Washington State Department of Transportation

Memorandum

December 8, 2005

TO: Rosario Revilla/Adam Brown
Northwest Region, MS NB 82-75

FROM: T. M. Allen/M. A. Frye
E&EP Geotechnical Division, 47365

SUBJECT: SR-90, MP 6.22 to 7.24, XL2423
Two Way Transit & HOV Operations, Stage 1
Retaining Walls 21 through 25,
Geotechnical Recommendations

Introduction

This memorandum presents geotechnical recommendations for the design of Retaining Walls 21 through 25 associated with the subject project. This project will provide Two-Way Transit and HOV lanes between Seattle and Bellevue. HOV lanes will be added to the left of the general purpose lanes on the eastbound and westbound mainline roadways. Where existing reversible lanes exist, they will be maintained in their current configuration.

Throughout the length of the project, the addition of new HOV lanes will require widening of the existing outside shoulders. Across Mercer Island, the widening will generally only take place between the existing bridges. Walls 21 through 25 will be constructed between the 80th Ave. SE bridge and the Luther Burbank Lid. Wall Recommendations for other retaining walls associated with this project will be provided under separate cover.

Retaining Wall Descriptions

Walls 21 and 22 will support the approach fill to the east abutment of the W-80th Ramp Bridge. These walls will have a maximum exposed height of approximately 15 feet and will support ramp traffic. A portion of Wall 22 will have a biofiltration swale at the toe of the wall.

Walls 23 through 25 will provide the transition from the proposed westbound HOV lane and the proposed W-80th Ramp Bridge. The exposed face of these walls will form the traffic barrier along the edge of the roadway shoulder. In general these walls will have exposed heights of less than 3 feet and will support median landscaping.

Subsurface Conditions

A report titled *Geotechnical and Geologic Type, Size, and Location Report, I-90 Two-Way Transit and High-Occupancy Vehicle Operations, I-5 to Bellevue Way, King County, Washington*, July 2, 2004, prepared by Shannon & Wilson, Inc. provides a detailed description of site geology and soil conditions. This report also contains site maps and copies of boring logs from previous geotechnical studies throughout the project corridor.

Based on our study of the above report, our files, contract documents, borings conducted for the foundation design of the W-80th Ramp Bridge (specifically BH-3-05), and our site visits, we believe Walls 21 through 25 will be founded on either glacially consolidated soils or fill placed during the construction of I-90. Soils at the foundation level of these walls will likely transition between native soils and fills several times along the length of the walls.

Groundwater is not expected to be encountered during construction of these walls.

Geotechnical Recommendations

We have evaluated allowable bearing capacity, settlement, and global stability for several wall types. Where specified, footing elevations are necessary to provide and adequate factor of safety for global stability and/or minimize settlement. We anticipate post construction settlements to be negligible.

Walls 21 and 22

Based on the subsurface conditions and wall geometry, several wall types are suitable for Walls 21 and 22. Standard Plan concrete cantilever walls, Standard Plan geosynthetic walls, and structural earth (SE) walls are all suitable wall types. Final wall type should be selected by your office based on cost, architectural requirements, construction sequencing, or other factors. Multiple wall types can be included in the Contract Plans as alternatives if the decision can be left up to the Contractor.

Standard Plans D-1a and D-1b (concrete cantilever walls) may be used for Walls 21 and 22 if a concrete cantilever wall is the preferred wall alternative. If used, these walls should be founded at or below elevation 67 feet. Where Wall 22 will be above the biofiltration swale, we recommend the swale be considered an adjacent ditch section. The top of the wall footing should be a minimum of 1-foot below the bottom of the biofiltration swale in accordance with the Standard Plans. Walls 21 and 22 should be backfilled in accordance with Standard Plan D-4.

A Type 1 permanent geosynthetic wall as shown in Standard Plan D-3 may also be used for Walls 21 and 22. The bottom of the walls should be at or below elevation 67 feet. Wall 22 should have a foundation at or below the bottom of the biofiltration swale.

Pre-approved, proprietary structural earth walls are also suitable for Walls 21 and 22. The bottom of the walls should be at or below elevation 67 feet. We have evaluated overall stability for SE walls; overturning, sliding, and bearing capacity will be evaluated by the manufacturer's designer. Design parameters for inclusion in General Special Provision, titled *Structural Earth Walls*, (GSP 13030201.FB6), are provided as follows:

Soil Parameters	Wall Backfill	Retained Soil	Foundation Soil
Unit Weight (pcf)	125	125	125
Friction Angle (deg)	36	36	32
Cohesion (psf)	0	0	0

Foundation Soil	AASHTO Load Group I	AASHTO Load Group VII
Allowable Bearing Capacity (tsf)	4	6
Acceleration Coefficient (g)	0	0.39

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

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. Wall face batter should be no steeper than 1H:48V.
3. The base width of the wall should be greater than or equal to 70 percent.
4. The top reinforcing layer should be placed no lower than 2 feet below the top of the wall.
5. Wall embedment should be at least 2 feet or 10 percent of the wall height, whichever is greater.
6. 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)).
7. 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 wall face.

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.

Wall 23

The cross sections we have been provided for Wall 23 indicate the wall will be a barrier wall retaining soil that slopes downwards at 3:1 (Horizontal:Vertical) away from the back of the wall. The downward sloping soil behind the wall will offer very little passive

pressure to resist traffic impacts on the wall. We recommend the moment slab barrier similar to that shown on Standard Plan D-3c be used for Wall 23. If a structural earth wall or geosynthetic wall is used for Wall 22, Wall 23 could be an extension of the moment slab barrier on Wall 22.

Walls 24 and 25

We understand Walls 24 and 25 will be designed as cantilever walls. We understand the intent is to use a pre-cast wall section that will be set in an excavation and backfilled. This wall can also be supported on a spread footing. A spread footing supported barrier could be designed similar to a Standard Plan Concrete Cantilever Wall or as an "L" shaped wall (similar to a moment slab barrier section). The following sections provide design recommendations for the two wall alternatives.

Cantilever Barrier Walls

Earth pressure diagrams are presented on Figures 2 and 3 for design of these walls. We recommend a resistance factor of 0.75 be used for the passive earth pressure. The passive resistance of the roadway surfacing materials may be used to design the walls. However, we recommend the structural designer analyze the temporary construction case with the wall constructed and backfilled, prior to placement of the roadway surfacing.

Spread Footing Supported Barrier Walls

The following tables provide design parameters for spread footings.

Bearing Capacity vs. Footing Width

Footing Width (ft)	Ultimate Bearing Capacity (ksf)	Service Bearing Capacity (ksf) Based on 1" of Settlement
2	7.0	6.0
3	8.8	4.2
4	10.5	3.2
5	12.3	2.7
6	14.0	2.5
7	15.7	2.2

Lateral Earth Pressure Coefficients and Soil Parameters

Parameter	Value
Backfill Unit Weight (γ)	125pcf
Backfill Soil Friction Angle (ϕ_f)	32°
Active Earth Pressure (K_a)	0.39
At Rest Earth Pressure (K_0)	0.62
Bearing Soil Friction Angle (ϕ_f)	32°
Passive Earth Pressure (K_p) - Unfactored	3.85*
Coefficient of Sliding	0.6
Seismic Coefficient (K_{ae})	0.67

* The passive earth pressure for roadway surfacing materials can be taken as 7.55.

We recommend the following resistance factors be used when evaluating the different limit states.

Spread Footing Resistance Factors

Limit State	Resistance Factor ϕ		
	Shear Resistance to Sliding	Passive Pressure Resistance to Sliding	Bearing
Strength	0.80	0.50	0.45
Service	N/A	N/A	1.00
Extreme	0.90	0.90	0.90

Construction Considerations

Backfill for Walls 24 and 25 should be placed concurrently on both sides of the wall up to the subgrade elevation on the roadway side the walls. Failure to backfill concurrently may result in wall rotation.

Recommended Additional Services

Because the future performance and integrity of the geotechnical elements of this project will depend largely on proper PS&E preparation and diligent construction procedures, we recommend that the Geotechnical Division (GD) in conjunction with the Regional Materials Engineer (RME) provide the following post-report services:

The GD should prepare the Summary of Geotechnical Conditions to be included in the PS&E as an appendix. The summary should be prepared as part of the PS&E review process.

The GD/RME should review all construction plans and specifications to verify that the design criteria presented in this report have been interpreted correctly and properly integrated into the design.

The GD/RME should attend pre-construction conferences with the Construction Project Engineer and Contractor to discuss important geotechnical related construction issues.

The GD/RME should review Contractor submittals for all shoring walls and other geotechnical elements of this project.

The RME should observe all exposed subgrades after completion of stripping and excavation to contract elevations. The RME should confirm that suitable soil conditions have been reached and determine appropriate subgrade compaction methods.

In addition to the aforementioned services, the Geotechnical Division can provide inspector training for construction personnel, assist in change of condition claims, and review cost reduction incentive proposals (CRIPs).

Intended Report Use and Limitations

This report has been prepared to assist the Washington State Department of Transportation in the engineering design and construction of the subject project. It should not be used, in part or in whole for other purposes without contacting the EEP Geotechnical Division for a review of the applicability of such reuse. This report should be made available to prospective contractors for their information or factual data only and not as a warranty of ground conditions.

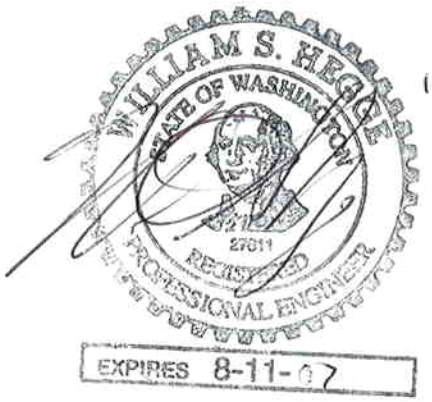
The conclusions and recommendations contained in this report are based on the Geotechnical Division's understanding of the project at the time that the report was written and on site conditions that existed at the time of the field exploration. If significant changes to the nature, configuration, or scope of the project occur during the design process, the Geotechnical Branch should be consulted to determine the impact of such changes on the recommendations and conclusions presented in this report.

Site exploration and testing describes subsurface conditions only at the sites of subsurface exploration and at the intervals where samples are collected. These data are interpreted by members of the Geotechnical Division who then render an opinion regarding the general subsurface conditions. The distribution, continuity, thickness, and characteristics of identified (and unidentified) subsurface materials may vary considerably from that indicated by the subsurface data. While nothing can be done to prevent such variability, the Geotechnical Division is prepared to work with the Design Team to reduce the impacts of variability on project design, construction, and performance. Periodic geotechnical observation during construction may be beneficial in this respect. This ongoing involvement of the Geotechnical Division throughout the design and project development process will also help to avoid costly mistakes associated with

misinterpretation of the contents of this report and resulting shortcomings of project design or contract documents.

The conclusions and recommendations presented in this report assume that surface and subsurface conditions, as observed during field exploration activities are representative of the site conditions throughout the project area. Because of this assumption, these recommendations should be considered subject to change depending on the actual subsurface conditions encountered. Actual subsurface conditions can be discovered only during earthwork and construction operations. Accordingly, the Geotechnical Division should be involved in the construction of the project in order to make appropriate observations and recommendations for alteration in design, as appropriate.

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



12/13/05

Prepared By:
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For:

Agency Approval Authority:
Tony M. Allen
State Geotechnical Engineer

TMA/maf
Attachment: Figures
Boring Logs

cc: Chris Johnson, Northwest Region Materials Engineer, MS NB 82-29
Munindra Talukdar, Bridge and Structures Office, MS 47340
Theresa D. McAuliffe, HNTB Corporation

Figure 1

Vicinity Map
Wall Locations Shown Are Approximate

JOB XL-2423 S.R. 90 C.S. LAYOUT

I-90 Two Way Transit & HOV Operations

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

DATE 10/2005
SCALE VERT.
HORIZ.
SHEET ___ OF ___
DRAWN BY DWG

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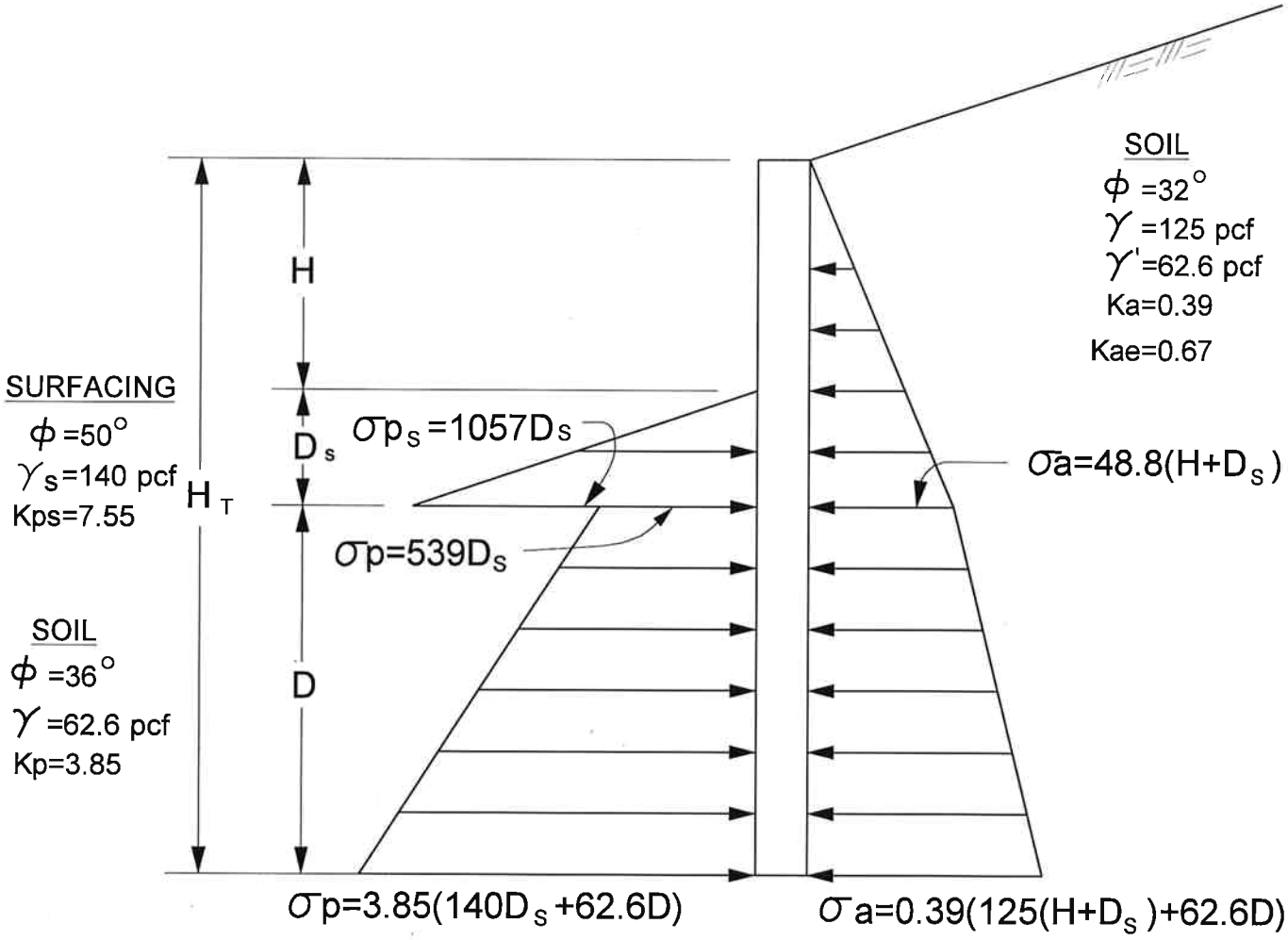
Strength Limit State



NOTES

① If the wall is backfilled prior to construction of the roadway surfacing, the temporary construction stage where Ds=0 should be evaluated.

② All pressures in psf.

③ D_S is the total depth of roadway surfacing including Portland Cement Concrete Pavement, Hot mix Asphalt Pavement, and Crushed Surfacing Base Course.

JOB XL-2423 S.R. 90 C.S. LAYOUT

I-90 Two Way Transit & HOV Operations

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

DATE 10/2005
SCALE NOT TO SCALE VERT. HORIZ.
SHEET ___ OF ___
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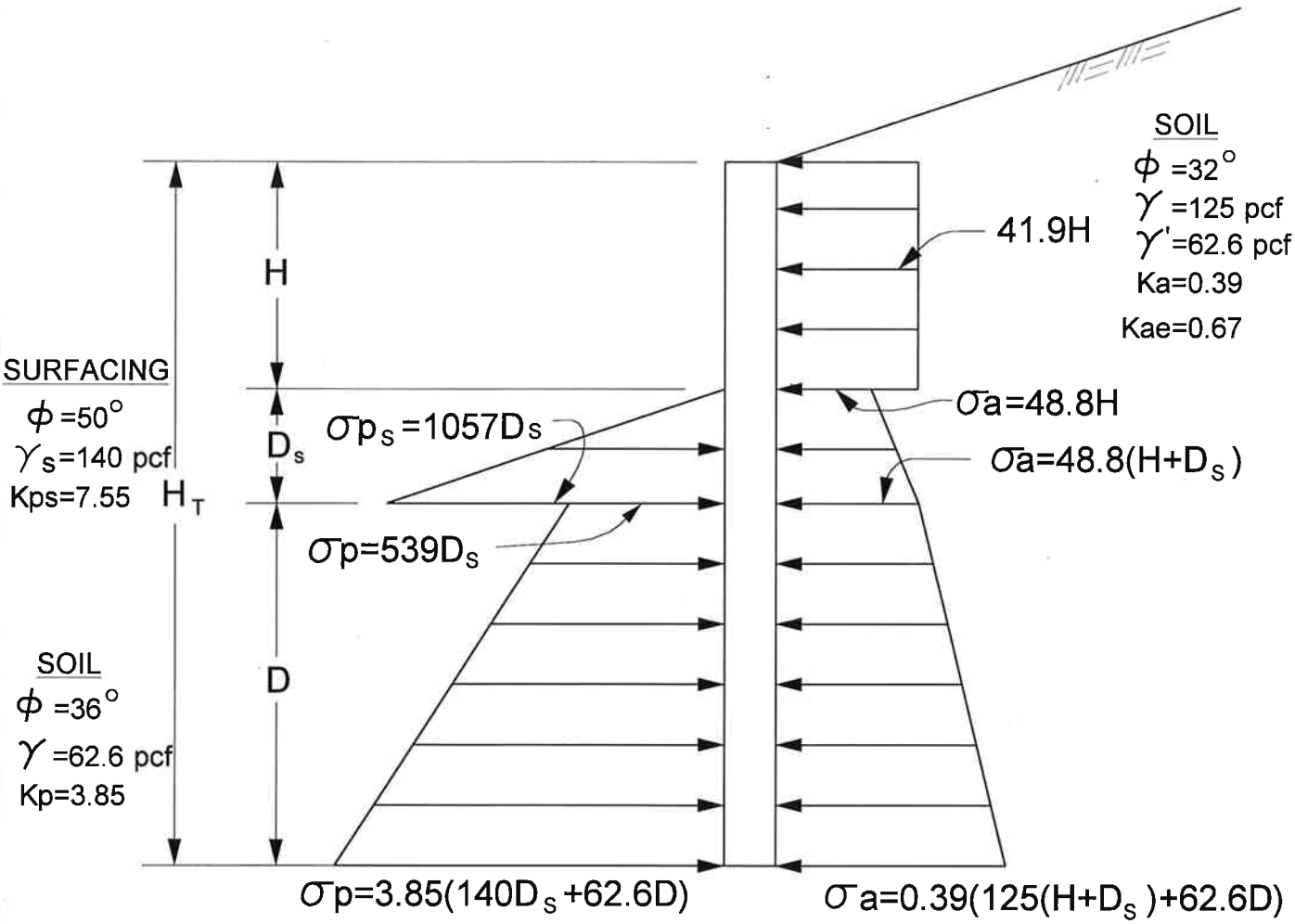
Figure 2: Earth Pressure Diagram
Walls 24 and 25

Extreme Limit State



NOTES

① If the wall is backfilled prior to construction of the roadway surfacing, the temporary construction stage where Ds=0 should be evaluated.

② All pressures in psf.

③ D_S is the total depth of roadway surfacing including Portland Cement Concrete Pavement, Hot mix Asphalt Pavement, and Crushed Surfacing Base Course.

JOB XL-2423 S.R. 90 C.S. LAYOUT

I-90 Two Way Transit & HOV Operations

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

DATE 10/2005
SCALE NOT TO SCALE VERT. HORIZ.
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Figure 3: Earth Pressure Diagram
Walls 24 and 25

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Washington State
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Test Boring Legend

Sampler Symbols

	Standard Penetration Test
	Oversized Penetration Test (Dames & Moore, California)
	Shelby Tube
P	Piston Sample
	Washington Undisturbed
	Vane Shear Test
	Core
	Becker Hammer
B	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, somtimes 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 imediately.

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

Washington State
Department of Transportation

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

Very Widely	Greater than 3 m
Widely	1 m to 3 m
Moderately	0.3 m to 1 m
Closely	50 mm to 300 mm
Very Closely	Less than 50 mm

RQD (%)

$$\frac{100(\text{length of core in pieces} > 100\text{mm})}{\text{Length of core run}}$$

Condition

Excellent	Very rough surfaces, no separation, hard discontinuity wall
Good	Slightly rough surfaces, separation less than 1 mm, hard discontinuity wall.
Fair	Slightly rough surfaces, separation greater than 1 mm, soft discontinuity wall.
Poor	Slickensided surfaces, or soft gouge less than 5 mm thick, or open discontinuities 1 to 5 mm.
Very Poor	Soft gouge greater than 5 mm thick, or open discontinuities greater than 5 mm.

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

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-66049

HOLE No. BH-1-05

Sheet 1 of 5

Job No. OL-3518 SR I-90 Elevation 76.2 ft (23.2 m)

Project I-90 Two Way Transit and HOV Operations

Driller Kerry Cooper Lic# 2552

Site Address SR-90 Vicinity of 80th Ave SE

Inspector Cleo Andrews

Start August 9, 2005 Completion August 10, 2005 Well ID# AKL-170 Equipment CME 45 w/ autohammer

Station 260+96.59 Offset 36.94' Rt. Casing (HWT 4" OD x 12.0')(HQ 3" OD x 110.0') Method Wet Rotary

Northing 217524.39 Easting 1295431.69 Latitude Longitude

County King Subsection NE 1/4 of the NE 1/4 Section 12 Range 4 EWM Township 24 N

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				1 3 4 (7)		D-1		Poorly graded SAND with organics(roots), loose, brown, dry, stratified. Length Recovered 1.5 ft, Length Retained 1.0 ft		
				4 6 10 (16)		D-2		Poorly graded SAND with gravel and organics(roots), medium dense, brown, moist, stratified. Length Recovered 1.5 ft, Length Retained 1.0 ft		
5	1			11 17 15 (32)		D-3		Poorly graded SAND with silt and gravel, subrounded, dense, olive gray, moist, homogeneous. Very little drilling fluid lost starting at 4.0'. Length Recovered 0.3 ft, Length Retained 0.3 ft		
	2			13 20 22 (42)		D-4		Poorly graded SAND with silt and gravel, subrounded, dense, olive gray, moist, homogeneous. Length Recovered 1.0 ft, Length Retained 1.0 ft		
10	3		>>	15 30 40 (70)		D-5		08/10/2005 A.T.D. Poorly graded SAND with silt and gravel, subrounded, very dense, dark brown, moist, homogeneous. Length Recovered 1.0 ft, Length Retained 1.0 ft	▽	
	4			14 18 18 (36)		D-6	GS MC	SP-SM, M.C.=9% Poorly graded SAND with silt and gravel, subrounded, dense, dark brown, moist, homogeneous. Length Recovered 1.0 ft, Length Retained 1.0 ft		
15	5			14 18 18 (36)		D-7		Poorly graded SAND with silt and gravel, subrounded, dense, dark brown, moist, homogeneous. Length Recovered 1.0 ft, Length Retained 1.0 ft		
			>>	32 45 45 (90)		D-8		Poorly graded SAND with silt and gravel, subrounded, very dense, dark brown, moist, homogeneous. Length Recovered 1.2 ft, Length Retained 1.0 ft		
20	6									

SOIL OL-3518 I-90 TWO WAY TRANSIT AND HOV OPERATIONS.GPJ SOIL.GDT 11/30/05 12:56:31

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-66049

Job No. OL-3518 SR I-90 Elevation 76.2 ft (23.2 m)

HOLE No. BH-1-05

Sheet 2 of 5

Project I-90 Two Way Transit and HOV Operations

Driller Kerry Cooper Lic# 2552

Depth (ft)	Meters (m)	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
			50/3" (50/3")		D-9		Poorly graded SAND with silt and gravel, subrounded, very dense, dark brown, moist, homogeneous. Length Recovered 0.2 ft, Length Retained 0.2 ft		
	7						08/24/2005	▼	
25	8		>> 22 30 45 (75)		D-10		Sandy SILT, with 0.2' of well graded gravel with sand, very dense, olive gray, moist, stratified (Changed at 24.7'). Length Recovered 1.2 ft, Length Retained 1.2 ft		
30	9		50/6" (50/6")		D-11		SILT, with horizontal fine grained sand lenses, very dense, olive gray, moist, laminated. Length Recovered 0.5 ft, Length Retained 0.5 ft		
	10								
35	11		13 50/5" (50/5")		D-12		SILT with sand, very dense, olive gray, moist, laminated with medium grained sand. Length Recovered 0.9 ft, Length Retained 0.9 ft		
	12								
40	13		50/5" (50/5")		D-13	GS MC	ML, M.C.=16% SILT with sand, very dense, olive gray, moist, homogeneous. Length Recovered 0.9 ft, Length Retained 0.9 ft		
45			50/6"		D-14	GS	ML, M.C.=21%		

SOIL OL-3518 I-90 TWO WAY TRANSIT AND HOV OPERATIONS.GPJ SOIL.GDT 11/30/05 12:56:31

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-66049

Job No. OL-3518 SR I-90 Elevation 76.2 ft (23.2 m)

HOLE No. BH-1-05

Sheet 3 of 5

Project I-90 Two Way Transit and HOV Operations

Driller Kerry Cooper Lic# 2552

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				(50/6")			MC	SILT with sand, very dense, olive gray, moist, homogeneous. Length Recovered 0.5 ft, Length Retained 0.5 ft		
	14									
	15			>> 60/4" (60/4")		D-15		SILT with sand, very dense, olive gray, moist, homogeneous. Sampler bouncing on gravel at 49.8' Length Recovered 0.3 ft, Length Retained 0.3 ft		
50										
	16									
				>> 60/5" (60/5")		D-16	GS MC AL	ML, M.C.=18%, LL=21, non plastic Sandy SILT with gravel, gravel are subrounded, very dense, medium dark gray, moist, homogeneous. Length Recovered 0.4 ft, Length Retained 0.4 ft with ID Californinia sampler.		
55	17									
	18			>> 60/4" (60/4")		D-17	GS MC	ML, M.C.=22% SILT with sand, with fine grained sand lenses, very dense, olive gray, moist, laminated. Length Recovered 0.4 ft, Length Retained 0.4 ft		
60	19									
				>> 60/4" (60/4")		D-18		SILT with sand, very dense, olive gray, moist, homogeneous, (Sample taken with 2" ID californinia sampler). Length Recovered 0.3 ft, Length Retained 0.3 ft		
65	20									
	21									
				>> 60/5"		D-19		SILT with sand, very dense, olive gray, moist,		
70										

SOIL OL-3518 I-90 TWO WAY TRANSIT AND HOV OPERATIONS.GPJ SOIL.GDT 11/30/05 12:56:31

Washington State Department of Transportation

LOG OF TEST BORING

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Job No. OL-3518 SR I-90 Elevation 76.2 ft (23.2 m)

HOLE No. BH-1-05

Sheet 4 of 5

Project I-90 Two Way Transit and HOV Operations

Driller Kerry Cooper Lic# 2552

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				(60/5")				homogeneous, (Sample taken with 2" ID California sampler). Length Recovered 0.4 ft, Length Retained 0.4 ft		
	22									
75	23			36 50/2" (50/2")	D-20			SILT with sand and gravel, subrounded, very dense, olive gray, moist, homogeneous, (Sample taken with 2" ID Californinia sampler). Changed at 76.0' no gravel indicated while drilling. Length Recovered 0.5 ft, Length Retained 0.5 ft		
	24									
80			>>	75/1" (75/1")	D-21			No Recovery		
	25									
85	26			50/4" (50/4")	D-22			Fat CLAY, very hard, olive gray, moist, homogeneous. Length Recovered 0.3 ft, Length Retained 0.3 ft		
	27									
90			>>	21 30 37 (62)	D-23		GS MC AL	CH, MC=29%,PI=44 Fat CLAY, very hard, dark gray, moist, homogeneous. Length Recovered 1.5 ft, Length Retained 1.0 ft		
	28									
95				14	D-24			Lean CLAY, hard, dark gray, moist, homogeneous.		

SOIL OL-3518 I-90 TWO WAY TRANSIT AND HOV OPERATIONS.GPJ SOIL.GDT 11/30/05 12:56:31

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-66049

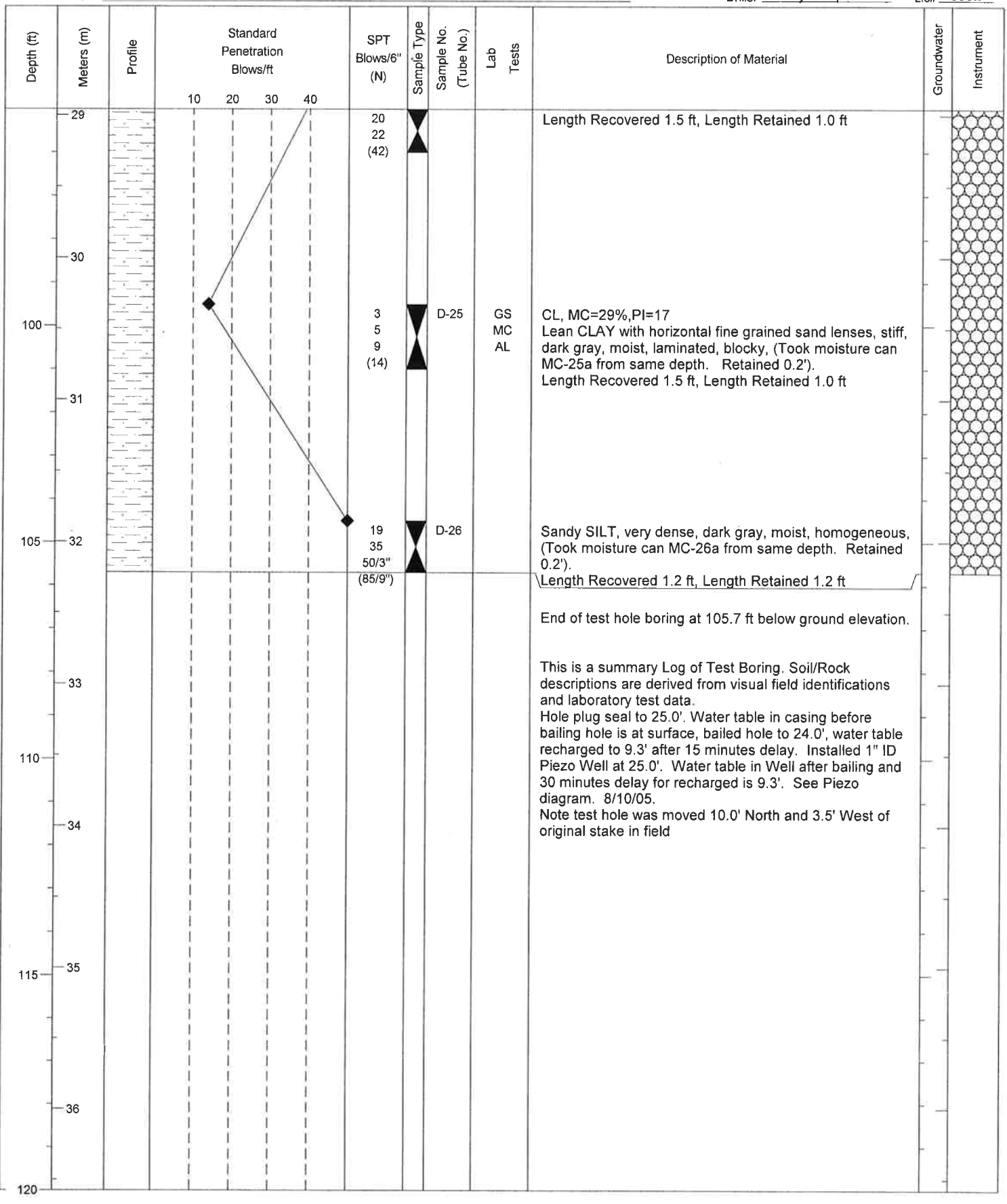
HOLE No. BH-1-05

Sheet 5 of 5

Job No. OL-3518 SR I-90 Elevation 76.2 ft (23.2 m)

Project I-90 Two Way Transit and HOV Operations

Driller Kerry Cooper Lic# 2552



SOIL OL-3518 I-90 TWO WAY TRANSIT AND HOV OPERATIONS.GPJ SOIL.GDT 11/30/05 12:56:31

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-66048

HOLE No. BH-2-05

Sheet 1 of 5

Job No. OL-3518 SR I-90 Elevation 76.6 ft (23.3 m)

Project I-90 Two Way Transit and HOV Operations Driller Thomas Harvey Lic# 2599

Site Address SR-90 Vicinity of 80th Ave. SE Inspector James Fetterly

Start August 9, 2005 Completion August 10, 2005 Well ID# AKL-168 Equipment Burly 4500 w/ cathead

Station 261+83.1 Offset 44.64' Rt. Casing 4"x100' Method Wet Rotary

Northing 217474 Easting 1295501.35 Latitude Longitude

County King Subsection NE/NE Section 12 Range 4 EWM Township 24 N

Depth (ft)	Meters (m)	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
5	1		5 4 3 (7)		D-1		Poorly graded SAND with gravel, loose, Lt. brown, moist, homogeneous, HCl reaction not tested. Length Recovered 0.6 ft, Length Retained 0.6 ft		
10	2	>>	10 23 28 38 (51)		D-2		SILT, very dense, grey, moist, homogeneous, HCl reaction not tested. Silt contact at 10.0'. Length Recovered 1.0 ft, Length Retained 1.0 ft		
	3	>>	13 23 28 40 (51)		D-3	GS MC	ML, M.C.=19% SILT, very dense, grey, moist, homogeneous, HCl reaction not tested. Length Recovered 1.0 ft, Length Retained 1.0 ft		
15	4								
	5	>>	11 27 28 (55)		D-4		SILT, very dense, grey, moist, homogeneous, HCl reaction not tested. Length Recovered 1.0 ft, Length Retained 0.8 ft		
20	6						8/10/05	▽	

SOIL OL-3518 I-90 TWO WAY TRANSIT AND HOV OPERATIONS.GPJ SOIL.GDT 11/30/05 12:56:32

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-66048

Job No. OL-3518 SR I-90 Elevation 76.6 ft (23.3 m)

HOLE No. BH-2-05

Sheet 2 of 5

Project I-90 Two Way Transit and HOV Operations

Driller Thomas Harvey Lic# 2599

Depth (ft)	Meters (m)	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
							A.T.D.		
		>>	18 35 41 (76)		D-5		SILT, very dense, grey, moist, homogeneous, HCl reaction not tested. Small Sand layer at 20.0'. Length Recovered 0.4 ft, Length Retained 0.4 ft		
	7								
25									
	8		35 50/4" (50)		D-6		SILT, and seashell fragments, very dense, grey, moist, homogeneous, weak HCl reaction, HCL reaction was on shell fragments. Length Recovered 0.9 ft, Length Retained 0.9 ft		
							8/24/05	▼	
	9								
30									
			33 50 (50)		D-7		SILT, very dense, grey, moist, homogeneous, HCl reaction not tested. Length Recovered 0.9 ft, Length Retained 0.9 ft		
	10								
35									
	11		30 43 50/3" (50)		D-8		SILT with sand, very dense, grey, moist, homogeneous, HCl reaction not tested. Length Recovered 0.3 ft, Length Retained 0.3 ft		
	12								
40									
		>>	17 19 39 (58)		D-9		SILT with sand, very dense, grey, moist, homogeneous, HCl reaction not tested. Small gravel layer at 39.0' as indicated by Drilling. Length Recovered 0.3 ft, Length Retained 0.3 ft		
	13								
45									

SOIL OL-3518 I-90 TWO WAY TRANSIT AND HOV OPERATIONS.GPJ SOIL.GDT 11/30/05 12:56:32

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-66048

HOLE No. BH-2-05

Job No. OL-3518 SR I-90 Elevation 76.6 ft (23.3 m)

Sheet 3 of 5

Project I-90 Two Way Transit and HOV Operations

Driller Thomas Harvey Lic# 2599

Depth (ft)	Meters (m)	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	14		6 5 4 (9)		D-10	GS MC	ML, M.C.=20% SILT with sand, loose, grey, moist, homogeneous, HCl reaction not tested. Most of Sample Knocked out by reverse hammer extraction, Sandy layers encountered at 44.0' Length Recovered 0.2 ft, Length Retained 0.2 ft		
	15								
50		>>	25 39 43 (82)		D-11		Sandy SILT, very dense, grey, moist, homogeneous, HCl reaction not tested. Length Recovered 0.6 ft, Length Retained 0.6 ft		
	16								
55									
	17	>>	32 42 50 (92)		D-12		Sandy SILT, very dense, grey, wet, homogeneous, HCl reaction not tested. Length Recovered 1.0 ft, Length Retained 1.0 ft		
	18								
60									
			41 50/4" (50)		D-13	GS MC	ML, M.C.=19% Sandy SILT, very dense, grey, moist, stratified, HCl reaction not tested, stratified with silt lenses. Length Recovered 0.9 ft, Length Retained 0.9 ft		
	19								
65									
	20	>>	4 18 50 (68)		D-14	GS MC	SP-SM, M.C.=16% Poorly graded SAND with silt, very dense, grey, moist, stratified, HCl reaction not tested, stratified with gavel layers, heavier gravel contact at 63.0'. Length Recovered 1.0 ft, Length Retained 1.0 ft		
	21								
70									

SOIL OL-3518 I-90 TWO WAY TRANSIT AND HOV OPERATIONS.GPJ SOIL.GDT 11/30/05,12:56:32