# Geotechnical Engineering Services

Lewis County Event Center & Sports Complex
Centralia, Washington

*for*
**City of Centralia**

May 7, 2010

GeoEngineers
Earth Science + Technology

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8410 154th Avenue NE
Redmond, Washington 98052
425.861.6000

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# Centralia, Washington

**File No. 1985-021-00**

**May 7, 2010**

Prepared for:

City of Centralia
1100 North Tower Avenue
Centralia, Washington 98531

Attention: Jan Stemkoski, PE

Prepared by:


GeoEngineers, Inc.
8410 154th Avenue NE
Redmond, Washington 98052
425.861.6024

Timothy D. Bailey, PE
Project Engineer

Shaun D. Stauffer, PE, LEED AP
Associate


SHAUN D. STAUFFER
STATE OF WASHINGTON
33250
REGISTERED
PROFESSIONAL ENGINEER

5/7/10

TB2:SDS:nlu


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# Table of Contents

**INTRODUCTION AND PROJECT DESCRIPTION** ..... **1**

**FIELD EXPLORATIONS AND LABORATORY TESTING** ..... **1**

Field Explorations ..... 1
Laboratory Testing ..... 2

**SITE CONDITIONS** ..... **2**

Geology ..... 2
Surface Conditions ..... 2
Subsurface Conditions ..... 2
Groundwater Conditions ..... 3

**CONCLUSIONS AND RECOMMENDATIONS** ..... **3**

General ..... 3
Earthquake Engineering ..... 4
- 2006 International Building Code (IBC) Design Parameters ..... 4
- Seismic Hazards ..... 4
- Surface Fault Rupture ..... 4

Shallow Foundations ..... 4
- Genera l ..... 4
- Allowable Bearing Pressure ..... 5
- Settlement ..... 5
- Lateral Resistance ..... 5
- Construction Considerations ..... 5

Slab-On-Grade Support ..... 6
Pavement Recommendations ..... 6
- Porous Pavement Design ..... 6
- Conventional Pavement Design ..... 8

Earthwork and Structural Fill ..... 9
- Excavation Considerations ..... 9
- Stripping, Clearing and Grubbing ..... 9
- Subgrade Preparation ..... 9
- Erosion and Sedimentation Control ..... 9
- Structural Fill ..... 10

Drainage Considerations ..... 12
- Footing Drains ..... 12
- Other Considerations ..... 12

**LIMITATIONS** ..... **13**

**REFERENCES** ..... **13**

## LIST OF FIGURES

Figure 1. Vicinity Map
Figure 2. Site Plan

## APPENDICES

Appendix A. Field Explorations
- Figure A-1 – Key to Exploration Logs
- Figures A-2 through A-5 – Log of Borings
- Figures A-6 through A-22 – Log of Test Pits

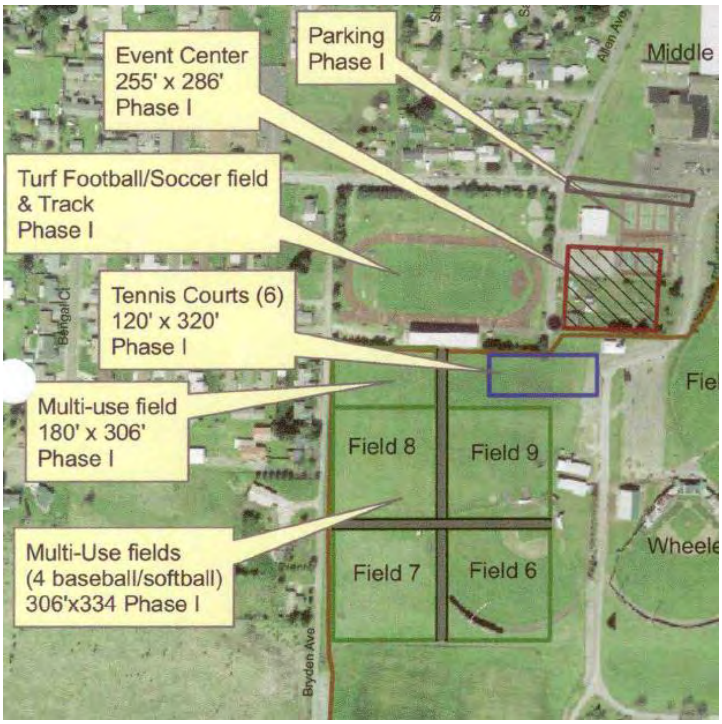
Appendix B. Laboratory Testing
- Figures B-1 through B-5 - Sieve Analysis Results
- Figures B-6 through B-7 – Atterberg Limits Test Results

Appendix C. Report Limitations and Guidelines for Use

## INTRODUCTION AND PROJECT DESCRIPTION

This report presents the results of our geotechnical engineering services for the Lewis County Event Center & Sports Complex project in Centralia, Washington. The project is located in Fort Borst Park, west of the Chehalis River. The project is shown relative to surrounding physical features on the Vicinity Map, Figure 1 and the Site Plan, Figure 2.

Our understanding of the project is based on information provided by Jan Stemkoski, City Engineer for the City of Centralia. We understand that the overall project is being jointly pursued by the city, the school district, a public facilities district and a private developer. The proposed Phase I improvements are illustrated in the aerial photograph below. The proposed Event Center will likely be a two-story metal building with a 73,000-square-foot footprint and will be completed as a design-build project. The parking improvements, totaling approximately 115,000 square feet, and a 400-foot-long roadway extension (not labeled but shown just north of the Event Center) will be designed by the city. Only Phase I parking is shown in aerial photo; other phases are expected to be located adjacent to the multi-use fields. The turf field and track, tennis courts and multi-use fields are being redeveloped by others.




Proposed project features and locations

The purpose of this study was to complete subsurface explorations at the project site and to provide geotechnical engineering conclusions and recommendations for the design and construction of the proposed Event Center building, parking and roadway areas. Our geotechnical engineering services were completed in general accordance with our proposal dated April 2, 2010.

## FIELD EXPLORATIONS AND LABORATORY TESTING

### Field Explorations

The subsurface soil and groundwater conditions at the project site were evaluated by drilling four borings (B-1 through B-4) and completing seventeen test pits (TP-1 through TP-17) on April 28 and 29, 2010. The borings were completed using track-mounted, limited-access, continuous-flight, hollow-stem auger drilling equipment to depths ranging from 31½ to 46½ feet below the ground

surface. The test pits were completed using a rubber-tired backhoe to depths ranging from 3½ to 12½ feet below the ground surface.

The approximate locations of the explorations completed for this project are presented on the Site Plan, Figure 2. Details of the field exploration program and logs of the explorations are presented in Appendix A.

### Laboratory Testing

Soil samples were obtained during the explorations and taken to GeoEngineers' laboratory for further evaluation. Selected samples were tested for the determination of moisture content, percent fines content (material passing the U.S. No. 200 sieve), grain size distribution (sieve analysis) and Atterberg limits (plasticity characteristics). A composite sample was also tested to determine the California Bearing Ratio (CBR) for pavement design. The tests were performed in general accordance with the test methods of ASTM International (ASTM). A description of the laboratory testing and the test results are presented in Appendix B.

## SITE CONDITIONS

### Geology

Geologic information for the project vicinity includes a Washington Division of Geology and Earth Resources map of the Centralia Quadrangle (Schasse, 1987). Mapped soils in the project vicinity consist of alluvium. Alluvium generally consists of silt, sand and gravel deposited in streambeds and fans. The alluvium at this site was deposited in the floodplain and channel of the nearby Chehalis River.

### Surface Conditions

The project site is located in Fort Borst Park, west of the Chehalis River in Centralia, Washington. The site is currently developed with improvements consisting of playfields, tennis courts, associated support buildings and facilities, and surface parking. The site is generally flat, and there are no surface water features in the immediate project area. The layout of the existing site features and improvement are illustrated on the Site Plan, Figure 2.

### Subsurface Conditions

Four borings (B-1 through B-4) and seventeen test pits (TP-1 through TP-17) were completed to evaluate subsurface soil and groundwater conditions in the project area. The logs of the explorations are presented in Appendix A.

The subsurface conditions at the site generally consist of either sand and gravel deposits or silt and silty sand deposits, depending on the relative location at the site. The approximate boundary between these soil deposits occurs on a relatively well-defined line, as illustrated on the Site Plan, Figure 2. The location of the soil boundary line is also shown on the online Natural Resources Conservation Service (NRCS) soil map, which is consistent with Figure 2. The soil boundary line is likely associated with the edge of a former channel of the Chehalis River; the sand and gravel

deposits north of the line consist of river deposits, and the silt and silty sand deposits south of the line consist of floodplain deposits.

The subsurface conditions north of the soil boundary line generally consist of sand and gravel with variable silt and cobble content (river deposits). The upper few feet have been regraded in areas and are loose with some organics, but the underlying sand and gravel layer is generally medium dense to very dense. The sand and gravel deposits were encountered for the full depth of the explorations. The subsurface conditions south of the soil boundary line generally consist of medium stiff to stiff silt with interbedded layers of medium dense silty sand (floodplain deposits). The upper few feet have been regraded in areas and are soft/loose with some organics. In the explorations near the boundary line (TP-8, TP-10 and TP-11), the thickness of the floodplain deposits is generally less than 5 feet. Further south of the boundary line, the floodplain deposits were encountered for the full depth of the explorations. River deposits consisting of medium dense to dense silty gravel were encountered below the floodplain deposits in TP-8, TP-10 and TP-11 at depths of 3 to 5 feet.

### Groundwater Conditions

In the northern portion of the site, the soils appeared to become wet around 15 to 20 feet below the ground surface in the borings, with an observed groundwater level on the drilling rods at depths of about 24 to 33 feet below the ground surface. The lower groundwater levels observed in B-3 and B-4 may be influenced by the nearby municipal water supply well. This well is located in the building just south of the soil boundary line (north of TP-10 and TP-11) on the Site Plan, Figure 2.

Perched groundwater was encountered in several test pit explorations in the southern portion of the site at depths ranging from 5 to 8 feet.

Groundwater levels are expected to fluctuate with season, precipitation, well pumping and other factors.

## CONCLUSIONS AND RECOMMENDATIONS

### General

Based on the results of our subsurface exploration program and our engineering evaluations, it is our opinion that the Lewis County Event Center & Sports Complex project is geotechnically feasible. The following sections present our conclusions and recommendations regarding:

- Earthquake Engineering
- Shallow Foundations
- Slab-on-Grade Support
- Pavement Recommendations
- Earthwork and Structural Fill
- Drainage Considerations

## Earthquake Engineering

### *2006 International Building Code (IBC) Design Parameters*

We recommend the 2006 IBC parameters for Site Class, short period spectral response acceleration ($S_S$), 1-second period spectral response acceleration ($S_1$), and Seismic Coefficients $F_A$ and $F_V$ presented in Table 1, below. These parameters are based on the 2002 United States Geological Survey (USGS) seismic hazard maps and were calculated using the USGS ground motion parameter calculator.

**TABLE 1. 2006 IBC SEISMIC PARAMETERS**

| 2006 IBC Parameter | Recommended Value |
|---|---|
| Site Class | D |
| Short Period Spectral Response Acceleration, $S_S$ (percent g) | 103.5 |
| 1-Second Period Spectral Response Acceleration, $S_1$ (percent g) | 40.7 |
| Seismic Coefficient, $F_A$ | 1.09 |
| Seismic Coefficient, $F_V$ | 1.59 |

### *Seismic Hazards*

We evaluated the site conditions for seismic hazards including liquefaction, lateral spreading and seismically induced landsliding. Our evaluation indicates that the site has low risk of liquefaction because of the depth to groundwater and presence of medium dense to very dense sand and gravel. The site also has a low risk of liquefaction-induced ground disturbance, including lateral spreading. Based on the flat site topography, there is also a low risk of seismically induced landsliding.

### *Surface Fault Rupture*

Based on USGS maps of active faults in western Washington, the site is not located near mapped faults (USGS website). There is a relatively low risk of surface fault rupture because of the distance to the nearest mapped fault (approximately 40 miles) and the thickness of alluvium overlying bedrock.

## Shallow Foundations

### *General*

Based on current development plans, the Event Center building will be located directly north of the soil boundary line illustrated on the Site Plan, Figure 2. Subsurface conditions are expected to consist of medium dense to dense sand and gravel (river deposits). In our opinion, the building may be supported on conventional spread and continuous wall footings bearing on the medium dense sand and gravel (river deposits) at the site or on structural fill extending down to these soils. If structural fill is placed below the foundations, the zone of structural fill should extend laterally beyond the footing edges a horizontal distance equal to the thickness of the fill.

We recommend that conventional spread footings be a minimum of 36 inches wide and that continuous wall footings be a minimum of 16 inches wide. Exterior footings should be founded a minimum of 18 inches below the lowest adjacent grade. Interior footings should be founded a minimum of 12 inches below the top of the slab.

***Allowable Bearing Pressure***

For foundations supported as recommended above, an allowable soil bearing pressure of 4,000 pounds per square foot (psf) is recommended for spread and continuous wall footings. If the footings are founded at least 5 feet below the existing ground surface, the allowable soil bearing pressure may be increased to 6,000 psf.

The allowable soil bearing pressures apply to the total of dead and long-term live loads and may be increased by up to one-third for wind or seismic loads.

***Settlement***

The postconstruction settlement of shallow footings supported as recommended above is estimated to be about ½ to 1 inch. Postconstruction differential settlement is estimated to be about ½ inch between similarly loaded column footings or over a distance of about 25 feet for continuous wall or mat foundations. These settlements will occur rapidly, essentially as the loads are applied.

***Lateral Resistance***

Lateral foundation loads may be resisted by passive resistance on the sides of the footings and by friction on the bases of the footings. For footings supported in accordance with our recommendations, the allowable frictional resistance may be computed using a coefficient of friction of 0.45 applied to vertical dead-load forces.

The allowable passive resistance may be computed using an equivalent fluid density of 300 pounds per cubic foot (pcf) if the footing is poured directly against undisturbed native soils or is surrounded by structural fill. The allowable passive resistance for structural fill assumes that the structural fill extends out from the face of the foundation element for a distance at least equal to three times the height of the element and is compacted to at least 95 percent of the maximum dry density (MDD) estimated in general accordance with ASTM D 1557. The above values incorporate a factor of safety of about 1.5.

***Construction Considerations***

The footing subgrade soils will be susceptible to disturbance when wet. It may be necessary to pour a lean concrete “mud mat” on the bottom of the footing excavations to protect the footing subgrade soils from water and/or wet weather during reinforcement bar placement and preparation for concrete placement. We recommend that the condition of all footing excavations be observed by a geotechnical engineer prior to placement of concrete to confirm that the bearing soils are undisturbed and are consistent with our recommendations contained in this report.

## Slab-On-Grade Support

Conventional slabs may be supported on-grade provided that the slabs are founded on either undisturbed native soils or recompacted existing soils, or on structural fill placed over these soils. For slabs designed as a beam on an elastic foundation, a modulus of subgrade reaction of 50 pounds per cubic inch (pci) may be used for subgrade soils prepared as recommended.

We recommend that a 6-inch-thick base course layer of 1½-inch minus clean crushed gravel with negligible sand or silt (in conformance with Section 9-03.1(4)C, grading No. 57 of the Washington State Department of Transportation [WSDOT] Standard Specifications) be placed to provide capillary break and uniform slab support. Prior to placing the base course layer, the subgrade should be proof-rolled as described below in the "Earthwork and Structural Fill" section of this report. The subgrade should be recompacted to a firm and unyielding condition.

Where moisture-sensitive floor coverings or moisture-sensitive equipment will be used, a vapor barrier consisting of 10-mil plastic sheeting should be installed below the slab to reduce the potential for migration of moisture. It may also be prudent to apply a sealer to the slab to further reduce the migration of moisture through the floor. The contractor should be made responsible for maintaining the integrity of the vapor barrier during construction.

We estimate that postconstruction settlement of the on-grade slabs will be on the order of ½ to 1 inch over a 25-foot distance.

## Pavement Recommendations

The design of the pavement areas will depend significantly on whether the pavement is intended to be traditional hot mix asphalt (HMA) or porous pavement. Our recommendations for design of porous and traditional HMA pavement sections are presented in the following sections.

### *Porous Pavement Design*

**GENERAL.** The design of porous pavements for stormwater management should consider storage capacity of the pervious pavement system and infiltration rate of the subgrade soils, as well as water quality treatment. Porous pavement may consist of porous concrete, porous HMA, porous pavers or some type of stabilized gravel surface. Our recommendations for design of porous pavement are presented in the following subsections.

**INFILTRATION.** As discussed previously in the "Subsurface Conditions" section of this report, the site has two areas with significantly different subsurface conditions, as illustrated on the Site Plan, Figure 2.

Two methods were used to evaluate an appropriate design (long-term) infiltration rate for the subgrade soils. The two methods consist of correlations based on United States Department of Agriculture (USDA) soil textural classification and ASTM gradation testing, as discussed in Section 3.3.6 of the Stormwater Management Manual for Western Washington (Ecology, 2005). The ASTM gradation testing was completed on soil samples obtained at depths of 3 to 7 feet, with the majority of the tests completed at depths of 3 to 4½ feet. Table 2 presents a summary of the estimated infiltration rates at the site.

**TABLE 2. ESTIMATED INFILTRATION RATE**

| Area | GeoEngineers Classification | USDA Textural Class | ASTM $D_{10}$ (mm) | SCS Series | Approximate Groundwater Depth (ft) [1] | Estimate of Infiltration Rate (inches/hour) [2] | |
|---|---|---|---|---|---|---|---|
| | | | | | | USDA | ASTM |
| North (Sand/Gravel) | GP/GM | Sandy gravel/ gravelly sand | 0.1 to 0.3 | Spanaway gravelly sandy loam | 15-20 | 2 to 10 | 0.5 to 6 |
| South (Silt) | SM/ML | Silt/ silt loam | 0.005 to 0.01[3] | Chehalis silty clay | Not encountered | <0.1 | 0.1 to 0.5 |

Notes:

[1] Depth to groundwater below existing ground surface, measured at time of explorations.

[2] Infiltration rates shown for two different methodologies.

[3] Extrapolated from sieve analyses.

The long-term infiltration rate is dependent on several factors, including site variability, degree of long-term maintenance, pretreatment for total suspended solids and depth to groundwater. For design of porous pavements, it is typically assumed that there will be low to moderate long-term maintenance and pretreatment. Therefore, for the north area of the site (where riverbed deposits were encountered), we recommend using a long-term design infiltration rate of 1 inch per hour, and for the south area of the site (where floodplain deposits were encountered), we recommend a long-term design infiltration rate of 0.1 inches per hour.

We anticipate that even when the subgrade soils are amended with compost and slightly recompacted as discussed in the "Water Quality Treatment" section below, the subgrade soils will maintain these long-term design infiltration rates.

**STORAGE CAPACITY.** The total stormwater storage capacity of the pervious pavement system includes the capacity of the porous pavement and the capacity of the crushed rock subbase. The storage capacity is directly dependant on the effective porosity (or percent voids that can be filled with stormwater) of the pavement and subbase materials. The porosity of pervious pavement depends on the mix design. The effective porosity used for design should be adjusted to account for naturally occurring moisture.

We recommend that shoulder ballast be used for the crushed rock subbase below the porous pavement. The shoulder ballast should meet the criteria described in Section 9-03.9(2) of the WSDOT Standard Specifications. Based on previous laboratory testing of crushed rock samples (1¼-inch and ⅝-inch clean crushed rock), we anticipate a total porosity of approximately 40 to 45 percent. For design, we recommend an effective porosity of 35 percent to account for natural moisture. The storage capacity for the crushed rock subbase should be calculated by multiplying the volume of subbase by the effective porosity. Typical subbase thicknesses range from 18 to 36 inches, depending on storage needs. A minimum of 24 inches of subbase should be used at this site to provide adequate support of traffic and to help "bridge" over the amended subgrade soils.

Additionally, landscaping areas adjacent to the pavement should be sloped to drain away from the path so that fines in runoff from the landscaping areas can be prevented from contaminating the pavement and crushed rock and reducing the storage capacity.

**WATER QUALITY TREATMENT.** A key element when considering porous pavement at this site is protection of the unconfined aquifer, which is a municipal water source for the city's well, located in the middle of the site.

Pavement areas are pollution-generating sources, and oils occur most prominently on busy streets and busy portions of parking lots. If porous paving is used, we recommend that the upper 2 feet of the underlying subgrade soils be mixed with compost at a rate of approximately 10 percent compost to 90 percent soil (per volume). Compost used for amending the subgrade soils below porous pavements must meet the Washington State compost regulations in Chapter 173-350 Washington Administrative Code (WAC), which is available at http://www.ecy.wa.gov/programs/compost. The 2 feet of mixed soil should be recompacted to a minimum of 90 percent of the MDD per ASTM D 1557.

It is our opinion that the amended subgrade soils will meet the Washington State Department of Ecology (Ecology) requirements for "treatment soils" with a minimum cation exchange capacity (CEC) of 5 microequivalents (meq). We recommend that CEC testing of the amended subgrade soils be completed during construction to verify that the soil meets Ecology requirements. The organics in the topsoil attract and bind contaminants typically found in runoff from pavement areas, and studies have shown that when stormwater is infiltrated through soils with adequate CEC, the groundwater leaving the site typically has contaminant levels equivalent to undeveloped areas. Additionally, studies have shown that porous pavement breaks down some oil pollutants through the biochemical activity of microbiota that use the pavement as a substrate (Ferguson, 2005).

It is our opinion that the use of porous pavements with amended subgrade soils is consistent with the goal of wellhead protection at the site.

***Conventional Pavement Design***

**DESIGN CONSIDERATIONS.** We recommend that the subgrade soils in conventional pavement areas be prepared and evaluated as described below in the "Earthwork and Structural Fill" section of this report.

For conventional HMA pavement, we recommend that paved areas exposed only to automobile traffic consist of at least 2 inches of HMA, Class ½ inch, PG 58-22 over 4 inches of crushed rock base course. In truck traffic areas and heavy traffic volume areas, new pavement sections should consist of at least 3 inches of HMA over a minimum of 6 inches of crushed rock base course. The crushed rock base course should meet the requirements of Section 9-03.9(3) of the WSDOT Standard Specifications.

The crushed rock base course should be compacted to at least 95 percent of the MDD prior to the placement of the asphalt concrete. We recommend that the geotechnical engineer observe the proof-rolling of the compacted base course prior to paving.

The pavement recommendations discussed above are based on a CBR value of 2 and typical parking lot loading. Detailed traffic loading information was not available for the new roadway extension at the time this report was prepared. We are available to complete pavement design calculations for the new roadway, as necessary.

**WATER QUALITY TREATMENT.** Bioswales may be used to provide water quality treatment and infiltration for runoff originating from conventional pavement. If bioswales are used, we recommend that they be designed using the infiltration rates previously presented above. GeoEngineers can provide references for soil mixes for bioswales if needed.

## Earthwork and Structural Fill

### *Excavation Considerations*

We anticipate that the on-site soils may be excavated with conventional excavation equipment, such as trackhoes or dozers. Based on the alluvial origin of the soils, cobbles and boulders are likely to be present. During construction, the contractor should be prepared to deal with cobbles and boulders as well as debris from previous site development.

### *Stripping, Clearing and Grubbing*

We recommend that all new pavement and structure areas be stripped of organic-rich soils (sod, grass and topsoil), vegetation and any existing pavement/structures. Any remaining below-grade elements from previous site development, if present, should also be removed. Based on our observations, we anticipate that stripping depths will be generally about 6 to 12 inches. Stripping depths will be locally greater where large trees are cleared and grubbed.

### *Subgrade Preparation*

The exposed subgrade in new structure and conventional pavement areas should be evaluated after site grading is complete. Proof-rolling with heavy, rubber-tired construction equipment should be used for this purpose during dry weather and if access for this equipment is practical. Probing should be used to evaluate the subgrade during periods of wet weather or if access is not feasible for construction equipment. Soft areas identified during proof-rolling or probing should be excavated and replaced with compacted structural fill.

### *Erosion and Sedimentation Control*

Potential sources or causes of erosion and sedimentation depend upon construction methods, slope length and gradient, amount of soil exposed and/or disturbed, soil type, construction sequencing and weather. Implementing an erosion and sedimentation control plan will reduce the project impact on erosion-prone areas. The plan should be designed in accordance with applicable city, county and/or state standards. The plan should incorporate basic planning principles including:

- Scheduling grading and construction to reduce soil exposure;
- Retaining existing pavement whenever feasible;
- Revegetating or mulching denuded areas;
- Directing runoff away from denuded areas;

- Decreasing runoff velocities;
- Preparing drainage ways and outlets to handle concentrated or increased runoff;
- Confining sediment to the project site; and
- Inspecting and maintaining control measures frequently.

Temporary erosion protection should be used and maintained in areas with exposed or disturbed soils to help reduce erosion and reduce transport of sediment to adjacent areas and receiving waters. Permanent erosion protection can be provided by paving, structure construction or landscape planting.

Until the permanent erosion protection is established and the site is stabilized, site monitoring should be performed by qualified personnel to evaluate the effectiveness of the erosion control measures and to repair and/or modify them as appropriate. Provisions for modifications to the erosion control system based on monitoring observations should be included in the erosion and sedimentation control plan.

***Structural Fill***

**GENERAL.** Materials placed to support structures or building pads and placed below pavements and sidewalks are classified as structural fill for the purposes of this report. The required quality of structural fill material varies depending upon its use, as discussed in previous sections and summarized below:

- During periods of dry weather, structural fill should, at a minimum, meet the criteria for common borrow, WSDOT Standard Specifications Section 9-03.14(3).
- During wet weather, if compaction is difficult using common borrow, structural backfill should meet the criteria for gravel borrow, WSDOT Standard Specifications Section 9-03.14(1), with the additional restriction that the fines content be limited to no more than 5 percent.
- Structural fill placed around footing drains should meet the requirements of gravel backfill for drains per WSDOT Standard Specifications Section 9-03.12(4).
- Structural fill placed for the crushed rock base course below conventional pavements should meet the criteria for WSDOT Standard Specifications Section 9-03.9(3).
- Structural fill placed for the crushed rock subbase below porous pavements should meet the criteria for shoulder ballast, WSDOT Standard Specifications Section 9-03.9(2).
- Compost used for amending the subgrade soils below porous pavements must meet the Washington State compost regulations in Chapter 173-350 WAC, which is available at http://www.ecy.wa.gov/programs/compost.

**USE OF ON-SITE SOILS.** The on-site soils encountered in the explorations contain a high percentage of fines and are moisture-sensitive, particularly in the southern half of the site. During dry weather, soils at the site may be suitable for reuse as common borrow, provided they can be properly moisture-conditioned. Some soils in the northern area of the site may also meet the criteria for gravel borrow. If the contractor intends to use on-site soils for structural fill, it will be important to cover stockpiles to prevent them from becoming saturated during periods of rainfall.

**FILL PLACEMENT AND COMPACTION CRITERIA.** Structural fill should be mechanically compacted to a firm and unyielding condition. Structural fill should be placed in loose lifts not exceeding 8 to 10 inches in thickness. Each lift should be conditioned to the proper moisture content and compacted to the specified density before placing subsequent lifts. Structural fill should be compacted to the following criteria:

- Structural fill placed below floor slabs and footings should be compacted to 95 percent of the MDD estimated in general accordance with ASTM D 1557.
- Structural fill in conventional pavement areas, including utility trench backfill, should be compacted to 90 percent of the MDD estimated in general accordance with ASTM D 1557, except that the upper 2 feet of fill below final subgrade should be compacted to 95 percent of the MDD.
- Structural fill placed as crushed rock base course below conventional pavements should be compacted to 95 percent of the MDD estimated in general accordance with ASTM D 1557.
- Structural fill below permeable pavement areas should be compacted to 85 to 90 percent of the MDD (ASTM D 1557) to maintain void space for infiltration and drainage.

We recommend that a geotechnical engineer be present during proof-rolling and/or probing of the exposed subgrade soils, and during placement of structural fill. The geotechnical engineer should evaluate the adequacy of the subgrade soils and identify areas needing further work, perform in-place moisture-density tests in the fill to evaluate whether the work is being done in accordance with the compaction specifications, and advise on any modifications to procedures that may be appropriate for the prevailing conditions.

**WEATHER CONSIDERATIONS.** The on-site soils generally contain a high percentage of fines (silt) and are moisture-sensitive, particularly those soils in the southern half of the site. When the moisture content of these soils is more than a few percent above the optimum moisture content, they become muddy and unstable. Operation of equipment in these conditions will be difficult, and the required compaction criteria will not be achieved. Additionally, disturbance of near-surface soils should be expected if earthwork is completed during periods of wet weather. During dry weather, the soils will: (1) be less susceptible to disturbance; (2) provide better support for construction equipment; and (3) be more likely to meet the required compaction criteria.

The wet weather season in western Washington generally begins in October and continues through May; however, periods of wet weather may occur during any month of the year. If wet weather earthwork is unavoidable, we recommend that the following steps be taken should the near-surface soil conditions begin to deteriorate:

- The ground surface should be graded so that areas of ponded water do not develop. The contractor should take measures to prevent surface water from collecting in excavations and trenches. Measures should be implemented to remove surface water from the work area.
- Earthwork activities should not take place during periods of heavy precipitation.
- The contractor should take necessary measures to prevent on-site soils and soils to be used as fill from becoming wet or unstable. These measures may include the use of plastic sheeting, sumps with pumps, and grading. The site soils should not be left uncompacted and exposed to

moisture. Sealing the surficial soils by rolling with a smooth-drum roller prior to periods of precipitation will help reduce the extent to which these soils become wet or unstable.

- Construction traffic should be restricted to specific areas of the site, preferably areas that are surfaced with working pad materials not susceptible to wet weather disturbance.

Construction activities should be scheduled so that the length of time that soils are left exposed to moisture is reduced to the extent practicable.

## Drainage Considerations

### *Footing Drains*

We recommend that perimeter footing drains be installed around the new Event Center building. The perimeter drains should be installed at the base of the exterior footings. The perimeter drains should be provided with cleanouts and should consist of at least 4-inch-diameter perforated pipe placed on a 4-inch bed of, and surrounded by 6 inches of, drainage material enclosed in a non-woven geotextile fabric such as Mirafi 140N (or approved equivalent) to prevent fine soil from migrating into the drainage material. The footing drainpipe should be installed at least 18 inches below the top of the adjacent floor slab. The drainage material should consist of gravel backfill for drains conforming to Section 9-03.12(4) of the WSDOT Standard Specifications.

We recommend that the drainpipe consist of either heavy-wall solid pipe (SDR-35 polyvinyl chloride [PVC], or equivalent) or rigid corrugated smooth interior polyethylene pipe (ADS N-12, or equivalent). We also recommend against using flexible tubing for footing drainpipes. The perimeter drains should be sloped to drain by gravity, if practicable, to a suitable discharge point, preferably a storm drain or a water treatment bioswale. We recommend that the cleanouts be covered and be placed in flush-mounted utility boxes. Water collected in roof downspout lines must not be routed to the footing drain lines.

### *Other Considerations*

The soils exposed in excavations will be moisture-sensitive and susceptible to disturbance from construction activities, especially when water is present on the subgrade. A system of curbs, berms, drainage ditches and swales should be installed around the perimeter of the excavation to intercept and collect surface water.

We recommend that all surfaces be sloped to drain away from the proposed building area. Pavement surfaces and open space areas should be sloped such that the surface water is collected and routed to suitable discharge points.

Roof drains should be connected to tightlines that discharge into the storm sewer disposal system or to water treatment bioswales. The roof drains should be kept separate from the footing drain lines.

## LIMITATIONS

We have prepared this report for the exclusive use of the City of Centralia for the Lewis County Event Center & Sports Complex project in Centralia, Washington. The data should be provided to prospective contractors for their bidding or estimating purposes, but our report and interpretations should not be construed as a warranty of the subsurface conditions.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering in this area at the time this report was prepared. No warranty or other conditions, express or implied, should be understood.

Any electronic form, facsimile or hard copy of the original document (email, text, table, and/or figure), if provided, and any attachments are only a copy of the original document. The original document is stored by GeoEngineers, Inc. and will serve as the official document of record.

Please refer to Appendix C titled "Report Limitations and Guidelines for Use" for additional information pertaining to use of this report.

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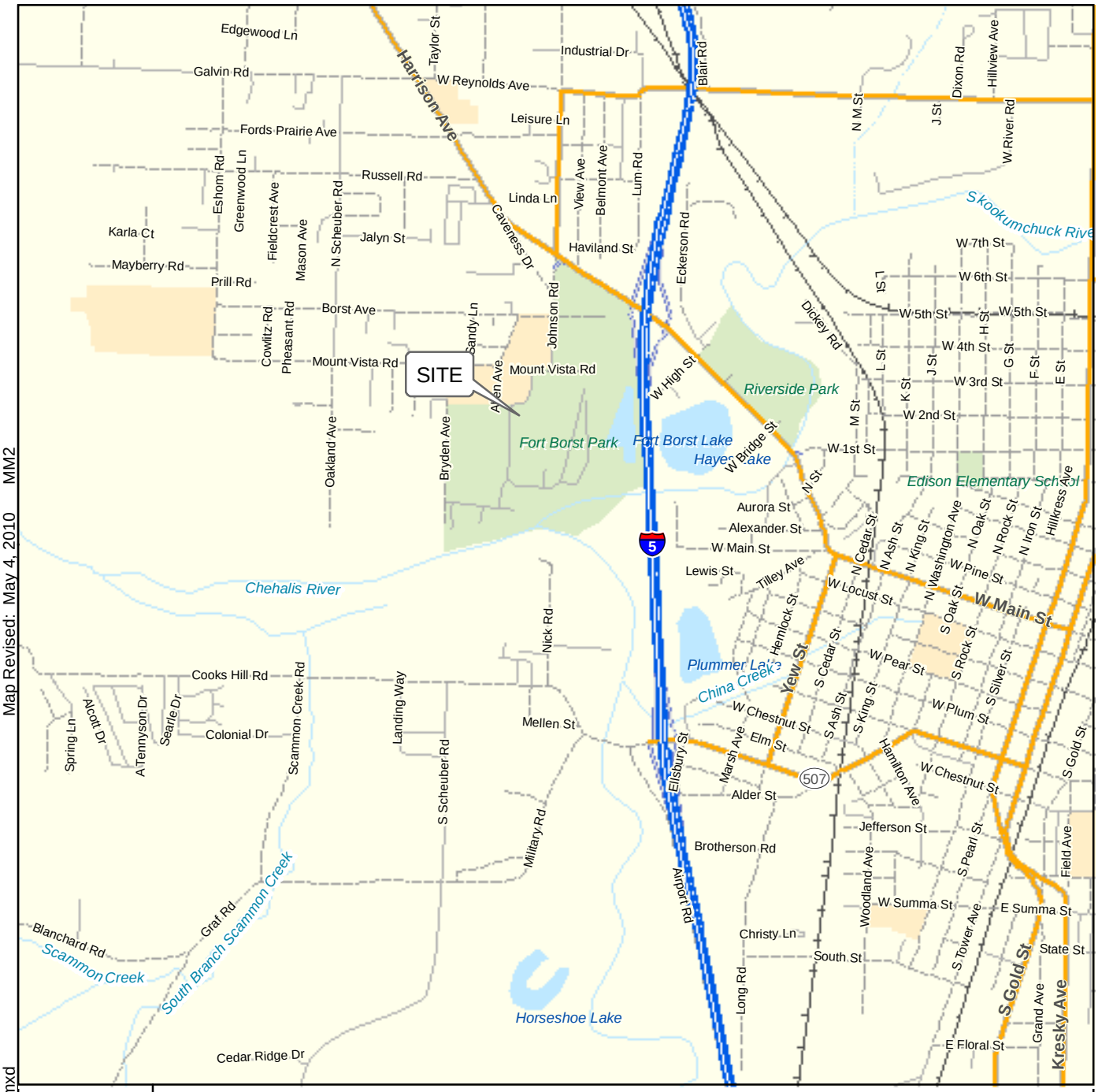
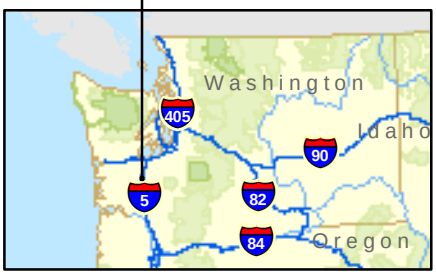
FIGURES

GeoEngineers




N
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2,000 0 2,000
Feet

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
3. It is unlawful to copy or reproduce all or any part thereof, whether for personal use or resale, without permission.

Data Sources: ESRI Data & Maps, Street Maps 2005

Transverse Mercator, Zone 10 N North, North American Datum 1983
North arrow oriented to grid north

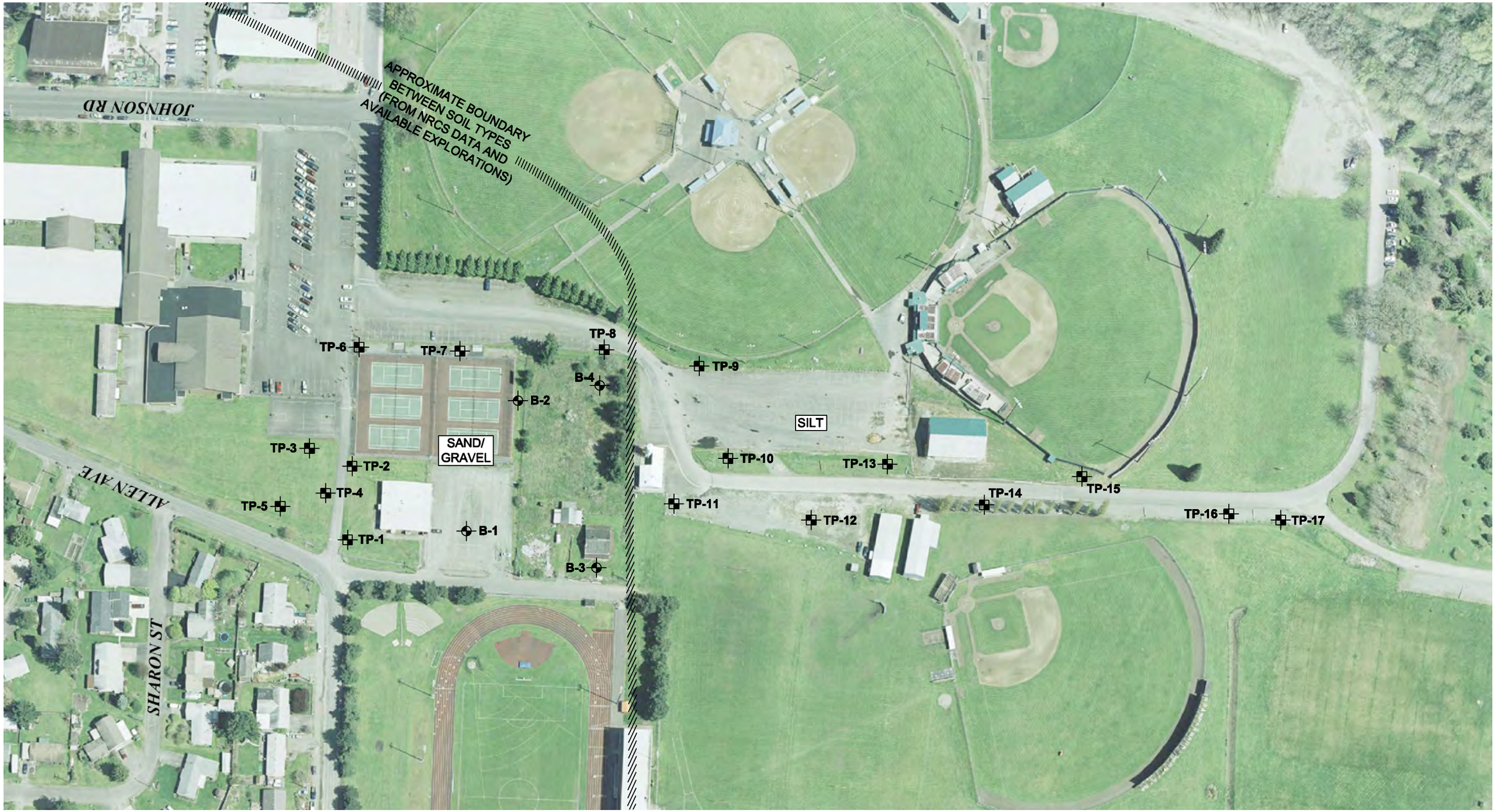
## Vicinity Map

Lewis County Event Center & Sports Complex
Centralia, Washington

GeoEngineers

**Figure 1**

Office: RED Path: P:\0\0186835\GIS\018683500_F1.mxd Map Revised: May 4, 2010 MM2




## Notes

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. can not guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Reference: Aerial photo provided by City of Centralia.
Soil Data from National Resource Conservation Service data:
http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx

## Legend

B-1 — Boring by GeoEngineers

TP-1 — Test Pit by GeoEngineers

Approximate Boundary between Soil Types (from NRCS Data and available explorations)

N E S W

200 0 200
FEET

**Site Plan**

Lewis County Event Center & Sports Complex
Centralia, Washington

GEOENGINEERS

**Figure 2**

W:\REDMOND\PROJECTS\1\198502\100\CAD\198502100 FIG 2.DWG\TAB:LANDSCAPE MODIFIED BY THICHAUD ON MAY 04, 2010 - 9:30

APPENDICES

GeoEngineers

# APPENDIX A
## Field Explorations

## APPENDIX A
## FIELD EXPLORATIONS

### General

Subsurface conditions at the site were explored by drilling four borings (B-1 through B-4) and completing seventeen test pits (TP-1 through TP-17). The borings were completed to depths ranging from about 31½ to 46½ feet below the existing ground surface. The drilling was performed by Boretec, Inc. on April 29, 2010. The test pits were completed to depths ranging from about 3½ to 12½ feet below the ground surface. The test pits were excavated by Kelly's Excavating on April 28 and April 29, 2010.

The locations and elevations of the explorations were estimated by taping/pacing from existing site features. The approximate locations of the explorations are shown on the Site Plan, Figure 2.

### Borings

The borings were completed using track-mounted, continuous-flight, hollow-stem auger drilling equipment. The borings were continuously monitored by geotechnical engineer from our firm who examined and classified the soils encountered, obtained representative soil samples, observed groundwater conditions and prepared a detailed log of each exploration.

The soils encountered in the borings were sampled at 5-foot vertical intervals with a 2-inch outside diameter split-barrel standard penetration test (SPT) sampler. The samples were obtained by driving the sampler 18 inches into the soil with a 140-pound rope and cathead hammer free-falling 30 inches. The number of blows required for each 6 inches of penetration was recorded. The blow count ("N-value") of the soil was calculated as the number of blows required for the final 12 inches of penetration. This resistance, or N-value, provides a measure of the relative density of granular soils and the relative consistency of cohesive soils. Where very dense soil conditions precluded driving the full 18 inches, the penetration resistance for the partial penetration was entered on the logs. The blow counts are shown on the boring logs at the respective sample depths.

Soils encountered in the borings were visually classified in general accordance with the classification system described in Figure A-1. A key to the boring log symbols is also presented in Figure A-1. The logs of the explorations are presented in Figures A-2 through A-5. The logs are based on our interpretation of the field and laboratory data and indicate the various types of soils and groundwater conditions encountered. The logs also indicate the depths at which these soils or their characteristics change, although the change may actually be gradual. If the change occurred between samples, it was interpreted. The densities noted on the logs are based on the blow count data obtained in the borings, difficulty in excavation and judgment based on the conditions encountered.

Observations of groundwater conditions were made during drilling, and the groundwater conditions encountered during drilling are presented on the boring logs. The observed groundwater conditions represent a short-term condition and may or may not be representative of the long-term

groundwater conditions at the site. Groundwater conditions observed during drilling should be considered approximate.

Borings were backfilled in accordance with Washington State Department of Ecology regulations.

### Test Pits

The test pits were excavated using a rubber-tired backhoe. The test pits were continuously observed by a geotechnical engineer from our firm who examined and classified the soils encountered, obtained representative soil samples, observed groundwater conditions and prepared a detailed log of each test pit.

Soils encountered in the test pits were visually classified in general accordance with the classification system described in Figure A-1. A key to the exploration log symbols is also presented in Figure A-1. The logs of the test pits are presented in Figures A-6 through A-22. The logs reflect our interpretation of the field conditions and the results of laboratory testing and evaluation of samples. They also indicate the depths at which the soil types or their characteristics change, although the change may actually be gradual.

The test pits were backfilled with the excavated soils and compacted to the extent practicable with the bucket of the excavator. The fill will not behave as structural fill and will likely need to be recompacted during construction.

## SOIL CLASSIFICATION CHART

| MAJOR DIVISIONS | | | SYMBOLS GRAPH | SYMBOLS LETTER | TYPICAL DESCRIPTIONS |
|---|---|---|---|---|---|
| COARSE GRAINED SOILS<br>MORE THAN 50% RETAINED ON NO. 200 SIEVE | GRAVEL AND GRAVELLY SOILS<br>MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE | CLEAN GRAVELS<br>(LITTLE OR NO FINES) | | GW | WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES |
| | | | | GP | POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES |
| | | GRAVELS WITH FINES<br>(APPRECIABLE AMOUNT OF FINES) | | GM | SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES |
| | | | | GC | CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES |
| | SAND AND SANDY SOILS<br>MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE | CLEAN SANDS<br>(LITTLE OR NO FINES) | | SW | WELL-GRADED SANDS, GRAVELLY SANDS |
| | | | | SP | POORLY-GRADED SANDS, GRAVELLY SAND |
| | | SANDS WITH FINES<br>(APPRECIABLE AMOUNT OF FINES) | | SM | SILTY SANDS, SAND - SILT MIXTURES |
| | | | | SC | CLAYEY SANDS, SAND - CLAY MIXTURES |
| FINE GRAINED SOILS<br>MORE THAN 50% PASSING NO. 200 SIEVE | SILTS AND CLAYS | LIQUID LIMIT LESS THAN 50 | | ML | INORGANIC SILTS, ROCK FLOUR, CLAYEY SILTS WITH SLIGHT PLASTICITY |
| | | | | CL | INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS |
| | | | | OL | ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY |
| | SILTS AND CLAYS | LIQUID LIMIT GREATER THAN 50 | | MH | INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS SILTY SOILS |
| | | | | CH | INORGANIC CLAYS OF HIGH PLASTICITY |
| | | | | OH | ORGANIC CLAYS AND SILTS OF MEDIUM TO HIGH PLASTICITY |
| HIGHLY ORGANIC SOILS | | | | PT | PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS |

NOTE: Multiple symbols are used to indicate borderline or dual soil classifications

## ADDITIONAL MATERIAL SYMBOLS

| SYMBOLS GRAPH | SYMBOLS LETTER | TYPICAL DESCRIPTIONS |
|---|---|---|
| | CC | Cement Concrete |
| | AC | Asphalt Concrete |
| | CR | Crushed Rock/ Quarry Spalls |
| | TS | Topsoil/ Forest Duff/Sod |

**Measured groundwater level in exploration, well, or piezometer**

**Groundwater observed at time of exploration**

**Perched water observed at time of exploration**

**Measured free product in well or piezometer**

### Graphic Log Contact

**Distinct contact between soil strata or geologic units**

**Approximate location of soil strata change within a geologic soil unit**

### Material Description Contact

**Distinct contact between soil strata or geologic units**

**Approximate location of soil strata change within a geologic soil unit**

### Sampler Symbol Descriptions

**2.4-inch I.D. split barrel**

**Standard Penetration Test (SPT)**

**Shelby tube**

**Piston**

**Direct-Push**

**Bulk or grab**

**Blowcount is recorded for driven samplers as the number of blows required to advance sampler 12 inches (or distance noted). See exploration log for hammer weight and drop.**

**A "P" indicates sampler pushed using the weight of the drill rig.**

### Laboratory / Field Tests

| | |
|---|---|
| %F | Percent fines |
| AL | Atterberg limits |
| CA | Chemical analysis |
| CP | Laboratory compaction test |
| CS | Consolidation test |
| DS | Direct shear |
| HA | Hydrometer analysis |
| MC | Moisture content |
| MD | Moisture content and dry density |
| OC | Organic content |
| PM | Permeability or hydraulic conductivity |
| PP | Pocket penetrometer |
| SA | Sieve analysis |
| TX | Triaxial compression |
| UC | Unconfined compression |
| VS | Vane shear |

### Sheen Classification

| | |
|---|---|
| NS | No Visible Sheen |
| SS | Slight Sheen |
| MS | Moderate Sheen |
| HS | Heavy Sheen |
| NT | Not Tested |

NOTE: The reader must refer to the discussion in the report text and the logs of explorations for a proper understanding of subsurface conditions. Descriptions on the logs apply only at the specific exploration locations and at the time the explorations were made; they are not warranted to be representative of subsurface conditions at other locations or times.

## KEY TO EXPLORATION LOGS

GEOENGINEERS

FIGURE A-1

| Drilled | Start 4/29/2010 | End 4/29/2010 | Total Depth (ft) | 46.5 | Logged By | JTM | Checked By | TB | Driller | Boretec Inc. | Drilling Method | Hollow Stem Auger |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Surface Elevation (ft) Vertical Datum | Undetermined | | | | Hammer Data | Rope and Cathead 140 (lb) 30-inch Drop | | | Drilling Equipment | Track Rig | | |
| Easting (X) Northing (Y) | | | | | System Datum | | | | Groundwater Date Measured | 4/29/2010 | Depth to Water (ft) | 24.0 |
| Notes: | | | | | | | | | Elevation (ft) | | | |

| Elevation (feet) | Depth (feet) | Interval | Recovered (in) | Blows/foot | Collected Sample | Sample Name Testing | Water Level | Graphic Log | Group Classification | MATERIAL DESCRIPTION | Moisture Content, % | Dry Density, (pcf) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | | | | | | | | AC | 1/2 " asphalt concrete | | | |
| | | | | | | | | | RX | 2" base coarse | | | |
| | | | | | | | | | SM | Brown silty fine to medium sand with gravel (loose to medium dense, moist) (fill) | | | |
| | 5 | | 3 | 15 | | 1 | | | | | | | Change in drilling at 5.5' (Harder drilling) |
| | | | | | | | | | GP-GM | Brown to gray fine to coarse gravel with silt, sand and cobbles (medium dense to very dense, moist) | | | |
| | 10 | | 4 | 31 | | 2 | | | | | | | Pounding on gravel |
| | 15 | | 4 | 50/4" | | 3 | | | | | | | Pounding on cobble |
| | 20 | | 4 | 50/6" | | 4 | | | | | | | Pounding on cobble |
| | | | | | | | | | | | | | Water observed in augers |
| | 25 | | | | | | | | | | | | Pounding on gravel |

Notes: Please see Figure A-1 for explanation of symbols.

# Log of Boring B-1

GEOENGINEERS

Project: Lewis County Event & Sports Complex
Project Location: Centralia, Washington
Project Number: 1985-021-00

Figure A-2
Sheet 1 of 2

Redmond: Date:5/6/10 Path:W:\REDMOND\PROJECTS\1\1985021\00\GINT\1985021\00LOGS.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GE8_GEOTECH_STANDARD

| Elevation (feet) | Depth (feet) | Interval | Recovered (in) | Blows/foot | Collected Sample | Sample Name / Testing | Water Level | Graphic Log | Group Classification | MATERIAL DESCRIPTION | Moisture Content, % | Dry Density, (pcf) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 25 | | 18 | 32 | | 5 / SA; %F; MC | | | | Fewer cobbles | 16 | | SA; %F = 7 |
| | 30 | | 12 | 51 | | 6 | | | | | | | Pounding on gravel |
| | | | | | | | | | SP-SM | Gray fine to medium sand with silt and gravel (dense to very dense, wet) | | | |
| | 35 | | 18 | 19 | | 7 | | | | | | | Possible heave-blowcount unreliable |
| | 40 | | 18 | 50/2" | | 8 | | | | | | | |
| | 45 | | 16 | 90 | | 9 | | | | | | | |

Notes: Please see Figure A-1 for explanation of symbols.

## Log of Boring B-1 (continued)

GEOENGINEERS

Project: Lewis County Event & Sports Complex
Project Location: Centralia, Washington
Project Number: 1985-021-00

Figure A-2
Sheet 2 of 2

Redmond: Date:5/6/10 Path:W:\REDMOND\PROJECTS\1198502100\GINT\1985021 00LOGS.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GE8_GEOTECH_STANDARD

| Drilled | Start 4/29/2010 | End 4/29/2010 | Total Depth (ft) 31.5 | Logged By JTM | Checked By TB | Driller Boretec Inc. | Drilling Method Hollow Stem Auger |
|---|---|---|---|---|---|---|---|
| Surface Elevation (ft) Vertical Datum | Undetermined | | Hammer Data | Rope and Cathead 140 (lb) 30-inch Drop | | Drilling Equipment | Track Rig |
| Easting (X) Northing (Y) | | | System Datum | | | Groundwater Date Measured 4/29/2010 | Depth to Water (ft) 24.0 / Elevation (ft) |
| Notes: | | | | | | | |

| Elevation (feet) | Depth (feet) | Interval | Recovered (in) | Blows/foot | Collected Sample | Sample Name Testing | Water Level | Graphic Log | Group Classification | MATERIAL DESCRIPTION | Moisture Content, % | Dry Density, (pcf) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | | | | | | | | SM | Brown silty fine to medium sand with gravel and trace organics (loose, moist) | | | |
| | | | | | | | | | GP | Brownish gray to gray fine to coarse gravel with silt, sand and cobbles (medium dense to dense, moist) | | | |
| | 5 | | 3 | 26 | | 1 | | | | | | | Pounding on gravel |
| | 10 | | 3 | 33 | | 2 | | | | | | | Pounding on gravel |
| | 15 | | 18 | 40 | | 3 | | | | | | | Pounding on gravel |
| | 20 | | 6 | 29 | | 4 | | | SP-SM | Gray fine to coarse sand with silt and gravel (medium dense to dense, wet) | | | |
| | | | | | | | ▽ | | | | | | Water observed in augers |
| | 25 | | | | | | | | | | | | |

Notes: Please see Figure A-1 for explanation of symbols.

# Log of Boring B-2

GEOENGINEERS

Project: Lewis County Event & Sports Complex
Project Location: Centralia, Washington
Project Number: 1985-021-00

Figure A-3
Sheet 1 of 2

Redmond: Date:5/6/10 Path:W:\REDMOND\PROJECTS\1\1985021\00\GINT\1985021\00LOGS.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GE8_GEOTECH_STANDARD

| Elevation (feet) | Depth (feet) | FIELD DATA: Interval | Recovered (in) | Blows/foot | Collected Sample | Sample Name / Testing | Water Level | Graphic Log | Group Classification | MATERIAL DESCRIPTION | Moisture Content, % | Dry Density, (pcf) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 25 | | 18 | 49 | | 5 SA: %F, MC | | | | | 11 | | SA: %F = 6 |
| | | | | | | | | | SP | Gray fine to coarse sand with gravel (dense to very dense, wet) | | | |
| | 30 | | 18 | 50 | | 6 %F, MC | | | | | 21 | | %F = 5 |

Notes: Please see Figure A-1 for explanation of symbols.

## Log of Boring B-2 (continued)

GEOENGINEERS

Project: Lewis County Event & Sports Complex
Project Location: Centralia, Washington
Project Number: 1985-021-00

Figure A-3
Sheet 2 of 2

Redmond: Date:5/6/10 Path:W:\REDMOND\PROJECTS\1\1985021\00\GINT\1985021\00LOGS.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GE8_GEOTECH_STANDARD

| Drilled Start 4/29/2010 | End 4/29/2010 | Total Depth (ft) 31.5 | Logged By JTM / Checked By TB | Driller Boretec Inc. | Drilling Method Hollow Stem Auger |
|---|---|---|---|---|---|
| Surface Elevation (ft) / Vertical Datum | Undetermined | Hammer Data | Rope and Cathead 140 (lb) 30-inch Drop | Drilling Equipment | Track Rig |
| Easting (X) / Northing (Y) | | System Datum | | Groundwater | |
| Notes: | | | | Date Measured 4/29/2010 | Depth to Water (ft) 27.0 / Elevation (ft) |

| Elevation (feet) | Depth (feet) | FIELD DATA: Interval Recovered (in) | Blows/foot | Collected Sample | Sample Name Testing | Water Level | Graphic Log | Group Classification | MATERIAL DESCRIPTION | Moisture Content, % | Dry Density, (pcf) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | | | | | | | SM | Brown silty fine to medium sand with gravel and trace organics (loose, moist) | | | |
| | | | | | | | | GP | Brownish gray fine to coarse gravel with sand, cobbles and trace silt (medium dense to dense, moist to wet) | | | |
| | 5 | 3 | 52 | | 1 | | | | | | | Pounding on gravel |
| | 10 | 5 | 41 | | 2 | | | | | | | Pounding on gravel |
| | 15 | 3 | 49 | | 3 | | | | | | | Pounding on gravel |
| | 20 | 18 | 40 | | 4 | | | | Becomes wet | | | Pounding on gravel |
| | | | | | | | | SP-SM | Gray fine to coarse sand with silt and gravel (very dense, wet) | | | |
| | 25 | | | | | | | | | | | |

Notes: Please see Figure A-1 for explanation of symbols.

# Log of Boring B-3

GEOENGINEERS

Project: Lewis County Event & Sports Complex
Project Location: Centralia, Washington
Project Number: 1985-021-00

Figure A-4
Sheet 1 of 2

Redmond: Date:5/6/10 Path:W:\REDMOND\PROJECTS\1\1985021\00\GINT\1985021\00LOGS.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GE8_GEOTECH_STANDARD

| Elevation (feet) | Depth (feet) | Interval | Recovered (in) | Blows/foot | Collected Sample | Sample Name / Testing | Water Level | Graphic Log | Group Classification | MATERIAL DESCRIPTION | Moisture Content, % | Dry Density, (pcf) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 25 | | 12 | 56 | | 5 %F, MC | | | | | 17 | | %F = 8 |
| | | | | | | | | | | | | | Water observed in augers |
| | 30 | | 6 | 36 | | 6 SA; %F, MC | | | | | 15 | | SA; %F = 6 |

Notes: Please see Figure A-1 for explanation of symbols.

## Log of Boring B-3 (continued)

GEOENGINEERS

Project: Lewis County Event & Sports Complex
Project Location: Centralia, Washington
Project Number: 1985-021-00

Figure A-4
Sheet 2 of 2

Redmond: Date:5/6/10 Path:W:\REDMOND\PROJECTS\1\1985021\00\GINT\1985021\00LOGS.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GE8_GEOTECH_STANDARD

| Drilled Start 4/29/2010 | End 4/29/2010 | Total Depth (ft) 41.5 | Logged By JTM / Checked By TB | Driller Boretec Inc. | Drilling Method Hollow Stem Auger |
|---|---|---|---|---|---|
| Surface Elevation (ft) / Vertical Datum: Undetermined | | Hammer Data: Rope and Cathead, 140 (lb) 30-inch Drop | | Drilling Equipment: Track Rig | |
| Easting (X) / Northing (Y) | | System Datum | | Groundwater: Date Measured 4/29/2010 | Depth to Water (ft) 33.0 / Elevation (ft) |
| Notes: | | | | | |

| Elevation (feet) | Depth (feet) | Interval | Recovered (in) | Blows/foot | Collected Sample | Sample Name Testing | Water Level | Graphic Log | Group Classification | MATERIAL DESCRIPTION | Moisture Content, % | Dry Density, (pcf) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | | | | | | | | GP | Brownish gray to gray fine to coarse gravel with sand (medium dense to very dense, moist) | | | |
| | 5 | | 3 | 50/4" | | 1 | | | | | | | Pounding on gravel |
| | 10 | | 4 | 50/4" | | 2 | | | | | | | Pounding on gravel |
| | | | | | | | | | SP-SM | Gray fine to coarse sand with silt, gravel and occasional cobbles (dense to very dense, wet) | | | |
| | 15 | | 6 | 42 | | 3 | | | | | | | |
| | 20 | | 6 | 54 | | 4 | | | | | | | |
| | 25 | | | | | | | | | | | | |

Notes: Please see Figure A-1 for explanation of symbols.

# Log of Boring B-4

GEOENGINEERS

Project: Lewis County Event & Sports Complex
Project Location: Centralia, Washington
Project Number: 1985-021-00

Figure A-5
Sheet 1 of 2

Redmond: Date:5/6/10 Path:W:\REDMOND\PROJECTS\1\1985021\00\GINT\1985021\00LOGS.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GE8_GEOTECH_STANDARD

| Elevation (feet) | Depth (feet) | Interval | Recovered (in) | Blows/foot | Collected Sample | Sample Name / Testing | Water Level | Graphic Log | Group Classification | MATERIAL DESCRIPTION | Moisture Content, % | Dry Density, (pcf) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 25 | | 12 | 50/2" | | 5 %F, MC | | | | | 17 | | %F = 11 |
| | | | | | | | | | GP-GM | Brown fine to coarse gravel with silt and sand (medium dense to very dense, wet) | | | |
| | 30 | | 12 | 40 | | 6 | | | | | | | Pounding on gravel |
| | | | | | | | ▽ | | | | | | Water observed in augers |
| | 35 | | 18 | 92 | | 7 SA; %F, MC | | | | | 14 | | SA; %F = 6 |
| | | | | | | | | | SP-SM | Gray fine to medium sand with silt and gravel (very dense, wet) | | | |
| | 40 | | 10 | 62 | | 8 SA; %F, MC | | | | | 13 | | SA; %F = 10 |

Notes: Please see Figure A-1 for explanation of symbols.

## Log of Boring B-4 (continued)

GEOENGINEERS

Project: Lewis County Event & Sports Complex
Project Location: Centralia, Washington
Project Number: 1985-021-00

Figure A-5
Sheet 2 of 2

Redmond: Date:5/6/10 Path:W:\REDMOND\PROJECTS\1\1985021\00\GINT\1985021\00LOGS.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GE8_GEOTECH_STANDARD

Date Excavated: 4/29/2010 Logged By: JTM

Equipment: Rubber Tire Backhoe Total Depth (ft) 7.5

| Elevation (feet) | Depth (feet) | SAMPLE: Testing Sample | SAMPLE: Sample Name / Testing | Graphic Log | Group Classification | Encountered Water | MATERIAL DESCRIPTION | Moisture Content, % | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| | | X | 1 | | SM | | Brown silty fine to medium sand with occasional gravel and trace organics (loose, moist) | | |
| | 1 | | | | | | | | |
| | 2 | | | | SM | | Brown silty fine to medium sand with occasional gravel (medium dense, moist) | | |
| | 3 | | | | | | | | |
| | | X | 2 / SA; %F | | SP | | Brown fine to medium sand with gravel and occasional cobbles (medium dense, moist) | 7 | %F=4; 8- to 12-inch cobbles |
| | 4 | | | | | | | | |
| | 5 | | | | | | | | |
| | 6 | | | | | | | | |
| | 7 | | | | | | | | |

Test pit completed at 7.5 feet
No groundwater seepage observed
Moderate to severe caving observed at 1 to 2 feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

## Log of Test Pit TP-1

GEOENGINEERS

Project: Lewis County Event & Sports Complex
Project Location: Centralia, Washington
Project Number: 1985-021-00

Figure A-6
Sheet 1 of 1

Redmond: Date:5/7/10 Path:W:\REDMOND\PROJECTS\11198502100\GINT\198502100TPS.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_TESTPIT_1P_GEOTEC

Date Excavated: 4/29/2010 Logged By: JTM

Equipment: Rubber Tire Backhoe Total Depth (ft) 8.5

| Elevation (feet) | Depth (feet) | SAMPLE: Testing Sample | SAMPLE: Sample Name / Testing | Graphic Log | Group Classification | Encountered Water | MATERIAL DESCRIPTION | Moisture Content, % | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | SM | | Brown silty fine to medium sand with occasional gravel and trace organics (loose to medium dense, moist) | | |
| | | X | 1 | | | | | | |
| | 1 | | | | | | | | |
| | 2 | | | | | | | | |
| | 3 | | | | | | | | |
| | | | | | GP | | Brown fine to coarse gravel with sand and cobbles (medium dense to dense, moist) | | |
| | 4 | X | 2 / SA; %F; MC | | | | | 8 | %F=4 |
| | 5 | | | | | | | | |
| | 6 | | | | | | | | |
| | | X | 3 / %F; MC | | | | | 7 | %F=4 |
| | 7 | | | | | | | | |
| | 8 | | | | | | | | |

Test pit completed at 8.5 feet
No groundwater seepage observed
No caving observed

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

## Log of Test Pit TP-2

GEOENGINEERS

Project: Lewis County Event & Sports Complex
Project Location: Centralia, Washington
Project Number: 1985-021-00

Figure A-7
Sheet 1 of 1

Redmond: Date:5/7/10 Path:W:\REDMOND\PROJECTS\11198502100\GINT\198502100TPS.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_TESTPIT_1P_GEOTEC

Date Excavated: 4/29/2010 Logged By: JTM

Equipment: Rubber Tire Backhoe Total Depth (ft) 3.5

| Elevation (feet) | Depth (feet) | SAMPLE: Testing Sample | SAMPLE: Sample Name / Testing | Graphic Log | Group Classification | Encountered Water | MATERIAL DESCRIPTION | Moisture Content, % | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | X | 1 | | SM | | Brown silty fine to medium sand with occasional gravel and trace organics (loose to medium dense, moist) | | |
| | 2 | | | | | | | | |
| | 3 | X | 2 / SA; %F; MC | | SP-SM | | Brownish-gray fine to medium sand with silt, gravel and occasional cobbles (medium dense, moist) | 11 | %F=7 |

Test pit completed at 3.5 feet
No groundwater seepage observed
No caving observed>6-inch concrete pipe encountered at 3 feet on north side of pipe, surrounded by pea gravel

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

## Log of Test Pit TP-3

GEOENGINEERS

Project: Lewis County Event & Sports Complex
Project Location: Centralia, Washington
Project Number: 1985-021-00

Figure A-8
Sheet 1 of 1

Redmond: Date:5/7/10 Path:W:\REDMOND\PROJECTS\11198502100\GINT\198502100TPS.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_TESTPIT_1P_GEOTEC

Date Excavated: 4/29/2010 Logged By: JTM

Equipment: Rubber Tire Backhoe Total Depth (ft) 5.0

| Elevation (feet) | Depth (feet) | SAMPLE: Testing Sample | SAMPLE: Sample Name / Testing | Graphic Log | Group Classification | Encountered Water | MATERIAL DESCRIPTION | Moisture Content, % | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| | | X | 1 | | SM | | Brown silty fine to medium sand with occasional gravel and trace organics (loose to medium dense, moist) | | |
| | 1 | | | | | | | | |
| | 2 | | | | | | | | |
| | | X | 2 / SA; %F; MC | | GP-GM | | Brown fine to coarse gravel with silt, sand and cobbles (loose to medium dense, moist) | 10 | %F=9 |
| | 3 | | | | | | | | |
| | 4 | | | | | | | | |
| | | X | 3 / %F; MC | | | | | 10 | %F=4 |
| | 5 | | | | | | | | |

Test pit completed at 5 feet
No groundwater seepage observed
Moderate to severe caving observed at 3 to 5 feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

## Log of Test Pit TP-4

GEOENGINEERS

Project: Lewis County Event & Sports Complex
Project Location: Centralia, Washington
Project Number: 1985-021-00

Figure A-9
Sheet 1 of 1

Redmond: Date:5/7/10 Path:W:\REDMOND\PROJECTS\11198502100\GINT\198502100TP-S.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_TESTPIT_1P_GEOTEC

Date Excavated: 4/29/2010 | Logged By: JTM

Equipment: Rubber Tire Backhoe | Total Depth (ft) 5.0

| Elevation (feet) | Depth (feet) | SAMPLE: Testing Sample | SAMPLE: Sample Name / Testing | Graphic Log | Group Classification | Encountered Water | MATERIAL DESCRIPTION | Moisture Content, % | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | | SM | | Brown silty fine to medium sand with occasional gravel and cobbles (loose to medium dense, moist) | | |
| | 1 | | | | | | | | |
| | 2 | | | | GP-GM | | Brown fine to coarse gravel with silt, sand and cobbles (medium dense, moist) | | 8-inch cobbles |
| | 3 | | | | | | | | |
| | | | 2 / MC | | | | | 6 | |
| | 4 | | | | | | | | |
| | | | 3 / SA; %F; MC | | | | | 7 | %F=8 |
| | 5 | | | | | | | | |

Test pit completed at 5 feet
No groundwater seepage observed
Severe caving observed at 3 to 4 feet (in pea gravel adjacent to test pit)

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

## Log of Test Pit TP-5

GEOENGINEERS

Project: Lewis County Event & Sports Complex
Project Location: Centralia, Washington
Project Number: 1985-021-00

Figure A-10
Sheet 1 of 1

Redmond: Date:5/7/10 Path:W:\REDMOND\PROJECTS\11198502100\GINT\198502100TP-S.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_TESTPIT_1P_GEOTEC

Date Excavated: 4/28/2010 | Logged By: JTM

Equipment: Rubber Tire Backhoe | Total Depth (ft) 11.0

| Elevation (feet) | Depth (feet) | SAMPLE: Testing Sample | SAMPLE: Sample Name / Testing | Graphic Log | Group Classification | Encountered Water | MATERIAL DESCRIPTION | Moisture Content, % | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| | | X | 1 | | SM | | Brown silty fine to medium sand with gravel (loose, moist) | | |
| | 1 | | | | SP | | Brown fine to medium sand with gravel and occasional cobbles (loose to medium dense, moist) | | |
| | | X | 2 / %F; MC | | | | | 8 | %F=2 |
| | 2 | | | | | | | | |
| | 3 | | | | | | | | |
| | 4 | | | | | | | | |
| | | X | 3 / SA; %F; MC | | | | | 12 | %F=5 |
| | 5 | | | | | | | | |
| | 6 | | | | | | | | |
| | | | | | GP | | Brown fine to coarse gravel with sand, cobbles and trace silt (medium dense, moist) | | |
| | 7 | | | | | | | | |
| | | X | 4 / MC | | | | | 8 | |
| | 8 | | | | | | | | |
| | 9 | | | | | | | | |
| | 10 | | | | | | | | |
| | 11 | | | | | | | | |

Test pit completed at 11 feet
No groundwater seepage observed
Slight to moderate caving observed at 4 to 11 feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

## Log of Test Pit TP-6

GEOENGINEERS

Project: Lewis County Event & Sports Complex
Project Location: Centralia, Washington
Project Number: 1985-021-00

Figure A-11
Sheet 1 of 1

Redmond: Date:5/7/10 Path:W:\REDMOND\PROJECTS\1198502100\GINT\198502100TPS.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_TESTPIT_1P_GEOTEC

Date Excavated: 4/28/2010 Logged By: JTM

Equipment: Rubber Tire Backhoe Total Depth (ft) 7.0

| Elevation (feet) | Depth (feet) | SAMPLE: Testing Sample | SAMPLE: Sample Name / Testing | Graphic Log | Group Classification | Encountered Water | MATERIAL DESCRIPTION | Moisture Content, % | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| | | X | 1 | | SM | | Dark brown silty fine to medium sand with gravel (loose, moist) (fill?) | | |
| | 1 | | | | | | | | |
| | | | | | GP | | Brown fine to coarse gravel with sand and cobbles (loose to medium dense, moist) | | |
| | 2 | | | | | | | | |
| | | X | 2 / SA; %F; MC | | | | | 8 | %F=5 |
| | 3 | | | | | | | | |
| | 4 | | | | | | | | |
| | 5 | X | 3 / MC | | | | | 6 | |
| | 6 | | | | | | | | |
| | | X | 4 / SA; %F; MC | | | | | 8 | %F=2 |
| | 7 | | | | | | | | |

Test pit completed at 7 feet
No groundwater seepage observed
Slight/moderate caving observed at 5 to 6 feet/6 to 7 feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

## Log of Test Pit TP-7

GEOENGINEERS

Project: Lewis County Event & Sports Complex
Project Location: Centralia, Washington
Project Number: 1985-021-00

Figure A-12
Sheet 1 of 1

Redmond: Date:5/7/10 Path:W:\REDMOND\PROJECTS\11198502100\GINT\198502100TP-S.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_TESTPIT_1P_GEOTEC

Date Excavated: 4/29/2010 | Logged By: JTM

Equipment: Rubber Tire Backhoe | Total Depth (ft) 7.5

| Elevation (feet) | Depth (feet) | SAMPLE: Testing Sample | SAMPLE: Sample Name / Testing | Graphic Log | Group Classification | Encountered Water | MATERIAL DESCRIPTION | Moisture Content, % | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| | | X | 1 | | ML | | Dark brown sandy silt with gravel and trace organics (stiff, moist) | | |
| | 1 | | | | | | | | |
| | 2 | | | | | | | | |
| | 3 | | | | GP-GM | | Brown fine to coarse gravel with sand, silt and cobbles (medium dense, moist) | | |
| | | X | 2 / %F; MC | | | | | 9 | %F=8 |
| | 4 | | | | | | | | |
| | 5 | | | | | | | | |
| | | | | | GP | | Brown fine to coarse gravel with sand and cobbles (medium dense, moist) | | |
| | 6 | | | | | | | | |
| | | X | 3 / SA; %F; MC | | | | | 5 | %F=2 |
| | 7 | | | | | | | | |

Test pit completed at 7.5 feet
No groundwater seepage observed
Slight caving observed at 3+ feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

# Log of Test Pit TP-8

GEOENGINEERS

Project: Lewis County Event & Sports Complex
Project Location: Centralia, Washington
Project Number: 1985-021-00

Figure A-13
Sheet 1 of 1

Redmond: Date:5/7/10 Path:W:\REDMOND\PROJECTS\1\1985021\00\GINT\1985021\00TP-S.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_TESTPIT_1P_GEOTEC

Date Excavated: 4/28/2010 | Logged By: JTM

Equipment: Rubber Tire Backhoe | Total Depth (ft) 7.0

| Elevation (feet) | Depth (feet) | SAMPLE: Testing Sample | SAMPLE: Sample Name / Testing | Graphic Log | Group Classification | Encountered Water | MATERIAL DESCRIPTION | Moisture Content, % | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| | | X | 1 | | SM | | Brown silty fine to medium sand with occasional gravel and concrete debris (loose, moist) (fill) | | |
| | 1 | | | | | | | | |
| | | | | | ML | | Light brown silt with sand and occasional gravel (medium stiff to stiff, moist) | | |
| | 2 | | | | | | | | |
| | | X | 2 | | | | | | |
| | 3 | | | | | | | | |
| | 4 | | | | | | | | |
| | | X | 3 / AL; MC | | | | | 30 | LL=46; PI=16 |
| | 5 | | | | | | | | |
| | 6 | | | | | | | | |
| | 7 | | | | | | | | |

Test pit completed at 7 feet
No groundwater seepage observed
Slight caving observed at 4 feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

## Log of Test Pit TP-9

GEOENGINEERS

Project: Lewis County Event & Sports Complex
Project Location: Centralia, Washington
Project Number: 1985-021-00

Figure A-14
Sheet 1 of 1

Redmond: Date:5/7/10 Path:W:\REDMOND\PROJECTS\11198502100\GINT\198502100TPS.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_TESTPIT_1P_GEOTEC

Date Excavated: 4/28/2010 | Logged By: JTM

Equipment: Rubber Tire Backhoe | Total Depth (ft) 10.0

| Elevation (feet) | Depth (feet) | SAMPLE: Testing Sample | SAMPLE: Sample Name / Testing | Graphic Log | Group Classification | Encountered Water | MATERIAL DESCRIPTION | Moisture Content, % | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| | | X | 1 | | ML | | Brown sandy silt (stiff, moist) (fill) | | |
| | 1 | | | | | | | | |
| | | | | | ML | | Light brown silt with sand and occasional gravel and cobbles (medium stiff to stiff, moist) | | |
| | 2 | | | | | | | | |
| | 3 | | | | | | | | |
| | | X | 2 / MC | | | | | 36 | 6-inch cobbles |
| | 4 | | | | | | | | |
| | | X | 3 | | GM | | Brown silty fine to coarse gravel with sand and cobbles (medium dense, moist to wet) | | Increasing gravel and cobbles |
| | 5 | | | | | | | | |
| | 6 | | | | | | | | |
| | 7 | | | | | | | | |
| | 8 | | | | | ▽ | | | Perched groundwater |
| | 9 | | | | | | | | |
| | 10 | | | | | | | | |

Test pit completed at 10 feet
Slight groundwater seepage observed at 8 feet
Slight caving observed at 4.5 feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

## Log of Test Pit TP-10

GEOENGINEERS

Project: Lewis County Event & Sports Complex
Project Location: Centralia, Washington
Project Number: 1985-021-00

Figure A-15
Sheet 1 of 1

Redmond: Date:5/7/10 Path:W:\REDMOND\PROJECTS\11198502100\GINT\1198502100TPS.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_TESTPIT_1P_GEOTEC

Date Excavated: 4/28/2010 | Logged By: JTM

Equipment: Rubber Tire Backhoe | Total Depth (ft) 7.5

| Elevation (feet) | Depth (feet) | SAMPLE: Testing Sample | SAMPLE: Sample Name / Testing | Graphic Log | Group Classification | Encountered Water | MATERIAL DESCRIPTION | Moisture Content, % | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | | ML | | Dark brown sandy silt and occasional gravel (medium stiff to stiff, moist) | | |
| | 1 | X | | | | | | | |
| | 2 | | | | | | | | |
| | | | 2 | | | | | | |
| | 3 | X | | | | | | | |
| | | | | | GM | | Brownish-gray silty fine to coarse gravel with sand (medium dense to dense, moist to wet) | | |
| | 4 | X | 3 %F; MC | | | | | 10 | %F=16 |
| | 5 | | | | | | | | |
| | 6 | X | 4 | | | | | | |
| | 7 | | | | | ▽ | | | Perched groundwater |

Test pit completed at 7.5 feet
Slight groundwater seepage observed at 7 feet
No caving observed

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

## Log of Test Pit TP-11

GEOENGINEERS

Project: Lewis County Event & Sports Complex
Project Location: Centralia, Washington
Project Number: 1985-021-00

Figure A-16
Sheet 1 of 1

Redmond: Date:5/7/10 Path:W:\REDMOND\PROJECTS\11198502100\GINT\198502100TPS.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_TESTPIT_1P_GEOTEC

Date Excavated: 4/28/2010 | Logged By: JTM

Equipment: Rubber Tire Backhoe | Total Depth (ft) 8.0

| Elevation (feet) | Depth (feet) | SAMPLE: Testing Sample | SAMPLE: Sample Name / Testing | Graphic Log | Group Classification | Encountered Water | MATERIAL DESCRIPTION | Moisture Content, % | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | | ML | | Brown sandy silt (medium stiff, moist) | | |
| | 1 | | | | | | | | |
| | | | | | ML | | Light brown silt with sand (medium stiff to stiff, moist) | | |
| | 2 | | 2 AL; MC | | | | | 30 | LL=45; PI=17 |
| | 3 | | | | | | | | |
| | 4 | | | | | | | | |
| | 5 | | | | | | | | |
| | 6 | | | | | | | | |
| | | | 3 | | CH | | Grayish-brown fat clay (stiff, moist) | 38 | LL=59; PI=31 |
| | 7 | | | | | | | | |
| | 8 | | | | | | | | Perched groundwater |

Test pit completed at 8 feet
Slight groundwater seepage observed at 8 feet
No caving observed

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

## Log of Test Pit TP-12

GEOENGINEERS

Project: Lewis County Event & Sports Complex
Project Location: Centralia, Washington
Project Number: 1985-021-00

Figure A-17
Sheet 1 of 1

Redmond: Date:5/7/10 Path:W:\REDMOND\PROJECTS\1\1985021\00\GINT\1985021\00TP.S.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_TESTPIT_1P_GEOTEC

Date Excavated: 4/28/2010 | Logged By: JTM

Equipment: Rubber Tire Backhoe | Total Depth (ft) 12.5

| Elevation (feet) | Depth (feet) | SAMPLE: Testing Sample | SAMPLE: Sample Name / Testing | Graphic Log | Group Classification | Encountered Water | MATERIAL DESCRIPTION | Moisture Content, % | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | ML | | Brown sandy silt with trace organics (medium stiff, moist) | | |
| | 1 | X | 1 | | | | | | |
| | 2 | | | | ML | | Light brown silt with sand (medium stiff to stiff, moist to wet) | | |
| | 3 | X | 2 | | | | | | |
| | 4 | | | | | | | | |
| | 5 | | | | | ▼ | | | Perched groundwater |
| | 6 | | | | | | | | |
| | 7 | | | | MH | | Grayish-brown elastic silt (stiff, moist) | | |
| | 8 | | | | | | | | |
| | 9 | X | 3 / MC | | | | | 44 | |
| | 10 | | | | SM | | Brown silty fine sand (medium dense, moist) | | |
| | 11 | X | 4 | | | | | | |
| | 12 | | | | | | | | |

Test pit completed at 12.5 feet
Moderate groundwater seepage observed at 5 feet
Slight caving observed at 10 feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

## Log of Test Pit TP-13

GEOENGINEERS

Project: Lewis County Event & Sports Complex
Project Location: Centralia, Washington
Project Number: 1985-021-00

Figure A-18
Sheet 1 of 1

Redmond: Date:5/7/10 Path:W:\REDMOND\PROJECTS\11198502100\GINT\1985021000TPS.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_TESTPIT_1P_GEOTEC

Date Excavated: 4/28/2010 | Logged By: JTM

Equipment: Rubber Tire Backhoe | Total Depth (ft) 7.5

| Elevation (feet) | Depth (feet) | SAMPLE: Testing Sample | SAMPLE: Sample Name / Testing | Graphic Log | Group Classification | Encountered Water | MATERIAL DESCRIPTION | Moisture Content, % | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | SM | | Brown silty fine to medium sand with trace organics (loose, moist) | | |
| | 1 | X | 1 | | | | | | |
| | 2 | | | | ML | | Light brownish-gray to gray sandy silt (medium stiff to stiff, moist to wet) | | |
| | 3 | | | | | | | | |
| | | X | 2 / MC | | | | | 33 | |
| | 4 | | | | | | | | |
| | 5 | | | | | ▼ | | | Perched groundwater |
| | 6 | | | | | | | | |
| | | X | 3 | | | | | | |
| | 7 | | | | | | | | |

Test pit completed at 7.5 feet
Slight groundwater seepage observed at 5 feet
No caving observed

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

## Log of Test Pit TP-14

GEOENGINEERS

Project: Lewis County Event & Sports Complex
Project Location: Centralia, Washington
Project Number: 1985-021-00

Figure A-19
Sheet 1 of 1

Redmond: Date:5/7/10 Path:W:\REDMOND\PROJECTS\11198502100\GINT\198502100TPS.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_TESTPIT_1P_GEOTEC

Date Excavated: 4/28/2010 | Logged By: JTM

Equipment: Rubber Tire Backhoe | Total Depth (ft) 8.5

| Elevation (feet) | Depth (feet) | SAMPLE: Testing Sample | SAMPLE: Sample Name / Testing | Graphic Log | Group Classification | Encountered Water | MATERIAL DESCRIPTION | Moisture Content, % | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | | ML | | Dark gray silt with sand (medium stiff, moist) | | |
| | 1 | | | | | | | | |
| | 2 | | | | MH | | Light brown elastic silt with sand (medium stiff to stiff, moist to wet) | | |
| | | | 2 / AL; MC | | | | | 32 | LL=51; PI=23 |
| | 3 | | | | | | | | |
| | 4 | | | | | | | | |
| | 5 | | | | | ▼ | | | Perched groundwater |
| | 6 | | | | | | | | |
| | 7 | | | | | | | | |
| | 8 | | 3 / MC | | | | | 44 | |

Test pit completed at 8.5 feet
Slight groundwater seepage observed at 5 feet
No caving observed

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

## Log of Test Pit TP-15

GEOENGINEERS

Project: Lewis County Event & Sports Complex
Project Location: Centralia, Washington
Project Number: 1985-021-00

Figure A-20
Sheet 1 of 1

Redmond: Date:5/7/10 Path:W:\REDMOND\PROJECTS\11198502100\GINT\198502100TPS.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_TESTPIT_1P_GEOTEC

Date Excavated: 4/28/2010 | Logged By: JTM

Equipment: Rubber Tire Backhoe | Total Depth (ft) 9.5

| Elevation (feet) | Depth (feet) | SAMPLE: Testing Sample | SAMPLE: Sample Name / Testing | Graphic Log | Group Classification | Encountered Water | MATERIAL DESCRIPTION | Moisture Content, % | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | ML | | Brown silt with sand (medium stiff to stiff, moist to wet) | | |
| | 1 | X | 1 | | | | | | |
| | 2 | | | | | | | | |
| | 3 | | | | | | | | |
| | 4 | | | | | | | | |
| | 5 | | | | | | | | |
| | 6 | X | 2 / AL; MC | | | | | 35 | LL=46; PI=17 |
| | 7 | | | | | ▼ | | | Perched groundwater |
| | 8 | | | | | | | | |
| | 9 | X | 3 | | SM | | Brown silty fine to medium sand (medium dense, moist to wet) | | |

Test pit completed at 9.5 feet
Slight groundwater seepage observed at 7 feet
Moderate caving observed at 8.5 feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

## Log of Test Pit TP-16

GEOENGINEERS

Project: Lewis County Event & Sports Complex
Project Location: Centralia, Washington
Project Number: 1985-021-00

Figure A-21
Sheet 1 of 1

Redmond: Date:5/7/10 Path:W:\REDMOND\PROJECTS\11198502100\GINT\198502100TPS.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_TESTPIT_1P_GEOTEC

Date Excavated: 4/28/2010 | Logged By: JTM

Equipment: Rubber Tire Backhoe | Total Depth (ft) 8.0

| Elevation (feet) | Depth (feet) | SAMPLE: Testing Sample | SAMPLE: Sample Name / Testing | Graphic Log | Group Classification | Encountered Water | MATERIAL DESCRIPTION | Moisture Content, % | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | MH | | Dark brown elastic silt with silt, occasional gravel and trace organics (medium stiff to stiff, moist to wet) | | |
| | 1 | X | 1 / AL; MC | | | | | 32 | LL=55; PI=25 |
| | 2 | | | | | | | | |
| | 3 | X | 2 | | | | | | |
| | 4 | | | | | | | | |
| | 5 | | | | | ▼ | | | Perched groundwater |
| | 6 | | | | | | | | |
| | 7 | X | 3 / MC | | | | | 36 | |
| | 8 | | | | | | | | |

Test pit completed at 8 feet
Slight groundwater seepage observed at 5 feet
Slight caving observed at 7 feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

## Log of Test Pit TP-17

GEOENGINEERS

Project: Lewis County Event & Sports Complex
Project Location: Centralia, Washington
Project Number: 1985-021-00

Figure A-22
Sheet 1 of 1

Redmond: Date:5/7/10 Path:W:\REDMOND\PROJECTS\11198502100\GINT\11985021000TPS.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_TESTPIT_1P_GEOTEC

# APPENDIX B
## Laboratory Testing

# APPENDIX B
# LABORATORY TESTING

## General

Soil samples obtained from the explorations were transported to our laboratory and examined to confirm or modify field classifications, as well as to evaluate index properties of the soil samples. Representative samples were selected for laboratory testing consisting of the determination of the moisture content, percent fines content, grain size distribution and Atterberg testing (plasticity characteristics). A composite sample was also tested to determine the California Bearing Ratio (CBR) for pavement design. The tests were performed in general accordance with test methods of ASTM International (ASTM) or other applicable procedures.

## Moisture Content Testing

Moisture content tests were completed in general accordance with ASTM D 2216 for representative samples obtained from the explorations. The results of these tests are presented on the exploration logs in Appendix A at the depths at which the samples were obtained.

## Percent Passing U.S. No. 200 Sieve

Selected samples were "washed" through the U.S. No. 200 mesh sieve to determine the relative percentages of coarse- and fine-grained particles in the soil. The percent passing value represents the percentage by weight of the sample finer than the U.S. No. 200 sieve. These tests were conducted to verify field descriptions and to determine the fines content for analysis purposes. The tests were conducted in general accordance with ASTM D 1140, and the results are shown on the exploration logs at the respective sample depths.

## Sieve Analyses

Sieve analyses were performed on selected samples in general accordance with ASTM D 422 to determine the sample grain size distribution. The wet sieve analysis method was used to determine the percentage of soil greater than the U.S. No. 200 mesh sieve. The results of the sieve analyses were plotted, were classified in general accordance with the Unified Soil Classification System (USCS) and are presented in Figures B-1 through B-5.

## Atterberg Limits Testing

Atterberg limits testing was performed on selected fine-grained soil samples. The tests were used to classify the soil as well as to evaluate index properties. The liquid limit and the plastic limit were estimated through a procedure performed in general accordance with ASTM D 4318. The results of the Atterberg limits testing are summarized in Figures B-6 and B-7.

## CBR Testing

A CBR test was performed on a composite soil sample in general accordance with ASTM D 1883. The results of the CBR test are presented in the following table.

| Sample Location | Sample Depth (feet) | Soil Type | Approximate Percent Maximum Dry Density | CBR |
|---|---|---|---|---|
| Composite | 2.0 –4.0 | SM with some organics | 90 | 2 |

The test was completed in general accordance with the ASTM D 1557 test procedure.

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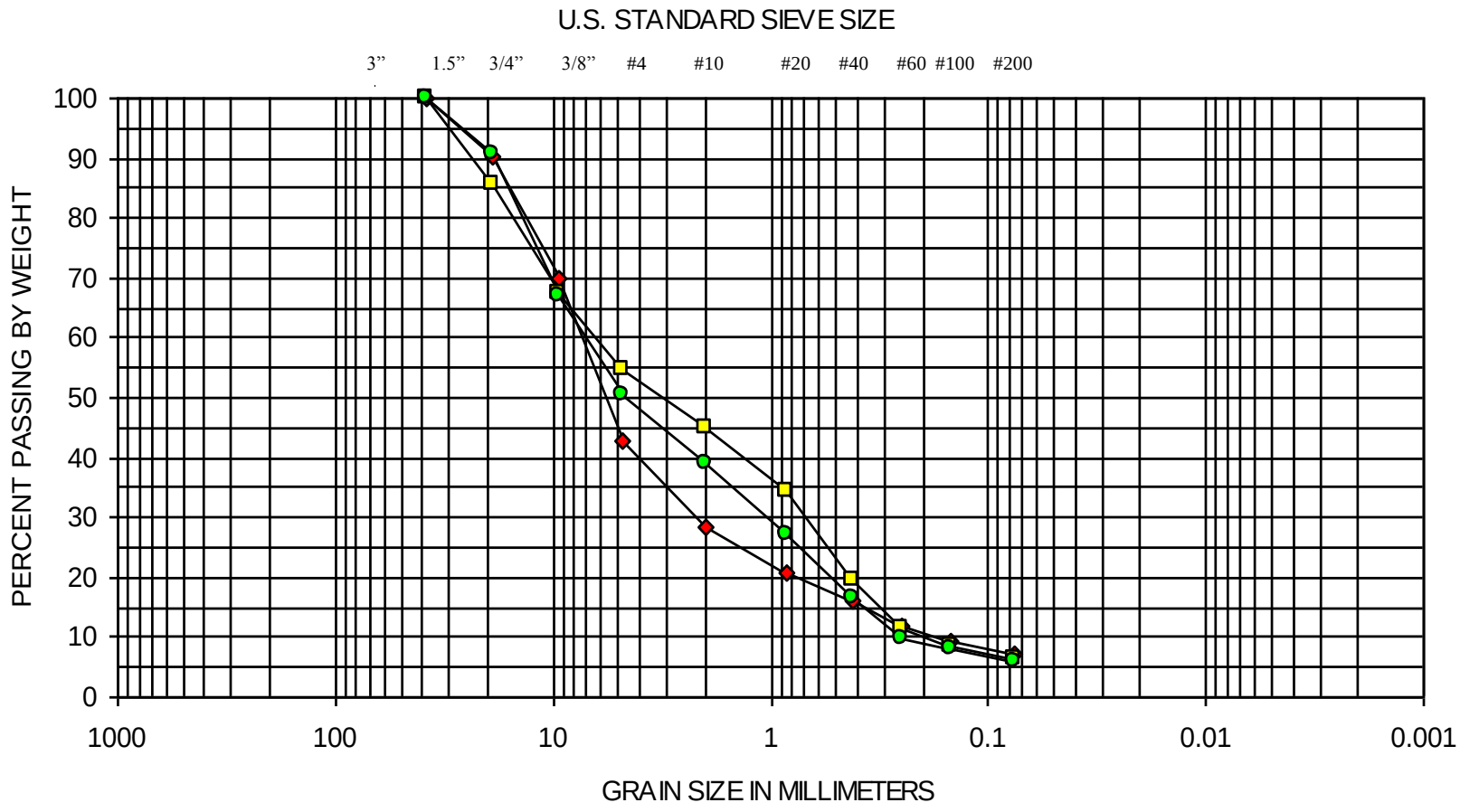


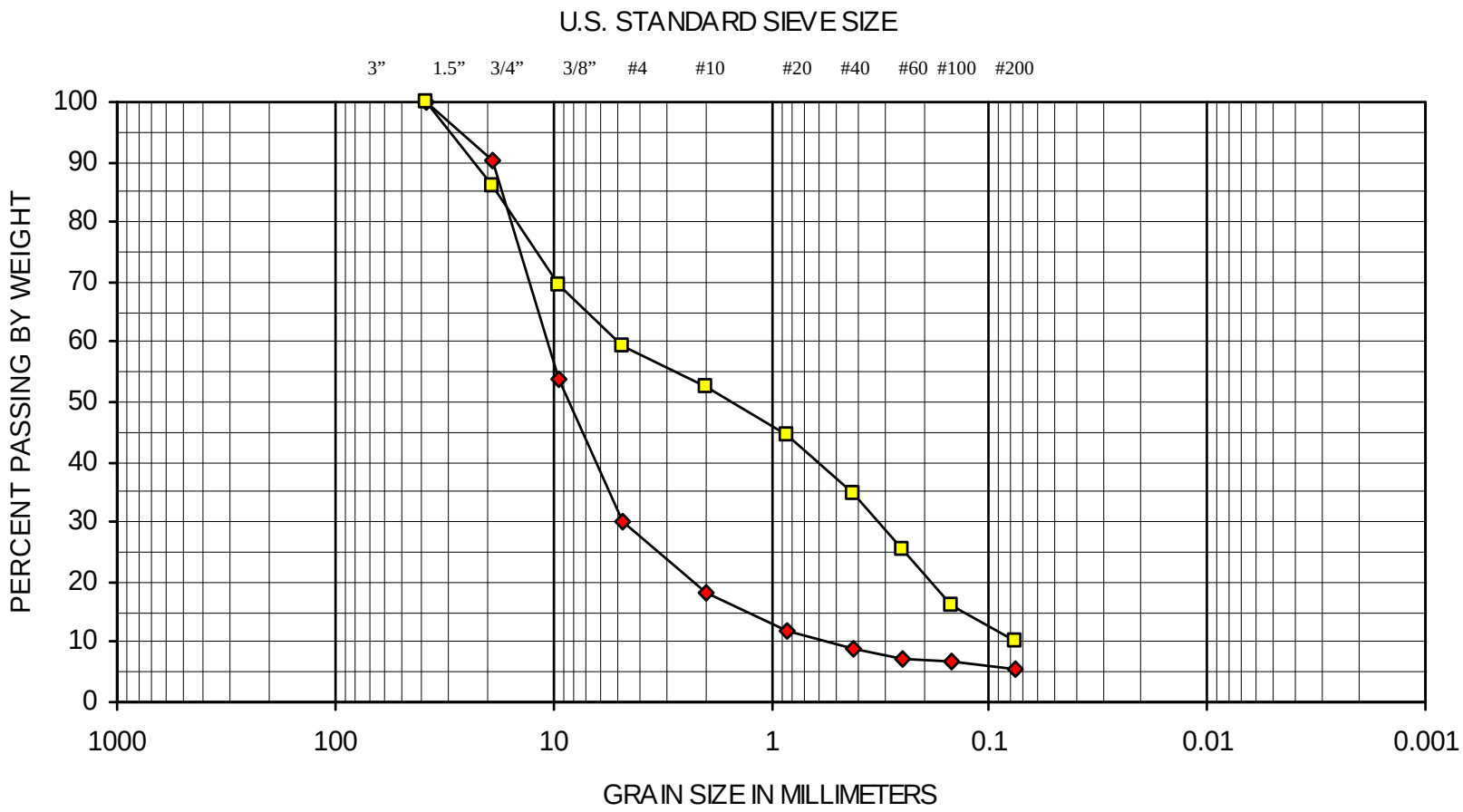

| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | COARSE | FINE | COARSE | MEDIUM | FINE | |

| SYMBOL | EXPLORATION NUMBER | DEPTH (ft) | SOIL CLASSIFICATION |
|---|---|---|---|
| ◆ | B-1, S-5 | 25 | Gray fine to coarse gravel with silt and sand (GP-GM) |
| ■ | B-2, S-5 | 25 | Gray fine to coarse sand with silt and gravel (SP-SM) |
| ● | B-3, S-6 | 30 | Gray fine to coarse sand with silt and gravel (SP-SM) |

**SIEVE ANALYSIS RESULTS**

**FIGURE B-1**

GEOENGINEERS



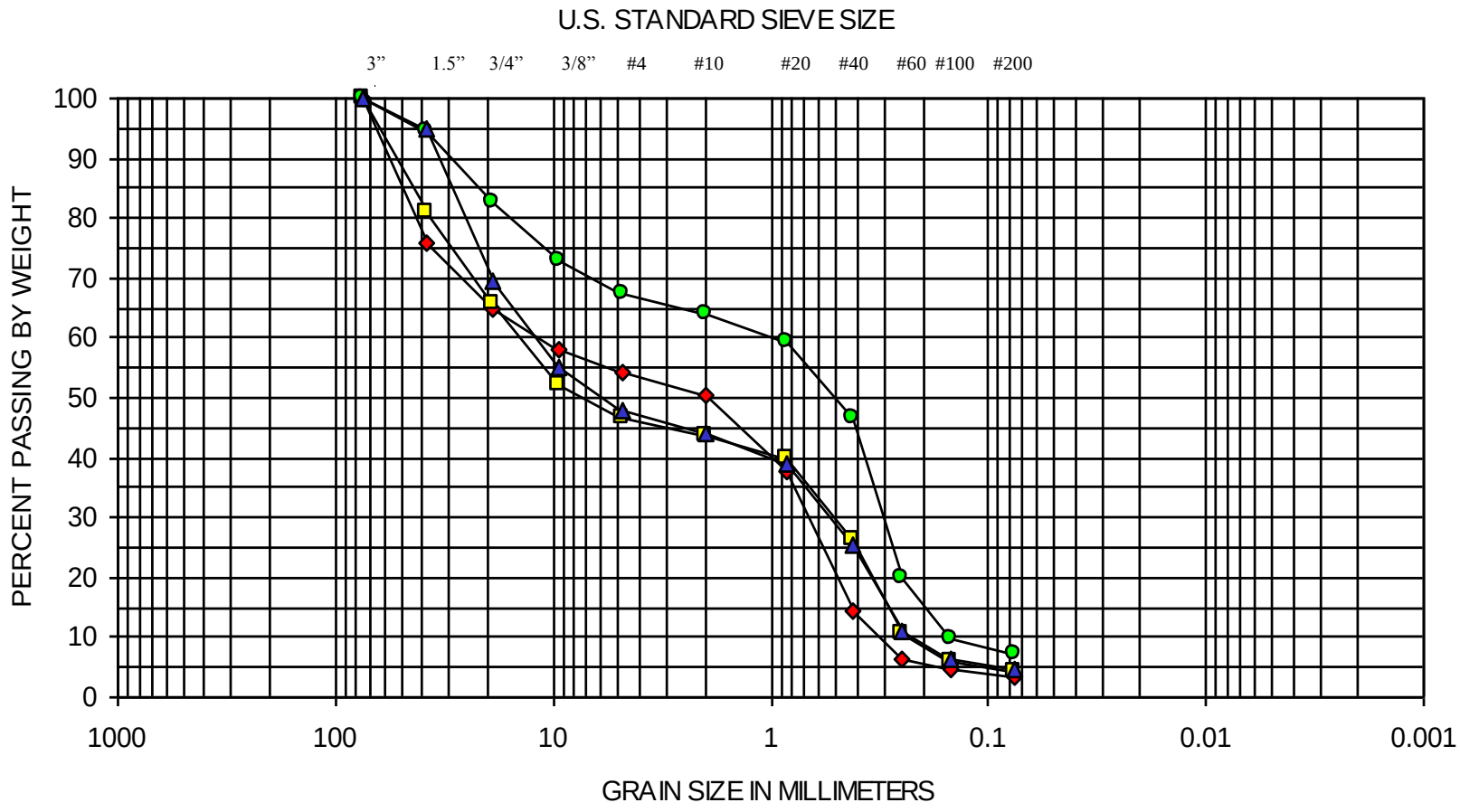

| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | COARSE | FINE | COARSE | MEDIUM | FINE | |

| SYMBOL | EXPLORATION NUMBER | DEPTH (ft) | SOIL CLASSIFICATION |
|---|---|---|---|
| ◆ | B-4, S-7 | 35 | Brown fine to coarse gravel with sand (GP-GM) |
| ■ | B-4, S-8 | 40 | Gray fine to medium sand with silt and gravel (SP-SM) |

**SIEVE ANALYSIS RESULTS**

**FIGURE B-2**

GEOENGINEERS



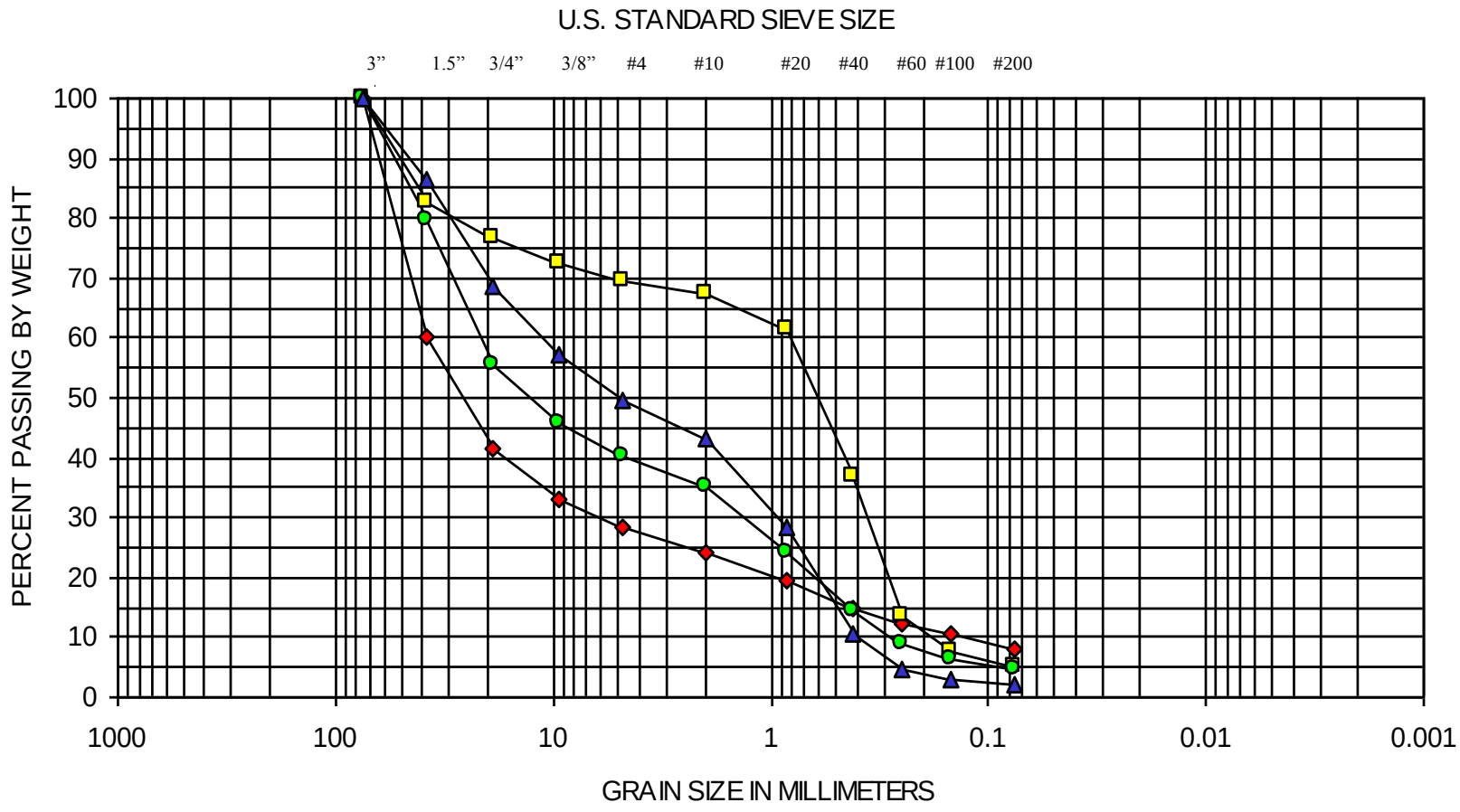

| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | COARSE | FINE | COARSE | MEDIUM | FINE | |

| SYMBOL | EXPLORATION NUMBER | DEPTH (ft) | SOIL CLASSIFICATION |
|---|---|---|---|
| ◆ | TP-1, S-2 | 4 | Brown fine to medium sand with gravel (SP) |
| ■ | TP-2, S-2 | 4.5 | Brown fine to coarse gravel with sand (GP) |
| ● | TP-3, S-2 | 3 | Brownish gray fine to medium sand with silt and gravel (SP-SM) |
| ▲ | TP-4, S-2 | 3 | Brown fine to coarse gravel with sand (GP-GM) |

**SIEVE ANALYSIS RESULTS**

**FIGURE B-3**

GEOENGINEERS



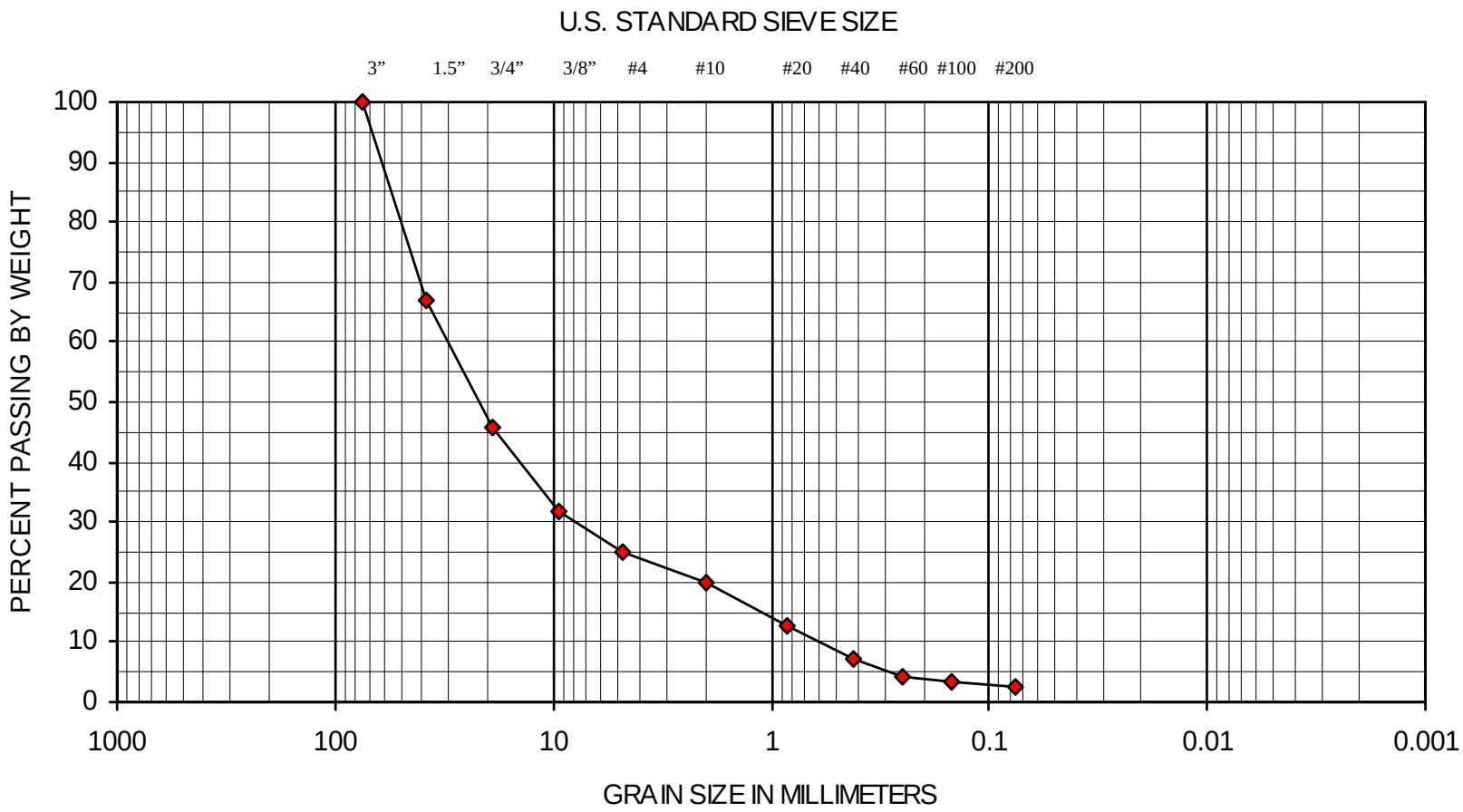

| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | COARSE | FINE | COARSE | MEDIUM | FINE | |

| SYMBOL | EXPLORATION NUMBER | DEPTH (ft) | SOIL CLASSIFICATION |
|---|---|---|---|
| ◆ | TP-5, S-3 | 5 | Brown fine to coarse gravel with silt and sand (GP-GM) |
| ■ | TP-6, S-3 | 4.5 | Brown fine to medium sand with gravel (SP) |
| ● | TP-8, S-2 | 3 | Brown fine to coarse gravel with sand (GP) |
| ▲ | TP-8, S-4 | 7 | Brown fine to coarse gravel with sand (GP) |

**SIEVE ANALYSIS RESULTS**

**FIGURE B-4**

GEOENGINEERS




| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | COARSE | FINE | COARSE | MEDIUM | FINE | |

| SYMBOL | EXPLORATION NUMBER | DEPTH (ft) | SOIL CLASSIFICATION |
|---|---|---|---|
| ◆ | TP-10, S-3 | 7 | Brown fine to coarse gravel with sand (GP) |

**SIEVE ANALYSIS RESULTS**

**FIGURE B-5**

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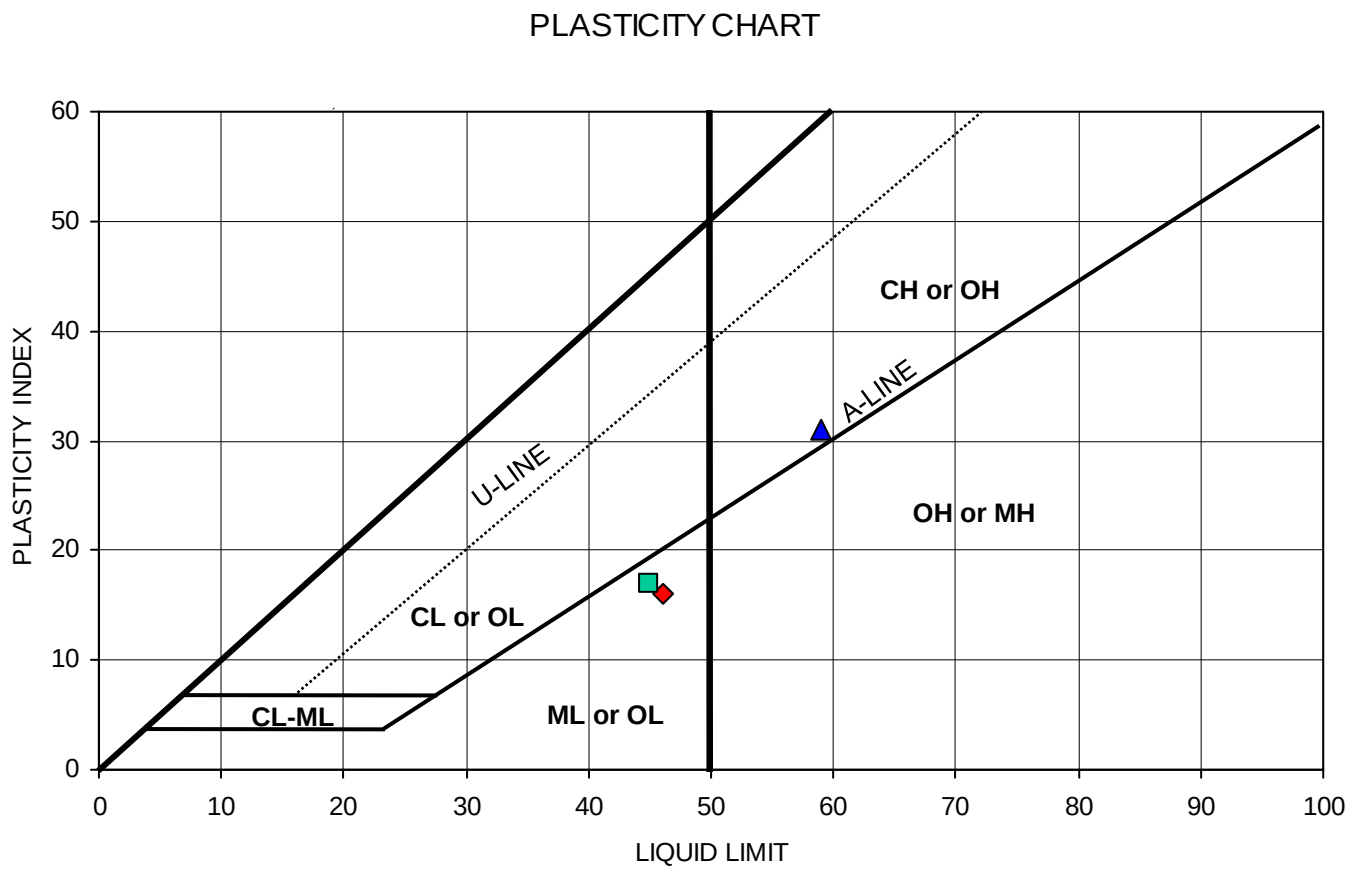
FIGURE B-6

ATTERBERG LIMITS TEST RESULTS




| SYMBOL | EXPLORATION NUMBER | SAMPLE DEPTH | MOISTURE CONTENT (%) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|
| ◆ | TP-9 | 3.0’ | 30 | 46 | 16 | Brown silt with trace of sand (ML) |
| ■ | TP-12 | 2.5’ | 30 | 45 | 17 | Dark-brown silt with trace sand (ML) |
| ▲ | TP-12 | 7.0’ | 38 | 59 | 31 | Dark-brown fat clay with trace sand (CH) |

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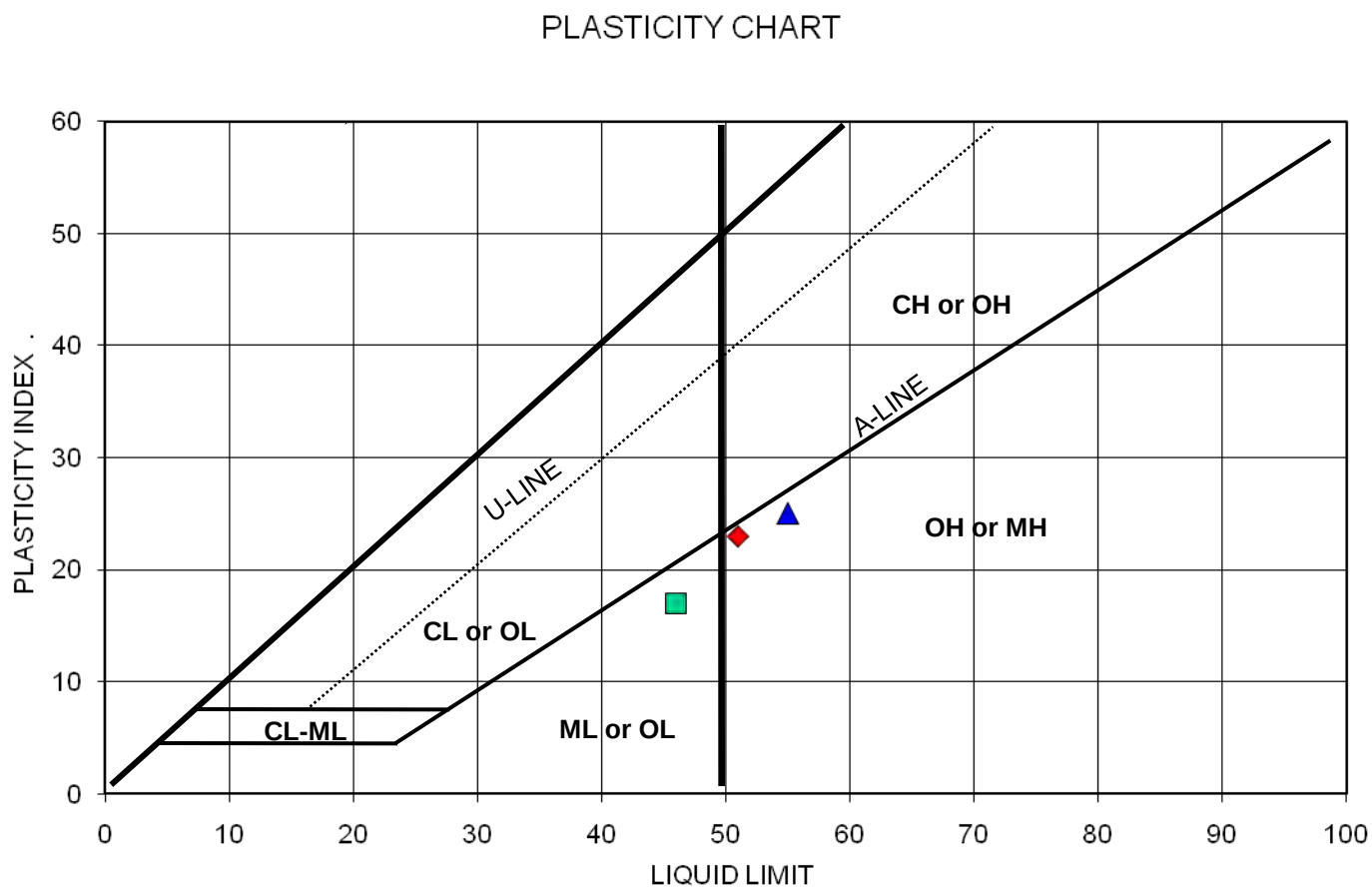
FIGURE B-7

ATTERBERG LIMITS TEST RESULTS




| SYMBOL | EXPLORATION NUMBER | SAMPLE DEPTH | MOISTURE CONTENT (%) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|
| ◆ | TP-15 | 3.0' | 32 | 51 | 23 | Brown elastic silt with trace sand (MH) |
| ■ | TP-16 | 6.5' | 35 | 46 | 17 | Brown silt with trace sand (ML) |
| ▲ | TP-17 | 3.0' | 32 | 55 | 25 | Dark-brown elastic silt with trace sand (MH) |

# APPENDIX C
## Report Limitations and Guidelines for Use

## APPENDIX C
## REPORT LIMITATIONS AND GUIDELINES FOR USE[1]

This appendix provides information to help you manage your risks with respect to the use of this report.

### Geotechnical Services Are Performed for Specific Purposes, Persons and Projects

This report has been prepared for the exclusive use of the City of Centralia for the Lewis County Event Center & Sports Complex project. This report is not intended for use by others, and the information contained herein is not applicable to other sites.

GeoEngineers structures our services to meet the specific needs of our clients. For example, a geotechnical or geologic study conducted for a civil engineer or architect may not fulfill the needs of a construction contractor or even another civil engineer or architect that are involved in the same project. Because each geotechnical or geologic study is unique, each geotechnical engineering or geologic report is unique, prepared solely for the specific client and project site. Our report is prepared for the exclusive use of our Client. No other party may rely on the product of our services unless we agree in advance to such reliance in writing. This is to provide our firm with reasonable protection against open-ended liability claims by third parties with whom there would otherwise be no contractual limits to their actions. Within the limitations of scope, schedule and budget, our services have been executed in accordance with our Agreement with the Client and generally accepted geotechnical practices in this area at the time this report was prepared. This report should not be applied for any purpose or project except the one originally contemplated.

### A Geotechnical Engineering or Geologic Report Is Based on a Unique Set of Project-Specific Factors

This report has been prepared for the Lewis County Event Center & Sports Complex project in Centralia, Washington. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, do not rely on this report if it was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

For example, changes that can affect the applicability of this report include those that affect:

- the function of the proposed structure;
- elevation, configuration, location, orientation or weight of the proposed structure;
- composition of the design team; or
- project ownership.

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[1] Developed based on material provided by ASFE, Professional Firms Practicing in the Geosciences; www.asfe.org.

If important changes are made after the date of this report, GeoEngineers should be given the opportunity to review our interpretations and recommendations and provide written modifications or confirmation, as appropriate.

### Subsurface Conditions Can Change

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by manmade events such as construction on or adjacent to the site, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations. Always contact GeoEngineers before applying a report to determine if it remains applicable.

### Most Geotechnical and Geologic Findings Are Professional Opinions

Our interpretations of subsurface conditions are based on field observations from widely spaced sampling locations at the site. Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoEngineers reviewed field and laboratory data and then applied our professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ, sometimes significantly, from those indicated in this report. Our report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions.

### Geotechnical Engineering Report Recommendations Are Not Final

Do not over-rely on the preliminary construction recommendations included in this report. These recommendations are not final, because they were developed principally from GeoEngineers' professional judgment and opinion. GeoEngineers' recommendations can be finalized only by observing actual subsurface conditions revealed during construction. GeoEngineers cannot assume responsibility or liability for this report's recommendations if we do not perform construction observation.

Sufficient monitoring, testing and consultation by GeoEngineers should be provided during construction to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated, and to evaluate whether or not earthwork activities are completed in accordance with our recommendations. Retaining GeoEngineers for construction observation for this project is the most effective method of managing the risks associated with unanticipated conditions.

### A Geotechnical Engineering or Geologic Report Could Be Subject to Misinterpretation

Misinterpretation of this report by other design team members can result in costly problems. You could lower that risk by having GeoEngineers confer with appropriate members of the design team after submitting the report. Also retain GeoEngineers to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering or geologic report. Reduce that risk by having GeoEngineers participate in pre-bid and preconstruction conferences, and by providing construction observation.

### Do Not Redraw the Exploration Logs

Geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering or geologic report should never be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, but recognize that separating logs from the report can elevate risk.

### Give Contractors a Complete Report and Guidance

Some owners and design professionals believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering or geologic report, but preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with GeoEngineers and/or to conduct additional study to obtain the specific types of information they need or prefer. A pre-bid conference can also be valuable. Be sure contractors have sufficient time to perform additional study. Only then might an owner be in a position to give contractors the best information available, while requiring them to at least share the financial responsibilities stemming from unanticipated conditions. Further, a contingency for unanticipated conditions should be included in your project budget and schedule.

### Contractors Are Responsible for Site Safety on Their Own Construction Projects

Our geotechnical recommendations are not intended to direct the contractor's procedures, methods, schedule or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and to adjacent properties.

### Read These Provisions Closely

Some clients, design professionals and contractors may not recognize that the geoscience practices (geotechnical engineering or geology) are far less exact than other engineering and natural science disciplines. This lack of understanding can create unrealistic expectations that could lead to disappointments, claims and disputes. GeoEngineers includes these explanatory "limitations" provisions in our reports to help reduce such risks. Please confer with GeoEngineers if you are unclear how these "Report Limitations and Guidelines for Use" apply to your project or site.

### Geotechnical, Geologic and Environmental Reports Should Not Be Interchanged

The equipment, techniques and personnel used to perform an environmental study differ significantly from those used to perform a geotechnical or geologic study and vice versa. For that reason, a geotechnical engineering or geologic report does not usually relate any environmental findings, conclusions or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. Similarly, environmental reports are not used to address geotechnical or geologic concerns regarding a specific project.

## Biological Pollutants

GeoEngineers' Scope of Work specifically excludes the investigation, detection, prevention or assessment of the presence of Biological Pollutants. Accordingly, this report does not include any interpretations, recommendations, findings, or conclusions regarding the detecting, assessing, preventing or abating of Biological Pollutants and no conclusions or inferences should be drawn regarding Biological Pollutants, as they may relate to this project. The term "Biological Pollutants" includes, but is not limited to, molds, fungi, spores, bacteria, and viruses, and/or any of their byproducts.

If Client desires these specialized services, they should be obtained from a consultant who offers services in this specialized field.

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