Geotechnical Data Report

Columbia River & North Portland Harbor Bridges

May 2024

Draft

Geotechnical Data Report

Columbia River & North Portland Harbor Bridges

Prepared for:

Oregon Department of Transportation

Washington State Department of Transportation

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TABLE OF CONTENTS

FIGURES

TABLES

APPENDICES

Appendix A. Columbia River Boring Logs and Core Photographs

Appendix B. North Portland Harbor Boring Logs and Core Photographs

Appendix C. Borehole Suspension Logging Results

Appendix D. Columbia River Laboratory Test Results

Appendix E. North Portland Harbor Laboratory Test Results

Appendix F. Important Information About Your Geotechnical/Environmental Report

ACRONYMS AND ABBREVIATIONS

ASTM	ASTM International
bgs	below ground surface
bpf	blows per foot
GDM	Geotechnical Design Manual
GDR	Geotechnical Data Report
IBR	Interstate Bridge Replacement
I.D.	Inside Diameter
LDP	Local Datum Plane
NAVD88	North American Vertical Datum of 1988
O.D.	Outside Diameter
ODOT	Oregon Department of Transportation
SPT	Standard Penetration Test
USCS	Unified Soil Classification System
USGS	United States Geological Survey
WSDOT	Washington State Department of Transportation

1. INTRODUCTION

1.1 Purpose and Scope

This Geotechnical Data Report (GDR) was prepared by Shannon & Wilson, Inc. (Shannon & Wilson), as a subconsultant to WSP, for the Interstate Bridge Replacement (IBR) Team. This report describes the data gathering procedures and presents the test boring logs, field test data, and laboratory testing data assembled for the Columbia River and North Portland Harbor bridge portions of this project. The purpose of the exploration and testing program was to collect geotechnical data to support the IBR Team in conceptual foundation design, identification of potential seismic hazards, and alternatives analyses and cost estimates for the IBR project. No engineering analyses, conclusions, or design recommendations are contained in this report. The design alignments and concepts shown herein are subject to change. The GDR should be used by the Design-Build contractor for final design and construction of the project. Additional geotechnical explorations may be required to meet the requirements of the applicable Geotechnical Design Manual (GDM) for final design of the project features.

1.2 Project Overview

The IBR Project has been developed by the Washington State Department of Transportation (WSDOT) and the Oregon Department of Transportation (ODOT) and includes highway, bridge, and transit improvements between Vancouver, Washington and Portland, Oregon. The approximate locations of the Columbia River and North Portland Harbor Bridges segments are shown on the Vicinity Map, Figure 1-1. Conceptual Columbia River bridge alignments are shown on Figure 1-2 and conceptual North Portland Harbor bridge alignments are shown on Figure 1-3.

1.3 Existing Information

A significant amount of historical geologic and geotechnical engineering information from various sources exists along much of the project corridor. This information was used by Shannon & Wilson and the IBR team to prepare the field exploration program. The data and information from these other sources are available in project reference documents.

2. GEOLOGIC SETTING

2.1 Area Overview

The greater Portland-Vancouver metropolitan area lies within a large geologic basin created by complex folding and faulting of the basement rocks. The Columbia and Willamette Rivers converge within the Portland Basin near the IBR project site. Those large rivers, along with their tributaries, deposited a thick sedimentary basin fill through the late Miocene, Pliocene, and Pleistocene Epochs (about 12.5 million to 11,700 years ago), including well-consolidated and variably cemented sandstone and conglomerate of the Troutdale Formation. Beeson and others (1991) indicate the Troutdale Formation consists of about 100 to 400 feet of well-consolidated friable to moderately well-cemented conglomerate and sandstone deposited around 12.5 million to 2.6 million years ago. The Troutdale Formation was partially eroded during the late Pleistocene ice ages by the ancestral Columbia and Willamette Rivers (Peterson and others, 2011). As a result, the surface of the Troutdale Formation displays variable river channel topography at depths greater than 200 feet below current sea level, near the major rivers in the Portland Basin. Younger late Pleistocene and Holocene sediments from the Columbia River drainage and fills made by humans form the shallow subsurface conditions in the project area.

A series of catastrophic glacial outburst floods, called herein the Missoula Floods, directly impacted and shaped the geologic conditions at the IBR site. During the late stages of the last great ice age, between about 18,000 and 15,000 years ago, a lobe of the continental ice sheet repeatedly blocked and dammed the Clark Fork River in western Montana, which then formed an immense glacial lake called Lake Missoula. The lake grew until its depth was sufficient to buoyantly lift and rupture the ice dam, which allowed the entire massive lake to empty catastrophically. Once the lake emptied, the ice sheet again gradually dammed the Clark Fork Valley and the lake refilled, leading to 40 or more repetitive outburst floods at intervals of decades (Allen and others, 2009). During each short-lived Missoula Flood episode, floodwaters washed across the Idaho panhandle and eastern Washington scablands, and through the Columbia River Gorge to the Pacific Ocean. In the Portland Basin these floods temporarily pooled to elevations of about 400 feet, forming massive-scale sedimentary deposits as fine-grained sediment settled out of the turbid floodwater. Boulders, cobbles, and gravel were deposited nearest the mouth of the gorge, locally downstream of other hard rock outcrops that were scoured by the energetic flood waters, and elsewhere by ice rafts. Great cobble-gravel bars reached westward across the basin, grading to thick blankets of micaceous sand (Allen and others, 2009).

Following the final glacial outburst floods, the sea level rose by about 300 feet in response to glacial retreat. This rapid sea level rise formed an estuarine environment that extended far upstream in the deep channels of the Columbia River. This low energy environment rapidly filled with Holocene sandy alluvium and broad floodplains developed along the primary Columbia River channel (Peterson and others, 2011). Many areas have been altered by grading, cuts, and fills made by humans.

2.2 Generalized Geologic Deposits

The following paragraphs provide a general description of the geologic units recognized in published geologic literature, to provide the reader with an overview of the project area. Geologic or engineering soil units are not presented on the boring logs. The designer is responsible for differentiating and evaluating the relative geotechnical properties of engineering soil units based on the data provided herein and collected by their team.

Holocene Fill is present in the project area and has been important to its development. Fill was placed by humans at various times using various placement methods. Examples include shoreline expansion and shoreline protection fills, debris, and embankment fill for I-5.

Latest Pleistocene to Holocene deposits of the Columbia River consist primarily of thick layers of sand, with minor fine-grained alluvium and gravel interbeds deposited in a fluvial environment.

Pleistocene alluvium near the project site predominantly consists of silt, sand, and gravel deposits, which include Missoula Flood deposits and material reworked by the Missoula Floods. The Pleistocene alluvium overlies the Troutdale Formation and generally consists of silt, sand, and coarse-grained material consisting of mostly basaltic gravel with cobbles, boulders, and sand lenses.

Late Miocene and Pliocene Troutdale Formation of variable composition is present across much of the Portland Basin. Near the project site, Troutdale Formation is recognized as a variably cemented conglomerate. Cobbles and boulders are present in the Troutdale Formation.

3. FIELD EXPLORATIONS

3.1 General

Field explorations were conducted by Shannon & Wilson. The following sections describe details of the exploration programs. Environmental implementations and archaeological measures were employed during the field explorations. Before each borehole was started, a steel circulation casing was pushed and/or driven to seal off any circulating drill fluids from the river. All drill cuttings and drilling fluids were contained within the borehole, the circulation casing, and the re-circulation (or "mud") tub on the barge deck. All soil cuttings and all drilling mud were collected in 55-gallon drums, which were removed from the site and disposed of by the drilling subcontractor at an appropriate facility. Turbidity monitoring was performed by Shannon & Wilson during drilling and periodic ODOT inspection of the barge was performed to confirm compliance with permitting. The IBR Team was responsible for managing the archaeological components of the exploration program. Please refer to their report for additional details.

3.2 Columbia River Bridges

Shannon & Wilson drilled six borings, designated IBR-03 through IBR-08, in the main channel of the Columbia River between November 2023 and February 2024. The locations of the borings are shown on the Site and Exploration Plan, Figure 1-2. During drilling, a Shannon & Wilson staff member was on site to locate borings, log the materials encountered, and collect soil samples. Both disturbed and undisturbed samples were collected at selected depths and continuous soil core sampling was used in some borings. The details of drilling and sampling procedures, a key to sample description terms, our logs of the materials encountered in the borings, and photographs of recovered soil core samples are presented in Appendix A, Columbia River Boring Logs and Core Photographs. Soil samples were described and identified in general accordance with the WSDOT GDM and Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), ASTM D2488. We refined our visual-manual soil descriptions and identifications based on the results of laboratory tests using elements of the Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System (USCS)), ASTM D2487. The specific terminology used in our soil descriptions is presented in Appendix A. Borehole suspension velocity logging to measure compressional and shear wave velocities of the materials encountered was performed in borings IBR-03, IBR-05, and IBR-07. Once drilling and testing were completed, all borings were backfilled with a high-solids bentonite cement grout, in accordance with Washington Department of Ecology and Oregon Water Resources Department regulations.

3.3 North Portland Harbor Bridges

Shannon & Wilson drilled two borings, designated IBR-01 and IBR-02, in the North Portland Harbor channel of the Columbia River in November 2023 and January 2024. The locations of the borings are shown on the Site and Exploration Plan, Figure 1-3. During drilling, a Shannon & Wilson staff member was on site to locate borings, log the materials encountered, and collect soil samples. Both disturbed and undisturbed samples were collected at selected depths and continuous soil core sampling was used in one boring. The details of drilling and sampling procedures, a key to sample description terms, our logs of the materials encountered in the borings, and photographs of recovered soil core samples are presented in Appendix B, North Portland Harbor Boring Logs and Core Photographs. Soil samples were described and identified in general accordance with the ODOT GDM and ASTM D2488. We refined our visual-manual soil descriptions and identifications based on the results of laboratory tests using elements of ASTM D2487. The specific terminology used in our soil descriptions is presented in Appendix B. Borehole suspension velocity logging was performed in boring IBR-02. Once drilling and testing were completed, the borings were backfilled with a high-solids bentonite cement grout, in accordance with Oregon Water Resources Department regulations.

3.4 Sampling Limitations and Difficult Drilling

Sampling methods and drilling methods have the potential to affect the sampled material. Materials encountered in the subsurface may also create difficult drilling conditions. Below is a discussion of the factors influencing sampled material and drilling conditions. Discussions of sampling methodology, drilling techniques, and boring logs are presented in Appendix A and Appendix B.

Based on observations of the drill rig action and recovered samples, and on observations of large-diameter excavations previously performed near the project site, the recovered samples from the gravel layers may not be fully representative of the in situ material. The gravel layers contain particle sizes such as cobbles and boulders larger than the diameter of conventional geotechnical samplers. These coarse gravel, cobble, and boulder clasts may be intercepted and partially sampled by a geotechnical boring but cannot be recovered and observed intact. Short drive lengths and very low sample recoveries are common with 2- to 3-inch outside diameter (O.D.) split-spoon samplers in these types of gravel layers. Rotosonic (sonic) soil core samples are capable of sampling small cobbles and coring through intercepted portions of large cobbles and boulders. However, the recovered clast sizes and distributions are still limited by the core barrel diameter.

Clasts with flat angular faces that appeared to have been freshly fractured were observed in recovered sonic core samples. Clasts that appeared to have been cut by the core barrel were also noted. Therefore, the grain size distribution curves included in the laboratory test results may include particles that were mechanically fractured or cut during drilling, suggesting smaller particle sizes than are present in the in situ material. Rotosonic drilling may also create fines as the gravel, cobbles or boulders are pulverized by the vibration and force of the drill bit. The fines are integrated into the samples and may increase the fines content of rotosonic samples which undergo grain size analysis.

Some sonic core samples appear to be segregated by grain size in the sample boxes. This segregation is often displayed by a sandy layer at the top of a run of predominantly coarse-grained gravel or by a thin up to a ¼- to ½-inch layer of fines around the circumference of a sonic core sample. Based on repeated observations and the consistency of the drill action, we suspect that the vibrations induced during rotosonic drilling may mechanically sort the sample by grain size vertically and also segregate fines to the outside of the sample. This creates sandy layers at the tops of the sonic core runs in coarser materials or a layer of fines around the circumference of the sample in both coarse-grained and sandy material. Soil samples collected for laboratory testing from the core boxes did not combine the sand layers with the adjoining gravel layers and generally included the outer layer of fines in the sand or gravel layers. There are commonly some finer-grained, sandy layers interbedded within naturally occurring gravel deposits and the observed bedding may or may not be representative of the in situ material.

During rotosonic sampling, retracting the inner core barrel may create suction at the bottom of the casing when it is withdrawn from the bottom of the borehole and retrieved through the casing for sampling. When drilling in sand, this combination of relatively low density drilling fluid and suction at the bottom of the borehole has the potential to result in heave. Heave is a condition where sand runs up into the casing due to differential water head conditions. Sand heave was encountered during rotosonic drilling in borings IBR-01 and IBR-04.

Difficult drilling conditions, including extreme mud loss, mud thinning, and hole collapse, were encountered during mud rotary drilling in borings IBR-02, IBR-03, and IBR-05.

In addition, sample recovery was sometimes difficult in both the rotosonic and mud rotary borings. In the rotosonic borings, some samples inadvertently fell out of the core barrel during retrieval and the core barrel was tripped back into the borehole to attempt to retrieve the sample. Some rotosonic core samples were not retrieved. In the mud rotary borings, some SPT samples had little or no recovery.

Difficult drilling conditions and sampling difficulties are noted on the logs in Appendix A and Appendix B. A summary of the notes from the logs is presented in Table 3-1, below.

In addition to the drilling difficulties described above, boring IBR-02 was terminated because approximately 130 feet of drill rod sheared off while drilling at 225.8 feet and the driller could not retrieve the drill bit and an approximate 1-foot section of rod from the bottom of the borehole.

Table 3-1. Difficult Drilling Conditions and Sampling Difficulties Summary

Boring Designation	Depth (ft)	Comments
IBR-01	12.5	Sand heave observed in sonic casing before Sample S2.
IBR-01	23.4	Driller switched to 4-inch ID auger sonic core barrel bit.
IBR-01	33.6	Driller switched to 4-inch ID flapper sonic core barrel bit.
IBR-01	43.6	Approximately 0.8 feet of sand heave measured in sonic casing before Sample S5.

Boring Designation	Depth (ft)	Comments
IBR-01	53.8-64	Driller switched to 4-inch ID auger sonic core barrel bit. No recovery of Sample S6. Driller switched to 4-inch ID flapper sonic core barrel bit and attempted to retrieve sample. Still no recovery.
IBR-01	64-74.2	No sample recovery in Sample S7.
IBR-01	92.4	Driller switched to 4-inch ID standard sonic core barrel bit.
IBR-01	125-127	Drill action indicates boulder from approximately 125 to 127 feet.
IBR-01	168.7-178.7	Driller attempted 20-foot sonic core run and could only penetrate 15 feet.
IBR-02	40-140	Driller noted borehole instability and sloughing between 40 and 140 feet.
IBR-02	60-105	Borehole sloughing from 60 to 105 feet.
IBR-02	109.3-162	Drill action indicates cobbles and possible boulders from 109.3 to 162 feet.
IBR-02	110.9	No sample recovery in Sample N23.
IBR-02	113-140	Lost drilling mud circulation at 113 feet. Occasional drilling mud circulation loss from 113 to 140 feet.
IBR-02	121.5	Borehole sloughing at 121.5 feet.
IBR-02	130-140	Lost drilling mud circulation and approximately 350 gallons of drilling mud loss from 130 to 140 feet. Driller used another 250 gallons of thick mud to attempt to regain circulation. Borehole sloughed and driller pulled rods to drill back down to 140 feet.
IBR-02	140-150	Approximately 1200 gallons of drilling mud loss from 140 to 150 feet.
IBR-02	150-160	Approximately 300 gallons of drilling mud loss from 150 to 160 feet.
IBR-02	160-170	Approximately 300 gallons of drilling mud loss from 160 to 170 feet.

Boring Designation	Depth (ft)	Comments
IBR-02	165-170	Drill action indicated intermittent cobbles from 165 to 170 feet.
IBR-02	170-180	Approximately 300 gallons of drilling mud loss from 170 to 180 feet.
IBR-02	180-190	Approximately 100 gallons of drilling mud loss from 180 to 190 feet.
IBR-02	187-215	Drill action indicates intermittent cobbles from 187 to 215 feet.
IBR-02	190-210	Approximately 50 gallons of drilling mud loss from 190 to 210 feet.
IBR-02	210-220	Approximately 300 gallons of drilling mud loss from 210 to 220 feet.
IBR-02	215-225.8	Drill action indicates cobbles and possible boulders from 215 to 225.8 feet.
IBR-02	225.8	Approximately 130 feet of drill rod sheared off in the borehole when drilling at 225.8 feet. Driller retrieved all but 1-foot section of rod and the bit from the bottom of the borehole. Boring terminated.
IBR-03	0-28	Slow continuous loss of drilling mud from 0 to 28 feet. Driller added grout.
IBR-03	5.7	Poor recovery in Sample N-1.
IBR-03	21-26	Approximately 50 gallons of drilling mud loss from 21 to 26 feet.
IBR-03	26-31	Approximately 50 gallons of drilling mud loss from 26 to 31 feet.
IBR-03	38.7	Bottom of Shelby tube damaged during sampling at 38.7 feet.
IBR-03	60-80	Driller noted borehole instability from 60 to 80 feet.
IBR-03	110-160	Driller noted borehole instability from 110 to 160 feet.
IBR-03	125	Borehole instability at 125 feet.
IBR-03	190-210	Lost drilling fluid circulation from 190 to 210 feet.

Boring Designation	Depth (ft)	Comments
IBR-03	217.5	Drill chatter at 217.5 feet.
IBR-03	225	Approximately 100 gallons of drilling mud loss at 225 feet.
IBR-03	232-240	Cobbles inferred from drill action from 232 to 240 feet.
IBR-03	270-271	Boulder inferred from drill action from 270 to 271 feet.
IBR-03	271-280	Cobbles inferred from drill action from 271 to 280 feet.
IBR-03	294-300	Cobbles inferred from drill action from 294 to 300 feet.
IBR-04	10	Sand heave observed in sonic casing before Sample SC-2.
IBR-04	29.5-38.6	Approximately 4.5 feet of sand heave measured in sonic casing before Sample SC-4. Sample SC-4 initially fell out of sonic core barrel; tripped core barrel back in to retrieve sample.
IBR-04	47.8-57.8	Approximately 8 feet of sand heave measured in sonic casing before Sample SC-6. Sample SC-6 initially fell out of sonic core barrel; tripped core barrel back in to retrieve sample.
IBR-04	70.7-79.8	Sample SC-8 initially fell out of sonic core barrel; tripped core barrel back in to retrieve sample.
IBR-04	79.8	Driller switched to 4-inch ID flapper sonic core barrel bit.
IBR-04	89.3	Sand heave observed in sonic casing before Sample SC-10.
IBR-04	120.6	A portion of Sample SC-11 was recovered with Sample SC-12.
IBR-04	130.8	Sand heave observed in sonic casing before Sample SC-13.
IBR-04	140.3	Approximately 9 feet of sand heave measured in sonic casing after Sample SC-13. Driller added bentonite grout to borehole to reduce sand heave.
IBR-04	150.6	Driller switched to 4-inch ID basket sonic core barrel bit.

Boring Designation	Depth (ft)	Comments
IBR-04	160.8	Driller switched to 4-inch ID auger sonic core barrel bit.
IBR-04	170.7-179.6	Driller switched to 4-inch ID flapper sonic core barrel bit. Sample SC-17 initially fell out of sonic core barrel; tripped core barrel back in to retrieve sample.
IBR-04	189-199.6	Driller switched to 4-inch ID standard sonic core barrel bit. No sample recovery in Sample SC-19.
IBR-05	60-110	Driller noted borehole instability from 60 to 110 feet.
IBR-05	175	Lost all drill mud at 175 feet.
IBR-05	192	Drill chatter at approximately 192 feet.
IBR-05	192-224	Cobbles inferred from intermittent drill chatter from 192 to 224 feet.
IBR-05	224-237	Cobbles inferred from drill action from 224 to 237 feet.
IBR-06	12.4-23.1	Poor recovery in Sample SC-2.
IBR-06	33.4	Driller switched to 4-inch flapper sonic barrel bit.
IBR-06	123.9-143.4	Driller switched to 4-inch ID auger sonic core barrel bit. Sample SC-9 initially fell out of sonic core barrel; tripped core barrel back in to retrieve sample.
IBR-06	191.1-192.6	Boulder inferred from drilling action from 191.1 to 192.6 feet.
IBR-07	67.8	Performed Dames & Moore sample after N-15 to obtain additional material.
IBR-07	73.0	Performed Dames & Moore sample after N-16 to obtain additional material with no recovery.
IBR-07	78.2	Performed Dames & Moore sample after N-17 to obtain additional material with no recovery.

Boring Designation	Depth (ft)	Comments
IBR-07	83.5	Performed Dames & Moore sample after N-18 to obtain additional material with no recovery.
IBR-07	88-110	Cobbles inferred from drill action from 88 to 110 feet.
IBR-07	91-93	Boulder inferred from drill action from approximately 91 to 93 feet.
IBR-07	94.2	Performed Dames & Moore sample after N-20 to obtain additional material with no recovery.
IBR-07	98.4	No recovery of Sample N-21. Performed Dames & Moore sample after N-21 to obtain additional material with no recovery.
IBR-07	108.1	No recovery of Sample N-22. Performed Dames & Moore sample after N-22 to obtain additional material with no recovery.
IBR-07	117.1	Performed Dames & Moore sample after N-23 to obtain additional material with no recovery.
IBR-07	120-133.8	Cobbles inferred from drill action from 120 to 133.8 feet.
IBR-07	127	Driller notes very hard drilling at 127 feet.
IBR-08	47.1-67	Suspected grain-size segregation from sonic vibration in samples SC-6 and SC-7.
IBR-08	64.4-65.4	Boulder inferred from drilling action from 64.4 to 65.4 feet.
IBR-08	87.5-88.1	Cobble inferred from drilling action from 87.5 to 88.1 feet.
IBR-08	94-95.5	Boulder inferred from drilling action from 94 to 95.5 feet.
IBR-08	96	Driller noted very hard drilling at 96 feet.

Note: See logs in Appendix A and Appendix B for additional information and notes.

4. LABORATORY TESTING

The samples we obtained during our field explorations were transported to our laboratory for further examination. We then selected representative samples for a suite of laboratory tests. The overall soil-testing program included visual-manual identifications and descriptions, moisture content analyses, Atterberg Limits tests, particle-size analyses, and analytical testing for corrosivity potential. All tests were performed in accordance with applicable ASTM International test standards. The results of the laboratory tests and a brief description of the test procedures are presented in Appendices D and E for the Columbia River and North Portland Harbor Bridges, respectively.

5. LIMITATIONS

This Geotechnical Data Report provides a compilation of field and laboratory data collected for use by the design and construction teams for the Interstate Bridge Replacement Program. No engineering analyses, conclusions, or design recommendations are contained in this report. This report was prepared for the exclusive use of the IBR Team, WSDOT, and ODOT for the Interstate Bridge Replacement Program. It should be made available to prospective contractors for use as factual data only. It does not represent a warranty of subsurface conditions.

The data contained herein are based upon site conditions as they existed during the time of our subsurface exploration program. Additionally, the explorations provide information only about the subsurface conditions at the drilled locations at the time of drilling using the means and methods described in this report. It cannot be assumed that the subsurface conditions throughout the project area are similar to those disclosed by the explorations. Within the limitations of the scope, schedule, and budget, the data presented in this report were collected and presented in accordance with generally accepted professional geotechnical practice in this area at the time this report was prepared. No other warranty, expressed or implied, is made. Additional geotechnical explorations may be required to meet the requirements of the applicable Geotechnical Design Manual (GDM) for final design of the project features.

If there is substantial lapse of time between the submission of this report and completion of the final design and the start of work at the site, or if conditions have changed because of natural or manmade forces, we recommend that this report be reviewed with respect to the changed conditions or the time lapse.

The scope of our geotechnical services did not include environmental site assessments or evaluations regarding the presence or absence of hazardous or toxic materials in the soil, surface water, groundwater, or air, on or below the site, or for evaluation or disposal of contaminated soils or groundwater associated with construction, should any be encountered, except as noted in this report.

Appendix F includes a document, "Important Information About Your Geotechnical/Environmental Report," to assist you and others in understanding the use and limitations of geotechnical documents.

6. REFERENCES

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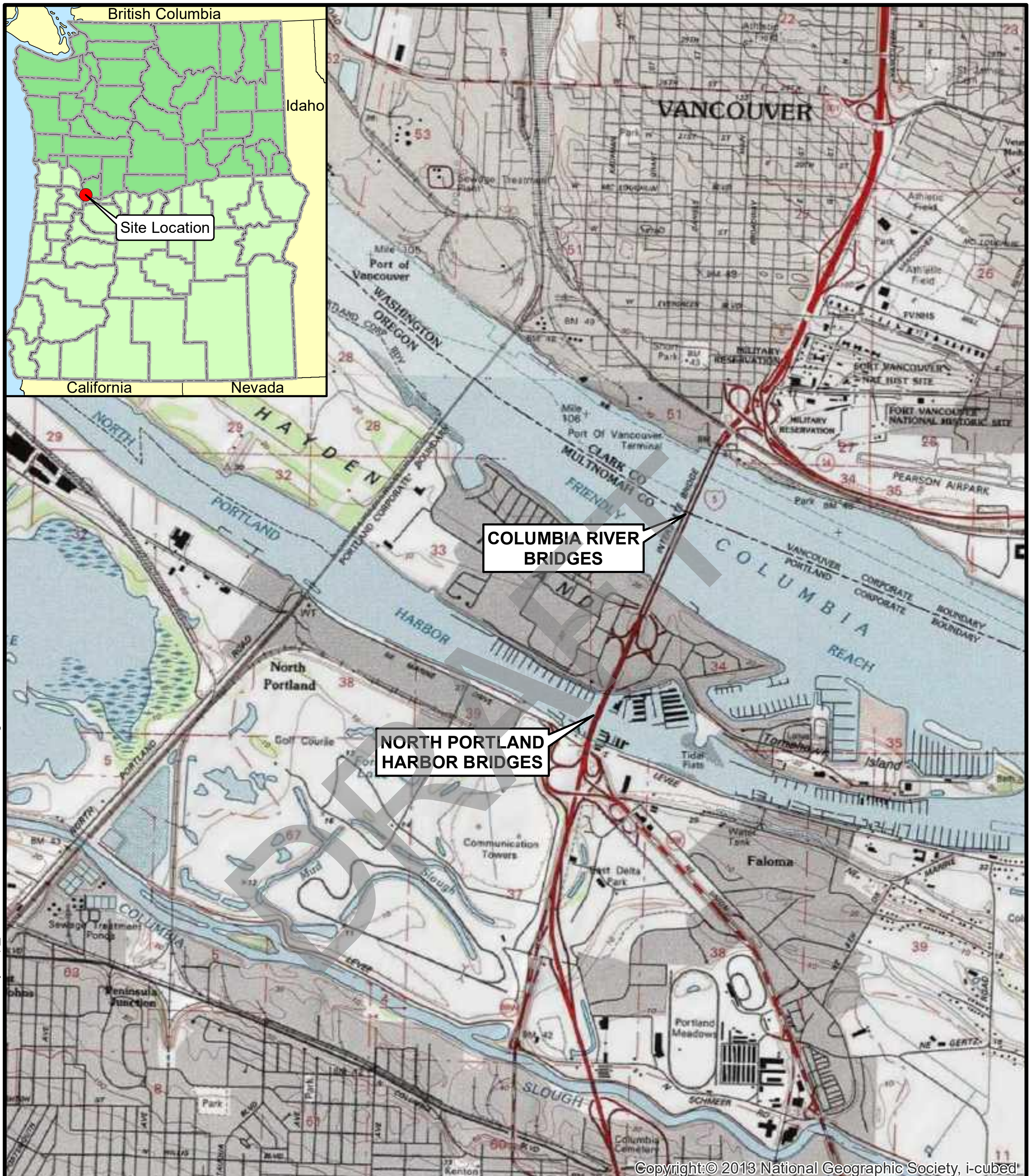


0 0.25 0.5 1
Scale in Miles

N

Interstate Bridge Replacement Program
Portland, Oregon / Vancouver, Washington

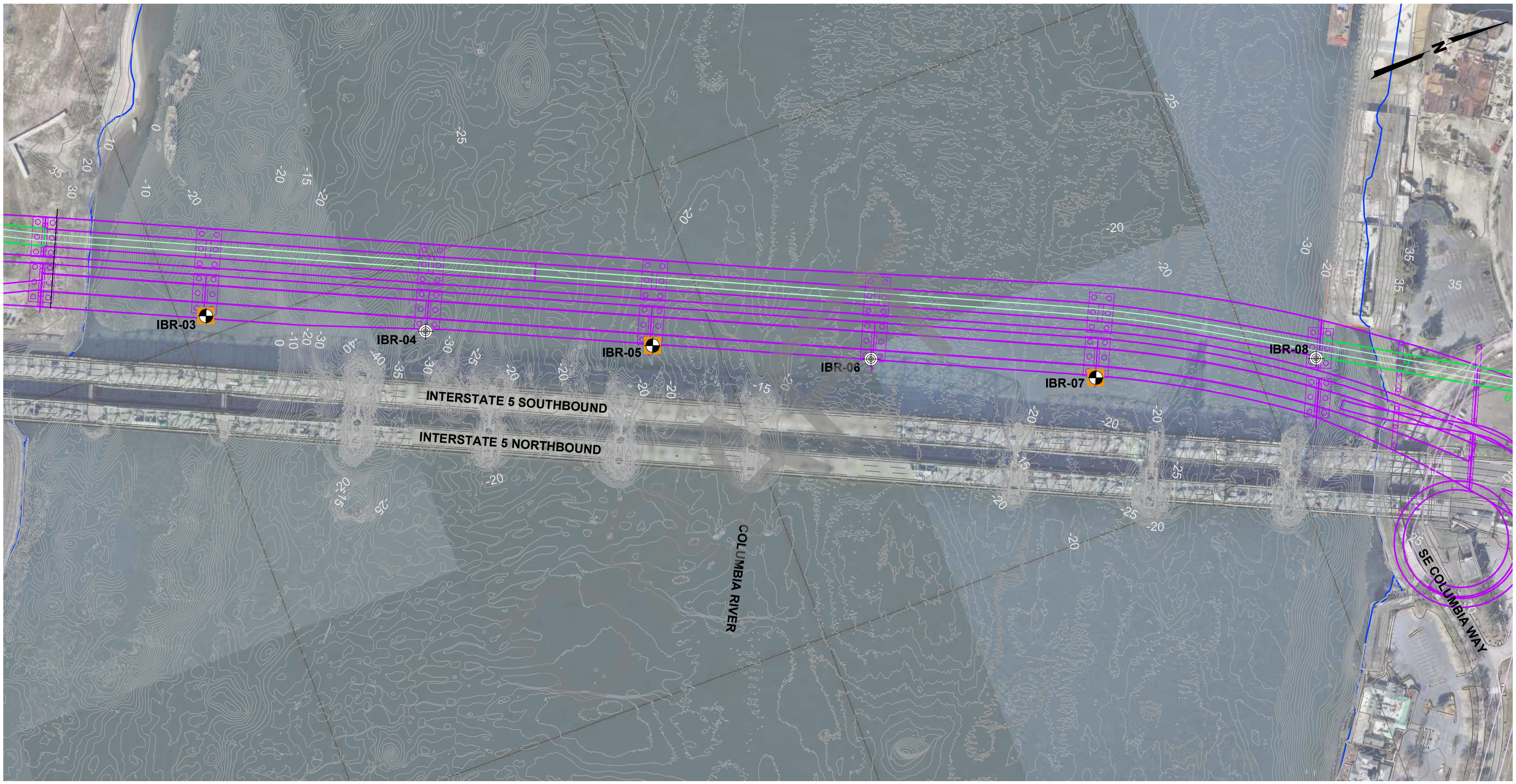
VICINITY MAP

May 2024 105511

SHANNON & WILSON

FIG. 1-1

Filename: P:\GIS\PDX\105000s\105511_WSDOT-ODOT Intel\Avmxd\VicinityMap_GDR.mxd Date: 4/15/2024 Login: AEH



LEGEND

- Location of Mud Rotary Boring
- Location of Rotosonic Boring
- Borehole Suspension Velocity Profile

0 200 400

Scale in Feet

NOTES

1. Aerial imagery downloaded from ProjectWise on April 13, 2023.
2. Existing topography and bathymetry from files downloaded from ProjectWise on May 10, 2023.
3. Existing features from files downloaded from ProjectWise on February 5, 2024.
4. Conceptual Alternative 102 features from files downloaded from ProjectWise on February 5, 2024.

Interstate Bridge Replacement Program
Portland, Oregon / Vancouver, Washington

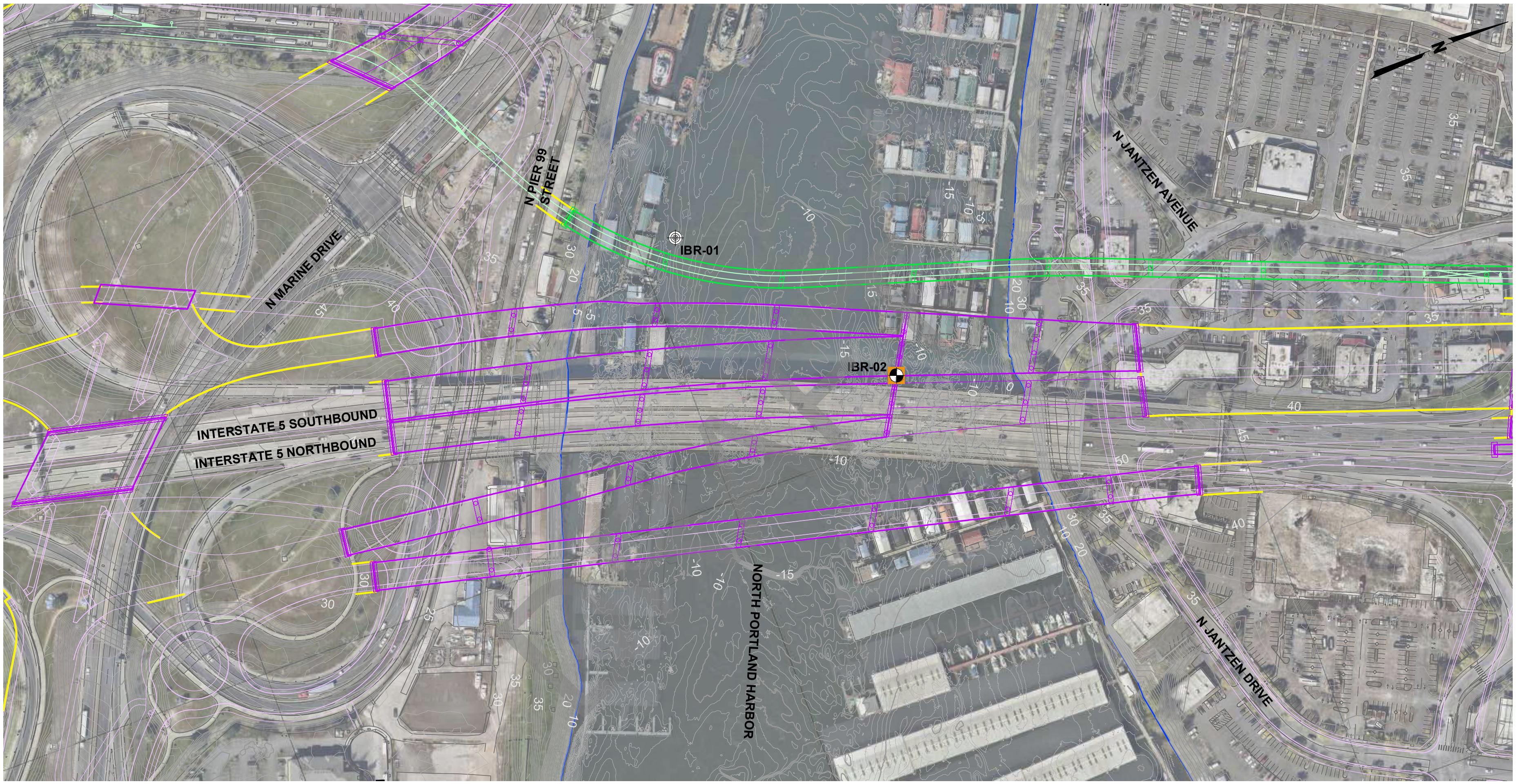
SITE AND EXPLORATION PLAN
COLUMBIA RIVER BRIDGES

May 2024 105511

SHANNON & WILSON

FIG. 1-2

File: P:\PDX\105000s\105511 WSDOT-ODOT Inte\DRAFTING\PlanProfile_020524.dwg Date: 5/5/2023 Author: AEH



LEGEND

- Location of Mud Rotary Boring
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1. Aerial imagery downloaded from ProjectWise on April 13, 2023.
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Interstate Bridge Replacement Program
Portland, Oregon / Vancouver, Washington

SITE AND EXPLORATION PLAN NORTH PORTLAND HARBOR BRIDGES

May 2024 105511

SHANNON & WILSON

FIG. 1-3

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APPENDIX A.
COLUMBIA RIVER BORING LOGS AND CORE PHOTOGRAPHS
TABLE OF CONTENTS

TABLES

ATTACHMENTS

1. GENERAL

Shannon & Wilson drilled six geotechnical borings in the main channel of the Columbia River for the IBR Project. Boring logs and core photographs from the two borings drilled in North Portland Harbor are presented separately in Appendix B. All borings were drilled from a barge over water. Table A-1 summarizes exploration designation, borehole coordinates, depth, and other details. The borings were completed between November 7, 2023, and February 23, 2024. All borings were surveyed during drilling by the design team relative to the IBR Project's Local Datum Plane (LDP) system. Elevations for the project are North American Vertical Datum of 1988 (NAVD88). Exploration locations are shown on the Site and Exploration Plan, Figure 1-2.

This appendix describes the techniques used to advance and sample the borings, presents logs of the materials encountered during drilling, and details the borehole backfill. Downhole suspension velocity testing was also conducted in each of the three mud rotary borings. These tests are described with their results in Appendix C, Borehole Suspension Logging Results.

Table A-1. Columbia River Drilling Summary

Exploration Designation	Northing (ft)[A]	Easting (ft)[A]	Mudline Elevation (ft)[B]	Total Depth (ft)	Drilling Method	Start Date	End Date
IBR-03	110582.3	1083179.1	-0.53	300.3	Mud Rotary	1/29/2024	2/9/2024
IBR-04	110986.4	1083359.0	-29.7	250.0	Rotosonic	11/7/2023	11/13/2023
IBR-05	111405.1	1083544.5	-21.9	261.0	Mud Rotary	2/13/2024	2/23/2024
IBR-06	111808.0	1083722.7	-18.5	237.2	Rotosonic	11/28/2023	11/29/2023
IBR-07	112219.6	1083915.4	-23.1	133.8	Mud Rotary	1/3/2024	1/8/2024
IBR-08	112649.2	1084033.3	-25.0	110.9	Rotosonic	11/14/2023	11/15/2023

Notes:
A IBR Project LDP, defined as Washington State Plane South/1.0000576 (US Survey Feet)
B NAVD88 (US Survey Feet)

2. DRILLING OVERVIEW

The geotechnical borings were drilled with two drill rigs provided and operated by Western States Soil Conservation, Inc. (Western States), of Hubbard, Oregon. The borings were drilled from a floating barge that was provided and operated by Mark Marine Service, Inc., of Washougal, Washington. Three borings were drilled using mud rotary techniques and three borings were drilled using rotosonic techniques. Drilling supervision, including sample collection and field logging of subsurface material, was performed by Shannon & Wilson.

3. GEOTECHNICAL DRILLING AND SAMPLING METHODOLOGY

3.1 Mud Rotary Drilling Technique

For mud rotary drilling performed over water, before the borehole is started, a steel circulation casing is pushed and/or driven to a depth of approximately 10 to 15 feet below the mud line (or more depending on conditions), sealing off any circulating drill fluids from the river. Often, the circulation casing is pushed to refusal using the drill rig hydraulic system or driven with a casing hammer. Once the casing is sealed below the mud line, the boring is advanced using a tri-cone bit and a string of hollow drill rods (narrower than the bit) through which bentonite drilling mud is pumped. The mud is mixed on site using water and powdered bentonite. The drilling mud serves to cool the bit, keep the hole open, and flush the cuttings to the surface. Returning drill mud is typically passed through the circulation casing from the borehole to a screen and tub that is situated over the circulation casing on the deck of the barge. The screen collects the drill cuttings from the borehole, and the tub collects the mud for recirculation back into the hole. If fine-grained, cohesive soils are encountered, other styles of drill bits may also be used with the mud-rotary method, such as scraper or drag bits.

3.1.1 Standard Penetration Test (SPT) Sampling

Disturbed samples were collected in the mud rotary borings at 2-, 5-, or 10-foot intervals using a standard 2-inch outside-diameter (O.D.) split spoon sampler in conjunction with Standard Penetration Testing. In a Standard Penetration Test (SPT), ASTM D1586, the sampler is driven 18 inches into the soil using a 140-pound hammer dropped 30 inches. The number of blows required to drive the sampler the last 12 inches is defined as the standard penetration resistance, or N-value. The SPT N-value provides a measure of in situ relative density of cohesionless soils (silt, sand, and gravel) and the consistency of cohesive soils (silt and clay). In some instances, a 3-inch-O.D. Dames & Moore sampler was used to collect disturbed samples. A 140-pound hammer was used to drive these larger-diameter samplers. All disturbed samples were visually identified and described in the field at the time of sampling, sealed in a labeled plastic jar or bag to retain moisture, and returned to the laboratory for additional examination and testing.

SPT N-values can be significantly affected by several factors, including the efficiency of the hammer used. Measured efficiencies of the automatic hammers used for this project, based on available information we received from our drilling subcontractor, are shown on the boring logs. The field recorded N-values are summarized on the boring logs. For any non-standard sized sampler, the field recorded N-value was corrected back to an SPT value per the AASHTO Manual on Subsurface Investigations (1988). Field recorded N-values, shown numerically on the logs, have not been corrected for hammer efficiency, overburden pressure, flexure of the rods, or silt content. N-values corrected only for sampler size and hammer energy are shown graphically on the boring logs as N_{60} values. An SPT was considered to have met refusal where more than 50 blows were required to drive the 2-inch-O.D. sampler 6 inches (100 blows for larger-O.D. samplers). In this case, the blows are reported as 50 over the distance driven in 50 blows, such as 50/4". Sample recovery is identified as a percentage of material retained for the length the sampler was driven.

3.1.2 Geotechnical Relatively Undisturbed Sampling

Relatively undisturbed samples were collected in some mud rotary borings in 3-inch-OD thin-wall Shelby tubes, which were hydraulically pushed into the undisturbed soil at the bottoms of boreholes. The soils exposed at the ends of the tubes were examined and described in the field. After examination, the ends of the tubes were sealed to preserve the natural moisture of the samples. The sealed tubes were stored in the upright position, and care was taken to avoid shock and vibration during their transport and storage in the laboratory.

3.2 Rotosonic Drilling Technique

During rotosonic drilling, also referred to as sonic rotary drilling, an inner core barrel is rotated while an oscillator in the drill head imposes a high frequency vibration into the drill rods and core barrel. This forces the core barrel and drill bit to be physically vibrating up and down in addition to being forced down and rotating. These three forces, vibration, rotation, and downward force combine to advance the core barrel through soil or bedrock. As the core barrel is advanced the center fills with the soil or rock it is being advanced through. When the core barrel is advanced a certain distance determined by the length of the core barrel it is stopped. An over-casing is advanced over the outside of the core barrel to the same depth as the core barrel tip using the same sonic vibration, rotation, and downward force. The over casing protects the borehole integrity and prevents the borehole from collapsing as the core barrel is retrieved. Multiple over casings may be used to maintain borehole integrity and reduce the outside forces on the inner core barrel and inner casings. The inner core barrel is retracted to the surface where it is emptied into long cylindrical bags as a long soil core or rock core sample. This alternating process of core barrel and over casing advancement with core barrel retrieval is continued to the terminal depth of the borehole.

3.2.1 Rotosonic Continuous Sampling

To retrieve a core sample, the core barrel is withdrawn from the hole and the sample is extruded into tubular plastic bags using vibration. During this exploration program, the boreholes were advanced in five- to twenty-foot intervals while continuously core sampling. The bags of approximately 4- to 6-inch diameter core were placed into wooden boxes and logged and photographed by a Shannon & Wilson geology staff member. Due to disturbance to the soil column during drilling and bagging of the sample, sample recoveries and discreet grab sample depths should be considered approximate.

4. BOREHOLE ABANDONMENT

Once drilling and testing were completed, all borings were backfilled with a high-solids bentonite cement grout, in accordance with Washington Department of Ecology and Oregon Water Resources Department regulations.

5. MATERIAL DESCRIPTIONS

In the field, soil samples were described and identified in accordance with Chapter 4 of the WSDOT Geotechnical Design Manual (2022). The ASTM International (ASTM) D2488 Visual-Manual method was also used as a guide in determining the key diagnostic properties of soils. Consistency, color, relative moisture, degree of plasticity, peculiar odors, and other distinguishing characteristics of the samples were noted. Once returned to the laboratory, the samples were re-examined, various standard laboratory tests were conducted, and the field descriptions and identifications were modified where necessary. We refined our visual-manual soil descriptions and identifications based on the results of the laboratory tests, using elements of the Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System), ASTM D2487. Please refer to the WSDOT Geotechnical Design Manual (2022) and ASTM D2487 for definitions of descriptive terminology used in the boring logs.

The WSDOT Geotechnical Design Manual does not provide quantification of cobble and/or boulder constituents, instead only indicates their presence. Cobbles are defined as “particles of rock that will pass a 12-inch square opening and be retained on a 3-inch sieve” and boulders are defined as “particles of rock that will not pass a 12-inch square opening.” The soil group name in ASTM D2487 and D2488 is based on the portion of the soil sample passing the 3-inch sieve. Refer to the photographs of samples obtained through rotosonic core drilling for estimating the quantities of cobble/boulder constituents recovered from those explorations. It should be noted that the samples presented in the photographs have been disturbed and the finer- and coarser-grained fractions can be segregated during drilling, sampling, and handling.

6. BORING LOGS AND CORE PHOTOGRAPHS

Summary logs of the borings are attached to this appendix. Logs of borings that included soil coring are followed by core photographs. Soil descriptions and interfaces on the logs are interpretive and actual changes may be gradual. The left-hand side of the drill logs provides depth and elevation with a graphic log. The center of the log shows individual sample intervals and identifications, feet recovery, Standard Penetration Test data, natural moisture contents, fines contents, and a list of laboratory tests. The right-hand portion provides material descriptions, miscellaneous comments, and a graphic depicting hole backfill details.