May 5, 2016

AHBL
2215 North 30th Street, Suite 200
Tacoma, Washington 98403-3350

Attention: Mr. Lucas Johnson, P.E.

Subject: Geotechnical Engineering Report
Larson River Road Storage
Puyallup, Washington
SSGC Project No. 16025

Mr. Johnson,

South Sound Geotechnical Consulting (SSGC) has completed a geotechnical assessment for planned improvements to the Larson vehicle storage site on River Road in Puyallup, Washington. Our services have been completed in general conformance with our proposal (P16014) dated March 10, 2016 and authorized per AHBL subconsultant agreement dated March 22, 2016. Our scope of services included excavation of four test pits on the site, two infiltration test holes, engineering analyses, and preparation of this report.

PROJECT INFORMATION

The car storage lot is located on the south side of the 1600 block of River Road. Plans include paving the site with conventional HMA asphalt concrete. Stormwater control will include infiltration facilities, if feasible.

SITE CONDITIONS

The site is undeveloped and mostly covered with grass and isolated gravel areas. An existing pond several feet deep is in the center-western portion of the site with a manhole near the southern end of the pond. Overall, the site is generally level with an estimated elevation change of less than 2 feet, with the exception of the pond. Several catch basins are present in the yard area.

SUBSURFACE CONDITIONS

Subsurface conditions were characterized by completing four (4) test pits and two (2) infiltration test holes on March 30, 2016. Approximate location of the test sites are shown on Figure 1, Exploration Plan. A summary description of observed subgrade conditions is provided below.

Soil Conditions

Topsoil was below the surface in test pits TP-1 through TP-3 and extended to depths between about 6 to 8 inches. Loose crushed gravel fill was at the surface in test pit TP-4 and extended to a depth of about 1 foot. Fill consisting of silty sand to sand with silt and gravel was observed in the infiltration test holes and extended to depths between 1 and 2 feet. An approximate 6 inch topsoil layer was below the fill in infiltration test IT-1.

Native silty fine sand was below the topsoil (or fill) in the test pits. This soil was in a loose condition and extended to depths ranging from 1 to 3 feet below the surface. Medium stiff silt with fine sand and clay was observed below the silty sand and continued to the bottom of the test pits at depths between 5.5 to 6.5 feet below the surface. Similar native soils were observed in the infiltration test holes.

Groundwater Conditions

Groundwater or seepage was observed at depths of about 4.5 to 5.5 feet in the test pits at the time of excavation. It should be anticipated that groundwater levels will fluctuate due to seasonal precipitation and on- and off-site drainage patterns.

Geologic Setting

The USDA Soil Conservation Service Soil Map of Pierce County, Washington (1977) shows soils in this part of ~~Eatonville~~ Puyallup mapped as Puyallup fine sandy loam. This soil reportedly formed in sandy mixed alluvium on natural levees. Native soils in the test holes appear to generally conform to the mapped soil type.

GEOTECHNICAL DESIGN CONSIDERATIONS

Paving of the storage area is considered feasible based on observed soil conditions in the test pits completed. Conventional HMA pavements are suitable over properly prepared subgrades and gravel bases. However, infiltration test results and a relatively high groundwater table suggest infiltration for stormwater control is not feasible at this site.

Recommendations presented in the following sections should be considered general and may require modifications when earthwork and grading occur. They are based upon the subsurface conditions observed in the test pits and our understanding 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 and slope conditions at the time of construction, as warranted.

General Site Preparation

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

Site grading should include removal (stripping) of existing fill and topsoil. We anticipate stripping depths to range from about 6 inches to 2 feet based on observed soils in the excavations, but should average less than 1 foot. Pavements subgrades should consist of native firm soils.

General Subgrade Preparation

Following stripping we recommend that exposed subgrades are proofrolled using a large roller, loaded dump truck, or other equipment to assess subgrade conditions. Proofrolling efforts should result in the upper 1 foot of subgrade soils achieving a compaction level of at least 95 percent of the maximum dry density (MDD) per the ASTM D1557 test method. Wet, loose, or soft subgrades that cannot achieve this compaction level should be removed and replaced with structural fill. 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 road subgrades or utility trenches 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 condition for soils that contain more than about 5 percent fines.

> <u>Site Soils:</u> Site soils will be very difficult to use as structural fill as the amount of fines (silt and clay) observed will make them moisture sensitive. They potentially could be used if allowed to dry to within optimal 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 consist of material which meets the specifications for *Gravel Borrow* as described in Section 9-03.14(1) of the 2014 Washington State Department of Transportation (WSDOT) Specifications for Road,

Bridge, and Municipal Construction (Publication M 41-10). 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 2014 WSDOT M-41 manual, with the modification that a maximum of 5 percent by weight shall pass the U.S. No. 200 sieve for these soil types.

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 Placement

We recommend structural fill is placed in lifts not exceeding about 10 to 12 inches in loose measure. It may be necessary to adjust lift thickness based on site and fill conditions during placement and compaction. 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 should not consist of frozen material.

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 as the native fine grained soils will be easily disturbed. 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 the exposed subgrade be allowed to thaw and be 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 both the excavation sides and bottom. 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 1.5H:1V (Horizontal:Vertical) or flatter, unless the contractor can demonstrate the safety of steeper inclinations. Deeper excavations that extend into the lower wet soils may require shoring to limit caving and loss of ground.

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

Pavements

We understand concrete asphalt (HMA) pavements will be used. Subgrades for pavement areas should be prepared as described in the site and subgrade preparation, and structural fill sections of this report. Subgrade soils below pavements should be compacted to at least 95 percent of the maximum dry density (ASTM D 1557) within at least one foot of the base of the section. Subgrades below pavement sections should also 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, the subgrade soils could become saturated, lose strength, and result in premature distress to the pavement. In addition, the pavement surfacing should also be graded to promote drainage and reduce the potential for ponding of water on the pavement surface.

Pavement section design has been prepared and is based on AASHTO design guidelines and the following assumed design parameters:

- 15-year life span;
- Estimated design life Equivalent Single Axle Loads (18 kips) of 50,000;
- Estimated subgrade CBR of 3;
- Terminal serviceability of 2.0; and,
- Level of reliability 85 percent.

Minimum recommended pavement sections for conventional pavement areas include:

Table 2. Minimum Pavement Section

Traffic Area	**Minimum Recommended Pavement Section Thickness (inches)**			
	Asphalt Concrete Surface[1]	**Aggregate Base Course[2]**	**Subbase Aggregate[3]**	**Total**
Access and General Parking	3	6	6	15

[1] 1/2 –inch nominal aggregate hot-mix asphalt (HMA) per WSDOT 9-03.8(1)
[2] Crushed Surfacing Base Course per WSDOT 9-03.9(3)
[3]Gravel Borrow per WSDOT 9-03.14(1) or Crushed Surfacing Base Course WSDOT 9-03.9(3)

The above recommended pavement section should be considered a minimum. Added life expectancy could be improved by providing a geotextile separation fabric (such as Mirafi 140N) between the prepared subgrade and subbase aggregate fill, or providing a thicker granular fill (subbase or base course) section. The purpose of the separation fabric is to maintain segregation of materials and limit the potential of the coarser fill from migrating into the softer native subgrade which can reduce the structural integrity of the granular fill section. Final pavement sections should conform to applicable City of Puyallup (or Pierce County) pavement standards. The estimated CBR value may not be suitable depending on actual subgrades encountered during construction which could affect the pavement sections.

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 existing fill or topsoil is left in-place beneath pavement sections.

Infiltration Characteristics

Two (2) infiltration tests were performed in the proposed storm tract in the southern portion of the site. Tests were completed in general conformance with procedures outlined in the US EPA falling head procedure per the 2012 Pierce County Stormwater Management and Site Development Manual. The approximate locations of the tests are presented on Figure 1, Site Plan. Results of the infiltration tests are presented in Table 2.

Table 2. Infiltration Test Results

Infiltration Test No.	Depth of Test from surface (feet)	Uncorrected (Field) Infiltration Rate (in/hr)	Estimated Long-Term Infiltration Rate (in/hr)	Correction Factors* (Ft/Fg/Fp)
IT-1	3.5	0.51	0.11	(0.5/0.65/0.7)
IT-2	3.75	0.375	0.08	(0.5/0.65/0.7)

*Correction Factors from the 2012 Pierce County Stormwater Management and Site Development Manual.

Results of the tests show native site soils have very low infiltration potential. Additionally, the groundwater table was within 1 to 2 feet of the bottom of the infiltration test sites. As such, it is not considered feasible to utilize infiltration facilities at this site.

REPORT CONDITIONS

This report has been prepared for the exclusive use of Larson Automotive Group and AHBL 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.

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

5-5-16

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

Attachments: Figure 1 – Exploration Plan
Appendix A – Field Exploration Procedures
Unified Soil Classification System

Legend

TP - 1

Approximate Test Pit Location

IT - 1

Approximate Infiltration Test

Base map from Google Maps.

Scale: NTS

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Figure 1 – Exploration Plan

Larson River Road Storage
Puyallup, WA

SSGC Project #16025

Test Pit TP-1

Depth (feet)	Material Description
0 – 0.67	**Topsoil:** Sandy SILT with organics: Loose, moist, dark brown.
0.67 – 3	Silty fine SAND: Medium dense, moist, brown. (Sample S-1 @ 2.5 feet)
3 – 6.5	SILT with fine sand and clay: Medium stiff, moist, gray with orange mottling. (Sample S-2 @ 3.5 feet)

Test pit completed at approximately 6.5 feet on 3/30/16.
Groundwater observed at about 4.5 feet at time of excavation.
No caving observed at time of excavation.
Approximate surface elevation: 37 feet

Test Pit TP-2

Depth (feet)	Material Description
0 – 0.5	**Topsoil:** Sandy SILT with organics: Loose, moist, dark brown.
0.5 – 1	Silty fine SAND: Medium dense, moist, brown.
1 - 6	SILT with fine sand and clay: Medium stiff, moist, gray with orange mottling.

Test pit completed at approximately 6.5 feet on 3/30/16.
Groundwater observed at about 4.5 feet at time of excavation.
No caving observed at time of excavation.
Approximate surface elevation: 37 feet

Test Pit TP-3

Depth (feet)	Material Description
0 – 0.67	**Topsoil:** Sandy SILT with organics: Loose, moist, dark brown.
0.67 – 2	Silty fine SAND: Medium dense, moist, orange/gray.
2 - 6	SILT with fine sand and clay: Medium stiff, moist, mottled brown/gray. Fine sand seam between 4 and 5 feet. Grades wet at 4 feet.

Test pit completed at approximately 6 feet on 3/30/16.
Groundwater observed at about 5 feet at time of excavation.
No caving observed at time of excavation.
Approximate surface elevation: 37 feet

Test Pit TP-4

Depth (feet)	Material Description
0 – 1	**Fill:** Sandy GRAVEL: Loose, moist, gray.
1 – 2	Silty fine SAND: Medium dense, moist, orange/gray.
2 – 5.5	SILT with fine sand and clay: Medium stiff, moist, mottled brown/gray. Fine sand seam between 4.5 and 5 feet. Grades wet at 4.5 feet.

Test pit completed at approximately 5.5 feet on 3/30/16.
Groundwater observed at about 4.5 feet at time of excavation.
No caving observed at time of excavation.
Approximate surface elevation: 37 feet

Appendix A

Field Exploration Procedures

Field Exploration Procedures

Our field exploration for this project included four (4) test pits and two (2) infiltration test holes completed on March 30, 2016. The approximate locations of the explorations are shown on Figure 1, Exploration Plan. The exploration locations were determined by pacing from site features. Ground surface elevations referenced on the logs were inferred from a site plan figure prepared by AHBL. The locations and elevations should be considered accurate only to the degree implied by the means and methods used.

An excavating contractor subcontracted to SSGC excavated the test pits and infiltration test holes. Soil samples were collected and stored in moisture tight containers for further assessment. Explorations were backfilled with excavated soils and tamped when completed. Please note that backfill in the explorations will likely settle with time. Backfill material in the test pits located in pavement or building 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.

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]				Soil Classification	
				Group Symbol	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 ≥ 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.