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Preliminary Subsurface Exploration, Geologic Hazard, and Geotechnical Engineering Report

BURDETTE-BLUEBERRY LANE

Monroe, Washington

Prepared For:

SAME INVESTMENT COMPANY LLC

Project No. KE080683B
May 23, 2016

Associated Earth Sciences, Inc.
911 5th Avenue
Kirkland, WA 98033
P (425) 827 7701
F (425) 827 5424

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Project No. KE080683B

SAME Investment Company LLC
636 120th Avenue NE
Bellevue, Washington 98005

Attention: Mr. Jeff Burdette

Subject: Preliminary Subsurface Exploration, Geologic Hazard, and Geotechnical Engineering Report
Burdette-Blueberry Lane
Monroe, Washington

Dear Mr. Burdette:

We are pleased to present the enclosed copies of the above-referenced report. This report summarizes the results of our subsurface exploration, geologic hazard, and geotechnical engineering studies and offers preliminary recommendations for the design and development of the proposed project. This report is based on a site plan titled "Burdett-Blueberry Site Plan" by Design Build Services, Inc. dated March 20, 2016. We should be allowed to review the recommendations presented in this report and modify them, if needed, once final project plans have been formulated.

We have enjoyed working with you on this study and are confident that 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.
Kirkland, Washington

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

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PRELIMINARY SUBSURFACE EXPLORATION, GEOLOGIC HAZARD, AND GEOTECHNICAL ENGINEERING REPORT

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I. PROJECT AND SITE CONDITIONS

1.0 INTRODUCTION

This report presents the results of our preliminary subsurface exploration, geologic hazard, and preliminary geotechnical engineering study for the proposed project. The site location is presented on Figure 1, "Vicinity Map." The proposed building locations and approximate locations of the explorations accomplished for this study are presented on the "Site and Exploration Plan," Figure 2 and logs of the subsurface explorations are included in the Appendix. In the event that any changes in the nature, design, or location of the improvements are planned, the conclusions and recommendations contained in this report should be reviewed and modified, or verified, as necessary.

1.1 Purpose and Scope

The purpose of this study was to provide subsurface data to be utilized in the preliminary design and development of the referenced project. This study included a review of selected available geologic literature, observing the excavation of eight exploration pits and performing geologic studies to assess the type, thickness, distribution, and physical properties of the subsurface sediments and ground water. Geotechnical engineering studies were completed to formulate preliminary recommendations for infiltration feasibility, permeable pavement, shallow foundations, pile foundations, anticipated settlements, floor support recommendations, and site preparation and drainage considerations. This report summarizes our fieldwork and offers preliminary geotechnical engineering recommendations based on our present understanding of the project. We recommend that we be allowed to review the recommendations presented in this report and revise them, if needed, if there are changes to the project plans.

1.2 Authorization

Verbal authorization to proceed with this study was granted by Mr. Jeff Burdette of the SAME Investment Company LLC. This report has been prepared for the exclusive use of the SAME Investment Company LLC and its agents for specific application to this project. Our services have been performed in general accordance with generally accepted geotechnical engineering and engineering geology practices in effect in this area at the time our report was prepared. Our observations, findings, and opinions are a means to identify and reduce the inherent risks to the owner. No other warranty, express or implied, is made.

2.0 PROJECT AND SITE DESCRIPTION

The project site is located north of Blueberry Lane in Monroe, Washington. The site includes Tax Parcel No. 27060100206000. The site is irregularly shaped in plan view and includes approximately 10 acres of overall area. The site consists of a man-made pond on the north side, with areas of low brush and scattered trees north and east of the pond. The existing pond extends off-site to the west, onto a parcel that also contains a multifamily housing building. The site is bordered to the north by a railroad right-of-way, to the east by an undeveloped parcel, and to the south by Blueberry Lane. Site topography includes generally flat grades with moderate slopes that descend toward the pond. The slopes are thought to be composed of both existing fill that was generated when the pond was created and fill that was generated during recent grading activities on-site.

The most recent grading on the site began approximately 2 years ago. A dike was constructed across the pond to separate the area to be filled (on the east) from the area of pond to remain (on the west). The project contractor has been importing and placing fill material on the southeast side of the site. Associated Earth Sciences, Inc. (AESI) has made periodic site visits, at the owner's request, to evaluate fill compaction generally in the southeast portion of the site and for the filled dike that intersects the on-site pond.

To our understanding, the proposed initial phase of the preliminary development plan will include two new multifamily housing buildings on the west end of the site (labeled 'A' on the site plan provided to us by you) close to existing grades, as well as installation of a rain garden to the south of the proposed housing buildings, a bioswale along the north end of the property, and permeable paving in private parking areas and/or on-site roads.

3.0 SUBSURFACE EXPLORATION

Our field study included observation of excavation of eight exploration pits, on May 3, 2016, to acquire subsurface information about the site. The various types of sediments, as well as the depths where characteristics of the sediments changed, are indicated on the exploration logs presented in the Appendix to this report. The depths indicated on the exploration logs where conditions changed may represent gradational variations between sediment types in the field. Our explorations were approximately located in the field by measuring from known site features.

The conclusions and recommendations presented in this report are based on the eight exploration pits completed for this study. Because of the nature of exploratory work below ground, extrapolation of subsurface conditions between field explorations is necessary. It should be noted that differing subsurface conditions are sometimes present 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 may not become fully evident until construction. If variations are observed at that time, it may be necessary to re-evaluate specific recommendations in this report and make appropriate changes.

3.1 Exploration Pits

The exploration pits were excavated using a tracked excavator with a 2-foot-wide bucket, provided and operated by the earthwork contractor on the subject site. The pits permitted direct, visual observation of subsurface conditions. Materials encountered in the exploration pits were studied and classified in the field by an experienced geologist from our firm. All exploration pits were backfilled after examination and logging. Selected samples were then transported to our laboratory for further visual classification.

4.0 SUBSURFACE CONDITIONS

Subsurface conditions at the project site were inferred from the field explorations accomplished for this study, visual reconnaissance of the site, and review of selected applicable geologic literature. As shown in the exploration logs, the exploration pits encountered up to 19 feet of loose existing fill material with various large deleterious debris and organics, underlain by native glacial sediments consisting of medium dense to dense sandy gravel and gravelly sand with trace amounts of silt (Vashon recessional outwash – deltaic outwash). The loose fill material with large deleterious debris and organics is not considered suitable for foundation and floor slab support.

Because of the nature of exploratory work below ground, interpolation of subsurface conditions between field explorations is necessary. It should be noted that differing subsurface conditions may sometimes be present 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 may not become fully evident until construction.

4.1 Stratigraphy

Sod/Topsoil

Exploration pits encountered surficial organic rich topsoil ranging from 8 to 24 inches thick. Topsoil is not suitable for structural support, and should be stripped from structural areas. Excavated topsoil may be suitable for reuse in landscape areas if allowed by project specifications.

Fill/Modified Ground

Existing fill soils (those not naturally placed) were encountered in EP-1 through EP-6 to a queried depth of 19 feet below existing ground surface. Fill soils in EP-1 and EP-2 consisted of loose, very silty sand with some gravel to a depth of 4 feet. Fill soils are not an acceptable receptor for infiltration purposes and should be removed in the proposed rain garden area. Existing fill soils in EP-5 and EP-6 (beneath the 'A' building to the east) consisted of loose, silty sand to a depth of 3 feet below existing grade. Because of the relatively shallow depth of fill under the eastern building, shallow foundations are feasible with proper replacement of loose fill as recommended in this report. Existing fill soils in EP-3 and EP-4 (beneath the 'A' building to the west) consisted of loose, very moist to wet, silty sand with various wood, brick, and asphalt debris up to 18 inches in diameter, with the presence of a strong organic odor throughout; to a depth of 19 feet below existing grade. These existing fill soils are not suitable for structural support and the westernmost of the two buildings proposed for construction during this phase should be supported on foundation piles.

Holocene Alluvium - Levee Deposits

In EP-6 we observed sediments interpreted to be Holocene-age alluvial levee deposits. These deposits were encountered beneath existing fill soils and were underlain by Vashon recessional outwash deposits from a depth of 3 to 8 feet below existing ground surface. The alluvial deposits consisted of very stiff, very sandy silt. Levee deposits were transported in river systems and deposited in elevated partitions between channels and floodplains as the river's energy decreased. Alluvial deposits contain a large quantity of silt and are considered moisture-sensitive. With appropriate remedial treatment, the soil, where moisture content is within the compactable range, may be considered suitable for support of slab-on-grade floors, hardscape, and paving.

Vashon Recessional Outwash - Deltaic Outwash

All exploration pits encountered sediments interpreted to be Vashon recessional deltaic outwash. The recessional outwash observed in our explorations generally graded from medium dense gravelly sand to dense sandy gravel which became cobbly at 8 to 10 feet in depth. In exploration pits EP-1 through EP-6 the recessional outwash soils were observed beneath variable existing fill soils ranging from 3 to 19 feet in depth. We queried the depth to native outwash in EP-4 because of the amount of existing fill material in the exploration pit and because we observed a change in soil type near the bottom of our exploration (20 feet). In EP-7 and EP-8, the native outwash was present near existing ground surface. Recessional outwash was deposited by meltwater streams emanating from retreating glaciers during the late Pleistocene. During ice recession a series of ice-marginal lakes formed. Recessional outwash rivers deposited sediment deltas of sand and gravel into the glacial lakes. The

recessional deltaic outwash is interpreted to be part of the Monroe fan that is graded to a glacial lake level of about 60 to 70 feet. The recessional deltaic outwash has not been overridden by glacial ice and is usually medium dense. In composition, it ranges from silty fine sand to clean coarse gravel with occasional cobbles and boulders. Due to the fluvial nature of deposition of recessional outwash, these materials are generally stratified. Recessional outwash is generally suitable for support of light to moderate foundation loads.

Detailed descriptions of the sediments encountered in our exploration are provided on the exploration logs included in the Appendix.

4.2 Geologic Mapping

Review of the regional geologic map titled *Geologic Map of the Monroe 7.5 Minute Quadrangle, King and Snohomish Counties, Washington,* by Joe D. Dragovich et al. (2011), indicates that the area of the subject site is underlain by levee deposits from the Holocene (Qa_l) and Vashon recessional deltaic outwash (Qgod). Our interpretation of the sediments encountered at the subject site is in general agreement with the regional geologic map.

4.3 Hydrology

Ground water was encountered in two of our exploration pits. We observed heavy seepage in EP-4 at a depth of 19 feet below ground surface at the contact between fill and Vashon recessional outwash and heavy seepage in EP-7 at a depth of 5 feet. These depths correspond approximately to the water level in the existing pond on site at the time of our explorations. However, ground water depths reported during our explorations should be considered approximate, and may not represent stabilized ground water elevations that would be recorded in a properly constructed monitoring well. Ground water encountered in our explorations is interpreted to represent the regional shallow water table.

Ground water may be encountered in excavations that penetrate into the underlying alluvial and recessional outwash soils. To our knowledge, no deep cuts are planned that will intersect the regional shallow ground water table. If such cuts will be made, ground water dewatering operations may be necessary. It should be noted that fluctuations in the level of the ground water may occur due to the time of year, variations in rainfall, and nearby river levels. Our work was conducted in May 2016, and is not reflective of the seasonal high water level.

4.4 Laboratory Testing

Four laboratory grain-size analyses were performed in accordance with the *American Society for Testing and Materials* (ASTM) D-422 on representative selected samples collected during our subsurface exploration. The data is summarized in Table 1. The grain-size analysis test

results (included in the Appendix) indicate that the soils tested from EP-1 and EP-7 correlate to a poorly-graded "SAND" with trace silt and the soils tested from EP-2 and EP-8 correlate to a poorly-graded "GRAVEL" with trace silt, based on ASTM D-2487 Unified Soil Classification System (USCS). The respective silt content as measured on the No. 200 sieve ranged from approximately 1 to 5 percent.

The grain-size distribution data were also interpreted to describe the U.S. Department of Agriculture (USDA) soil texture. The grain-size distributions were normalized to the No. 10 sieve—i.e., the coarse sand and gravel fraction of the sample is discounted and the remainder is taken as 100 percent of the sample. The fines were assessed relative to the No. 270 sieve. The respective USDA fines content as measured on the No. 270 sieve after adjusting to remove the weight retained on the No. 10 sieve ranged from approximately 1 to 5 percent.

Table 1
Summary of Grain Size Data

Exploration Number	Depth (feet)	Geologic Unit	USCS Soil Description	USDA Soil Texture*	D_{10} (mm)
EP-1	6.5	Vashon recessional outwash - deltaic outwash	Very gravelly SAND, trace silt. Medium to coarse sand is major constituent.	SAND	0.479
EP-2	6	Vashon recessional outwash - deltaic outwash	Very sandy GRAVEL, trace silt. Gravel is major constituent.	LOAMY SAND to SAND	1.344
EP-7	5.5	Vashon recessional outwash - deltaic outwash	SAND, trace silt, trace gravel. Medium Sand is major constituent.	SAND	0.237
EP-8	5	Vashon recessional outwash - deltaic outwash	Very sandy GRAVEL, trace silt. Gravel is major constituent.	SAND	0.822

USDA - U.S. Department of Agriculture
USCS - Unified Soil Classification System
mm - millimeter
* No hydrometers were performed. If USDA soil texture is presented as a range, the range reflects possible textures assuming fines consist entirely of silt to entirely of clay.

4.5 Infiltration Feasibility and Recommendations

We understand that the City of Monroe's storm water regulations currently refer to the 2012 (as amended in 2014) edition of the Department of Ecology's *Stormwater Management Manual for Western Washington* (Ecology Manual) for the handling of storm water runoff. Our explorations and grain-size analyses indicate that, from a geotechnical standpoint, portions of the subject site where the native recessional outwash sediments are at or near existing ground surface are suitable for storm water infiltration.

We understand that runoff from the site will be collected and infiltrated by a proposed rain garden on the west end of the site and a proposed bioswale along the north end of the site. At the east end of the proposed bioswale location, Vashon recessional outwash deposits consisting of primarily very sandy gravel with trace silt were encountered beneath the thin layer of topsoil in EP-8. At the time of our site reconnaissance, we did not have access to observe explorations along the central and west portions of the proposed bioswale. We recommend that AESI be given the opportunity to observe additional explorations along the remaining length of the bioswale once the area is accessible. At the location of the proposed rain garden, Vashon recessional outwash deposits, consisting of primarily very gravelly sand with trace silt and very sandy gravel with trace silt were encountered beneath 3 to 4 feet of existing fill material in EP-1 and EP-2.

Our explorations and grain-size analyses indicate that the outwash at this site generally consists of very gravelly sands and very sandy gravels with trace amounts of silt. In our opinion, storm water infiltration into the native Vashon recessional outwash deposits is feasible. The infiltration design is highly dependent on the amount of silt at a particular location, the depth to seasonal ground water, and the proposed amount of inflow. The Ecology Manual requires a ground water mounding assessment for projects where the depth to seasonal high ground water is less than 15 feet from the proposed base of facility, and the facility has a drainage area exceeding 1 acre. For initial sizing purposes, we recommend a planning-level infiltration rate of 5 to 10 inches per hour, to be further refined by infiltration testing and ground water mounding. We also recommend that shallow ground water monitoring wells be installed and monitored to estimate seasonal high ground water level. Field infiltration testing, well installation, and ground water mounding are outside our current scope of work, but could be provided by AESI. We are available to discuss in-depth infiltration strategies, testing methods, and costs on request.

II. GEOLOGIC HAZARDS AND MITIGATIONS

The following discussion of potential geologic hazards is based on the geologic, slope, and ground water conditions as observed and discussed herein. The discussion will be limited to seismic, landslide, and erosion hazards, including sediment transport.

5.0 SLOPE STABILITY HAZARDS AND RECOMMENDED MITIGATION

Based on the site map that was provided to us and recent visual reconnaissance of the site, it does not appear that any slopes on-site meet City of Monroe definitions for treatment as Steep Slope or Landslide Hazard critical areas. No detailed assessment of slope stability was prepared as part of this report and none is warranted, in our opinion.

6.0 SEISMIC HAZARDS AND RECOMMENDED MITIGATION

Earthquakes occur in the Puget Sound Lowland with great regularity. Most of these events are small and are usually not felt by people. However, large earthquakes do occur, as evidenced by the most recent 6.8-magnitude event on February 28, 2001 near Olympia Washington; the 1965, 6.5-magnitude event; and the 1949, 7.2-magnitude event. The 1949 earthquake appears to have been the largest in this area during recorded history. Evaluation of return rates indicates that an earthquake of the magnitude between 5.5 and 6.0 is likely within a given 20-year period.

Generally, there are four types of potential geologic hazards associated with large seismic events: 1) surficial ground rupture, 2) seismically induced landslides, 3) liquefaction, and 4) ground motion. The potential for each of these hazards to adversely impact the proposed project is discussed below.

6.1 Surficial Ground Rupture

There are several inferred faults near the subject site with the closest being the Monroe Fault, located approximately ½ mile to the south. Data pertaining to the Monroe Fault are not well documented but no evidence of surficial ground rupture has been noted.

The recurrence intervals for movement along this fault system are still unknown, although they are hypothesized to be in excess of several thousand years. Due to the suspected long recurrence intervals and the distance to this fault zone, the potential for surficial ground rupture is considered to be low during the expected life of the structures and no mitigation

efforts beyond complying with the current (2012) *International Building Code* (IBC) are recommended.

6.2 Seismically Induced Landslides

It is our opinion that the potential risk of damage to the proposed development by seismically induced slope failures is low due to the lack of steep slopes in the immediate project area.

6.3 Liquefaction

Liquefaction is a process through which unconsolidated soil loses strength as a result of vibrations, such as those which occur during a seismic event. During normal conditions, the weight of the soil is supported by both grain-to-grain contacts and by the fluid pressure within the pore spaces of the soil below the water table. Extreme vibratory shaking can disrupt the grain-to-grain contact, increase the pore pressure, and result in a temporary decrease in soil shear strength. The soil is said to be liquefied when nearly all of the weight of the soil is supported by pore pressure alone. Liquefaction can result in deformation of the sediment and settlement of overlying structures. Areas most susceptible to liquefaction include those areas underlain by non-cohesive silt and sand with low relative densities, accompanied by a shallow water table.

Our explorations suggest that a liquefaction analysis is warranted and we recommend that one be completed. The analysis requires completion of exploration borings which were not completed as part of our current study.

6.4 Ground Motion

Structural design of the buildings should follow 2012 IBC standards. The final determination of seismic site class will depend on liquefaction analyses which have not been completed. For preliminary planning purposes, the Vashon recessional outwash soils are consistent with 2012 IBC Site Class “D” when unsaturated and “F” when saturated, as defined in IBC Table 20.3-1 of *American Society of Civil Engineers* (ASCE) *7 – Minimum Design Loads for Buildings and Other Structures*. The alluvial levee deposits are consistent with Site Class “D”. The existing fill soils are consistent with Site Class “E” or “F.”

7.0 EROSION HAZARDS AND MITIGATIONS

As of October 1, 2008, the Washington State Department of Ecology (Ecology) Construction Storm Water General Permit (also known as the National Pollutant Discharge Elimination System [NPDES] permit) requires weekly Temporary Erosion and Sedimentation Control (TESC)

inspections and turbidity and pH monitoring of site runoff for all sites 1 or more acres in size that discharge storm water to surface waters of the state. The following sections provide recommendations to address these inspection and reporting requirements, as well as recommendations related to general erosion control and mitigation.

The TESC inspections and turbidity and pH monitoring of runoff must be completed by a Certified Erosion and Sediment Control Lead (CESCL) for the duration of the construction. The weekly TESC reports do not need to be sent to Ecology, but should be logged into the project Storm Water Pollution Prevention Plan (SWPPP). Ecology requires a monthly summary report of the turbidity monitoring results signed by the NPDES permit holder. If the monitored turbidity equals or exceeds 25 nephelometric turbidity units (NTU) (Ecology benchmark standard), the project best management practices (BMPs) should be modified to decrease the turbidity of storm water leaving the site. Changes and upgrades to the BMPs should be documented in the weekly TESC reports and continued until the weekly turbidity reading is 25 NTU or lower. If the monitored turbidity exceeds 250 NTU, the results must be reported to Ecology via phone within 24 hours and corrective actions should be implemented as soon as possible. Daily turbidity monitoring is continued until the corrective actions lower the turbidity to below 25 NTU, or until the discharge stops. This description of the sampling benchmarks and reporting requirements is a brief summary of the Construction Storm Water General Permit conditions. The general permit is available on the internet.

In order to meet the current Ecology requirements, a properly developed, constructed, and maintained erosion control plan consistent with City of Monroe standards and best management erosion control practices will be required for this project. AESI is available to assist the project civil engineer in developing site-specific erosion control plans. Based on past experience, it will be necessary to make adjustments and provide additional measures to the TESC plan in order to optimize its effectiveness. Ultimately, the success of the TESC plan depends on a proactive approach to project planning and contractor implementation and maintenance.

The most effective erosion control measure is the maintenance of adequate ground cover. Maintaining cover measures atop disturbed ground provides the greatest reduction to the potential generation of turbid runoff and sediment transport. During the local wet season (October 1st through March 31st), exposed soil should not remain uncovered for more than 2 days unless it is actively being worked. Ground-cover measures can include erosion control matting, plastic sheeting, straw mulch, crushed rock or recycled concrete, or mature hydroseed.

Surface drainage control measures are also essential for collecting and controlling the site runoff. Flow paths across slopes should be kept to less than 50 feet in order to reduce the erosion and sediment transport potential of concentrated flow. Ditch/swale spacing will need

to be shortened with increasing slope gradient. Ditches and swales that exceed a gradient of about 7 to 10 percent, depending on their flow length, should have properly constructed check dams installed to reduce the flow velocity of the runoff and reduce the erosion potential within the ditch. Flow paths that are required to be constructed on gradients between 10 to 15 percent should be placed in a riprap-lined swale with the riprap properly sized for the anticipated flow conditions. Flow paths constructed on slope gradients steeper than 15 percent should be placed in a pipe slope drain. AESI is available to assist the project civil engineer in developing a suitable erosion control plan with proper flow control.

With respect to water quality, having ground cover prior to rain events is one of the most important and effective means to maintain water quality. Once very fine sediment is suspended in water, the settling times of the smallest particles are on the order of weeks and months. Therefore, the typical retention times of sediment traps or ponds will not reduce the turbidity of highly turbid site runoff to the benchmark turbidity of 25 NTU. Reduction of turbidity from a construction site is almost entirely a function of cover measures and drainage control that have been implemented prior to rain events. Temporary sediment traps and ponds are necessary to control the release rate of the runoff and to provide a catchment for sand-sized and larger soil particles, but are very ineffective at reducing the turbidity of the runoff.

Silt fencing should be utilized as buffer protection and not as a flow-control measure. Silt fencing is meant to be placed parallel with topographic contours to prevent sediment-laden runoff from leaving a work area or entering a sensitive area. Silt fences should not be placed to cross contour lines without having separate flow control in front of the silt fence. A swale/berm combination should be constructed to provide flow control rather than let the runoff build up behind the silt fence and utilize the silt fence as the flow-control measure. Runoff flowing in front of a silt fence will cause additional erosion and usually will cause a failure of the silt fence. Improperly installed silt fencing has the potential to cause a much larger erosion hazard than if the silt fence was not installed at all. The use of silt fencing should be limited to protect sensitive areas, and swales should be used to provide flow control.

7.1 Erosion Hazard Mitigation

To mitigate the erosion hazards and potential for off-site sediment transport, we would recommend the following:

1. Construction activity should be scheduled or phased as much as possible to reduce the amount of earthwork activity that is performed during the winter months.

2. The winter performance of a site is dependent on a well-conceived plan for control of site erosion and storm water runoff. It is easier to keep the soil on the ground than to

remove it from storm water. The owner and the design team should include adequate ground-cover measures, access roads, and staging areas in the project bid to give the selected contractor a workable site. The selected contractor needs to be prepared to implement and maintain the required measures to reduce the amount of exposed ground. A site maintenance plan should be in place in the event storm water turbidity measurements are greater than the Ecology standards.

3. TESC measures for a given area to be graded or otherwise worked should be installed soon after ground clearing or timber harvesting. The recommended sequence of construction within a given area after clearing/timber harvesting would be to install sediment traps and/or ponds and establish perimeter flow control prior to starting mass grading.

4. During the wetter months of the year, or when large storm events are predicted during the summer months, each work area should be stabilized so that if showers occur, the work area can receive the rainfall without excessive erosion or sediment transport. The required measures for an area to be "buttoned-up" will depend on the time of year and the duration the area will be left un-worked. During the winter months, areas that are to be left un-worked for more than 2 days should be mulched or covered with plastic. During the summer months, stabilization will usually consist of seal-rolling the subgrade. Such measures will aid in the contractor's ability to get back into a work area after a storm event. The stabilization process also includes establishing temporary storm water conveyance channels through work areas to route runoff to the approved treatment facilities.

5. All disturbed areas should be revegetated as soon as possible. If it is outside of the growing season, the disturbed areas should be covered with mulch, as recommended in the erosion control plan. Straw mulch provides a cost-effective cover measure and can be made wind-resistant with the application of a tackifier after it is placed.

6. Surface runoff and discharge should be controlled during and following development. Uncontrolled discharge may promote erosion and sediment transport. Under no circumstances should concentrated discharges be allowed to flow over the top of steep slopes.

7. Soils that are to be reused around the site should be stored in such a manner as to reduce erosion from the stockpile. Protective measures may include, but are not limited to, covering with plastic sheeting, the use of low stockpiles in flat areas, or the use of silt fences around pile perimeters. During the period between October 1st and March 31st, these measures are required.

8. On-site erosion control inspections and turbidity monitoring (if required) should be performed in accordance with Ecology requirements. Weekly and monthly reporting to Ecology should be performed on a regularly scheduled basis. A discussion of temporary erosion control and site runoff monitoring should be part of the weekly construction team meetings. Temporary and permanent erosion control and drainage measures should be adjusted and maintained, as necessary, for the duration of project construction.

It is our opinion that with the proper implementation of the TESC plans and by field-adjusting appropriate mitigation elements (BMPs) throughout construction, as recommended by the erosion control inspector, the potential adverse impacts from erosion hazards on the project may be mitigated.

III. PRELIMINARY DESIGN RECOMMENDATIONS

8.0 INTRODUCTION

Existing fill soils are not suitable for structural support. Existing fill and native soils are granular and partially saturated, warranting completion of a liquefaction analysis. Completion of the liquefaction analysis and developing final geotechnical engineering recommendations for foundation support will be completed when a final geotechnical engineering report is prepared. The following preliminary recommendations may be used for planning purposes.

The proposed project is feasible from a geotechnical engineering standpoint using pile foundations for the west 'A' building. Loose fill soils beneath the west building should be removed and replaced with structural fill prior to construction. Pavement or hardscaping support on existing soils is possible with some near-surface remedial improvements.

9.0 SITE PREPARATION

Site preparation of planned building and road/parking areas should include removal of all existing utilities, asphalt, landscaping, debris, and any other surficial deleterious material that are not part of the planned project. Additionally, any upper organic topsoil encountered should be removed and the remaining roots grubbed. Areas where loose surficial soils exist due to demolition or stripping/grubbing operations should be considered as fill to the depth of disturbance and treated as subsequently recommended for structural fill placement.

Fill was encountered in six of our exploration pits (EP-1 through EP-6) to depths ranging from 3 feet to 19 feet below existing ground surface. The density, thickness, and content of the fill across the site may be highly variable. We anticipate that any upper loose surficial fill soils, once recompacted or replaced with structural fill, will be adequate for support of pavement and other external surfacing, such as sidewalks or segmented paving units. However, there will be a risk of long-term damage to these surfaces including, but not limited to, rutting, yielding, cracking, etc., if any uncontrolled loose fill or surficial loose soil is not completely removed and replaced with compacted structural fill. The risk can be reduced by selective removal and replacement of the most settlement-sensitive, near-surface soils. Utilities founded above loose, uncontrolled fill are also at risk of settlement and associated damage.

The extent of stripping necessary in areas of the site to receive external surfacing, such as sidewalks and pavement, can best be determined in the field by the geotechnical engineer or engineering geologist. We recommend proof-rolling road and parking areas with a loaded tandem-axle dump truck to identify any soft spots. If construction is to proceed during wet weather, we recommend systematic probing in place of proof-rolling to identify soft areas of the exposed subgrade. These soft areas should be overexcavated and backfilled with structural fill.

Existing fill should be removed from below the footprint of the proposed east building and replace as needed with structural fill. Existing fill below the footprint of the planned west building should be proof-rolled under the observation of AESI. Soft or yielding areas should be repaired as needed, followed by placement of 1 foot or more of granular fill to act as a working surface. Sand and gravel soils derived on site are suitable for construction of the working surface, but silty soils should not be used in this application.

Some of the on-site fill and surface soils contain a high percentage of fine-grained material, which makes them moisture-sensitive and subject to disturbance when wet. The contractor must use care during site preparation and excavation operations so that the underlying soils are not softened. If disturbance occurs, the softened soils should be removed and the area brought to grade with structural fill.

10.0 STRUCTURAL FILL

All references to structural fill in this report refer to subgrade preparation, fill type and placement, and compaction of materials, as discussed in this section. If a percentage of compaction is specified under another section of this report, the value given in that section should be used.

After stripping, planned excavation, and any required overexcavation have been performed to the satisfaction of the geotechnical engineer, the upper 12 inches of exposed ground in areas to receive fill should be recompacted to 90 percent of the modified Proctor maximum density using ASTM D-1557 as the standard. If the subgrade contains silty soils and too much moisture, adequate recompaction may be difficult or impossible to obtain and should probably not be attempted. In lieu of recompaction, the area to receive fill should be blanketed with washed rock or quarry spalls to act as a capillary break between the new fill and the wet subgrade. Where the exposed ground remains soft and further overexcavation is impractical, placement of an engineering stabilization fabric may be necessary to prevent contamination of the free-draining layer by silt migration from below.

After recompaction of the exposed ground is tested and approved, or a free-draining rock course is laid, structural fill may be placed to attain desired grades. Structural fill is defined as non-organic soil, acceptable to the geotechnical engineer, placed in maximum 8-inch loose lifts, with each lift being compacted to 95 percent of the modified Proctor maximum density using ASTM D-1557 as the standard. In the case of roadway and utility trench filling, the backfill should be placed and compacted in accordance with current local codes and standards. The top of the compacted fill should extend horizontally outward a minimum distance of 3 feet beyond the location of the roadway edges before sloping down at an angle of 2H:1V (Horizontal:Vertical).

The contractor should note that any proposed fill soils must be evaluated by AESI prior to their use in fills. This would require that we have a sample of the material 72 hours in advance to perform a Proctor test and determine its field compaction standard. Soils in which the amount of fine-grained material (smaller than the No. 200 sieve) is greater than approximately 5 percent (measured on the minus No. 4 sieve size) should be considered moisture-sensitive. Use of moisture-sensitive soil in structural fills should be limited to favorable dry weather conditions. Some on-site soils contained significant amounts of silt and are considered moisture-sensitive. In addition, construction equipment traversing the site when the soils are wet can cause considerable disturbance. If fill is placed during wet weather or if proper compaction cannot be obtained, a select import material consisting of a clean, free-draining gravel and/or sand should be used. Free-draining fill consists of non-organic soil with the amount of fine-grained material limited to 5 percent by weight when measured on the minus No. 4 sieve fraction with at least 25 percent retained on the No. 4 sieve.

A representative from our firm should inspect the stripped subgrade and be present during placement of structural fill to observe the work and perform a representative number of in-place density tests. In this way, the adequacy of the earthwork may be evaluated as filling progresses and any problem areas may be corrected at that time. It is important to understand that taking random compaction tests on a part-time basis will not assure uniformity or acceptable performance of a fill. As such, we are available to aid the owner in developing a suitable monitoring and testing program.

11.0 FOUNDATIONS

To mitigate post-construction consolidation settlement and the effects of seismically induced liquefaction, we recommend a pile foundation system for the west 'A' building where we encountered up to 19 feet of loose, very moist to wet, existing fill soils with various debris. We are available to discuss in-depth pile installation strategies and costs on request. In the area of the east 'A' building we encountered up to 3 feet of existing fill soils. Contingent on completion of a liquefaction analysis, it is our opinion that conventional shallow foundations

may be used for foundation support of the east 'A' building with removal and replacement of the existing fill soils.

12.0 FLOOR SUPPORT

As discussed earlier in this report, existing fill soils beneath the west 'A' building are considered to be settlement-prone, and we therefore recommend that the floor slab be designed as a structural slab and supported on pile foundations. The floor for the east building may be supported on structural fill. Floor slabs should be cast atop a minimum of 4 inches of clean washed crushed rock or pea gravel to act as a capillary break. Areas of subgrade that are disturbed (loosened) during construction should be compacted to a non-yielding condition prior to placement of capillary break material. It should also be protected from dampness by an impervious moisture barrier at least 10 mils thick. The impervious barrier should be placed between the capillary break material and the concrete slab.

13.0 DRAINAGE CONSIDERATIONS

All exterior grade beams should be provided with a drain at least 12 inches below the base of the adjacent interior slab elevation. Drains should consist of rigid, perforated, polyvinyl chloride (PVC) pipe surrounded by washed pea gravel. The drains should be constructed with sufficient gradient to allow gravity discharge away from the building. Roof and surface runoff should not discharge into the footing drain system, but should be handled by a separate, rigid, tightline drain. In planning, exterior grades adjacent to walls should be sloped downward away from the structure to achieve surface drainage.

14.0 PAVEMENT RECOMMENDATIONS

We anticipate that the proposed project will include construction of paved private parking areas and on-site roads. No new city streets are anticipated. Due to loose/soft soils near the surface, some remedial measures may be necessary for support of new pavement or for areas of hardscaping (e.g., paving stones).

After the area to be paved is stripped and recompacted to the extent possible, the area should be proof-rolled with a loaded truck under the observation of AESI. Any soft, wet, organic, or yielding areas should be repaired as recommended during construction. If warranted, engineering stabilization fabric, such as Mirafi 500X (or equivalent), should be placed over the subgrade with the edges overlapped in accordance with the manufacturer's recommendations. Following subgrade preparation, clean, free-draining structural fill should be placed over the

fabric and compacted to 95 percent of ASTM D-1557. Where fabric is exposed, spreading should be performed such that the dozer remains on the fill material and is not allowed to operate on uncovered fabric. When 12 inches of fill has been placed, the fabric should be proof-rolled with a loaded dump truck to pretension the fabric and identify soft spots in the fill. Upon completing the proof-rolling operation, additional structural fill should be placed and compacted to attain desired grades.

Upon completion of the structural fill, a pavement section consisting of 4 inches of asphalt concrete pavement (ACP) underlain by 2 inches of $^5/_8$-inch crushed surfacing top course and 6 inches of 1¼-inch crushed surfacing base course is the recommended minimum. The crushed rock courses must be compacted to 95 percent of maximum density. Given the potentially variable in-place density of existing fill subgrade, some settlement of paved areas should be anticipated unless existing fill is entirely removed and replaced with structural fill.

14.1 Permeable Paving Recommendations

We recommend that the subgrade for permeable paving areas be prepared by stripping existing topsoil and vegetation, demolishing existing structures and buried utilities, and excavating to pavement subgrade elevation, as needed. Existing fill should then be addressed. Where existing fill is present below pavement subgrade elevation and is silty, it should be removed to expose granular soils suitable for infiltration. City design requirements may mandate removal of existing fill from below permeable paving regardless of the gradation of the fill. The resulting surface should be proof-rolled with a loaded dump truck or other suitable heavy equipment under the observation of the geotechnical engineer. Any soft or yielding subgrade soils should receive remedial preparation, as needed, to establish a firm and unyielding subgrade suitable for support of paving or structural fill, as needed. Remedial preparation of wet subgrades is discussed in further detail in Section 14.0 of this report. Structural fill should be placed as previously referenced in this report. Although the native subgrade materials are expected to consist of medium dense to dense recessional outwash sediments, unnecessary traffic over the stripped subgrade should be avoided so that the infiltration potential is not reduced. The paving subgrade should be graded at an inclination of at least ½ percent to drain to a series of perforated drain pipes placed above the underlying native soils. The perforated drain pipes should be laid out by the civil engineer in such a way that drainage paths between adjacent drain pipes are on the order of 15 feet or less.

Following subgrade preparation, we recommend a private parking pavement section consisting of a 4-inch compacted permeable asphalt concrete pavement (ACP) above a 2-inch thickness of "choker course" consisting of ¼- by $^5/_8$-inch washed, crushed rock or approved equivalent. Areas that will receive heavy traffic should be provided with a layer of permeable pavement surfacing at least 5 inches thick, underlain by a 2-inch choker course as previously described. Below the choker course, a 12- to 18-inch-thick storage layer consisting of 2-inch crushed,

washed ballast conforming to the Washington State Department of Transportation (WSDOT) specification for Permeable Ballast 9-03.9 (2) should be placed above the soil subgrade. The storage layer should be sized for an appropriate amount of storm water storage assuming a porosity of 0.30. At this site, we understand that permeable paving may be used both in on-site roads and private parking stalls. Turning motions, such as those caused by entering and exiting parking stalls and right angle turns from a stop, impose stress on paving that can cause damage to permeable paving. We recommend laying paving out in such a way that severe turning motions are limited as much as possible on permeable paving. We also recommend careful construction quality control to verify that the asphalt mix provided at the site conforms to project specifications and is adequately placed and compacted. These extra steps in design and construction are important aspects of the project that will reduce the potential for damage to the permeable paving caused by turning motions.

Permeable asphalt requires regular maintenance to avoid becoming clogged with silt and contaminants and to maintain the permeable properties. We recommend establishing a cleaning schedule as part of the long-term site maintenance.

15.0 PROJECT DESIGN AND CONSTRUCTION MONITORING

At the time of this report, site grading, structural plans, and construction methods have not been finalized. We are available to provide additional geotechnical consultation as the project design develops and possibly changes from that upon which this report is based. We recommend completion of exploration borings and completion of a liquefaction analysis. We recommend that AESI perform a geotechnical review of the plans prior to final design completion. In this way, our earthwork and foundation recommendations may be properly interpreted and implemented in the design.

We are also available to provide geotechnical engineering and monitoring services during construction. The integrity of the proposed pile foundation system depends on proper site preparation and construction procedures. In addition, engineering decisions may have to be made in the field in the event that variations in subsurface conditions become apparent. Construction monitoring services are not part of this current scope of work. If these services are desired, please let us know, and we will prepare a cost proposal.

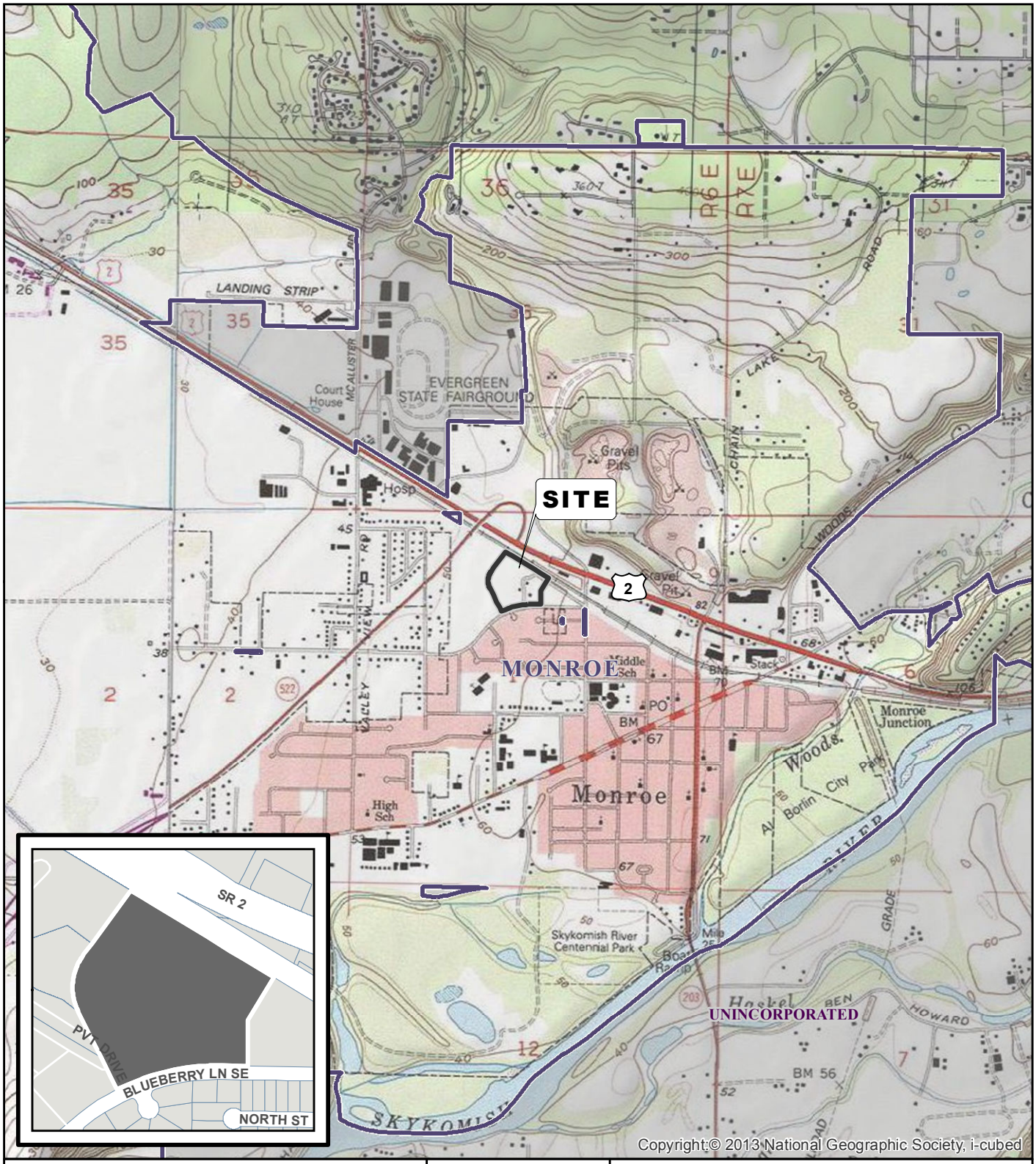
We have enjoyed working with you on this study and are confident that these recommendations will aid in the successful completion of your project. If you should have any questions or require further assistance, please do not hesitate to call.

Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Kirkland, Washington

Dan Voth
Staff Geologist

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

Attachments: Figure 1: Vicinity Map
Figure 2: Site and Exploration Plan
Appendix: Exploration Logs
Grain Size Analyses



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DATA SOURCES / REFERENCES:
USGS: 24K SERIES TOPOGRPAHIC MAPS
SNOHOMISH CO: STREETS, PARCELS

LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE

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

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VICINITY MAP

BURDETTE - BLUEBERRY LANE
MONROE, WASHINGTON

PROJ NO.	DATE:	FIGURE:
KE080683B	5/16	1

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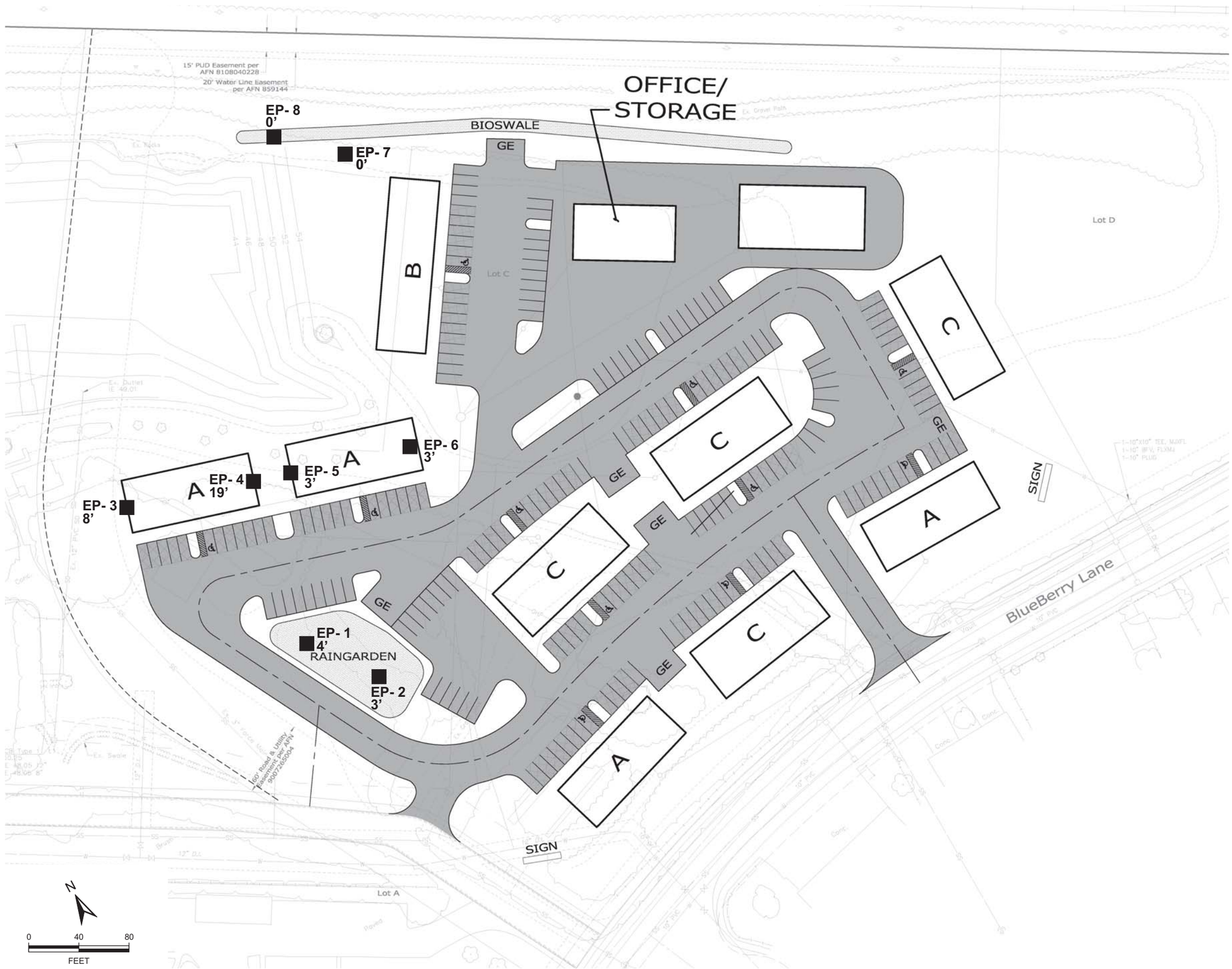

LEGEND:

■ **EP** EXPLORATION PIT WITH DEPTH OF FILL

CONTOUR INTERVAL = 2'

NOTE: LOCATION AND DISTANCES SHOWN ARE APPROXIMATE.

NOTES:

1. BASE MAP REFERENCE: DESIGN BUILD SERVICES, INC BURDETT - BLUEBERRY LANE, SITE PLAN, SHEET 1 OF 2, DATED 3-20-2016

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SITE AND EXPLORATION PLAN

BURDETTE - BLUEBERRY LANE
MONROE, WASHINGTON

PROJ NO.	DATE:	FIGURE:
KE080683B	5/16	2

080863 Party Pit \ 080683 F2 Site and Explor.cdr

APPENDIX

LOG OF EXPLORATION PIT NO. EP-1

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION**
	Topsoil / Grass / Roots
1	
2	**Fill**
3	Loose, very moist, brown, very silty, SAND, some gravel (SM).
4	**Vashon Recessional Outwash - Deltaic Outwash**
5	Medium dense to dense, moist, yellowish brown, very gravelly, SAND, trace silt; sand predominantly medium sized (SP).
6	
7	
8	
9	Becomes cobbly.
10	
11	
12	Bottom of exploration pit at depth 11 feet No seepage. No caving.
13	
14	
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Burette-Blueberry Lane
Monroe, WA

Logged by: DV

Approved by: JHS

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Project No. KE080683B

5/3/16

LOG OF EXPLORATION PIT NO. EP-2

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION**
	Topsoil / Grass / Roots
1	**Fill**
2	Loose, very moist, brown, very silty, SAND, some gravel, trace charcoal (SM).
3	**Vashon Recessional Outwash - Deltaic Outwash**
4	Medium dense to dense, moist, yellowish brown, very sandy, GRAVEL, trace silt (GP).
5	
6	
7	
8	Becomes cobbly.
9	
10	
11	
12	Bottom of exploration pit at depth 11 feet No seepage. No caving.
13	
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5/3/16

LOG OF EXPLORATION PIT NO. EP-3

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION**
	Topsoil / Grass / Roots
1	
	Fill
2	Loose, very moist, brown, silty, gravelly, SAND (SM).
3	Loose, moist, yellowish brown, gravelly, SAND, some silt (SP).
4	
5	
6	Becomes silty with chunks of silt and roots.
7	
8	**Vashon Recessional Outwash - Deltaic Outwash**
9	Medium dense to dense, moist, yellowish brown, very sandy, GRAVEL, trace silt (GP).
10	
11	
12	Bottom of exploration pit at depth 11 feet No seepage. Moderate caving from 2 to 8 feet.
13	
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19	
20	

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Project No. KE080683B

5/3/16

LOG OF EXPLORATION PIT NO. EP-4

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION**
	Fill
1	
2	Loose, moist, gray, gravelly, silty, SAND; strong organic odor (SM).
3	
4	
5	
6	Some roots present.
7	
8	
9	Loose, wet, gray, very silty, sandy, GRAVEL, some wood and brick debris, trace asphalt chunks (up to 18" in diameter); strong organic odor (GM).
10	3 foot diameter boulder present.
11	
12	
13	Soft, very moist, brown, sandy, SILT, trace gravel, some roots (ML).
14	
15	
16	
17	
18	
19	**Vashon Recessional Outwash - Deltaic Outwash**
20	Medium dense to dense, wet, yellowish brown, sandy, GRAVEL, trace silt (GP).

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5/3/16

LOG OF EXPLORATION PIT NO. EP-4

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION**	
21	Bottom of exploration pit at depth 20 feet Heavy seepage at 19 feet. Heavy caving 1 to 18 feet.	
22		
23		
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Project No. KE080683B

5/3/16

LOG OF EXPLORATION PIT NO. EP-5

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION**
	Fill
1	Medium dense, gray, very silty, SAND, some gravel (SM).
2	Loose, moist, brown, very silty, SAND, some gravel, some wood debris, trace roots (SM).
3	**Vashon Recessional Outwash - Deltaic Outwash**
4	Medium dense to dense, moist, yellowish brown, very sandy, GRAVEL, trace silt (GP).
5	
6	
7	
8	
9	Medium dense to dense, moist, yellowish brown, very gravelly, SAND, trace silt (SP).
	Becomes cobbly.
10	
11	Bottom of exploration pit at depth 10 feet No seepage. Minor caving from 1 to 3 feet.
12	
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Burette-Blueberry Lane
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Project No. KE080683B

5/3/16

LOG OF EXPLORATION PIT NO. EP-6

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION**
	Fill
1	Medium dense to dense, slightly moist, dark brown, sandy, GRAVEL, some silt, some brick debris (GP).
2	
3	Loose, moist, light brown, very silty, SAND, some gravel (SM).
	Holocene Alluvium - Levee Deposits
4	Very stiff, moist, brown, very sandy, SILT, trace gravel; micaceous (ML).
5	
6	
7	
8	**Vashon Recessional Outwash - Deltaic Outwash**
9	Medium dense to dense, moist, yellowish brown, silty, gravelly, SAND (SM).
10	
11	Bottom of exploration pit at depth 10 feet No seepage. Minor to moderate caving from 1 to 3 feet.
12	
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Project No. KE080683B

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LOG OF EXPLORATION PIT NO. EP-7

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION**
	Vashon Recessional Outwash - Deltaic Outwash
1	Medium dense, very moist, brown, very sandy, GRAVEL, some silt (GP).
2	
3	
4	
5	Medium dense, moist, brown, SAND, trace silt, trace gravel (SP).
6	
7	
8	Bottom of exploration pit at depth 7 feet Heavy seepage at 5 feet. Moderate caving.
9	
10	
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LOG OF EXPLORATION PIT NO. EP-8

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION**
	Topsoil / Grass / Roots
1	**Vashon Recessional Outwash - Deltaic Outwash**
2	Medium dense to dense, moist, brown, very sandy, GRAVEL, trace silt (GP).
3	
4	
5	
6	
7	Bottom of exploration pit at depth 6 feet No seepage. No caving.
8	
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Burette-Blueberry Lane
Monroe, WA

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Project No. KE080683B

5/3/16

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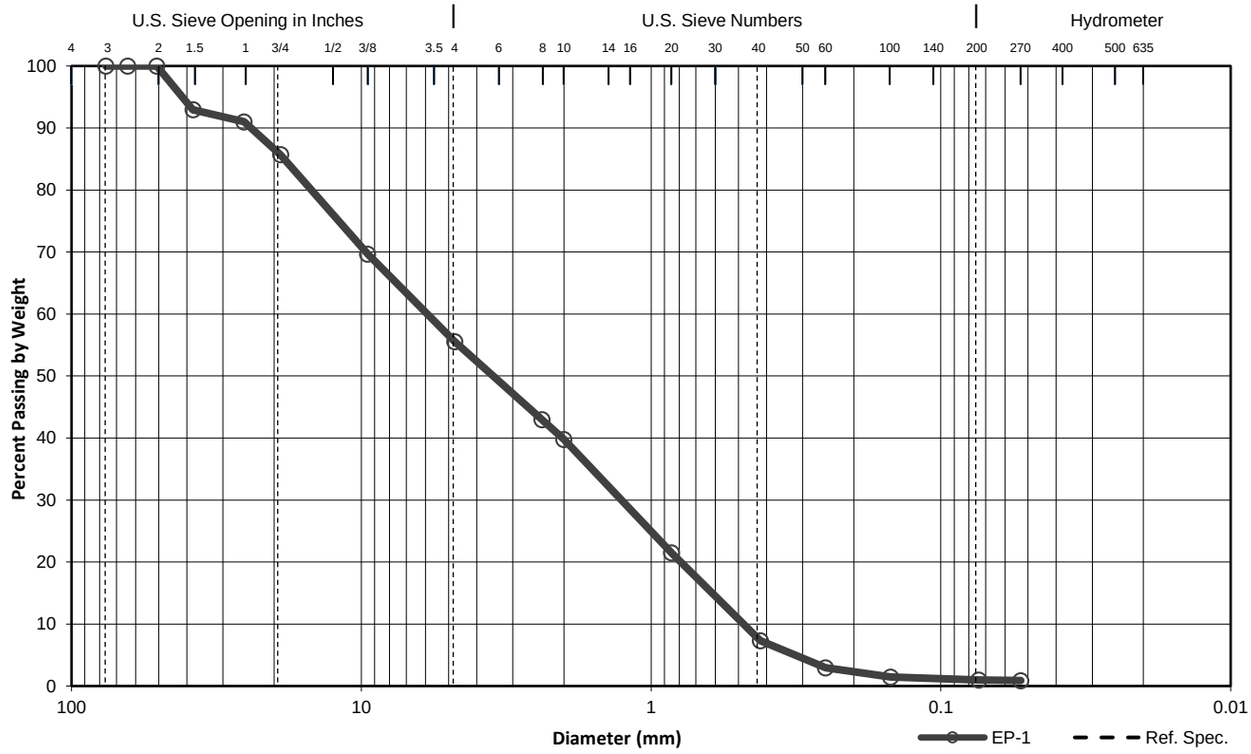
GRAIN SIZE ANALYSIS - MECHANICAL ASTM D422

Project Name	Project Number	Date Sampled	Date Tested	Tested By
Burdette-Blueberry Lane	**KE080683B**	**5/4/2016**	**5/5/2016**	**MS**

Sample Source	Sample No.	Depth (ft)	Soil Description
Onsite	**EP-1**	**6.5**	**very gravelly SAND, trace silt (SP)**

Total Sample Dry Wt. (g)	Moisture Content (%)	D_{10} (mm)	Reference Specification
3092.6	**6**	**0.479**	



Cobb.	Gravel		Sand			Silt or Clay
	Coarse	Fine	Coarse	Medium	Fine	

Sieve No.	Diam. (mm)	Cum. Wt. Ret. (g)	% Ret. by Wt.	% Passing by Wt.	% Specs. Pass. by Wt.	
					Min	Max
3	76.1		0.0	100.0		
2.5	64		0.0	100.0		
2	50.8		0.0	100.0		
1.5	38.1	217.9	7.0	93.0		
1	25.4	277.8	9.0	91.0		
3/4	19	442.4	14.3	85.7		
3/8	9.51	937.6	30.3	69.7		
#4	4.76	1374.9	44.5	55.5		
#8	2.38	1763.8	57.0	43.0		
#10	2	1862.0	60.2	39.8		
#20	0.85	2428.6	78.5	21.5		
#40	0.42	2866.2	92.7	7.3		
#60	0.25	3001.6	97.1	2.9		
#100	0.149	3047.3	98.5	1.5		
#200	0.074	3062.6	99.0	1.0		
#270	0.053	3065.2	99.1	0.9		

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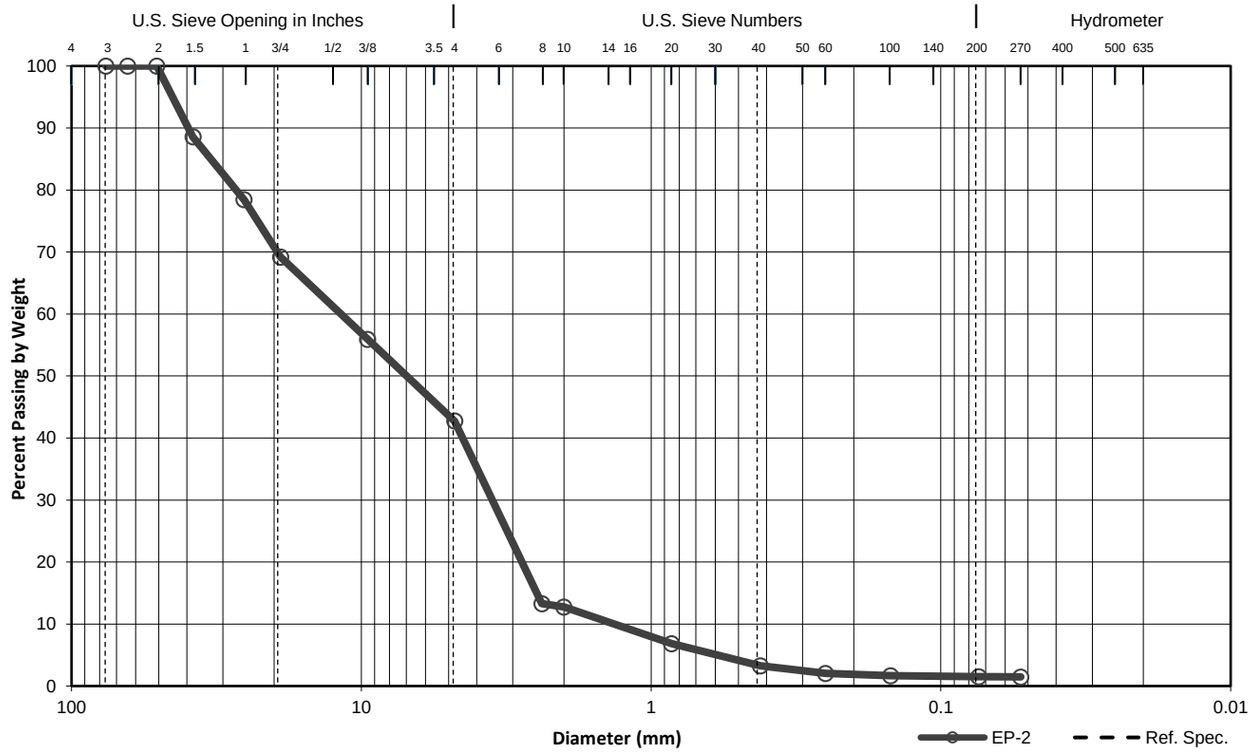
GRAIN SIZE ANALYSIS - MECHANICAL ASTM D422

Project Name	Project Number	Date Sampled	Date Tested	Tested By
Burdette-Blueberry Lane	**KE080683B**	**5/4/2016**	**5/5/2016**	**MS**

Sample Source	Sample No.	Depth (ft)	Soil Description
Onsite	**EP-2**	**6**	**very sandy GRAVEL, trace silt (GP)**

Total Sample Dry Wt. (g)	Moisture Content (%)	D_{10} (mm)	Reference Specification
2912.3	**6**	**1.344**	



Cobb.	Gravel		Sand			Silt or Clay
	Coarse	Fine	Coarse	Medium	Fine	

Sieve No.	Diam. (mm)	Cum. Wt. Ret. (g)	% Ret. by Wt.	% Passing by Wt.	% Specs. Pass. by Wt.	
					Min	Max
3	76.1		0.0	100.0		
2.5	64		0.0	100.0		
2	50.8		0.0	100.0		
1.5	38.1	332.6	11.4	88.6		
1	25.4	627.4	21.5	78.5		
3/4	19	896.8	30.8	69.2		
3/8	9.51	1283.8	44.1	55.9		
#4	4.76	1667.5	57.3	42.7		
#8	2.38	2524.9	86.7	13.3		
#10	2	2541.2	87.3	12.7		
#20	0.85	2713.5	93.2	6.8		
#40	0.42	2816.5	96.7	3.3		
#60	0.25	2852.2	97.9	2.1		
#100	0.149	2863.0	98.3	1.7		
#200	0.074	2868.2	98.5	1.5		
#270	0.053	2869.2	98.5	1.5		

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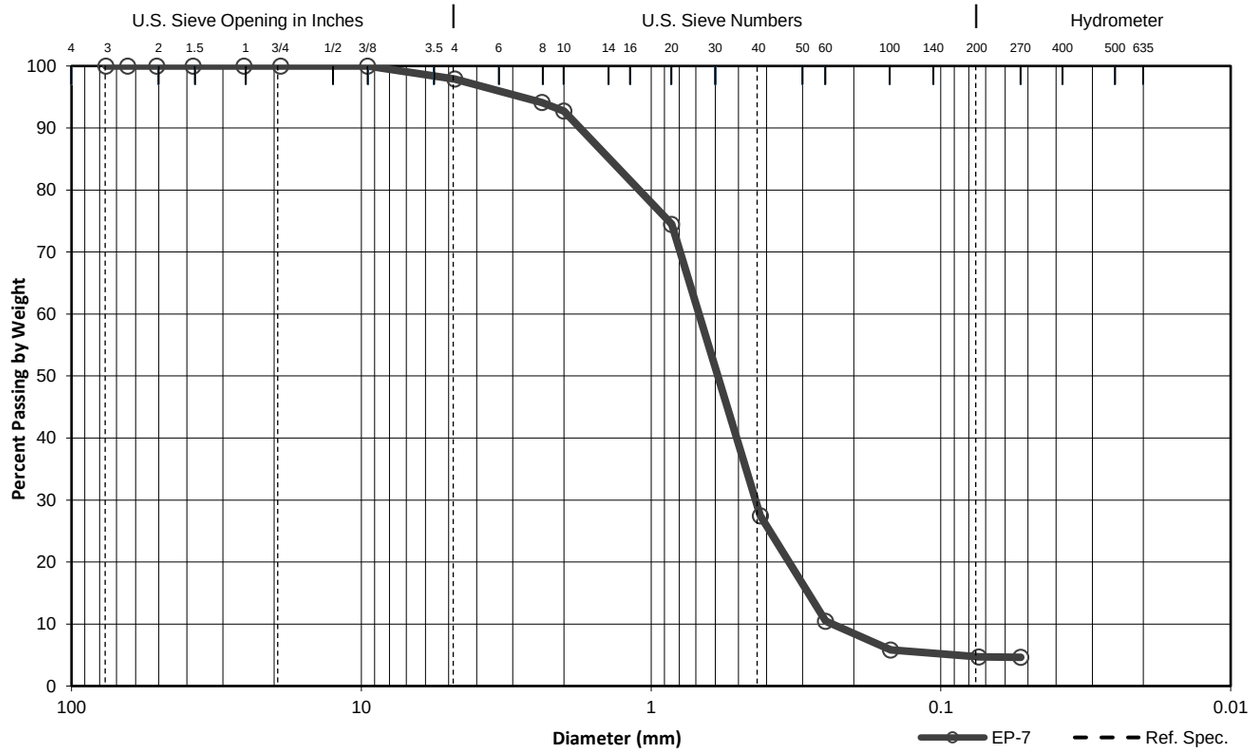
GRAIN SIZE ANALYSIS - MECHANICAL ASTM D422

Project Name	Project Number	Date Sampled	Date Tested	Tested By
Burdette-Blueberry Lane	**KE080683B**	**5/4/2016**	**5/5/2016**	**MS**

Sample Source	Sample No.	Depth (ft)	Soil Description
Onsite	**EP-7**	**5.5**	**SAND, trace silt, trace gravel (SP)**

Total Sample Dry Wt. (g)	Moisture Content (%)	D_{10} (mm)	Reference Specification
699.4	**17**	**0.237**	



Cobb.	Gravel		Sand			Silt or Clay
	Coarse	Fine	Coarse	Medium	Fine	

Sieve No.	Diam. (mm)	Cum. Wt. Ret. (g)	% Ret. by Wt.	% Passing by Wt.	% Specs. Pass. by Wt.	
					Min	Max
3	76.1		0.0	100.0		
2.5	64		0.0	100.0		
2	50.8		0.0	100.0		
1.5	38.1		0.0	100.0		
1	25.4		0.0	100.0		
3/4	19		0.0	100.0		
3/8	9.51		0.0	100.0		
#4	4.76	14.7	2.1	97.9		
#8	2.38	41.0	5.9	94.1		
#10	2	50.7	7.3	92.7		
#20	0.85	178.4	25.5	74.5		
#40	0.42	507.3	72.5	27.5		
#60	0.25	626.2	89.5	10.5		
#100	0.149	658.5	94.2	5.8		
#200	0.074	666.5	95.3	4.7		
#270	0.053	667.0	95.4	4.6		

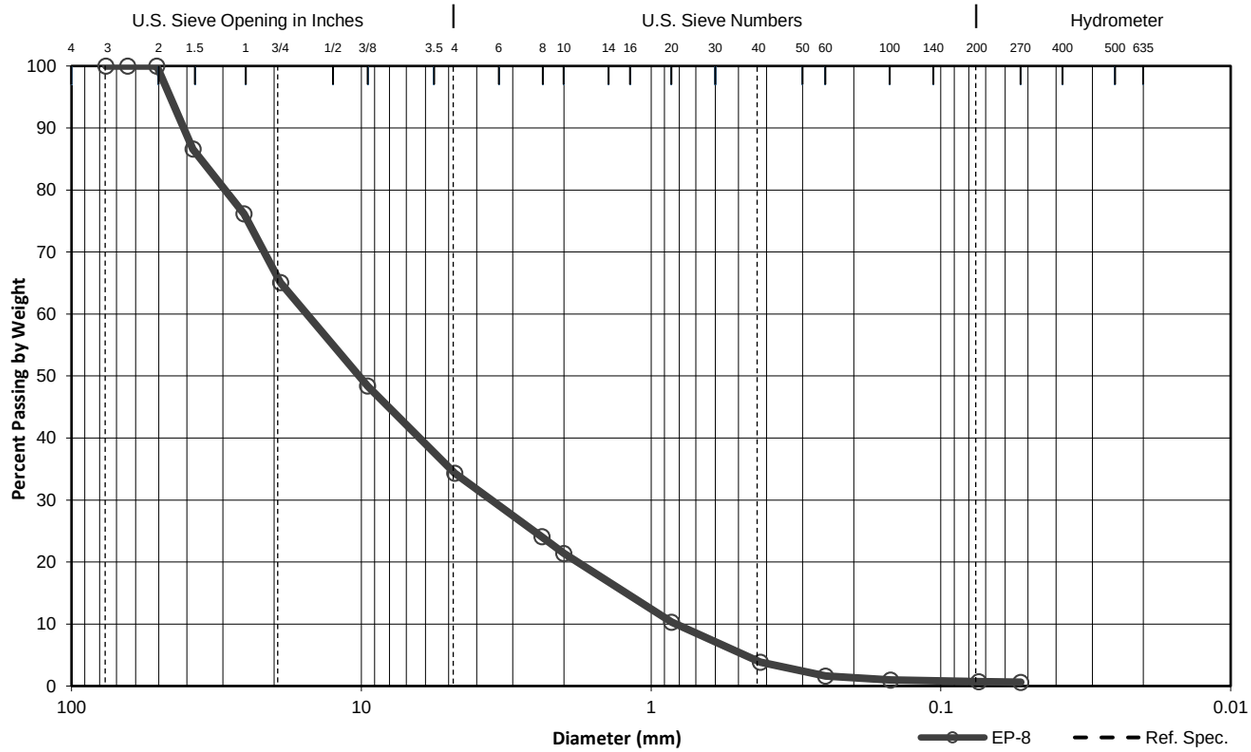
associated earth sciences incorporated

GRAIN SIZE ANALYSIS - MECHANICAL ASTM D422

Project Name	Project Number	Date Sampled	Date Tested	Tested By
Burdette-Blueberry Lane	**KE080683B**	**5/4/2016**	**5/5/2016**	**MS**

Sample Source	Sample No.	Depth (ft)	Soil Description
Onsite	**EP-8**	**5**	**very sandy GRAVEL, trace silt (GP)**

Total Sample Dry Wt. (g)	Moisture Content (%)	D_{10} (mm)	Reference Specification
2911.2	**4**	**0.822**	



Cobb.	Gravel		Sand			Silt or Clay
	Coarse	Fine	Coarse	Medium	Fine	

Sieve No.	Diam. (mm)	Cum. Wt. Ret. (g)	% Ret. by Wt.	% Passing by Wt.	% Specs. Pass. by Wt.	
					Min	Max
3	76.1		0.0	100.0		
2.5	64		0.0	100.0		
2	50.8		0.0	100.0		
1.5	38.1	389.6	13.4	86.6		
1	25.4	693.8	23.8	76.2		
3/4	19	1016.6	34.9	65.1		
3/8	9.51	1502.6	51.6	48.4		
#4	4.76	1911.0	65.6	34.4		
#8	2.38	2210.1	75.9	24.1		
#10	2	2288.4	78.6	21.4		
#20	0.85	2611.3	89.7	10.3		
#40	0.42	2798.8	96.1	3.9		
#60	0.25	2864.2	98.4	1.6		
#100	0.149	2882.6	99.0	1.0		
#200	0.074	2891.1	99.3	0.7		
#270	0.053	2893.3	99.4	0.6		