lateral foundation loads may be resisted by passive resistance on the sides of the footings and by friction on the base of the footings. For footings supported on structural fill placed and compacted in accordance with our recommendations, the allowable frictional resistance may be computed using a coefficient of friction of 0.35 applied to vertical dead-load forces. The allowable passive resistance may be computed using an equivalent fluid density of 300 pcf (triangular distribution). The upper foot of soil should be neglected when calculating passive resistance, unless the soil is overlain by slabs or pavement. The above coefficient of friction and passive equivalent fluid density values incorporate a factor of safety of 1.5.

5.4.6. Footing Drains

As currently envisioned, structures with interior space requiring protection from moisture with footing drains are not planned for the site. If these types of structures are planned, we recommend that perimeter footing drains be installed. GeoEngineers can provide footing drain recommendations, if needed.

5.5. Conventional Retaining Walls and Below-Grade Structures

5.5.1. Design Parameters

Footings for retaining walls or below-grade structures may be designed in accordance with the “Shallow Foundations” recommendations above. We recommend retaining structures that are free to deflect at least 0.001H, where H is the height of the retaining structures, be designed for active earth pressures using an equivalent fluid unit weight of 35 pcf for the level backfill condition. For structures with backfill sloping upward behind the wall at 2H:1V, we recommend an equivalent fluid density of 52 pcf. If the retaining structures are restrained against rotation, we recommend they be designed for an at-rest equivalent fluid unit weight of 55 pcf. This value assumes a level, drained backfill condition.

Surcharge loads applied closer than one-half of the retaining structure height may be considered as uniformly distributed horizontal pressures equal to one-third of the distributed vertical surcharge pressure. A uniform seismic pressure of 10H psf, where H is the height of the retaining structure, should be included.
when designing permanent retaining structures for seismic loads. This seismic pressure assumes a level backfill condition.

5.5.2. Drainage

Positive drainage is imperative behind retaining walls and below-grade retaining structures. This can be accomplished by using a zone of free-draining material behind the retaining structure with perforated pipes to collect seepage water. The drainage material should consist of material similar to “gravel backfill for drains” described in Section 9-03.12(4) of the WSDOT Standard Specifications. The drainage zone should extend horizontally at least 18 inches from the back of the retaining structure.

A perforated smooth-walled rigid polyvinyl chloride (PVC) pipe with a minimum diameter of 4 inches should be placed at the bottom of the drainage zone along the entire length of the retaining structure with the pipe invert at or below the elevation of the base of the footing. The drainpipes should collect water and direct it to a tightline leading to an appropriate disposal system. Cleanouts must be incorporated into the design of the drains in order to provide access for regular maintenance. Roof downspouts, perimeter drains or other types of drainage systems must not be connected to drain systems for retaining walls or below-grade structures.

5.6. Pavement Recommendations

5.6.1. Pavement Subgrade Preparation

New pavement sections must be installed over a dense and unyielding subgrade. If structural fill is required beneath pavements, it should be prepared, placed and compacted as previously described. Prior to the placement of base course materials, the exposed subgrade should be proof-rolled. Proof-rolling should be accomplished with a loaded dump truck, large self-propelled vibrating roller or equivalent piece of equipment. The purpose of this effort is to identify possible loose or soft soil and recom pact disturbed areas of subgrade.

Proof-rolling should be carefully observed by a member of our firm. Areas exhibiting significant deflection, pumping or saturated soils that cannot be readily compacted should be overexcavated to firm and unyielding soil. Overexcavated areas should be backfilled with compacted structural fill. During periods of wet weather, proof-rolling could damage exposed subgrade. Under these conditions, a member of our firm should observe subgrade conditions to determine if proof-rolling is feasible.

5.6.2. Pavement Design

Based on our experience, we provide recommended asphalt concrete pavement (ACP) and PCC pavement sections below. These pavement sections may not be adequate for heavy construction traffic loads. Additional pavement thickness may be necessary to prevent pavement damage during construction. The recommended sections assume that final improvements surrounding the pavement will be designed and constructed such that stormwater or excess irrigation water from landscape areas does not accumulate below the pavement section or pond on the pavement surfaces.

Pavement subgrade must be prepared, placed and observed, as previously described. Crushed surfacing base course (CSBC) and subbase must be moisture-conditioned to near optimum moisture content and compacted to at least 95 percent of MDD (ASTM D 1577).
CSBC must conform to applicable sections of 4-04 and 9-03.9(3) of the WSDOT Standard Specifications. Hot mix asphalt (HMA) must conform to applicable sections of 5-04, 9-02 and 9-03 of the WSDOT Standard Specifications. PCC must conform to applicable sections of 5-05, 9-01 and 9-03 of the WSDOT Standard Specifications.

5.6.3. Standard-Duty ACP – Automobile Driveways and Parking Areas

- Two inches of HMA, class ½ inch, PG 58-22.
- Four inches of CSBC.
- Six inches of subbase consisting of select granular fill to provide uniform grading and pavement support, to maintain drainage and to provide separation from fine-grained subgrade soil.
- Native subgrade or structural fill prepared in accordance with the Pavement Subgrade Preparation section.

5.6.4. Heavy-Duty ACP – Areas Subject to Heavy Truck Traffic

- Three inches of HMA, class ½ inch, PG 58-22.
- Four inches of CSBC.
- Six inches of subbase consisting of select granular fill to provide uniform grading and pavement support, maintain drainage and provide separation from fine-grained subgrade soil.
- Native subgrade or structural fill prepared in accordance with the Pavement Subgrade Preparation section.

5.6.5. PCC Pavement – Areas Subject to Heavy Truck Traffic

- Six inches of PCC pavement (28-day compressive strength of 6,000 pounds per square inch [psi] and a modulus of rupture of 600 psi).
- Six inches of CSBC.
- Native subgrade or structural fill prepared in accordance with the Pavement Subgrade Preparation section.

6.0 CONCLUSIONS AND RECOMMENDED ADDITIONAL GEOTECHNICAL SERVICES

Based on the results of our site evaluation, subsurface exploration and analyses, it is our opinion that the proposed improvements to the Kirkland Maintenance Facility can be undertaken safely, provided the recommendations presented in this report are incorporated into the project plans.

GeoEngineers should be retained to review the project plans and specifications when complete, to confirm that our design recommendations have been implemented as intended.

During construction, GeoEngineers should evaluate bearing surface preparation for foundations, pavement subgrades and evaluate the compaction of structural fill. The purposes of GeoEngineers’ construction phase services are to confirm that the subsurface conditions are consistent with those described in this report and for other reasons described in Appendix C, “Report Limitations and Guidelines for Use.”
7.0 LIMITATIONS

We have prepared this report of geotechnical engineering design services for use by KPFF Consulting Engineers for the City of Kirkland Maintenance Center project in Kirkland, Washington. KPFF may distribute copies of this report to authorized agents and regulatory agencies as may be required for the project.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering in this area at the time this report was prepared. No warranty or other conditions expressed or implied should be understood.

Please refer to Appendix C, “Report Limitations and Guidelines for Use,” for additional information pertaining to use of this report.

8.0 REFERENCES


State of Washington, “Excavation, Trenching and Shoring,” Title 296 Washington Administrative Code (WAC), Part N.


Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Mapbox Open Street Map, 2018
Projection: NAD 1983 UTM Zone 10N
Figure 4

Slope/W Analysis of CKC - Existing Slope Condition

Kirkland Maintenance Center SWPPP
Kirkland, Washington

Notes:
City of Kirkland Maintenance Yard Topography (09-09-1985).
Revised: 07-17-1987
Provided on 03-26-2020

Analysis completed using GeoStudio 2020 version 10.2.19666
Slope/W Analysis of CKC - Temporary Slope Condition
Kirkland Maintenance Center SWPPP
Kirkland, Washington

Notes:
City of Kirkland Maintenance Yard Topography (09-09-1985).
Revised: 07-17-1987
Provided on 03-26-2020

Analysis completed using GeoStudio 2020 version 10.2.19666
Figure 6
Slope/W Analysis of CKC - Permanent Slope Condition
Kirkland Maintenance Center SWPPP
Kirkland, Washington

Notes:
City of Kirkland Maintenance Yard Topography (09-09-1985).
Revised: 07-17-1987
Provided on 03-26-2020

Analysis completed using GeoStudio 2020 version 10.2.19666
Notes:
City of Kirkland Maintenance Yard Topography (09-09-1985).
Revised: 07-17-1987
Provided on 03-26-2020

Slope/W Analysis of CKC - Seismic – Permanent Slope Condition
Kirkland Maintenance Center SWPPP
Kirkland, Washington

Analysis completed using GeoStudio 2020 version 10.2.19666
SLAMMER Results
Rigid Block

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<th></th>
<th>Rigid block (in.)</th>
<th>Rigid block (in.)</th>
<th>Rigid block (in.)</th>
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<tr>
<td></td>
<td>Normal</td>
<td>Inverse</td>
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<tr>
<td>Mean value</td>
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<td>Median value</td>
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<td>Standard deviation</td>
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<td>1.70</td>
<td>1.96</td>
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Notes:
- 2% in 50 years return rate

Legend

Recommended Compaction as a Percentage of Maximum Dry Density, by Test Method ASTM D1557 (Modified Proctor)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>95</td>
<td>Concrete or Asphalt Pavement</td>
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<tr>
<td></td>
<td>Base Course</td>
</tr>
<tr>
<td></td>
<td>Trench Backfill</td>
</tr>
<tr>
<td></td>
<td>Pipe Bedding</td>
</tr>
</tbody>
</table>

Notes:

1. All backfill under building areas should be compacted to at least 95 percent per ASTM D1557.
APPENDIX A

Field Explorations and Laboratory Testing
APPENDIX A
FIELD EXPLORATIONS AND LABORATORY TESTING

Borings

Subsurface soil and groundwater conditions for the project were evaluated by completing three borings (Borings A, B and C). Borings A and B were completed with a hollow-stem auger (HSA) drilling equipment operated by Holocene Drilling on December 27, 2018. Boring C was completed with HSA drilling equipment operated by Advance Drill Technologies, Inc. on February 18, 2020.

The locations of the completed explorations are shown on Figure 2. The exploration locations were approximately located by pacing from existing site features and structures. Exploration locations should be considered approximate, based on the methods used.

The borings were continuously monitored by a geotechnical engineer from our firm who examined and classified the soils encountered, obtained representative soil samples, observed groundwater conditions and prepared a detailed log of each exploration. Soil encountered was classified in the field using the classification chart listed in Key to Exploration Logs, Figure A-1. The boring logs are presented in the Logs of Borings, Figures A-2 through A-4.

The soils encountered in the borings were generally sampled at 2½- and 5-foot intervals with a 2-inch-outside-diameter split-barrel standard penetration test (SPT) sampler. Disturbed samples were obtained by driving the sampler 18 inches into the soil with a 140-pound automatic hammer free-falling 30 inches. The number of blows required for each 6 inches of penetration was recorded. The blow count (“N-value”) of the soil was calculated, as the number of blows required for the final 12 inches of penetration. This resistance, or N-value, provides a measure of the relative density of granular soils and the relative consistency of cohesive soils. Where very dense soil conditions precluded driving the full 18 inches, the penetration resistance for the partial penetration was entered on the logs. The blow counts are shown on the boring logs at the respective sample depths. The samples were placed in plastic bags to maintain the moisture content and transported back to our laboratory in Redmond, Washington for analysis and testing.

Observations of groundwater conditions were made during drilling. The groundwater conditions encountered during drilling are presented on the boring logs. Groundwater conditions observed during drilling represent a short-term condition and may or may not be representative of the long-term groundwater conditions at the site. Groundwater conditions observed during drilling should be considered approximate.

Borings A and B were backfilled by Holocene Drilling on December 27, 2018. Boring C was backfilled by Advance Drill Technologies on February 18, 2020.

Laboratory Testing

Soil samples obtained from the explorations were transported to GeoEngineers, Inc.’s (GeoEngineers) laboratory in Redmond, Washington and evaluated to confirm or modify field classifications, as well as to evaluate engineering properties of the soil samples. Representative samples were selected for laboratory testing to determine the moisture content, percent fines (material passing the U.S. No. 200 sieve) and grain size distribution (sieve analysis). The tests were performed in general accordance with test methods of ASTM International (ASTM).
The sieve analysis results are presented in Figures A-5 and A-6. The results of the moisture content and percent fines determinations are presented at the respective sample depths on the exploration logs in this appendix.

**Moisture Content**

Moisture content tests were completed in general accordance with ASTM D 2216 for representative samples obtained from the explorations. The results of these tests are presented on the exploration logs in this appendix at the respective sample depths.

**Percent Passing U.S. No. 200 Sieve (%F)**

Selected samples were “washed” through the U.S. No. 200 mesh sieve to estimate the relative percentages of coarse- and fine-grained particles in the soil. The percent passing value represents the percentage by weight of the sample finer than the U.S. No. 200 sieve. These tests were conducted to confirm field descriptions and to estimate the fines content for analysis purposes. The tests were conducted in accordance with ASTM D 1140 and the results are shown on the exploration logs in this appendix at the respective sample depths.

**Sieve Analysis**

We completed sieve analysis (grain size distribution) on selected samples. Sieve analyses were performed on selected samples in general accordance with ASTM D 422 to determine the sample grain-size distribution. The wet sieve analysis method was used to determine the percentage of soil greater than the U.S. No. 200 mesh sieve. The results of the sieve were plotted and classified in general accordance with the Unified Soil Classification System (USCS). The results of the sieve analyses are presented in Figures A-5 and A-6.
SOIL CLASSIFICATION CHART

<table>
<thead>
<tr>
<th>MAJOR DIVISIONS</th>
<th>SYMBOLS</th>
<th>TYPICAL DESCRIPTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>GRAVEL AND GRAVELY SOILS</td>
<td>GW</td>
<td>WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES</td>
</tr>
<tr>
<td>COARSE GRAINED SOILS</td>
<td>GP</td>
<td>POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES</td>
</tr>
<tr>
<td>SAND AND SANDY SOILS</td>
<td>SW</td>
<td>WELL-GRADED SANDS, GRAVELLY SANDS</td>
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<tr>
<td>SANDY SOILS</td>
<td>SP</td>
<td>POORLY-GRADED SANDS, GRAVELLY SAND</td>
</tr>
<tr>
<td>SILTIES AND CLAYS</td>
<td>SM</td>
<td>CLAYEY SANDS, SAND - SILT MIXTURES</td>
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<tr>
<td>FINE GRAINED SOILS</td>
<td>SC</td>
<td>CLAYEY SANDS, SAND - Silt Mixtures</td>
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<td>SILTIES</td>
<td>CL</td>
<td>INORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY</td>
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<td>MEDIUM ORGANIC SOILS</td>
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<td>ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY</td>
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<td>ORGANIC CLAYS</td>
<td>CH</td>
<td>INORGANIC CLAYS OF HIGH PLASTICITY</td>
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NOTE: Multiple symbols are used to indicate borderline or dual soil classifications.

Sample Symbol Descriptions
- 2.4-inch I.D. split barrel
- Standard Penetration Test (SPT)
- Shelby tube
- Piston
- Direct-Push
- Bulk or grab
- Continuous Coring

Blowcount is recorded for driven samplers as the number of blows required to advance sampler 12 inches (or distance noted). See exploration log for hammer weight and drop.

"P" indicates sampler pushed using the weight of the drill rig.

"WOH" indicates sampler pushed using the weight of the hammer.

NOTE: The reader must refer to the discussion in the report text and the logs of explorations for a proper understanding of subsurface conditions. Descriptions on the logs apply only at the specific exploration locations and at the time the explorations were made; they are not warranted to be representative of subsurface conditions at other locations or times.

ADDITIONAL MATERIAL SYMBOLS

<table>
<thead>
<tr>
<th>SYMBOLS</th>
<th>TYPICAL DESCRIPTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC</td>
<td>Asphalt Concrete</td>
</tr>
<tr>
<td>CC</td>
<td>Cement Concrete</td>
</tr>
<tr>
<td>CR</td>
<td>Crushed Rock/Quarry Spalls</td>
</tr>
<tr>
<td>SOD</td>
<td>Sod/Forest Duff</td>
</tr>
<tr>
<td>TS</td>
<td>Topsoil</td>
</tr>
</tbody>
</table>

Groundwater Contact

- Measured groundwater level in exploration, well, or piezometer

Graphic Log Contact

- Distinct contact between soil strata
- Approximate contact between soil strata

Material Description Contact

- Contact between geologic units
- Contact between soil of the same geologic unit

Laboratory / Field Tests

- %F Percent fines
- %G Percent gravel
- AL Atterberg limits
- CA Chemical analysis
- CP Laboratory compaction test
- CS Consolidation test
- DD Dry density
- DS Direct shear
- HA Hydrometer analysis
- MC Moisture content
- MD Moisture density
- Mohs Mohs hardness scale
- OC Organic content
- PM Permeability or hydraulic conductivity
- PI Plasticity index
- PP Pocket penetrometer
- SA Sieve analysis
- TX Triaxial compression
- UC Unconfined compression
- VS Vane shear

Sheen Classification

- NS No Visible Sheen
- SS Slight Sheen
- MS Moderate Sheen
- HS Heavy Sheen

Key to Exploration Logs

Figure A-1
Notes:

31.5 CAH

MM Holocene Drilling, Inc. Hollow-stem Auger

Truck-mounted Drilling Equipment

Autohammer 140 (lbs) / 30 (in) Drop

WA State Plane North NAD83 (feet)

See "Remarks" section for groundwater observed

Note: See Figure A-1 for explanation of symbols.

Coordinates Data Source: Horizontal approximated based on Aerial Imagery. Vertical approximated based on Google Earth.

Log of Boring A

Project: City of Kirkland Maintenance Center SWPPP

Project Location: Kirkland, Washington

Project Number: 0231-092-00

Figure A-2

Sheet 1 of 1
### Field Data

<table>
<thead>
<tr>
<th>Elevation (feet)</th>
<th>Depth (feet)</th>
<th>Interval</th>
<th>Recovered (in)</th>
<th>Blows/foot</th>
<th>Collected Sample</th>
<th>Testing</th>
<th>Material Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Approximately 5 inches of asphalt concrete pavement</td>
</tr>
<tr>
<td>4.5</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Brown silty fine to medium sand with gravel and debris (glass fragments, brick and wood) (medium dense, moist) (fill)</td>
</tr>
<tr>
<td>10</td>
<td>5</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Brown fine to medium sand with gravel and occasional wood (loose, moist) (fill)</td>
</tr>
<tr>
<td>12</td>
<td>9</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Becomes gray in color and grades to occasional gravel</td>
</tr>
<tr>
<td>16</td>
<td>12</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Gray fine to medium sand with silt, gravel and oxidation staining (medium dense, moist) (transitional beds)</td>
</tr>
<tr>
<td>20</td>
<td>15</td>
<td>15</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Gray fine to coarse sand with gravel (loose, moist)</td>
</tr>
<tr>
<td>25</td>
<td>18</td>
<td>18</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Brown sandy silt with oxidation staining (stiff, moist)</td>
</tr>
<tr>
<td>30</td>
<td>24</td>
<td>24</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Bluish gray silty fine to coarse sand with gravel (very dense, moist) (Pre-Fraser deposits)</td>
</tr>
</tbody>
</table>

### Remarks

- Rock at bottom of sampler
- Sample moist to wet, driller states no standing water within auger
- Driller notes no standing water in auger

---

**Log of Boring B**

**Project:** City of Kirkland Maintenance Center SWPPP  
**Project Location:** Kirkland, Washington  
**Project Number:** 0231-092-00
Drilled past sample

No recovery with standard split spoon, driller retrieved sample with modified barrel

Driller noted groundwater at 16½ feet

Driller noted gravel at approximately 28 feet, observed chatter in drill rig

Note: See Figure A-1 for explanation of symbols.

Coordinates Data Source: Horizontal approximated based on Aerial Imagery. Vertical approximated based on Google Earth.
PERCENT PASSING BY WEIGHT

GRAIN SIZE IN MILLIMETERS

U.S. STANDARD SIEVE SIZE

3'  1.5'  3/4'  3/8'  #4  #10  #20  #40  #60  #100  #200

COBBLES  GRAVEL  SAND  SILT OR CLAY

COARSE  FINE  COARSE  MEDIUM  FINE

Symbol  Boring Number  Depth (feet)  Moisture (%)  Soil Description

Diamond  A  5  11  Silty fine to medium sand with gravel (SM)

Square  A  7.5  7  Fine gravel with silt and sand (GW-GM)

Triangle  B  5  7  Fine to medium sand with silt and occasional gravel (SP-SM)

Circle  B  7.5  7  Fine to medium sand with silt and gravel (SW-SM)

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The grain size analysis results were obtained in general accordance with ASTM D 6913. GeoEngineers 17425 NE Union Hill Road Ste 250, Redmond, WA 98052.
Sieve Analysis Results

Kirkland Maintenance Center SWPPP
Kirkland, Washington

Figure A-6

Note: This report may not be reproduced, except in full, without written approval of GeoEngineers, Inc. Test results are applicable only to the specific sample on which they were performed, and should not be interpreted as representative of any other samples obtained at other times, depths or locations, or generated by separate operations or processes.

The grain size analysis results were obtained in general accordance with ASTM C 136. GeoEngineers 17425 NE Union Hill Road Ste 250, Redmond, WA 98052
APPENDIX B

Boring Logs, Test Pits and Laboratory Data from Previous Explorations
APPENDIX B
BORING LOGS, TEST PITS AND LABORATORY DATA FROM PREVIOUS EXPLORATIONS

Included in Appendix B are logs and test pits that were completed as part of previous studies within the existing City of Kirkland Maintenance Facility.

- Logs of 24 test pits (Test Pits 1 through 24) completed by GeoEngineers, Inc. in 1987 for the geotechnical engineering services for the proposed service center for the City.

- Laboratory test data for test pits completed by GeoEngineers, Inc. in 1987, laboratory testing, includes: moisture content, grain-size distribution, compaction characteristics of soil using modified effort (ASTM International [ASTM] D 1557).

- Logs of three borings (EB-1, EB-2 and EB-3) completed by Associated Earth Sciences, Inc. in 2013 for the geotechnical engineering study of the City of Kirkland Stormwater Decant Facility Expansion.
REFERENCE: DRAWING ENTITLED "KIRKLAND SERVICE CENTER, PREFERRED ALTERNATIVE" BY WAGNER & TABASINSKE, DATED 4-24-87.
### Soil Classification System

<table>
<thead>
<tr>
<th>Major Divisions</th>
<th>Group Symbol</th>
<th>Group Name</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Coarse Grained Soils</strong></td>
<td><strong>Gravel</strong></td>
<td><strong>Clean Gravel</strong></td>
</tr>
<tr>
<td>More than 50% retained on No. 200 sieve</td>
<td>GW</td>
<td>Well-Graded Gravel, Fine to Coarse Gravel</td>
</tr>
<tr>
<td></td>
<td>GP</td>
<td>Poorly-Graded Gravel</td>
</tr>
<tr>
<td></td>
<td>GM</td>
<td>Silty Gravel</td>
</tr>
<tr>
<td></td>
<td>GC</td>
<td>Clayey Gravel</td>
</tr>
<tr>
<td><strong>Gravel With Fines</strong></td>
<td>SW</td>
<td>Well-Graded Sand, Fine to Coarse Sand</td>
</tr>
<tr>
<td></td>
<td>SP</td>
<td>Poorly-Graded Sand</td>
</tr>
<tr>
<td><strong>Sand</strong></td>
<td>SM</td>
<td>Silty Sand</td>
</tr>
<tr>
<td>More than 50% of coarse fraction passed No. 4 sieve</td>
<td>SC</td>
<td>Clayey Sand</td>
</tr>
<tr>
<td><strong>Fine Grained Soils</strong></td>
<td><strong>Silt and Clay</strong></td>
<td><strong>Inorganic</strong></td>
</tr>
<tr>
<td>More than 50% passes No. 200 sieve</td>
<td>ML</td>
<td>Silt</td>
</tr>
<tr>
<td></td>
<td>CL</td>
<td>Clay</td>
</tr>
<tr>
<td></td>
<td>OL</td>
<td>Organic Silt, Organic Clay</td>
</tr>
<tr>
<td><strong>Silt and Clay With Fines</strong></td>
<td>MH</td>
<td>Silt of High Plasticity, Elastic Silt</td>
</tr>
<tr>
<td></td>
<td>CH</td>
<td>Clay of High Plasticity, Fat Clay</td>
</tr>
<tr>
<td><strong>Organic</strong></td>
<td>OH</td>
<td>Organic Clay, Organic Silt</td>
</tr>
<tr>
<td><strong>Highly Organic Soils</strong></td>
<td>PT</td>
<td>Peat</td>
</tr>
</tbody>
</table>

### Notes:
1. Field classification is based on visual examination of soil in general accordance with ASTM D2488-83.
2. Soil classification using laboratory tests is based on ASTM D2487-83.
3. Descriptions of soil density or consistency are based on interpretation of blowcount data, visual appearance of soils, and/or test data.

### Soil Moisture Modifiers:
- **Dry** - Absence of moisture, dusty, dry to the touch
- **Moist** - Damp, but no visible water
- **Wet** - Visible free water or saturated, usually soil is obtained from below water table
<table>
<thead>
<tr>
<th>DEPTH BELOW GROUND SURFACE (FEET)</th>
<th>GROUP SOIL CLASSIFICATION SYMBOL</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 0.3</td>
<td>SOD LAYER</td>
<td>TEST PIT 1</td>
</tr>
<tr>
<td>0.3 - 1.0</td>
<td>SM</td>
<td>APPROXIMATE ELEVATION: 137-1/2 FEET</td>
</tr>
<tr>
<td>1.0 - 2.0</td>
<td>ML</td>
<td>LIGHT BROWN SILTY FINE TO MEDIUM SAND WITH GRAVEL (LOOSE, DRY) (FILL)</td>
</tr>
<tr>
<td>2.0 - 5.0</td>
<td>SM</td>
<td>BROWNISH GRAY SANDY SILT WITH GRAVEL (STIFF, MOIST)</td>
</tr>
<tr>
<td>5.0 - 9.5</td>
<td>SM</td>
<td>GRAY Silty FINE TO COARSE SAND WITH GRAVEL AND COBBLES (MEDIUM DENSE, WET)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TEST PIT COMPLETED AT 9.5 FEET ON 8/24/87</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8-INCH ASBESTOS CONCRETE PIPE ENCOUNTERED AT 2.0 FEET IN WEST SIDE OF TEST PIT</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GROUND WATER SEEPAGE OBSERVED AT 5.0 FEET</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 INCH MONITOR WELL INSTALLED TO 9.5 FEET</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DISTURBED SAMPLES OBTAINED AT 1.5, 3.0 AND 5.0 FEET</td>
</tr>
<tr>
<td>0 - 0.3</td>
<td>SOD LAYER</td>
<td>TEST PIT 2</td>
</tr>
<tr>
<td>0.3 - 2.0</td>
<td>SP-SM</td>
<td>APPROXIMATE ELEVATION: 130-1/2 FEET</td>
</tr>
<tr>
<td>2.0 - 5.5</td>
<td>SM</td>
<td>LIGHT BROWN FINE SAND WITH SILT, GRAVEL AND ROOTS (LOOSE, DRY) (FILL)</td>
</tr>
<tr>
<td>5.5 - 9.5</td>
<td>SM</td>
<td>BROWN SILTY FINE TO MEDIUM SAND WITH GRAVEL AND OCCASIONAL COBBLES (MEDIUM DENSE, MOIST)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TEST PIT COMPLETED AT 9.5 FEET ON 8/24/87</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NO GROUND WATER SEEPAGE OBSERVED</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DISTURBED SAMPLES OBTAINED AT 1.5, 2.5 AND 9.0 FEET</td>
</tr>
<tr>
<td>0 - 0.5</td>
<td>SOD LAYER</td>
<td>TEST PIT 3</td>
</tr>
<tr>
<td>0.5 - 4.0</td>
<td>SP-SM</td>
<td>APPROXIMATE ELEVATION: 127 FEET</td>
</tr>
<tr>
<td>4.0 - 9.7</td>
<td>SP-SM</td>
<td>YELLOWISH-BROWN FINE TO MEDIUM SAND WITH SILT AND OCCASIONAL GRAVEL (LOOSE TO MEDIUM DENSE, MOIST?) (FILL?)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TEST PIT COMPLETED AT 9.7 FEET ON 8/24/87</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GROUND WATER SEEPAGE OBSERVED AT 6.5 FEET</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DISTURBED SAMPLES OBTAINED AT 3.0 AND 9.5 FEET</td>
</tr>
</tbody>
</table>

THE ELEVATIONS AND DEPTHS ON THE TEST PIT LOGS, ALTHOUGH SHOWN TO 0.1 FEET, ARE BASED ON AN AVERAGE OF MEASUREMENTS ACROSS THE TEST PIT AND SHOULD BE CONSIDERED ACCURATE TO 0.5 FEET.
<table>
<thead>
<tr>
<th>DEPTH BELOW GROUND SURFACE (FEET)</th>
<th>GROUP SOIL CLASSIFICATION SYMBOL</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 0.9</td>
<td>SM</td>
<td>SOD LAYER</td>
</tr>
<tr>
<td>0.9 - 3.6</td>
<td>BM</td>
<td>LIGHT BROWN SILTY FINE SAND WITH GRAVEL (LOOSE TO MEDIUM DENSE, MOIST) (FILL)</td>
</tr>
<tr>
<td>3.6 - 3.4</td>
<td>SM</td>
<td>BROWN SILTY FINE SAND WITH OCCASIONAL GRAVEL (MEDIUM DENSE, MOIST TO WET)</td>
</tr>
<tr>
<td>5.4 - 9.4</td>
<td>SM</td>
<td>GRAY SILTY FINE TO MEDIUM SAND WITH OCCASIONAL GRAVEL (MEDIUM DENSE, WET)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TEST PIT COMPLETED AT 9.4 FEET ON 8/24/87</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GROUND WATER SEEPAGE OBSERVED AT 5.5 FEET</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DISTURBED SAMPLES OBTAINED AT 4.5 AND 9.0 FEET</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TEST PIT 4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>APPROXIMATE ELEVATION: 124 FEET</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TEST PIT 5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>APPROXIMATE ELEVATION: 126 FEET</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TEST PIT 6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>APPROXIMATE ELEVATION: 129 FEET</td>
</tr>
<tr>
<td>0 - 0.6</td>
<td>SM</td>
<td>SOD LAYER</td>
</tr>
<tr>
<td>0.6 - 6.0</td>
<td>SM/ML</td>
<td>LIGHT BROWN SILTY FINE TO MEDIUM SAND WITH OCCASIONAL GRAVEL (LOOSE TO MEDIUM DENSE, MOIST) (FILL?)</td>
</tr>
<tr>
<td>6.0 - 9.2</td>
<td>SM/ML</td>
<td>BROWNISH-GRAY SILTY FINE SAND AND SANDY SILT WITH OCCASIONAL GRAVEL (MEDIUM DENSE AND STIFF, MOIST TO WET)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TEST PIT COMPLETED AT 9.2 FEET ON 8/24/87</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NO GROUND WATER SEEPAGE OBSERVED</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DISTURBED SAMPLES OBTAINED AT 5.0 AND 9.2 FEET</td>
</tr>
<tr>
<td>0 - 0.3</td>
<td>SM</td>
<td>SOD LAYER</td>
</tr>
<tr>
<td>0.3 - 3.0</td>
<td>SM</td>
<td>DARK BROWN SILTY FINE TO MEDIUM SAND WITH OCCASIONAL GRAVEL (LOOSE TO MEDIUM DENSE, MOIST) (FILL)</td>
</tr>
<tr>
<td>3.0 - 9.2</td>
<td>SM</td>
<td>GRAY SILTY FINE TO MEDIUM SAND WITH OCCASIONAL GRAVEL (MEDIUM DENSE, MOIST TO WET)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TEST PIT COMPLETED AT 9.2 FEET ON 8/24/87</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NO GROUND WATER SEEPAGE OBSERVED</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DISTURBED SAMPLE OBTAINED AT 6.0 FEET</td>
</tr>
</tbody>
</table>
## LOG OF TEST PIT

<table>
<thead>
<tr>
<th>Depth Below Ground Surface (Feet)</th>
<th>Group Soil Classification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 0.3</td>
<td>SM</td>
<td>SOD LAYER</td>
</tr>
<tr>
<td>0.3 - 8.0</td>
<td>ML</td>
<td>BROWN SILTY FINE TO MEDIUM SAND WITH OCCASIONAL GRAVEL AND COBBLES (LOOSE TO MEDIUM DENSE, MOIST)</td>
</tr>
<tr>
<td>8.0 - 9.9</td>
<td></td>
<td>GRAY SANDY Silt with OCCASIONAL GRAVEL (HARD, MOIST)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TEST PIT COMPLETED AT 9.9 FEET ON 8/24/87</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NO GROUND WATER SEEPAGE OBSERVED</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DISTURBED SAMPLES OBTAINED AT 3.0 AND 9.7 FEET</td>
</tr>
</tbody>
</table>

### TEST PIT 8

APPROXIMATE ELEVATION: 125 FEET

<table>
<thead>
<tr>
<th>Depth Below Ground Surface (Feet)</th>
<th>Group Soil Classification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 0.4</td>
<td>SP-SM</td>
<td>SOD LAYER</td>
</tr>
<tr>
<td>0.4 - 4.8</td>
<td></td>
<td>BROWN FINE TO MEDIUM SAND WITH SILT AND GRAVEL</td>
</tr>
<tr>
<td>4.8 - 9.5</td>
<td>SP-SM</td>
<td>(LOOSE TO MEDIUM DENSE, DRY TO MOIST) (FILL)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TEST PIT COMPLETED AT 9.5 FEET ON 8/24/87</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NO GROUND WATER SEEPAGE OBSERVED</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DISTURBED SAMPLES OBTAINED AT 2.0 AND 9.5 FEET</td>
</tr>
</tbody>
</table>

### TEST PIT 9

APPROXIMATE ELEVATION: 141 FEET

<table>
<thead>
<tr>
<th>Depth Below Ground Surface (Feet)</th>
<th>Group Soil Classification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 0.7</td>
<td>SP-SM</td>
<td>SOD LAYER</td>
</tr>
<tr>
<td>0.7 - 8.0</td>
<td>ML</td>
<td>LIGHT BROWN FINE TO MEDIUM SAND WITH OCCASIONAL GRAVEL AND COBBLES (MEDIUM HARD, MOIST)</td>
</tr>
<tr>
<td>8.0 - 10.0</td>
<td></td>
<td>GRAY SILT WITH OCCASIONAL GRAVEL (HARD, MOIST)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TEST PIT COMPLETED AT 10.0 FEET ON 8/24/87</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NO GROUND WATER SEEPAGE OBSERVED</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DISTURBED SAMPLE OBTAINED AT 4.0 FEET</td>
</tr>
</tbody>
</table>

### TEST PIT 10

APPROXIMATE ELEVATION: 139 FEET

<table>
<thead>
<tr>
<th>Depth Below Ground Surface (Feet)</th>
<th>Group Soil Classification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 0.3</td>
<td>SM</td>
<td>SOD LAYER</td>
</tr>
<tr>
<td>0.3 - 4.0</td>
<td></td>
<td>BROWN SILTY FINE TO COARSE SAND WITH GRAVEL AND COBBLES (LOOSE, DRY)</td>
</tr>
<tr>
<td>4.0 - 9.2</td>
<td></td>
<td>DARK BROWN SILTY FINE TO COARSE SAND WITH GRAVEL AND COBBLES (MEDIUM DENSE, MOIST)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TEST PIT COMPLETED AT 9.2 FEET ON 8/25/87</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NO GROUND WATER SEEPAGE OBSERVED</td>
</tr>
</tbody>
</table>
### Log of Test Pit

<table>
<thead>
<tr>
<th>DEPTH BELOW GROUND SURFACE (FEET)</th>
<th>GROUP SOIL CLASSIFICATION SYMBOL</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 0.4</td>
<td>SM</td>
<td>SOD LAYER</td>
</tr>
<tr>
<td>0.4 - 1.0</td>
<td>SM</td>
<td>YELLOWISH-BROWN SILTY FINE TO MEDIUM SAND WITH OCCASIONAL GRAVEL AND COBBLES (LOOSE, MOIST)</td>
</tr>
<tr>
<td>1.0 - 3.0</td>
<td>SM</td>
<td>BROWNISH-GRAY SILTY FINE SAND WITH OCCASIONAL GRAVEL (MEDIUM DENSE, MOIST TO WET)</td>
</tr>
<tr>
<td>3.0 - 10.0</td>
<td>SM</td>
<td>GRAY SILTY FINE TO MEDIUM SAND (MEDIUM DENSE, WET)</td>
</tr>
</tbody>
</table>

**Test Pit 11**

Approximate Elevation: 141 Feet

Test Pit completed at 10.0 feet on 8/25/87.

Ground water seepage observed at 4.5 feet.

Disturbed sample obtained at 2.5 feet.

**Test Pit 12**

Approximate Elevation: 143 Feet

Test Pit completed at 10.2 feet on 8/25/87.

Ground water seepage observed at 7.5 feet.

Storm drain encountered at 4.6 feet on west side of test pit.

**Test Pit 13**

Approximate Elevation: 144 Feet

Test Pit completed at 10.8 feet on 8/25/87.

No ground water seepage observed.

**Test Pit 14**

Approximate Elevation: 140 Feet

Test Pit completed at 9.2 feet on 8/25/87.

No ground water seepage observed.

Disturbed samples obtained at 1.5 and 9.0 feet.
## LOG OF TEST PIT

<table>
<thead>
<tr>
<th>DEPTH BELOW GROUND SURFACE (FEET)</th>
<th>GROUP SOIL CLASSIFICATION SYMBOL</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 0.6</td>
<td>SP</td>
<td>SOD LAYER</td>
</tr>
<tr>
<td>0.6 - 2.3</td>
<td>SP</td>
<td>LIGHT BROWN FINE TO MEDIUM SAND WITH GRAVEL AND COBBLES (LOOSE, DRY TO MOIST) (FILL)</td>
</tr>
<tr>
<td>2.3 - 5.0</td>
<td>SP</td>
<td>LIGHT BROWN FINE TO MEDIUM SAND WITH OCCASIONAL GRAVEL AND COBBLES (MEDIUM DENSE, DRY)</td>
</tr>
<tr>
<td>5.0 - 9.3</td>
<td>SP-SM</td>
<td>BROWN FINE TO MEDIUM SAND WITH SILT AND OCCASIONAL GRAVEL (MEDIUM DENSE, MOIST)</td>
</tr>
</tbody>
</table>

TEST PIT COMPLETED AT 9.3 FEET ON 8/25/87

NO GROUND WATER SEEPAGE OBSERVED

DISTURBED SAMPLES OBTAINED AT 1.6, 4.0 AND 8.0 FEET

### TEST PIT 16

<table>
<thead>
<tr>
<th>APPROXIMATE ELEVATION: 149-1/2 FEET</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOD LAYER</td>
</tr>
<tr>
<td>0 - 0.2</td>
</tr>
<tr>
<td>0.2 - 5.0</td>
</tr>
<tr>
<td>5.0 - 8.8</td>
</tr>
</tbody>
</table>

YELLOWISH-BROWN FINE SAND (LOOSE TO MEDIUM DENSE, MOIST)

GRAYISH-BROWN FINE TO MEDIUM SAND WITH GRAVEL (MEDIUM DENSE, MOIST TO WET)

TEST PIT COMPLETED AT 8.8 FEET ON 8/25/87

NO GROUND WATER SEEPAGE OBSERVED

DISTURBED SAMPLES OBTAINED AT 3.0 AND 8.8 FEET

### TEST PIT 17

<table>
<thead>
<tr>
<th>APPROXIMATE ELEVATION: 155 FEET</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOD LAYER</td>
</tr>
<tr>
<td>0 - 0.4</td>
</tr>
<tr>
<td>0.4 - 3.5</td>
</tr>
<tr>
<td>3.5 - 8.7</td>
</tr>
</tbody>
</table>

BROWN SILTY FINE SAND WITH GRAVEL AND COBBLES (LOOSE, DRY TO MOIST) (FILL)

YELLOWISH-BROWN FINE TO MEDIUM SAND (MEDIUM DENSE, MOIST)

TEST PIT COMPLETED AT 8.7 FEET ON 8/25/87

NO GROUND WATER SEEPAGE OBSERVED

DISTURBED SAMPLE OBTAINED AT 5.0 FEET
<table>
<thead>
<tr>
<th>DEPTH BELOW GROUND SURFACE (FEET)</th>
<th>GROUP SOIL CLASSIFICATION SYMBOL</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 0.1</td>
<td>GP</td>
<td>ASPHALT CONCRETE PAVEMENT</td>
</tr>
<tr>
<td>0.1 - 0.3</td>
<td>SM</td>
<td>CRUSHED ROCK (MEDIUM DENSE, MOIST) (FILL)</td>
</tr>
<tr>
<td>0.3 - 4.5</td>
<td>SP-SM</td>
<td>BROWN SILTY FINE TO MEDIUM SAND WITH GRAVEL AND OCCASIONAL COBBLES (LOOSE, MOIST) (FILL)</td>
</tr>
<tr>
<td>4.5 - 8.6</td>
<td></td>
<td>YELLOWISH-BROWN FINE TO MEDIUM SAND WITH SILT (MEDIUM DENSE, MOIST)</td>
</tr>
</tbody>
</table>

**TEST PIT 18**

APPROXIMATE ELEVATION: 146-1/2 FEET

TEST PIT COMPLETED AT 8.6 FEET ON 8/25/87

NO GROUND WATER SEEPAGE OBSERVED

2-INCH MONITOR WELL INSTALLED TO 8.6 FEET

DISTURBED SAMPLES OBTAINED AT 3.0 AND 8.5 FEET

**TEST PIT 19**

APPROXIMATE ELEVATION: 134 FEET

SOD LAYER

GROUND WATER SEEPAGE OBSERVED AT 4.5 FEET

DISTURBED SAMPLES OBTAINED AT 2.0 AND 8.9 FEET

**TEST PIT 20**

APPROXIMATE ELEVATION: 132 FEET

SOD LAYER

NO GROUND WATER SEEPAGE OBSERVED
<table>
<thead>
<tr>
<th>DEPTH BELOW GROUND SURFACE (FEET)</th>
<th>GROUP SOIL CLASSIFICATION SYMBOL</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TEST PIT 21</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 - 0.6</td>
<td>SM</td>
<td>SOD LAYER</td>
</tr>
<tr>
<td>0.6 - 4.0</td>
<td>SM</td>
<td>BROWN SILTY FINE SAND WITH GRAVEL AND OCCASIONAL COBBLES AND ASPHALT FRAGMENTS (LOOSE TO MEDIUM DENSE, DRY TO MOIST) (FILL)</td>
</tr>
<tr>
<td>4.0 - 5.2</td>
<td>SM</td>
<td>GRAY SILTY FINE SAND (MEDIUM DENSE, MOIST TO WET)</td>
</tr>
<tr>
<td>5.2 - 7.6</td>
<td>SM</td>
<td>DARK BROWN SILTY FINE TO MEDIUM SAND WITH GRAVEL AND OCCASIONAL COBBLES</td>
</tr>
<tr>
<td>7.6 - 9.3</td>
<td>ML</td>
<td>GRAY SANDY SILT WITH OCCASIONAL GRAVEL (HARD, MOIST)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TEST PIT COMPLETED AT 9.3 FEET ON 8/25/87</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NO GROUND WATER SEEPAGE OBSERVED</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DISTURBED SAMPLES OBTAINED AT 2.0 AND 5.5 FEET</td>
</tr>
<tr>
<td><strong>TEST PIT 22</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 - 0.6</td>
<td>SM</td>
<td>SOD LAYER</td>
</tr>
<tr>
<td>0.6 - 5.0</td>
<td>SM</td>
<td>BROWN SILTY FINE TO MEDIUM SAND WITH OCCASIONAL GRAVEL (MEDIUM DENSE, MOIST)</td>
</tr>
<tr>
<td>5.0 - 3.8</td>
<td>ML</td>
<td>GRAY SANDY SILT WITH OCCASIONAL GRAVEL (HARD, WET)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TEST PIT COMPLETED AT 8.8 FEET ON 8/25/87</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GROUND WATER SEEPAGE OBSERVED AT 8.0 FEET</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DISTURBED SAMPLE OBTAINED AT 2.0 FEET</td>
</tr>
<tr>
<td><strong>TEST PIT 23</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 - 0.6</td>
<td>SM</td>
<td>SOD LAYER</td>
</tr>
<tr>
<td>0.6 - 4.0</td>
<td>SM</td>
<td>BROWN SILTY FINE SAND WITH OCCASIONAL GRAVEL (MEDIUM DENSE, DRY TO MOIST)</td>
</tr>
<tr>
<td>4.0 - 12.3</td>
<td>SP-SP</td>
<td>BROWNISH-GRAY FINE TO MEDIUM SAND WITH SILT AND GRAVEL (MEDIUM DENSE, MOIST TO WET)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TEST PIT COMPLETED AT 12.3 FEET ON 8/25/87</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GROUND WATER SEEPAGE OBSERVED AT 12.3 FEET</td>
</tr>
<tr>
<td><strong>TEST PIT 24</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 - 0.6</td>
<td>SM</td>
<td>SOD LAYER</td>
</tr>
<tr>
<td>0.6 - 2.0</td>
<td>SM</td>
<td>BROWN SILTY FINE TO MEDIUM SAND WITH GRAVEL AND OCCASIONAL COBBLES (LOOSE, DRY TO MOIST) (FILL)</td>
</tr>
<tr>
<td>2.0 - 9.8</td>
<td>ML</td>
<td>LIGHT BROWN SANDY SILT WITH OCCASIONAL GRAVEL (STIFF, MOIST)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TEST PIT COMPLETED AT 9.8 FEET ON 8/25/87</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NO GROUND WATER SEEPAGE OBSERVED</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DISTURBED SAMPLE OBTAINED AT 4.0 FEET</td>
</tr>
<tr>
<td>Test Pit</td>
<td>Sample Depth (feet)</td>
<td>Soil Type</td>
</tr>
<tr>
<td>----------</td>
<td>---------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>1</td>
<td>1.5</td>
<td>ML</td>
</tr>
<tr>
<td>1</td>
<td>3.0</td>
<td>SM</td>
</tr>
<tr>
<td>1</td>
<td>5.0</td>
<td>SM</td>
</tr>
<tr>
<td>2</td>
<td>1.5</td>
<td>SP-SM</td>
</tr>
<tr>
<td>2</td>
<td>2.5</td>
<td>SM</td>
</tr>
<tr>
<td>2</td>
<td>9.0</td>
<td>SM</td>
</tr>
<tr>
<td>3</td>
<td>3.0</td>
<td>SP-SM</td>
</tr>
<tr>
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<td>9.5</td>
<td>SP-SM</td>
</tr>
<tr>
<td>4</td>
<td>4.5</td>
<td>SM</td>
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<tr>
<td>4</td>
<td>9.0</td>
<td>SM</td>
</tr>
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<td>5.0</td>
<td>SM</td>
</tr>
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<td>9.2</td>
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<td>2.0</td>
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</tr>
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<td>7</td>
<td>9.9</td>
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</tr>
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<td>SP-SM</td>
</tr>
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<td>4.0</td>
<td>SP-SM</td>
</tr>
<tr>
<td>11</td>
<td>2.5</td>
<td>SM</td>
</tr>
<tr>
<td>14</td>
<td>1.5</td>
<td>SM</td>
</tr>
<tr>
<td>14</td>
<td>9.0</td>
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</tr>
<tr>
<td>15</td>
<td>1.6</td>
<td>SP</td>
</tr>
<tr>
<td>15</td>
<td>4.0</td>
<td>SP</td>
</tr>
<tr>
<td>15</td>
<td>8.0</td>
<td>SP-SM</td>
</tr>
<tr>
<td>16</td>
<td>3.0</td>
<td>SP</td>
</tr>
<tr>
<td>16</td>
<td>8.8</td>
<td>SP-SM</td>
</tr>
<tr>
<td>17</td>
<td>5.0</td>
<td>SP</td>
</tr>
<tr>
<td>18</td>
<td>3.0</td>
<td>SM</td>
</tr>
<tr>
<td>18</td>
<td>8.5</td>
<td>SP-SM</td>
</tr>
<tr>
<td>19</td>
<td>8.9</td>
<td>SM</td>
</tr>
<tr>
<td>21</td>
<td>2.0</td>
<td>SM</td>
</tr>
<tr>
<td>21</td>
<td>5.5</td>
<td>SM</td>
</tr>
<tr>
<td>22</td>
<td>2.0</td>
<td>SM</td>
</tr>
<tr>
<td>24</td>
<td>4.0</td>
<td>ML</td>
</tr>
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<td>SAMPLE DEPTH</td>
</tr>
<tr>
<td>--------</td>
<td>-------------------</td>
<td>--------------</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>5.0'</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>4.0'</td>
</tr>
<tr>
<td>SYMBOL</td>
<td>EXPLORATION NUMBER</td>
<td>SAMPLE DEPTH</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>------</td>
<td>--------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>------</td>
<td>15</td>
<td>4.0'</td>
</tr>
<tr>
<td>------</td>
<td>17</td>
<td>5.0'</td>
</tr>
</tbody>
</table>
**U.S. STANDARD SIEVE SIZE**

**GRAIN SIZE IN MILLIMETERS**

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>EXPLORATION NUMBER</th>
<th>SAMPLE DEPTH</th>
<th>SOIL DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>19</td>
<td>8.9'</td>
<td>SILTY FINE TO MEDIUM SAND WITH OCCASIONAL GRAVEL (SM)</td>
</tr>
</tbody>
</table>
### Table: Exploration Depth and Soil Description

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>EXPLORATION NUMBER</th>
<th>SAMPLE DEPTH (FEET)</th>
<th>SOIL DESCRIPTION</th>
<th>OPTIMUM MOISTURE CONTENT (%)</th>
<th>MAXIMUM DRY DENSITY (PCF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMPOSITE:</td>
<td>TEST PIT 2</td>
<td>1.5</td>
<td>FINE TO MEDIUM SAND WITH SILT (SP-SM)</td>
<td>10.5</td>
<td>120.5</td>
</tr>
<tr>
<td></td>
<td>TEST PIT 8</td>
<td>2.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TEST PIT 9</td>
<td>4.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TEST PIT 15</td>
<td>16, 4.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TEST PIT 16</td>
<td>3.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TEST PIT 17</td>
<td>5.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TEST PIT 18</td>
<td>3.0 &amp; 8.5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** Tests performed in accordance with ASTM D1557.

**Figure A-13**

**GeoEngineers Incorporated**

**Compaction Test Results**
The methods of ASTM D-2487 and D-2488 were used as an identification guide for the Unified Soil Classification System. Plasticity estimates should not be construed to imply field or laboratory testing unless presented herein. Visual-manual and/or laboratory classification 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. Estimation of these properties is based on the standards and methods outlined in ASTM D-2487 and D-2488, which provide a reliable framework for soil classification.

### Terms Describing Relative Density and Consistency

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
<th>Dry Density</th>
<th>Very Soft</th>
<th>Medium Stiff</th>
<th>Very Stiff</th>
<th>Hard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coarse-Grained Soils</td>
<td>Coarse Gravel</td>
<td>3&quot; to No. 4 (4.75 mm)</td>
<td>No. 4 (4.75 mm)</td>
<td>No. 200 (0.075 mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fine-Grained Soils</td>
<td>Fine Gravel</td>
<td>3/4&quot; to No. 4 (4.75 mm)</td>
<td>No. 40 (0.075 mm)</td>
<td>No. 200 (0.075 mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sand</td>
<td>No. 4 (4.75 mm) to No. 200 (0.075 mm)</td>
<td>No. 40 (0.075 mm)</td>
<td>No. 200 (0.075 mm)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Component Definitions

- **Descriptive Term**
- **Size Range and Sieve Number**

### Estimated Percentage

- **Component**
- **Percentage by Weight**

### Moisture Content

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

- **Slightly Moist**
  - Perceptible moisture

- **Moist**
  - Damp but no visible moisture

- **Very Moist**
  - Water visible but not free draining

- **Wet**
  - Visible free water, usually from below water table

### Symbols

- **Cement grout surface seal**
- ** Bentonite seal**
- **Filter pack with blank casing section**
- **Screened casing with filter pack and end cap**

### Explorations Log Key

- **2.0" OD Split-Spoon Sampler (SPT)**
- **3.0" OD Thin-Wall Tube Sampler (including Shelby tube)**
- **Grab Sample**

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. They 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.
Project Name: Kirkland Stormwater Decant Facility  
Location: Kirkland, WA  
Driller/Equipment: Geologic Drill / XL  
Hammer Weight/Drop: 140# / 30"  

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Samples</th>
<th>Graphic Symbol</th>
<th>DESCRIPTION</th>
<th>Blows/Foot</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
<td>Asphalt - 1.25 inches</td>
<td>10 16</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Asphalt - 2 inches</td>
<td>20 19</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fill</td>
<td>30 21</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>40 40</td>
</tr>
<tr>
<td>5</td>
<td>S-1</td>
<td></td>
<td>Moist, slightly rust stained brown and gray, fine to medium SAND, with silt, with gravel (SP-SM).</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>S-2</td>
<td></td>
<td>As above.</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>S-3</td>
<td></td>
<td>Weathered Vashon Advance Outwash</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Moist, reddish brown, fine SAND (SP).</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>S-4</td>
<td></td>
<td>Vashon Advance Outwash</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>As above, with increased gravel content.</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>S-5</td>
<td></td>
<td>Moist, brownish gray, fine to medium SAND, trace gravel (SP).</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>S-6</td>
<td></td>
<td>As above.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Bottom of exploration boring at 21.5 feet</td>
<td></td>
</tr>
</tbody>
</table>

Sampler Type (ST):  
- 2' OD Split Spoon Sampler (SPT)  
- 3' OD Split Spoon Sampler (D & M)  
- Ring Sample  
- Grab Sample  
- Shelby Tube Sample  

Logged by: JPL  
Approved by:
**Exploration Log**

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Samples</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>S-1</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>S-2</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>S-3</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>S-4</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>S-5</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>S-6</td>
<td></td>
</tr>
</tbody>
</table>

**DESCRIPTION**

- **Asphalt - 4 inches**
  
  Moist, slightly rust stained brown and gray, silty SAND, with gravel, with organics (SM).

- **Weathersed Vashon Advance Outwash**
  
  Moist, brown, fine to medium SAND (SP).

  - As above.

  Moist, slightly rust stained brown, fine to medium SAND, with silt, with gravel (SP-SM).

- **Vashon Advance Outwash**
  
  Moist, rust stained brownish gray, fine to medium SAND, with silt, with gravel (SP-SM).

  - Moist, bluish gray, fine to coarse SAND, with gravel (SW).

  Moist, gray, silty fine SAND, with gravel in sampler tip (SM).

  - Moist, gray, silty fine to medium SAND, with gravel (SM).

  Bottom of exploration boring at 30.4 feet.

**Blows/Foot**

- 10
- 20
- 30
- 40

**Other Tests**

- **Sampler Type (ST):**
  - 2" OD Split Spoon Sampler (SPT)
  - 3" OD Split Spoon Sampler (D & M)
  - Ring Sample
  - Grab Sample
  - Shelby Tube Sample

- **Logged by:** JPL
- **Approved by:**
Project Name: Kirkland Stormwater Decant Facility
Elevation (Top of Well Casing):
Water Level Elevation:
Drilling/Equipment: Geologic Drill / XL
Hammer Weight/Drop: 140# / 30'

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**WELL CONSTRUCTION**

- **Flush mount monument**
- **Concrete surface seal 0 to 1.5 feet**
- **Bentonite chips 1.5 to 7 feet**
- **1.5-inch I.D. PVC blank: 0 to 10 feet**
- **10/20 sand 7 to 20 feet**
- **1.5-inch I.D. PVC well screen: 0.020-inch slot width, 10 to 20 feet**
- **Slip cap**
- **Native slough**
- **Well Tag # BJ-332**

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**DESCRIPTION**

**Pre-Fraser Nonglacial Deposits**

- Moist, brownish gray, fine to medium SAND, with silt, with gravel (SP-SM).
- No recovery.
- Wet, gray, fine GRAVEL (GP).
- Wet, gray, fine to medium SAND, with gravel, with silt (SP-SM).
- Moist to wet, gray, fine to coarse SAND, with silt and silty zones, with gravel (SW-SM).
- Moist to wet, gray, silty fine to medium SAND, with gravel, silt beds, and sand beds (SM).

Boring terminated at 21.5 feet.
Well completed at 20 feet on 11/26/13.

---

**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
- Moisture
- Water Level (H)
- Water Level at time of drilling (ATD)

Logged by: JPL
Approved by:
APPENDIX C
REPORT LIMITATIONS AND GUIDELINES FOR USE\(^1\)

This appendix provides information to help you manage your risks with respect to the use of this report.

Geotechnical Services Are Performed for Specific Purposes, Persons and Projects

This report has been prepared for the City of Kirkland Maintenance Center Improvements project. The information contained herein is not applicable to other sites.

GeoEngineers structures our services to meet the specific needs of our clients. No party other than KPFF Consulting Engineers and their authorized agents may rely on the product of our services unless we agree to such reliance in advance and in writing. This is to provide our firm with reasonable protection against open-ended liability claims by third parties with whom there would otherwise be no contractual limits to their actions. Within the limitations of scope, schedule and budget, our services have been executed in accordance with our Agreement with the Client and generally accepted geotechnical practices in this area at the time this report was prepared. Use of this report is not recommended for any purpose or project except the one originally contemplated.

A Geotechnical Engineering or Geologic Report Is Based on a Unique Set of Project-Specific Factors

This report has been prepared for the City of Kirkland Maintenance Center project in Kirkland, Washington. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, it is important not to rely on this report if it was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

For example, changes that can affect the applicability of this report include those that affect:

- the function of the proposed structure;
- elevation, configuration, location, orientation or weight of the proposed structure;
- composition of the design team; or
- project ownership.

\(^1\) Developed based on material provided by ASFE, Professional Firms Practicing in the Geosciences; www.asfe.org.
If important changes are made after the date of this report, we recommend that GeoEngineers be given the opportunity to review our interpretations and recommendations. Based on that review, we can provide written modifications or confirmation, as appropriate.

**Subsurface Conditions Can Change**

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by man-made events such as construction on or adjacent to the site, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations. If more than a few months have passed since issuance of our report or work product, or if any of the described events may have occurred, please contact GeoEngineers before applying this report for its intended purpose so that we may evaluate whether changed conditions affect the continued reliability or applicability of our conclusions and recommendations.

**Most Geotechnical and Geologic Findings Are Professional Opinions**

Our interpretations of subsurface conditions are based on field observations from widely spaced sampling locations at the site. Site exploration identifies the specific subsurface conditions only at those points where subsurface tests are conducted, or samples are taken. GeoEngineers reviewed field and laboratory data and then applied our professional judgment to render an informed opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ, sometimes significantly, from those indicated in this report. Our report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions.

**Geotechnical Engineering Report Recommendations Are Not Final**

The construction recommendations included in this report are preliminary and should not be considered final. GeoEngineers’ recommendations can be finalized only by observing actual subsurface conditions revealed during construction. GeoEngineers is unable to assume responsibility for the recommendations in this report without performing construction observation.

We recommend that you allow sufficient monitoring, testing and consultation during construction by GeoEngineers to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes if the conditions revealed during the work differ from those anticipated, and to evaluate whether earthwork activities are completed in accordance with our recommendations. Retaining GeoEngineers for construction observation for this project is the most effective method of managing the risks associated with unanticipated conditions.

**A Geotechnical Engineering or Geologic Report Could Be Subject to Misinterpretation**

Misinterpretation of this report by members of the design team or by contractors can result in costly problems. GeoEngineers can help reduce the risks of misinterpretation by conferring with appropriate members of the design team after submitting the report, reviewing pertinent elements of the design team’s plans and specifications, participating in pre-bid and preconstruction conferences, and providing construction observation.

**Do Not Redraw the Exploration Logs**

Geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. The logs included in a geotechnical engineering or geologic report should
never be redrawn for inclusion in architectural or other design drawings. Photographic or electronic reproduction is acceptable, but separating logs from the report can create a risk of misinterpretation.

**Give Contractors a Complete Report and Guidance**

To help prevent costly problems associated with unanticipated subsurface conditions, we recommend giving contractors the complete geotechnical engineering or geologic report but preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report's accuracy is limited. In addition, encourage them to confer with GeoEngineers and/or to conduct additional study to obtain the specific types of information they need or prefer.

**Contractors Are Responsible for Site Safety on Their Own Construction Projects**

Our geotechnical recommendations are not intended to direct the contractor’s procedures, methods, schedule or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and adjacent properties.

**Read These Provisions Closely**

It is important to recognize that the geoscience practices (geotechnical engineering, geology and environmental science) are less exact than other engineering and natural science disciplines. Without this understanding, there may be expectations that could lead to disappointments, claims and disputes. GeoEngineers includes these explanatory “limitations” provisions in our reports to help reduce such risks. Please confer with GeoEngineers if you need to know more how these “Report Limitations and Guidelines for Use” apply to your project or site.

**Geotechnical, Geologic and Environmental Reports Should not be Interchanged**

The equipment, techniques and personnel used to perform an environmental study differ significantly from those used to perform a geotechnical or geologic study and vice versa. For that reason, a geotechnical engineering or geologic report does not usually relate any environmental findings, conclusions or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated containments. Similarly, environmental reports are not used to address geotechnical or geologic concerns regarding a specific project.

**Biological Pollutants**

GeoEngineers’ Scope of Work specifically excludes the investigation, detection, prevention or assessment of the presence of Biological Pollutants. Accordingly, this report does not include any interpretations, recommendations, findings or conclusions regarding the detecting, assessing, preventing or abating of Biological Pollutants, and no conclusions or inferences should be drawn regarding Biological Pollutants as they may relate to this project. The term “Biological Pollutants” includes, but is not limited to, molds, fungi, spores, bacteria and viruses and/or any of their byproducts.