South Sound Geotechnical Consulting

September 20, 2022

RB Engineering
91 SW 13th Street
Chehalis, WA 98532

Attention: Mr. Robert Balmelli, P.E.

Subject: Geotechnical Engineering Report
Hampe Way Improvements and 12-Acre Development
Centralia, Washington
SSGC Project No. 2202

Mr. Balmelli,

South Sound Geotechnical Consulting (SSGC) has completed a geotechnical assessment for the planned Wilson Commercial development on the above addressed property in Centralia, Washington. Our services have been completed in general conformance with our proposal P21132 (dated October 26, 2021) and authorized per signature of our agreement for services. Our scope of services included completion of six borings and three test pits, engineering analyses, and preparation of this report.

PROJECT INFORMATION

A new residential development is planned on 12-acres located north of the current Elks Club on the private extension of Hampe Way, east of Kresky Road in Centralia, Washington. Improvements to the private drive will be completed to provide access to the new development. The 12-acre site is currently undeveloped and lightly forested on west-facing sloping ground.

SUBSURFACE CONDITIONS

Subsurface conditions were characterized by completing five borings on April 4, 2022 and six test pits on the site on May 26, 2022. Explorations were advanced to depths between about 4 and 21.5 feet below existing ground surface. Approximate locations of the explorations are shown on Figure 1, Exploration Plan. A summary description of observed subgrade conditions is provided below. Logs of the explorations are provided in Appendix A.

Soil Conditions - Private Drive

Four of the five borings were completed along the private drive servicing the Elks Club. The pavement section included about 2-inches of asphalt over several inches of base course. Fill was observed below the pavement section in three of the borings (B-1, B-2, B-3). Fill below the pavement section consisted principally of silty clay, clayey silt, silty sand, with minor gravel or rock in a generally medium stiff condition. Fill extended to depths between about 2.5 to 14 feet.

An approximate 1-foot layer of wood debris mixed with topsoil was below the finer grained fill in boring B-2 between 3.5 to 4.5 feet.

Native soil below the fill was clayey silt to silty clay. These soils were in a medium stiff to stiff condition and extended to the termination depth of the borings.

Soil Conditions – 12-acre Site

Explorations in the 12-acre site consisted of one boring and six test pits. Topsoil was typically encountered at the surface and extended to about 1 foot. Localized fill of mixed silt, sand, rock and debris was observed in a couple of the test pits and likely associated with previous logging activities. The presence and thickness of localized fill should be variable across the site.

Native soil below the topsoil or fill was clayey silt to silty clay. These soils were in a medium stiff to stiff condition and extended to the termination depth of the explorations in the 12-acre site.

Groundwater Conditions

Groundwater and/or seepage was observed in one of the deeper borings (B-3) at a depth of about 18 feet, with some seepage in test pit TP-1 at about 4 feet. This test pit was near a drainage swale in the higher elevated eastern portion of the site. Groundwater/seepage was not observed in the remaining explorations at the time of excavation. However, native soils are considered impermeable and can create perched groundwater, particularly during the wetter seasons of the year. Groundwater levels will vary throughout the year based on seasonal precipitation and on- and off-site drainage patterns.

Geologic Setting

Two native soils are mapped in the project limits per the USDA Soil Conservation Service of Lewis County. Melbourne loam is mapped over most of the site, with lesser Buckwheat silt loam. These soils reportedly formed in residuum from siltstone and sandstone. Native soils in the test pits appear to conform to the mapped soil type.

GEOTECHNICAL DESIGN CONSIDERATIONS

Planned development is considered feasible based on observed soil conditions in the explorations. Firm native soils are considered suitable for support of planned buildings and new roads. However, planned road improvements over observed undocumented fill creates conditions that make future road sections susceptible to settlement in the existing Elks Club access road. Typically, over-excavation of fill and replacement with a zone of granular structural fill would be used to improve road subgrades.

Recommendations presented in the following sections should be considered general and may require modifications when final site layout is developed and earthwork and grading occur. They are based upon the subsurface conditions observed in the explorations and the assumption that finish site grades will be similar to existing grades. It should be noted that subsurface conditions across the site may vary from those depicted on the exploration logs and can change with time. Therefore, proper site preparation will depend upon the weather and soil conditions encountered at the time of construction. We recommend that SSGC review final plans and further assess subgrade conditions at the time of construction, as warranted.

General Site Preparation

Site grading and earthwork should include procedures to control surface water runoff. Grading the site without adequate drainage control measures may negatively impact site soils, resulting in increased export of impacted soil and import of fill materials, potentially increasing the cost of the earthwork and subgrade preparation phases of the project.

Site grading in the 12-acre parcel should include removal (stripping) of topsoil and debris rich fill in new building and pavement areas. Subgrades should consist of firm native soils following stripping. Stripping depth will vary across the site. Final stripping depths can only be determined at the time of construction.

Observed fill thickness extended to 14 feet in the borings along the existing Hampe Way access alignment and may be thicker in other areas. This fill is interpreted to consist of excavated side-cast material from the higher east side of the road placed during original construction. We are unaware of placement methods and compaction efforts during fill placement. As such, it is recommended that all existing fill is removed within the existing road alignment to firm native soil and replaced with structural fill. However, we recognize that substantial costs for total removal may be prohibitive for the development. If the owner is willing to accept the risk of potential reduced pavement life and added replacement/maintenance costs, lesser amounts of existing fill could be considered. We would recommend at least 5 feet of existing fill is removed in the access road alignment. Exposed subgrades following stripping should be prepared as described in the subgrade preparation section below.

General Subgrade Preparation

Subgrades in building and pavement areas should consist of firm soil. We recommend exposed subgrades in building and pavement areas are proofrolled using a large roller, loaded dump truck, or other mechanical equipment to assess subgrade conditions following stripping. Proofrolling efforts should result in the upper 1 foot of subgrade soils achieving a firm and unyielding condition and a compaction level of at least 92 percent of the maximum dry density (MDD) per the ASTM D1557 test method. Wet, loose, organic rich, or soft subgrades that cannot achieve a firm and unyielding condition should be removed (over-excavated) and replaced with structural fill. The depth of over-excavation should be based on soil conditions at the time of construction. A representative of SSGC should be present to assess subgrade conditions during proofrolling.

Grading and Drainage

Positive drainage should be provided during construction and maintained throughout the life of the development. Allowing surface water into cut or fill areas, utility trenches, and building footprints should be prevented.

Structural Fill Materials

The suitability of soil for use as structural fill will depend on the gradation and moisture content of the soil when it is placed. Soils with higher fines content (soil fraction passing the U.S. No. 200 sieve) will become sensitive with higher moisture content. It is often difficult to achieve adequate compaction if soil moisture is outside of optimum ranges for soils that contain more than about 5 percent fines.

> <u>Site Soils:</u> Observed fill and native soils are fine grained (principally silt and clay) making them are moisture sensitive and would be difficult to use as structural fill unless conditioned to optimum moisture content. Optimum moisture is considered within about +/- 2 percent of the moisture content required to achieve the maximum density per the ASTM D-1557 test method. If moisture content is higher or lower than optimum, soils would need to be dried or wetted prior to placement as structural fill.
>
> <u>Import Fill Materials:</u> We recommend import structural fill placed during dry weather periods consist of material which meets the specifications for *Gravel Borrow* as described in Section 9-03.14(1) of the Washington State Department of Transportation (WSDOT) Specifications for Road, Bridge, and Municipal Construction (Publication M41-10). Gravel Borrow should be protected from disturbance if exposed to wet conditions after placement.
>
> During wet weather, or for backfill on wet subgrades, import soil suitable for compaction in wetter conditions should be provided. Imported fill for use in wet conditions should generally conform to specifications for *Select Borrow* as described in Section 9-03.14(2), or *Crushed Surfacing* per Section 9-03.9(3) of the WSDOT M41-10 manual, with the modification that a maximum of 5 percent by weight shall pass the U.S. No. 200 sieve.
>
> It should be noted that structural fill placement and compaction is weather-dependent. Delays due to inclement weather are common, even when using select granular fill. We recommend site grading and earthwork be scheduled for the drier months of the year. Structural fill should not consist of frozen material.

Structural Fill Placement

We recommend structural fill is placed in lifts not exceeding about 10 inches in loose measure. It may be necessary to adjust lift thickness based on site and fill conditions during placement and compaction. Finer grained soil used as structural fill and/or lighter weight compaction equipment may require significantly thinner lifts to attain required compaction levels. Granular soil with lower fines contents could potentially be placed in thicker lifts if they can be adequately compacted. Structural fill should be compacted to attain the recommended levels presented in Table 1, Compaction Criteria.

Table 1. Compaction Criteria

Fill Application	Compaction Criteria*
Footing areas (below structures and retaining walls)	95 %
Upper 2 feet in pavement areas, slabs and sidewalks, and utility trenches	95 %
Below 2 feet in pavement areas, slabs and sidewalks, and utility trenches	92 %
Utility trenches or general fill in non-paved or -building areas	90 %

*Per the ASTM D 1557 test method.

Trench backfill within about 2 feet of utility lines should not be over-compacted to reduce the risk of damage to the line. In some instances, the top of the utility line may be within 2 feet of the surface. Backfill in these circumstances should be compacted to a firm and unyielding condition.

We recommend fill procedures include maintaining grades that promote drainage and do not allow ponding of water within the fill area. The contractor should protect compacted fill subgrades from disturbance during wet weather. In the event of rain during structural fill placement, the exposed fill surface should be allowed to dry prior to placement of additional fill. Alternatively, the wet soil can be removed. We recommend consideration be given to protecting haul routes and other high traffic areas with free-draining granular fill material (i.e. sand and gravel containing less than 5 percent fines) or quarry spalls to reduce the potential for disturbance to the subgrade during inclement weather.

Structural fill placed on sloping ground should be constructed using a benched (stairstep) methodology. Benches should be cut level or with a slight downward incline into the slope in firm native soil. Benches should be at least 3 feet wide and wide enough to accommodate compaction equipment and be a maximum of two feet high.

Earthwork Procedures

Conventional earthmoving equipment should be suitable for earthwork at this site. Earthwork may be difficult during periods of wet weather or if elevated soil moisture is present. Excavated site soils may not be suitable as structural fill depending on the soil moisture content and weather conditions at the time of earthwork. If soils are stockpiled and wet weather is anticipated, the stockpile should be protected with securely anchored plastic sheeting. If stockpiled soils become unusable, it may become necessary to import clean, granular soils to complete wet weather site work.

Wet or disturbed subgrade soils should be over-excavated to expose firm, non-yielding, non-organic soils and backfilled with compacted structural fill. We recommend the earthwork portion of this project be completed during extended periods of dry weather. If earthwork is completed during the wet season (typically late October through May) it may be necessary to take extra measures to protect subgrade soils.

If earthwork takes place during freezing conditions, we recommend exposed subgrades are allowed to thaw and re-compacted prior to placing subsequent lifts of structural fill. Alternatively, the frozen soil can be removed to unfrozen soil and replaced with structural fill.

The contractor is responsible for designing and constructing stable, temporary excavations (including utility trenches) as required to maintain stability of excavation sides and bottoms. Excavations should be sloped or shored in the interest of safety following local and federal regulations, including current OSHA excavation and trench safety standards. Temporary excavation cuts should be sloped at inclinations of 1H:1.5V (Horizontal:Vertical) or flatter, unless the contractor can demonstrate the safety of steeper inclinations. Shoring may be required in deeper excavations (below 4 feet) as soft soils may cave into open excavations.

A geotechnical engineer and accredited material testing laboratory should be retained during the construction phase of the project to observe earthwork operations and perform necessary tests and observations during subgrade preparation, placement and compaction of structural fill, and backfilling of excavations.

Foundations

We recommend foundations are placed on a zone of granular structural fill above prepared native subgrade soils prepared as described in this report. This zone should be a minimum of 6-inches thick and compacted to a firm and unyielding condition. The purpose of the structural fill pad is to limit disturbance to the fine grained native soils during forming for footings. The following recommendations are for conventional spread footing foundations:

Bearing Capacity (net allowable): 2,000 pounds per square foot (psf) for foundations supported on native soils prepared as described in this report.

Footing Width (Minimum): 18 inches (Strip)
24 inches (Column)

Embedment Depth (Minimum): 18 inches (Exterior)
12 inches (Interior)

Settlement: Total: < 1.5 inch
Differential: < 1/2 inch (over 30 feet)

Allowable Lateral Passive Resistance: 325 psf/ft* (below 18 inches)

Allowable Coefficient of Friction: 0.35*

*These values include a factor of safety of approximately 1.5.

The net allowable bearing pressures presented above may be increased by one-third to resist transient, dynamic loads such as wind or seismic forces. Lateral resistance to footings should be ignored in the upper 12-inches from exterior finish grade. Although conventional spread footings could be used for support of the building, the owner should be aware that additional differential settlement could occur.

Foundation Construction Considerations

All foundation subgrades should be free of water and loose soil prior to placing concrete and should be prepared as recommended in this report. Concrete should be placed soon after excavating and compaction to reduce disturbance to bearing soils. Should soils at foundation level become excessively dry, disturbed, saturated, or frozen, the affected soil should be removed prior to placing concrete. We recommend SSGC observe all foundation subgrades prior to placement of concrete.

Foundation Drainage

Ground surface adjacent foundations should be sloped away from the building. We recommend footing drains are installed around perimeter thickened edge footings. Footing drains should include a minimum 4-inch diameter perforated rigid plastic drain line installed at the base of the footing. The perforated drain lines should be connected to a tight line pipe that discharges to an approved storm drain receptor. The drain line should be surrounded by a zone of clean, free-draining granular material having less than 5 percent passing the No. 200 sieve or meeting the requirements of section 9-03.12(2) "Gravel Backfill for Walls" in the 2018 WSDOT Standard Specifications for Road, Bridge, and Municipal Construction manual (M41-10). The free-draining aggregate zone should be at least 12 inches wide and wrapped in filter fabric. The granular fill should extend to within 6 inches of final grade where it should be capped with compacted fill containing sufficient fines to reduce infiltration of surface water into the footing drains. Cleanouts are recommended for maintenance of the drain system.

On-Grade Floor Slabs

On-grade floor slabs should be placed on prepared subgrades as described in this report. We recommend a modulus subgrade reaction of 125 pounds per square inch per inch (psi/in) for floor slabs on subgrade soils.

We recommend a capillary break is provided between the prepared subgrade and bottom of slab. Capillary break material should be a minimum of 4 inches thick and consist of compacted clean, free-draining, well graded coarse sand and gravel. The capillary break material should contain less than 5 percent fines, based on that soil fraction passing the U.S. No. 4 sieve. Alternatively, a clean angular gravel such as No. 7 aggregate per Section 9-03.1(4)C of the 2018 WSDOT (M41-10) manual could be used for this purpose.

Seismic Considerations

Seismic parameters and values in Table 2 are recommended based on the 2018 International Building Code (IBC).

Table 2. Seismic Parameters

PARAMETER	VALUE
2018 International Building Code (IBC) Site Classification[1]	E
S_s Spectral Acceleration for a Short Period	1.196
S_1 Spectral Acceleration for a 1-Second Period	0.487g

[1] Note: In general accordance with the *2018 International Building Code,* for risk categories I,II,III. IBC Site Class is based on the estimated characteristics of the upper 100 feet of the subsurface profile.

Liquefaction

Soil liquefaction is a condition where loose, typically granular soils located below the groundwater surface lose strength during ground shaking, and is often associated with earthquakes. The risk of liquefaction at this site is considered low due to the overall fine-grained nature of native site soils and underlying bedrock.

Lateral Earth Pressures

We anticipate basement or retaining walls will be used due to sloping ground across the site. Below grade walls will be subject to lateral earth pressures. Subgrade walls are typically designed for “active” or “at-rest” earth pressure conditions. Active earth pressure is commonly used for design of free-standing cantilever retaining walls and assumes lateral movement at the top of the wall of around 0.002H to 0.004H, where H is the height of the wall. The at-rest condition assumes no wall movement.

The following recommended earth pressures (Table 3) should be applied as a triangular distribution starting at the top of the wall (for active and at-rest pressures). Passive pressures should be ignored in the upper 12 inches below the ground surface at the bottom of wall unless restrained by pavement. Recommended lateral pressures assume:

- Backfill behind walls is level and no surcharge loads will be applied;
- Drainage is provided behind the wall to prevent the development of hydrostatic pressures.

Table 3. Lateral Earth Pressures

Soil Type	Earth Pressure Coefficient*	Equivalent Fluid Pressure (pcf)*
Native Clayey Silt/Silty Clay	Active: 0.32 At-rest: 0.44 Passive: 3.00	Active: 35 At-rest: 50 Passive: 325

Additional lateral pressure should be added to these values to model surcharges such as sloped backfill traffic and temporary construction loads behind the walls, and seismic loads. We recommend an active seismic pressure of 9H psf (where H is the height of the subgrade wall) and an at-rest seismic pressure of 16H. The effects of other surcharge loads should be accounted for as appropriate.

Wall Backfill

Backfill behind retaining walls should consist of granular material that satisfies the criteria of Section 9-03.12(2) "Gravel Backfill for Walls" per the WSDOT (M41-10) manual, or as approved by the engineer.

Wall backfill should be placed in lifts not exceeding 8 inches and compacted with hand-operated compaction equipment. Compaction of wall backfill should be between 90 to 92 percent of the maximum dry density (MDD) per the ASTM D1557 test method within 3 feet of the back of the wall. At a distance greater than 3 feet behind the back of the wall, backfill can be compacted using conventional rollers, with backfill compacted to at least 92 percent of the MDD (ASTM D1557).

Wall Drainage

Drainage should be provided behind subgrade walls to reduce the potential for hydrostatic pressure developing against the wall and to reduce the risk of groundwater from entering subgrade floors. We recommend a minimum 12-inch wide zone of free draining granular soil (WSDOT Section 9-03.12(4), or as approved by the engineer) is placed directly behind the wall. Alternatively, a drainage mat can be used behind the wall. A perforated rigid plastic drainpipe at least 6-inches in diameter should be installed behind the base of the wall within 6-inches of the bottom of the footing. The drain line should be surrounded with the free-draining granular soil zone and sloped to provide flow to an approved storm water receptor. The granular fill zone should extend to within 1 foot of final grade of the wall, where it should be capped with compacted low permeable fill containing sufficient fines to reduce infiltration of surface water into the drainage zone. A filter fabric (such as Mirafi 140N, or other approved material) should be placed between native soils and the granular drain material to limit siltation into the drainage zone. Cleanouts are recommended for maintenance of the drain system.

Conventional Asphalt Pavement Sections

Subgrades for conventional pavement areas should be prepared as described in the "*Subgrade Preparation*" section of this report. Subgrades below pavement sections should be graded or crowned to promote drainage and not allow for ponding of water beneath the section. If drainage is not provided and ponding occurs, subgrade soils could become saturated, lose strength, and result in premature distress or failure of the section. In addition, the pavement surfacing should also be graded to promote drainage and reduce the potential for ponding of water on the pavement surface.

We recommend a separation fabric (such as Mirafi 140N) is placed on new pavement subgrades that consist of native clayey silt prior to placement of structural or pavement section fill. The purpose of the fabric is to provide segregation between new granular structural fill and the finer grained subgrade soil. Without the fabric, the new granular fill will have the tendency to migrate into the softer subgrade soil over time, which can compromise the structural integrity of the structural fill zone leading to premature distress of the pavement section.

Minimum recommended pavement sections for conventional asphalt pavements are presented in Table 3. New pavement sections in public right-of-ways should conform to City of Centralia standards.

Table 3. Minimum Pavement Sections

Traffic Area	Minimum Recommended Pavement Section Thickness (inches)			
	Asphalt Concrete Surface[1]	Portland Cement Concrete[2]	Aggregate Base Course[3,4]	Subbase Aggregate[5]
Access Roads	3	6	4	12
Driveways/Parking	2	5	4	12

[1] 1/2 –inch nominal aggregate hot-mix asphalt (HMA) per WSDOT 9-03.8(1)

[2] A 28-day minimum compressive strength of 4,000 psi and an allowable flexural strength of at least 250 psi

[3] Crushed Surfacing Base Course per WSDOT 9-03.9(3)

[4] Although not required for structural support under concrete pavements, a minimum four-inch-thick base course layer is recommended to help reduce potential for slab curl, shrinkage cracking, and subgrade "pumping" through joints

[5] 95% compacted native subgrade or Gravel Borrow per WSDOT 9-03.14(1) or Crushed Surfacing Base Course WSDOT 9-03.9(3)

Conventional Pavement Maintenance

The performance and lifespan of pavements can be significantly impacted by future maintenance. The above pavement sections represent minimum recommended thicknesses and, as such, periodic maintenance should be completed. Proper maintenance will slow the rate of pavement deterioration and will improve pavement performance and life. Preventive maintenance consists of both localized maintenance (crack and joint sealing and patching) and global maintenance (surface sealing). Added maintenance measures should be anticipated over the lifetime of the pavement section if any fill or topsoil is left in-place beneath pavement sections.

REPORT CONDITIONS

This report has been prepared for the exclusive use of RB Engineering for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices in the area. No warranties, either express or implied, are intended or made. The analysis and recommendations presented in this report are based on observed soil conditions and test results at the indicated locations, and from other geologic information discussed. This report does not reflect variations that may occur across the site, or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

This report was prepared for the planned type of development of the site as discussed herein. It is not valid for third party entities or alternate types of development on the site without the express written consent of SSGC. If development plans change, we should be notified to review those changes and modify our recommendations as necessary.

The scope of services for this project does not include any environmental or biological assessment of the site including identification or prevention of pollutants, hazardous materials, or conditions. Other studies should be completed if the owner is concerned about the potential for contamination or pollution.

We appreciate the opportunity to work with you on this project. Please contact us if additional information is required or we can be of further assistance.

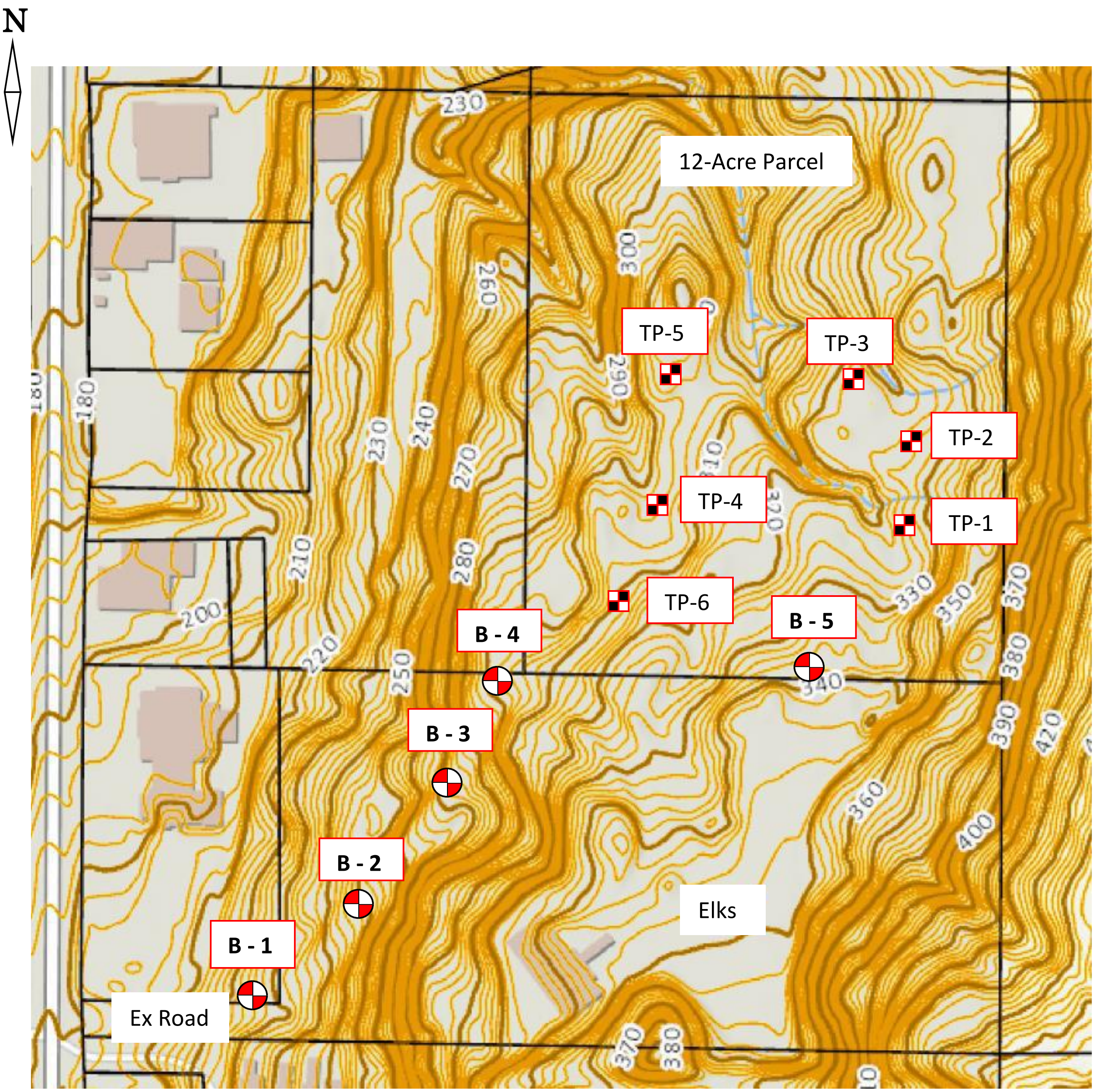
Respectfully,

South Sound Geotechnical Consulting

9-20-22

Timothy H. Roberts, P.E.
Member/Geotechnical Engineer

Attachments: Figure 1 – Exploration Plan
Appendix A – Field Exploration Procedures and Test Pit Logs
Unified Soil Classification System



Legend

B- 1

Approximate Boring Location

TP - 1

Approximate Test Pit Location

No Scale

Base map from drawing by RB Engineering

South Sound Geotechnical Consulting
P.O. Box 39500
Lakewood, WA 98496
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Figure 1 – Exploration Plan

Hampe Way Improvements – 12 Acre Development Centralia, WA

SSGC Project #22027

Appendix A

Field Exploration Procedures and Exploration Logs

Field Exploration Procedures

Our field exploration for this project included five borings completed on April 4, 2022 and six test pits completed on May 26, 2022. The approximate locations of the explorations are shown on Figure 1, Exploration Plan. Exploration locations were determined by pacing from site features. Exploration locations should be considered accurate only to the degree implied by the means and methods used.

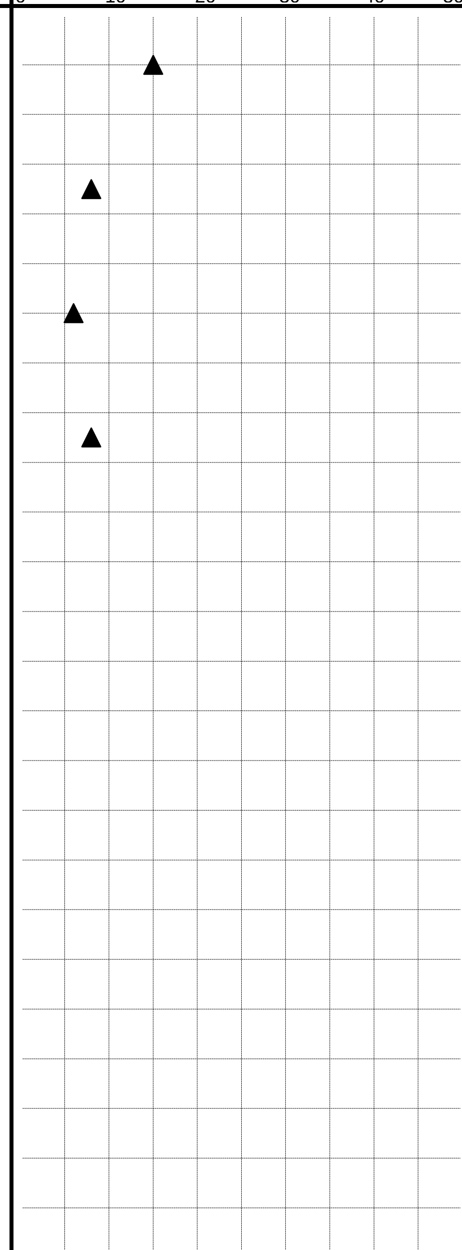
A private excavation contractor dug the test pits. A private drilling company drilled the borings. Select soil samples were collected and stored in moisture tight containers for further assessment and laboratory testing. Test pits were backfilled with excavated soils and tamped when completed. The driller was responsible for backfilling borings in compliance with Washington DOE requirements. A surface asphalt cold patch was placed in the borings in pavement areas. Please note that backfill in the explorations may settle with time. Backfill material in test pits located in building or pavement areas should be re-excavated and recompacted, or replaced with structural fill.

The following logs indicate the observed lithology of soils and other materials observed in the explorations at the time of excavation. Where a soil contact was observed to be gradational, our log indicates the average contact depth. Our logs also indicate the approximate depth to groundwater (where observed at the time of excavation), along with sample numbers and approximate sample depths. Soil descriptions on the logs are based on the Unified Soil Classification System.

PROJECT: Hampe Way Extension **JOB NO.** 22027 **BORING** B-1 **PAGE 1 OF** 1

Location: Centralia, Washington **Approximate Elevation:** 39 feet

Depth (ft)	Soil Description	Sample Interval	Sample Number	Ground Water	Penetration Resistance (▲ Standard / △ Other, Blows per foot)	N-values	Testing
0–2	**2.5 " asphalt over 3" base course over Fill: Silty SAND:** Medium dense, moist, brown.		S-1			15	
2–9	**Clayey SILT/Silty CLAY:** Medium stiff, moist, gray. (ML/CL)		S-2			8	
			S-3			6	
			S-4			8	
9–25	Boring completed at approximately 9 feet on 4/4/22. Groundwater not observed at time of drilling.						



Explanation

2-inch O.D. split spoon sample

3-inch I.D Shelby tube sample

No Recovery

ATD Groundwater level at time of drilling or date of measurement

Monitoring Well Key

- Clean Sand
- Cuttings
- Bentonite
- Grout
- Screened Casing

Moisture Content

Plastic Limit — **Natural** — **Liquid Limit**

South Sound Geotechnical Consulting	**BORING LOG**	**Boring B-1**
	Date Drilled: 4/4/22	**Logged By: THR**

PROJECT: Hampe Way Extension	**JOB NO.** 22027	**BORING** B-2	**PAGE 1 OF 1**
Location: Centralia, Washington	**Approximate Elevation:** 263 feet		

Depth (ft)	Soil Description	Sample Interval	Sample Number	Ground Water	Penetration Resistance (Standard / Other; Blows per foot, 0–50)	N-values	Testing
0	**2" asphalt over 3" base course over Fill: Clayey Silt/Silty Clay with some rocks:** Medium stiff, moist, brown.	I	S-1		▲	8	
	Wood debris and topsoil	I	S-2		▲	9	
5	**Clayey SILT/Silty CLAY:** Medium stiff, moist, gray. (ML/CL)	I	S-3		▲	8	
		I	S-4		▲	6	
10	Boring completed at approximately 9 feet on 4/4/22. Groundwater not observed at time of drilling.						
15							
20							
25							

Explanation

- 2-inch O.D. split spoon sample
- 3-inch I.D Shelby tube sample
- No Recovery
- Groundwater level at time of drilling or date of measurement (ATD)

Monitoring Well Key

- Clean Sand
- Cuttings
- Bentonite
- Grout
- Screened Casing

Moisture Content

Plastic Limit — **Natural** — **Liquid Limit**

South Sound Geotechnical Consulting	BORING LOG	Boring B-2
	Date Drilled: 4/4/22	Logged By: THR

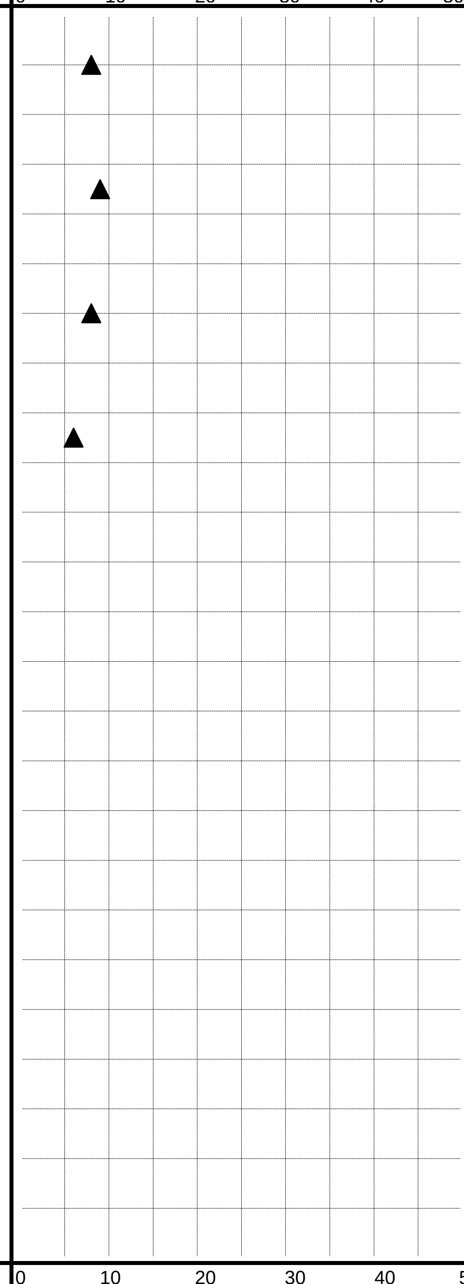
PROJECT: Hampe Way Extension | **JOB NO.** 22027 | **BORING** B-3 | **PAGE 1 OF 1**

Location: Centralia, Washington | **Approximate Elevation:** 290 feet

Depth (ft)	Soil Description	Sample Interval	Sample Number	Ground Water	N-values	Testing
0–1	**2" asphalt over 3" base course over Fill: Clayey Silt/Silty Clay:** Medium stiff, moist, grayish brown.	I	S-1		6	
3		I	S-2		7	
5–6		I	S-3		7	
8		I	S-4		11	
10	Some sand, brown.	I	S-5			
15	**Silty CLAY:** Medium stiff, moist, mottled orange gray. (CL)					
16		I	S-6		6	
18	Grades wet.			▼ ATD		
21		I	S-7		5	
22	Boring completed at approximately 21.5 feet on 4/4/22. Groundwater observed at about 18 feet at time of drilling.					
25						

Penetration Resistance

▲ Standard — Blows per foot — △ Other



Explanation

- I — 2-inch O.D. split spoon sample
- II — 3-inch I.D Shelby tube sample
- ⊗ — No Recovery
- ▼ ATD — Groundwater level at time of drilling or date of measurement

Monitoring Well Key

- Clean Sand
- Cuttings
- Bentonite
- Grout
- Screened Casing

Moisture Content

Plastic Limit — Natural — Liquid Limit

South Sound Geotechnical Consulting	BORING LOG	Boring B-3
	Date Drilled: 4/4/22	Logged By: THR

PROJECT: Hampe Way Extension **JOB NO.** 22027 **BORING** B-4 **PAGE 1 OF 1**

Location: Centralia, Washington **Approximate Elevation:** 303 feet

Depth (ft)	Soil Description	Sample Interval	Sample Number	Ground Water	Penetration Resistance (Standard / Other, Blows per foot, 0–50)	N-values	Testing
0	**2" asphalt over 3" base course over crushed rock**						
	Clayey SILT/Silty CLAY: Stiff, moist, gray. (ML/CL)	I	S-1		▲	50	
		I	S-2		▲	15	
5		I	S-3		▲	11	
		I	S-4		▲	9	
10	Boring completed at approximately 9 feet on 4/4/22. Groundwater not observed at time of drilling.						
15							
20							
25							

Explanation

- I — 2-inch O.D. split spoon sample
- II — 3-inch I.D Shelby tube sample
- ⊗ — No Recovery
- ▼ ATD — Groundwater level at time of drilling or date of measurement

Monitoring Well Key

- Clean Sand
- Cuttings
- Bentonite
- Grout
- Screened Casing

Moisture Content (0–50)

Plastic Limit — **Natural** — **Liquid Limit**

South Sound Geotechnical Consulting	**BORING LOG**	**Boring B-4**
	Date Drilled: 4/4/22	**Logged By: THR**

PROJECT: Hampe Way Extension | **JOB NO.** 22027 | **BORING** B-5 | **PAGE 1 OF 1**

Location: Centralia, Washington | **Approximate Elevation:** 340 feet

Depth (ft)	Soil Description	Sample Interval	Sample Number	Ground Water	Penetration Resistance (Blows per foot; ▲ Standard, △ Other; 0–50)	N-values	Testing
0	**Topsoil**						
1	**Clayey SILT/Silty CLAY:** Stiff, moist, brown. (ML/CL)						
3.5		I	S-1		▲	11	
6	Grades orange gray	I	S-2		▲	10	
8.5		I	S-3		▲	10	
11		I	S-4		▲	10	
12.5	Grades gray						
16		I	S-5		▲	10	
16.5	Boring completed at approximately 16.5 feet on 4/4/22. Groundwater not observed at time of drilling.						
20							
25							

Explanation

- I — 2-inch O.D. split spoon sample
- II — 3-inch I.D Shelby tube sample
- ⊗ — No Recovery
- ▼ ATD — Groundwater level at time of drilling or date of measurement

Monitoring Well Key

- Clean Sand
- Cuttings
- Bentonite
- Grout
- Screened Casing

Moisture Content (0, 10, 20, 30, 40, 50)

Plastic Limit — **Natural** — **Liquid Limit**

South Sound Geotechnical Consulting | **BORING LOG** | **Boring B-5**
Date Drilled: 4/4/22 | **Logged By: THR**

Test Pit TP-1

Depth (feet)	Material Description
0 – 4	**Fill:** Silt, sand, gravel, wood debris, stone: Loose, moist to wet, brown, gray, dark brown.
4 – 9	Clayey SILT/Silty CLAY with some fine sand: Medium stiff, moist to wet, gray. (ML/CL)

Test pit completed at approximately 9 feet on 5/26/22.
Seepage observed at about 4 feet at time of excavation.

Test Pit TP-2

Depth (feet)	Material Description
0 – 1	**Topsoil**
1 – 10	Silt and sand with some clay (Weathered Bedrock): Stiff to very stiff, blocky, damp, orange-brown.

Test pit completed at approximately 10 feet on 5/26/22.
Groundwater not observed at time of excavation.

Test Pit TP-3

Depth (feet)	Material Description
0 – 1	**Topsoil**
1 – 8	Clayey SILT with some fine sand: Stiff, moist, mottled orange gray. (ML)

Test pit completed at approximately 8 feet on 5/26/22.
Groundwater not observed at time of excavation.

Test Pit TP-4

Depth (feet)	Material Description
0 – 1	**Topsoil**
1– 6	Clayey SILT/Silty CLAY with some fine sand: Soft, wet, mottled orange gray. (ML/CL)
	Test pit completed at approximately 6 feet on 5/26/22. Groundwater not observed at time of excavation.

Test Pit TP-5

Depth (feet)	Material Description
0 – 1.5	**Fill:** Clayey SILT: Soft, moist, brown to gray.
1.5 – 4	Clayey SILT/Silty CLAY with some fine sand: Soft, wet, mottled orange gray. (ML/CL)
4 – 6	Silt and sand with some clay (Weathered Bedrock): Stiff to very stiff, blocky, damp, orange-brown.
	Test pit completed at approximately 6 feet on 5/26/22. Groundwater not observed at time of excavation.

Test Pit TP-6

Depth (feet)	Material Description
0 – 1	**Topsoil**
1 – 4	Silt and sand with some clay (Weathered Bedrock): Stiff to very stiff, blocky, damp, orange-brown.
	Test pit completed at approximately 4 feet on 5/26/22. Groundwater not observed at time of excavation.

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]				Soil Classification: Group Symbol	Soil Classification: Group Name[B]
Coarse Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines[C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$[E]	GW	Well-graded gravel[F]
			$Cu < 4$ and/or $1 > Cc > 3$[E]	GP	Poorly graded gravel[F]
		Gravels with Fines More than 12% fines[C]	Fines classify as ML or MH	GM	Silty gravel[F,G,H]
			Fines classify as CL or CH	GC	Clayey gravel[F,G,H]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines[D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$[E]	SW	Well-graded sand[I]
			$Cu < 6$ and/or $1 > Cc > 3$[E]	SP	Poorly graded sand[I]
		Sands with Fines More than 12% fines[D]	Fines classify as ML or MH	SM	Silty sand[G,H,I]
			Fines Classify as CL or CH	SC	Clayey sand[G,H,I]
Fine-Grained Soils 50% or more passes the No. 200 sieve	Silts and Clays Liquid limit less than 50	inorganic	$PI > 7$ and plots on or above "A" line[J]	CL	Lean clay[K,L,M]
			$PI < 4$ or plots below "A" line[J]	ML	Silt[K,L,M]
		organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OL	Organic clay[K,L,M,N]
					Organic silt[K,L,M,O]
	Silts and Clays Liquid limit 50 or more	inorganic	PI plots on or above "A" line	CH	Fat clay[K,L,M]
			PI plots below "A" line	MH	Elastic Silt[K,L,M]
		organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OH	Organic clay[K,L,M,P]
					Organic silt[K,L,M,Q]
Highly organic soils	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-in. (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10} \quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] $PI \geq 4$ and plots on or above "A" line.

[O] $PI < 4$ or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.