GEOTECHNICAL REPORT

Suzuki Residential Development
Kitsap County Parcel Number 222502-4-006-2005
Bainbridge Island, Washington

Prepared for: Olympic Property Group

Project No. 150365-02 • November 5, 2018 Final

Aspect
CONSULTING

earth + water

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1 Introduction

This report presents the results of Aspect Consulting, LLC's (Aspect) geotechnical engineering study for the proposed Suzuki residential development (Project). The Project is located on Kitsap County Parcel No. 222502-4-006-2005, located at the southeast corner of the intersection of NE New Brooklyn Road and Sportsman Club Road NE in Bainbridge Island, Washington (Site), as shown on Figure 1, *Site Location Map*. We performed a background review, a subsurface exploration program, and geotechnical engineering evaluation in accordance with our agreed upon revised scope of work dated April 9, 2018 and authorized by you on August 6, 2018. We also performed a Phase 1 Environmental Site Assessment (ESA) in support of the proposed Project. The details of the Phase 1 ESA are in a separate report.

1.1 Scope of Services

Our geotechnical scope of work included gathering and reviewing existing subsurface information near the Site, a geologic reconnaissance, subsurface characterization through excavated test pits and hand tool explorations, performing laboratory testing of soils, completing geotechnical engineering analyses, and preparing this report. This report includes:

- Site and project description
- Distribution and characteristics of subsurface soils and groundwater
- Seismic design considerations in accordance with the 2015 International Building Code (IBC)
- Slope stability analysis of the moderately steep slope along the western edge of the Site and associated design criteria and construction considerations
- Suitable shallow foundation types and allowable soil bearing pressure(s)
- Geotechnical design criteria for short retaining walls
- A general (qualitative) assessment of stormwater infiltration potential at the Site
- Pavement design recommendations
- Site preparation recommendations and general construction recommendations

1.2 Project Description

Current Project plans include construction of 18 single-family residences and 7 multi-family residential buildings (attached townhomes) with associated infrastructure including new utilities, parking areas, and open spaces. The development is planned on about 4.2 acres across the northern half of the Site with 0.7 acres designated in a reserve development area. The southern half of the Site, about 9 acres, will remain undeveloped, designated open space to protect the existing pond, wetlands, and mature trees. The southern area of the Site will also include the creation of a 300-foot-wide wildlife corridor.

In general, the Site slopes down to the west. The City of Bainbridge Island's (City) Critical Areas Ordinance (CAO) map designates the area west of the planned development area as a Moderate Slope (15 to 40 percent) (COBI, 2018a). Based on the City's Municipal Code related to Moderate Slopes, there is no standard setback or buffer, but a geotechnical engineering evaluation is required to assess the stability of the slope as they relate to the Project and develop appropriate design recommendations to mitigate any identified geologic hazards (COBI, 2018b).

2 Surface Conditions

We assessed the surface conditions of the Site, including any geologic hazards present, through a literature review and geologic reconnaissance with field observations. Site visits were performed on August 14, 17, 20, and 21, 2018.

2.1 Site Conditions and Topography

The Site is bordered by NE New Brooklyn Road to the north, Sportsman Club Road NE to the west, single-family residential properties to the south, and an access roadway to the maintenance facility for the Bainbridge Island School District to the east. A concrete sidewalk runs along the north side of the Site and a gravel, recreational trail runs along the west and east sides of the Site. The access roadway for the maintenance facility is paved at the northeast portion of the Site but becomes a gravel road about 300 feet to the south of NE New Brooklyn Road.

The Site is relatively level with gentle undulations on the eastern 500 feet of the Site at an average Elevation 215 feet (North American Vertical Datum 88, [NAVD88]). The western portion of the Site slopes moderately down from east to west from about Elevation 215 down to about Elevation 175 feet along Sportsman Club Road NE. The lowest area of the Site is at the southwest corner at Elevation 145 feet. The highest area of the Site is at the southeast corner at Elevation 240 feet. (AGO, 2018).

The Site topography, proposed development areas, select existing features, and the locations of our subsurface explorations are shown on Figure 2, *Site Exploration Plan.*

2.2 Drainage

During our Site visits in August, we did not observe any standing water or surface water flow across the Site. It is our understanding that seasonal water flow is observed west of the proposed development area, however, we did not observe flow or evidence of flowing water due to the vegetation growth. Surface drainage conditions will vary with fluctuations in precipitation, Site usage (such as irrigation), and off-Site land use.

2.3 Vegetation

The Site has two distinct areas of vegetation. The northern area, roughly the area of the proposed development area, is vegetated with a dense array of evergreen trees with up to approximately 1-foot diameter at breast height (DBH). The understory in this area is almost nonexistent, with fallen tree trunks, limbs, and moss comprising the groundcover. The southern area and the moderate slope in the western portion of the Site are vegetated with young to mature coniferous and deciduous trees with an established and relatively dense understory of woody shrubs and herbaceous ground cover. In general, the mature coniferous trees on and near the moderate slope were relatively straight.

3 Subsurface Conditions

Subsurface conditions at the Site were inferred from our review of applicable geologic literature, our completed field explorations, and our experience with the local geology.

3.1 Geologic Setting

The Site is located within the Puget Lowland, a broad area of tectonic subsidence flanked by two mountain ranges: the Cascades to the east and the Olympics to the west. The sediments within the Puget Lowland are the result of repeated cycles of glacial and nonglacial deposition and erosion. The most recent cycle, the Vashon Stade of the Fraser Glaciation (about 13,000 to 16,000 years ago), is responsible for most of the present day geologic and topographic conditions. During the Vashon Stade, the 1,000-foot-thick, Cordilleran Glacier advanced into the Puget Lowland. As the Cordilleran Glacier advanced southward, lacustrine and fluvial sediments were deposited in front of the glacier. Preglacial and proglacial sediments were overridden and consolidated by the advancing glacier, creating dense and hard soil deposits. At the interface between the advance soils and the glacial ice, the Cordilleran Glacier sculpted and smoothed the surface, and then deposited a consolidated basal till. As the Cordilleran Glacier retreated northward from Puget Lowlands to British Columbia, it left an unconsolidated sediment veneer over glacially consolidated deposits.

The geologic map of the Site (Haugerud and Troost, 2011) indicates that the Site is underlain by Vashon till (Qvt). Vashon till is the basal material deposited at the base of the Cordilleran Glacier. Therefore, it was overridden and compacted by glacial ice, creating a dense/hard configuration. Vashon till is described as a matrix-supported, dense, sandy diamict composed of a mixture of silt, sand, and gravel.

3.2 Subsurface Explorations

Aspect completed 12 test pits, TP-01 through TP-12, on August 20 and 21, 2018 at the locations indicated on Figure 2. The test pits were terminated between 5 and 13 feet below the existing ground surface (bgs). We also completed a hand exploration, HE-13, on September 20, 2018 at the location shown on Figure 2 that was terminated 3.2 feet bgs. We advanced dynamic cone penetrometer tests (DCPTs) at various depths to determine the relative density of encountered soils. A summary of the subsurface conditions encountered is described below. For a detailed description, the test pit logs and hand exploration log are presented in Appendix A of this report. Soils were classified per the Unified Soil Classification System (USCS) in general accordance with the American Society for Testing and Materials International (ASTM) D2488, Standard Practice for Description and Identification of Soils (Visual and Manual Procedure) (ASTM, 2018). A key to the symbols and terms used on the logs is provided on Figure A-1.

Our subsurface explorations encountered a thin layer of surficial material including topsoil and fill underlain by the Vashon till in agreement with the geologic map (Haugerud and Troost, 2011). The topsoil and fill did not extend deeper than 0.5 feet bgs.

3.2.1 Topsoil

Topsoil refers to a loose layer of soil that forms at the ground surface and contains a high percentage of organics. We encountered 0.2 to 0.5 feet of topsoil at the ground surface in all explorations except TP-03. The topsoil consisted of loose, dark brown, SILTY SAND WITH GRAVEL (SM) and numerous roots.

3.2.2 Fill

Fill refers to material placed by human activities. We encountered a 0.5-feet-thick layer of fill at the ground surface in TP-03. The fill consisted of loose, dark brown, SANDY SILT WITH GRAVEL (ML), with trash debris such as cans, bottles, and metal car parts.

The fill has moderate to high compressibility and low shear strength. Due to the significant fines content, the fill has moderate to high moisture sensitivity.

3.2.3 Vashon Till

Vashon till was encountered underlying the topsoil or fill in all of the explorations. All twelve test pits and the hand exploration were terminated in the Vashon till between 3 and 13 feet bgs. The Vashon till primarily consisted of SILTY SAND WITH GRAVEL (SM) with fine to coarse sand, gravel, cobbles, and rare boulders up to 1.3 feet in diameter. We encountered a medium dense to dense, weathered interval in every exploration in the upper 2 to 2.5 feet bgs. The underlying unweathered Vashon till was very dense and the gravels were socketed into the silty sand matrix. We observed 0.5 to 1.5 of horizontal sidewall caving in the weathered Vashon till, whereas the sidewall below the weathered interval remained vertical during the advancement of the explorations. The weathered Vashon till was also brown yellow to light brown in color, while the unweathered Vashon till was light gray to light brown.

In three of the test pits in the southern portion of the Site, TP-03, TP-07, and TP-08, we encountered a lens within the Vashon till unit layer consisting of very dense, moist, light gray SILT (ML). Test pits TP-03 and TP-07 were terminated in this material, however, in test pit TP-08, we observed this material from 2.5 to 6 feet bgs. Test pit TP-03 encountered this silt layer from 6.5 to 12 feet bgs. Test pit TP-07 encounter this silt layer from 9 to 13 feet bgs.

The DCPT results in the weathered Vashon till typically ranged from 9 to 13 blows per 1.75 inches and in the unweathered Vashon till exceeded 30 blows per 1.75 inches. The unweathered Vashon till possesses low compressibility and high shear strength characteristics. It also has low to moderate moisture sensitivity due to the presence of silt in the unit and low permeability.

3.3 Groundwater

We did not encounter any groundwater or seepage in our test pit explorations. We anticipate that a perched groundwater (above the unweathered Vashon till) condition develops during the wet, winter months. A perched groundwater condition occurs when water percolates into the shallow subsurface and collects on relatively impermeable materials. The topsoil, fill, and lower density, weathered Vashon till are considered low permeability, while the deeper, very dense Vashon till is essentially impermeable.

Groundwater conditions at the Site will vary with fluctuations in precipitation, Site usage (such as irrigation), and off-Site land use.

3.4 Geotechnical Laboratory Results

Laboratory tests were conducted on select samples to characterize engineering and index properties of the Site soils, and the results are presented in Tables 1 and 2 below. Aspect completed one grain size distribution and three fines content tests, while two additional grain size distribution tests were completed by others. The natural moisture contents of these soil samples were also determined. The tables below contain summaries of the results from the grain size distributions and fines content along with soil type based on the USCS and the geologic classification. The natural moisture contents are presented on the test pit logs. The test methodology and results of all the laboratory testing are presented in Appendix B.

Table 1. Summary of Grain Size Distribution Results

Exploration Number	Sample Depth (feet bgs)	Percent Gravel	Percent Sand	Percent Fines	Moisture Content (percent)	USCS	Geologic Classification
TP-02	2.5 – 3	43	43	14	7	SP	Vashon till
TP-08	0.3 - 2.5	5.3	49.8	44.9	N/R	SM	Weathered Vashon till
TP-08	2.5 – 4.5	0	29.4	70.6	N/R	ML	Vashon till

Notes:
USCS = Unified Soil Classification System
bgs = below ground surface
N/R = not reported

Table 2. Summary of Fines Content Results

Exploration Number	Sample Depth (feet bgs)	Percent Fines	Moisture Content (percent)	Geologic Classification
TP-03	11 - 11.5	91	24	Vashon till
TP-07	9.5 - 10	92	33	Vashon till
TP-08	5 - 5.5	97	26	Vashon till

Notes:
bgs = below ground surface

4 Seismic Design Considerations

4.1 Earthquake Engineering

The Site is located within the Puget Lowland physiographic province, an area of active seismicity that is subject to earthquakes on shallow crustal faults and deeper subduction zone earthquakes. The Site lies about 1 mile north of the Seattle fault zone, which consists of shallow crustal tectonic structures that are considered active (evidence for movement within the Holocene [since about 15,000 years ago]) and is believed to be capable of producing earthquakes of magnitude 7.3 or greater. The recurrence interval of earthquakes on this fault zone is believed to be on the order of a thousand years or more. The most recent large earthquake on the Seattle fault occurred about 1,100 years ago (Pratt et al., 2015). There are also several other shallow crustal faults in the region capable of producing earthquakes and strong ground shaking.

The Site area also lies within the zone of strong ground shaking from earthquakes associated with the Cascadia Subduction Zone (CSZ). Subduction zone earthquakes occur due to rupture between the subducting oceanic plate and the overlying continental plate. The CSZ can produce earthquakes up to magnitude 9.3 and the recurrence interval is thought to be on the order of about 500 years. A recent study estimates the most recent subduction zone earthquake occurred around 1700 (Atwater et al., 2015).

Deep intra-slab earthquakes, which occur from tensional rupture of the sinking oceanic plate, are also associated with the CSZ. An example of this type of seismicity is the 2001 Nisqually earthquake. Deep intra-slab earthquakes typically are magnitude 7.5 or less and occur approximately every 10 to 30 years.

The following sections present descriptions of seismic design considerations for the Project.

4.1.1 Ground Response

The International Building Code (IBC) seismic design is based on the "Maximum Considered Earthquake (MCE)" with a 2 percent probability of exceedance (PE) in 50 years (2,475-year return period) (ICC, 2015). The U.S. Geological Survey (USGS, 2017) has completed probabilistic ground motion studies and maps for Washington. The various ground motions are determined by the regional seismicity and the Site Class. The Site Class accounts for the seismic response of the soil profile and is based on the density and stiffness of the soil profile underlying the Site. The Site Class can be correlated to the estimated average shear wave velocity, standard penetration resistance (NSPT), or undrained shear strength in the upper 100 feet of the soil profile. The Site Class definitions are shown on Table 3 below.

Table 3. Seismic Site Class Definitions

Site Class	Soil Type
A	Hard Rock
B	Rock
C	Very Dense Soil or Soft Rock
D	Stiff Soil
E	Soft Clay Soil
F	Soils Requiring Site Response Analysis (i.e. Liquefiable Soils)

Based on our characterization of the subsurface conditions, which include very dense soils that are anticipated to perform well during earthquakes, a Site Class C should be assumed for the Site.

Seismic design should be completed with the specific ground motion parameters listed in Table 4 below.

Table 4. Seismic Design Parameters

Design Parameter	Recommended Value
Site Class	C
Peak Ground Acceleration (PGA)	0.575g(1)
Short Period Spectral Acceleration (S_s)	1.397g
1-Second Period Spectral Acceleration (S_1)	0.550g
Site Coefficient (F_a)	1.0
Site Coefficient (F_v)	1.3
Design Short Period Spectral Acceleration (S_{DS})	0.931g
Design 1-Second Period Spectral Acceleration (S_{D1})	0.476g

Notes:

1) G = Gravitational force
2) Based on the latitude and longitude of the Site: 47.64249°N, 122.52795°W
3) The risk category used was I/II/III

4.1.2 Surficial Ground Rupture

A trace of an east-west trending thrust fault zone (Seattle fault zone) projects through Bainbridge Island, with the nearest known active fault trace mapped approximately 1 mile south of the Site (USGS, 2010). The recurrence interval of earthquakes on this fault zone is believed to be on the order of a thousand years or more. The most recent large earthquake on the Seattle fault occurred about 1,100 years ago. Due to the suspected long recurrence interval and the proximity of the Site from the mapped fault trace, the potential for surficial ground rupture at the Site is considered low during the expected life of the Project.

4.1.3 Seismically Induced Liquefaction

Liquefaction occurs when loose, saturated, and relatively cohesionless soil deposits temporarily lose strength from seismic shaking. The primary factors controlling the onset of liquefaction include intensity and duration of strong ground motion, characteristics of subsurface soil, *in situ* stress conditions, and the depth to groundwater.

The Washington Department of Natural Resources (DNR) maps the Site as having very low liquefaction susceptibility (DNR, 2004). Given the relative density, grain size distribution, and geologic origin of the soils at the Site, we do not consider liquefaction to be a significant hazard for the Project.

5 Erosion and Landslide Hazards

The Site contains sloping topography and a mapped geologically hazardous area (Moderate Slope). The following sections describe and discuss the pertinent erosion and landslide hazards at the Site.

5.1 Erosion Hazard

The soils encountered at the Site have a low to moderate erosion potential, due to the gently to moderately sloping topography of the area, but the erosion hazard will increase where groundcover is sparse or the Site is disturbed for the proposed construction area. Care should be taken during construction to prevent any erosion on the Site. Vegetation on the Moderate Slope should be maintained at all times or otherwise supplemented with erosion control measures during construction.

5.2 Landslide Hazards

Landslides may be triggered by natural causes, such as precipitation, freeze-thaw cycles, or a seismic event, or be man-made (e.g., broken water pipes or stormwater flow). Three types of landslides (Varnes, 1978) are common on steep slopes in the Puget Sound: topples, deep-seated rotational slides, and shallow flows.

The Site and nearby areas lack the overly steep topography associated with topples. The observations from our geologic reconnaissance including relatively straight conifer trees on and near the steep slope and an absence of prominent/concentrated groundwater seepage on/near the slope do not indicate signs of historical, recent, or incipient landslide activity.

No landslides are mapped on the Site (Haugerud, 2011; McKenna et al., 2008; and Ecology, 1979). Recent Light Detection and Ranging (LiDAR) studies (PSLC, 2015) do not indicate deep-seated landslide headscarps at or within 300 feet of the Site.

In our opinion, the risk of deep-seated rotational landslide activity at or near the Site is very low. The Moderate Slope at the Site presents a low to moderate risk of shallow flow failures. To further evaluate the stability of the Site and the implications of the landslide hazards to the Project, we completed a slope stability analysis described in Section 5.3.

5.3 Slope Stability Analyses

Based on our review of the existing Site and nearby topography, we conducted a stability analysis of a critical section transecting the Site, Moderate Slope, and the proposed development area (Section A-A’) using the computer model SLIDE (Rocscience, 2017). The location of the critical section is shown on Figure 2. The soil engineering properties assumed for the model are summarized in Table 5 below.

Table 5. Summary of Soil Engineering Properties Used in Slope Stability Analyses

Geologic Unit	Unit Weight (pcf)(1)	Strength Parameters	
		Friction Angle (deg)(1)	Cohesion (psf)(1)
Weathered Vashon Till	115	32	0
Vashon Till	130	45	200
Roadway	125	36	0

Notes:

1) pcf = pounds per cubic foot; psf = pounds per square foot; and deg = degrees.

The engineering properties summarized in Table 5 and used in our analyses are primarily based on our experience in similar geologic settings with similar geologic materials. Back calculations of the existing slope configuration indicate the values assumed are conservative. The strength values assumed are correlated with the DCPT data and the engineering properties for the Vashon till and are within the bounds of the suggested parameters in Chapter 5 of the Washington State Department of Transportation (WSDOT) Geotechnical Design Manual (GDM; WSDOT, 2015).

Structure loads for the proposed development area were estimated using Chapter 16 of the IBC and Table C3-1 from the ASCE Standard 7-10. Details of the proposed foundation layouts were unknown at the time of reporting; therefore, a conservative aerial load of 400 pounds per square foot (psf) was applied to the slope stability model across an inferred building footprint extending up to the boundary of the proposed development area.

The SLIDE program performs slope stability computations based on the modeled slope conditions and calculates a factor of safety against slope failure, which is defined as the ratio of resisting forces to driving forces. A factor of safety of 1.0 indicates a “just-stable” condition, and a factor of safety less than one would indicate unstable conditions.

We utilized Spencer’s method in our SLIDE analyses. The results of our stability analyses for the proposed conditions are summarized in Table 6 below.

Table 6. Summary of Slope Stability Analyses Results

Static Factor of Safety(1)	Seismic(2) Factor of Safety
7.05	2.54

Notes:

1) Factor of Safety—The minimum FS found using Spencer’s method in computer program SLIDE.
2) Pseudostatic seismic analysis utilize a seismic coefficient (kh) of 0.2875g.

The calculated factors of safety are for failure surfaces intersecting the proposed development area and indicate the Moderate Slope is typically stable and construction within the proposed development area can result in stable conditions. Graphical and detailed results for the slope stability analyses are shown in Appendix C.

6 Conclusions and Recommendations

Based on our geotechnical evaluation of the Site that included data review, Site reconnaissance, subsurface explorations, and geotechnical engineering analyses, it is our opinion that the proposed Project is feasible at the Site provided the recommendations contained in this report are incorporated into the design and construction of the project. The key findings and conclusions include:

- The proposed buildings may be grade-supported on shallow foundations and slabs-on-grade, provided the subgrade materials under the foundations and slabs-on-grade are properly prepared and compacted.
- The Moderate Slope in the western area of the Site is stable and our analyses indicate that new residential structures located within the proposed development area will not destabilize the Moderate Slope.
- The Site soils that are moisture sensitive and shallow, perched groundwater can be expected in portions of the Site during the wet weather season. This combination will make Site grading during the wet weather season and periods of precipitation difficult and will require additional specific construction considerations during grading to protect and successfully prepare the foundation subgrade.
- Subsurface conditions at the Site consist of a shallow, continuous, and relatively thick sequence of Vashon till that is essentially an aquitard; therefore, the conditions at the Site appear unsuitable for concentrated stormwater infiltration.
- Similarly, the presence of Vashon till across the majority of the Site indicates the potential for precipitation to infiltrate through the Site soils and provide recharge to deeper aquifers is low. Existing conditions appear to shed and divert precipitation and runoff to the east and southwest towards existing wetlands and drainages.

The grading and final development plans for the project had not been completed when this report was prepared. Once completed, Aspect should be engaged to review the project plans to confirm our recommendations have been appropriately incorporated and/or to update our recommendations as necessary.

6.1 Slope Stability and Geologically Hazardous Areas Considerations

The City's CAO map designates the area west of the proposed development area as a Moderate Slope (15 to 40 percent slopes). Based on the results of our reconnaissance and slope stability analysis, the Moderate Slope is stable and new residential structures located within the proposed development area will not destabilize the Moderate Slope. We did not observe any evidence of recent or incipient landslides or erosive stream activity. Additionally, we did not observe continuous and prominent groundwater seepage at the Site, and the geologic sequence does not appear to be prone to landslide activity within the context of the Site conditions, topography, and Project. As Project plans are finalized, Aspect should review the Site plan and development layout.

6.1.1 Temporary and Permanent Erosion Control

To prevent Site erosion during construction, appropriate temporary erosion and sedimentation control (TESC) measures should be used in accordance with the recommendations above and the local BMPs. Specific TESC measures may include appropriately placed silt fencing, straw wattles, rock check dams, and plastic covering of exposed slope cuts and soil stockpiles. Outside of the proposed construction areas, the existing vegetation should be retained.

Permanent erosion control within the areas of construction should be achieved through pavement surfacing or the re-establishment of vegetation.

Areas on/near the Site slopes exposed to construction activities should be aggressively revegetated. Depending on the weather patterns, slope inclination, and degree of disturbance, the placement of an erosion control blanket to provide temporary ground cover while vegetation takes root, or the use of live-staking, may be required to ensure successful establishment of new vegetation.

Irrigation should be installed to allow for ease of inspection and with easily accessible shut-off valves for winterizing. At no time should uncontrolled runoff or surface water be allowed to flow across the Site.

6.2 Earthwork Considerations

Based on the explorations performed across the Site and our understanding of the Project, it is our opinion that the Contractor should be able to complete planned excavations with standard construction equipment.

Oversized materials such as logs, construction debris (concrete, etc.), cobbles, and boulders that can impede earthwork activities should be anticipated in the fill and Vashon till soils. Encountering such obstructions should be expected during construction.

The Vashon till soils encountered at the Site contain a significant percentage of fines (particles passing the U.S. Standard No. 200 sieve), making them moisture sensitive and subject to disturbance upon exposure to weather and when wet. We recommend planning the earthwork portions of the Project during the drier summer months.

We encountered two types of Vashon till across the Site including more coarse-grained SILTY SAND WITH GRAVEL (SM) and a layer of more fine-grained SILT (ML) along the southern edge of the proposed development area. While the coarse-grained Vashon till is likely suitable for reuse as structural fill under dry conditions, it is likely that the fine-grained Vashon till soils will not be suitable for reuse as structural fill on the Project due to their moisture sensitivity and difficulty in achieving uniform compaction.

We recommend that earthwork activities be specified in accordance with the following Washington State Department of Transportation (WSDOT) *Standard Specifications,* except where specifically addressed in this report (WSDOT, 2018). Appropriate erosion control measures should be in accordance with Section 1-07.15, *Temporary Water Pollution/Erosion Control,* and should be implemented prior to beginning earthwork activities.

6.2.1 Wet Weather Earthwork

If earthwork is to be performed or fill is to be placed in wet weather or under wet conditions when soil moisture content is difficult to control, the following recommendations should be incorporated into the contract specifications:

- Earthwork should be performed in small areas to minimize exposure to wet weather.
- The size and type of construction equipment used may have to be limited to prevent soil disturbance.
- Excavation or the removal of unsuitable soils should be followed promptly by the placement and compaction of clean structural fill. The size and type of construction equipment used may have to be limited to prevent soil disturbance.
- Material used as structural fill should consist of clean, granular soil containing less than 7 percent fines, such as Gravel Borrow as specified in Section 9-03.14(1) of the Standard Specifications (WSDOT, 2018). The fines should be nonplastic.
- The ground surface within the construction area should be graded to promote runoff of surface water and to prevent the ponding of water.
- The ground surface within the construction area should be sealed by a smooth drum vibratory roller (or equivalent) and under no circumstances should be left uncompacted and exposed to moisture. Soils which become too wet for compaction should be removed and replaced with clean granular materials.
- Excavation and placement of fill should be observed by the Geotechnical Engineer to verify that all unsuitable materials are removed, and suitable compaction is achieved.
- Appropriate erosion and sedimentation best management practices (BMPs) should be strategically implemented in accordance with City of Bainbridge Island BMPs.

6.2.2 Temporary Excavation Stability

Maintenance of safe working conditions, including temporary excavation stability, is the responsibility of the Contractor. All temporary cuts in excess of 4 feet in height that are not protected by trench boxes or otherwise shored should be sloped in accordance with Part N of Washington Administrative Code (WAC) 296-155 (WAC, 2009), as shown in Table 7 below.

Table 7. Temporary Excavation Cut Slope Recommendations

Soil Unit	OSHA Soil Classification	Maximum Temporary Slope	Maximum Height (ft)
Fill	C	1.5H:1V	20
Weathered Vashon Till	C	1.5H:1V	20
Vashon Till	A	0.75H:1V	20

Notes:
OSHA = Occupational Safety and Health Administration; H:V = Horizontal:Vertical

The estimated maximum cut slope inclinations are provided for planning purposes only and are applicable to excavations without groundwater seepage or runoff, and assume dewatered conditions. Flatter slopes will likely be necessary in areas where groundwater seepage exists, or where construction equipment surcharges are placed in close proximity to the crest of the excavation.

With time and the presence of seepage and/or precipitation, the stability of temporary unsupported cut slopes can be significantly reduced. Therefore, all temporary slopes should be protected from erosion by installing a surface water diversion ditch or berm at the top of the slope. In addition, the Contractor should monitor the stability of the temporary cut slopes, and adjust the construction schedule and slope inclination accordingly. Vibrations created by traffic and construction equipment may cause caving and raveling of the temporary slopes. In such an event, lateral support for the temporary slopes should be provided by the Contractor to prevent loss of ground support.

Permanent slopes for the Project should be no steeper than 2H:1V (Horizontal:Vertical).

6.2.3 Site Preparation

Site preparation within the proposed construction area footprint should include removal of all debris and any other deleterious material including all fill materials and topsoil with significant root debris within the proposed footing areas. The Contractor must use care during Site preparation and excavation operations so that any bearing surfaces are not disturbed. If this occurs, the disturbed material should be removed to expose undisturbed material or compacted in-place. Overexcavated soils in footing subgrade areas should be replaced with compacted crushed surfacing base course (CSBC) as specified in Section 9-03.9(3) of the Washington State Department of Transportation (WSDOT) Standard Specifications (WSDOT, 2018) as described in Section 6.2.4.

All footing excavations should be trimmed neat and the bottom of the excavation should be carefully prepared. All loose or softened soil should be removed from the footing excavation or compacted in-place prior to placing reinforcing steel bars. We recommend that footing excavations be observed by the geotechnical engineer prior to placing steel and concrete, to verify that the recommendations of this report have been followed.

If footing excavations are open during the winter season or periods of wet weather, we recommend providing a layer of crushed rock or gravel to help preserve the subgrade until concrete is placed. Gravel used to protect the bearing surfaces should meet the gradation requirements for Class A Gravel Backfill for Foundations, as described in Section 9-03.12(1)A of the WSDOT Standard Specifications (WSDOT, 2018).

6.2.4 Structural Fill and Compaction

Structural fill is anticipated to be required for minor grade adjustments and for utility trench backfill. We anticipate that selectively screened portions of the coarse-grained Vashon till material excavated for the Project may be suitable for reuse as structural fill during the dry season. The fine-grained Vashon till encountered along the southern edge of the proposed development area is unlikely to be suitable for reuse as structural fill. Excavated material should be visually inspected by the Geotechnical Engineer to determine its potential use as structural fill. Excavated material that is unsuitable as structural fill may be suitable as backfill for unimproved areas (i.e., landscaped areas) that are not susceptible to differential settlement over time.

Imported structural fill should consist of relatively freely draining, uniformly graded sand and gravel. We recommend Gravel Borrow, as specified in Section 9-03.14(1) of the Standard Specifications (WSDOT, 2018), be specified for imported structural fill.

Structural fill should be at or near optimum moisture content at the time of placement and should be compacted to at least 95 percent of the maximum dry density (MDD) as determined by test method ASTM International (ASTM) D1557. In new pavement areas where the fill is placed more than 2 feet below the proposed finish grade, compaction to at least 90 percent of the MDD should be achieved. In non-structural areas, fill should be placed and compacted to a moderately firm/dense condition.

Class A Gravel Backfill for Foundations as specified in Section 9-03.12(1)A of the Standard Specifications (WSDOT, 2018) should be used for base rock underneath structures. Crushed Surfacing Base Course (CSBC) as specified in Section 9-03.9(3) of the Standard Specifications (WSDOT, 2018) should be used as base rock for new pavement. If desired, lean concrete or controlled density fill (CDF) can also be used as structural fill.

The procedure to achieve the specified minimum relative compaction depends on the size and type of compacting equipment, the number of passes, thickness of the layer being compacted, and certain soil properties. When size of the excavation restricts the use of heavy equipment, smaller equipment can be used, but the soil must be placed in thin enough lifts to achieve the required compaction. A sufficient number of in-place density tests should be performed as the fill is placed to verify the required relative compaction is being achieved. The frequency of the in-place density testing can be determined at the time of final design, when more details of the Project grading and backfilling plans are available.

Generally, loosely compacted soils are a result of poor construction technique or improper moisture content. Soils with a high percentage of silt or clay are particularly susceptible to becoming too wet, and coarse-grained materials easily become too dry, for proper compaction. Silty or clayey soils with a moisture content too high for adequate compaction should be dried as necessary, or moisture conditioned by mixing with drier materials, or other methods.

6.3 Foundations

Although current Site plans are conceptual, the following general foundation criteria are provided in this section. Shallow foundations or spread footings may be used for building supports gaining support from the Vashon till. Bearing surfaces for the footings should be prepared as described in Section 6.2.3. Based on our observations of the Site soil conditions, we estimate the adequate bearing strata typically consisting of dense to very dense, SILTY SAND WITH GRAVEL (SM) interpreted as unweathered Vashon till to be within approximately 2.5 to 3 feet of the existing ground surface.

6.3.1 Shallow Foundations

For shallow foundations gaining support from the bearing strata described above, we recommend an allowable foundation bearing pressure of 3,000 pounds per square foot (psf) be utilized for design purposes, including both dead and live loads for the proposed structure. Recommendations within the *Site Preparation* and *Structural Fill* sections (Sections 6.2.3 and 6.2.4, respectively) of this report must be followed in order for this allowable bearing pressure to be used. An increase in the above-mentioned bearing pressure of one-third may be used for short-term wind or seismic loading. Perimeter footings should be buried at least 18 inches into the surrounding soil for frost protection and be a minimum of 14 inches wide; interior footings require only 12 inches burial below outside grade. No footing should be founded in or above yielding/loose or organic soils.

We estimate the total settlement of the foundation designed in accordance with our recommendations will be less than 1 inch. Differential settlements can be expected to be less than half of the total settlement. Our experience indicates the majority of these settlements will occur during construction.

Wind, earthquakes, and unbalanced earth loads will subject the proposed structures to lateral forces. Lateral forces on a structure will be resisted by a combination of sliding resistance of its base or footing on the underlying soil and passive earth pressure against the buried portions of the structures.

For use in design, an ultimate coefficient of friction of 0.55 may be assumed along the interface between the base of the footing and subgrade soils. An ultimate passive earth pressure of 400 pounds per cubic foot (pcf) may be assumed for native soils adjacent to below-grade elements. The recommended passive earth pressure includes reductions for the sloping topography of the Site. The upper 1 foot of passive resistance should be neglected in design. The recommended coefficient of friction and passive pressure values are ultimate values that do not include a safety factor. We recommend applying a factor of safety of at least 1.5 in design for determining allowable values for coefficient of friction and passive pressure.

6.3.2 Slab-on-Grade Floors

Floor slabs should be supported over a drainage layer and Vashon till, or structural fill placed directly over the Vashon till.

Concrete slabs-on-grade should be designed in accordance with the American Concrete Institute (ACI) Committee 360 Guide to Design of Slabs-on-Ground (ACI, 2010). We recommend overexcavation of any loose soil or deleterious matter and replacement with structural fill beneath all slabs. To provide uniform support for the floor slab and to provide a capillary break, we recommend the floor slab be underlain by a capillary break section. The capillary break material should consist of a minimum of 6 inches of free-draining, crushed rock or well-graded sand and gravel compacted to at least 95 percent MDD. The capillary break material should have a maximum particle size of 3/4 inch, with no more than 80 percent passing the No. 4 sieve and less than 5 percent fines (material passing the U.S. Standard No. 200 sieve). In areas where moisture will be detrimental to floor coverings or equipment inside the proposed structures, a 10-mil polyethylene vapor barrier should be placed directly over the capillary break. The vapor barrier should be installed in accordance with the manufacturer's recommendations.

Slab-on-grade floors prepared as described above can be designed assuming a modulus of subgrade reaction of 150 pounds per cubic inch (pci).

6.4 Wall Considerations

Low retaining walls may be incorporated in the Project design to accommodate minor grade adjustments across the Site.

Yielding walls, such as cantilever retaining walls, should be designed using a lateral earth pressure based on an equivalent fluid having a unit weight of 35 pcf. Nonyielding or restrained walls should be designed for an equivalent fluid weight of 55 pcf. A level backslope and adequate drainage is assumed for the recommended earth pressure values. Adequate drainage should consist of a subsurface drain combined with a free-draining wall backfill material that meets the gradation requirements described in Section 9-03.12(2) of the WSDOT Standard Specifications for Gravel Backfill for Walls (WSDOT, 2018). Refer to Section 6.5, *Stormwater Drainage Considerations* for detailed subsurface drain recommendations.

Earthquake shaking will subject retaining walls to a temporary additional earth pressure. We estimated the lateral seismic soil pressure increment using the Mononobe-Okabe method, with consideration of the possible backfill soil properties and MCE. We recommend an average seismic soil pressure increment of 13H (where H is the height of the wall) represented by a uniform rectangular pressure along the height of the wall.

For exterior retaining walls that are separate from the new building and less than 10 feet tall, we do not recommend incorporation of seismic earth pressures.

Over-compaction of the backfill behind walls should be avoided. Over-compaction of backfill can result in increased horizontal pressures against newly cast and sensitive walls that are still acquiring strength through the concrete curing process. These elevated pressures can lead to cracking or deflection of the walls. In this regard, we recommend compacting the backfill to about 90 percent of the MDD (ASTM D1557). Heavy compactors and large pieces of construction equipment should not operate within 5 feet of any embedded wall to avoid the buildup of excessive lateral pressures. Within a lateral distance of 3 feet of any wall, smaller, possibly hand-operated equipment should be used in conjunction with thinner soil lifts to achieve the required compaction, so as not to damage the wall.

Lateral forces that may be induced on the wall due to other surcharge loads should be considered by the structural engineer.

6.5 Stormwater Drainage Considerations

The presence of relatively impermeable Vashon till combined with our understanding that surface water features are present during the wet, winter months indicates that large-scale, concentrated stormwater infiltration is infeasible at the Site. Our primary recommendation is to design the Site stormwater management using conventional methods. However, if Low Impact Development (LID) methods are required by the City of Bainbridge Island, we recommend stormwater management be accomplished using LID methods combined with conventional methods, including catch basins and storm drain pipes that discharge into an appropriate system. LID methods, such as small raingardens, bioswales, and dispersion, are feasible provided the systems incorporate underdrains and/or overflow redundancy to account for the low permeability and low-infiltration capacity of the Site soils.

Final grades around the proposed structures should be sloped such that surface water drains away from the structures. Water from hard surfaces should be collected and diverted to the stormwater outfall system. Downspouts and roof drains should not be connected to the foundation drains and under-slab drains in order to reduce the potential for clogging and flooding foundation drains.

6.5.1 Foundation and Wall Drainage

The outside edge of all perimeter footings and upslope side of all walls should be provided with a drainage system consisting of 4-inch-diameter, perforated, rigid plastic pipe embedded in a clean, free-draining sand and gravel meeting the requirements of Section 9-03.12(4) of the WSDOT Standard Specifications for Gravel Backfill for Drains (WSDOT, 2018). The drainpipe and surrounding drain rock should be wrapped in filter fabric to minimize the potential for clogging and/or ground loss due to piping. A washed rock drain curtain at least 1-foot-thick should extend from the footing continuously upward to within 1 foot of the ground surface. A layer of low permeability soils should be used on the upper foot to reduce potential for surface water to enter the drain curtain. The footing drains should include cleanouts to allow periodic maintenance and inspection.

6.6 Pavement Design and Construction Considerations

Flexible (asphalt) pavements are feasible for the Project. New pavements can be constructed over the weathered and unweathered Vashon till with appropriate subgrade preparation and slightly more robust pavement sections. The following sections present recommended pavement sections for flexible pavements and associated construction considerations.

6.6.1 Pavement Design

In non-roadway and non-heavy traffic parking areas, a pavement section consisting of 3 inches of hot mix asphalt (HMA) over 6 inches of CSBC is recommended. However, along access drives or in the areas of heavy traffic, we recommend a minimum section of 4 inches of HMA over 8 inches of CSBC. We recommend CSBC for the pavement base course, and Crushed Surfacing Top Course (CSTC) may be used over the CSBC for the upper 2 to 3 inches of the base course section. CSBC and CSTC, as specified in Section 9-03.9(3) of the WSDOT Standard Specifications (WSDOT, 2018), should be used as base course for pavements.

6.6.2 Pavement Construction Considerations

Within the footprint of proposed pavement areas, the loose and organic-rich topsoil and possibly some weathered Vashon till should be removed. Pavement sections should either gain support from undisturbed, medium dense or better, weathered or unweathered

Vashon till or from structural fill placed directly over the Vashon till. All pavement subgrades should be carefully prepared. Prior to placing base course and pavement, all pavement subgrades should be proof-rolled with a fully loaded 10-cubic-yard dump truck or equivalent. An Aspect representative should observe and evaluate the proof rolling operation. Any soft areas detected by the proof-rolling or other methods should be compacted in-place or overexcavated to firm ground and backfilled with compacted structural fill to the design subgrade elevation. To provide for quality construction practices and materials, we recommend all pavement work and mix-design considerations conform to WSDOT standards.

The recommended pavement section is not intended to support extensive construction traffic, such as dump trucks and concrete Redi-Mix trucks. Pavements subject to heavy construction traffic may be damaged and require repair.

Proper drainage is essential to long-term pavement performance. We recommend providing all paved areas with positive drainage to remove surface water and water within the base coarse. This will be particularly important in cut sections or at low points within the paved areas, such as at catch basins.

6.7 Additional Project Design and Construction Monitoring

At the time of this report, site grading, structural plans, and construction methods were not finalized, and the recommendations presented herein are preliminary. We are available to provide additional geotechnical consultation as the Project design develops, and possibly changes, from that upon which this report is based. Additional explorations, testing, and assessments may be needed as the Project plans develop. The information and recommendations contained herein should be brought to the attention of the appropriate design team personnel and incorporated into the Project plans and specifications.

We recommend a pre-construction meeting be organized at the start of construction including you, your contractor, and Aspect. During this meeting, we will understand the goals and schedule to be upheld during construction. We will also discuss effective lines of communication. The integrity of the Project and the overall Site stability depends on proper site preparation and construction procedures. In addition, engineering decisions may have to be made in the field in the event that variations in subsurface conditions become apparent.

Upon completion of construction, the City will require Aspect to complete a Step 3 Form prior to issuing the Certificate of Occupancy. For Aspect to complete this form, we must be involved during certain construction activities, including but not limited to, foundation subgrade preparation, installation of the stormwater outfall system, and installation of the site and foundation drainage elements.

7 References

A G O Land Surveying, LLC (AGO), 2018, Preliminary Topography of a portion of Northwest ¼ Southeast ¼, Sec. 22, T.25N., R.2E., W.M., City of Bainbridge Island, Kitsap County, Washington, Prepared for: Olympic Property Group, Drawing 6582T, Field Book 1493, September 10, 2018.

American Concrete Institute (ACI), 2010, Guide to Design of Slabs-on-Ground, Reported by ACI Committee 360, April 2010.

ASTM International (ASTM), 2018, 2018 Annual Book of ASTM Standards, West Conshohocken, Pennsylvania.

Atwater, B.F., S. Musumi-Rokkaku, K. Satake, Y. Tsuji, K. Ueda, and D.K. Yamaguci, 2015, The orphan tsunami of 1700—Japanese clues to a parent earthquake in North America, US Geological Survey, Professional Paper 1707.

City of Bainbridge Island (COBI), 2018a, GIS Mapping & Map Gallery, 2ftTopo, https://cityofbi.maps.arcgis.com/home/webmap/viewer.html?layers=1cb05de9c2544b81aef61622f42b4ead, accessed August 16, 2018.

COBI, 2018b, Bainbridge Island Municipal Code, Ordinance 2018-15, passed May 8, 2018.

Haugerud, R.A. and K.G. Troost, 2011, Geologic map of the Suquamish 7.5' Quadrangle and part of the Seattle North 7.5' x 15' Quadrangle, Kitsap County, Washington: U.S. Geological Survey Scientific Investigations Map 3181, scale 1:24,000.

International Code Counsel (ICC), 2015, International Building Code (IBC), Prepared by International Code Council, January 2015.

McKenna, J.P., Lidke, D.J., Coe, J.A., 2008, Landslides mapped from LiDAR imagery, Kitsap County, Washington: U.S. Geological Survey Open-File Report 2007–1292, 81 p.

Puget Sound Lidar Consortium (PSLC), 2015, Data Download, http://pugetsoundlidar.ess.washington.edu/lidardata/restricted/, accessed August 16, 2018.

Pratt, T.L., K.G. Troost, J.K. Odum, and W.J. Stephenson, 2015, Kinematics of shallow backthrusts in the Seattle fault zone, Washington State, Geosphere, v. 11, no. 6, p. 1–27, doi:10.1130/GES01179.1.

Rocscience, Inc., 2017, Slide, version 7.022.

U.S. Geological Survey (USGS), 2010, Seattle Zone Fault Traces. Gower, H. D.; Yount, J. C.; Crosson, R. S., 1985, Seismotectonic map of the Puget Sound region, Washington: U.S. Geological Survey Miscellaneous Investigations Series Map I-1613, 15 p., 1 plate, scale 1:250,000.

USGS, 2017, U.S. Seismic Design Maps tool, U.S. Department of the Interior, http://earthquake.usgs.gov/designmaps/us/application.php July 27. accessed August 16, 2018.

Varnes, D.J., 1978, Slope movement types and processes, in Schuster, R.L., and Krizek, R.J., eds., Landslides—Analysis and control: National Research Council, Washington, D.C., Transportation Research Board, Special Report 176, p. 11–33.

Washington State Department of Ecology (Ecology), 1979, Coastal Zone Atlas of Washington, available at: https://fortress.wa.gov/ecy/coastalatlas/.

Washington State Department of Natural Resources (DNR), 2004, Liquefaction Susceptibility and Site Class Maps of Washington State, By County. Washington Division of Geology and Earth Resource Open File Report 2004-20, by Palmer, S.P.; Magsino, S.L., Bilderback, E.L., Poelstra, J.L., Folger, D.S., and Niggemann, R.A., 2004, September 2004.

Washington State Department of Transportation (WSDOT), 2015, Geotechnical Design Manual M46-03.11.

Washington State Department of Transportation (WSDOT), 2018, Standard Specifications for Road, Bridge and Municipal Construction, Document M 41-10.

Washington State Legislature, 2009, Washington Administrative Code (WAC), April 1, 2009.

8 Limitations

Work for this project was performed for Olympic Property Group (Client), and this report was prepared consistent with recognized standards of professionals in the same locality and involving similar conditions, at the time the work was performed. No other warranty, expressed or implied, is made by Aspect Consulting, LLC (Aspect).

Recommendations presented herein are based on our interpretation of site conditions, geotechnical engineering calculations, and judgment in accordance with our mutually agreed-upon scope of work. Our recommendations are unique and specific to the project, site, and Client. Application of this report for any purpose other than the project should be done only after consultation with Aspect.

Variations may exist between the soil and groundwater conditions reported and those actually underlying the site. The nature and extent of such soil variations may change over time and may not be evident before construction begins. If any soil conditions are encountered at the site that are different from those described in this report, Aspect should be notified immediately to review the applicability of our recommendations.

Risks are inherent with any site involving slopes and no recommendations, geologic analysis, or engineering design can assure slope stability. Our observations, findings, and opinions are a means to identify and reduce the inherent risks to the Client.

It is the Client's responsibility to see that all parties to this project, including the designer, contractor, subcontractors, and agents, are made aware of this report in its entirety. At the time of this report, design plans and construction methods have not been finalized, and the recommendations presented herein are based on preliminary project information. If project developments result in changes from the preliminary project information, Aspect should be contacted to determine if our recommendations contained in this report should be revised and/or expanded upon.

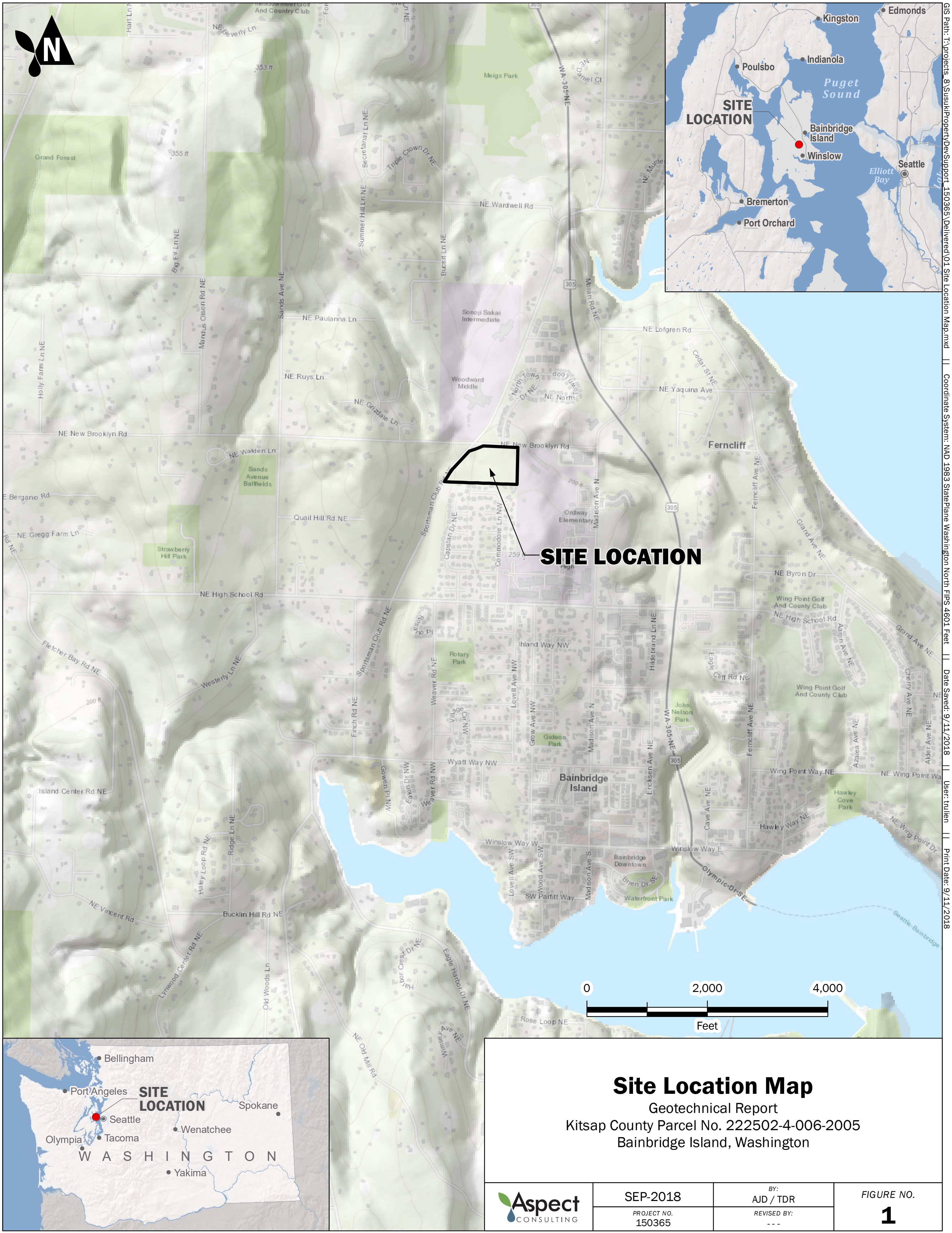
The scope of work does not include services related to construction safety precautions. Site safety is typically the responsibility of the contractor, and our recommendations are not intended to direct the contractor's site safety methods, techniques, sequences, or procedures. The scope of our work also does not include the assessment of environmental characteristics, particularly those involving potentially hazardous substances in soil or groundwater.

All reports prepared by Aspect for the Client apply only to the services described in the Agreement(s) with the Client. Any use or reuse by any party other than the Client is at the sole risk of that party, and without liability to Aspect. Aspect's original files/reports shall govern in the event of any dispute regarding the content of electronic documents furnished to others.

Please refer to Appendix D titled "Report Limitations and Guidelines for Use" for additional information governing the use of this report.

We appreciate the opportunity to perform these services. If you have any questions please call Alison Dennison, Project Geologist, at 206-780-7717 or Andrew Holmson, Associate, at 206-780-7731.

FIGURES



Site Location Map

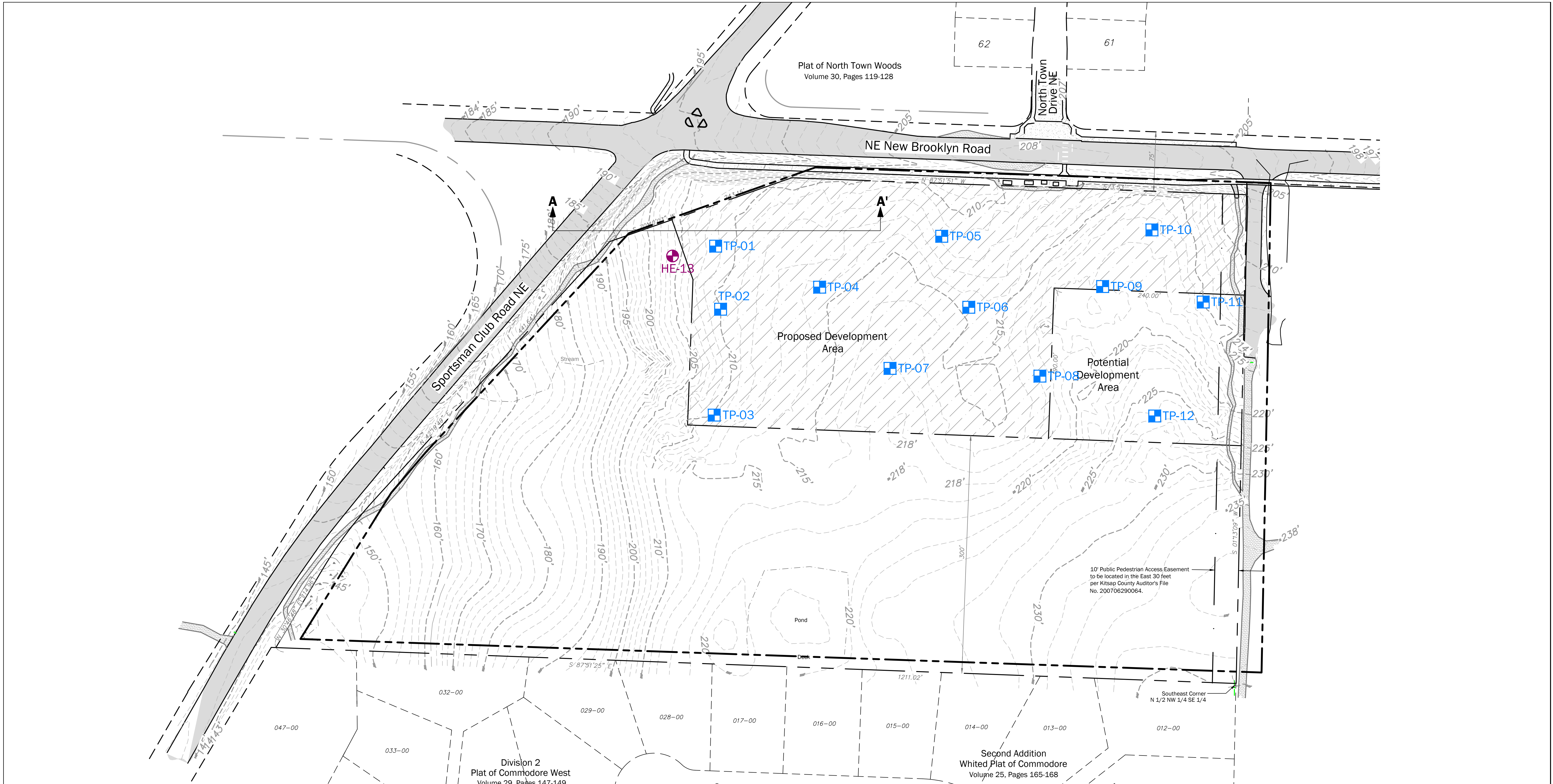
Geotechnical Report
Kitsap County Parcel No. 222502-4-006-2005
Bainbridge Island, Washington

Aspect CONSULTING

SEP-2018	BY: AJD / TDR	FIGURE NO.
PROJECT NO. 150365	REVISED BY: - - -	1

GIS Path: T:\projects_8\SusukiPropertyDevSupport_150365\Delivered\01 Site Location Map.mxd || Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet || Date Saved: 9/11/2018 || User: tullen || Print Date: 9/11/2018

Basemap Layer Credits || Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community



Source: Base map provided by Davis Studio Architecture, dated 4/2/2018. Topography provided by AGO Land Surveying, file dated 9/27/2018. Vertical datum: City of Bainbridge Island Vertical Control Network, BM4359 elevation is 173.2 feet.

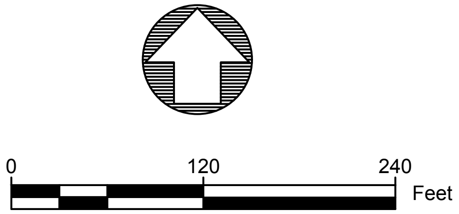
Legend

🟦 Test Pit Location

⊕ Hand Exploration

- - - Site Boundary

A A' Section Location For Stability Analysis



Site Exploration Plan

Suzuki Residential Development

Kitsap County Parcel Number 222502-4-006-2005
Bainbridge Island, Washington

Aspect CONSULTING

Nov-2018	BY: AJD/CMV		FIGURE NO.
PROJECT NO. 150365	REVISED BY: -		2

CAD Path: Q:_GeoTech\150365 Suzuki Property\150365-02.dwg Fig 2 - GeoTech || Date Saved: Nov 05, 2018 9:09am || User: cvanslyke

APPENDIX A

Subsurface Explorations

A. Test Pits and Hand Explorations

Test pits TP-01 through TP-12 were excavated using a tracked Hitachi 85USB excavator. The excavation was completed by High Meadows Excavating, LLC under direction of Aspect. Hand exploration HE-13 was advanced by an Aspect geologist using hand tools. The locations of explorations are shown on Figure 2 and were collected in the field using a global positioning system (GPS). Copies of the exploration logs are included in Appendix A. The terminology used in the soil classifications and other modifiers are defined and presented on the attached Figure A-1 included in Appendix A.

Samples were obtained from select soil units to aid in the determination of engineering properties of the subsurface materials. The relative density/consistency of the soils was evaluated qualitatively with a 0.5-inch-diameter steel t-probe and DCPT and observation of digging difficulty at various depth intervals within the test pits, as noted on the test pit logs. The test pits were backfilled with the native soils and compacted with the excavator bucket.

The DCPT method involves a 15-pound steel mass falling 20 inches to strike an anvil, which drives a 1.5 inch-diameter, 45-degree cone into the soil. The number of blows required to drive the cone 1.75 inches is considered one data point. The DCPT data has been calibrated with Standard Penetration Test (SPT, ASTM Method D 1586) results to provide a more refined estimate of soil relative density and consistency.

Detailed descriptions of the subsurface conditions encountered in our explorations, as well as the depths where characteristics of the soils changed, are indicated on the test pit logs. The depths indicated on the logs where conditions changed may represent gradational variations between soil types. Soils were classified per the Unified Soil Classification System (USCS) in general accordance with ASTM International (ASTM) D-2488, *Standard Practice for Description and Identification of Soils (Visual and Manual Procedure*).

Coarse-Grained Soils - More than 50% (1) Retained on No. 200 Sieve	Gravels - More than 50% (1) of Coarse Fraction Retained on No. 4 Sieve	≤5% Fines (5)	GW	Well-graded gravel and gravel with sand, little to no fines
			GP	Poorly-graded gravel and gravel with sand, little to no fines
		≥15% Fines (5)	GM	Silty gravel and silty gravel with sand
			GC	Clayey gravel and clayey gravel with sand
	Sands - 50% (1) or More of Coarse Fraction Passes No. 4 Sieve	≤5% Fines (5)	SW	Well-graded sand and sand with gravel, little to no fines
			SP	Poorly-graded sand and sand with gravel, little to no fines
		≥15% Fines (5)	SM	Silty sand and silty sand with gravel
			SC	Clayey sand and clayey sand with gravel
Fine-Grained Soils - 50% (1) or More Passes No. 200 Sieve	Silts and Clays Liquid Limit Less than 50		ML	Silt, sandy silt, gravelly silt, silt with sand or gravel
			CL	Clay of low to medium plasticity; silty, sandy, or gravelly clay, lean clay
			OL	Organic clay or silt of low plasticity
	Silts and Clays Liquid Limit 50 or More		MH	Elastic silt, clayey silt, silt with micaceous or diatomaceous fine sand or silt
			CH	Clay of high plasticity, sandy or gravelly clay, fat clay with sand or gravel
			OH	Organic clay or silt of medium to high plasticity
Highly Organic Soils			PT	Peat, muck and other highly organic soils

Terms Describing Relative Density and Consistency

	Density	SPT (2) blows/foot
Coarse-Grained Soils	Very Loose	0 to 4
	Loose	4 to 10
	Medium Dense	10 to 30
	Dense	30 to 50
	Very Dense	>50

	Consistency	SPT (2) blows/foot
Fine-Grained Soils	Very Soft	0 to 2
	Soft	2 to 4
	Medium Stiff	4 to 8
	Stiff	8 to 15
	Very Stiff	15 to 30
	Hard	>30

Test Symbols

FC = Fines Content
G = Grain Size
M = Moisture Content
A = Atterberg Limits
C = Consolidation
DD = Dry Density
K = Permeability
Str = Shear Strength
Env = Environmental
PiD = Photoionization Detector

Component Definitions

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

(3) Estimated Percentage

Percentage by Weight	Modifier
<5	Trace
5 to 15	Slightly (sandy, silty, clayey, gravelly)
15 to 30	Sandy, silty, clayey, gravelly)
30 to 49	Very (sandy, silty, clayey, gravelly)

Moisture Content

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

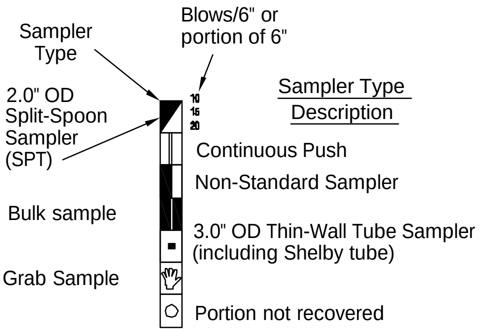
Slightly Moist - Perceptible moisture

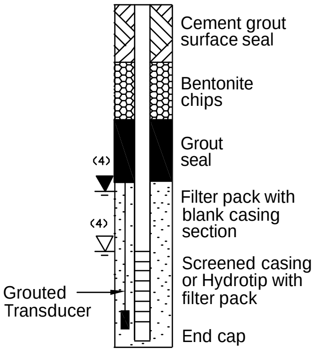
Moist - Damp but no visible water

Very Moist - Water visible but not free draining

Wet - Visible free water, usually from below water table

Symbols





(1) Percentage by dry weight
(2) (SPT) Standard Penetration Test (ASTM D-1586)
(3) In General Accordance with Standard Practice for Description and Identification of Soils (ASTM D-2488)
(4) Depth of groundwater
▽ ATD = At time of drilling
▼ Static water level (date)
(5) Combined USCS symbols used for fines between 5% and 15% as estimated in General Accordance with Standard Practice for Description and Identification of Soils (ASTM D-2488)

BGS = below ground surface

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

Aspect CONSULTING

Exploration Log Key

DATE:
DESIGNED BY:
DRAWN BY:
REVISED BY:
PROJECT NO.
FIGURE NO.
A-1

Q:_ACAD Standards\Standard Details\Exploration Log Key A1.dwg

Aspect CONSULTING	**Suzuki Development - 150365-01** *Project Address & Site Specific Location* New Brooklyn Rd & Sportsman Club Rd, Bainbridge Island, WA, west part of site		**Geotechnical Exploration Log** *Coordinates (Lat,Lon WGS84)* 47.64262, -122.52933	*Exploration Number* **HE-01**
Contractor Aspect Consulting	*Equipment* Hand	*Sampling Method* Grab	*Ground Surface (GS) Elev. (COBI VCN)* 203'	
Operator Bill Grimm	*Exploration Method(s)* Hand tools	*Work Start/Completion Dates* 9/20/2018	*Top of Casing Elev. (COBI VCN)* NA	*Depth to Water (Below GS)* No Water Encountered

Depth (feet)	Elev. (feet)	Exploration Completion and Notes	Sample Type/ID	Blows/foot ▲ Water Content (%)● 0 10 20 30 40 50	Blows/6"	Tests	Material Type	Description	Depth (ft)
		Hole backfilled with excavated soil.						**TOPSOIL** TOPSOIL; moist, dark brown; numerous organics, roots **WEATHERED VASHON TILL** SILTY SAND WITH GRAVEL (SM); slightly moist, light brown; fine to coarse sand, fine to coarse rounded to subangular gravel	
1	202								1
2	201							**VASHON TILL** SILTY SAND WITH GRAVEL (SM); very dense, slightly moist, light brown to light gray; fine to coarse sand, fine to coarse rounded to subangular gravel, hard to dig at 2.2 ft. bgs	2
3	200					DCPT =30/0.25"		Bottom of exploration at 3.2 ft. bgs. Note: Post hole digger to 2.6 ft.; hand auger from 2.6 ft. to bottom.	3
4	199								4
5	198								5
6	197								6
7	196								7
8	195								8
9	194								9
10	193								10
11	192								11
12	191								12
13	190								13
14	189								14

Legend

Sample Type

Plastic Limit ├──┤ Liquid Limit

Water Level

No Water Encountered

See Exploration Log Key for explanation of symbols

Logged by: WEG
Approved by: AJD 9/24/2018

Exploration Log
HE-01
Sheet 1 of 1

Aspect CONSULTING

Suzuki Development - 150365-01

Geotechnical Exploration Log

Project Address & Site Specific Location			*Coordinates (Lat,Lon WGS84)*	*Exploration Number*
New Brooklyn Rd & Sportsman Club Rd, Bainbridge Island, WA, near NW corner			47.64274, -122.52907	**TP-01**
Contractor	*Equipment*	*Sampling Method*	*Ground Surface (GS) Elev. (COBI VCN)*	
High Meadows Excavating	Hitachi 85USB	Grab	207'	
Operator	*Exploration Method(s)*	*Work Start/Completion Dates*	*Top of Casing Elev. (COBI VCN)*	*Depth to Water (Below GS)*
Andrew Monsaas	Trackhoe	8/20/2018	NA	No Water Encountered

Depth (feet)	Elev. (feet)	Exploration Completion and Notes	Sample Type/ID	Blows/foot ▲ Water Content (%)● 0 10 20 30 40 50	Blows/6"	Tests	Material Type	Description	Depth (ft)
		Test pit backfilled with excavated soil and tamped in place with excavator bucket.						**TOPSOIL** SILTY SAND WITH GRAVEL (SM); loose, slightly moist, dark brown; numerous roots and rootlets.	
								WEATHERED VASHON TILL SILTY SAND WITH GRAVEL (SM); medium dense, dry, light brown; fine to coarse sand; rounded to subangular, fine to coarse gravel; few cobbles and trace boulders up to 1' diameter; trace roots up to 1" diameter.	
1	206					T-probe =5"			1
2	205		✋ S1			T-probe =2" DCPT =10,30/1"		2 ft: Becomes dense.	2
			✋ S2			DCPT =50/1"		**VASHON TILL** SILTY SAND WITH GRAVEL (SM); very dense, slightly moist to moist, light gray; fine to coarse sand; rounded to subangular, fine to coarse gravel; few cobbles and trace boulders up to 1' diameter; socketed gravels and cobbles.	
3	204								3
4	203								4
5	202								5
6	201								6
7	200								7
8	199		✋ S3						8
								Bottom of exploration at 8.5 ft. bgs. Note: Refusal with excavator at bottom of test pit; up to 0.5 ft of caving observed from 0 to 2 ft bgs.	
9	198								9
10	197								10
11	196								11
12	195								12
13	194								13
14	193								14

Legend

Sample Type: ✋ Grab sample

Plastic Limit ├──┤ Liquid Limit

Water Level: No Water Encountered

See Exploration Log Key for explanation of symbols

Logged by: NHC
Approved by: AJD 9/17/2018

Exploration Log
TP-01
Sheet 1 of 1

Suzuki Development - 150365-01

Geotechnical Exploration Log

Project Address & Site Specific Location			*Coordinates (Lat,Lon WGS84)*	*Exploration Number*
New Brooklyn Rd & Sportsman Club Rd, Bainbridge Island, WA, west part of site			47.64252, -122.52904	**TP-02**
Contractor	*Equipment*	*Sampling Method*	*Ground Surface (GS) Elev. (COBI VCN)*	
High Meadows Excavating	Hitachi 85USB	Grab	208'	
Operator	*Exploration Method(s)*	*Work Start/Completion Dates*	*Top of Casing Elev. (COBI VCN)*	*Depth to Water (Below GS)*
Andrew Monsaas	Trackhoe	8/20/2018	NA	No Water Encountered

Depth (feet)	Elev. (feet)	Exploration Completion and Notes	Sample Type/ID	Blows/foot ▲ Water Content (%) ● 0 10 20 30 40 50	Blows/6"	Tests	Material Type	Description	Depth (ft)
		Test pit backfilled with excavated soil and tamped in place with excavator bucket.						**TOPSOIL** SILTY SAND WITH GRAVEL (SM); loose, slightly moist, dark brown; numerous roots and rootlets.	
1	207							**WEATHERED VASHON TILL** SILTY SAND WITH GRAVEL (SM); medium dense, dry, light brown; fine to coarse sand; rounded to subangular, fine to coarse gravel; few cobbles and trace boulders up to 1' diameter; numerous roots up to 2" diameter.	1
2	206					T-probe =1-2"		2 ft: Becomes dense.	2
			✋ S1	●		DCPT =42 GS FC=14%		**VASHON TILL** SILTY SAND WITH GRAVEL (SM); very dense, slightly moist, brown; fine to coarse sand; rounded to subangular, fine to coarse gravel; few cobbles and trace boulders up to 1' diameter; socketed gravels and cobbles.	
3	205								3
4	204							4 ft: Becomes moist.	4
5	203								5
6	202								6
								Bottom of exploration at 6.5 ft. bgs. Note: Refusal with excavator at bottom of test pit; up to 2 ft of caving observed from 0 to 2 ft bgs.	
7	201								7
8	200								8
9	199								9
10	198								10
11	197								11
12	196								12
13	195								13
14	194								14

Legend

Sample Type: ✋ Grab sample

Plastic Limit ├──┤ Liquid Limit

Water Level: No Water Encountered

See Exploration Log Key for explanation of symbols

Logged by: NHC
Approved by: AJD 9/17/2018

Exploration Log
TP-02
Sheet 1 of 1

Aspect CONSULTING

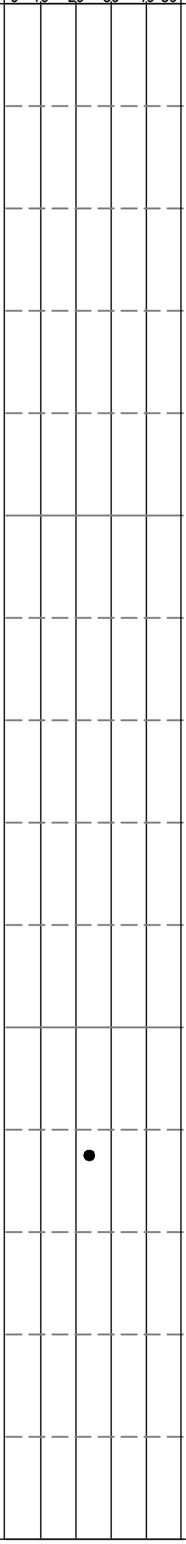
Suzuki Development - 150365-01

Geotechnical Exploration Log

Project Address & Site Specific Location	New Brooklyn Rd & Sportsman Club Rd, Bainbridge Island, WA, near SW corner
Coordinates (Lat,Lon WGS84)	47.64216, -122.52906
Exploration Number	**TP-03**
Contractor	High Meadows Excavating
Equipment	Hitachi 85USB
Sampling Method	Grab
Ground Surface (GS) Elev. (COBI VCN)	210'
Operator	Andrew Monsaas
Exploration Method(s)	Trackhoe
Work Start/Completion Dates	8/20/2018
Top of Casing Elev. (COBI VCN)	NA
Depth to Water (Below GS)	No Water Encountered

Depth (feet)	Elev. (feet)	Exploration Completion and Notes	Sample Type/ID	Tests
0	210	Test pit backfilled with excavated soil and tamped in place with excavator bucket.		
1	209		✋ S1	T-probe =1-2"
2	208			DCPT =60/1.5"
3	207			
4	206			
5	205			
6	204			
7	203		✋ S2	DCPT =22,34
8	202			
9	201			
10	200			
11	199		✋ S3	FC FC=91%
12	198			
13	197			
14	196			

Blows/foot ▲ Water Content (%) ●



Blows/6"

Material Type

Description

FILL

SANDY SILT (ML); loose, dry, dark brown; fine to coarse sand; rounded to subangular, fine to coarse gravel; few cobbles; trash (cans, bottles, car parts); numerous rootlets and roots up to 2" diameter.

WEATHERED VASHON TILL

SILTY SAND WITH GRAVEL (SM); dense, dry, brown yellow; fine to coarse sand; rounded to subangular, fine to coarse gravel; few cobbles and trace boulders up to 1' diameter; trace rootlets.

VASHON TILL

SILTY SAND WITH GRAVEL (SM); very dense, slightly moist, light gray to light brown; fine to coarse sand; rounded to subangular, fine to coarse gravel; few cobbles and trace boulders up to 1' diameter; socketed gravels and cobbles; trace rootlets.

2.5 ft: Becomes moist; no organics observed.

SILT (ML); dense, moist, light gray; low plasticity; thickly laminated with iron-oxide stained layers.

Bottom of exploration at 12 ft. bgs.

Note: Up to 0.5 ft of caving observed from 0 to 1.5 ft bgs.

Legend

Sample Type: ✋ Grab sample

Plastic Limit ├──┤ Liquid Limit

Water Level: No Water Encountered

See Exploration Log Key for explanation of symbols

Logged by: NHC
Approved by: AJD 9/17/2018

Exploration Log
TP-03
Sheet 1 of 1

NEW STANDARD LOG FORM P:\GINTW\PROJECTS\2018_SUZUKI PROPERTY_150365.GPJ November 5, 2018

Aspect CONSULTING

Suzuki Development - 150365-01

Geotechnical Exploration Log

Project Address & Site Specific Location			*Coordinates (Lat,Lon WGS84)*	*Exploration Number*	
New Brooklyn Rd & Sportsman Club Rd, Bainbridge Island, WA, west part of site			47.64261, -122.52854	**TP-04**	
Contractor	*Equipment*	*Sampling Method*	*Ground Surface (GS) Elev. (COBI VCN)*		
High Meadows Excavating	Hitachi 85USB	Grab	213'		
Operator	*Exploration Method(s)*	*Work Start/Completion Dates*	*Top of Casing Elev. (COBI VCN)*	*Depth to Water (Below GS)*	
Andrew Monsaas	Trackhoe	8/20/2018	NA	No Water Encountered	

Depth (feet)	Elev. (feet)	Exploration Completion and Notes	Sample Type/ID	Blows/foot ▲ Water Content (%)● 0 10 20 30 40 50	Blows/6"	Tests	Material Type	Description	Depth (ft)
		Test pit backfilled with excavated soil and tamped in place with excavator bucket.						**TOPSOIL** SILTY SAND WITH GRAVEL (SM); loose, slightly moist, dark brown; numerous roots up to 2" diameter. **WEATHERED VASHON TILL** SILTY SAND WITH GRAVEL (SM); medium dense, dry, light brown; fine to coarse sand; rounded to subangular, fine to coarse gravel; few cobbles and trace boulders up to 1' diameter; trace roots up to 1" diameter.	
1	212								1
2	211					T-probe =1-2"		**VASHON TILL** SILTY SAND WITH GRAVEL (SM); dense, slightly moist, light brown to light gray; fine to coarse sand; rounded to subangular, fine to coarse gravel; few cobbles and trace boulders up to 1' diameter; socketed gravels and cobbles.	2
3	210								3
4	209								4
5	208							5 ft: Becomes very dense and moist.	5
6	207								6
7	206								7
8	205							Bottom of exploration at 8 ft. bgs. Note: Up to 1 ft of caving observed from 0 to 1.5 ft bgs.	8
9	204								9
10	203								10
11	202								11
12	201								12
13	200								13
14	199								14

Legend

Sample Type

Plastic Limit ⊢⊣ Liquid Limit

Water Level

No Water Encountered

See Exploration Log Key for explanation of symbols

Logged by: NHC
Approved by: AJD 9/17/2018

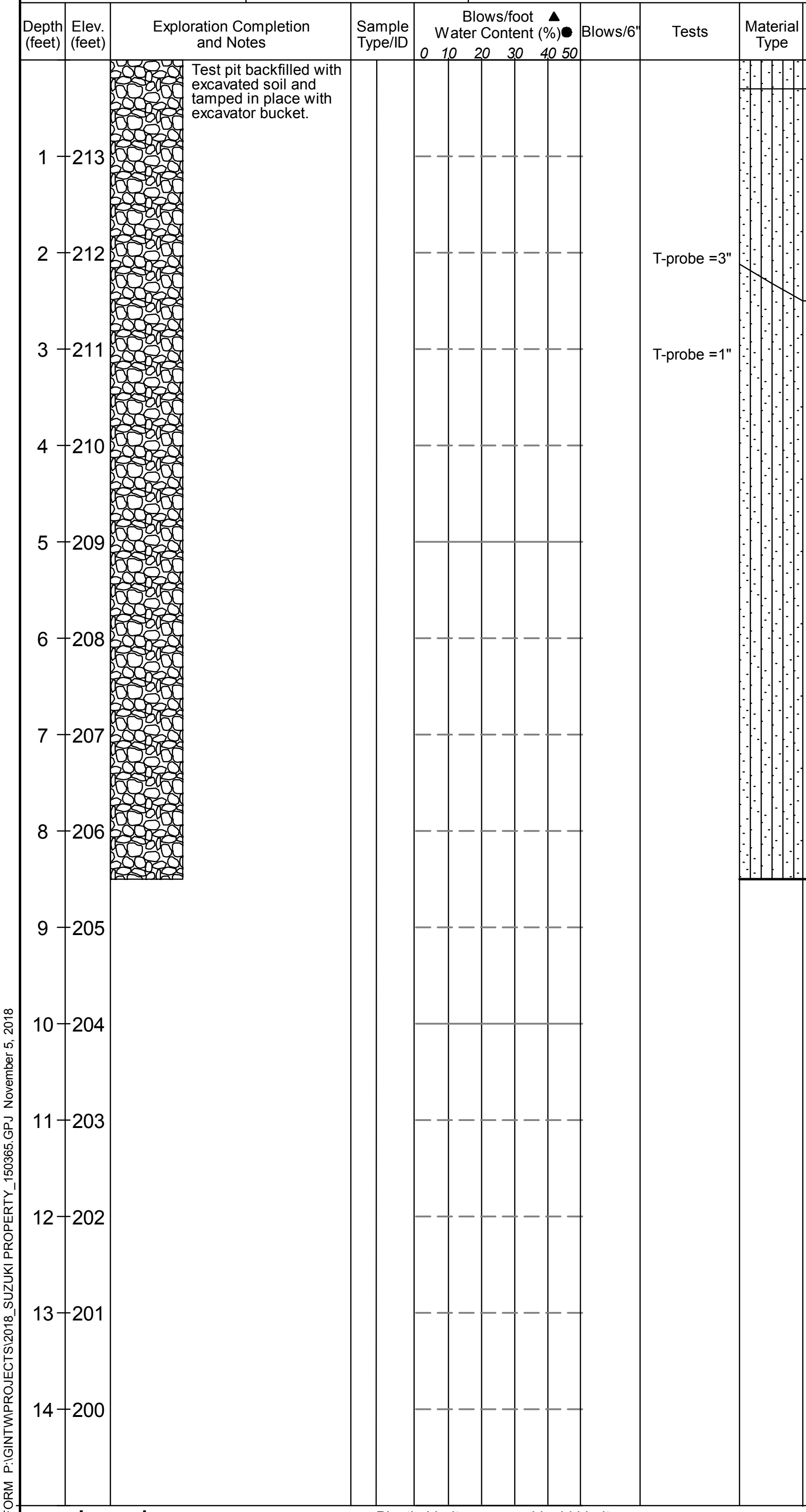
Exploration Log
TP-04
Sheet 1 of 1

Aspect CONSULTING

Suzuki Development - 150365-01

Geotechnical Exploration Log

Project Address & Site Specific Location			*Coordinates (Lat,Lon WGS84)*	*Exploration Number*
New Brooklyn Rd & Sportsman Club Rd, Bainbridge Island, WA, north part of site			47.64279, -122.52792	**TP-05**
Contractor	*Equipment*	*Sampling Method*	*Ground Surface (GS) Elev. (COBI VCN)*	
High Meadows Excavating	Hitachi 85USB	Grab	214'	
Operator	*Exploration Method(s)*	*Work Start/Completion Dates*	*Top of Casing Elev. (COBI VCN)*	*Depth to Water (Below GS)*
Andrew Monsaas	Trackhoe	8/21/2018	NA	No Water Encountered



Test pit backfilled with excavated soil and tamped in place with excavator bucket.

T-probe =3"

T-probe =1"

Description	Depth (ft)
TOPSOIL SILTY SAND WITH GRAVEL (SM); loose, slightly moist, dark brown; numerous roots up to 1" diameter.	
WEATHERED VASHON TILL SILTY SAND WITH GRAVEL (SM); medium dense, dry, brown; fine to coarse sand; rounded to subangular, fine to coarse gravel; few cobbles and trace boulders up to 1.3' diameter; trace roots up to 1" diameter.	1 2
VASHON TILL SILTY SAND WITH GRAVEL (SM); very dense, moist, light gray; fine to coarse sand; rounded to subangular, fine to coarse gravel; few cobbles and trace boulders up to 1' diameter; socketed gravels and cobbles.	3 4 5 6 7 8
Bottom of exploration at 8.5 ft. bgs. Note: Up to 1.5 ft of caving observed from 0 to 2.5 ft bgs.	9 10 11 12 13 14

Legend

Sample Type

Plastic Limit ├───┤ Liquid Limit

Water Level

No Water Encountered

See Exploration Log Key for explanation of symbols

Logged by: NHC
Approved by: AJD 9/17/2018

Exploration Log
TP-05
Sheet 1 of 1

Aspect CONSULTING

Suzuki Development - 150365-01

Geotechnical Exploration Log

Project Address & Site Specific Location	*Coordinates (Lat,Lon WGS84)*	*Exploration Number*
New Brooklyn Rd & Sportsman Club Rd, Bainbridge Island, WA, central part of site	47.64255, -122.52777	**TP-06**

Contractor	*Equipment*	*Sampling Method*	*Ground Surface (GS) Elev. (COBI VCN)*
High Meadows Excavating	Hitachi 85USB	Grab	216'

Operator	*Exploration Method(s)*	*Work Start/Completion Dates*	*Top of Casing Elev. (COBI VCN)*	*Depth to Water (Below GS)*
Andrew Monsaas	Trackhoe	8/21/2018	NA	No Water Encountered

Depth (feet)	Elev. (feet)	Exploration Completion and Notes	Sample Type/ID	Blows/foot ▲ Water Content (%)● 0 10 20 30 40 50	Blows/6"	Tests	Material Type	Description	Depth (ft)
		Test pit backfilled with excavated soil and tamped in place with excavator bucket.						**TOPSOIL** SILTY SAND WITH GRAVEL (SM); loose, dry, dark brown; numerous roots up to 1/2" diameter. **WEATHERED VASHON TILL** SILTY SAND WITH GRAVEL (SM); medium dense, dry, brown; fine to coarse sand; rounded to subangular, fine to coarse gravel; few cobbles and trace boulders up to 1' diameter; iron-oxide staining; numerous roots up to 1/2" diameter.	
1	215								1
2	214					T-probe =1"		**VASHON TILL** SILTY SAND WITH GRAVEL (SM); very dense, moist, light gray; fine to coarse sand; rounded to subangular, fine to coarse gravel; few cobbles and trace boulders up to 1' diameter; socketed gravels and cobbles.	2
3	213								3
4	212								4
5	211								5
6	210								6
7	209							Bottom of exploration at 7 ft. bgs. Note: Up to 1 ft of caving observed from 0 to 1 ft bgs.	7
8	208								8
9	207								9
10	206								10
11	205								11
12	204								12
13	203								13
14	202								14

Legend

Sample Type

Plastic Limit ⊢—⊣ Liquid Limit

Water Level: No Water Encountered

See Exploration Log Key for explanation of symbols

Logged by: NHC
Approved by: AJD 9/17/2018

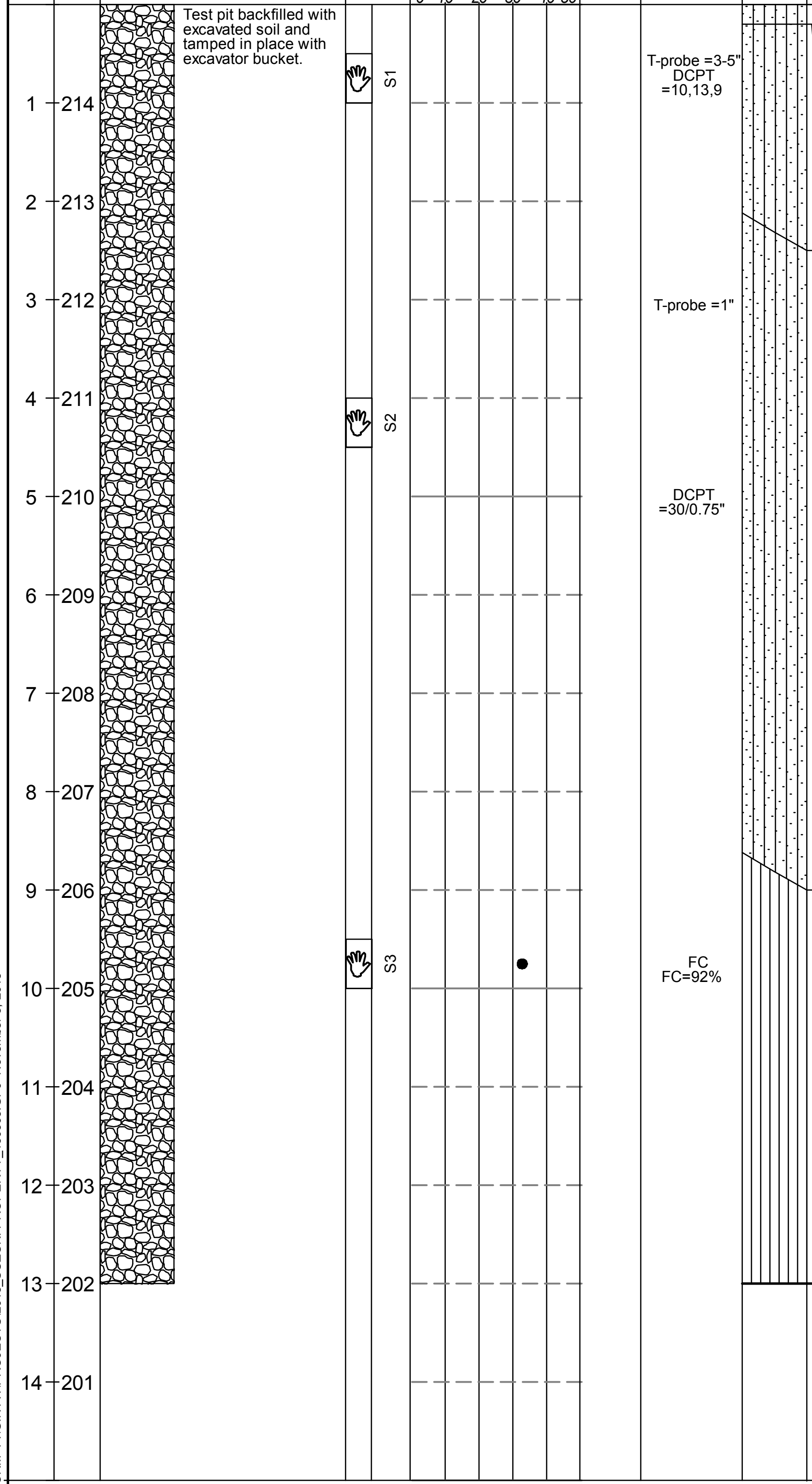
Exploration Log TP-06

Sheet 1 of 1

Suzuki Development - 150365-01

Geotechnical Exploration Log

Project Address & Site Specific Location	New Brooklyn Rd & Sportsman Club Rd, Bainbridge Island, WA, central part of site	*Coordinates (Lat,Lon WGS84)*	47.64233, -122.52817	*Exploration Number* **TP-07**
Contractor	High Meadows Excavating	*Equipment*	Hitachi 85USB	
Sampling Method	Grab	*Ground Surface (GS) Elev. (COBI VCN)*	215'	
Operator	Andrew Monsaas	*Exploration Method(s)*	Trackhoe	
Work Start/Completion Dates	8/21/2018	*Top of Casing Elev. (COBI VCN)*	NA	*Depth to Water (Below GS)* No Water Encountered



Depth (feet)	Elev. (feet)	Exploration Completion and Notes	Sample Type/ID	Tests	Description
0	215	Test pit backfilled with excavated soil and tamped in place with excavator bucket.			**TOPSOIL** SILTY SAND WITH GRAVEL (SM); loose, slightly moist, dark brown; numerous rootlets.
0.5–1			✋ S1	T-probe =3-5" DCPT =10,13,9	**WEATHERED VASHON TILL** SILTY SAND WITH GRAVEL (SM); medium dense, dry, brown; fine to coarse sand; rounded to subangular, fine to coarse gravel; few cobbles and trace boulders up to 1' diameter; numerous rootlets.
2.5					**VASHON TILL** SILTY SAND WITH GRAVEL (SM); very dense, moist, light gray; fine to coarse sand; rounded to subangular, fine to coarse gravel; few cobbles and trace boulders up to 1' diameter; socketed gravels and cobbles.
3	212			T-probe =1"	
4–4.5			✋ S2		4.5 ft to 5.5 ft: Increased sand content and reduced gravel socketing observed.
5	210			DCPT =30/0.75"	
9	206				SILT (ML); very dense, moist, light gray; low plasticity; trace iron-oxide staining; thickly laminated.
9.5–10			✋ S3	FC FC=92%	
13	202				Bottom of exploration at 13 ft. bgs.

Depth (ft): 1 2 3 4 5 6 7 8 9 10 11 12 13 14 — Elev. (feet): 214 213 212 211 210 209 208 207 206 205 204 203 202 201

Legend

Sample Type: ✋ Grab sample

Plastic Limit ├──┤ Liquid Limit

Water Level: No Water Encountered

See Exploration Log Key for explanation of symbols

Logged by: NHC
Approved by: AJD 9/17/2018

Exploration Log
TP-07
Sheet 1 of 1

Aspect CONSULTING

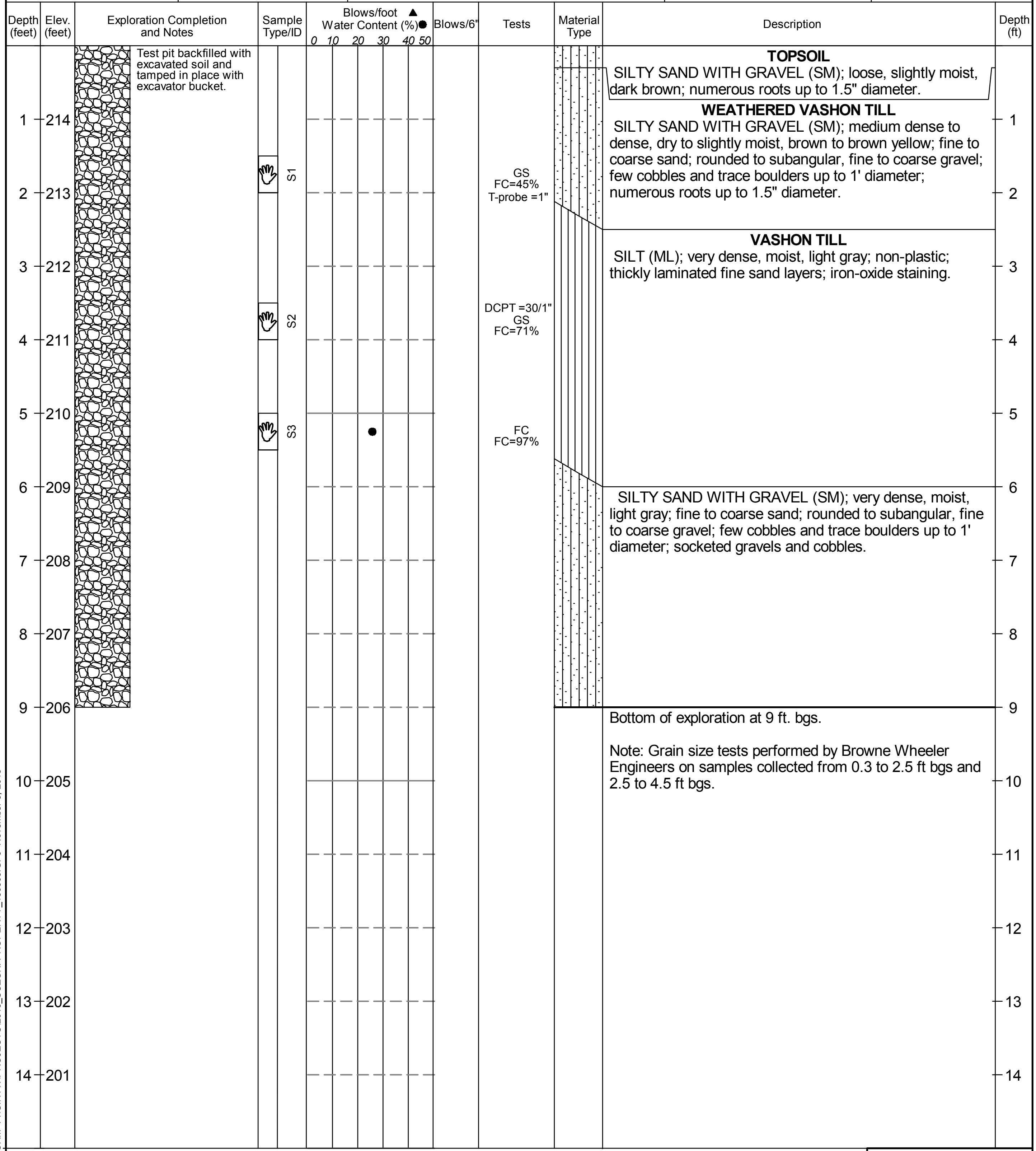
Suzuki Development - 150365-01

Geotechnical Exploration Log

Project Address & Site Specific Location	Coordinates (Lat,Lon WGS84)	Exploration Number
New Brooklyn Rd & Sportsman Club Rd, Bainbridge Island, WA, SE part of site	47.64232, -122.52740	**TP-08**

Contractor	Equipment	Sampling Method	Ground Surface (GS) Elev. (COBI VCN)
High Meadows Excavating	Hitachi 85USB	Grab	215'

Operator	Exploration Method(s)	Work Start/Completion Dates	Top of Casing Elev. (COBI VCN)	Depth to Water (Below GS)
Andrew Monsaas	Trackhoe	8/21/2018	NA	No Water Encountered



Depth (feet)	Elev. (feet)	Exploration Completion and Notes	Sample Type/ID	Blows/foot ▲ Water Content (%) ●	Blows/6"	Tests	Material Type	Description	Depth (ft)
		Test pit backfilled with excavated soil and tamped in place with excavator bucket.						**TOPSOIL** SILTY SAND WITH GRAVEL (SM); loose, slightly moist, dark brown; numerous roots up to 1.5" diameter.	
1	214							**WEATHERED VASHON TILL** SILTY SAND WITH GRAVEL (SM); medium dense to dense, dry to slightly moist, brown to brown yellow; fine to coarse sand; rounded to subangular, fine to coarse gravel; few cobbles and trace boulders up to 1' diameter; numerous roots up to 1.5" diameter.	1
2	213		S1			GS FC=45% T-probe =1"			2
3	212							**VASHON TILL** SILT (ML); very dense, moist, light gray; non-plastic; thickly laminated fine sand layers; iron-oxide staining.	3
4	211		S2			DCPT =30/1" GS FC=71%			4
5	210		S3	●		FC FC=97%			5
6	209							SILTY SAND WITH GRAVEL (SM); very dense, moist, light gray; fine to coarse sand; rounded to subangular, fine to coarse gravel; few cobbles and trace boulders up to 1' diameter; socketed gravels and cobbles.	6
7	208								7
8	207								8
9	206							Bottom of exploration at 9 ft. bgs. Note: Grain size tests performed by Browne Wheeler Engineers on samples collected from 0.3 to 2.5 ft bgs and 2.5 to 4.5 ft bgs.	9
10	205								10
11	204								11
12	203								12
13	202								13
14	201								14

Legend

Sample Type: Grab sample

Plastic Limit ├──┤ Liquid Limit

Water Level: No Water Encountered

See Exploration Log Key for explanation of symbols

Logged by: NHC
Approved by: AJD 9/17/2018

Exploration Log TP-08

Sheet 1 of 1

Aspect CONSULTING	Suzuki Development - 150365-01	Geotechnical Exploration Log	
	Project Address & Site Specific Location New Brooklyn Rd & Sportsman Club Rd, Bainbridge Island, WA, east part of site	*Coordinates (Lat,Lon WGS84)* 47.64263, -122.52709	*Exploration Number* **TP-09**

Contractor	*Equipment*	*Sampling Method*	*Ground Surface (GS) Elev. (COBI VCN)*
High Meadows Excavating	Hitachi 85USB	Grab	217'

Operator	*Exploration Method(s)*	*Work Start/Completion Dates*	*Top of Casing Elev. (COBI VCN)*	*Depth to Water (Below GS)*
Andrew Monsaas	Trackhoe	8/20/2018	NA	No Water Encountered

Depth (feet)	Elev. (feet)	Exploration Completion and Notes	Sample Type/ID	Blows/foot ▲ Water Content (%)● 0 10 20 30 40 50	Blows/6"	Tests	Material Type	Description	Depth (ft)
		Test pit backfilled with excavated soil and tamped in place with excavator bucket.						**TOPSOIL** SILTY SAND WITH GRAVEL (SM); loose, slightly moist, dark brown; numerous rootlets and roots up to 1.5" diameter.	
1	216							**WEATHERED VASHON TILL** SILTY SAND WITH GRAVEL (SM); medium dense, dry, brown; fine to coarse sand; rounded to subangular, fine to coarse gravel; few cobbles and trace boulders up to 1' diameter; numerous roots up to 0.5" diameter.	1
2	215								2
						T-probe =1-2"		**VASHON TILL** SILTY SAND WITH GRAVEL (SM); dense, slightly moist, brown; fine to coarse sand; rounded to subangular, fine to coarse gravel; few cobbles and trace boulders up to 1' diameter; socketed gravels and cobbles.	
3	214								3
4	213					T-probe =<1"		4 ft: Becomes very dense.	4
5	212							5 ft: Becomes moist and light gray.	5
6	211								6
7	210							Bottom of exploration at 7 ft. bgs. Note: Up to 1 ft of caving observed from 0 to 2 ft bgs.	7
8	209								8
9	208								9
10	207								10
11	206								11
12	205								12
13	204								13
14	203								14

Legend

Sample Type

Plastic Limit ├──┤ Liquid Limit

Water Level

No Water Encountered

See Exploration Log Key for explanation of symbols

Logged by: NHC
Approved by: AJD 9/17/2018

Exploration Log
TP-09
Sheet 1 of 1

Aspect CONSULTING	**Suzuki Development - 150365-01** *Project Address & Site Specific Location* New Brooklyn Rd & Sportsman Club Rd, Bainbridge Island, WA, near NE corner		**Geotechnical Exploration Log** *Coordinates (Lat,Lon WGS84)* 47.64283, -122.52685	*Exploration Number* **TP-10**
Contractor High Meadows Excavating	*Equipment* Hitachi 85USB	*Sampling Method* Grab	*Ground Surface (GS) Elev. (COBI VCN)* 217'	
Operator Andrew Monsaas	*Exploration Method(s)* Trackhoe	*Work Start/Completion Dates* 8/21/2018	*Top of Casing Elev. (COBI VCN)* NA	*Depth to Water (Below GS)* No Water Encountered

Depth (feet)	Elev. (feet)	Exploration Completion and Notes	Sample Type/ID	Blows/foot ▲ Water Content (%)● 0 10 20 30 40 50	Blows/6"	Tests	Material Type	Description	Depth (ft)
		Test pit backfilled with excavated soil and tamped in place with excavator bucket.						**TOPSOIL** SILTY SAND WITH GRAVEL (SM); loose, slightly moist, dark brown; numerous roots up to 0.5" diameter. **WEATHERED VASHON TILL** SILTY SAND WITH GRAVEL (SM); medium dense, dry, light brown; fine to coarse sand; rounded to subangular, fine to coarse gravel; few cobbles and trace boulders up to 1' diameter; numerous roots up to 0.5" diameter.	
1	216								1
2	215					T-probe =3"		**VASHON TILL** SILTY SAND WITH GRAVEL (SM); very dense, moist, light gray; fine to coarse sand; rounded to subangular, fine to coarse gravel; few cobbles and trace boulders up to 1' diameter; socketed gravels and cobbles.	2
3	214								3
4	213								4
5	212								5
6	211							Bottom of exploration at 6 ft. bgs. Note: Up to 0.5 ft of caving observed from 0 to 2.5 ft bgs.	6
7	210								7
8	209								8
9	208								9
10	207								10
11	206								11
12	205								12
13	204								13
14	203								14

Legend

Sample Type

Plastic Limit ⊢⊣ Liquid Limit

Water Level

No Water Encountered

See Exploration Log Key for explanation of symbols

Logged by: NHC
Approved by: AJD 9/17/2018

Exploration Log
TP-10
Sheet 1 of 1

NEW STANDARD LOG FORM P:\GINTW\PROJECTS\2018_SUZUKI PROPERTY_150365.GPJ November 5, 2018

Aspect CONSULTING

Suzuki Development - 150365-01

Geotechnical Exploration Log

	Project Address & Site Specific Location New Brooklyn Rd & Sportsman Club Rd, Bainbridge Island, WA, east part of site			*Coordinates (Lat,Lon WGS84)* 47.64258, -122.52658	*Exploration Number* **TP-11**
Contractor High Meadows Excavating	*Equipment* Hitachi 85USB	*Sampling Method* Grab		*Ground Surface (GS) Elev. (COBI VCN)* 218'	
Operator Andrew Monsaas	*Exploration Method(s)* Trackhoe	*Work Start/Completion Dates* 8/21/2018		*Top of Casing Elev. (COBI VCN)* NA	*Depth to Water (Below GS)* No Water Encountered

Depth (feet)	Elev. (feet)	Exploration Completion and Notes	Sample Type/ID	Blows/foot ▲ Water Content (%)● 0 10 20 30 40 50	Blows/6"	Tests	Material Type	Description	Depth (ft)
		Test pit backfilled with excavated soil and tamped in place with excavator bucket.						**TOPSOIL** SILTY SAND WITH GRAVEL (SM); loose, slightly moist, dark brown; numerous roots up to 0.5" diameter. **WEATHERED VASHON TILL** SILTY SAND WITH GRAVEL (SM); medium dense, dry, light brown; fine to coarse sand; rounded to subangular, fine to coarse gravel; few cobbles and trace boulders up to 1' diameter; numerous roots up to 1" diameter.	
1	217								1
2	216							**VASHON TILL** SILTY SAND WITH GRAVEL (SM); very dense, moist, light gray; fine to coarse sand; rounded to subangular, fine to coarse gravel; few cobbles and trace boulders up to 1' diameter; socketed gravels and cobbles.	2
3	215					T-probe =<1"			3
4	214								4
5	213							Bottom of exploration at 5 ft. bgs. Note: Refusal with excavator at bottom of test pit.	5
6	212								6
7	211								7
8	210								8
9	209								9
10	208								10
11	207								11
12	206								12
13	205								13
14	204								14

Legend

Sample Type

Plastic Limit ├──┤ Liquid Limit

Water Level

No Water Encountered

See Exploration Log Key for explanation of symbols

Logged by: NHC
Approved by: AJD 9/17/2018

Exploration Log
TP-11
Sheet 1 of 1

Aspect Consulting	Suzuki Development - 150365-01			Geotechnical Exploration Log	
	Project Address & Site Specific Location New Brooklyn Rd & Sportsman Club Rd, Bainbridge Island, WA, near SE corner			*Coordinates (Lat,Lon WGS84)* 47.64219, -122.52681	*Exploration Number* **TP-12**
Contractor High Meadows Excavating	*Equipment* Hitachi 85USB	*Sampling Method* Grab		*Ground Surface (GS) Elev. (COBI VCN)* 225'	
Operator Andrew Monsaas	*Exploration Method(s)* Trackhoe	*Work Start/Completion Dates* 8/21/2018		*Top of Casing Elev. (COBI VCN)* NA	*Depth to Water (Below GS)* No Water Encountered

Depth (feet)	Elev. (feet)	Exploration Completion and Notes	Sample Type/ID	Blows/foot ▲ Water Content (%)● 0 10 20 30 40 50	Blows/6"	Tests	Material Type	Description	Depth (ft)
0	225	Test pit backfilled with excavated soil and tamped in place with excavator bucket.						**TOPSOIL** SILTY SAND WITH GRAVEL (SM); loose, slightly moist, dark brown; numerous roots up to 1" diameter. **WEATHERED VASHON TILL** SILTY SAND WITH GRAVEL (SM); medium dense, dry, light brown; fine to coarse sand; rounded to subangular, fine to coarse gravel; few cobbles and trace boulders up to 1' diameter; numerous roots up to 1" diameter.	
1	224								1
2	223								2
3	222					T-probe =<1"		**VASHON TILL** SILTY SAND WITH GRAVEL (SM); very dense, moist, light gray; fine to coarse sand; rounded to subangular, fine to coarse gravel; few cobbles and trace boulders up to 1' diameter; socketed gravels and cobbles.	3
4	221								4
5	220								5
6	219							Bottom of exploration at 6 ft. bgs.	6
7	218								7
8	217								8
9	216								9
10	215								10
11	214								11
12	213								12
13	212								13
14	211								14

Legend

Sample Type

Plastic Limit ├──┤ Liquid Limit

Water Level

No Water Encountered

See Exploration Log Key for explanation of symbols

Logged by: NHC
Approved by: AJD 9/17/2018

Exploration Log TP-12

Sheet 1 of 1

APPENDIX B

Geotechnical Laboratory Testing Results

B. Geotechnical Laboratory Testing

Geotechnical laboratory tests were conducted on selected soil samples collected during the field exploration program. The tests performed and the procedures followed are outlined below. The laboratory tests were conducted in general accordance with appropriate ASTM International (ASTM) test methods and were completed by Aspect and by Phoenix Soil Research subcontracted to Browne Wheeler Engineers, Inc. Test procedures are discussed below.

Moisture Content Determination, MC

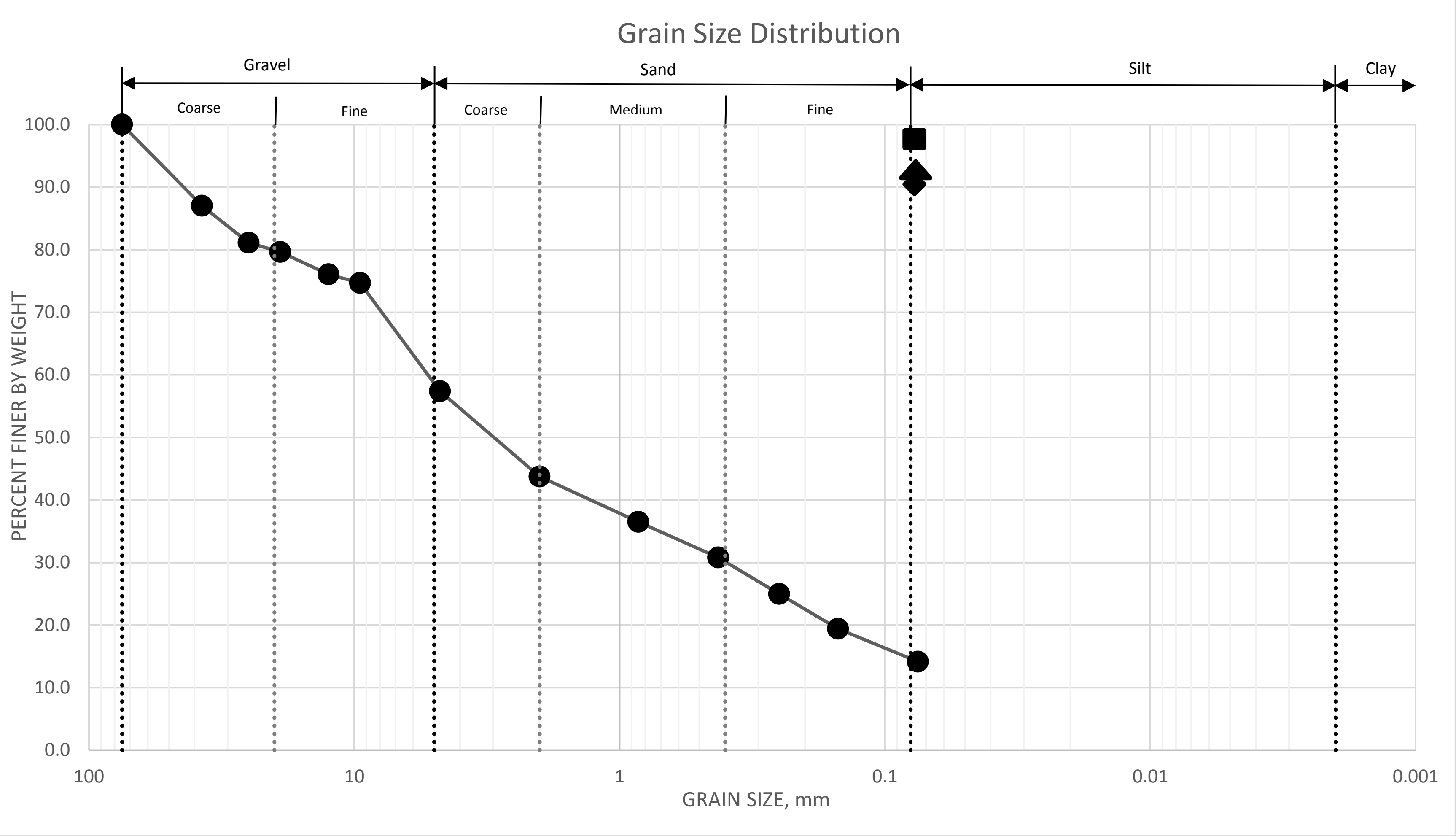
The moisture content of selected soil samples was determined in general accordance with ASTM D2216. The results of the tests are shown on the exploration logs.

Fines Content Determination, FC

The fines contents of selected soil samples was determined in general accordance with ASTM D1140. The results of the tests are shown on the exploration logs.

Grain Size Analysis, GS

Grain size analyses were performed on selected soil samples in general accordance with ASTM D6913. The results of the tests are presented in this appendix as curves depicting the percent finer by weight versus grain size.



Symbol	Exploration, Sample, Depth	Moisture Content (%)	Silt/Clay Content (%)	Sand Content (%)	Gravel Content (%)	Coefficient of Uniformity, Cu	Coefficient of Curvature, Cc	USCS Soil Type
●	TP-02, S1, 2.5-3.0*	7	14.1	43.2	42.6	164.6	0.8	SM
◆	TP-03, S3, 11-11.5**	24	90.9					ML
▲	TP-07, S3, 9.5-10**	33	92.4					ML
■	TP-08, S3, 5-5.5**	26	96.8					ML

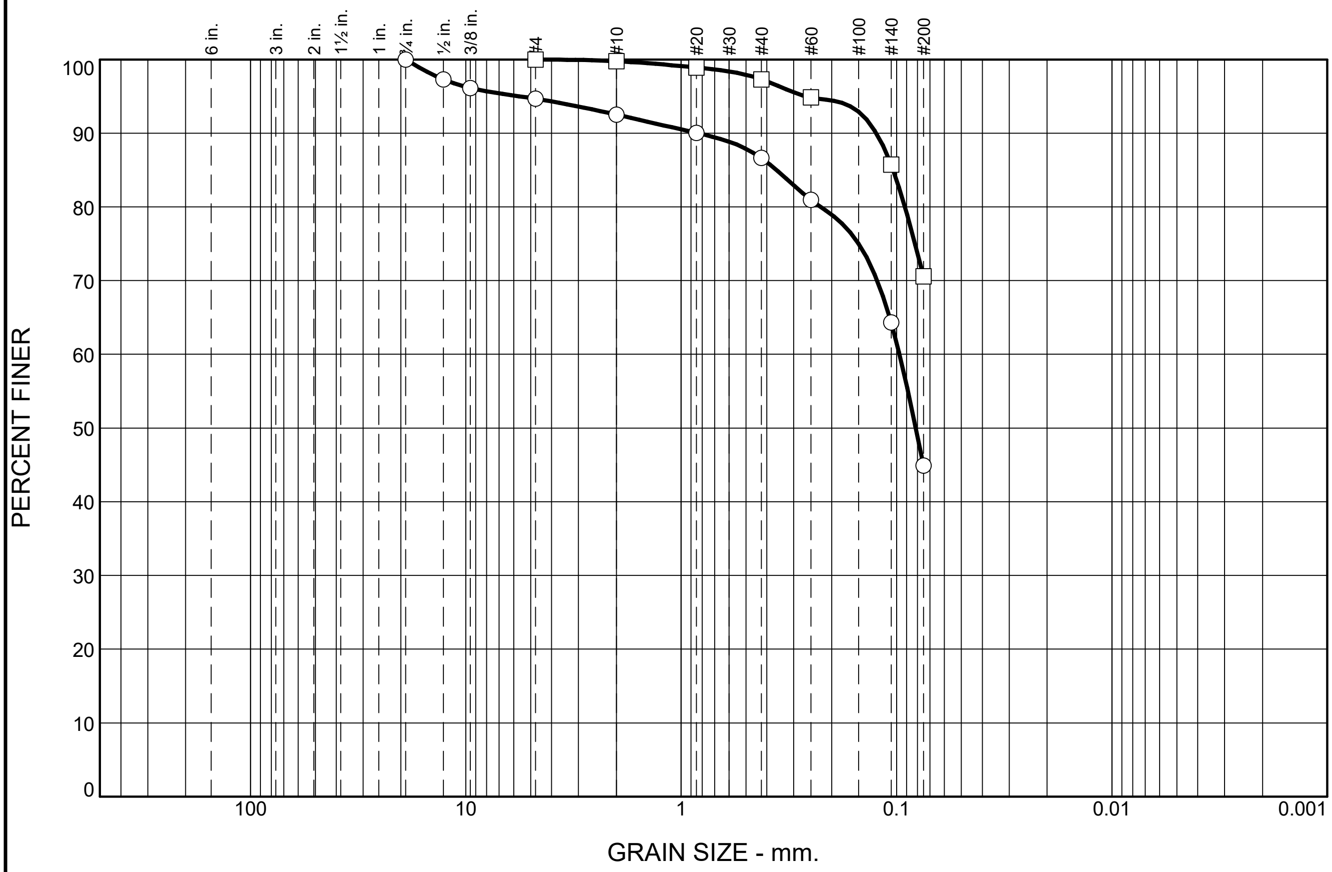
*The sample(s) tested may not include oversized particles and may only be representative of a portion of the sample/site soil conditions.

**Fines content test only in accordance with ASTM D1140

Project Name: SUZUKI

Project Number: 150365

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○	0.0	5.3	49.8	44.9		SM	A-4(0)	NP	NV
□	0.0	0.0	29.4	70.6		ML	A-4(0)	NP	NV

SIEVE inches size	PERCENT FINER ○	□	
0.75	100.0		
0.5	97.3		
0.375	96.1		
	GRAIN SIZE		
D_{60}	0.0970		
D_{30}			
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○	□	
#4	94.7	100.0	
#10	92.5	99.8	
#20	90.0	98.9	
#40	86.6	97.3	
#60	81.0	94.8	
#140	64.3	85.7	
#200	44.9	70.6	

Material Description

○ silty sand

□ silt with sand

REMARKS:

○ Classification based on grainsize only

□ Classification based on grainsize only

○ Depth: 0.3-2.5 Sample Number: TP08
□ Depth: 2.5-4.5 Sample Number: TP08

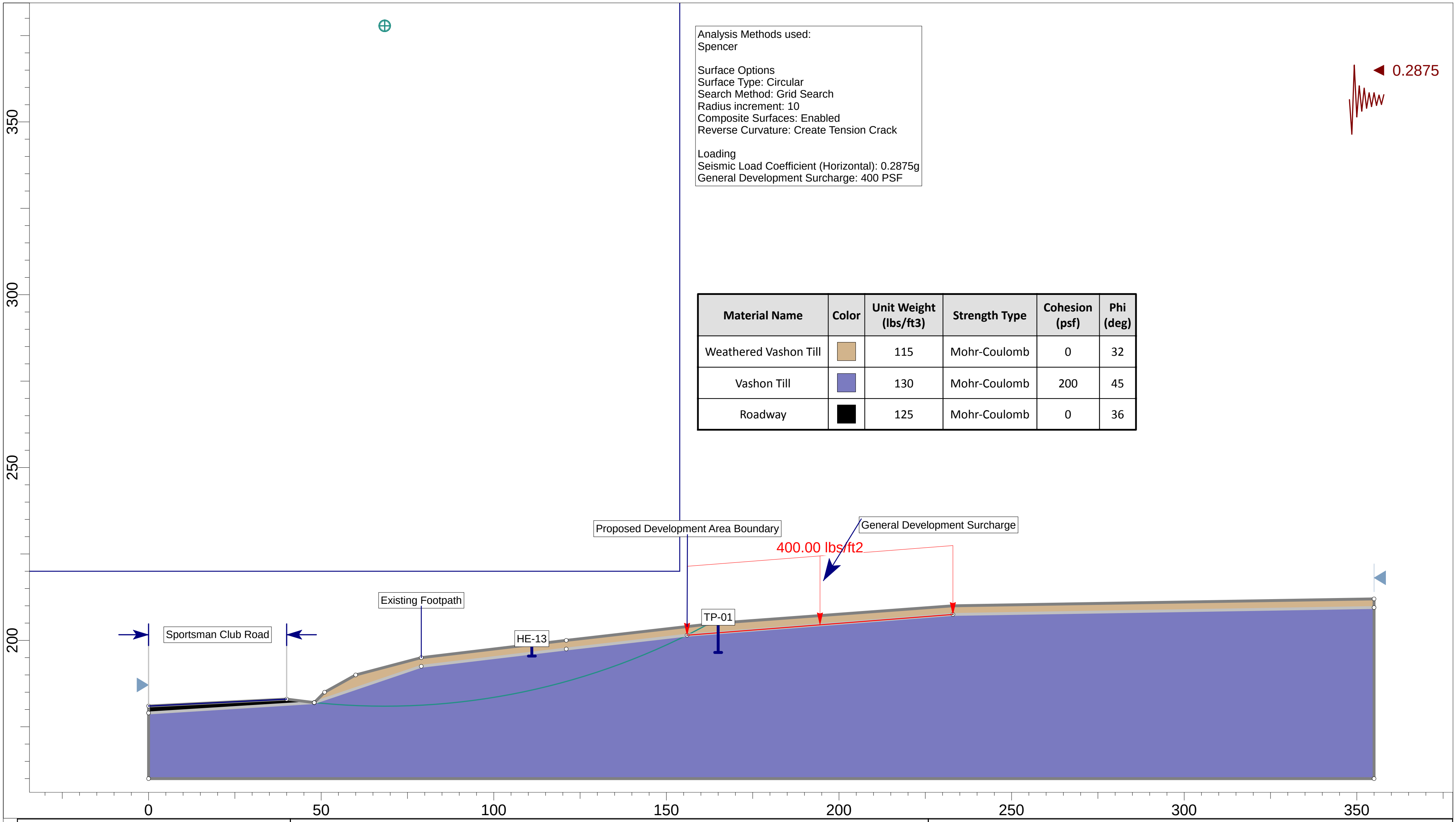
Phoenix Soil Research

Kingston, WA

Client: Browne Wheeler Engineers, Inc
Project: Suzuki
Project No.: PSR18-40-0804 Figure 1

APPENDIX C

Slope Stability Analyses



Analysis Methods used:
Spencer

Surface Options
Surface Type: Circular
Search Method: Grid Search
Radius increment: 10
Composite Surfaces: Enabled
Reverse Curvature: Create Tension Crack

Loading
Seismic Load Coefficient (Horizontal): 0.2875g
General Development Surcharge: 400 PSF

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Weathered Vashon Till	🟫	115	Mohr-Coulomb	0	32
Vashon Till	🟪	130	Mohr-Coulomb	200	45
Roadway	⬛	125	Mohr-Coulomb	0	36

Legend

- Search Grid
- Search Limits
- Modelled Groundwater Level
- Boring Location and Depth

Section A-A' - Model Setup

Suzuki Residential Development

Kitsap County Parcel Number 222502-4-006-2005
Bainbridge Island, Washington

SLIDEINTERPRET 7.024

SCALE: 1" = 40'

\\biserver1\projects_GEOTECH\Suzuki Property_New Brooklyn\Data\Analyses\SSA\Suzuki West Slope_seismic.slim

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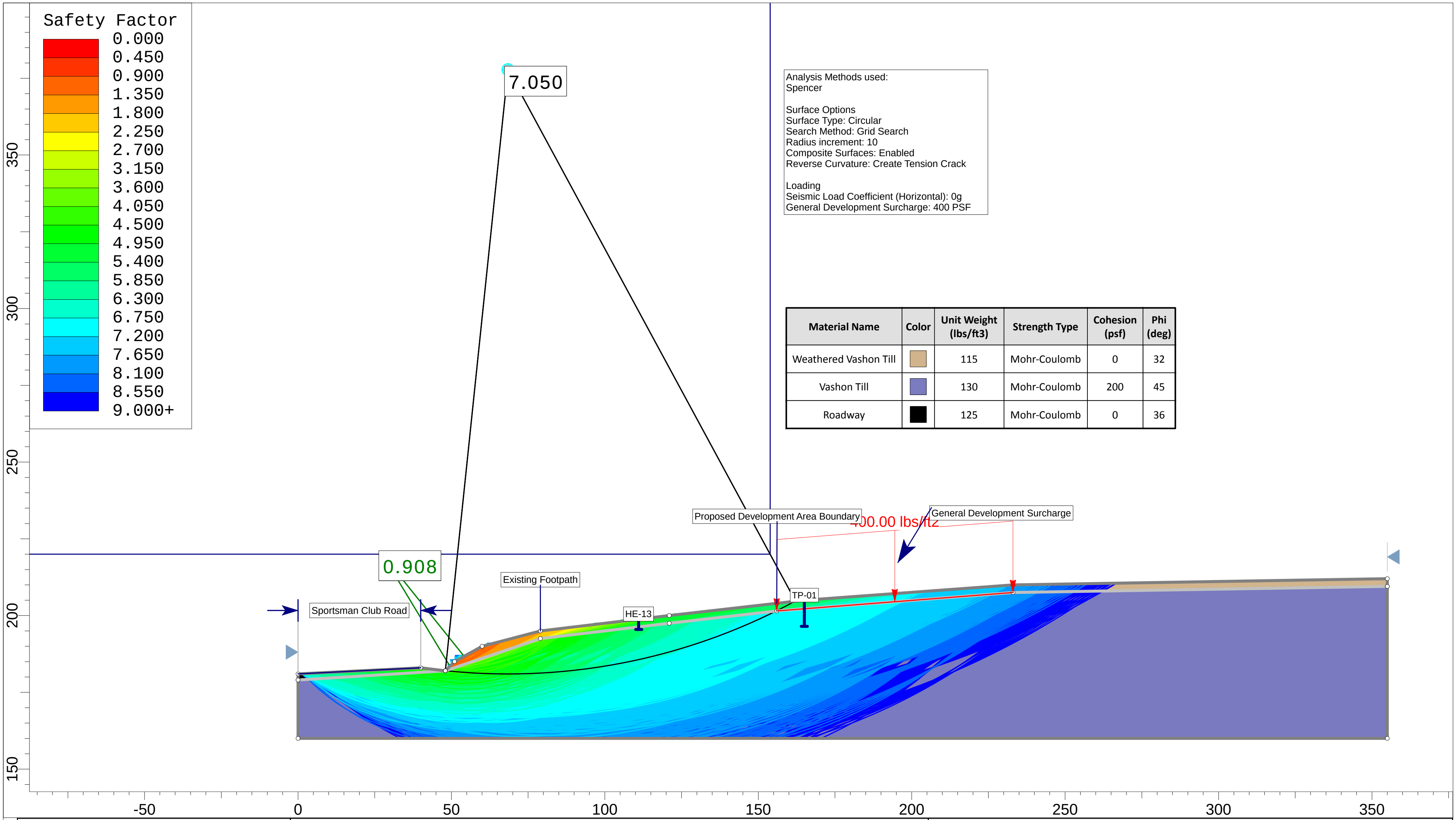
10/1/2018

PROJECT NO.
150365-02

BY:
AJH

REVISED BY:

APPENDIX:
C-1



Analysis Methods used:
Spencer

Surface Options
Surface Type: Circular
Search Method: Grid Search
Radius increment: 10
Composite Surfaces: Enabled
Reverse Curvature: Create Tension Crack

Loading
Seismic Load Coefficient (Horizontal): 0g
General Development Surcharge: 400 PSF

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Weathered Vashon Till	🟫	115	Mohr-Coulomb	0	32
Vashon Till	🟪	130	Mohr-Coulomb	200	45
Roadway	⬛	125	Mohr-Coulomb	0	36

Legend

- Search Grid
- Search Limits
- Modelled Groundwater Level
- Boring Location and Depth

Section A-A' - Static Conditions

Suzuki Residential Development

Kitsap County Parcel Number 222502-4-006-2005
Bainbridge Island, Washington

SLIDEINTERPRET 7.024

SCALE: 1" = 45'

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10/1/2018

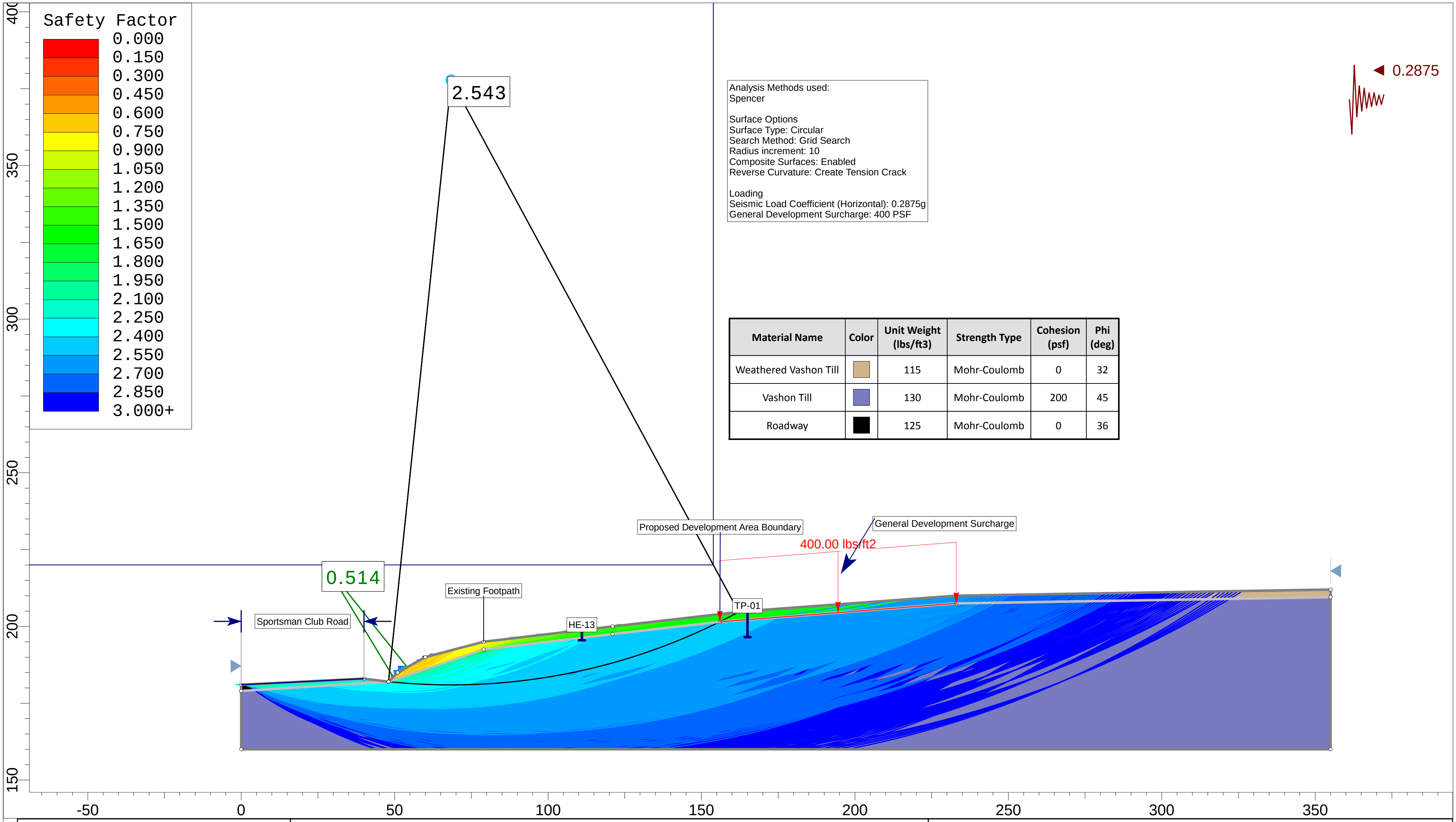
BY:
AJH

PROJECT NO.
150365-02

REVISED BY:

APPENDIX:

C-2



Analysis Methods used:
Spencer

Surface Options
Surface Type: Circular
Search Method: Grid Search
Radius increment: 10
Composite Surfaces: Enabled
Reverse Curvature: Create Tension Crack

Loading
Seismic Load Coefficient (Horizontal): 0.2875g
General Development Surcharge: 400 PSF

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Weathered Vashon Till	🟫	115	Mohr-Coulomb	0	32
Vashon Till	🟪	130	Mohr-Coulomb	200	45
Roadway	⬛	125	Mohr-Coulomb	0	36

Legend

☐ Search Grid
Search Limits
Modelled Groundwater Level
Boring Location and Depth

Section A-A' - Seismic Conditions

Suzuki Residential Development

Kitsap County Parcel Number 222502-4-006-2005
Bainbridge Island, Washington

SLIDEINTERPRET 7.024

SCALE: 1" = 45'

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10/1/2018

PROJECT NO.
150365-02

BY:
AJH

REVISED BY:

APPENDIX:
C-3

APPENDIX D

Report Limitations and Guidelines for Use

REPORT LIMITATIONS AND GUIDELINES FOR USE

Geoscience is Not Exact

The geoscience practices (geotechnical engineering, geology, and environmental science) are far less exact than other engineering and natural science disciplines. It is important to recognize this limitation in evaluating the content of the report. If you are unclear how these "Report Limitations and Guidelines for Use" apply to your project or property, you should contact Aspect Consulting, LLC (Aspect).

This Report and Project-Specific Factors

Aspect's services are designed to meet the specific needs of our clients. Aspect has performed the services in general accordance with our agreement (the Agreement) with the Client (defined under the Limitations section of this project's work product). This report has been prepared for the exclusive use of the Client. This report should not be applied for any purpose or project except the purpose described in the Agreement.

Aspect considered many unique, project-specific factors when establishing the Scope of Work for this project and report. You should not rely on this report if it was:

- Not prepared for you;
- Not prepared for the specific purpose identified in the Agreement;
- Not prepared for the specific subject property assessed; or
- Completed before important changes occurred concerning the subject property, project, or governmental regulatory actions.

If changes are made to the project or subject property after the date of this report, Aspect should be retained to assess the impact of the changes with respect to the conclusions contained in the report.

Reliance Conditions for Third Parties

This report was prepared for the exclusive use of the Client. No other party may rely on the product of our services unless we agree in advance to such reliance in writing. This is to provide our firm with reasonable protection against liability claims by third parties with whom there would otherwise be no contractual limitations. Within the limitations of scope, schedule, and budget, our services have been executed in accordance with our Agreement with the Client and recognized geoscience practices in the same locality and involving similar conditions at the time this report was prepared

Property Conditions Change Over Time

This 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 events such as a change in property use or occupancy, or by natural events, such as floods, earthquakes, slope instability, or groundwater fluctuations. If any of the described events may have occurred following the issuance of the report, you should contact Aspect so that we may evaluate whether changed conditions affect the continued reliability or applicability of our conclusions and recommendations.

Geotechnical, Geologic, and Environmental Reports Are Not Interchangeable

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

We appreciate the opportunity to perform these services. If you have any questions please contact the Aspect Project Manager for this project.