E3RA

Geotechnical Engineering Report
Smokey Point Ambulatory Center
3809 172nd Street NE
Arlington, Washington

Submitted to:

Cascade Valley Hospital
c/o Marc Estvold, Inc., AIA
3302 Oakes Avenue
Anacortes, Washington 98221

Submitted by:

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August 2, 2010

E10008

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Subject: **Geotechnical Engineering Report**
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Dear Mr. Estvold:

E3RA is pleased to submit this report describing the results of our geotechnical engineering evaluation for the Smokey Point Ambulatory Center. The site is located at 3809 172nd Street NE in the Smokey Point area of Arlington, Washington.

This report has been prepared for the exclusive use of Cascade Valley Hospital and their consultants, for specific application to this project, in accordance with generally accepted geotechnical engineering practice.

1.0 SITE AND PROJECT DESCRIPTION

The site is a vacant, rectangular parcel that measures about 340 feet along the north side of the 172nd Street NE alignment and extends north approximately 710 feet. It is bordered by retail shopping and restaurants to the west and south, by open space to the northwest, an old homestead to the east, and by residential housing to the north.

Plans call for construction of an ambulatory medical facility on the south-central part of the site with adjacent paved parking. Paved entry to the site will be gained from the northwest, the southeast, and the southwest. Storm water generated on site will be infiltrated on site. Rain gardens are planned for the east and west boundary areas while an infiltration trench is planned for the north boundary area, immediately south of the right of way for 173rd Street NE. We understand that storm water that will be introduced into the trench near the north boundary will be filtered prior to infiltration so that no pollutants will enter the water table.

It is likely that new ambulatory facility will be constructed slab-on-grade with conventional spread footings.

2.0 EXPLORATORY METHODS

We explored surface and subsurface conditions at the project site on February 10 and July 28, 2010. Our exploration program comprised the following elements:

- A surface reconnaissance of the site;
- Seven hand borings (designated HB-1 through HB-7), advanced on site; and
- Three geotechnical auger borings (designated B-1 through B-3), with ground water monitor wells, advanced on site; and
- A review of published geologic and seismologic maps and literature.

Table 1 summarizes the approximate functional locations and termination depths of our subsurface explorations, and Figure 2 depicts their approximate relative locations. The following sections describe the procedures used for excavation of test pits.

TABLE 1
APPROXIMATE LOCATIONS AND DEPTHS OF EXPLORATIONS

Exploration	Functional Location	Termination Depth (feet)
HB-1	Southeast site	7
HB-2	East-central site	7
HB-3	Northwest site, in area of planned infiltration	7½
B-1	Northwest site, near area of planned infiltration	11½
B-2	West-central site, near area of planned infiltration	11½
B-3	West –central site, near area of planned infiltration	11½

The specific number and locations of our explorations were selected in relation to the existing site features, under the constraints of surface access, underground utility conflicts, and budget considerations. We estimated the relative location of each exploration. Consequently, the data listed in Table 1 and the locations depicted on Figure 2 should be considered accurate only to the degree permitted by our data sources and implied by our measuring methods.

It should be realized that the explorations performed and utilized for this evaluation reveal subsurface conditions only at discrete locations across the project site and that actual conditions in other areas could vary. Furthermore, the nature and extent of any such variations would not become evident until additional explorations are performed or until construction activities have begun. If significant variations are observed at that time, we may need to modify our conclusions and recommendations contained in this report to reflect the actual site conditions.

2.1 Auger Boring Procedures

Our exploratory borings were advanced through the soil with a hollow-stem auger, using a track-mounted drill rig operated by an independent drilling firm working under subcontract to E3RA. A geologist from our firm continuously observed the borings, logged the subsurface conditions, and collected representative soil samples. All samples were stored in airtight containers and later transported to a laboratory for further visual examination. After each boring was completed, the borehole was backfilled with bentonite chips. The soils were classified visually in general accordance with the system described in Figure A-1, which includes a key to the exploration logs. Summary logs of the explorations are included as Figures A-5 and A-11.

Throughout the drilling operation, soil samples were obtained at 5-foot depth intervals by means of the Standard Penetration Test (SPT) per American Society for Testing and Materials (ASTM) D-1586. This testing and sampling procedure consists of driving a standard 2-inch-diameter steel split-spoon sampler 18 inches into the soil with a 140-pound hammer free-falling 30 inches. The number of blows required to drive the sampler through each 6-inch interval is counted, and the total number of blows struck during the final 12 inches is recorded as the Standard Penetration Resistance, or "SPT blow count." If a total of 50 blows are struck within any 6-inch interval, the driving is stopped and the blow count is recorded as 50 blows for the actual penetration distance. The resulting Standard Penetration Resistance values indicate the relative density of granular soils and the relative consistency of cohesive soils.

The enclosed boring logs describe the vertical sequence of soils and materials encountered in our borings, based primarily on our field classifications and supported by our subsequent laboratory examination and testing. Where a soil contact was observed to be gradational, our logs indicate the average contact depth. Where a soil type changed between sample intervals, we inferred the contact depth. Our logs also graphically indicate the blow count, sample type, sample number, and approximate depth of each soil sample obtained from the borings, as well as any laboratory tests performed on these soil samples. If any groundwater was encountered in the boreholes, the approximate groundwater depth is depicted on the boring logs. Groundwater depth estimates are typically based on the moisture content of soil samples, the wetted height on the drilling rods, and the water level measured in the boreholes after the auger has been extracted.

2.2 Hand Boring Procedures

Our exploratory hand borings were advanced by an E3RA geologist using a shovel and 3-inch hand auger. The enclosed hand boring logs describe the vertical sequence of soils and materials encountered in our hand boring, based on our field classification. Where a soil contact was observed to be gradational or undulating, our logs indicate the average contact depth. Our logs also indicate the approximate depth of any sidewall caving or groundwater seepage observed in the boring. Soils were classified visually in general accordance with the system described in Figure A-1, which includes a key to the exploration logs. Summary logs of the explorations are included as Figures A-2 and A-4.

2.3 Infiltration Test Procedures

Falling head tests were performed in general accordance with the procedures listed in the EPA publication *On-site Wastewater Treatment and Disposal Systems, 1980.* A hole was excavated down to the infiltration layer using a shovel and post hole digger. A 6-inch-diameter PVC pipe was tamped into the soil of the upper part of the infiltration layer, then rock was placed at the bottom of the pipe to prevent scouring. Soil was placed and tamped outside the pipe for stabilization and to prevent upwelling of test water around the pipe. The pipe was then filled twice with 1 foot of water to pre-saturate the test soils. Because, in all cases, 1 foot of water infiltrated the test soils in less than 10 minutes, as stipulated by the EPA publication, further saturation was deemed unnecessary and the infiltration test proceeded. The pipe was then filled with 6 inches of water, and, because site soils were found to be rapidly permeable, the time required for infiltration of the entire 6 inch column of water was recorded.

3.0 SITE CONDITIONS

The following sections present our observations, measurements, findings, and interpretations regarding, surface, soil, groundwater, seismic, and liquefaction conditions.

3.1 Surface Conditions

The site and surrounding areas are relatively level. It lies 3 to 4 feet lower than a retail complex, adjacent to the west, where grades have been raised.

Vegetation consists of high grass, dense black berry thickets, scotch broom, scattered smaller alders and cottonwoods, and scattered small to moderately large Douglas Firs. A small cedar grows mid-site and a small stand of firs extends north approximately 200 feet from 172nd Street NE.

No streams, ponds or other indicators of surface hydrology were observed. No seeps, springs, or other surface expressions of groundwater were noted. No erosional features were observed.

A small pile of concrete rubble and a small pile of old tires were observed on the northwest part of the site. An old concrete cistern or septic structure was observed on the southeast part of the site.

3.2 Soil Conditions

Our onsite explorations revealed that soil stratigraphy is relatively uniform across the site. Generally, we observed 6 to 12 inches of sod and topsoil overlying, to a depth of 2 to 2½ feet, loose, silty, fine to medium sand. Below the loose silty sand, we observed loose to medium dense, relatively fines-free, fine to medium recessional glacial outwash sand with varying amounts of gravel. The fines-free sand became somewhat more coarse and gravelly below a depth of 5 feet, and extended to the termination of all of our explorations, which ranged in depth from 4½ to 11½ feet.

Our hand borings, HB-1 through HB-3, conducted on February 10, 2010, which were located in the southeast, east-central, and northwest parts of the site, met refusal on coarse gravel at depths of 7 to 7½ feet and HB-7, conducted on July 28, 2010, met refusal on a rock at 4½ feet.

The attached exploration logs provide a detailed description of the soil strata encountered in our subsurface explorations.

3.3 Groundwater Conditions

At the time of our first site reconnaissance and subsurface explorations (February 10, 2010), we encountered groundwater at a depth of 7½ feet in our three auger borings, located on the west and north parts of the site, and in hand boring HB-3, located on the northwest part of the site. Groundwater was encountered at a depth of 7 feet in hand boring HB-1, located on the southeast part of the site. Groundwater was not encountered in hand boring HB-2, located on the east-central part of the site, which extended to a depth of 7 feet.

We monitored the water levels in our three monitor wells from the date o installation, February 10, 2010, and through the "rainy season" until May 26, 2010. The results of our well monitoring are presented below in Table 2.

TABLE 2 GROUNDWATER LEVELS			
Date	Feet Below Surface, B-1	Feet Below Surface, B-2	Feet Below Surface, B-3
2/10/2010	7.5	7.5	7.5
2/26/2010	7.1	6.8	6.8
3/18/1010	7.6	7.2	7.2
4/9/2010	7.3	6.9	6.9
5/26/2010	7.55	7.25	7.25

Rainfall during this past winter in the Arlington area was somewhat dry of normal, while spring rainfall was at normal or somewhat wet of normal levels. We estimate that the seasonally high groundwater level during wet winter and spring seasons, based on the levels recorded above, to be about 6 feet.

3.4 Seismic Conditions

Based on our analysis of subsurface exploration logs and our review of published geologic maps, we interpret the onsite soil conditions to correspond with site class D, as defined by Table 1613.5.2 of the 2009 *International Building Code (IBC)*.

3.5 Liquefaction Potential

Liquefaction is a sudden increase in pore water pressure and a sudden loss of soil shear strength caused by shear strains, as could result from an earthquake. Research has shown that saturated, loose, fine to medium sands with a fines (silt and clay) content less than about 20 percent are most susceptible to liquefaction. Our soil boring logs indicate that soils within the water table, where soils are saturated, are consolidated to a medium dense condition, so will likely not liquefy. However, should liquefaction occur, we expect it would be restricted to discontinuous and isolated zones with little or no expression at the ground surface.

3.6 Infiltration Conditions

Generally, the upper 2 to 2½ feet of soils observed on the site, which consist of a mantle of topsoil overlying silty fine sand, are not recommended for infiltration. Underlying the topsoil and silty sand, we encountered very permeable, relatively fines-free sand with varying amounts of gravel. This layer extends down to the water table and will provide a good medium for infiltration.

We collected samples depths of 3½ to 4 feet from the relatively fines-free sand layer from four of the explorations conducted on February 10, 2010. We also collected samples from the same layer from our July 28 borings, at depths ranging from 2½ to 4 feet, in the locations of the planned rain gardens. We performed Grain Size analyses on some of the samples. Our analyses generally indicate that native soils at infiltration depth across the site, including the vicinity of the rain gardens, consist of fine to medium sand or fine to medium gravelly sand with a fines content that ranges from 2 to 5 percent and with a D_{10} that ranges from 0.14 to 0.18.

According to the Table 3.8, Volume III of the DOE's 2005 *Stormwater Management Manual for Western Washington*, which uses D_{10} size from grain size analyses to determine the long term infiltration rate for soils, the relatively fines-frees sand layer that underlies the site at depths greater than 2 to 2½ feet has a Design Infiltration Rate of 2 inches per hour. We recommend using this rate for the rain gardens that are planned for the site.

TABLE 3
LABORATORY TEST RESULTS FOR NON-ORGANIC ONSITE SOILS

Soil Sample, Depth Sampled, Infiltration Area	% Coarse Gravel	% Fine Gravel	% Coarse Sand	% Medium Sand	% Fine Sand	% Fines	D_{10}
B-1, G-1, 3½ - 4 feet, North area	0	3	6	34	54	3	0.14
HB-3, G-1, 3½ - 4 feet, North area	15	5	20	20	38	2	0.18
B-2, G-1, 3½ - 4 feet, West area	0	17	23	25	30	5	0.15
B-3, G-1, 3½ - 4 feet, West area	0	1	2	18	76	3	0.16
HB-4, S-1, 3 feet, East rain garden	12	15	23	18	30	3	0.17
HB-7, S-1, West rain garden	12	4	15	18	49	3	0.15

We performed two falling head infiltration tests in the alignment of the infiltration trench planned near the north boundary. Our tests were conducted below the silty sand layer, at depths of a bit less than 3 feet. The results of our tests are presented in Table 4.

TABLE 4
FIELD INFILTATION TEST RESULTS

Test Number	Location	Depth of Test	Field Infiltration Rate for 6 inch Column
IT-1	East end north boundary trench	33 inches	2 min 42 sec/6 inches
IT-2	West end north boundary trench	35 inches	3min 48 sec/6 inches

The maximum Field Infiltration Rate recognized in most jurisdictions is 60 inches/hour, which, as the test results in Table 4 indicate, is the field infiltration rate value that should be used for calculating a Design Infiltration Rate for the trench. We recommend that a Factor of Safety of 4 be applied to the field rate, in order to address long-term plugging that might occur within the trench. Based on these values, we recommend a Design Infiltration Rate of 15 inches per hour for the trench, provided that the trench invert lies beneath the upper silty sand layer, which generally underlies the site at depths of 2½ feet, and if storm water is adequately filtered before infiltration. We strongly recommend that, both during construction and afterwards, when the trench is in operation, that care is taken to prevent silty sand from entering the infiltration trench invert.

4.0 CONCLUSIONS AND RECOMMENDATIONS

Plans call for construction of an ambulatory medical facility on the south-central part of the site with adjacent paved parking. Storm water generated on site will be infiltrated on site. An infiltration trench is planned for the north boundary area, immediately south of the right of way for 173rd Street NE, while rain gardens are planned for other boundary areas. We understand that storm water that will be introduced into the trench near the north boundary will be filtered prior to infiltration so that no pollutants will enter the water table. We offer the following general geotechnical conclusions and recommendations concerning this project.

- Feasibility: Based on our field explorations, research, and analyses, the proposed development appears feasible from a geotechnical standpoint, provided that the recommendations in Section 4 and in this report are followed.
- Foundation Options: We recommend conventional spread footings that bear on subgrades consisting of the medium dense or denser soils. Soils can be somewhat loose at the likely foundation elevation, so they should be vigorously surface compacted to a firm and non-yielding condition before forms are placed. Recommendations for spread footings are provided in Section 4.2.

- Floor Options: Subgrades for slab on grade floors can be somewhat loose at likely floor subgrade elevation, so they should be vigorously surface compacted to a firm and non-yielding condition before the floor section is placed. Recommendations for slab-on-grade floors are included in Section 4.3.

- Pavement Sections: We recommend a pavement section comprised of an asphalt concrete over a crushed rock base course. Pavement subbases do not generally appear necessary, but subgrade compaction to a firm condition before the base course is placed will be necessary. Pavement recommendations are presented in Section 4.5.

- Infiltration Conditions: Storm water should be infiltrated into the relatively fines-free sand that underlies the site at depths of 2 to 2½ feet. If invert elevations for the planned infiltration facilities are planned at an elevation within the silty fine sand layer that overlies the infiltration layer, the overlying silty sand should be over-excavated down to the fines-free sand and replaced with drain rock.

  Based on our grain size analyses, we recommend a Design Infiltration Rate of 2 inches per hour for the rain gardens. Based on our falling head infiltration testing, we recommend a Design Infiltration Rate of 15 inches per hour for the infiltration trench planned for the north edge of the site, provided that the storm water is adequately filtered prior to infiltration. We strongly recommend that, both during construction and afterwards, when the trench is in operation, that care is taken to prevent silty sand from entering the infiltration invert area.

- Groundwater Mounding: Based on the estimated level of seasonally high groundwater, the thickness of the infiltration layer is somewhat less than the 5 to 6 feet recommended in most of the storm water management manuals currently used in Western Washington.

  However, it is our opinion that the potential for groundwater mounding under the north trench and the rain gardens in other boundary areas is low. We base this opinion on two factors. The first factor is the rapid infiltration rate measured in the field during our falling head tests. Because of this, the rapidly permeable soil that underlies the site will also have a high rate of hydraulic conductivity, so groundwater will redistribute horizontally very rapidly. The second factor is the geometry of the planned facilities. The planned trench is long and narrow, and the planned rain gardens are not particularly wide. Narrow infiltration facilities are markedly less susceptible to groundwater mounding than those which are wide and equi-dimensional.

The following sections of this report present our specific geotechnical conclusions and recommendations concerning site preparation, spread footings, slab-on-grade floors, drainage, and structural fill. The Washington State Department of Transportation (WSDOT) Standard Specifications and Standard Plans cited herein refer to WSDOT publications M41-10, *Standard Specifications for Road, Bridge, and Municipal Construction*, and M21-01, *Standard Plans for Road, Bridge, and Municipal Construction*, respectively.

4.1 Site Preparation

Preparation of the project site should involve erosion control, temporary drainage, clearing, stripping, cutting, filling, excavations, and subgrade compaction.

Erosion Control: Before new construction begins, an appropriate erosion control system should be installed. This system should collect and filter all surface water runoff through silt fencing. We anticipate a system of berms and drainage ditches around construction areas will provide an adequate collection system. Silt fencing fabric should meet the requirements of WSDOT Standard Specification 9-33.2 Table 3. In addition, silt fencing should embed a minimum of 6 inches below existing grade. An erosion control system requires occasional observation and maintenance. Specifically, holes in the filter and areas where the filter has shifted above ground surface should be replaced or repaired as soon as they are identified.

Temporary Drainage: We recommend intercepting and diverting any potential sources of surface or near-surface water within the construction zones before stripping begins. Because the selection of an appropriate drainage system will depend on the water quantity, season, weather conditions, construction sequence, and contractor's methods, final decisions regarding drainage systems are best made in the field at the time of construction. Based on our current understanding of the construction plans, surface and subsurface conditions, we anticipate that curbs, berms, or ditches placed around the work areas will adequately intercept surface water runoff.

Clearing and Stripping: After surface and near-surface water sources have been controlled, the construction areas should be cleared and stripped of sod, duff, and topsoil, and any other organic materials. Our explorations indicate that a ½ foot to 1 foot of sod, topsoil, and, in some areas, duff overlies the site. Stripping is best performed during a period of dry weather.

Site Excavations: Based on our explorations, we expect that excavations will encounter loose to medium dense sandy soils, which can easily be excavated using standard excavation equipment.

Dewatering: Our onsite explorations encountered groundwater at depths of about 7 feet below existing elevations, and the seasonally high water level could rise to an elevation of 6 feet below existing grades. Excavations into the groundwater table might require the use of expensive dewatering equipment, such as well points or sheet piles. However, these are not anticipated at this time. If deeper excavations are planned in the future, please contact E3RA for design of a dewatering system.

Temporary Cut Slopes: All temporary soil slopes associated with site cutting or excavations should be adequately inclined to prevent sloughing and collapse. Temporary cut slopes in site soils should be no steeper than 1½H:1V, and should conform to Washington Industrial Safety and Health Act (WISHA) regulations.

Subgrade Compaction: Exposed subgrades for footings and floors should be compacted to a firm, unyielding state before new concrete or fill soils are placed. Any localized zones of looser granular soils observed within a subgrade should be compacted to a density commensurate with the surrounding soils. In contrast, any organic, soft, or pumping soils observed within a subgrade should be overexcavated and replaced with a suitable structural fill material.

Site Filling: Our conclusions regarding the reuse of onsite soils and our comments regarding wet-weather filling are presented subsequently. Regardless of soil type, all fill should be placed and compacted according to our recommendations presented in the Structural Fill section of this report. Specifically, building pad fill soil should be compacted to a uniform density of at least 95 percent (based on ASTM:D-1557).

Onsite Soils: We offer the following evaluation of these onsite soils in relation to potential use as structural fill:

- *Surficial Organic Soils*: Surficial organic soils, like duff, topsoil, and root-rich soil are *not* suitable for use as structural fill under any circumstances, due to high organic content. Consequently, this material can be used only for non-structural purposes, such as in landscaping areas.
- *Silty Sand*: The silty sand layer, which extends down to depths of 2 to 2½ feet, is currently dry of the optimum moisture content and will need hydration before reuse as structural fill. It is also moisture sensitive, so it will be difficult to reuse during wet weather.
- *Relatively Fines-Free Glacial Outwash Sand*: The recessional glacial outwash sand that underlies the site at depths greater than 2 to 2½ feet is relatively insensitive to moisture content variations and can be reused as structural fill in all but the wettest of weather conditions.

Permanent Slopes: All permanent cut slopes and fill slopes should be adequately inclined to reduce long-term raveling, sloughing, and erosion. We generally recommend that no permanent slopes be steeper than 2H:1V. For all soil types, the use of flatter slopes (such as 2½H:1V) would further reduce long-term erosion and facilitate revegetation.

Slope Protection: We recommend that a permanent berm, swale, or curb be constructed along the top edge of all permanent slopes to intercept surface flow. Also, a hardy vegetative groundcover should be established as soon as feasible, to further protect the slopes from runoff water erosion. Alternatively, permanent slopes could be armored with quarry spalls or a geosynthetic erosion mat.

4.2 Spread Footings

In our opinion, conventional spread footings will provide adequate support for onsite structures onsite if the subgrades are properly prepared.

Footing Depths and Widths: For frost and erosion protection, the bases of all exterior footings should bear at least 18 inches below adjacent outside grades, whereas the bases of interior footings need bear only 12 inches below the surrounding slab surface level. To reduce post-construction settlements, continuous (wall) and isolated (column) footings should be at least 18 and 24 inches wide, respectively.

Bearing Subgrades: Footings should bear on medium dense or denser, undisturbed native soils which have been stripped of surficial organic soils, or on properly compacted structural fill which bears on undisturbed native soils which have been stripped of surficial organic soils. Soils are somewhat loose within a few feet of the surface, so we recommend that all footing subgrades be surface compacted to a firm and unyielding condition.

In general, before footing concrete is placed, any localized zones of loose soils exposed across the footing subgrades should be compacted to a firm, unyielding condition, and any localized zones of soft, organic, or debris-laden soils should be overexcavated and replaced with suitable structural fill.

Subgrade Observation: All footing subgrades should consist of firm, unyielding, native soils or structural fill materials compacted to a density of at least 95 percent (based on ASTM:D-1557). Footings should never be cast atop loose, soft, or frozen soil, slough, debris, existing uncontrolled fill, or surfaces covered by standing water.

Bearing Pressures: In our opinion, for static loading, footings that bear on properly prepared subgrades can be designed for a maximum allowable soil bearing pressure of 2,000 psf. A one-third increase in allowable soil bearing capacity may be used for short-term loads created by seismic or wind related activities.

Footing Settlements: Assuming that structural fill soils are compacted to a medium dense or denser state, we estimate that total post-construction settlements of properly designed footings bearing on properly prepared subgrades will not exceed 1 inch. Differential settlements for comparably loaded elements may approach one-half of the actual total settlement over horizontal distances of approximately 50 feet.

Footing Backfill: To provide erosion protection and lateral load resistance, we recommend that all footing excavations be backfilled on both sides of the footings and stemwalls after the concrete has cured. Either imported structural fill or non-organic onsite soils can be used for this purpose, contingent on suitable moisture content at the time of placement. Regardless of soil type, all footing backfill soil should be compacted to a density of at least 90 percent (based on ASTM:D-1557).

Lateral Resistance: Footings that have been properly backfilled as recommended above will resist lateral movements by means of passive earth pressure and base friction. We recommend using an allowable passive earth pressure of 250 psf and an allowable base friction coefficient of 0.35 for site soils.

4.3 Slab-On-Grade Floors

In our opinion, soil-supported slab-on-grade floors can be used in structures if the subgrades are properly prepared. We offer the following comments and recommendations concerning slab-on-grade floors.

Floor Subbase: Structural fill subbases do not appear to be needed under soil-supported slab-on-grade floors. However, because surficial soils are somewhat loose, surface compaction of slab subgrades to a firm, non-yielding condition will be necessary.

If a subbase is needed, all subbase fill should be compacted to a density of at least 95 percent (based on ASTM:D-1557).

Capillary Break and Vapor Barrier: To retard the upward wicking of moisture beneath the floor slab, we recommend that a capillary break be placed over the subgrade. Ideally, this capillary break would consist of a 4-inch-thick layer of pea gravel or other clean, uniform, well-rounded gravel, such as "Gravel Backfill for Drains" per WSDOT Standard Specification 9-03.12(4), but clean angular gravel can be used if it adequately prevents capillary wicking. In addition, a layer of plastic sheeting (such as Crosstuff, Visqueen, or Moistop) should be placed over the capillary break to serve as a vapor barrier. During subsequent casting of the concrete slab, the contractor should exercise care to avoid puncturing this vapor barrier.

4.4 Drainage Systems

In our opinion, structures should be provided with permanent drainage systems to reduce the risk of future moisture problems. We offer the following recommendations and comments for drainage design and construction purposes.

Perimeter Drains: We recommend that buildings be encircled with a perimeter drain system to collect seepage water. This drain should consist of a 4-inch-diameter perforated pipe within an envelope of pea gravel or washed rock, extending at least 6 inches on all sides of the pipe, and the gravel envelope should be wrapped with filter fabric to reduce the migration of fines from the surrounding soils. Ideally, the drain invert would be installed no more than 8 inches above the base of the perimeter footings.

Subfloor Drains: Based on the groundwater conditions observed in our site explorations, we do not infer a need for subfloor drains.

Discharge Considerations: If possible, all perimeter drains should discharge to a storm sewer system or other suitable location by gravity flow. Check valves should be installed along any drainpipes that discharge to a storm sewer system, to prevent sewage backflow into the drain system.

Runoff Water: Roof-runoff and surface-runoff water should *not* discharge into the perimeter drain system. Instead, these sources should discharge into separate tightline pipes and be routed away from the building to a storm drain or other appropriate location.

Grading and Capping: Final site grades should slope downward away from the buildings so that runoff water will flow by gravity to suitable collection points, rather than ponding near the building. Ideally, the area surrounding the building would be capped with concrete, asphalt, or low-permeability (silty) soils to minimize or preclude surface-water infiltration.

4.5 Asphalt Pavement

Since asphaltic pavements will be used for the driveways and parking areas, we offer the following comments and recommendations for pavement design and construction.

Subgrade Preparation: All soil subgrades should be thoroughly compacted, then proof-rolled with a loaded dump truck or heavy compactor. Any localized zones of yielding subgrade disclosed during this proof-rolling operation should be over excavated to a maximum depth of 12 inches and replaced with a suitable structural fill material. All structural fill should be compacted according to our recommendations given in the Structural Fill section. Specifically, the upper 2 feet of soils underlying pavement section should be compacted to at least 95 percent (based on ASTM D-1557), and all soils below 2 feet should be compacted to at least 90 percent.

Pavement Materials: For the base course, we recommend using imported crushed rock, such as "Crushed Surfacing Top Course" per WSDOT Standard Specification 9-03.9(3). If a subbase course is needed, we recommend using imported, clean, well-graded sand and gravel such as "Ballast" or "Gravel Borrow" per WSDOT Standard Specifications 9-03.9(1) and 9-03.14, respectively.

Conventional Asphalt Sections: A conventional pavement section typically comprises an asphalt concrete pavement over a crushed rock base course. Using the estimated design values stated above, we recommend using the following conventional pavement sections:

Pavement Course	Minimum Thickness Parking Areas	High Traffic Areas
Asphalt Concrete Pavement	2 inches	3 inches
Crushed Rock Base	4 inches	6 inches
Granular Fill Subbase (if needed)	6 inches	12 inches

Compaction and Observation: All subbase and base course material should be compacted to at least 95 percent of the Modified Proctor maximum dry density (ASTM D-1557), and all asphalt concrete should be compacted to at least 92 percent of the Rice value (ASTM D-2041). We recommend that an E3RA representative be retained to observe the compaction of each course before any overlying layer is placed. For the subbase and pavement course, compaction is best observed by means of frequent density testing. For the base course, methodology observations and hand-probing are more appropriate than density testing.

Pavement Life and Maintenance: No asphalt pavement is maintenance-free. The above described pavement sections present our minimum recommendations for an average level of performance during a 20-year design life; therefore, an average level of maintenance will likely be required. Furthermore, a 20-year pavement life typically assumes that an overlay will be placed after about 10 years. Thicker asphalt and/or thicker base and subbase courses would offer better long-term performance, but would cost more initially; thinner courses would be more susceptible to "alligator" cracking and other failure modes. As such, pavement design can be considered a compromise between a high initial cost and low maintenance costs versus a low initial cost and higher maintenance costs.

4.6 Structural Fill

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

Materials: Typical structural fill materials include clean sand, gravel, washed rock, crushed rock, well-graded mixtures of sand and gravel (commonly called "gravel borrow" or "pit-run"), and miscellaneous mixtures of silt, sand, and gravel. Recycled asphalt, concrete, and glass, which are derived from pulverizing the parent materials, are also potentially useful as structural fill in certain applications. Soils used for structural fill should not contain any organic matter or debris, nor any individual particles greater than about 6 inches in diameter.

Fill Placement: Clean sand, gravel, crushed rock, soil mixtures, and recycled materials should be placed in horizontal lifts not exceeding 8 inches in loose thickness, and each lift should be thoroughly compacted with a mechanical compactor.

Compaction Criteria: Using the Modified Proctor test (ASTM:D-1557) as a standard, we recommend that structural fill used for various onsite applications be compacted to the following minimum densities:

Fill Application	Minimum Compaction
Footing subgrade and bearing pad	95 percent
Foundation backfill	90 percent
Slab-on-grade floor subgrade and subbase	95 percent
Asphalt pavement base and subbase	95 percent
Asphalt pavement subgrade (upper 2 feet)	95 percent
Asphalt pavement subgrade (below 2 feet)	90 percent

Subgrade Observation and Compaction Testing: Regardless of material or location, all structural fill should be placed over firm, unyielding subgrades prepared in accordance with the Site Preparation section of this report. The condition of all subgrades should be observed by geotechnical personnel before filling or construction begins. Also, fill soil compaction should be verified by means of in-place density tests performed during fill placement so that adequacy of soil compaction efforts may be evaluated as earthwork progresses.

Soil Moisture Considerations: The suitability of soils used for structural fill depends primarily on their grain-size distribution and moisture content when they are placed. As the "fines" content (that soil fraction passing the U.S. No. 200 Sieve) increases, soils become more sensitive to small changes in moisture content. Soils containing more than about 5 percent fines (by weight) cannot be consistently compacted to a firm, unyielding condition when the moisture content is more than 2 percentage points above or below optimum. For fill placement during wet-weather site work, we recommend using "clean" fill, which refers to soils that have a fines content of 5 percent or less (by weight) based on the soil fraction passing the U.S. No. 4 Sieve.

5.0 RECOMMENDED ADDITIONAL SERVICES

Because the future performance and integrity of the structural elements will depend largely on proper site preparation, drainage, fill placement, and construction procedures, monitoring and testing by experienced geotechnical personnel should be considered an integral part of the construction process. Consequently, we recommend that E3RA be retained to provide the following post-report services:

- Review all construction plans and specifications to verify that our design criteria presented in this report have been properly integrated into the design;
- Prepare a letter summarizing all review comments (if required by the City of Arlington);
- Check all completed subgrades for footings and slab-on-grade floors before concrete is poured, in order to verify their bearing capacity; and
- Prepare a post-construction letter summarizing all field observations, inspections, and test results (if required by City of Arlington).

6.0 CLOSURE

The conclusions and recommendations presented in this report are based, in part, on the explorations that we observed for this study; therefore, if variations in the subgrade conditions are observed at a later time, we may need to modify this report to reflect those changes. Also, because the future performance and integrity of the project elements depend largely on proper initial site preparation, drainage, and construction procedures, monitoring and testing by experienced geotechnical personnel should be considered an integral part of the construction process. E3RA is available to provide geotechnical monitoring of soils throughout construction.

We appreciate the opportunity to be of service on this project. If you have any questions regarding this report or any aspects of the project, please feel free to contact our office.

Sincerely,

E3RA, Inc.

Fred Ernest Rennebaum

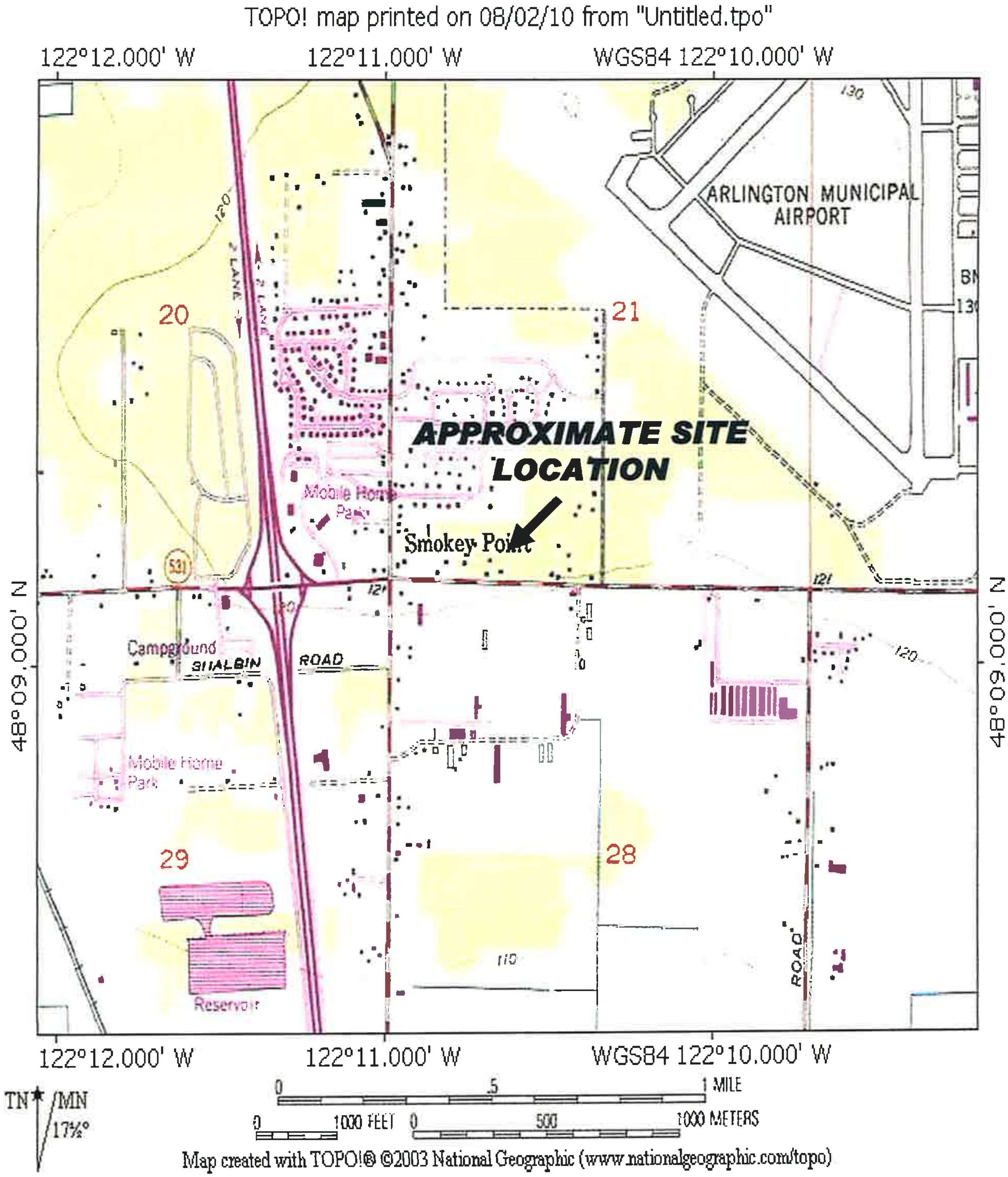
8/2/10

Fred E. Rennebaum, L.E.G.
Senior Geologist

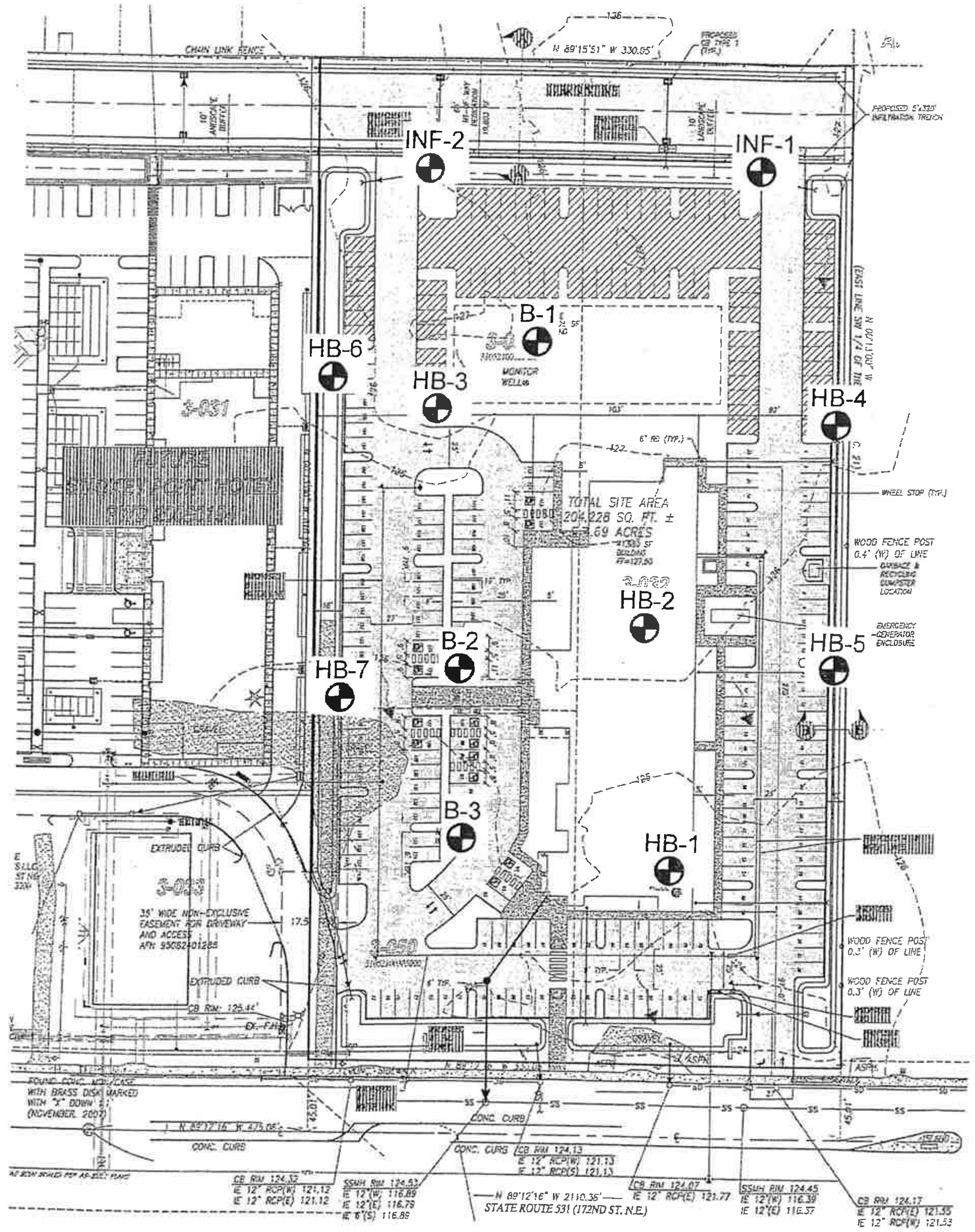
Dean M. White, P.E.
Principal Engineer

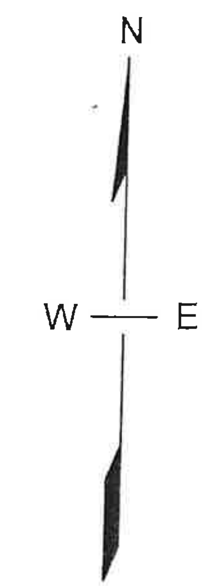
FER:JEB:jb
TACO\\Tacoma-server\c\JOB FILES\everett job files\E10008 KEY PORT AMBULATORY\E10008 Smokey Point Ambulatory Report.doc

Four copies submitted



E3RA, Inc. **9802 29th Ave W Ste B102** **Everett, WA 98204**	SMOKEY POINT AMBULATORY CENTER TOPOGRAPHIC AND LOCATION MAP ARLINGTON, WASHINGTON	**FIGURE 1** **E10008**





INFILTRATION TEST LOCATION

INF-1

HAND BORING LOCATION

HB-1

BORING LOCATION

B-1

NOTE:
BOUNDARY AND TOPOGRAPHY ARE BASED ON MAPPING PROVIDED TO E3RA AND OBSERVATIONS MADE IN THE FIELD. THE INFORMATION SHOWN DOES NOT CONSTITUTE A FIELD SURVEY BY E3RA.

E3RA Inc. 9802 29th Ave. W. Suite B102 Everett, WA 98204 425-356-3372 425-356-3374 fax www.e3ra.com	PROJECT: Smokey Point Ambulatory Center Snohomish County, Washington	
	SHEET TITLE: Site and Exploration Plan	
	DESIGNER: CRL	JOB NO. E10008
	DRAWN BY: CRL	SCALE: 1" = 80
	CHECKED BY: JEB	FIGURE:2
	DATE: July 30, 2010	FILE: Fig 2.dwg

APPENDIX A
SOILS CLASSIFICATION CHART AND KEY TO TEST DATA

LOGS OF EXPLORATIONS

MAJOR DIVISIONS				TYPICAL NAMES
COARSE GRAINED SOILS More than Half > #200 sieve	GRAVELS MORE THAN HALF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES
			GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES
		GRAVELS WITH OVER 15% FINES	GM	SILTY GRAVELS, POORLY GRADED GRAVEL-SAND-SILT MIXTURES
			GC	CLAYEY GRAVELS, POORLY GRADED GRAVEL-SAND-CLAY MIXTURES
	SANDS MORE THAN HALF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE	CLEAN SANDS WITH LITTLE OR NO FINES	SW	WELL GRADED SANDS, GRAVELLY SANDS
			SP	POORLY GRADED SANDS, GRAVELLY SANDS
		SANDS WITH OVER 15% FINES	SM	SILTY SANDS, POOORLY GRADED SAND-SILT MIXTURES
			SC	CLAYEY SANDS, POORLY GRADED SAND-CLAY MIXTURES
FINE GRAINED SOILS More than Half < #200 sieve	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS, OR CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC CLAYS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACIOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS			Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS

⊠ (filled)	Modified California	RV	R-Value
⊠	Split Spoon	SA	Sieve Analysis
■	Pushed Shelby Tube	SW	Swell Test
◧	Auger Cuttings	TC	Cyclic Triaxial
(hand symbol)	Grab Sample	TX	Unconsolidated Undrained Triaxial
■	Sample Attempt with No Recovery	TV	Torvane Shear
CA	Chemical Analysis	UC	Unconfined Compression
CN	Consolidation	(1.2)	(Shear Strength, ksf)
CP	Compaction	WA	Wash Analysis
DS	Direct Shear	(20)	(with % Passing No. 200 Sieve)
PM	Permeability	▽	Water Level at Time of Drilling
PP	Pocket Penetrometer	▼	Water Level after Drilling(with date measured)

SOIL CLASSIFICATION CHART AND KEY TO TEST DATA **Figure A-1**	**E3RA**

E3RA, Inc.
P.O. Box 44840
E3RA Inc. Tacoma, Washington 98448
Telephone: 253-537-9400
Fax: 253-537-9401

BORING NUMBER B-1

CLIENT Cascade Valley Hospital c/o Mark Estvold Inc. AIA
PROJECT NAME Smokey Point Ambulatory Center
PROJECT NUMBER E10008
PROJECT LOCATION Washington
DATE STARTED 2/10/10 **COMPLETED** 2/10/10
GROUND ELEVATION **HOLE SIZE**
DRILLING CONTRACTOR
GROUND WATER LEVELS:
DRILLING METHOD
∇ **AT TIME OF DRILLING** 7.00 ft
LOGGED BY FER **CHECKED BY** DMW
AT END OF DRILLING —
NOTES
AFTER DRILLING —

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY LENGTH (in)	N VALUE	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0						Sod and Topsoil
0.5	SS S-1	18	3-2-1 (3)	SM		(SM) Red-brown silty sand (loose, moist)
2.5						
4.0				SP		(SP) Gray-brown medium sand with trace silt and some gravel (medium dense, moist)
5.0	SS S-2	18	6-10-6 (16)			
7.5						∇
10.0	SS S-3	18	4-6-7 (13)	SP		(SP) Gray gravelly sand with trace silt (medium dense, wet)
11.5						Bottom of borehole at 11.5 feet.

GENERAL BH / TP / WELL - GINT US.GDT - 7/29/10 11:30 - \\TACOMA-SERVER\C\JOB FILES\EVERETT JOB FILES\E10008 KEY PORT AMBULATORY\E10008 BORING LOGS.GPJ

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E[3]RA Inc.

BORING NUMBER B-2

Figure A-10

CLIENT Cascade Valley Hospital c/o Mark Estvold Inc. AIA
PROJECT NAME Smokey Point Ambulatory Center
PROJECT NUMBER E10008
PROJECT LOCATION Washington
DATE STARTED 2/10/10 **COMPLETED** 2/10/10
GROUND ELEVATION **HOLE SIZE**
DRILLING CONTRACTOR
GROUND WATER LEVELS:
DRILLING METHOD
∇ **AT TIME OF DRILLING** 7.00 ft
LOGGED BY FER **CHECKED BY** DMW
AT END OF DRILLING —
NOTES
AFTER DRILLING —

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY LENGTH (in)	N VALUE	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0						Sod and Topsoil
	SS S-1	18	3-2-1 (3)	SM	0.5	(SM) Orange-brown silty sand (loose, moist)
2.5						
5.0	SS S-2	18	5-9-10 (19)	SP	5.0	(SP) Gray-brown medium sand with trace silt (medium dense, moist)
7.5						∇
10.0	SS S-3	18	6-9-9 (18)	SP	10.0	(SP) Gray gravelly sand with trace silt (medium dense, wet)
					11.5	Bottom of borehole at 11.5 feet.

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BORING NUMBER B-3

Figure A-11

CLIENT Cascade Valley Hospital c/o Mark Estvold Inc. AIA
PROJECT NAME Smokey Point Ambulatory Center
PROJECT NUMBER E10008
PROJECT LOCATION Washington
DATE STARTED 2/10/10 **COMPLETED** 2/10/10
GROUND ELEVATION **HOLE SIZE**
DRILLING CONTRACTOR
GROUND WATER LEVELS:
DRILLING METHOD
∇ **AT TIME OF DRILLING** 7.00 ft
LOGGED BY FER **CHECKED BY** DMW
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY LENGTH (in)	N VALUE	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0						Sod and Topsoil
	SS S-1	18	2-2-2 (4)	SM	0.5	(SM) Orange-brown silty sand (loose, moist)
2.5					2.5	(SP) Gray-brown medium sand with trace silt (medium dense, moist)
5.0	SS S-2	12	5-9-9 (18)	SP		
7.5						∇
10.0	SS S-3	12	8-12-10 (22)	SP	10.0	(SP) Gray sandy gravel with trace silt (medium dense, wet)
					11.5	Bottom of borehole at 11.5 feet.

GENERAL BH / TP / WELL - GINT US.GDT - 7/29/10 11:31 - \\TACOMA-SERVER\CJOB FILES\EVERETT JOB FILES\E10008 KEY PORT AMBULATORY\E10008 BORING LOGS.GPJ

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Fax: 253-537-9401

E[3]RA Inc.

BORING NUMBER HB-1

Figure A-2

CLIENT Cascade Valley Hospital c/o Mark Estvold Inc. AIA
PROJECT NAME Smokey Point Ambulatory Center
PROJECT NUMBER E10008
PROJECT LOCATION Washington
DATE STARTED 2/10/10 **COMPLETED** 2/10/10
GROUND ELEVATION **HOLE SIZE**
DRILLING CONTRACTOR
GROUND WATER LEVELS:
DRILLING METHOD
▽ **AT TIME OF DRILLING** 7.00 ft Slow seepage
LOGGED BY FER **CHECKED BY** DMW
AT END OF DRILLING —
NOTES
AFTER DRILLING —

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0			0.5	Sod and Topsoil
		SM	2.5	(SM) Orange-brown silty fine to medium sand (loose, moist)
2.5		SP	5.0	(SP) Gray-brown fine to medium sand with some/trace silt and trace gravel (medium dense, moist)
5.0		SP	7.0 ▽	(SP) Gray-brown gravelly sand with trace silt (medium dense, wet)
				Bottom of borehole at 7.0 feet.

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BORING NUMBER HB-2

Figure A-3

CLIENT Cascade Valley Hospital c/o Mark Estvold Inc. AIA	**PROJECT NAME** Smokey Point Ambulatory Center
PROJECT NUMBER E10008	**PROJECT LOCATION** Washington
DATE STARTED 2/10/10 **COMPLETED** 2/10/10	**GROUND ELEVATION** **HOLE SIZE**
DRILLING CONTRACTOR	**GROUND WATER LEVELS:**
DRILLING METHOD	**AT TIME OF DRILLING** —
LOGGED BY FER **CHECKED BY** DMW	**AT END OF DRILLING** —
NOTES	**AFTER DRILLING** —

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0				Sod and Topsoil
		SM	0.5	(SM) Orange-brown silty fine to medium sand (loose, moist)
2.5		SP	2.5	(SP) Gray-brown fine to medium sand with some/trace silt and trace gravel (medium dense, moist)
5.0		SP	5.0	(SP) Gray-brown gravelly sand with trace silt (medium dense, wet)
			7.0	Bottom of borehole at 7.0 feet.

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BORING NUMBER HB-3

Figure A-4

CLIENT Cascade Valley Hospital c/o Mark Estvold Inc. AIA	**PROJECT NAME** Smokey Point Ambulatory Center
PROJECT NUMBER E10008	**PROJECT LOCATION** Washington
DATE STARTED 2/10/10 **COMPLETED** 2/10/10	**GROUND ELEVATION** **HOLE SIZE**
DRILLING CONTRACTOR	**GROUND WATER LEVELS:**
DRILLING METHOD	▽ **AT TIME OF DRILLING** 7.50 ft Slow seepage
LOGGED BY FER **CHECKED BY** DMW	**AT END OF DRILLING** —
NOTES	**AFTER DRILLING** —

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0			0.5	Sod and Topsoil
		SM	1.5	(SM) Loose, moist, orange brown, silty fine to medium SAND (SM)
2.5		SP	5.0	(SP) Gray brown fine to medium sand with some/trace silt and trace gravel (medium dense)
5.0			7.5 ▽	Gray-brown gravelly sand with trace silt (medium dense, wet)
7.5				Bottom of borehole at 7.5 feet.

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BORING NUMBER HB-4

CLIENT Cascade Valley Hospital c/o Mark Estvold Inc. AIA		**PROJECT NAME** Smokey Point Ambulatory Center	
PROJECT NUMBER E10008		**PROJECT LOCATION** Washington	
DATE STARTED 7/28/10	**COMPLETED** 7/28/10	**GROUND ELEVATION**	**HOLE SIZE**
DRILLING CONTRACTOR		**GROUND WATER LEVELS:**	
DRILLING METHOD		**AT TIME OF DRILLING** —	
LOGGED BY FER	**CHECKED BY** DMW	**AT END OF DRILLING** —	
NOTES		**AFTER DRILLING** —	

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0				10 inches Sod and Topsoil
			0.8	(SM) Orange brown silty fine to medium sand (loose, damp)
		SM		
2.5			2.5	(SP) Gray brown fine to medium sand with trace silt and some gravel (medium dense, damp to moist)
		SP		
5.0				Grades to somewhat gravelly below 5 feet
			6.0	Bottom of borehole at 6.0 feet.

GENERAL BH / TP / WELL - GINT US.GDT - 7/29/10 11:40 - \\TACOMA-SERVER\C\JOB FILES\EVERETT JOB FILES\E10008 KEY PORT AMBULATORY\E10008 HAND BORING LOGS.GPJ

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Fax: 253-537-9401

E[3]RA Inc.

BORING NUMBER HB-5

Figure A-6

CLIENT Cascade Valley Hospital c/o Mark Estvold Inc. AIA
PROJECT NAME Smokey Point Ambulatory Center
PROJECT NUMBER E10008
PROJECT LOCATION Washington
DATE STARTED 7/28/10 **COMPLETED** 7/28/10
GROUND ELEVATION **HOLE SIZE**
DRILLING CONTRACTOR
GROUND WATER LEVELS:
DRILLING METHOD
AT TIME OF DRILLING ---
LOGGED BY FER **CHECKED BY** DMW
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0			0.8	10 inches Sod and Topsoil
		SM	2.5	(SM) Orange brown silty fine to medium sand (loose, damp)
2.5		SP	6.0	(SP) Gray brown fine to medium sand with trace silt gravel (medium dense, damp to moist)
5.0				Grades to somewhat gravelly below 5 feet
				Bottom of borehole at 6.0 feet.

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BORING NUMBER HB-6

Figure A-7

CLIENT Cascade Valley Hospital c/o Mark Estvold Inc. AIA
PROJECT NAME Smokey Point Ambulatory Center
PROJECT NUMBER E10008
PROJECT LOCATION Washington
DATE STARTED 7/28/10 **COMPLETED** 7/28/10
GROUND ELEVATION **HOLE SIZE**
DRILLING CONTRACTOR
GROUND WATER LEVELS:
DRILLING METHOD
AT TIME OF DRILLING —
LOGGED BY FER **CHECKED BY** DMW
AT END OF DRILLING —
NOTES
AFTER DRILLING —

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0			0.3	4 inches compacted Sod and Topsoil
		SM	2.0	(SM) Orange brown silty fine to medium sand with trace gravel (loose, damp)
2.5		SP		(SP) Gray brown fine to medium sand with trace silt and gravel (medium dense, damp to moist)
5.0			6.0	Grades to somewhat gravelly below 5 feet
				Bottom of borehole at 6.0 feet.

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BORING NUMBER HB-7

Figure A-8

CLIENT Cascade Valley Hospital c/o Mark Estvold Inc. AIA
PROJECT NAME Smokey Point Ambulatory Center
PROJECT NUMBER E10008
PROJECT LOCATION Washington
DATE STARTED 7/28/10 COMPLETED 7/28/10
GROUND ELEVATION HOLE SIZE
DRILLING CONTRACTOR
GROUND WATER LEVELS:
DRILLING METHOD
AT TIME OF DRILLING —
LOGGED BY FER CHECKED BY DMW
AT END OF DRILLING —
NOTES
AFTER DRILLING —

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0			0.3	4 inches compacted Sod and Topsoil
		SM	2.0	(SM) Orange brown silty fine to medium sand with trace gravel (loose, damp)
2.5		SP	4.5	(SP) Gray brown fine to medium sand with trace silt and some gravel (medium dense, damp to moist)
				Bottom of borehole at 4.5 feet.

APPENDIX B
LABORATORY TEST RESULTS

Particle Size Analysis Summary Data

Job Name: Key Port Ambulatory
Job Number: E10008
Tested By: dar
Date: 2-12-10
Boring #: B-1
Sample #: G-1
Depth: 3 1/2 - 4

Moisture Content (%)	8.4%

Sieve Size	Percent Passing (%)
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	100.0
3/8 in. (9.5-mm)	97.7
No. 4 (4.75-mm)	96.7
No. 10 (2.00-mm)	91.2
No. 20 (.850-mm)	84.8
No. 40 (.425-mm)	57.2
No. 60 (.250-mm)	26.8
No. 100 (.150-mm)	10.5
No. 200 (.075-mm)	3.2

Size Fraction	Percent By Weight
Coarse Gravel	
Fine Gravel	3.3
Coarse Sand	5.5
Medium Sand	34.0
Fine Sand	54.0
Fines	3.2
Total	100.0

LL ______
PI ______

D10 0.14
D30 0.26
D60 0.46

Cc 1.07
Cu 3.18

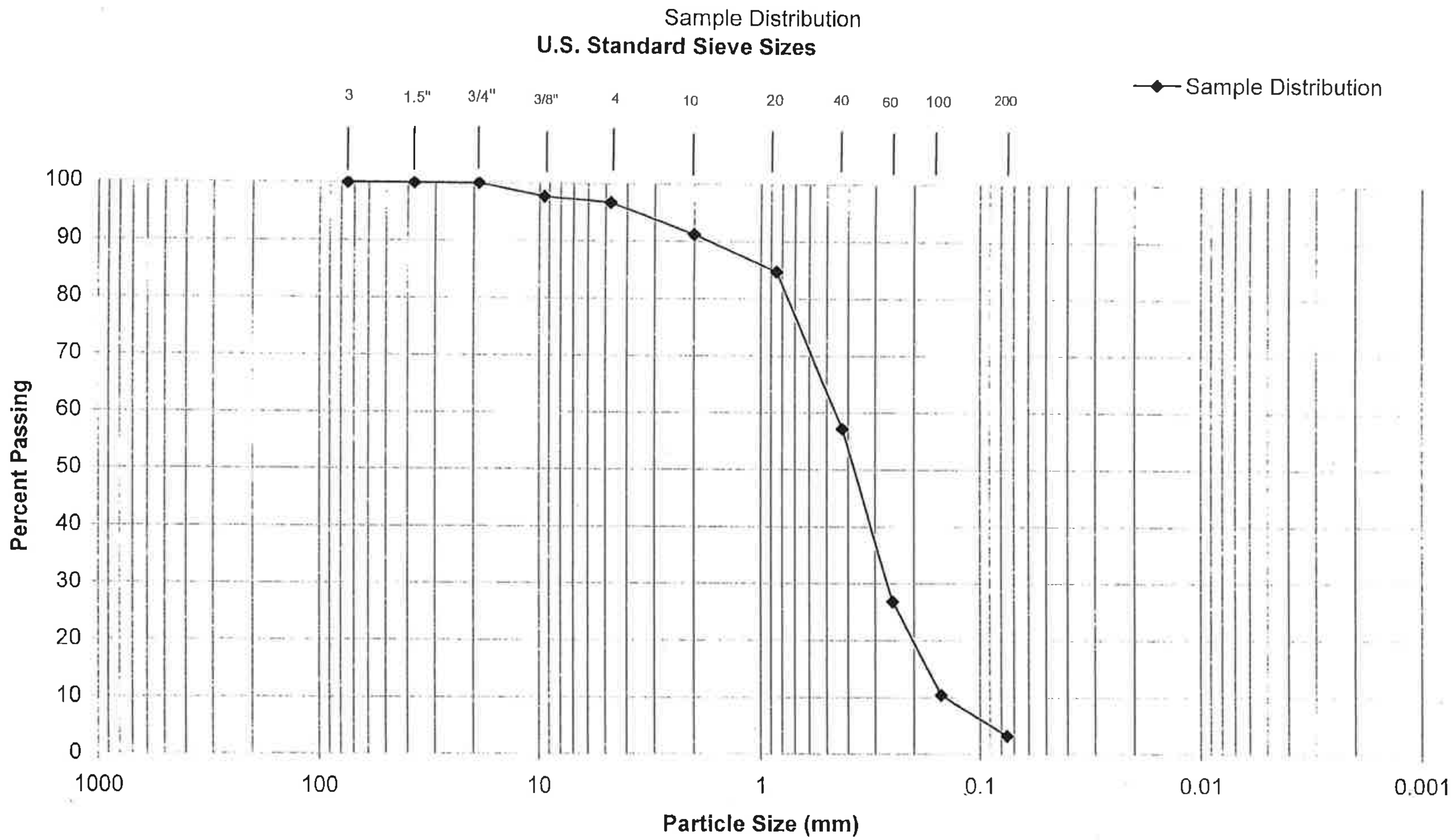
ASTM Classification

Group Name Brown poorly graded sand
Symbol (SP)

E3RA

Figure

Soil Classification Data Sheet



E3RA	Sample Distribution	Job Name:	Key Port Ambulatory	Sample #:	G-1
		Job Number:	E10008	Date:	2-12-10
	Figure:	Tested By:	dar	Depth:	3 1/2 - 4
		Exploration #:	B-1		

Sieve Data

Sieve Size	Cumm. Retained Wt (g)	Corrected Retained wt.(gr)	Percent Passing (%)
3 in. (75-mm)			#VALUE!
1.5in. (37.5-mm)			#VALUE!
3/4 in. (19-mm)		0	#VALUE!
3/8 in. (9.5-mm)		9.19	#VALUE!
No. 4 (4.75mm)		13.22	#VALUE!
No. 10 (2.00-mm)	23.04	#VALUE!	#VALUE!
No. 20 (.850-mm)	50.16	#VALUE!	#VALUE!
No. 40 (.425-mm)	166.04	#VALUE!	#VALUE!
No. 60 (.250-mm)	293.41	#VALUE!	#VALUE!
No. 100 (.150-mm)	362.43	#VALUE!	#VALUE!
No. 200 (.075-mm)	392.85	#VALUE!	#VALUE!
Pan	396.53	#VALUE!	

FRACTIONAL CORRECTION?

- ○ Fractonal Correction Required
- ◉ Fractional Correction Not Required

INCLUDE SPECIFICATION CURVE?

- ◉ No
- ○ Yes

Moisture Content	
Pan #:	9
Pan & Wet Soil:	451.08
Pan & Dry Soil:	416.91
Moisture loss:	#VALUE!
Pan wt:	12.12
Dry soil wt:	#VALUE!
Moisture Content (%)	#VALUE!

-200 Wash	
Pan #:	9
Pan & Dry Soil (Before)	416.91
Pan & Dry Soil (After)	407.43
-200 From Wash	#VALUE!
Pan wt:	12.12
Dry soil wt:	#VALUE!
% of -200	#VALUE!
Total Washed Soil Wt (g)	#VALUE!

Att. Limits

	ML
LL	
PI	

Particle Sizes (mm)

D_{10}	
D_{30}	
D_{60}	
C_c	
C_u	

ASTM Classification

Group Name
Symbol

Job and Sample Data

Job Name: Key Point Ambulatory

Job Number: E 10008

Tested By: DAR

Date:

Boring #: B-1

Sample #: G-1

Depth: 3 1/2 to 4'

Particle Size Analysis Summary Data

Job Name: Key Port Ambulatory
Job Number: E10008
Tested By: dar
Date: 2-12-10
Boring #: B-2
Sample #: G-1
Depth: 3 1/2 - 4

Moisture Content (%)	13.1%

Sieve Size	Percent Passing (%)
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	100.0
3/8 in. (9.5-mm)	91.1
No. 4 (4.75-mm)	82.5
No. 10 (2.00-mm)	59.8
No. 20 (.850-mm)	48.7
No. 40 (.425-mm)	34.9
No. 60 (.250-mm)	20.7
No. 100 (.150-mm)	9.5
No. 200 (.075-mm)	4.8

Size Fraction	Percent By Weight
Coarse Gravel	
Fine Gravel	17.5
Coarse Sand	22.7
Medium Sand	24.9
Fine Sand	30.1
Fines	4.8
Total	100.0

LL ______
PI ______

D10 0.15
D30 0.35
D60 2.01

Cc 0.41
Cu 13.13

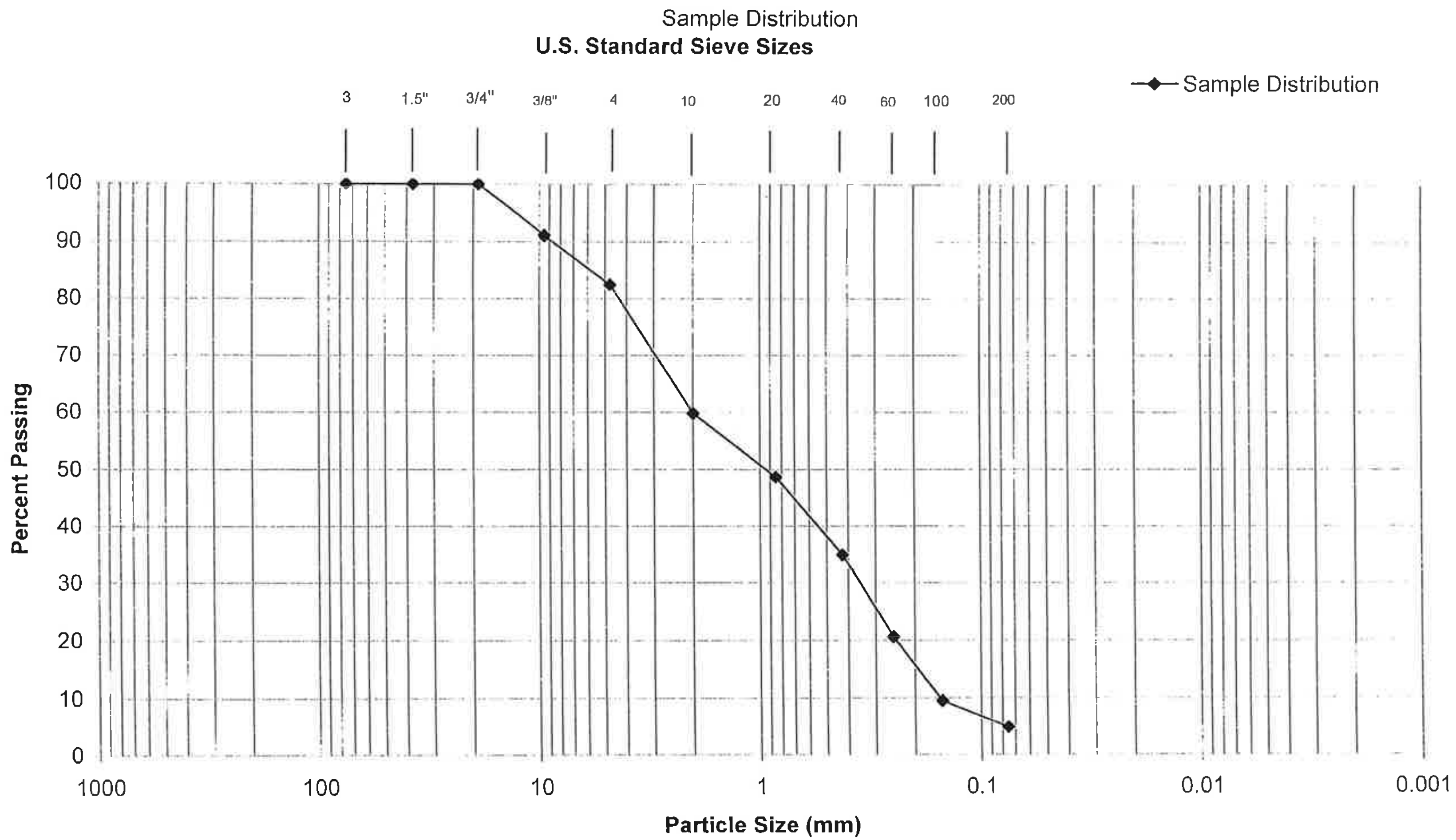
ASTM Classification

Group Name Brown poorly graded sand with gravel
Symbol (SP)

E3RA

Figure

Soil Classification Data Sheet



E3RA	Sample Distribution	Job Name:	Key Port Ambulatory	Sample #:	G-1
		Job Number:	E10008	Date:	2-12-10
	Figure:	Tested By:	dar	Depth:	3 1/2 - 4
		Exploration #:	B-2		

Sieve Data

Sieve Size	Cumm. Retained Wt (g)	Corrected Retained wt.(gr)	Percent Passing (%)
3 in. (75-mm)			#VALUE!
1.5in. (37.5-mm)			#VALUE!
3/4 in. (19-mm)		Ø	#VALUE!
3/8 in. (9.5-mm)		36.36	#VALUE!
No. 4 (4.75mm)		71.67	#VALUE!
No. 10 (2.00-mm)	113.79	#VALUE!	#VALUE!
No. 20 (.850-mm)	169.38	#VALUE!	#VALUE!
No. 40 (.425-mm)	238.67	#VALUE!	#VALUE!
No. 60 (.250-mm)	310.07	#VALUE!	#VALUE!
No. 100 (.150-mm)	365.83	#VALUE!	#VALUE!
No. 200 (.075-mm)	389.35	#VALUE!	#VALUE!
Pan	391.76	#VALUE!	

FRACTIONAL CORRECTION?

- ○ Fractonal Correction Required
- ◉ Fractional Correction Not Required

INCLUDE SPECIFICATION CURVE?

- ◉ No
- ○ Yes

Moisture Content	
Pan #:	8
Pan & Wet Soil:	475.75
Pan & Dry Soil:	422.15
Moisture loss:	#VALUE!
Pan wt:	12.04
Dry soil wt:	#VALUE!
Moisture Content (%)	#VALUE!

-200 Wash	
Pan #:	8
Pan & Dry Soil (Before)	422.15
Pan & Dry Soil (After)	404.27
-200 From Wash	#VALUE!
Pan wt:	18.04
Dry soil wt:	#VALUE!
% of -200	#VALUE!
Total Washed Soil Wt (g)	#VALUE!

Att. Limits

	ML
LL	
PI	

Particle Sizes (mm)

D_{10}	
D_{30}	
D_{60}	
C_c	
C_u	

ASTM Classification

Group Name
Symbol

Job and Sample Data

Job Name: Key Port Ambulatory

Job Number: E 10008

Tested By: DAR Date: 2-12-10

Boring #: B-2

Sample #: G-1 Depth: 3 1/2 - 4'

Particle Size Analysis Summary Data

Job Name: Key Port Ambulatory
Job Number: E10008
Tested By: dar
Date: 2-12-10
Boring #: B-3
Sample #: G-1
Depth: 3 1/2 - 4

Moisture Content (%)	6.8%

Sieve Size	Percent Passing (%)
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	100.0
3/8 in. (9.5-mm)	100.0
No. 4 (4.75-mm)	98.6
No. 10 (2.00-mm)	96.3
No. 20 (.850-mm)	93.9
No. 40 (.425-mm)	78.3
No. 60 (.250-mm)	31.3
No. 100 (.150-mm)	8.3
No. 200 (.075-mm)	2.5

Size Fraction	Percent By Weight
Coarse Gravel	
Fine Gravel	1.4
Coarse Sand	2.3
Medium Sand	18.0
Fine Sand	75.8
Fines	2.5
Total	100.0

LL ______
PI ______

D10 0.16
D30 0.24
D60 0.35

Cc 1.09
Cu 2.22

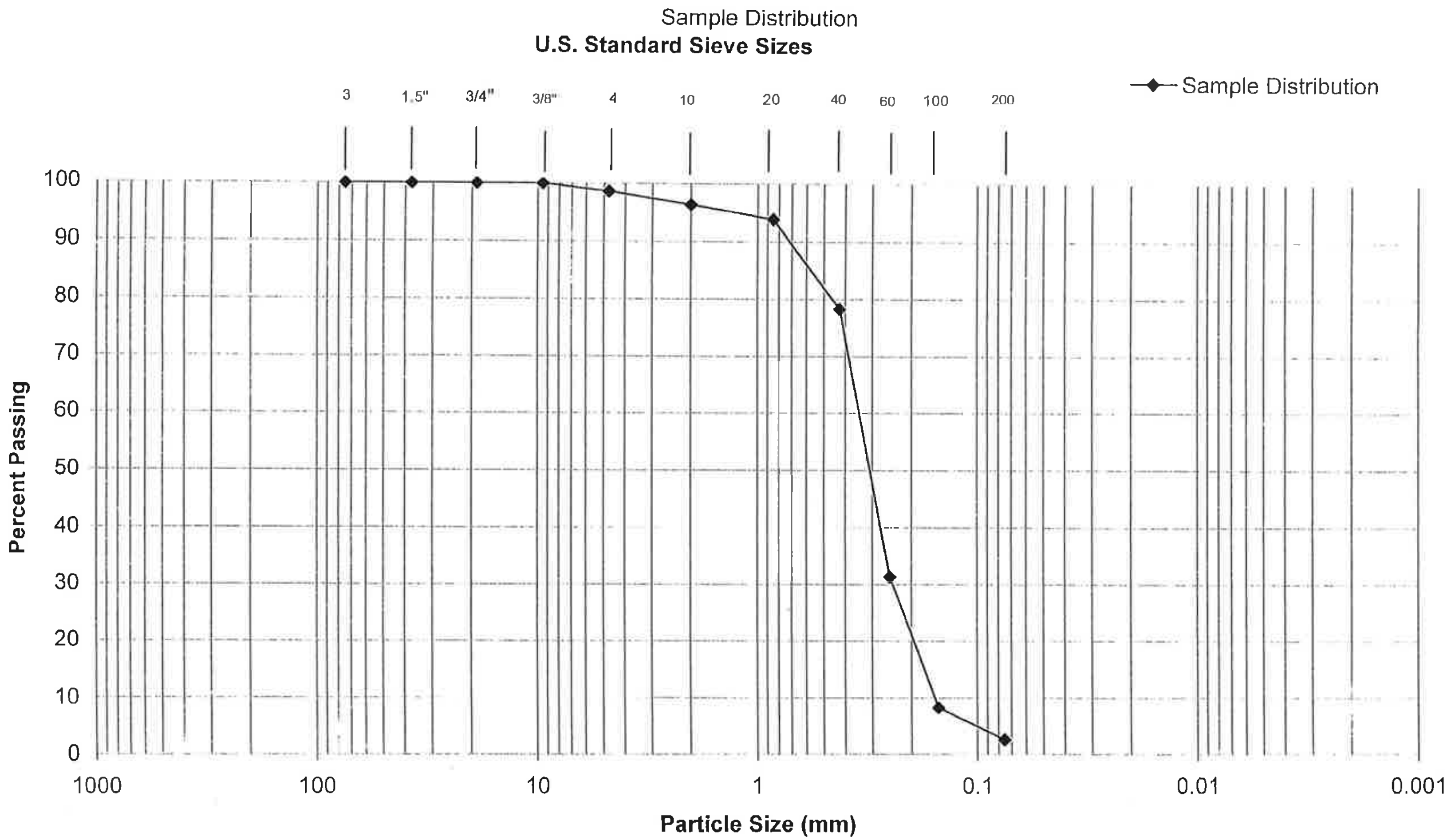
ASTM Classification

Group Name Brown poorly graded sand
Symbol (SP)

E3RA

Figure

Soil Classification Data Sheet



E3RA	Sample Distribution	Job Name: Key Port Ambulatory	Sample #: G-1
		Job Number: E10008	Date: 2-12-10
	Figure:	Tested By: dar	Depth: 3 1/2 - 4
		Exploration #: B-3	

Sieve Data

Sieve Size	Cumm. Retained Wt (g)	Corrected Retained wt.(gr)	Percent Passing (%)
3 in. (75-mm)			#VALUE!
1.5in. (37.5-mm)			#VALUE!
3/4 in. (19-mm)			#VALUE!
3/8 in. (9.5-mm)			#VALUE!
No. 4 (4.75mm)		6.18	#VALUE!
No. 10 (2.00-mm)	10.63	#VALUE!	#VALUE!
No. 20 (.850-mm)	21.91	#VALUE!	#VALUE!
No. 40 (.425-mm)	93.61	#VALUE!	#VALUE!
No. 60 (.250-mm)	310.22	#VALUE!	#VALUE!
No. 100 (.150-mm)	414.39	#VALUE!	#VALUE!
No. 200 (.075-mm)	442.95	#VALUE!	#VALUE!
Pan	447.06	#VALUE!	

FRACTIONAL CORRECTION?

- ○ Fractonal Correction Required
- ◉ Fractional Correction Not Required

INCLUDE SPECIFICATION CURVE?

- ◉ No
- ○ Yes

Moisture Content	
Pan #:	7
Pan & Wet Soil:	621.23
Pan & Dry Soil:	590.52
Moisture loss:	#VALUE!
Pan wt:	136.56
Dry soil wt:	#VALUE!
Moisture Content (%)	#VALUE!

-200 Wash	
Pan #:	7
Pan & Dry Soil (Before)	590.52
Pan & Dry Soil (After)	582.99
-200 From Wash	#VALUE!
Pan wt:	136.56
Dry soil wt:	#VALUE!
% of -200	#VALUE!
Total Washed Soil Wt (g)	#VALUE!

Att. Limits

	ML
LL	
PI	

Particle Sizes (mm)

D_{10}	
D_{30}	
D_{60}	
C_c	
C_u	

ASTM Classification

Group Name
Symbol

Job and Sample Data

Job Name: KVA

Job Number: E10008

Tested By: DAR Date: 2-12-10

Boring #: B-3

Sample #: G-1 Depth: 3½-4'

Particle Size Analysis Summary Data

Job Name: Key Port Ambulatory
Job Number: E10008
Tested By: dar
Date: 2-12-10
Boring #: HB-3
Sample #: G-1
Depth: 2 1/.2 - 3

Moisture Content (%)	6.4%

Sieve Size	Percent Passing (%)
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	84.9
3/8 in. (9.5-mm)	83.1
No. 4 (4.75-mm)	79.9
No. 10 (2.00-mm)	59.4
No. 20 (.850-mm)	53.2
No. 40 (.425-mm)	39.7
No. 60 (.250-mm)	17.4
No. 100 (.150-mm)	5.6
No. 200 (.075-mm)	2.1

Size Fraction	Percent By Weight
Coarse Gravel	15.1
Fine Gravel	5.0
Coarse Sand	20.5
Medium Sand	19.7
Fine Sand	37.6
Fines	2.1
Total	100.0

LL ______
PI ______

D10 0.18
D30 0.34
D60 2.05

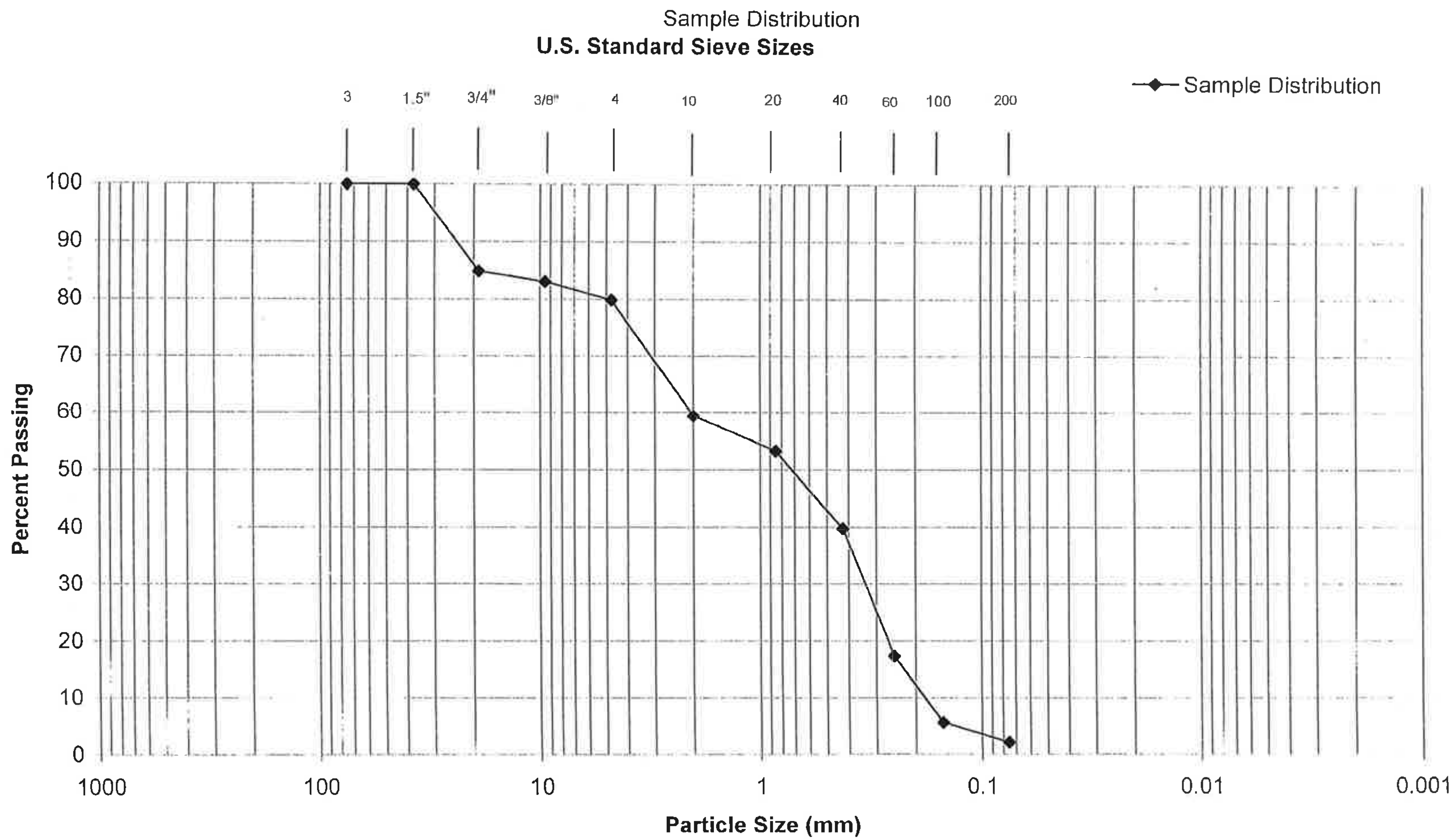
Cc 0.31
Cu 11.29

ASTM Classification
Group Name Brown poorly graded sand with gravel
Symbol (SP)

E3RA

Figure

Soil Classification Data Sheet



E3RA	Sample Distribution	Job Name: Key Port Ambulatory	Sample #: G-1
		Job Number: E10008	Date: 2-12-10
	Figure:	Tested By: dar	Depth: 2 1/.2 - 3
		Exploration #: HB-3	

Sieve Data

Sieve Size	Cumm. Retained Wt (g)	Corrected Retained wt.(gr)	Percent Passing (%)
3 in. (75-mm)			#VALUE!
1.5in. (37.5-mm)		0	#VALUE!
3/4 in. (19-mm)		63.97	#VALUE!
3/8 in. (9.5-mm)		71.62	#VALUE!
No. 4 (4.75mm)		85.14	#VALUE!
No. 10 (2.00-mm)	109.18	#VALUE!	#VALUE!
No. 20 (.850-mm)	142.07	#VALUE!	#VALUE!
No. 40 (.425-mm)	214.15	#VALUE!	#VALUE!
No. 60 (.250-mm)	332.93	#VALUE!	#VALUE!
No. 100 (.150-mm)	395.98	#VALUE!	#VALUE!
No. 200 (.075-mm)	414.37	#VALUE!	#VALUE!
Pan	416.27	#VALUE!	

FRACTIONAL CORRECTION?

- ○ Fractonal Correction Required
- ◉ Fractional Correction Not Required

INCLUDE SPECIFICATION CURVE?

- ◉ No
- ○ Yes

Moisture Content	
Pan #: 21	21
Pan & Wet Soil:	462.82
Pan & Dry Soil:	435.74
Moisture loss:	#VALUE!
Pan wt:	12.06
Dry soil wt:	#VALUE!
Moisture Content (%)	#VALUE!

-200 Wash	
Pan #:	21
Pan & Dry Soil (Before)	435.74
Pan & Dry Soil (After)	428.25
-200 From Wash	#VALUE!
Pan wt:	12.06
Dry soil wt:	#VALUE!
% of -200	#VALUE!
Total Washed Soil Wt (g)	#VALUE!

Att. Limits

	ML
LL	
PI	

Particle Sizes (mm)

D_{10}	
D_{30}	
D_{60}	
C_c	
C_u	

ASTM Classification

Group Name
Symbol

Job and Sample Data

Job Name: Key Port Ambulatory

Job Number: E10008

Tested By: DAR   Date: 2-12-10

Boring #(H)B-3

Sample #: G-1   Depth: 2 1/2-3

Particle Size Analysis Summary Data

Job Name: Smokey Point Amb.
Job Number: E10008
Tested By: dar
Date: 062910
Boring #: HB-4
Sample #: S1
Depth: 3

Moisture Content (%)	3.2%

Sieve Size	Percent Passing (%)
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	88.3
3/8 in. (9.5-mm)	78.8
No. 4 (4.75-mm)	72.9
No. 10 (2.00-mm)	50.4
No. 20 (.850-mm)	46.0
No. 40 (.425-mm)	32.4
No. 60 (.250-mm)	17.5
No. 100 (.150-mm)	7.4
No. 200 (.075-mm)	2.8

Size Fraction	Percent By Weight
Coarse Gravel	11.7
Fine Gravel	15.4
Coarse Sand	22.5
Medium Sand	18.1
Fine Sand	29.6
Fines	2.8
Total	100.0

LL ______
PI ______

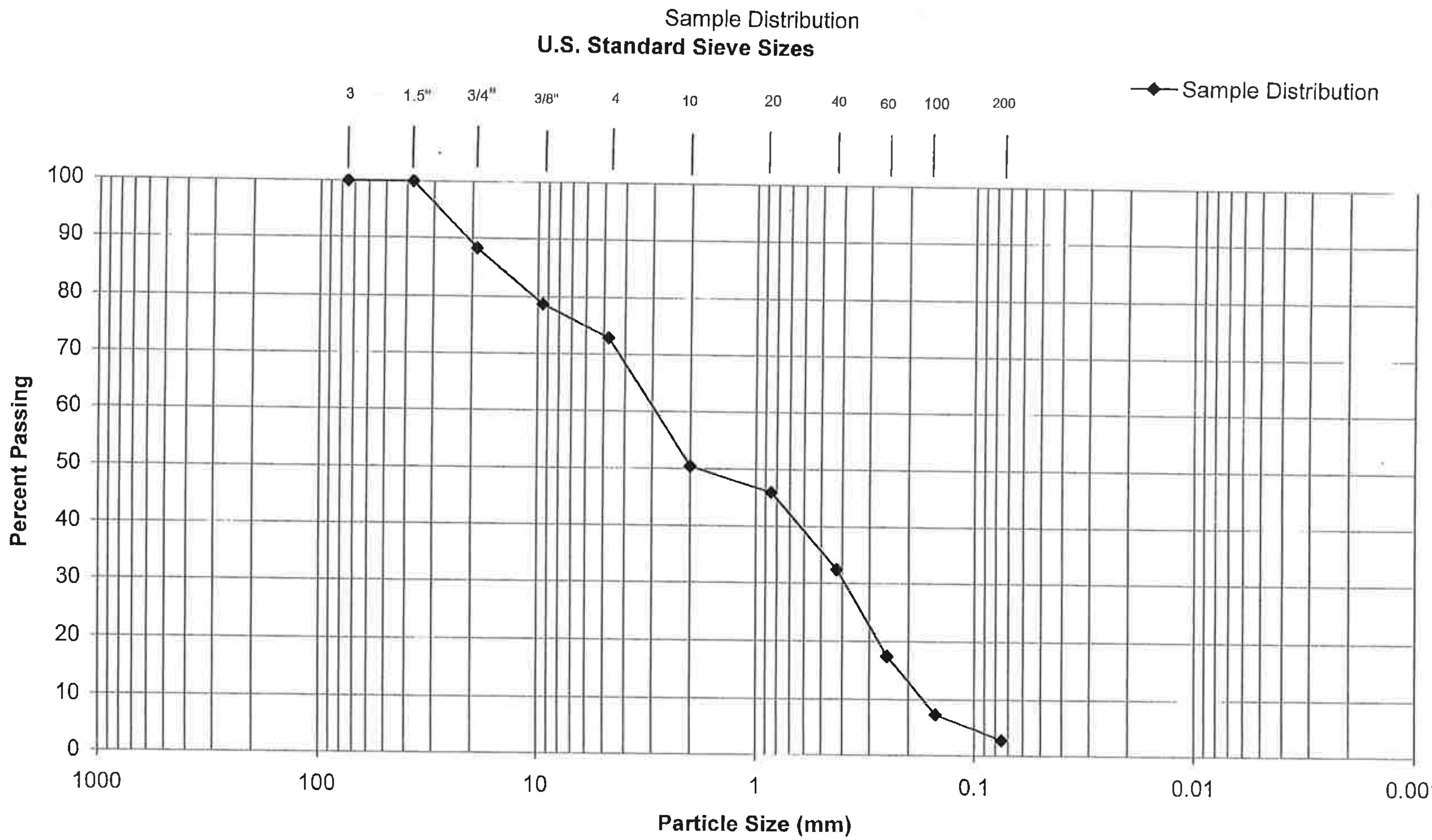
D10 0.17
D30 0.39
D60 2.89

Cc 0.31
Cu 16.90

ASTM Classification

Group Name Brown poorly graded sand with gravel
Symbol (SP)

E3RA	Figure Soil Classification Data Sheet



E3RA	Sample Distribution	Job Name:	Smokey Point Amb.	Sample #:	S1
		Job Number:	E10008	Date:	062910
	Figure:	Tested By:	dar	Depth:	3
		Exploration #:	HB-4		

Particle Size Analysis Summary Data

Job Name: Smokey Point Amb.
Job Number: E10008
Tested By: dar
Date: 062910
Boring #: HB-7
Sample #: S1
Depth: 3

Moisture Content (%)	3.6%

Sieve Size	Percent Passing (%)
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	88.0
3/8 in. (9.5-mm)	86.4
No. 4 (4.75-mm)	84.4
No. 10 (2.00-mm)	69.6
No. 20 (.850-mm)	65.8
No. 40 (.425-mm)	52.2
No. 60 (.250-mm)	27.5
No. 100 (.150-mm)	10.0
No. 200 (.075-mm)	3.2

Size Fraction	Percent By Weight
Coarse Gravel	12.0
Fine Gravel	3.6
Coarse Sand	14.8
Medium Sand	17.5
Fine Sand	49.0
Fines	3.2
Total	100.0

LL ______
PI ______

D10 0.15
D30 0.26
D60 0.63

Cc 0.73
Cu 4.23

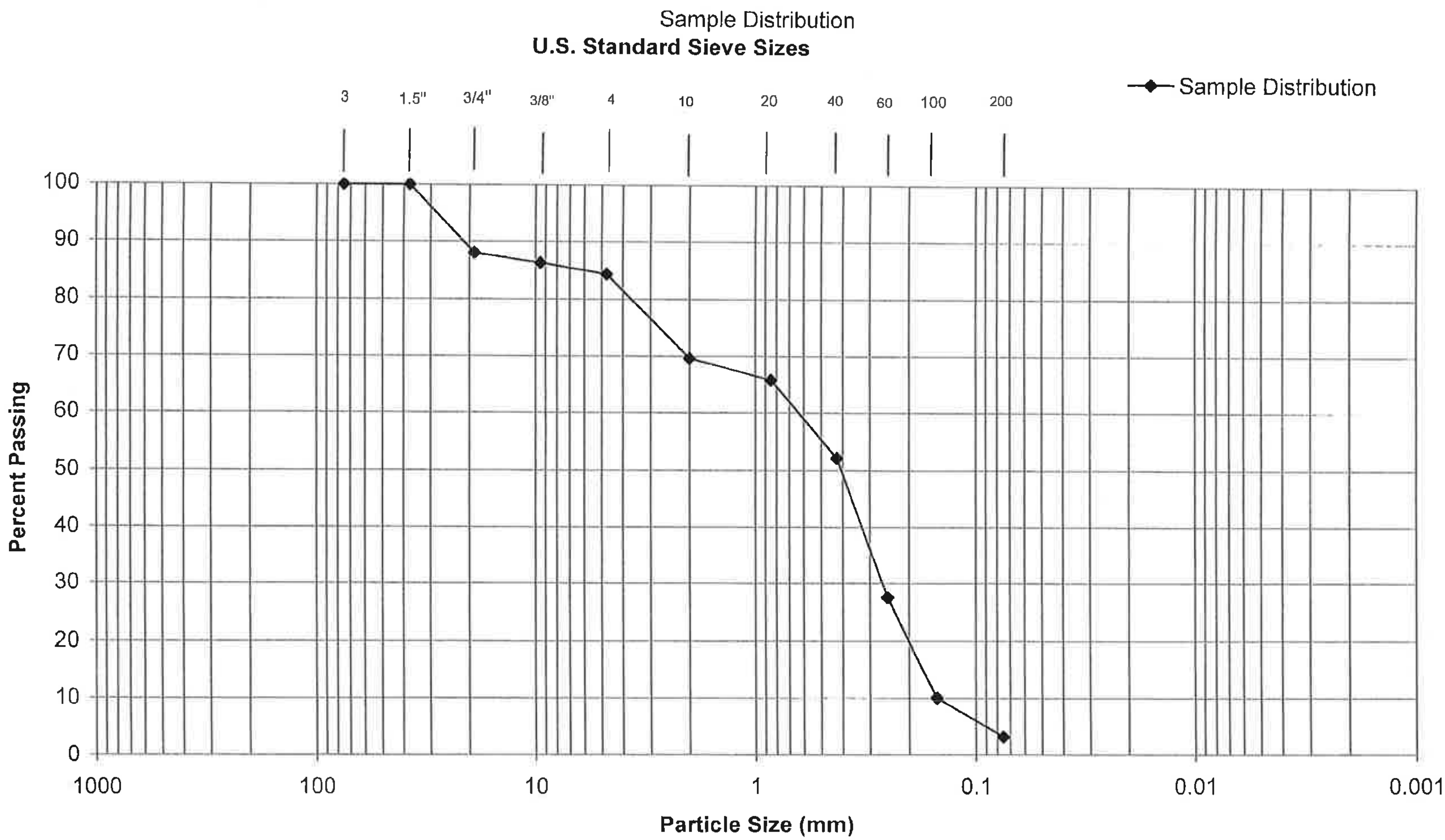
ASTM Classification

Group Name Brown poorly graded sand with gravel
Symbol (SP)

E3RA

Figure

Soil Classification Data Sheet



E3RA	Sample Distribution	Job Name:	Smokey Point Amb.	Sample #:	S1
		Job Number:	E10008	Date:	062910
	Figure:	Tested By:	dar	Depth:	3
		Exploration #:	HB-7		