SOIL/ROCK DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.

### PENETRATION RESISTANCE (blows/foot)

- Hammer Wt. & Drop: 140 lbs / 30 inches

---

- Granodiorite boulder from 32.6 to 33.7 feet.

- Granodiorite boulder from 39 to 40.2 feet, UCS (Point Load) = 32,200 psi

- Granodiorite boulder from 44.6 to 47.7 feet.

---

BOTTOM OF BORING COMPLETED 8/29/2011

Note: Boring location not surveyed.

---

### LEGEND

- * Sample Not Recovered
- Rock Core
- Standard Penetration Test
- Grab Sample
- Piezometer Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level in VWP

### NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location was measured from existing site features and should be considered approximate.
Borehole Data

Material Description

Very dense, brown, fine gravelly, silty SAND; moist; locally trace of clay, scattered iron-oxide staining; (Qc) SM.

Note: Blow counts may be artificially high due to the presence of gravel.

Dense, gray-brown, silty, sandy GRAVEL; moist; locally trace of clay; (Qc) GM

Note: Blow counts may be artificially high due to the presence of gravel.

GRANODIORITE: Moderate to medium-high strength, gray, medium- to coarse-grained, igneous, smooth to rough, medium- to wide-spaced joints, scattered joints with less than 1- to 2-millimeter slick and sand infilling, fresh (1ig).

- UCS (Point Load) = 5,600 psi

- UCS (Unconfined Compression Test) = 9.510 psi

- Close- to medium-spaced fractures from 27.2 to 29.7 feet.

- UCS (Point Load) = 6,800 psi

Strength Index

Approximate UCS

Discontinuity Data

Type

Depth (ft)

Groundwater

Weathering Index

Note:

1. The contacts represent the approximate boundaries between lithology types, and the transition may be gradual.

2. The discussion in the text of this report is necessary for a proper understanding of the nature of the subsurface materials.

3. The locations of the discontinuities shown on the boring logs are approximate. For clarity, not all of the discontinuities are shown.
**Borehole Data**

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Sampled Depth (ft)</th>
<th>Discontinuity Data</th>
<th>Test Data</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
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<td>4</td>
</tr>
<tr>
<td>4</td>
<td>910</td>
<td></td>
<td>5</td>
</tr>
</tbody>
</table>

**Material Description**

Loose to medium dense, red-brown, silty, sandy GRAVEL; wet, scattered cobbles and boulders based on drill action, abundant iron oxide staining; (Qc) GM.

**Density Data**

- Very loose, gray GRAVEL; moist; (Qc) GP.

**Discontinuity Index**

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Discontinuity Data</th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
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<tr>
<td>890</td>
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<td>895</td>
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<td>900</td>
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<tr>
<td>905</td>
<td></td>
</tr>
<tr>
<td>910</td>
<td></td>
</tr>
</tbody>
</table>

**Strength Index**

- UCS (Point Load) = 33,200 psi
- UCS (Point Load) = 30,300 psi

**Joint Roughness Coefficient**

- 1
- 10
- 20
**Borehole Data**

- **Total Depth:** 55.5 ft
- **Ground Surface Elevation:** 915 ft
- **Depth in Rock:** ft

**Material Description**

- **GRANODIORITE:** Moderate to high strength, gray, medium- to coarse-grained, igneous, smooth to rough, medium- to wide-spaced joints, scattered joints with less than 1-millimeter silt and sand infilling, fresh to slightly weathered (Fig).

**Test Data**

- **SPT ▲ Blow/Foot Recovery (%)**
  - RD (%) □

**Weathering Index**

- **Ground Water**
  - **Vibrating Wire Piezometer**
  - **Sand Filter**
  - ** Bentonite Chips/Pellets**
  - **Bentonite Grout**

**Joint Roughness Coefficient**

- **Note:** Downhole geophysical logging performed in this boring. See Appendix E for geophysical data.

**LOG OF BORING B-3L**

December 2012

Index Galena Flood Repair Project
Milepost 6.4 to 6.9
Snohomish County, Washington

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

Sheet 2 of 2
**Borehole Data**

- **Total Depth:** 196.8 ft
- **Ground Surface Elevation:** 53.8 ft
- **Depth in Rock:** ft

**Material Description**

9.15

- Medium dense to very dense, brown, slightly silty to silty, sandy GRAVEL, wet; abundant cobbles and boulders based on drill action, scattered sandy silt pockets. (Oc) GP-GM-GM.
- Granodiorite boulder from 1.3 to 1.5 feet.
- Granodiorite boulder from 2.6 to 4.0 feet.

Note: Blow counts are artificially high due to the presence of gravel, cobbles, and boulders.

9.15

- Granodiorite boulder from 6.6 to 7.3 feet.

9.05

- Granodiorite boulder from 9.4 to 10.7 feet.

9.05

- Granodiorite boulder from 12.0 to 13.5 feet.

9.00

- Hard, brown, slightly sandy, silty CLAY, moist to wet; QvLCL.

9.00

- Medium dense, brown, trace of silt to slightly silty, sandy GRAVEL, wet, scattered boulders; (Oc) GP/GP-GM.
- Granodiorite boulder from 16.1 to 17.8 feet.

18.00

- Very stiff, brown, slightly sandy, clayey SILT, trace of fine gravel; moist to wet; scattered silty sand seams with iron-oxide staining, scattered silty clay seams; (QvHt) M L.

18.00

- Medium dense to very dense, gray-brown to brown, slightly silty, gravelly SAND to slightly silty, sandy GRAVEL, wet; scattered to abundant cobbles and boulders, scattered pockets with iron-oxide staining; (Oc) SP-SM/GP-GM.

Note: Blow counts are artificially high due to the presence of gravel, cobbles, and boulders.

---

**STRENGTH INDEX**

- **APPROXIMATE UCS:**
  - Very Low 1
  - Low 2
  - Moderate 3
  - Medium High 4
  - High 5
  - Very High 6

**DISCONTINUITY DATA**

- **TURN:**
  - Degrees relative to horizontal plane
  - Turn Index:
  - Infilling:

**WEATHERING INDEX**

- **TURN:**
  - Index:
  - Description:

**GROUNDWATER**

- **Vibrating Wire Piezometer:**
- **Sand Filter:**
- ** Bentonite Chips/Points:**
- ** Bentonite Grout:**

**SAMPLES**

- **SPT Sample No.:**
- **Core Run No.:**

**TEST DATA**

- **I = Water Content (%):**
- **L = Liquefied Limit:**
- **PL = Plastic Limit:**
- **UCS = Unconfined Compressive Strength (psi):**
- **RDS = Rate Loss of Test (sec):**
- **S = Stability (PMU%):**

---

**LOG OF BORING B-4L**

- **Index Galena Flood Repairs Project:**
- **Milepost 6.4 to 6.9:**
- **Snohomish County, Washington:**

- **December 2012:**
- **21-121116-031:**

SHANNON & WILSON, INC.

Technical and Environmental Consultants

FIG. A-6

Sheet 1 of 2
**SOIL DESCRIPTION**

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.

**TOPSOIL.**

Soft to medium stiff; gray to gray-brown, slightly sandy to sandy, silty CLAY; moist; scattered wet, silty, fine to medium sand seams with abundant iron-oxide staining; (Qvrl) CL.

- Boulder from 1.3 - to 2.4 feet, UCS (Point Load) = 23,300 psi

**Note:** Blow counts for S-5 are artificially high due to the presence of gravel, cobbles, and boulders in the underlying unit.

Dense to very dense, brown, slightly sandy to sandy GRAVEL, trace of silt; wet; scattered cobbles and boulders; (Qc) GP.

Note: Blow counts are artificially high due to the presence of gravel, cobbles, and boulders.

Loose, brown, slightly fine sandy SILT, trace of clay; moist to wet; non-plastic, scattered pockets with iron-oxide staining; (Qvrl) ML.

---

**LEGEND**

- * Sample Not Recovered
- Standard Penetration Test
- Rock Core
- Grab Sample
- Piezometer Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level in WWP

**NOTES**

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.

---

**LOG OF BORING B-5L**

December 2012

Index Galena Flood Repairs Project
Milepost 6.4 to 6.9
Snohomish County, Washington
### SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.

- Boulder from 30 to 31.3 feet, UCS (Point Load) = 15,100 psi
- Boulder from 35.6 to 36.6 feet.

**Very dense, sandy GRAVEL; wet; scattered to abundant cobbles and boulders based on drill action; (Qc) GP.**

### BOTTOM OF BORING

COMPLETED 8/26/2011

---

**LEGEND**

- Sample Not Recovered
- Standard Penetration Test
- Rock Core
- Grab Sample

- Piezometer Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout

- Ground Water Level in WWP

**NOTES**

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.

---

**LOG OF BORING B-5L**

December 2012  
21-1-21116-031

SHANNON & WILSON, INC.  
Geotechnical and Environmental Consultants  
Sheet 2 of 2
SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.

Soft, brown to gray-brown, slightly sandy, silty CLAY, trace of gravel; moist to wet; scattered organics, scattered silty, fine to medium sand partings; (Qvr1) CL.

Stiff, gray to gray-brown, silty CLAY, trace of sand; moist to wet; scattered red-brown, silty, fine sand and fine sandy silt interbeds with iron-oxide staining, laminated; (Qvr1) CL.

Medium dense, gray-brown, slightly silty, fine gravelly SAND; wet; (Qc) SW-SM.

Medium dense, brown, slightly fine sandy SILT, trace of fine gravel; wet; non-plastic, scattered iron-oxide staining; (Qvr1) ML.

Very dense, gray-brown, slightly silty, gravelly SAND; wet; scattered seams with abundant iron-oxide staining; (Qc) SW-SM.

Note: Blow count may be artificially high due to the presence of gravel.

Dense to very dense, brown to red-brown, slightly sandy SAND, trace of fine gravel; moist to wet; slight iron-oxide staining; (Qal) SP-SM.

Very dense, gray-brown, trace to slightly silty, slightly sandy to sandy GRAVEL; wet; abundant cobbles and boulders, scattered sand layers; (Qc) GP/GP-GM.

Legend:
- Sample Not Recovered
- Standard Penetration Test
- Rock Core
- Thin Wall Sample
- Grab Sample

Notes:
1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.

Index Galena Flood Repairs Project
Milepost 6.4 to 6.9
Snohomish County, Washington

LOG OF BORING B-6L

December 2012
21-1-21116-031

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants
FIG. A-8
Sheet 1 of 2
### SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.

Note: Blow counts may be artificially high due to the presence of gravel, cobbles, and boulders.
- Granodiorite boulder from 26.4 to 29.2 feet.
- Driller noted sand based on drill action from 29.2 to 30 feet.
- Granodiorite boulder from 30 to 33 feet, UCS (Point Load) = 12,300 psi
- Granodiorite cobble from 35.7 to 36.2 feet.
- Granodiorite boulder from 37 to 38.2 feet, UCS (Point Load) = 8,300 psi
- Soft zone from 39 to 40 feet.

- Circulation lost at 44.5 feet.

### BOTTOM OF BORING
COMPLETED 8/24/2011

### LEGEND

- Sample Not Recovered
- Standard Penetration Test
- Rock Core
- Thin Wall Sample
- Grab Sample

### NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
### SOIL/ROCK DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.

#### TOPSOIL

Gray to gray-brown, sandy GRAVEL, trace of silt; wet; predominantly cobbles and boulders, clast-supported; (Oc) GP.

- Granodiorite cobble/boulder from 6.7 to 7.4 feet, UCS (Point Load) = 30,200 psi
  Medium dense, brown, trace of gravel to gravelly, slightly silty to silty SAND; wet; trace of organics; (Qal) SP-SM/SM.

- Iron-oxide staining at about 14 feet.

Medium dense, brown, fine sandy SILT to silty, fine SAND, trace of clay; wet; non-plastic, scattered pockets with iron-oxide staining, scattered organics; (Qvr) ML/SM.

Note: Blow counts are artificially high due to the presence of gravel, cobbles, and boulders.

- Scattered gravel, cobbles, and boulders below 17 feet.

- Granodiorite boulder from 18.7 to 20 feet.

Medium dense, brown, sandy SILT, trace of clay and fine gravel; moist; non-plastic, scattered seams of wet, silty sand; (Qvr) ML.

Very dense, brown, slightly silty, sandy GRAVEL to slightly silty, gravelly SAND; wet; predominantly cobbles and boulders, clast-supported; (Oc) GP, GM/SM/SM.

---

**LEGEND**

- Sample Not Recovered
- Rock Core
- Grab Sample
- Standard Penetration Test

- Piezometer Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout

**GROUND WATER LEVEL in VWP**

**NOTES**

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.

---

**Index Galena Flood Repairs Project**

Milepost 6.4 to 6.9

Snohomish County, Washington

---

**LOG OF BORING B-7L**

December 2012

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-9
Sheet 1 of 2
### SOIL/ROCK DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.

- Granodiorite boulder from 22.8 to 23.8 feet.
- Granodiorite cobble from 24.1 to 24.6 feet.
- Granodiorite boulder from 24.9 to 26.6 feet, UCS (Point Load) = 24,800 psi.
- Granodiorite boulder from 26.9 to 28.4 feet.

**Note:** Blow counts may be artificially high due to the presence of gravel, cobbles, and boulders.

Gray to gray-brown, trace to slightly sandy GRAVEL, trace of silt to gravelly SAND, trace of silt; wet; predominantly cobbles and boulders, clast-supported; (Qc) GP/SP.

- Granodiorite boulder from 36.7 to 38.7 feet.

- Granodiorite boulder from 41.4 to 43.6 feet.

- Granodiorite boulder from 46.5 to 48.1 feet.

### PENETRATION RESISTANCE (blows/foot)

- Hammer Wt. & Drop: 140 lbs / 30 inches

### BOTTOM OF BORING COMPLETED 8/18/2011

### LEGEND

- * Sample Not Recovered
- Rock Core
- Grab Sample
- Standard Penetration Test
- Ground Water Level in WWP
- Piezometer Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout

### NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.

---

**Index Galena Flood Repairs Project**

Milepost 6.4 to 6.9

Snohomish County, Washington

**LOG OF BORING B-7L**

December 2012

21-1-21116-031
SOIL/ROCK DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.

TOPSOIL

Very dense, brown, silty, gravelly SAND; wet; (Qc) SM.
Note: Blow counts may be artificially high due to the presence of gravel.

Very dense, gray and brown, trace to slightly silty, sandy GRAVEL; wet; (Qc) GP/GP-GM.

- Granodiorite boulder from 4.4 to 7.2 feet.

- Granodiorite boulder from 10.8 to 12.2 feet, UCS (Point Load) = 19,500 psi
- Granodiorite boulder from 12.2 to 13.6 feet. Note: Blow counts are artificially high due to the presence of gravel and boulders.

LEGEND

- Sample Not Recovered
- Rock Core
- Standard Penetration Test
- Grab Sample

PENETRATION RESISTANCE (blows/foot)

▲ Hammer Wt. & Drop: 140 lbs / 30 inches

CONTINUED NEXT SHEET

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
SOIL/ROCK DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.

- Very soft drilling from 32.7 to 34.2 feet.

GRANODIORITE: Moderate to high strength, gray, medium- to coarse-grained, igneous, close- to medium-spaced joints, smooth to rough, scattered joints with less than 1- to 2-millimeter silt infilling, scattered joints with iron-oxide staining; fresh to slightly weathered.

- UCS (Point Load) = 15,300 psi

- UCS (Point Load) = 15,700 psi

- UCS (Unconfined Compression Test) = 17,210 psi

BOTTOM OF BORING
COMPLETED 9/8/2011

Note: Downhole geophysical logging performed in this boring. See Appendix E for geophysical data.

LEGEND

Sample Not Recovered
Rock Core
Standard Penetration Test
Grab Sample

NOTES
1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
**SOIL DESCRIPTION**

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.

Very loose, dark brown, silty SAND, trace of fine gravel; moist; locally slightly clayey, abundant organics; (Qm) SM.

Very loose, dark brown, silty SAND, trace of fine gravel; moist; abundant organics, scattered slightly clayey silt seams; (Qm) SM.

Very loose, dark brown, fine gravelly, silty SAND; wet; scattered to abundant organics, scattered wood fragments; (Qal) SM.

Loose, gray-brown, slightly silty, sandy GRAVEL; wet; trace of organics, wood fragments in core barrel at 7.5 feet; (Qal) GP-GM.

Note: Blow counts are locally artificially high due to the presence of wood and gravel.

Medium dense, brown to red-brown, slightly gravelly to gravelly, silty SAND; wet; scattered pockets with iron-oxide staining, scattered cobbles; (Qal) SM.

Very dense, brown, slightly fine gravelly, sandy SILT; wet; locally trace of clay, scattered pockets with iron-oxide staining; (Qal) ML.

Note: Blow counts are artificially high due to the presence of boulders.
- Granodiorite boulder from 18.3 to 19.3 feet.
- Granodiorite boulder from 20 to 21.2 feet.
- Granodiorite boulder from 23.3 to 24.3 feet.
- Granodiorite boulder from 27 to 28.4 feet.
- Granodiorite boulder from 28.4 to 29.9 feet.

**NOTES**

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.

BOTTOM OF BORING

COMPLETED 8/16/2011

LEGEND

* Sample Not Recovered
Standard Penetration Test
Rock Core
Thin Wall Sample

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.

Index Galena Flood Repairs Project
Milepost 6.4 to 6.9
Snohomish County, Washington

LOG OF BORING B-10L

December 2012 21-1-21116-031

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants
FIG. A-11
Sheet 2 of 2