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CONCEPTUAL GEOTECHNICAL ENGINEERING REPORT
MONOHON LANDING ROAD LANDSLIDES
RAYMOND, WASHINGTON

1.0 INTRODUCTION

This report presents the results of our literature review of previous studies, aerial photographs, and geotechnical engineering analyses for two active landslides on Monohon Landing Road east of Raymond, Washington. Previous geotechnical studies were completed by:

- Washington State Department of Transportation (WSDOT), 1979
- GeoEngineers Inc. (GeoEngineers), 1998
- Geotechnical Testing Laboratory Inc. (GTL), 2008
- GTL, 2009

The purpose of our services is to evaluate the subsurface conditions at the site, provide geotechnical engineering recommendations for remediation alternatives of the two landslides, and assist Pacific County (the County) in developing a preferred alternative(s) and opinions of probable remediation costs. Our current study includes reviewing 17 previous boring logs at the site, reviewing previous geotechnical laboratory test results, performing engineering analyses, and preparing this report. Our services were accomplished in general accordance with our proposal dated April 21, 2009. Michael Collins provided notice to proceed by signing and returning our proposal with an effective date of April 29, 2009.

2.0 SITE AND PROJECT DESCRIPTION

The project site is located north of the Willapa River on Monohon Landing Road near Raymond, Washington, as shown in the Vicinity Map, Figure 1. Two landslides are present approximately between mileposts 0.5 and 0.7 on Monohon Landing Road (see the Site and Exploration Plan, Figure 2). The head scarps of both landslides run along the north side of Monohon Landing Road and extend south to the Willapa River. The west and east landslides are approximately 175 and 250 feet in length, respectively, measured parallel to the roadway. The two landslides are separated by approximately 500 feet.

County personnel report that these landslides have been active since Monohon Landing Road was constructed in the early 1900s. We assume that the landslides are moving generally southward, toward the Willapa River. The section of Monohon Landing Road within each

sliding mass has been repaired continually over the past century, using placement of fill to return the road to the design grade and, sometimes, repaving the damaged section.

3.0 PREVIOUS SUBSURFACE EXPLORATIONS AND GEOTECHNICAL LABORATORY TESTING

The Pacific County Department of Public Works provided Shannon & Wilson, Inc. with copies of subsurface explorations and reports performed by WSDOT in 1979, GeoEngineers in 1990, and GTL in 2008 and 2009. These reports contain logs of 17 subsurface explorations. Approximate locations of these explorations are shown in Figure 2. A summary of the subsurface explorations is presented in Table 1 and copies of the previous boring logs are presented in Appendix A. The previous geotechnical laboratory test results for these explorations are presented in Appendix B. Shannon & Wilson, Inc. used the field observations and laboratory test data as they were presented, and makes no warranty as to the accuracy of the data.

4.0 GEOLOGY AND SUBSURFACE CONDITIONS

The 1967 U.S. Geological Survey geologic map shows the site is underlain by Tertiary siltstone of the Lincoln Creek formation. Alluvium is locally present near the Willapa River. The geologic map does not show active or ancient landslides at the site.

4.1 Soil

Figures 3 and 4 present our interpretation of the geologic subsurface conditions at the west and east landslides, respectively. The subsurface conditions at the site generally consist of southward-sloping, lightly overconsolidated, non-plastic sandy silt; plastic clayey silt; and silty clay of varying thickness, overlying Tertiary siltstone bedrock.

Beneath the roadway at each landslide location, the subsurface conditions consist of about 15 to 25 feet of loose to medium dense fill that consists of silty sand, gravel, oyster shells, and multiple layers of asphalt. The fill is underlain by non-plastic, medium stiff to stiff, sandy, slightly clayey silt that is approximately 10 feet thick at the west landslide and a few feet thick at the east landslide. At the west landslide, the borings encountered medium stiff to stiff, plastic silt/clay below the non-plastic silt extending to approximately Elevation -26 feet. Siltstone bedrock was encountered in the borings below about Elevation -26 and +6 feet at the west and east landslides, respectively.

Based on soil descriptions, trends in the Standard Penetration Test blow counts, and previous reports by WSDOT, GeoEngineers, and GTL, we estimate the depth of the sliding surface below the southern boundary of the roadway at approximately Elevations +4 and +12 feet for the west and east landslides, respectively. We assume that the thickness of the sliding mass decreases near the toe and that the sliding surface exits the northern bank of the Willapa River near Elevations -1 and +2 feet for the west and east landslides, respectively.

4.2 Groundwater

Observations made during drilling and well measurements at various times of the year indicate that the groundwater elevation fluctuates seasonally and may be affected by the level of the Willapa River. At the west landslide, the groundwater surface below the existing roadway varies from approximately Elevation +12 feet during the wet season to approximately Elevation +6 feet during the dry season. At the east landslide, the groundwater surface below the existing roadway varies from approximately Elevation +25 feet during the wet season to approximately Elevation +11 feet during the dry season.

Measurements provided by GTL from September to December 2008 show the Willapa River had an average high tide elevation of approximately +11 feet and an average low tide elevation of approximately +2 feet. The combination of well measurements and river elevations reported by GTL suggest that the tidal fluctuation does not affect the elevation of the groundwater near the location of the existing roadway in the west and east landslides. However, the groundwater elevation at the toe of the west and east landslides may respond to the tidal variation in the river.

5.0 GEOTECHNICAL ANALYSES AND RECOMMENDATIONS

5.1 Analysis Criteria and Methods

We performed limit equilibrium slope stability analyses for the west and east landslides using the computer program SLOPE/W version 7.13 (GEO-SLOPE International, 2007). We defined the slip surfaces by specifying the full path of the sliding surface, as estimated from the subsurface explorations and geologic cross sections. We selected the Spencer (1967) method, which satisfies both moment and force equilibrium and considers both shear and normal interslice forces to determine the reported factors of safety.

5.2 Global Stability Analyses

We used our interpretation of the dry season conditions to back-calculate the residual drained shear strength along the sliding surface. We varied the strength of the soil along the sliding surface until a factor of safety (FS) of unity was achieved. We assumed that a significant portion of the landslide movement occurs during the wet season and, during this time, the FS is slightly less than one. Summaries of the variation of residual friction angle and resulting FS for the west and east landslide are presented in Figures 5 and 6, respectively.

The results of these analyses suggest that an average residual friction angle of about 11 degrees would appropriately characterize the behavior of the landslides. However, many factors contribute to uncertainty in these analyses (e.g., landslide geometry, groundwater conditions, etc.). As an additional check, we estimated the residual friction angle of the slide planes using correlations with soil index properties developed by Stark et al. (2005). These correlations showed that a residual friction angle of about 11 degrees would be reasonable.

Table 2 summarizes our global stability analysis results. Representative analyses showing the sliding mass geometry, generalized subsurface conditions, and assumed failure surface are presented in Figures 7 and 8 for the west landslide and Figures 10 and 11 for the east landslide.

Without simultaneously monitoring the landslide movement and groundwater levels, it is not practical to confirm our interpretation that the FS is essentially 1.0 during the dry season conditions. If our assumption is incorrect, and the FS is actually substantially less than 1.0, then the recommendations presented below could be unconservative.

5.3 Conclusions

Based on our understanding and analyses of the current conditions at the west and east landslides, we conclude that the landslide movement occurs primarily when elevated groundwater tables occur during the wet season or wet conditions. Soil erosion at the landslide toe by the Willapa River and the addition of sand, gravel, oyster shells, and asphalt to maintain the elevation of the roadway keep the landslide from achieving a stable configuration.

Landslide movement occurs when the driving forces acting on the sliding mass exceed the resisting forces (FS less than 1.0). Remediation options generally consist of actions that will either increase the resisting forces or decrease the driving forces, therefore increasing the FS.

Remediation options include:

- Lower the roadway grade to reduce driving forces.
- Replace a portion of the fill beneath the existing roadway with lightweight fill to reduce driving forces.
- Lower the groundwater table within the sliding mass to increase sliding resistance.
- Redirect surface stormwater so there is no "ponding" within the sliding mass, to lower groundwater and increase sliding resistance.
- Drive piles that extend to undisturbed soil or siltstone to increase sliding resistance.
- Construct deep, soil mix columns that extend to undisturbed soil or siltstone to increase sliding resistance.
- Overexcavate the landslide mass and reconstruct the roadway on undisturbed soil or siltstone, thereby increasing sliding resistance.
- Construct a toe buttress to reduce erosion and increase sliding resistance.
- Construct a shear key to increase sliding resistance.

Alternatively, the County could continue its current practice of maintaining the roadway by adding fill and repaving when necessary. This option would essentially be the same as previous practices. These options may be considered individually or in combination.

5.4 Recommendations

Based on our analyses and discussions with County personnel, we recommend a combination of lowering the existing roadway grade and installing surface stormwater and subsurface drainage. These measures should reduce driving forces and increase sliding resistance; therefore, reducing the likelihood of continued movement of the west and east landslides. We understand the County would like to lower the roadway grades to improve sight distance and improve the roadway geometrics. We provide general recommendations for making stable slopes north of (above) the roadway.

We performed global stability analyses to estimate the amount of soil that would need to be excavated to achieve an adequate FS. As discussed above, we assume the FS during dry season is essentially 1.0. Improving landslide stability when conditions are reasonably well understood and the consequences of failure do not include life safety means that an FS of 1.2 is commonly considered adequate. As discussed previously, some uncertainty exists regarding our assumption

of groundwater levels in the landslide when the FS is 1.0; i.e., the groundwater level when movement ceases. Therefore, some risk exists that landslide movement could continue if the recommendations in this report are implemented. Alternatives to reduce risk could include adopting a more conservative design; e.g., design for a higher FS, collect undisturbed soil samples and measure soil strength, and/or perform additional monitoring to refine the conditions when the landslides are not moving; i.e., have an FS equal to 1.0.

5.4.1 Lower Existing Roadway

For the conditions described above and an assumed sliding surface residual friction angle of 11 degrees, we recommend lowering the roadway surface about 8 and 12 feet (Elevations +20 and +30 feet) at the west and east landslides, respectively. Figures 9 and 12 present the global stability results for the west and east landslides, respectively. Please note that our analyses assume the excavations would be made with double-sided cuts; i.e., cuts on the up and downhill sides of the road. If the County chooses to make a single-sided cut by extending the excavation to the south to increase sight distance or realign the existing roadway, the FS would be lower because weight would be removed from a resisting portion of the slide surface. Figure 13 shows this case.

Figures 5 and 6 could be used to select deeper excavation depths if the County elects to design for a more conservative FS to reduce the risk of future movement. For example, an FS equal to about 1.3 could be achieved with a 10-foot-deep excavation at the west landslide.

The excavations should extend the width of the existing roadway in the landslide areas, and side slopes should be at 2 horizontal to 1 vertical (2H:1V), as shown in Figure 12. If the County prefers to make the excavation south beyond the width of the roadway, the excavation depth should be 2 feet deeper, or 10 and 14 feet below ground surface (bgs) (Elevations +18 and +28 feet), at the west and east landslides, respectively.

5.4.2 Stormwater Drainage

Surface stormwater drainage ditches should be constructed at an appropriate grade along the roadway shoulder to prevent water from ponding and infiltrating the sliding mass. The base of the ditch should be compacted to a dense condition and lined with slowly pervious material to further impede the infiltration of surface water. Lining materials could include clay or a flexible

geomembrane. The lining material should be protected from damage with about 1 foot of soil such as a crushed surfacing aggregate. The lined ditches should discharge to suitable locations, such as a catch basin, where the runoff is collected into a tightline and conveyed away from the landslide areas.

The landslide mass should be regraded to remove sags and low areas where water could pond. The finished slopes should be graded to promote runoff.

5.4.3 Slopes North of the Roadway

Lowering the roadway grade would reduce the driving forces and increase the FS for the west and east landslides, but could potentially activate a pre-existing or new sliding surface in the slopes north of the roadway. Once movement is activated, the soil strength along sliding surfaces decreases to the residual soil strength. If this occurs, large movement above the roadway could occur. The available subsurface data is not sufficient to evaluate the likelihood of new landslides occurring north of the roadway if regrading occurs. Therefore, our recommendations for the slopes north of the roadway are general. In our opinion, the risk of activating a landslide north of the roadway could be reduced by:

- Grading slopes above the roadway no steeper than 2H:1V.
- Installing subsurface drainage to lower groundwater levels. Subsurface drainage could be constructed by using drilled horizontal drains or by excavating trenches and backfilling them with pervious aggregate. To prevent piping, the backfill for trench drains should be designed so it meets filter criteria for the native soil. A perforated drain pipe can be installed in the bottom of a trench drain to facilitate maintenance.

We recommend performing additional geotechnical studies to evaluate slope stability north of the roadway. These studies should include borings with continuous sampling, groundwater monitoring wells, and soil strength testing. This information is needed to provide specific design recommendations for making cuts in the slope north of the roadway and for stabilization measures, if required.

5.5 Remediation Quantity Estimates

Based on roadway sections provided by the County, we calculated the approximate excavation volume that would be required to achieve the recommended finished grades; i.e., depths of 8 and 12 feet bgs (Elevations +20 and +30 feet) at the west and east landslides, respectively. We used

an approximate end-averaging method to make our calculations. We did not make estimates for the amount of overexcavation that would be needed to excavate to pavement subgrade nor excavation volumes for roadway ditches. We estimate about 16,000 cubic yards of excavation would be needed to achieve the recommended final grades, including extending the excavation approximately 100 feet west of the west landslide and 100 feet east of the east landslide and excavating soil between the two landslides to grade. This estimate does include flattening the northern slope to 2H:1V in the landslide areas within the right-of-way. Our estimate does not include making a single-sided cut by removing soil south of the roadway.

We recommend constructing lined ditches on both sides of the roadway through the landslide areas and continuing at least 50 feet on each side of the landslides. Therefore, about 1,250 feet of lined ditch would be required.

6.0 ADDITIONAL SERVICES

The conclusions and recommendations presented in this report are based on information provided by others. As discussed in this report, some risk remains that the assumption of an FS equal to 1.0 during dry conditions, which we used in our stability calculations, could be unconservative. If the County wishes to reduce risk, two alternatives discussed above include additional studies either to verify the conditions when the landslides are not moving or to make laboratory soil strength measurements. We can discuss these alternatives with you further if you desire.

The proposed construction is within 200 feet of a river and includes wet areas. Therefore, we anticipate that natural resource permits could be required for the proposed construction. We would be pleased to assist the County with these services.

Our recommendations are general in nature. Other design studies should be performed, including roadway geometrics, pavement design, etc. We should be retained to assist the civil/roadway designer in the final grading plan to verify that it is in accordance with our recommendations.

We recommend that Shannon & Wilson, Inc. be retained to review those portions of the plans and specifications that pertain to foundations and earthwork to evaluate whether they are consistent with the recommendations in this report.

We recommend that we be retained to provide on-call geotechnical construction observation services during construction activities. Our analyses and recommendations are based on the subsurface conditions reported on boring logs prepared by others. During construction, we should verify that the subsurface conditions actually encountered are consistent with our observations. Our services would include the monitoring of structural fill placement and compaction, subgrade preparation, drainage, regrading, and other geotechnical-related earthwork activities.

7.0 LIMITATIONS

This report was prepared for the exclusive use of Pacific County Department of Public Works. The data and report should be provided to the contractors for their information, but our report, conclusions, and interpretations should not be construed as a warranty of subsurface conditions included in this report.

The analyses, conclusions, and recommendations contained in this report are based on site conditions as they presently exist and further assume that the explorations performed by others are representative of the subsurface conditions throughout the site; that is, the subsurface conditions everywhere are not significantly different from those disclosed by the explorations. If, during construction, subsurface conditions different from those encountered in the explorations are encountered, or appear to be present, we should be advised at once so that we can review these conditions and reconsider our recommendations, where necessary. If there is a substantial lapse of time between the submission of this report and the start of construction at the site, or if conditions have changed due to natural forces or construction operations at or adjacent to the site, we recommend that we review our report to determine the applicability of the conclusions and recommendations.

Within the limitations of scope, schedule, and budget, the analyses, conclusions, and recommendations presented in this report were prepared in accordance with generally accepted professional geotechnical engineering principles and practice in this area at the time this report was prepared. We make no other warranty, either express or implied. These conclusions and recommendations are based on our understanding of the project as described in this report.

Unanticipated soil conditions are commonly encountered and cannot be fully determined merely by taking soil samples from test borings. Such unexpected conditions frequently require that additional expenditures be made to attain a properly constructed project. Therefore, some contingency fund is recommended to accommodate such potential extra costs.

The scope of our present work did not include environmental assessments or evaluations regarding the presence or absence of wetlands or hazardous or toxic substances in the soil, surface water, groundwater, or air, on or below or around this site, or the evaluation of or disposal of contaminated soil or groundwater should any be encountered. Shannon & Wilson, Inc. has prepared and included in Appendix C, "Important Information About Your Geotechnical/Environmental Report," to assist you and others in understanding the use and limitations of our reports.

SHANNON & WILSON, INC.

Christopher A. Robertson, P.E., L.E.G.
Vice President

CIJ:JNB:CAR/cij

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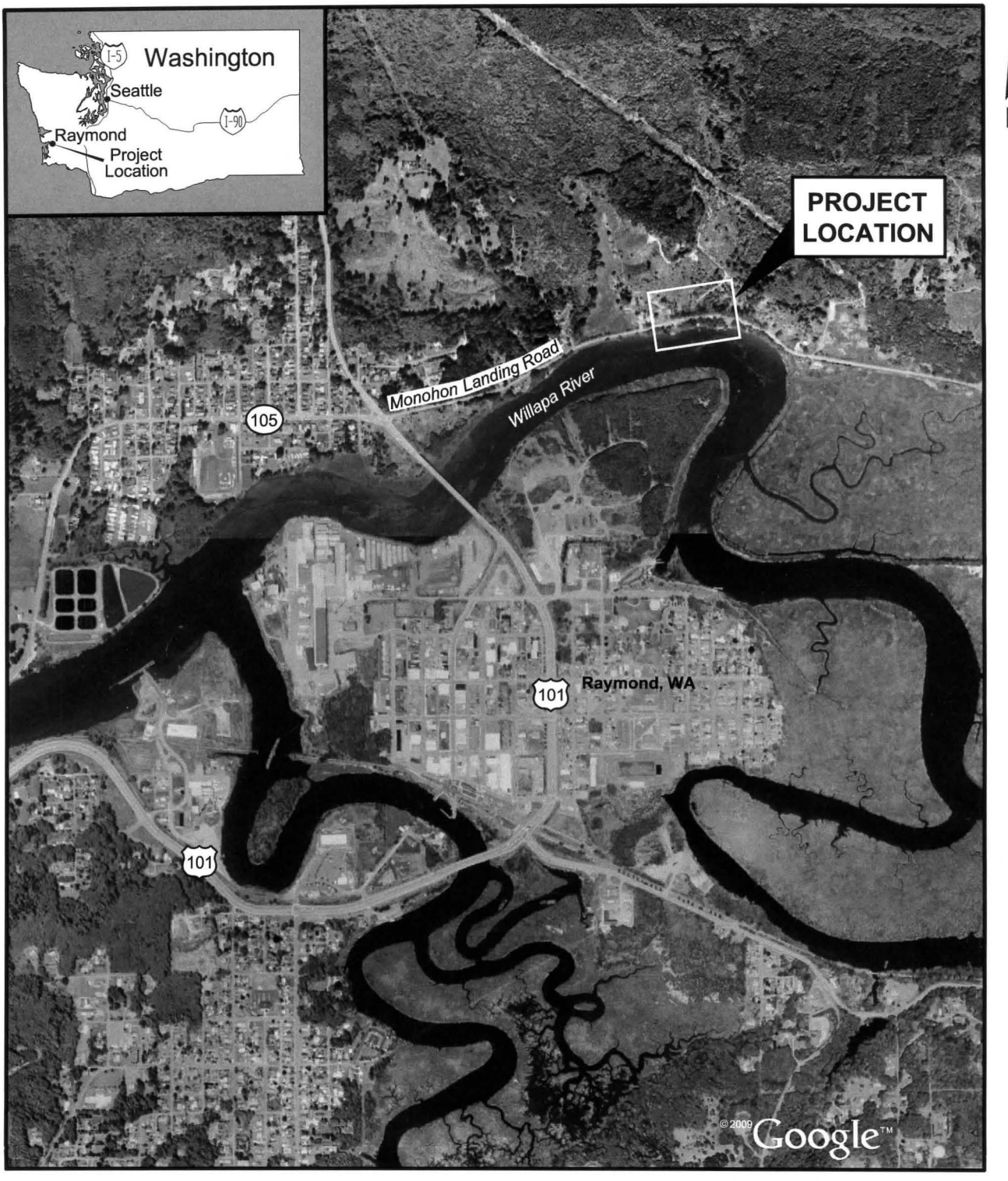
TABLE 1
SUMMARY OF SUBSURACE EXPLORATIONS

Boring Designation	Performed By	Total Depth (feet)	Date Drilled
WSDOT-1	Washington State Department of Transportation	40.4	1/29/79
WSDOT-2	Washington State Department of Transportation	38.0	1/24/79
WSDOT-3	Washington State Department of Transportation	42.5	1/18/79
WSDOT-4	Washington State Department of Transportation	5.0	1/23/79
GEI-1	GeoEngineers, Inc.	33.5	6/27/90
GEI-2	GeoEngineers, Inc.	54.0	6/28/90
GEI-3	GeoEngineers, Inc.	59.0	6/28/90
GLT-H-1	Geotechnical Testing Laboratory, Inc.	61.0	1/16/08
GLT-H-2	Geotechnical Testing Laboratory, Inc.	90.0	1/17/08
GLT-H-3	Geotechnical Testing Laboratory, Inc.	90.0	1/20/08
GLT-H-5	Geotechnical Testing Laboratory, Inc.	90.0	1/28/08
GLT-H-6	Geotechnical Testing Laboratory, Inc.	25.0	2/1/08
GTL-1	Geotechnical Testing Laboratory, Inc.	55.0	2/5/09
GTL-2	Geotechnical Testing Laboratory, Inc.	20.0	2/6/09
GTL-3	Geotechnical Testing Laboratory, Inc.	25.0	2/9/09
GTL-4	Geotechnical Testing Laboratory, Inc.	15.0	2/10/09

TABLE 2
SUMMARY OF GLOBAL STABILITY ANALYSES

Case	Factor of Safety
East Landslide – Wet Season	0.88
East Landslide – Dry Season	1.02
East Landslide – Excavate 8 Feet	1.20
West Landslide – Wet Season	0.83
West Landslide – Dry Season	1.01
West Landslide – Excavate 12 Feet	1.22
West Landslide – Excavate 12 Feet, Improved Sight Distance	1.17



0 1,500 3,000

Approximate Scale in Feet

NOTE

Map adapted from aerial imagery provided by Google Earth Pro, Image © 2009 DigitalGlobe, Image USDA Farm Service Agency, reproduced by permission granted by Google Earth ™ Mapping Service.

Monohon Landing Road Landslide
Raymond, Washington

VICINITY MAP

July 2009 21-1-21159-001

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FIG. 1

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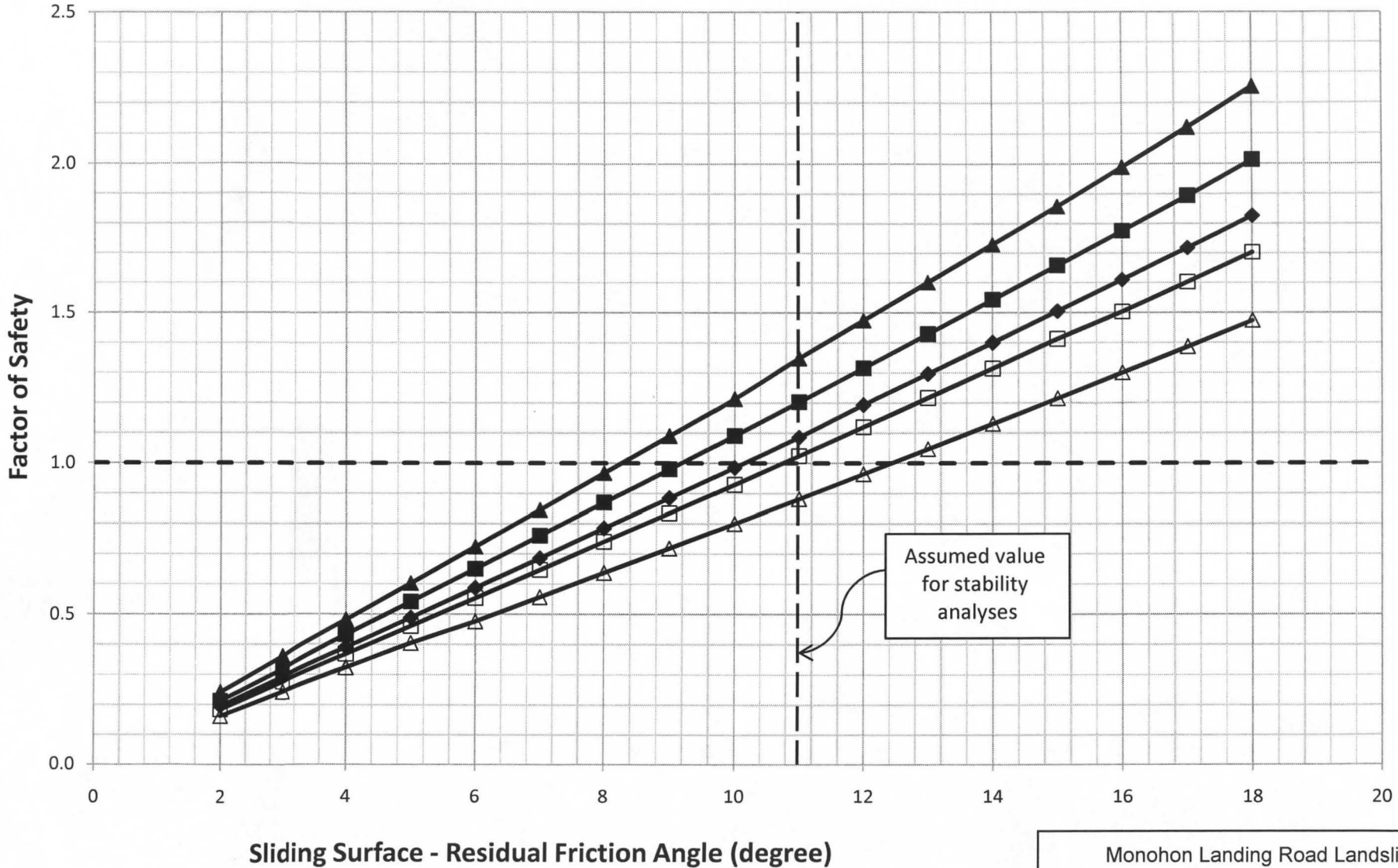

Existing Conditions - Dry Season
Existing Conditions - Wet Season
Excavate 6 ft
Excavate 8 ft
Excavate 10 ft
FS = 1.0

Monohon Landing Road Landslide
Raymond Washington

SENSITIVITY ANALYSIS
WEST LANDSLIDE

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FIG. 5

FIG. 5

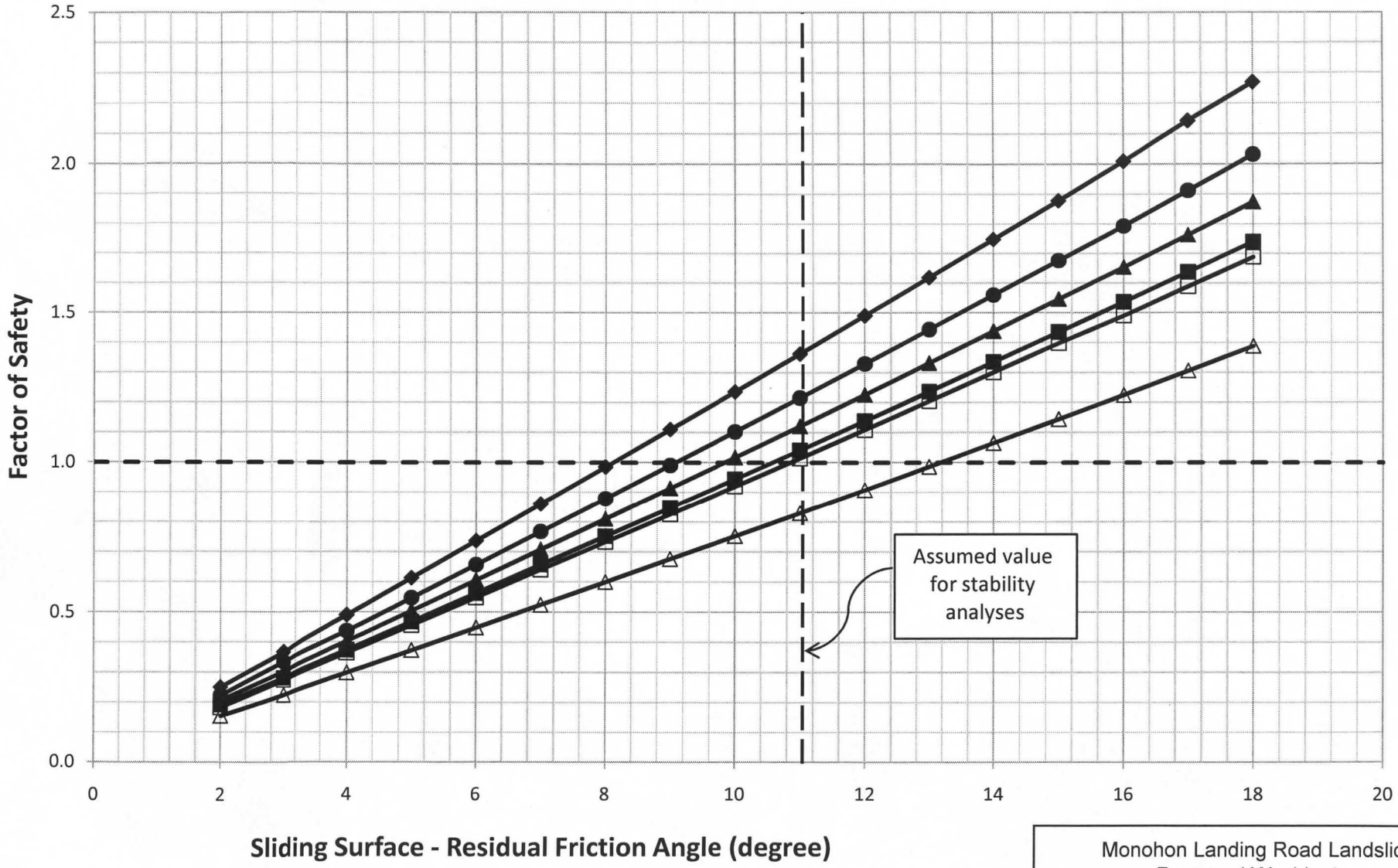

FIG. 6

Monohon Landing Road Landslide
Raymond Washington

SENSITIVITY ANALYSIS
EAST LANDSLIDE

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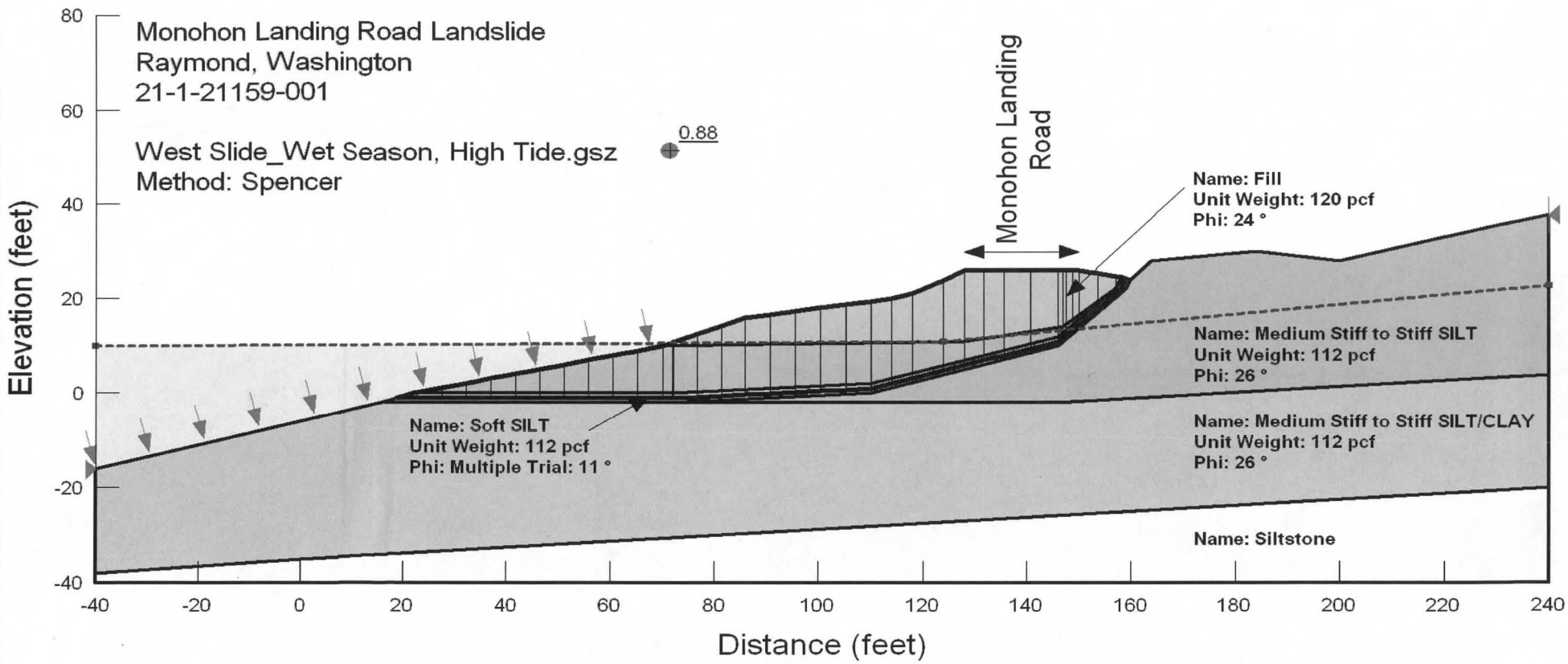
FIG. 6



Monohon Landing Road Landslide
Raymond Washington

GLOBAL STABILITY RESULTS
WEST LANDSLIDE - WET SEASON

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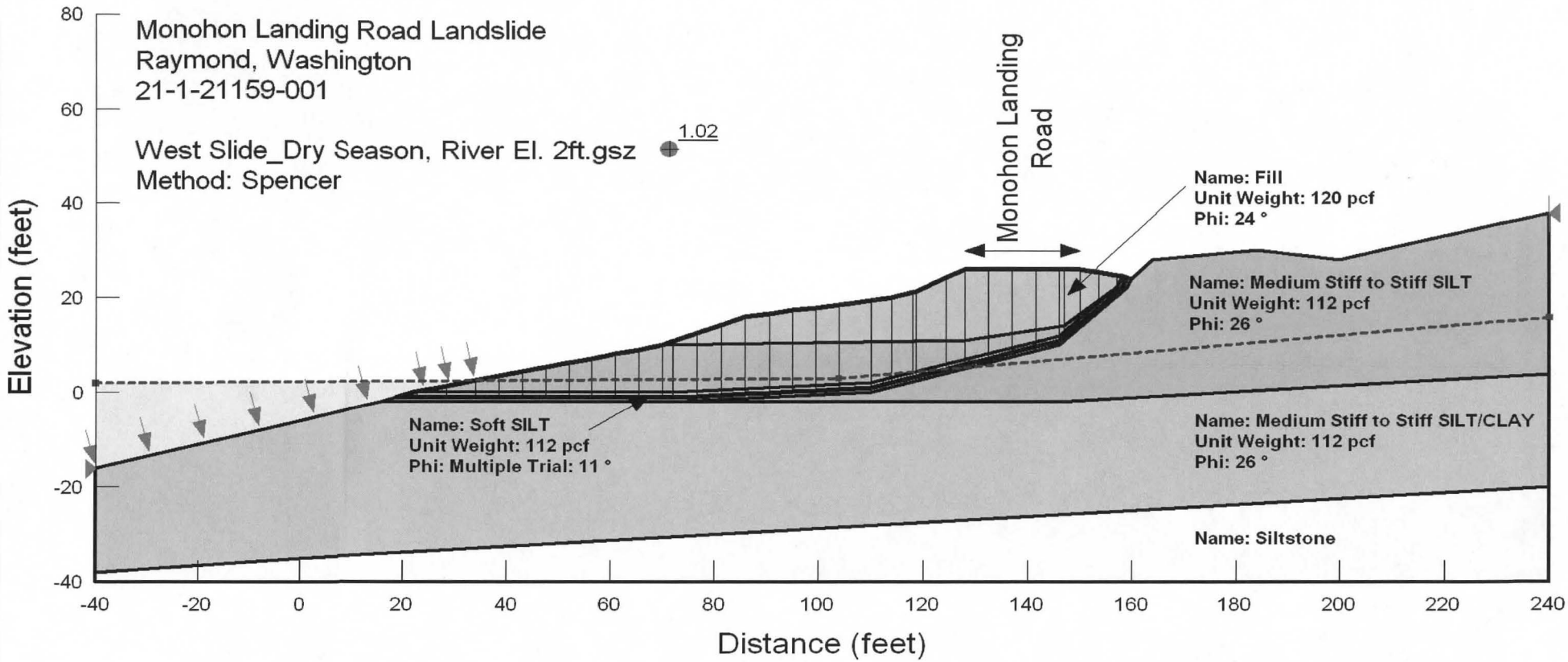
FIG. 7

FIG. 7



Monohon Landing Road Landslide
Raymond Washington

GLOBAL STABILITY RESULTS
WEST LANDSLIDE - DRY SEASON

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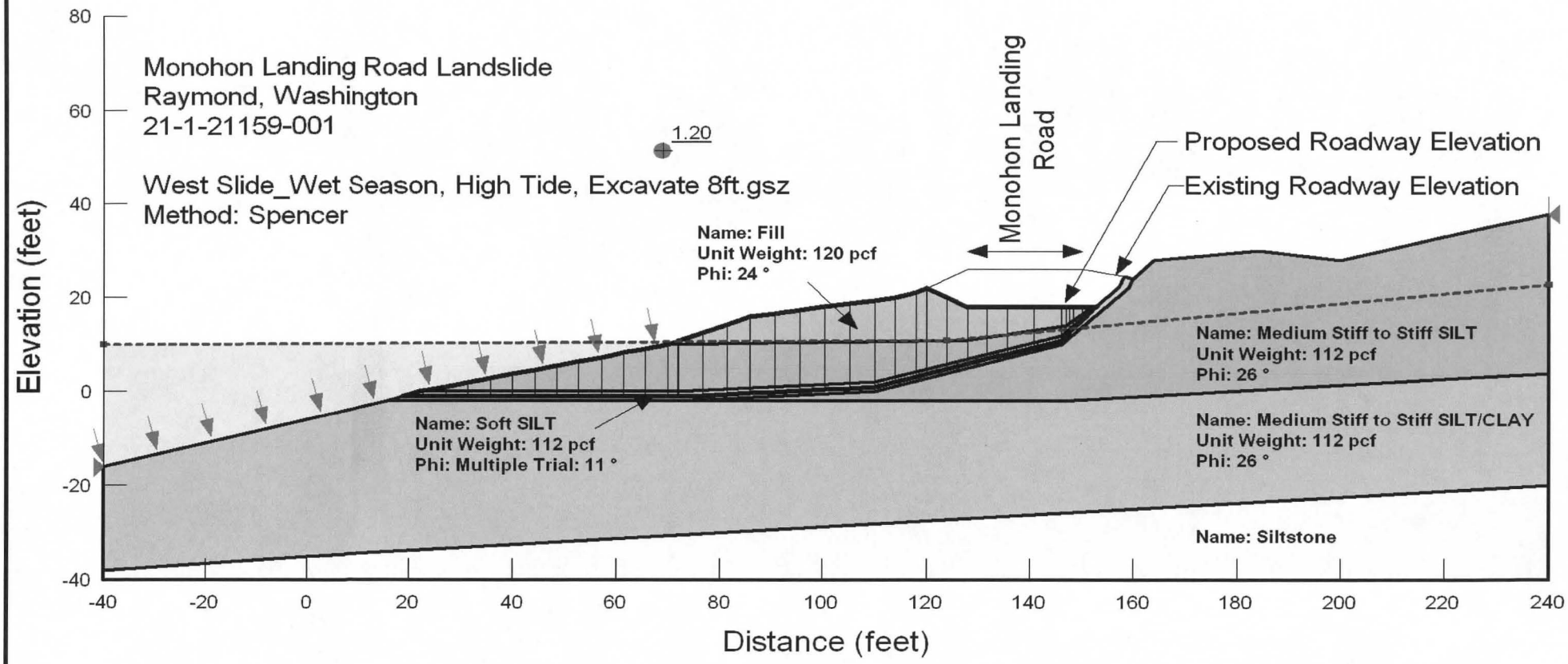
FIG. 8

FIG. 8



Monohon Landing Road Landslide
Raymond Washington

GLOBAL STABILITY RESULTS
WEST LANDSLIDE - EXCAVATE 8 FEET

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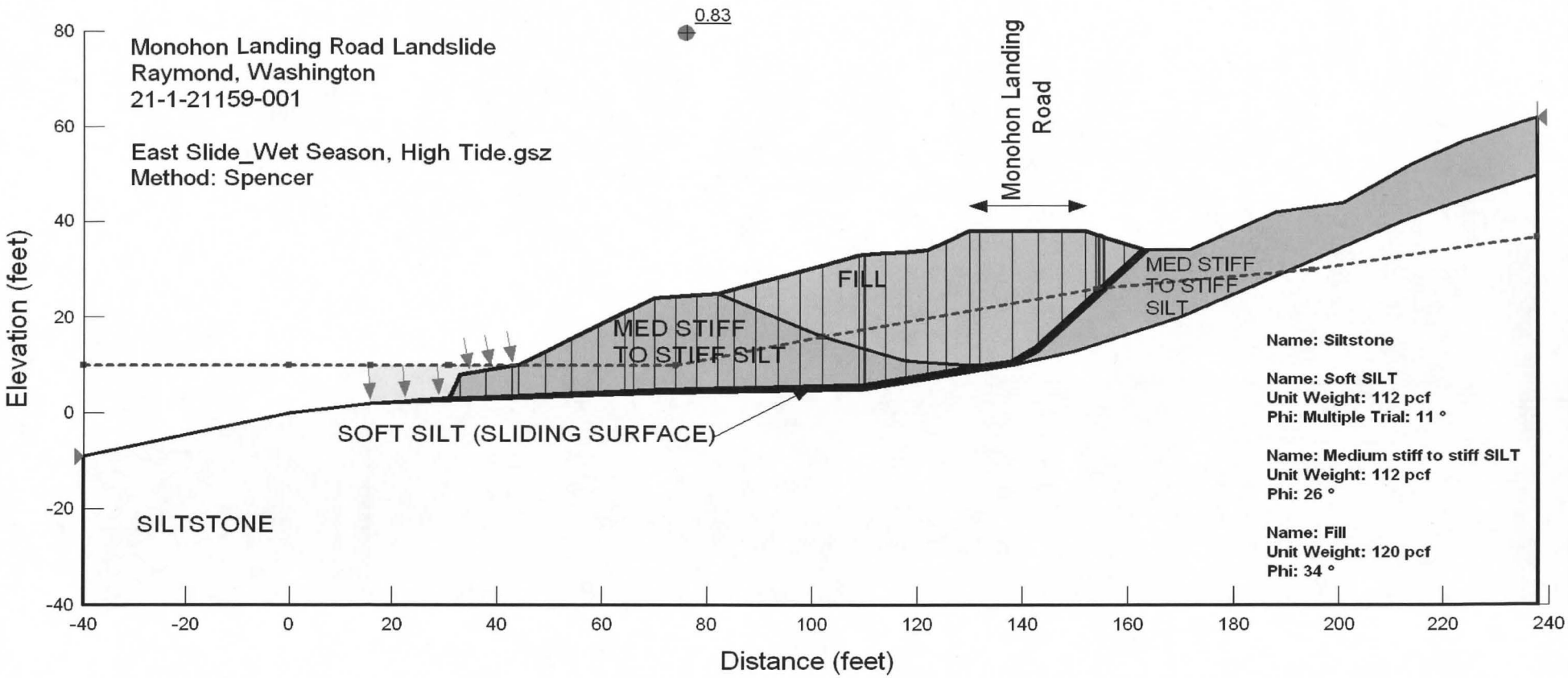
FIG. 9

FIG. 9



Monohon Landing Road Landslide
Raymond Washington

GLOBAL STABILITY RESULTS
EAST LANDSLIDE - WET SEASON

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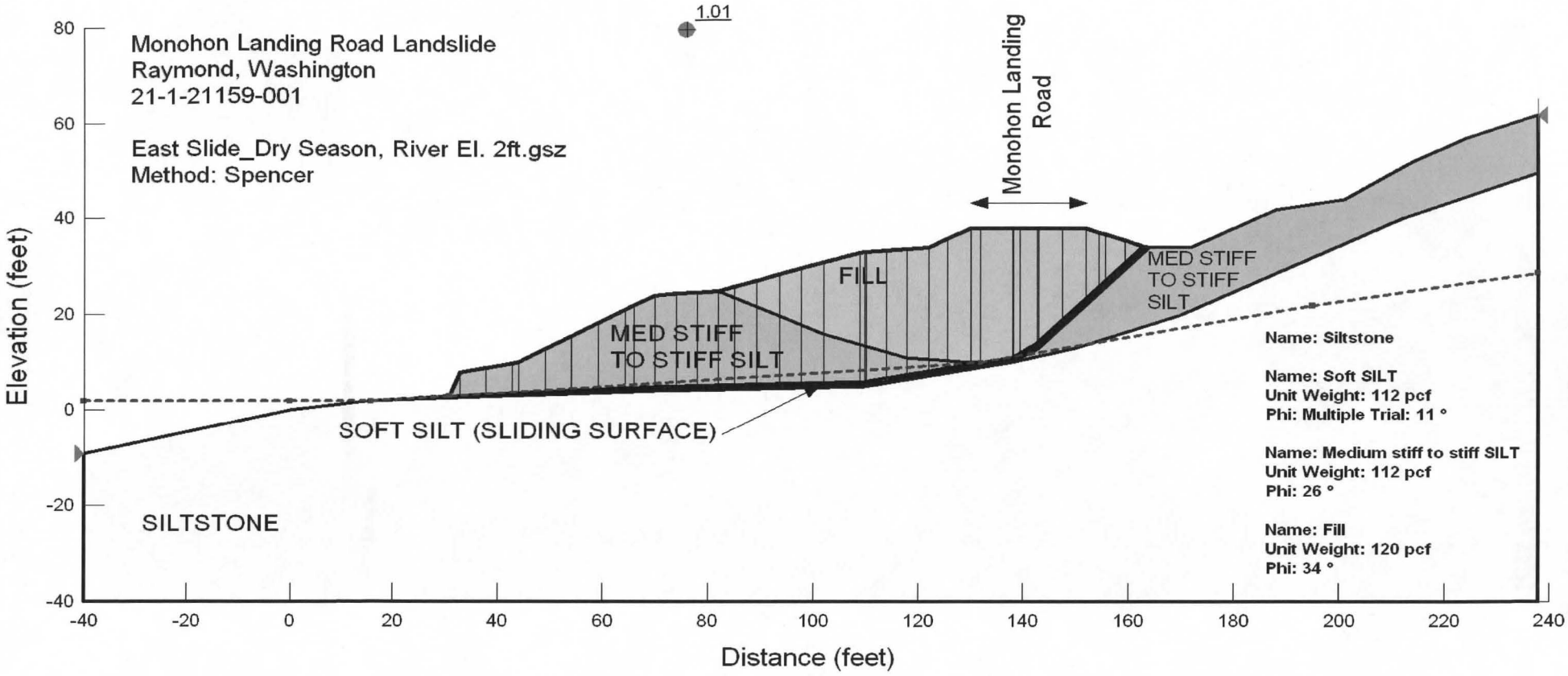
FIG. 10

FIG. 10



Monohon Landing Road Landslide
Raymond Washington

GLOBAL STABILITY RESULTS
EAST LANDSLIDE - DRY SEASON

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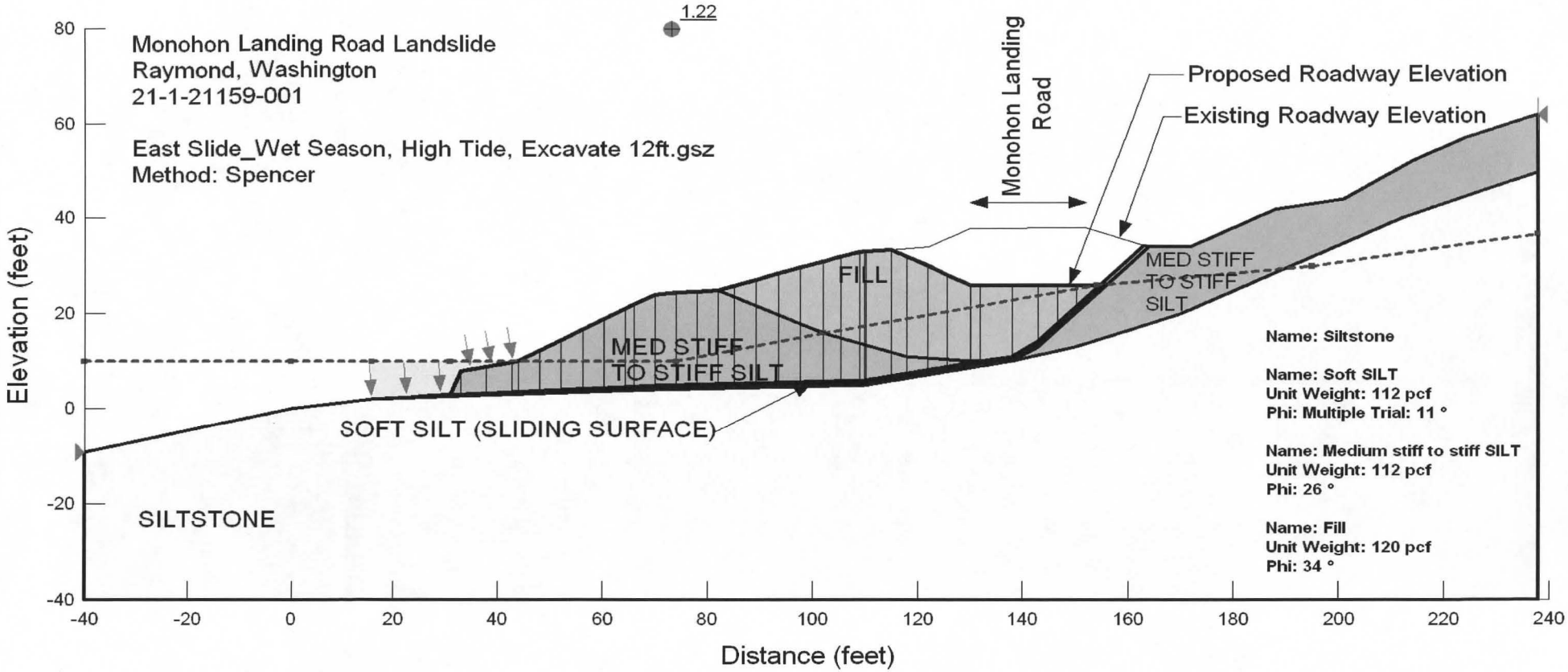
FIG. 11

FIG. 11



Monohon Landing Road Landslide
Raymond Washington

GLOBAL STABILITY RESULTS
EAST LANDSLIDE - EXCAVATE 12 FEET

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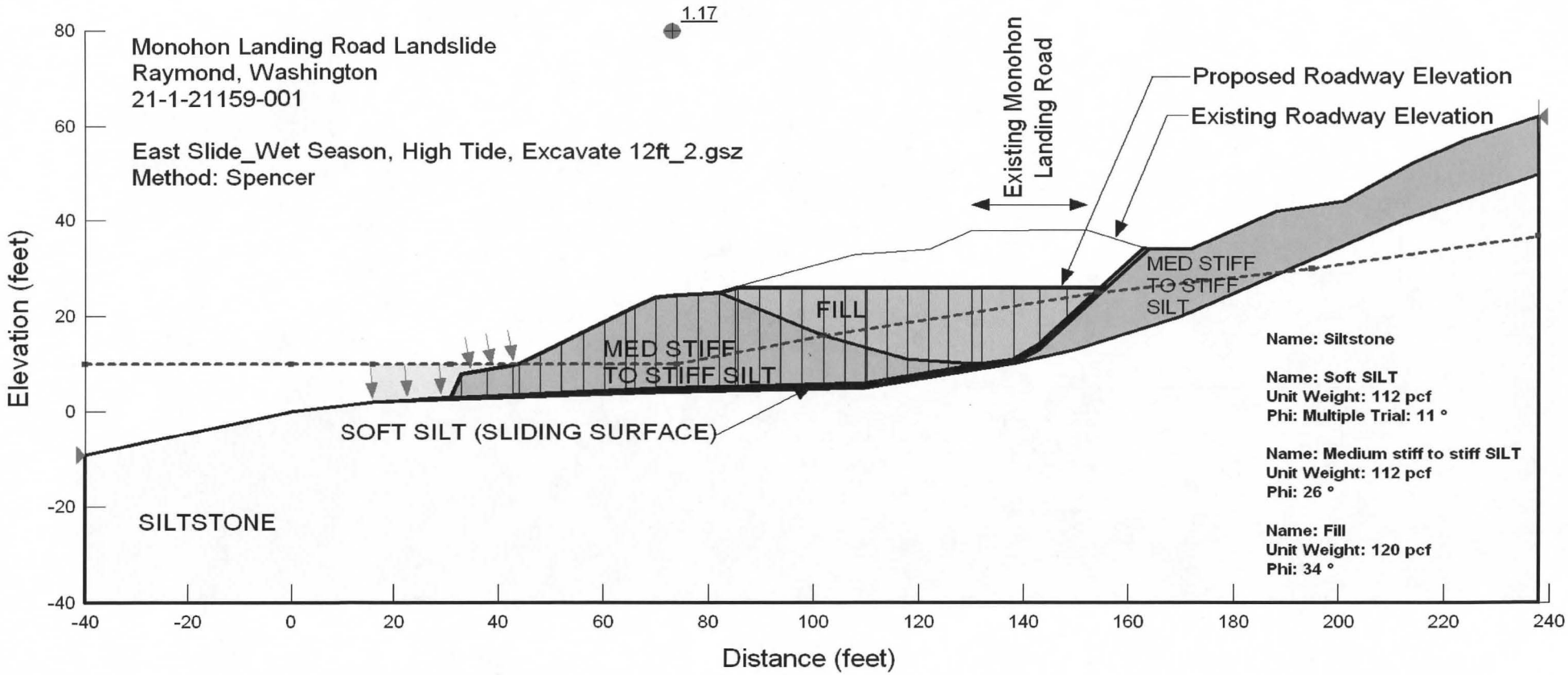
FIG. 12

FIG. 12



Monohon Landing Road Landslide
Raymond Washington

GLOBAL STABILITY RESULTS
EAST LANDSLIDE - EXCAVATE 12 FEET
IMPROVED SIGHT DISTANCE

July 2009 21-1-21159-001

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FIG. 13

FIG. 13

APPENDIX A

PREVIOUS SUBSURFACE EXPLORATIONS

APPENDIX A

PREVIOUS SUBSURFACE EXPLORATIONS

FIGURES

Washington Department of Transportation (1979)

A-1 Log of Boring WSDOT-1 (2 sheets)
A-2 Log of Boring WSDOT-2 (2 sheets)
A-3 Log of Boring WSDOT-3 (2 sheets)
A-4 Log of Boring WSDOT-4

GeoEngineers, Inc. (1990)

A-5 GeoEngineers Soil Classification System
A-6 GeoEngineers Key to Boring Log Symbols
A-7 Log of Boring GEI-1
A-8 Log of Boring GEI-2 (2 sheets)
A-9 Log of Boring GEI-3 (2 sheets)

Geotechnical Testing Laboratory, Inc. (2008 and 2009)

A-10 Geotechnical Testing Laboratory Geotechnical General Notes
A-11 Log of Boring GTL-H-1
A-12 Log of Boring GTL-H-2
A-13 Log of Boring GTL-H-3
A-14 Log of Boring GTL-H-5
A-15 Log of Boring GTL-H-6
A-16 Log of Boring GTL-1
A-17 Log of Boring GTL-2
A-18 Log of Boring GTL-3
A-19 Log of Boring GTL-4

BORING WSDOT-1

H. F. 28.66 (Rev. 5-67)

WASHINGTON
STATE HIGHWAY COMMISSION
DEPARTMENT OF HIGHWAYS

Original to Materials Engineer
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LOG OF TEST BORING

F. CIFIC CO.
MONOHAN RD.

~~SH.~~ ~~SR.~~ Section MONOHAN RD. SLIDE Job No. RO-1508

Hole No. 1 Sub Section PACIFIC CO. Cont. Sec.

Station 0+00 Offset 9' RT Ground El. 383'

Type of Boring B-61 Casing HOLLOW AUGER W.T. El. 213'

Inspector D. ZASKE Date 1-29-79 Sheet 1 of 2

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
0				ROAD SHOULDER ~ LAYERS OF
				ASPHALT, CRUSHED & BROKEN
				ROCK.
5'				
10'				
	12			D-1-P (10'-11'-6") 6/6" 5/6" 7/6"
				CRUSHED ROCK
15'				
	13			D-2-P (15'-16'-6") 7/6" 6/6" 7/6"
20				

LOG OF BORING
FIG. A-1
(SHEET 1 OF 2)

WV Form 351-003-a (H. F. 26.66-A).
Revised 5-67.

BORING WSDOT-1
(Continued)

Hole No. 1 Sub Section MONOHAN RD- SLIDE Sheet 2 of 2

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
20'	18		JS#1	D-3-P(20'-21'-6") 7/6" 9/6" 9/6"
				BRN. SILT & SILTSTONE FRAG'S
25'	14		JS#2	D-4-P(25-26'-6") 5/6" 5/6" 9/6"
				GRAY SILT & SILTSTONE FRAG'S
30'	88		JS#3	D-5-P(30-31'-6") 24/6" 25/6" 63/6"
				VERY HARD, GRAY SILTSTONE
35'				SAME
40'	100/5"			D-6-P(40'-40'-5") 100/5"
				END OF HOLE: @ 40'-5"

LOG OF BORING
FIG. A-1
(SHEET 2 OF 2)

BORING WSDOT-2

H. F. 26.66 (Rev. 5-67)

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LOG OF TEST BORING

~~S.H.~~ ~~S.R.~~ Section MONOHAN RD. SLIDE Job No. RD-1503
Hole No. 2 Sub Section PACIFIC CO. Cont. Sec. _____
Station 0+00 Offset 32' RT Ground El. 32.5'
Type of Boring ACKER/WASH Casing 25' W.T. El. 19.5'
Inspector D. ZASKE Date 1-24-79 Sheet 1 of 2

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
0'				ROAD FILL ~ BROWN SILT
				& BROKEN ROCK.
5'				
	19		JS #1	D-1-P(5'-6'-6") 7/6" 7/6" 12/6"
10'				
	7			D-2-P(10'-11'-6") 6/6" 4/6" 3/6"
				BROWN SILT W/SOME BROKEN ROCK
15'				
	12			D-3-P(15'-16'-6") 6/6" 5/6" 7/6"
				BROWN SILT, & GRAY SILTSTONE
				FRAGMENTS.
20'				

LOG OF BORING
FIG. A-2
(SHEET 1 OF 2)

W Form 31-003-b (H. F. 26 66-A).
Revised 5-67.

BORING WSDOT-2
(Continued)

Hole No. 2 Sub Section MONOHAN RD. SLIDE Sheet 2 of 2

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
0'	18			D-4-P(20'-21'-6") 10/6" 9/6" 9/6"
				BROWN SILT & GRAY SILTSTONE FRAGMENTS
25'	25			D-5-P(25'-26'-6") 10/6" 11/6" 14/6"
				VERY HARD, GRAY SILTSTONE.
30'	100			D-6-P(30'-31') 30/6" 70/6"
			A	D-7-U(32'-33') 200/12"
35'				
	100/2"			D-8-P(37'-37'-2") 100/2"
				END OF HOLE @ 38'-0

LOG OF BORING
FIG. A-2
(SHEET 2 OF 2)

BORING WSDOT-3

H. F. 26.66 (Rev. 5-67)

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DEPARTMENT OF HIGHWAYS

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PACIFIC CO.
MUNOHAN RD.

LOG OF TEST BORING

~~S.H.~~ ~~S.R.~~ Section MONOHAN RD. SLIDE — Job No. RO-1508
Hole No. 3 — Sub Section PACIFIC CO. — Cont. Sec.
Station 0+00 — Offset 72' RT — Ground El. 24±
Type of Boring ACKER/WASH — Casing 23' — W.T. El. 7±
Inspector D. ZASKE — Date 1-18-79 — Sheet 1 of 2

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
0'				BROWN SILT, ROOTS & LEAVES
			A	D-1-U (3'-5') 6/12" 7/12"
5'				
	5		JS #1	D-2-P (5'-6'-6") 2/6" 2/6" 3/6"
				BROWN SILT & SILTSTONE, FRAG
			A B	D-3-U (8'-10') 4/12" 7/12"
10'				
	14		JS #2	D-4-P (10'-11'-6") 2/6" 2/6" 2/6"
			A B	D-5-U (13'-15') 8/12" 8/12"
15'				
				L-6-P (15'-16-6") NO G
				BRN. & GRAY SILT & SILTSTONE FRAG
			A B	D-7-U (18'-20) 8/12" 32/12"
20'				HARD, GRAY SILTSTONE

LOG OF BORING
FIG. A-3
(SHEET 1 OF 2)

HWY Form 351-003-a (H. F. 26.66 A).
Revised 5-67.

BORING WSDOT-3
(Continued)

Hole No. 3 Sub Section MONOHAN RD. SLIDE Sheet 2 of 2

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
20'	34		IS #3	D-8-P(20'-21'-6") 8/6" 8/6" 26/6"
				HARD, GRAY SILTSTONE
25'	36			D-9-P(25'-26'-6") 10/6" 18/6" 18/6"
				SAME
30'	110			D-10-P(30'-31'-6") 28/6" 49/6" 61/6"
				SAME MAT'L (VERY HARD)
35'				
40'	100/6"			D-11-P(42'-42'-6") 100/6"
				SAME (VERY HARD)
				END OF HOLE @ 42'-6"

LOG OF BORING
FIG. A-3
(SHEET 2 OF 2)

BORING WSDOT-4

H: F. 26.66 (Rev. 5-67)

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DEPARTMENT OF HIGHWAYS

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LOG OF TEST BORING

~~SR~~ ~~SR~~ Section MONOHAN RD. SLIDE Job No. RO-15C8

Hole No. A Sub Section PACIFIC Co. Cont. Sec.

Station 0+00 Offset 122' RT Ground El. 2'

Type of Boring HAND AUGER Casing — W.T. El. —

Inspector D. ZASKE Date 1-23-79 Sheet 1 of 1

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	TIDE WATER DESCRIPTION OF MATERIAL
0'				BROWN & GRAY SILT
				GRAY SILTSTONE
5'				
10'				

LOG OF BORING

FIG. A-4

SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOL	GROUP NAME
COARSE GRAINED SOILS More Than 50% Retained on No. 200 Sieve	GRAVEL More Than 50% of Coarse Fraction Retained on No. 4 Sieve	CLEAN GRAVEL	GW	WELL-GRADED GRAVEL, FINE TO COARSE GRAVEL
			GP	POORLY-GRADED GRAVEL
		GRAVEL WITH FINES	GM	SILTY GRAVEL
			GC	CLAYEY GRAVEL
	SAND More Than 50% of Coarse Fraction Passes No. 4 Sieve	CLEAN SAND	SW	WELL-GRADED SAND, FINE TO COARSE SAND
			SP	POORLY-GRADED SAND
		SAND WITH FINES	SM	SILTY SAND
			SC	CLAYEY SAND
FINE GRAINED SOILS More Than 50% Passes No. 200 Sieve	SILT AND CLAY Liquid Limit Less Than 50	INORGANIC	ML	SILT
			CL	CLAY
		ORGANIC	OL	ORGANIC SILT, ORGANIC CLAY
	SILT AND CLAY Liquid Limit 50 or More	INORGANIC	MH	SILT OF HIGH PLASTICITY, ELASTIC SILT
			CH	CLAY OF HIGH PLASTICITY, FAT CLAY
		ORGANIC	OH	ORGANIC CLAY, ORGANIC SILT
HIGHLY ORGANIC SOILS			PT	PEAT

NOTES:

1. Field classification is based on visual examination of soil in general accordance with ASTM D2488-90.
2. Soil classification using laboratory tests is based on ASTM D2487-90.
3. Descriptions of soil density or consistency are based on interpretation of blow count data, visual appearance of soils, and/or test data.

SOIL MOISTURE MODIFIERS:

Dry - Absence of moisture, dusty, dry to the touch

Moist - Damp, but no visible water

Wet - Visible free water or saturated, usually soil is obtained from below water table

GEI 85-85 Rev. 05/93

Geo Engineers

SOIL CLASSIFICATION SYSTEM

FIG. A-5

LABORATORY TESTS:

AL	Atterberg limits
CP	Compaction
CS	Consolidation
DS	Direct shear
GS	Grain-size
%F	Percent fines
HA	Hydrometer analysis
SK	Permeability
SM	Moisture content
MD	Moisture and density
SP	Swelling pressure
TX	Triaxial compression
UC	Unconfined compression
CA	Chemical analysis

SOIL GRAPH:

SM Soil Group Symbol (See Note 2)

Distinct Contact Between Soil Strata

Gradual or Approximate Location of Change Between Soil Strata

Water Level

Bottom of Boring

BLOW COUNT/SAMPLE DATA:

Blows required to drive a 2.4-inch I.D. split-barrel sampler 12 inches or other indicated distances using a 300-pound hammer falling 30 inches.

- 22 ■ Location of relatively undisturbed sample
- 12 ⊠ Location of disturbed sample
- 17 □ Location of sampling attempt with no recovery

Blows required to drive a 1.5-inch I.D. (SPT) split-barrel sampler 12 inches or other indicated distances using a 140-pound hammer falling 30 inches.

- 10 ◨ Location of sample obtained in general accordance with Standard Penetration Test (ASTM D 1586) procedures
- 26 ◫ Location of SPT sampling attempt with no recovery

▤ Location of grab sample

"P" indicates sampler pushed with weight of hammer or against weight of drill rig.

NOTES:

1. The reader must refer to the discussion in the report text, the Key to Boring Log Symbols and the exploration logs for a proper understanding of subsurface conditions.
2. Soil classification system is summarized in Figure A-1.

GEI 86-88 Rev. 2/94

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KEY TO BORING LOG SYMBOLS

FIG. A-6

BORING GEI-1

Approximate Station: 6+79, 12 ft. rt.

Surface Elevation (ft.): 43.0

Lab Tests	Moisture Content (%)	Dry Density (pcf)	Blow Count	Samples	Group Symbol	DESCRIPTION
					GM	Dark gray and brown silty fine gravel with sand and multiple layers of asphalt concrete (loose, moist) (fill)
			16	■		
MD	11	100	4	■		
					GM	Dark gray silty fine gravel with sand and asphalt fragments (loose to medium dense, moist) (fill)
			8	□		
SM	9		17	■		
MD	8	121	13	■		
MD	28	97	6	■	SM	Brown silty fine to coarse sand with gravel (loose, wet) (fill)
MD, AL, TX	30	92	11	■	MH	Gray elastic silt with sand (stiff, wet)
					ML	Gray silt (hard, moist) (siltstone)
SM	22		50/5"	■		

DEPTH IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

Boring completed at 33.5 feet on 06/27/90
Piezometer installed to 31.0 feet
Ground water level measured at 29.0 feet on 08/06/90

Note: See Figure A-2 for explanation of symbols

:HRP:CDG:CMS 12/17/97

1322-003-06-1130

Geo Engineers

LOG OF BORING

FIG. A-7

BORING GEI-2

Approximate Station: 1+71, 8 ft. lt.

Surface Elevation (ft.): 27.0

Depth (ft)	Lab Tests	Moisture Content (%)	Dry Density (pcf)	Blow Count	Samples	Group Symbol	DESCRIPTION
0						ASPHALT	Asphalt concrete pavement, 4 inches thick
						GM	Brownish gray silty fine gravel with sand (loose, moist) (fill)
						ASPHALT	Asphalt concrete layers
5							
						SM	Gray silty fine to coarse sand with gravel (loose, moist) (fill)
				11	■		
10							
						ML	Gray and brown silt with sand (soft to medium stiff, moist)
	SM	28		5	■		
15							
	MD	42	78	6	■		
20							
	MD	40	76	8	■		
25							
						ML	Gray silt (very soft, wet)
						CH	Dark gray fat clay (stiff, moist)
30	MD, AL, TX	45	77	13	■		
	MD	35	85	14	■		Grades with a trace of organic matter
35							
				16	■		
40							

DEPTH IN FEET

Note: See Figure A-2 for explanation of symbols

:HRP:CDG:CMS 12/17/97

1322-003-06-1130

Geo Engineers

LOG OF BORING

FIG. A-8

(SHEET 1 OF 2)

TEST DATA

BORING GEI-2
(Continued)

DESCRIPTION

Lab Tests	Moisture Content (%)	Dry Density (pcf)	Blow Count	Samples	Group Symbol	Description
MD	33	87	13	■		
			49	■	ML	Dark gray silt (hard, moist) (siltstone)
MD	19	108	50/3"	■		

Boring completed at 54.0 feet on 06/28/90
Piezometer installed to 50.9 feet
Ground water level measured at 17.2 feet on 08/06/90

DEPTH IN FEET: 40, 45, 50, 55, 60, 65, 70, 75, 80

Note: See Figure A-2 for explanation of symbols

:HRP:CDG:CMS 12/17/97

1322-003-06-1130

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LOG OF BORING

FIG. A-8
(SHEET 2 OF 2)

BORING GEI-3

Approximate Station: 1+54, 12 ft. rt.

Surface Elevation (ft.): 27.0

Depth (ft.)	Lab Tests	Moisture Content (%)	Dry Density (pcf)	Blow Count	Samples	Group Symbol	DESCRIPTION
0						GM	Gray silty fine gravel with sand and multiple layers of asphalt concrete (medium dense, moist) (fill)
				44	■		
5							
	MD	11	116	26	■		
10							
				33	■		
15						ML	Mottled orangish brown and gray silt (medium stiff, moist to wet)
	MD	45	96	5	■		
20							
	MD	33	89	8	■		Grades to gray
25							
	MD	41	80	7	■		
						MH	Gray elastic silt (medium stiff, wet)
	MD, AL, TX	41	80	9	■		
30							
	MD	40	92	8	■		
35							
	MD	39	81	6	■		
40							

DEPTH IN FEET

Note: See Figure A-2 for explanation of symbols

:HRP:CDG:CMS 12/17/97

1322-003-06-1130

Geo Engineers

LOG OF BORING

FIG. A-9

(SHEET 1 OF 2)

TEST DATA

BORING GEI-3
(Continued)

DESCRIPTION

Lab Tests	Moisture Content (%)	Dry Density (pcf)	Blow Count	Samples	Group Symbol	Description
			10			
MD, DS	33	86	11		SM/CH	Layers of gray silty fine sand and elastic silt (loose to medium stiff, wet)
MD, AL, TX	34	58	7			Grades with fragments of fractured silt
					ML	Gray silt (hard, moist) (siltstone)
MD	25	98	50/5"			

Boring completed at 59.0 feet on 06/28/90
Piezometer installed to 59.0 feet
Ground water level measured at 23.9 feet on 08/06/90

DEPTH IN FEET: 40, 45, 50, 55, 60, 65, 70, 75, 80

Note: See Figure A-2 for explanation of symbols

:HRP:CDG:CMS 12/17/97

1322-003-06-1130

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LOG OF BORING

FIG. A-9
(SHEET 2 OF 2)

GEOTECHNICAL TESTING LABORATORY

GEOTECHNICAL GENERAL NOTES

SOIL PROPERTY SYMBOLS

N: Standard "N" penetration: Blows per foot of a 140 pound hammer falling 30 inches on a 2 inch O.D. split-spoon.
Qu: Unconfined compressive strength, tons/ft2
Qp: Penetrometer value, unconfined compressive strength, lbs/ft2
V: Vane value, ultimate shearing strength, lbs/ft2
M: Water content, %
LL: Liquid limit, %
PI: Plasticity index, %
D: Natural dry density, lbs/ft3
WT: Apparent groundwater level at time noted after completion.

DRILLING AND SAMPLING SYMBOLS

SS: Split-Spoon - 1 3/8" I.D., 2" O.D., except where noted.
ST: Shelby Tube - 3" O.D., except where noted.
AU: Auger Sample.
GB: Grab Sample.
DB: Diamond Bit.
CB: Carbide Bit.
WS: Washed Sample.

RELATIVE DENSITY AND CONSISTENCY CLASSIFICATION

Terms (Non-Cohesive Soils)	**Standard Penetration Resistance**
Very Loose	0 - 2
Loose	2 - 4
Slightly Compact	4 - 8
Medium Dense	8 - 16
Dense	16 - 26
Very Dense	Over 26

Terms (Cohesive Soils)	**Qu - (tons/ft2)**
Very Soft	0 - 0.25
Soft	0.25 - 0.50
Firm (Medium)	0.50 - 1.00
Stiff	1.00 - 2.00
Very Stiff	2.00 - 4.00
Hard	4.00+

PARTICLE SIZE

Boulders	8 in. +	**Coarse Sand**	5 mm - 0.6 mm	**Silts**	0.074 mm - 0.005 mm
Cobbles	8 in. -3 in.	**Medium Sand**	0.6 mm - 0.2 mm	**Clays**	0.005 mm & Smaller
Gravel	3 in. -5 mm	**Fine Sand**	0.2 mm - 0.074 mm		

FIG. A-10

GEOTECHNICAL TESTING LABORATORY

Ground 23.3 9+00

BORING LOG H - 1

88 dat

Elev

Date: 1/16/2008 N 46° 41' 768" **File #:** 07-0424
Boring Log #: 1 W123° 43' 524" **Client:** Pacific County
Boring Type: Hollow Stem Auger **Depth Drilled:** 61 feet

	Depth (Ft)	Laboratory Soil Description	Change in Soils	% M	N	Q_p	Q_p	V	LL	PL	PI	Percent Minus 3/4"	#4	#200	Drillers Comments
	2.5														Silt w/ sand
	5.0	Sand w/ Silty Clay		27.3%	10							100.0%	99.8%	11.1%	Brown Silt, moist
	7.5	(SW-SC)													
	10.0			41.6%	20							100.0%	100.0%	76.9%	
	12.5														
	15.0				8							100.0%	99.9%	11.6%	
	17.5														
3.3	20.0	CH or OH		32.6%	13				63.0	24.0	39.0				
	22.5														Gray silt with sand
-1.7	25.0	Silt w/ Sand		23.4%	20							100.0%	99.3%	87.1%	ML
	27.5														
-6.7	30.0	CH or OH			47				51.4	21.0	30.4				
	32.5														Groundwater Encountered
	35.0				25										
	37.5														
	40.0				28				69.5	19.6	50.0				
	42.5														
	45.0				4										
	47.5														
	50.0				67										
	52.5														
	55.0	Sand w/ Silt & Gravel		23.4%	39							100.0%	70.8%	8.5%	
	57.5	SP-SM													White Material
	60.0				50										
	62.5	Silt w/ Sand		15.9%								100.0%	98.5%	80.7%	

Groundwater Encountered at approximately 33 feet bgs.

GEOTECHNICAL TESTING LABORATORY

88dat

grand 26.7' 10+60

BORING LOG H - 2

Date: 1/17/2008 N 46° 41' 774" **File #:** 07-0424
Boring Log #: 2 W 123° 43' 419" **Client:** Pacific County
Boring Type: Hollow Stem Auger **Depth Drilled:** 90 feet

Depth (Ft)	Laboratory Soil Description	Change in Soils	% M	N	Q_s	Q_p	V	LL	PL	PI	Percent Minus 3/4"	#4	#200	Drillers Comments
2.5														Crushed Rock
5.0				42										
7.5														Pea Gravel
10.0				50										50 blows for 3-inches
12.5														Crushed rock with asphalt
15.0				50/5"										50 blows for 5-inches
17.5														
6.7 — 20.0				58										
22.5														Silty sand with few gravel
1.7 — 25.0				8										
27.5														
30.0				9										Silty Sand and Gravel
32.5														
-8.3 — 35.0				7										Clayey Silt
37.5														
40.0				15										
42.5														
45.0				13										
47.5														
-23.3 — 50.0	CL-OL		32.5%	16				49.0	19.0	30.2				
52.5														
55.0				59										
57.5														Hard Drilling
60.0	CH-OH		25.3%	50/4"				98.2	24.3	73.8				50 blows for 4-inches
62.5														
65.0				50/5"										50 blows for 5-inches
67.5														
70.0				50/4"										50 blows for 4-inches
72.5														
75.0				50/5"										50 blows for 5-inches
77.5														
80.0				50/5"										50 blows for 5-inches
82.5														
85.0				50/5"										50 blows for 5-inches
87.5														
90.0				50/5"										50 blows for 5-inches

Groundwater Encountered at approximately 42 feet bgs.

GEOTECHNICAL TESTING LABORATORY

88 dat
30.5 12+30

BORING LOG H - 3

Date: 1/20/2008 N 46° 41' 776" **File #:** 07-0424
Boring Log #: 3 W 123° 43' 445" **Client:** Pacific County
Boring Type: Hollow Stem Auger **Depth Drilled:** 90 feet

Depth (Ft)	Laboratory Soil Description	Change in Soils	% M	N	Q_u	Q_p	V	LL	PL	PI	Percent Minus 3/4"	#4	#200	Drillers Comments
2.5														Crushed Rock
5.0				4										Reddish Brown Silt
7.5														
10.0	Silt w/ Sand ML		45.7%	8							100.0%	97.8%	83.5%	
12.5														Gray Silt
15.0				6										
17.5														
20.0	Silt w/ Sand ML		42.8%	8							100.0%	98.1%	75.9%	
22.5														
5.5 – 25.0				7										
27.5														
30.0				8										
32.5														
-4.5 – 35.0	CH-OH		42.2%	11				83.0	20.6	62.4				
37.5														Moist soil
40.0				10										
42.5														Very Wet, Possibly Water
45.0	Silt ML		42.2%	16							100.0%	99.6%	96.9%	
47.5														
-14.5 – 50.0	CH-OH		27.5%	28				74.7	22.5	52.2				
52.5														Hard Drilling
55.0				50										50 blows for 5-inches
57.5														
60.0	Silt w/ Sand ML		53.4%	50							100.0%	90.1%	60.7%	50 blows for 5-inches
62.5														
65.0				50										50 blows for 5-inches
67.5														
70.0				50										50 blows for 4-inches
72.5														
75.0				50										50 blows for 5-inches
77.5														
80.0				50										50 blows for 5-inches
82.5														
85.0				50										50 blows for 5-inches
87.5														
90.0				50										50 blows for 5-inches

Groundwater Encountered at approximately 42 feet bgs.

GEOTECHNICAL TESTING LABORATORY

40.3 88dat 14470

BORING LOG H - 5

Date: 1/28/2008 N 46° 41' 785" **File #:** 07-0424
Boring Log #: 5 W 123° 43' 380" **Client:** Pacific County
Boring Type: Hollow Stem Auger **Depth Drilled:** 90 feet

Depth (Ft)	Laboratory Soil Description	Change in Soils	% M	N	Q_u	Q_p	V	LL	PL	PI	Percent Minus 3/4"	#4	#200	Drillers Comments
2.5														
5.0	Silt w/ Sand			8							100.0%	98.9%	77.8%	
7.5	ML													Gray silt
10.0				5										
12.5														
15.0				11										
17.5														
20.0 (20.3)	CH- OH		42.4%	15				57.5	27.3	30.2				
22.5														
25.0	CH- OH		30.1%	19				58.8	25.2	33.6				
27.5														
30.0 (10.3)				29										
32.5														
35.0				26										
37.5														
40.0 (0.3)				50										50 blows for 5-inches
42.5														Hard Drilling
45.0	CH- OH		17.5%	50				113.6	23.0	90.6				50 blows for 4-inches
47.5														
50.0				77										Hard Drilling
52.5														
55.0				48										
57.5														
60.0				50										50 blows for 5-inches
62.5														
65.0				50										50 blows for 5-inches
67.5														
70.0				50										50 blows for 5-inches
72.5														
75.0			33.2%	50										50 blows for 5-inches
77.5														
80.0				50										50 blows for 2-inches
82.5														
85.0				50										50 blows for 2-inches
87.5														
90.0				50										50 blows for 2-inches

Groundwater Not Reported

GEOTECHNICAL TESTING LABORATORY

42.1 1780 88 datum

BORING LOG H - 6

Date: 2/1/2008 N 46° 41' 778" **File #:** 07-0424
Boring Log #: 6 W 123° 43' 314" **Client:** Pacific County
Boring Type: Hollow Stem Auger **Depth Drilled:** 25 feet

	Depth (Ft)	Laboratory Soil Description	Change in Soils	% M	N	Q_u	Q_p	V	LL	PL	PI	Percent Minus 3/4"	#4	#200	Drillers Comments
	1.0														2-inch asphalt
	2.0														Crushed rock
	3.0														
	4.0														Light brown silt
	5.0	Silt w/ Sand		16.8%								100.0%	98.7%	76.5%	
	6.0	ML													
	7.0														Dark brown silt, moist
	8.0														
	9.0														Gray Silt
	10.0														
	11.0														
30.1	12.0				11										
	13.0														
	14.0				12										
	15.0	CH-OH		44.7%					71.1	21.0	50.1				Groundwater Encountered
26.1	16.0				24										
	17.0														
	18.0				26										
	19.0														
22.1	20.0				61										
	21.0				11										
	22.0														
19.1	23.0				12										
	24.0														
	25.0				24										

Groundwater Encountered at approximately 16 feet bgs.

Geotechnical Testing Laboratory

88 datum

Date: 2/5/2009 **File #:** 07-0424
Boring Log #: 1 **Client:** Pacific County
Boring Type: Hollow Stem Auger **Depth Drilled:** 55'

Depth (ft)	Field Description	Change in Soils	% M	N	LL	PL	PI	Percent Minus 3/4"	#4	#200
1	0 to 1.5' Oyster Shells									
2										
3	1.5' to 3' Top Soil									
4										
5				10						
6										
7										
8										
9										
10				7						
11	3' to 18' Light Brown									
12	Sticky Silt									
13										
14										
15				8						
16										
17										
18										
19										
20	18' to 21' Gray Stiff Silt			8						
21										
22										
23										
24	21' to 27' Brown Sandy Silt									
25	with Traces of Gravel			13						
26										
27										
28										
29										
30				11						
31										
32										
33										
34										
35				18						
36										
37										
38	27' to 51' Gray Silt									
39										
40				18						
41										
42										
43										
44										
45				12						
46										
47										
48										
49										
50				40						
51	51' to 53' Gray Hard Silt (wet)									
52										
53										
54	53' to 55' Gray Silt Stone									
55				53						
	Water Not Encountered									

30 27 9.0 3.0 0 -10 -20 -23

center line of Rd 27'

9815 Blomberg St. SW
Olympia, WA 98512

FIG. A-16

Geotechnical Testing Laboratory

88 Pat

Date: 2/6/2009 **File #:** 07-0424
Boring Log #: 2 **Client:** Pacific County
Boring Type: Hollow Stem Auger **Depth Drilled:** 20'

Depth (ft)	Field Description	Change in Soils	% M	N	LL	PL	PI	Percent Minus 3/4"	#4	#200
51.0 1	0 to 3' Dark Brown Silt									
2										
3										
4										
5				6						
6										
7										
8	3' to 12' Light Brown Silt									
9										
41.0 10				10						
11										
12										
13										
14	12' to 16' Gray Sticky Silt									
15				40						
16										
17										
18	16' to 20' Gray Silt Stone									
19										
31.0 20				50						
	Water Not Encountered									

℄ Road 27'

Geotechnical Testing Laboratory

Date: 2/9/2009 **File #:** 07-0424
Boring Log #: 3 **Client:** Pacific County
Boring Type: Hollow Stem Auger **Depth Drilled:** 25'

Depth (ft)	Field Description	Change in Soils	% M	N	LL	PL	PI	Percent Minus 3/4"	#4	#200
~~72.0~~ 75.0										
1	0 to 3' Dark Brown Silt									
2										
3										
4										
5				9						
6										
7										
8	3' to 12' Light Brown Silt									
9										
10				22						
~~42.0~~ 65.0										
11										
12										
13										
14	12' to 17' Gray Stiff Silt									
15				12						
16										
17										
18										
19										
20				43						
~~32.0~~ 55.0										
21	17' to 25' Gray Silt Stone									
22										
23										
24										
25	Blow counts 50 for 5"			92						
	Water Not Encountered									

Center line of Rd 45°

9815 Blomberg St. SW
Olympia, WA 98512

FIG. A-18

Geotechnical Testing Laboratory

Date: 2/10/2009 **File #:** 07-0424
Boring Log #: 4 **Client:** Pacific County
Boring Type: Hollow Stem Auger **Depth Drilled:** 15'

Depth (ft)	Field Description	Change in Soils	% M	N	LL	PL	PI	Percent Minus 3/4"	#4	#200
1	0 to 11' Brown Silt									
2										
3										
4										
5				4						
6										
7										
8										
9										
10				53						
11										
12	11' to 15' Gray Silt Stone									
13										
14										
15										
	Water Not Encountered									

~~75.0~~ 52.0

~~65.0~~ 42.0

Centerline of Rd 45

APPENDIX B

PREVIOUS GEOTECHNICAL LABORATORY TESTING RESULTS

APPENDIX B

PREVIOUS GEOTECHNICAL LABORATORY TESTING RESULTS

FIGURES

GeoEngineers, Inc. (1990)

B-1 Atterberg Limit Test Results
B-2 Direct Shear Test Data
B-3 Unconfined Undrained Triaxial Compression Test Data

Geotechnical Testing Laboratory, Inc. (2008 and 2009)

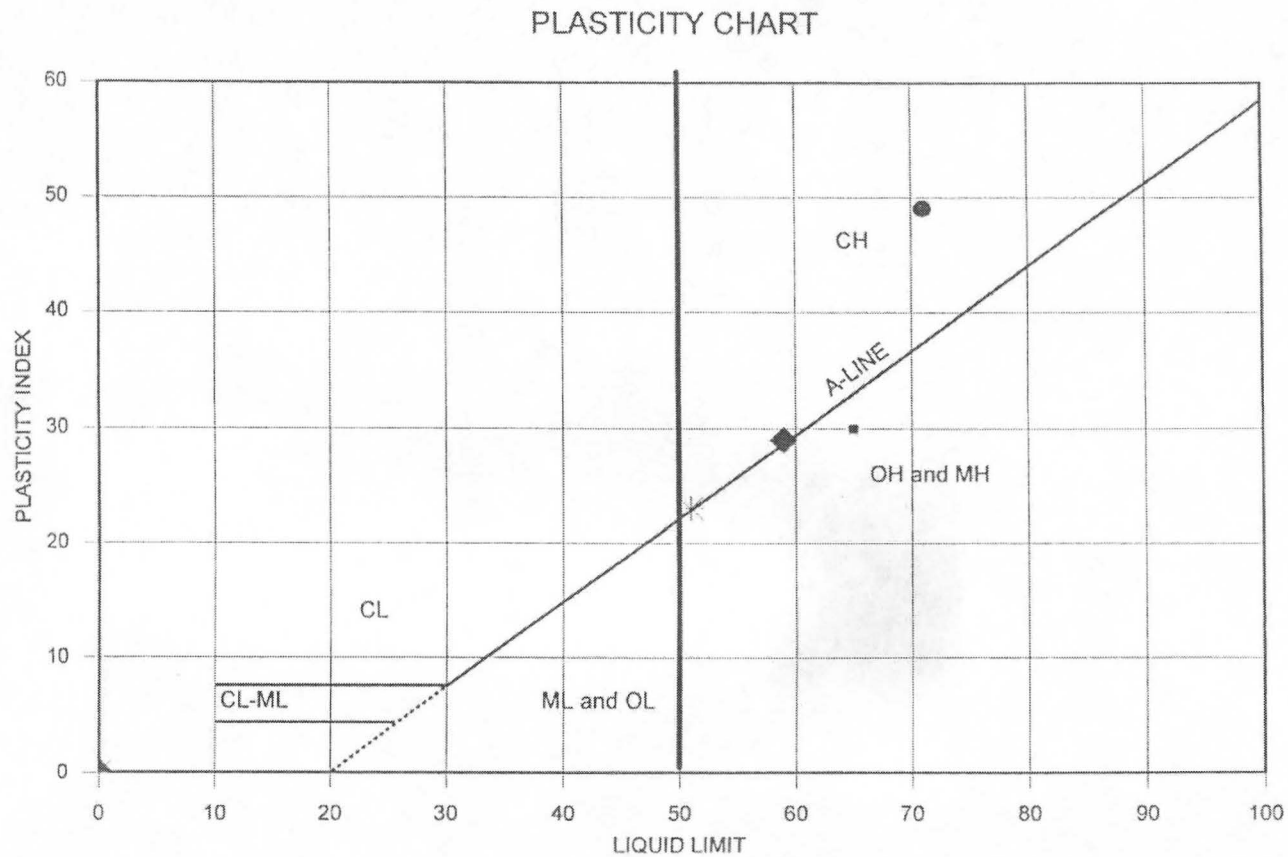
B-4 Grains Size Analysis Results (12 sheets)
B-5 Atterberg Limit Test Results (11 sheets)

1322-011-06-1130 HRP:GMD:cms 08/13/97 (P:\ATTRBERG.PRE)

Geo Engineers

FIG. B-1

ATTERBERG LIMITS TEST RESULTS



EXPLORATION NUMBER	SAMPLE DEPTH (ft)	MOISTURE CONTENT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	SOIL DESCRIPTION
◆ GEI-1	28	30	59	29	Elastic silt with sand (MH)
● GEI-2	29.5	45	71	49	Fat clay (CH)
■ GEI-3	28	41	65	30	Elastic silt with organic matter (MH)
✳ GEI-3	53	34	51	23	Elastic silt with sand (MH)

DIRECT SHEAR TEST DATA

Boring Number	Sample Depth (feet)	Sample Description	Moisture Content (%)	Dry Density (pcf)	Confining Pressure (psf)	Peak Strength (psf)
GEI-3	48	Silty fine sand/elastic silt (SM/MH)	33	86	4,000	2,600
	48	Silty fine sand/elastic silt (SM/MH)	33	86	8,000	4,700

Geo Engineers

DIRECT SHEAR TEST DATA

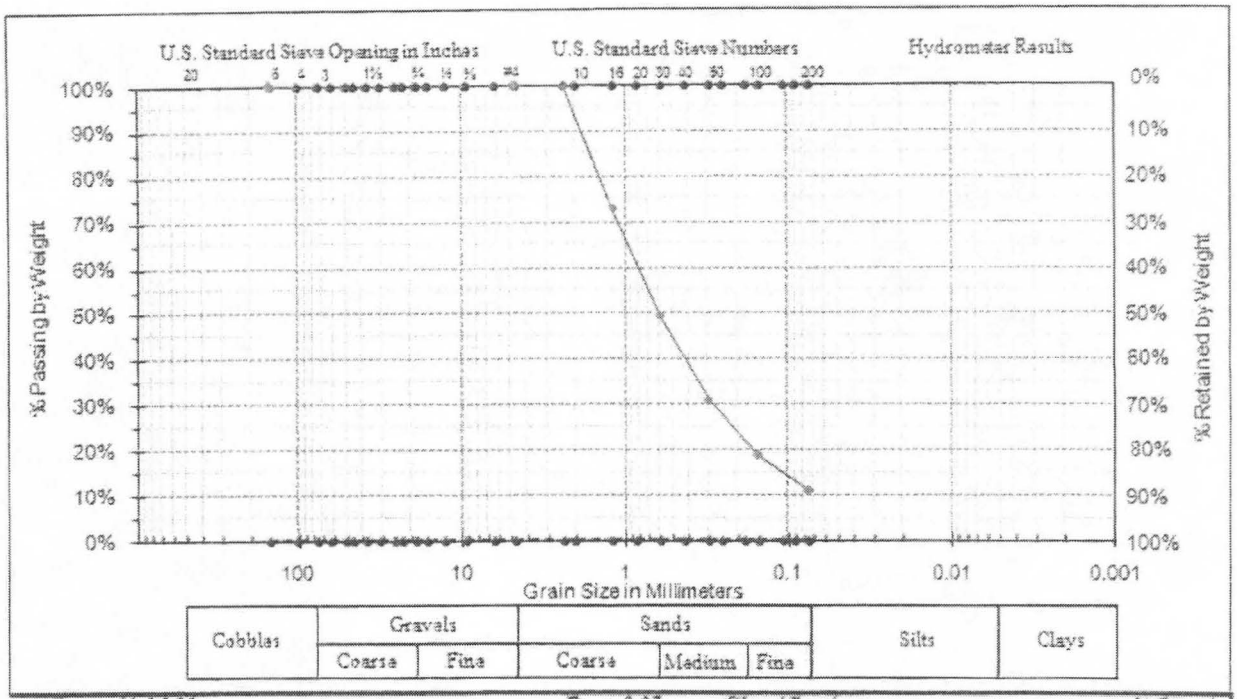
FIG. B-2

UNCONFINED UNDRAINED
TRIAXIAL COMPRESSION TEST DATA

Boring Number	Sample Depth (feet)	Soil Description	Moisture Content (%)	Dry Density (pcf)	Confining Pressure (psf)	Peak Deviator Stress (psf)
GEI-1	28	Elastic silt with sand (MH)	30	92	3,000	2,600
GEI-2	29.5	Elastic silt (MH)	45	77	3,000	2,000
GEI-3	28	Elastic silt (MH)	41	80	3,000	1,650
GEI-3	53	Elastic silt (MH)	34	58	5,000	2,450

GEOTECHNICAL TESTING LABORATORY

LAB ANALYSIS H – 1, 5 FEET



Date : 01/16/08	D_{10} = 0.07	**Classification**		% Gravel
Sample #: 81	D_{30} = 0.29	SW-SC, Well-graded Sand with Silty Clay		0.17%
Sample ID: Sand with Silty Clay	D_{60} = 0.87	**Specifications**		% Sand
Source: H-1	C_C = 1.40	No Specs		88.77%
Project: Monohon Rd	C_U = 12.76	% Moisture 27.3%		% Silt & Clay
Client: Pacific County	Liquid Limit= 0.00	Dust Ratio=		11.06%
ASTM#: C-136	Plastic Limit= 0.00	Fineness Modulus		Sample Meets Specs
Depth: 5'	Plasticity Index= 0.00	2.29		Yes

Coarse Section		Actual Cumulative	Interpolated Cumulative		
Sieve Size US	Sieve Size Metric	Percent Passing	Percent Passing	Specs Max	Specs Min
6.00"	150.00		100.0%		
4.00"	100.00		100.0%		
3.00"	75.00		100.0%		
2.50"	63.00		100.0%		
2.00"	50.00		100.0%		
1.75"	45.00		100.0%		
1.50"	37.50		100.0%		
1.25"	31.50		100.0%		
1.00"	25.00		100.0%		
7/8"	22.40		100.0%		
3/4"	19.00		100.0%		
5/8"	16.00		100.0%		
1/2"	12.50		100.0%		
3/8"	9.50		100.0%		
1/4"	6.30		100.0%		

Fines Section		Actual Cumulative	Interpolated Cumulative		
Sieve Size US	Sieve Size Metric	Percent Passing	Percent Passing	Specs Max	Specs Min
#4	4.750	99.8%	99.8%		
#8	2.360	99.8%	99.8%		
#10	2.000		91.5%		
#16	1.180	72.6%	72.6%		
#20	0.850		59.4%		
#30	0.600	49.4%	49.4%		
#40	0.425		38.7%		
#50	0.300	31.1%	31.1%		
#60	0.250		27.0%		
#80	0.180		21.2%		
#100	0.150	18.7%	18.7%		
#140	0.106		14.2%		
#170	0.090		12.6%		
#200	0.075	11.1%	11.1%		
#270	0.053				

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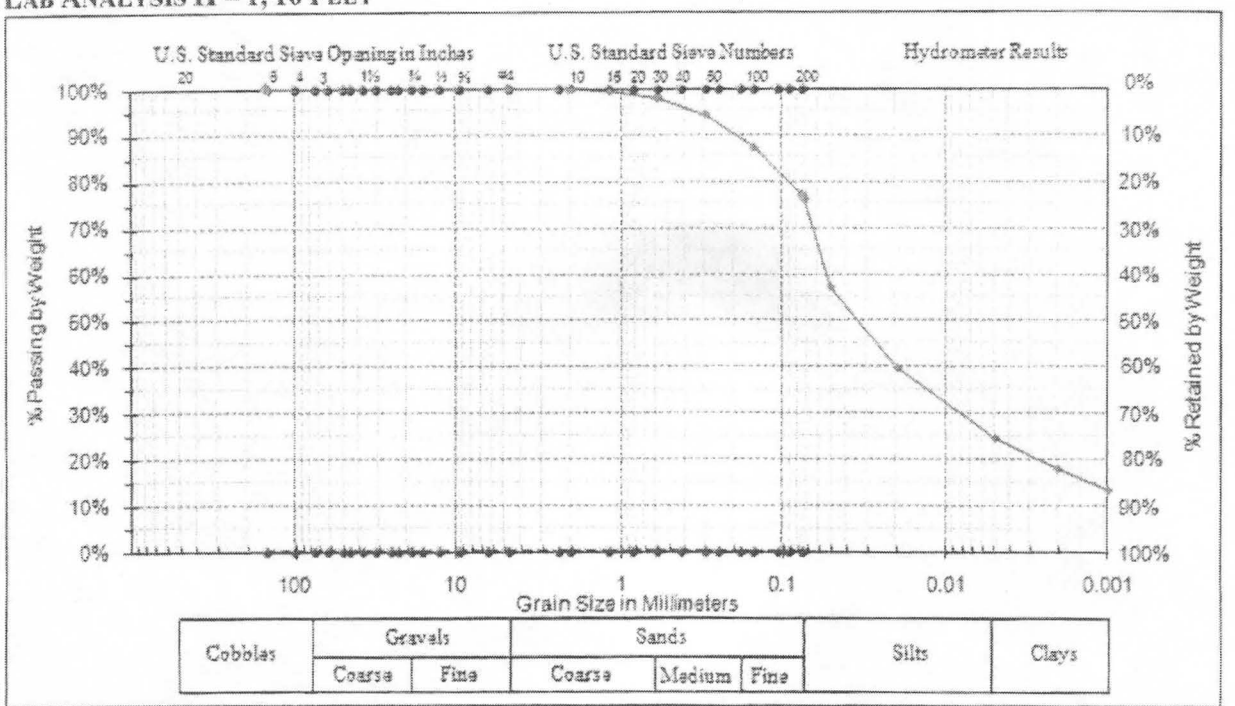
GEOTECHNICAL TESTING LABORATORY

LAB ANALYSIS H – 1, 10 FEET



Date : 01/16/08	D_{10} = 0.01	**Classification**		% Gravel
Sample #: 82	D_{30} = 0.03	ML, Silt with Sand		0.00%
Sample ID: Silt with Sand	D_{60} = 0.06	**Specifications**		% Sand
Source: H-1	C_C = 1.50	No Specs		23.15%
Project: Monohon Rd	C_U = 6.00	% Moisture 41.6%		% Silt & Clay
Client: Pacific County	Liquid Limit= 0.00	Dust Ratio=		76.85%
ASTM#: D-422	Plastic Limit= 0.00	Fineness Modulus		Sample Meets Specs
Depth: 10'	Plasticity Index= 0.00	0.22		Yes

Coarse Section Sieve Size US	Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
6.00"	150.00		100.0%		
4.00"	100.00		100.0%		
3.00"	75.00		100.0%		
2.50"	63.00		100.0%		
2.00"	50.00		100.0%		
1.75"	45.00		100.0%		
1.50"	37.50		100.0%		
1.25"	31.50		100.0%		
1.00"	25.00		100.0%		
7/8"	22.40		100.0%		
3/4"	19.00		100.0%		
5/8"	16.00		100.0%		
1/2"	12.50		100.0%		
3/8"	9.50		100.0%		
1/4"	6.30		100.0%		

Fines Section Sieve Size US	Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
#4	4.750	100.0%	100.0%		
#8	2.360		99.7%		
#10	2.000	99.7%	99.7%		
#16	1.180	99.3%	99.3%		
#20	0.850		98.5%		
#30	0.600	97.8%	97.8%		
#40	0.425		95.7%		
#50	0.300	94.1%	94.1%		
#60	0.250		91.8%		
#80	0.180		88.6%		
#100	0.150	87.2%	87.2%		
#140	0.106		81.1%		
#170	0.090		78.9%		
#200	0.075	76.9%	76.9%		
#270	0.053				

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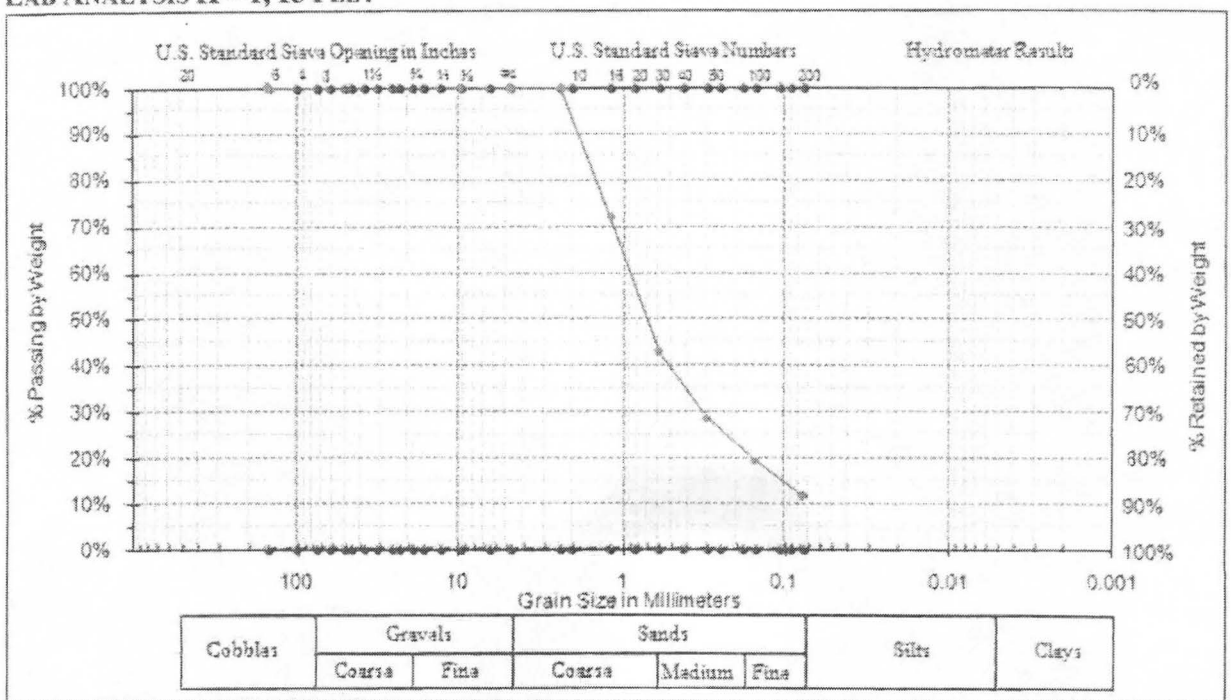
FIG. B-4
(SHEET 2 OF 12)

GEOTECHNICAL TESTING LABORATORY

LAB ANALYSIS H – 1, 15 FEET



Date : 01/16/08		D_{10} = 0.06	**Classification**		% Gravel
Sample #: 83		D_{30} = 0.33	SW-SC, Well-graded Sand with Silty Clay		0.10%
Sample ID: Sand with Silty Clay		D_{60} = 0.94	**Specifications**		% Sand
Source: H-1		C_C = 1.78	No Specs		88.32%
Project: Monohon Rd		C_U = 14.55	% Moisture 45.1%		% Silt & Clay
Client: Pacific County		Liquid Limit= 0.00	Dust Ratio=		11.58%
ASTM#: C-136		Plastic Limit= 0.00	Fineness Modulus		Sample Meets Specs
Depth: 15'		Plasticity Index= 0.00	2.38		Yes

Coarse Section Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
6.00"	150.00		100.0%		
4.00"	100.00		100.0%		
3.00"	75.00		100.0%		
2.50"	63.00		100.0%		
2.00"	50.00		100.0%		
1.75"	45.00		100.0%		
1.50"	37.50		100.0%		
1.25"	31.50		100.0%		
1.00"	25.00		100.0%		
7/8"	22.40		100.0%		
3/4"	19.00		100.0%		
5/8"	16.00		100.0%		
1/2"	12.50		100.0%		
3/8"	9.50	100.0%	100.0%		
1/4"	6.30		99.9%		

Fines Section Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
#4	4.750	99.9%	99.9%		
#8	2.360	99.8%	99.8%		
#10	2.000		91.2%		
#16	1.180	71.8%	71.8%		
#20	0.850		55.4%		
#30	0.600	43.0%	43.0%		
#40	0.425		34.6%		
#50	0.300	28.6%	28.6%		
#60	0.250		25.5%		
#80	0.180		21.1%		
#100	0.150	19.3%	19.3%		
#140	0.106		14.8%		
#170	0.090		13.1%		
#200	0.075	11.6%	11.6%		
#270	0.053				

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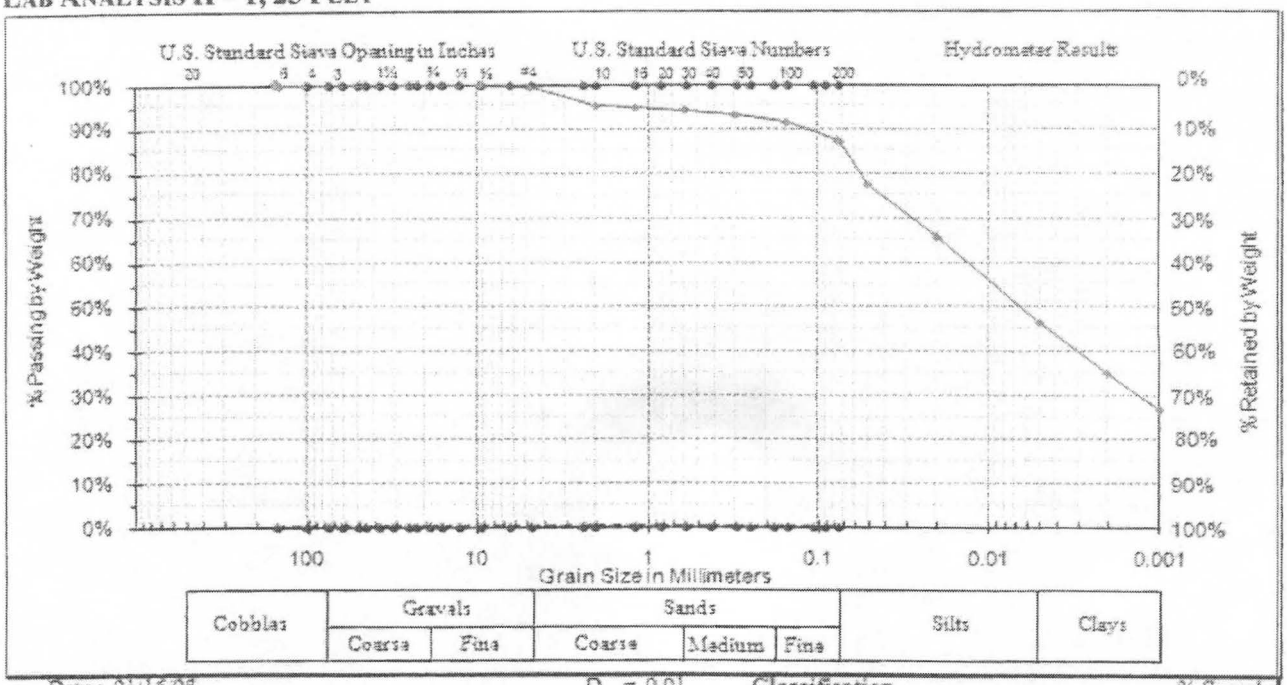
FIG. B-4
(SHEET 3 OF 12)

GEOTECHNICAL TESTING LABORATORY

LAB ANALYSIS H – 1, 25 FEET



Date : 01/16/08	D_{10} = 0.01	**Classification**		% Gravel
Sample #: 85	D_{30} = 0.03	ML, Silt		0.71%
Sample ID: Silt	D_{60} = 0.05	**Specifications**		% Sand
Source: H-1	C_C = 1.50	No Specs		12.21%
Project: Monohon Rd	C_U = 6.00	% Moisture 23.4%		% Silt & Clay
Client: Pacific County	Liquid Limit= 0.00	Dust Ratio=		87.08%
ASTM#: D-422	Plastic Limit= 0.00	Fineness Modulus		Sample Meets Specs
Depth: 25'	Plasticity Index= 0.00	0.32		Yes

Coarse Section Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
6.00"	150.00		100.0%		
4.00"	100.00		100.0%		
3.00"	75.00		100.0%		
2.50"	63.00		100.0%		
2.00"	50.00		100.0%		
1.75"	45.00		100.0%		
1.50"	37.50		100.0%		
1.25"	31.50		100.0%		
1.00"	25.00		100.0%		
7/8"	22.40		100.0%		
3/4"	19.00		100.0%		
5/8"	16.00		100.0%		
1/2"	12.50		100.0%		
3/8"	9.50	100.0%	100.0%		
1/4"	6.30		99.5%		

Fines Section Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
#4	4.750	99.3%	99.3%		
#8	2.360		95.6%		
#10	2.000	95.1%	95.1%		
#16	1.180	94.7%	94.7%		
#20	0.850		94.4%		
#30	0.600	94.1%	94.1%		
#40	0.425		93.4%		
#50	0.300	93.0%	93.0%		
#60	0.250		92.4%		
#80	0.180		91.7%		
#100	0.150	91.4%	91.4%		
#140	0.106		88.9%		
#170	0.090		87.9%		
#200	0.075	87.1%	87.1%		
#270	0.053				

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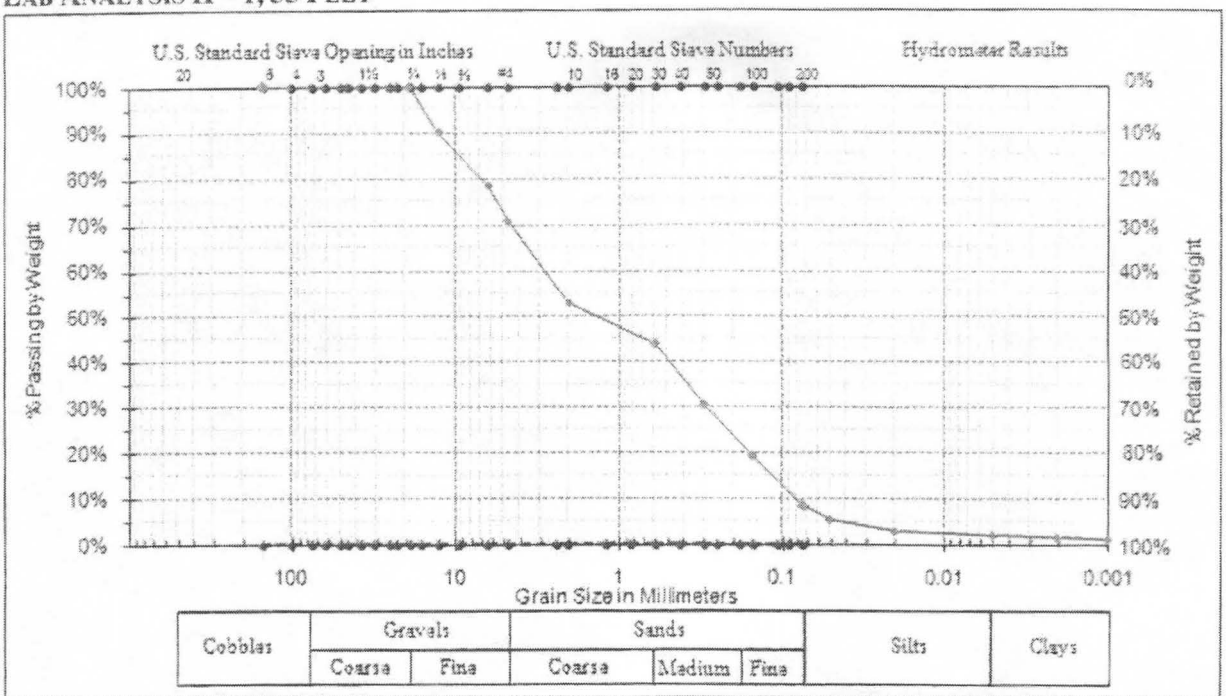
FIG. B-4
(SHEET 4 OF 12)

GEOTECHNICAL TESTING LABORATORY

LAB ANALYSIS H – 1, 55 FEET



Date : 01/16/08	D_{10} = 0.09	**Classification**		% Gravel
Sample #: 91	D_{30} = 0.30	SP-SM, Poorly graded Sand with Silt and Grave		29.20%
Sample ID: Sand with Silt and Gravel	D_{60} = 3.10	**Specifications**		% Sand
Source: H-1	C_C = 0.33	No Specs		62.33%
Project: Monohon Rd	C_U = 36.10	% Moisture 23.4%		% Silt & Clay
Client: Pacific County	Liquid Limit= 0.00	Dust Ratio=		8.47%
ASTM#: D-422	Plastic Limit= 0.00	Fineness Modulus		Sample Meets Specs
Depth: 55'	Plasticity Index= 0.00	3.49		Yes

Coarse Section Sieve Size US	Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
6.00"	150.00		100.0%		
4.00"	100.00		100.0%		
3.00"	75.00		100.0%		
2.50"	63.00		100.0%		
2.00"	50.00		100.0%		
1.75"	45.00		100.0%		
1.50"	37.50		100.0%		
1.25"	31.50		100.0%		
1.00"	25.00		100.0%		
7/8"	22.40		100.0%		
3/4"	19.00	100.0%	100.0%		
5/8"	16.00		95.3%		
1/2"	12.50	89.9%	89.9%		
3/8"	9.50		84.3%		
1/4"	6.30	78.3%	78.3%		

Fines Section Sieve Size US	Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
#4	4.750	70.8%	70.8%		
#8	2.360		55.2%		
#10	2.000	52.8%	52.8%		
#16	1.180		47.5%		
#20	0.850		45.4%		
#30	0.600	43.7%	43.7%		
#40	0.425		35.9%		
#50	0.300	30.4%	30.4%		
#60	0.250		26.6%		
#80	0.180		21.4%		
#100	0.150	19.1%	19.1%		
#140	0.106		12.9%		
#170	0.090		10.6%		
#200	0.075	8.5%	8.5%		
#270	0.053				

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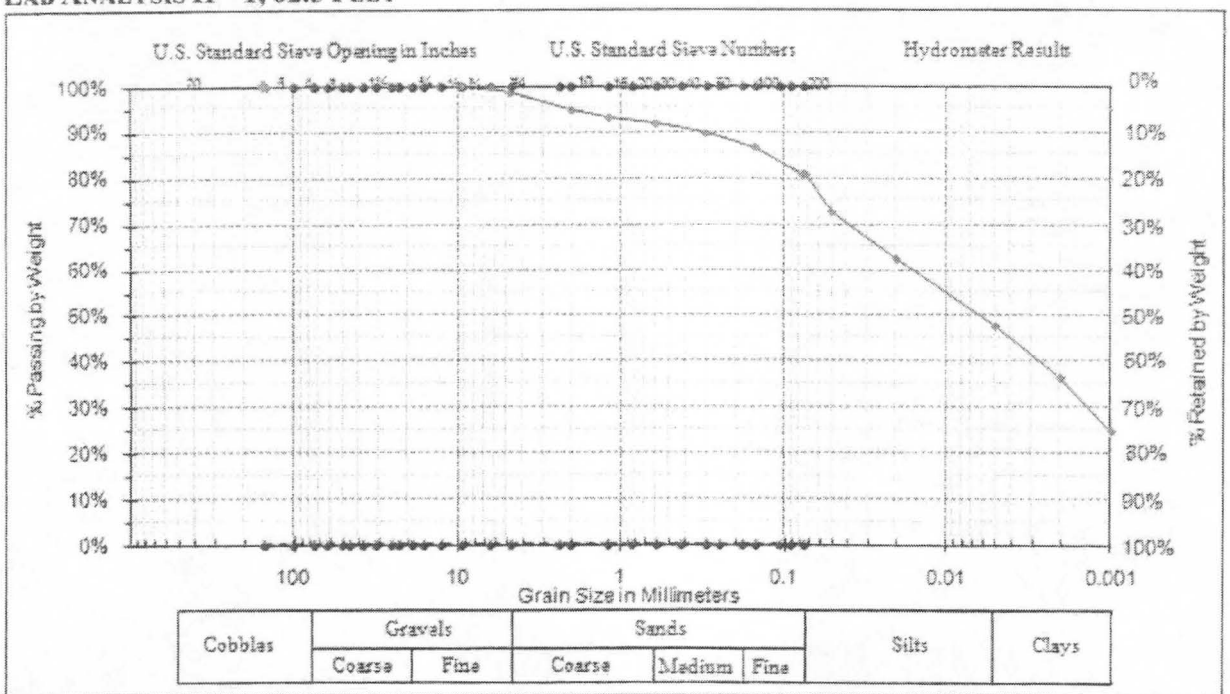
FIG. B-4
(SHEET 5 OF 12)

GEOTECHNICAL TESTING LABORATORY

LAB ANALYSIS H – 1, 62.5 FEET



Date : 01/16/08	D_{10} = 0.01	**Classification**		% Gravel
Sample #: 93	D_{30} = 0.03	ML, Silt with Sand		1.52%
Sample ID: Silt with Sand	D_{60} = 0.06	**Specifications**		% Sand
Source: H-1	C_C = 1.50	No Specs		17.77%
Project: Monohon Rd	C_U = 6.00	% Moisture 15.9%		% Silt & Clay
Client: Pacific County	Liquid Limit= 0.00	Dust Ratio=		80.70%
ASTM#: D-422	Plastic Limit= 0.00	Fineness Modulus		Sample Meets Specs
Depth: 62.5'	Plasticity Index= 0.00	0.45		**Yes**

Coarse Section		Actual Cumulative	Interpolated Cumulative		
Sieve US	Size Metric	Percent Passing	Percent Passing	Specs Max	Specs Min
6.00"	150.00		100.0%		
4.00"	100.00		100.0%		
3.00"	75.00		100.0%		
2.50"	63.00		100.0%		
2.00"	50.00		100.0%		
1.75"	45.00		100.0%		
1.50"	37.50		100.0%		
1.25"	31.50		100.0%		
1.00"	25.00		100.0%		
7/8"	22.40		100.0%		
3/4"	19.00		100.0%		
5/8"	16.00		100.0%		
1/2"	12.50		100.0%		
3/8"	9.50	100.0%	100.0%		
1/4"	6.30	99.5%	99.5%		

Fines Section		Actual Cumulative	Interpolated Cumulative		
Sieve US	Size Metric	Percent Passing	Percent Passing	Specs Max	Specs Min
#4	4.750	98.5%	98.5%		
#8	2.360		95.1%		
#10	2.000	94.6%	94.6%		
#16	1.180	93.0%	93.0%		
#20	0.850		92.2%		
#30	0.600	91.7%	91.7%		
#40	0.425		90.5%		
#50	0.300	89.7%	89.7%		
#60	0.250		88.7%		
#80	0.180		87.2%		
#100	0.150	86.6%	86.6%		
#140	0.106		83.1%		
#170	0.090		81.9%		
#200	0.075	80.7%	80.7%		
#270	0.053				

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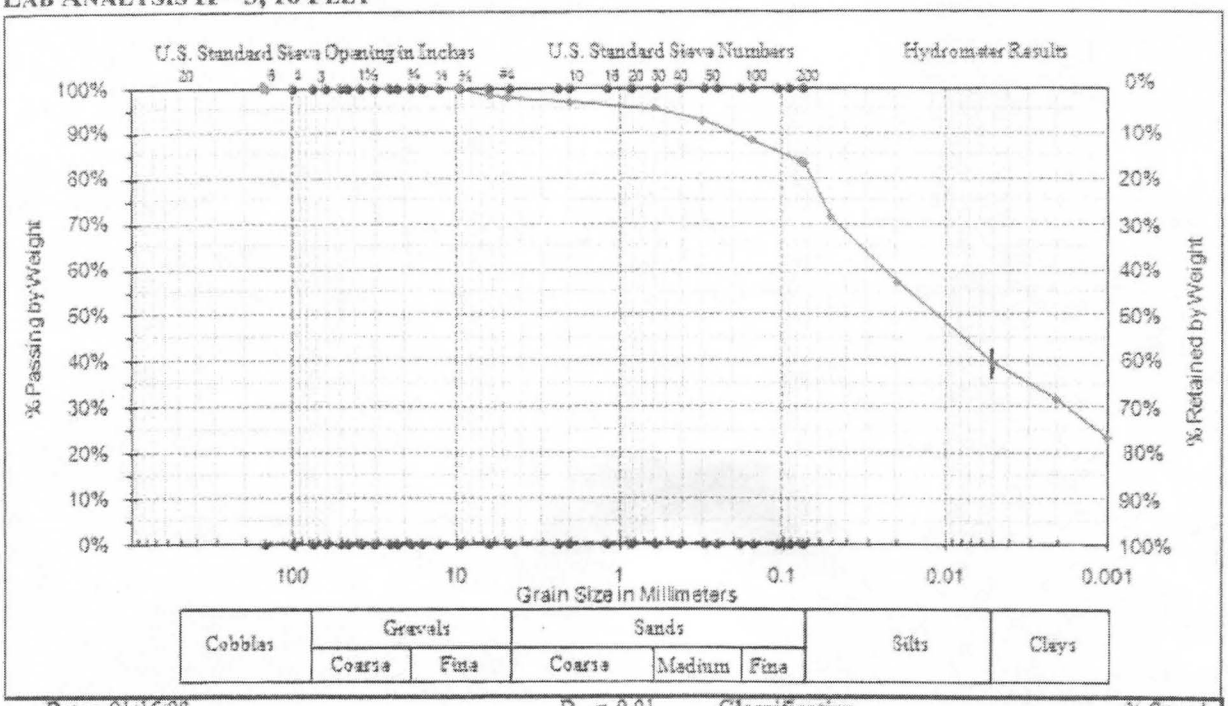
GEOTECHNICAL TESTING LABORATORY

LAB ANALYSIS H – 3, 10 FEET



Date : 01/16/08	D_{10} = 0.01	**Classification**		% Gravel
Sample #: 146	D_{30} = 0.03	ML, Silt with Sand		2.25%
Sample ID:	D_{60} = 0.05	**Specifications**		% Sand
Source: H-3	C_C = 1.50	No Specs		14.24%
Project: Monohon Rd	C_U = 6.00	% Moisture 45.7%		% Silt & Clay
Client: Pacific County	Liquid Limit= 0.00	Dust Ratio=		83.51%
ASTM#: D-422	Plastic Limit= 0.00	Fineness Modulus		Sample Meets Specs
Depth: 10'	Plasticity Index= 0.00	0.33		Yes

Coarse Section		Actual Cumulative	Interpolated Cumulative		
Sieve Size US	Sieve Size Metric	Percent Passing	Percent Passing	Specs Max	Specs Min
6.00"	150.00		100.0%		
4.00"	100.00		100.0%		
3.00"	75.00		100.0%		
2.50"	63.00		100.0%		
2.00"	50.00		100.0%		
1.75"	45.00		100.0%		
1.50"	37.50		100.0%		
1.25"	31.50		100.0%		
1.00"	25.00		100.0%		
7/8"	22.40		100.0%		
3/4"	19.00		100.0%		
5/8"	16.00		100.0%		
1/2"	12.50		100.0%		
3/8"	9.50	100.0%	100.0%		
1/4"	6.30	98.2%	98.2%		

Fines Section		Actual Cumulative	Interpolated Cumulative		
Sieve Size US	Sieve Size Metric	Percent Passing	Percent Passing	Specs Max	Specs Min
#4	4.750	97.8%	97.8%		
#8	2.360		96.8%		
#10	2.000	96.7%	96.7%		
#16	1.180		95.9%		
#20	0.850		95.6%		
#30	0.600	95.4%	95.4%		
#40	0.425		93.7%		
#50	0.300	92.6%	92.6%		
#60	0.250		91.1%		
#80	0.180		89.1%		
#100	0.150	88.2%	88.2%		
#140	0.106		85.5%		
#170	0.090		84.5%		
#200	0.075	83.5%	83.5%		
#270	0.053				

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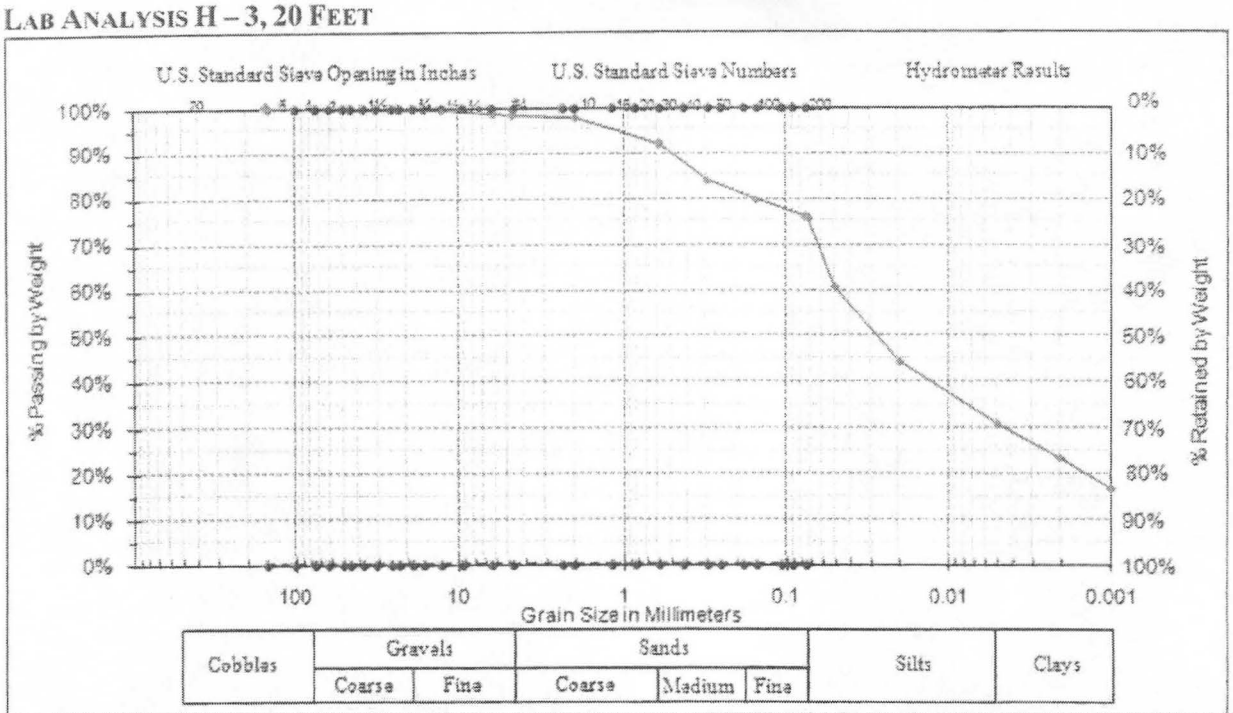
FIG. B-4
(SHEET 7 OF 12)

GEOTECHNICAL TESTING LABORATORY

LAB ANALYSIS H – 3, 20 FEET



Date : 01/16/08	D_{10} = 0.01	**Classification**		% Gravel
Sample #: 148	D_{30} = 0.03	ML, Silt with Sand		1.87%
Sample ID:	D_{60} = 0.06	**Specifications**		% Sand
Source: H-3	C_C = 1.50	No Specs		22.20%
Project: Monohon Rd	C_U = 6.00	% Moisture 42.8%		% Silt & Clay
Client: Pacific County	Liquid Limit= 0.00	Dust Ratio=		75.94%
ASTM#: D-422	Plastic Limit= 0.00	Fineness Modulus		Sample Meets Specs
Depth: 20'	Plasticity Index= 0.00	0.56		**Yes**

Coarse Section Sieve Size US	Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
6.00"	150.00		100.0%		
4.00"	100.00		100.0%		
3.00"	75.00		100.0%		
2.50"	63.00		100.0%		
2.00"	50.00		100.0%		
1.75"	45.00		100.0%		
1.50"	37.50		100.0%		
1.25"	31.50		100.0%		
1.00"	25.00		100.0%		
7/8"	22.40		100.0%		
3/4"	19.00		100.0%		
5/8"	16.00		100.0%		
1/2"	12.50	99.3%	99.3%		
3/8"	9.50		98.9%		
1/4"	6.30	98.5%	98.5%		

Fines Section Sieve Size US	Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
#4	4.750	98.1%	98.1%		
#8	2.360		97.8%		
#10	2.000	97.5%	97.5%		
#16	1.180		94.3%		
#20	0.850		92.9%		
#30	0.600	91.9%	91.9%		
#40	0.425		87.1%		
#50	0.300	83.7%	83.7%		
#60	0.250		82.3%		
#80	0.180		80.4%		
#100	0.150	79.6%	79.6%		
#140	0.106		77.5%		
#170	0.090		76.7%		
#200	0.075	75.9%	75.9%		
#270	0.053				

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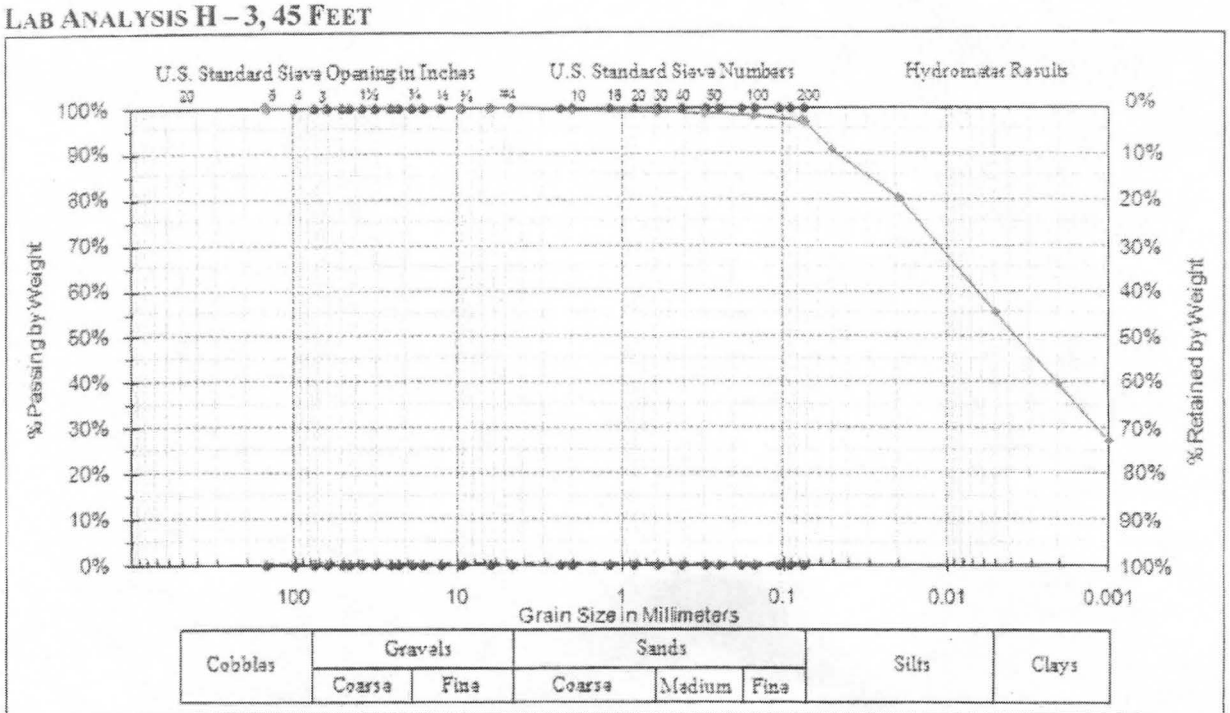
FIG. B-5
(SHEET 1 OF 12)

FIG. B-4
(SHEET 8 OF 12)

GEOTECHNICAL TESTING LABORATORY

LAB ANALYSIS H – 3, 45 FEET



Date : 01/16/08	D_{10} = 0.01	**Classification**		% Gravel
Sample #: 153	D_{30} = 0.02	ML, Silt		0.37%
Sample ID:	D_{60} = 0.05	**Specifications**		% Sand
Source: H-3	C_C = 1.50	No Specs		2.73%
Project: Monohon Rd	C_U = 6.00	% Moisture 42.2%		% Silt & Clay
Client: Pacific County	Liquid Limit= 0.00	Dust Ratio=		96.90%
ASTM#: D-422	Plastic Limit= 0.00	Fineness Modulus		Sample Meets Specs
Depth: 45'	Plasticity Index= 0.00	0.07		Yes

Coarse Section		Actual Cumulative	Interpolated Cumulative		
Sieve Size US	Sieve Size Metric	Percent Passing	Percent Passing	Specs Max	Specs Min
6.00"	150.00		100.0%		
4.00"	100.00		100.0%		
3.00"	75.00		100.0%		
2.50"	63.00		100.0%		
2.00"	50.00		100.0%		
1.75"	45.00		100.0%		
1.50"	37.50		100.0%		
1.25"	31.50		100.0%		
1.00"	25.00		100.0%		
7/8"	22.40		100.0%		
3/4"	19.00		100.0%		
5/8"	16.00		100.0%		
1/2"	12.50		100.0%		
3/8"	9.50	100.0%	100.0%		
1/4"	6.30	99.7%	99.7%		

Fines Section		Actual Cumulative	Interpolated Cumulative		
Sieve Size US	Sieve Size Metric	Percent Passing	Percent Passing	Specs Max	Specs Min
#4	4.750	99.6%	99.6%		
#8	2.360		99.4%		
#10	2.000	99.3%	99.3%		
#16	1.180		99.0%		
#20	0.850		98.9%		
#30	0.600	98.8%	98.8%		
#40	0.425		98.7%		
#50	0.300	98.6%	98.6%		
#60	0.250		98.4%		
#80	0.180		98.1%		
#100	0.150	98.0%	98.0%		
#140	0.106		97.4%		
#170	0.090		97.1%		
#200	0.075	96.9%	96.9%		
#270	0.053				

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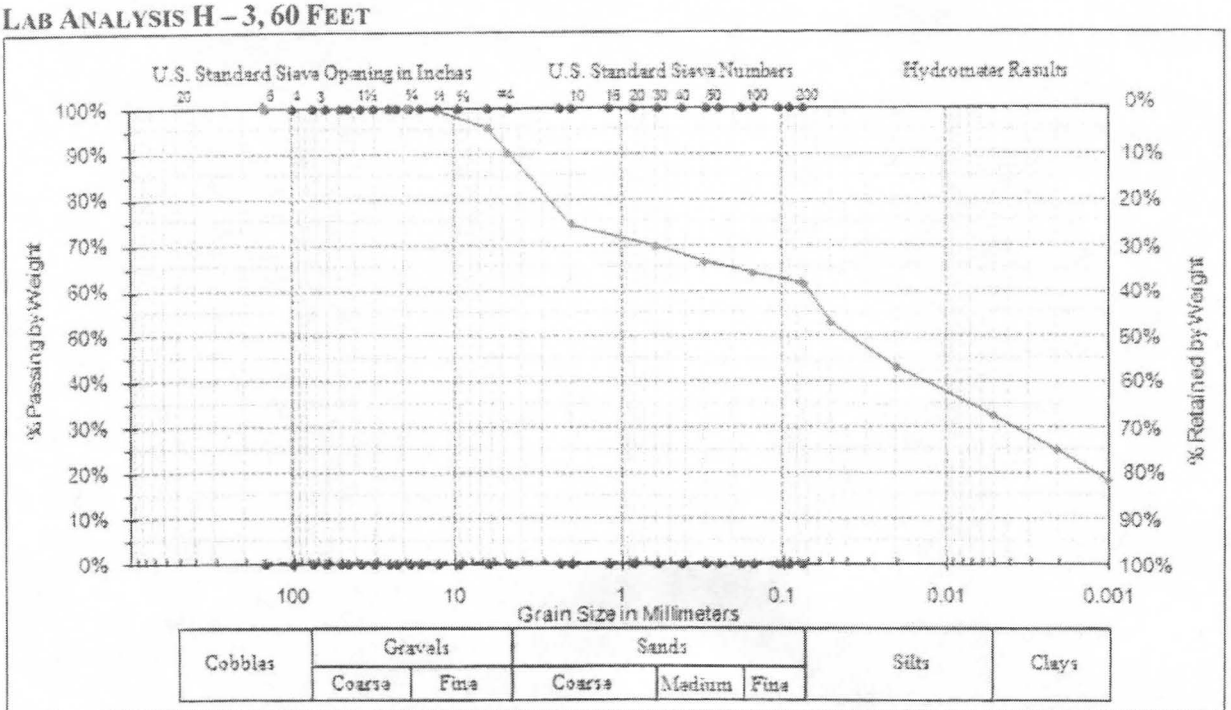
FIG. B-4
(SHEET 9 OF 12)

GEOTECHNICAL TESTING LABORATORY

LAB ANALYSIS H – 3, 60 FEET



Data : 01/16/08	D_{10} = 0.01	**Classification**		% Gravel
Sample #: 156	D_{30} = 0.04	ML, Sandy Silt		9.94%
Sample ID:	D_{60} = 0.07	**Specifications**		% Sand
Source: H-3	C_C = 1.50	No Specs		28.39%
Project: Monohon Rd	C_U = 6.00	% Moisture 53.4%		% Silt & Clay
Client: Pacific County	Liquid Limit= 0.00	Dust Ratio=		61.67%
ASTM#: D-422	Plastic Limit= 0.00	Fineness Modulus		Sample Meets Specs
Depth: 60'	Plasticity Index= 0.00	1.65		Yes

Coarse Section Sieve US	Coarse Section Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min	Fines Section Sieve US	Fines Section Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
6.00"	150.00		100.0%			#4	4.750	90.1%	90.1%		
4.00"	100.00		100.0%			#8	2.360		76.4%		
3.00"	75.00		100.0%			#10	2.000	74.3%	74.3%		
2.50"	63.00		100.0%			#16	1.180		71.5%		
2.00"	50.00		100.0%			#20	0.850		70.4%		
1.75"	45.00		100.0%			#30	0.600	69.6%	69.6%		
1.50"	37.50		100.0%			#40	0.425		67.6%		
1.25"	31.50		100.0%			#50	0.300	66.2%	66.2%		
1.00"	25.00		100.0%			#60	0.250		65.4%		
7/8"	22.40		100.0%			#80	0.180		64.2%		
3/4"	19.00	100.0%	100.0%			#100	0.150	63.7%	63.7%		
5/8"	16.00		99.7%			#140	0.106		62.5%		
1/2"	12.50	99.3%	99.3%			#170	0.090		62.1%		
3/8"	9.50		97.4%			#200	0.075	61.7%	61.7%		
1/4"	6.30	95.5%	95.5%			#270	0.053				

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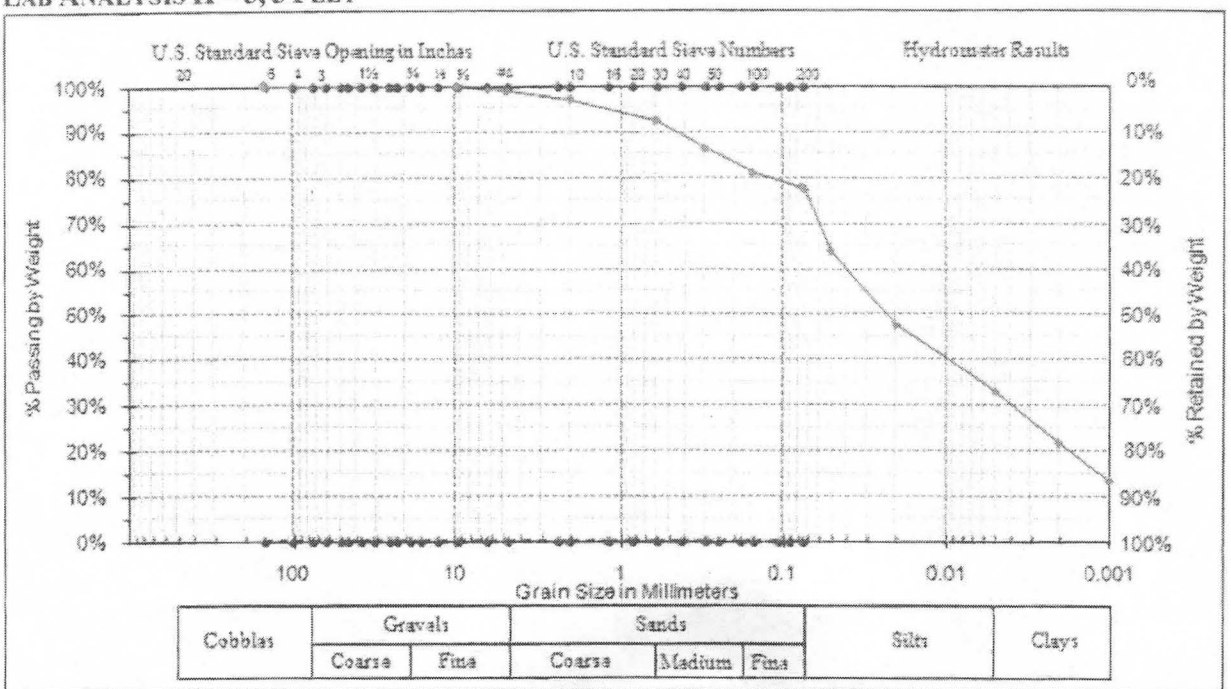
FIG. B-4
(SHEET 10 OF 12)

GEOTECHNICAL TESTING LABORATORY

LAB ANALYSIS H – 5, 5 FEET



Date : 01/16/08	D_{10} = 0.01	**Classification**		% Gravel
Sample #: 181	D_{30} = 0.03	ML, Silt with Sand		1.08%
Sample ID:	D_{60} = 0.06	**Specifications**		% Sand
Source: H-5	C_C = 1.50	No Specs		21.16%
Project: Monohon Rd	C_U = 6.00	% Moisture #DIV/0!		% Silt & Clay
Client: Pacific County	Liquid Limit= 0.00	Dust Ratio=		77.76%
ASTM#:	Plastic Limit= 0.00	Fineness Modulus		Sample Meets Specs
Depth: 5'	Plasticity Index= 0.00	0.50		Yes

Coarse Section Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
6.00"	150.00		100.0%		
4.00"	100.00		100.0%		
3.00"	75.00		100.0%		
2.50"	63.00		100.0%		
2.00"	50.00		100.0%		
1.75"	45.00		100.0%		
1.50"	37.50		100.0%		
1.25"	31.50		100.0%		
1.00"	25.00		100.0%		
7/8"	22.40		100.0%		
3/4"	19.00		100.0%		
5/8"	16.00		100.0%		
1/2"	12.50		100.0%		
3/8"	9.50	100.0%	100.0%		
1/4"	6.30	99.2%	99.2%		

Fines Section Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
#4	4.750	98.9%	98.9%		
#8	2.360		97.1%		
#10	2.000	96.9%	96.9%		
#16	1.180		94.2%		
#20	0.850		93.2%		
#30	0.600	92.3%	92.3%		
#40	0.425		88.8%		
#50	0.300	86.3%	86.3%		
#60	0.250		84.5%		
#80	0.180		81.9%		
#100	0.150	80.8%	80.8%		
#140	0.106		79.0%		
#170	0.090		78.4%		
#200	0.075	77.8%	77.8%		
#270	0.053				

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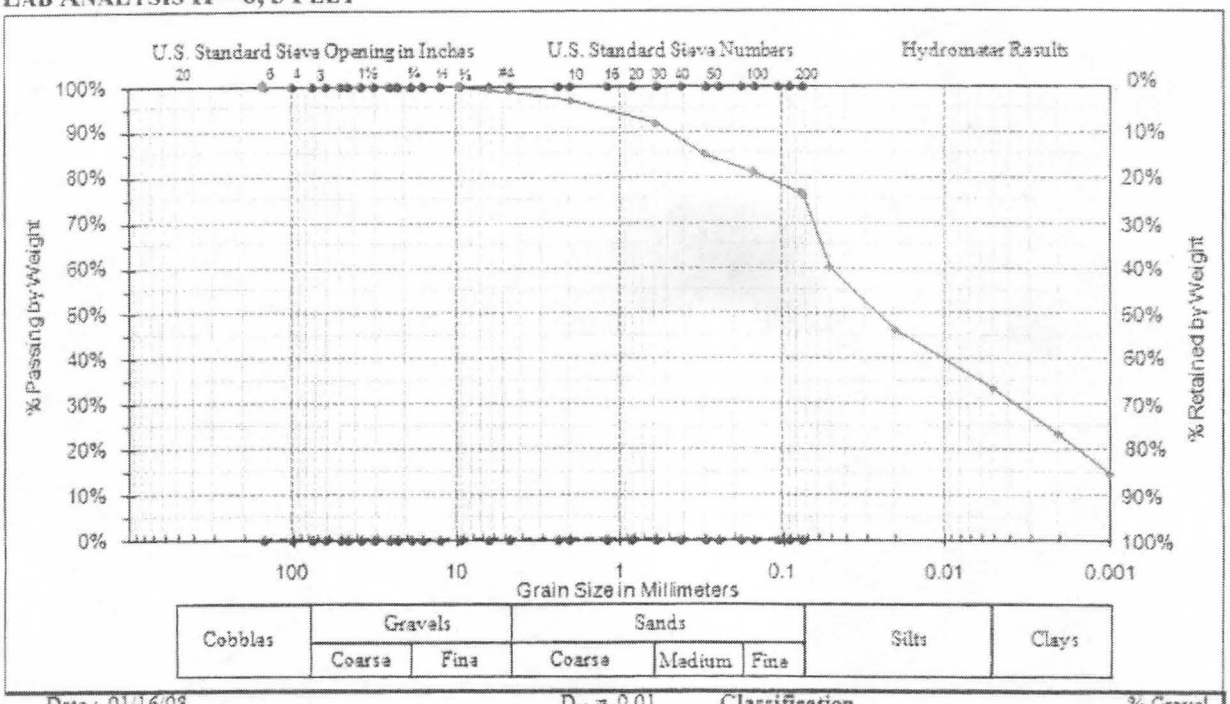
FIG. B-4
(SHEET 11 OF 12)

GEOTECHNICAL TESTING LABORATORY

LAB ANALYSIS H – 6, 5 FEET



Date : 01/16/08	D_{10} = 0.01	**Classification**		% Gravel
Sample #: 198	D_{30} = 0.03	ML, Silt with Sand		1.26%
Sample ID:	D_{60} = 0.06	**Specifications**		% Sand
Source: H-6	C_C = 1.50	No Specs		22.21%
Project: Monohon Rd	C_U = 6.00	% Moisture 16.8%		% Silt & Clay
Client: Pacific County	Liquid Limit= 0.00	Dust Ratio=		76.53%
ASTM#:	Plastic Limit= 0.00	Fineness Modulus		Sample Meets Specs
Depth: 5'	Plasticity Index= 0.00	0.53		Yes

Coarse Section Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
6.00"	150.00		100.0%		
4.00"	100.00		100.0%		
3.00"	75.00		100.0%		
2.50"	63.00		100.0%		
2.00"	50.00		100.0%		
1.75"	45.00		100.0%		
1.50"	37.50		100.0%		
1.25"	31.50		100.0%		
1.00"	25.00		100.0%		
7/8"	22.40		100.0%		
3/4"	19.00		100.0%		
5/8"	16.00		100.0%		
1/2"	12.50		100.0%		
3/8"	9.50	100.0%	100.0%		
1/4"	6.30	99.2%	99.2%		

Fines Section Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
#4	4.750	98.7%	98.7%		
#8	2.360		97.1%		
#10	2.000	96.8%	96.8%		
#16	1.180		93.8%		
#20	0.850		92.6%		
#30	0.600	91.7%	91.7%		
#40	0.425		87.7%		
#50	0.300	84.9%	84.9%		
#60	0.250		83.6%		
#80	0.180		81.8%		
#100	0.150	81.1%	81.1%		
#140	0.106		78.4%		
#170	0.090		77.4%		
#200	0.075	76.5%	76.5%		
#270	0.053				

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FIG. B-4
(SHEET 12 OF 12)

GEOTECHNICAL TESTING LABORATORY

LAB ANALYSIS H – 1, 20 FEET

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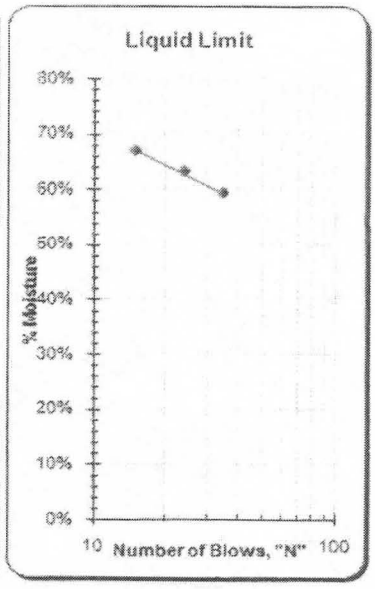
Date Received: 1/16/2008 **Project:** Monohon Rd
Sample #: 34 **Client:** Pacific County
Sample ID: **ASTM#:**
Source: H-1 **Depth:** 20'

ASTM D-2487, Unified Soils Classification System

No Data Provided

Liquid Limit Determination

	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	38.08	42.26	45.49			
Weight of Dry Soils + Pan:	31.92	34.28	35.90			
Weight of Pan:	21.52	21.68	21.56			
Weight of Dry Soils:	10.40	12.60	14.34			
Weight of Moisture:	6.16	7.98	9.59			
% Moisture:	59.2 %	63.3 %	66.9 %			
N:	35	24	15			



Liquid Limit @ 25 Blows: 63.0 %
Plastic Limit: 24.0 %
Plasticity Index, I_P: 39.0 %

Plastic Limit Determination

	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	24.97	24.79	24.81			
Weight of Dry Soils + Pan:	24.40	24.15	24.11			
Weight of Pan:	21.99	21.46	21.26			
Weight of Dry Soils:	2.41	2.69	2.85			
Weight of Moisture:	0.57	0.64	0.70			
% Moisture:	23.7 %	23.8 %	24.6 %			

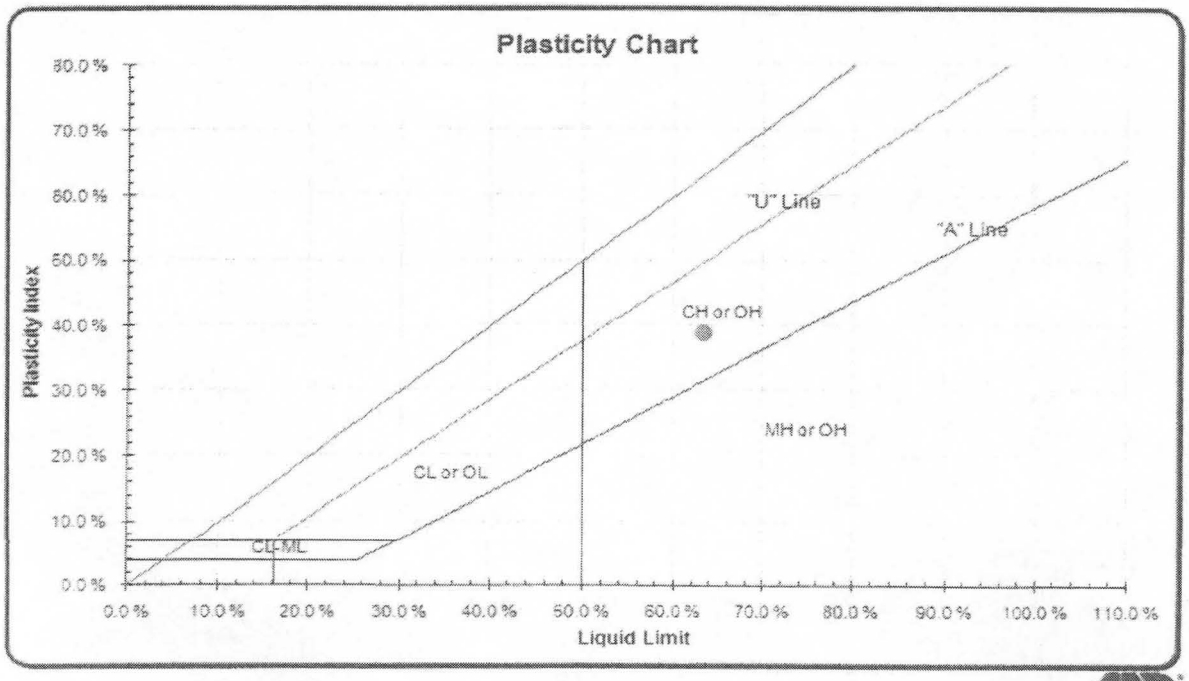


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FIG. B-5
(SHEET 1 OF 11)

GEOTECHNICAL TESTING LABORATORY

LAB ANALYSIS H – 1, 30 FEET

Copyright Spears Engineering & Technical Services PS, 1996-2004

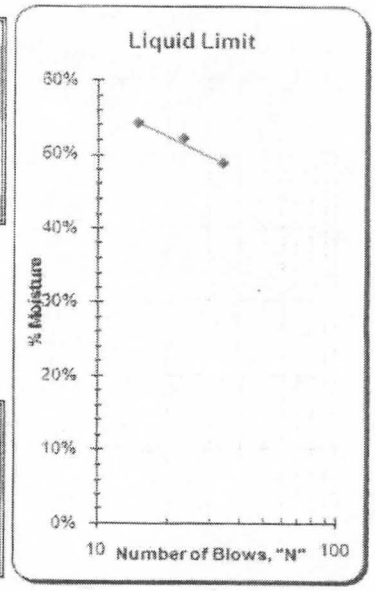
Date Received: 1/16/2008 **Project:** Monohon Rd
Sample #: 86 **Client:** Pacific County
Sample ID: **ASTM#:**
Source: H-1 **Depth:** 30'

ASTM D-2487, Unified Soils Classification System

No Data Provided

Liquid Limit Determination

	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	43.82	49.26	41.98			
Weight of Dry Soils + Pan:	36.44	39.84	34.95			
Weight of Pan:	21.30	21.76	21.99			
Weight of Dry Soils:	15.14	18.08	12.96			
Weight of Moisture:	7.38	9.42	7.03			
% Moisture:	48.8 %	52.1 %	54.2 %			
N:	34	23	15			



Liquid Limit @ 25 Blows: 51.4 %
Plastic Limit: 21.0 %
Plasticity Index, I_P: 30.4 %

Plastic Limit Determination

	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	23.61	23.19	23.48			
Weight of Dry Soils + Pan:	23.31	22.93	23.11			
Weight of Pan:	21.95	21.61	21.36			
Weight of Dry Soils:	1.36	1.32	1.75			
Weight of Moisture:	0.30	0.26	0.37			
% Moisture:	22.1 %	19.7 %	21.1 %			

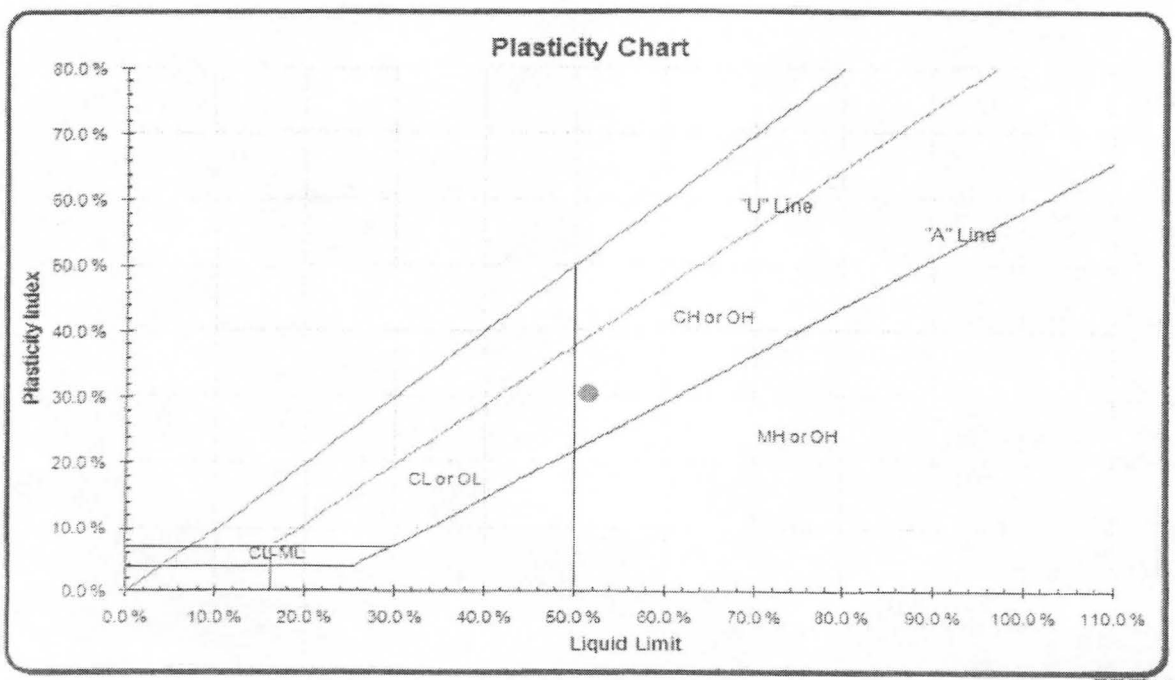


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FIG. B-5
(SHEET 2 OF 11)

GEOTECHNICAL TESTING LABORATORY

LAB ANALYSIS H – 1, 40 FEET

Copyright Spears Engineering & Technical Services PS, 1996-2004

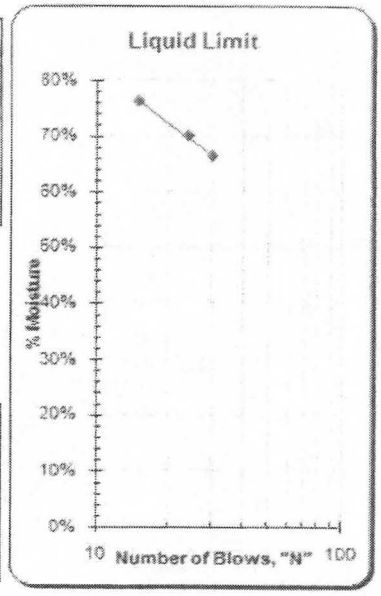
Date Received: 1/16/2008 **Project:** Monohon Rd
Sample #: 88 **Client:** Pacific County
Sample ID: **ASTM#:**
Source: H-1 **Depth:** 40'

ASTM D-2487, Unified Soils Classification System

No Data Provided

Liquid Limit Determination

	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	45.47	44.18	50.16			
Weight of Dry Soils + Pan:	35.94	35.01	37.90			
Weight of Pan:	21.58	21.91	21.80			
Weight of Dry Soils:	14.36	13.10	16.10			
Weight of Moisture:	9.53	9.17	12.26			
% Moisture:	66.4 %	70.0 %	76.2 %			
N:	30	24	15			



Liquid Limit @ 25 Blows: 69.5 %
Plastic Limit: 19.6 %
Plasticity Index, I_p: 50.0 %

Plastic Limit Determination

	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	26.84	28.15	27.96			
Weight of Dry Soils + Pan:	26.10	27.02	27.03			
Weight of Pan:	21.90	21.69	22.35			
Weight of Dry Soils:	4.20	5.33	4.68			
Weight of Moisture:	0.74	1.13	0.93			
% Moisture:	17.6 %	21.2 %	19.9 %			

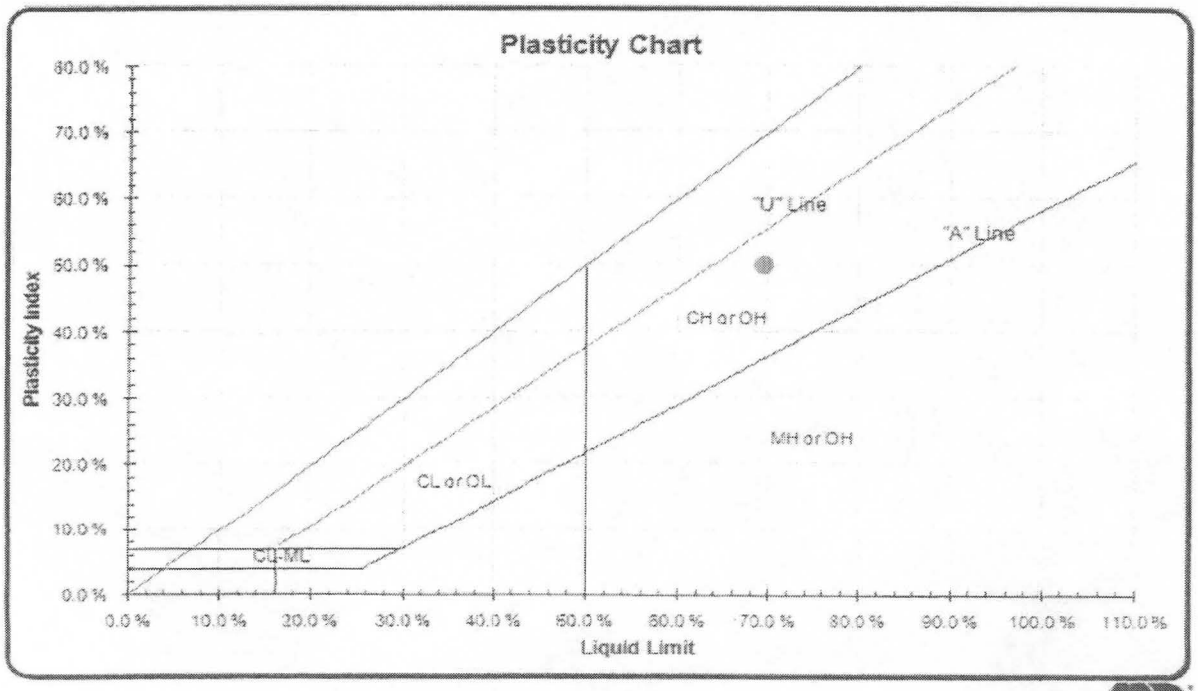


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FIG. B-5
(SHEET 3 OF 11)

GEOTECHNICAL TESTING LABORATORY

LAB ANALYSIS H – 2, 50FEET

Copyright Spears Engineering & Technical Services PS, 1996-2004

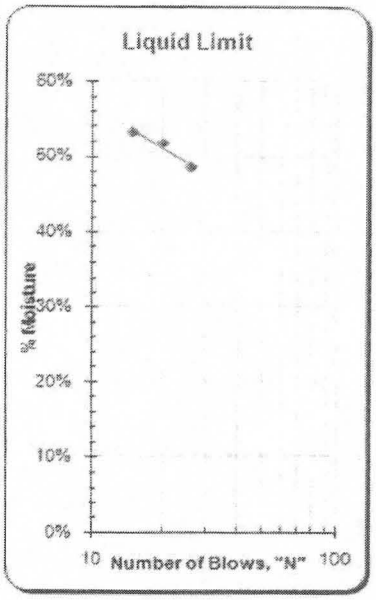
Date Received: 1/16/2008 **Project:** Monohon Rd
Sample #: 137 **Client:** Pacific County
Sample ID: **ASTM#:**
Source: H-2 **Depth:** 50'

ASTM D-2487, Unified Soils Classification System

No Data Provided

Liquid Limit Determination

	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	41.35	41.44	44.37			
Weight of Dry Soils + Pan:	34.89	34.66	36.52			
Weight of Pan:	21.57	21.56	21.75			
Weight of Dry Soils:	13.32	13.10	14.77			
Weight of Moisture:	6.46	6.78	7.85			
% Moisture:	48.5 %	51.8 %	53.2 %			
N:	26	20	15			



Liquid Limit @ 25 Blows: 49.1 %
Plastic Limit: 19.0 %
Plasticity Index, I_P: 30.2 %

Plastic Limit Determination

	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	26.35	25.46	24.92			
Weight of Dry Soils + Pan:	25.58	24.90	24.35			
Weight of Pan:	21.56	21.89	21.45			
Weight of Dry Soils:	4.02	3.01	2.90			
Weight of Moisture:	0.75	0.56	0.57			
% Moisture:	18.7 %	18.6 %	19.7 %			

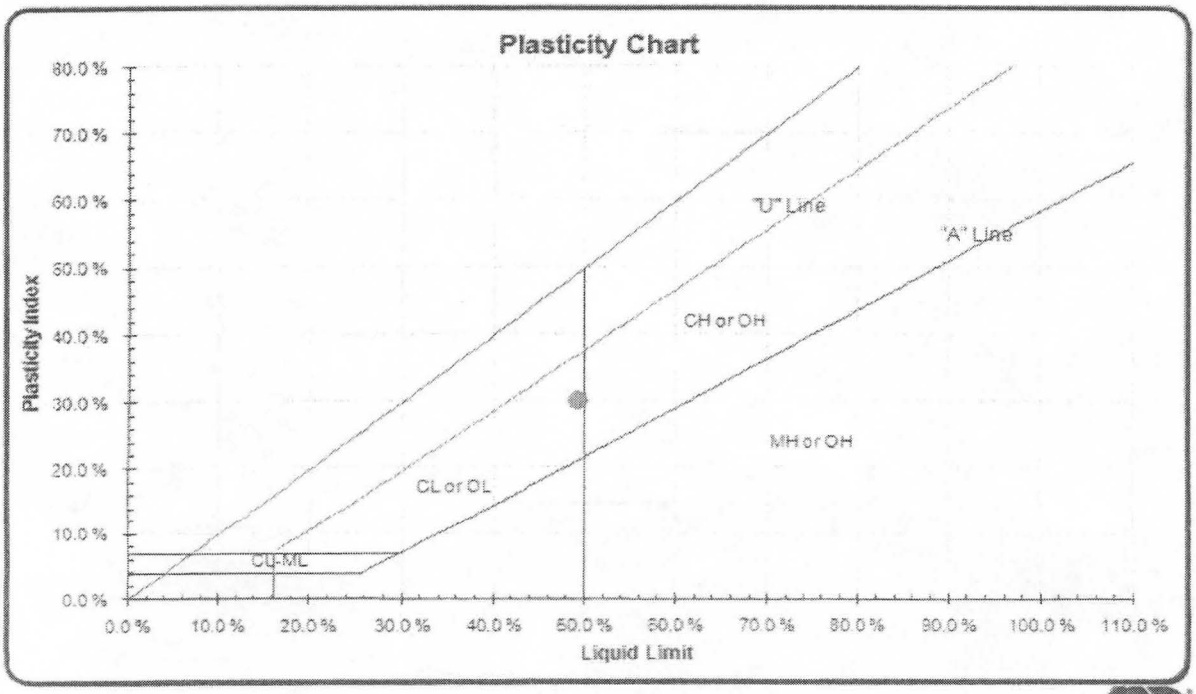


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FIG. B-5
(SHEET 4 OF 11)

GEOTECHNICAL TESTING LABORATORY

LAB ANALYSIS H – 2, 60 FEET

Copyright Spears Engineering & Technical Services PS, 1986-2004

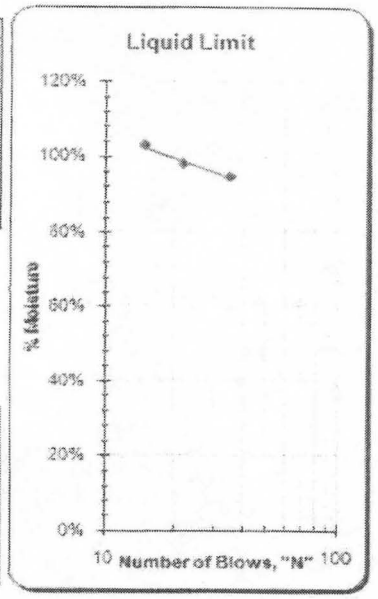
Date Received: 1/16/2008 **Project:** Monohon Rd
Sample #: 139 **Client:** Pacific County
Sample ID: **ASTM#:**
Source: H-2 **Depth:** 60'

ASTM D-2487, Unified Soils Classification System

No Data Provided

Liquid Limit Determination

	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	41.82	47.54	49.22			
Weight of Dry Soils + Pan:	31.88	34.60	35.13			
Weight of Pan:	21.38	21.41	21.44			
Weight of Dry Soils:	10.50	13.19	13.69			
Weight of Moisture:	9.94	12.94	14.09			
% Moisture:	94.7 %	98.1 %	102.9 %			
N:	35	22	15			



Liquid Limit @ 25 Blows: 98.2 %
Plastic Limit: 24.3 %
Plasticity Index, I_p: 73.8 %

Plastic Limit Determination

	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	23.34	23.98	24.61			
Weight of Dry Soils + Pan:	22.96	23.59	24.01			
Weight of Pan:	21.42	21.98	21.52			
Weight of Dry Soils:	1.54	1.61	2.49			
Weight of Moisture:	0.38	0.39	0.60			
% Moisture:	24.7 %	24.2 %	24.1 %			

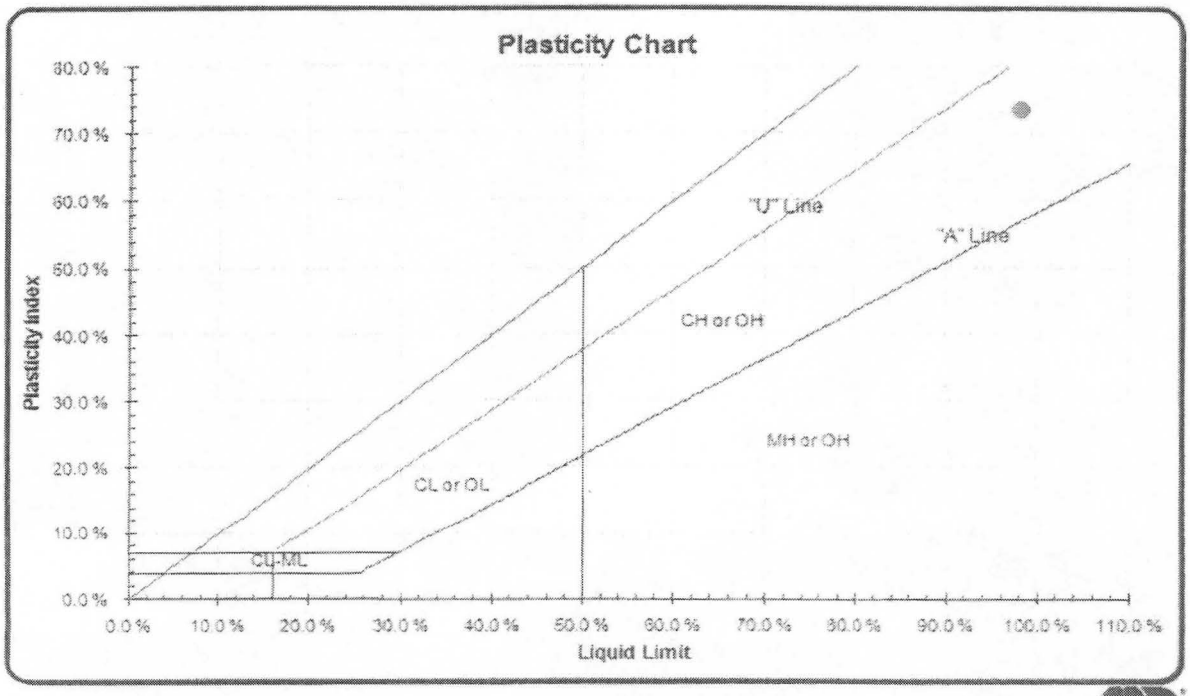


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FIG. B-5
(SHEET 5 OF 11)

GEOTECHNICAL TESTING LABORATORY

LAB ANALYSIS H – 3, 35 FEET

Copyright Spears Engineering & Technical Services PS, 1996-2004

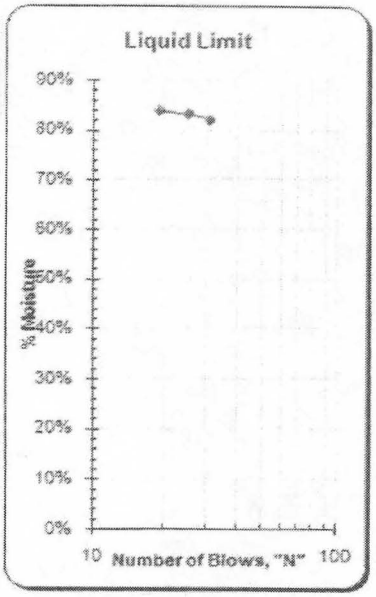
Date Received: 1/16/2008 **Project:** Monohon Rd
Sample #: 151 **Client:** Pacific County
Sample ID: **ASTM#:**
Source: H-3 **Depth:** 35'

ASTM D-2487, Unified Soils Classification System

No Data Provided

Liquid Limit Determination

	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	40.89	41.34	45.36			
Weight of Dry Soils + Pan:	32.29	32.45	34.70			
Weight of Pan:	21.81	21.75	21.98			
Weight of Dry Soils:	10.48	10.70	12.72			
Weight of Moisture:	8.60	8.89	10.66			
% Moisture:	82.1 %	83.1 %	83.8 %			
N:	31	25	19			



Liquid Limit @ 25 Blows: 83.0 %
Plastic Limit: 20.6 %
Plasticity Index, I_P: 62.4 %

Plastic Limit Determination

	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	23.09	23.54	23.71			
Weight of Dry Soils + Pan:	22.81	23.25	23.36			
Weight of Pan:	21.44	21.86	21.65			
Weight of Dry Soils:	1.37	1.39	1.71			
Weight of Moisture:	0.28	0.29	0.35			
% Moisture:	20.4 %	20.9 %	20.5 %			

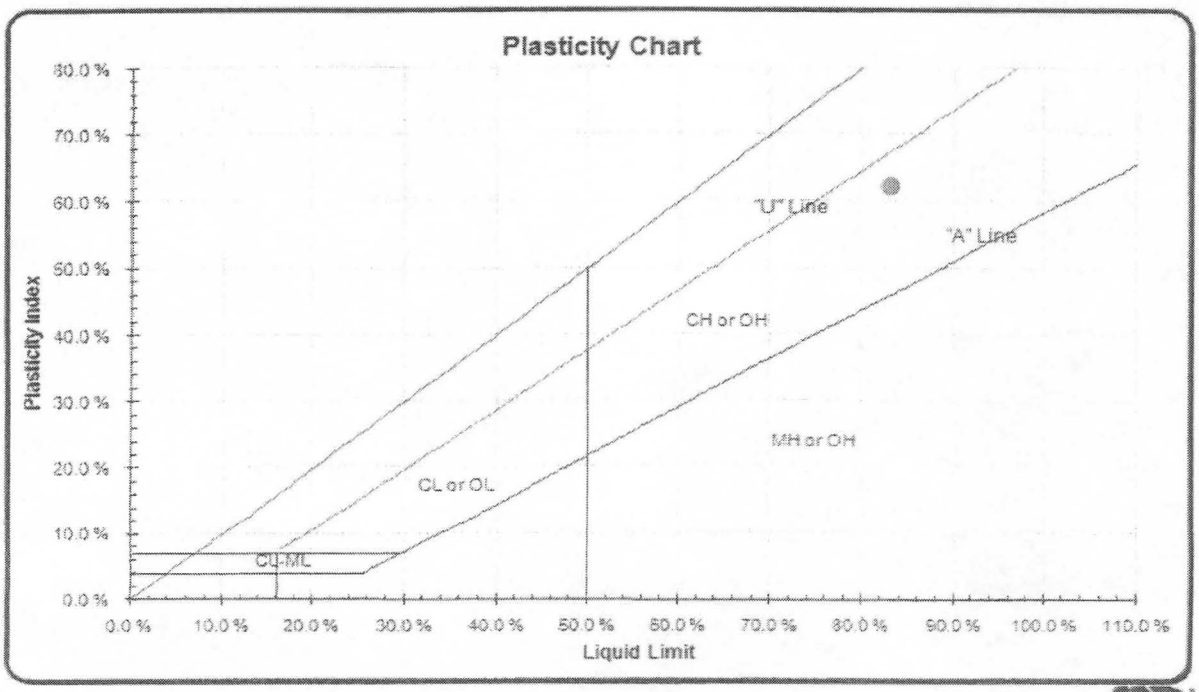


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FIG. B-5
(SHEET 6 OF 11)

GEOTECHNICAL TESTING LABORATORY

LAB ANALYSIS H – 3, 50 FEET

Copyright Spears Engineering & Technical Services PS, 1996-2004

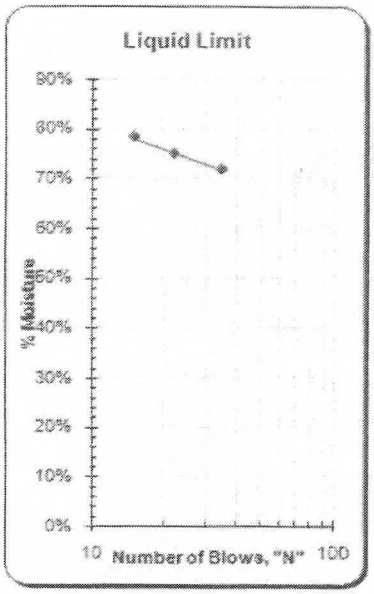
Date Received: 1/16/2008 **Project:** Monohon Rd
Sample #: 154 **Client:** Pacific County
Sample ID: **ASTM#:**
Source: H-3 **Depth:** 50'

ASTM D-2487, Unified Soils Classification System

No Data Provided

Liquid Limit Determination

	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	50.50	45.22	50.97			
Weight of Dry Soils + Pan:	38.46	35.23	38.00			
Weight of Pan:	21.68	21.89	21.46			
Weight of Dry Soils:	16.78	13.34	16.54			
Weight of Moisture:	12.04	9.99	12.97			
% Moisture:	71.8 %	74.9 %	78.4 %			
N:	35	22	15			



Liquid Limit @ 25 Blows: 74.7 %
Plastic Limit: 22.5 %
Plasticity Index, I_p: 52.2 %

Plastic Limit Determination

	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	23.77	24.01	24.22			
Weight of Dry Soils + Pan:	23.34	23.58	23.71			
Weight of Pan:	21.40	21.68	21.45			
Weight of Dry Soils:	1.94	1.90	2.26			
Weight of Moisture:	0.43	0.43	0.51			
% Moisture:	22.2 %	22.6 %	22.6 %			

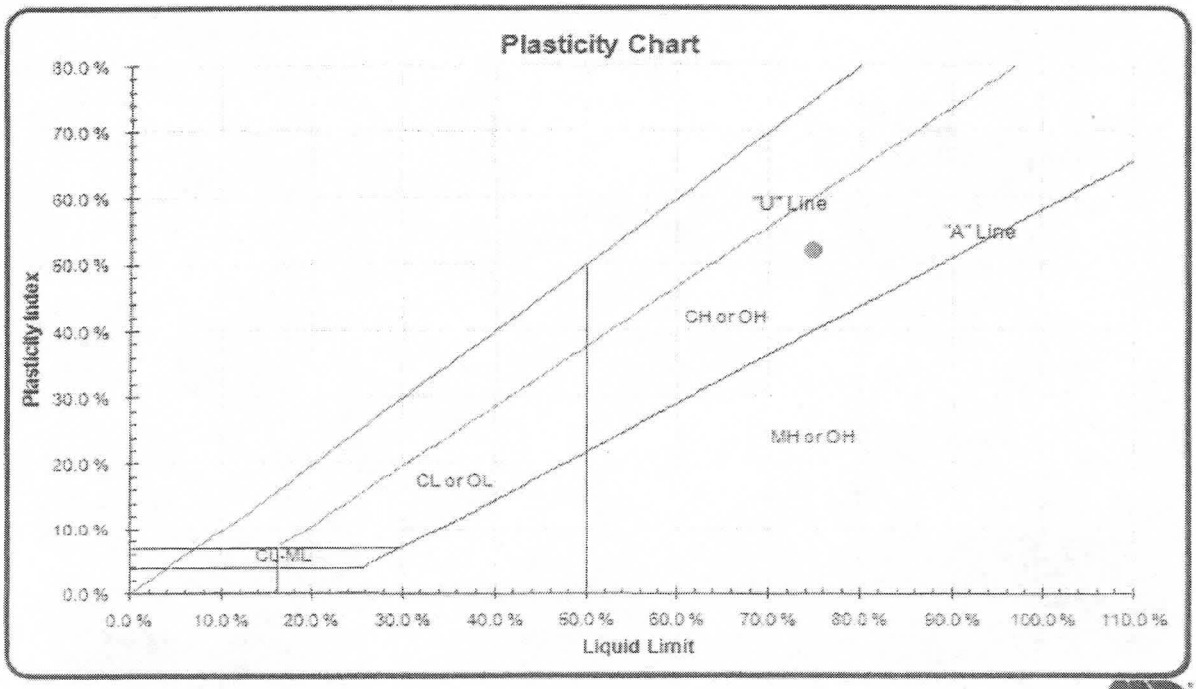


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FIG. B-5
(SHEET 7 OF 11)

GEOTECHNICAL TESTING LABORATORY

LAB ANALYSIS H – 5, 20 FEET

Copyright Spears Engineering & Technical Services PS, 1996-2004

Date Received: 1/16/2008 **Project:** Monohon Rd
Sample #: 184 **Client:** Pacific County
Sample ID: **ASTM#:**
Source: H-5 **Depth:** 20'

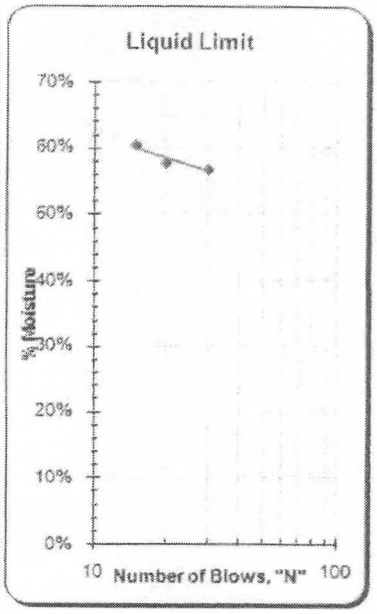
ASTM D-2487, Unified Soils Classification System

No Data Provided

Liquid Limit Determination

	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	49.41	48.79	47.72			
Weight of Dry Soils + Pan:	39.29	38.99	37.78			
Weight of Pan:	21.45	21.99	21.32			
Weight of Dry Soils:	17.84	17.00	16.46			
Weight of Moisture:	10.12	9.80	9.94			
% Moisture:	56.7 %	57.7 %	60.4 %			
N:	30	20	15			

Liquid Limit @ 25 Blows: 57.5 %
Plastic Limit: 27.3 %
Plasticity Index, I_P: 30.2 %



Plastic Limit Determination

	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	22.50	24.56	24.11			
Weight of Dry Soils + Pan:	22.30	23.89	23.61			
Weight of Pan:	21.56	21.45	21.79			
Weight of Dry Soils:	0.74	2.44	1.82			
Weight of Moisture:	0.20	0.67	0.50			
% Moisture:	27.0 %	27.5 %	27.5 %			

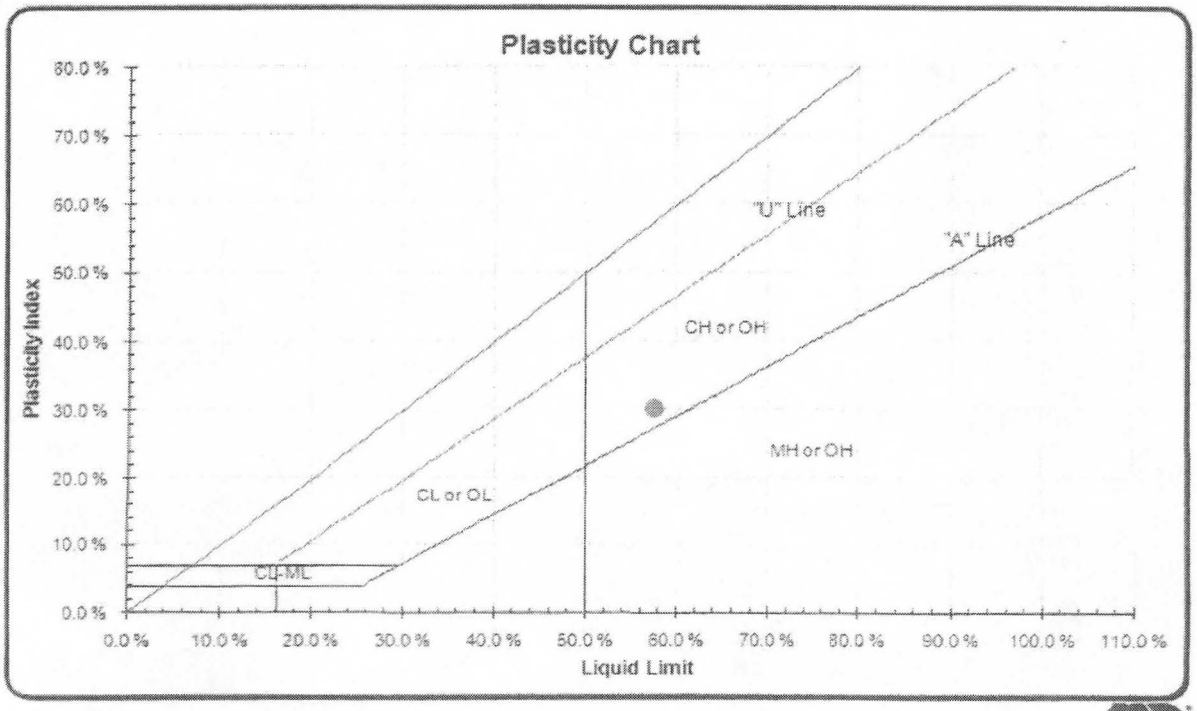


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FIG. B-5
(SHEET 8 OF 11)

GEOTECHNICAL TESTING LABORATORY

LAB ANALYSIS H – 5, 25 FEET

Copyright Spears Engineering & Technical Services PS, 1996-2004

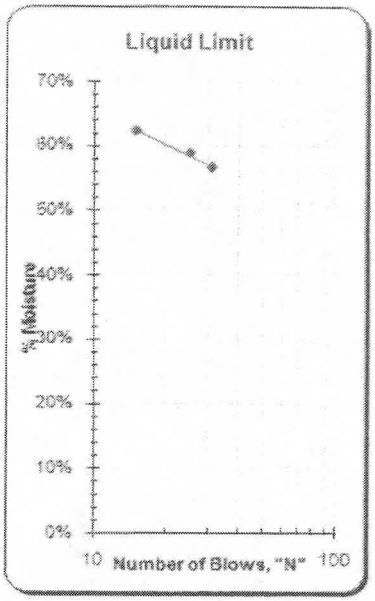
Date Received: 1/16/2008 **Project:** Monolton Rd
Sample #: 185 **Client:** Pacific County
Sample ID: **ASTM#:**
Source: H-5 **Depth:** 25'

ASTM D-2487, Unified Soils Classification System

No Data Provided

Liquid Limit Determination

	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	44.20	46.25	45.34			
Weight of Dry Soils + Pan:	35.91	37.11	36.36			
Weight of Pan:	21.25	21.59	21.95			
Weight of Dry Soils:	14.66	15.52	14.41			
Weight of Moisture:	8.29	9.14	8.98			
% Moisture:	56.6 %	58.9 %	62.3 %			
N:	31	25	15			



Liquid Limit @ 25 Blows: 58.8 %
Plastic Limit: 25.2 %
Plasticity Index, I_P: 33.6 %

Plastic Limit Determination

	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	23.24	25.41	23.51			
Weight of Dry Soils + Pan:	22.94	24.71	23.10			
Weight of Pan:	21.74	21.98	21.45			
Weight of Dry Soils:	1.20	2.73	1.65			
Weight of Moisture:	0.30	0.70	0.41			
% Moisture:	25.0 %	25.6 %	24.9 %			

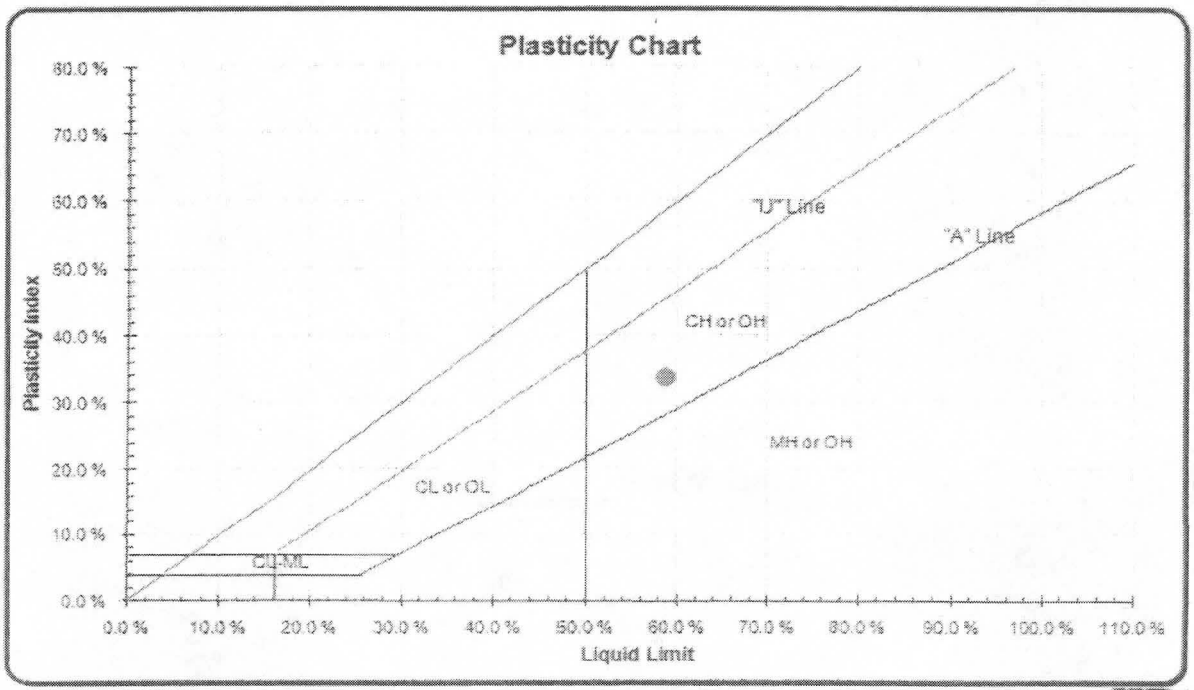


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FIG. B-5
(SHEET 9 OF 11)

GEOTECHNICAL TESTING LABORATORY

LAB ANALYSIS H – 5, 45 FEET

Copyright Spear Engineering & Technical Services PS, 1996-2004

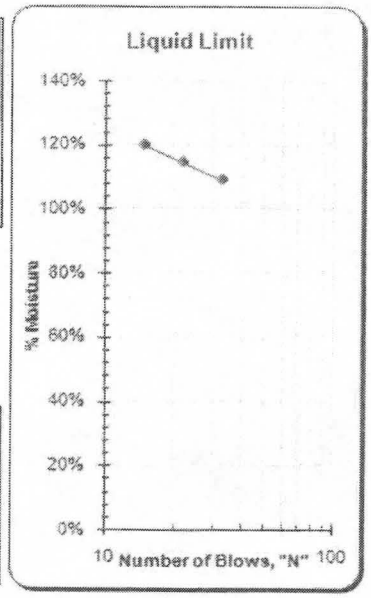
Date Received: 1/16/2008 **Project:** Monohon Rd
Sample #: 189 **Client:** Pacific County
Sample ID: **ASTM#:**
Source: H-5 **Depth:** 45'

ASTM D-2487, Unified Soils Classification System

No Data Provided

Liquid Limit Determination

	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	49.76	42.33	50.21			
Weight of Dry Soils + Pan:	35.05	31.29	34.72			
Weight of Pan:	21.57	21.67	21.80			
Weight of Dry Soils:	13.48	9.62	12.92			
Weight of Moisture:	14.71	11.04	15.49			
% Moisture:	109.1 %	114.8 %	119.9 %			
N:	33	22	15			



Liquid Limit @ 25 Blows: 113.6 %
Plastic Limit: 23.0 %
Plasticity Index, I_P: 90.6 %

Plastic Limit Determination

	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	23.17	24.16	24.72			
Weight of Dry Soils + Pan:	22.94	23.64	24.17			
Weight of Pan:	21.93	21.45	21.73			
Weight of Dry Soils:	1.01	2.19	2.44			
Weight of Moisture:	0.23	0.52	0.55			
% Moisture:	22.8 %	23.7 %	22.5 %			

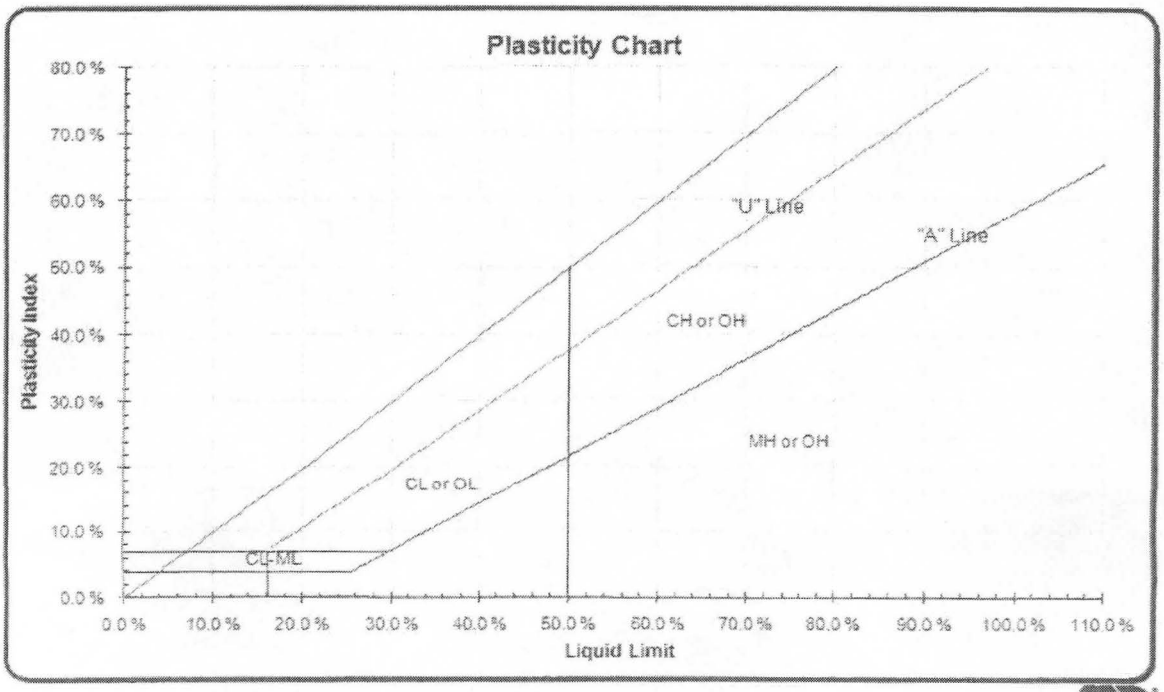


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FIG. B-5
(SHEET 10 OF 11)

GEOTECHNICAL TESTING LABORATORY

LAB ANALYSIS H – 6, 15 FEET

Copyright Spears Engineering & Technical Services PS, 1996-2004

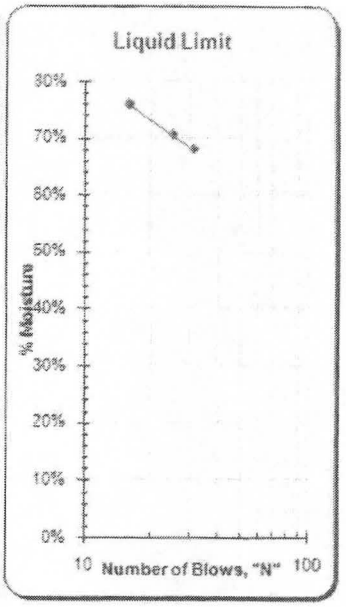
Date Received: 1/16/2008 **Project:** Monohon Rd
Sample #: 200 **Client:** Pacific County
Sample ID: **ASTM #:**
Source: H-6 **Depth:** 15'

ASTM D-2487, Unified Soils Classification System

No Data Provided

Liquid Limit Determination

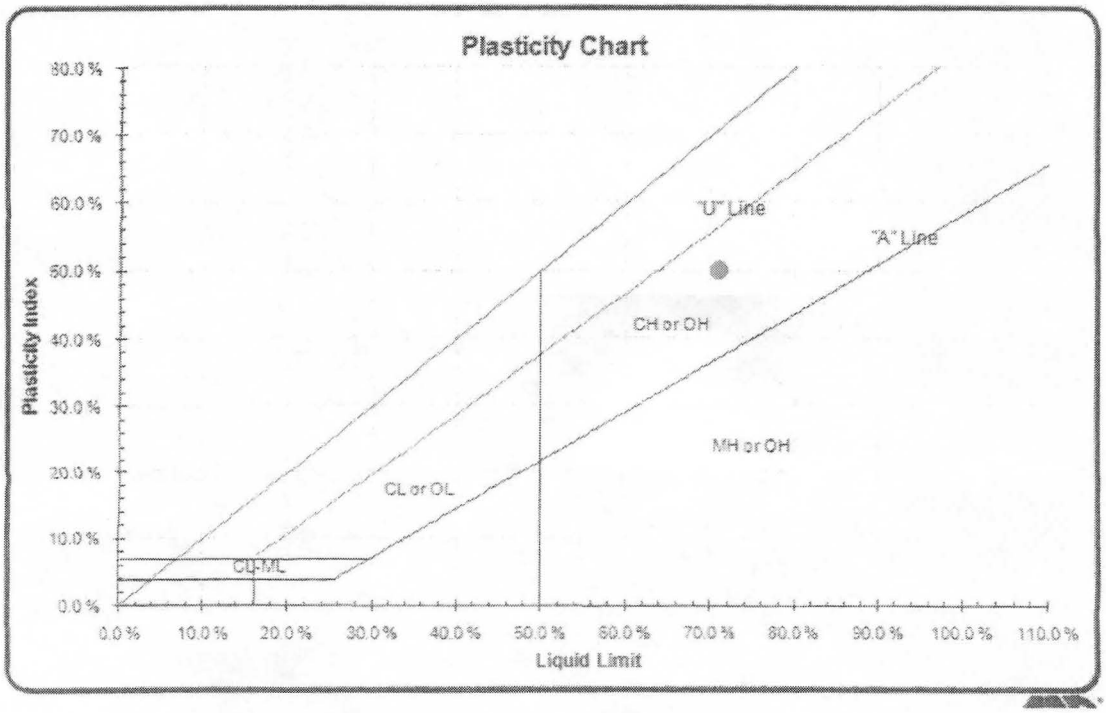
	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	42.16	42.63	43.76			
Weight of Dry Soils + Pan:	33.98	33.86	34.35			
Weight of Pan:	21.98	21.45	21.96			
Weight of Dry Soils:	12.00	12.41	12.39			
Weight of Moisture:	8.18	8.77	9.41			
% Moisture:	68.2 %	70.7 %	76.0 %			
N:	31	25	16			



Liquid Limit @ 25 Blows: 71.1 %
Plastic Limit: 21.0 %
Plasticity Index, I_p: 50.1 %

Plastic Limit Determination

	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	25.16	24.32	26.72			
Weight of Dry Soils + Pan:	24.48	23.82	25.86			
Weight of Pan:	21.35	21.46	21.59			
Weight of Dry Soils:	3.13	2.36	4.27			
Weight of Moisture:	0.68	0.50	0.86			
% Moisture:	21.7 %	21.2 %	20.1 %			



10011 Blomberg Street SW, Olympia, WA 98512
Phone #: (360) 754-4612 Fax #: (360) 754-4848

FIG. B-5
(SHEET 11 OF 11)

APPENDIX C

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL/ENVIRONMENTAL REPORT

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

Attachment to and part of Report 21-1-21159-001

Date: July 9, 2009
To: Michael W. Collins, P.E., PLS
Pacific County Department of Public Works

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL/ENVIRONMENTAL REPORT

CONSULTING SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND FOR SPECIFIC CLIENTS.

Consultants prepare reports to meet the specific needs of specific individuals. A report prepared for a civil engineer may not be adequate for a construction contractor or even another civil engineer. Unless indicated otherwise, your consultant prepared your report expressly for you and expressly for the purposes you indicated. No one other than you should apply this report for its intended purpose without first conferring with the consultant. No party should apply this report for any purpose other than that originally contemplated without first conferring with the consultant.

THE CONSULTANT'S REPORT IS BASED ON PROJECT-SPECIFIC FACTORS.

A geotechnical/environmental report is based on a subsurface exploration plan designed to consider a unique set of project-specific factors. Depending on the project, these may include: the general nature of the structure and property involved; its size and configuration; its historical use and practice; the location of the structure on the site and its orientation; other improvements such as access roads, parking lots, and underground utilities; and the additional risk created by scope-of-service limitations imposed by the client. To help avoid costly problems, ask the consultant to evaluate how any factors that change subsequent to the date of the report may affect the recommendations. Unless your consultant indicates otherwise, your report should not be used: (1) when the nature of the proposed project is changed (for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one, or chemicals are discovered on or near the site); (2) when the size, elevation, or configuration of the proposed project is altered; (3) when the location or orientation of the proposed project is modified; (4) when there is a change of ownership; or (5) for application to an adjacent site. Consultants cannot accept responsibility for problems that may occur if they are not consulted after factors which were considered in the development of the report have changed.

SUBSURFACE CONDITIONS CAN CHANGE.

Subsurface conditions may be affected as a result of natural processes or human activity. Because a geotechnical/environmental report is based on conditions that existed at the time of subsurface exploration, construction decisions should not be based on a report whose adequacy may have been affected by time. Ask the consultant to advise if additional tests are desirable before construction starts; for example, groundwater conditions commonly vary seasonally.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes, or groundwater fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical/environmental report. The consultant should be kept apprised of any such events, and should be consulted to determine if additional tests are necessary.

MOST RECOMMENDATIONS ARE PROFESSIONAL JUDGMENTS.

Site exploration and testing identifies actual surface and subsurface conditions only at those points where samples are taken. The data were extrapolated by your consultant, who then applied judgment to render an opinion about overall subsurface conditions. The actual interface between materials may be far more gradual or abrupt than your report indicates. Actual conditions in areas not sampled may differ from those predicted in your report. While nothing can be done to prevent such situations, you and your consultant can work together to help reduce their impacts. Retaining your consultant to observe subsurface construction operations can be particularly beneficial in this respect.

A REPORT'S CONCLUSIONS ARE PRELIMINARY.

The conclusions contained in your consultant's report are preliminary because they must be based on the assumption that conditions revealed through selective exploratory sampling are indicative of actual conditions throughout a site. Actual subsurface conditions can be discerned only during earthwork; therefore, you should retain your consultant to observe actual conditions and to provide conclusions. Only the consultant who prepared the report is fully familiar with the background information needed to determine whether or not the report's recommendations based on those conclusions are valid and whether or not the contractor is abiding by applicable recommendations. The consultant who developed your report cannot assume responsibility or liability for the adequacy of the report's recommendations if another party is retained to observe construction.

THE CONSULTANT'S REPORT IS SUBJECT TO MISINTERPRETATION.

Costly problems can occur when other design professionals develop their plans based on misinterpretation of a geotechnical/environmental report. To help avoid these problems, the consultant should be retained to work with other project design professionals to explain relevant geotechnical, geological, hydrogeological, and environmental findings, and to review the adequacy of their plans and specifications relative to these issues.

BORING LOGS AND/OR MONITORING WELL DATA SHOULD NOT BE SEPARATED FROM THE REPORT.

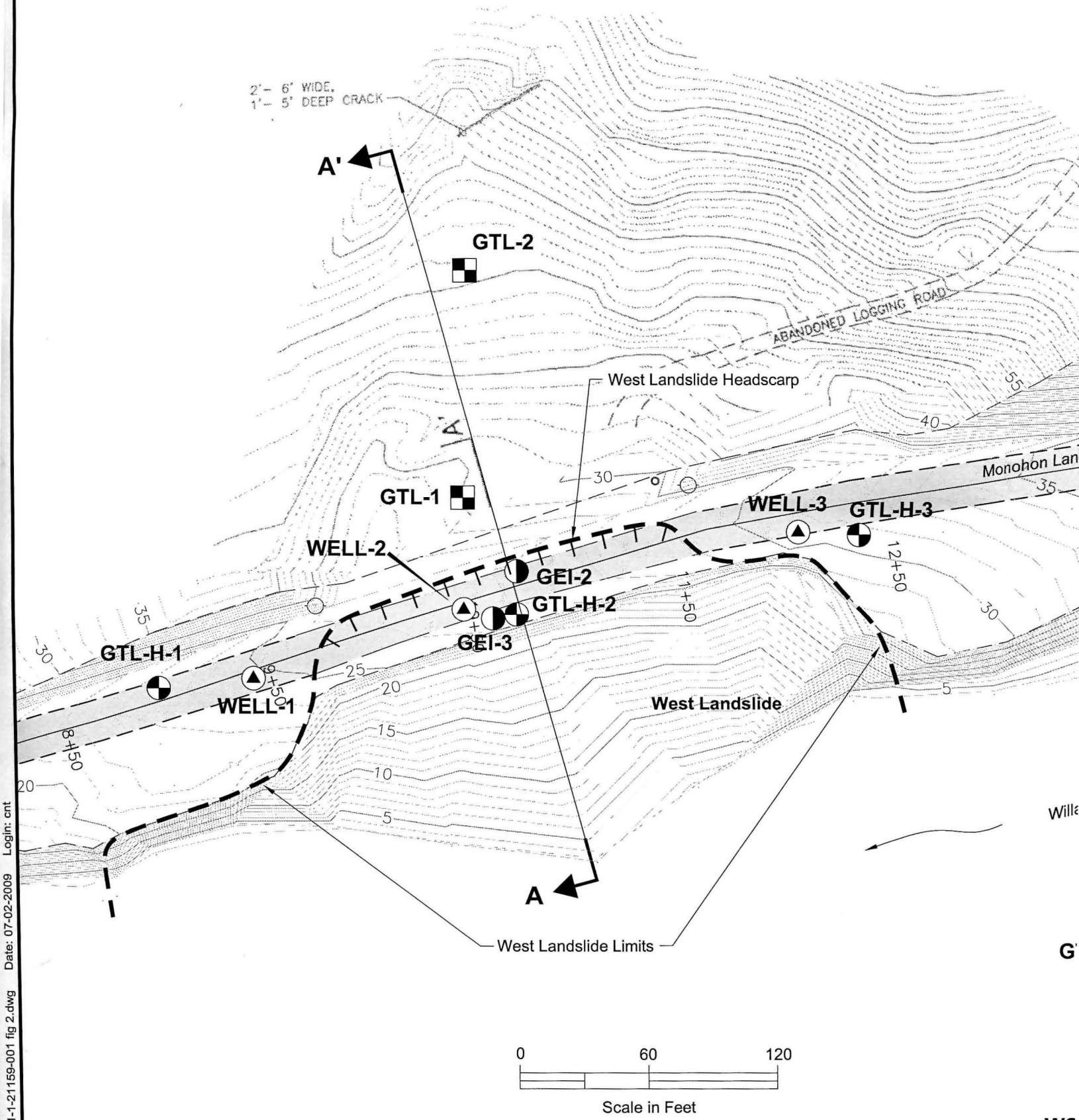
Final boring logs developed by the consultant are based upon interpretation of field logs (assembled by site personnel), field test results, and laboratory and/or office evaluation of field samples and data. Only final boring logs and data are customarily included in geotechnical/environmental reports. These final logs should not, under any circumstances, be redrawn for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process.

To reduce the likelihood of boring log or monitoring well misinterpretation, contractors should be given ready access to the complete geotechnical engineering/environmental report prepared or authorized for their use. If access is provided only to the report prepared for you, you should advise contractors of the report's limitations, assuming that a contractor was not one of the specific persons for whom the report was prepared, and that developing construction cost estimates was not one of the specific purposes for which it was prepared. While a contractor may gain important knowledge from a report prepared for another party, the contractor should discuss the report with your consultant and perform the additional or alternative work believed necessary to obtain the data specifically appropriate for construction cost estimating purposes. Some clients hold the mistaken impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes that aggravate them to a disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY.

Because geotechnical/environmental engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against consultants. To help prevent this problem, consultants have developed a number of clauses for use in their contracts, reports and other documents. These responsibility clauses are not exculpatory clauses designed to transfer the consultant's liabilities to other parties; rather, they are definitive clauses that identify where the consultant's responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your report, and you are encouraged to read them closely. Your consultant will be pleased to give full and frank answers to your questions.

The preceding paragraphs are based on information provided by the
ASFE/Association of Engineering Firms Practicing in the Geosciences, Silver Spring, Maryland



0 60 120

Scale in Feet

NOTE

Figure adapted from electronic files provided by Pacific County Department of Public Works, received 5-3-2009 and GeoEngineers (1990) report.

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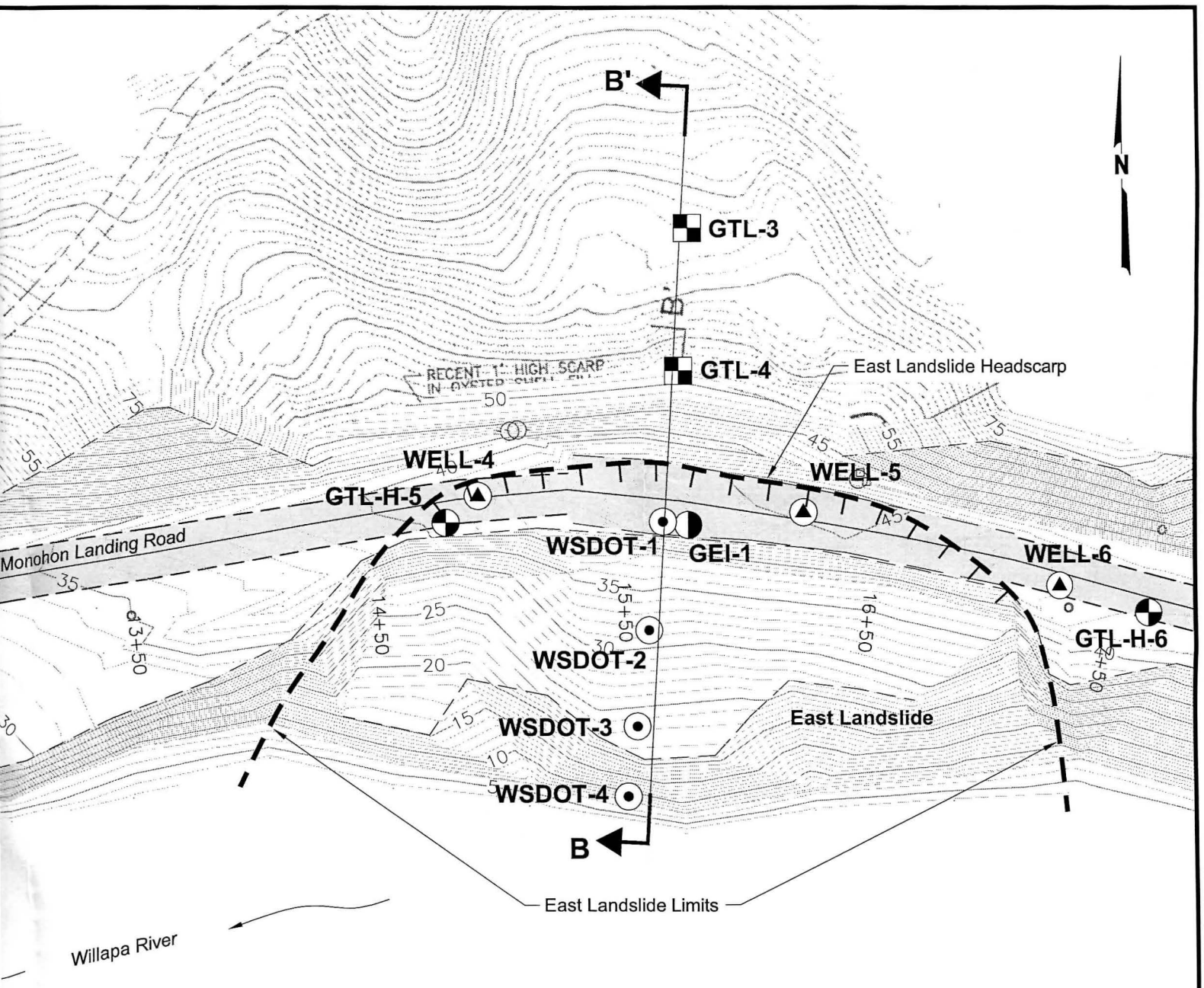

LEGEND

GTL-H-1	Boring Designation and Approximate Location (Geotechnical Testing Laboratory, Inc., 2009)
GTL-1	Boring Designation and Approximate Location (Geotechnical Testing Laboratory, Inc., 2008)
GEI-1	Boring Designation and Approximate Location (GeoEngineers, 1998)
WSDOT-1	Boring Designation and Approximate Location (WSDOT, 1979)
WELL-1	Monitoring Well Designation and Approximate Location (Geotechnical Testing Laboratory, Inc., 2008)
A	Generalized Subsurface Profile Designation and Approximate Location

Monohon Landing Road Landslide
Raymond, Washington

SITE AND EXPLORATION PLAN

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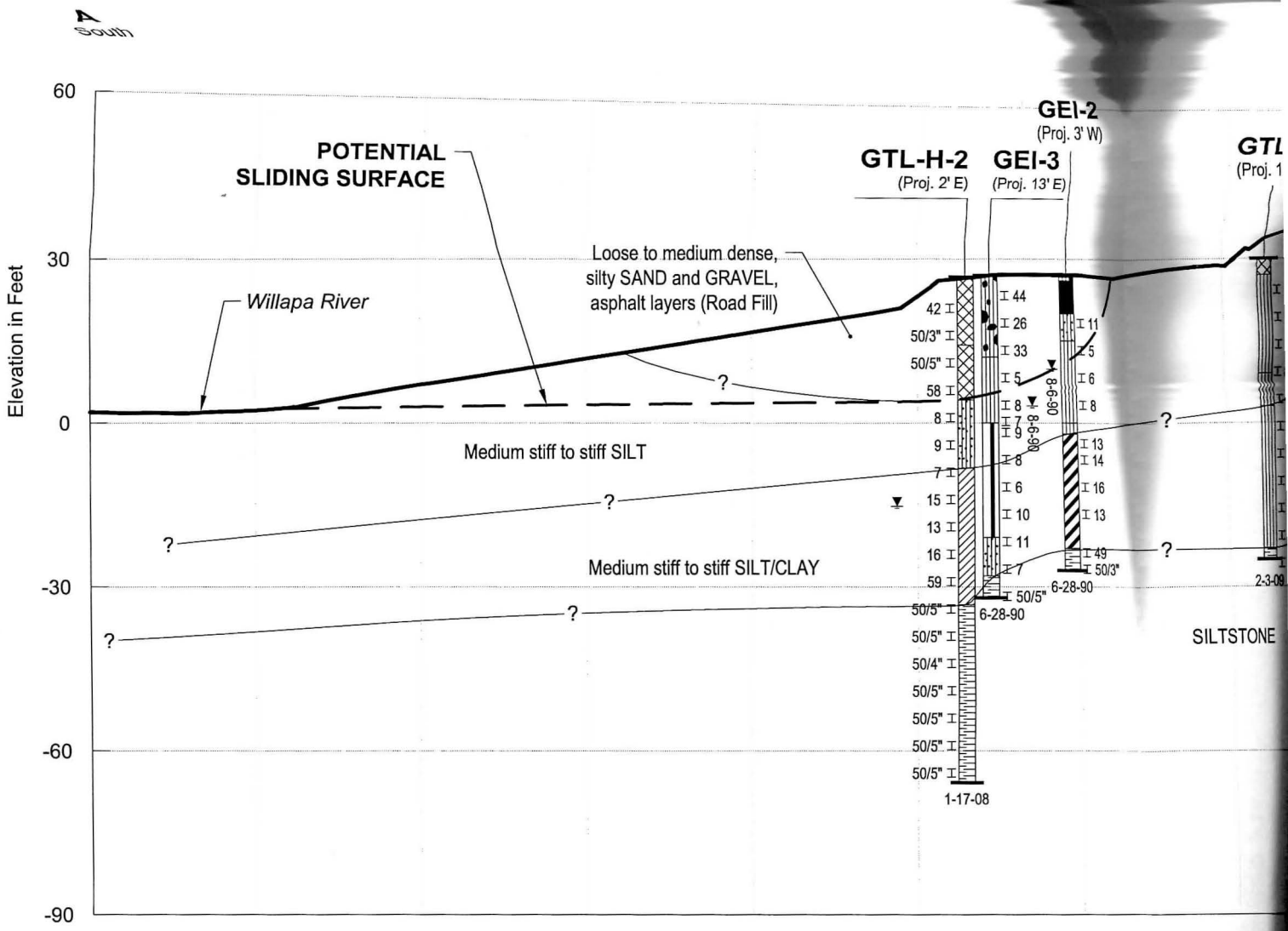
Geotechnical and Environmental Consultants

FIG. 2



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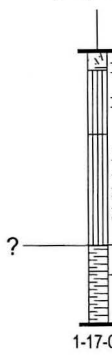
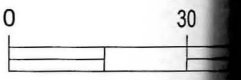


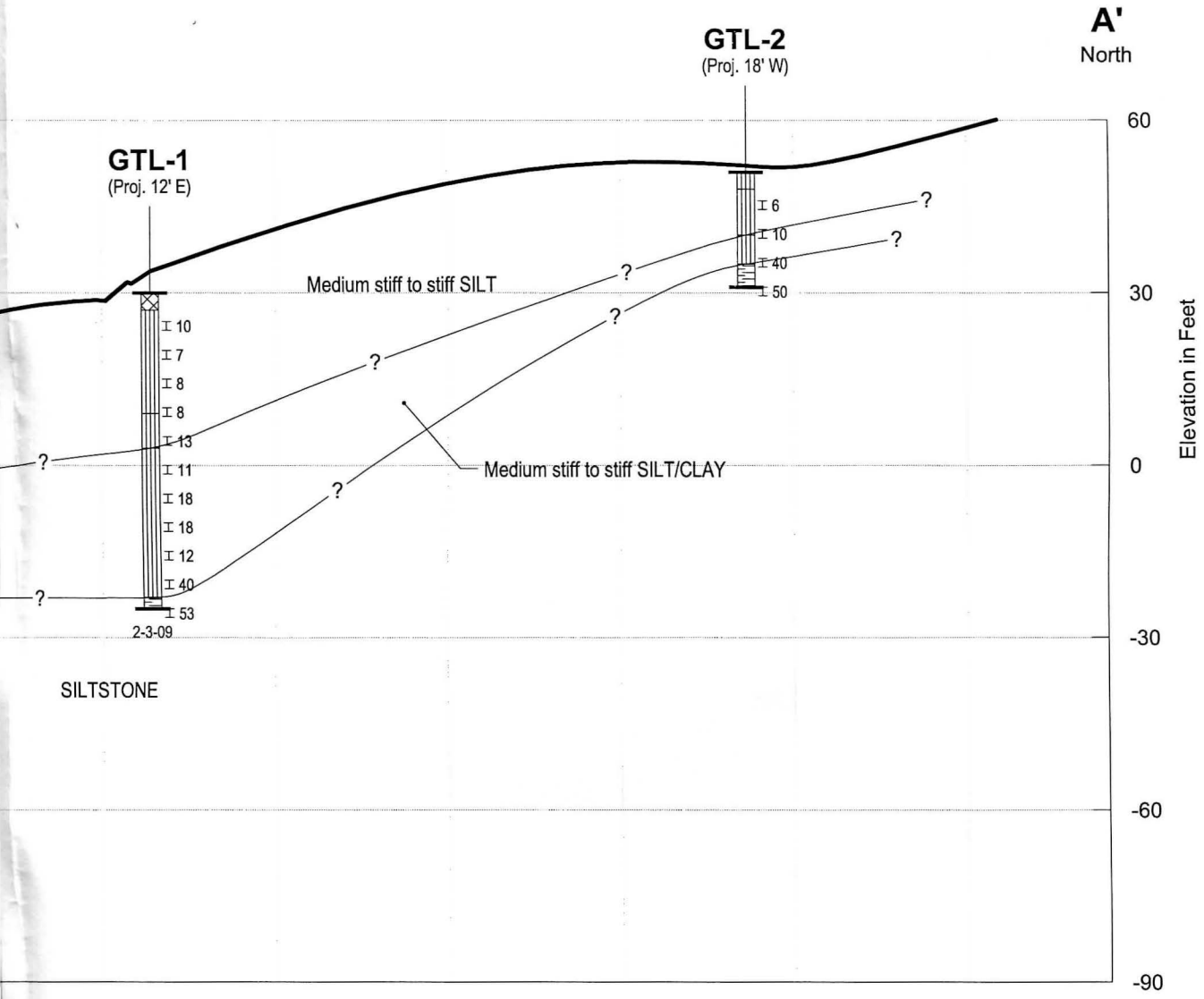
Boring Designation
Projected Distance
Standard Penetration Test Blows/Foot or Blows/Inches Driven
Water Level and Date Observed
? Approximate Geologic Contact
USCS Symbol
Bottom of Boring
Date Completed

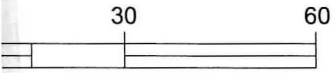


Scale in Fe
Vertical = Hori

NOTE

This subsurface profile is ge
materials observed in soil bo
exist between profile and ac





Scale in Feet
Vertical = Horizontal

NOTE

rface profile is generalized from
bserved in soil borings. Variations may
een profile and actual conditions.

Monohon Landing Road Landslide
Raymond, Washington

GENERALIZED SUBSURFACE PROFILE A-A' WEST LANDSLIDE

July 2009 21-1-21159-001

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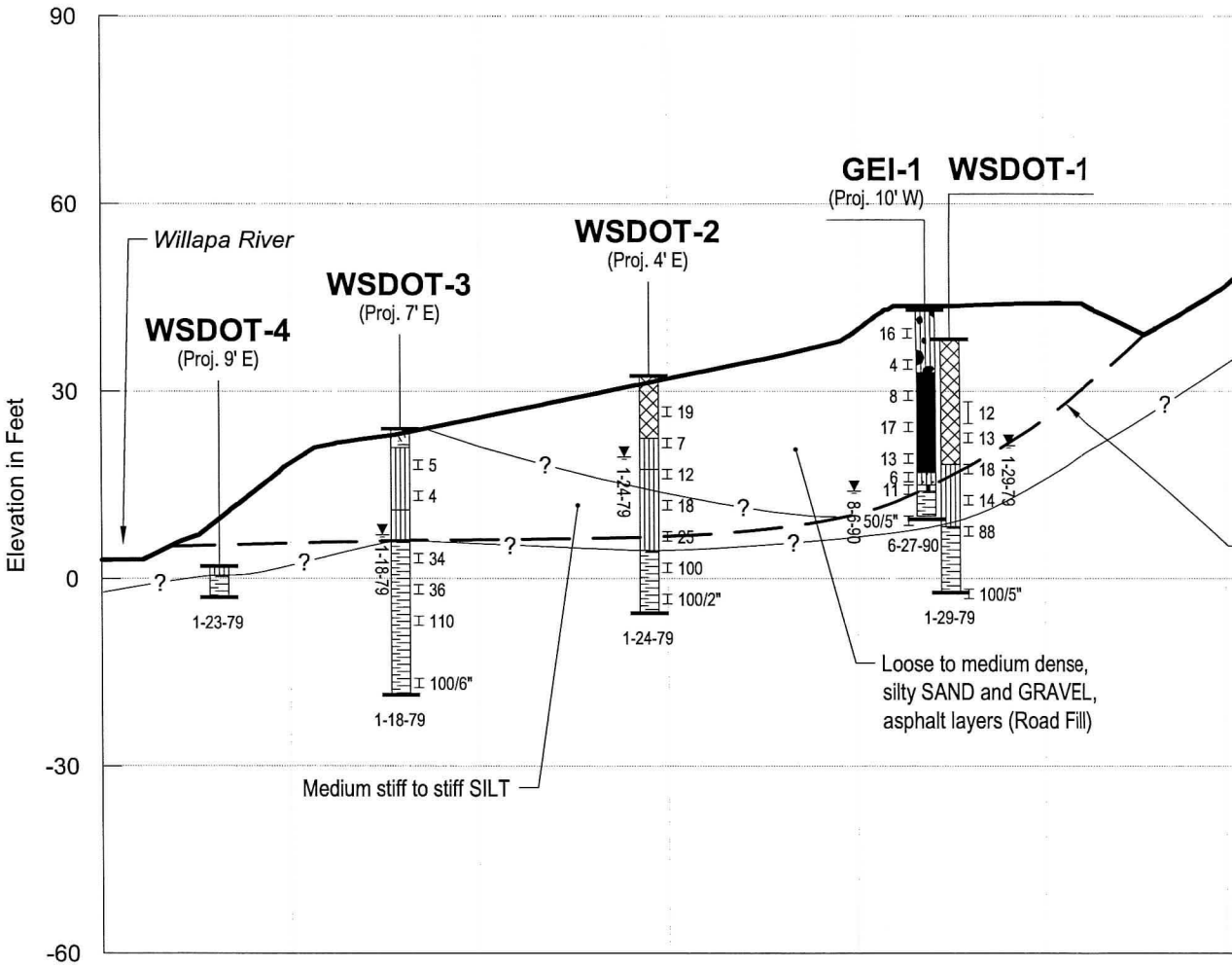
Geotechnical and Environmental Consultants

FIG. 3

B

South



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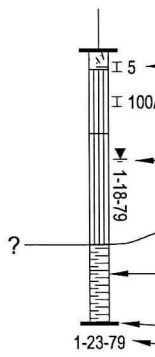
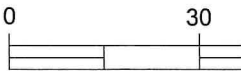


- WSDOT-3 — Boring Designation
- (Proj. 7' E) — Projected Distance
- 5 — Standard Penetration Test Blows/Foot or
- 100/6" — Blows/Inches Driven
- 1-18-79 — Water Level and Date Observed
- ? — Approximate Geologic Contact
- USCS Symbol
- 1-23-79 — Bottom of Boring Date Completed

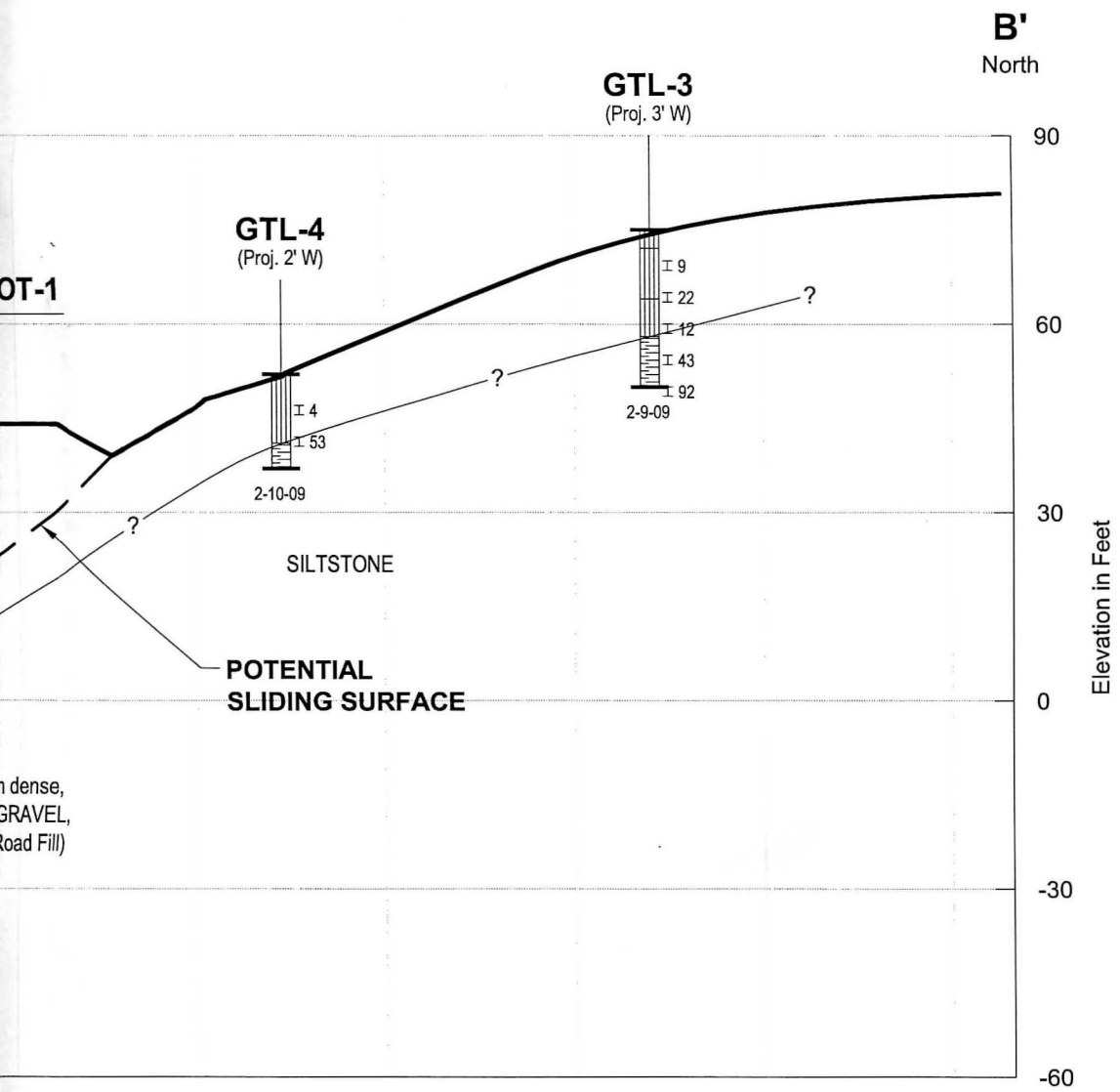


Scale in Fe

Vertical = Hori

NOTE

This subsurface profile is ge
materials observed in soil b
exist between profile and ac



30 60

Scale in Feet
Vertical = Horizontal

NOTE

ubsurface profile is generalized from
als observed in soil borings. Variations may
etween profile and actual conditions.

Monohon Landing Road Landslide
Raymond, Washington

GENERALIZED SUBSURFACE PROFILE B-B' EAST LANDSLIDE

July 2009 21-1-21159-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. 4