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*Final Report*

# Geotechnical Baseline Report for Trenchless Undercrossing Bend Southeast Interceptor

Prepared for  
**City of Bend, Oregon**

January 2012

**CH2MHILL®**



EXPIRATION DATE: 12-31-2013

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# Contents

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Section	Page
<b>1.0 Introduction.....</b>	<b>1-1</b>
1.1 Purpose and Use of the Geotechnical Baseline Report.....	1-1
1.1.1 Purpose.....	1-1
1.1.2 Use.....	1-1
1.2 Precedence of This Document.....	1-2
1.3 Organization of Report.....	1-2
1.4 Limitations.....	1-2
<b>2.0 Project Description.....</b>	<b>2-1</b>
2.1.1 BNSF Crossing.....	2-1
<b>3.0 Sources of Information.....</b>	<b>3-1</b>
3.1 Topographic Data.....	3-1
3.2 Geologic Setting.....	3-1
3.3 Previous Geotechnical Explorations.....	3-1
3.4 Undercrossing Project Geotechnical Exploration.....	3-2
3.5 Recent Local Construction Observations.....	3-3
<b>4.0 Ground Characterization.....</b>	<b>4-1</b>
4.1 General.....	4-1
4.2 Subsurface Ground Conditions Encountered.....	4-1
4.3 Baseline Subsurface Conditions.....	4-2
<b>5.0 Construction Considerations.....</b>	<b>5-1</b>
5.1 General.....	5-1
5.2 Launch and Reception Pits/Shafts.....	5-1
5.2.1 5.2.1 Groundwater and Dewatering.....	5-1
5.2.2 Pit/Shaft Excavation Methods.....	5-1
5.2.3 Identified Pit/Shaft Risks.....	5-2
5.3 Tunneled Crossing.....	5-2
5.3.1 Machine Tunneling Excavation Method.....	5-2
5.3.2 Identified Tunnel Risks.....	5-3
5.4 Excavated Material Disposal.....	5-3
<b>6.0 References.....</b>	<b>6-1</b>

## Tables

1	Geotechnical Baseline Conditions for BNSF Railroad Undercrossing
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## Figures

1	Location and Vicinity Maps
2	Newberry Lava Flows
3	Unconfined Compression Strength Data Summary for SE Bend Area
4	BNSF Undercrossing Boring and Location Plan
5	Murphy Road Trench Support



# Introduction

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The 24-inch and 30-inch diameter City of Bend Southeast (SE) Interceptor gravity sewer pipeline extends from the existing plant interceptor near the North Unit Irrigation District (NUID) canal along Deschutes Market Road and southward approximately 6 miles to the intersection of Brosterhous Road and Murphy Road. The alignment includes a 360-foot-long trenchless crossing of the Burlington Northern Santa Fe (BNSF) railroad, between Brosterhous Road and SE 15th Street, roughly in alignment with a future extension of Murphy Road. The overall alignment is shown in Figure 1. The pipe crossing will be cased using an oversized welded steel pipe to support the tunnel and facilitate installation and future maintenance of the pipeline. The BNSF railroad crossing and the associated launch and reception pit and shafts are the subject of this Geotechnical Baseline Report (GBR). Figure 1 shows the approximate location of the crossing.

## 1.1 Purpose and Use of the Geotechnical Baseline Report

This GBR establishes a contractual understanding of the geotechnical conditions anticipated to be encountered during construction of the 24-inch sewer undercrossing of the BNSF railroad for the Bend SE Interceptor project.

### 1.1.1 Purpose

The principal purpose of the GBR is to set baselines for geotechnical conditions and materials behavior anticipated to be encountered during tunnel, pit and shaft, and associated riser construction in order to provide a basis for bidding and assist in resolving disputes that may arise over subsurface conditions. In addition, this GBR does the following:

- Presents the geotechnical and construction conditions that formed the basis of design of the crossing
- Identifies important considerations, key project constraints, and select requirements that must be addressed by the Contractor during bid preparation and construction
- Provides information to assist the Contractor in evaluating requirements for excavating and supporting the ground
- Provides guidance to the construction management team in administering the contract and monitoring Contractor performance

### 1.1.2 Use

The GBR provides the basis for identifying geotechnical and geologic conditions that qualify as changed conditions. The geotechnical baseline conditions (baseline) contained within this GBR are not necessarily geotechnical fact. The baseline was developed using judgment to interpolate between borings and extrapolate beyond the boring logs and laboratory test data. Bidders should use the baseline subsurface conditions and the surface conditions that can be observed during a site visit as the basis for bids. It should be noted that the project design was based on assumed construction methods and levels of workmanship. The behavior of the geologic materials present in the surface and subsurface excavations will be influenced by the Contractor's selected equipment, means, and methods.

The results of the project geotechnical investigations are contained in a geotechnical data report (GDR) titled Geotechnical Data Report – Bend Southeast Interceptor Project by CH2M HILL (CH2M HILL, January 2012). This GDR is incorporated into the contract documents. If there are disagreements or ambiguities between the geotechnical and geologic interpretations presented in this GBR and the data presented in the GDR, the GBR takes precedence.

The contract documents, including project plans and project technical specifications, should also be reviewed in conjunction with the GBR. Bidders should have a geotechnical engineer or engineering geologist review and

explain the information in this report to assure a complete understanding of the information contained in the report as a basis for submitting a bid.

Certain plans and figures contained in other documents in the contract facilitate an understanding of related site conditions and elements of the work. These plans and figures are referenced, but are not reproduced in, this report. Additional documents used to develop the GBR are listed in Section 6.0 References in this report. With the exception of the GDR, the documents listed in Section 6.0 are not incorporated as contract documents and are provided for reference only.

## 1.2 Precedence of This Document

The GBR is part of the contract documents. The precedence of contract documents is defined in Section 00150 – Control of Work of the contract documents. Note that City of Bend Special Conditions and Project Special Conditions may modify the Oregon Department of Transportation’s 2008 Standard Specifications for Construction.

## 1.3 Organization of Report

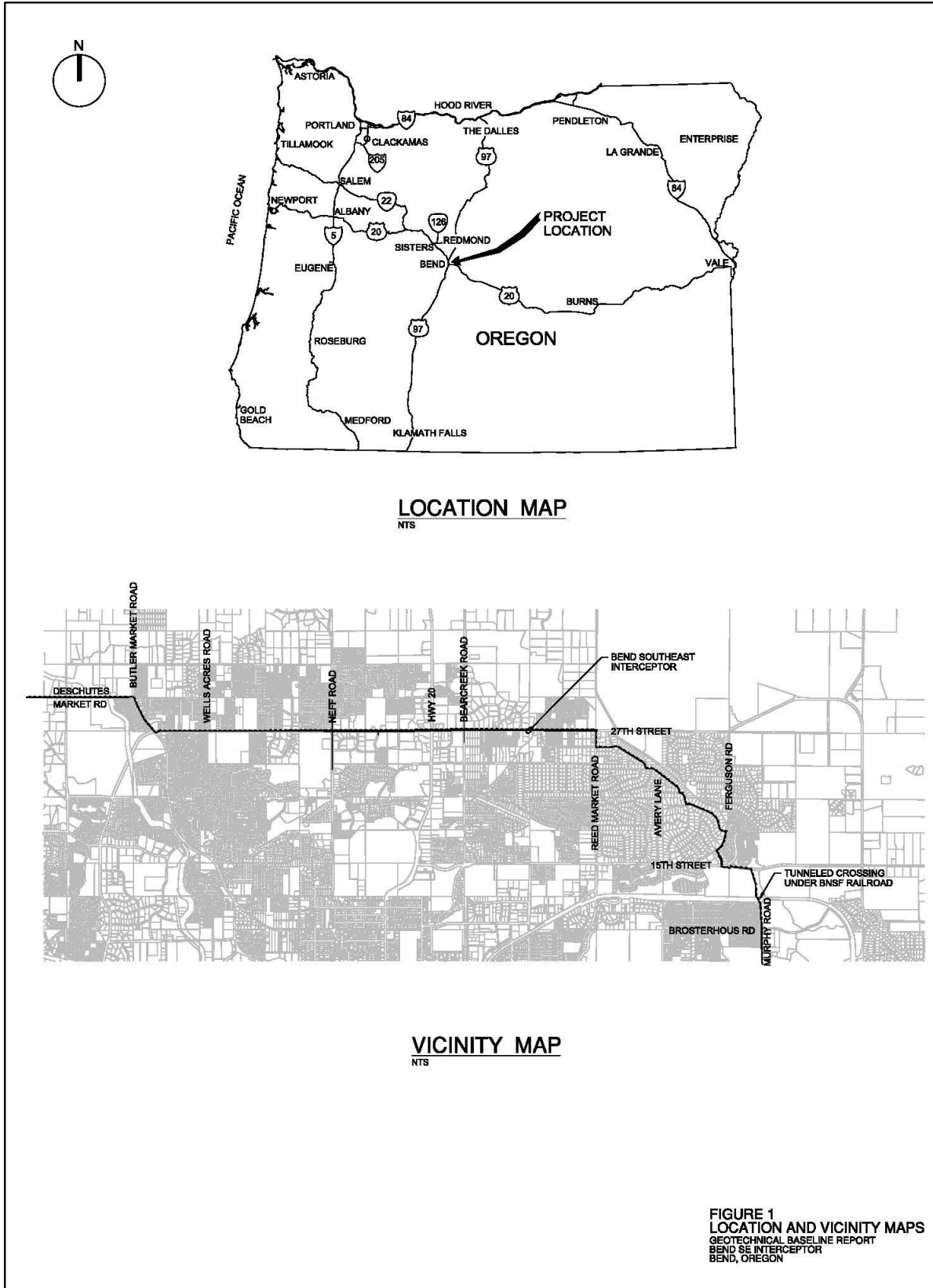
This report is organized into the following sections:

- **Section 1.0: Introduction**—Provides a general project overview and outlines the purpose of the GBR.
- **Section 2.0: Project Description**—Provides a more detailed description of the Bend SE Interceptor Undercrossing of the BNSF railroad.
- **Section 3.0: Sources of Information**—Provides sources of project information and subsurface conditions, and the geologic project setting.
- **Section 4.0: Ground Characterization**—Provides descriptions of conditions encountered for the tunnel and pits/shafts of the Project. Presents baseline conditions and key material properties to be encountered during construction.
- **Section 5.0: Construction Considerations**—Provides considerations that should be addressed during construction of the tunnel and pits/shafts.
- **Section 6.0: References**—Lists the documents used to prepare this GBR.

## 1.4 Limitations

This GBR has been prepared for specific application to the tunneled crossing of the BNSF Railroad as part of the Bend SE Interceptor Project, in accordance with generally accepted geotechnical engineering practice common to the project area. No amount of investigation and analysis can predict exact characteristics, quality, or distribution of materials or behavior of those materials during construction. Such characteristics will vary with depth and areal extent. Behavior will depend on material characteristics and their inherent variability, as well as construction means and methods.

FIGURE 1  
Location and Vicinity Maps



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# Project Description

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The SE Interceptor pipeline is being constructed to address the current system capacity deficiencies in compliance with the new conveyance capacity as identified in the City's wastewater Collection System Master Plan. This Master Plan was completed in 2008, during which much of the proposed route, sizing, and depth of the pipeline was determined.

## 2.1.1 BNSF Crossing

The pipeline crossing of the BNSF Railroad is located along the proposed Murphy Road extension corridor between Brosterhous Road and 15th Street in southeast Bend. The pipeline crosses the railroad at a location where the ground surface adjacent to the railroad transitions from a cut in the basalt rock, which is roughly 10 feet high on the west side of the tracks, to a relatively flat open area that is undeveloped. The railroad is cut through a somewhat hummocky area south of the alignment and then transitions to an open range area where the railroad is founded on standard ballast fill over flat terrain.

The future Murphy Road crossing of the BNSF tracks is anticipated to include the construction of a new roadway bridge and the placement of up to 30 feet of approach embankment fill. The significant planned fill thicknesses necessitated that the SE Interceptor alignment be adjusted so that the pipeline crossing would occur at approximately a 30 degree angle from the centerline of the proposed new road to minimize the need for deep manholes within the planned fill.



## Sources of Information

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Several sources of information, which are described further below, were consulted in compiling this report.

### 3.1 Topographic Data

An aerial photogrammetric survey of the original alignment for the undercrossing was performed by CH2M HILL in 2007. Additional field surveying was performed in August 2010 to widen the extent of the original aerial survey to accommodate the skewed crossing. A ground surface profile was developed based on a combination of these two survey efforts.

Topography at the BNSF railroad undercrossing indicates the elevation varies from about 3,750 feet to about 3,738 feet. All elevations referenced in this report are based on the North American Vertical Datum of 1929 (NAVD, 1929).

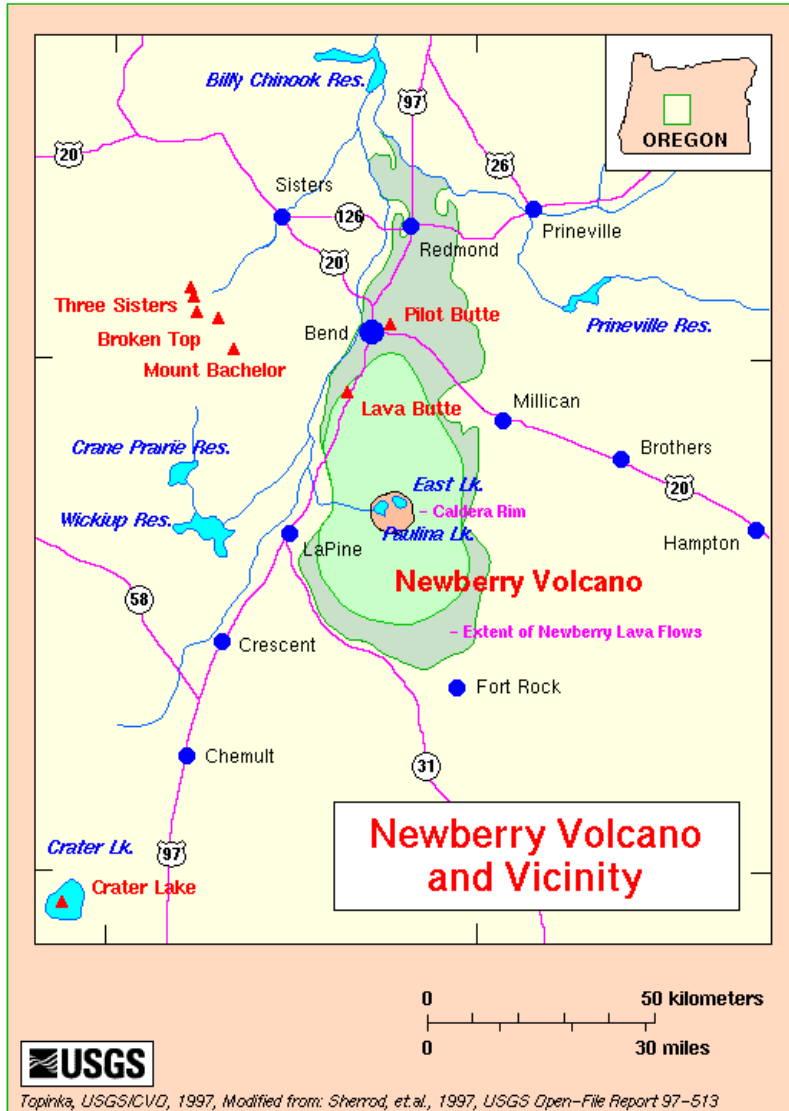
### 3.2 Geologic Setting

Available published geology literature, reports, and mapping were reviewed. Geologic information relevant to the project is included in the GDR. In summary, the primary geology unit mapped in the project vicinity is the basalt of the Newberry Volcano (Qbn), which is from the Pleistocene era. This unit was deposited as a result of lava flows and eruptions from vents and fissures on the north side of the Newberry Volcano, located south of the project site (Figure 2). The volcanic debris and lava flowed north through Bend and beyond to Redmond (Sherrod et al., 2004). The rock is typically open-textured and vesicular, meaning that small cavities were formed in the rock by expanding gas bubbles or by steam during the solidification of the rock.

### 3.3 Previous Geotechnical Explorations

Previous geotechnical explorations performed in the area include the eight (8) borings performed for the Bend SE Interceptor – Murphy Road Section in August of 2008 (CH2M HILL, 2008). These borings were located west of Brosterhouse Road along the existing Murphy Road for installation of the new pipeline section. Geotechnical data from this exploration program are included in the GDR.

FIGURE 2  
Newberry Lava Flows



## 3.4 Undercrossing Project Geotechnical Exploration

### BNSF Undercrossing

The exploration program for the BNSF railroad undercrossing consisted of advancing two borings: one at the west side, and one on the east side of the BNSF Railroad along the centerline of the proposed Murphy Road alignment, east of Brosterhous Road. Borings B-28-10 and B-29-10 were drilled May 5, 2010 with a CME 75 rubber tired drill rig using HQ wire-line rock coring methods. Rock coring was initiated 5 feet below ground surface in each boring. Surficial soils and rock fragments in the upper 5 feet were drilled using hollow-stem auger drilling, which also facilitated casing for the upper portion of the borings.

The boring on the east side of the railroad was designated B-28-10 and was advanced to a depth of 35 feet from an approximate elevation of 3,737.6 feet at the edge of the open range area, near the bottom of the hummocky area to the south. The boring on the west side of the railroad was designated B-29-10 and was advanced to a depth of 45 feet from an approximate elevation of 3,749.9 feet. B-29-10 was bored in the northeast corner of an old trailer parking area that has recently been abandoned for construction of the new facilities.

## 3.5 Recent Local Construction Observations

The information in this section was obtained from conversations with City of Bend personnel (City of Bend, 2010), as well as CH2M HILL personnel who have pipeline construction experience in the Bend area.

Based on these discussions, it was observed by these individuals that groundwater has not historically been encountered on Bend construction projects with which they were familiar. Short-term perched groundwater associated with intense rainfall events is possible, and pipelines and manholes are designed to resist uplift in the final, buried condition only. Well logs in Bend from the Oregon Water Resources Department website ([http://apps.wrd.state.or.us/apps/gw/well\\_log/](http://apps.wrd.state.or.us/apps/gw/well_log/)) indicate groundwater ranges from about 200 to 500 feet below ground surface (bgs).

Excavations throughout the Bend area typically encounter basalt at shallow depths. The strength of the basalt can vary, and the City has observed that heavy-duty excavators can typically be used to excavate the soil above the basalt, as well as the highly fractured in situ basalt that has been encountered in some of their projects across Bend. Contractors appear to have had more success using excavators on the western side of Bend and more success using controlled blasting on the eastern side of Bend. The project site for the undercrossing is located roughly in the southeast area of Bend. The City indicated that for the recent pipeline construction work along Murphy Road, excavation was performed primarily using controlled blasting supplemented with hydraulic rock hammers operated from an excavator to remove residual rock from blasted sections, or where blasting posed too high a risk of damage to adjacent utilities or structures.

According to the City it is common to find pockets of cinders and small lava tubes or voids throughout the Bend area (City of Bend, 2010). These were encountered during the construction of the original sewer pipeline and Bend Water Reclamation Facility (WRF) in Bend. Cinders and voids have been observed in local sewer construction on Brosterhous Road near Murphy Road in August-October 2010. For the original sewer pipeline network and construction at the WRF, contractors typically pumped weak grout into these zones when they were encountered. For the small pockets of cinders encountered during local sewer construction in Brosterhous Road, the contractor over-excavated the cinders or soil as needed and backfilled with crushed rock material. The presence of cinders and voids reduced the effectiveness of the blasting methods, requiring additional hydraulic hammer excavation after blasting to remove unfractured rock material. When constructing facilities at the WRF where the presence of cinders, small lava tubes, and voids was a possibility, contractors used closely spaced pneumatic drilling underneath the footprint of proposed structures as a way to locate cinder zones and small lava tubes so that the soft zones or voids could be compaction-grouted.

It was noted that the basalt that was excavated for the original pipeline project in Bend was crushed and used to backfill the trenches.

A large tracked rock trencher was recently used on a deep storm sewer trench in Redmond, Oregon, in similar basalt conditions. This equipment was capable of achieving trench depths of 18 feet.



## Ground Characterization

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In preparing this GBR, soil has been classified in accordance with the Unified Soil Classification System (ASTM D 2487). Rock has been classified in general compliance with the recommendations of the American Society for Testing Materials (ASTM) D 2113, Diamond Core Drilling for Site Investigation.

### 4.1 General

The rock quality designation (RQD) of the rock samples (shown on the boring logs included in the GDR) is an index of the degree of fracturing of the rock mass and is calculated by dividing the sum of the lengths of intact core greater than 100 millimeters (mm) in length by the sum of the total core run and multiplying by 100 percent (in accordance with ASTM D 6032). Because of micro fractures and mechanical fractures that were occasionally observed in the rock cores, some interpretation was required by the observer as to which were actual in situ fractures and which were caused by the coring process, a not uncommon occurrence in rock coring operations.

The Cerchar Abrasiveness Index (CAI) is a measure of abrasiveness as it affects cutter, pick, and tool wear during rock excavation. The test consists of measuring the wear on the tip of the steel stylus with a cone shape and known Rockwell Hardness, caused by scratching against a freshly broken or saw-cut rock surface for a prescribed 10 mm distance using the test apparatus (ASTM D 7625).

### 4.2 Subsurface Ground Conditions Encountered

As previously discussed, two borings were drilled in the vicinity of the BNSF Railroad undercrossing. Information on the general rock properties was also obtained from the other borings for the SE Interceptor project. The logs of all the borings are included in the GDR. The subsurface conditions are generally summarized below.

Beginning at the ground surface, the subsurface conditions encountered in the borings were as follows:

- Silty Sand (SM) with Cobbles and Boulders – This surficial overburden layer consists of fine sand with silt and some cobbles and boulders (consisting of fractured rock pieces as noted from driller). This layer was observed to be 2.5 feet thick in boring B-29-10, and 4 feet thick in boring B-28-10. Exploration borings west of Brosterhous Road along Murphy Road (CH2M HILL, 2008) indicate the soil material contains between 20 to 40 percent fines with standard penetration test (SPT) N-values ranging from 2 to 58 blows per foot, indicating very loose to very dense soil conditions. The higher blow counts were most likely attributed to rock fragments in the soil or in the upper portions of the rock interface. Prior to advancing the boring on the east side of the railroad (B-28-10), a pothole was dug with shovels to approximately 3.5 feet deep in the location of the boring. The pothole was excavated with moderate effort with manual labor and shovels. A few cobble-sized pieces of fractured basalt were observed in the excavation.
- Basalt Bedrock at BNSF Railroad – The basalt bedrock consists of hard, gray vesicular basalt. The depth to bedrock on the west side of the BNSF Railroad as observed in B-29-10 is generally less than 2.5 feet bgs. Some wood fragments were encountered from 5 to about 5.9 feet deep that may be from an old log or stump founded in the upper fractured basalt. The B-29-10 location is at the top of the railroad cut in the adjacent former trailer park. On the east side of the BNSF Railroad, in B-28-10, bedrock is located at a depth of 4 feet bgs. The measured RQD on the west side in B-29-10 increased gradually until 20 feet bgs, ranging from 8 percent from 5 to 10 feet bgs; 56 percent from 10 to 15 feet bgs; and 70 percent from 15 to 20 feet bgs. From 20 feet to 45 feet bgs, RQD remained relatively consistent, ranging from 86 percent to 99 percent. The measured RQD of samples obtained from the east side in B-28-10 was somewhat more consistent, with RQDs generally ranging from 86 to 98 percent. RQD was somewhat lower between 20 and 25 feet bgs, where it was determined to be 78 percent. Three CAI tests were performed, with results ranging from 3.2 to 3.6 (1/10-mm), indicating hard rock abrasiveness with a medium scratch depth. In borings B-28-10 and B-29-10, six unconfined compression strength (UCS) tests were performed, with results ranging from 2,327 pounds per

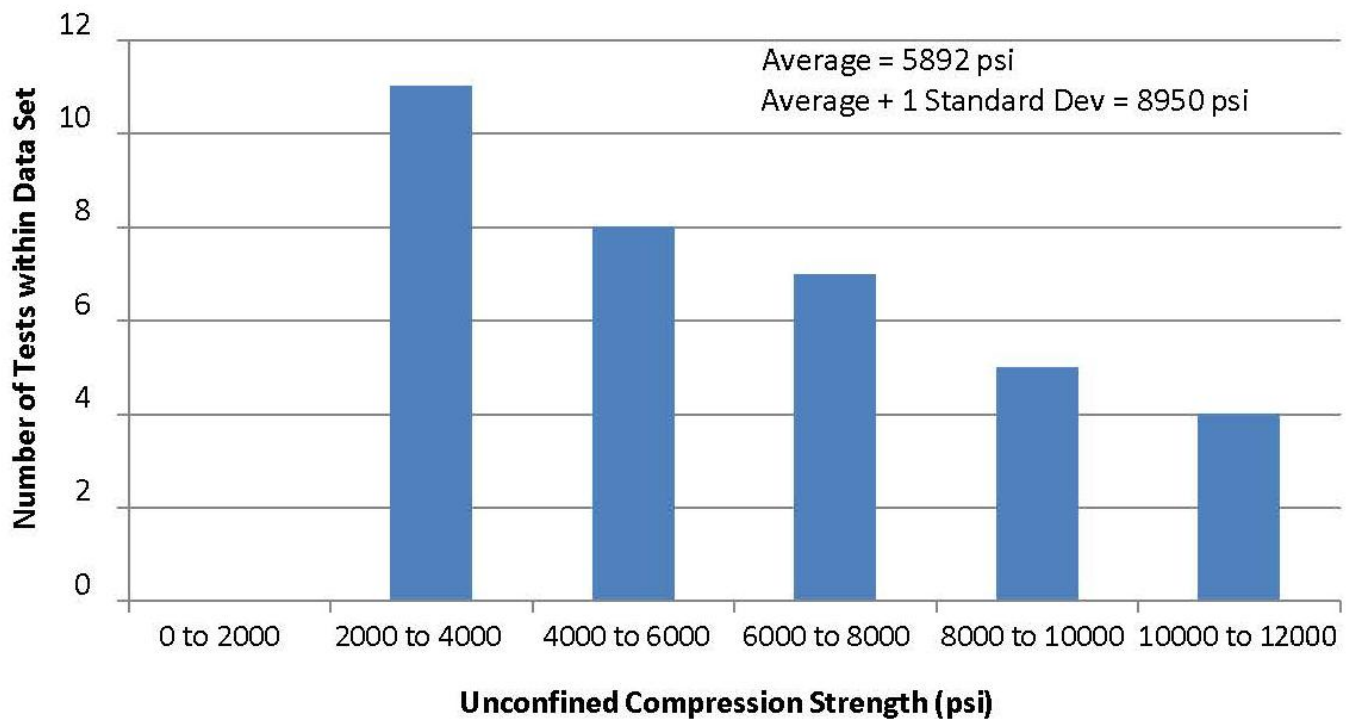
square inch (psi) to 4,594 psi. A total of 14 UCS tests were performed, with results ranging from 2,098 psi to 11,797 psi. A histogram summarizing UCS tests performed for this project and other projects in the vicinity is shown in Figure 3.

Because the rock coring technique uses water as a circulation and flushing fluid, it was not possible to detect the presence of groundwater in the borings drilled for the crossing. Water was not encountered during the recent sewer construction on Murphy Road and Brosterhous Road in summer 2010. As discussed previously, groundwater is not expected to be encountered at the depth of the planned crossing.

### 4.3 Baseline Subsurface Conditions

The baseline subsurface conditions contained in Table 1 were developed in consideration of the conditions encountered in the borings drilled at the crossing, data from other project borings, local experience, and engineering judgment. The transitions between materials shown in Figure 4 are approximate, and if there is a discrepancy between the information presented in Figure 4 and Table 1, Table 1 shall take precedence. Baseline UCS of basalt is shown in Figure 3.

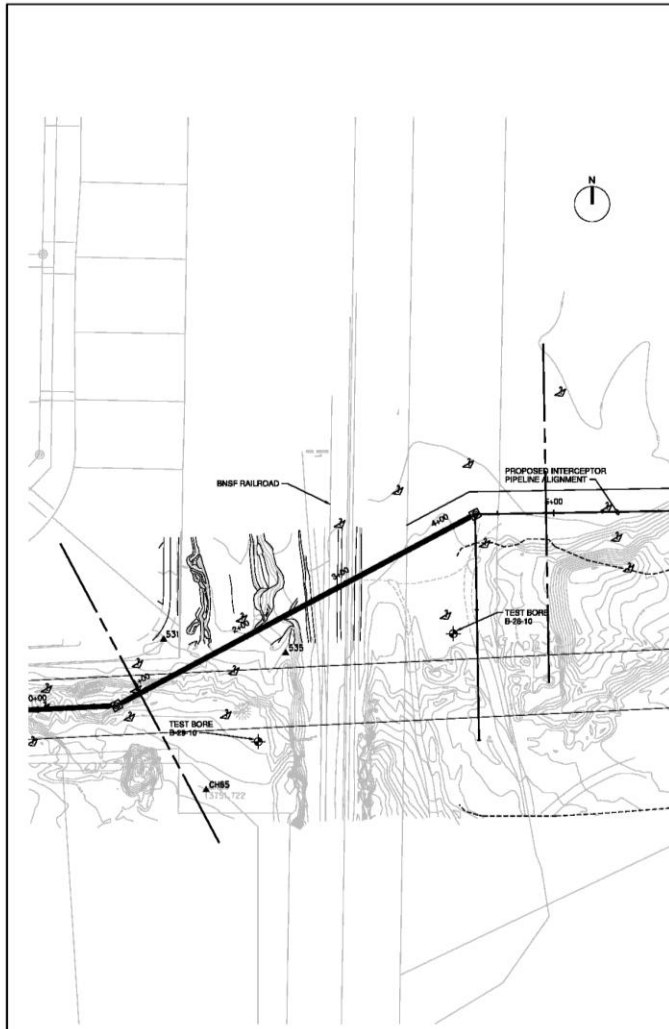
FIGURE 3  
Unconfined Compression Strength Data Summary for SE Bend Area



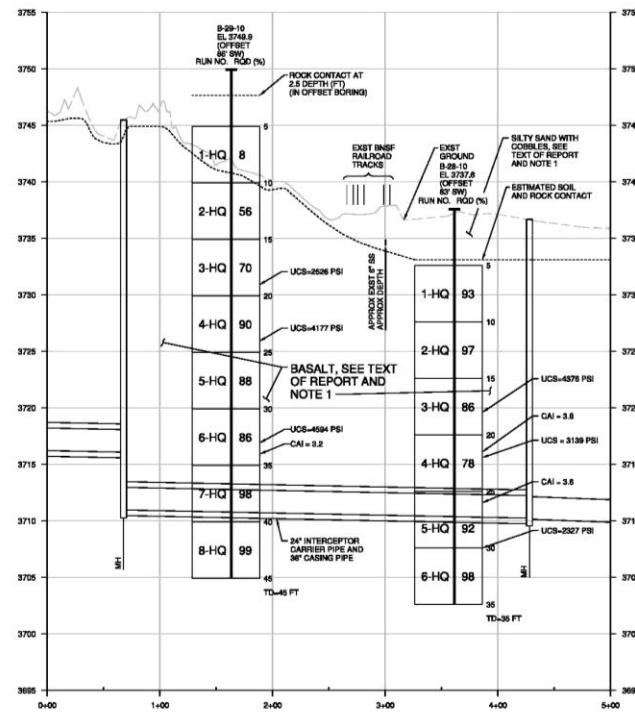


**TABLE 1**  
**Geotechnical Baseline Conditions for BNSF Railroad Undercrossing**

Feature	Geotechnical Baseline Condition
West Pit	<p>Ground surface (elevation 3,749.9 feet) to elevation 3,744 feet: Loose Silty Sand (SM) with up to 20% fractured basalt cobbles ranging in size to 8 inches in maximum dimension and containing wood debris such as a log or stump from old tree. Basalt cobbles will have UCS value of less than 10,000 psi.</p> <p>Elevation 3,744 to 3,730 feet: Hard Basalt bedrock. Rock quality designation (RQD) will increase linearly from 0% at elevation 3,744 feet to 70% at elevation 3,730 feet, as measured over 5-foot intervals.</p> <p>Elevation 3,730 feet to 3,705 feet: Hard Basalt bedrock with an RQD of between 85 and 100%.</p> <p>Basalt will have a CERCHAR abrasivity index of 4.0. Basalt will have occasional soil or secondary mineral infilling in joints. Joint thickness will vary from microfractures (less than 0.1-inch) to larger open joints up to 0.3-inch thick. Joint angles are highly varied, from 0 degrees (vertical) to 90 degrees (horizontal). Up to 75% of the basalt is vesicular with vesicles up to 1.5 inches in size. Some sections have minimal to no vesicles present. Up to 15% of the basalt material encountered (by in-place volume) will consist of cinders, voids, and/or loose soil-like materials.</p> <p>No groundwater will be encountered.</p>
East Pit	<p>Ground surface (elevation 3,718.5 feet) to elevation 3,732.5 feet: Loose Silty Sand (SM) with up to 20% fractured basalt cobbles ranging in size to 8 inches in maximum dimension and containing wood debris such as a log or stump from old tree. Basalt cobbles will have UCS value of less than 10,000 psi.</p> <p>Elevation 3,732.5 to 3,702.5 feet: Basalt. Hard Basalt bedrock with an RQD of between 70 and 100%.</p> <p>Basalt will have a CERCHAR abrasivity index of 4.0. Basalt will have occasional soil or secondary mineral infilling in joints. Joint thickness will vary from micro- fractures (less than 0.1-inch) to larger open joints up to 0.3-inch thick. Joint angles are highly varied, from 0 degrees (vertical) to 90 degrees (horizontal). Up to 60% of the basalt is vesicular with vesicles up to 2 inches in size. Up to 15% of the basalt material encountered (by in-place volume) will consist of cinders, voids, and/or loose soil-like materials.</p> <p>No groundwater will be encountered.</p> <p>Tunneled Crossing Basalt. Hard Basalt bedrock with an RQD of between 70 and 100%.</p> <p>Basalt will have a CERCHAR abrasivity index of 4.0. Basalt will have occasional soil or secondary mineral infilling in joints. Joint thickness will vary from micro- fractures (less than 0.1-inch) to larger open joints up to 0.3-inch thick. Joint angles are highly varied, from 0 degrees (vertical) to 90 degrees (horizontal).</p> <p>Up to 60% of the basalt is vesicular, with vesicles up to 2 inches in size. Up to 15% of the basalt material encountered (by in-place volume) will consist of cinders, voids, and/or loose soil-like materials. This material will be encountered above casing springline for up to 15 feet of tunneled length and below casing springline for up to 15 feet.</p> <p>No groundwater will be encountered.</p>



**SITE PLAN**  
SCALE: 1" = 100'



**PROFILE**  
SCALE:  
HORIZ: 1" = 100'  
VERT: 1" = 10'

**NOTES:**

1. CONDITIONS OF SOIL AND ROCK ARE GENERALIZED. SEE TEXT OF REPORT AND TABLE 1 OF REPORT FOR SPECIFIC BASELINE.
2. UCS, ROD AND CAI TEST RESULTS SHOWN ARE SPECIFIC TO EACH BORING. SEE TEXT OF REPORT FOR BASELINE STRENGTHS, ROD AND ABRASIVITY.

**FIGURE 4**  
BNSF UNDERCROSSING  
BORING AND LOCATION PLAN  
GEOTECHNICAL BASELINE REPORT  
BEND SE INTERCEPTOR  
BEND, OREGON

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# Construction Considerations

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## 5.1 General

All pit/shaft construction activities must be completed within established easements shown on the contract drawings. The Contractor shall be responsible for protecting existing utilities and structures and for restoring the ground surface to its original condition following construction. At the BNSF crossing the Contractor should locate the launch/receiving pits such as to minimize risk to the railroad. This will likely require a shored pit/shaft wall to avoid affecting the existing railroad or railroad embankments. The launch and receiving pits will be located outside the BNSF Railroad right-of way; however, permits will be required for the tunneled section of the work. The City has obtained construction easements, permanent easements, and the BNSF Railroad crossing permit. Easements and right-of-way limits are shown on the drawings, and the railroad crossing permit is provided in the contract documents.

The City is obtaining an Oregon Department of Environmental Quality 1200-C permit for the SE Interceptor project. Contractor shall comply with all provisions of this 1200-C permit.

## 5.2 Launch and Reception Pits/Shafts

Special consideration must be given when constructing the launch and reception pits and shafts.

### 5.2.1 Groundwater and Dewatering

No groundwater is expected. The Contractor shall grade the site to prevent runoff from entering the shafts/pits. The Contractor is responsible for providing all permits necessary to allow disposal of sumped water resulting from precipitation entering the shaft.

### 5.2.2 Pit/Shaft Excavation Methods

The Contractor is responsible for selecting the appropriate pit/shaft support systems, and must consider the presence of loose silty sand (containing basalt cobbles and boulders) and highly abrasive basalt bedrock with varied RQD. Unsupported excavations in the upper 20 feet of overburden soil materials and/or basalt with zero RQD will experience rapid caving, sloughing, and instability of the excavation side walls, and will require excavation support to provide safe working conditions. The Contractor must consider the variability in rock quality, compressive strength, jointing, and abrasivity, along with pit/shaft size requirements, temporary easements, and schedule constraints when selecting a pit/shaft construction method. Given the potential proximity of the launch/receiving pits to the BNSF Railroad, the Contractor must assume that the pits will be shored to prevent movement of the excavations and adjacent ground surface.

The rock is considered highly abrasive to mechanical tools, cutters, and picks based on its very high CAI. Contingency plans should be developed prior to pit/shaft construction to mitigate difficulties associated with the baselined site conditions and other anticipated difficulties and challenges. A photograph of the recent excavation west of Brosterhous Road along Murphy Road is shown in Figure 5.

FIGURE 5  
 Murphy Road Trench Support  
 (24-inch gravity sewer approximately 25 feet below existing grade – presplitting and controlled blasting employed)



### 5.2.3 Identified Pit/Shaft Risks

As discussed above, protection of workers in the shaft will be vital, given the presence of silty sand with basalt cobbles overlying fractured basalt. Cinders, soil-like materials, and voids are anticipated within the basalt bedrock. These materials will require additional excavation support and this support must be provided in the shoring design.

## 5.3 Tunneled Crossing

The following text discusses the boring method that will be used on this project.

### 5.3.1 Machine Tunneling Excavation Method

Given the absence of groundwater, auger boring is the specified method for the BNSF Railroad undercrossing. The UCS of the basalt bedrock is considered by machine manufacturers to be too great for excavation by conventional auger boring using conventional rock heads, such as a “Christmas tree” (Long & Kocab, 2008). The use of a steerable small boring unit (SBU-A) or steerable and motorized small boring unit (SBU-M) with disc cutters is required.

Auger boring operations shall be controlled by the Contractor to avoid pipe damage, displacement of the pipe from the specified alignment grade, damage to adjacent structures and utilities, and settlement or heaving of the ground surface. The equipment for installing the pipe should be compatible with the baseline ground conditions at the site and fully able to meet the requirements of the project. Specific attention should be given the highly abrasive nature of the basalt rock.

### 5.3.2 Identified Tunnel Risks

Although the majority of the tunnels will be completed in basalt with an RQD generally between 50 to 100 percent, the Contractor shall anticipate encountering cinders, voids, or loose soil-like materials in the tunnel heading (as baselined in Table 1). Depending on where they are encountered within the tunnel face, these can result in steering difficulties; overexcavation; deviation from line or grade; clogging or jamming of the cutter head, cutter head openings, and spoil augers; or clogging of the annular space surrounding the casing. Lubrication grout should be used to completely fill the annular space to reduce the potential for jamming of rock fines and rock fragments within the annular space.

The Contractor must be aware of the stringent grade requirements for this crossing, necessitated by the gravity-flow purpose of the pipeline. For grade requirements, see drawings and specifications.

## 5.4 Excavated Material Disposal

All material excavated from the tunnels must be removed and disposed of offsite and in accordance with all state and federal regulations. This includes any lubricants or grouts used in tunnel construction.



## SECTION 6.0

# References

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