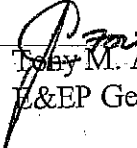




August 27, 2004

TO: Don Owings/Steve Vestal
Southwest Region, MS S-15

FROM:  Mark A. Frye
I&EP Geotechnical Division, 47365

SUBJECT: SR-5, MP 14.21 vic, XL-2013
SR-501 Safety Improvements
Retaining Walls
Geotechnical Recommendations

As you requested, we are providing geotechnical recommendations for two retaining walls associated with the subject project. We understand the northbound and southbound off-ramps from I-5 to SR-501 will be widened to create right turn lanes. The widening will require the construction of a retaining wall on each ramp to avoid impacts to wetlands adjacent to the existing embankment. A site layout showing the planned locations of the walls is provided on Figure 2 in Appendix A.

Retaining Wall 1 will be constructed on the west side of the southbound off-ramp from SR 5. Wall 1 will be 190 feet in length and have a maximum height of 12 to 13 feet. Retaining Wall 2 will be constructed along the east side of the northbound off-ramp from SR 5. Wall 2 will be 245 feet in length and have a maximum height of 9 to 10 feet. Each wall will support approximately a 2-foot soil surcharge, guardrail, and off-ramp traffic.

This memorandum presents the geotechnical recommendations for the subject project. The analyses, conclusions, and recommendations presented in this memorandum are based on the project description and site conditions that existed at the time of the field exploration. We assume the exploratory borings represent the subsurface conditions throughout the project area. If different subsurface conditions are encountered or appear to be present, we should be contacted so that we can reevaluate our recommendations and assist you.

Field Exploration

Two test borings were advanced along or near the alignments of each wall. Test borings H-1-04 and H-2-04 were drilled along the alignment of Wall 1. Test borings H-3-04 and H-4-04 were drilled along the alignment of Wall 2. All of the borings were conducted on the existing ramp embankments and extended 20 to 30 feet into the underlying in-situ soils.

Locations of the test holes are shown on Figure 2 in Appendix A. The boring logs and laboratory test results are included in Appendices B and C. The boring logs should be included in the contract documents.

Site Soil and Groundwater Conditions

The field explorations and laboratory testing indicate the soils underlying Walls 1 and 2 consist of two soil units:

Unit 1 consists of loose to medium dense sandy silt. This unit consists of the fill material making up the existing ramp embankments.

Unit 2 consists of loose to medium dense sandy silt, clayey sand, and soft to very stiff sandy lean clay.

Construction records indicate the existing embankments were constructed from on-site soils. The field exploration and the laboratory testing show little difference between the embankment soils and the in-situ soils.

Groundwater was generally recorded approximately 15 to 20 feet below the ground surface where the explorations were conducted. This corresponds to or slightly below the existing ground surface in the vicinity of the embankments. Mapped wetlands near each wall location, and an existing pond to the west of Wall 1 indicate the groundwater is at the ground surface at the base of the existing embankments.

Geotechnical Design Recommendations

Based on the subsurface conditions and the proposed geometry, we consider Structural Earth (SE) walls appropriate for both Walls 1 and 2. Potential settlements preclude the use of cast-in-place concrete walls. While a soldier pile wall is a feasible option, it would cost two to four times as much as a SE wall. A typical section for SE walls is provided in Figure 5. Based on the relatively loose subgrade, the base width and embedment for these walls is greater than is typically used for SE walls.

For preapproved proprietary SE walls, the following design parameters are provided for inclusion in the General Special Provisions.

<u>Soil Parameters</u>	<u>Wall Backfill</u>	<u>Retained Soil</u>	<u>Foundation Soil</u>
Unit Weight (pcf)	130	125	115
Friction Angle (deg)	36	30	28
Cohesion (psf)	0	0	0

<u>Foundation Soil</u>	<u>AASHTO Load Group I</u>	<u>AASHTO Load Group VII</u>
Allowable Bearing Capacity, Wall 1 (psf)	3500	7000
Allowable Bearing Capacity, Wall 2 (psf)	2200	4400
Acceleration Coefficient (g)	N/A	0.23

A traffic surcharge of 250 psf should be added when designing the wall.

The SE wall system should meet the following requirements.

1. The wall should be placed on a level (in direction perpendicular to the wall face) and firm foundation. Walls can be allowed to slope along their length up to 4H:1V (horizontal:vertical).
2. The base width of the walls should be greater than or equal to 125 percent of the wall height.
3. The top reinforcing layer should be placed no lower than 2 feet below the top of the wall.
4. Wall embedment should be a minimum of 4 feet for Wall 1, and 2 feet for Wall 2. A four-foot horizontal bench should be provided in front of the wall.
5. Provisions for permanent control of subsurface water behind the wall should consist of a slotted drain pipe embedded in Gravel Backfill for Drains (Section 9-03.12(4)) as shown in Figure 1130-2 of the Design Manual.
6. Drainage structures should be located outside the reinforced zone where possible. If drainage structures are planned within the reinforced zone, they must be shown on the plans and profile sheets provided to the wall proprietor so they can account for the structures in their design. If drainage structures are located behind the face of a MSE wall, the outfall pipe should run perpendicular to the face of the wall.

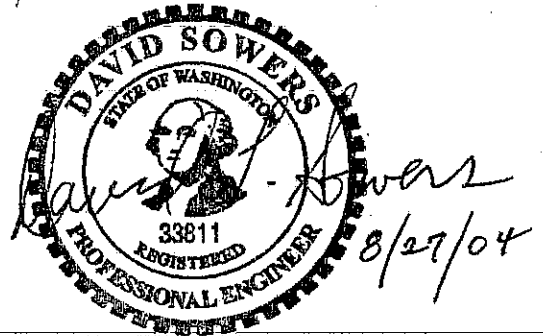
Settlement is anticipated to be approximately 2 to 3 inches. We do not anticipate groundwater will be encountered during construction.

Prior to contract advertisement, the Project office should contact each of the wall proprietors listed in the General Special Provisions to confirm that they want to be included in the contract.

Construction Considerations

Temporary shoring or extra excavation will be required to construct these walls. The site soils are moisture sensitive. If extra excavation is used in lieu of shoring, we recommend the construction take place in the drier late summer or early fall months. Temporary construction slopes should be no steeper than 1H:1V. The Contractor should be prepared to protect open cuts in the event of rainfall.

If you have questions or require further information, please contact Tony Allen at (360) 709-5450 or Mark Frye at (360) 709-5469.



Mark A. Frye

EXPIRES 7/12/05

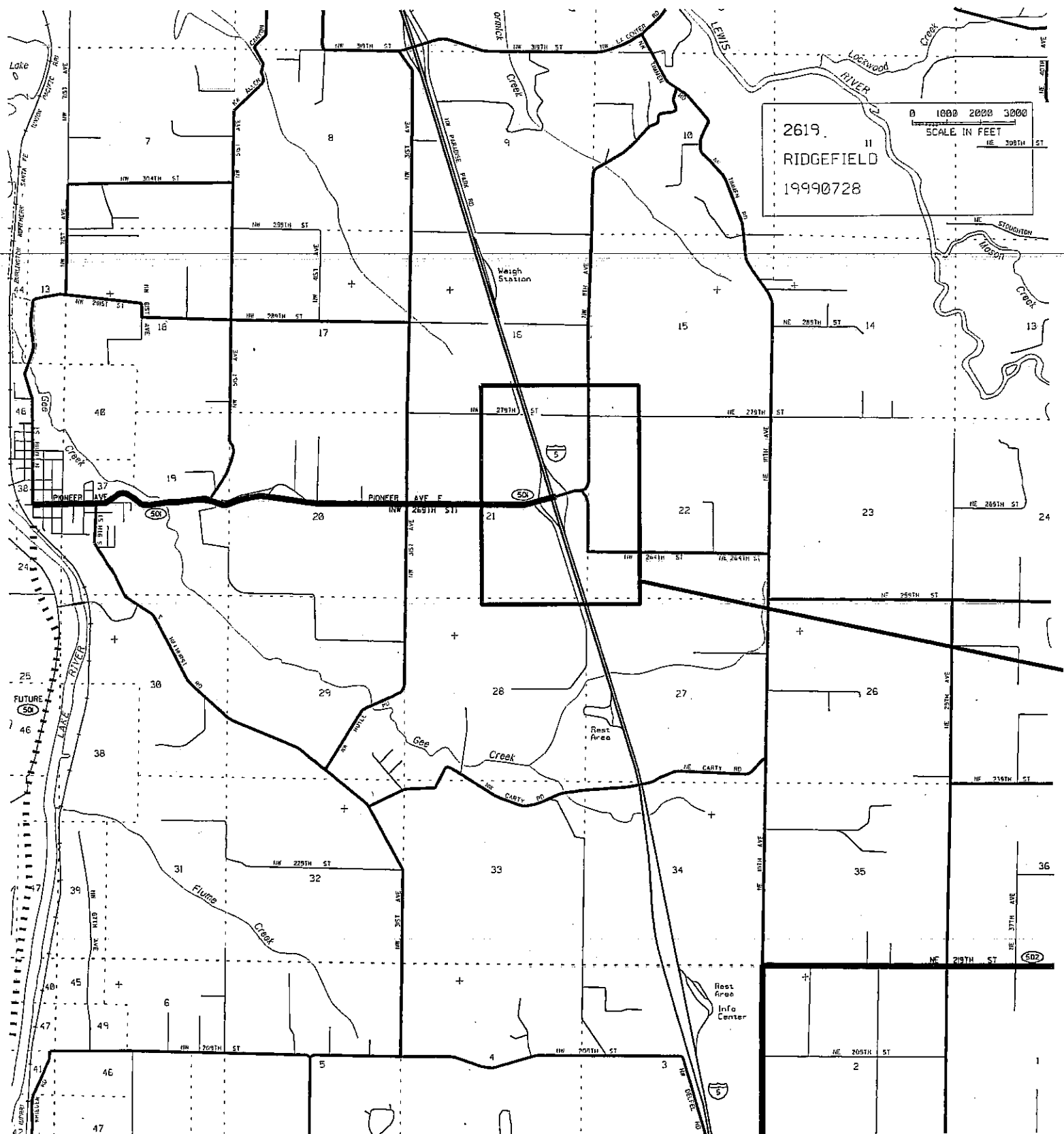
Prepared By: Mark A. Frye
Geotechnical Engineer

Reviewed By: David Sowers
Senior Geotechnical
Engineer

TMA/maf

Attachments: Appendix A: Figures
Appendix B: Boring Logs
Appendix C: Laboratory Testing

cc: Harry Horn, Southwest Region Materials Laboratory
Jugesh Kapur, Bridge and Structures, MS 47340



Project Location

Project Vicinity

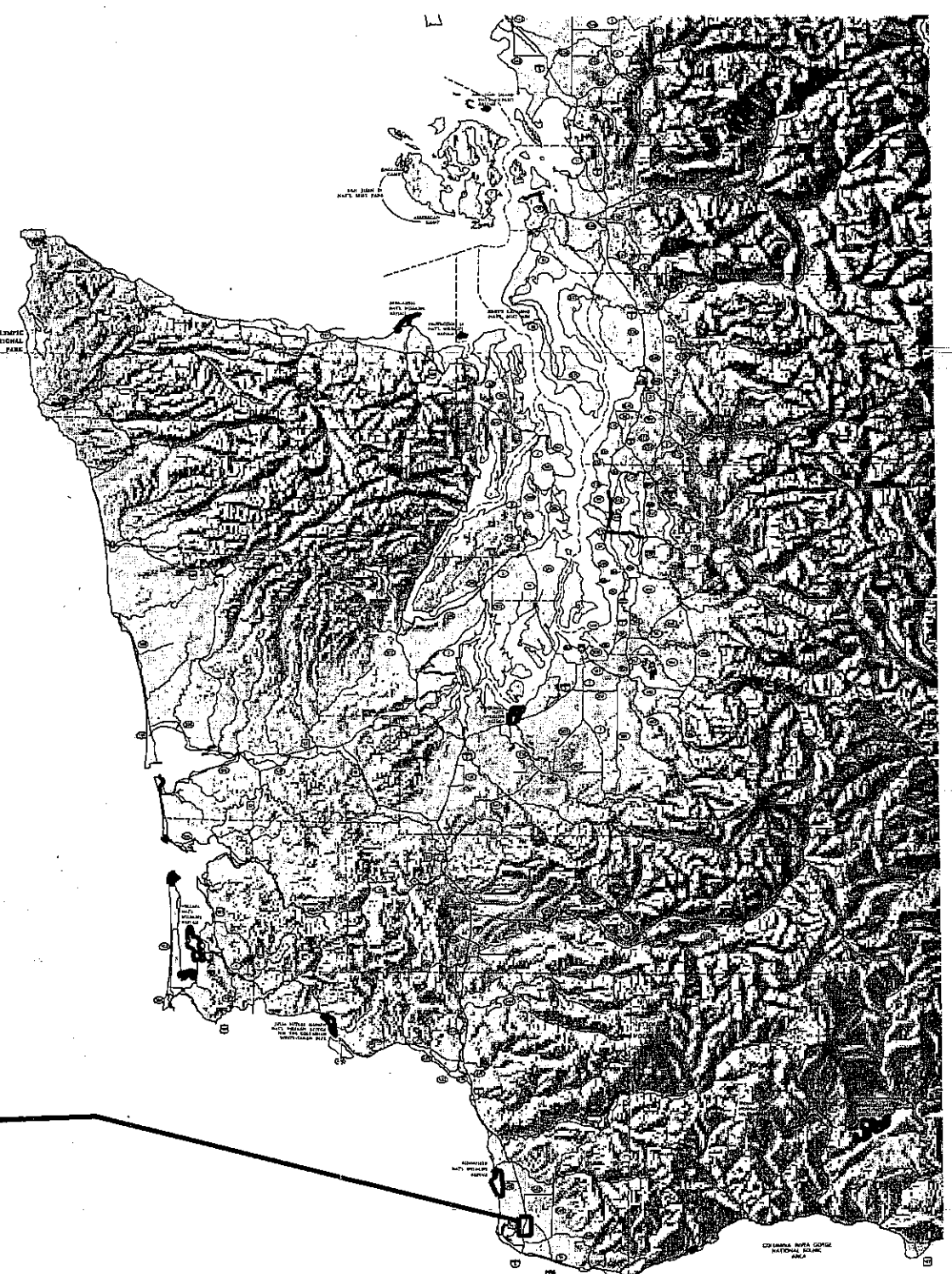


Figure 1: Vicinity Map

JOB XL-2013 S.F. 501 C.S. LAYOUT

SR-501 Safety Improvements

	WASHINGTON STATE TRANSPORTATION COMMISSION DEPARTMENT OF TRANSPORTATION	DATE 8/04
	MATERIALS BRANCH T. E. BAUER MATERIALS ENGINEER	SCALE 1"=200' VERT. 1"=200' HORIZ.
	SHEET ___ OF ___ DRAWN BY DWG	

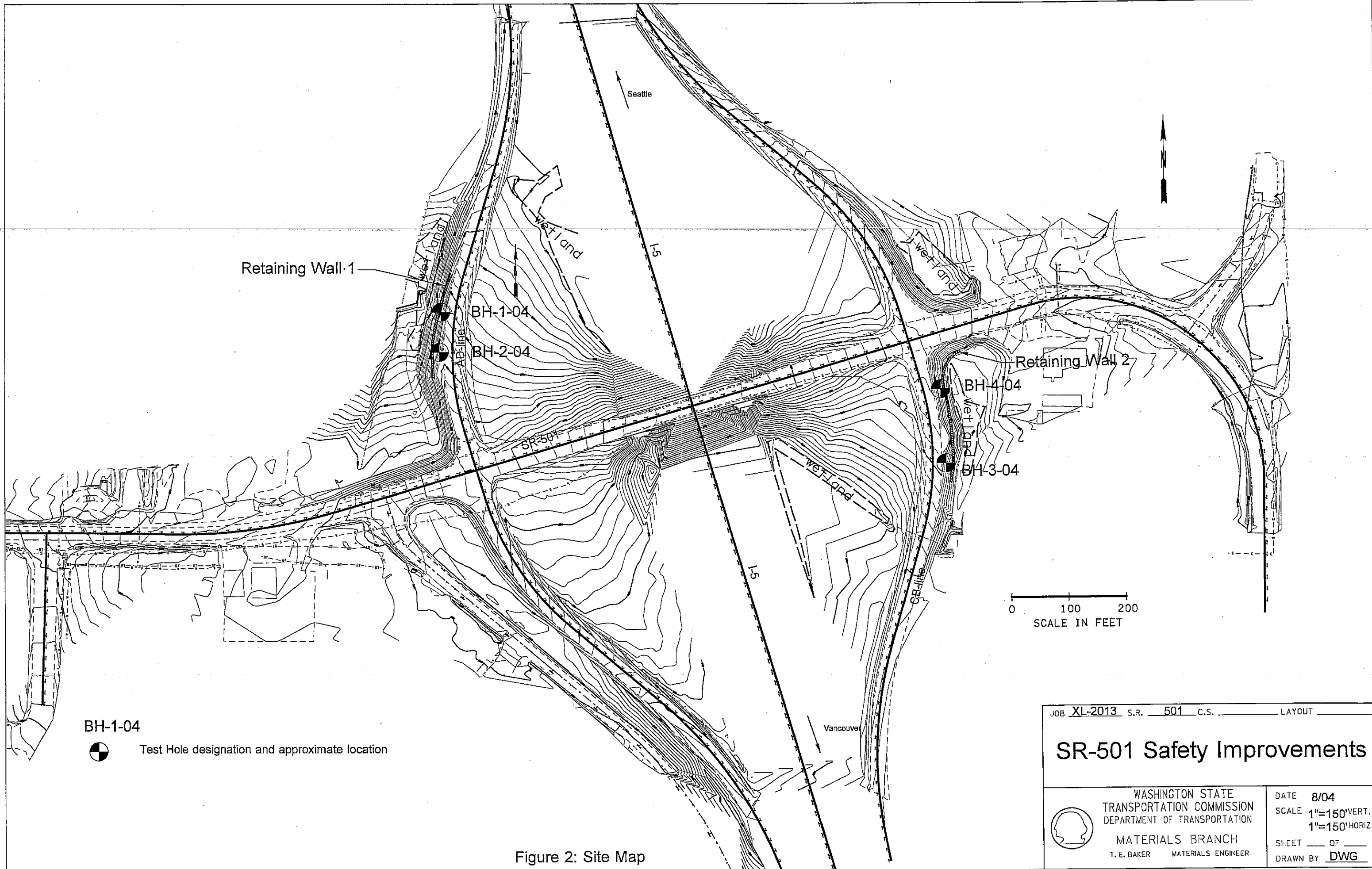


Figure 2: Site Map

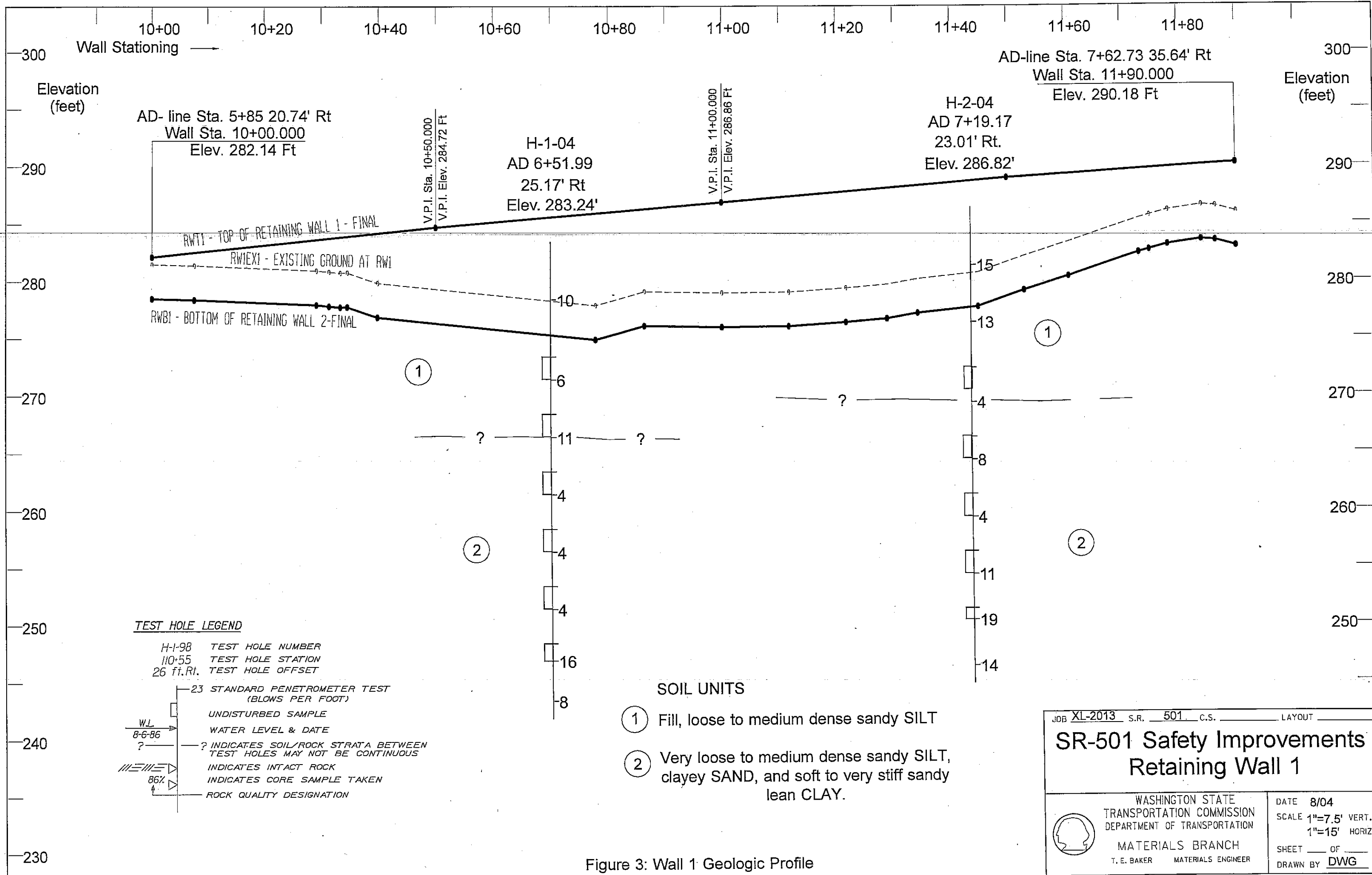


Figure 3: Wall 1 Geologic Profile

JOB XL-2013 S.R. 501 C.S. LAYOUT

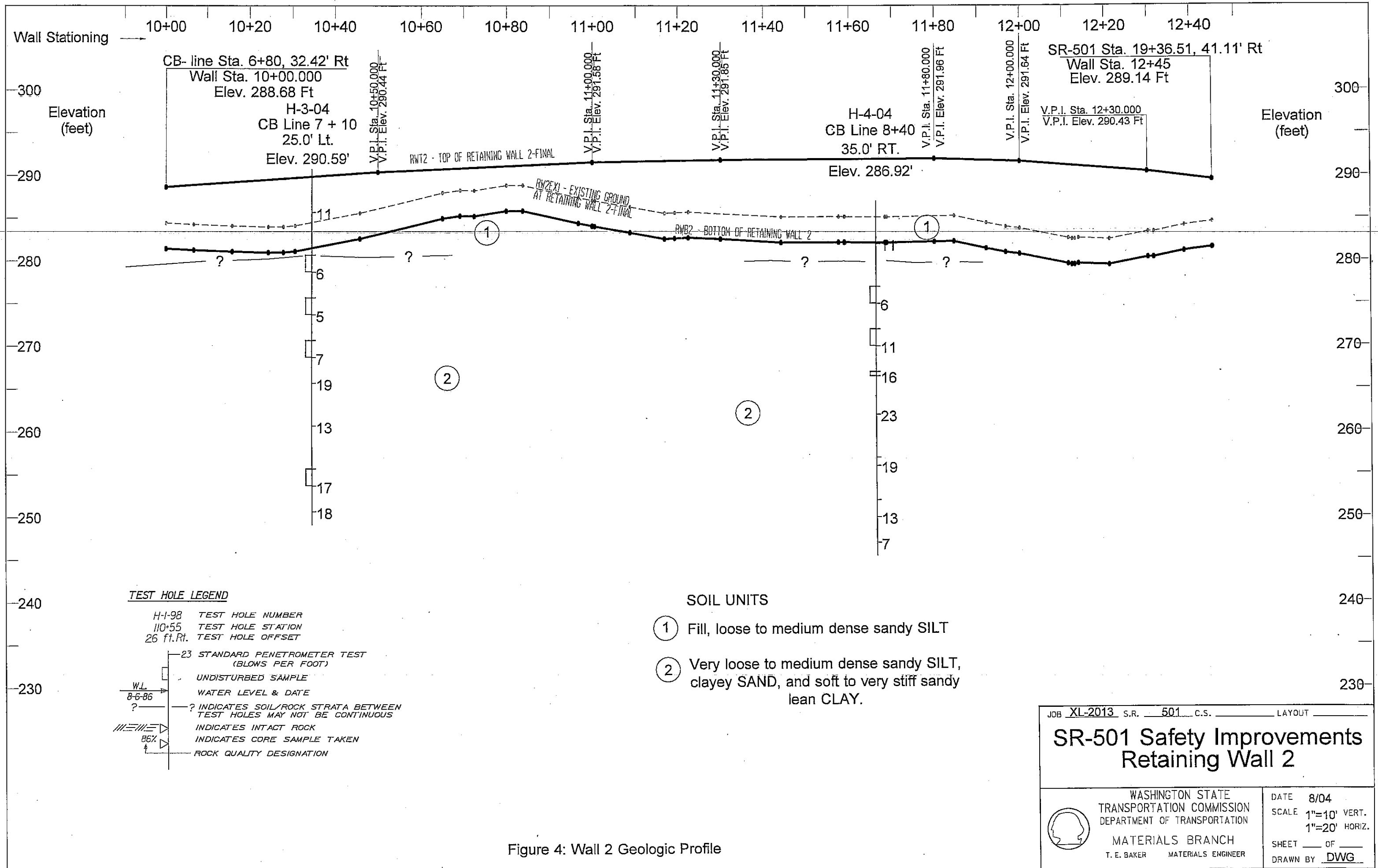
SR-501 Safety Improvements Retaining Wall 1

WASHINGTON STATE
TRANSPORTATION COMMISSION
DEPARTMENT OF TRANSPORTATION

MATERIALS BRANCH
T. E. BAKER MATERIALS ENGINEER

DATE 8/04
SCALE 1"=7.5' VERT.
1"=15' HORIZ.

SHEET ___ OF ___
DRAWN BY DWG



JOB XL-2013 S.R. 501 C.S. LAYOUT

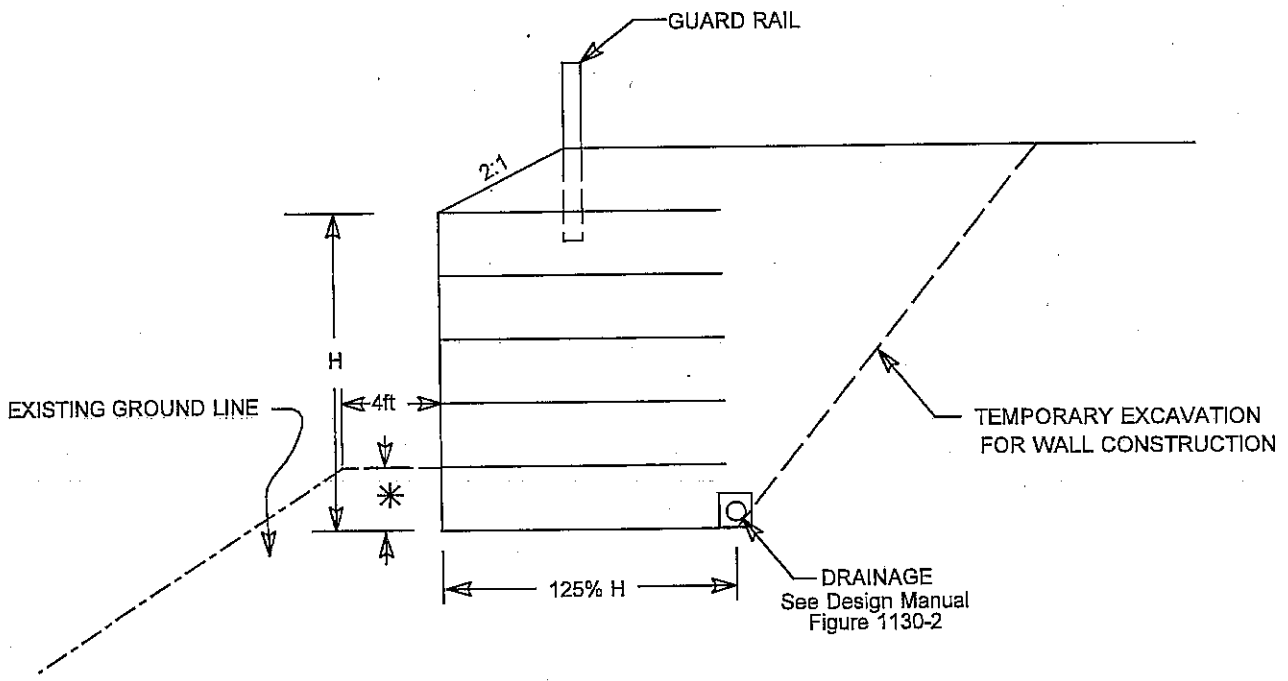
SR-501 Safety Improvements Retaining Wall 2

WASHINGTON STATE
 TRANSPORTATION COMMISSION
 DEPARTMENT OF TRANSPORTATION

MATERIALS BRANCH
 T. E. BAKER MATERIALS ENGINEER

DATE 8/04
 SCALE 1"=10' VERT.
 1"=20' HORIZ.

SHEET ___ OF ___
 DRAWN BY DWG



* 4ft minimum for Wall 1
2ft minimum for Wall 2

FIGURE 5: TYPICAL WALL CROSS SECTION

JOB XL-2013 s.R. 501 c.S. _____

SR-501 Safety Improvements



WASHINGTON STATE
TRANSPORTATION COMMISSION
DEPARTMENT OF TRANSPORTATION
MATERIALS BRANCH
T. E. BAKER MATERIALS ENGINEER

DATE 8/04
SCALE N.T.S. VERT. HORIZ.
SHEET ____ OF ____
DRAWN BY DWG

Appendix B
Field Exploration

Field Exploration

Geotechnical drilling was performed using a CME 45 skid mounted drill rig. Test holes were advanced to depths up to 40 feet below the ground surface using mud rotary drilling methods. At each location, soil samples were obtained using a SPT (Standard Penetration Test) sampler, in general accordance with ASTM D-1586. SPTs are obtained by driving a 2-inch outside diameter split-spoon sampler 18-inches into the soil with a 140-pound hammer. The number of blows required to achieve each 6 inches of penetration is recorded and the soil's SPT resistance, or N-value, is calculated as the number of blows required to achieve the final 12 inches of penetration. Each drill rig is equipped with an automatic trip hammer to drive the split-spoon sampler. The automatic hammers on these two drill rigs are rated at approximately 70 percent efficiency, as compared to approximately 60 percent for manual hammers.

Select soil samples were then submitted to the OSC Materials Laboratory for laboratory testing.



Test Boring Legend

Sampler Symbols	
	Standard Penetration Test
	Oversized Penetration Test (Dames & Moore, California)
	Shelby Tube
	Piston Sample
	Washington Undisturbed
	Vane Shear Test
	Core
	Becker Hammer
	Bag Sample

Well Symbols	
	Cement Surface Seal
	Piezometer Pipe in Granular Bentonite Seal
	Piezometer Pipe in Sand
	Well Screen in Sand
	Granular Bentonite Bottom Seal
	Inclinometer Casing in Concrete Bentonite Grout

Laboratory Testing Codes	
UU	Unconsolidated Undrained Triaxial
CU	Consolidated Undrained Triaxial
CD	Consolidated Drained Triaxial
UC	Unconfined Compression Test
DS	Direct Shear Test
CN	Consolidation Test
GS	Grain Size Distribution
MC	Moisture Content
SG	Specific Gravity
OR	Organic Content
DN	Density
AL	Atterberg Limits
PT	Point Load Compressive Test
SL	Slake Test
DG	Degradation
LA	LA Abrasion
HT	Hydrometer Test

Soil Density Modifiers			
Gravel, Sand & Non-plastic Silt		Elastic Silts and Clay	
SPT Blows/ft	Density	SPT Blows/ft	Consistency
0-4	Very Loose	0-1	Very Soft
5-10	Loose	2-4	Soft
11-24	Medium Dense	5-8	Medium Stiff
25-50	Dense	9-15	Stiff
>50	Very Dense	16-30	Very Stiff
		31-60	Hard
		>60	Very Hard

Angularity of Gravel & Cobbles	
Angular	Coarse particles have sharp edges and relatively plane sides with unpolished surfaces.
Subangular	Coarse grained particles are similar to angular but have rounded edges.
Subrounded	Coarse grained particles have nearly plane sides but have well rounded corners and edges.
Rounded	Coarse grained particles have smoothly curved sides and no edges.

Soil Moisture Modifiers	
Dry	Absence of moisture; dusty, dry to touch
Moist	Damp but no visible water
Wet	Visible free water

Soil Structure	
Stratified	Alternating layers of varying material or color at least 6mm thick; note thickness and inclination.
Laminated	Alternating layers of varying material or color less than 6mm thick; note thickness and inclination.
Fissured	Breaks along definite planes of fracture with little resistance to fracturing.
Slickensided	Fracture planes appear polished or glossy, sometimes striated.
Blocky	Cohesive soil that can be broken down into smaller angular lumps which resist further breakdown.
Disrupted	Soil structure is broken and mixed. Infers that material has moved substantially - landslide debris.
Homogeneous	Same color and appearance throughout.

HCL Reaction	
No HCL Reaction	No visible reaction.
Weak HCL Reaction	Some reaction with bubbles forming slowly.
Strong HCL Reaction	Violent reaction with bubbles forming immediately.

Degree of Vesicularity of Pyroclastic Rocks	
Slightly Vesicular	5 to 10 percent of total
Moderately Vesicular	10 to 25 percent of total
Highly Vesicular	25 to 50 percent of total
Scoriaceous	Greater than 50 percent of total



Test Boring Legend

Grain Size		
Fine Grained	< 1mm	Few crystal boundaries/grains are distinguishable in the field or with hand lens.
Medium Grained	1mm to 5mm	Most crystal boundaries/grains are distinguishable with the aid of a hand lens.
Coarse Grained	> 5mm	Most crystal boundaries/grains are distinguishable with the naked eye.

Weathered State		
Term	Description	Grade
Fresh	No visible sign of rock material weathering; perhaps slight discoloration in major discontinuity surfaces.	I
Slightly Weathered	Discoloration indicates weathering of rock material and discontinuity surfaces. All the rock material may be discolored by weathering and may be somewhat weaker externally than its fresh condition.	II
Moderately Weathered	Less than half of the rock material is decomposed and/or disintegrated to soil. Fresh or discolored rock is present either as a continuous framework or as core stones.	III
Highly Weathered	More than half of the rock material is decomposed and/or disintegrated to soil. Fresh or discolored rock is present either as discontinuous framework or as core stone.	IV
Completely Weathered	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.	V
Residual Soil	All rock material is converted to soil. The mass structure and material fabric is destroyed. There is a large change in volume, but the soil has not been significantly transported.	VI

Relative Rock Strength			
Grade	Description	Field Identification	Uniaxial Compressive Strength approx
R1	Very Weak	Specimen crumbles under sharp blow from point of geological hammer, and can be cut with a pocket knife.	150-3500 psi
R2	Moderately Weak	Shallow cuts or scrapes can be made in a specimen with a pocket knife. Geological hammer point indents deeply with firm blow.	3500-7500 psi
R3	Moderately Strong	Specimen cannot be scraped or cut with a pocket knife, shallow indentation can be made under firm blows from a hammer.	7500-15000 psi
R4	Strong	Specimen breaks with one firm blow from the hammer end of a geological hammer.	15000-350000 psi
R5	Very Strong	Specimen requires many blows of a geological hammer to break intact sample.	Greater than 30000 psi

Discontinuities			
Spacing		Condition	
Very Widely	Greater than 3 m	Excellent	Very rough surfaces, no separation, hard discontinuity wall
Widely	1 m to 3 m	Good	Slightly rough surfaces, separation less than 1 mm, hard discontinuity wall.
Moderately	0.3 m to 1 m	Fair	Slightly rough surfaces, separation greater than 1 mm, soft discontinuity wall.
Closely	50 mm to 300 mm	Poor	Slickensided surfaces, or soft gouge less than 5 mm thick, or open discontinuities 1 to 5 mm.
Very Closely	Less than 50 mm	Very Poor	Soft gouge greater than 5 mm thick, or open discontinuities greater than 5 mm.
RQD (%) $\frac{100(\text{length of core in pieces} > 100\text{mm})}{\text{Length of core run}}$			

Fracture Frequency (FF) is the average number of fractures per 300 mm of core. Does not include mechanical breaks caused by drilling or handling.



LOG OF TEST BORING

Start Card R 65905

Job No. XL-2013 SR 5

Elevation 283.2 ft (86.3 m)

HOLE No. H-1-04

Sheet 1 of 3

Project SR 501 - Safety Improvement

Driller Kerry Cooper Lic# 2552

Site Address Vicinity of SR-5 and SR-501

Inspector Cleo Andrews

Start July 27, 2004 Completion July 27, 2004 Well ID# AHN-676 Equipment CME 45 w/ autohammer

Station AD 6 + 51.99 Offset 25.17' Rt Casing HWT 4" ID x 45.0' Method Wet Rotary

Northing 184073.792 Easting 1082593.128 Latitude _____ Longitude _____

County Clark Subsection SE 1/4 of the NE 1/4 Section 21 Range 1 EWM Township 4

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft				SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
			10	20	30	40							
0 - 5	0 - 1.5										0.0' to 5.0' silty GRAVEL with sand as indicated by drilling and wash return. 100% drilling fluid return.		
5 - 2	1.5 - 0.6							D-1			Sandy SILT, stiff, olive brown, moist, Homogeneous, HCl reaction not tested, traces of brownish orange and gray stains. Length Recovered 1.5 ft, Length Retained 1.2 ft		
2 - 10	0.6 - 3.0							SH-2			No Recovery		
10 - 4	3.0 - 1.2							D-3	GS MC AL		ML, MC=25%, LL=32 Sandy SILT, loose, brownish gray, moist, Homogeneous, HCl reaction not tested, traces of brownish orange stains. (Took moisture can sample from same depth, retained 0.2'). Length Recovered 1.0 ft, Length Retained 1.0 ft		
4 - 15	1.2 - 4.6							SH-4			Sandy silty CLAY, medium dense, brownish gray, moist, Homogeneous, HCl reaction not tested, traces of brownish orange and greenish gray stains. (100-500 PSI to push shelly tube 2.0'). Length Recovered 2.0 ft, Length Retained 2.0 ft		
15 - 6	4.6 - 1.8							D-5	GS MC AL		CL-ML, MC=27%, PI=6 Sandy silty CLAY, medium dense, brownish gray, moist, Homogeneous, HCl reaction not tested, traces of brown, greenish gray, spots and stains through out soil mass. (Took moisture can sample MC-5a from same depth, retained 0.2'). Length Recovered 1.5 ft, Length Retained 1.2 ft		
6 - 20	1.8 - 6.1												

SOIL XL-2013 SR 501 - SAFETY IMPROVEMENT.GPJ SOIL.GDT 8/25/04 2:03:00 PM



LOG OF TEST BORING

Start Card R 65905

Job No. XL-2013 SR 5

Elevation 283.2 ft (86.3 m)

HOLE No. H-1-04

Sheet 3 of 3

Project SR 501 - Safety Improvement

Driller Kerry Cooper Lic# 2552

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft				SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
			10	20	30	40							
14											5.0' of casing, bailed hole to 39.0', after 15 minutes delay 20.8'. Installed piezo well after 1 hour delay water table stabilized at 19.2'		
											<p>WATER LEVEL READINGS</p> <p>DATE 07/29/2004 DEPTH -18.9</p>		
15													
50													
16													
55													
17													
18													
60													
19													
65													
20													
21													
70													

SOIL XL-2013 SR 501 - SAFETY IMPROVEMENT.GPJ SOIL.GDT 8/19/04,11:27:04 AB



LOG OF TEST BORING

Start Card S 23986

Job No XL-2013 SR 5

Elevation 286.8 ft (87.4 m)

HOLE No. H-2-04

Sheet 1 of 3

Project SR 501 - Safety Improvement

Driller Kerry Cooper Lic# 2552

Site Address Vicinity of SR-5 and SR-501

Inspector Cleo Andrews

Start July 27, 2004 Completion July 27, 2004 Well ID# _____ Equipment CME 45 w/ autohammer

Station AD 7 + 19.17 Offset 2301' Rt Casing HQ 3" ID x 45.0' Method Wet Rotary

Northing 184003.291 Easting 1082590.436 Latitude _____ Longitude _____

County Clark Subsection NE1/4 of the SE 1/4 Section 21 Range 1 EWM Township 4

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft				SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
			10	20	30	40							
0.0'										0.0' to 5.0' sandy SILT with gravel as indicated by drilling and wash return. 100% drilling fluid return.			
5.0'						5 7 8 (15)	D-1			Sandy SILT with gravel, organic, root hairs and brownish orange stains through out soil mass, medium dense, dark gray, moist, Stratified, HCl reaction not tested Length Recovered 1.5 ft, Length Retained 1.0 ft			
10.0'						3 5 8 (13)	D-2	GS MC AL		CL, MC=19%, PI=16 Sandy Lean CLAY, stiff, grayish brown, moist, Stratified, HCl reaction not tested, (Took moisture can sample MC-2a same depth, retained 0.2'). Note fill material to approximately 9.0' as shown by drilling, sampling and wash return. Length Recovered 1.5 ft, Length Retained 1.2 ft			
15.0'							U-3 A B			Sandy Lean CLAY, with sand lenses, soft, grayish brown, moist, Laminated, HCl reaction not tested, traces of organics and gravel as shown in end of sampler, took 100 to 400 psi to push undisturbed sampler 2.0'. Length Recovered 0.7 ft, Length Retained 0.7 ft			
20.0'						2 2 2 (4)	D-4	GS MC AL		ML, MC=30%, PI=6 Sandy SILT, with gravel, very loose, dark olive gray, moist, stratified with organics, black in color. Length Recovered 1.0 ft, Length Retained 1.0 ft			

SOIL XL-2013 SR 501 - SAFETY IMPROVEMENT.GPJ SOIL.GDT 8/25/04 2:11:01 PM

07/27/2004



Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft				SPT Blows/6" (N)	Sample Type	Sample No. ("Tube No.")	Lab Tests	Description of Material	Groundwater	Instrument
			10	20	30	40							
								U-5 A to F		Sandy SILT, with silt lens, gray in color, loose, grayish brown, moist, Laminated, HCl reaction not tested Length Recovered 2.0 ft, Length Retained 2.0 ft			
7						3 4 4 (8)		D-6		Sandy SILT, loose, dark brown, moist, Homogeneous, HCl reaction not tested, traces of organic, black in color and light gray stains Length Recovered 1.5 ft, Length Retained 1.2 ft			
25								U-7 A to F		Sandy SILT, loose, grayish brown, moist, Homogeneous, HCl reaction not tested, traces of light gray stains as shown in end of sampler. (Took moisture can sampler MC-6a from 22.0' to 23.5', retained 0.2'). Length Recovered 2.0 ft, Length Retained 2.0 ft			
8						2 2 2 (4)		D-8		Sandy SILT, very loose, dark brown, moist, Homogeneous, HCl reaction not tested, traces of light gray stains, took moisture can sampler MC-8a from same depth, retained 0.2'. Length Recovered 1.5 ft, Length Retained 1.2 ft			
9								U-9 A B C D		Sandy lean CLAY, soft, light gray, moist, Homogeneous, HCl reaction not tested, traces of brownish stains as shown in end of sampler, took 100 to 300 PSI to push undisturbed sampler 2.0'. Length Recovered 1.7 ft, Length Retained 1.7 ft			
30						2 5 6 (11)		D-10	GS MC AL	CL, MC=27%, PI=18 Sandy Lean CLAY with small pieces highly weathered sandstone that can be broken down with fingers, very stiff, grayish brown, moist, Stratified, HCl reaction not tested, brownish orange stains through out soil mass, took moisture can sample MC-10a from same depth, retained 0.2'. Length Recovered 1.5 ft, Length Retained 1.2 ft			
10								U-11 A B C		Sandy lean CLAY, with small pieces of highly weathered sandstone reddish black in color, breaks down when mashed with fingers, medium dense, brownish gray, moist, Stratified, HCl reaction not tested, as shown in end of sampler, refusal at 36.0'. Length Recovered 1.0 ft, Length Retained 1.0 ft			
35						6 8 11 (19)		D-12	GS MC AL	CL, MC=27%, PI=22 Sandy Lean CLAY, light gray to pinkish gray in color, medium dense, brown, moist, Stratified, HCl reaction not tested, traces of dark reddish brown oxidized stained coarse grained sand that breaks down when crushed with fingers. Length Recovered 1.5 ft, Length Retained 1.2 ft			
11													
40						5 7 7 (14)		D-13		Sandy lean CLAY, with silt lenses, light gray in color, medium dense, brownish orange, moist, Stratified, HCl reaction not tested, traces of dark reddish black oxidized stains. Took moisture cans sample MC-12a from 36.0' to 37.5', retained 0.2' and MC-13a 40.0' to 41.5', retained 0.2'. Length Recovered 1.5 ft, Length Retained 1.2 ft			
12													
45										End of test hole boring at 41.5 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.			
13													

SOIL_XL-2013 SR 501 - SAFETY IMPROVEMENT.GPJ SOIL.GDT 8/25/04 2:11:01 PM



LOG OF TEST BORING

Start Card S 23986

Job No. XL-2013 SR 5

Elevation 286.8 ft (87.4 m)

HOLE No. H-2-04

Sheet 3 of 3

Project SR 501 - Safety Improvement

Driller Kerry Cooper

Lic# 2552

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft				SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
			10	20	30	40							
14										Water table in hole before bailing is 8.0', bailed hole to 39.0', recharged to 17.0' after 30 minutes delay and after pulling 20.0' of casing.			
15													
50													
16													
55													
17													
18													
60													
19													
65													
20													
21													
70													

SOIL_XL-2013_SR_501 - SAFETY IMPROVEMENT.GPJ SOIL_GDT 8/25/04,2:11:01 PB



LOG OF TEST BORING

Start Card R65905

Job No. XL-2013 SR 5

Elevation 290.6 ft (88.6 m)

HOLE No. H-3-04

Sheet 1 of 3

Project SR 501 - Safety Improvement

Driller Kerry Cooper Lic# 2552

Site Address Vicinity of I-5 and SR-501

Inspector Cleo Andrews

Start July 28, 2004 Completion July 28, 2004 Well ID# AHN677 Equipment CME 45 w/ autohammer

Station CB Line 7 + 10 Offset 25.0' Lt. Casing HQ 3" ID x 45.0' Method Wet Rotary

Northing 183805.552 Easting 1083470.605 Latitude _____ Longitude _____

County Clark Subsection SE 1/4 of the NE 1/4 Section 21 Range 1 EWM Township 4

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft				SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
			10	20	30	40							
0.0' to 3.0'											0.0' to 3.0' silty GRAVEL with sand as indicated by drilling and wash return. 100% drilling fluid return. Change to natural ground at approximately 3.0'.		
5						3	D-1				Sandy SILT, with very fine grained sand lenses, traces of root hairs, brown and light gray stains, medium dense, Olive gray, moist, Laminated, HCl reaction not tested, (Took moisture can sample MC - 1a from same depth, retained 0.2'). Length Recovered 1.5 ft, Length Retained 1.2 ft		
10						3	SH-2				Sandy SILT, medium dense, grayish brown, moist, Homogeneous, HCl reaction not tested, traces of gray and brown oxidized stains throughout soil mass. (100 to 500 PSI to push shelly tube 2.0'). Length Recovered 1.5 ft, Length Retained 1.5 ft		
15						3	D-3		GS MC AL		ML, MC=35%, LL=36 Sandy SILT, loose, grayish brown, moist, Homogeneous, HCl reaction not tested, traces of gray and brown oxidized stains throughout soil mass Length Recovered 1.5 ft, Length Retained 1.0 ft		
20						3	U-4				Sandy SILT, loose, grayish brown, moist, Homogeneous, HCl reaction not tested, traces of gray and brown oxidized stains throughout soil mass (100 - 350 PSI to push undisturbed sampler 2.0') Length Recovered 1.3 ft, Length Retained 1.3 ft		
25						2	D-5		GS MC AL		ML, MC=31%, LL=32 SILT with sand, loose, grayish brown, moist, Homogeneous, traces of gray and brown oxidized stains throughout soil mass Length Recovered 1.5 ft, Length Retained 1.0 ft		
30						2							
35						3							
40						(5)							

SOIL XL-2013 SR 501 - SAFETY IMPROVEMENT.GPJ SOIL.GDT 07/25/04 2:04:51 PM



Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft				SPT Blows/6" (N)	Sample Type Sample No. (Tube No.)	Lab. Tests	Description of Material	Groundwater	Instrument
			10	20	30	40						
							U-6 A B C		Sandy SILT, loose, brown, wet, Homogeneous, HCl reaction not tested, (100 to 500 PSI to push undisturbed sampler 2.0') Length Recovered 1.0 ft, Length Retained 1.0 ft			
7						3 3 4 (7)	D-7	GS MC AL	ML, MC=37% Sandy SILT, loose, brown, wet, Laminated, HCl reaction not tested, traces of brown stains Length Recovered 1.5 ft, Length Retained 1.0 ft			
25						5 8 11 (19)	D-8		Sandy SILT, with sandy Silt lenses, very stiff, grayish brown, moist, Stratified, HCl reaction not tested, lenses are gray in color and are throughout soil mass (Took MC - 8a from same depth, retained 0.2'). Length Recovered 1.5 ft, Length Retained 1.2 ft			
30						5 6 7 (13)	D-9	GS MC AL	SC, MC=27%, PI=22 Clayey SAND, with silt lenses, medium dense, grayish brown, moist, Stratified, HCl reaction not tested, lenses are light gray in color and throughout soil mass (took MC - 9a from same depth, retained 0.2'). Length Recovered 1.5 ft, Length Retained 1.2 ft			
35							U-10 A B C		Silty SAND, with organic lenses black in color, medium dense, brown, moist, Stratified, HCl reaction not tested, (100 - 500 PSI to push undisturbed sampler 1.0') Length Recovered 1.0 ft, Length Retained 1.0 ft			
						5 8 9 (17)	D-11		Silty SAND, with organic lenses black in color, medium dense, brown, moist, Stratified, HCl reaction not tested Length Recovered 1.5 ft, Length Retained 1.0 ft			
40						6 9 9 (18)	D-12		Silty SAND, medium dense, brown, moist, Homogeneous, HCl reaction not tested, traces of organic spots black in color (took MC - 12a from same depth, retained 0.2'). Length Recovered 1.5 ft, Length Retained 1.2 ft			
									End of test hole boring at 41.5 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.			
									Water in casing before bailing casing is 3.0', pulled 5.0' of			

SOIL_XL-2013 SR 501 - SAFETY IMPROVEMENT.GPJ SOIL_GDT 8/19/04, 11:27:06 A8



Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft				SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
			10	20	30	40							
14											casing, bailed hole to 39.0', after 30 minutes delay 22.0', 7/29/04 is 20.4'.		
15													
50													
16													
55													
17													
18													
60													
19													
65													
20													
21													
70													

SOIL_XL-2013 SR 501 - SAFETY IMPROVEMENT.GPJ SOIL_GDT 8/19/04,11:27:36 A8



Job No. XL-2013 SR 5

Elevation 286.9 ft (87.4 m)

HOLE No. H-4-04

Sheet 1 of 3

Project SR 501 - Safety Improvement

Driller Kerry Cooper Lic# 2552

Site Address Vicinity of I-5 and SR-501

Inspector Cleo Andrews

Start July 29, 2004 Completion July 29, 2004 Well ID# _____ Equipment CME 45 w/ autohammer

Station CB Line 8+40 Offset 35.0' RT. Casing (HWT 4"IDx30')(HQ 3"IDx45') Method Wet Rotary

Northing 183935.56 Easting 1083462.127 Latitude _____ Longitude _____

County Clark Subsection SE 1/4 of the NE 1/4 Section 21 Range 1 EWM Township 4

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft				SPT Blows/6" (N)	SPT Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
			10	20	30	40							
0.0										0.0' to 3.0' silty GRAVEL with sand as indicated by drilling and wash return. Changed to natural ground at approximately 3.0'. 100% drilling fluid return.			
5						3 4 5 (9)	D-1	GS MC AL	ML, MC=26%, LL=30 Sandy SILT, with very fine grained sand lenses, medium dense, olive gray, moist, Laminated, HCl reaction not tested, traces of root hairs and brown and light gray stains. (Took moisture can MC-1a from same depth, retained 0.2'). Length Recovered 1.5 ft, Length Retained 1.2 ft				
10							SH-2		Sandy SILT, with organic, loose, grayish brown, moist, Stratified, HCl reaction not tested. (Took 100-400 PSI to push shelly tube 2.0') Length Recovered 2.0 ft, Length Retained 2.0 ft				
15						3 3 3 (6)	D-3		SILT with sand, medium dense, grayish brown, moist, Homogeneous, HCl reaction not tested, traces of brown stains throughout soil mass Length Recovered 1.5 ft, Length Retained 1.2 ft				
20							SH-4		Sandy Lean CLAY, stiff, grayish brown, moist, Homogeneous, HCl reaction not tested, (Took 100-300 PSI to push shelly tube 2.0') Length Recovered 2.0 ft, Length Retained 2.0 ft				
25						2 5 6 (11)	D-5	GS MC AL	CL, MC=24%, PI=18 Sandy Lean CLAY, stiff, grayish brown, moist, Homogeneous, HCl reaction not tested, traces of brownish orange stains throughout soil mass. (Took moisture can sample MC-5a from same depth, retained 0.2'). Length Recovered 1.5 ft, Length Retained 1.2 ft				

SOIL_XL-2013 SR 501 - SAFETY IMPROVEMENT.GPJ SOIL.GDT 8/19/04, 11:27:06 AB



Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft				SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
			10	20	30	40							
								SH-6			No Recovery		
						5 8 8 (16)		D-7			Sandy lean CLAY, with sandy silt lenses, very stiff, brownish gray, moist, Stratified, HCl reaction not tested, lenses are light gray in color, traces of black spots throughout soil mass. (Took moisture can sample MC-7a from same depth, retained 0.2').	▽	
											Length Recovered 1.5 ft, Length Retained 1.2 ft 07/29/2004		
7													
25						8 9 14 (23)		D-8	GS MC AL		SC, MC=23%, PI=47 Clayey SAND, with brownish orange stains throughout soil mass, very stiff, light gray, moist, Stratified, HCl reaction not tested, (Took moisture can sample from same depth, retained 0.2') Length Recovered 1.5 ft, Length Retained 1.2 ft		
8													
30													
9													
35													
10						6 8 11 (19)		U-9 A B C D-10	GS MC AL		Sandy lean CLAY, very stiff, light gray, moist, Homogeneous, HCl reaction not tested, (Took 400-500 PSI to push undisturbed sampler 1.0') Length Recovered 1.0 ft, Length Retained 1.0 ft CL, MC=24%, PI=18 Sandy Lean CLAY, very stiff, brownish orange, moist, Homogeneous, HCl reaction not tested, traces of brown and black spots throughout soil mass. (Took moisture can sample MC-10a from same depth, retained 0.2'). Length Recovered 1.5 ft, Length Retained 1.2 ft		
35													
11													
40													
12						5 6 7 (13)		D-12	GS MC AL		SC, MC=27%, PI=12 Clayey SAND, stiff, reddish brown, moist, Homogeneous, HCl reaction not tested, traces of brownish orange and black spots throughout soil mas. (Took moisture can sample MC-12a from same depth, retained 0.2'). Length Recovered 1.5 ft, Length Retained 1.2 ft		
40													
13						4 3 4 (7)		D-13			Clayey SAND, loose, reddish brown, moist, Homogeneous, HCl reaction not tested, traces of brownish orange and black spots throughout soil mass. (Took moisture can sample MC-13a from same depth, retained 0.2'). Length Recovered 1.5 ft, Length Retained 1.2 ft		
45											End of test hole boring at 41.5 ft below ground elevation.		
											This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.		

SOIL_XL-2013 SR 501 - SAFETY IMPROVEMENT.GPJ SOIL_GDT 8/19/04, 11:27:06 AM



LOG OF TEST BORING

Start Card S 23986

Job No. XL-2013

SR 5

Elevation 286.9 ft (87.4 m)

HOLE No. H-4-04

Sheet 3 of 3

Project SR 501 - Safety Improvement

Driller Kerry Cooper

Lic# 2552

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft				SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
			10	20	30	40							
14													
15													
50													
16													
55													
17													
18													
60													
19													
65													
20													
21													
70													

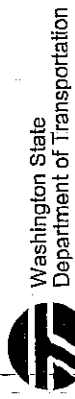
Water in casing before bailing is 2.0', bailed casing to 31.0', pulled 5.0' of casing, water table recharged in hole to 22.2' after 30 minutes delay. Ended and abandoned test boring at 41.5' below ground elevation. 7/29/04.

SOIL_XL-2013 SR 501 - SAFETY IMPROVEMENT.GPJ SOIL.GDT 8/19/04, 11:27:06 AM

Appendix C
Laboratory Testing

Laboratory Testing

Laboratory testing was performed on selected samples from the field exploration program. Testing included performing moisture content, grain size analyses and Atterberg Limits. The tests were done in general accordance with AASHTO T-88, T-89, and T-90 guide specifications, respectively. After the testing was complete, the samples were classified in general accordance with the Unified Soil Classification System (USCS).



Washington State
Department of Transportation

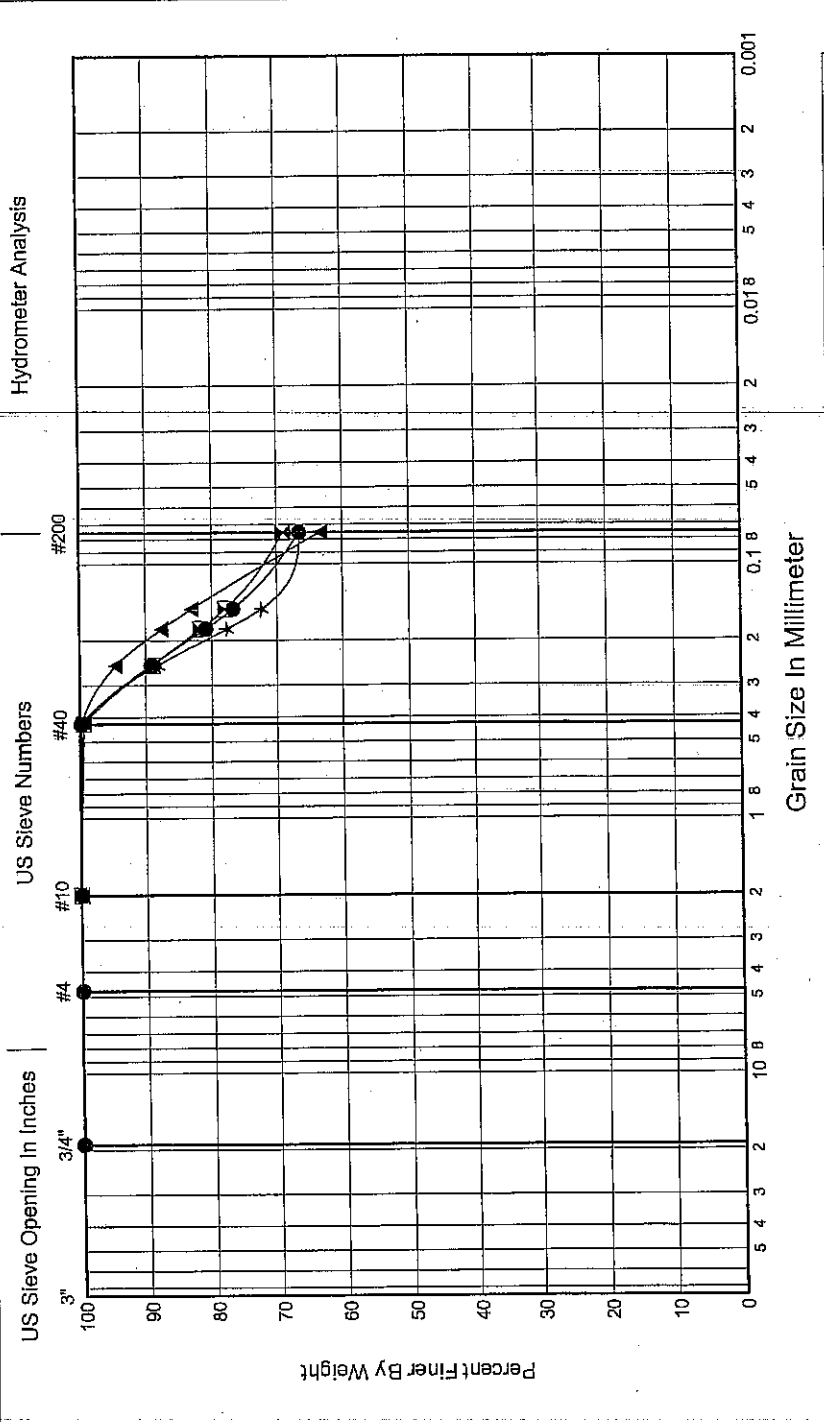
Laboratory Summary

Date **August 9, 2004**
Sheet **1** of **1**

Job No. **XL-2013**
Hole No. **H1-1-04**
Project **SR 501 - Safety Improvement**

Depth (ft)	Depth (m)	Sample No.	USCS	Color	Description	MC%	LL	PL	PI
● 12.0	3.66	D-3	ML	See Boring Log	SANDY SILT	25	32	NP	NA
☒ 17.0	5.18	D-5	CL-ML	See Boring Log	SANDY SILTY CLAY	27	27	21	6
▲ 27.0	8.23	D-9	ML	See Boring Log	SANDY SILT	32	26	NP	NA
★ 32.0	9.75	D-11	CL	See Boring Log	SANDY LEAN CLAY	26	39	18	21

GRADATION FRACTIONS					
	%Gravel	%Sand	%Fines	Cc	Cu
●	0.1	33.5	66.4		
☒	0.0	31.0	69.0		
▲	0.0	36.9	63.1		
★	0.0	33.6	66.4		



GRADATION VALUES					
	D60	D50	D30	D20	D10
●					
☒					
▲					
★					

Sand			Silt and Clay	
Coarse	Medium	Fine		

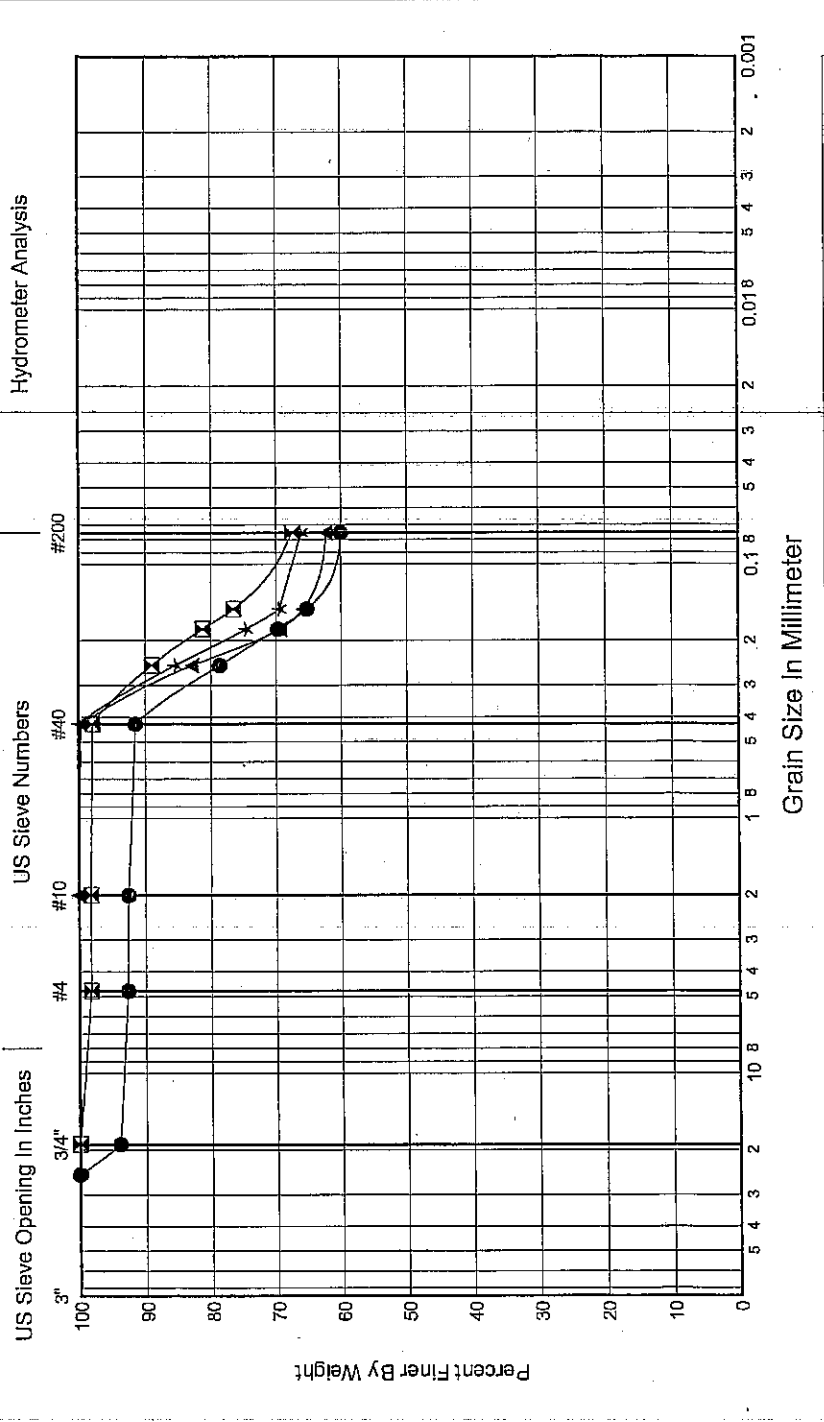
Laboratory Summary

Date August 9, 2004
Sheet 1 of 1

Job No. XL-2013
Hole No. H-2-04
Project SR 501 - Safety Improvement

Depth (ft)	Depth (m)	Sample No.	USCS	Color	Description	MC%	LL	PL	PI
● 10.0	3.05	D-2	CL	See Boring Log	SANDY LEAN CLAY	19	37	21	16
☒ 17.0	5.18	D-4	ML	See Boring Log	SANDY SILT	30	29	23	6
▲ 32.0	9.75	D-10	CL	See Boring Log	SANDY LEAN CLAY	27	38	20	18
★ 36.0	10.97	D-12	CL	See Boring Log	SANDY LEAN CLAY	27	46	24	22

GRADATION FRACTIONS					
	%Gravel	%Sand	%Fines	Cc	Cu
●	7.3	32.7	60.0		
☒	1.8	30.8	67.5		
▲	0.0	37.8	62.2		
★	0.0	33.9	66.1		



GRADATION VALUES					
	D60	D50	D30	D20	D10
●	0.075				
☒					
▲					
★					

Gravel

Coarse

Medium

Fine

Silt and Clay

Laboratory Summary

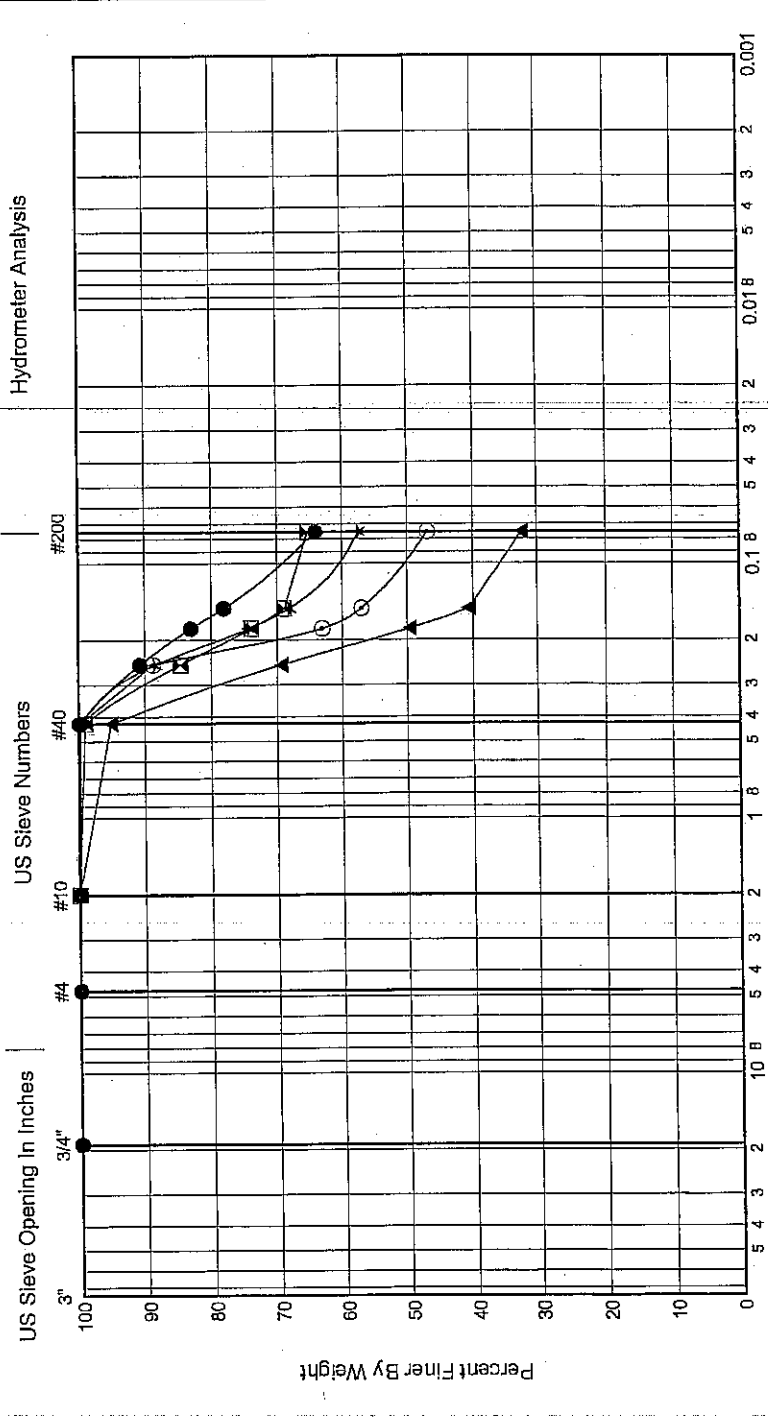
Date August 9, 2004
Sheet 1 of 1

Job No. XL-2013
Hole No. H-4-04
Project SR 501 - Safety Improvement

Depth (ft.)	Depth (m)	Sample No.	USCS	Color	Description	MC%	LL	PL	PI
● 5.0	1.52	D-1	ML	See Boring Log	SANDY SILT	26	30	NP	NA
☒ 17.0	5.18	D-5	CL	See Boring Log	SANDY LEAN CLAY	24	39	21	18
▲ 25.0	7.62	D-8	SC	See Boring Log	CLAYEY SAND	23	73	26	47
★ 31.0	9.45	D-10	CL	See Boring Log	SANDY LEAN CLAY	24	39	21	18
◎ 37.0	11.28	D-12	SC	See Boring Log	CLAYEY SAND	27	29	17	12

GRADATION FRACTIONS

	%Gravel	%Sand	%Fines	Cc	Cu
●	0.1	35.9	64.0		
☒	0.0	34.8	65.2		
▲	0.0	67.6	32.4		
★	0.0	42.5	57.5		
◎	0.0	53.2	46.8		



GRADATION VALUES

	D60	D50	D30	D20	D10
●					
☒					
▲	0.214	0.18			
★	0.089				
◎	0.164	0.09			

