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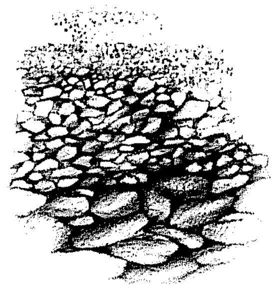

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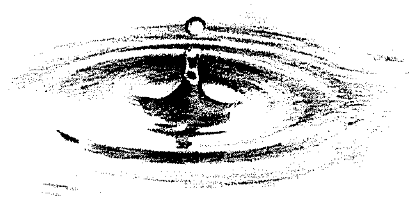

Water Resources

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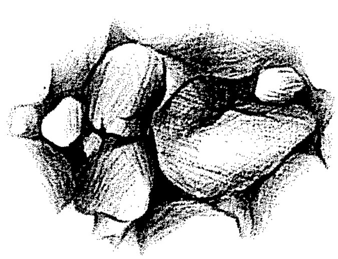
Sustainable Development Services



Geologic Assessments

Subsurface Exploration, Geologic Hazard, and Preliminary Geotechnical Engineering Report

RIO VISTA - LOT 18

Duvall, Washington

Prepared for

Rio Vista, LLC

Project No. KE060691D
August 7, 2008

Associated Earth Sciences, Inc.

Celebrating Over 25 Years of Service

August 7, 2008
Project No. KE060691D

Rio Vista, LLC
P.O. Box 1282
Bellevue, Washington 98009-1282

Attention: Mr. Mike Reid

Subject: Subsurface Exploration, Geologic Hazard, and Preliminary Geotechnical Engineering Report
Rio Vista, Lot 18
26854 NE 143rd Place
Duvall, Washington

Dear Mr. Reid:

We are pleased to present the enclosed copies of the referenced report. This report summarizes the results of our subsurface exploration, geologic hazard, and preliminary geotechnical engineering studies and offers recommendations for the preliminary design and development of the proposed project. Our recommendations are preliminary in that project plans are still under development at the time of this report.

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

FOR

Jesse P. Overton, P.G.
Project Geologist

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SUBSURFACE EXPLORATION, GEOLOGIC HAZARD, AND PRELIMINARY GEOTECHNICAL ENGINEERING REPORT

RIO VISTA
LOT 18

Duvall, Washington

Prepared for:
Rio Vista, LLC
P.O. Box 1282
Bellevue, Washington 98009-1282

Prepared by:
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August 7, 2008
Project No. KE060691D

I. PROJECT AND SITE CONDITIONS

1.0 INTRODUCTION

This report presents the results of our subsurface exploration, geologic hazard, and preliminary geotechnical engineering study for the proposed short-plat development. Our recommendations are preliminary in that project plans are still under development at the time of our exploration and preparation of this report. The location of the project site is shown on the "Vicinity Map," Figure 1. The existing site conditions and approximate locations of the explorations accomplished for this study are presented on the "Site and Exploration Plan," Figure 2. If there are any substantial changes in the nature, design, or location of the proposed development, 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 used in the preliminary design of the project. Our study included a review of selected geologic literature, excavating exploration pits, and performing geologic studies to assess the type, thickness, distribution, and physical properties of the subsurface sediments and shallow ground water conditions. Preliminary geotechnical engineering studies were completed to formulate our recommendations for site preparation, site grading, home construction, drainage, and paving. This report summarizes our current fieldwork and offers development recommendations based on our present understanding of the project. We recommend that we be allowed to review project plans prior to construction to verify that our geotechnical recommendations have been correctly interpreted and incorporated into the design. Additional exploration or design modifications/review may be required to finalize project documentation.

1.2 Authorization

Verbal authorization to proceed with this study was granted by Mr. Mike Reid of Rio Vista, LLC during our office meeting on August 16, 2007. Our study was accomplished in general accordance with our written proposal and scope of work for geotechnical services dated July 23, 2007. This report has been prepared for the exclusive use of Rio Vista, LLC and their agents, for specific application to this project.

Within the limitations of scope, schedule, and budget, our services have been performed in accordance with generally accepted geotechnical engineering and engineering geology practices in effect in this area at the time our report was prepared. No other warranty, express or implied, is made.

2.0 PROJECT AND SITE DESCRIPTION

This report was completed with an understanding of the project based on the boundary and topographic survey prepared by ESM Consulting Engineers, LLC (ESM) dated August 10, 2006 and our conversations with Mr. Mike Reid. It is our understanding that the existing residence and outbuildings will be demolished and replaced with a short-plat development consisting of an undetermined number of dwelling units.

The project site is located over 3.52 acres within Township 26N, Range 6E, Section 13 at 27066 NE 143rd Place in Duvall, King County, Washington. The site is bordered to the east, west and north by private, residential lots, and to the south by NE 143rd Place. Site topography is relatively flat with a very slight downward grade towards the northeast.

At present, the site supports one single-family residence with a detached garage and shop outbuilding across the west side of the property with driveway access from NE 143rd Place. Vegetation across the property consists of native field grass, a few stands of blackberry vines, and a small orchard of fruit trees in the southwest corner of the property.

3.0 SUBSURFACE EXPLORATION

Our field study included the excavation of two exploration pits to gain 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. The depths indicated on the logs where conditions changed may represent gradational variations between sediment types in the field.

The conclusions and recommendations presented in this report are based on the two exploration pits completed for this study. The number, locations, and depths of the explorations were completed within site and budgetary constraints. 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 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. 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 Test Pits

The exploration pits were excavated using a rubber-tired backhoe under sub-contract to our firm. The pits permitted direct, visual observation of subsurface conditions. Materials encountered in the exploration pits were studied and classified in the field by an engineering geologist from our firm. All exploration pits were backfilled immediately after examination and logging. Selected samples were then transported to our laboratory for further visual classification and testing, as necessary.

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 geologic literature. As shown on the field logs, the explorations encountered a surficial layer of topsoil over dense till soils.

4.1 Stratigraphy

Topsoil

We encountered a thin, surficial layer of topsoil within each of our exploration pits EP-6 and EP-7. The topsoil generally consisted of loose, moist, dark brown, silty sand rich with organic material. We observed the topsoil to a maximum depth of 8 inches. This unit is not considered suitable for the support of foundations and should be removed from the foundation areas.

Lodgement Till

Natural sediments encountered below the topsoil consisted of medium dense to very dense, medium to fine grained sand with variable amounts of silt, gravel, and cobbles with occasional boulders. These sediments were interpreted to be representative of Vashon lodgement till. Vashon lodgement till consists of an unsorted mixture of silt, sand, gravel, and cobbles that was deposited by basal, debris-laden glacial ice during the Vashon Stade of the Fraser Glaciation approximately 12,500 to 15,000 years ago. Lodgement till typically possesses high strength and low compressibility attributes that are favorable for support of foundations, floor slabs, and paving with proper preparation. The high relative density characteristic of Vashon lodgement till is due to its consolidation by the massive weight of the glacial ice from which it was deposited. In the areas such as the subject site, where Vashon lodgement till sediments are exposed at or near the ground surface, the density of the upper several feet of the Vashon lodgement till typically becomes reduced to a loose to medium dense state by weathering. Where the weathering process rendered these soils loose, the weathered till is not suitable for direct foundation support, but may be suitable for reuse as structural fill provided it can be properly moisture conditioned and compacted to project specifications.

Our interpretations of subsurface conditions on-site are consistent with a published geologic map of the area (*Geologic Map of King County, Washington,* by Booth, Haugerud, and Sackett, 2002).

4.2 Hydrology

No ground water was encountered in any of our exploration pits at the time of our site exploration. It should be noted that fluctuations in the level of ground water may occur due to the time of the year and variations in rainfall, and may occur randomly from fill/disturbed soil layers.

II. GEOLOGIC HAZARDS AND MITIGATIONS

The following discussion of potential geologic hazards is based on the geologic, slope, and shallow ground water conditions as observed and discussed herein.

5.0 SEISMIC HAZARDS AND RECOMMENDED MITIGATION

Earthquakes occur in the Puget Lowland with great regularity. The vast majority of these events are small and are usually not felt. However, large earthquakes do occur as evidenced by the 1949, 7.2-magnitude event; the 1965, 6.5-magnitude event; and the 2001, 6.8-magnitude event. The 1949 earthquake appears to have been the largest in this area during recorded history and was centered in the Olympia area. Evaluation of earthquake return rates in the Puget Sound area indicates that an earthquake of the magnitude between 5.5 and 6.0 will likely occur every 25 to 40 years in the Puget Sound area.

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.

5.1 Surficial Ground Rupture

The nearest known fault trace to the project site is the Seattle Fault located approximately 12 miles to the south. Recent studies by the U.S. Geological Survey (USGS) (e.g., Johnson et al., 1994, *Origin and Evolution of the Seattle Fault and Seattle Basin, Washington,* Geology, v. 22, pp. 71-74; and Johnson et al., 1999, *Active Tectonics of the Seattle Fault and Central Puget Sound Washington - Implications for Earthquake Hazards*, Geological Society of America Bulletin, July 1999, v. 111, n. 7, pp. 1042-1053) have provided evidence of surficial ground rupture along a northern splay of the Seattle Fault. The recognition of this fault splay is relatively new, and data pertaining to it are limited, with the studies still ongoing. According to the USGS studies, the latest movement of this fault was about 1,100 years ago when about 20 feet of surficial displacement took place. This displacement can presently be seen in the form of raised, wave-cut beach terraces along Alki Point in West Seattle and Restoration Point at the south end of Bainbridge Island. The recurrence interval of movement along this fault system is still unknown, although it is hypothesized to be in excess of several thousand years. Due to the suspected long recurrence interval, the potential for surficial ground rupture is considered to be low during the expected life of the proposed structures.

5.2 Seismically Induced Landslides

Based upon the relatively flat topography across the site, it is our opinion that the potential risk of damage to the proposed dwellings by seismically induced landsliding is low provided the recommendations contained herein are properly followed.

5.3 Liquefaction

Liquefaction is a condition that occurs when loose, saturated sand is subjected to a high intensity, cyclic loading (such as an earthquake) and it loses its shear strength. The encountered stratigraphy has a low potential for liquefaction due to its relatively dense, consolidated state and lack of adverse ground water conditions.

5.4 Ground Motion

Based on the encountered stratigraphy and our visual reconnaissance of the site, it is our opinion that earthquake damage to the proposed dwellings, when founded on a suitable bearing stratum in accordance with the recommendations presented in this report, would likely be caused by the intensity and acceleration associated with the event.

Guidelines presented in the 2006 *International Building Code* (IBC) standards using a Site Class "C" designation, as defined in Table 1613.5.2, were used. The 2006 IBC seismic design parameters for short period (S_S) and 1-second period (S_1) spectral acceleration values were determined by the latitude and longitude of the project site using the USGS National Seismic Hazard Mapping Project website (http://earthquake.usgs.gov/hazmaps/). Based on the 2002 data, the USGS website interpolated ground motions at the project site for the period of 0.2 seconds at 1.018 and for a 1-second period at 0.33, with a 2 percent chance of exceedence in 50 years.

6.0 EROSION HAZARDS AND MITIGATION

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 weekly turbidity monitoring of storm water leaving the site for all sites 1 or more acres in size that discharge storm water to surface waters of the state. The TESC inspections and turbidity monitoring must be completed by a Certified Erosion and Sediment Control Lead (CESCL) for the duration of the construction. TESC reports and weekly turbidity levels do not need to be sent to Ecology, but should be logged into the project Storm Water Pollution Prevention Plan (SWPPP). If the project does not require a SWPPP, the TESC reports should be kept in a file on-site, or by the permit holder if there is no facility on-site. Ecology requires a monthly summary report of the turbidity monitoring results (if performed) signed by the NPDES permit holder. If the monitored turbidity equals or exceeds 25 nephelometric turbidity units (NTUs) (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 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 within 24 hours and corrective action taken. Daily turbidity monitoring is continued until the corrective action lowers the turbidity to below 25 NTU.

In order to meet the current Ecology requirements, a properly developed, constructed, and maintained erosion control plan consistent with the City of Duvall standards and best management erosion control practices will be required for this project. Associated Earth Sciences, Inc. (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 erosion hazard of the site soils is high. 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.

Flow-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 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.

Some fine-grained surface soils are the result of natural weathering processes that have broken down parent materials into their mineral components. These mineral components can have an inherent electrical charge. Electrically charged mineral fines will attract oppositely charged particles and can combine (flocculate) to form larger particles that will settle out of suspension.

The sediments produced during the recent glaciation of Puget Sound are, however, most commonly the suspended soils that are carried by site storm water. The fine-grained fraction of the glacially derived soil is referred to as "rock flour," which is primarily a silt-sized particle with no electrical charge. These particles, once suspended in water, may have settling times in periods of months, not hours.

Therefore, the flow length within a temporary sediment control trap or pond has virtually no effect on the water quality of the discharge since it is not going to settle out of suspension in the time it takes to flow from one end of the pond to the other. Reduction of turbidity from a construction site is almost entirely a function of cover measures and flow control. 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.

6.1 Erosion Hazard Mitigation

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

1. Surface water should not be allowed to flow across the site over unprotected surfaces.

2. Silt fences should be placed and maintained around the perimeter of the proposed construction area throughout the entire construction phase of the project until permanent landscaping and permanent storm water collection facilities have been installed.

3. 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 necessarily limited to, covering with plastic sheeting, the use of low stockpiles in flat areas behind the residence, or the use of straw bales and/or additional silt fences around pile perimeters. Soils should not be stockpiled on the steeply sloping portions of the lot.

4. Areas stripped of natural vegetation during construction should be replanted and mulched as soon as possible or otherwise protected.

5. All storm water from impermeable surfaces, including driveways and roofs, should be permanently tightlined to a suitable storm water collection system.

6. A rocked construction entrance should be provided for truck traffic onto and off the site.

III. PRELIMINARY DESIGN RECOMMENDATIONS

7.0 INTRODUCTION

Our exploration indicates that, from a geotechnical standpoint, the proposed project is feasible provided the recommendations contained herein are properly followed. The bearing stratum appears relatively shallow across the property; therefore, we recommend the use of standard spread footing foundations to support the new structures.

8.0 SITE PREPARATION

Any existing buildings, paving, buried utilities, and any other structures should be removed from areas where structures or paving are planned. Any existing underground heating oil storage tanks (USTs) should be emptied, inerted, and removed in accordance with Ecology requirements and the resulting excavation backfilled with structural fill. AESI can assist the owner with proper UST abandonment, sampling, contaminated soil remediation (in the unlikely event that contamination is encountered), and State-required documentation.

Adequate TESCs should be constructed in accordance with City of Duvall requirements and the project civil engineering TESC design. We recommend that the project contractor work together with the design team and the City of Duvall to design, install, and maintain the erosion control measures. It is easier and much less costly to keep fine-grained soils in place than it is to remove suspended sediment from site storm runoff.

Site preparation of planned structural fill, building, and paving areas should include removal of all trees, brush, landscaping, debris, and any other deleterious material. Additionally, the upper, organic topsoil should be removed and the remaining roots grubbed. One should refer to topsoil thicknesses depicted on the exploration logs in the Appendix for specific observed values. Topsoil materials will "swell" some 20 to 30 percent upon excavation. Project stripping volume estimates should include this swell factor. Areas where loose surficial soils exist below finished grade due to demolition or grubbing operations should be considered as fill to the depth of disturbance and treated as subsequently recommended for structural fill placement. Topsoil should be processed and reused as topsoil, if allowed by the project plans and specifications, or should be removed from the site or used as fill in non-structural areas. If some minor settlement can be tolerated, the topsoil could be placed as fill in non-structural areas as long as it is free of stumps and roots larger than 3 inches in diameter and is compacted to a firm and unyielding condition in lifts, as described for structural fill. We should be involved in the planning of the location and thickness of all fill and should observe the placement and compaction operations.

8.1 Site Drainage and Surface Water Control

Adequate temporary and permanent control of surface water runoff will be required in order to allow site access and grading for construction of the new buildings, access driveways, installation of underground utilities, and other proposed improvements. Excavation, filling, subgrade, and grade preparation should be performed in a manner and sequence that will provide controlled drainage at all times and proper control of erosion. Surface water should be collected and pumped or drained to provide a suitable working platform. Successful drainage of wet zones due to ground water flow and accumulations of surface water runoff could be accomplished by ditching and/or the installation of cut-off trenches or "French" drains, where necessary.

The site should be graded to prevent water from ponding in construction areas and/or flowing into excavations. Exposed grades should be crowned, sloped, and smooth-drum rolled at the end of each day to facilitate drainage. Accumulated water must be removed from subgrades and work areas immediately prior to performing further work in the area. Equipment access may be limited, and the amount of soil rendered unfit for use as structural fill may be greatly increased if drainage efforts are not accomplished in a timely sequence. If an effective drainage system is not utilized, project delays and increased costs could be incurred due to the greater quantities of wet and unsuitable fill, or poor access and unstable conditions.

Final exterior grades should promote free and positive drainage away from the building at all times. Water must not be allowed to pond or to collect adjacent to foundations or within the immediate building area. We recommend that a gradient of at least 3 percent for a minimum distance of 10 feet from the building perimeters be provided, except in paved locations. In paved locations, a minimum gradient of 1 percent should be provided unless provisions are included for collection and disposal of surface water adjacent to the structures.

8.2 Wet Weather Conditions

If construction proceeds during an extended wet weather construction period and the moisture-sensitive, silty site soils become wet, they will become unstable. Therefore, the bids for site grading operations should be based upon the time of year that construction will proceed. Construction during wet weather is expected to require protection of subgrades in staging and construction areas, as recommended in the "Subgrade Protection" section of this report. It is expected that in wet conditions, additional soils may need to be removed and/or other stabilization methods used, such as a coarse, crushed rock working mat to develop a stable condition if silty subgrade soils are disturbed in the presence of excess moisture. The severity of construction problems will be dependent, in part, on the precautions that are taken by the contractor to protect the moisture- and disturbance-sensitive site soils. If overexcavation is necessary, it should be confirmed through continuous observation and testing by a representative of our firm. The site contractor should provide properly surfaced access roads to fill areas. Maintenance and reconstruction of access roads will be necessary. Daily "sealing" of fill surfaces and drainage improvements is required. It is the contractor's responsibility to keep silt-laden runoff to a minimum by protecting exposed subgrades and maintaining erosion control measures.

8.3 Subgrade Protection

The site soils that are expected below the building pad and paving subgrades contain a significant silt fraction and are considered to be moisture- and disturbance-sensitive. These soils will become unstable if disturbed by construction equipment while at elevated moisture contents, requiring additional soil removal at an increased cost. Therefore, in addition to the recommendations presented in the "Site Drainage and Surface Water Control" section of this report, site preparation and initial construction activities should be planned to minimize disturbance to the existing ground surface, particularly during extended wet weather periods and the wet season (typically October through May). Construction traffic should be restricted to specific rock-surfaced drive areas to limit the area where disturbance of the subgrade will occur. If site stripping and grading activities are performed during extended dry weather periods, we anticipate that site stabilization requirements will be much less.

If construction will proceed in the winter, we recommend the use of a temporary working surface of sand and gravel, crushed rock, or quarry spalls to protect the silty soils, particularly in areas supporting concentrated equipment traffic. In winter construction staging areas, a minimum thickness of 12 inches of quarry spalls or 18 inches of pit run sand and gravel is recommended. If subgrade conditions are soft and silty, a geotextile separation fabric, such as Mirafi 500x or approved equivalent, should be used between the subgrade and the new fill. For building pads where floor slabs and foundation construction will be completed in the winter, a similar working surface, composed of at least 12 inches of pit run sand and gravel or crushed rock, should be used. Construction of working surfaces from advancing fill pads could be used to avoid directly exposing the subgrade soils to vehicular traffic. Similar minimum (or greater) sections will be required for temporary access road construction.

Foundation subgrades may require protection from foot and equipment traffic, and ponding of runoff during wet weather conditions. Typically, compacted crushed rock or a lean-mix concrete mat placed over a properly prepared subgrade provides adequate subgrade protection. Foundation concrete should be placed and excavations backfilled as soon as possible to protect the bearing grade.

8.4 Proof-Rolling and Subgrade Compaction

Following the recommended demolition, site stripping procedures, and required excavation to grade, the stripped subgrade within the building and pavement areas should be proof-rolled with heavy, rubber-tired construction equipment, such as a fully loaded, tandem-axle dump truck. Proof-rolling should be performed prior to structural fill placement or foundation excavation. The proof-roll should be observed by the geotechnical engineer so that any soft or yielding subgrade soils can be identified. Any soft/loose, yielding soils should be removed to a stable subgrade. The subgrade should then be scarified, adjusted in moisture content, and recompacted to the required density. Proof-rolling should only be attempted if soil moisture contents are at or near optimum moisture content. Proof-rolling of wet subgrades could result in further degradation. Low areas and excavations may then be raised to the planned finished grade with compacted structural fill. Subgrade preparation and selection, placement, and compaction of structural fill should be performed under engineering-controlled conditions in accordance with the project specifications.

8.5 Overexcavation/Stabilization

Construction during extended wet weather periods could create the need to overexcavate exposed soils if they become disturbed and cannot be recompacted due to elevated moisture content and/or weather conditions. During dry weather periods, soft/wet soils, which may need to be overexcavated, may be encountered in some portions of the site. If necessary, this should be confirmed through continuous observation and testing by AESI. Soils that have become unstable may require remedial measures in the form of one or more of the following:

1. Drying and recompaction. Selective drying may be accomplished by scarifying or windrowing surficial material during extended periods of dry and warm weather.

2. Removal of affected soils to expose a suitable bearing subgrade and replacement with compacted structural fill.

3. Mechanical stabilization with a coarse, crushed aggregate compacted into the subgrade, possibly in conjunction with a geotextile.

4. Admixture stabilization with cement powder. Admixture design and installation procedures need to be reviewed and approved by the design team and City prior to site use.

8.6 Temporary and Permanent Cut Slopes

In our opinion, stable construction slopes should be the responsibility of the contractor and should be determined during construction. For estimating purposes, however, we anticipate that temporary, unsupported cut slopes in the upper, weathered till section should not exceed a slope of 1.5H:1V (Horizontal:Vertical). Unsupported cut slopes within the unsaturated till at depth can be made at a maximum slope of 1H:1V or flatter. As is typical with earthwork operations, some sloughing and raveling may occur, and cut slopes may have to be adjusted in the field. If ground water seepage is encountered in cut slopes or if surface water is not routed away from temporary cut slope faces, flatter slopes will be required. In addition, WISHA/OSHA regulations should be followed at all times. Permanent cut and structural fill slopes that are not intended to be exposed to surface water should be designed at inclinations of 2H:1V or flatter. Slopes that are intended to be exposed to surface water, such as bioswale side slopes, if planned, should be designed at inclinations of 3H:1V or flatter. All permanent cut or fill slopes should be compacted to at least 95 percent of the modified Proctor maximum dry density, as determined by *American Society for Testing and Materials* (ASTM):D 1557, and the slopes should be protected from erosion by sheet plastic until vegetation cover can be established during favorable weather.

8.7 Frozen Subgrades

If earthwork takes place during freezing conditions, all exposed subgrades should be allowed to thaw and then be recompacted prior to placing subsequent lifts of structural fill or foundation components. Alternatively, the frozen material could be stripped from the subgrade to reveal unfrozen soil prior to placing subsequent lifts of fill or foundation components. The frozen soil should not be reused as structural fill until allowed to thaw and adjusted to the proper moisture content, which may not be possible during winter months.

9.0 STRUCTURAL FILL

Structural fill may be necessary to establish desired grades. All references to structural fill in this report refer to subgrade preparation, fill type, 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/engineering geologist, the upper 12 inches of exposed ground should be recompacted to 90 percent of ASTM:D 1557. If the subgrade contains 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 ASTM:D 1557. In the case of roadway and utility trench filling, the backfill should be placed and compacted in accordance with City of

Duvall codes and standards. The top of the compacted fill should extend horizontally outward a minimum distance of 3 feet beyond the location of the perimeter footings or roadway edges before sloping down at a maximum angle of 2H:1V.

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 of filling activities 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. The on-site, native till soils contain substantial amounts of silt and fine sand and are considered highly moisture-sensitive when excavated and used as fill materials. We anticipate that all excavated site soils will require aeration and drying prior to compaction in structural fill applications. 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 and with at least 25 percent retained on the No. 4 sieve.

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 and at least 25 percent retained on the No. 4 sieve.

10.0 HOUSE FOUNDATIONS

Spread footings may be used for building support when founded upon the native, at least medium dense till soils prepared as recommended in this report. Based on our observations, suitable foundation bearing soils are expected approximately 2 feet below the existing ground surface. If existing fill is discovered around existing structures, it should be removed and replaced with structural fill, which is also suitable for foundation support.

The footings for the proposed dwelling units may be designed for an allowable foundation soil bearing pressure of 2,500 pounds per square foot (psf) including both dead and live loads. An increase of one-third may be used for short-term wind or seismic loading. Perimeter footings should be buried at least 18 inches into the surrounding soil for frost protection. However, all foundation elements must penetrate to the prescribed bearing stratum and no foundation elements should be constructed in or above loose, organic, or existing fill soils.

Anticipated settlement of footings founded as recommended should be on the order of ¾ inch or less, with differential settlement of ½ inch or less. However, disturbed material not removed from footing trenches prior to footing placement could result in increased settlements. All footing areas should be inspected by AESI prior to placing concrete to verify that the foundation subgrades are undisturbed and construction conforms to the recommendations contained in this report. Such inspections may be required by City of Duvall. Perimeter footing drains should be provided as discussed under the section on "Drainage Considerations."

It should be noted that the area bounded by lines extending downward at 1H:1V from any footing must not intersect another footing or intersect a filled area which has not been compacted to at least 95 percent of ASTM:D 1557. In addition, a 1.5H:1V line extending down and away from any footing must not daylight because sloughing or raveling may eventually undermine the footing. Thus, footings should not be placed near the edge of steps or cuts in the bearing soils.

11.0 FLOOR SUPPORT

We anticipate the use of concrete, slab-on-grade floors within the proposed dwelling units. The concrete, slab-on-grade floor should be cast atop a minimum of 4 inches of pea gravel to act as a capillary break. The floors should also be protected from dampness by covering the capillary break layer with an impervious moisture barrier at least 10 mils in thickness. Floor slabs may be supported by native soils.

12.0 DRAINAGE CONSIDERATIONS

All retaining and perimeter footing walls should be provided with a drain at the footing elevation. Drains should consist of rigid, perforated, polyvinyl chloride (PVC) pipe surrounded by washed pea gravel or drain rock. The level of the perforations in the pipe should be set approximately 2 inches below the bottom of the footing and should be constructed with sufficient gradient to allow gravity discharge away from the buildings. In addition, all retaining walls should be lined with a minimum, 12-inch-thick, washed gravel or washed crushed rock blanket provided over the full height of the wall that ties into the footing drain. Roof and surface runoff should not be discharged 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 structures to achieve surface drainage.

13.0 PROJECT DESIGN AND CONSTRUCTION MONITORING

At the time of this report, site grading, structural plans, and construction methods have not been finalized, and the recommendations presented herein are preliminary. 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 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 foundations for buildings and of new pavement 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 the 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.

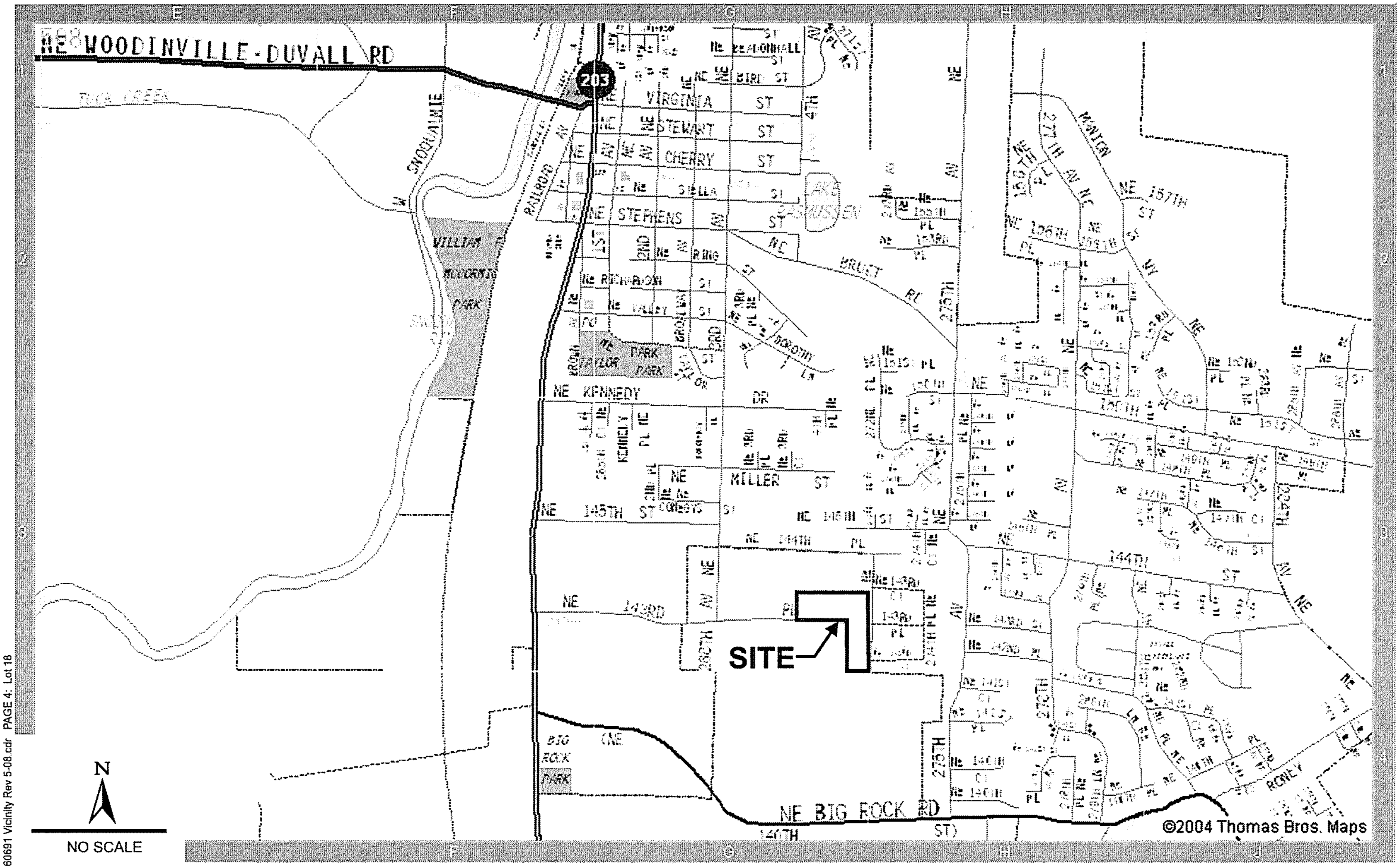
Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Kirkland, Washington

MATTHEW A. MILLER
STATE OF WASHINGTON
30284
REGISTERED
PROFESSIONAL ENGINEER
8-7-08

Jesse P. Overton, P.G.
Project Geologist

Matthew A. Miller, P.E.
Associate Engineer

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



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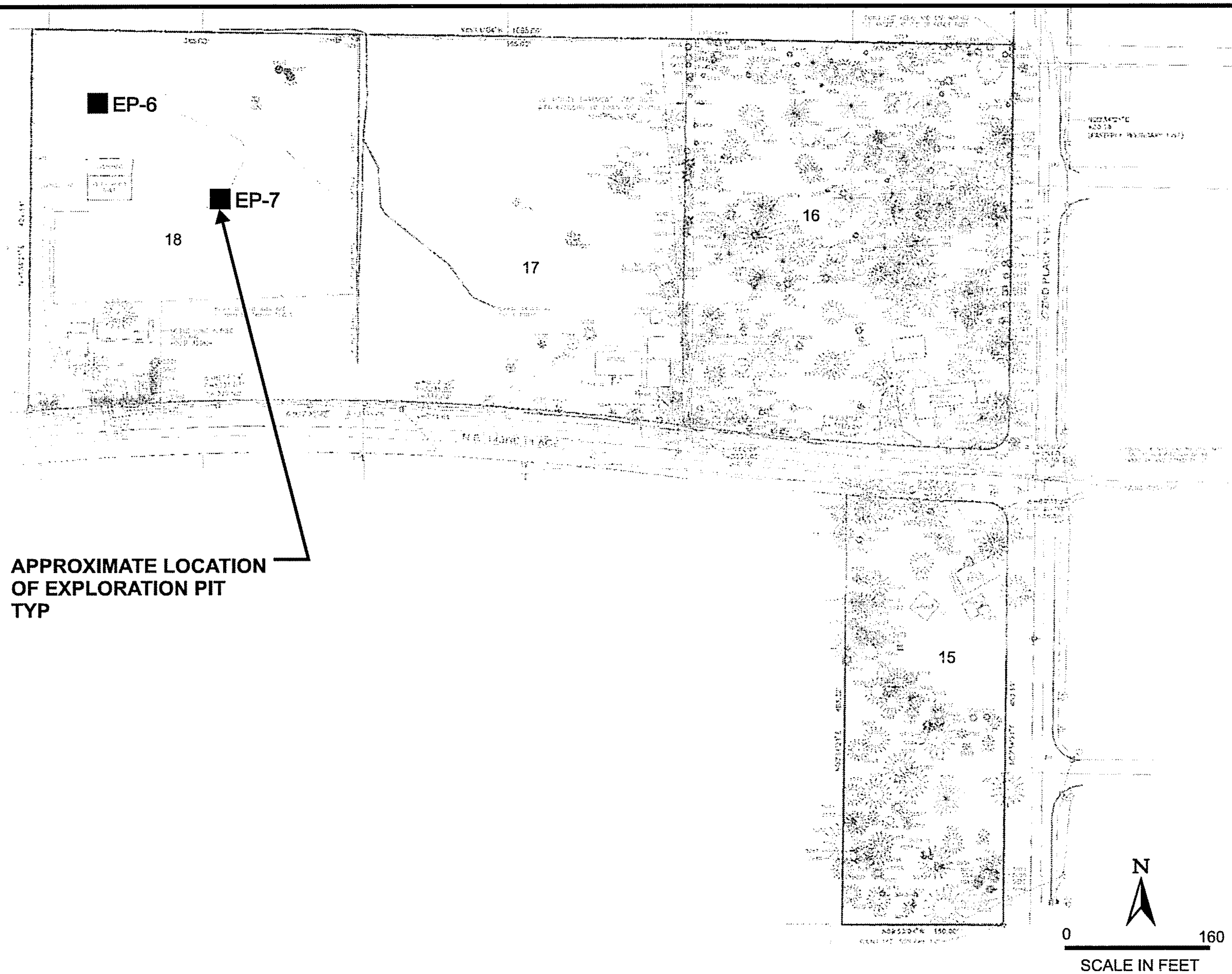
VICINITY MAP
RIO VISTA - LOT 18
DUVALL, WASHINGTON

FIGURE 1
DATE 5/08
PROJ. NO. KE060691D



Reference: ESM

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SITE AND EXPLORATION PLAN
RIO VISTA - LOT 18
DUVALL, WASHINGTON

FIGURE 2

DATE 5/08

PROJ. NO. KE060691D

060691 Rio Vista Lots 15-18 \ 060691 Site and Explr-D-Rev 5-08.cdr

APPENDIX

Major Division	Subdivision	Fines	Symbol	Description
Coarse-Grained Soils - More than 50%[1] Retained on No. 200 Sieve	Gravels - More than 50%[1] of Coarse Fraction Retained on No. 4 Sieve	≤5% Fines[5]	GW	Well-graded gravel and gravel with sand, little to no fines
			GP	Poorly-graded gravel and gravel with sand, little to no fines
		≥15% Fines[5]	GM	Silty gravel and silty gravel with sand
			GC	Clayey gravel and clayey gravel with sand
	Sands - 50%[1] or More of Coarse Fraction Passes No. 4 Sieve	≤5% Fines[5]	SW	Well-graded sand and sand with gravel, little to no fines
			SP	Poorly-graded sand and sand with gravel, little to no fines
		≥15% Fines[5]	SM	Silty sand and silty sand with gravel
			SC	Clayey sand and clayey sand with gravel
Fine-Grained Soils - 50%[1] or More Passes No. 200 Sieve	Silts and Clays Liquid Limit Less than 50		ML	Silt, sandy silt, gravelly silt, silt with sand or gravel
			CL	Clay of low to medium plasticity; silty, sandy, or gravelly clay, lean clay
			OL	Organic clay or silt of low plasticity
	Silts and Clays Liquid Limit 50 or More		MH	Elastic silt, clayey silt, silt with micaceous or diatomaceous fine sand or silt
			CH	Clay of high plasticity, sandy or gravelly clay, fat clay with sand or gravel
			OH	Organic clay or silt of medium to high plasticity
Highly Organic Soils			PT	Peat, muck and other highly organic soils

Terms Describing Relative Density and Consistency

	Density	SPT[2] blows/foot
Coarse-Grained Soils	Very Loose	0 to 4
	Loose	4 to 10
	Medium Dense	10 to 30
	Dense	30 to 50
	Very Dense	>50

	Consistency	SPT[2] blows/foot
Fine-Grained Soils	Very Soft	0 to 2
	Soft	2 to 4
	Medium Stiff	4 to 8
	Stiff	8 to 15
	Very Stiff	15 to 30
	Hard	>30

Test Symbols

G = Grain Size
M = Moisture Content
A = Atterberg Limits
C = Chemical
DD = Dry Density
K = Permeability

Component Definitions

Descriptive Term	Size Range and Sieve Number
Boulders	Larger than 12"
Cobbles	3" to 12"
Gravel	3" to No. 4 (4.75 mm)
Coarse Gravel	3" to 3/4"
Fine Gravel	3/4" to No. 4 (4.75 mm)
Sand	No. 4 (4.75 mm) to No. 200 (0.075 mm)
Coarse Sand	No. 4 (4.75 mm) to No. 10 (2.00 mm)
Medium Sand	No. 10 (2.00 mm) to No. 40 (0.425 mm)
Fine Sand	No. 40 (0.425 mm) to No. 200 (0.075 mm)
Silt and Clay	Smaller than No. 200 (0.075 mm)

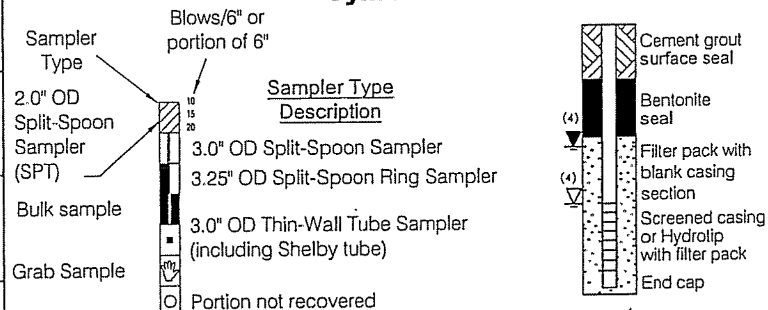
[3] Estimated Percentage

Component	Percentage by Weight
Trace	<5
Few	5 to 10
Little	15 to 25
With	- Non-primary coarse constituents: ≥ 15% - Fines content between 5% and 15%

Moisture Content

Dry - Absence of moisture, dusty, dry to the touch
Slightly Moist - Perceptible moisture
Moist - Damp but no visible water
Very Moist - Water visible but not free draining
Wet - Visible free water, usually from below water table

Symbols



(1) Percentage by dry weight
(2) (SPT) Standard Penetration Test (ASTM D-1586)
(3) In General Accordance with Standard Practice for Description and Identification of Soils (ASTM D-2488)
(4) Depth of ground water
▼ ATD = At time of drilling
▽ Static water level (date)
(5) Combined USCS symbols used for fines between 5% and 15%

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.

blocks\log_key.dwg LAYOUT: Layout2

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EXPLORATION LOG KEY

FIGURE A1

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**
	Topsoil
1	Medium dense, moist, brown, silty fine SAND, trace gravel.
2	**Vashon Till**
3	Dense, moist, gray, silty SAND, little gravel.
4	Dense, moist, gray, fine to medium SAND, little gravel, little silt, trace cobbles.
5	
6	
7	
8	Very dense, moist, gray, silty SAND, little gravel.
9	
10	
11	Bottom of exploration pit at depth 10 feet
12	
13	
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17	
18	
19	
20	

KCTP3 060691D.GPJ May 20, 2008

Rio Vista, Lot 18
Duvall, WA

Associated Earth Sciences, Inc.

Logged by: JPO

Approved by:

Project No. KE060691D

9/5/07

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**
	Topsoil
1	**Vashon Till** Dense, moist, gray, silty fine to medium SAND, little gravel, trace cobbles.
2	
3	
4	
5	
6	More dense with depth.
7	
8	
9	Bottom of exploration pit at depth 8 feet Very difficult digging.
10	
11	
12	
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19	
20	

Rio Vista, Lot 18
Duvall, WA

Associated Earth Sciences, Inc.

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Approved by:

Project No. KE060691D

9/5/07