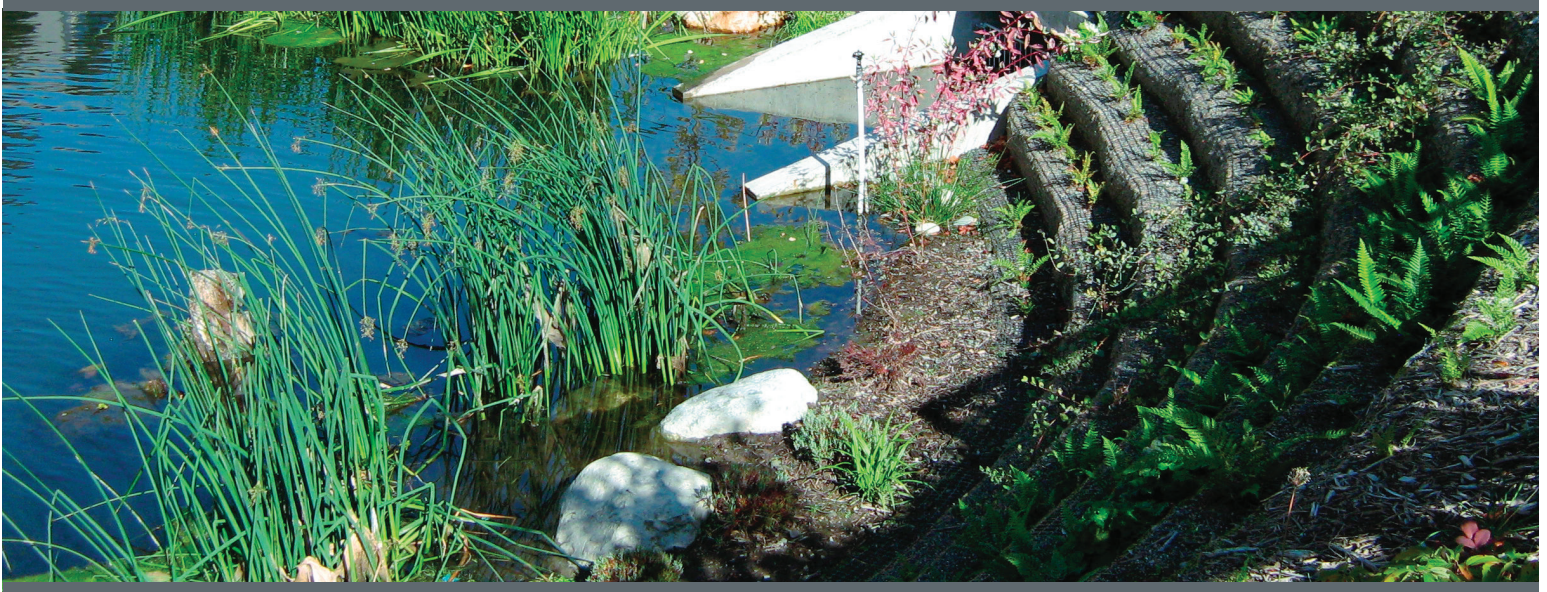


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*Subsurface Exploration and
Geotechnical Engineering Evaluation*

POPE ELEMENTARY SCHOOL ADDITION

Pierce County, Washington

Prepared For:

PUYALLUP SCHOOL DISTRICT

Project No. 170209E001

January 31, 2018



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January 31, 2018
Project No. 170209E001

Puyallup School District
323 - 12th Street NW
Puyallup, Washington 98371

Attention: Mike Meadows

Subject: Subsurface Exploration and Geotechnical Engineering Evaluation
Pope Elementary School Addition
15102 - 122nd Avenue East
Puyallup, Washington

Dear Mr. Meadows:

Associated Earth Sciences, Inc. (AESI) is pleased to submit this revised report describing our subsurface exploration and geotechnical engineering evaluation concerning the planned building addition and related improvements at Pope Elementary School in Pierce County, Washington. Our services were completed in general accordance with our proposal, dated May 9, 2017, and were authorized by your "Agreement for Consulting Services," dated June 8, 2017, and your Purchase Order No. CP2202, dated June 26, 2017.

We have enjoyed working with you on this study and are confident the recommendations presented in this report will aid in the successful completion of your project. If you should have any questions, or if we can be of additional help to you, please do not hesitate to call.

Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Tacoma, Washington

James M. Brisbine, P.E., L.G., L.E.G.
Senior Associate Geotechnical Engineer

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**SUBSURFACE EXPLORATION AND
GEOTECHNICAL ENGINEERING EVALUATION**

POPE ELEMENTARY SCHOOL ADDITION

Pierce County, Washington

Prepared for:

Puyallup School District
323 - 12th Street NW
Puyallup, Washington 98371

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January 31, 2018
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1.0 PROJECT AND SITE DESCRIPTION

The project site comprises an existing elementary school campus located in the South Hill area of Pierce County, as shown on the attached “Vicinity Map” (Figure 1). This campus is visually delineated by residential properties on the north, by 152nd Street East on the south, by 120th Avenue Court East on the west, and by 122nd Avenue East on the east. It has a roughly rectangular shape that measures approximately 600 feet by 800 feet overall and covers about 9 acres. Presently, the southern portion of the campus is occupied by a main school building, numerous portable buildings, hardtop playgrounds, a parking lot, and a bus loop, whereas the northern portion is occupied by a grassy playfield. Our attached “Site and Exploration Plan” (Figure 2) illustrates the existing site features.

Improvement plans call for constructing a new classroom addition immediately north of the existing school building, as shown on Figure 2. This addition will be situated within an area currently occupied by a hardtop playground and a portable building. It will be a single-story, at-grade structure with dimensions on the order of 100 feet by 200 feet, and we assume it will impose low to moderate foundation loads. Other planned or potential site improvements include a playshed located closely northeast of the building addition, a widened bus drop-off lane along the western edge of the campus, small bioretention areas in the east-side parking lot, and stormwater facilities located in the northwestern portion of the campus. We assume that stormwater will be infiltrated onsite if suitable receptor soils are found; otherwise, stormwater would likely need to be detained onsite, and then conveyed off-site.

2.0 PURPOSE AND SCOPE

Associated Earth Sciences, Inc. (AESI) performed this study to characterize subsurface conditions below the site, such that we can derive geotechnical conclusions and recommendations concerning the planned improvements. Our scope of work included the following tasks.

- Reviewed topographic maps, geologic maps, site layout drawings, aerial photos, and other available information pertaining to the site vicinity.
- Performed a visual surface reconnaissance of the site and immediate surroundings.
- Advanced 11 exploration borings (designated EB-1 through EB-11) to a maximum depth of about 35 feet, at strategic locations across the site.
- Installed two groundwater monitoring wells (designated EB-2w and EB-3w) at strategic site locations.
- Visually classified all soil samples obtained from our explorations.

- Conducted one laboratory grain-size (sieve) test on a representative sample of the near-surface soils.
- Submitted three samples of the near-surface soils to an independent analytical laboratory for cation-exchange capacity and organic content testing.
- Analyzed all research, field, and laboratory data in context with the proposed site development features.
- Prepared this report summarizing our geotechnical findings, conclusions, and recommendations.

Figure 2 shows the locations of all subsurface explorations with respect to existing and proposed site features. Appendix A contains our field exploration logs, and Appendix B contains our laboratory testing data.

3.0 FIELD EXPLORATION PROCEDURES

We explored subsurface conditions at the site on July 12 to 13, 2017. The number, locations, and depths of our explorations were completed within the constraints of surface access, utility conflicts, and project budgets. Our exploration procedures are described below. The various types of sediments, as well as the depths where characteristics of the sediments changed, are indicated on the exploration logs presented in Appendix A. Soil contact depths shown on the logs should be regarded as only an approximation; the actual changes between sediment types are often gradational and/or undulating.

The conclusions and recommendations presented in this report are based, in part, on conditions encountered by our explorations completed for this study. Due to the nature of subsurface exploratory work, it is necessary to interpolate and extrapolate soil conditions between and beyond the field explorations. Differing subsurface conditions could be present outside the area of the explorations due to the random nature of deposition and the alteration of topography by past grading and/or filling. The nature and extent of any variations between the field explorations might not become fully evident until construction. If variations are observed at that time, it could be necessary to modify specific conclusions or recommendations in this report.

3.1 Exploration Borings

All exploration borings were performed by Holocene Drilling, Inc., an independent firm working under subcontract to AESI. Each boring was completed by advancing an 8-inch outside-diameter, hollow-stem auger with a truck-mounted drill rig. During the drilling process, disturbed but representative soil samples were obtained at 2½- or 5-foot-depth intervals using the Standard Penetration Test (SPT) procedure in accordance with the *American Society for*

Testing and Materials (ASTM) specification D-1586. After completion of drilling, each borehole was backfilled with bentonite chips, and the surface was patched with concrete.

The SPT testing and sampling procedure consists of driving a standard, 2-inch outside-diameter, split-barrel sampler a distance of 18 inches into the soil with a 140-pound hammer free-falling a distance of 30 inches. 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 represents the Standard Penetration Resistance (also known as the “N-value”). If a total of 50 blows is reached within one 6-inch interval, the N-value is recorded as 50 blows for the corresponding number of inches of penetration. The N-value provides a measure of the relative density of granular soils or the relative consistency of cohesive soils. Higher N-values correspond to a denser or stiffer soil. Our measured N-values are plotted on the exploration boring logs presented in Appendix A.

All exploration borings were continuously observed and logged by an AESI geologist. The materials obtained from the split-barrel sampler were classified in the field, and representative portions were placed in watertight containers. These soil samples were then transported to our office for further visual classification and/or laboratory testing. The soil descriptions shown on our exploration logs are generally based on a combination of factors, such as N-values, drilling action, field observations, and laboratory test results.

3.2 Monitoring Wells

All groundwater monitoring wells were installed by Holocene Drilling, Inc. in conjunction with our exploration borings. Each well consists of a 2-inch-diameter, plastic well casing with threaded connections, the lower 10 feet of which is finely slotted to allow water inflow. The annular space around the well screen was backfilled with clean sand, and the upper portion of annulus was sealed with bentonite chips and concrete. A flush-mounted steel monument was placed over the top of the wellhead for protection. The as-built well configurations are illustrated on the boring logs in Appendix A. Within several weeks after installation, an AESI representative developed the wells by adding and then bailing out several well volumes of water. We also installed an electronic data logger in the well casings to allow for continuous monitoring of future groundwater levels.

4.0 SITE CONDITIONS

The following text sections describe current site conditions, including development features, regional and local topography, regional geology, local soils, and local groundwater. Our sources of information include topographic and geologic maps published by the U.S. Geological Survey (USGS), geologic maps published by the Washington State Department of Natural Resources (DNR), topographic survey plans prepared by Sitts & Hill Engineers, and aerial photographs published by Google Earth.

4.1 Development Features

The southwestern portion of the campus is presently occupied by a single-story school building, numerous portable buildings, and hardtop playgrounds, while the southeastern portion is occupied by a parking lot and a bus loop. A grassy playfield occupies the northern half of the site, and a septic drainfield is located in the northeastern corner. The existing school building appears to have adequate foundation support; we did not observe any obvious indications of settlement, such as cracking, tilting, or warping in the exterior walls. Our explorations within the hardscape areas revealed 2 to 3 inches of asphaltic pavement.

4.2 Regional and Local Topography

The project site is located near the eastern edge of a broad topographic plateau that abuts the Puyallup River valley. Regional surface grades across this plateau are moderately undulating and hummocky, which is typical for a post-glacial landscape. Local surface grades across the site vicinity slope very slightly downward to the west, but on-site grades are fairly level except for a slight upward slope in the northeastern corner. It appears that only a minor amount of surface grading was performed as part of the original school development. The average surface elevation at the site is approximately 570 feet (USGS datum).

4.3 Regional Geology

The 1987 DNR *Geologic Map of the South Half of the Tacoma Quadrangle, Washington* (1:100,000 scale) indicates that the project site and surrounding areas are underlain by a Vashon-age deposit of undifferentiated glacial drift. The updated 2006 USGS draft *Geologic Map of the Puyallup 7.5-Minute Quadrangle* (1:24,000 scale) does not specifically include the project site, but it shows that the area immediately to the north is underlain by a widespread deposit of Vashon-age glacial ice-contact sediments. Both of these units typically comprise a mixture of glacial outwash, lacustrine (lake) sediments, and/or glacial till. Texturally, they tend to contain variable amounts of silt, sand, gravel, and cobbles. Densities are usually moderate, and thicknesses can range from several feet to several tens of feet. Ice-contact deposits are often overlain by recessional outwash and/or underlain by lodgement till.

4.4 Local Soils

Our subsurface explorations confirmed the presence of glacial deposits at the site, as shown on the regional geology map. However, these glacial soils appear to be mantled by fill soils and/or organic topsoil in many locations that we explored. The following paragraphs describe our soil observations, and the exploration logs contained in Appendix A provide additional subsurface information.

Uncontrolled Fill and Topsoil: Six of our exploration borings disclosed a surficial layer of loose to medium dense sands, gravels, and silty sands with prevalent organic matter. We infer that this

layer represents a combination of uncontrolled fill soils, relic topsoil, and marsh deposits. The total thickness ranged from 3 to 4½ feet across the central part of the site, but borings EB-3w and EB-4 revealed 7 to 10½ feet at the northwestern part of the site. It appears that topsoil strippings generated during the original school construction might have been placed in the northwestern corner to level out the playfield.

Upper Undifferentiated Deposit: Five of our exploration borings disclosed a surficial layer of medium dense to dense, sandy gravels and gravelly sands, with scattered cobbles. It was difficult to determine the origin of these soils, but we infer that they probably represent some combination of structural fill (likely placed during the original school construction) and native material. The total observed thickness ranged from 5½ to 9½ feet, generally increasing with proximity to the existing school building.

Glacial Deposits: At depths ranging from about 4½ to 10½ feet below ground surface, our exploration borings encountered a fairly thick sequence of silts, sands, and gravels. These soils ranged from loose to dense, or from soft to stiff. We interpret the soils to be a combination of recessional outwash, glaciolacustrine (lake) sediments, and ice-contact sediments. The total thickness is not known, because these deposits extended beyond the maximum termination depth of our borings (35 feet).

4.5 Local Groundwater

Most of our exploration borings encountered groundwater at the time of drilling (July 12 to 13, 2017). The observed water levels ranged from about 8 to 15 feet below existing grades. A check of our two on-site wells about a week later (July 21, 2017) disclosed groundwater depths between 8 and 17 feet, and our first wet-season measurements (December 9, 2017) yielded depths of about 7½ and 15½ feet. At all locations, we infer that these groundwater occurrences represent a shallow aquifer and/or a perched water condition. In either case, groundwater levels will tend to fluctuate with changes in precipitation patterns, off-site development, and other factors, such that higher water levels will likely occur later in the winter and spring months. AESI is currently monitoring on-site water levels throughout the 2017-2018 wet season.

5.0 PRELIMINARY INFILTRATION ASSESSMENT

Based on the 2015 Pierce County *Stormwater and Site Development Manual* (SWSDM), permeable pavements and bioretention facilities are generally required to meet low-impact development (LID) guidelines unless one or more site conditions render them infeasible. However, these LID systems can be considered infeasible if the subgrade soils have a measured ("short-term" or "initial") infiltration rate less than 0.30 inches per hour (in/hr) or if the site has a very shallow groundwater level. The following paragraphs describe our preliminary infiltration assessment of the site in context with the SWSDM.

5.1 Stratigraphic Considerations

Our subsurface explorations revealed a general stratigraphic sequence comprising surficial fill soils and organic soil over native outwash and ice-contact deposits. The latter deposit extended beyond our maximum exploration depth (35 feet). The localized zones of surficial non-organic fill and native soils appear suitable for limited stormwater infiltration using shallow facilities such as permeable pavements, raingardens, and bioretention swales. The deeper deposits of recessional outwash and ice-contact soils, where composed of sands and gravels, would provide a generally favorable receptor for stormwater infiltration. However, these deposits appear constrained by hydrogeologic conditions, as discussed below.

5.2 Hydrogeologic Considerations

Our explorations and monitoring wells revealed groundwater at depths ranging from 7½ to 15½ feet below existing site grades. The observed water levels generally corresponded to the native recessional outwash and ice-contact deposits discussed above. Considering that groundwater levels typically rise during the wet season, we do not anticipate that these native soils will provide a sufficient thickness of unsaturated soils for stormwater infiltration purposes. Nonetheless, AESI will monitor on-site groundwater levels throughout the 2017-2018 wet season in order to verify this conclusion.

5.3 Water-Quality Treatment Considerations

If the on-site soils are proposed to be used for in-situ water-quality treatment purposes, the SWSDM requires that infiltration subgrade soils have a cation exchange capacity (CEC) greater than 5 milliequivalents per 100 grams (meq/100g) and an organic content (OC) of at least 1 percent. We obtained three shallow samples from the various site locations and submitted them to Spectra Laboratories in Tacoma, Washington, for determination of these soil properties. Their laboratory testing results are contained in Appendix B and are summarized in Table 2. The soil samples were found to have an average CEC of 14.9 meq/100g and an average OC of 5.4 percent. Both of these average values exceed the minimum requirements of the SWSDM. It should be noted that the water-quality requirements do not apply to infiltration facilities used only for flow control.

Table 1
Summary of Soil Properties for Water-Quality Treatment Assessment

Soil Sample Designation	Soil Sample Depth (feet)	Cation Exchange Capacity (meq/100g)	Organic Content (percent)
EB-2 / S-2	2½ - 4	19.5	6.2
EB-3 / S-2	2½ - 4	16.9	8.2
EB-11 / S-2	2½ - 4	8.2	1.8
Average	--	14.9	5.4

meq/100g - milliequivalents per 100 grams

6.0 CONCLUSIONS AND RECOMMENDATIONS

Based on our surface reconnaissance, subsurface explorations, and document research, we conclude that the proposed site improvements are feasible from a geotechnical standpoint, contingent on proper design implementation and proper construction practices. Our geotechnical conclusions and recommendations concerning general considerations, site preparations, excavations, foundations, slab-on-grade floors, drainage systems, retaining walls, pavement sections, and structural fill are presented herein.

Specification Codes: The following reference documents are cited for specification purposes within subsequent report sections.

- ASTM: Refers to the latest manual published by the *American Society for Testing and Materials* (ASTM).
- SWSDM: Refers to the 2015 edition of the Pierce County *Stormwater and Site Development Manual* (SWSDM).
- WSDOT: Refers to the 2014 edition of *Standard Specifications for Road, Bridge, and Municipal Construction* published by the Washington State Department of Transportation (WSDOT).

6.1 General Considerations

We offer the following comments, conclusions, and recommendations concerning general geotechnical design issues affecting the overall project.

Geological Hazards: Our evaluation did not reveal any geological hazards associated with steep slopes, erosion zones, landslide zones, or abandoned landfills in the site vicinity. However, the upper zone of loose to medium dense sands (recessional outwash and ice-contact sediments) appears to have some potential for seismically induced liquefaction, especially during the wet season when groundwater levels are relatively high. To assess a worst-case scenario, we used the soil conditions found in boring EB-7 and assumed a groundwater level of 5 feet. We subsequently calculated a liquefaction settlement value slightly less than 1 inch. Because such settlement would be very localized and also greatly mitigated by the non-liquefiable overburden soils, we conclude that effects on the new building addition would be negligible. Other earthquake effects, such as shaking and ground rupture, do not appear to be significantly higher at this site than elsewhere in the region. Consequently, the proposed site development is not constrained by any prevailing geological hazards, in our opinion.

Foundation Support: Our subsurface exploration borings advanced within the proposed building addition footprint encountered subgrade soils that would not be suitable for foundation support, due to the risk of excessive long-term settlements resulting from static compression of the loose or soft soils. In our opinion, the new building addition can be

supported on conventional spread footings only if remedial measures are undertaken to minimize settlements. Other areas of the site, however, appear suitable for direct subgrade support of shallow spread footings.

Closure Pours: Because some gradual settlement of the new addition is inevitable, differential settlements will occur relative to the existing school building. This differential settlement will be most apparent at the contact line between the existing and new structures. To minimize the adverse effects of such differential settlement, we recommend that any closure pours connecting the existing and new structures be delayed as long as practical in the construction process.

Earthwork Scheduling: Our explorations indicate that much of the on-site soils have a moderately high silt content. These existing soils are moisture-sensitive and highly susceptible to disturbance when wet. As such, we expect that most of the on-site soils will be difficult to reuse during periods of wet weather. Earthwork should be scheduled for the dry season in order to maximize the potential for reusing on-site soils. Greater export and import quantities should be expected during the wet season.

Seismic Site Class: The 2015 *International Building Code* (IBC) assigns a seismic Site Class on the basis of geological conditions prevailing within a depth of 100 feet below the local ground surface. Although our subsurface explorations did not extend to such a depth, we infer from shallower soil observations and from available geologic maps that the subsurface conditions correspond to Site Class "D" as defined by the IBC.

Shallow and Deep Infiltration Potential: Based on our observations of soil stratigraphy and groundwater levels, we infer that the use of very shallow infiltration features, such as permeable pavements, raingardens, or bioretention swales, would be feasible in certain parts of the site. Preliminarily, the western and eastern sides of the site appear most suitable for shallow infiltration systems, but field infiltration testing would be needed to determine appropriate design infiltration rates. Deeper infiltration systems, such as vaults or ponds, are likely not feasible at the project site, due to generally high groundwater levels. Nonetheless, AESI will monitor groundwater levels throughout the wet season in order to confirm this conclusion.

6.2 Site Preparation

Preparation of the project site will involve tasks such as temporary drainage, stripping, cutting, erosion control, and subgrade compaction. The paragraphs below present our geotechnical comments and recommendations concerning these various site issues.

Site Demolition: We anticipate that initial site preparation will involve demolition or removal of certain existing site structures. We recommend that any underground foundation elements or abandoned utilities be removed as part of this work. Removal of any underground storage

tanks, if present, would require special environmental oversight; AESI is available to assist with such a task upon request.

Well Decommissioning: Our field exploration program for this project included the installation of two groundwater monitoring wells. These wells can be used by the future construction contractor to measure on-site groundwater levels before and during earthwork. Once the wells are no longer needed, they should be decommissioned by a licensed well driller in accordance with *Washington Administrative Code* (WAC) 173-160. We recommend that all decommissioning activities be included in the contractor's scope of work.

Temporary Drainage: Any sources of surface or near-surface water that could potentially enter the construction zones should be intercepted and diverted before stripping and excavating activities begin. We tentatively anticipate that a system of temporary swales or berms placed around the construction zone will adequately intercept most off-site surface water runoff. Because the selection of an appropriate drainage system will depend on the water quantity, season, weather conditions, construction sequence, and contractor's methods, final decisions regarding temporary drainage details are best made in the field at the time of construction.

Clearing and Stripping: After surface and near-surface water sources have been controlled, the construction zones should be cleared and stripped of all existing vegetation, sod, topsoil, pavements, and other surface features. Our exploration borings disclosed about 6 to 12 inches of sod and organic topsoil mantling landscaped or undeveloped areas, as well as relic topsoil or marsh sediments layers extending to a depth of 3 to 4½ feet in some locations. We also observed about 2 to 3 inches of asphaltic pavement in hardscape areas. In all cases, the actual thicknesses could vary considerably from one location to another.

Temporary Cut Slopes: All temporary cut slopes associated with site grading and utility excavations should be suitably inclined to mitigate the potential for sloughing and collapse. For the various soil deposits that will likely be encountered during on-site earthwork, we tentatively infer that the following maximum inclinations (given as a horizontal to vertical, or "H:V" ratio) could be planned. However, appropriate inclinations will depend on the actual soil and groundwater conditions encountered during earthwork. Ultimately, the site contractor must be responsible for maintaining safe excavation slopes that comply with applicable regulations.

Cuts in Loose or Soft Soils:	1.5H:1V
Cuts in Medium Dense or Stiff Soils:	1.0H:1V

Weather Considerations: It should be realized that if the stripping or grading operations proceed during wet weather, greater stripping depths will likely be necessary to remove moisture-sensitive subgrade soil areas that become saturated and disturbed. For this reason, site earthwork should be avoided during periods of wet weather. During the summer months, sprinkling will likely be needed to moisture-condition soils that have become too dry.

Erosion Control Measures: Because stripped surfaces and soil stockpiles are typically a source of runoff sediments, they should be given particular attention. If earthwork occurs during wet weather, we recommend that all stripped surfaces be covered with straw to reduce runoff erosion. Similarly, soil stockpiles and cut slopes should be covered with plastic sheeting for erosion protection. We also recommend that silt fences, berms, and/or swales be maintained around stripped areas and stockpiles in order to capture runoff water and thereby reduce the downslope sediment transport. Stripped areas should be revegetated as soon as possible, also reducing the potential for erosion.

Runoff Water: On-site stormwater runoff water should be conveyed to appropriate temporary detention and treatment facilities, rather than to any permanent infiltration facilities. In order to avoid siltation and fouling of the receptor soils, all permanent infiltration systems must remain offline during construction. We recommend that stormwater runoff not be routed to the new infiltration facilities until the site is stabilized and all runoff water is clear.

6.3 Building Foundations

Our exploratory borings encountered variably thick deposits of unsuitable soils below the proposed building addition footprint. To reduce the risk of excessive long-term differential settlements, we recommend that the addition be supported by conventional spread footings that bear either on structural fill pads or on an array of compacted aggregate piers. In contrast, ancillary structures can be supported by spread footings that bear directly on existing soils. Our comments and recommendations concerning spread footings and aggregate piers are presented below. It should be noted that a mat or raft foundation would also be feasible for building support, but we anticipate that the cost would be somewhat greater.

Bearing Pads: One option for supporting the new building is to construct aggregate bearing pads beneath all footings. This option offers the advantage of using conventional earthworking techniques, such that no specialty subcontractors are required. However, it involves a greater amount of soil excavation and backfilling. Our recommended procedure is outlined below.

1. The first step is to overexcavate unsuitable soils from below future footings. Based on our exploration borings, we anticipate that an overexcavation depth of 5 feet below existing grade would be adequate in most or all areas of the building addition footprint. However, the actual depths would need to be determined by an AESI representative at the time of earthwork.
2. Each overexcavation should be extended laterally outward beyond the footing edges a minimum distance equal to 50 percent of the overexcavation depth at that location.
3. The exposed subgrade at the bottom of each overexcavation should be thoroughly compacted to a firm and unyielding condition using a heavy vibratory roller or a hydraulic oscillator ("hoe-packer").

4. Each overexcavation should be backfilled with coarse granular fill to create bearing pads below the footings. Suitable backfill options would include mixtures of on-site sands, gravels, and cobbles; imported 2-inch angular rock ("railroad ballast"); 2- to 4-inch quarry spalls; and crushed recycled concrete.

Aggregate Piers: A second option for supporting the new building is to install aggregate piers under the footings. An aggregate pier is installed by creating a hole with an auger or mandrel, and then backfilling the hole with compacted angular rock. "Geopier" is a tradename for the most common type of aggregate pier, but other types are locally available. Regardless of type, we recommend that all aggregate piers extend at least 2 foot into firm, native soils, thereby resulting in tip depths ranging from about 10 to 16 feet below existing grades within the addition footprint. Figure 2 indicates our recommended minimum pier depth at each boring location. Due to the proprietary nature of aggregate piers, the specialty contractor should be responsible for determining the spacing, diameters, materials, and other details needed to achieve the allowable bearing capacities stated below for the new footings.

Footing Depths and Widths: For frost and erosion protection, the bottoms of all exterior footings should bear at least 18 inches below adjacent outside grades, whereas the bottoms of interior footings need bear only 12 inches below the surrounding slab or crawl-space level. To reduce post-construction settlements, continuous (wall) and isolated (column) footings should be at least 18 and 24 inches wide, respectively. It should be noted, however, that greater depths or widths might be needed for other reasons, as determined by the project structural engineer.

Footing Setbacks: For stability purposes, footings should not be placed near steep slopes or steps in the bearing soils. We specifically recommend keeping all footings at least 3 feet behind any slopes, and also behind a 0.75H:1V (Horizontal:Vertical) line extending upward from the toe of any retaining walls. Furthermore, utility trenches, footing trenches, and other excavations should not encroach on a 1H:1V influence line extending downward from any existing footing.

Excavations Adjacent to Existing Footings: If the new building is supported on bearing pads as described above, we anticipate that overexcavations will be required very close to the existing footings. In order to reduce the risk of destabilizing these footings, the adjacent overexcavation and backfilling operation should be performed in short, alternating segments. We preliminarily recommend that each segment be no more than 5 feet wide and that no more than one-third of the existing footing be exposed at any given time. AESI can confirm or modify this preliminary recommendation based on actual soil conditions observed at the time of construction.

Bearing Capacities for Building Addition: Assuming that all footings rest on properly constructed bearing pads or on properly installed aggregate piers, we recommend using the following maximum allowable bearing capacities for footing design purposes. These allowable

capacities are stated in pounds per square foot (psf), and they incorporate static and transient (wind or seismic) safety factors of at least 2.0 and 1.5, respectively. In our opinion, the native soil conditions would not provide a higher bearing capacity option.

Static Allowable Bearing Capacity:	2,500 psf
Transient Allowable Bearing Capacity:	3,300 psf

Bearing Capacities for Ancillary Structures: We understand that a detached playshed and other ancillary structures will be included in the site development. Because these structures are relatively lightweight compared to the building addition, they would not necessarily need to be supported on bearing pads or aggregate piers. Instead, ancillary structures can be supported on low-capacity spread footings that bear on existing subgrade soils after being compacted to a fairly firm condition. We specifically recommend using the following maximum allowable bearing capacities for footing subgrades prepared in this manner.

Static Allowable Bearing Capacity:	1,500 psf
Transient Allowable Bearing Capacity:	2,000 psf

Footing Settlements: We estimate that total post-construction settlements of properly designed footings bearing on a properly remediated subgrade will not exceed 1 inch. Differential settlements between new foundation elements over horizontal spans on the order of 50 feet could approach $\frac{3}{4}$ inch. In all cases, these settlements would be reduced if the actual design bearing pressures are lower than our recommended maximum allowable pressures.

Footing and Stemwall Backfill: To provide erosion protection and lateral load resistance, we recommend that backfill be placed on both sides of the footings and stemwalls after the concrete has cured. Either on-site or imported granular soils can be used for this purpose. All footing and stemwall backfill soil should be compacted to a uniform density of at least 90 percent (based on ASTM D-1557).

Lateral Resistance: Footings and stemwalls that have been properly backfilled as described above will resist lateral loads by means of both passive earth pressure and base friction. We recommend using the following allowable values. These earth pressures are stated in pounds per cubic foot (pcf), and they incorporate static and transient (wind or seismic) safety factors of at least 1.5 and 1.1, respectively. Allowable base friction, which includes a safety factor of 1.5, can be combined with the respective passive pressure to resist static and transient loads.

Allowable Static Passive Pressure:	300 pcf
Allowable Transient Passive Pressure:	400 pcf
Base Friction Coefficient:	0.35

Subgrade Verification and Construction Monitoring: Footings should never be cast atop loose, soft, organic, or frozen soil, slough, debris, uncontrolled fill, or surfaces covered by standing

water. We recommend that the condition of all subgrades be verified by an AESI representative before any concrete is placed. Furthermore, all aggregate piers installations and any other subgrade remediation work should be continuously monitored and/or tested by an AESI representative.

6.4 Slab-On-Grade Floors

Because floor slabs typically carry a light load in comparison to building foundations, they allow more latitude concerning support options. Nonetheless, certain provisions will be needed to control long-term settlements and reduce the risk of associated warping or cracking. We offer the following comments and recommendations for slab-on-grade floors.

Floor Sections: A conventional slab-on-grade floor section typically comprises a reinforced concrete slab over a vapor retarder over an aggregate base course over a granular subbase course. Assuming that the slab has a conventional thickness on the order of 4 inches and is subjected to typical loads, we recommend the following underslab layers (top to bottom) and minimum thicknesses for floors in the new building addition.

Vapor Retarder:	10 mils
Base Course:	4 inches
Subbase Course:	6 inches

Subgrade Preparation: After the floor footprint has been excavated as needed to accommodate the above-recommended floor section, the exposed subgrade should be compacted to a firm and unyielding condition using a heavy vibratory roller. Any localized zones of soft, organic-rich, or saturated soils revealed during compaction should be overexcavated and replaced with granular structural fill.

Subbase Course: A subbase course helps to provide more uniform structural support for a floor slab, thereby reducing long-term differential settlements. Non-organic, granular, on-site soils could be used for this purpose. Suitable imported materials would include "Ballast" per WSDOT 9-03.9(1); "Gravel Borrow" per WSDOT 9-03.14; and "Crushed Surfacing Base Course" per WSDOT 9-03.9(3). In all cases, the subbase should be compacted with a vibratory roller to achieve a uniform density equivalent to at least 90 percent of the maximum dry density (based on ASTM D-1557).

Base Course: The base course serves as both a capillary break layer and a leveling layer for the floor slab. Ideally, the base course would consist of clean, uniform, well-rounded gravel, such as $5/8$ -inch or $7/8$ -inch washed rock. It would also be acceptable to use a washed, angular gravel or crushed rock for this purpose. In all cases, the base course should be compacted with a vibratory roller or sled to create a firm, smooth surface.

Vapor Retarder: A vapor retarder consists of heavy-duty plastic sheeting that is placed between the base course and floor slab. In our opinion, a vapor retarder provides a significant benefit by reducing the amount of ground moisture that penetrates the floor slab. We recommend that a vapor retarder be installed beneath all floor areas that will be covered by carpet, wood, tile, or any other moisture-sensitive materials. The vapor retarder should be selected on the basis of allowable vapor transmission rates for the planned floor finish materials, and should be installed in strict accordance with the manufacturer's guidelines.

Floor Settlements: If the subgrade and underslab layers are properly constructed, we estimate that total post-construction static settlements of the slab-on-grade floor will not exceed 1 inch under conventional loading conditions. Differential settlements across the length or width of the floor could approach one-half of the actual total settlement.

Subgrade Verification and Construction Monitoring: Floor slab sections should never be placed atop loose, soft, organic-rich, or frozen soil, slough, debris, or surfaces covered by standing water. We recommend that an AESI representative be allowed to monitor all floor slab construction to verify suitable conditions. Our monitoring services would include probings of subgrade soils, observation and testing of underslab fill layers, and a check of layer thicknesses.

6.5 Drainage Systems

In order to reduce the risk of future moisture problems, the new building addition should be provided with a permanent drainage system. We offer the following recommendations and comments regarding various drainage elements and related features.

Foundation Drains: We recommend that the new addition be encircled with a perimeter foundation drain to collect exterior seepage water. This drain should consist of a 4-inch-diameter, rigid, perforated pipe within an envelope of pea gravel or washed rock, extending at least 6 inches on all sides of the pipe. The gravel envelope should be wrapped with filter fabric (such as Mirafi 140N) to reduce the migration of fines from the surrounding soils. Ideally, the drain invert would be installed no more than 8 inches above or below the base of the perimeter footings.

Subfloor Drains: Based on the soil and groundwater conditions observed in our site explorations, we currently do not infer a need for drains beneath the floor slabs if the foundation drains are properly installed. However, the final decision regarding the need for subfloor drains should be made at the time of construction, after the floor subgrade has been exposed and the foundation walls have been cast.

Runoff Water: Roof downspouts, parking lot drains, and drains from any other runoff surfaces should not be tied into the perforated piping system of the foundation drain. Instead, the runoff water collected from such sources should be routed through a separate tightline piping

system. Also, final site grades should be sloped so that surface water flows away from the building rather than ponding near the foundation walls.

6.6 Backfilled Retaining Walls

We anticipate that backfilled concrete retaining walls might be used to accommodate grade changes at the site. Also, if any subsurface vaults are included in the project, the vault walls should be designed as backfilled retaining walls. Our design and construction recommendations for new backfilled retaining walls are presented below.

Wall Foundations: To avoid excessive differential settlement of any new retaining walls, they should be supported on non-organic native soils in accordance with our recommendations presented in the "Spread Footings" section of this report. The allowable static and transient bearing capacities presented in that text section would apply to the wall footings.

Static Lateral Earth Pressures: Yielding (cantilever) walls that are allowed to deflect more than 0.005 times the wall height should be designed to withstand an appropriate static *active* lateral earth pressure. Non-yielding (restrained) walls that are allowed to deflect less than 0.005 times the wall height should be designed to withstand an appropriate static *at-rest* lateral earth pressure. These pressures act over the entire back of the wall and vary with the backslope inclination. For retaining walls with a level or 2H:1V backslope and well-drained conditions, we recommend using the following values, which are given in pcf of equivalent fluid pressure.

Static Active Earth Pressure with Level Backslope:	35 pcf
Static Active Earth Pressure with 2H:1V Backslope:	50 pcf
Static At-Rest Earth Pressure with Level Backslope:	55 pcf
Static At-Rest Earth Pressure with 2H:1V Backslope:	80 pcf

Static Lateral Surcharge Pressures: Any backslope load located within a 45-degree plane projected upward from the wall base will apply a lateral surcharge on the wall. Possible sources of surcharge loading include parking lots, traffic lanes, and structure footings. These surcharge pressures act over the portion of wall adjacent to the load source. For distributed vertical loads, active and at-rest static lateral surcharge pressures can be approximated by multiplying the vertical pressure "Q" (in psf) by the appropriate coefficient shown below. We recommend using a vertical pressure of 250 psf to model traffic and parking loads behind the wall.

Static Active Surcharge Pressure:	0.30(Q) psf
Static At-Rest Surcharge Pressure:	0.45(Q) psf

Seismic Lateral Surcharge Pressures: The total static pressures acting on a wall should be increased to account for seismic surcharge loadings resulting from lateral earthquake motions. These surcharge pressures act over the entire back of the wall and vary with the backslope inclination, the seismic acceleration, and the wall height. For retaining walls with a level

backslope, active and at-rest seismic lateral surcharge pressures can be approximated by multiplying the wall height “H” (in feet) by the appropriate coefficient shown below.

Seismic Active Surcharge Pressure:	8(H) psf
Seismic At-Rest Surcharge Pressure:	12(H) psf

Curtain Drains: A curtain drain is a vertical layer of drainage material placed against the back of a wall to dissipate hydrostatic pressures. We recommend that a curtain of washed gravel be used behind all walls. This curtain drain should extend outward at least 12 inches from the wall and should extend upward nearly to the ground surface. The backslope directly above this drain should be capped with asphalt or concrete or a layer of low-permeability soil.

Heel Drains: A heel drain is a horizontal drainage element placed behind the rearward projection (heel) of a wall foundation to collect water from the curtain drain. We recommend that a heel drain be included behind the subject wall. The heel drain should comprise a 4-inch-diameter perforated pipe surrounded by at least 6 inches of washed gravel, all wrapped with filter fabric (such as Mirafi 140N). The drainpipe should then be connected to a tightline discharge pipe that routes water to an appropriate location.

Backfill Soil: We recommend that all backfill placed behind the curtain drain consist of granular structural fill. Suitable materials include on-site sands and gravel mixtures, as well as imported mixtures, such as “Ballast” per WSDOT 9-03.9(1) or “Gravel Borrow” per WSDOT 9-03.14. If the backfill soil contains more than 10 percent fines, a layer of filter fabric (such as Mirafi 140N) should be placed between the curtain drain and backfill.

Backfill Compaction: Because soil compactors place significant lateral pressures on walls, we recommend that only small, hand-operated compaction equipment be used within 3 feet of a wall. Also, the soil within 3 feet should be compacted to a density as close as possible to 90 percent of the maximum dry density (based on ASTM D-1557). A greater degree of compaction closely behind the wall would increase the lateral earth pressure, whereas a lesser degree of compaction might lead to excessive post-construction settlements. Structural backfill placed more than 3 feet behind the wall should be compacted to a density of at least 95 percent.

Construction Monitoring: We recommend that an AESI representative be allowed to monitor all retaining wall construction. Our monitoring services would include verification of foundation systems, observation of drainage components, and testing of backfill compaction.

6.7 Conventional Pavement Sections

We understand that conventional (impermeable) flexible (asphalt concrete) pavements might be used in new car parking areas and driveways, whereas conventional rigid (cement concrete) pavements might be used for the bus loop and/or certain other locations. The following

comments and recommendations are given for conventional pavement design and construction purposes.

Soil Design Values: Soil conditions can be defined by a California Bearing Ratio (CBR), which quantitatively predicts the effects of wheel loads imposed on a saturated subgrade. Although our scope of work did not include a CBR test on the surficial site soils, we infer from our observations and limited textural testing that a CBR value on the order of 5 to 8 would likely be appropriate for pavement design purposes. This value corresponds to a subgrade modulus of about 100 to 200 pounds per cubic inch (pci).

Traffic Design Values: Traffic conditions can be defined by a Traffic Index (TI), which quantifies the combined effects of projected car and truck traffic. Although no specific traffic data was available at the time of our analysis, we estimate that a TI of 3.0 to 4.0 would likely be appropriate for the car parking areas. A higher TI of about 5.0 to 6.0 appears appropriate for driveways and other areas that are occasionally or periodically subjected to school buses, delivery trucks, or similar vehicles.

Flexible Pavement Sections: A flexible pavement section typically comprises an asphalt concrete pavement (ACP) over a crushed aggregate base (CAB) over a granular subbase (GSB). Our recommended minimum thicknesses for flexible pavement sections, which are based on the aforementioned design values and a 20-year lifespan, are shown below.

Car Parking Lots and Playgrounds

Asphalt Concrete Pavement (ACP):	2½ inches
Crushed Aggregate Base Course (CAB):	3 inches
Granular Subbase Course (GSB):	6 inches

Bus Loops and Access Driveways

Asphalt Concrete Pavement (ACP):	4 inches
Crushed Aggregate Base Course (CAB):	4 inches
Granular Subbase Course (GSB):	10 inches

Rigid Pavement Sections: A rigid pavement section typically comprises a cement concrete pavement (CCP) over a CAB over a GSB. We recommend the following minimum thicknesses for a rigid pavement section that is subjected to school buses and occasional delivery trucks. Pavements and slabs that are subjected to frequent truck traffic or to other heavy structural loads would require a special design.

Bus Loops and Access Driveways

Cement Concrete Pavement (CCP):	7 inches
Crushed Aggregate Base Course (CAB):	2 inches
Granular Subbase Course (GSB):	8 inches

Subgrade Preparation: All pavement subgrades should be compacted to a firm and unyielding condition before any pavement layers are placed. We recommend using a heavy vibratory-drum roller for granular (sand and gravel) subgrades. The resulting subgrade condition should then be verified by proof-rolling with a loaded dump truck or other heavy construction vehicle, in the presence of an AESI representative. Any localized zones of soft, organic-rich, or debris-laden soils disclosed during proof-rolling should be overexcavated and replaced with compacted structural fill.

Granular Subbase: A GSB helps to provide more-uniform structural support for a pavement section. For the subject site, we recommend using an imported, well-graded sand and gravel, such as “Ballast” per WSDOT 9-03.9(1) or “Gravel Borrow” per WSDOT 9-03.14. It would also be acceptable to use a crushed recycled concrete, provided that it meets the same general textural criteria as the aforementioned WSDOT materials. In all cases, the GSB should be vibratory-compacted to at least 95 percent based on the modified Proctor maximum dry density (per ASTM D-1557).

Crushed Aggregate Base: We recommend that all CAB material conform to the criteria for “Crushed Surfacing Base Course” or “Crushed Surfacing Top Course” per WSDOT 9-03.9(3). In the interest of using recycled materials from on-site or off-site sources, it would be acceptable to substitute up to 20 percent of the CAB with crushed cement concrete, provided that the final mixture meets the same grain-size criteria as the aforementioned WSDOT material. Regardless of composition, all CAB material should be compacted to at least 95 percent based on the modified Proctor maximum dry density (per ASTM D-1557).

Asphalt Concrete Pavement: We recommend that the ACP aggregate gradation conform to the control points for a ½-inch mix (per WSDOT 9-03.8(6)) and that the binder conform to Performance Grade 58-22 criteria (per WSDOT 9-02.1(4)). We also recommend that the ACP be compacted to a target average density of 92 percent, with no individual locations compacted to less than 90 percent nor more than 96 percent, based on the Rice theoretical maximum density for that material (per ASTM D-2041).

Cement Concrete Pavement: We recommend that the CCP consist of Portland cement concrete with a minimum compressive strength of 4,000 pounds per square inch (psi) and a minimum rupture modulus of 500. We also recommend that the concrete be reinforced with a welded wire mesh, such as W2-6x6, positioned at a one-third depth within the CCP layer.

Pavement Life and Maintenance: It should be realized that conventional asphaltic pavements are not maintenance-free. The foregoing pavement sections represent our minimum recommendations for an average level of performance during a 20-year design life; therefore, an average level of maintenance will likely be required. Furthermore, a 20-year pavement life typically assumes that an overlay will be placed after about 10 years. Thicker asphalt, base, and subbase courses would offer better long-term performance, but would cost more initially; thinner courses would be more susceptible to “alligator” cracking and other failure modes. As

such, pavement design can be considered a compromise between a high initial cost and low maintenance costs versus a low initial cost and higher maintenance costs.

6.8 Permeable Pavement Sections

We understand that permeable flexible (asphalt concrete) pavements might be used for new playgrounds and/or parking areas, whereas permeable rigid (cement concrete) pavements might be used for certain other locations. Our geotechnical comments and recommendations concerning permeable pavements are presented in the following paragraphs.

Structural Design Values: For design of permeable flexible and rigid pavement sections, we have assumed the same soil and traffic design values discussed in the “Conventional Pavement Sections” portion of this report. It should be noted that driveways are assumed to be subjected to school buses or delivery trucks, but not garbage trucks or other very heavy vehicles.

Subgrade Infiltration: We anticipate that subgrade infiltration conditions will vary greatly below the permeable pavements. Some subgrade areas will consist of sands and gravels, which will provide moderately high infiltration rates, whereas other subgrade areas will consist of silty soils, which will provide lower rates. In the latter areas, it would be geotechnically possible to use permeable pavement sections as a detention system, if an adequate thickness of reservoir base rock is provided for temporary storage purposes. Collector drains could be installed along the edges of permeable pavements to convey stored water away from building areas and discharge it at suitable locations. For design purposes, we recommend that an overall average subgrade infiltration rate of 1.0 in/hr be assumed.

Permeable Pavement Layers: A permeable pavement section typically comprises a porous asphalt concrete pavement (PACP) or pervious cement concrete pavement (PCCP) over an aggregate drainage base (ADB). In some situations, an aggregate choker base (ACC) is placed between the pavement and base courses, but we regard this as an optional item to be used at the discretion of the civil engineer or paving contractor. Our recommended minimum layer thicknesses for various on-site uses are shown below.

Playgrounds and Car Parking Lots - Flexible Section

Pervious Asphalt Concrete Pavement (PACP):	3 inches
Aggregate Drainage Base (ADB):	8 inches

Car and Truck Driveways - Flexible Section

Pervious Asphalt Concrete Pavement (PACP):	5 inches
Aggregate Drainage Base (ADB):	12 inches

Car and Truck Driveways - Rigid Section

Pervious Cement Concrete Pavement (PCCP):	7 inches
Aggregate Drainage Base (ADB):	10 inches

Subgrade Preparation: All pervious pavement subgrades should be lightly compacted to achieve a firm condition. However, excessive compaction should be avoided because it can reduce the infiltration characteristics of the subgrade soils. After compaction, the surface should be hand-raked or gently scarified to eliminate any “soil skin” that has formed.

Filter Fabric: If the subgrade consists of silt or clay soils, we recommend that a layer of non-woven filter fabric (such as Mirafi 140N) be placed between the prepared subgrade and the ADB layer. This fabric will help prevent migration of native soils into the ADB gravel.

Aggregate Drainage Base: The ADB serves as both a reservoir and discharge layer for stormwater. As such, the actual thickness might need to be increased beyond our recommended minimum if greater storage capacity is required. Regardless of thickness, we recommend using an imported, uniform, coarse, angular gravel meeting the specifications of “Permeable Ballast” per WSDOT 9-03.9(2) or “No. 3 Stone” per ASTM C-33. The ADB material should be lightly compacted to achieve a reasonably firm and stable condition, but excessive compaction should be avoided.

Aggregate Choker Course: Because the ADB consists of a moderately large-grained material, some contractors prefer to cover it with a choker course to serve as a leveling layer. Where a choker course is desired, we recommend using 2 inches of imported, uniform, medium-grained, angular gravel meeting the specifications of “No. 57 Stone” per ASTM C-33. The choker course should be lightly compacted to achieve a reasonably firm, smooth, and stable condition, but excessive compaction should be avoided.

Porous Asphalt Concrete Pavement: We recommend that PACP use an aggregate consisting of uniform, small- to medium-grained, crushed gravel meeting the specifications of “No. 8 Stone” per ASTM C-33. The binder should conform to PG 70-22 criteria and should be placed at a ratio of 5.75 to 6.00 percent by weight. We also recommend that the PACP be compacted to a firm condition by means of approximately two passes with a heavy vibratory roller. Excessive compaction should be avoided. Ultimately, the finished PACP should provide a minimum infiltration rate of 200 in/hr.

Pervious Cement Concrete Pavement: We recommend that PCCP use an aggregate consisting of uniform, small- to medium-grained, crushed gravel meeting the specifications of “No. 8 Stone” per ASTM C-33. Typically, the concrete paste is a six-sack mix with a water/cement ratio in the range of 0.27 to 0.35. Ultimately, the finished PCCP should provide a minimum compressive strength of 2,000 psi, and a minimum infiltration rate of 200 in/hr.

Pavement Life and Maintenance: It should be realized that all permeable pavements require routine maintenance to maintain their permeability. The entire surface should be vacuum swept at least once per year under normal conditions; if the pavement is exposed to dirt, excessive traffic, or turbid water, then vacuum sweeping should be performed more frequently.

In addition, routine structural maintenance, such as patching, will likely be required over the 20-year pavement life.

6.9 Structural Fill

The term *structural fill* refers to any materials placed under foundations, retaining walls, slab-on-grade floors, sidewalks, pavements, and other such features. Our comments, conclusions, and recommendations concerning structural fill are presented in the following paragraphs.

Soil Moisture Considerations: The suitability of soils used for structural fill depends primarily on their grain-size distribution and moisture content when they are placed. As the fines content (that soil fraction passing the U.S. No. 200 Sieve) increases, soils become more sensitive to small changes in moisture content. Soils containing more than about 5 percent fines (by weight) cannot be consistently compacted to a firm, unyielding condition when the moisture content is more than 2 percentage points above or below optimum.

Structural Fill Materials: For general use, a well-graded mixture of sand and gravel with a low fines content (commonly called “gravel borrow” or “pit-run”) provides an economical structural fill material. For specialized applications, it may be necessary to use a highly processed material such as crushed rock, quarry spalls, clean sand, granolithic gravel, pea gravel, drain rock, controlled-density fill (CDF), or lean-mix concrete (LMC). Recycled asphalt or concrete, which are derived from pulverizing the parent materials, are also potentially useful as structural fill in certain applications. Soils used for structural fill should not contain any organic matter, debris, environmental contaminants, or individual particles greater than about 6 inches in diameter.

On-Site Soils: We expect that moderate quantities of on-site soils will be generated by the building excavation and other grading activities. Much of these on-site soils will likely consist of sands and gravels with variable amounts of silt. We anticipate that such soils will be generally suitable for reuse as structural fill. It should be noted that silty portions of the on-site soils would be reusable during the summer months, but would be difficult to reuse during the wet season or during isolated periods of rainy weather.

Fill Placement and Compaction: Structural fill materials should be placed in horizontal lifts not exceeding about 12 inches in loose thickness. Unless stated otherwise in this report, we recommend that each lift then be thoroughly compacted with a mechanical compactor to a uniform density of at least 95 percent, based on the modified Proctor maximum dry density (per ASTM D-1557). Compaction is not necessary for certain structural fill materials, such as pea gravel, drain rock, quarry spalls, CDF, and LMC.

Subgrade Verification and Compaction Testing: Regardless of material or location, all structural fill should be placed over firm, unyielding subgrades prepared in accordance with our various recommendations for site preparation. The condition of all subgrades should be verified by an

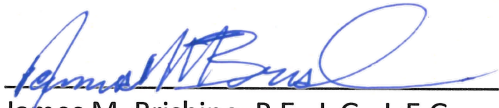
AESI representative before soil or concrete placement begins. Also, fill soil compaction should be verified by means of in-place density testing, hand-probing, proof-rolling, or other appropriate methods performed during fill placement so that the adequacy of soil compaction efforts may be evaluated as earthwork progresses.

7.0 CLOSURE

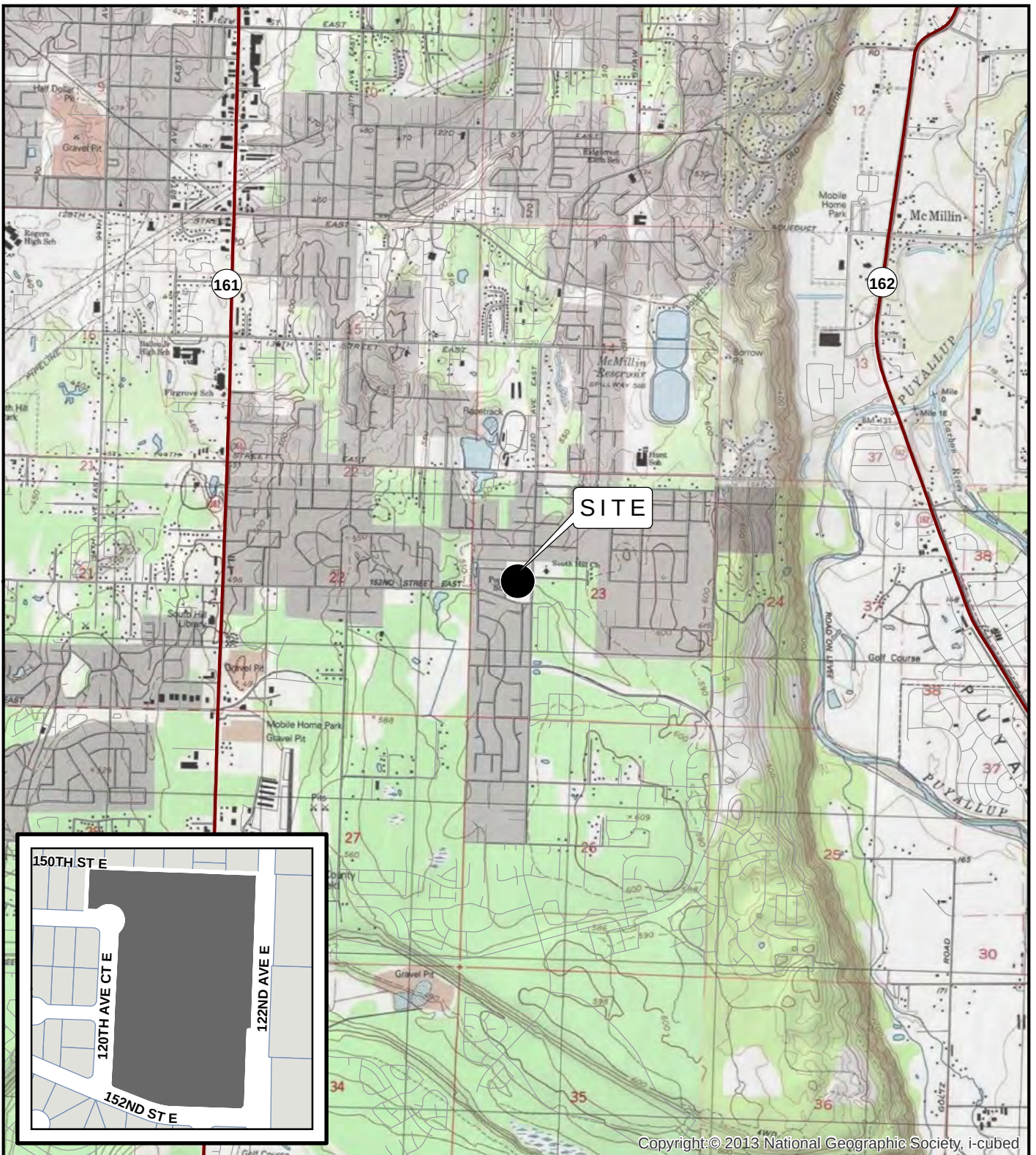
AESI has prepared this report for the exclusive use of our client and their agents, for specific application to this project. Within the limitations of scope and schedule, our services have been performed in accordance with generally accepted local geotechnical engineering practices in effect at the time our report was prepared. No other warranty, express or implied, is made.

We appreciate the opportunity to be of continued service to you on this project. Should you have any questions regarding this report or other geotechnical aspects of the project, please call us at your earliest convenience.

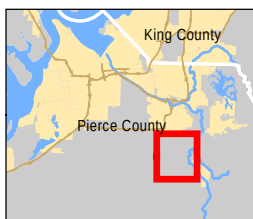
Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Tacoma, Washington


James M. Brisbine, P.E., L.G., L.E.G.
Senior Associate Geotechnical Engineer

Kurt D. Merriman, P.E.
Senior Principal Geotechnical Engineer

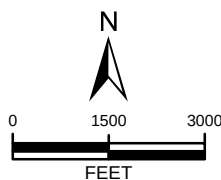


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DATA SOURCES / REFERENCES:
USGS: 24K SERIES TOPOGRAPHIC MAPS
PIERCE CO: STREETS, CITY LIMITS, PARCELS 02/17

LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE



NOTE: BLACK AND WHITE
REPRODUCTION OF THIS COLOR
ORIGINAL MAY REDUCE ITS
EFFECTIVENESS AND LEAD TO
INCORRECT INTERPRETATION

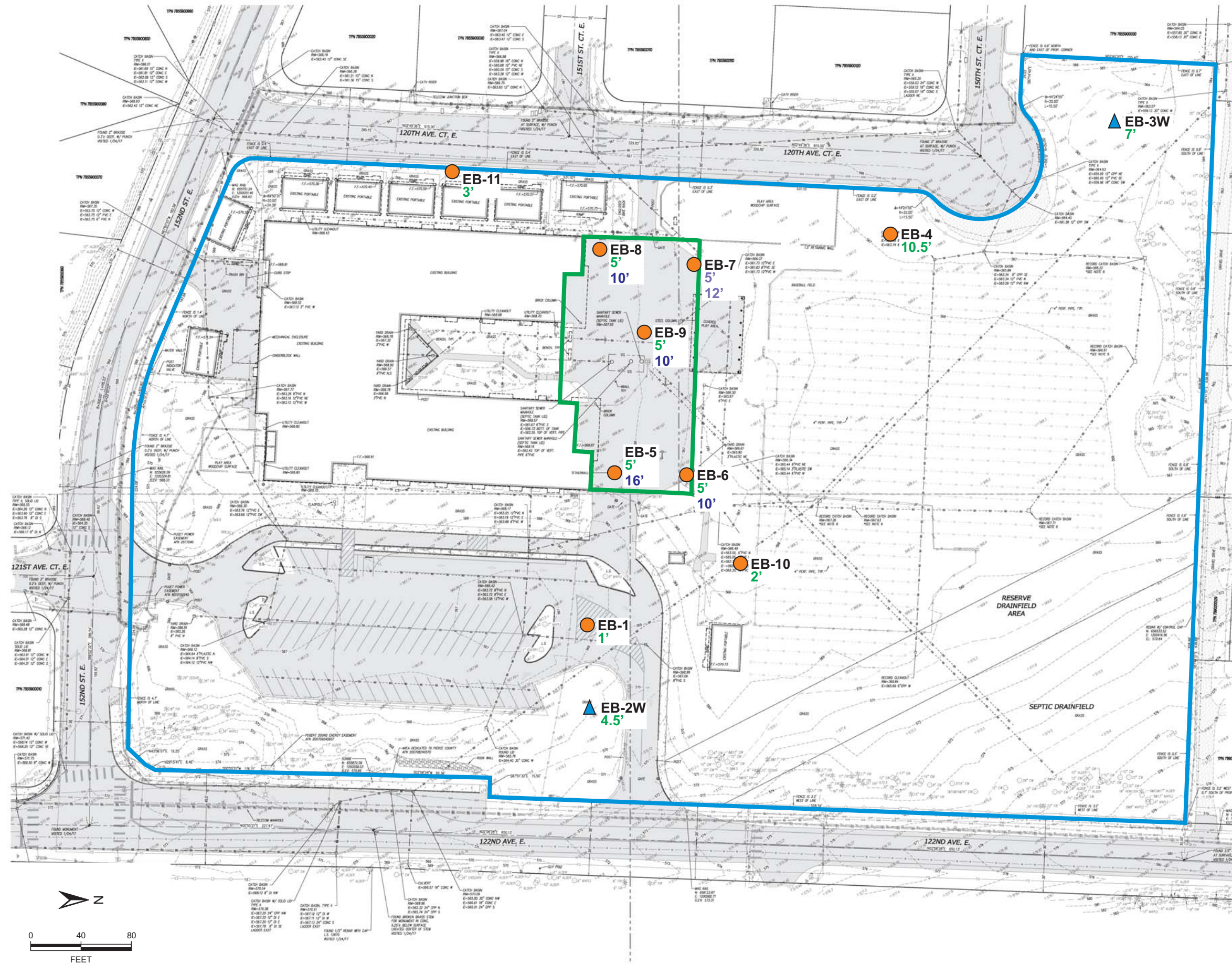


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VICINITY MAP

POPE ELEMENTARY SCHOOL ADDITION PIERCE COUNTY, WASHINGTON

PROJ NO.	DATE:	FIGURE:
170209E001	7/17	1



- LEGEND:**
- EB EXPLORATION BORING
 - EB EXPLORATION BORING WITH MONITORING WELL
 - XX' MINIMUM DEPTH (FT) TO BEARING SUBGRADE OR OVEREXCAVATION SUBGRADE BELOW EXISTING GROUND SURFACE
 - XX' MINIMUM TIP DEPTH (FT) OF AGGREGATE PIERS BELOW EXISTING GROUND SURFACE
 - PROPOSED ADDITION
 - SITE BOUNDARY

CONTOUR INTERVAL = 1'

NOTE: LOCATION AND DISTANCES SHOWN ARE APPROXIMATE.

NOTES:
1. BASE MAP REFERENCE: LPD ENGINEERING, POPE ELEMENTARY SCHOOL ADDITION, COMPOSITE SITE SURVEY, NO PAGE #, DATED 5/1/2017

BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION.



SITE AND EXPLORATION PLAN

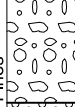
POPE ELEMENTARY SCHOOL ADDITION
PIERCE COUNTY, WASHINGTON

PROJ NO. 170209E001 DATE: 8/17 FIGURE: 2

APPENDIX A

Field Exploration Logs

blocks \ dwg \ log_key.dwg LAYOUT: Layout 4 -2014 Qty Chng

Coarse-Grained Soils - More than 50% ⁽¹⁾ Retained on No. 200 Sieve			Terms Describing Relative Density and Consistency	
Gravels - More than 50% ⁽¹⁾ of Coarse Fraction Retained on No. 4 Sieve		GW	Well-graded gravel and gravel with sand, little to no fines	Density SPT ⁽²⁾ blows/foot Coarse-Grained Soils Very Loose0 to 4 Loose4 to 10 Medium Dense10 to 30 Dense30 to 50 Very Dense>50 Consistency SPT ⁽²⁾ blows/foot Fine-Grained Soils Very Soft0 to 2 Soft2 to 4 Medium Stiff4 to 8 Stiff8 to 15 Very Stiff15 to 30 Hard>30 Test Symbols G = Grain Size M = Moisture Content A = Atterberg Limits C = Chemical DD = Dry Density K = Permeability

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.



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EXPLORATION LOG KEY

FIGURE A1



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Exploration Log

Project Number
170209E001

Exploration Number
EB-1

Sheet
1 of 1

Project Name Pope Elementary School Addition Ground Surface Elevation (ft) 568
Location Pierce County, WA Datum Project Datum
Driller/Equipment Holocene Drilling, Inc. / D-50 Track-Mounted Date Start/Finish 7/12/17, 7/12/17
Hammer Weight/Drop 140# / 30" Hole Diameter (in) 8 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot				Other Tests
								10	20	30	40	
		S-1		Upper Fill or Native Deposit Slightly moist, brown with faint iron oxide staining, gravelly, fine to coarse SAND, trace silt; weakly stratified (SW).		31 50/3"						▲ 81/9"
		S-2		No recovery. Cuttings include dry to slightly moist, sandy, fine to coarse GRAVEL, trace silt (GW).		50/3"						▲ 50/3"
5				Bottom of exploration boring at 2.5 feet No groundwater encountered. Backfilled with bentonite and concrete patch.								
10				Refusal due to high coarse gravel to cobble content; possibly on a boulder.								
15												

Sampler Type (ST):



2" OD Split Spoon Sampler (SPT)



No Recovery

M - Moisture



3" OD Split Spoon Sampler (D & M)



Ring Sample

▽ Water Level ()



Grab Sample



Shelby Tube Sample



Water Level at time of drilling (ATD)

Logged by: LBK

Approved by: JMB

Project Number
170209E001

Exploration Number
EB-2W

Sheet
1 of 2

Hammer Weight/Drop	140# / 30"
--------------------	------------

Hole Diameter (in) 8 inches

Sampler Type (ST):

-  2" OD Split Spoon Sampler (SPT)
-  3" OD Split Spoon Sampler (D & M)
-  Grab Sample

-  No Recovery
 Ring Sample
 Shelby Tube

M - Moisture

 Water Level (7/21/17)

▼ Water Level at time of drilling (ATD)

Logged by: LBK

Approved by: JMB



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Exploration Log

Project Number
170209E001

Exploration Number
EB-2W

Sheet
2 of 2

Project Name Pope Elementary School Addition

Location Pierce County, WA

Driller/Equipment Holocene Drilling, Inc. / D-50 Track-Mounted

Hammer Weight/Drop 140# / 30"

Ground Surface Elevation (ft) 569

Datum Project Datum

Date Start/Finish 7/12/17, 7/12/17

Hole Diameter (in) 8 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level Blows/6"	Blows/Foot				Other Tests
							10	20	30	40	
		S-6		Wet, grayish brown, very silty, fine to coarse SAND, some fine to coarse gravel; stratified (SM).		28 50/5"					▲78/11"
25		S-7		Wet, grayish brown, silty, gravelly, fine to coarse SAND; stratified (SM).		24 50/5"					▲74/11"
				Bottom of exploration boring at 25.9 feet Groundwater at ~8 feet. Completed as a monitoring well. See below for completion details.							
30				Well Completion: Flush mount monument 0 to 1 foot: Concrete seal 1 to 13 feet: Bentonite chips 13 to 25.9 feet: Sand pack, 10/20 Colorado silica sand 0.4 to 15 feet: Well casing, PVC, 2-inch I.D., schedule 40, threaded connections 15 to 25 feet: Well screen, 0.020-inch slot, PVC, 2-inch I.D. schedule 40, threaded connections End cap, threaded Ecology well tag: #BKL-618							
35											

Sampler Type (ST):



2" OD Split Spoon Sampler (SPT)



3" OD Split Spoon Sampler (D & M)



Grab Sample



No Recovery



Ring Sample



Shelby Tube Sample

M - Moisture



Water Level (7/21/17)



Water Level at time of drilling (ATD)

Logged by: LBK

Approved by: JMB



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Exploration Log

Project Number
170209E001

Exploration Number
EB-3W

Sheet
1 of 3

Project Name Pope Elementary School Addition
Location Pierce County, WA
Driller/Equipment Holocene Drilling, Inc. / D-50 Track-Mounted
Hammer Weight/Drop 140# / 30"

Ground Surface Elevation (ft) 565
Datum Project Datum
Date Start/Finish 7/12/17, 7/12/17
Hole Diameter (in) 8 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level Blows/6"	Blows/Foot				Other Tests
							10	20	30	40	
				Grass / Fill - Uncontrolled							
		S-1		Dry, brown, silty, fine SAND, some fine to coarse gravel (SM).							
				Old Topsoil / Marsh Deposit							
		S-2		Moist, dark brown to black, SILT, some sand, some gravel; abundant organics (ML). Poor recovery.		5 6 3	▲ ₉				
5		S-3		Moist, dark brown, very silty, fine to coarse SAND, some fine to coarse gravel; abundant organics; unsorted (SM).		5 10 16			▲ ₂₆		
				Vashon Recessional Outwash							
		S-4		Drilling action becomes rough. Abundant coarse gravel in cuttings. Slightly moist, brown, fine to medium SAND, trace silt; massive (SP). Slightly moist, brown, fine SAND, trace silt; very faint fine laminae (SP).		10 12 12			▲ ₂₄		
10		S-5		Very moist to wet, brown, very fine to fine SAND, trace silt; very faint fine laminae; vague fining downward (SP). Driller notes water at ~10.5 feet		8 11 12			▲ ₂₃		
15		S-6		Wet, brown, fine SAND, trace silt; massive (SP).		9 11 13			▲ ₂₄		

Sampler Type (ST):



2" OD Split Spoon Sampler (SPT)



No Recovery

M - Moisture



3" OD Split Spoon Sampler (D & M)



Ring Sample



Water Level (7/21/17)



Grab Sample



Shelby Tube Sample



Water Level at time of drilling (ATD)

Logged by: LBK

Approved by: JMB



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Exploration Log

Project Number
170209E001

Exploration Number
EB-3W

Sheet
2 of 3

Project Name Pope Elementary School Addition

Location Pierce County, WA

Driller/Equipment Holocene Drilling, Inc. / D-50 Track-Mounted

Hammer Weight/Drop 140# / 30"

Ground Surface Elevation (ft) 565

Datum Project Datum

Date Start/Finish 7/12/17, 7/12/17

Hole Diameter (in) 8 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6" Blows/ft	Blows/Foot				Other Tests
								10	20	30	40	
		S-7		Vashon Ice Contact Sediments Wet, brown, silty, gravelly, fine to coarse SAND; weakly stratified and areas of faint lamination (SM). Partial recovery; blowcounts likely overstated due to high gravel content.		16 38 38						▲76
25		S-8		Wet, brown, very gravelly, fine to coarse SAND, some silt; stratified (SW-SM). Partial recovery; blowcounts likely overstated due to high gravel content. Drilling action becomes very rough.		10 24 50						▲74
30		S-9		Slightly moist, grayish brown, very silty, fine to medium SAND, some fine to coarse gravel; unsorted (SM).		50/2"						▲50/2"
35		S-10		Wet, grayish brown, very gravelly, fine to coarse SAND, some silt; stratified (SW-SM). Blowcounts likely overstated due to high gravel content.		18 50/3"						▲68/9"
				Bottom of exploration boring at 35.8 feet Groundwater at ~10.5 feet. Completed as a monitoring well. See below for completion details.								

Sampler Type (ST):



2" OD Split Spoon Sampler (SPT)



No Recovery

M - Moisture



3" OD Split Spoon Sampler (D & M)



Ring Sample

▽ Water Level (7/21/17)



Grab Sample



Shelby Tube Sample

▼ Water Level at time of drilling (ATD)

Logged by: LBK

Approved by: JMB



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Exploration Log

Project Number
170209E001

Exploration Number
EB-3W

Sheet
3 of 3

Project Name	Pope Elementary School Addition	Ground Surface Elevation (ft)	565
Location	Pierce County, WA	Datum	Project Datum
Driller/Equipment	Holocene Drilling, Inc. / D-50 Track-Mounted	Date Start/Finish	7/12/17, 7/12/17
Hammer Weight/Drop	140# / 30"	Hole Diameter (in)	8 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot				Other Tests
								10	20	30	40	
45				<u>Well Completion:</u> Flush mount monument 0 to 1 foot: Concrete seal 1 to 11 feet: Bentonite chips 11 to 26 feet: Sand pack, 10/20 Colorado silica sand 0.6 to 15 feet: Well casing, PVC, 2-inch I.D., schedule 40, threaded connections 15 to 25 feet: Well screen, 0.020-inch slot, PVC, 2-inch I.D. schedule 40, threaded connections End cap, threaded 26 to 35.8 feet: Bentonite chips Ecology well tag: #BKL-619								
50												
55												

Sampler Type (ST):



2" OD Split Spoon Sampler (SPT)



No Recovery

M - Moisture



3" OD Split Spoon Sampler (D & M)



Ring Sample

Water Level (7/21/17)



Grab Sample



Shelby Tube Sample

Water Level at time of drilling (ATD)

Logged by: LBK

Approved by: JMB



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Exploration Log

Project Number
170209E001

Exploration Number
EB-4

Sheet
1 of 2

Project Name Pope Elementary School Addition

Location Pierce County, WA

Driller/Equipment Holocene Drilling, Inc. / D-50 Track-Mounted

Hammer Weight/Drop 140# / 30"

Ground Surface Elevation (ft) 567

Datum Project Datum

Date Start/Finish 7/12/17, 7/12/17

Hole Diameter (in) 8 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6" Blows/ft	Blows/Foot				Other Tests
								10	20	30	40	
5		S-1		Grass / Fill - Uncontrolled Moist, brown, gravelly, fine to coarse SAND, trace silt (SW).								
				Dry, gray, sandy, fine to coarse GRAVEL, some silt; unsorted (GW-GM).								
				Old Topsoil / Marsh Deposit Moist, dark brown to black, SILT, some fine sand; abundant organics and woody debris (ML).								
				Moist, dark brown to black, sandy SILT; abundant organics and woody debris (ML).								
				Vashon Ice Contact Sediments Moist, brown, gravelly, fine to coarse SAND, trace silt; stratified (SW). Becomes wet.								
10		S-4		Moist, brown, gravelly, fine to coarse SAND, trace silt; stratified (SW). Becomes wet.		5 10 11						
15		S-5		Wet, brown, fine to coarse SAND, some fine gravel, trace silt; well sorted (SP).		12 37 31						

Sampler Type (ST):



2" OD Split Spoon Sampler (SPT)



3" OD Split Spoon Sampler (D & M)



Grab Sample



No Recovery



Ring Sample



Shelby Tube Sample

M - Moisture



Water Level ()



Water Level at time of drilling (ATD)

Logged by: LBK

Approved by: JMB

Project Number
170209E001

Exploration Number
EB-4

Sheet
2 of 2

Hammer Weight/Drop	140# / 30"
--------------------	------------

Hole Diameter (in)	8 inches
--------------------	----------

Depth (ft)

CS

Samples

Graphic
Symbol

DESCRIPTION

Well Completion

Water Level

Blows/6"

Blows/Foot

10 20 30 40

Other Tests

S-6

Wet, grayish brown, fine to medium SAND, some fine gravel, some silt; well sorted (SP).
Very moist to wet, gray, silty, fine SAND, some medium to coarse sand, and gravel; unsorted (SM).

Rough drilling at 22 feet

Tooling stuck at 25 feet; removing tooling; refusal.

Bottom of exploration boring at 25 feet
Groundwater encountered at ~10.8 feet. Backfilled with bentonite and grass replaced.

13
23
40

63

Sampler Type (ST):



2" OD Split Spoon Sampler (SPT)



No Recovery

M - Moisture



3" OD Split Spoon Sampler (D & M)



Ring Sample



 Water Level ()



Grab Sample



Shelby Tube Sample



 Water Level at time of drilling (ATD)

Logged by: LBK

Approved by: JMB



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Exploration Log

Project Number
170209E001

Exploration Number
EB-5

Sheet
1 of 2

Project Name Pope Elementary School Addition Ground Surface Elevation (ft) 568.5
Location Pierce County, WA Datum Project Datum
Driller/Equipment Holocene Drilling, Inc. / D-50 Track-Mounted Date Start/Finish 7/12/17, 7/12/17
Hammer Weight/Drop 140# / 30" Hole Diameter (in) 8 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6" Blows/6"	Blows/Foot				Other Tests
								10	20	30	40	
				Asphalt - 2 inches Upper Fill or Native Deposit								
		S-1		Recovery only consists of broken gravel. Cuttings include of fine to coarse gravel and cobbles. Blowcounts are overstated due to gravel and cobble.		50/5"						▲50/5"
5		S-2		Broken coarse gravel. Cuttings include wet, gray-brown, gravelly, fine to coarse SAND. Very poor recovery.		11 6 6		▲12				
10		S-3		Vashon Recessional Lacustrine Deposits Moist, brown with heavy orange mottling, SILT/CLAY, with interbeds (1/2" thick) of very silty, very fine sand; massive (ML/SM). Driller notes groundwater at ~12 feet.		1 2 1	▲3					
15		S-4		Vashon Ice Contact Sediments Wet, grayish brown, silty, fine to medium SAND, trace gravel, with interbeds (1/2" to 1" thick) fine to medium sand, trace silt (SM/SP). Driller notes gravel from 17 feet to BOH. Wet, grayish, brown, very gravelly, fine to coarse SAND, trace silt; stratified (SW).		7 10 11		▲21				

Sampler Type (ST):



2" OD Split Spoon Sampler (SPT)



No Recovery

M - Moisture



3" OD Split Spoon Sampler (D & M)



Ring Sample

Water Level ()



Grab Sample



Shelby Tube Sample



Water Level at time of drilling (ATD)

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Exploration Log

Project Number
170209E001

Exploration Number
EB-5

Sheet
2 of 2

Project Name	Pope Elementary School Addition	Ground Surface Elevation (ft)	568.5
Location	Pierce County, WA	Datum	Project Datum
Driller/Equipment	Holocene Drilling, Inc. / D-50 Track-Mounted	Date Start/Finish	7/12/17, 7/12/17
Hammer Weight/Drop	140# / 30"	Hole Diameter (in)	8 inches

Depth (ft)	10	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot				Other Tests		
								10	20	30	40			
		S-5		Blowcounts possibly overstated due to high gravel content.			24 50/3"						▲ 74/9"	
				Bottom of exploration boring at 20.8 feet Groundwater encountered at ~12 feet. Backfilled with bentonite and concrete patch.										
25														
30														
35														

Sampler Type (ST):



2" OD Split Spoon Sampler (SPT)



No Recovery

M - Moisture



3" OD Split Spoon Sampler (D & M)



Ring Sample

Water Level ()



Grab Sample



Shelby Tube Sample



Water Level at time of drilling (ATD)

Logged by: LBK

Approved by: JMB



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Exploration Log

Project Number
170209E001

Exploration Number
EB-6

Sheet
1 of 2

Project Name Pope Elementary School Addition

Location Pierce County, WA

Driller/Equipment Holocene Drilling, Inc. / D-50 Track-Mounted

Hammer Weight/Drop 140# / 30"

Ground Surface Elevation (ft) 567

Datum Project Datum

Date Start/Finish 7/13/17, 7/13/17

Hole Diameter (in) 8 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot				Other Tests
								10	20	30	40	
				Asphalt - 2 inches Fill - Uncontrolled								
				Old Topsoil / Marsh Deposit								
		S-1		Moist, dark brown, very silty, fine SAND, some medium to coarse sand; few rootlets and organics; unsorted (SM). Poor recovery.		15 16 10			▲26			
5		S-2		Vashon Recessional Outwash / Vashon Recessional Lacustrine Deposits Moist, grayish brown with faint iron oxide mottling, fine SAND, trace silt, grading to very fine SAND, some silt; faint fine laminae (SP/SP-SM).		6 4 4		▲8				
				Vashon Ice Contact Sediments								
10		S-3		Slightly moist, brown with faint iron oxide mottling, SILT, some fine to coarse sand, some fine to coarse gravel; unsorted (ML).		4 10 14			▲24			
15		S-4		Driller notes groundwater at ~15 feet. Wet, brown with faint iron oxide mottling, very silty, fine to medium SAND, some fine to coarse gravel; unsorted (SM).		6 10 14			▲24			
				Very moist, brown, very silty, fine to medium SAND, some fine to coarse gravel; unsorted; with thin (1/2 to 1 inch thick) seams of fine to coarse								

Sampler Type (ST):



2" OD Split Spoon Sampler (SPT)



No Recovery

M - Moisture



3" OD Split Spoon Sampler (D & M)



Ring Sample

Water Level ()



Grab Sample



Shelby Tube Sample



Water Level at time of drilling (ATD)

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Exploration Log

Project Number
170209E001

Exploration Number
EB-6

Sheet
2 of 2

Project Name	Pope Elementary School Addition	Ground Surface Elevation (ft)	567
Location	Pierce County, WA	Datum	Project Datum
Driller/Equipment	Holocene Drilling, Inc. / D-50 Track-Mounted	Date Start/Finish	7/13/17, 7/13/17
Hammer Weight/Drop	140# / 30"	Hole Diameter (in)	8 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot				Other Tests	
								10	20	30	40		
		S-5		sand, some fine to coarse gravel, trace silt (SM).			27 50/5"					▲ 77/11"	
				Bottom of exploration boring at 20.9 feet Groundwater encountered at ~15 feet. Backfilled with bentonite and concrete patch.									
25													
30													
35													

Sampler Type (ST):



2" OD Split Spoon Sampler (SPT)



3" OD Split Spoon Sampler (D & M)



Grab Sample



No Recovery



Ring Sample



Shelby Tube Sample

M - Moisture



Water Level ()



Water Level at time of drilling (ATD)

Logged by: LBK

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Exploration Log

Project Number
170209E001

Exploration Number
EB-7

Sheet
1 of 2

Project Name Pope Elementary School Addition

Location Pierce County, WA

Driller/Equipment Holocene Drilling, Inc. / D-50 Track-Mounted

Hammer Weight/Drop 140# / 30"

Ground Surface Elevation (ft) 567

Datum Project Datum

Date Start/Finish 7/13/17, 7/13/17

Hole Diameter (in) 8 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6" Blows/ft	Blows/Foot				Other Tests
								10	20	30	40	
				Gravel Cover over Asphalt - 3 inches Fill - Uncontrolled								
				Slightly moist, grayish brown, very gravelly, fine to coarse SAND, trace silt; unsorted (SW).								
		S-1		Old Topsoil / Marsh Deposit Moist, dark brown to black, SILT, some fine sand; abundant organics and woody debris (ML).		18 17 9				▲26		
5		S-2		Vashon Recessional Outwash / Vashon Recessional Lacustrine Deposits Moist, brown, very fine to fine SAND, trace silt; massive (SP).		4 6 5				▲11		
				Driller notes groundwater at ~9 feet.	▼							
10		S-3		Vashon Recessional Lacustrine Deposits Wet, grayish brown, fine to medium SAND, some coarse sand, trace silt; well sorted (SP). Wet, orangish brown with grayish brown mottling, very fine to fine SAND, some silt; faint fine laminae (SP-SM).		3 5 7				▲12		
				Vashon Ice Contact Wet, grayish brown, fine to medium SAND, some coarse sand, trace fine gravel, trace silt; well sorted (SP). Wet, orangish brown, very fine to fine SAND, some silt; faint fine laminae (SP-SM).								
15		S-4				17 50/5"						▲67/11"
				Wet, grayish brown with iron oxide staining, fine to coarse SAND, some								

Sampler Type (ST):



2" OD Split Spoon Sampler (SPT)



3" OD Split Spoon Sampler (D & M)



Grab Sample



No Recovery



Ring Sample



Shelby Tube Sample

M - Moisture



Water Level ()



Water Level at time of drilling (ATD)

Logged by: LBK

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Exploration Log

Project Number
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Exploration Number
EB-7

Sheet
2 of 2

Project Name Pope Elementary School Addition

Location Pierce County, WA

Driller/Equipment Holocene Drilling, Inc. / D-50 Track-Mounted

Hammer Weight/Drop 140# / 30"

Ground Surface Elevation (ft) 567

Datum Project Datum

Date Start/Finish 7/13/17, 7/13/17

Hole Diameter (in) 8 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot				Other Tests
								10	20	30	40	
		S-5		fine to coarse gravel, trace silt; weakly cemented (SW). Bottom of exploration boring at 20.4 feet Groundwater encountered at ~9 feet. Backfilled with bentonite and concrete patch.			50/5"					▲ 50/5"
25												
30												
35												

Sampler Type (ST):



2" OD Split Spoon Sampler (SPT)



3" OD Split Spoon Sampler (D & M)



Grab Sample



No Recovery



Ring Sample



Shelby Tube Sample

M - Moisture



Water Level ()



Water Level at time of drilling (ATD)

Logged by: LBK

Approved by: JMB



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Exploration Log

Project Number
170209E001

Exploration Number
EB-8

Sheet
1 of 2

Project Name Pope Elementary School Addition Ground Surface Elevation (ft) 568.5
Location Pierce County, WA Datum Project Datum
Driller/Equipment Holocene Drilling, Inc. / D-50 Track-Mounted Date Start/Finish 7/13/17, 7/13/17
Hammer Weight/Drop 140# / 30" Hole Diameter (in) 8 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6" Blows/ft	Blows/Foot				Other Tests
								10	20	30	40	
				Asphalt - 2 inches Upper Fill or Native Deposit								
		S-1		Slightly moist, grayish brown, very gravelly, fine to coarse SAND, trace silt; unsorted (SW). Blowcounts overstated due to gravel.		12 23 22						▲45
5		S-2		Moist, dark brown, silty, fine GRAVEL, some fine to coarse sand (GM). Slightly moist, brown, gravelly, fine to coarse SAND, trace silt; gravel and coarse sand slightly weathered (SW).		5 8 16			▲24			
				Vashon Recessional Outwash								
10		S-3		Driller notes groundwater at ~8 feet. Wet, grayish brown with faint iron oxide staining, fine to coarse SAND, some fine gravel, trace silt, with interbeds (1 to 2 inches thick) of gray with orange iron oxide mottling, SILT (SW/ML).		6 8 13			▲21			
15		S-4		Wet, grayish brown, very gravelly, medium to coarse SAND, some fine sand, trace silt; well sorted (SP). Vashon Ice Contact Sediments Moist, brown with faint orange iron oxide mottling, very silty, fine SAND, some fine to coarse gravel, some medium to coarse sand; unsorted (SM). Wet, orangish brown to brown, very gravelly, fine to coarse SAND, trace		7 14 16			▲30			

Sampler Type (ST):



2" OD Split Spoon Sampler (SPT)



No Recovery

M - Moisture



3" OD Split Spoon Sampler (D & M)



Ring Sample

Water Level ()



Grab Sample



Shelby Tube Sample



Water Level at time of drilling (ATD)

Logged by: LBK

Approved by: JMB



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Exploration Log

Project Number
170209E001

Exploration Number
EB-8

Sheet
2 of 2

Project Name	Pope Elementary School Addition	Ground Surface Elevation (ft)	568.5
Location	Pierce County, WA	Datum	Project Datum
Driller/Equipment	Holocene Drilling, Inc. / D-50 Track-Mounted	Date Start/Finish	7/13/17, 7/13/17
Hammer Weight/Drop	140# / 30"	Hole Diameter (in)	8 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot				Other Tests
								10	20	30	40	
		S-5		silt; weakly stratified (SW). Bottom of exploration boring at 20.5 feet Groundwater encountered at ~8 feet. Backfilled with bentonite and concrete patch.			50/5.5"					▲ 50/5.5"
25												
30												
35												

Sampler Type (ST):



2" OD Split Spoon Sampler (SPT)



No Recovery

M - Moisture



3" OD Split Spoon Sampler (D & M)



Ring Sample

▽ Water Level ()



Grab Sample



Shelby Tube Sample



Water Level at time of drilling (ATD)

Logged by: LBK

Approved by: JMB



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Exploration Log

Project Number
170209E001

Exploration Number
EB-9

Sheet
1 of 2

Project Name Pope Elementary School Addition

Location Pierce County, WA

Driller/Equipment Holocene Drilling, Inc. / D-50 Track-Mounted

Hammer Weight/Drop 140# / 30"

Ground Surface Elevation (ft) 568

Datum Project Datum

Date Start/Finish 7/13/17, 7/13/17

Hole Diameter (in) 8 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6" Blows/ft	Blows/Foot				Other Tests
								10	20	30	40	
				Asphalt - 3 inches Upper Fill or Native Deposit								
				Dry to slightly moist, grayish brown, very gravelly, fine to coarse SAND, trace silt; unsorted (SW). Blowcounts overstated due to high coarse gravel content.		15 32 34						▲66
5				Slightly moist, brown with faint orange iron oxide staining, very gravelly, fine to coarse SAND, trace silt (SW). Partial recovery. Blowcounts overstated due to high coarse gravel content.		15 23 25						▲48
				Vashon Ice Contact Sediments	▼							
10				Wet, grayish brown, gravelly, fine to coarse SAND, trace silt (SW). Blowcounts likely overstated due to high gravel content.		12 14 20						▲34
15				Moist to very moist, gray, fine to coarse SAND, some fine to coarse gravel, some silt; weakly stratified (SW).		6 14 25						▲39
				Moist, gray, very silty, fine to medium SAND, some fine to coarse gravel; unsorted (SM).								

Sampler Type (ST):



2" OD Split Spoon Sampler (SPT)



3" OD Split Spoon Sampler (D & M)



Grab Sample



No Recovery



Ring Sample



Shelby Tube Sample

M - Moisture



Water Level ()



Water Level at time of drilling (ATD)

Logged by: LBK

Approved by: JMB



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Exploration Log

Project Number
170209E001

Exploration Number
EB-9

Sheet
2 of 2

Project Name Pope Elementary School Addition

Location Pierce County, WA

Driller/Equipment Holocene Drilling, Inc. / D-50 Track-Mounted

Hammer Weight/Drop 140# / 30"

Ground Surface Elevation (ft) 568

Datum Project Datum

Date Start/Finish 7/13/17, 7/13/17

Hole Diameter (in) 8 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot				Other Tests
								10	20	30	40	
		S-5		Wet, gray, medium SAND, some fine to coarse sand, trace silt; well sorted (SP). Very moist to wet, brown with faint orange iron oxide staining, silty, fine SAND, some medium sand, trace coarse sand, trace fine gravel; weakly stratified; weakly cemented (SM).			24 34 36					▲70
25		S-6		Trouble with rods getting stuck in the auger when driving 25 foot sample. Very moist, gray, gravelly, fine to medium SAND, some silt; weakly stratified (SP-SM). Drilling action very rough.			25 50/3"					▲75/9"
30		S-7		Slightly moist, gray, fine sandy, SILT, trace gravel; unsorted (ML).			50/4"					▲50/4"
35				No recovery. Driller notes drill action seems like formation is glacial till.			50/2"					▲50/2"
				Bottom of exploration boring at 35.2 feet Groundwater encountered at ~8 feet. Backfilled with bentonite and concrete patch.								

Sampler Type (ST):



2" OD Split Spoon Sampler (SPT)



No Recovery

M - Moisture



3" OD Split Spoon Sampler (D & M)



Ring Sample

▽ Water Level ()



Grab Sample



Shelby Tube Sample



Water Level at time of drilling (ATD)

Logged by: L BK

Approved by: J MB



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Exploration Log

Project Number
170209E001

Exploration Number
EB-10

Sheet
1 of 2

Project Name Pope Elementary School Addition Ground Surface Elevation (ft) 567.5
Location Pierce County, WA Datum Project Datum
Driller/Equipment Holocene Drilling, Inc. / D-50 Track-Mounted Date Start/Finish 7/13/17, 7/13/17
Hammer Weight/Drop 140# / 30" Hole Diameter (in) 8 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6" Blows/6"	Blows/Foot				Other Tests
								10	20	30	40	
				Grass / Upper Fill or Native Deposit								
				Drill action rough.								
		S-1		No recovery. Pounding on gravel. Cuttings generally consist of brown, gravelly, fine to medium SAND, with minor amounts of silt. Blowcount overstated due to gravel.		50/5"						▲50/5"
5		S-2		Drill action begins to smooth out. Slightly moist, orangish brown, very gravelly, fine to coarse SAND, some silt; unsorted; some weathering on gravel (SW-SM).		25 15 12			▲27			
				Vashon Recessional Outwash								
				Slightly moist, grayish brown, very fine to fine SAND, trace silt; massive (SP). Partial recovery.								
				Driller notes groundwater ~8 to ~10 feet.		▼						
10		S-3		Moist, brown, very silty, very fine to fine SAND, some medium to coarse sand; massive (SM). Partial recovery.		23 50/4"						▲73/10"
				Vashon Ice Contact Sediments								
15		S-4		Moist, brown with faint orange iron oxide staining, very silty, fine SAND, some fine to coarse gravel; unsorted (SM).		26 25 27						▲52

Sampler Type (ST):



2" OD Split Spoon Sampler (SPT)



No Recovery

M - Moisture



3" OD Split Spoon Sampler (D & M)



Ring Sample

▼ Water Level ()



Grab Sample



Shelby Tube Sample



Water Level at time of drilling (ATD)

Logged by: LBK

Approved by: JMB



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Exploration Log

Project Number
170209E001

Exploration Number
EB-10

Sheet
2 of 2

Project Name	Pope Elementary School Addition	Ground Surface Elevation (ft)	567.5
Location	Pierce County, WA	Datum	Project Datum
Driller/Equipment	Holocene Drilling, Inc. / D-50 Track-Mounted	Date Start/Finish	7/13/17, 7/13/17
Hammer Weight/Drop	140# / 30"	Hole Diameter (in)	8 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot				Other Tests
								10	20	30	40	
		S-5		Wet, brown, silty, gravelly, fine to medium SAND; unsorted (SM). Bottom of exploration boring at 20.5 feet Groundwater ~8 to ~10 feet and ~20 to 20.5. Backfilled with bentonite and grass replaced.		50/5.5"						▲ 50/5.5"
25												
30												
35												

Sampler Type (ST):



2" OD Split Spoon Sampler (SPT)



No Recovery

M - Moisture



3" OD Split Spoon Sampler (D & M)



Ring Sample

Water Level ()



Grab Sample



Shelby Tube Sample



Water Level at time of drilling (ATD)

Logged by: LBK

Approved by: JMB



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Exploration Log

Project Number
170209E001

Exploration Number
EB-11

Sheet
1 of 1

Project Name Pope Elementary School Addition Ground Surface Elevation (ft) 568
Location Pierce County, WA Datum Project Datum
Driller/Equipment Holocene Drilling, Inc. / D-50 Track-Mounted Date Start/Finish 7/13/17, 7/13/17
Hammer Weight/Drop 140# / 30" Hole Diameter (in) 8 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6" Blows/ft	Blows/Foot				Other Tests
								10	20	30	40	
				Asphalt - 3 inches Fill - Uncontrolled								
		S-1		Moist, dark brown, gravelly, fine to coarse SAND, some silt; unsorted (SM).								
				Old Topsoil								
		S-2		Moist, dark brown, very silty, fine to medium SAND, some fine to coarse gravel; unsorted (SM).			5 10 8		▲18			
				Vashon Ice Contact Deposit ?								
				Slightly moist, orangish brown, gravelly, fine to coarse SAND, some silt; unsorted (SW-SM). Partial recovery.								
5		S-3		No recovery. Cuttings generally as above.			18 17 13			▲30		
				Bottom of exploration boring at 6.5 feet No groundwater encountered. Backfilled with bentonite and concrete patch.								
10												
15												

Sampler Type (ST):



2" OD Split Spoon Sampler (SPT)



No Recovery

M - Moisture



3" OD Split Spoon Sampler (D & M)



Ring Sample

Water Level ()



Grab Sample



Shelby Tube Sample

Water Level at time of drilling (ATD)

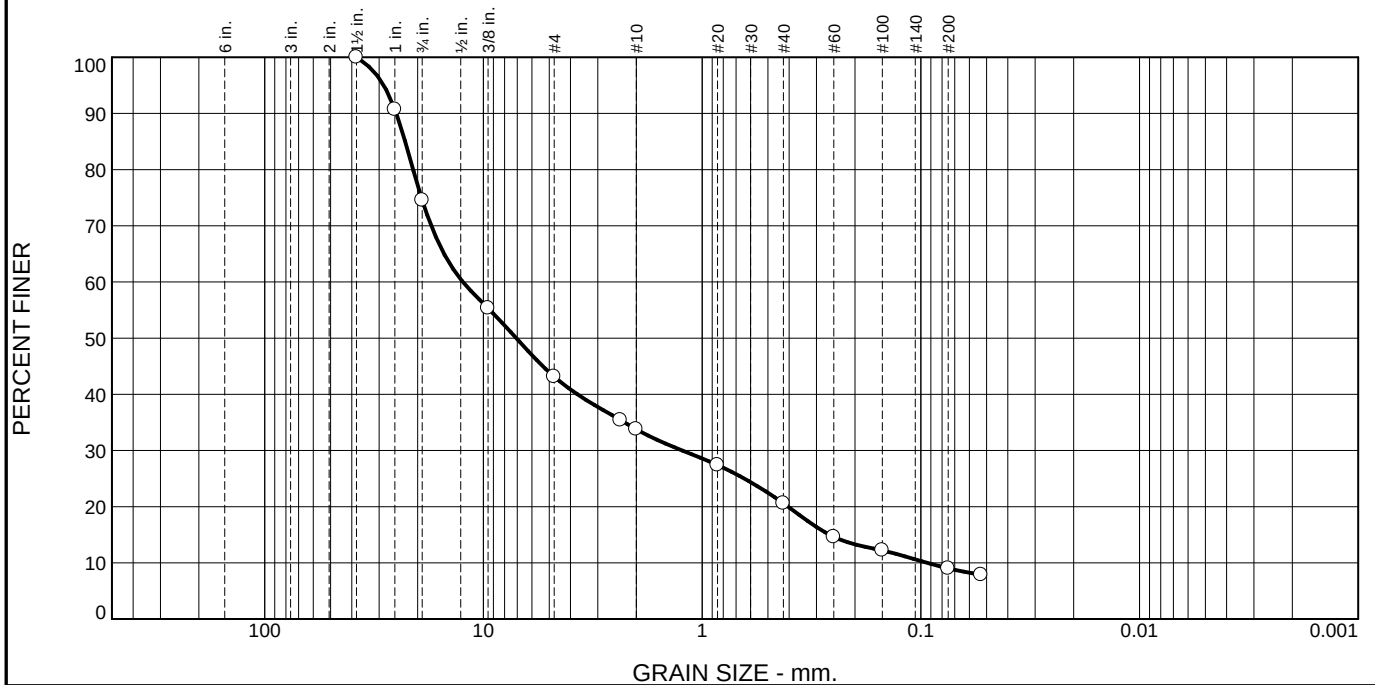
Logged by: LBK

Approved by: JMB

APPENDIX B

Laboratory Testing Data

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	25.5	31.4	9.3	13.2	11.6	9.0	

TEST RESULTS			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1.5	100.0		
1	90.7		
.75	74.5		
.375	55.3		
#4	43.1		
#8	35.4		
#10	33.8		
#20	27.4		
#40	20.6		
#60	14.6		
#100	12.2		
#200	9.0		
#270	7.9		

* (no specification provided)

Material Description

very sandy, GRAVEL, some silt

Atterberg Limits (ASTM D 4318)

PL= NP

LL= NV

PI=

Classification

USCS (D 2487)= GW-GM AASHTO (M 145)= A-1-a

Coefficients

D₉₀= 25.0220

D₈₅= 22.7997

D₆₀= 12.4169

D₅₀= 7.0819

D₃₀= 1.2313

D₁₅= 0.2616

D₁₀= 0.0934

C_u= 132.87

C_c= 1.31

Remarks

Date Received: 8-15-2017

Date Tested: 8-18-2017

Tested By: BN

Checked By: JMB

Title:

Location: Onsite- Fill

Date Sampled: 7-13-2017



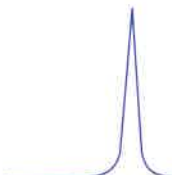
associated
earth sciences
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Client: Puyallup School District

Project: Pope Elementary School

Project No: 170209 E001

Figure



SPECTRA Laboratories

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08/24/2017

Associated Earth Sciences, Inc
911 5th Ave
Kirkland, WA 98033

P.O.#: 170209E001
Project: Pope Elementary School
Sample Matrix: Soil
Date Sampled: 07/12/2017
Date Received: 08/16/2017
Spectra Project: 2017080432

<u>Client ID</u>	<u>Spectra #</u>	<u>Analyte</u>	<u>Result</u>	<u>Units</u>	<u>Method</u>
EB-2W:2.5ft	1	Organic Matter	6.2	wt. % Dry	ASTM D-2974-13
EB-2W:2.5ft	1	Cation Exchange Capacity	19.5	Na, mEq/ 100g	SW846 9081
EB-3W:2.5-5ft	2	Organic Matter	8.2	wt. % Dry	ASTM D-2974-13
EB-3W:2.5-5ft	2	Cation Exchange Capacity	16.9	Na, mEq/ 100g	SW846 9081
EB-11:2.5ft	3	Organic Matter	1.8	wt. % Dry	ASTM D-2974-13
EB-11:2.5ft	3	Cation Exchange Capacity	8.23	Na, mEq/ 100g	SW846 9081

SPECTRA LABORATORIES


Jeffrey Cooper, Laboratory Manager
a7/mkw

