SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

June 16, 2017

Otak, Inc.
700 Washington Street, Suite 401
Vancouver, Washington 98660
Attn: Allen Hendy, PE

**RE: GEOTECHNICAL MEMORANDUM FOR 30 PERCENT DESIGN**
**5TH STREET TO KINSMAN ROAD EXTENTION PROJECT**
**WILSONVILLE, OREGON**

This project memorandum is to support Otak, Inc., with their 30 percent design submittal for the 5th Street to Kinsman Road Extension project. The project site is located in the City of Wilsonville, Oregon, just north of the Willamette River and West of Interstate 5, as shown on Figure 1, Vicinity Map. This project memorandum includes summary of field explorations and laboratory testing, discussions of site geology and subsurface conditions, and evaluations of seismic hazards, and bridge foundation alternatives.

## Field Explorations

The subsurface conditions at the project site were explored with 12 drilled borings, designated B-1 through B-12. The locations of the borings are shown in Figure 2, Site and Exploration Plan.

The drilling of Borings B-1, B-2, B-4 through B-7, and B-9 was subcontracted by Shannon & Wilson, Inc., to Western States Soil Conservation of Hubbard, Oregon. The borings were drilled between April 17 and 21, 2017, using the mud-rotary technique with a track-mounted CME-75 drill rig. Samples were collected using a standard split spoon sampler and an automatic hammer with a hammer efficiency of 88 percent. One undisturbed sample was collected at Boring B-2 using an Osterberg piston sampler.

The drilling of Borings B-3, B-8, and B-10 through B-12 was subcontracted by Shannon & Wilson to Dan J Fisher Excavating of Forest Grove, Oregon. The borings were drilled between April 17 and 21, 2017, using the solid-stem auger technique with a trailer-mounted Buck Rogers drill rig. Samples were collected using a standard split spoon sampler and a manual cat-head hammer.

A Shannon & Wilson geology staff member logged the materials encountered during drilling and collected soil samples. Table 1 summarizes exploration data including drilling dates, depths, and

surveyed elevations. The logs of the materials encountered, as well as DCP test results, are presented in Attachment A. Infiltration test results will be provided in the Geotechnical Design Report.

**TABLE 1: SUMMARY OF EXPLORATIONS**

| Boring[1] | Depth (feet) | Purpose | Date Completed | Surface Elevation (feet) | Bottom Elevation (feet) | Infiltration Test (y/n) | Dynamic Cone Penetration Test (y/n) |
|---|---|---|---|---|---|---|---|
| B-1 | 56.5 | Kinsman Road Bridge | 4/17/2017 | 143.7 | 87.2 | n | y |
| B-2 | 54.0 | Kinsman Road Bridge | 4/18/2017 | 143.6 | 89.6 | n | y |
| B-3 | 12.1 | Pavement Design | 4/24/2017 | 153.7 | 141.6 | n | y |
| B-4 | 51.5 | 5th Street Bridge | 4/21/2017 | 140.6 | 89.1 | n | y |
| B-5 | 51.5 | 5th Street Bridge | 4/20/2017 | 135.3 | 83.8 | n | n |
| B-6[2] | 41.5 | Railroad Undercrossing | 4/19/2017 | 144.5 | 103.0 | n | y |
| B-7 | 41.5 | Railroad Undercrossing | 4/19/2017 | 148.0 | 106.5 | n | y |
| B-8 | 11.5 | Pavement Design | 4/24/2017 | 148.2 | 136.7 | n | y |
| B-9 | 6.5 | Infiltration | 4/21/2017 | 147.4 | 140.9 | y | y |
| B-10 | 6.5 | Pavement Design | 4/24/2017 | 148.1 | 141.6 | n | y |
| B-11 | 5.0 | Infiltration | 4/24/2017 | 153.5 | 148.5 | y | y |
| B-12 | 5.0 | Infiltration | 4/24/2017 | 147.9 | 142.9 | y | y |

[1] Boring locations were surveyed by Otak. Elevations are in NAVD 88, feet.

[2] A Groundwater monitoring well (vibrating wire piezometer) was installed at boring B-6.

In addition to drilling and soil sampling, we also conducted a total of 11 dynamic cone penetration (DCP) tests and 3 field infiltration tests at or near the boring locations shown in Table 1. Results from DCP tests are correlated to parameters used for pavement design. Field infiltration tests were conducted to determine infiltration capacity for potential stormwater management design.

**Laboratory Tests**

Geotechnical laboratory tests were performed on selected samples retrieved from the borings to determine basic index and engineering properties of the soils encountered. The geotechnical laboratory testing program included visual-manual classifications, moisture content, grain size distributions, Atterberg limits, and an undisturbed dry unit weight test. Laboratory testing was performed in general accordance with the ASTM International standard test procedures. Results of the laboratory tests are presented in Attachment B.

**Site Geology and Subsurface Conditions**

The project site is situated over Missoula Flood Deposits which generally consist of 4 to 10 feet of fine grain silty clay and sandy silt deposits underlain by a 40- to 50-foot-thick layer of Missoula Flood Deposits -Gravel Facies consisting of clayey gravel with cobbles and boulders. The Gravel Facies are underlain by additional fine-grain flood deposits to an unknown depth. Near Coffee Lake Creek, the upper fine-grain flood deposits have been eroded away, and the creek has channeled into the Gravel Facies. In recent times, portions of the site have been graded and filled during the course of development.

The Fine-Grained Facies was present at or near the surface in Borings B-03, B-06, and B-08 through B-12, but was not observed at or near the surface in any of the bridge abutment borings (B-1, B-2, B-4, or B-5). The surface soils at the bridge sites consist of 4.5 to 7 feet of fill. The fill material at the Kinsman Road Bridge consists of up to 7 feet of silty/clayey gravel which was likely placed for the existing Ore Pac access road bridge approaches. The fill material at the proposed 5$^{th}$ Street Bridge site consists of 4.5 feet of sandy silt and silty clay.

Missoula Flood Deposits – Gravel Facies was encountered in all bridge abutment borings below the fill material. The thickness of the Gravel Facies unit ranged from 38.5 to 44 feet. The unit consists of medium dense to very dense gravels, with varying amounts of sands and fines, including USCS group designations GC, GP-GC, GM and GP-GM. Cobbles and boulders are present throughout the unit. Trace lenses of clay and sand may also be present.

The Missoula Flood Deposits – Fine-Grained Facies was encountered in all the bridge abutment borings below the Gravel Facies at depths ranging from 45 to 50 feet with an observed upper elevation of 95.6 feet in Boring B-2. The Fine-Grained Facies at these depths consisted of medium stiff to stiff Silty CLAY to CLAY with trace sand. Boring B-05 encountered medium

stiff to stiff SILT with trace sand. SPT N-Values ranged from 6 to 8 blows per foot (bpf), except for B-05, N-13, where the blow count of 30 bpf was most likely influenced by gravel in the shoe of the sampler.

The six deeper geotechnical boring were drilled using mud rotary drilling techniques, which make it difficult to discern the depth to groundwater, if it is encountered. A vibrating wire piezometer was installed in Boring B-6 near the proposed railroad utility undercrossing approximately 800 feet west of Coffee Lake Creek. Daily Piezometer readings were logged between May 5 and June 15, 2017. During this time the ground water elevation decreased from 128.1 feet to 124.2 feet. The groundwater table at the bridge locations is likely hydraulically connected to Coffee Lake Creek. The Coffee Lake Creek ordinary high water elevation varies between approximately 137 feet at the proposed Kinsman Road Bridge to approximately 131 feet at the proposed 5$^{th}$ Street Bridge. The Coffee Lake Creek ordinary high water elevations were assumed for the design of bridge foundations and approach embankments.

**Seismic Hazards**

Based on the subsurface conditions encountered in the borings, our evaluation indicates that the site is classified as Seismic Site Class D. The expected seismic hazard at the project site is strong ground shaking. The on-site materials do not appear to be susceptible to liquefaction or related effects, based upon the design groundwater levels. Potential for slope instability appears to be low given the relatively competent nature of the subsurface soils at the bridge locations. The potential for fault rupture is low given the distance (approximately 4 miles) between the bridge site and nearest potentially active fault. The risk of seismically induced tsunami and seiche is also very low at the site.

**Bridge Foundation Alternatives**

The selection of an appropriate foundation system for the proposed bridge structures is dependent upon several factors, including foundation capacities, tolerance to total and differential settlement resulting from static loads, scour potential, and construction considerations. Based on the explored subsurface conditions and the design loads, we considered driven pile, drilled shaft, and spread footing foundations.

We understand that if deep foundations were used, the pile caps would need to extend into the clayey gravel layer to protect the approach embankments from scour; a longer bridge may be

required to accommodate the scour protection riprap. The gravel layer may support the proposed bridge loads on spread footings. Spread footings are typically more cost effective and generally are constructed using conventional construction equipment. In addition, the presence of cobbles and boulders would create difficulties during drilled shaft excavations or pile installation and construction delays could arise.

Based on the current bridge design concept, the bottom of the footings for both bridges will be located outside of scour zones defined by the design team hydraulic engineer and founded at the coffee lake creek streambed elevation. We understand that the creek is not expected to scour below the current streambed. ODOT GDM requires that spread footing be founded below the scour depth. However, we understand that permanent scour protection will be designed by Otak to guard the spread footings from undermining during flooding.

The footing excavations will most likely extend below the groundwater table. Based on our limited number of explorations near the bridge abutments, the clayey gravel layer appears to have a low hydraulic conductivity which would allow for relatively simple dewatering of footing excavations using a drainage pad and series of embedded submersible pumps. However, due to the variability of soils near stream channels, there is a heightened risk of encountering zones of more permeable soil within the footing excavations. If significant dewatering measures are needed, then deep foundations may be more cost effective and provide a reduction in risk during construction. We recommend digging test pits at each bridge abutment to observe seepage conditions at the proposed footing elevations.

The factored bearing resistance of the clayey gravels at the proposed footing elevations is approximately 6 to 8 kips per square feet (ksf). The bearing resistance of the spread footings is dependent on its proximity to a slope. If the full factored bearing resistance is to be used, the footings should bear below a plane extending from the outside lower edge of the scour prism away from the creek at an inclination of 2 horizontal to 1 vertical (2H:1V).

**Pedestrian Bridge Foundations**

We understand that a separate pedestrian bridge at the 5$^{th}$ Street Coffee Lake Creek crossing is proposed south of the planned roadway bridge. We understand that the bridge will have an approximate span of 84 feet, and the preferred foundations are shallow spread footings. Undocumented fill was observed at the surface in both the 5$^{th}$ Street Bridge abutment borings.

Founding footings on undocumented fill significantly increases the risk of bearing and/or global stability failure. We recommend over-excavating the undocumented fill to the Missoula Flood Deposits – Gravel Facies and replacing it with structural fill (i.e. 1 ½-inch minus or ¾-inch minus crushed rock) at 1H:1V slopes. A factored bearing resistance of 2.5 ksf should be used If the footings are founded on the structural fill. If the footings are founded on the native clayey gravel, a factored bearing resistance of 4 ksf may be used. As with the roadway bridge footings, the pedestrian bridge footings should bear below a plane extending from the outside lower edge of the scour prism away from the creek at an inclination of 2H:1V.

Sincerely,

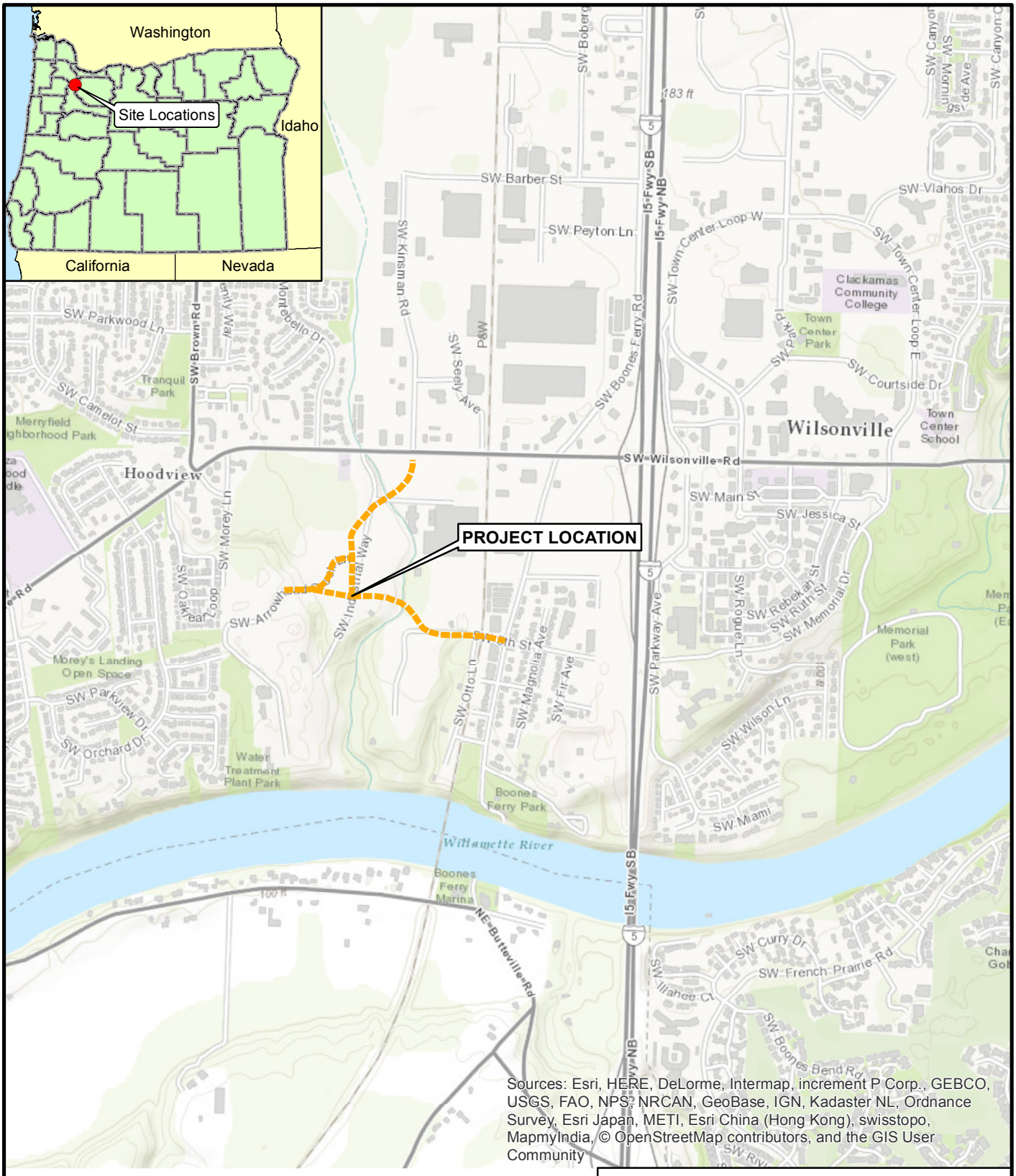
**SHANNON & WILSON, INC.**

Risheng (Park) Piao, PE, GE
Vice President | Geotechnical Engineer

James Walters, PE
Senior Engineer

JJW:RPP/hrr

Attachments: Figure 1 – Vicinity Map
Figure 2 – Site and Exploration Plan
Attachment A – Subsurface Explorations
Attachment B – Laboratory Test Results
Attachment C – Important Information about you Geotechnical/Environmental Report




5th Street to Kinsman Road Extension
Wilsonville, Oregon

## VICINITY MAP

June 2017

24-1-04041-002

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIG. 1

Filename: T:\Projects\24-1\3952_Wilsonville Outfalls\Avmxd\VicinityMap.mxd Date: 3/29/2017 Login: clv


LEGEND

B-10 Approximate Location and Designation of Shallow Boring

B-1 Approximate Location and Designation of Deep Boring

0 200 400

Scale in Feet

NOTES

1. Base map from drawing 18004_11x17_SITEMAP_021517_r.pdf, provided by Otak, Inc. on February 15, 2017.
2. Site features including borings were from drawings 18250x190.dwg and 18250xSURF.dwg, provided by Otak, Inc. on May 24, 2017.
3. Infiltration tests were completed at boring locations B-9, B-10, and B-11.
4. Dynamic Cone Penetrometer (DCP) tests were completed at all boring locations except boring B-5.

5th Street to Kinsman Road Extension
Wilsonville, Oregon

# SITE AND EXPLORATION PLAN

June 2017 24-1-04041-002

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. 2

File: I:\EF\24-1.PDX\04000s\04041 East West Connector\Graphics\CAD\Site Plan.dwg Date: 06-16-2017 Author: clv

# ATTACHMENT A

# SUBSURFACE EXPLORATIONS

**SHANNON & WILSON, INC.**
Geotechnical and Environmental Consultants

# DRILL LOG
OREGON DEPARTMENT OF TRANSPORTATION



| | | | |
|---|---|---|---|
| | | | Hole No. **B-01** |
| Project **5th Street to Kinsman Road Extension** | | Purpose **Bridge** | E.A. No. **N/A** |
| Highway **N/A** | | County **Clackamas County** | Key No. **N/A** |
| Hole Location Northing: **~ 604,353** | Easting: **~ 7,615,841** | | Start Card No. **N/A** |
| Equipment **CME-75 Truck Rig (Hammer Efficiency = 88%)** | | Driller **Hard Core Drilling** | Bridge No. **N/A** |
| Project Geologist **Adrian A.J. Holmes** | | Recorder **Nathan Villeneuve** | Ground Elev. **~ 144 ft.** |
| Start Date **April 17, 2017** | End Date **April 17, 2017** | Total Depth **56.50 ft** | Tube Height **N/A** |

**Test Type**
"A" - Auger Core "GP" - GeoProbe®
"X" - Auger
"C" - Core, Barrel Type
"N" - Standard Penetration
"U" - Undisturbed Sample
"T" - Test Pit

**Rock Abbreviations**

| Discontinuity | Shape | Surface Roughness |
|---|---|---|
| J - Joint | Pl - Planar | P - Polished |
| F - Fault | C - Curved | Sl - Slickensided |
| B - Bedding | U - Undulating | Sm - Smooth |
| Fo - Foliation | St - Stepped | R - Rough |
| S - Shear | Ir - Irregular | VR - Very Rough |

**Typical Drilling Abbreviations**

| Drilling Methods | Drilling Remarks |
|---|---|
| WL - Wire Line | LW - Lost Water |
| HS - Hollow Stem Auger | WR - Water Return |
| DF - Drill Fluid | WC - Water Color |
| SA - Solid Auger | DP - Down Pressure |
| CA - Casing Advancer | DR - Drill Rate |
| HA - Hand Auger | DA - Drill Action |

| Depth (ft) | Test Type, No. | Percent Recovery | Soil / Rock: Driving Resistance / Discontinuity Data Or RQD% | Percent Natural Moisture | Material Description (SOIL: Soil Name, USCS, Color, Plasticity, Moisture, Consistency/Relative Density, Texture, Cementation, Structure, Origin. ROCK: Rock Name, Color, Weathering, Hardness, Discontinuity Spacing, Joint Filling, Core Recovery, Formation Name.) | Unit Description |
|---|---|---|---|---|---|---|
| 0 | | | | | | **0.00 - 0.50 Asphalt Concrete; 6 inches thick** |
| | N1 | 66 | 6-13-50/5" | | N- 1 (2.50-3.90) Silty / Clayey GRAVEL with some sand; GM/GC; Dark brown; Low to medium plasticity fines; Wet; Very dense; Fine to coarse, angular to subrounded gravel; Fine to coarse sand; Disturbed texture; (Fill) | **0.50 - 1.00 Base Aggregate; 6 inches thick** |
| 5 | N2 | 66 | 17-12-9 | 28 | N- 2 (5.00-6.50) Silty / Clayey GRAVEL with some sand; GM/GC; Dark brown; Low to medium plasticity fines; Moist to wet; Medium dense; Fine to coarse, angular to subrounded gravel; Fine to coarse sand; Disturbed texture; (Fill) | **1.00 - 7.00 Silty / Clayey GRAVEL with some sand; GM/GC; Dark brown; Low to medium plasticity fines; Moist to wet; Medium dense to very dense; Fine to coarse, angular to subrounded gravel; Fine to coarse sand; (Fill)** |
| | N3 | 40 | 16-7-8 | | N- 3 (7.50-9.00) Clayey GRAVEL with some sand; GC; Brown; Medium plasticity fines; Wet; Medium dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | |
| 10 | N4 | 60 | 50/1st 4" | | N- 4 (10.00-11.50) GRAVEL with some clay and some sand; GP-GC; Gray; Medium plasticity fines; Wet; Very dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | **7.00 - 49.50 Clayey GRAVEL with some sand, with cobbles and boulders; GC; Brown and gray; Medium plasticity fines; Moist to wet; Medium dense to very dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; Trace 0.5- to 1.0-ft-thick interbeds of Gravelly CLAY with trace sand; CH; (Missoula Flood Deposits - Gravel Facies)** |
| | N5A | 100 | 6-14-13 | 33 | N- 5A (12.50-13.10) Gravelly CLAY with trace sand; CH; Gray and brown; Medium to high plasticity; Moist; Very stiff; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | |
| | N5B | | | 31 | N- 5B (13.10-14.00) Clayey GRAVEL with some sand; GC; Brown and gray; Medium to high plasticity fines; Wet; Medium dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | |
| 15 | N6 | 66 | 19-17-27 | | N- 6 (15.00-16.50) Clayey GRAVEL with some sand; GC; Brown and gray; Medium plasticity fines; Wet; Dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | |
| 20 | N7 | 66 | 11-12-50/5" | | N- 7 (20.00-21.40) Clayey GRAVEL with some sand; GC; Brown, gray, and red-yellow mottled; Medium plasticity fines; Wet; Very dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | |
| 25 | | | | | | |

Graphic Log | Drilling Methods, Size and Remarks / Water Level/ Date | Backfill/ Instrumentation

Mud rotary drilling technique (5-inch dia. hole)

Cobbles from 11 to 49.5 ft

Large cobble at 12 ft

Large cobble at 16 ft

ODOT DRILL LOG 24-1-04041-002.GPJ ODOT_MAN.GDT 6/15/17

| Depth (ft) | Test Type, No. | Percent Recovery | Soil / Rock: Driving Resistance / Discontinuity Data Or RQD% | Percent Natural Moisture | Material Description (SOIL: Soil Name, USCS, Color, Plasticity, Moisture, Consistency/Relative Density, Texture, Cementation, Structure, Origin. ROCK: Rock Name, Color, Weathering, Hardness, Discontinuity Spacing, Joint Filling, Core Recovery, Formation Name.) | Unit Description | Graphic Log | Drilling Methods, Size and Remarks / Water Level/ Date | Backfill/ Instrumentation |
|---|---|---|---|---|---|---|---|---|
| 25 | N8 | 80 | 12-30-22 | | N- 8 (25.00-26.50) Clayey GRAVEL with some sand; GC; Brown and gray; Medium plasticity fines; Wet; Very dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | | | Boulder from 26 to 29 ft | |
| 30 | N9 | 73 | 18-17-32 | 19 | N- 9 (30.00-31.50) Clayey GRAVEL with some sand; GC; Brown and gray; Medium plasticity fines; Wet; Dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | | | | |
| 35 | N10 | 66 | 15-15-13 | | N- 10 (35.00-36.50) Clayey GRAVEL with some sand; GC; Gray; Medium plasticity fines; Wet; Medium dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | | | | |
| 40 | N11 | 0 | 50/1st 1" | | N- 11 (40.00-40.10) No recovery | | | Boulder from 39.5 to 41.5 ft | |
| 45 | N12 | 73 | 13-18-14 | | N- 12 (45.00-46.50) Clayey GRAVEL with some sand; GC; Brown and gray; Medium plasticity fines; Wet; Dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | | | | |
| 50 | N13 | 100 | 2-3-5 | 43 | N- 13 (50.00-51.50) CLAY with trace sand; CH; Gray; Medium plasticity; Moist; Medium stiff to stiff; Fine sand; Micaceous; (Missoula Flood Deposits - Fine-Grained Facies) | **49.50 - 56.50 CLAY with trace sand; CH; Gray; Medium plasticity; Moist; Medium stiff to stiff; Fine sand; Micaceous; (Missoula Flood Deposits - Fine-Grained Facies)** | | | |
| 55 | N14 | 100 | 3-3-5 | | N- 14 (55.00-56.50) CLAY with trace sand; CH; Gray; Medium plasticity; Moist; Medium stiff to stiff; Fine sand; Micaceous; (Missoula Flood Deposits - Fine-Grained Facies) | **56.50 End of hole** | | | |
| 60 | | | | | | | | | |
| 63 | | | | | | | | | |

**SHANNON & WILSON, INC.**
Geotechnical and Environmental Consultants

# DRILL LOG
OREGON DEPARTMENT OF TRANSPORTATION



| | | | |
|---|---|---|---|
| | | | Hole No. **B-02** |
| Project **5th Street to Kinsman Road Extension** | | Purpose **Bridge** | E.A. No. **N/A** |
| Highway **N/A** | | County **Clackamas County** | Key No. **N/A** |
| Hole Location | Northing: **~ 604,339** | Easting: **~ 7,615,726** | Start Card No. **N/A** |
| Equipment **CME-75 Truck Rig (Hammer Efficiency = 88%)** | | Driller **Hard Core Drilling** | Bridge No. **N/A** |
| Project Geologist **Adrian A.J. Holmes** | | Recorder **Nathan Villeneuve** | Ground Elev. **~ 144 ft.** |
| Start Date **April 17, 2017** | End Date **April 18, 2017** | Total Depth **54.00 ft** | Tube Height **N/A** |

**Test Type**
"A" - Auger Core
"X" - Auger
"C" - Core, Barrel Type
"N" - Standard Penetration
"U" - Undisturbed Sample
"T" - Test Pit
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| B - Bedding | U - Undulating | Sm - Smooth |
| Fo - Foliation | St - Stepped | R - Rough |
| S - Shear | Ir - Irregular | VR - Very Rough |

**Typical Drilling Abbreviations**

| Drilling Methods | Drilling Remarks |
|---|---|
| WL - Wire Line | LW - Lost Water |
| HS - Hollow Stem Auger | WR - Water Return |
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| SA - Solid Auger | DP - Down Pressure |
| CA - Casing Advancer | DR - Drill Rate |
| HA - Hand Auger | DA - Drill Action |

| Depth (ft) | Test Type, No. | Percent Recovery | Soil / Rock: Driving Resistance / Discontinuity Data Or RQD% | Percent Natural Moisture | Material Description (SOIL: Soil Name, USCS, Color, Plasticity, Moisture, Consistency/Relative Density, Texture, Cementation, Structure, Origin. ROCK: Rock Name, Color, Weathering, Hardness, Discontinuity Spacing, Joint Filling, Core Recovery, Formation Name.) | Unit Description | Graphic Log | Drilling Methods, Size and Remarks / Water Level/ Date | Backfill/ Instrumentation |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | **0.00 - 0.50 Asphalt Concrete; 6 inches thick** | | Mud rotary drilling technique (5-inch dia. hole) | |
| | N1 | 73 | 3-8-17 | | N- 1 (2.50-4.00) Clayey GRAVEL with some sand; GC; Brown and gray; Medium plasticity fines; Moist; Medium dense; Fine to coarse, angular to subrounded gravel; Fine to coarse sand; Disturbed texture; (Fill) | **0.50 - 1.00 Base Aggregate; 6 inches thick** | | | |
| | | | | | | **1.00 - 4.50 Clayey GRAVEL with some sand; GC; Brown and gray; Medium plasticity fines; Moist; Medium dense; Fine to coarse, angular to subrounded gravel; Fine to coarse sand; Disturbed texture; (Fill)** | | | |
| 5 | N2 | 60 | 5-8-9 | | N- 2 (5.00-6.50) Clayey GRAVEL with some sand; GC; Brown and gray; Medium plasticity fines; Moist; Medium dense; Fine to coarse, angular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | | | | |
| | N3 | 47 | 20-40-31 | | N- 3 (7.50-9.00) Clayey GRAVEL with some sand; GC; Brown and gray; Medium plasticity fines; Moist; Very dense; Fine to coarse, angular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | | | | |
| 10 | N4 | 53 | 13-9-10 | 26 | N- 4 (10.00-11.50) Clayey GRAVEL with some sand; GC; Brown and gray; Medium plasticity fines; Moist; Medium dense; Fine to coarse, angular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | **4.50 - 42.00 Clayey GRAVEL with some sand, with cobbles and boulders; GC; Brown and gray; Medium plasticity fines; Moist to wet; Medium dense to very dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies)** | | | |
| | N5 | 40 | 13-15-13 | | N- 5 (12.50-14.00) Clayey GRAVEL with some sand; GC; Brown and gray; Medium plasticity fines; Moist to wet; Medium dense; Fine to coarse, angular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | | | Cobbles from 12 to 49.5 ft | |
| 15 | N6 | 55 | 16-50/5" | | N- 6 (15.00-15.90) Clayey GRAVEL with some sand; GC; Brown and gray; Medium plasticity fines; Moist to wet; Very dense; Fine to coarse, angular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | | | Large cobble at 15 ft | |
| 20 | N7 | 80 | 17-22-19 | 21 | N- 7 (20.00-21.50) Clayey GRAVEL with some sand; GC; Brown and gray; Medium plasticity fines; Wet; Dense; Fine to coarse, angular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | | | | |
| 25 | | | | | | | | Large cobble at 24 ft | |

| Depth (ft) | Test Type, No. | Percent Recovery | Soil / Rock: Driving Resistance / Discontinuity Data Or RQD% | Percent Natural Moisture | Material Description (SOIL: Soil Name, USCS, Color, Plasticity, Moisture, Consistency/Relative Density, Texture, Cementation, Structure, Origin. ROCK: Rock Name, Color, Weathering, Hardness, Discontinuity Spacing, Joint Filling, Core Recovery, Formation Name.) | Unit Description | Graphic Log | Drilling Methods, Size and Remarks / Water Level/ Date | Backfill/ Instrumentation |
|---|---|---|---|---|---|---|---|---|---|
| 25 | N8 | 60 | 10-30-26 | | N- 8 (25.00-26.50) Clayey GRAVEL with some sand; GC; Gray; Medium plasticity fines; Wet; Very dense; Fine to coarse, angular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | | | | |
| 30 | N9 | 47 | 16-16-18 | | N- 9 (30.00-31.50) Clayey GRAVEL with some sand; GC; Gray; Medium plasticity fines; Wet; Dense; Fine to coarse, angular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | | | Large cobble at 32 ft | |
| 35 | N10 | 47 | 13-14-12 | | N- 10 (35.00-36.50) Clayey GRAVEL with some sand; GC; Gray; Medium plasticity fines; Wet; Medium dense; Fine to coarse, angular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | | | | |
| 40 | N11 | 40 | 13-14-17 | | N- 11 (40.00-41.50) Clayey GRAVEL with some sand; GC; Gray; Medium plasticity fines; Wet; Dense; Fine to coarse, angular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | | | | |
| | | | | | | **42.00 - 48.00 GRAVEL with some clay and some sand, with cobbles and boulders; GP-GC; Gray; Medium plasticity fines; Wet; Very dense; Fine to coarse, angular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies)** | | Boulder from 42 to 44 ft | |
| 45 | N12 | 53 | 19-20-50/5" | | N- 12 (45.00-46.50) GRAVEL with some clay and some sand; GP-GC; Gray; Medium plasticity fines; Wet; Very dense; Fine to coarse, angular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | | | | |
| 50 | N13 | 100 | 2-3-3 | | N- 13 (50.00-51.50) Silty CLAY with trace sand; CL; Gray; Medium plasticity; Moist; Medium stiff; Fine sand; Micaceous; (Missoula Flood Deposits - Fine-Grained Facies) | **48.00 - 54.00 Silty CLAY with trace sand; CL; Gray; Medium plasticity; Moist; Medium stiff; Fine sand; Micaceous; (Missoula Flood Deposits - Fine-Grained Facies)** | | | |
| | U1 | 100 | | 41 | U- 1 (52.00-54.00) Silty CLAY with trace sand; CL; Gray; Medium plasticity; Moist; Medium stiff; Fine sand; Micaceous; (Missoula Flood Deposits - Fine-Grained Facies) | | | Sample U1: dry unit weight = 79.5 lbs/ft$^3$ | |
| 55 | | | | | | **54.00 End of hole** | | | |
| 60 | | | | | | | | | |
| 63 | | | | | | | | | |

ODOT DRILL LOG 24-1-04041-002.GPJ ODOT_MAN.GDT 6/15/17

**SHANNON & WILSON, INC.**
Geotechnical and Environmental Consultants

# DRILL LOG

OREGON DEPARTMENT OF TRANSPORTATION



| | | | |
|---|---|---|---|
| | | | Hole No. **B-03** |
| Project **5th Street to Kinsman Road Extension** | | Purpose **Subgrade** | E.A. No. **N/A** |
| Highway **N/A** | | County **Clackamas County** | Key No. **N/A** |
| Hole Location Northing: **~ 603,450** | | Easting: **~ 7,615,457** | Start Card No. **N/A** |
| Equipment **Buck Rodgers (Manual Hammer)** | | Driller **Dan Fisher** | Bridge No. **N/A** |
| Project Geologist **Adrian A.J. Holmes** | | Recorder **Nathan Villeneuve** | Ground Elev. **~ 154 ft.** |
| Start Date **April 24, 2017** | End Date **April 24, 2017** | Total Depth **12.10 ft** | Tube Height **N/A** |

**Test Type**
"A" - Auger Core "GP" - GeoProbe®
"X" - Auger
"C" - Core, Barrel Type
"N" - Standard Penetration
"U" - Undisturbed Sample
"T" - Test Pit

**Rock Abbreviations**

| Discontinuity | Shape | Surface Roughness |
|---|---|---|
| J - Joint | Pl - Planar | P - Polished |
| F - Fault | C - Curved | Sl - Slickensided |
| B - Bedding | U - Undulating | Sm - Smooth |
| Fo - Foliation | St - Stepped | R - Rough |
| S - Shear | Ir - Irregular | VR - Very Rough |

**Typical Drilling Abbreviations**

| Drilling Methods | Drilling Remarks |
|---|---|
| WL - Wire Line | LW - Lost Water |
| HS - Hollow Stem Auger | WR - Water Return |
| DF - Drill Fluid | WC - Water Color |
| SA - Solid Auger | DP - Down Pressure |
| CA - Casing Advancer | DR - Drill Rate |
| HA - Hand Auger | DA - Drill Action |

| Depth (ft) | Test Type, No. | Percent Recovery | Soil / Rock: Driving Resistance / Discontinuity Data Or RQD% | Percent Natural Moisture | Material Description (SOIL: Soil Name, USCS, Color, Plasticity, Moisture, Consistency/Relative Density, Texture, Cementation, Structure, Origin. ROCK: Rock Name, Color, Weathering, Hardness, Discontinuity Spacing, Joint Filling, Core Recovery, Formation Name.) | Unit Description | Graphic Log | Drilling Methods, Size and Remarks / Water Level/ Date | Backfill/ Instrumentation |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | **0.00 - 4.50 Silty CLAY with some sand; CL; Brown; Medium plasticity; Moist; Medium stiff to stiff; Fine sand; Micaceous; Trace organics; (Missoula Flood Deposits - Fine-Grained Facies)** | | Solid-stem auger drilling technique (4.5-inch dia. hole) | |
| | N1 | 87 | 3-3-5 | 32 | N- 1 (2.50-4.00) Silty CLAY with some sand; CL; Brown; Medium plasticity; Moist; Medium stiff to stiff; Fine sand; Micaceous, Trace organics; (Missoula Flood Deposits - Fine-Grained Facies) | | | | |
| 5 | N2 | 80 | 2-3-4 | | N- 2 (5.00-6.50) Sandy SILT; ML; Brown; Nonplastic to low plasticity; Moist; Loose / medium stiff; Fine sand; Micaceous; (Missoula Flood Deposits - Fine-Grained Facies) | **4.50 - 11.70 Sandy SILT; ML; Brown; Nonplastic to low plasticity; Moist to wet; Loose / medium stiff; Fine sand, Micaceous; Interbedded with layers of Silty SAND; SM; (Missoula Flood Deposits - Fine-Grained Facies)** | | | |
| | N3 | 67 | 2-3-3 | 25 | N- 3 (7.50-9.00) Silty SAND; SM; Brown; Nonplastic fines; Moist; Loose; Fine sand; Micaceous; (Missoula Flood Deposits - Fine-Grained Facies) | | | | |
| 10 | N4 | 100 | 3-3-4 | | N- 4 (10.00-11.50) Sandy SILT; ML; Brown; Low plasticity; Wet; Medium stiff; Fine sand; Micaceous, Interbedded with Silty Sand; (Missoula Flood Deposits - Fine-Grained Facies) | **10.00 Grades to wet** | | | |
| | N5 | 0 | 50/1st 1" | | N- 5 (12.00-12.10) No recovery | **11.70 - 12.10 Clayey GRAVEL with some sand, with cobbles and boulders; GC; inferred; (Missoula Flood Deposits - Gravel Facies)** | | | |
| 15 | | | | | | **12.10 End of hole** | | | |
| 20 | | | | | | | | | |
| 25 | | | | | | | | | |

**SHANNON & WILSON, INC.**
Geotechnical and Environmental Consultants

# DRILL LOG
OREGON DEPARTMENT OF TRANSPORTATION



| | | | |
|---|---|---|---|
| | | | Hole No. **B-04** |
| Project **5th Street to Kinsman Road Extension** | | Purpose **Bridge** | E.A. No. **N/A** |
| Highway **N/A** | | County **Clackamas County** | Key No. **N/A** |
| Hole Location Northing: **~ 603,453** | Easting: **~ 7,615,881** | | Start Card No. **N/A** |
| Equipment **CME-850 Track Rig (Hammer Efficiency = 87%)** | | Driller **Hard Core Drilling** | Bridge No. **N/A** |
| Project Geologist **Adrian A.J. Holmes** | | Recorder **Nathan Villeneuve** | Ground Elev. **~ 141 ft.** |
| Start Date **April 21, 2017** | End Date **April 21, 2017** | Total Depth **51.50 ft** | Tube Height **N/A** |

**Test Type**
"A" - Auger Core
"X" - Auger
"C" - Core, Barrel Type
"N" - Standard Penetration
"U" - Undisturbed Sample
"T" - Test Pit
"GP" - GeoProbe®

**Rock Abbreviations**

| Discontinuity | Shape | Surface Roughness |
|---|---|---|
| J - Joint | Pl - Planar | P - Polished |
| F - Fault | C - Curved | Sl - Slickensided |
| B - Bedding | U - Undulating | Sm - Smooth |
| Fo - Foliation | St - Stepped | R - Rough |
| S - Shear | Ir - Irregular | VR - Very Rough |

**Typical Drilling Abbreviations**

| Drilling Methods | Drilling Remarks |
|---|---|
| WL - Wire Line | LW - Lost Water |
| HS - Hollow Stem Auger | WR - Water Return |
| DF - Drill Fluid | WC - Water Color |
| SA - Solid Auger | DP - Down Pressure |
| CA - Casing Advancer | DR - Drill Rate |
| HA - Hand Auger | DA - Drill Action |

| Depth (ft) | Test Type, No. | Percent Recovery | Soil / Rock: Driving Resistance / Discontinuity Data Or RQD% | Percent Natural Moisture | Material Description (SOIL: Soil Name, USCS, Color, Plasticity, Moisture, Consistency/Relative Density, Texture, Cementation, Structure, Origin. ROCK: Rock Name, Color, Weathering, Hardness, Discontinuity Spacing, Joint Filling, Core Recovery, Formation Name.) | Unit Description | Graphic Log | Drilling Methods, Size and Remarks / Water Level/ Date | Backfill/ Instrumentation |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | **0.00 - 4.50 Sandy SILT with trace gravel; ML; Brown; Low plasticity; Moist; Stiff; Fine to medium sand; Micaceous; (Fill)** | | Mud rotary drilling technique (5-inch dia. hole) | |
| | N1 | 100 | 3-6-6 | | N- 1 (2.50-4.00) Sandy SILT with trace gravel; ML; Brown; Low plasticity; Moist; Stiff; Fine to medium sand; Micaceous; (Fill) | | | | |
| 5 | N2 | 80 | 14-22-16 | 23 | N- 2 (5.00-6.50) Sandy clayey GRAVEL; GC; Brown and gray; Medium plasticity fines; Moist; Dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | **4.50 - 48.50 Clayey GRAVEL with some sand to Sandy clayey GRAVEL, with cobbles and boulders; GC; Brown and gray; Medium plasticity fines; Moist; Medium dense to very dense; Fine to coarse, subangular to rounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies)** | | | |
| | N3 | 60 | 10-11-50/4" | | N- 3 (7.50-9.00) Clayey GRAVEL with some sand; GC; Brown and gray; Medium plasticity fines; Moist; Very dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | | | Cobbles from 9 to 50 ft | |
| 10 | N4 | 100 | 9-17-21 | | N- 4 (10.00-11.50) Clayey GRAVEL with some sand; GC; Brown and gray; Medium plasticity fines; Moist; Dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | | | Large cobble at 10.5 ft | |
| | N5 | 67 | 18-27-24 | | N- 5 (12.50-14.00) Clayey GRAVEL with some sand; GC; Brown and gray; Medium plasticity fines; Moist; Dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | | | | |
| 15 | N6 | 100 | 12-17-15 | | N- 6 (15.00-16.50) Clayey GRAVEL with some sand; GC; Brown and gray; Medium plasticity fines; Moist; Dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | | | | |
| 20 | N7 | | 14-14-22 | | N- 7 (20.00-21.50) GRAVEL with some clay and some sand to Clayey GRAVEL with some sand; GP-GC/GC; Brown and gray; Medium plasticity fines; Wet; Dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | | | | |
| 25 | | | | | | | | | |

| Depth (ft) | Test Type, No. | Percent Recovery | Soil / Rock: Driving Resistance / Discontinuity Data Or RQD% | Percent Natural Moisture | Material Description (SOIL: Soil Name, USCS, Color, Plasticity, Moisture, Consistency/Relative Density, Texture, Cementation, Structure, Origin. ROCK: Rock Name, Color, Weathering, Hardness, Discontinuity Spacing, Joint Filling, Core Recovery, Formation Name.) | Unit Description | Graphic Log | Drilling Methods, Size and Remarks / Water Level/ Date | Backfill/ Instrumentation |
|---|---|---|---|---|---|---|---|---|---|
| 25 | N8 | 73 | 9-11-11 | | N- 8 (25.00-26.50) Clayey GRAVEL with some sand; GC; Brown and gray; Medium plasticity fines; Moist; Medium dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | | | | |
| 30 | N9 | 67 | 11-15-13 | | N- 9 (30.00-31.50) Clayey GRAVEL with some sand; GC; Brown and gray; Medium plasticity fines; Moist; Medium dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | | | Large cobble at 32 ft | |
| 35 | N10 | 47 | 18-21-17 | | N- 10 (35.00-36.50) Clayey GRAVEL with some sand; GC; Brown and gray; Medium plasticity fines; Moist; Dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | | | | |
| 40 | N11 | 47 | 21-20-15 | | N- 11 (40.00-41.50) Clayey GRAVEL with some sand; GC; Gray; Medium plasticity fines; Moist to wet; Dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | | | Large cobble at 39 ft | |
| 45 | N12 | 40 | 28-50/1" | | N- 12 (45.00-46.50) Clayey GRAVEL with some sand; GC; Gray; Medium plasticity fines; Moist to wet; Very dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | | | Large cobble at 46.5 ft | |
| 50 | N13 | 100 | 1-3-3 | | N- 13 (50.00-51.50) Silty CLAY with trace sand; CL; Gray; Medium plasticity; Moist; Medium stiff; Fine sand; Micaceous; (Missoula Flood Deposits - Fine-Grained Facies) | **48.50 - 51.50 Silty CLAY with trace sand; CL; Gray; Medium plasticity; Moist; Medium stiff; Fine sand; Micaceous; (Missoula Flood Deposits - Fine-Grained Facies)** **51.50 End of hole** | | | |
| 55 | | | | | | | | | |
| 60 | | | | | | | | | |
| 63 | | | | | | | | | |

**SHANNON & WILSON, INC.**
Geotechnical and Environmental Consultants

# DRILL LOG
OREGON DEPARTMENT OF TRANSPORTATION



| | | | |
|---|---|---|---|
| | | | Hole No. **B-05** |
| Project **5th Street to Kinsman Road Extension** | | Purpose **Bridge** | E.A. No. **N/A** |
| Highway **N/A** | | County **Clackamas County** | Key No. **N/A** |
| Hole Location Northing: **~ 603,364** | Easting: **~ 7,615,978** | | Start Card No. **N/A** |
| Equipment **CME-75 Truck Rig (Hammer Efficiency = 88%)** | | Driller **Hard Core Drilling** | Bridge No. **N/A** |
| Project Geologist **Adrian A.J. Holmes** | | Recorder **Nathan Villeneuve** | Ground Elev. **~ 135 ft.** |
| Start Date **April 20, 2017** | End Date **April 20, 2017** | Total Depth **51.50 ft** | Tube Height **N/A** |

**Test Type**
"A" - Auger Core
"X" - Auger
"C" - Core, Barrel Type
"N" - Standard Penetration
"U" - Undisturbed Sample
"T" - Test Pit
"GP" - GeoProbe®

**Rock Abbreviations**

| Discontinuity | Shape | Surface Roughness |
|---|---|---|
| J - Joint | Pl - Planar | P - Polished |
| F - Fault | C - Curved | Sl - Slickensided |
| B - Bedding | U - Undulating | Sm - Smooth |
| Fo - Foliation | St - Stepped | R - Rough |
| S - Shear | Ir - Irregular | VR - Very Rough |

**Typical Drilling Abbreviations**

| Drilling Methods | Drilling Remarks |
|---|---|
| WL - Wire Line | LW - Lost Water |
| HS - Hollow Stem Auger | WR - Water Return |
| DF - Drill Fluid | WC - Water Color |
| SA - Solid Auger | DP - Down Pressure |
| CA - Casing Advancer | DR - Drill Rate |
| HA - Hand Auger | DA - Drill Action |

| Depth (ft) | Test Type, No. | Percent Recovery | Soil / Rock: Driving Resistance / Discontinuity Data Or RQD% | Percent Natural Moisture | Material Description (SOIL: Soil Name, USCS, Color, Plasticity, Moisture, Consistency/Relative Density, Texture, Cementation, Structure, Origin. ROCK: Rock Name, Color, Weathering, Hardness, Discontinuity Spacing, Joint Filling, Core Recovery, Formation Name.) | Unit Description | Graphic Log | Drilling Methods, Size and Remarks / Water Level/ Date | Backfill/ Instrumentation |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | **0.00 - 4.50 Silty CLAY with some sand and trace gravel, with cobbles and boulders; CL; Brown; Medium plasticity; Moist; Medium stiff to stiff; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; Trace organics; (Fill)** | | Mud rotary drilling technique (5-inch dia. hole)<br>Cobbles and boulders visible on ground surface | |
| | N1 | 33 | 2-4-4 | | N- 1 (2.50-4.00) Silty CLAY with some sand and trace gravel; CL; Brown; Medium plasticity; Moist; Medium stiff to stiff; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; Trace organics; (Fill) | | | | |
| 5 | N2 | 100 | 20-29-24 | | N- 2 (5.00-6.50) Clayey GRAVEL with some sand; GC; Brown, gray, and red-yellow mottled; Medium plasticity fines; Moist; Very dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | | | Possible boulder from 4.8 to 5.5 ft | |
| | N3 | 100 | 26-31-39 | | N- 3 (7.50-9.00) Clayey GRAVEL with some sand; GC; Brown, gray, and red-yellow mottled; Medium plasticity fines; Moist; Very dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | **4.50 - 38.00 Clayey GRAVEL with some sand, with cobbles and boulders; GC; Brown, gray, and red-yellow mottled; Medium plasticity fines; Moist; Dense to very dense; Fine to coarse, subangular to rounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies)** | | Large cobble at 8 ft | |
| 10 | N4 | 66 | 21-50/5" | | N- 4 (10.00-10.90) Clayey GRAVEL with some sand; GC; Brown, gray, and red-yellow mottled; Medium plasticity fines; Moist; Very dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | | | Large cobble at 11 ft | |
| | N5 | 100 | 14/34/34 | | N- 5 (12.50-14.00) Clayey GRAVEL with some sand; GC; Brown, gray, and red-yellow mottled; Medium plasticity fines; Moist; Very dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | | | | |
| 15 | N6 | 100 | 16-21-19 | 22 | N- 6 (15.00-16.50) Clayey GRAVEL with some sand; GC; Brown and gray; Medium plasticity fines; Moist; Dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | **15.00 Grades to brown and gray** | | | |
| 20 | N7 | 80 | 15-20-20 | | N- 7 (20.00-21.50) Clayey GRAVEL with some sand; GC; Brown and gray; Medium plasticity fines; Moist; Dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | | | | |
| 25 | | | | | | | | | |

| Depth (ft) | Test Type, No. | Percent Recovery | Soil / Rock: Driving Resistance / Discontinuity Data Or RQD% | Percent Natural Moisture | Material Description (SOIL: Soil Name, USCS, Color, Plasticity, Moisture, Consistency/Relative Density, Texture, Cementation, Structure, Origin. ROCK: Rock Name, Color, Weathering, Hardness, Discontinuity Spacing, Joint Filling, Core Recovery, Formation Name.) | Unit Description | Graphic Log | Drilling Methods, Size and Remarks / Water Level/ Date | Backfill/ Instrumentation |
|---|---|---|---|---|---|---|---|---|---|
| 25 | N8 | 100 | 17-22-21 | | N- 8 (25.00-26.50) Clayey GRAVEL with some sand; GC; Brown and gray; Medium plasticity fines; Wet; Dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | | | | |
| 30 | N9 | 67 | 18-14-30 | | N- 9 (30.00-31.50) Clayey GRAVEL with some sand; GC; Brown and gray; Medium plasticity fines; Wet; Dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; 2-inch-thick interbed of nonplastic Sandy SILT; ML; (Missoula Flood Deposits - Gravel Facies) | | | | |
| 35 | N10 | 67 | 17-19-17 | | N- 10 (35.00-36.50) Clayey GRAVEL with some sand; GC; Gray; Medium plasticity fines; Moist; Dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | | | | |
| 40 | N11 | 85 | 38-50/2" | | N- 11 (40.00-40.60) GRAVEL with some clay and some sand; GP-GC; Gray; Medium plasticity fines; Moist; Very dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | **38.00 - 43.00 GRAVEL with some clay and some sand, with cobbles and boulders; GP-GC; Brown and gray; Medium plasticity fines; Moist; Very dense; Fine to coarse, subangular to rounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies)** | | Lost approx. 60 gallons of drilling mud at 41 ft | |
| 45 | N12 | 100 | 3-5-3 | | N- 12 (45.00-46.50) SILT with trace sand; ML; Gray; Low plasticity; Moist; Medium stiff to stiff; Fine sand; Micaceous; (Missoula Flood Deposits - Fine-Grained Facies) | **43.00 - 51.50 SILT grading down to Silty CLAY with trace sand; ML to CL; Gray; Low to medium plasticity; Moist; Medium stiff to stiff; Fine sand; Micaceous; (Missoula Flood Deposits - Fine-Grained Facies)** | | | |
| 50 | N13 | 100 | 2/3/28 | | N- 13 (50.00-51.50) Silty CLAY with trace sand; CL; Gray; Medium plasticity; Moist; Medium stiff to stiff; Fine sand; Micaceous; Gravel clast stuck in shoe; (Missoula Flood Deposits - Fine-Grained Facies) | **51.50 End of hole** | | Gravel clast stuck in shoe at 50 ft; N-value possibly affected | |
| 55 | | | | | | | | | |
| 60 | | | | | | | | | |
| 63 | | | | | | | | | |

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Geotechnical and Environmental Consultants

# DRILL LOG
OREGON DEPARTMENT OF TRANSPORTATION



| | | | |
|---|---|---|---|
| | | | Hole No. **B-06** |
| Project **5th Street to Kinsman Road Extension** | | Purpose **Railroad Undercrossing** | E.A. No. **N/A** |
| Highway **N/A** | | County **Clackamas County** | Key No. **N/A** |
| Hole Location Northing: **~ 603,116** | Easting: **~ 7,616,672** | | Start Card No. **N/A** |
| Equipment **CME-75 Truck Rig (Hammer Efficiency = 88%)** | | Driller **Hard Core Drilling** | Bridge No. **N/A** |
| Project Geologist **Adrian A.J. Holmes** | | Recorder **Nathan Villeneuve** | Ground Elev. **~ 144 ft.** |
| Start Date **April 18, 2017** | End Date **April 19, 2017** | Total Depth **41.50 ft** | Tube Height **N/A** |

**Test Type**
"A" - Auger Core
"X" - Auger
"C" - Core, Barrel Type
"N" - Standard Penetration
"U" - Undisturbed Sample
"T" - Test Pit
"GP" - GeoProbe®

**Rock Abbreviations**

| Discontinuity | Shape | Surface Roughness |
|---|---|---|
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| F - Fault | C - Curved | Sl - Slickensided |
| B - Bedding | U - Undulating | Sm - Smooth |
| Fo - Foliation | St - Stepped | R - Rough |
| S - Shear | Ir - Irregular | VR - Very Rough |

**Typical Drilling Abbreviations**

| Drilling Methods | Drilling Remarks |
|---|---|
| WL - Wire Line | LW - Lost Water |
| HS - Hollow Stem Auger | WR - Water Return |
| DF - Drill Fluid | WC - Water Color |
| SA - Solid Auger | DP - Down Pressure |
| CA - Casing Advancer | DR - Drill Rate |
| HA - Hand Auger | DA - Drill Action |

| Depth (ft) | Test Type, No. | Percent Recovery | Soil / Rock: Driving Resistance / Discontinuity Data Or RQD% | Percent Natural Moisture | Material Description (SOIL: Soil Name, USCS, Color, Plasticity, Moisture, Consistency/Relative Density, Texture, Cementation, Structure, Origin. ROCK: Rock Name, Color, Weathering, Hardness, Discontinuity Spacing, Joint Filling, Core Recovery, Formation Name.) | Unit Description | Graphic Log | Drilling Methods, Size and Remarks / Water Level/ Date | Backfill/ Instrumentation |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | **0.00 - 1.00 Topsoil** | | Mud rotary drilling technique (5-inch dia. hole) | |
| | | | | | | **1.00 - 2.50 GRAVEL; GP; (Fill)** | | | |
| | N1 | 66 | 1-3-4 | | N- 1 (2.50-4.00) Silty CLAY with trace sand and gravel; CL; Brown; Medium plasticity; Moist; Medium stiff; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Fine-Grained Facies) | **2.50 - 7.00 Silty CLAY with trace sand; CL; Brown; Medium plasticity; Moist; Medium stiff to stiff; Fine sand; (Missoula Flood Deposits - Fine-Grained Facies)** | | | |
| 5 | N2 | 100 | 3-4-5 | 36 | N- 2 (5.00-6.50) Silty CLAY with trace sand; CL; Brown; Medium plasticity; Moist; Stiff; Fine sand; (Missoula Flood Deposits - Fine-Grained Facies) | | | | |
| | N3 | 87 | 27-25-21 | | N- 3 (7.50-9.00) Clayey GRAVEL with some sand; GC; Brown and gray; Medium plasticity fines; Moist; Dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | **7.00 - 28.00 Clayey GRAVEL with some sand, with cobbles and boulders; GC; Brown; Medium plasticity fines; Moist; Dense to very dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies)** | | | |
| 10 | N4 | 100 | 13-18-17 | | N- 4 (10.00-11.50) Clayey GRAVEL with some sand; GC; Brown and gray; Medium plasticity fines; Moist; Dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | | | | |
| | N5 | 100 | 18-21-17 | 16 | N- 5 (12.50-14.00) Clayey GRAVEL with some sand; GC; Brown and gray; Medium plasticity fines; Moist; Dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | | | Lost approx. 30 gallons of drilling mud at 14 ft | |
| 15 | N6 | 73 | 13-13-21 | | N- 6 (15.00-16.50) Clayey GRAVEL with some sand; GC; Brown and gray; Medium plasticity fines; Moist; Dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | | | Large cobble at 16 ft | |
| 20 | N7 | 93 | 13-21-50/4" | | N- 7 (20.00-21.30) Clayey GRAVEL with some sand; GC; Brown and gray; Medium plasticity fines; Moist; Very dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | | | | |
| 25 | | | | | | | | | |

| Depth (ft) | Test Type, No. | Percent Recovery | Soil / Rock: Driving Resistance / Discontinuity Data Or RQD% | Percent Natural Moisture | Material Description (SOIL: Soil Name, USCS, Color, Plasticity, Moisture, Consistency/Relative Density, Texture, Cementation, Structure, Origin. ROCK: Rock Name, Color, Weathering, Hardness, Discontinuity Spacing, Joint Filling, Core Recovery, Formation Name.) | Unit Description | Graphic Log | Drilling Methods, Size and Remarks / Water Level/ Date | Backfill/ Instrumentation |
|---|---|---|---|---|---|---|---|---|---|
| 25 | N8 | 66 | 31-12-19 | | N- 8 (25.00-26.50) Clayey GRAVEL with some sand; GC; Brown and gray; Medium plasticity fines; Moist to wet; Dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | | | Lost approx. 60 gallons of drilling mud at 25 ft | |
| 30 | N9 | 66 | 12-13-18 | | N- 9 (30.00-31.50) Sandy silty GRAVEL; GM; Brown and gray; Low plasticity fines; Moist to wet; Dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; Micaceous; 2-inch-thick interbed of Silty SAND; SM; (Missoula Flood Deposits - Gravel Facies) | **28.00 - 38.00 Sandy silty GRAVEL; GM; Brown to gray; Low plasticity fines; Moist to wet; Dense to very dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; Trace 2- to 3-inch-thick interbeds of Silty SAND; SM; (Missoula Flood Deposits - Gravel Facies)** | | Large cobble at 32 ft | |
| 35 | N10 | 66 | 15-21-36 | | N- 10 (35.00-36.50) Sandy silty GRAVEL; GM; Brown and gray; Low plasticity fines; Moist to wet; Very dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; Micaceous; (Missoula Flood Deposits - Gravel Facies) | | | Large cobble at 36 ft | |
| 40 | N11 | 66 | 3-40-37 | | N- 11 (40.00-41.50) Sandy SILT with some gravel; ML; Brown; Nonplastic; Wet; Very dense; Fine to coarse, subangular to subrounded gravel; Mostly fine sand; Micaceous | **38.00 - 41.50 Sandy SILT with some gravel; ML; Brown; Nonplastic; Wet; Very dense; Fine to coarse, subangular to subrounded gravel; Mostly fine sand; Micaceous; (Missoula Flood Deposits - Fine-Grained Facies)** | | GeoKon 4500S Vibrating Wire SN: 1709934 installed at 39 ft | |
| 45 | | | | | | **41.50 End of hole** | | | |
| 50 | | | | | | | | | |
| 55 | | | | | | | | | |
| 60 | | | | | | | | | |
| 63 | | | | | | | | | |

**SHANNON & WILSON, INC.**
Geotechnical and Environmental Consultants

# DRILL LOG
OREGON DEPARTMENT OF TRANSPORTATION



| | | | |
|---|---|---|---|
| | | | Hole No. **B-07** |
| Project **5th Street to Kinsman Road Extension** | | Purpose **Railraod Undercrossing** | E.A. No. **N/A** |
| Highway **N/A** | | County **Clackamas County** | Key No. **N/A** |
| Hole Location Northing: **~ 603,015** | Easting: **~ 7,616,796** | | Start Card No. **N/A** |
| Equipment **CME-75 Truck Rig (Hammer Efficiency = 88%)** | | Driller **Hard Core Drilling** | Bridge No. **N/A** |
| Project Geologist **Adrian A.J. Holmes** | | Recorder **Nathan Villeneuve** | Ground Elev. **~ 148 ft.** |
| Start Date **April 18, 2017** | End Date **April 19, 2017** | Total Depth **41.50 ft** | Tube Height **N/A** |

**Test Type**
"A" - Auger Core
"X" - Auger
"C" - Core, Barrel Type
"N" - Standard Penetration
"U" - Undisturbed Sample
"T" - Test Pit
"GP" - GeoProbe®

**Rock Abbreviations**

| Discontinuity | Shape | Surface Roughness |
|---|---|---|
| J - Joint | Pl - Planar | P - Polished |
| F - Fault | C - Curved | Sl - Slickensided |
| B - Bedding | U - Undulating | Sm - Smooth |
| Fo - Foliation | St - Stepped | R - Rough |
| S - Shear | Ir - Irregular | VR - Very Rough |

**Typical Drilling Abbreviations**

| Drilling Methods | Drilling Remarks |
|---|---|
| WL - Wire Line | LW - Lost Water |
| HS - Hollow Stem Auger | WR - Water Return |
| DF - Drill Fluid | WC - Water Color |
| SA - Solid Auger | DP - Down Pressure |
| CA - Casing Advancer | DR - Drill Rate |
| HA - Hand Auger | DA - Drill Action |

| Depth (ft) | Test Type, No. | Percent Recovery | Soil / Rock: Driving Resistance / Discontinuity Data Or RQD% | Percent Natural Moisture | Material Description (SOIL: Soil Name, USCS, Color, Plasticity, Moisture, Consistency/Relative Density, Texture, Cementation, Structure, Origin. ROCK: Rock Name, Color, Weathering, Hardness, Discontinuity Spacing, Joint Filling, Core Recovery, Formation Name.) | Unit Description | Graphic Log | Drilling Methods, Size and Remarks / Water Level/ Date | Backfill/ Instrumentation |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | **0.00 - 0.50 Asphalt Concrete; 6 inches thick** | | Mud rotary drilling technique (5-inch dia. hole) | |
| | N1 | 33 | 1-2-3 | | N- 1 (2.50-4.00) Silty CLAY with trace sand and gravel; CL; Brown; Medium plasticity; Moist; Medium stiff; Fine, subangular to subrounded gravel; Fine to coarse sand; Micaceous; (Fill) | **0.50 - 1.50 Base Aggregate; 12 inches thick** | | | |
| | | | | | | **1.50 - 4.50 Silty CLAY with trace sand and gravel; CL; Brown; Medium plasticity; Moist; Medium stiff; (Fill)** | | | |
| 5 | N2 | 47 | 18-50/5" | | N- 2 (5.00-5.90) Silty GRAVEL with some sand; GM; Brown to gray; Low plasticity fines; Moist to wet; Very dense; Fine to coarse, angular to subrounded gravel; Fine to coarse sand; Slight odor; (Fill) | **4.50 - 7.00 Silty GRAVEL with some sand; GM; Brown to gray; Low plasticity fines; Moist to wet; Very dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; Slight odor; (Fill)** | | | |
| | N3 | 60 | 9-11-16 | | N- 3 (7.50-9.00) Clayey GRAVEL with some sand; GC; Brown to gray; Medium plasticity fines; Moist; Medium dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | | | | |
| 10 | N4 | 53 | 5-9-8 | | N- 4 (10.00-11.50) Clayey GRAVEL with some sand; GC; Brown to gray; Medium plasticity fines; Moist; Medium dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; Micaceous; (Missoula Flood Deposits - Gravel Facies) | | | Lost approx. 60 gallons of drilling mud at 10 ft | |
| | N5 | 53 | 5-15-14 | | N- 5 (12.50-14.00) GRAVEL with some clay and some sand; GP-GC; Brown to gray; Medium plasticity fines; Moist; Medium dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; Micaceous; (Missoula Flood Deposits - Gravel Facies) | **7.00 - 17.80 Clayey GRAVEL with some sand to GRAVEL with some clay and some sand, with cobbles and boulders; GC and GP-GC; Brown to gray; Moist; Medium dense to very dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies)** | | Lost mud circulation at 12.4 ft | |
| 15 | N6 | 66 | 9-44-50 | 15 | N- 6 (15.00-16.50) Clayey GRAVEL with some sand; GC; Red-brown to gray; Medium plasticity fines; Moist; Very dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | | | | |
| 20 | N7 | 80 | 5-8-12 | | N- 7 (20.00-21.50) Gravelly CLAY with some sand; CH; Brown; High plasticity; Moist; Very stiff; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | **17.80 - 21.50 Gravelly CLAY with some sand; CH; Brown; High plasticity; Moist; Very stiff; Fine to coarse gravel; fine to coarse sand; (Missoula Flood Deposits -** | | Boulder at 21.5 ft | |
| 25 | | | | | | | | | |

| Depth (ft) | Test Type, No. | Percent Recovery | Soil / Rock: Driving Resistance / Discontinuity Data Or RQD% | Percent Natural Moisture | Material Description (SOIL: Soil Name, USCS, Color, Plasticity, Moisture, Consistency/Relative Density, Texture, Cementation, Structure, Origin. ROCK: Rock Name, Color, Weathering, Hardness, Discontinuity Spacing, Joint Filling, Core Recovery, Formation Name.) | Unit Description | Graphic Log | Drilling Methods, Size and Remarks / Water Level/ Date | Backfill/ Instrumentation |
|---|---|---|---|---|---|---|---|---|---|
| 25 | N8 | 60 | 21-27-27 | | N- 8 (25.00-26.50) GRAVEL with some silt and some sand; GP-GM; Brown and gray; Low plasticity fines; Wet; Very dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | **Gravel Facies)** | | | |
| | | | | | | **21.50 - 28.50 GRAVEL with some silt and some sand, with cobbles and boulders; GP-GM; Brown and gray; Low plasticity fines; Wet; Very dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies)** | | Large cobble at 28 ft | |
| 30 | N9 | 47 | 9-15-29 | | N- 9 (30.00-31.50) Clayey GRAVEL with some sand; GC; Brown and gray; Medium plasticity fines; Wet; Dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | | | | |
| | | | | | | **28.50 - 41.50 Clayey GRAVEL with some sand, with cobbles and boulders; GC; Brown and gray; Medium plasticity fines; Moist to wet; Dense to very dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies)** | | | |
| 35 | N10 | 53 | 15-27-20 | | N- 10 (35.00-36.50) Clayey GRAVEL with some sand; GC; Brown and gray; Medium plasticity fines; Moist; Dense; Fine to coarse, subangular to rounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | | | | |
| 40 | N11 | 66 | 18-29-26 | | N- 11 (40.00-41.50) Clayey GRAVEL with some sand; GC; Brown; Medium plasticity fines; Moist; Very dense; Fine to coarse, subangular to subrounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | | | | |
| | | | | | | **41.50 End of hole** | | | |
| 45 | | | | | | | | | |
| 50 | | | | | | | | | |
| 55 | | | | | | | | | |
| 60 | | | | | | | | | |
| 63 | | | | | | | | | |

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Geotechnical and Environmental Consultants

# DRILL LOG
OREGON DEPARTMENT OF TRANSPORTATION



| | | | |
|---|---|---|---|
| | | | Hole No. **B-08** |
| Project **5th Street to Kinsman Road Extension** | | Purpose **Subgrade** | E.A. No. **N/A** |
| Highway **N/A** | | County **Clackamas County** | Key No. **N/A** |
| Hole Location Northing: **~ 603,189** | Easting: **~ 7,616,060** | | Start Card No. **N/A** |
| Equipment **Buck Rodgers (Manual Hammer)** | | Driller **Dan Fisher** | Bridge No. **N/A** |
| Project Geologist **Adrian A.J. Holmes** | | Recorder **Nathan Villeneuve** | Ground Elev. **~ 148 ft.** |
| Start Date **April 24, 2017** | End Date **April 24, 2017** | Total Depth **11.50 ft** | Tube Height **N/A** |

**Test Type**
"A" - Auger Core
"X" - Auger
"C" - Core, Barrel Type
"N" - Standard Penetration
"U" - Undisturbed Sample
"T" - Test Pit
"GP" - GeoProbe®

**Rock Abbreviations**

| Discontinuity | Shape | Surface Roughness |
|---|---|---|
| J - Joint | Pl - Planar | P - Polished |
| F - Fault | C - Curved | Sl - Slickensided |
| B - Bedding | U - Undulating | Sm - Smooth |
| Fo - Foliation | St - Stepped | R - Rough |
| S - Shear | Ir - Irregular | VR - Very Rough |

**Typical Drilling Abbreviations**

| Drilling Methods | Drilling Remarks |
|---|---|
| WL - Wire Line | LW - Lost Water |
| HS - Hollow Stem Auger | WR - Water Return |
| DF - Drill Fluid | WC - Water Color |
| SA - Solid Auger | DP - Down Pressure |
| CA - Casing Advancer | DR - Drill Rate |
| HA - Hand Auger | DA - Drill Action |

| Depth (ft) | Test Type, No. | Percent Recovery | Soil / Rock: Driving Resistance / Discontinuity Data Or RQD% | Percent Natural Moisture | Material Description (SOIL: Soil Name, USCS, Color, Plasticity, Moisture, Consistency/Relative Density, Texture, Cementation, Structure, Origin. ROCK: Rock Name, Color, Weathering, Hardness, Discontinuity Spacing, Joint Filling, Core Recovery, Formation Name.) | Unit Description | Graphic Log | Drilling Methods, Size and Remarks / Water Level/ Date | Backfill/ Instrumentation |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | **0.00 - 4.50 Silty CLAY with some sand and trace gravel; CL; Brown; Low to medium plasticity; Moist; Medium stiff; Fine to coarse gravel; Fine to coarse sand; Micaceous; (Fill)** | | Solid-stem auger drilling technique (4.5-inch hole) | |
| | N1 | 100 | 2-2-4 | | N- 1 (2.50-4.00) Silty CLAY with some sand and trace gravel; CL; Brown; Low to medium plasticity; Moist; Medium stiff; Fine to coarse gravel; Fine to coarse sand; Micaceous; (Fill) | | | | |
| 5 | N2 | 100 | 3-3-5 | | N- 2 (5.00-6.50) Silty CLAY with trace to some sand; CL; Brown; Medium plasticity; Moist; Medium stiff to stiff; Fine sand; Micaceous; (Missoula Flood Deposits - Fine-Grained Facies) | **4.50 - 10.00 Silty CLAY with trace to some sand; CL; Brown; Medium plasticity; Moist; Medium stiff to stiff; Fine sand; Micaceous; (Missoula Flood Deposits - Fine-Grained Facies)** | | | |
| | N3 | 100 | 4-5-7 | | N- 3 (7.50-9.00) Silty CLAY with some sand; CL; Brown; Medium plasticity; Moist; Stiff; Fine sand; Micaceous; (Missoula Flood Deposits - Fine-Grained Facies) | | | | |
| 10 | N4 | 93 | 16-26-35 | | N- 4 (10.00-11.50) Clayey GRAVEL with some sand to Sandy clayey GRAVEL; GC; Brown and gray; Medium plasticity fines; Moist; Very dense; Fine to coarse, subangular to rounded gravel; Fine to coarse sand; Moderate iron oxidation; (Missoula Flood Deposits - Gravel Facies) | **10.00 - 11.50 Clayey GRAVEL with some sand to Sandy clayey GRAVEL; GC; Brown and gray; Medium plasticity fines; Moist; Very dense; Fine to coarse, subangular to rounded gravel; Fine to coarse sand; Moderate iron oxidation; (Missoula Flood Deposits - Gravel Facies)** | | | |
| 15 | | | | | | **11.50 End of hole** | | | |
| 20 | | | | | | | | | |
| 25 | | | | | | | | | |

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# DRILL LOG
OREGON DEPARTMENT OF TRANSPORTATION



| | | | |
|---|---|---|---|
| | | | Hole No. **B-09** |
| Project **5th Street to Kinsman Road Extension** | | Purpose **Infiltration** | E.A. No. **N/A** |
| Highway **N/A** | | County **Clackamas County** | Key No. **N/A** |
| Hole Location Northing: **~ 603,349** | Easting: **~ 7,615,666** | | Start Card No. **N/A** |
| Equipment **CME-850 Track Rig (Hammer Efficiency = 87%)** | | Driller **Hard Core Drilling** | Bridge No. **N/A** |
| Project Geologist **Adrian A.J. Holmes** | | Recorder **Nathan Villeneuve** | Ground Elev. **~ 147 ft.** |
| Start Date **April 21, 2017** | End Date **April 21, 2017** | Total Depth **6.50 ft** | Tube Height **N/A** |

**Test Type**
"A" - Auger Core
"X" - Auger
"C" - Core, Barrel Type
"N" - Standard Penetration
"U" - Undisturbed Sample
"T" - Test Pit
"GP" - GeoProbe®

**Rock Abbreviations**

| Discontinuity | Shape | Surface Roughness |
|---|---|---|
| J - Joint | Pl - Planar | P - Polished |
| F - Fault | C - Curved | Sl - Slickensided |
| B - Bedding | U - Undulating | Sm - Smooth |
| Fo - Foliation | St - Stepped | R - Rough |
| S - Shear | Ir - Irregular | VR - Very Rough |

**Typical Drilling Abbreviations**

| Drilling Methods | Drilling Remarks |
|---|---|
| WL - Wire Line | LW - Lost Water |
| HS - Hollow Stem Auger | WR - Water Return |
| DF - Drill Fluid | WC - Water Color |
| SA - Solid Auger | DP - Down Pressure |
| CA - Casing Advancer | DR - Drill Rate |
| HA - Hand Auger | DA - Drill Action |

| Depth (ft) | Test Type, No. | Percent Recovery | Soil / Rock: Driving Resistance / Discontinuity Data Or RQD% | Percent Natural Moisture | Material Description (SOIL: Soil Name, USCS, Color, Plasticity, Moisture, Consistency/Relative Density, Texture, Cementation, Structure, Origin. ROCK: Rock Name, Color, Weathering, Hardness, Discontinuity Spacing, Joint Filling, Core Recovery, Formation Name.) | Unit Description | Graphic Log | Drilling Methods, Size and Remarks / Water Level/ Date | Backfill/ Instrumentation |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | **0.00 - 6.50 Sandy SILT; ML; Brown; Nonplastic to low plasticity; Moist; Loose / medium stiff; Fine sand; Micaceous; (Missoula Flood Deposits - Fine-Grained Facies)** | | Hollow-stem auger drilling technique (6-inch dia. hole) | |
| | N1 | 47 | 2-2-3 | | N- 1 (2.50-4.00) Sandy SILT; ML; Brown; Low plasticity; Moist; Medium stiff; Fine sand; Micaceous; (Fill) | | | | |
| 5 | N2 | 53 | 2-4-3 | | N- 2 (5.00-6.50) Sandy SILT; ML; Brown; Nonplastic to low plasticity; Moist; Loose / medium stiff; Fine sand; Micaceous; (Fill) | | | | |
| | | | | | | **6.50 End of hole** | | | |
| 10 | | | | | | | | | |
| 15 | | | | | | | | | |
| 20 | | | | | | | | | |
| 25 | | | | | | | | | |

ODOT DRILL LOG 24-1-04041-002.GPJ ODOT_MAN.GDT 6/15/17

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Geotechnical and Environmental Consultants

# DRILL LOG

OREGON DEPARTMENT OF TRANSPORTATION



| | | | |
|---|---|---|---|
| | | | Hole No. **B-10** |
| Project **5th Street to Kinsman Road Extension** | | Purpose **Pavement** | E.A. No. **N/A** |
| Highway **N/A** | | County **Clackamas County** | Key No. **N/A** |
| Hole Location Northing: **~ 604,022** | Easting: **~ 7,615,614** | | Start Card No. **N/A** |
| Equipment **Buck Rodgers (Manual Hammer)** | | Driller **Dan Fisher** | Bridge No. **N/A** |
| Project Geologist **Adrian A.J. Holmes** | | Recorder **Nathan Villeneuve** | Ground Elev. **~ 148 ft.** |
| Start Date **April 24, 2017** | End Date **April 24, 2017** | Total Depth **6.50 ft** | Tube Height **N/A** |

**Test Type**
"A" - Auger Core
"X" - Auger
"C" - Core, Barrel Type
"N" - Standard Penetration
"U" - Undisturbed Sample
"T" - Test Pit
"GP" - GeoProbe®

**Rock Abbreviations**

| Discontinuity | Shape | Surface Roughness |
|---|---|---|
| J - Joint | Pl - Planar | P - Polished |
| F - Fault | C - Curved | Sl - Slickensided |
| B - Bedding | U - Undulating | Sm - Smooth |
| Fo - Foliation | St - Stepped | R - Rough |
| S - Shear | Ir - Irregular | VR - Very Rough |

**Typical Drilling Abbreviations**

| Drilling Methods | Drilling Remarks |
|---|---|
| WL - Wire Line | LW - Lost Water |
| HS - Hollow Stem Auger | WR - Water Return |
| DF - Drill Fluid | WC - Water Color |
| SA - Solid Auger | DP - Down Pressure |
| CA - Casing Advancer | DR - Drill Rate |
| HA - Hand Auger | DA - Drill Action |

| Depth (ft) | Test Type, No. | Percent Recovery | Soil / Rock: Driving Resistance / Discontinuity Data Or RQD% | Percent Natural Moisture | Material Description (SOIL: Soil Name, USCS, Color, Plasticity, Moisture, Consistency/Relative Density, Texture, Cementation, Structure, Origin. ROCK: Rock Name, Color, Weathering, Hardness, Discontinuity Spacing, Joint Filling, Core Recovery, Formation Name.) | Unit Description | Graphic Log | Drilling Methods, Size and Remarks / Water Level/ Date | Backfill/ Instrumentation |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | **0.00 - 0.50 Asphalt Concrete; 6 inches thick** | | Solid-stem auger drilling technique (4.5-inch dia. hole) | |
| | | | | | | **0.50 - 0.70 Base Aggregate; 2.5 inches thick** | | | |
| | N1 | 100 | 3-4-5 | | N- 1 (2.50-4.00) SILT with some sand; ML; Brown; Low plasticity; Moist; Stiff; Fine sand; Micaceous; (Missoula Flood Deposits - Fine-Grained Facies) | **0.70 - 6.30 SILT to Silty CLAY with some sand; ML/CL; Brown; Low to medium plasticity; Moist; Stiff; Fine sand; Micaceous; (Missoula Flood Deposits - Fine-Grained Facies)** | | | |
| 5 | N2A | 100 | 3-7-19 | | (5.00-6.50) N- 2A (5.00) SILT to Silty CLAY with some sand; ML/CL; Olive-Brown; Low to medium plasticity; Moist; Stiff; Fine sand; Micaceous; (Missoula Flood Deposits - Fine-Grained Facies) | | | | |
| | N2B | | | | N- 2B (6.30) Clayey GRAVEL with some sand; GC; Gray and brown; Low to medium plasticity fines; Moist; Medium dense; Fine to coarse, subangular to rounded gravel, Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies) | **6.30 - 6.50 Clayey GRAVEL with some sand; GC; Gray and brown; Low to medium plasticity fines; Moist; Medium dense; Fine to coarse, subangular to rounded gravel; Fine to coarse sand; (Missoula Flood Deposits - Gravel Facies)** | | | |
| 10 | | | | | | **6.50 End of hole** | | | |
| 15 | | | | | | | | | |
| 20 | | | | | | | | | |
| 25 | | | | | | | | | |

ODOT DRILL LOG 24-1-04041-002.GPJ ODOT_MAN.GDT 6/15/17

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# DRILL LOG
OREGON DEPARTMENT OF TRANSPORTATION



| | | | |
|---|---|---|---|
| | | | Hole No. **B-11** |
| Project **5th Street to Kinsman Road Extension** | | Purpose **Infiltration** | E.A. No. **N/A** |
| Highway **N/A** | | County **Clackamas County** | Key No. **N/A** |
| Hole Location Northing: **~ 603,686** | Easting: **~ 7,615,519** | | Start Card No. **N/A** |
| Equipment **Buck Rodgers (Manual Hammer)** | | Driller **Dan Fisher** | Bridge No. **N/A** |
| Project Geologist **Adrian A.J. Holmes** | | Recorder **Nathan Villeneuve** | Ground Elev. **~ 153 ft.** |
| Start Date **April 24, 2017** | End Date **April 24, 2017** | Total Depth **5.00 ft** | Tube Height **N/A** |

**Test Type**
"A" - Auger Core
"X" - Auger
"C" - Core, Barrel Type
"N" - Standard Penetration
"U" - Undisturbed Sample
"T" - Test Pit
"GP" - GeoProbe®

**Rock Abbreviations**

| Discontinuity | Shape | Surface Roughness |
|---|---|---|
| J - Joint | Pl - Planar | P - Polished |
| F - Fault | C - Curved | Sl - Slickensided |
| B - Bedding | U - Undulating | Sm - Smooth |
| Fo - Foliation | St - Stepped | R - Rough |
| S - Shear | Ir - Irregular | VR - Very Rough |

**Typical Drilling Abbreviations**

| Drilling Methods | Drilling Remarks |
|---|---|
| WL - Wire Line | LW - Lost Water |
| HS - Hollow Stem Auger | WR - Water Return |
| DF - Drill Fluid | WC - Water Color |
| SA - Solid Auger | DP - Down Pressure |
| CA - Casing Advancer | DR - Drill Rate |
| HA - Hand Auger | DA - Drill Action |

| Depth (ft) | Test Type, No. | Percent Recovery | Soil / Rock: Driving Resistance / Discontinuity Data Or RQD% | Percent Natural Moisture | Material Description (SOIL: Soil Name, USCS, Color, Plasticity, Moisture, Consistency/Relative Density, Texture, Cementation, Structure, Origin. ROCK: Rock Name, Color, Weathering, Hardness, Discontinuity Spacing, Joint Filling, Core Recovery, Formation Name.) | Unit Description | Graphic Log | Drilling Methods, Size and Remarks / Water Level/ Date | Backfill/ Instrumentation |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | **0.00 - 5.00 Silty CLAY with some sand; CL; Brown; Medium plasticity; Moist; Medium stiff; Fine sand; Micaceous; (Missoula Flood Deposits - Fine-Grained Facies)** | | Solid-stem auger drilling technique (6-inch dia. hole) | |
| | N1 | 100 | 3-3-4 | | N- 1 (2.50-4.00) Silty CLAY with some sand; CL; Brown; Medium plasticity; Moist; Medium stiff; Fine sand; Micaceous; (Missoula Flood Deposits - Fine-Grained Facies) | | | | |
| 5 | | | | | | **5.00 End of hole** | | | |
| 10 | | | | | | | | | |
| 15 | | | | | | | | | |
| 20 | | | | | | | | | |
| 25 | | | | | | | | | |

ODOT DRILL LOG 24-1-04041-002.GPJ ODOT_MAN.GDT 6/15/17

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# DRILL LOG
OREGON DEPARTMENT OF TRANSPORTATION

Figure **A12**
Page **1** of **1**

| | | |
|---|---|---|
| | | Hole No. **B-12** |
| Project **5th Street to Kinsman Road Extension** | Purpose **Infiltration** | E.A. No. **N/A** |
| Highway **N/A** | County **Clackamas County** | Key No. **N/A** |
| Hole Location Northing: **~ 603,075** Easting: **~ 7,616,325** | | Start Card No. **N/A** |
| Equipment **Buck Rodgers (Manual Hammer)** | Driller **Dan Fisher** | Bridge No. **N/A** |
| Project Geologist **Adrian A.J. Holmes** | Recorder **Nathan Villeneuve** | Ground Elev. **~ 148 ft.** |
| Start Date **April 24, 2017** End Date **April 24, 2017** | Total Depth **5.00 ft** | Tube Height **N/A** |

**Test Type**
"A" - Auger Core
"X" - Auger
"C" - Core, Barrel Type
"N" - Standard Penetration
"U" - Undisturbed Sample
"T" - Test Pit
"GP" - GeoProbe®

**Rock Abbreviations**

| Discontinuity | Shape | Surface Roughness |
|---|---|---|
| J - Joint | Pl - Planar | P - Polished |
| F - Fault | C - Curved | Sl - Slickensided |
| B - Bedding | U - Undulating | Sm - Smooth |
| Fo - Foliation | St - Stepped | R - Rough |
| S - Shear | Ir - Irregular | VR - Very Rough |

**Typical Drilling Abbreviations**

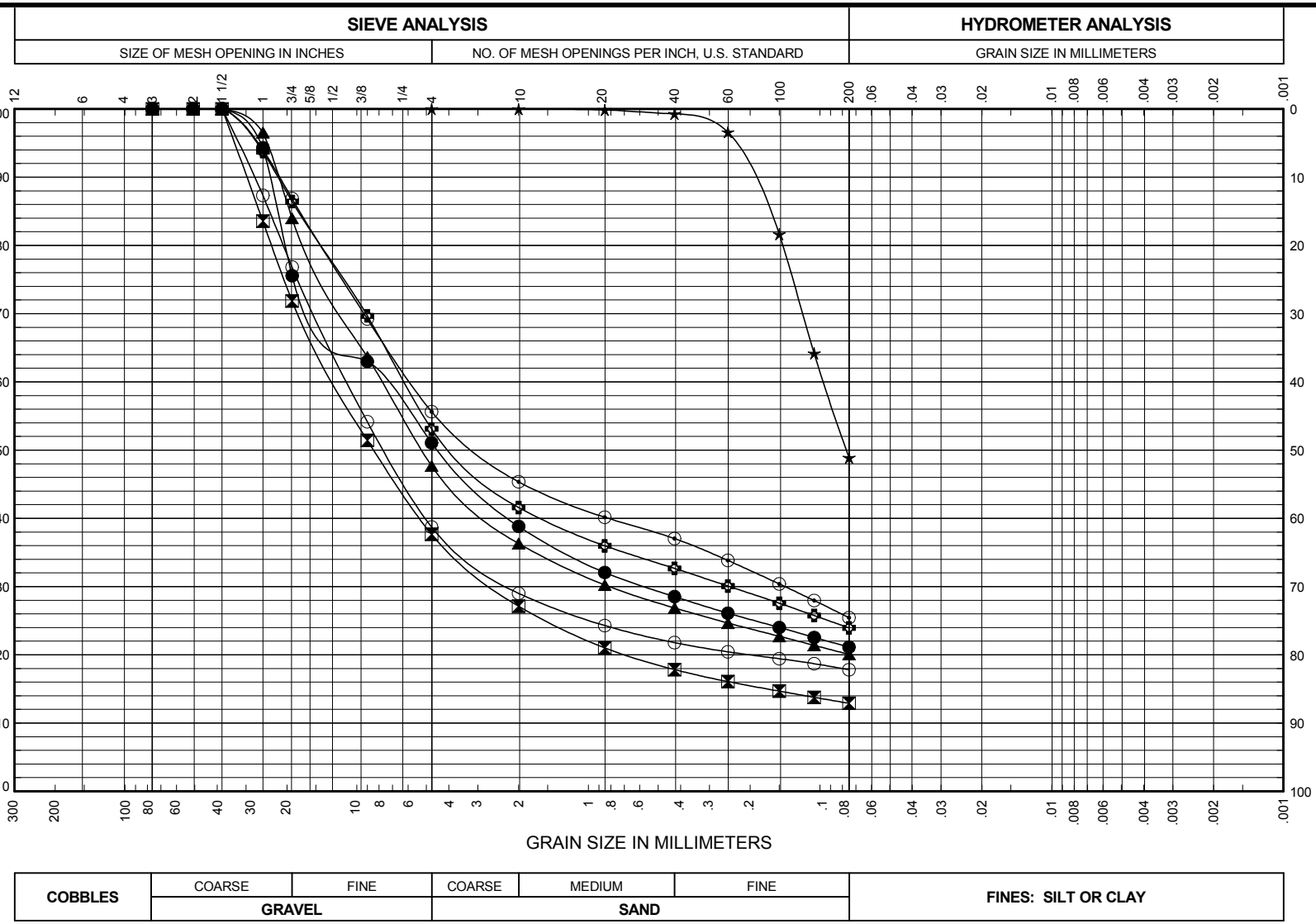
| Drilling Methods | Drilling Remarks |
|---|---|
| WL - Wire Line | LW - Lost Water |
| HS - Hollow Stem Auger | WR - Water Return |
| DF - Drill Fluid | WC - Water Color |
| SA - Solid Auger | DP - Down Pressure |
| CA - Casing Advancer | DR - Drill Rate |
| HA - Hand Auger | DA - Drill Action |

| Depth (ft) | Test Type, No. | Percent Recovery | Soil Driving Resistance / Rock Discontinuity Data Or RQD% | Percent Natural Moisture | Material Description (SOIL: Soil Name, USCS, Color, Plasticity, Moisture, Consistency/Relative Density, Texture, Cementation, Structure, Origin. ROCK: Rock Name, Color, Weathering, Hardness, Discontinuity Spacing, Joint Filling, Core Recovery, Formation Name.) | Unit Description | Graphic Log | Drilling Methods, Size and Remarks / Water Level/ Date | Backfill/ Instrumentation |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | **0.00 - 5.00 Silty CLAY with some sand; CL; Brown; Medium plasticity; Moist; Medium stiff; Fine sand; Micaceous; (Missoula Flood Deposits - Fine-Grained Facies)** | | Solid-stem auger drilling technique (6-inch dia. hole) | |
| | N1 | 100 | 2-2-3 | | N- 1 (2.50-4.00) Silty CLAY with some sand; CL; Brown; Medium plasticity; Moist; Medium stiff; Fine sand; Micaceous; (Missoula Flood Deposits - Fine-Grained Facies) | | | | |
| 5 | | | | | | **5.00 End of hole** | | | |
| 10 | | | | | | | | | |
| 15 | | | | | | | | | |
| 20 | | | | | | | | | |
| 25 | | | | | | | | | |

ODOT DRILL LOG 24-1-04041-002.GPJ ODOT_MAN.GDT 6/15/17

# ATTACHMENT B

# LABORATORY TEST RESULTS




NOTES:
1) Sieve analyses were performed in general accordance with ASTM D6913, sieve with hydrometer analyses were performed in general accordance with ASTM D422, and amount finer than #200 sieve analyses were performed in general accordance with ASTM D1140 unless otherwise noted in the report.
2) Group Name and Group Symbol are in accordance with ASTM D2488 and are refined in accordance with ASTM D2487 where appropriate laboratory tests are performed.

| BORING AND SAMPLE NO. | DEPTH (feet) | GROUP SYMBOL[2] | GROUP NAME[2] | GRAVEL % | SAND % | FINES % | NAT. W.C. % | DRY DENSITY PCF |
|---|---|---|---|---|---|---|---|---|
| ● B-01, N2 | 5.0 | *GM* | *Silty GRAVEL with some sand* | 49 | 30 | 21 | 28 | |
| ⊠ B-01, N9 | 30.0 | *GC* | *Clayey GRAVEL with some sand* | 62 | 25 | 13 | 19 | |
| ▲ B-02, N7 | 20.0 | *GC* | *Clayey GRAVEL with some sand* | 52 | 28 | 20 | 21 | |
| ★ B-03, N3 | 7.5 | *SM* | *Silty SAND* | 0 | 51 | 49 | 25 | |
| ⊙ B-04, N2 | 5.0 | *GC* | *Sandy clayey GRAVEL* | 44 | 30 | 25 | 23 | |
| ✿ B-05, N6 | 15.0 | *GC* | *Clayey GRAVEL with some sand* | 47 | 29 | 24 | 22 | |
| ○ B-06, N5 | 12.5 | *GC* | *Clayey GRAVEL with some sand* | 61 | 21 | 18 | 16 | |

5th Street to Kinsman Road Extension
Wilsonville, Oregon

## GRAIN SIZE DISTRIBUTION

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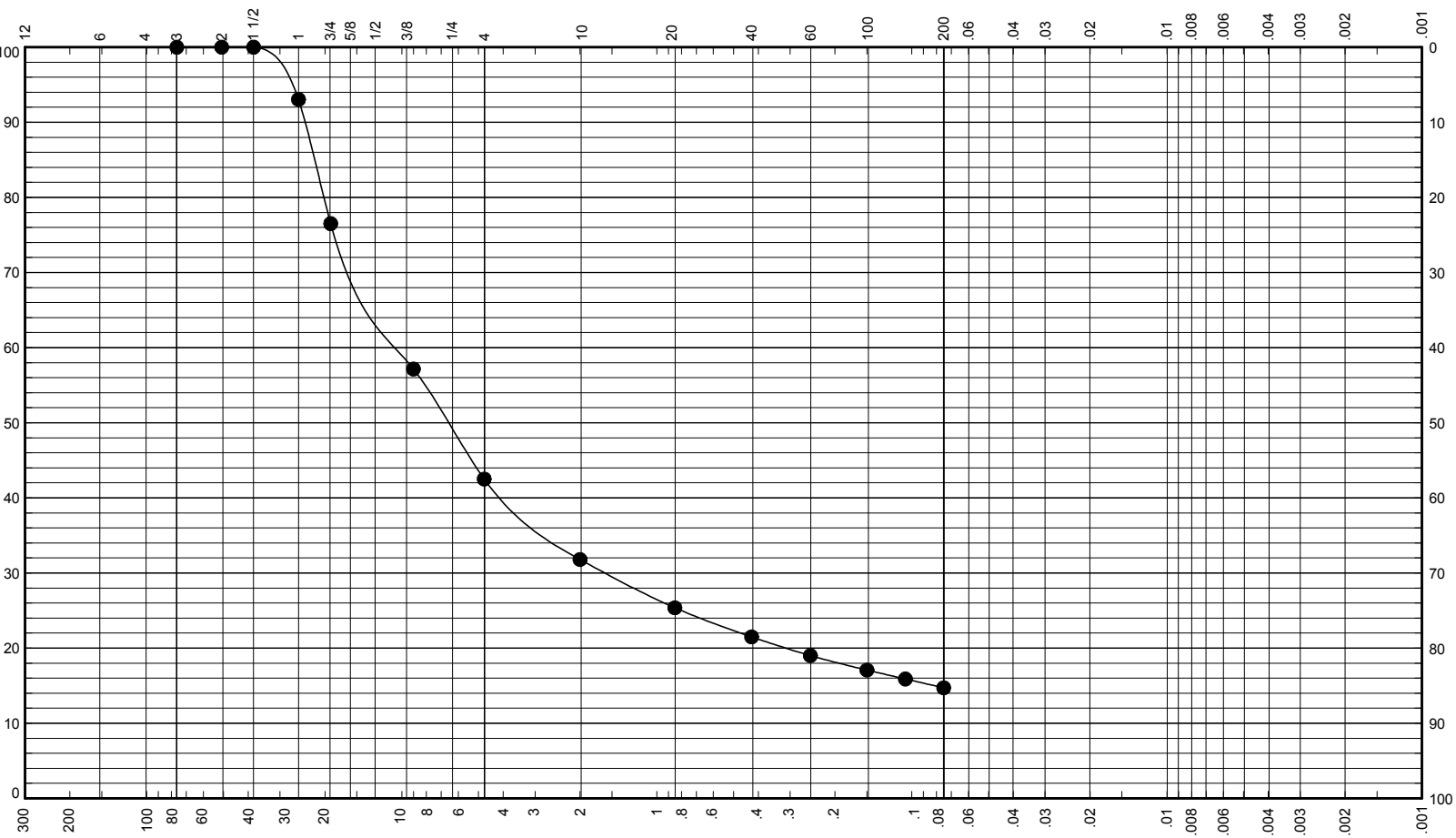
**FIG. B1**
Sheet 1 of 2

FIG. B1

GSA MAIN 24-1-04041-002.GPJ SHAN WIL.GDT 6/15/17




NOTES:
1) Sieve analyses were performed in general accordance with ASTM D6913, sieve with hydrometer analyses were performed in general accordance with ASTM D422, and amount finer than #200 sieve analyses were performed in general accordance with ASTM D1140 unless otherwise noted in the report.
2) Group Name and Group Symbol are in accordance with ASTM D2488 and are refined in accordance with ASTM D2487 where appropriate laboratory tests are performed.

| BORING AND SAMPLE NO. | DEPTH (feet) | GROUP SYMBOL[2] | GROUP NAME[2] | GRAVEL % | SAND % | FINES % | NAT. W.C. % | DRY DENSITY PCF |
|---|---|---|---|---|---|---|---|---|
| ● B-07, N6 | 15.0 | *GC* | *Clayey GRAVEL with some sand* | 57 | 28 | 15 | 15 | |

5th Street to Kinsman Road Extension
Wilsonville, Oregon

## GRAIN SIZE DISTRIBUTION

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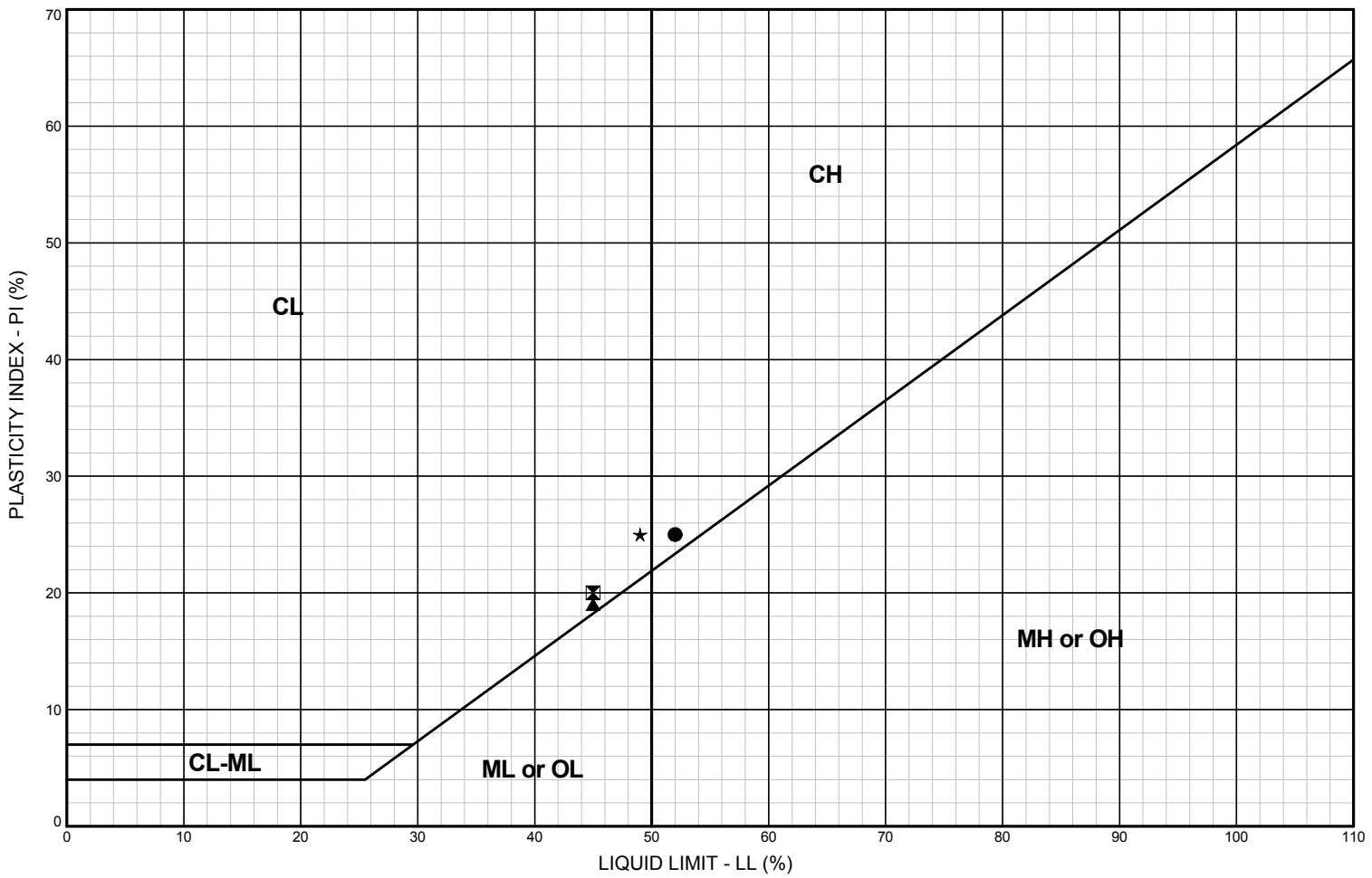
**FIG. B1**
Sheet 2 of 2

FIG. B1

GSA MAIN 24-1-04041-002.GPJ SHAN WIL.GDT 6/15/17




NOTES

1) Atterberg limits tests were performed in general accordance with ASTM D4318 unless otherwise noted in the report.

2) Group Name and Group Symbol are in accordance with ASTM D2488 and are refined in accordance with ASTM D2487 where appropriate laboratory tests are performed.

3) Plasticity adjectives used in sample descriptions correspond to plasticity index as follows:
- Nonplastic (NP) (< 3%)
- Low Plasticity (3 to 15%)
- Medium Plasticity (15 to 30%)
- High Plasticity (> 30%)

| BORING AND SAMPLE NO. | DEPTH (feet) | GROUP SYMBOL[2] | GROUP NAME[2] | LL % | PL % | PI %[3] | NAT. W.C. % | FINES % |
|---|---|---|---|---|---|---|---|---|
| ● B-01, N13 | 50.0 | *CH* | *CLAY with trace sand* | 52 | 27 | 25 | 43 | |
| ⧓ B-02, U1 | 52.0 | *CL* | *Silty CLAY with trace sand* | 45 | 25 | 20 | 41 | |
| ▲ B-03, N1 | 2.5 | *CL* | *Silty CLAY with some sand* | 45 | 26 | 19 | 32 | |
| ★ B-06, N2 | 5.0 | *CL* | *Silty CLAY with trace sand and gravel* | 49 | 24 | 25 | 36 | |

5th Street to Kinsman Road Extension
Wilsonville, Oregon

## ATTERBERG LIMITS RESULTS

May 2017 24-1-04041-002

**SHANNON & WILSON, INC.**
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**FIG. B2**

FIG. B2

# ATTACHMENT C

# IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL/ENVIRONMENTAL REPORT

**SHANNON & WILSON, INC.**
Geotechnical and Environmental Consultants

Attachment to and part of Report 24-1-04041-002

Date: June 16, 2017
To: Allen Hendy, PE
Otak

# 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