GEOTECHNICAL ENGINEERING REPORT
Zackuse Creek Fish Passage Project
Sammamish, Washington

Prepared for: City of Sammamish

Project No. 160277 • December 11, 2017 DRAFT

Aspect CONSULTING

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1 Introduction and Project Description

This draft geotechnical report presents the results of a site reconnaissance, subsurface explorations, and geotechnical analyses and recommendations performed by Aspect Consulting, LLC (Aspect) in support of the Zackuse Creek Fish Passage Project (Project). Our services were provided in support of engineering studies led by OTAK, Inc (Otak) for the City of Sammamish (Client).

The Project involves the replacement of an existing 30-inch-diameter concrete culvert under East Lake Sammamish Parkway (ELSP) and rerouting portions of Zackuse Creek east of ELSP. The culvert replacement is designed to provide upstream fish passage and spawning habitat for native Lake Sammamish kokanee. The project location is shown on Figure 1, *Project Area Location Map*.

We anticipate that design and construction of the culvert and associated roadway improvements will be in accordance with the current American Association of State Highway and Transportation Officials (AASHTO) Load and Resistance Factor Design (LRFD) Bridge Design Specifications (BDS; AASHTO, 2014), and selected Washington State Department of Transportation (WSDOT; WSDOT, 2016) guidance and methodologies.

This draft report summarizes the results of the completed field explorations and presents Aspect's geotechnical engineering conclusions and design recommendations for plan, specification, and estimate (PS&E) development. This draft report is submitted following OTAK's 90% review set of project plans. The conclusions and recommendations formally provided herein were previously provided to OTAK informally (by email and/or verbally in design meetings).

2 Site Conditions

The Project area consists of a hummocky alluvial plain and wetland to the east of ELSP and a generally southwest to northeast trending fill embankment supporting ELSP above the surrounding alluvial plain. Zackuse Creek meanders across the alluvial plain traversing generally east to west before ponding up against and travelling north along ELSP about 200 feet south of a concrete culvert. The 30-inch-diameter concrete culvert carries Zackuse Creek beneath ELSP at the elevation of the alluvial plain. Zackuse Creek passes through two additional culverts before entering Lake Sammamish about 200 feet west of ELSP.

Project area topography is a generally flat alluvial plain with incised stream channels between ELSP and a west-facing slope about 650 feet east of ELSP. The fill embankment supporting ELSP is between 5-feet and 7-feet above the surrounding alluvial plain. The sides of the embankment are typically around a 1H:1V slope. The Zackuse Creek stream channel is incised into the surrounding alluvial plain up to 5-feet east exploration HA-3. West of exploration HA-3, Zackuse Creek is typically wider than upstream and near the elevation of the ground surface. Project area topography is shown on Figure 2.

2.1 Surface Conditions

Surface conditions near the culvert replacement generally consist of relatively flat asphalt paved roadway over the existing culvert, shrubs and bushes on either side of the fill embankment, and wetland vegetation consisting of bushes, common juvenile deciduous trees, and occasional large conifers growing on the alluvial plain east of ELSP.

2.2 Tectonics and Regional Geology

The Puget Lowland is located within an area of repeated glaciations in a complex tectonic environment with active seismicity. Starting about 25 million years ago, the geologic evolution of western Washington has been dominated by the subduction of the Juan de Fuca oceanic plate beneath the North American continental plate. This convergence of plates has created the Puget Trough, which is flanked by the Olympic Mountains to the west and the Cascade Range to the east. The Project will be constructed within the Puget Trough. The Tertiary and Quaternary deposits in the Puget Trough are estimated to be up to 4 miles thick.

The Project area lies about two miles north of the Seattle fault zone, in the Seattle basin, a trough containing a thick accumulation of Quaternary and Tertiary sediments. Northward-directed compression of the Puget Trough has resulted in formation of a chain of sedimentary basins that extend from the Chehalis area of Washington northward past the Canadian border. These sedimentary basins are separated by fold-and-thrust belts that occur as broad zones of active thrust faults, strike-slip faults, folds, and uplifted and deformed bedrock and sediments.

The present-day land surface in the Project area reflects deposition of postglacial sediments that lie above glacial and nonglacial sediments that were deposited during the Quaternary Period (within the last 2.6 million years). During episodes of cooler mean global temperatures, continental ice sheets originating in Canada advanced southward covering much of the Puget Lowland with glacial ice over a mile thick in places, and up to about 3,000 feet thick in the Project Area. Glacial ice and meltwater from the glaciers and glacially impounded Puget Lowland rivers deposited sequences of clayey and silty to sandy glaciolacustrine (glacial lake) deposits in glacially impounded areas, broad sheets of outwash sand and gravel, glacial tills and diamicts (poorly sorted deposits), and sandy to gravelly recessional outwash.

Lake Sammamish resulted from this subglacial meltwater scour and erosion. The slopes above the lake, including those east of Lower Coal Creek, were then modified by normal slope erosion processes including landslides and incision by ravines and drainages from the uplands. Geological mapping indicates the Project area is underlain by Quaternary Alluvium, Mass Wasting Deposits, and Vashon Stade recessional outwash; till, and advance outwash from the Vashon Stade glaciation are mapped on the slopes to the east of the Project area (Booth et. al, 2012).

Artificial fill is not mapped at the Project Area, but is present in the roadway embankment. We did not encounter mass wasting deposits in our explorations. Soil units encountered in soil boring explorations completed at the Project Area are described in more detail below in Section 3.2.

2.3 Seismic Hazards

The Project will be constructed within an area of active tectonic forces associated with the interaction of the offshore Juan de Fuca plate, the Pacific plate, and the onshore North American plate. These plate interactions result in seismic hazards to the Project. Significant hazards include regional ground shaking from subduction zone earthquakes, deep earthquakes, and shallow crustal earthquakes; liquefaction of soft ground; seismically triggered landslides; and the potential for surficial ground rupture.

The Project lies within two miles of the Seattle fault zone. This broad zone of compressional folding and faulting is known to be active, and has ruptured and triggered earthquakes several times during the last 10,000 years. The U. S. Geological Survey (USGS; USGS, 2014) estimates that it is capable of producing earthquakes of magnitude 7.3 or greater. The last large earthquake on this fault system was about 1,100 years ago, and resulted in up to 27 feet of uplift in parts of west Seattle, and surficial ground rupture at Vasa Park east of the Project Area. Faulting was likely associated with surficial ground rupture elsewhere in Bellevue, although most traces of the rupture have been obliterated by erosion and urban development.

The Project Area also lies within the zone of strong shaking from subduction zone earthquakes. The recurrence interval of these earthquakes is thought to be on the order of about 500 years. The most recent subduction zone earthquake occurred about 300 years ago. Deep intraslab earthquakes also occur in the region every decade or two, including the 2001 Nisqually earthquake. These earthquakes are generally less severe than the shallow crustal and subduction zone earthquakes, but have the potential to cause damage to older structures built before modern seismic codes were enacted, and those in areas susceptible to liquefaction.

The Project Area shallow subsurface is underlain by loose gravel, sand, and soft silts that are susceptible to liquefaction during a large earthquake. Liquefaction could result in vertical settlement and lateral displacements of the roadway fill embankment and unconsolidated alluvial sediments.

However, AASHTO and WSDOT standards for design of buried concrete culverts is that they do not need to be designed for seismic effects: AASHTO qualifies this policy for projects that are not along known active faults; WSDOT qualifies this policy for culverts with a span width of less than 20 feet. There are no known active faults crossing the Project Area, and the planned culvert will have a span width of about 12 feet. Therefore, the culvert will not be designed for seismic hazards.

3 Subsurface Conditions

3.1 Field Exploration Program

We completed two machine-drilled borings on December 8 and December 9, 2016. The borings, designated MW-1 and B-2, were completed on either side of the existing culvert and along the proposed replacement alignment (Figure 2). A 2-inch-diameter slotted piezometer was installed in the southwestern boring, MW-1.

The borings were sampled at 2.5-foot intervals from the surface to 20 feet below ground surface (bgs), and sampled at 5-foot intervals from 20 feet bgs to the end of hole. Disturbed soil and bedrock samples were taken using Standard Penetration Testing (SPT) methods for soil density and consistency correlation.

Along the proposed creek re-alignment to the east of ELSP, we completed five shallow borings using hand tools along. These shallow borings, HA-1 to HA-5 were selectively sampled and relative soil density/ consistency measurements taken at depths determined by Aspect field staff. Locations of all borings are shown on Figure 2.

Descriptions of the soils units encountered in the borings, as well as the depths where characteristics of the geology and engineering units changed, are indicated on the exploration logs presented in Appendix A. Definitions of the terminology and symbols used on the logs are included as Appendix A-1.

Selected soil samples were submitted to a subcontracted geotechnical testing laboratory (Materials Testing and Consulting, Inc) to complete index testing consisting of moisture content, grain-size distribution, percent fines content, and organic content. Further description of the soil samples submitted, test methods, and results are presented in Appendix B.

3.2 Stratigraphy

From the roadway surface, we observed a 4-inch-thick layer of hot mix asphalt over a 3-inch-thick layer of concrete. Beneath the roadway, we observed roadway embankment fill overlying non-glacially consolidated Quaternary Alluvium and Vashon Stade Glacial Recessional Deposits. Beneath the non-glacially consolidated deposits, we encountered glacially consolidated Glacial till and Glacial outwash of the Vashon Stade. Figure 3 presents a cross-section with our interpretation of geologic conditions across the existing culvert.

3.2.1 Roadway Embankment Fill

Below pavement, both of our borings, MW-1 and B-2 encountered roadway embankment fill (fill) that extended between 5-feet and 5.5-feet bgs. This fill was moist, very gravelly, silty SAND (SM)[1] or slightly silty SAND (SP-SM) and contained scattered organic

[1] Soil Classification per the Unified Soil Classification System (USCS). Refer to ASTM D2488 (ASTM, 2012).

fragments. Embankment fill was not observed in the shallow hand borings to the east of ELSP.

SPT[2] sampling indicates the fill has medium dense to dense relative density. The fill is expected to exhibit moderate to high shear strength and low compressibility.

3.2.2 Quaternary Alluvium

Quaternary alluvium (alluvium) was encountered below the fill to 21 feet and 25 feet bgs in borings MW-1 and B-2 respectively. Additionally, alluvium was encountered in all the shallow hand borings (HA-1 to HA-5). The alluvium typically consisted of wet, brown and gray, PEAT (PT), SILT (ML), slightly silty SAND (SP-SM), silty SAND (SM), or GRAVEL (GP). Soil units were interbedded with beds between 1 foot and 5 feet thick. The high variability of the soils in the alluvium units is indicative of a low-gradient stream frequently traversing a wetland and floodplain environment.

SPT sampling indicates the alluvium has very loose to medium dense density or soft to medium stiff consistency. The fill is expected to exhibit low shear strength and high compressibility. Under seismic shaking conditions, saturated areas of the alluvium may liquefy.

3.2.3 Glacial Deposits of the Vashon Stade

Recessional Deposits

Vashon Stade glacial recessional deposits were encountered beneath the alluvium to between 35 feet and 36 feet bgs in both borings MW-1 and B-2. Recessional glacial deposits were wet, brown and yellow-brown, SILT (ML), slightly silty SAND (SP-SM), silty SAND (SM), or slightly silty GRAVEL (GP-GM). The variations in soil types within the glacial recessional deposits indicate a variable fluvial and lacustrine environment encounter during glacial recession.

The glacial recessional deposit silt was non-plastic to low plasticity, the sand fraction was fine to coarse, and the gravel fraction was typically fine. SPT sampling indicates the glacial recessional deposits are medium dense to dense. The glacial recessional deposits are expected to exhibit moderate to high shear strength and low compressibility.

Till

Vashon Stade till was encountered beneath recessional deposits from 35 feet to 40 feet in boring MW-1 and from 36 feet to 51.5 feet (end of the boring) in B-2. Till typically consisted of very moist or wet, gray, gravelly, silty SAND (SM) and exhibited a distinctive diamict grain-size distribution and texture.

The till sand fraction was fine to coarse and the gravel fraction was typically fine. SPT sampling indicated the was very dense. The till is expected to exhibit high shear strength and little to no compressibility.

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[2] SPT blow count refers to standard penetration test (SPT) N-values, in accordance with ASTM D1586.

Advance Outwash

Vashon Stade advance outwash was encountered beneath till in boring MW-1 from 40 feet to 46.5 feet (end of the boring). Advance outwash consisted of wet, brown, very gravelly, slightly silty SAND (SM).

The advance outwash sand and gravel fractions were fine to coarse. SPT sampling indicated the advance outwash was very dense and is expected to exhibit high shear strength and little to no compressibility.

3.3 Groundwater

We measured groundwater at 7.5 feet below the pavement in both borings, MW-1 and B-2 during drilling. Subsequently, groundwater was measured at 1-foot bgs in MW-1 on December 15, 2016 at the completion of the monument. On September 26, 2017 we returned to the site and measured groundwater to be 0.7 feet below the pavement. Given these groundwater measurements are higher than the average creek and wetland elevation, we conclude the piezometer screened zone is influenced by a partially confined aquifer layer.

Groundwater levels are expected to vary due to seasonal variations in weather, snowmelt, and the water level of Lake Sammamish.

4 Conclusions and Recommendations

4.1 Pre-Cast Concrete Box Culvert

The new culvert will be placed on the same alignment as the existing metal pipe culvert being replaced. The new culvert will be a four-sided, pre-cast concrete box, with inside dimensions of 12 feet wide by 6 feet tall. The culvert bottom will be covered with imported gravel to simulate a natural streambed. The culvert will be constructed with a six percent slope to approximately match the existing stream gradient, which is approximately 6 percent.

We understand the work will be completed with a combination of single-lane closures of ELSP and complete road closure is limited to two weeks total duration. To minimize the roadway closure period, the Project will utilize pre-cast concrete elements to the maximum extent possible. The contractor will have the option to shore the proposed excavation to reduce impacts of construction in the road sections. We have assumed shoring will be completed using two rows of internally-braced sheet piling.

The current 90 percent plans show the box culvert bottom at approximate Elevation +39 mean sea level (MSL) at the southeast/inlet end, and approximate Elevation +36.5 MSL at the northwest/outlet end.

The recent alluvium encountered in our explorations MW-1 and B-2 revealed interbeds of soft peat extending below proposed culvert bottom. Peat is highly compressible when loaded, and it exhibits significant long-term settlement, or secondary compression, characteristics.

In our boring B-2 on the north side of the culvert, a loose sandy peat interbed was encountered that extended down to approximate Elevation +31 feet MSL. In boring MW-1 on the south side of the culvert, very soft to medium stiff peat with variable sand and gravel content, was encountered extending down to approximate Elevation +28 feet MSL. Below these elevations, the alluvium is granular and mostly free of peat (in B-2) or recessional outwash sand exists, which is also free of peat (in MW-1).

The base of the proposed culvert is anticipated to range from Elevation +36.74 to +38.87 feet MSL. The bottom of peat is anticipated to range from Elevation +28 to +31 feet MSL.

4.1.1 Estimated Settlement if Peat is not Removed

We performed three-dimensional settlement analyses to model settlement as a result of loading the peat-rich alluvium with the proposed box culvert, leaving the peat in place with a 36-inch thick gravel pad installed below the culvert bottom. We utilized the program Settle 3D (Rocscience, 2017) to model and evaluate the presence of the culvert, the gravel bearing pad, the imported streambed gravel, imported granular backfill against the culvert walls, and granular fill and pavement over the top of the culvert. These analyses considered the rigidity of the four-sided box culvert, with interlocking joints.

The analyses predicted total settlements under the rigid box culvert of about 3 to 4 inches after 12 months, and 5 to 6 inches after 24 months, with no appreciable consolidation settlement thereafter. The rigidity of the four-sided box culvert, combined with relatively uniform subsurface conditions, are such that settlements should be relatively uniform across its width and length. However, moving away from the box culvert in the direction parallel to the roadway, the analyses predict settlement will taper over about 14 feet (the culvert width), with no appreciable settlement beyond these points. With respect to the culvert, from structural and stream flow capacity perspectives, we believe these predicted settlements are tolerable. However, through coordination with OTAK and the City of Sammamish, from roadway and buried utility serviceability perspectives, this magnitude of settlement is unacceptable.

4.1.2 Sub-Excavation of Peat

Sub-excavation of the alluvial peat from below the box culvert, and replacement with angular crushed rock, will limit the expected settlement to less than one inch. The Peat sub-excavation would extend down to target Elevation +28 feet MSL replacing the sub-excavation with quarry spalls and crushed rock back up to culvert bottom elevation.

The 5½- to 8-foot deeper sub-excavation will increase the size of the temporary excavation, and will lengthen the project duration, but will essentially eliminate future roadway and buried utility serviceability issues at this crossing location.

Sub-excavation of the peat can be completed in the wet using a long-reach excavator. Sounding in the wet using a weighted tape and/or a long-handled steel soil probe would be done to confirm the peat is adequately removed and granular materials are exposed at the target subgrade Elevation +28 feet MSL.

The sub-excavation would be replaced in the wet using clean quarry spalls as specified in Section 9-13.1(5) of the WSDOT Standard Specifications. The clean quarry spalls would be placed in the wet, and tamped into place with the long-reach excavator bucket. The quarry spalls would then be capped with crushed surfacing base course, as specified in Section 9-03.9(3) of the WSDOT Standard Specifications. The CSBC cap would be graded to a uniform slope condition providing a smooth base for the box culvert. We recommend the CSBC cap be 24 inches thick. The CSBC would need to be placed and compacted in the dry; thus, the excavation would need to be dewatered to at least 2 feet below the culvert bottom.

There will be some mixing and migration of smaller CSBC aggregate into voids at the top of the quarry spalls during placement and vibratory compaction. However, a granular filter will develop in the interface of these layers that will stabilize during placement and compaction. There should be no appreciable settlement after the We recommend the bid quantity for CSBC include a 50% increase (for an effective thickness of 3 feet) to account for mixing and migration of material.

If a complete peat sub-excavation and replacement with quarry spalls and crushed surfacing were completed in the manner described above, total and differential post-construction settlements are expected to be less than one inch.

4.2 Culvert Wing Walls

The 90 percent plans call for 10- to 13-foot-long, pre-cast concrete cantilever wing walls extending at 45 degrees away from the culvert centerline. The retained height of soils behind the wingwalls will vary from about 10 or 12 feet where they tie in to the culvert, to about 7 to 8 feet at the opposite ends.

The planned sub-excavation and replacement of peat with compacted gravel from below the box culvert to the full extent of the peat Elevation +28, will largely mitigate the potential for differential settlement where the wingwalls connect to the box culvert. However, it may be impractical to sub-excavate and replace the peat to Elevation +28 under the entire wingwalls.

Our analyses indicate that constructing pre-cast concrete cantilever walls over the existing peat-rich alluvium will result in differential settlement along the length of the walls. If the wingwalls were not structurally connected to the culvert, differential wingwall movement could appear as outward wall rotation, or differential in-plane rotation/movement, either of would tend to cause gaps to form between segments and between the wingwall and the box culvert. The magnitude of total and differential settlement could be in the range of several inches, and settlements will be highly differential given the variation in exposed heights of the walls and steps in foundation elevation moving away from the culvert.

In our opinion, to avoid such aesthetic issues with differential wingwall movement, we recommend the wingwall panels be structurally connected (to the culvert and individual segments to one-another) using epoxy-doweled anchors and structural steel clips.

We recommend that a 24-inch-thick leveling pad of compacted crushed surfacing base course should be placed under each pre-cast concrete wingwall footing. The CSBC pad should extend the full width of the footing under all of the wingwalls.

4.3 Temporary Excavations and Construction Dewatering

It is understood that a bypass of Zackuse Creek will be installed during construction. The bypass will collect and divert creek water in a temporary force main to a discharge location downstream from the project. Our piezometer reading taken in December 2016 encountered groundwater about 1 foot below the roadway pavement. We expect groundwater at the Project area will be highly influenced by creek flow and the time of year. Stream diversion will likely bring down the water level appreciably; however, construction dewatering will still be necessary to complete this culvert replacement project.

Ideally construction would be completed during the late summer or early fall months, when groundwater levels are typically at seasonally lowest levels. Aspect is not currently aware of any fish or shoreline permit construction window limitations that may further constrain the construction schedule.

4.3.1 Temporary Shoring Using Sheet Piling

Given the project will mostly be completed with a combination of single lane road closures, we anticipate temporary shoring using sheet piling will be most economical for the Project. We recommend rows of interlocking steel sheet piling, installed parallel to the culvert, and would be internally braced using walers and struts. The contractor should be required to design and install the temporary shoring. Recommended lateral earth pressures for use in temporary shoring design are provided in Figure 4. The sheet piling should be installed using a vibratory hammer to minimum tip Elevation +13 feet (15 feet below the target sub-excavation depth). This tip elevation approximately coincides with the top of the Vashon Till which was encountered in both borings MW-1 and B-2 at approximate Elevation +14 feet. In our opinion, it will be possible to advance the sheet piling about 1 foot into the Vashon Till.

After the box culvert is set and the spaces between the box culvert and sheets have been backfilled, the sheet piling should be removed. Alternatively, with approval from the City, the sheet piling could cut off a sufficient depth below the finished roadway surface, and left in the ground.

4.3.2 Open Cuts

The existing fill and alluvium classifies as Type C Soil per Washington Administrative Code (WAC) 296-155 Part N. Temporary cuts in Type C Soil not greater than 20 feet deep, should be inclined no steeper than 1½H:1V (horizontal:vertical). Flatter slopes are required where groundwater seepage exists, if traffic or construction surcharges are present, or where less stable soils are present. It is the Contractor’s responsibility to design and construct the temporary excavation and complete the work safely and in accordance with state safety regulations.

4.3.3 Construction Dewatering

Construction dewatering can be accomplished with the aid of a wellpoint eductor system. This consists of a series of small diameter slotted steel pipes that are driven or jetted vertically into the ground along both sides of the temporary excavation, on a horizontal spacing of typically about six feet. At the surface, the vertical well points would be connected to a surface-mounted header system which is in turn attached to a large pump which applies a vacuum to the wellpoints. The practical maximum depth of drawdown with a wellpoint eductor system is typically about 20 feet.

For this project, assuming sheet piling is utilized, the wellpoints would be installed just inside (stream-side) of the sheet piling, in the recessed/fluted area of sheet piling. The upper-most waler that is attached to inside face of the sheet piling can be used to support the header system.

4.4 Structural Fill

The existing Project area soils have a high percentage of organics and silt/clay and therefore they will be unsuitable for re-use as structural fills.

A variety of imported structural fills will be required/recommended for this project. Recommendations for these various materials are provided here

- Quarry spalls placed below "in the wet" or groundwater, under the box culvert should conform to the gradation requirements of Section 9-13.1(5) of the WSDOT *Standard Specifications*. The quarry spalls should extend from approximate Elevation +28 feet to two feet below the bottom of the box culvert.

- Gravel pad material, that will be placed under pre-cast concrete wingwall segments, and directly under the four-sided box culvert, should consist of Crushed Surfacing Base Course, as specified in Section 9-03.9(3) of the WSDOT *Standard Specifications*. Crushed surfacing is also appropriate for use as base course under the restored pavement section. The CSBC pad, below both the box culvert and the pre-cast concrete wingwalls, should be 24 inches thick. We recommend a 50% increase be included in the bid quantity for CSBC placed over the quarry spalls, to account for initial loss of finer material into the quarry spall voids.

- For wall backfill placed against the culvert walls or the pre-cast concrete wing wall segments, we recommend Gravel Backfill for Walls, as specified in Section 9-03.12(2) of the WSDOT *Standard Specifications*.

- Streambed gravel will be determined by OTAK; but Streambed Sediment is described in Section 9-03.11(1) of the WSDOT *Standard Specifications.* This material is not considered structural fill.

All structural fills placed as wall backfill or as a foundation/leveling pad should be placed in horizontal lifts and compacted to a dense and unyielding condition.

4.5 Stream Re-Alignment Considerations

The Project includes re-alignment of Zackuse Creek toward the north with a more favorable approach to the culvert. Our hand auger explorations encountered recent alluvium consisting mostly of silty sand and silty gravel, with occasional peat interbeds.

We recommend the new stream channels be constructed with 3H:1V permanent sideslopes. To reduce scour and erosion issues with the fine-grained alluvium, the constructed stream bottom should be armored/protected with imported gravel such as streambed sediment. The 90 percent plans have incorporated these recommendations.

We understand the stream profile will include several boulder-lined drops (boulder steps) which will facilitate grade changes and allow for flatter, more habitable, stream segments. We have no comments on this from a geotechnical engineering perspective.

4.6 Continuing Engineering Support

We have prepared this final draft report to formalize our conclusions and recommendations to date and to accompany the 90 percent plan set. Aspect will collaborate with the design team and City of Sammamish to refine and finalize any outstanding geotechnical engineering issues related to the design. We request any review comments or requests on this final draft report, which will be addressed in our final geotechnical engineering report.

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Limitations

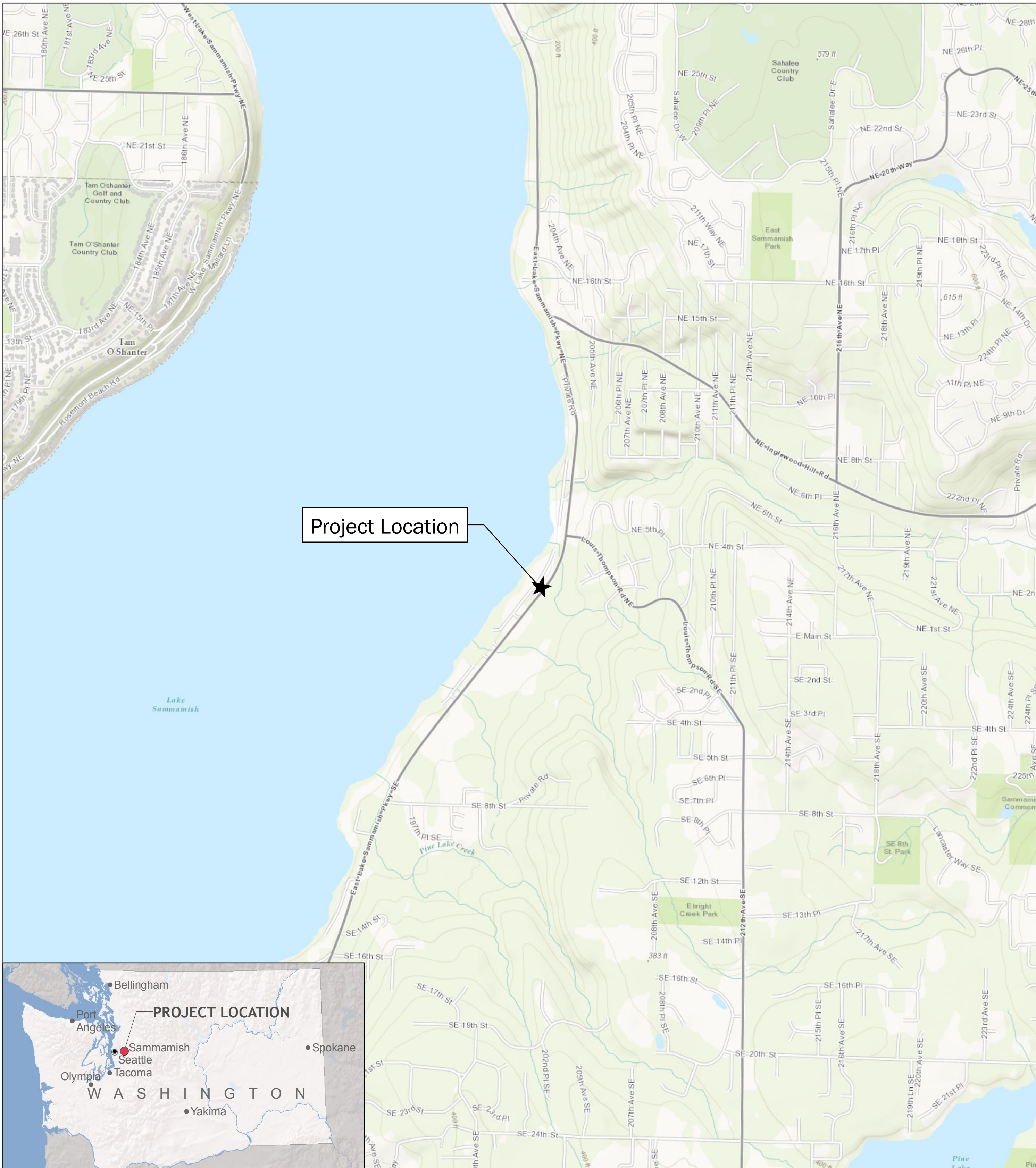
Work for this Project was performed for OTAK Inc and the City of Sammamish (Client), and this report prepared in accordance with generally accepted professional practices for the nature and conditions of work completed in the same or similar localities, at the time the work was performed.

All reports prepared by Aspect Consulting are intended solely for the Client and apply only to the services described in the Agreement with Client. Any use or reuse by Client for purposes outside of the scope of Client's Agreement is at the sole risk of Client and without liability to Aspect Consulting. Aspect Consulting shall not be liable for any third parties' use of the deliverables provided by Aspect Consulting. Aspect Consulting's original files/reports shall govern in the event of any dispute regarding the content of electronic documents furnished to others.

This report and our conclusions and interpretations should not be construed as a warranty of the subsurface conditions. Experience has shown that subsurface soil and groundwater conditions can vary significantly over small distances. Inconsistent conditions can occur between explorations and may not be detected by a geotechnical study. Further geotechnical evaluations, analyses and recommendations may be necessary for the final design of this Project.

If there is a substantial lapse of time between the submission of this report and the start of construction, or if conditions have changed due to construction operations at or near the Site, it is recommended that this report be reviewed to determine the applicability of the conclusions and recommendations considering the changed conditions and time lapse.

FIGURES



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Project Location Map

Zackuse Creek Fish Passage Project

City of Sammamish

East Lake Sammamish Pkwy NE, Sammamish, WA

Aspect CONSULTING	JAN-2017	BY: JF / SCC	FIGURE NO.
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Cross Section Location

Boring

Hand Auger

Monitoring Well

Elevation Contours (2 Ft Interval)

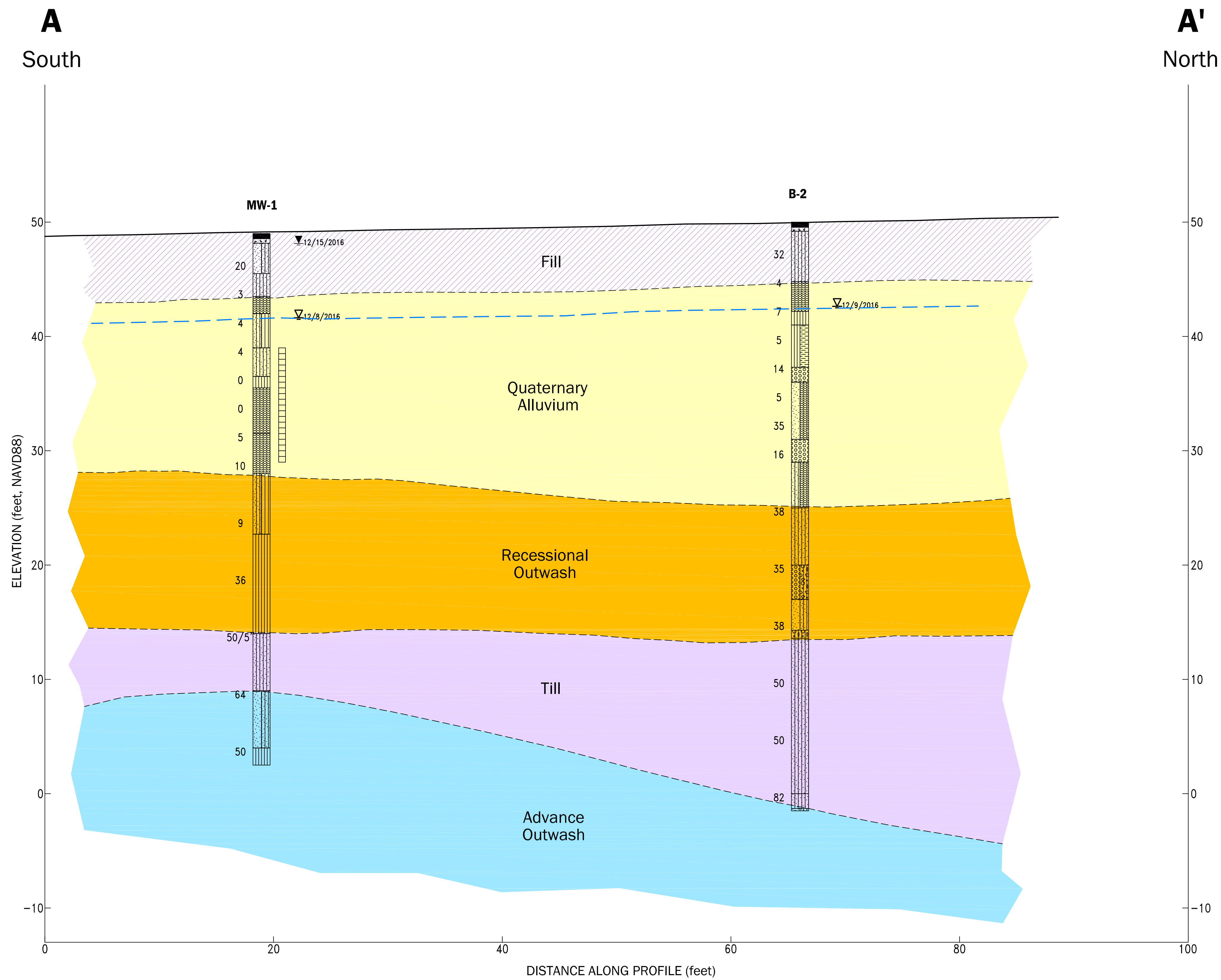
Elevation contours from January 27, 2011 version of the Puget Sound Supermosaic. Harvey Greenberg.

Project Area and Exploration Map

Zackuse Creek Fish Passage Project
City of Sammamish
East Lake Sammamish Pkwy NE, Sammamish, WA

Aspect CONSULTING	SEP-2017	BY: JF / SCC	FIGURE NO.
	PROJECT NO. 160277	REVISED BY: - - -	2

Basemap Layer Credits || Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Lithology

Asphalt	Concrete	SM: USCS Silty Sand
PT: USCS Peat	ML: USCS Silt	ML-PT: USCS Silt and Peat
GP: USCS Poorly-graded Gravel	SP/PT: Layers of Poorly Graded Sand and Peat	SM/PT: Sand with Silt; Peat Interbeds

B-1 — Well or Borehole ID
SPT Blow Count N Value — 23
Material Type (see Lithology Graphics)
Water Level in Borehole at time of drilling
Water Level in Well, Date
Well Screen Interval

Horizontal Scale: 1" = 10'
Vertical Scale: 1" = 10'
Vertical Exaggeration 1x

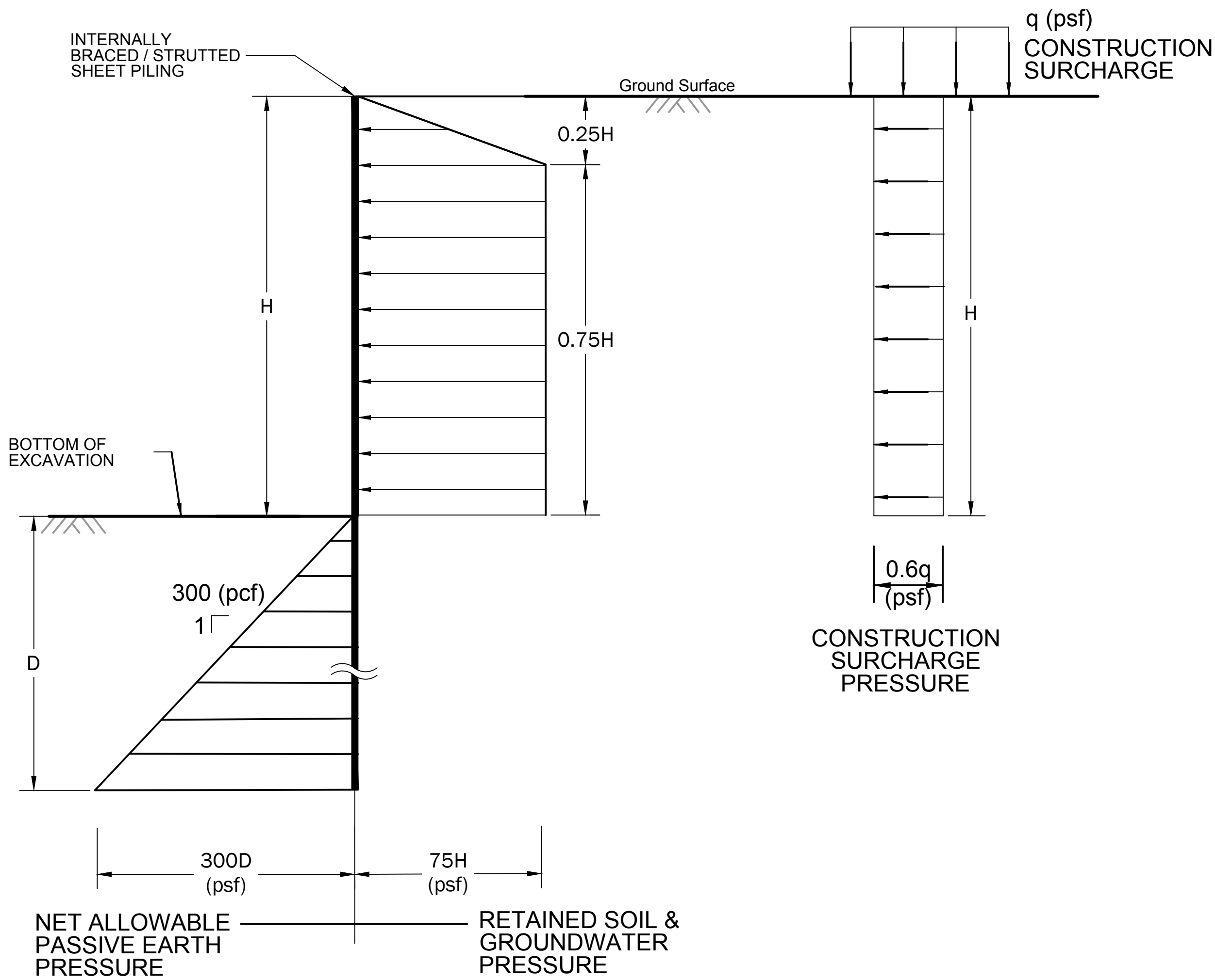
0 10 20 Feet

Geologic Cross Section A-A'
Zackuse Creek Fish Passage Project
City of Sammamish
East Lake Sammamish Parkway NE
Sammamish, Washington

Aspect CONSULTING	Feb-2017	BY: JGF/SCC	FIGURE NO.
	PROJECT NO. 160227	REVISED BY: -	3

CAD Path: Q:\City of Sammamish\160227 Zackuse Creek Fish Passage\2017-01 Cross Section\160227-AA.dwg 11x17 Landscape || Date Saved: Feb 23, 2017 3:35pm || User: scudd

TEMPORARY SHORING LATERAL EARTH PRESSURES FOR
INTERNALLY BRACED SHEET PILING



NOT TO SCALE

NOTES

1. THIS EARTH PRESSURE DIAGRAM IS APPLICABLE FOR INTERNALLY BRACED SHEET PILING.

2. PRESSURES SHOWN ARE IN UNITS OF POUNDS PER SQUARE FOOT (PSF). LINEAR DIMENSIONS ARE IN UNITS OF FEET (FT).

3. THE DEPTH OF EXCAVATION, H, IS ASSUMED TO BE APPROXIMATELY 19 FEET.

4. GROUNDWATER ON THE RETAINED SIDE IS ASSUMED TO BE INITIALLY AT OR NEAR GROUND SURFACE ELEVATION. THE ACTUAL GROUNDWATER LEVEL ON THE EXCAVATION SIDE WILL BE LOWER AND RELATED TO THE STREAM BYPASS. THE RETAINED SOILS AND GROUNDWATER EARTH PRESSURE SHOWN WAS DEVELOPED USING APPARENT EARTH PRESSURE THEORY FOR SATURATED COHESIVE SOILS.

5. SURCHARGE LOADS FROM CONSTRUCTION EQUIPMENT OR ANY VEHICULAR TRAFFIC SHOULD BE CONSIDERED.

6. THE DEPTH OF EMBEDMENT, D, SHOULD BE DETERMINED BY SOLVING EQUILIBRIUM EQUATIONS BUT SHOULD NOT BE LESS THAN 15 FEET. THE ALLOWABLE PASSIVE PRESSURE SHOWN INCLUDES A FACTOR OF SAFETY OF ABOUT 1.5.

7. REFER TO THE REPORT TEXT FOR ADDITIONAL DISCUSSION AND RECOMMENDATIONS,

Temporary Shoring Lateral Earth Pressures for Internally Braced Sheet Piling

Zackuse Creek Culvert
Sammamish, Washington

Aspect Consulting	Dec-2017	BY: MO	FIGURE NO.
	PROJECT NO. 160277	REVISED BY: -	4

CAD Path: M:\Sammamish\zackuse creek\Figure 4 - Zackuse Creek Culvert.dwg 04 - Temporary Shoring || Date Saved: Dec 08, 2017 9:12am || User: motto

APPENDIX A

Subsurface Explorations

A.1 Field Exploration Program

A.1.1 Geotechnical Borings

Between December 8 and December 13, 2016, we performed a site reconnaissance, completed two machine drilled geotechnical soil borings, and completed five shallow borings with hand tools.

The machine drilled borings were advanced using a truck-mounted Mobile Drill B-59 rotary drill rig using 6-inch outer diameter mud-rotary methods. The borings were sampled at selected depth intervals using the Standard Penetration Test (SPT) in general accordance with ASTM method D158. The locations of the borings are shown on Figure 2 of the report.

SPT sampling involves driving a 2-inch outside diameter split-barrel sampler 18-inches into the soil with a 140-pound hammer free-falling from 30-inches (the drill rig employed on this project used an automatic-trip hammer). The number of blows for each 6-inch interval is recorded and the number of blows required to drive the sampler the final 12 inches is known as the Standard Penetration Resistance (“N”) or blow count. The resistance, or N-value, provides a measure of the relative density of granular soils or the relative consistency of cohesive soils.

The shallow borings with hand tools were advanced using a 2.5-inch outer diameter hand auger. The hand auger was advanced at 6-inch intervals and a continuous, disturbed sample of the subsurface is obtained. Grab samples are taken at intervals determined by the Aspect field representative. Relative density is tested at selected depths by using a Dynamic Cone Penetrometer (DCP). The DCP test involves driving a 1.5-inch diameter steel-tipped cone 1.75-inches using a 15-pound anvil with a 20-inch drop. The number of blows for each 1.75-inch interval is recorded. The number of blows is correlated to resistance and provides a means of estimating soil density

An Aspect Consulting geologist was present throughout the field exploration program to observe the drilling procedure, assist in sampling, and to prepare descriptive logs of the exploration. Soils were classified in general accordance with ASTM D2488, *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)*. The summary exploration log represents our interpretation of the contents of the field logs. The stratigraphic contacts shown on the individual summary logs represent the approximate boundaries between soil types; actual transitions may be more gradual. The subsurface conditions depicted are only for the specific date and locations reported, and therefore, are not necessarily representative of other locations and times.

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)

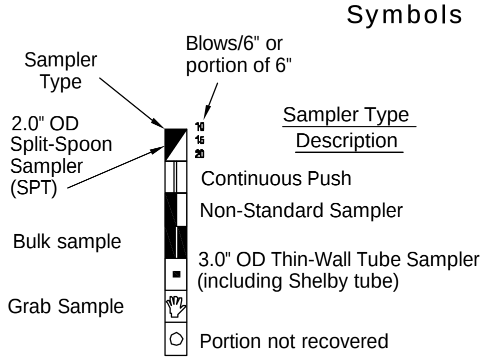
(3) Estimated Percentage

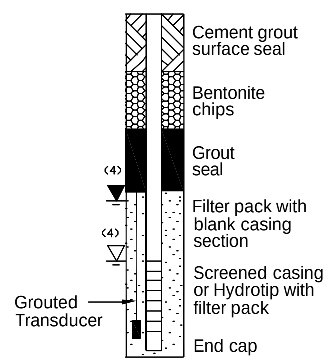
Percentage by Weight	Modifier
<5	Trace
5 to 15	Slightly (sandy, silty, clayey, gravelly)
15 to 30	Sandy, silty, clayey, gravelly)
30 to 49	Very (sandy, silty, clayey, gravelly)

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

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

Aspect CONSULTING	Zackuse Creek Fish Passage - 160277		Geotechnical Exploration Log	
	Project Address & Site Specific Location East Lake Sammamish Parkway, Sammamish, Washington, Fogline of southbound travel lane.		*Coordinates (SPN NAD83 ft)* E:225276.7 N:1335480 (est)	*Exploration Number* **MW-1**
Contractor Holt Services	*Equipment* Truck-mounted Mobile Drilling B-59	*Sampling Method* Autohammer; 140 lb hammer; 30" drop	*Ground Surface (GS) Elev. (NAVD88)* 49'(est)	Ecology Well Tag No. BKY-345
Operator Kevin Bacon	*Exploration Method(s)* 6-inch OD Mud rotary	*Work Start/Completion Dates* 12/8/2016	*Top of Casing Elev. (NAVD88)* NA	*Depth to Water (Below GS)* 1' (Static)

Depth (feet)	Elev. (feet)	Exploration Completion and Notes	Sample Type/ID	Blows/foot ▲ Water Content (%) ●	Blows/6"	Tests	Description
0–1	49–48	8-inch diameter steel flushmount monument; Concrete surface seal; ▼ 12/15/2016					**ARTIFICIAL FILL** 5-inches Hot Mix Asphalt; 4-inches Concrete
1–3.5	48–45.5		S1 (2.5–4)	▲	14 / 11 / 9		Medium dense, moist, brown, gravelly, slightly silty SAND (SP-SM); fine to coarse sand, fine and coarse subrounded to angular gravel.
3.5–5.5	45.5–43.5	Backfilled with 3/8" bentonite chips 1.5 - 8' bgs	S2 (5–6.5)	▲ 55.6 ●	5 / 2 / 1	=7.9%	**QUATERNARY ALLUVIUM** Medium dense, moist, dark brown, silty SAND (SM); fine to coarse sand, fine and coarse subrounded to angular gravel, numerous organic fragments.
5.5–7	43.5–42						Soft, moist, dark brown, fine-grained PEAT (PT); trace fine to medium sand, trace fine subangular gravel.
7–10	42–39	▽ 12/8/2016	S3 (7.5–9)	▲	1 / 2 / 2		Soft, wet, gray and brown banded, very sandy SILT (ML) interbedded with fibrous PEAT (PT) and silty SAND (SM); non-plastic, fine to medium sand, frequent thin interbeds.
10–12.5	39–36.5		S4 (10–11.5)	▲	2 / 3 / 1	FC FC=59.2%	Loose, wet, gray, silty SAND (SM); fine sand, scattered PEAT (PT) interbeds.
12.5–14	36.5–35		S5a	▲	WOH		Very loose, wet, gray, sandy SILT (ML); non-plastic, fine sand.
14–17.5	35–31.5	10/20 Silica sand 8 - 21' bgs; 0.010-inch slotted sched. 40 PVC screen 10 - 20' bgs	S5b; S6	207.4 ●; ▲	WOH	=29.9%	Very soft, wet, dark brown, fibrous PEAT (PT). Becomes slightly sandy and thinly laminated.
17.5–21	31.5–28		S7; S8	▲; ▲	0 / 0 / 5; 0 / 3 / 7		Mediun stiff, wet, dark brown, slightly sandy, fine-grained PEAT (PT) interbedded with fibrous PEAT (PT); fine sand, trace fine subrounded gravel, 15% fibrous peat. Becomes gravelly.
21–25	28–24	Backfilled with 3/8-inch bentonite chips 21 - 46.5' bgs					**VASHON STADE RECESSIONAL OUTWASH** Medium dense, wet, brown, slightly gravelly, silty SAND (SM) interbedded with dark gray SILT (ML); non-plastic, fine to coarse sand, fine subangular gravel.

Legend

Plastic Limit ├──┤ Liquid Limit

Sample Method:
- ◯ No Soil Sample Recovery
- ◩ Split Barrel 2" X 1.375" (SPT)

Water Level:
- ▼ Static Water Level
- ▽ Water Level ATD

See Exploration Log Key for explanation of symbols

Logged by: JGF
Approved by: EOA - 9/12/2017

Exploration Log MW-1

Aspect CONSULTING	Zackuse Creek Fish Passage - 160277		Geotechnical Exploration Log	
	Project Address & Site Specific Location East Lake Sammamish Parkway, Sammamish, Washington, Fogline of southbound travel lane.		*Coordinates (SPN NAD83 ft)* E:225276.7 N:1335480 (est)	*Exploration Number* **MW-1**
Contractor Holt Services	*Equipment* Truck-mounted Mobile Drilling B-59	*Sampling Method* Autohammer; 140 lb hammer; 30" drop	*Ground Surface (GS) Elev. (NAVD88)* 49'(est)	Ecology Well Tag No. BKY-345
Operator Kevin Bacon	*Exploration Method(s)* 6-inch OD Mud rotary	*Work Start/Completion Dates* 12/8/2016	*Top of Casing Elev. (NAVD88)* NA	*Depth to Water (Below GS)* 1' (Static)

Depth (feet)	Elev. (feet)	Sample Type/ID	Blows/6"	Tests	Description	Depth (ft)
		S9	13 4 5			
26	23				Stiff, wet, brown to yellow-brown, slighly sandy SILT (ML); low-plasticity, fine sand.	26
27	22					27
28	21					28
29	20				Gravelly drilling. No recovery	29
30	19	S10	13 19 17			30
31	18					31
32	17					32
33	16					33
34	15					34
35	14	S11	50/5"		**VASHON STADE TILL** Very dense, very moist, gray, slightly gravelly, silty SAND (SM); fine to medium sand, fine subrounded to subangular gravel.	35
36	13					36
37	12					37
38	11					38
39	10					39
40	9	S12	34 33 31	GS	**VASHON STADE ADVANCE OUTWASH** Very dense, wet, brown, very gravelly slightly silty SAND (SP-SM); fine to coarse sand, fine and coarse subrounded to subangular gravel.	40
41	8					41
42	7					42
43	6					43
44	5					44
45	4	S13	24 25 25		Very dense, wet, brown, very sandy SILT (ML); non-plastic, fine sand, trace organics, very thinly laminated.	45
46	3				Bottom of exploration at 46.5 ft. bgs.	46
47	2					47
48	1					48
49	0					49

Blows/foot ▲ Water Content (%) ● 0 10 20 30 40 50

Legend

Sample Method: No Soil Sample Recovery; Split Barrel 2" X 1.375" (SPT)

Plastic Limit ├──┤ Liquid Limit

Water Level: Static Water Level; Water Level ATD

See Exploration Log Key for explanation of symbols

Logged by: JGF
Approved by: EOA - 9/12/2017

Exploration Log MW-1

Aspect CONSULTING	Zackuse Creek Fish Passage - 160277		Geotechnical Exploration Log	
	Project Address & Site Specific Location East Lake Sammamish Parkway, Sammamish, Washington, Center of northbound travel lane.		*Coordinates (SPN NAD83 ft)* E:225301.9 N:1335520 (est)	*Exploration Number* **B-2**
Contractor Holt Services	*Equipment* Truck-mounted Mobile Drilling B-59	*Sampling Method* Autohammer; 140 lb hammer; 30" drop	*Ground Surface (GS) Elev. (NAVD88)* 50'(est)	
Operator Kevin Bacon	*Exploration Method(s)* 6-inch OD Mud rotary	*Work Start/Completion Dates* 12/9/2016	*Top of Casing Elev. (NAVD88)* NA	*Depth to Water (Below GS)* 7.5' (ATD)

Depth (feet)	Elev. (feet)	Exploration Completion and Notes	Sample Type/ID	Blows/foot ▲ Water Content (%)●	Blows/6"	Tests	Description
0–1	50–49						**ARTIFICIAL FILL** 4-inches Hot Mix Asphalt; 3.5-inches Concrete
1–5.2	49–45	Borehole backfilled with bentonite grout and capped with high-strength concrete.	S1		23 20 12	GS	Dense, moist, gray, very gravelly, silty SAND (SM); fine to coarse sand, fine and coarse subrounded to angular gravel.
5.2–7.8	45–42	∇ 12/9/2016	S2		5 2 2		**QUATERNARY ALLUVIUM** Soft, moist, dark brown, gravelly, fine-grained PEAT (PT); trace fine sand, fine and coarse rounded gravel.
7.8–9	42–41		S3		2 2 5	FC=56.8%	Medium stiff, wet, gray, SILT (ML); low-plasticity, fine to coarse sand, very thinly bedded silty sand.
9–12.7	41–37		S4		2 1 4		Medium stiff, wet, brown and gray, sandy, fine-grained PEAT (PT) interbedded with SILT (ML); non-plastic, fine to coarse sand.
12.7–14	37–36		S5		5 10 4		Medium dense, wet, gray, sandy GRAVEL (GP); trace silt, fine to coarse sand, fine subangular to angular gravel.
14–19	36–31		S6, S7		0 4 1; 0 14 21	=4.5%	Loose, wet, brown and gray, gravelly, slightly silty SAND (SP-SM) interbedded with medium stiff, brown, fine-grained PEAT (PT); fine to coarse sand, fine subangular to angular gravel.
19–21	31–29		S8		15 12 4		Medium dense, wet, gray, sandy GRAVEL (GP); fine to coarse sand, subrounded to rounded fine and coarse gravel.
21–25	29–25						Medium dense, wet, gray, silty SAND (SM) interbedded with rare laminations of PEAT (PT); fine to coarse sand.

Legend

Sample Method: No Soil Sample Recovery; Split Barrel 2" X 1.375" (SPT)

Plastic Limit ⊢—⊣ Liquid Limit

Water Level: ∇ Water Level ATD

See Exploration Log Key for explanation of symbols

Logged by: JGF
Approved by: EOA - 9/12/2017

Exploration Log B-2

Sheet 1 of 3

ASPECT STANDARD EXPLORATION LOG TEMPLATE P:\GINTW\PROJECTS\ZACKUSE CREEK CULVERT.GPJ September 11, 2017

Zackuse Creek Fish Passage - 160277		Geotechnical Exploration Log	
Aspect CONSULTING	*Project Address & Site Specific Location* East Lake Sammamish Parkway, Sammamish, Washington, Center of northbound travel lane.	*Coordinates (SPN NAD83 ft)* E:225301.9 N:1335520 (est)	*Exploration Number* **B-2**

Contractor	*Equipment*	*Sampling Method*	*Ground Surface (GS) Elev. (NAVD88)*
Holt Services	Truck-mounted Mobile Drilling B-59	Autohammer; 140 lb hammer; 30" drop	50'(est)

Operator	*Exploration Method(s)*	*Work Start/Completion Dates*	*Top of Casing Elev. (NAVD88)*	*Depth to Water (Below GS)*
Kevin Bacon	6-inch OD Mud rotary	12/9/2016	NA	7.5' (ATD)

Depth (feet)	Elev. (feet)	Sample Type/ID	Blows/6"	Tests	Description
25–26	25–24	S9	11, 19, 19		**VASHON STADE RECESSIONAL OUTWASH** Dense, wet, gray and yellow-brown, slightly gravelly, silty SAND (SM); fine to coarse sand, fine subrounded to subangular gravel.
30–31	20–19	S10	22, 20, 15		Dense, wet, gray and yellow-brown, sandy, slightly silty GRAVEL (GP-GM); fine to coarse sand, fine and coarse gravel.
33	17				Dense, wet, brown and orange-brown, slightly silty SAND (SP-SM); fine to coarse sand.
35–36	15–14	S11a	11, 16, 22		
36	14	S11b		GS	Dense, wet, brown, sandy, silty GRAVEL (GM); fine sand, fine and coarse rounded gravel.
36.5	13.5				**VASHON STADE TILL** Very dense, wet, gray, gravelly, silty SAND (SM); fine to medium sand, fine subrounded to subangular gravel, diamict texture.
40–41	10–9	S12	50		
45–46	5–4	S13	50		

Depth scale: 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49

Blows/foot ▲ Water Content (%)● 0 10 20 30 40 50

Exploration Completion and Notes

Material Type

Legend

Sample Method: No Soil Sample Recovery; Split Barrel 2" X 1.375" (SPT)

Plastic Limit ├──┤ Liquid Limit

Water Level: ▽ Water Level ATD

See Exploration Log Key for explanation of symbols

Logged by: JGF
Approved by: EOA - 9/12/2017

Exploration Log B-2

Aspect CONSULTING	Zackuse Creek Fish Passage - 160277		Geotechnical Exploration Log	
	Project Address & Site Specific Location East Lake Sammamish Parkway, Sammamish, Washington, Center of northbound travel lane.		*Coordinates (SPN NAD83 ft)* E:225301.9 N:1335520 (est)	*Exploration Number* **B-2**
Contractor Holt Services	*Equipment* Truck-mounted Mobile Drilling B-59	*Sampling Method* Autohammer; 140 lb hammer; 30" drop	*Ground Surface (GS) Elev. (NAVD88)* 50'(est)	
Operator Kevin Bacon	*Exploration Method(s)* 6-inch OD Mud rotary	*Work Start/Completion Dates* 12/9/2016	*Top of Casing Elev. (NAVD88)* NA	*Depth to Water (Below GS)* 7.5' (ATD)

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)
			S14	▲	28 40 42	FC=19.5%		Very dense, wet, gray, silty SAND (SM); fine to medium sand, trace organics, iron-oxide staining.	
51	-1								51
								Very dense, wet, gray, gravelly, slightly silty SAND (SP-SM); fine to coarse sand, fine subangular gravel.	
52	-2							Bottom of exploration at 51.5 ft. bgs.	52
53	-3								53
54	-4								54
55	-5								55
56	-6								56
57	-7								57
58	-8								58
59	-9								59
60	-10								60
61	-11								61
62	-12								62
63	-13								63
64	-14								64
65	-15								65
66	-16								66
67	-17								67
68	-18								68
69	-19								69
70	-20								70
71	-21								71
72	-22								72
73	-23								73
74	-24								74

Legend

Sample Method
- No Soil Sample Recovery
- Split Barrel 2" X 1.375" (SPT)

Plastic Limit ├─┤ Liquid Limit

Water Level
- ∇ Water Level ATD

See Exploration Log Key for explanation of symbols

Logged by: JGF
Approved by: EOA - 9/12/2017

Exploration Log B-2

Aspect CONSULTING

Zackuse Creek Fish Passage - 160277			Geotechnical Exploration Log	
Project Address & Site Specific Location			Coordinates (SPN NAD83 ft)	Exploration Number
East Lake Sammamish Parkway, Sammamish, Washington, -			E:225028.8 N:1335940 (est)	HA-1
Contractor	Equipment	Sampling Method	Ground Surface (GS) Elev. (NAVD88)	
Aspect Consulting	2.5-inch OD Hand Auger	Grab / DCPT	76'(est)	
Operator	Exploration Method(s)	Work Start/Completion Dates	Top of Casing Elev. (NAVD88)	Depth to Water (Below GS)
JGF	Hand tools	12/13/2016	NA	3.1' (ATD)

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)
						T-probe= 14"		**QUATERNARY ALLUVIUM**	
1	75	Boring backfilled with excavated soil.						Loose, moist, dark brown, slightly gravelly, very silty SAND (SM); fine to medium sand, fine subrounded to subangular gravel, scattered organic content.	1
2	74		S1			DCPT= 2,3,3		Loose, moist, brown, sandy, silty GRAVEL (GM); fine to coarse sand, fine and coarse rounded to subangular gravel.	2
3	73	∇ 12/13/2016				DCPT= 5,6		Very loose, slightly moist, light brown, gravelly, silty SAND (SM); fine to medium sand, fine and coarse rounded to subangular gravel. Becomes wet at 3.1' bgs.	3
4	72								4
5	71							Bottom of exploration at 4.8 ft. bgs.	5
6	70							Note: Refusal due to coarse gravel.	6
7	69								7
8	68								8
9	67								9
10	66								10
11	65								11
12	64								12
13	63								13
14	62								14
15	61								15
16	60								16
17	59								17
18	58								18
19	57								19
20	56								20
21	55								21
22	54								22
23	53								23
24	52								24

Legend

Sample Method: Grab Sample

Plastic Limit ⊢—⊣ Liquid Limit

Water Level: ∇ Water Level ATD

See Exploration Log Key for explanation of symbols

Logged by: JGF
Approved by: EOA - 9/12/2017

Exploration Log HA-1

Sheet 1 of 1

Aspect CONSULTING	Zackuse Creek Fish Passage - 160277			Geotechnical Exploration Log	
	Project Address & Site Specific Location			Coordinates (SPN NAD83 ft)	Exploration Number
	East Lake Sammamish Parkway, Sammamish, Washington, -			E:224965.2 N:1335860 (est)	HA-2
Contractor	Equipment	Sampling Method		Ground Surface (GS) Elev. (NAVD88)	
Aspect Consulting	2.5-inch OD Hand Auger	Grab / DCPT		67'(est)	
Operator	Exploration Method(s)	Work Start/Completion Dates		Top of Casing Elev. (NAVD88)	Depth to Water (Below GS)
JGF	Hand tools	12/13/2016		NA	1' (ATD)

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)
						T-probe= 6"		**QUATERNARY ALLUVIUM**	
1	66	▽ 12/13/2016 Boring backfilled with excavated soil.						Loose, very moist, dark brown, sandy, silty GRAVEL (GM); fine to coarse sand, fine and coarse rounded to subangular gravel.	1
2	65							Loose, wet, dark brown, sandy, No recovery	2
3	64					DCPT= 5,8,9,10,11			3
4	63							Bottom of exploration at 3.8 ft. bgs.	4
5	62							Note: Hole collapsing from 1' bgs; refusal because of collapsing walls.	5
6	61								6
7	60								7
8	59								8
9	58								9
10	57								10
11	56								11
12	55								12
13	54								13
14	53								14
15	52								15
16	51								16
17	50								17
18	49								18
19	48								19
20	47								20
21	46								21
22	45								22
23	44								23
24	43								24

Legend

Sample Method

Plastic Limit ⊢—⊣ Liquid Limit

Water Level: ▽ Water Level ATD

See Exploration Log Key for explanation of symbols

Logged by: JGF
Approved by: EOA - 9/12/2017

Exploration Log HA-2

Sheet 1 of 1

Aspect CONSULTING	Zackuse Creek Fish Passage - 160277		Geotechnical Exploration Log	
	Project Address & Site Specific Location East Lake Sammamish Parkway, Sammamish, Washington, -		*Coordinates (SPN NAD83 ft)* E:225001.4 N:1335730 (est)	*Exploration Number* **HA-3**
Contractor Aspect Consulting	*Equipment* 2.5-inch OD Hand Auger	*Sampling Method* Grab / DCPT	*Ground Surface (GS) Elev. (NAVD88)* 62'(est)	
Operator JGF	*Exploration Method(s)* Hand tools	*Work Start/Completion Dates* 12/13/2016	*Top of Casing Elev. (NAVD88)* NA	*Depth to Water (Below GS)* 2.8' (ATD)

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)
						T-probe= 12"		**QUATERNARY ALLUVIUM** Very loose, moist, dark brown, sandy, slightly silty GRAVEL (GP-GM); fine to coarse sand, fine and coarse rounded to subangular gravel.	
1	61	Boring backfilled with excavated soil.				T-probe= 8"			1
2	60		S1	●		GS DCPT= 3,1,1		Very loose, wet, brown, gravelly, silty SAND (SM); fine to coarse sand, fine rounded to subrounded gravel.	2
3	59	∇ 12/13/2016						Soft, wet, dark brown, fine-grained PEAT (PT).	3
4	58					DCPT= 13,18,15		Loose, wet, brown, gravelly, silty SAND (SM); fine to coarse sand, fine and coarse rounded to subangular gravel.	4
5	57							Bottom of exploration at 4 ft. bgs. Note: Refusal because of collapsing walls at 3.2' bgs.	5
6	56								6
7	55								7
8	54								8
9	53								9
10	52								10
11	51								11
12	50								12
13	49								13
14	48								14
15	47								15
16	46								16
17	45								17
18	44								18
19	43								19
20	42								20
21	41								21
22	40								22
23	39								23
24	38								24

Legend

Sample Method: Grab Sample

Plastic Limit ⊢⊣ Liquid Limit

Water Level: ∇ Water Level ATD

See Exploration Log Key for explanation of symbols

Logged by: JGF
Approved by: EOA - 9/12/2017

Exploration Log HA-3

Sheet 1 of 1

Aspect CONSULTING	Zackuse Creek Fish Passage - 160277			Geotechnical Exploration Log	
	Project Address & Site Specific Location			*Coordinates (SPN NAD83 ft)*	*Exploration Number*
	East Lake Sammamish Parkway, Sammamish, Washington, -			E:225088.8 N:1335660 (est)	**HA-4**
Contractor	*Equipment*	*Sampling Method*		*Ground Surface (GS) Elev. (NAVD88)*	
Aspect Consulting	2.5-inch OD Hand Auger	Grab / DCPT		58'(est)	
Operator	*Exploration Method(s)*	*Work Start/Completion Dates*		*Top of Casing Elev. (NAVD88)*	*Depth to Water (Below GS)*
JGF	Hand tools	12/13/2016		NA	0.5' (ATD)

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)
		▽ 12/13/2016				T-probe= 36"		**TOPSOIL** Very loose, very moist, dark brown, gravelly, silty SAND (SM).	
1	57	Boring backfilled with excavated soil.							1
2	56							**QUATERNARY ALLUVIUM** Very loose, wet, gray, very gravelly, slightly silty SAND (SP-SM); fine to coarse sand, fine and coarse subrounded to subangular gravel.	2
3	55					DCPT= 10,12,18,20		No recovery.	3
4	54							Bottom of exploration at 3.5 ft. bgs. Note: Refusal because of collapsing walls at 2.7' bgs.	4
5	53								5
6	52								6
7	51								7
8	50								8
9	49								9
10	48								10
11	47								11
12	46								12
13	45								13
14	44								14
15	43								15
16	42								16
17	41								17
18	40								18
19	39								19
20	38								20
21	37								21
22	36								22
23	35								23
24	34								24

Legend

Sample Method

Plastic Limit ├──┤ Liquid Limit

Water Level: ▽ Water Level ATD

See Exploration Log Key for explanation of symbols

Logged by: JGF
Approved by: EOA - 9/12/2017

Exploration Log
HA-4
Sheet 1 of 1

Aspect Consulting	Zackuse Creek Fish Passage - 160277	Geotechnical Exploration Log	
	Project Address & Site Specific Location: East Lake Sammamish Parkway, Sammamish, Washington, -	Coordinates (SPN NAD83 ft): E:225146.4 N:1335590 (est)	Exploration Number: **HA-5**
Contractor: Aspect Consulting	Equipment: 2.5-inch OD Hand Auger; Sampling Method: Grab / DCPT	Ground Surface (GS) Elev. (NAVD88): 54'(est)	
Operator: JGF	Exploration Method(s): Hand tools; Work Start/Completion Dates: 12/13/2016	Top of Casing Elev. (NAVD88): NA	Depth to Water (Below GS): 1.5' (ATD)

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)
						T-probe= 16"		**TOPSOIL** Very soft, wet, dark brown, slightly gravelly, sandy organic SILT (OL); low-plasticity, fine sand, fine and coarse subangular gravel.	
1	53	Boring backfilled with excavated soil. ▽ 12/13/2016							1
			S1	●		DCPT= 6,6,6 GS		**QUATERNARY ALLUVIUM** Loose, wet, gray, very sandy, slightly silty GRAVEL (GP-GM); fine to coarse sand, fine and coarse subrounded to subangular gravel.	
2	52								2
			S2						
3	51					DCPT= 13,>30		Stiff, wet, dark brown, slightly gravelly, fine-grained PEAT (PT); low-plasticity, trace fine to medium sand, fine and coarse subrounded to subangular gravel.	3
4	50							Bottom of exploration at 3.8 ft. bgs.	4
5	49							Note: Refusal because of collapsing walls at 2' bgs.	5
6	48								6
7	47								7
8	46								8
9	45								9
10	44								10
11	43								11
12	42								12
13	41								13
14	40								14
15	39								15
16	38								16
17	37								17
18	36								18
19	35								19
20	34								20
21	33								21
22	32								22
23	31								23
24	30								24

Legend

Sample Method: Grab Sample

Plastic Limit ⊢—⊣ Liquid Limit

Water Level: ▽ Water Level ATD

See Exploration Log Key for explanation of symbols

Logged by: JGF
Approved by: EOA - 9/12/2017

Exploration Log HA-5

Sheet 1 of 1

APPENDIX B

Geotechnical Laboratory Test Results

B.1 Geotechnical Laboratory Testing

Geotechnical laboratory tests were conducted on selected soil and rock samples collected during the field exploration program. Eight samples were dispatched to Materials Testing and Consulting, Inc. for determination of moisture content, grain size distribution, percent material passing a 200# sieve (fines content), or organic content:

- Moisture content was determined by ASTM D2216, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*.
- Grain size analysis was conducted in accordance with ASTM C136, *Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates* and ASTM C117 *Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing*
- Percent material passing a 200# sieve (fines content) was conducted in accordance with C117 *Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing*
- Organic content was conducted in accordance with ASTM D2974 *Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils*.

The results of the tests are provided in the attached data sheets.

Materials Testing & Consulting, Inc.

Geotechnical Engineering • Special Inspection • Materials Testing • Environmental Consulting

Project:	Zackuse Creek Fish Passage	**Date Received:**	December 21, 2016
Project #:	16T023-06	**Sampled By:**	Others
Client :	Aspect Consulting	**Date Reported:**	December 29, 2016
Source:	Multiple	**Tested By:**	K. O'Connell
MTC Sample#:	Multiple		

CASE NARRATIVE

1. Eleven samples were submitted for analysis.
2. Three samples were submitted for Percent Finer Than the No. 200 sieve according to ASTM C117.
3. Three samples were submitted for loss on ignition determination according to ASTM D2974. Per client request, gravel was separated prior to analysis.
4. Five samples were submitted for grain size determination according to ASTM C136 and C117.
5. The samples are reported in summary tables and plots.
6. There were no other noted anomalies in this project.

Reviewed by: Elizabeth Noble

Corporate ~ 777 Chrysler Drive • Burlington, WA 98233 • Phone (360) 755-1990 • Fax (360) 755-1980

Regional Offices: Olympia ~ 360.534.9777 Bellingham ~ 360.647.6111 Silverdale ~ 360.698.6787 Tukwila ~ 206.241.1974

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Materials Testing & Consulting, Inc.

Geotechnical Engineering • Special Inspection • Materials Testing • Environmental Consulting

Project: Zackuse Creek Fish Passage
Project #: 16T023-06
Date Received: December 21, 2016
Date Tested: December 28, 2016

Client: Aspect Consulting
Sampled by: Others
Tested by: K. O'Connell

Amount of Materials Finer Than #200 Sieve - ASTM C117

Sample #	Location	Tare	Before Wash + Tare	After Wash + Tare	Amount of Loss	% -#200
T16-2378	B-1 S4 10	10.2	176.4	78.0	98.4	59.2%
T16-2382	B-2 S3 7.5	10.7	141.8	67.3	74.5	56.8%
T16-2385	B-2 S14 50	10.7	264.0	214.6	49.4	19.5%

Reviewed by: Elizabeth Noble

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Materials Testing & Consulting, Inc.

Geotechnical Engineering • Special Inspection • Materials Testing • Environmental Consulting

Project: Zackuse Creek Fish Passage
Project #: 16T023-06
Date Received: December 21, 2016
Date Tested: December 28, 2016

Client: Aspect Consulting
Sampled by: Others
Tested by: K. O'Connell

Moisture Content - ASTM D2216

Sample #	Location	Tare	Wet + Tare	Dry + Tare	Wgt. Of Moisture	Wgt. Of Soil	% Moisture
T16-2377	B-1 S2 5	101.77	225.09	181.04	44.05	79.27	55.6%
T16-2379	B-1 S5b 13.5	103.49	220.16	141.44	78.72	37.95	207.4%
T16-2383	B-2 S7 17.5	102.20	237.84	199.50	38.34	97.30	39.4%

Organic Content - ASTM D2974

Sample #	Location	Tare	Soil + Tare, Pre-Ignition	Soil + Tare, Post Ignition	% Organics
T16-2377	B-1 S2 5	101.77	181.04	174.76	7.9%
T16-2379	B-1 S5b 13.5	103.49	141.44	130.08	29.9%
T16-2383	B-2 S7 17.5	102.20	199.50	195.17	4.5%

Reviewed by: Elizabeth Noble

Sieve Report

Project: Zackuse Creek Fish Passage
Project #: 16T023-06
Client: Aspect Consulting
Source: B-1 S12 40
Sample#: T16-2380

Date Received: 21-Dec-16
Sampled By: Others
Date Tested: 28-Dec-16
Tested By: K. O'Connell

ASTM D-2487 Unified Soils Classification System
SP-SM, Poorly graded Sand with Silt and Gravel
Sample Color:
Gray

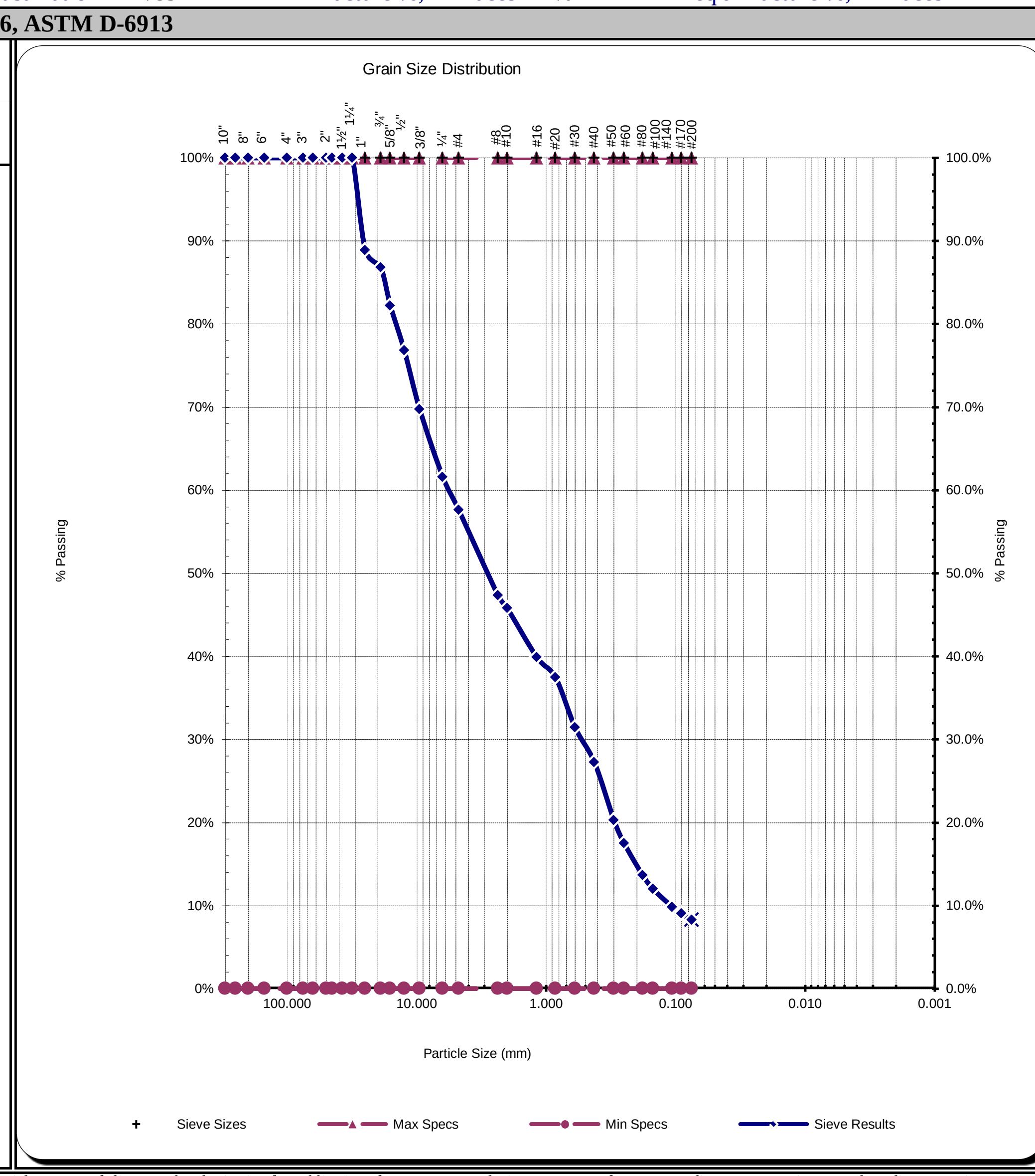
ASTM D-2216, ASTM D-2419, ASTM D-4318, ASTM D-5821

Specifications
No Specs
Sample Meets Specs ? N/A

$D_{(5)}$ = 0.045 mm	% Gravel = 42.4%	Coeff. of Curvature, C_C = 0.47
$D_{(10)}$ = 0.110 mm	% Sand = 49.4%	Coeff. of Uniformity, C_U = 51.79
$D_{(15)}$ = 0.205 mm	% Silt & Clay = 8.3%	Fineness Modulus = 4.35
$D_{(30)}$ = 0.540 mm	Liquid Limit = n/a	Plastic Limit = n/a
$D_{(50)}$ = 2.978 mm	Plasticity Index = n/a	Moisture %, as sampled = 8.1%
$D_{(60)}$ = 5.678 mm	Sand Equivalent = n/a	Req'd Sand Equivalent =
$D_{(90)}$ = 25.668 mm	Fracture %, 1 Face = n/a	Req'd Fracture %, 1 Face =
Dust Ratio = 27/89	Fracture %, 2+ Faces = n/a	Req'd Fracture %, 2+ Faces =

ASTM C-136, ASTM D-6913

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
12.00"	300.00		100%	100.0%	0.0%
10.00"	250.00		100%	100.0%	0.0%
8.00"	200.00		100%	100.0%	0.0%
6.00"	150.00		100%	100.0%	0.0%
4.00"	100.00		100%	100.0%	0.0%
3.00"	75.00		100%	100.0%	0.0%
2.50"	63.00		100%	100.0%	0.0%
2.00"	50.00		100%	100.0%	0.0%
1.75"	45.00		100%	100.0%	0.0%
1.50"	37.50		100%	100.0%	0.0%
1.25"	31.50		100%	100.0%	0.0%
1.00"	25.00	89%	89%	100.0%	0.0%
3/4"	19.00	87%	87%	100.0%	0.0%
5/8"	16.00		82%	100.0%	0.0%
1/2"	12.50	77%	77%	100.0%	0.0%
3/8"	9.50	70%	70%	100.0%	0.0%
1/4"	6.30		62%	100.0%	0.0%
#4	4.75	58%	58%	100.0%	0.0%
#8	2.36		47%	100.0%	0.0%
#10	2.00	46%	46%	100.0%	0.0%
#16	1.18		40%	100.0%	0.0%
#20	0.850	37%	37%	100.0%	0.0%
#30	0.600		31%	100.0%	0.0%
#40	0.425	27%	27%	100.0%	0.0%
#50	0.300		20%	100.0%	0.0%
#60	0.250	17%	17%	100.0%	0.0%
#80	0.180		14%	100.0%	0.0%
#100	0.150	12%	12%	100.0%	0.0%
#140	0.106		10%	100.0%	0.0%
#170	0.090		9%	100.0%	0.0%
#200	0.075	8.3%	8.3%	100.0%	0.0%



Comments: ____________________

Reviewed by: EGabe Noble

Materials Testing & Consulting, Inc.

Geotechnical Engineering • Special Inspection • Materials Testing • Environmental Consulting

Sieve Report

Project:	Zackuse Creek Fish Passage	**Date Received:**	21-Dec-16
Project #:	16T023-06	**Sampled By:**	Others
Client:	Aspect Consulting	**Date Tested:**	28-Dec-16
Source:	B-2 S1 2.5	**Tested By:**	K. O'Connell
Sample#:	T16-2381		

ASTM D-2487 Unified Soils Classification System
SM, Silty Sand with Gravel
Sample Color:
Gray

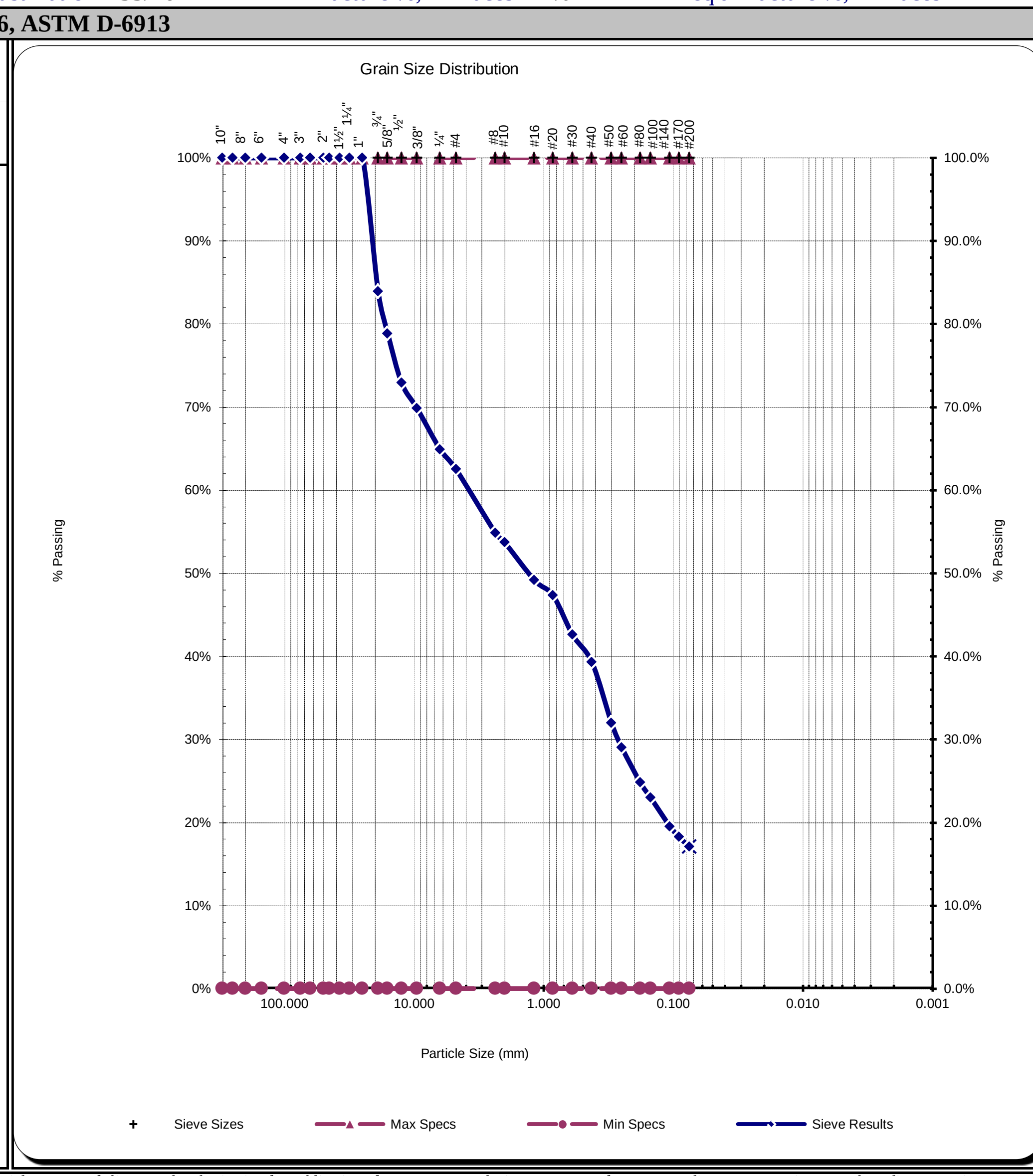
ASTM D-2216, ASTM D-2419, ASTM D-4318, ASTM D-5821

Specifications
No Specs
Sample Meets Specs ? N/A

$D_{(5)}$ = 0.022 mm	% Gravel = 37.5%	Coeff. of Curvature, C_C = 0.41
$D_{(10)}$ = 0.044 mm	% Sand = 45.4%	Coeff. of Uniformity, C_U = 90.29
$D_{(15)}$ = 0.066 mm	% Silt & Clay = 17.0%	Fineness Modulus = 3.82
$D_{(30)}$ = 0.267 mm	Liquid Limit = n/a	Plastic Limit = n/a
$D_{(50)}$ = 1.332 mm	Plasticity Index = n/a	Moisture %, as sampled = 12.7%
$D_{(60)}$ = 3.972 mm	Sand Equivalent = n/a	Req'd Sand Equivalent =
$D_{(90)}$ = 21.269 mm	Fracture %, 1 Face = n/a	Req'd Fracture %, 1 Face =
Dust Ratio = 33/76	Fracture %, 2+ Faces = n/a	Req'd Fracture %, 2+ Faces =

ASTM C-136, ASTM D-6913

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
12.00"	300.00		100%	100.0%	0.0%
10.00"	250.00		100%	100.0%	0.0%
8.00"	200.00		100%	100.0%	0.0%
6.00"	150.00		100%	100.0%	0.0%
4.00"	100.00		100%	100.0%	0.0%
3.00"	75.00		100%	100.0%	0.0%
2.50"	63.00		100%	100.0%	0.0%
2.00"	50.00		100%	100.0%	0.0%
1.75"	45.00		100%	100.0%	0.0%
1.50"	37.50		100%	100.0%	0.0%
1.25"	31.50		100%	100.0%	0.0%
1.00"	25.00		100%	100.0%	0.0%
3/4"	19.00	84%	84%	100.0%	0.0%
5/8"	16.00		79%	100.0%	0.0%
1/2"	12.50	73%	73%	100.0%	0.0%
3/8"	9.50	70%	70%	100.0%	0.0%
1/4"	6.30		65%	100.0%	0.0%
#4	4.75	62%	62%	100.0%	0.0%
#8	2.36		55%	100.0%	0.0%
#10	2.00	54%	54%	100.0%	0.0%
#16	1.18		49%	100.0%	0.0%
#20	0.850	47%	47%	100.0%	0.0%
#30	0.600		43%	100.0%	0.0%
#40	0.425	39%	39%	100.0%	0.0%
#50	0.300		32%	100.0%	0.0%
#60	0.250	29%	29%	100.0%	0.0%
#80	0.180		25%	100.0%	0.0%
#100	0.150	23%	23%	100.0%	0.0%
#140	0.106		20%	100.0%	0.0%
#170	0.090		18%	100.0%	0.0%
#200	0.075	17.0%	17.0%	100.0%	0.0%



Comments: ______

Reviewed by: Egabi Noble

Materials Testing & Consulting, Inc.

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Sieve Report

Project: Zackuse Creek Fish Passage
Project #: 16T023-06
Client: Aspect Consulting
Source: B-2 S11b 36
Sample#: T16-2384

Date Received: 21-Dec-16
Sampled By: Others
Date Tested: 28-Dec-16
Tested By: K. O'Connell

ASTM D-2487 Unified Soils Classification System
GM, Silty Gravel with Sand
Sample Color:
Gray

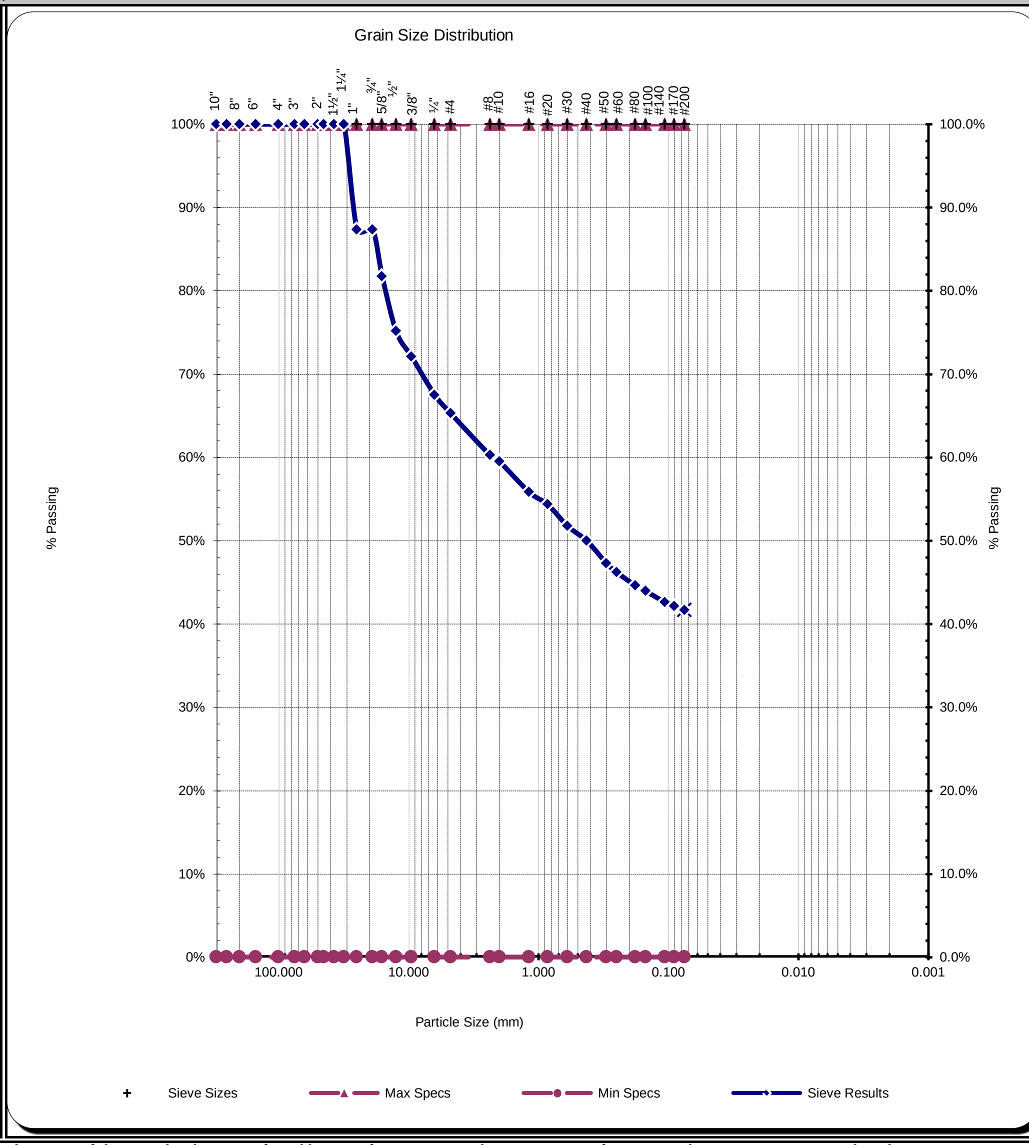
ASTM D-2216, ASTM D-2419, ASTM D-4318, ASTM D-5821

Specifications
No Specs
Sample Meets Specs ? N/A

$D_{(5)}$ = 0.009 mm	% Gravel = 34.7%	Coeff. of Curvature, C_C = 0.07
$D_{(10)}$ = 0.018 mm	% Sand = 23.6%	Coeff. of Uniformity, C_U = 124.44
$D_{(15)}$ = 0.027 mm	% Silt & Clay = 41.7%	Fineness Modulus = 3.16
$D_{(30)}$ = 0.054 mm	Liquid Limit = n/a	Plastic Limit = n/a
$D_{(50)}$ = 0.427 mm	Plasticity Index = n/a	Moisture %, as sampled = 13.3%
$D_{(60)}$ = 2.241 mm	Sand Equivalent = n/a	Req'd Sand Equivalent =
$D_{(90)}$ = 26.360 mm	Fracture %, 1 Face = n/a	Req'd Fracture %, 1 Face =
Dust Ratio = 5/6	Fracture %, 2+ Faces = n/a	Req'd Fracture %, 2+ Faces =

ASTM C-136, ASTM D-6913

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
12.00"	300.00		100%	100.0%	0.0%
10.00"	250.00		100%	100.0%	0.0%
8.00"	200.00		100%	100.0%	0.0%
6.00"	150.00		100%	100.0%	0.0%
4.00"	100.00		100%	100.0%	0.0%
3.00"	75.00		100%	100.0%	0.0%
2.50"	63.00		100%	100.0%	0.0%
2.00"	50.00		100%	100.0%	0.0%
1.75"	45.00		100%	100.0%	0.0%
1.50"	37.50		100%	100.0%	0.0%
1.25"	31.50		100%	100.0%	0.0%
1.00"	25.00	87%	87%	100.0%	0.0%
3/4"	19.00	87%	87%	100.0%	0.0%
5/8"	16.00		82%	100.0%	0.0%
1/2"	12.50	75%	75%	100.0%	0.0%
3/8"	9.50	72%	72%	100.0%	0.0%
1/4"	6.30		67%	100.0%	0.0%
#4	4.75	65%	65%	100.0%	0.0%
#8	2.36		60%	100.0%	0.0%
#10	2.00	59%	59%	100.0%	0.0%
#16	1.18		56%	100.0%	0.0%
#20	0.850	54%	54%	100.0%	0.0%
#30	0.600		52%	100.0%	0.0%
#40	0.425	50%	50%	100.0%	0.0%
#50	0.300		47%	100.0%	0.0%
#60	0.250	46%	46%	100.0%	0.0%
#80	0.180		45%	100.0%	0.0%
#100	0.150	44%	44%	100.0%	0.0%
#140	0.106		43%	100.0%	0.0%
#170	0.090		42%	100.0%	0.0%
#200	0.075	41.7%	41.7%	100.0%	0.0%



Comments:

Reviewed by: Egbert Noble

Materials Testing & Consulting, Inc.

Geotechnical Engineering • Special Inspection • Materials Testing • Environmental Consulting

Sieve Report

Project: Zackuse Creek Fish Passage
Project #: 16T023-06
Client: Aspect Consulting
Source: HA-3 S1 1.5
Sample#: T16-2386

Date Received: 21-Dec-16
Sampled By: Others
Date Tested: 28-Dec-16
Tested By: K. O'Connell

ASTM D-2487 Unified Soils Classification System
GP-GM, Poorly graded Gravel with Silt and Sand
Sample Color:
Gray

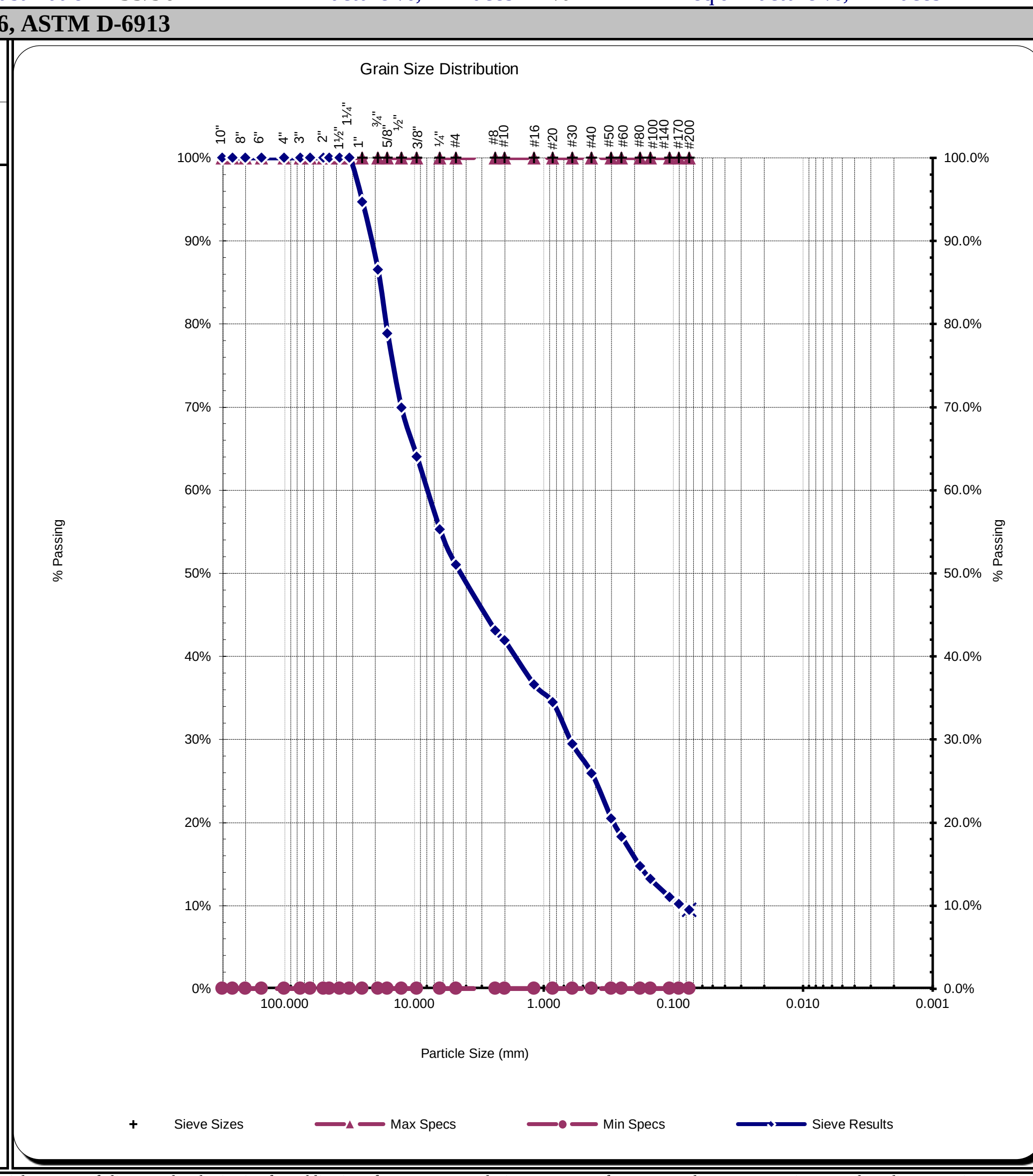
ASTM D-2216, ASTM D-2419, ASTM D-4318, ASTM D-5821

Specifications
No Specs
Sample Meets Specs ? N/A

$D_{(5)}$ = 0.040 mm	% Gravel = 49.0%	Coeff. of Curvature, C_C = 0.57
$D_{(10)}$ = 0.086 mm	% Sand = 41.5%	Coeff. of Uniformity, C_U = 93.27
$D_{(15)}$ = 0.186 mm	% Silt & Clay = 9.4%	Fineness Modulus = 4.56
$D_{(30)}$ = 0.629 mm	Liquid Limit = n/a	Plastic Limit = n/a
$D_{(50)}$ = 4.456 mm	Plasticity Index = n/a	Moisture %, as sampled = 12.0%
$D_{(60)}$ = 8.040 mm	Sand Equivalent = n/a	Req'd Sand Equivalent =
$D_{(90)}$ = 21.574 mm	Fracture %, 1 Face = n/a	Req'd Fracture %, 1 Face =
Dust Ratio = 35/96	Fracture %, 2+ Faces = n/a	Req'd Fracture %, 2+ Faces =

ASTM C-136, ASTM D-6913

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
12.00"	300.00		100%	100.0%	0.0%
10.00"	250.00		100%	100.0%	0.0%
8.00"	200.00		100%	100.0%	0.0%
6.00"	150.00		100%	100.0%	0.0%
4.00"	100.00		100%	100.0%	0.0%
3.00"	75.00		100%	100.0%	0.0%
2.50"	63.00		100%	100.0%	0.0%
2.00"	50.00		100%	100.0%	0.0%
1.75"	45.00		100%	100.0%	0.0%
1.50"	37.50		100%	100.0%	0.0%
1.25"	31.50		100%	100.0%	0.0%
1.00"	25.00	95%	95%	100.0%	0.0%
3/4"	19.00	86%	86%	100.0%	0.0%
5/8"	16.00		79%	100.0%	0.0%
1/2"	12.50	70%	70%	100.0%	0.0%
3/8"	9.50	64%	64%	100.0%	0.0%
1/4"	6.30		55%	100.0%	0.0%
#4	4.75	51%	51%	100.0%	0.0%
#8	2.36		43%	100.0%	0.0%
#10	2.00	42%	42%	100.0%	0.0%
#16	1.18		37%	100.0%	0.0%
#20	0.850	34%	34%	100.0%	0.0%
#30	0.600		29%	100.0%	0.0%
#40	0.425	26%	26%	100.0%	0.0%
#50	0.300		20%	100.0%	0.0%
#60	0.250	18%	18%	100.0%	0.0%
#80	0.180		15%	100.0%	0.0%
#100	0.150	13%	13%	100.0%	0.0%
#140	0.106		11%	100.0%	0.0%
#170	0.090		10%	100.0%	0.0%
#200	0.075	9.4%	9.4%	100.0%	0.0%



Comments:

Reviewed by: Egabin Noble

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Visit our website: www.mtc-inc.net

Materials Testing & Consulting, Inc.

Geotechnical Engineering • Special Inspection • Materials Testing • Environmental Consulting

Sieve Report

Project: Zackuse Creek Fish Passage
Project #: 16T023-06
Client: Aspect Consulting
Source: HA-5 S1 1.5
Sample#: T16-2387

Date Received: 21-Dec-16
Sampled By: Others
Date Tested: 28-Dec-16
Tested By: K. O'Connell

ASTM D-2487 Unified Soils Classification System
GP-GM, Poorly graded Gravel with Silt and Sand
Sample Color:
Gray

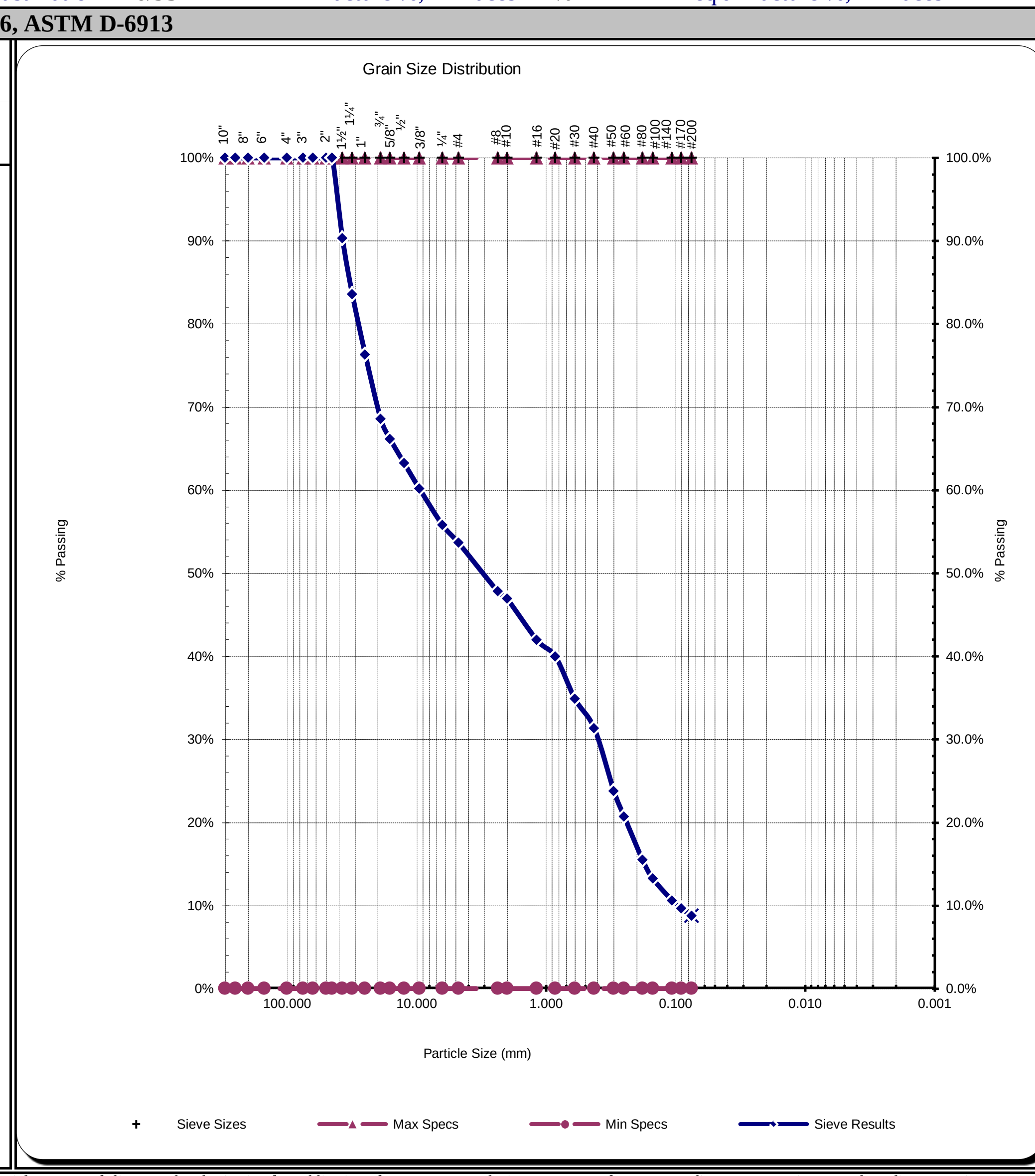
ASTM D-2216, ASTM D-2419, ASTM D-4318, ASTM D-5821

Specifications
No Specs
Sample Meets Specs ? N/A

$D_{(5)}$ = 0.043 mm	% Gravel = 46.4%	Coeff. of Curvature, C_C = 0.18
$D_{(10)}$ = 0.096 mm	% Sand = 44.9%	Coeff. of Uniformity, C_U = 98.06
$D_{(15)}$ = 0.174 mm	% Silt & Clay = 8.8%	Fineness Modulus = 4.56
$D_{(30)}$ = 0.404 mm	Liquid Limit = n/a	Plastic Limit = n/a
$D_{(50)}$ = 3.267 mm	Plasticity Index = n/a	Moisture %, as sampled = 17.8%
$D_{(60)}$ = 9.410 mm	Sand Equivalent = n/a	Req'd Sand Equivalent =
$D_{(90)}$ = 37.245 mm	Fracture %, 1 Face = n/a	Req'd Fracture %, 1 Face =
Dust Ratio = 26/93	Fracture %, 2+ Faces = n/a	Req'd Fracture %, 2+ Faces =

ASTM C-136, ASTM D-6913

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
12.00"	300.00		100%	100.0%	0.0%
10.00"	250.00		100%	100.0%	0.0%
8.00"	200.00		100%	100.0%	0.0%
6.00"	150.00		100%	100.0%	0.0%
4.00"	100.00		100%	100.0%	0.0%
3.00"	75.00		100%	100.0%	0.0%
2.50"	63.00		100%	100.0%	0.0%
2.00"	50.00		100%	100.0%	0.0%
1.75"	45.00		100%	100.0%	0.0%
1.50"	37.50	90%	90%	100.0%	0.0%
1.25"	31.50		84%	100.0%	0.0%
1.00"	25.00	76%	76%	100.0%	0.0%
3/4"	19.00	69%	69%	100.0%	0.0%
5/8"	16.00		66%	100.0%	0.0%
1/2"	12.50	63%	63%	100.0%	0.0%
3/8"	9.50	60%	60%	100.0%	0.0%
1/4"	6.30		56%	100.0%	0.0%
#4	4.75	54%	54%	100.0%	0.0%
#8	2.36		48%	100.0%	0.0%
#10	2.00	47%	47%	100.0%	0.0%
#16	1.18		42%	100.0%	0.0%
#20	0.850	40%	40%	100.0%	0.0%
#30	0.600		35%	100.0%	0.0%
#40	0.425	31%	31%	100.0%	0.0%
#50	0.300		24%	100.0%	0.0%
#60	0.250	21%	21%	100.0%	0.0%
#80	0.180		15%	100.0%	0.0%
#100	0.150	13%	13%	100.0%	0.0%
#140	0.106		11%	100.0%	0.0%
#170	0.090		10%	100.0%	0.0%
#200	0.075	8.8%	8.8%	100.0%	0.0%



Comments:

Reviewed by: Ejabin Noble