ALPINE RIDGE GEOTECHNICAL SERVICES

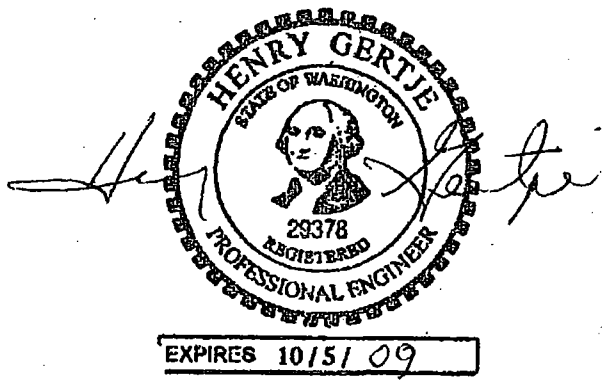
GEOTECHNICAL ENGINEERING REPORT

For

PROPOSED MAYTOWN FIRE STATION

Owner
Littlerock Fire Rescue
Thurston County Fire Protection District #11

Prepared By



Henry Gertje, P.E., President
Alpine Ridge Geotechnical Services

March 31, 2008

Resource Stewardship & Land Use

Littlerock Fire Department
Maytown Site Map

SITE VICINITY MAP
Location near
Interstate 5
Maytown Exit 88

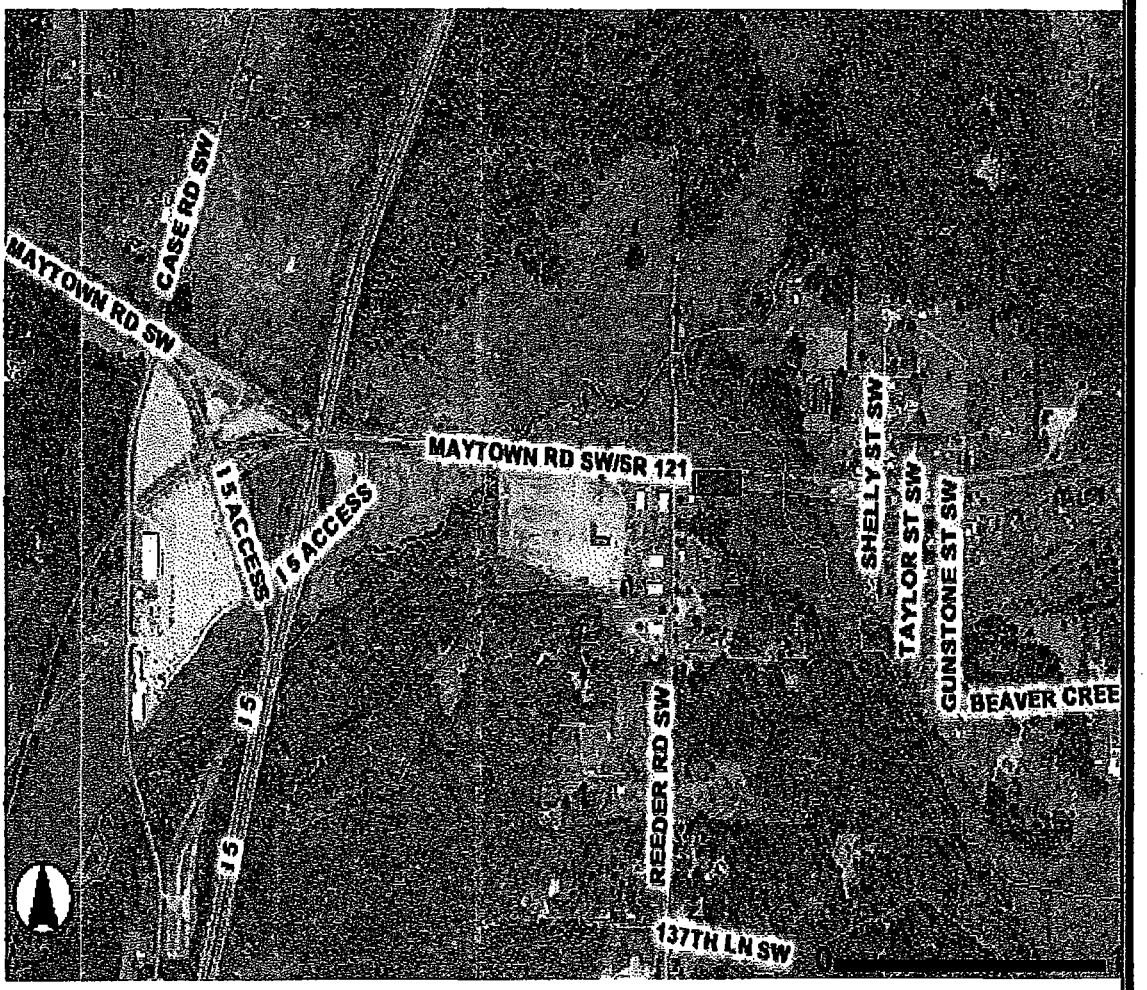


FIGURE 1

Littlerock Fire Department
Maytown Site Map

Site Aerial Photo with Contours

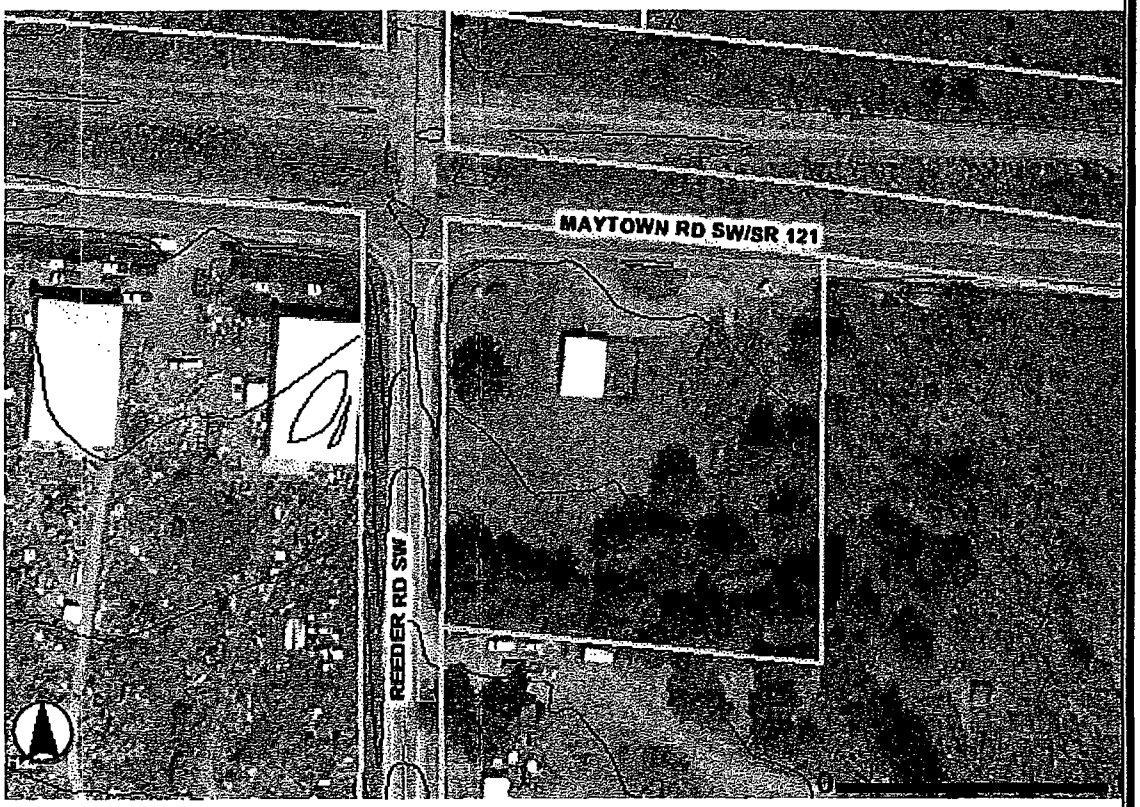
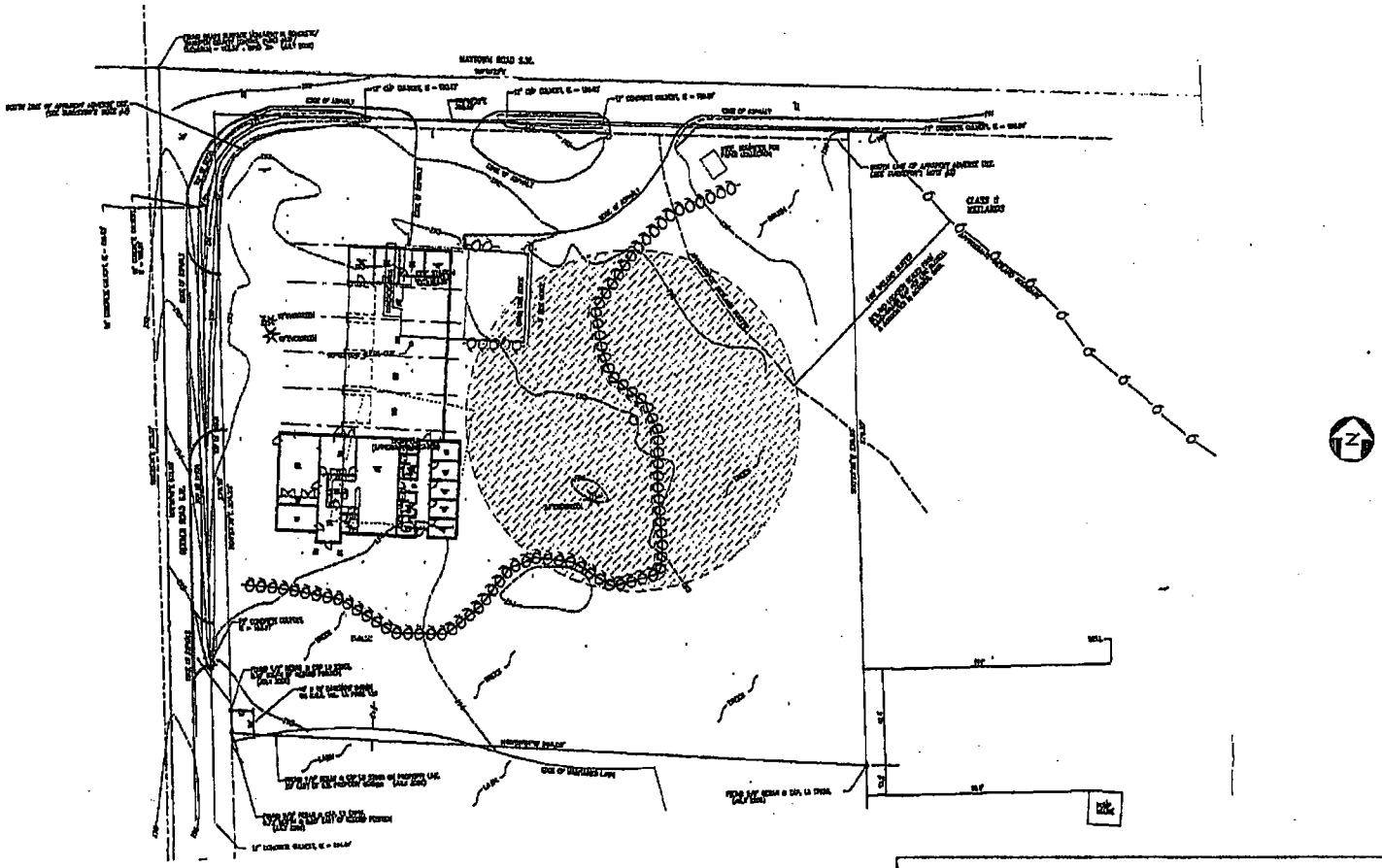
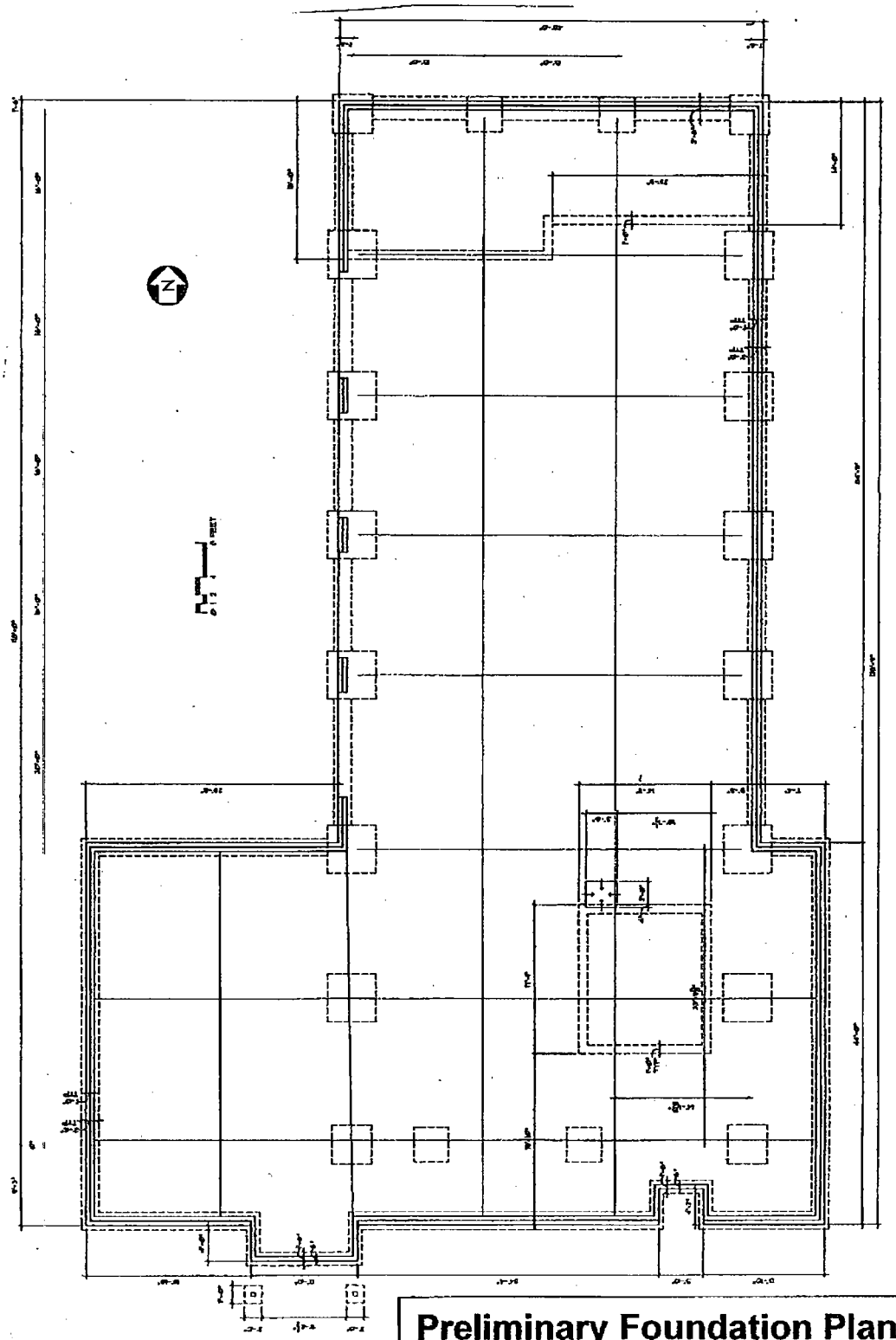


Figure 2



Preliminary Site Plan

Figure 3



Preliminary Foundation Plan

Figure 4

MAYTOWN FIRE STATION GEOTECHNICAL REPORT

TABLE OF CONTENTS

Section-Subject	Page
1.0 PURPOSE OF GEOTECHNICAL INVESTIGATION	1
2.0 PROJECT DESCRIPTION	1
3.0 SCOPE OF SERVICES	1
4.0 SITE CONDITIONS	2
4.1 Project Site Conditions	
4.2 Subsurface Explorations	
4.3 Subsurface Conditions	
5.0 LABORATORY TESTING PROGRAM	5
6.0 DESCRIPTION OF ENGINEERED PROJECT COMPONENTS	5
7.0 CONCLUSIONS	5
8.1 Geological Interpretations	
8.2 Seismic Risks	
8.3 Site Stormwater Infiltration	
8.0 RECOMMENDATIONS	6
8.1 General	
8.2 Seismic Design	
8.3 Foundation Design	
8.4 Roadway Pavement and Building Slabs	
8.5 Construction Monitoring, Geotechnical Engineering Certification	
9.0 LIMITATIONS	9

ATTACHMENTS

Attachment A: Test Pit Layout and Logs
Attachment B: Laboratory Testing Data
Attachment C: Subsurface Data by Others
Attachment D: Thurston County Soil Infiltration Form

1.0 PURPOSE OF GEOTECHNICAL INVESTIGATION

This geotechnical investigation report provides the basis for engineering design and construction of the proposed Maytown fire station. Geotechnical engineering characterizations, conclusions and recommendations are provided for design and construction of structural pavements and slabs, structure foundations, stormwater infiltration and construction criteria for the subject project.

2.0 PROJECT DESCRIPTION

Littlerock Fire District has planned and is developing engineering plans and specifications for permitting and constructing the subject Maytown Fire Station. The site is to be located in the southeastern quadrant of Reeder Road and Maytown Road in South Thurston County. We understand the station will be a new 5,400 square foot structure with four truck bays, three dorm rooms, offices and ancillary rooms. Figures 3 and 4 provide a preliminary site plan and a preliminary floor plan. The buildings will be single story with high ceilings and mezzanines, steel framed with reinforced concrete spread footing foundations and slabs on grade.

Final site, building, and foundation layouts were provided by Calvin Jordan Associates, Inc. on January 28, 2008. Foundation layout is being provided by J. R. Bonnett Engineering. Civil site design is by Warner Engineering.

3.0 SCOPE OF SERVICES

Alpine Ridge Geotechnical Services (AR) basic services to the Littlerock Fire Department are described in AR's proposal letter of July 19, 2006. A field investigation was performed in August 2006, followed by a feasibility report dated August 16, 2006 for preliminary design and planning. Client and design team communications lead to a second field investigation in January 2007 to provide groundwater level monitoring near the southern edge of the property. Groundwater elevations were observed periodically by AR.

Geotechnical engineering services include recommendations for foundation soil bearing capacity, seismic parameters for structural design, stormwater retention and infiltration systems, pavement sections for parking and driveways, soil characterization for septic system, grading and subgrade preparation requirements, field investigation and laboratory soil testing. Construction specifications and monitoring requirements are provided. This report is to be submitted with the building permit submittal to Thurston County Development Services.

Resource Stewardship & Land Use

4.0 SITE CONDITIONS

4.1 Project Site Description

The Maytown Project Site is located in the southeast quadrant of the State Route 121 (Maytown Road)/Reeder Road intersection. The lot is County Parcel 126-043-30200 at 3131 Maytown Road. Please refer to the Site Vicinity Map, Figure 1. The site is located approximately 0.5 mile east of the Interstate 5 Maytown Interchange at Milepost 95.

The existing fire station and road approach occupy the north-central portion of the lot. A warehouse/trucking company is located immediately west of the site. Burlington Northern rail road line parallels SR 121. North of the railroad is a large hayfield. Approximately 0.2 miles east of the site is Maytown village. South of the site, meadow lots cover an east-west trending slope.

The site is located near the south-central potion of an east-west valley. Beaver Creek meanders through the valley floor, passing immediately east of the subject lot, trending northwest beneath SR 121, bending west, then southwest, crossing SR 121 again before crossing under I-5 south of the Maytown Interchange. Topographically, the ground in the project site area is nearly level, sloping very gently towards the west with less than 1 foot relief over the property.

The lot surface is vegetated by mowed grass. A narrow grove of Douglas Fir trees ranging from 4 to 12 inches in diameter is present along the southern margin of the property. Several other isolated fir trees up to 1-foot in diameter are also present. The eastern quarter of the property is covered by medium to light brush, including scotch broom, blackberries and other perennial plants. Several old orchard apple trees are located in this area.

4.2 Subsurface Explorations

The Preliminary Site Plan, Attachment A. Figure 1, illustrates where test pits were excavated. Four pits were excavated on August 4, 2006 and a fifth test pit was added on March 4, 2007 to gather groundwater data in another location. Test pits were advanced by David Nelson, backhoe owner-operator, to depths ranging from 8.7 to 10.0 feet. Alpine Ridge Geotechnical Services, Henry Gertje, observed the excavations, sampled materials and logged test pits. Test pits were evaluated for stability and groundwater seepage, then backfilled immediately. Standpipe piezometers were installed in Test Pits 1 and 5 to depths of 9.5 feet below grade. Logs of the test pits are provided in Attachment B.

4.3 Subsurface Conditions

4.3.1 Soil Stratigraphy

The following soil layers were encountered and generally characterized on the basis of field measurements, observations and laboratory testing.

Resource Stewardship & Land Use

Soil Unit 1: Topsoil ranging in thickness from 0.5 to 1.3 feet. In Test Pit 3, a deeper area of topsoil was observed with substantial fines content. Topsoil consists of medium brown clayey silty well-graded Sand with gravel. Grass roots and organic matter are prevalent in the top 3 to 4 inches.

Soil Unit 2: Inorganic Silty Sand and Sandy Gravel ranging from 0.5 minimum to approximately 3 feet in maximum depth. This deposit varies gradationally from sand with up to 10% fines (minus 200-sieve content), to gravelly sand with less than 5% fines. Relative density is medium to dense. Density and gravel content increase with depth. In Test Pit 3, northwestern quadrant of the lot, the soil in the 1 to 2.0 foot depth range contains little gravel and substantial silty clay. The other three test pits exhibited lower fines contents (2% to 5%) within the approximate depth range of 1.0 to 3 feet. Plasticity of the fines is high. Moisture content during the dry period of the year was approximately 7%.

A composite sample of moistened soil from this depth range exhibited slightly plastic behavior and complete loss of granularity above an approximate moisture content of 15%. The presence of high plasticity clay imparts overall plasticity to this soil matrix when the fines content exceeds 5%. When the average mixture contains less than 5% fines, the soil is predominantly skeletal in nature and has moderate to low sensitivity.

Soil Unit 3: Inorganic Sandy well graded Gravel with Cobbles ranging from approximately 2.5 to greater than 10 feet in depth. At depths below 2.5 feet, the soil grades to predominantly well-graded, subrounded gravel with varying amounts of well-graded sand and cobbles. Density of Soil Unit 3 increases with depth from dense to very dense. At approximately 7 feet depth, the cobbles and gravel are coated by a black mineral deposit. Cementation of the coarser particles was evident. Minor caving of the top 5 feet of the test pits occurred; however, the high soil density at depth resulted in very slow excavation rates and nearly vertical side walls.

4.3.2 Water Table

An extended period of dryness preceded the investigation of July 2006. Groundwater was not encountered. Soil moisture increased from dry to very moist near the maximum depth explored of 10.0 feet. Piezometer 2, installed in March 2007, measured groundwater near 9 feet depth. Black mineral staining was observed in all four test pits, in the depth range of 6.5 feet to about 8 feet. Groundwater table rises within this range in late winter to early spring as summarized in Table 4.1. Groundwater elevation was monitored via standpipe piezometer during the winters of late 2006 to early 2008.

Resource Stewardship & Land Use

Table 4.1

Maytown Fire Station Site Piezometer Readings				
Date measured	Depth below ground surface, ft.	Previous week rainfall at Tumwater	Average rainfall prev week at Tumwater	Comments
Test Pit 1: Eastern Edge of property				
Nov. 8, 2006	5.2	11.5"	~2"	Nov 7-8 was a 50-year rainfall
Nov. 9, 2006	5.5	11.0"	~2"	
Nov. 12, 2006	4.5	4.0"	~2"	
Nov. 15, 2006	4.8	4.0"	2.2"	
Nov. 19, 2006	5.9	2"	2.2"	
Dec. 2, 2006	3.6	0	2.3"	Well was being drilled ~ 10' south. Groundwater conditions disturbed
Dec. 20, 2006	3.9	2"	2.4"	Piezometer silted by well drilling
Jan 26, 2007	5.7	<0.5", <1.0" in 2 weeks	2.5"	
Mar. 7, 2007	NR	NR	1.5"	
Feb. 9, 2008	5.9	3.0"	~2"	
Test Pit 5: Southern Area of property				
Mar. 7, 2007	8.5	<0.5"	1.5"	Piezometer was installed on 3/04/07
Feb. 9, 2008	6.7	3.0", 5.5" in last 2 weeks	~2"	

As indicated in Table 4.1 above, Piezometer 1 was disturbed by drilling of a water well nearby in December 2006. Localized temporary rise in the water table resulted. Piezometer 5 was installed to obtain data in an area where infiltration is more likely to be routed. The measurements indicate the water table surface is approximately 1 foot lower in the Piezometer 5 area.

4.3.3 Subsurface Data Obtained by Others

Detailed test boring and laboratory information obtained by the Washington State Department of Transportation (WSDOT) near the project site is included in Attachment C. At least seven WSDOT borings explored deep soil conditions in the Maytown Interchange within ½ mile of the Maytown project site. WSDOT Test Boring H-29-2005 located approximately 1400 feet west of the site is included because its stratigraphy appears to represent general subsurface conditions under the valley. Standard Penetrometer Tests (SPT, ASTM D-1586) were advanced by WSDOT at 5-foot intervals. Laboratory classifications and basic index testing properties were performed for each SPT.

H-29-2005 encountered dense silty sand below a similar stratigraphy described for the

project site above. Underlying the dense sand is stiff, high plasticity clay and plastic silt extending to a maximum depth of approximately 115 feet, underlain by siltstone. Standard Penetrometer Tests in the deeper plastic soil range 9 to 28 blows per foot, indicating stiff to hard conditions.

5.0 LABORATORY TESTING

Laboratory testing consisted of wet sieve and dry sieve analyses (ASTM D-2487). Particle size distribution reports of 5 samples are provided in Appendix C. All samples tested were from the top six feet and are predominantly coarse grained soil. Shallow samples less than 2 feet depth contained 8 to 10 percent fines (-200 sieve), while samples in the 3 to 6 foot depth range contained less than 2 percent fines.

The sieve analysis data show that Soil Unit 3, generally below 30 inches in depth, is approximately 80% gravel. It should be noted that these do not include the cobble sized components. Visual estimation of the cobble and coarser fraction is 5 to 10 percent. Soil Unit 3 is therefore 85 to 90 percent gravel or coarser.

6.0 DESCRIPTION OF ENGINEERED PROJECT COMPONENTS

In addition to the description provided in Section 3.0 above, our understanding of engineered project components includes the following.
1) Shallow spread footings placed on native soil or shallow structural fill. Minimum frost embedment is assumed.
2) Floor slabs will be cast on subgrade, shallow structural fill or insulation.
3) Pervious concrete or asphalt will be used in parking areas with graded filter base layers.
4) The pavement section will be 10" pervious concrete over 4" shoulder ballast (WSDOT Standard Specification 9-03.9(2), over 24" sand. The shoulder ballast will provide infiltration and storage volume and the sand layer will provide water quality treatment. The total depth from finished grade to bottom of the "storm system" is 3.167 feet.
5) Roof runoff will be routed through cisterns with overflow directed into infiltration galleries.

7.0 CONCLUSIONS

7.1 Geological Interpretations

Geological soil sequences were deposited under this area during glacial advances and recessions. Above siltstone bedrock, lake or marine deposits of 80 feet thickness consist of fine-grained plastic lacustrine silt and clay. A glacial re-advance is evident as these soils are over-consolidated, rendering this plastic material strong and essentially pre-settled. Prevailing theories hold that the southernmost advance of the last sheet ice (Vashon Stade, 10,000+ years ago), are located near the project site. The cobbly gravel deposited above the lacustrine soils indicative of a glacial end-moraine texture. The gravel is blanketed by shallow clayey sand alluvium. The finer, yet granular near-surface soil is more variable than the underlying gravel soils below.

Soil Survey of Thurston County, USDA SCS, Washington State Department of Natural

Resource Stewardship & Land Use

Resources, indicates the site is underlain by Everett very gravelly sandy loam. The soil is described as somewhat excessively drained, and formed in glacial outwash. Permeability is rapid. The soil is classified as well-suited for home sites. Poor filtration capacity is available for septic systems. The soil has limited moisture retention capacity. The explorations by ARGS confirm these general conditions and conclusions.

The site is well-suited for the proposed construction from a geotechnical standpoint. Shallow foundations will provide support for the proposed structures with good seismic performance and low risks for settlement. Earthwork construction may be accomplished during moderately wet weather conditions if carefully scheduled and managed. Excavation of the shallow alluvial soils up to 30 inches in depth should be anticipated in most structural areas.

7.2 Seismic Risks

Earthquakes of magnitude 7.0 to 7.5 magnitude with peak site accelerations ranging up to 0.32g are known to occur in the project site location. Recurrence intervals for earthquakes of this strength are approximately 35 years. Soil liquefaction risk is very low for this site. As no major filling is expected and there are no slopes in the area, ground stability and settlement concerns will be very minimal. This assumes reasonable care and engineering oversight of ground preparation.

7.3 Site Stormwater Infiltration and Groundwater

Stormwater infiltration rates in the upper 2 feet of soil will be moderate, 2 to 6 inches per hour if un-compacted. Soils below 2 feet depth are very highly permeable, much greater than 20 inches per hour where gravel is dominant.

The water table surface is influenced by adjacent Beaver Creek, located along the eastern edge of the site. Piezometric measurements, summarized in Table 4.1 indicate that the water table is generally 1.5 feet higher in the eastern edge than under the center of the lot. The levels measured closer to Beaver Creek indicated that maximum storm events have about a 3 to 4 day lag time to peak water table surface. Following a 50-year event in the late fall of 2006, the groundwater in this area rose to within 4.5 feet of the surface. Under typical winter conditions, the water table appears to range from 5.5 to 6.5 feet depth in the eastern edge, and from 6.0 to 8.0 feet in the south central portion of the site. Secondary information such as mottling and mineral staining indicates that the water table is typically in the depth range of 6 to 8 feet in winter and greater than 10 feet in the remainder of the year.

8.0 RECOMMENDATIONS

8.1 General

The proposed building foundation design, shallow spread footings interior, and strip footings on the exterior walls should conform to the International Building Code, American Concrete Institute ACI 318 Code and Thurston County requirements. In general, our

Resource Stewardship & Land Use

recommendations address these criteria.

8.2 Seismic Design
Section 8 above describes that the project site is located within a seismic zone. Structural engineering design should address the following criteria.

2006 IBC: Earthquake Load Criteria per Section 1613:
Building Occupancy Category: IV , Table 1604.5
Site Class: D
- Max Considered Earthquake Ground Motion,
  0.2 Second Spectral Response Acceleration, Ss: 1.10 g
  1.0 Second Spectral Response Acceleration, S1: 0.38g
- Design Spectral Response Acceleration:
  0.2 Second Short Periods, S_{DS}: 0.81 g
  1.0 Second Periods, S_{D1}: 0.43 g
- Seismic Design Category: D

8.3 Foundation Design
Shallow spread footings should be designed and constructed to meet the following criteria for safe soil bearing pressure and total settlement potential of less than ½ inch.
- Minimum widths: exterior strip: 18 inches, interior square or rectangular 30 inches.
- Allowable Foundation pressures: 2500 pounds per square foot;
  Factor of Safety = 2.5. Allow 1/3rd increase for transient loads.
- Minimum backfill embedment above footing base: 18 inches.
- Coefficient of Lateral Sliding: 0.30 for Native Soil, 0.38 for crushed rock structural fill.
- Maximum Post Earthquake Settlement Estimate: 0.5 inches per 50 feet differential.

For construction under wet conditions, some sub-excavation and replacement should be anticipated. Local areas of disturbed moisture sensitive soils may require replacement to a maximum depth of 30 inches beneath foundations. The native soil replacement footprint area must extent laterally outside the footing areas for a distance equal to the excavation depth.

Under optimal native soil moisture conditions, some over-breaking, filling and re-compaction of lower Soil Unit 2 and upper Soil Unit 3 will be necessary to achieve smooth surfaces. Equipment access for foundation work may be extended into wet season construction if supported on a roadway base section constructed around the building footprint. All bearing soils or structural fill shall be compacted to 95% of Modified Proctor maximum density (ASHHTO T-99/ASTM D-1557).

8.4 Roadway and Building Slabs
We understand the parking and roadway pavement section will be 10-inch thick pervious concrete over 4" shoulder ballast (WSDOT Standard Specification 9-03.9), over 24" non-

Resource Stewardship & Land Use

specified sand. The shoulder ballast is expected to provide infiltration and storage volume and the sand layer will provide water quality treatment. The total depth from finished grade to bottom of the storm infiltration system will be 3.2 feet. The sand layer is expected to be placed over native soil Unit 3 gravel.

The Soil Unit 3 gravel subgrade should be proof rolled to assure that no potential settlement areas are present. The 24-inch thick basal sand layer should be placed in uniform 8-inch maximum lifts and compacted to 92% of Modified Proctor Density (ASHHTO 7-99/ASTM D-1557). Compaction should be verified on each lift and before shoulder ballast placement. The basal sand layer gradation should be specified by the Civil or Geotechnical Engineer to assure the best-fit for porosity, permeability and stability. The source submittal should be verified prior to construction. Compacted density of the ballast layer should be verified by static proof rolling with a minimum 6-ton roller. Further details for preparation and placement of the roadway section are provided in the Section 8.5.

Unheated interior floor slabs may bear directly on native soil subgrade. Code for heated areas will require R-10 minimum insulation. For slabs cast directly on Soil Unit 2, care must be taken during subgrade preparation to assure uniformity and specified soil density. Compacted density of Soil Unit 2 should exceed 95% of maximum Modified Proctor density. A modulus of subgrade reaction of 250,000 psi/in may be assumed on computed native Soil Unit 2. For compacted crushed rock, WSDOT Standard Specifications Crushed Surfacing Base Course, 9-03.9(3) or for Soil Unit 3, 600,000 psi/in may be assumed. The crushed layer depth must exceed 8 inches in depth and compaction must exceed 95% of maximum Modified Proctor Density.

In heated areas, building codes will require insulation beneath floor slabs. Generally, this is provided by stiff polystryrene insulation boards. Insulation board material quality should be specified. Slab design based on the modulus of polystryrene insulation boards should be as recommended by the manufacturer. A 2-inch thick layer of pea gravel or filler sand should underlie the insulation boards for uniform stress distribution. All slab areas should also be underlain by vapor barrier.

8.5 Construction Monitoring, Geotechnical Engineering Certification

Site earthwork is expected to result in ground surface elevation changes of less than 2 feet and over limited areas. No structural embankments are known at this time. Selective removal of Topsoil and Soil Unit 2 under new pavement areas, building foundations and slabs may involve excavation of 1000 cubic yards or less. Excavated topsoil and Soil Unit 2 may be used in berms, landscaping or other non-structural applications or hauled offsite. Soil Unit 2 is not recommended for use as structural fill.

Earthwork and other construction activities should be managed carefully if weather conditions are winter-like or excessively dry. Pavement, foundation and slabs may be constructed under a range of weather conditions, but soil moisture content in Soil Unit 2

Resource Stewardship & Land Use

will be the limiting factor. Soil Unit 2 is moderately sensitive to moisture variations and may become plastic and or muddy if disturbed. Soil Unit 2 is variable in fines and organics content. Soil Unit 2 generally contains only a trace of deleterious organic matter; however, the northwestern area of the site, where the new building is to be cited may contain deleterious proportions of clay and organic matter. Test Pit 3 is located in this area and the upper soils may require replacement with compacted structural backfill.

In structural areas, an experienced soil technician or engineer under the supervision of a licensed professional engineer should be present to interpret conditions in relation to these recommendations and specified compaction criteria. The majority of Soil Unit 2 will likely be removed while excavating down to the foundation bearing surfaces. Some over-excavation and replacement with compacted crushed surfacing base course should be anticipated under most of the foundation areas and some of the slab areas. The designed pavement thickness of 3.2 feet will result in nearly complete removal of Soil Unit 2 under the pervious pavement areas.

Work sequencing and equipment usage needs to be managed during pavement and underground drainage systems to assure that Soil Unit 2 under the structural and slab areas is not disturbed and weakened. Care should be taken to assure that earthwork and underground construction during moisture-gaining weather patterns do not result in unnecessary dig-outs of Soil Unit 2.

A moisture-density soil compaction relationship tests according to ASHHTO T-99/ASTM D1557, Modified Proctor Density procedure will be provided by Alpine Ridge Geotechnical Services for Soil Unit 2 prior to construction. This testing will provide compaction criteria for native soil in the 1.5 to 3 foot depth range. Verification of compacted soil density of Soil Unit 3 shall be based upon visual confirmation by the geotechnical engineer.

9.0 LIMITATIONS

This geotechnical engineering report is provided strictly for use by the Littlerock Fire Rescue Department and authorized project team members for the intended project, the Maytown Fire Station. Other applications are not authorized. Use or reproduction of this report by third parties without written permission of Alpine Ridge Geotechnical Services is prohibited. No part of the geotechnical report should be used separately from the remainder of the report. Interpretations, modifications and implementation of these recommendations and findings are the sole responsibility of the user.

Geotechnical engineering applies engineering principles to properties of natural earth materials. Material properties are represented by a limited quantity of explorations and testing, and conditions may vary outside the ranges described. Conclusions and recommendations are professional opinions based upon observations, experience and economy for the client. The level of care provided in this report is consistent with other licensed members of the profession in good standing. No other warranties are offered or implied.

Resource Stewardship & Land Use

As construction develops, unanticipated conditions may be revealed. ARGS should be advised of such conditions, so these recommendations may be re-evaluated and modified as necessary.

Alpine Ridge Geotechnical Services

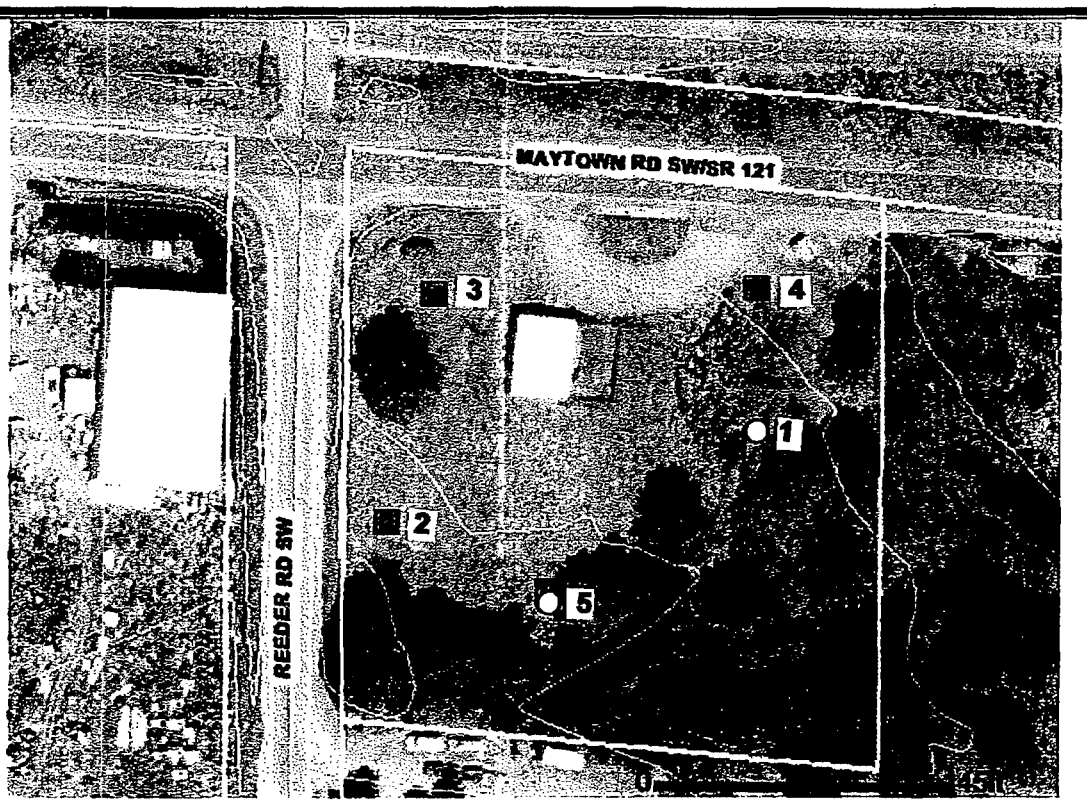
Geotechnical Engineering Report

Maytown Fire Station

ATTACHMENT A

Test Pit Layout and Logs

Littlerock Fire Department
Maytown Site Map



Approximate Test Pit Locations

Piezometer Installed in Test Pits #1 and #5

ATTACHMENT A
FIGURE 1

Test Pit Layout on Maytown Fire Station Site

Test Pit Log 1 of 4

Littlerock Fire District: Proposed Maytown Station Site

SR 121, Maytown Road and Reeder Road

Test Pit 1 Location: Dimensions:	Excavated, Logged on 08/04/06 Eastern Edge of Lot, 100' ESE of SE Corner of Firehouse ~10'L * 3' W* 10.0' Deep	Backhoe Excavated Piezometer Installed to 10.0 ft depth Logged by H. Gertje
Depth Range	**Material Description**	**Sampling, Lab Testing**
0 to 0.5'	Top Soil: light brown coarse to fine silty Sand; grass roots, dry.	S-1
0.5' - 2.5'	light brown silty SAND, trace gravel; dry, very dense, trace organics	S-2 Sieve Analysis
2.5' - 8.0'	light brown, well graded Gravel with silt and sand; damp to moist, gravel content increases, coarsens with depth; at 6.5 feet gray-brown, moist	S-3 @ 6.3 ft. Sieve Analysis
8.0' to 10.0'	medium gray and brown well graded Gravel with sand and cobbles, trace silt, very moist at 9' depth; cobbles have black and gray oxidation staining , odorless No free water.	S-4

Test Pit Log 2 of 4

Littlerock Fire District: Proposed Maytown Station Site

SR 121, Maytown Road and Reeder Road

Test Pit 2 Location: Dimensions:	Excavated, Logged on 08/04/06 Near SW Corner of Lot ~10'L * 3' W* 9.0' Deep	Backhoe Excavated Logged by H. Gertje
Depth Range	**Material Description**	**Sampling, Lab Testing**
0 to 0.5'	Top Soil: light brown coarse to fine silty, Sand, grass roots, dry.	
0.5' - 2.4'	light brown silty SAND with gravel, trace cobbles; damp, very dense, trace organics	S-1, Sack 1 Wet Sieve Analysis
2.4' - 7.5'	light brown Gravel and cobbles with sand, trace silt; damp, gravel content increases and coarsens with depth; at 6.5 feet gray-brown, moist at 7.5 feet, black cementatious coating on rocks	S-2
7.5' - 9.0'	medium brown and black coarse to fine Gravel and Sand with cobbles, trace silt, moist at 9' depth; cobbles have black and gray oxidation staining , odorless No free water. Caving of upper hole	S-4

Test Pit Log 3 of 4

Littlerock Fire District: Proposed Maytown Station Site

SR 121, Maytown Road and Reeder Road

Test Pit 3	Excavated, Logged on 08/04/06	Backhoe Excavated
Location: Dimensions:	NW corner of Lot, 40' west of Firehouse ~8'L * 3' W* 8.7' Deep	Logged by H. Gertje
Depth Range	**Material Description**	**Sampling, Lab Testing**
0 to 0.5'	Top Soil: light brown coarse to fine silty Sand; grass roots, dry.	
0.5' - 2.5'	light brown silty SAND, trace gravel; dry, very dense, trace organics	S-1
2.0' - 6.8'	light brown coarse to fine Gravel with sand, cobbles; damp, dense; gravel content increases, coarsens with depth	S-2 Sieve analysis
6.8' - 8.7'	Top Soil: light brown coarse to fine silty Sand; grass roots, dry.	

Test Pit Log 4 of 4

Littlerock Fire District: Proposed Maytown Station Site

SR 121, Maytown Road and Reeder Road

Test Pit 4	Excavated, Logged on 08/04/06	Backhoe Excavated
Location:	Northeast Corner of Lot, edge of existing drive	
Dimensions:	~6'L * 3' W*4.5' deep	Logged by H. Gertje
Depth Range	**Material Description**	**Sampling, Lab Testing**
0 to 1.0'	Coarse to fine Gravel and Sand; dry, dense, FILL	
1.0' - 3.0'	light brown coarse to fine SAND with gravel, trace silt, trace cobbles; dry, very dense.	S-1 Sieve Analysis
3.0' - 4.5'	coarse to fine Gravel with Sand, trace cobbles, dry, very dense. Total Depth = 4.5 feet	S-2

Alpine Ridge Geotechnical Services

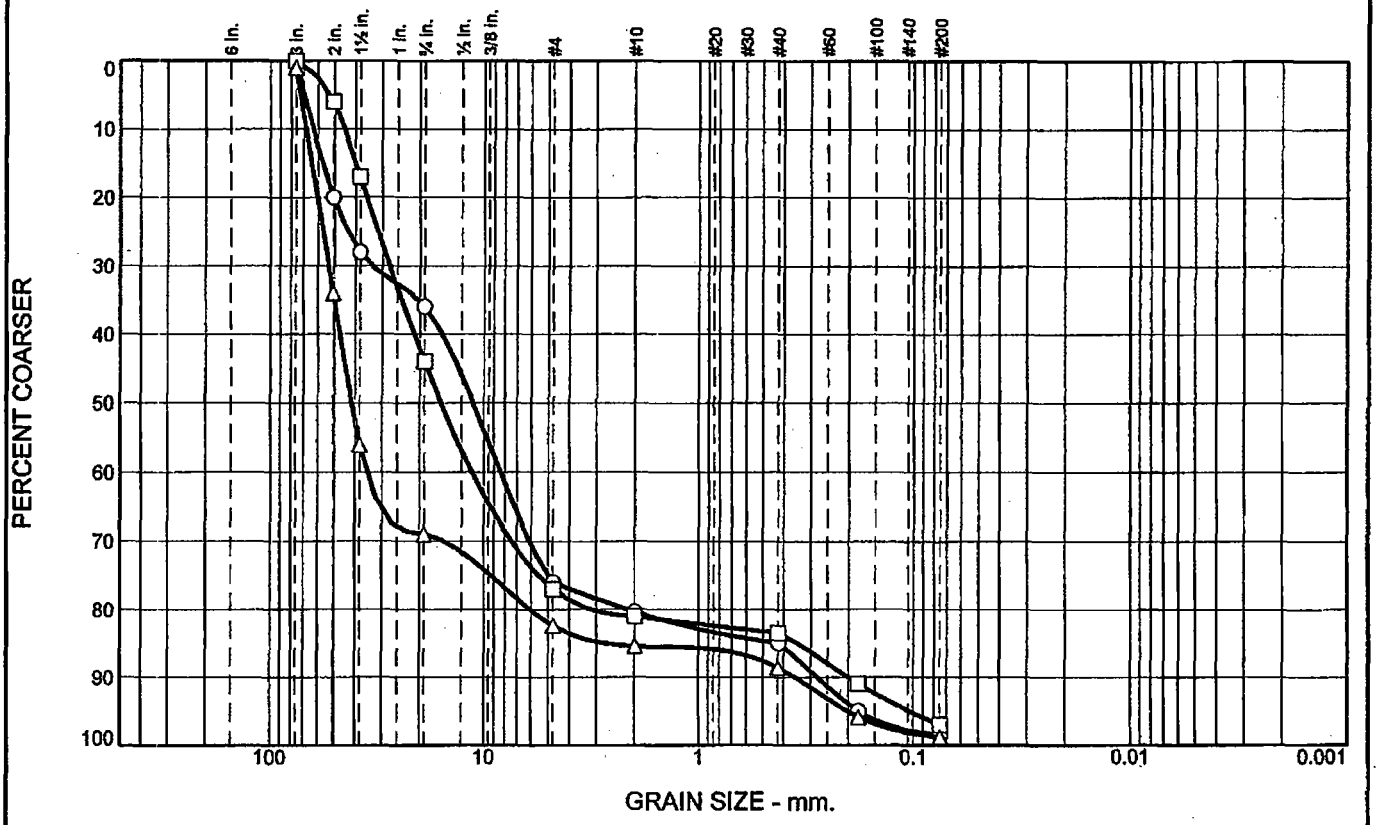
Geotechnical Engineering Report

Maytown Fire Station

ATTACHMENT B

Laboratory Testing Data

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○	0.0	80.3	18.2	1.5		GP	A-1-a	NP	NP
□	0.0	81.0	16.0	3.0		GW	A-1-a	NP	NP
△		84.4	13.4	1.2		GP	A-1-a	NP	NP

SIEVE inches size	PERCENT FINER ○	□	△
3"	100.0	100.0	99.0
2"	80.0	94.0	66.0
1-1/2	72.0	83.0	44.0
3/4"	64.0	56.0	31.0
	GRAIN SIZE		
D_{60}	15.7466	21.3149	47.2894
D_{30}	6.1217	7.4535	15.3866
D_{10}	0.2800	0.2014	0.3558
	COEFFICIENTS		
C_C	8.50	12.94	14.07
C_u	56.23	105.83	132.93

SIEVE number size	PERCENT FINER ○	□	△
#4	24.0	23.0	17.6
#10	19.7	19.0	14.6
#40	15.0	16.5	11.4
#80	5.0	9.0	4.1
#200	1.5	3.0	1.2

Material Description

○ well graded GRAVEL with sand, Cobbles, coarsening with depth

□ well graded Gravel with sand, trace cobbles, trace silt

△ coarse to fine Gravel with sand and trace cobbles

REMARKS:

○ Test Pit 3, S-2, Dry Sieve

□ Test Pit 1, S-3, Dry Sieve

△ Test Pit 4, S-1, Dry Sieve

○ Location: Test Pit #3 Depth: 4.0-5.0 ft Sample Number: S-2
□ Location: Test Pit 1 Depth: 2.5-6.4 ft. Sample Number: S-3
△ Location: Test Pit #4 Depth: 3.5-4.0 ft. Sample Number: S-1

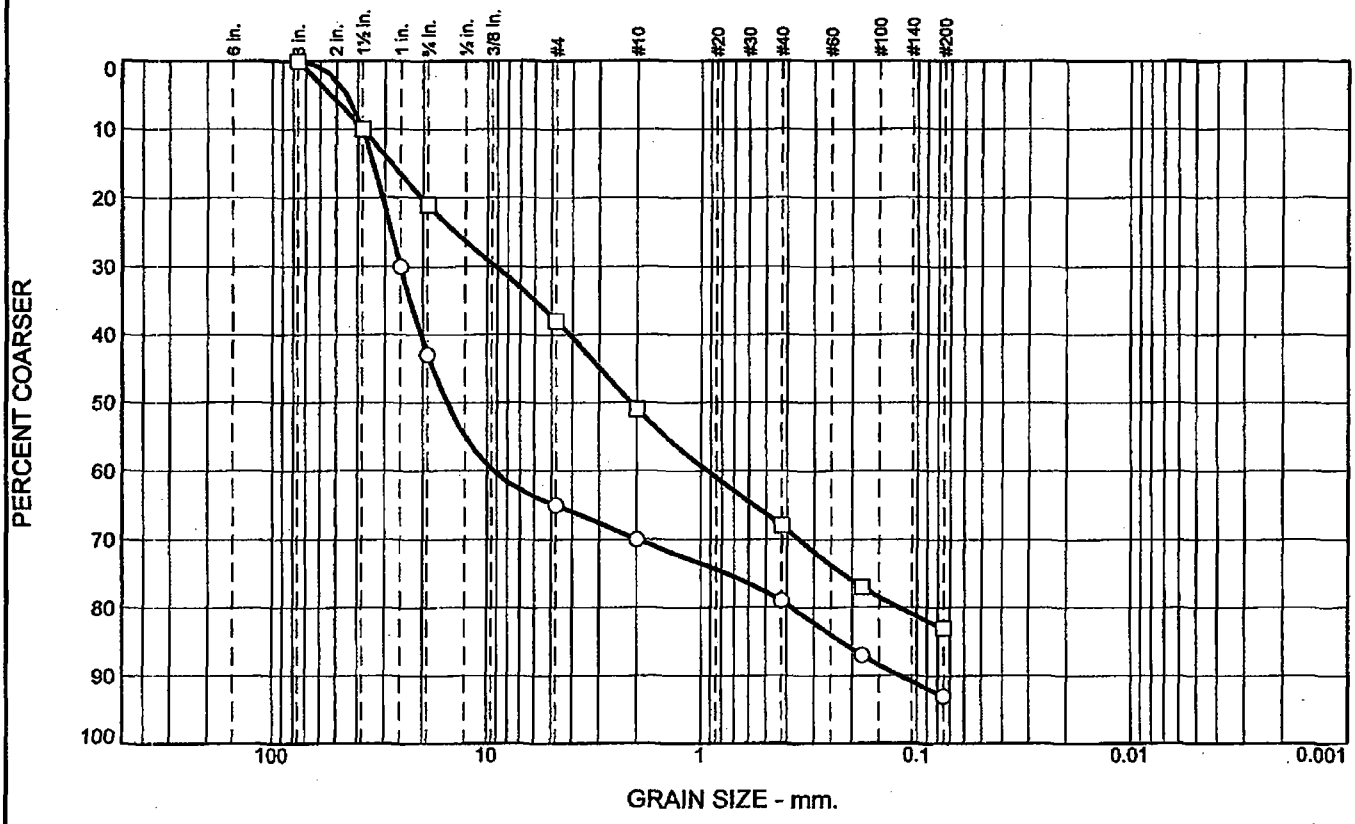
Alpine Ridge Geotechnical Services

Olympia, WA

Client: Littlerock Fire Rescue, Thurston County FPD #11
Project: PROPOSED MAYTOWN FIRE STATION
3131 Maytown Road SW, Olympia WA July 2006-April 2007
Project No.: 070706LFD Figure A-2

Tested By: G. Gertje **Checked By:** H. Gertje

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○	0.0	70.0	23.0	7.0		SW	A-3	NP	NP
□	0.0	51.0	32.0	17.0		SM	A-1-b	NP	NP

SIEVE Inches size	PERCENT FINER ○	PERCENT FINER □
3"	100.0	100.0
1-1/2"	90.0	90.0
1"	70.0	
3/4"	57.0	79.0
GRAIN SIZE		
D_{60}	20.5186	4.1312
D_{30}	2.0000	0.3533
D_{10}	0.1211	
COEFFICIENTS		
C_c	1.61	
C_u	169.45	

SIEVE number size	PERCENT FINER ○	PERCENT FINER □
#4	35.0	62.0
#10	30.0	49.0
#40	21.0	32.0
#80	13.0	23.0
#200	7.0	17.0

Material Description

○ Silty Sand with gravel

□ SAND with silt and gravel; trace cobbles

REMARKS:

○ Test Pit 1, S-2 Dry Sieve.

□ Test Pit 2 S-1 Washed -200 sieve

○ Location: Test Pit 1 Depth: 0.5-2.5 ft. Sample Number: S-2

□ Location: Test Pit #2 Depth: 1.5-2.5 ft Sample Number: S-1

Alpine Ridge Geotechnical Services

Olympia, WA

Client: Littlerock Fire Rescue, Thurston County FPD #11

Project: PROPOSED MAYTOWN FIRE STATION
3131 Maytown Road SW, Olympia WA July 2006-April 2007

Project No.: 070706LFD Figure A-1

Tested By: G. Gertje **Checked By:** H. Gertje

Alpine Ridge Geotechnical Services

Geotechnical Engineering Report

Maytown Fire Station

ATTACHMENT C

Subsurface Data by Others

2005 Soil Boring by WSDOT

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-65979

HOLE No. H-29-05

Sheet 1 of 6

Job No. OL-3451 SR 5 Elevation 194.2 ft

Project SR 5 Grand Mound to Maytown Widening

Driller Robert Shepherd Lic# 2710 T

Site Address Maytown Bridge 5/308

Inspector Bill Hanning

Start July 13, 2005 Completion July 15, 2005 Well ID# AHN 973

Equipment CME 55 w/ autohammer

Station 750+80 Offset 53' Lt. Hole Dia (Inches) 5"

Method Wet Rotary

Northing 907834.7966 Easting 1353455.2541 Latitude Longitude

County Thurston Subsection SW/SE Section 5 Range 2 WWM Township 16 N

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	194.0									
	193.0									
	192.0									
	191.0							02/17/2006	▽	
	190.0		◆	1		D-1		Silty SAND, with some fine gravel, loose, dark yellowish brown, moist, Homogeneous, no HCl reaction		
5	189.0			3 4 (7)				Length Recovered 0.2 ft, Length Retained 0.2 ft		
	188.0							10/06/2005	▼	
	187.0									
	186.0									
	185.0		◆	28		D-2		Silty GRAVEL with sand, rounded, dense, olive brown, moist, Homogeneous, no HCl reaction		
10	184.0			17 20 (37)				Length Recovered 0.8 ft, Length Retained 0.8 ft		
	183.0									
	182.0									
	181.0									
	180.0		✚ ◆	8		D-3	GS MC	SM, M.C. = 20% Silty SAND, dense, yellowish brown with Iron oxidized throughout, moist, Stratified, no HCl reaction		
15	179.0			14 17 (31)				Length Recovered 1.2 ft, Length Retained 1.2 ft		
	178.0									
	177.0									
	176.0									
	175.0									
20										

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-65979

HOLE No. H-29-05

Job No. OL-3451 SR 5 Elevation 194.2 ft (59.2 m)

Sheet 2 of 6

Project SR 5 Grand Mound to Maytown Widening

Driller Robert Shepherd Lic# 2710 T

◆ Field SPT (N) ✚ Moisture Content ▨ RQD (20 40 60 80)

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				S-4	GS MC AL UU	MH, MC=49%, PI=13 Sandy elastic SILT, soft, dark greenish gray, moist, Homogeneous, no HCl reaction Length Recovered 1.8 ft, Length Retained 1.8 ft		
		2 5 5 (10)		D-5		Lean CLAY, with sand and coal, soft, dark greenish gray, wet, Stratified, no HCl reaction Length Recovered 1.5 ft, Length Retained 1.5 ft		
	170	2 4 5 (9)		D-6		SILT, loose, dark greenish gray, moist, Homogeneous, no HCl reaction Length Recovered 1.5 ft, Length Retained 1.5 ft		
25								
	165	2 4 5 (9)		D-7		SILT, loose, dark greenish gray, moist, Homogeneous, no HCl reaction Length Recovered 1.5 ft, Length Retained 1.5 ft		
30						Antestian zone at 29 ft. 5 gal. / hour with 7 ft. of head.		
	160	2 5 10 (15)		D-8		SILT, medium dense, very dark greenish gray, moist, blocky, no HCl reaction Length Recovered 1.5 ft, Length Retained 1.5 ft		
35								
	155							
40				S-9	GS MC AL UU	ML, MC=34%, PI=13 SILT, medium dense, dark greenish gray, moist, Homogeneous, no HCl reaction Length Recovered 1.5 ft, Length Retained 1.5 ft		
		8 11 12 (23)		D-10		SILT, medium dense, dark greenish gray, moist, blocky, no HCl reaction Length Recovered 1.5 ft, Length Retained 1.5 ft		
	150	4 7		D-11		SILT, medium dense, dark greenish gray, moist, Homogeneous, no HCl reaction		
45								

SOILA OL-3451 SR 5 GRANDMOUND TO MAYTOWN WIDENING.GPJ SOIL.GDT 7/17/06 1:07:47 P7

Resource Engineering & Land Use

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-65979

HOLE No. H-29-05

Job No. 0L-3451 SR 5 Elevation 194.2 ft (59.2 m)

Sheet 3 of 6

Project SR 5 Grand Mound to Maytown Widening

Driller Robert Shepherd Lic# 2710 T

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				9 (16)				Length Recovered 1.5 ft, Length Retained 1.5 ft		
	145			9 9 9 (18)		D-12		SILT, medium dense, dark greenish gray, moist, Homogeneous, no HCl reaction Length Recovered 1.5 ft, Length Retained 1.5 ft		
50										
	140			3 4 6 (10)		D-13		Elastic SILT, medium stiff, greenish black, moist, Homogeneous, no HCl reaction Length Recovered 1.5 ft, Length Retained 1.5 ft (Logan Hill Formation?)		
55										
	135			4 5 6 (11)		D-14		Elastic SILT with sand, medium stiff, dark greenish gray, moist, blocky, weak HCl reaction Length Recovered 1.5 ft, Length Retained 1.5 ft Completely weathered gravel and sand		
60						U-15 A thru D	GS MC AL CN UU	61.0 ft., MH, M.C. = 37%, PI = 20 61.3 ft., MH, M.C. = 31%, PI = 22 Elastic SILT with sand, medium stiff, greenish black, moist, Homogeneous, no HCl reaction Length Recovered 1.3 ft, Length Retained 1.3 ft (Logan Hill Formation)		
	130			6 12 11 (23)		D-16		Elastic SILT with sand, medium stiff, greenish black, moist, Homogeneous, no HCl reaction Length Recovered 1.5 ft, Length Retained 1.5 ft completely weathered sand and gravel (Logan Hill Formation)		
65										
	125			7 12		D-17	GS MC	ML, M.C. = 30%, PI = 16 SILT with sand, with some lean clay, dense, dark		
70										

SOILA 0L-3451 SR 5 GRANDMOUND TO MAYTOWN WIDENING.GPJ SOIL.GDT 7/17/06, 1:07:47 P7

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-65979

HOLE No. H-29-05

Job No. 0L-3451 SR 5 Elevation 194.2 ft (59.2 m)

Sheet 4 of 6

Project SR 5 Grand Mound to Maytown Widening

Driller Robert Shepherd Lic# 2710 T

◆ Field SPT (N) ✚ Moisture Content ▨ RQD

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
		16 (28)			AL	greenish gray, moist, Homogeneous, no HCl reaction Length Recovered 1.5 ft, Length Retained 1.5 ft (Logan Hill Formation)		
75	120	7 12 19 (31)		D-18		SILT, dense, dark greenish gray, moist, Homogeneous, no HCl reaction Length Recovered 1.5 ft, Length Retained 1.5 ft (Logan Hill Formation)		
80	115	6 8 13 (21)		D-19		SILT, medium dense, dark greenish gray, moist, Homogeneous, no HCl reaction Length Recovered 1.5 ft, Length Retained 1.5 ft (Logan Hill Formation)		
85	110	4 7 11 (18)		D-20		Lean CLAY, with completely weathered sand and gravel., medium stiff, greenish black, moist, Blocky, no HCl reaction Length Recovered 1.5 ft, Length Retained 1.5 ft (Logan Hill Formation)		
90	105			U-21 A thru E	GS MC AL CN UU	90.8 ft., MH, M.C. = 36%, PI = 29 91.2 ft., MH, M.C. = 34%, PI = 32 Elastic SILT, medium stiff, greenish black, moist, Blocky, no HCl reaction Length Recovered 1.6 ft, Length Retained 1.6 ft		
		7 12 14 (26)		D-22		Elastic SILT, medium stiff, greenish black, moist, Blocky, no HCl reaction Length Recovered 1.5 ft, Length Retained 1.5 ft Completely with weathered sand and gravel		
95	100	5 6		D-23		Elastic SILT, medium stiff, greenish black, moist, Blocky, no HCl reaction		

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-65979

HOLE No. H-29-05

Job No. OL-3451 SR 5 Elevation 194.2 ft (59.2 m)

Sheet 5 of 6

Project SR 5 Grand Mound to Maytown Widening

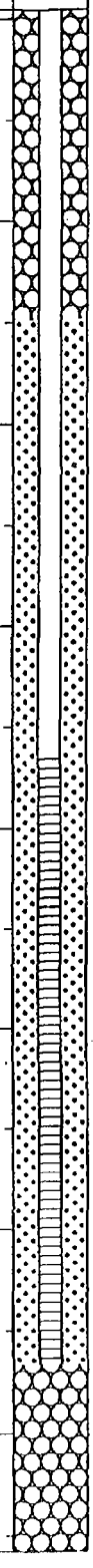
Driller Robert Shepherd Lic# 2710 T

◆ Field SPT (N) ✚ Moisture Content ▨ RQD

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material
		9 (15)				Length Recovered 1.5 ft, Length Retained 1.5 ft completely weathered sand and gravel (Logan Hill Formation)
	95	5 8 12 (20)		D-24		Elastic SILT, medium stiff, olive, moist, Blocky, no HCl reaction Length Recovered 1.5 ft, Length Retained 1.5 ft Completely with weathered sand and gravel (Logan Hill Formation)
100						
	90	5 8 9 (17)		D-25		SILT, medium dense, dark greenish gray, moist, Homogeneous, no HCl reaction Length Recovered 1.5 ft, Length Retained 1.5 ft (Logan Hill Formation)
105						
	85	6 8 12 (20)		D-26		SILT, with some clay, medium dense, olive, moist, Blocky, no HCl reaction Length Recovered 1.5 ft, Length Retained 1.5 ft Logan Hill Formation)
110						
	80	12 14 12 (26)		D-27	GS MC AL	SM, M.C. = 50%, LL = 51, PI = NP Silty SAND, dense, greenish black, moist, Blocky, no HCl reaction Length Recovered 1.5 ft, Length Retained 1.5 ft completely gravel and some decomposed wood debris (Logan Hill Formation)
115						
	75	RQD 12 FF 20		C-28		SILTSTONE, very dark gray, fine grained, moderately weathered, moderately weak rock, no HCl reaction. Discontinuities are very closely spaced and in fair condition. Percent Recovered 100.0%
120						

Groundwater

Instrument



SOILA OL-3451 SR 5 GRANDMOUND TO MAYTOWN WIDENING.GPJ SOIL.GDT 7/17/06 1:07:47 P7

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-65979

HOLE No. H-29-05

Job No. OL-3451 SR 5 Elevation 194.2 ft (59.2 m)

Sheet 6 of 6

Project SR 5 Grand Mound to Maytown Widening

Driller Robert Shepherd Lic# 2710 T

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				RQD 80 FF 4		C-29		SANDSTONE, dark gray, fine grained, fresh, moderately weak rock, no HCl reaction. Discontinuities are very closely spaced and in good condition, Percent Recovered 100.0%		
125	70							End of test hole boring at 125.5 ft below ground elevation.		
130	65							This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.		
135	60							Bailed to 71.0 ft. Recharged at the following test 10 minutes 48.0 ft. 20 minutes 44.0 ft. 30 minutes 39.0 ft.		
140	55							WATER LEVEL READINGS		
145	50									

DATE	DEPTH	ELEVATION (ft.)
07/18/2005	-39.0	155.2 ft.
08/03/2005	-4.8	189.4 ft.
09/01/2005	-5.4	188.9 ft.
10/06/2005	-6.0	188.2 ft.
11/07/2005	-5.3	188.9 ft.
12/08/2005	-3.8	190.4 ft.
01/25/2006	-3.2	191.0 ft.
02/17/2006	-3.0	191.2 ft.
03/03/2006	-3.0	191.2 ft.
04/04/2006	-3.0	191.2 ft.

SOILA OL-3451 SR 5 GRANDMOUND TO MAYTOWN WIDENING.GPJ SOIL.GDT 7/17/06 1:07:47 P7

Alpine Ridge Geotechnical Services

Geotechnical Engineering Report

Maytown Fire Station

ATTACHMENT D

Thurston County Soil/Stormwater Infiltration Forms

SOIL EVALUATION REPORT
FORM 1: GENERAL SITE INFORMATION

Project Title: LRFD Proposed Maytown Fire Station — Sheet 1 of 2
Project No. : Thurston Tax Parcel 12604330200 — Date: April 2007
Prepared by : Henry Gertje, P.E., Alpine Ridge Geotechnical Services

1. Site Address or legal description:
3131 Southwest Maytown Road, Olympia WA 98512. Southeast corner of the intersection of Maytown Road and Reeder Road. 1.93 acres.

2. Project Description:
5,400 square foot, three bay fire station with three dorm rooms, a watch office and living room. The building will be two-story, commercial type slab on grade, access road, parking areas and small adjoining storage structures.

3. Site Description:
The project site area is nearly level. The lot surface is vegetated by mowed grass. A narrow grove of Douglas Fir trees ranging from 4 to 12 inches in diameter is present along the southern margin of the property. Several other isolated fir trees up to 1-foot in diameter are also present. The eastern forth of the property is covered by medium to light brush, including scotch broom, blackberries and other perennial plants. Several old orchard apple trees are located in this area.

4. Summary of Soils Work Performed:
As illustrated in Figure 2, the Preliminary Site Plan, four (4) test pits were excavated and logged on the subject project site on August 4, 2006. Test pits were advanced to depths ranging from 4.5 to 10.0 feet. A standpipe piezometer was installed in Test Pit 1 to a depth of 10.0 feet. In February 2007, a second standpipe piezometer was installed in the approximate location of the proposed infiltration galleries.

5. Additional Soils Work Recommended: None.

6. Findings (Including pre-development site percolation rate):
The soils below 2.5 feet depth are predominantly coarse Gravel with sand, cobbles, trace non-plastic silt. Dense. Light cementing and black staining at approximately 7 feet depth implies a seasonal high groundwater table near this depth. Standpipe piezometer readings yielded a maximum rise to within 5-3/4 feet near the eastern property line to 7.5 feet near the western property line. The infiltration rate, pre and post development below 2.0 feet depth will exceed 20 inches per hour.

7. Recommendations:
Native soil below 2.0 feet may be assigned an infiltration rate of 20 inches per hour. The seasonal high saturation level, equivalent to maximum seasonal water table rise should be taken as 7.0 feet blow the existing ground surface in the location of the proposed infiltration trenches. Site grading may need to be raised with structural fill to provide sufficient hydraulic head for stormwater treatment. This Form shall not be separated from the Subsurface Investigation for the Maytown Fire Station by Alpine Ridge Geotechnical Services.

I hereby certify that I prepared this report, and conducted or supervised the performance of related work. I certify that I am qualified to do this work. I represent my work to be complete and accurate within the bounds of uncertainty inherent to the practice of soil science, and to be suitable for its use.

SIGNED:_____

DATE: _____

SOIL EVALUATION REPORT
FORM 2: SOIL LOG INFORMATION

Project Title: Project No. : Prepared by :		Sheet of Date:
Soil Log: Location:		
1. Types of test Done	2. SCS Soil Series:	3. Land Form:
4. Deposition History:	5. Hydrologic Soil Group:	6. Depth to Seasonal HW:
7. Current Water Depth:	8. Hydrologic Soil Group:	9. Misc:

10. Potential For:	Erosion	Runoff	Ponding

11. Soil Strata Description:

Horz	Depth	Color	Texture	%CL	%Org	% CF	STR	MOT	IND	CEM	ROO	<X>	FSP

12. Site Percolation Rate:	
13. Findings and Recommendations:	