Report - October 2014

Peninsula Drainage District No. 2

Levee Engineering Assessment

Portland, Oregon

CORNFORTH CONSULTANTS

Report to

Multnomah County Drainage District
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PENINSULA DRAINAGE DISTRICT NO. 2
LEVEE ENGINEERING ASSESSMENT

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1. INTRODUCTION

1.1 General

A large portion of North and Northeast Portland are natural floodplains. Beginning in 1917, a system of levees and pump stations has been constructed to provide critical flood protection and stormwater management functions for the Columbia Corridor. This levee system is broken into four distinct subsystems. These are Peninsula Drainage District No. 1 (PEN 1), Peninsula Drainage District No. 2 (PEN 2), Multnomah County Drainage District (MCDD), and the Sandy Drainage Improvement Company (SDIC). This system is a valuable asset that is the product of local, state, and federal investment. It reduces the risk of flooding for an area that is home to thousands of people, 10 percent of the jobs in Multnomah County, and billions of dollars in investment.

In 2013, MCDD, the agency responsible for managing the Columbia Corridor levee system, received notification that the system was no longer meeting federal standards. In particular, PEN 2's United States Army Corps of Engineers (USACE) certification expired in August 2013. The loss of this certification creates the potential for the loss of levee accreditation under the Federal Emergency Management Agency's (FEMA) National Flood Insurance Program (NFIP).

Beginning in June 2013, MCDD retained Cornforth Consultants to assist with the levee certification studies and accreditation application submittal for PEN 2. In October 2013 more than twenty jurisdictions and other regional partners came together to work on the levee improvement project through a Governor-designated Oregon Solutions process convened by Portland Mayor Charlie Hales and Multnomah County Commissioner Jules Bailey. The Oregon Solutions Project Team is working to ensure that the Columbia Corridor levee system meets federal standards and reduces the risk of damage to lives and property that can result from flooding. The first step in this process, and the purpose of this Levee Engineering Assessment, is to deliver a collaboratively-sponsored evaluation of the current condition of the levee system in PEN 2.

The Oregon Solutions Project Team will use these findings as a starting point to determine the community's flood risk tolerance and identify flood risk reduction strategies. The assessment does not identify strategies for improving levee performance or reducing flood risk. Nor does the report estimate the costs to address the areas of concern. Identifying and selecting strategies to address identified concerns, and estimating the associated costs, is part of what the Oregon Solutions Project Team will address next. The Oregon Solutions Project Team will work to engage all communities with current or historical ties to the levee system in a collaborative discussion about how to address the technical and community based implications of levee maintenance and improvements.

1.2 Focus of Current Study

A levee system must be certified in order to apply for accreditation from FEMA. The criteria for certification are described in the Code of Federal Regulations (CFR) 44 CFR 65.10. The FEMA standard for flood protection is known as the "base flood" or "1-percent-annual-chance flood," which is described in more detail below. The certification of a levee consists of documentation that is signed and sealed by a registered Professional Engineer and must demonstrate how the system meets 44 CFR 65.10. The CFR references USACE engineering analysis procedures and guidelines that may be used to assess the levee system's capacity for meeting the safety requirements. Once the levee meets the requirements of 44 CFR 65.10, FEMA can accredit the levee system. FEMA accredits a levee system as providing adequate risk reduction on the Flood Insurance Rate Map (FIRM) if the certification and adopted operation and maintenance plan provided by the levee owner are confirmed to be adequate. Once accreditation is achieved, FEMA can show the areas behind the levee as a moderate-risk area on a FIRM. An accredited levee system has other implied advantages, including:

- Property owners are not required to buy flood insurance
- If desired, property owners can acquire low cost insurance through the National Flood Insurance Program (NFIP)
- City of Portland Floodplain Development Code standards do not apply to developments in the leveed area.

The field investigations and engineering analyses performed for this assignment are focused on the requirements for certification of the PEN 1 levee network and must meet 44 CFR 65.10. Specifically, the engineering analyses discussed herein include: (i) freeboard; (ii) embankment erosion and scour protection; (iii) embankment and foundation stability and potential seepage; and (iv) interior drainage. The intent of this report is to identify the segments of the levee that currently do not or may not meet 44 CFR 65.10. It is understood that the results of this report will assist the Oregon Solutions Project Team in developing action plans and budgeting cycles for upgrading the identified levee segments to meet 44 CFR 65.10. Please note that the analyses of other potential hazards such as seismic stability and flooding related to climate change are outside the current scope of work. In addition, this Levee Engineering Assessment does not address technical issues related to the USACE Rehabilitation and Inspection Program (RIP). The Oregon Solutions Project Team may retain a consultant to evaluate the RIP criteria under a separate authorization.

1.3 Cross-Levee between PEN 1 and PEN 2

The western boundary of PEN 2 is a cross-levee that is shared with the neighboring district to the west, PEN 1. The certification investigations specific to this cross-levee are summarized in a companion Levee Engineering Assessment for the PEN 1 system, which was prepared simultaneously with this study. The PEN 1 report is titled "Peninsula Drainage District No. 1, Levee Engineering Assessment," dated October 2014.

1.4 FEMA 1-Percent-Annual-Chance Flood Standard

The analyses and supporting information for certification requires documentation that the levee system will provide protection under a "base flood" event on the Columbia River. The base flood is defined in regulation as a flood event with a 1-percent-annual-chance exceedance probability. This flood has a one in 100 chance of occurring in any year, and an average recurrence interval of 100 years. It is often referred to as the "1-percent-annual-chance flood". In addition, levee certification studies must analyze the interior drainage of the area within the levee system. This analysis identifies the scale of flooding that may occur within PEN 2 during simultaneous 1-percent rainfall and river flood events.

1.5 Phase 1 and Phase 2 Studies

The engineering assessment described in this report was performed in two phases. The first phase included a review of the PEN 2 and USACE Portland District archives to determine if any studies and documentation required for certification have already been completed. The Phase 1 investigation uncovered information on the history of levee construction, construction plans, site investigations, and some limited engineering analyses. The results of the Phase 1 study were presented in a memorandum to MCDD dated August 21, 2013. Following this work, MCDD and Cornforth Consultants developed a Phase 2 investigation plan to help fill the gaps in information required to complete an analysis for certification. This investigation plan included subsurface field explorations throughout the levee system. Subsequently, MCDD and Cornforth Consultants met with representatives of the USACE Portland District in September 2013 to discuss the proposed Phase 2 field and laboratory investigation plans and engineering analyses of the levee system. The formal Phase 2 Site Investigation Work Plan was submitted to MCDD on December 23, 2013, and the plan was reviewed by the USACE in January 2014. The Phase 2 Site Investigation Work Plan moved forward as proposed. Field drilling work occurred between the months of February and May 2014, and the laboratory testing and office analyses continued through August and September 2014.

The information provided in this initial report is a supplemental engineering assessment that was not part of the original Phase 2 scope of work. Through the course of periodic stakeholder meetings in the spring and summer months of 2014, it became evident that an interim engineering assessment would be beneficial to provide the Oregon Solutions Project Team with timely information on the likely repairs that will be needed for certification to assist with their planning and budgeting efforts. As such, this assessment focuses on the most critical elements of the Phase 2 tasks with regard to potential impacts to planning efforts and construction costs, namely: embankment erosion and scour protection; embankment and foundation stability and potential seepage; potential settlement and loss of levee freeboard; interior drainage modeling review; and review As-Built plans. These same tasks and the remaining tasks will be covered in greater detail under the Phase 2 summary report (Task 9) described in Section 2 that will be developed to include with the accreditation submittal to FEMA.

1.6 Consultant Team

The investigation team for the studies summarized in this report includes: Cornforth Consultants as the prime consultant and geotechnical engineer; WEST Consultants of Salem, Oregon to assist with hydrology/hydraulic issues; and Western States Soil Conservation of Hubbard, Oregon to provide subsurface explorations. Outside of this consultant team, MCDD separately retained Gibbs and Olson of Longview, Washington to provide a topographic survey of the PEN 2 District; and Group Mackenzie of Portland, Oregon to develop As-Built maps and cross-sections. MCDD internally handled select portions of the levee certification studies, including the interior drainage studies and development of the Operations and Maintenance, and Emergency Response manuals.

2. BACKGROUND INFORMATION AND SCOPE OF WORK

2.1 Project Description and Background

PEN 2 is located in North Portland and within Multnomah County, Oregon. According to USACE reports, the district protects an area of about 1,475 acres. Approximately 1,300 acres are improved, and 20 acres are sloughs and drainage canals. Ground surface elevations range from 13 to 30 feet (NAVD88). Land use in the district is divided among commercial, residential, industrial, recreation, and agriculture. Developments within the district include Columbia Edgewater Golf and Country Club, Delta Park Sports Complex, Portland Meadows Race Track, Bridges Middle School, numerous commercial and retail businesses, small industrial buildings, and a large number of residences. Residential areas make up approximately 35percent of PEN 2's area. PEN 2 is bounded to the west by the Interstate 5 embankment, to the east by the Peninsula Drainage Canal cross-levee, to the north by the Bridgeton Road and N Marine Drive levee, and to the south by the Columbia Slough levee. The Interstate 5 embankment is a shared boundary PEN 1 to the west. The east side of the Peninsula Drainage Canal is referred to as the "PEN 2 Cross-Levee" as it is a shared boundary with MCDD to the east.

The PEN 2 system is approximately 6.5 miles in length, including the inactive portion of the Peninsula Drainage Canal and the Interstate 5 embankment. Without the Peninsula Drainage Canal segment, the total length is approximately 5.3 miles. A Vicinity Map of the PEN 2 district is shown on Figure 1. The Site Plans, Figures 2A through 2D, include aerial photographs with associated levee station information for orientation. The top width of the levee is a minimum of 12 feet. The levee reaches a maximum top width of 90 feet at the Interstate 5 Embankment. The top elevation of the levee ranges up to 39.3 feet (NAVD88). The interior drainage system consists of the Peninsula Drainage Canal, Leonard Lake drainage ditch, Switzler Lake east drainage ditch, and smaller ditches, pipes, and channels that drain to two pump stations. The district has two pumping plants; both featuring dual pumps with a capacity of 20,000 gallons per minute (gpm) for each pump (40,000 gpm total for each station).

The district has two segments of concrete floodwalls located along the Oregon Slough boundary (i.e. north side). The two walls are located between Station 41+16 to 44+62, and between Station 73+50 and 79+60 (lengths are 346 feet and 610 feet, respectively, see Fig. 2A for locations). Both walls were constructed to relatively low heights, approximately 3¼ feet maximum, and are presently difficult to recognize in the field because of localized fill placement around them. According to USACE construction documents, the top elevations of the walls range between approximately 36 and 36½ feet (NAVD88).

The Peninsula Drainage Canal is dammed with earth fill at both ends, at its intersection with the Columbia Slough in the southeast corner of the district, and at its intersection with the Columbia River in the northeast corner of the district. The Martin Luther King Boulevard fill crosses the district in a southeast-northwest direction and intersects the Interstate 5 embankment in the northwest corner of the district.

In 1956, the USACE identified two levee segments in a residential area along Oregon Slough (i.e. in the northeast/Marine Drive area) that did not meet the freeboard requirements. Due to concerns over impacts to the residences, the USACE concluded that these localized areas can be readily raised by sandbagging or other temporary construction during a flood event. These sandbag segments are technically defined as "closure structures" in the USACE inspection reports.

2.2 Design and Construction History

Construction of the original PEN 2 levee embankments and pumping and drainage facilities were completed from 1917 to 1921 by local interests; with multiple levee improvements and pump station upgrades at various times over the past 93 years. According to MCDD reports, from 1921 until the present time, major repairs and improvements made to the PEN 2 system are as follows:

From 1939-1940, the USACE improved portions of the existing levee. The project included reinforcing and raising 3,200 linear feet of levee, placing riprap revetment erosion protection, constructing 956 linear feet of concrete wall, installing culverts and drain pipes, and constructing a drainage ditch and pump station.

In late May 1948, a major flood event (now known as the Vanport flood) occurred along the Columbia and Willamette Rivers and their tributaries and the protection system was damaged. Repairs and restoration work included cleaning out drains, sewer outlets, and ditches, and repairing a pumping plant. A 72-inch culvert was constructed under Martin Luther King Boulevard, and ring levees on that roadway were replaced. In 1959, repairs of a section of levee were completed, levee toe reinforcement was placed, and relief wells and pump station were constructed. The Peninsula Drainage Canal Closure No. 1 was also completed that year. Material was placed at the north and south end of the canal, removing its hydrologic connectivity to both the Columbia River and the Columbia Slough.

In 1963, a sand blanket was placed on the landward slope of the levee along the Oregon Slough. In 1966, the USACE Portland District repaired the levee at Station 38+00 (see Fig. 2A). In 1967, a sunken area was repaired; additionally, a sand blanket was placed on the landside slope of the levee at Interstate 5 and NE Schmeer Road.

In 1970, 230 linear feet of bank protection was placed. In 1979, PEN 2 upgraded the levee system to provide protection against the 1-percent-annual-chance flood, which was determined to be elevation 32.0 feet (NAVD88). The 1-percent-annual-chance flood elevation was later updated to 31.0 feet (NAVD88) in a USACE North Pacific Division draft report titled "Review of Flood Control", dated November 1987. In 1982, PEN 2 constructed the 13th Avenue Pump Station along Columbia Slough at Station 194+00 (see Fig. 2C). Revetment was placed along the Columbia Slough levee in 1987.

In 1996 the USACE repaired approximately 100 linear feet of the riverside levee slope along Columbia Slough damaged by the 1996 flood. In 1998, the USACE and MCDD completed a levee rehabilitation project, repairing the toe of the levee with 40,000 tons of riprap along NE Schmeer Road.

The NE Schmeer Road pumping station, located at Station 270+00 (see Fig. 2D), originally constructed in 1959, was reconstructed in 1999. The 13th Ave. pump station, located at Station

194+00 (see Fig. 2C), originally constructed in 1982, was reconstructed in 1988. Complete control system upgrades were performed at both pump stations in 1999.

2.3 Engineering Assessment Background

As mentioned in Section 1, a second phase of work was employed to complete the additional engineering analyses and site investigations to address information gaps identified by the Phase 1 documentation review. The specifics of the engineering analysis are listed below, along with a brief description of what each task entails. Task 9 describes a Summary Report that will be prepared at the completion of the Phase 2 studies and subsequent system improvement, which ultimately will be provided to FEMA along with the PEN 2 application for levee accreditation. The Summary Report is separate from this Levee Engineering Assessment and will be finalized after all of the deficiencies in the PEN 2 District have been addressed. The ultimate purpose of the Summary Report and accreditation application is to provide FEMA with a single, comprehensive document that indicates that all conditions for accreditation are met.

The Phase 2 studies include the following tasks:

Task 1 – Embankment Erosion and Scour Protection Analyses. WEST Consultants performed this task with some assistance from Cornforth Consultants. Their work tasks included site reconnaissance visits to observe and document existing levee slope conditions, levee closures, and existing interior drainage facilities. Their analyses include an evaluation of existing bank erosion protection, estimation of toe scour potential, impacts due to wind and wave action, and the potential impacts from ice, debris and debris flows. A brief discussion of the major results is presented in Section 6 of this assessment.

Task 2 – Embankment and Foundation Stability and Potential Seepage Analysis. Cornforth Consultants took the lead on evaluating the stability of the embankment and foundation materials using information developed from a comprehensive field investigation and laboratory testing program (presented below under Task 4) to characterize existing subsurface conditions. FEMA requires analyses that demonstrate levee stability during the base flood loading conditions. These analyses must include potential shear failure surfaces within both the embankment and foundation soils, as well as an assessment of the potential seepage through and underneath the levee. The key results from these analyses are presented in Section 6 of this assessment.

Task 3 – Analysis of Potential Settlement and Loss of Levee Freeboard. The 44 CFR 65.10 requires engineering analyses that assess the potential and magnitude of future losses of freeboard as a result of levee settlement. The analyses must address embankment loads, compressibility of embankment and foundation soils, age of the levee, and construction compaction methods. The CFR also specifies that settlement analyses shall be performed using procedures such as those described in the USACE manual EM 1110-2-1904, Soil Mechanics Design – Settlement Analysis. Cornforth Consultants completed these analyses using information obtained from the field exploration and laboratory testing programs. Results are presented in Section 6 of this assessment.

Task 4 – Additional Subsurface Explorations and Laboratory Testing. Cornforth Consultants has completed subsurface and laboratory testing programs to obtain data needed to perform the required engineering analyses. These programs are briefly described below.

Subsurface Explorations. The exploration program for PEN 2 included 74 borings overall, with 51 performed on land and 23 performed overwater from a barge. Out of the 74 borings, 26 were completed through the levee crest, 24 at the waterward toe (some can be accessed from land), and 24 at the landward toe. Details on the subsurface investigation program are presented in Section 3 of this assessment.

Laboratory Testing. A laboratory testing program was performed on representative samples obtained from the drilling program to develop soil parameters that was used in the engineering analyses. The laboratory testing consisted of: (i) natural moisture contents on all samples; (ii) index tests that include grain size, plasticity and unit weights; (iii) consolidation testing (settlement parameters); and (iv) shear strength testing. Details on the laboratory program are included in Section 5 of this assessment.

Task 5 – Interior Drainage Modeling Review. MCDD's engineering staff performed interior drainage studies for the PEN 2 system. WEST Consultants has completed a peer review of MCDD's models and analyses to check for conformance with the 44 CFR 65.10 requirements. WEST's review comments were communicated directly to MCDD during the study, along with recommendations, as needed, to help MCDD develop base flood inundation zone maps for inclusion in the FEMA accreditation submittal. WEST's review comments are summarized in Section 6 of this assessment.

Task 6 – Review and Assessment of Operation Plan. MCDD will be preparing an updated operation plan for the PEN 2 levee system in accordance with the requirements of 44 CFR 65.10. Cornforth Consultants will provide review comments and assessments of a draft version of the MCDD's plan. This review will be based on Cornforth Consultants understanding of the CFR criteria and their recent experience with other levee certification projects.

Task 7 – Review and Assessment of Maintenance Plan. As with the operation plan discussed above, MCDD will also prepare a maintenance plan for the PEN 2 levee system in accordance with the requirements outlined in 44 CFR 65.10. Cornforth Consultants will provide review comments and assessments of a draft version of the MCDD's maintenance plan. As stated earlier, the assessments would be based on their understanding of the CFR criteria and their recent involvement with other levee systems. The final version of the maintenance plan would also be incorporated into the FEMA accreditation submittal.

Task 8 – Review As-Builts. MCDD retained Gibbs & Olson to provide a set of topographic maps to show the current levee geometry to meet CFR certification requirements. MCDD also retained Group Mackenzie consultants to use the new topographic maps and add-on utilities and buildings along the levee alignment to assess the current conditions of any potential encroachments into the original levee design geometry. Cornforth Consultants assisted MCDD with the reviews of both map sets to provide editorial comments and recommendations for revisions to the Gibbs & Olson topographic map and the As-Built maps and cross-sections prepared by Group Mackenzie. Further details on the As-Built drawings are presented in Section 7 of this assessment.

Task 9 – Phase 2 Summary Report. The results of all field investigations, laboratory testing and engineering analyses will be summarized in a report that the participating community could submit to FEMA in addition to the accreditation application. The report will ultimately include: (i) summary logs of all exploratory borings; (ii) plots and tabulations of laboratory test results; (iii) summaries and key results of engineering analyses; (iv) conclusions on the interior drainage analyses and Operations, Maintenance, and Emergency Response manuals prepared by MCDD; and (v) conclusions on the overall compliance of the levee system with the requirements for FEMA accreditation. The summary report preparation is on-going at this time.

Task 10 – Levee Certification Application Package. Following completion of the Phase 2 Summary Report, Cornforth Consultants will assist in the preparation of an application package to FEMA Region X for levee accreditation.

Task 11 - Regulatory Review Period Assistance. Cornforth Consultants will assist as necessary during the review period by responding to technical questions from the regulatory agencies and help with drafting response letters or documents.

3. SUBSURFACE EXPLORATIONS

3.1 Field Explorations

In order to obtain additional information on the condition of the levee, a field exploration program of the PEN 2 system was completed between February 11 and May 16, 2014. Western States Soil Conservation, Inc. performed the borehole drilling. Western States' drilling equipment included a truck-mounted CME 55 mud-rotary/auger drill rig, a track-mounted CME 850 mud-rotary/auger drill rig, and a skid-mounted CME 45 mud-rotary drill rig. The latter was loaded onto a small, self-propelled barge for most of the over-water borings. Some of the over-water borings were completed using a barge supplied by MCDD.

The program consisted of 74 exploratory borings. The borings were aligned into rows of two to three borings per location at intervals varying from approximately 600 to 1,400 feet along the levee alignment, with an average spacing of about 1,009 feet. The program included 26 crest borings, 24 landward toe borings, and 24 waterward toe borings. Of the toe borings, 23 were over water and required the use of a barge. MCDD provided a small barge for five overwater borings located within the Peninsula Drainage Canal, which were not accessible with the subcontract driller's larger barge. All 74 boring locations are shown on the four Site Plans included on Figures 2A through 2D.

The locations of borings (identified by hand GPS units in the field) were shared with MCDD for use in the development of new topographic maps and cross-sections. The borings are designated as P2-CC-1 through P2-CC-74, beginning at N. Marine Drive and I-5 and continuing clockwise around the drainage district along Bridgeton Road and N Marine Drive, the levee along the Peninsula Drainage Canal between PEN 2 and the Multnomah County Drainage District, and the levee along the north side of the Columbia Slough up to Denver Avenue. The Denver Avenue/I-5 highway embankment forms a shared boundary between the PEN 1 and PEN 2 districts. As described in Section 1, the subsurface investigations and analyses of the cross levee are summarized in a companion report for PEN 1.

Representative samples of the soils were taken vertically at approximately 5-foot intervals using Standard Penetration Test (SPT) procedures. In addition, an occasional 3-inch diameter thin-wall Shelby tube sample was obtained at select depths to acquire relatively undisturbed soil samples for laboratory testing. The exploratory boring depths ranged from 21.5 to 86.5 feet. The total drilling footage was approximately 2,387 feet.

A field engineer from Cornforth Consultants was present throughout all of the field explorations to collect and log the recovered soil samples, prepare a descriptive field log of the subsurface conditions encountered by the drilling, and to collect digital data during field falling head permeability testing. The Cornforth Consultants field representative also coordinated and assisted the driller during the backfilling and clean-up efforts for each boring.

A summary log of the subsurface conditions encountered in each boring is shown on Summary Boring Logs, Figures A1 through A74 in Appendix A. The Summary Boring Logs describe the drilling methods, materials encountered, depths and types of samples, SPT blowcounts,

interpretive layer thicknesses, and natural water contents of collected samples. The results of the Atterberg tests performed on select samples are also depicted graphically on the logs. The ground surface elevations noted in the Summary Boring Logs are approximate and based on the topography provided by MCDD contractors (Gibbs & Olson) and the GPS locations of the borings collected by the Cornforth Consultants field representative.

3.2 Previous Field Explorations by Others

Unrelated to the current levee evaluation study, numerous other geotechnical studies by various firms have been conducted in the project area, particularly along the Interstate 5 embankment and the bridges over the Columbia Slough. Referencing these earlier reports, an additional four boring logs were identified and acquired to use as substitutes for four of the originally-planned borings. These selected boring logs come from a total of three previous geotechnical reports, with the borings themselves completed between June 2006 and August 2013. The summary logs from these previous explorations are shown in Appendix B, Figures B1 through B4. The locations of these older borings are also shown on the Site Plan Figures 2A through 2D.

3.3 Field Permeability Testing

A total of 19 falling head field permeability tests were performed in 14 borings to evaluate the approximate permeability of the soil layers at selected depths. Most of the falling head tests were conducted in borings that were later used in the seepage and stability analysis cross sections (see Section 6 of this report). In general, testing was performed with the hollow-stem auger cutting bit resting on the base of the drilled hole, making the seepage area equal to the base area within the interior diameter of the casing. Occasionally, the rate of seepage was slow and the casing was raised above the base of the drillhole a short length, making the seepage area equal to the base area and the exposed sidewall surface area of the hole.

The results of the field permeability testing are summarized below in Table 1.

Table 1 – Falling Head Field Permeability Test Results

Boring	Drilled Depth (ft)	"k" value (cm/sec)	"k" value (ft/min)	Summary Log Classification
P2-CC-3	20	2.1E-04	4.2E-04	sl. sandy, sl. clayey to clayey SILT
P2-CC-04	15	3.0E-04	5.8E-04	sl. sandy, sl. clayey SILT
P2-CC-09	20	5.5E-04	1.1E-03	sl. sandy, sl. clayey SILT
P2-CC-10	20	1.2E-03	2.4E-03	clayey SILT
P2-CC-10	35	8.9E-05	1.8E-04	sl. sandy, sl. clayey SILT
P2-CC-27	20	6.2E-04	1.2E-03	very sandy SILT
P2-CC-28	20	1.1E-02	2.1E-02	sandy SILT
P2-CC-28	35	9.3E-03	1.8E-02	sl. silty fine SAND
P2-CC-34	15	3.9E-04	7.7E-04	sl. silty fine SAND
P2-CC-34	45	2.8E-04	5.5E-04	sandy SILT
P2-CC-35	15	7.3E-05	1.4E-04	sl. clayey to clayey SILT
P2-CC-43	15	6.3E-04	1.2E-03	Fine SAND
P2-CC-48	20	3.6E-02	7.1E-02	sl. sandy, sl. clayey SILT
P2-CC-49	15	1.8E-02	3.6E-02	sandy SILT
P2-CC-49	50	1.2E-03	2.4E-03	sandy, clayey SILT
P2-CC-58	25	3.8E-04	7.5E-04	sl. clayey, sandy SILT
P2-CC-69	25	1.0E-05	2.0E-05	sl. sandy SILT
P2-CC-70	10	1.1E-02	2.2E-02	sandy, clayey SILT
P2-CC-70	40	2.4E-03	4.8E-03	sandy SILT

4. SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Site Geology

The PEN 2 Levee District is located along the south shoreline of the Oregon Slough, from River Mile 106.5 to 108.2. The levee is approximately 5 miles north of the downtown Portland, Oregon. Published geologic reports and mapping of this area show the native soils in the upper approximately 100 to 130 feet beneath the levee embankments generally consist of non-glacial Quaternary Alluvium Sediments of the Columbia River; comprised of silt, sand, organic-rich clay and minor gravel deposits. The overall surface of the alluvial deposits is relatively undissected, except for small interior drainage channels and ponds. The Summary Boring Logs, Figures A1 to A74 in Appendix A, identify all native alluvial sediments beneath the levee embankments as "Alluvium".

4.2 General Stratigraphy

Subsurface conditions along the levee generally consist of man-made embankments placed over geologically-recent river alluvium. There are also some localized fills covering the natural alluvium. Generally the exploratory borings show the embankment fills to be composed mostly of silty fine sand, with scattered zones of relatively clean sand, sandy silt, and layers of slightly clayey silt with varying amounts of sand content. The relative densities of the embankment soils are generally classified as loose, with some zones or layers of very loose, medium dense or dense soils. The river alluvium is mostly inter-layered deposits of sandy and clayey silt, silty sand, and minor amounts of silty clay. A dense gravel layer was found at depth, at the southwest corner of the district. It is anticipated that denser sands and gravels would be encountered at greater boring depths all across the district. The relative densities of cohesionless-type soils in the upper river alluvium are generally classified as very loose to loose, and the consistencies of finer-grained cohesive soils as very soft to soft. At depth the relative densities or consistencies are more variable ranging from very loose to very dense for cohesionless soils and very soft to medium stiff for cohesive soils.

4.3 Levee Embankment Fill

The embankment materials along the levee were very consistent being classified mostly as silty fine sand with varying amounts of silt or clay content, as indicated above. The material classifications are consistent with what would be expected for dredged river alluvium, which is assumed to be one of the primary source materials for the levee. A review of the Summary Boring Logs for the crest borings indicates there is little change in the Standard Penetration Test (SPT) blow-count values when the borings penetrated through the embankment fill into the underlying river alluvium, except for five borings (P2-CC-43, P2-CC-58, P2-CC-64, P2-CC-67, and P2-CC-73) where there was a slight decrease going from the fill into the alluvium. The depth of the embankment fills varied from approximately 12 feet (P2-CC-72) to 38 feet (P2-CC-52).

4.4 River Alluvium

The upper river alluvium soils generally consist of inter-layered silt and sand with varying amounts of minor constituents that include some clay and gravel. These materials are similar to the overlying levee embankment soils. All of the alluvial materials are randomly inter-layered across individual levee cross-sections and along the levee alignment. Underlying the upper alluvial soils the layers at depth were generally found to be similar, but with more sand content and less silt and clay.

Five crest borings at select locations along the levee were drilled to greater depths to check the subsurface conditions at lower elevations. The five select borings included: P2-CC-10 (drilled depth – 61.5 feet); P2-CC-28 (drilled depth – 61.5 feet); P2-CC-34 (drilled depth – 61.5 feet); P2-CC-49 (drilled depth – 86.5 feet); and P2-CC-70 (drilled depth – 81.5 feet). The deeper borings generally encountered slightly denser soils at depth as compared to the upper alluvial soils. One boring along the Columbia Slough (P2-CC-70) encountered near refusal (the condition reached when the drill bit could not penetrate further) in a sandy gravel layer at 79 feet depth (Troutdale Formation).

The heterogeneous mixture of silt, sand, clay and gravel layers is typical of many Pacific Northwest river alluvial deposits. In general, the borings did not encounter any unusual conditions that would not be expected in this geologic setting.

4.5 Groundwater Conditions

Groundwater conditions within and near the levee are anticipated to be heavily influenced by the water levels in the adjacent Oregon Slough (Columbia River), and to a lesser extent by the Columbia Slough (slack water slough along the southern boundary). The flow volumes and water levels in the Columbia River are closely controlled by the dams that have been constructed along the lower reaches of the river (Bonneville Dam, The Dalles Dam, John Day Dam, etc.).

5. LABORATORY TESTING

Laboratory testing was performed to determine soil index and engineering properties on representative samples from the site exploration borings. All testing was performed at Cornforth Consultants' soil testing laboratory in Portland, Oregon in general accordance with American Society for Testing and Materials (ASTM) standards and with the USACE's EM 1110-2-1906, Laboratory Testing Procedures. Tests were conducted on samples selected from the field explorations to verify field classifications and to determine the following properties:

- natural moisture content
- grain-size distribution (gradations)
- Atterberg limits
- unit weights
- consolidation properties
- shear strength parameters: angle of internal friction and cohesion intercept, (consolidated-undrained triaxial shear strength testing and direct shear strength testing)

Soil Classification. All soil samples obtained from the field explorations were visually re-examined in the laboratory to confirm the field classifications, using ASTM guidelines. Final soil descriptions were prepared based on a combination of the visual examination and additional laboratory testing of index properties. The final classifications, layer descriptions, and interpretive layer contacts are presented on the Summary Boring Logs, Figures A1 to A74 in Appendix A. All laboratory test plots, except moisture contents, are included in Appendix C.

Natural Moisture Content. All soil samples collected from the borings were tested to determine their natural moisture contents in general accordance with ASTM D-2216-10. The results of these tests are plotted graphically on the Summary Boring Logs, Figures A1 to A74 in Appendix A.

Grain-Size Distribution (Gradations). Grain-size distribution analyses (gradation analyses) by both mechanical-only and combined mechanical/hydrometer test methods were performed on select samples in general accordance with ASTM D-422-63R07. Mechanical-only gradation tests were performed on one embankment fill sample and nine foundation samples. Hydrometer tests were performed on four embankment samples and five foundation samples. The results of the embankment gradation tests are plotted on Gradation Graphs, Figures C1 and C2. The results of the gradation tests on foundation soils are plotted on Figures C3 through C5 in Appendix C.

Atterberg Limits. Liquid and plastic limits (Atterberg limits) were determined for five embankment and fourteen foundation soil samples collected during the field investigations. Of the nineteen samples tested, five were found to be non-plastic (one in the embankment and four in the foundation). Test procedures were in general accordance with ASTM D-4318-10. Results of this testing are shown in Tables 2 (embankment) and 3 (foundation) on the next page and plotted graphically on Plasticity Charts for the embankment samples (Figure C6) and foundation samples (Figure C7) in Appendix C.

Table 2 - Atterberg Limits and Natural Moisture Contents of Select Embankment Soils

Boring No.	Sample No.	Depth (ft)	Natural Moisture (%)	LL (%)	PL (%)	PI (%)	Atterberg Limit Classification
P2-CC-2	S-4	20	40	34	29	5	ML
P2-CC-10	S-4	20	34	46	28	18	ML
P2-CC-25	S-3	15	36	41	30	11	ML
P2-CC-40	S-3	15	35	-	-	-	Non-plastic
P2-CC-70	S-3	15	44	54	32	22	MH

Table 3 - Atterberg Limits and Natural Moisture Contents of Select Foundation Soils

Boring No.	Sample No.	Depth (ft)	Natural Moisture (%)	LL (%)	PL (%)	PI (%)	Atterberg Limit Classification
P2-CC-3	S-3	15	38	40	27	13	ML
P2-CC-15	S-3	15	37	38	24	14	ML/CL
P2-CC-19	S-4*	20	26	-	-	-	Non-plastic
P2-CC-22	S-4	20	45	42	26	16	ML/CL
P2-CC-28	S-7	35	32	-	-	-	Non-plastic
P2-CC-32	S-4	20	41	37	30	7	ML
P2-CC-37	S-4*	20	33	38	26	12	ML
P2-CC-49	S-5	25	36	43	25	18	CL
P2-CC-52	S-11	50	38	-	-	-	Non-plastic
P2-CC-55	S-6	30	35	-	-	-	Non-plastic
P2-CC-58	S-5*	25	33	32	26	6	ML
P2-CC-64	S-8	40	73	58	46	12	MH
P2-CC-67	S-7	35	71	75	42	33	MH
P2-CC-73	S-8	35	53	54	33	21	MH

***** *denotes sample at boundary between embankment and foundation soils*

Unit Weights. Unit weight determinations were performed on numerous samples, including: nine samples used in the consolidated-undrained triaxial shear tests; one sample used in the direct shear test; and twenty-one tests performed only to obtain unit weights. Unit weights were determined for ten samples from the embankment soils, three samples from the boundary between embankment and foundation soils, and twenty-one samples from the foundation soils. These analyses were performed in general accordance with ASTM D7263-09. The results of these tests are summarized in Tables 4 and 5 on the next page.

Table 4 – Moist and Dry Unit Weights of Select Embankment Samples

Boring No.	Sample No.	Depth (ft)	Moist Unit Weight (pcf)	Dry Unit Weight (pcf)	Summary Log Classification
P2-CC-2	S-4	19.4-19.8	107.0	76.9	sandy SILT
P2-CC-10	S-4	19.4-19.8	109.4	81.7	clayey SILT
P2-CC-25	S-3	13.0-13.4	116.3	88.8	sl. clayey SILT
P2-CC-25	S-3	13.4-13.8	111.8	84.5	sl. clayey SILT
P2-CC-25	S-3	13.8-14.2	112.0	84.3	sl. clayey SILT
P2-CC-40	S-3	14.4-14.8	114.5	84.6	sandy SILT
P2-CC-70	S-3	12.9-13.4	115.3	87.0	sandy, clayey SILT
P2-CC-70	S-3	13.4-13.9	112.3	82.0	sandy, clayey SILT
P2-CC-70	S-3	13.9-14.4	109.5	76.2	sandy, clayey SILT
P2-CC-70	S-3	14.4-14.8	107.5	74.7	sandy, clayey SILT

Table 5 – Moist and Dry Unit Weights of Select Foundation Samples

Boring No.	Sample No.	Depth (ft)	Moist Unit Weight (pcf)	Dry Unit Weight (pcf)	Summary Log Classification
P2-CC-3	S-3	14.4-14.8	115.4	84.4	clayey SILT
P2-CC-15	S-3	13.1-13.6	112.2	84.1	clayey SILT
P2-CC-15	S-3	13.6-14.1	108.0	81.8	clayey SILT
P2-CC-15	S-3	14.1-14.6	107.8	80.2	clayey SILT
P2-CC-15	S-3	14.6-14.8	108.3	79.3	clayey SILT
P2-CC-19	S-4*	19.4-19.8	93.4	77.0	very sandy SILT
P2-CC-22	S-4	19.4-19.8	109.6	75.6	clayey SILT
P2-CC-28	S-7	34.4-34.8	117.2	88.5	sl. silty SAND
P2-CC-32	S-4	18.5-18.7	109.3	74.9	sl. clayey SILT
P2-CC-32	S-4	18.7-18.9	111.9	80.2	sl. clayey SILT
P2-CC-32	S-4	18.9-19.1	109.0	76.4	sl. clayey SILT
P2-CC-32	S-4	19.1-19.3	112.1	77.4	sl. clayey SILT
P2-CC-32	S-4	19.3-19.8	109.3	74.9	sl. clayey SILT
P2-CC-37	S-4*	19.4-19.8	116.9	88.1	sandy, clayey SILT
P2-CC-49	S-5	24.4-24.8	114.2	84.2	clayey SILT
P2-CC-52	S-11	49.4-49.8	112.7	81.6	silty SAND
P2-CC-55	S-6	29.4-29.8	116.7	86.5	very sandy SILT
P2-CC-58	S-5*	24.4-24.8	118.1	88.5	very sandy SILT
P2-CC-64	S-8	39.4-39.8	96.3	55.8	sl. clayey SILT
P2-CC-67	S-7	34.4-34.8	97.5	56.9	sandy, clayey SILT
P2-CC-73	S-8	34.4-34.8	104.1	68.2	sandy, clayey SILT

***** *denotes sample at boundary between embankment and foundation soils*

Consolidation Tests. Consolidation tests were performed on one embankment sample and two foundation samples in general accordance with ASTM D-2435-04. All of the samples were obtained from soft silt soils. One sample was obtained from the soft to medium stiff embankment material, to model settlement within the levee itself; while the other two samples were obtained from soft silt foundation soils on the landward toe of the levee, to model the settlement characteristics of foundation materials that had not been previously overlain by fill. All samples were collected in the field using a 3-inch diameter, thin-walled, Shelby tube sampler; and extruded in the laboratory prior to testing. The samples were tested under an incrementally-applied controlled stress load. Representative calculated consolidation parameters: coefficient of consolidation, c_v, secondary compression index, C_α, and permeability values, k, at a loading of 1 ton per square foot (tsf) are shown in Table 6 below. Graphical plots of the consolidation test results are shown on Consolidation Test plots, Figures C8 through C10 in Appendix C.

Table 6 – Summary of Consolidation Test Parameters/Results (at 1tsf loading)

Boring No.	Sample No.	Depth (ft)	c_v (ft^2/yr)	C_α	k (cm/s)	k (ft/min)	Summary Log Classification
P2-CC-15	S-3	14.6	2689	6.0E-4	5.5E-06	1.5E-3	clayey SILT
P2-CC-32	S-4	18.5	3138	8.0E-4	6.3E-06	1.8E-3	sl. clayey SILT
P2-CC-70	S-3	14.4	2402	4.3E-4	4.5E-06	1.3E-3	sandy, clayey SILT

Consolidated-Undrained Triaxial Shear Strength Tests. Nine individual consolidated-undrained triaxial compression shear tests were performed at incremental confining pressures to evaluate typical shear strength parameters of the levee embankment and the foundation soils. Each soil sample was collected in the field using a 3-inch diameter, thin-walled, Shelby tube sampler; and extruded in the laboratory prior to testing. The consolidated-undrained tests were divided between three samples with three tests each. The samples were tested under the same series of confining pressures, consisting of 1,000 pounds per square foot (psf), 2,000 psf, and 4,000 psf. Testing was performed in general accordance with ASTM D-4767-04. The key results from the triaxial shear testing are summarized in terms of the internal angle of friction (ϕ') and the cohesion intercept (c') as determined from a Mohr Diagram plot. The results from the testing are presented below in Table 7 and on Mohr Diagram plots and supporting stress-strain and stress path diagrams for the three samples; as shown on Figures C11 through C19 in Appendix C.

Table 7 – Summary of Consolidated-Undrained Triaxial Shear Strength Test Results

Boring No.	Sample No.	Depth (ft)	Internal Angle of Friction ϕ' (degrees)	Cohesion Intercept c' (psf)	Summary Log Classification
P2-CC-15	S-3	13.1-14.6	33	101	clayey SILT
P2-CC-25	S-3	13.0-14.5	30	29	sl. clayey SILT
P2-CC-70	S-3	12.9-14.4	32	86	sandy, clayey SILT

Direct Shear Strength Tests. Three direct shear tests were performed at incremental confining pressures to evaluate typical shear strength parameters of the sandy foundation soils. The test sample was collected in the field using a 3-inch diameter, thin-walled, Shelby tube sampler; and extruded in the laboratory prior to testing. The direct shear test consisted of one sample with three test different loadings. The sample was tested under a series of confining pressures, consisting of 970 psf, 1,940 psf, and 3,880 psf. Testing was performed in general accordance with ASTM D-4767-04. The key results of the direct shear testing are summarized in terms of the internal angle of friction (ϕ') and the cohesion intercept (c') as determined from a Mohr Diagram plot. The results from the testing are presented below in Table 8 and on a Mohr Diagram plot for the sample as shown on Figure C20 in Appendix C.

Table 8 – Summary of Direct Shear Strength Test Results

Boring No.	Sample No.	Depth (ft)	Internal Angle of Friction ϕ' (degrees)	Cohesion Intercept c' (psf)	Summary Log Classification
P2-CC-32	S-4	19.5-20	37	420	sandy, sl. clayey SILT

6. ENGINEERING ANALYSES

6.1 General

The analyses summarized in this section of the report are associated with a 1-percent-annual-chance flood in accordance with 44 CFR 65.10. Specifically, the engineering analyses discussed herein include: (i) freeboard; (ii) embankment erosion and scour protection; (iii) embankment and foundation stability and potential seepage; and (iv) interior drainage. Details on each are provided below.

6.2 Freeboard

6.2.1 General Freeboard Analysis

For a levee system to receive FEMA accreditation, information must be provided to show that the existing levee meets the requirements established by 44 CFR 65.10 (b)(1) for minimum freeboard during a 1-percent-annual-chance flood. The requirements for minimum freeboard from 44 CFR 65.10 states:

> "Riverine levees must provide a minimum freeboard of three feet above the water-surface level of the 1-percent-annual-chance flood. An additional one foot above the minimum is required within 100 feet on either side of structures (such as bridges) riverward of the levee or whenever the flow is constricted. An additional one-half foot above the minimum at the upstream end of the levee, tapering to not less than the minimum at the downstream end of the levee, is also required."

To evaluate the current freeboard conditions along the PEN 2 levee network, two tasks were completed. The first was to develop updated information on the existing crest elevations along the levee alignment. This was accomplished by a new topographic survey completed by Gibbs & Olson, Inc., which was finalized in October 2013.

The second task was to identify the anticipated 1-percent-annual-chance water surface elevations from published reports and compare those elevations with the existing levee crest elevations. WEST Consultants, Inc. completed a review of freeboard conditions and other issues related to levee certification as part of the ongoing engineering assessments for PEN 2. The freeboard analysis utilized the Gibbs & Olson updated survey data and published 1-percent- annual-chance water surface elevations along the Columbia River published by FEMA (FEMA, 2000) and by the USACE (USACE, 2007).

This comparison included four primary geographic locations based on their flooding sources: along the Oregon Slough (Columbia River) to the north; along MCDD to the east; along the Columbia Slough to the south; and along the adjacent PEN 1 to the west. Stationing along the levee alignment begins at 0+00 in the northwest corner of PEN 2 and encircles the district in a clockwise direction. The levee stationing for the eastern boundary of PEN 2 follows an secondary alignment along the east edge of the Peninsula Drainage Canal, jogging back to the primary PEN 2 levee station line at the engineered 'plug' located at station 168+52.41 (see Fig. 2C). The secondary alignment has a separate levee stationing, beginning at 10+00 and extending to 82+58 (see Figs. 2B and 2C). This

alignment is referred to in this report as the PEN 2 Cross-Levee. For the freeboard analysis on the cross-levee between PEN 1 and PEN 2, the 1-percent-annual-chance flood elevation within PEN 1 was assumed to be the maximum possible elevation achieved should the PEN 1 levee along the Oregon Slough fail, fully inundating PEN 1 to the elevation of the Oregon Slough 1-percent-annual-chance flood.

Plots illustrating the top-of-levee elevation versus the 1-percent-annual-chance flood profile and required freeboard are presented in Figures 3 through 6 from the WEST analysis. As Figures 3 and 4 indicate, the portions of the PEN 2 levee system along the Oregon Slough satisfy freeboard requirements with the exception of a short stretch between approximate stations 101+04 and 101+98 (see Fig. 2B). The ground elevation at this location is too low, resulting in freeboard of only 3.0 to 3.4 feet when 3.5 feet are necessary at this location. Along the PEN 2 Cross-Levee and Columbia Slough segments of the PEN 2 levee, the top-of-levee elevation is sufficiently high to meet freeboard requirements. The analysis did determine that a significant portion of the embankment between PEN 1 and PEN 2 does not meet the required freeboard. Between approximate stations 327+90 and 331+20 (using the historic PEN 2 stationing alignment, see Fig. 2A) drop to a freeboard of only 2.0 feet. This is the segment of Interstate 5 entering the clover leaf interchange from the south as it dips under the overpass for Oregon 99E.

6.2.2 Potential Freeboard Loss Due to Settlement

General. Levee certification requires an analysis to check for the potential and magnitude of future settlement that could lead to a loss of levee freeboard. The settlement analyses must consider the embankment loading conditions, compressibility of the embankment and foundation soils, the age of the levee, and the methods of levee construction.

Settlement Potential. The site investigations of the PEN 2 levee embankment and foundation soils indicate that although the soils are relatively soft/loose, they have low plasticity. This suggests that the soils can exhibit a significant amount of settlement under the fill loads, but the settlement is likely to occur relatively quickly. As discussed in Section 2 of this report, the bulk of the PEN 2 levee network was built in the 1910's to early 1920's, with some major modifications in the 1940's. The levee crest elevation is currently close to the original as-built elevation (typically within about 12 to 18 inches), and it is Cornforth Consultants' understanding that the MCDD has not noticed any settlement problems, nor have they placed any additional fills on top of the levee to the knowledge of the current and past employees. This apparent lack of on-going settlement confirms the statement above that the soils probably settled over a short time period after the fill placement occurred.

Estimate of Total Settlement. Settlement analyses of the PEN 2 levee system were performed at a representative levee section at Station 218+90 (see Fig. 2C). The levee fill thickness at that location is approximately 23 feet. The analyses were performed using the consolidation test data presented in Appendix C (see Figs. C8 through C10). The settlement calculation was made using a conservative assumption that the entire embankment fill was placed instantaneously (versus the periodic placement that actually occurred). The total estimated settlement is 40 inches, which is higher than the observed settlement of 12 to 18 inches described above. This difference is likely due to the fact that much of the settlement probably occurred as the levee embankment was being constructed in stages over the decades.

Time Rate of Settlement. Consolidation tests performed as part of this current investigation on samples of the alluvium soils indicate that they have a relatively high coefficient of consolidation, c_v of approximately 2,500 to 2,700 square feet per year (see Section 5 of this report). This suggests that for an alluvium layer measuring 60 to 70 feet in thickness it should only take 2 to 3 years for 95 percent of the primary consolidation to occur under the levee embankment load (assuming the alluvium layer is singly drained). Since over 70 years have passed, it is evident that the primary consolidation was completed long ago, and the compressible foundation should now be experiencing only minor secondary creep. Based on the foregoing, the potential for loss of freeboard due to settlement of the levee embankment is estimated to be very small or negligible.

6.3 Embankment Erosion and Scour Protection

The embankment erosion protection of the PEN 2 levee was evaluated per requirements of 44 CFR 65.10(b)(3). The following potential influences on embankment erosion protection were evaluated: (i) the base flood (1-percent-annual-chance flood); (ii) expected wind and wave action; (iii) ice loading; (iv) impact of debris; and (v) duration of flooding.

6.3.1 Observed Embankment Erosion Protection

USACE plans of various dates indicate the presence of riprap embankment protection along portions of the PEN 2 levee system, primarily along the north segment of the levee against the Oregon Slough. Proposed improvement plans (USACE, 1952) indicate the presence of existing bank protection in the form of "dumped stone." The material is indicated at approximate levee stations 0+00 to 30+00, 50+00 to 53+50, 64+00 to 70+50, and 101+00 to 104+00 (see Figs. 2A and 2B for locations). There is no indication of the size or gradation of the material in the plans. A site inspection conducted in April 2014 along this segment of the PEN 2 levee was limited in scope due to lack of access to private property. The riprap observed along the western portion of the levee, from approximate station 0+00 to 29+50 (see Fig. 2A) was largely obscured from sight by thick grass and other vegetation. Observations that were possible are listed in Table 9.

Table 9 – Observed and Documented Riprap Characteristics

	Observed Embankment Protection				Riprap Shown On
Approximate Levee Station	D_{50} (in)	D_{100} (in)	Est. Top of Riprap (ft, NAVD88)	Estimated Riprap Class[1]	As-Constructed USACE Plans[2]
15+00	16	24	26	Class IV	"Dumped Stone"
58+00	6	8	30	Class I	None Indicated
97+00	16	24	25	Class IV	None Indicated
104+00	26	36	24	Class V	"Dumped Stone"

Notes:
[1] Class based solely on observed D50 and D100. Estimate does not consider characteristics such as uniformity ratio.
[2] USACE Portland District; Peninsula Drainage district No. 2; Proposed Improvements, Flood Protection; Plate 24; CL-05-16/24; June 2, 1952.

There is no indication in the 1952 proposed improvement plans that embankment protection is present along south portion of the levee. However, field verification during site reconnaissance did

identify two locations where riprap was possibly installed. Rock with a D_{50} between 7 inches and 10 inches (typical of Class I) was observed at two locations along the Columbia Slough – at approximate stations 276+00 and 227+60 (see Fig. 2D). Due to the small size and very limited spatial coverage at both locations, it is not clear if the material was intended for embankment erosion protection or was placed for other purposes.

6.3.2 1-Percent-Annual-Chance Flood Event

In order to evaluate the adequacy of the PEN 2 levee embankment protection for the 1-percent-annual-chance flood, riprap sizing calculations were performed and compared to the observed characteristics of the existing riprap protection. CHANLPRO software (USACE, 1999) was used to determine the minimum required riprap size at representative locations along the levee alignment. Hydraulic parameters at the river cross section locations for the 1-percent-annual-chance flood were determined using an existing HEC-RAS model of the lower Columbia River (USACE, 2011). The calculations were only carried out along the portion of the PEN 2 levee system along the Oregon Slough. During the 1-percent-annual-chance flood, the Columbia Slough is a backwater area inundated by floodwater from the main channel of the Columbia River. This area would have no significant current and is therefore not subject to potential erosive forces associated with the 1-percent-annual-chance flood. The scenario of a PEN 1 levee breach and flooding within PEN 1 against the Interstate 5 embankment would not result in erosive forces adequate to threaten the integrity of the embankment. Similarly, a breach of MCDD levee flooding the interior of MCDD would also not result in erosive forces adequate to threaten the integrity of the PEN 2 Cross-Levee. Both of these breaching scenarios would result in a slow filling of the interior of the drainage districts, which would not result in the velocity of flowing water necessary to produce erosive forces.

A comparison of observed riprap characteristics and the minimum computed riprap size along the Oregon Slough segment of the levee system is shown in Table 10. The results in Table 10 utilize a design factor of safety of 1.1.

Table 10 – Observed and Minimum Required Riprap Size

Approximate Levee Station (ft)	Average Observed Riprap Size (in)		Minimum Required Riprap Equivalent Spherical Diameter (in)			
	D_{100}	D_{50}	D_{100}	D_{50}	D_{15}	Adequate?
92+50	--- [1]	--- [1]	6.6	5.3	3.6	Unknown
86+00	--- [1]	--- [1]	6.6	5.3	3.6	Unknown
63+00	--- [1]	--- [1]	6.6	5.3	3.6	Unknown
42+75	8	6	6.6	5.3	3.6	Yes
19+50	24	16	6.6	5.3	3.6	Yes
11+00	24	16	6.6	5.3	3.6	Yes
0+00	24	16	6.6	5.3	3.6	Yes

Notes:
[1] This portion of the levee was not accessible due to private property.

As indicated in Table 10, the portions of the levee lined with riprap are adequately protected from erosion for the 1-percent-annual-chance flood. In the areas where access to the embankment was limited or unavailable (upstream of approximate levee station 62+00, see Fig. 2B), it is impossible to determine the adequacy of any embankment protection present.

It should be noted that the presence of substantial permanent docks and moorings immediately adjacent to the levee along much of the Oregon Slough adds a level of protection from high flow velocities associated with potential embankment erosion. Such features are present from approximately levee stations 0+00 to 7+50 and 23+00 to 97+00 (see Figs. 2A and 2B). Aerial imagery also suggests the presence of riprap along some of the Pier 99 embankment, at the northwest corner of PEN 2.

6.3.3 Wind and Wave Action

The existing embankment protection for the PEN 2 levee was evaluated for potential erosion by wind and wave action. Wind data was obtained and used to carry out calculations of erosion potential at four locations along the northern PEN 2 levee along the Oregon Slough to determine the minimum riprap size for an expected range of wind velocities. An average fetch distance at each location was estimated from a wave fetch analysis based on aerial photography.

Wave height was calculated by the restricted fetch limited equation documented in Automated Coastal Engineering System Technical Reference (USACE, 1992). The minimum required stone size of the embankment protection was computed using the Hudson equation documented in EM-1110-2-1100, Coastal Engineering Manual (USACE, 2002). A factor of safety of 1.5 was used in the riprap sizing calculations. Wind speed, wave height, and corresponding minimum riprap size estimated from the Hudson equation are shown in Table 11.

Table 11 - Wind Speed, Wave Height, and Minimum Riprap Size

Location	Levee Station	Fetch (ft)	Estimated wave height (ft)		Minimum D_{50} riprap size for wind speed (in)		Minimum W_{50} riprap weight for wind speed (lbs)	
			45 mph	50 mph	45 mph	50 mph	45 mph	50 mph
1	15+00	16,500	2.2	2.5	13.6	15.1	125	172
2	33+50	19,730	2.5	2.7	17.7	19.6	278	378
3	90+00	11,650	1.9	2.1	13.4	14.9	121	166

The highest sustained wind speed recorded at the Portland Jetport RAWS station is approximately 46 miles per hour. At this speed, the calculated minimum D_{50} stone sizes are 13.6, 17.7, and 13.4 inches at Locations 1, 2, and 3, respectively. The observed D_{50} riprap at Location 1 is approximately 16 inches in diameter and is sufficient to resist predicted erosion potential from wind and wave action. The sufficiency of riprap with respect to wind and wave action at Locations 2 and 3 cannot be determined due to lack of access to document the presence or absence of riprap.

As mentioned previously, it should be noted that the presence of the permanent docks and moorings along portions of the riverward bank of the north levee provide an additional measure of protection from erosion caused by wind-generated wave action. The maximum fetch distances calculated for

Locations 2 and 3 in Table 11 do not account for the interference to wave propagation that would result with these features. While this additional protection is not readily quantifiable, it is noteworthy when considering the levee's vulnerability to erosion caused by wind-generated wave action.

6.3.4 Ice Loading

The existing embankment erosion protection for the PEN 2 levee was evaluated for potential of erosion by ice loading. Anecdotal historical records, primarily from newspaper headlines, indicate that while stable ice cover has occurred along the Columbia in the past, most recently in 1949 near the confluence with the Willamette River, there have been no such formations in the last 62 years. Little if any specific historical information is available regarding stable ice forming in the immediate vicinity of PEN 2.

The likelihood of the formation of a stable ice cover on the Columbia River in the vicinity of PEN 2 was evaluated. In order for a stable ice cover to form on the Columbia River, the water must be supercooled to below 32°F. Usually, an air temperature of 18°F or lower for an extended period is required for the supercooling of turbulent water (USACE, 2002). Typical climatic conditions of this region do not support the conditions necessary for the formation of a stable ice cover on the Columbia River.

A climate station located at the Portland International Airport provides typical climate conditions of the area. The examined period of record extends from 1941 to 2010 (WRCC, 2011). The lowest monthly average minimum air temperature of 34^{o}F occurs in January, which is above an air temperature of 18^{o}F. This supports the conclusion that climatic conditions in the vicinity are unlikely to promote the formation of a stable ice cover on the Columbia River.

In the unlikely event of the formation of a stable ice cover, the existing riprap was evaluated for ice generated erosion problems. Where ice flows have historically caused problems, a safety factor of 1.6 – 2.0 should be used to increase the design rock size (FHWA, 1989). To account for ice generated erosion, a safety factor of 1.6 was applied to the calculations of the minimum riprap size and then compared to existing riprap protection. CHANLPRO software (USACE, 1999) was used to determine minimum riprap sizing. Increasing the factor of safety to 1.6 in the calculations yielded identical results for minimum riprap sizing as with a factor of safety set to 1.1 (see Table 10). This indicates that the portions of the PEN 2 levee embankment which were accessible for inspection and exhibit riprap embankment protection are adequate to resist erosion caused by ice loading.

6.3.5 Impact of Debris

The existing embankment erosion protection for the PEN 2 levee was also evaluated for potential erosion from the impact of debris. The Oregon Slough does have potential for transporting floating debris. As noted in section 6.3.2, there are many permanent docks and moorings along the Oregon Slough which could also serve as possible sources for floating debris capable of causing damage to the revetment protecting the PEN 2 levee.

A safety factor of 1.6 should be applied when sizing riprap to account for the impact potential from floating debris (FHWA, 1989). As discussed in the previous sub-section, a safety factor of 1.6 was applied to the calculations of minimum riprap size. The portions of the PEN 2 levee embankment

where embankment erosion protection was documented are adequate to resist the added erosion potential from floating debris.

6.3.6 Duration of Flooding

A flow duration analysis is ongoing for the project site. Historical stream flow data for the Columbia River have been collected and will be evaluated for the United States Geological Survey (USGS) Gage 14128870, "Columbia River Below Bonneville Dam, OR" (USGS, 2011). The gage has 30 years of daily stage data which encompasses several significant flooding events.

The analysis will determine a stage correlation using the 1-percent-annual-chance flood profile for the prediction of the stage near the PEN 2 levee based on the stage observed below Bonneville Dam. This will allow the calculation of durations for which the toe of the PEN 2 levee has been inundated by more than five feet.

6.4 Embankment and Foundation Stability and Potential Seepage

6.4.1 Levee Reaches

The criteria listed in 44 CFR 65.10 require that the overall stability and potential seepage through and under a levee be evaluated under the 1-percent-annual-chance flood loading conditions. When performing seepage and stability evaluations of levees, the analyses are performed by separating the levee into segments with similar features and conditions. These segments with similar properties are generally referred to as "reaches." This method allows several miles of levee alignment to be analyzed in manageable pieces. For the purposes of this investigation, the PEN 2 District was partitioned into 15 reaches. These reaches have been grouped based on: (i) levee embankment configuration; (ii) subsurface conditions; (iii) levee height; and (iv) prior performance history. The approximate limits of the reaches are shown on Figures 2A through 2D.

6.4.2 Analysis Cross-Section Models

The stability and seepage analyses were performed on geologic cross-sections through the levee embankment, which were developed using: (i) the topographic information of the site collected by Gibbs & Olson; (ii) bathymetry data acquired by MCDD for the adjacent waterways (Oregon Slough and Columbia Slough); and (iii) the subsurface information obtained from Cornforth Consultants' field investigation program. Analyses were performed on representative cross-sections for all of the reaches except for Reach 2-6, which is flat ground with no embankment. Two separate analyses were performed for Reach 2-9, which included a section across the dam embankment that separates the Columbia Slough from the Peninsula Drainage Canal, and another representative cross-section through the levee at Station 186+67 (see Fig. 2C). Cross-sections for the analyzed levee reaches are presented on Figures 7 through 21.

6.4.3 1-Percent-Annual-Chance Flood Elevations

The 1-percent-annual-chance flood water surface elevations were determined by WEST Consultants from the Digital Flood Insurance Rate Map (DFIRM) Database for the City of Portland, Oregon. The water surface elevations are based on the combined stage-frequency curves developed from seven gage locations along the Columbia River between River Miles 60 and 123, and one location on the Willamette River.

6.4.4 Analysis Methods / Material Properties

The analysis cross-sections were used as the basis for developing analytical models in the seepage and slope stability software programs SEEP/W-2007 and SLOPE/W-2007; both are modules of the GEO-STUDIO 2007 suite of programs. Based on the data collected from the field investigations, laboratory testing program, and Cornforth Consultants' experience with similar soils, generalized soil properties were developed for the materials encountered by the borings. The material properties used in the seepage and stability analyses are summarized below in Table 12.

Table 12 – Summary of Estimated Soil Properties for Stability and Seepage Analyses

Material Descriptions	Unit Weight γ (pcf)	Friction Angle ϕ' (degrees)	Cohesion Intercept c' (psf)	Permeability k (ft/sec)	Permeability Ratio, k_h/k_v
Levee Fill: Silty Sand to Sandy Silt	108	33	0	$8.3x10^{-5}$	4
Levee Fill: Clayey Silt	112	31	0	$6.7x10^{-5}$	4
Foundation: Clayey Silt to Silty Clay; (River Alluvium)	110	32	0	$1.1x10^{-5}$	4
Foundation: Silty Sand to Sandy Silt; (River Alluvium)	113	33	0	$2.4x10^{-5}$	4

Note* Value estimated based on available information

6.4.5 Seepage Analyses

SEEP/W uses a finite element analysis to model seepage passing through the foundation and embankment soils as a result of higher water levels acting on the riverward side of the levee. Although the finite element mesh is generated by SEEP/W using an internal algorithm, the finite element size can be adjusted by the user. For this project, the approximate element size for all analyses was 2 feet x 2 feet. Using the 1-percent-annual-chance flood level recommended by WEST Consultants, seepage through the foundation and embankment soils was calculated under saturated, steady-state conditions. As recommended by the SEEP/W manual, the exit gradient at the landward

toe of the levee was averaged over 2 mesh units (4 feet). The exit gradients from these analyses were then compared to the recommended maximum exit gradient (i.e. exit gradients should be no higher than 0.5 at the toe of the landward embankment slope) suggested by the USACE in EM 1110-2-1913 (USACE, 2000).

Results of Seepage Analyses. For all of the analysis sections on the PEN 2 levee, the calculated exit gradient was significantly lower than the maximum value of 0.5 recommended by the USACE. The exit gradients varied from 0 to 0.3. The results of the seepage analyses (i.e. exit gradients) are shown below in Table 13 for each of the reaches analyzed, and also on Figures 7 through 21. The key reason for the low exit gradient calculated is that the 1-percent-annual-chance flood elevation only rises a few feet above the riverward toe. On that basis, there is very little seepage force acting across the embankment.

6.4.6 Embankment Stability Analyses

The slope stability program SLOPE/W performs analyses to calculate the factor of safety (FS) for potential unstable slope conditions using conventional limit equilibrium theory. The steady-state seepage data generated in the SEEP/W model were imported directly into the SLOPE/W model to account for the pore water pressure conditions. The critical slip surface with the lowest FS for specific embankment conditions was determined using a grid and radius search routine with factors of safety calculated for multiple circular-slip surfaces. A minimum failure surface depth of 10 feet was set as a limiting parameter in the model to ensure that minor, surficial failures would be excluded from the analysis results. These types of shallow failure surfaces may show lower calculated factors of safety; however, they are considered to be far less significant to deeper failures that pose an actual threat to the integrity of the levee. It is assumed that MCDD would be able to treat any shallow failure areas with good maintenance practices as they occur to prevent them from developing into much larger failures that could endanger the levee.

Results of Stability Analyses. The results of the slope stability analyses are summarized on Table 13 below and also on Figures 7 through 21. The calculated FS from each levee reach was compared against the minimum value recommended by USACE in EM 1110-2-1913 (USACE, 2000); which requires FS greater than 1.4 for static, steady-state seepage conditions. This threshold FS value was met for all the levee reaches except for Levee Reaches 2-7 and 2-8.

Table 13 – Results of Seepage and Stability Analyses

Levee Reach	Station	100 yr Flood Elevation	Max Exit Gradient	Landward FS	Waterward FS	Meets USACE Standard?
2-1	2+52	31.7	0.1	2.17	1.56	Yes
2-2	12+98	31.7	0	3.41	1.41	Yes
2-3	53+09	31.9	0	5.39	1.79	Yes
2-4	71+20	32.0	0	2.38	2.30	Yes
2-5	97+39	32.3	0.1	4.35	2.29	Yes
2-7	34+75*	32.3	0.1	0.99	1.75	No
2-8	58+60*	32.3	0.1	1.09	1.61	No
2-9	80+80*	31.0	0.2	1.50	2.42	Yes
2-9	186+67	31.0	0.3	1.73	1.63	Yes
2-10	210+02	31.0	0.1	2.15	1.40	Yes
2-11	218+08	31.0	0	-	1.44	Yes
2-12	234+97	31.0	0	2.71	1.41	Yes
2-13	244+73	31.0	0	2.00	1.53	Yes
2-14	254+35	31.0	0.1	1.88	1.49	Yes
2-15	272+98	31.0	0.2	1.71	1.97	Yes

Note* Stationing specific to cross levee shared with neighboring district (see Figures 2B and 2C)

6.5 Interior Drainage Modeling Review

Interior drainage modeling has been completed by MCDD. WEST conducted an independent review of that modeling in September 2014. Few technical issues were identified with the interior drainage modeling, and those had little effect on the overall results of the analysis. Comments provided to MCDD were applied and the modeling finalized. The independent review was finalized in September 2014 and ultimately concluded that interior drainage modeling of the PEN 2 levee system was conducted according to standard engineering practice.

7. AS-BUILT DOCUMENTS

The provisions for levee certification under 44 CFR 65.10 require levee districts to provide "certified as-built plans". These are as-built plans of the levee network in its current condition, and not actual as-built documents from the original construction. To develop the as-built maps and cross-sections, MCDD retained Gibbs and Olson to develop a current topographic map of the district. Gibbs and Olson completed their survey in October 2013. Subsequently, MCDD retained Group Mackenzie to develop detailed As-Built maps of the district using the Gibbs and Olson topographic data as well as additional information from LIDAR and utility companies. The Group Mackenzie documents include both topographic maps of PEN 2 and representative cross-sections through the levee embankment. The Group Mackenzie As-Built maps are presented in Appendix D and the As-Built cross-sections are presented in Appendix E of this report.

8. ENCROACHMENTS

8.1 FEMA Accreditation Focus

The FEMA criterion for levee accreditation focuses on the structural integrity of the levee and its ability to maintain protection of the district interior area under 1-percent-annual-chance flood conditions (i.e. embankment stability, seepage and settlement or freeboard loss). The guidelines do not address the issue of flood fighting concerns caused by encroachments or potential issues related to trees/vegetation, beyond their potential impacts to stability, seepage and freeboard. However, FEMA guidelines do require that the district adopt formal operations and maintenance manuals that outline the operation standards for routine and emergency conditions, and maintenance requirements for equipment upkeep and vegetation control. As described previously, this study was performed to assess whether the district meets FEMA accreditation requirements; therefore, the embankment encroachments were evaluated primarily for their potential to impair the structural integrity of the levee. For the purposes of this levee engineering assessment, encroachments were classified using typical USACE definitions, which includes unauthorized excavations, structures and other obstructions within the levee project easement. Accordingly, engineering evaluations were completed to identify any major encroachments on or adjacent to the PEN 2 levee embankment that could threaten levee stability.

8.2 Encroachment Assessment for FEMA Accreditation

Original Design Section and Levee Overbuild. At many locations throughout PEN 2, the present ground configuration is significantly different from how it was depicted in the original USACE construction documents. The levee embankments frequently exhibit more fill than the original design sections indicate. This excess fill is referred to as “overbuild”. The excess fill is most prominent on the landward and waterward sides of the levee (i.e. making for a wider embankment), and at some locations on the levee crest. As discussed in Section 7, the cross-sections developed by Group Mackenzie contrast the existing ground surface versus the original design levee sections. These cross-sections are presented in Appendix E. Representative cross-sections demonstrating overbuild include Stations 43+80, 97+50, 199+20, and 263+00. In general, encroachments such as buildings and utilities situated within the levee overbuild areas were considered not to be a significant risk to the levee with regard to the criteria in 44 CFR 65.10, because they do not affect the structural integrity of the original levee section.

Buildings, Utility Lines and Outfalls. Consideration was given to the buildings, multiple utility lines and outfalls identified in the levee sections, particularly those levee segments along residential and developed areas. The PEN 2 levee alignment is heavily residential along the northern boundary from about Station 30+00 through 97+00 (see Figs. 2A and 2B). This includes the segment along Bridgeton Road and N Marine Drive. In general, the bulk of the structures and utility encroachments along the Bridgeton segment are located in the levee overbuild, and most-commonly on the landward side. However, in the segment along N Marine Drive, several structures do overlie the levee crest. Based on the foregoing, close attention was paid to the potential impacts from these structures and their associated utilities to the design levee section. Minor feeder utility lines to these buildings (such

as gas and water) were generally not considered seepage hazards, because they are typically very small diameter and situated at higher elevations in the embankment.

Due to the large numbers of structures in the residential areas (some of which included townhomes/multi-family buildings), the encroachment analyses focused on representative structures from within a group in a levee reach. The key focus was placed on structures that are situated closest to the levee centerline and/or embedded the most into the levee embankment (see As-Built drawings in Appendices D and E). As part of this endeavor, Gibbs and Olson obtained interior floor elevations for many of the structures during their survey work.

As shown on the As-Built cross-sections in Appendix E, there are multiple duct banks and larger utility lines that extend longitudinally along the levee alignment. It is our opinion that these longitudinal lines do not pose a significant risk to embankment stability, or to the potential for excessive seepage within the embankment. Many of these utilities are shown to be at or above the 1-percent-annual-chance water level, which would produce very small to no head differential seepage across the section. Also, many of the utilities are shown to be located in wide embankment sections with relatively flat landward slopes or flat ground surfaces with no slopes. Again, the risk of potential slope instability associated with these utility lines specific to the 1-percent-annual-chance flood is considered to be very small to non-existent.

Reviewed Encroachments in Levee Design Section. Table 14 below summarizes the encroachments within the levee sections. The table also includes comments on the expected severity of the encroachments.

Table 14 – Design Section Encroachments on the PEN 2 Levee

Levee Alignment Stationing	Assessment or Comments
2+50	Two buildings outside of design levee section, one encroaches into an overbuild embankment section, existing overbuild ground surface is higher and wider than design levee section. No apparent impacts with regard to seepage or stability during a 1-percent-annual-chance flood.
33+00	One building on landward side slope, encroaches into an overbuild embankment section, but does not impact design levee section. Water and gas lines extend longitudinally beneath levee crest, but not expected to pose seepage concerns. Ground surface elevation on landward side is relatively high. No apparent impacts from encroachments with regard to seepage and stability during a 1-percent-annual-chance flood.
34+75	Two buildings outside of design levee section; one encroaches into an overbuild embankment section on the landward side. Existing overbuild ground surface is slightly higher and wider than design section; therefore, no expected concerns for embankment instability. Water and gas lines extend longitudinally beneath levee crest, but not expected to pose seepage concerns. Landward side ground elevation is high. No apparent impacts with regard to seepage and stability during a 1-percent-annual-chance flood.

Table 14 – Design Section Encroachments on the PEN 2 Levee Embankments (cont.)

Levee Alignment Stationing	Assessment or Comments
37+75	Two buildings outside of design levee section; both encroach slightly into the overbuild. Both structures are higher than the 1-percent-annual-chance flood elevation. Water and gas lines extend longitudinally beneath levee crest, but not expected to present seepage concerns. Ground surface elevation on landward side is relatively high. No apparent impacts from encroachments with regard to seepage and stability during a 1-percent-annual-chance flood.
43+80	One building on landward side with very slight encroachment into design section, but mostly in an overbuild section. Existing ground surface is much wider than original levee design section, no apparent concerns for embankment instability. Water and gas lines extend longitudinally beneath levee crest, but not expected to pose seepage concerns. Ground surface elevation on landward side is relatively high. No apparent impacts from encroachments with regard to seepage and stability during a 1-percent-annual-chance flood.
52+63.6	Building on landward side with very slight encroachment into design section. Existing levee embankment is much wider than design section, with no apparent concerns for embankment instability during a 1-percent-annual-chance flood. Small diameter water lines extend transverse through levee crest, but situated above the 1-percent-annual-chance flood elevation. Ground surface elevation on landward side is relatively high. No apparent impacts from encroachments with regard to seepage and stability during a 1-percent-annual-chance flood.
56+50	Buildings on landward and waterward sides of the design section, both positioned in overbuild sections of the embankment. Both structures are higher than the 1-percent-annual-chance flood elevation. Existing levee embankment is much wider than the design levee section. Water line extends longitudinally beneath levee crest, but not expected to pose seepage concern. Ground surface on landward side is relatively high. No apparent impacts from encroachments with regard to seepage and stability during a 1-percent-annual-chance flood.
82+60	One house near the crest of the levee design section, slight encroachment into top of crest. House base is higher than the 1-percent-annual-chance flood elevation. Existing ground surface is higher and much wider than design section, with little to no landward side slope. No apparent impacts from encroachment with regard to seepage or stability during a 1-percent-annual-chance flood.

Table 14 – Design Section Encroachments on the PEN 2 Levee Embankments (cont.)

Levee Alignment Stationing	Assessment or Comments
85+80	One house encroaches into the waterward side crest of the design levee section. Base of house is higher than the 1-percent-annual-chance flood elevation. Existing ground surface is higher and much wider on both sides of the levee design section, and waterward and landward ground surfaces are relatively flat for extended distances on either side of the levee. No apparent impacts from encroachment with regard to seepage or stability during a 1-percent-annual-chance flood.
93+90	One house on waterward side of design levee section, which encroaches into an overbuild embankment section. Base of house is higher than the 1-percent-annual-chance flood elevation, and does not impact design levee section. Existing ground surface is higher and much wider than design section, with no levee slopes for extended distances. No apparent impacts from encroachment with regard to seepage or stability during a 1-percent-annual-chance flood.
209+33	One building at landward side toe, with slight encroachment into an overbuild section. Does not impact the design levee section, and the existing ground surface is slightly higher and wider than design section. No apparent impacts from encroachment with regard to seepage or stability during a 1-percent-annual-chance flood.
218+10	Ten-inch diameter elm tree positioned within overbuild on the waterward side of the design levee section. Root mass may slightly penetrate into design section. Existing embankment is much wider than design levee section, and there is little to no slope on the landward side. No apparent impacts from encroachment with regard to seepage or stability during a 1-percent-annual-chance flood.
220+35	One building on landward side flat ground, founded on overbuild. No encroachment into the design levee section, and the structure is much higher than the 1-percent-annual-chance flood elevation. Twelve-inch diameter elm positioned within overbuild on the waterward side, with root mass that is likely within overbuild. Existing embankment is much wider than design levee section, and there is little to no slope on the landward side. No apparent impacts from encroachments with regard to seepage or stability during a 1-percent-annual-chance flood.
263+00	One building on the landward side, which encroaches into an overbuild section. Structure does not impact the design levee section. Existing embankment is wider than the design levee section. No apparent impacts with regard to seepage or stability during 1-percent-annual-chance flood.

8.3 USACE Encroachment Standards

The information below provides a preliminary overview of encroachments under the purview of the USACE Rehabilitation and Inspection Program (RIP). While this Levee Engineering Assessment was not scoped to address technical issues related to the USACE RIP, the information below provides a basic overview on how the RIP evaluates encroachments. The Oregon Solutions Project Team may retain a consultant to evaluate encroachments in regards to RIP criteria under a separate authorization.

Authorized Encroachments. The USACE has historically reviewed applications from the general public for encroachments into the levee right-of-way to help ensure that they do not adversely affect the system. Since the early 1980's, the USACE has approved 50 separate construction projects within PEN 2. Authorized encroachments have varied from utility lines, hotels, apartments and condominiums, fences, and bike paths on overbuilt portions of the levee (i.e. sections where fill has been placed on top of the original levee design section).

RIP Inspections and Unauthorized Encroachments. PEN 2 participates in the USACE's RIP review. On that basis, the USACE performs routine inspections every one to two years, and more-detailed 5-year periodic inspections of the district to identify deficiencies relating to levee conditions and operations. These inspections provide assurance that the levee districts are maintaining the levee systems to USACE standards, and are also intended to help the levee districts recognize areas of concern, and to assist them in prioritizing levee maintenance and repairs. From a general standpoint, encroachments receive close scrutiny during the USACE inspections because they may negatively impact proper operation and maintenance, or possibly impair the structural integrity of the levee embankment and its ability to prevent flooding of the protected areas. Another critical concern is the potential for encroachments to impede flood fighting capabilities during a flood-related emergency. Trees and other large vegetation growing within the levee footprint have traditionally been considered unauthorized encroachments due to their potential for: (i) seepage issues caused by root penetration; (ii) the capacity to interfere with flood fighting; and (iii) concealment of the ground surface conditions that could prevent the detection of problems.

The most recent 5-year periodic inspection report from the USACE for PEN 2 was completed in January 2011, and subsequent routine inspections have followed. The periodic inspection report identified over 90 unauthorized encroachments within 15 feet of the levee footprint in PEN 2. The encroachments were typically identified as residential and commercial structures, utility poles, debris, large tree vegetation, and construction materials. The unauthorized encroachments were rated as "unacceptable" in the inspection reports, presumably for their potential to interfere with maintenance activities and flood fighting. As mentioned above, unauthorized encroachments will need to be addressed in coordination with the USACE Portland District in the future.

9. CONCLUSIONS

9.1 General

In general, the engineering analyses indicate that several long segments of the PEN 2 levee system meet the requirements of 44 CFR 65.10 for certification. However, there are some reaches that do not meet these standards. The primary area of concern is the levee embankment along the Peninsula Drainage Canal that comprises the eastern boundary of PEN 2 (i.e. Reaches 2-7 and 2-8). This levee segment is shared with the neighboring district to the east, MCDD. As described in Section 6.4.6 of this report, the calculated factor of safety for stability along these reaches is below the acceptable level. This deficiency occurs under a modeled scenario where MCDD is breached and flooded during a 1-percent-annual-chance flood.

A summary of the engineering evaluations is presented in Table 15 below:

Table 15 – Summary of Engineering Evaluations per 44 CFR 65.10

Levee Alignment Stationing	Levee Reaches	Assessment or Comments
0+00 through 80+00	Reach 2-1 through Reach 2-4	Meets engineering requirements for certification under 44 CFR 65.10.
80+00 through 104+00	Reach 2-5	Minor freeboard deficiency. Otherwise, the embankment meets the requirements of 44 CFR 65.10 for seepage and stability.
10+00* through 27+00*	Reach 2-6	No levee embankment. Area is high ground
27+00* through 78+50*	Reach 2-7 through Reach 2-8	Levee embankment does not meet requirements of 44 CFR 65.10 for stability.
168+50 through 283+80	Reach 2-9 through Reach 2-15	Meets engineering requirements for certification under 44 CFR 65.10.

Note* Stationing specific to levee shared with neighboring district to the east (See Figs. 2B and 2C)

9.2 Cross-Levee Between PEN 1 and PEN 2

As discussed previously, the results of the engineering assessments for the cross-levee between PEN 1 and PEN 2 are presented in a companion report for PEN 1. However, for convenience, a brief summary from those studies is provided below.

The PEN 1 and PEN 2 levees merge at the southern end of the cross-levee at PEN 2 Station 283+80 (see Fig. 2D). This location coincides with PEN 1 Station 199+26. The cross levee extends from that merger point to the northern limit at PEN 1 Station 263+55 (see Fig. 2A). For

the purposes of the engineering evaluations, this stretch of levee was divided into four reaches that were identified as Reach 1-12 through Reach 1-15 in the PEN 1 report. The engineering analyses determined that all four of these reaches meet the seepage and stability requirements for certification under 44 CFR 65.10. However, there are freeboard deficiencies within Reach 1-15, which extends from PEN 1 Stations 245+00 through 263+50 (see Fig. 2A). As described in Section 6.2.1 – General Freeboard Analysis of both the PEN 1 report and this PEN 2 report, these freeboard deficiencies are localized to relatively short segments of the levee located near the Interstate 5/Oregon 99E overpass, and the crossing over N Pier 99 Street.

The findings of the Levee Engineering Assessment represent a significant first step in understanding the safety and resiliency of the communities protected by the levee system. After vetting the findings presented in this report, the Oregon Solutions team will engage in a discussion to determine what level of flood protection the community desires. Then, the team will identify the proper design, construction, and financing options that will achieve these community goals and keep the levee system in compliance with FEMA and USACE standards.

10. PHOTOGRAPH LOG

PENINSULA DRAIANAGE DISTRICT NO. 2

Photo No. 1 Photo Date: 9/18/2014 Orientation: South Description: Interstate 5 functions as the cross-levee between PEN 1 and 2. There is a flood wall on the landward side of the levee adjacent to the Oregon Slough at this location.	

Photo No. 2 Photo Date: 9/18/2014 Orientation: South Description: PEN 2 has a number of residential and business structures located within levee right-of-way. To the east of the Interstate 5 cross-levee the Pier 99 building is located within the levee right-of-way, but is constructed on the overbuild.	

Photo No. 3 Photo Date: 9/16/2014 Orientation: West Description: The north side of PEN 2 levee protects the district from the high water in the Oregon Slough on the Columbia River. This section of levee has rip rap on the waterward toe.	

Photo No. 4 Photo Date: 9/16/2014 Orientation: Southwest Description: Townhouses are located on the south side of Bridgeton Road. The levee centerline is located along Bridgeton Road. There is a large amount of overbuild over the USACE design section of the levee. There are also multiple utilities within the levee right-of-way.	

Photo No. 5 Photo Date: 9/16/2014 Orientation: West Description: The levee has steep slopes along Bridgeton Road. Vegetation is managed manually once a year along.	

Photo No. 6 Photo Date: 9/16/2014 Orientation: North Description: An image of the many floating homes located to the north of PEN 2.	

Photo No. 7 Photo Date: 9/16/2014 Orientation: South Description: This image shows that the levee does not have a steep slope on the landward side along Bridgeton Road.	

Photo No. 8 Photo Date: 9/16/2014 Orientation: West Description: The waterward side of the levee along Bridgeton Road.	

Photo No. 9 Photo Date: 9/16/2014 Orientation: East Description: Bridgeton Road has parking lots to the north and townhouses to the south. The levee centerline is located along Bridgeton Road.	

Photo No. 10 Photo Date: 9/18/2014 Orientation: South Description: Along the Oregon Slough there are many floating homes located to the north of the PEN 2 levee system.	

Photo No.11 Photo Date: 9/16/2014 Orientation: West Description: A view of the floating homes along the Oregon slough.	

Photo No. 12 Photo Date: 9/18/2014 Orientation: South Description: There are large residences located to the north of Marine Drive. The levee centerline runs along many of these properties. The levee does not have a standard levee prism along this location as it ties into level ground along Marine Drive, and there is no slope on the landward toe.	

Photo No. 13	
Photo Date: 9/18/2014	
Orientation: Southwest	
Description: Another view of homes along Marine Drive.	

Photo No. 14	
Photo Date: 9/16/2014	
Orientation: Northeast	
Description: A property in the northeast corner of PEN 2 is owned by the Port of Portland. The site used to be the location of the Columbia Edgewater Country Clubhouse before the building caught on fire and was removed. The property is vacant and closed to the public by a fence.	

Photo No. 15 Photo Date: 9/16/2014 Orientation: West Description: The vacant Port of Portland property is located to the north of Marine Drive and across from the Columbia Edgewater Country Club	

Photo No. 16 Photo Date: 9/16/2014 Orientation: South Description: The Peninsula Slough Drainage Canal separates PEN 2 and MCDD. The levee along the east side of the canal is the cross-levee between PEN 2 and MCDD. This image shows the beginning of the cross-levee prior to the beginning of the canal.	

Photo No. 17 Photo Date: 9/16/2014 Orientation: Northeast Description: A view of the Port of Portland property that is located on the MCDD side of the Peninsula Drainage Canal cross-levee.	

Photo No. 18 Photo Date: 9/16/2014 Orientation: South Description: The northern end of the Peninsula Slough Drainage Canal.	

Photo No. 19 Photo Date: 9/16/2014 Orientation: South Description: The Peninsula Slough Drainage Canal and the cross-levee between PEN 2 and MCDD. The canal provides habitat for sensitive species including the Western painted turtle.	

Photo No. 20 Photo Date: 9/16/2014 Orientation: North Description: The Peninsula Slough Drainage Canal and the cross-levee between PEN 2 and MCDD. The canal is not hydraulically connected to the Columbia River or the upper Columbia Slough. Water enters the canal as rainfall or groundwater.	

11. REFERENCES

Cornforth Consultants, Inc., *Memorandum, Phase 1 - Documentation Review, Peninsula Drainage District No. 2, Portland, Oregon,* August 2013.

Federal Emergency Management Agency (FEMA), *Flood Insurance Study, City of Portland, Oregon*, November 2010.

Federal Emergency Management Agency (FEMA), *Flood Insurance Rate Map, Panel No. 4101830080F*, City of Portland, Oregon, November 2010.

Federal Emergency Management Agency (FEMA), *Flood Insurance Rate Map, Panel No. 4101830085F*, City of Portland, Oregon, November 2010.

Federal Highway Administration, Design of Riprap Revetment, FHWA-IP-89-016, *Hydraulic Engineering Circular No. 11*, First Edition, McLean, VA, March 1989.

Gibbs & Olson, Inc., *New Topographic Map along the Peninsula Drainage District No. 2 Levee, Portland, Oregon,* October 2013.

PBS&J, *Portland District National Levee Inventory Database*, September 2007.

United States Department of the Army, Corps of Engineers (USACE), *EM 1110-2-1906, Laboratory Soils Testing*, August 20, 1986.

United States Department of the Army, Corps of Engineers (USACE), *EM 1110-1-1904, Soil Mechanics Design – Settlement Analysis,* September 30, 1990.

United States Department of the Army, Corps of Engineers (USACE), *Automated Coastal Engineering System (ACSE) Technical Reference,* Waterways Experiment Station, Coastal Engineering Research Center, September 1992.

United States Department of the Army, Corps of Engineers (USACE), *CHANLPRO Modeling System Computer Software, Version 2.0,* November 1999.

United States Department of the Army, Corps of Engineers (USACE), *EM 1110-2-1913, Engineering and Design - Design and Construction of Levees*, April 30, 2000.

United States Department of the Army, Corps of Engineers (USACE), *EM 1110-2-1100, Coastal Engineering Manual*, April 30, 2002

United States Department of the Army, Corps of Engineers, Portland District (USACE), *Combined Probability Flood Profiles for the Lower Columbia River*, April 2007.

United States Department of the Army, Corps of Engineers (USACE), *HEC-RAS Hydraulic Model of the Lower Columbia River, Columbia River Treaty*, 2011.

United States Department of the Army, Corps of Engineers, Portland District (USACE), *Peninsula Drainage District No. 2, Proposed Improvements, Flood Protection, Stations PD2 0+00 to PD2 33+65.56, Sheet CLW-107-23/2*, date unknown.

United States Department of the Army, Corps of Engineers, Portland District (USACE), *Peninsula Drainage District No. 2, Proposed Improvements, Flood Protection, Stations PD2 33+65.56 to PD2 127+00, Sheet CLW-107-23/3*, date unknown.

United States Department of the Army, Corps of Engineers, Portland District (USACE), *Peninsula Drainage District No. 2, Proposed Improvements, Flood Protection, Stations PD2 170+00 to PD2 214+35, Sheet CLW-107-23/4*, date unknown.

United States Department of the Army, Corps of Engineers, Portland District (USACE), *Peninsula Drainage District No. 2, Proposed Improvements, Flood Protection, Stations PD2 214+35 to PD2 288+25, Sheet CLW-107-23/5*, date unknown.

United States Department of the Army, Corps of Engineers, Portland District (USACE), *Peninsula Drainage District No. 1, Proposed Improvements, Flood Protection, Plan & Profile, Sheets CLW-114-86/5 and CLW-114-86/6, September 1957*.

United States Geological Survey (USGS) Gage 14128870, *Columbia River Below Bonneville Dam*, 2011.

Western Region Climate Center, website, http://www.wrcc.dri.edu, 2011

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Limitations in the Use and Interpretation of this Geotechnical Report

Our professional services were performed, our findings obtained, and our recommendations prepared in accordance with generally accepted engineering principles and practices. This warranty is in lieu of all other warranties, either expressed or implied.

The geotechnical report was prepared for the use of the Owner in the design of the subject facility and should be made available to potential contractors and/or the Contractor for information on factual data only. This report should not be used for contractual purposes as a warranty of interpreted subsurface conditions such as those indicated by the interpretive boring and test pit logs, cross-sections, or discussion of subsurface conditions contained herein.

The analyses, conclusions and recommendations contained in the report are based on site conditions as they presently exist and assume that the exploratory borings, test pits, and/or probes are representative of the subsurface conditions of the site. If, during construction, subsurface conditions are found which are significantly different from those observed in the exploratory borings and test pits, or assumed to exist in the excavations, we should be advised at once so that we can review these conditions and reconsider our recommendations where necessary. If there is a substantial lapse of time between the submission of this report and the start of work at the site, or if conditions have changed due to natural causes or construction operations at or adjacent to the site, this report should be reviewed to determine the applicability of the conclusions and recommendations considering the changed conditions and time lapse.

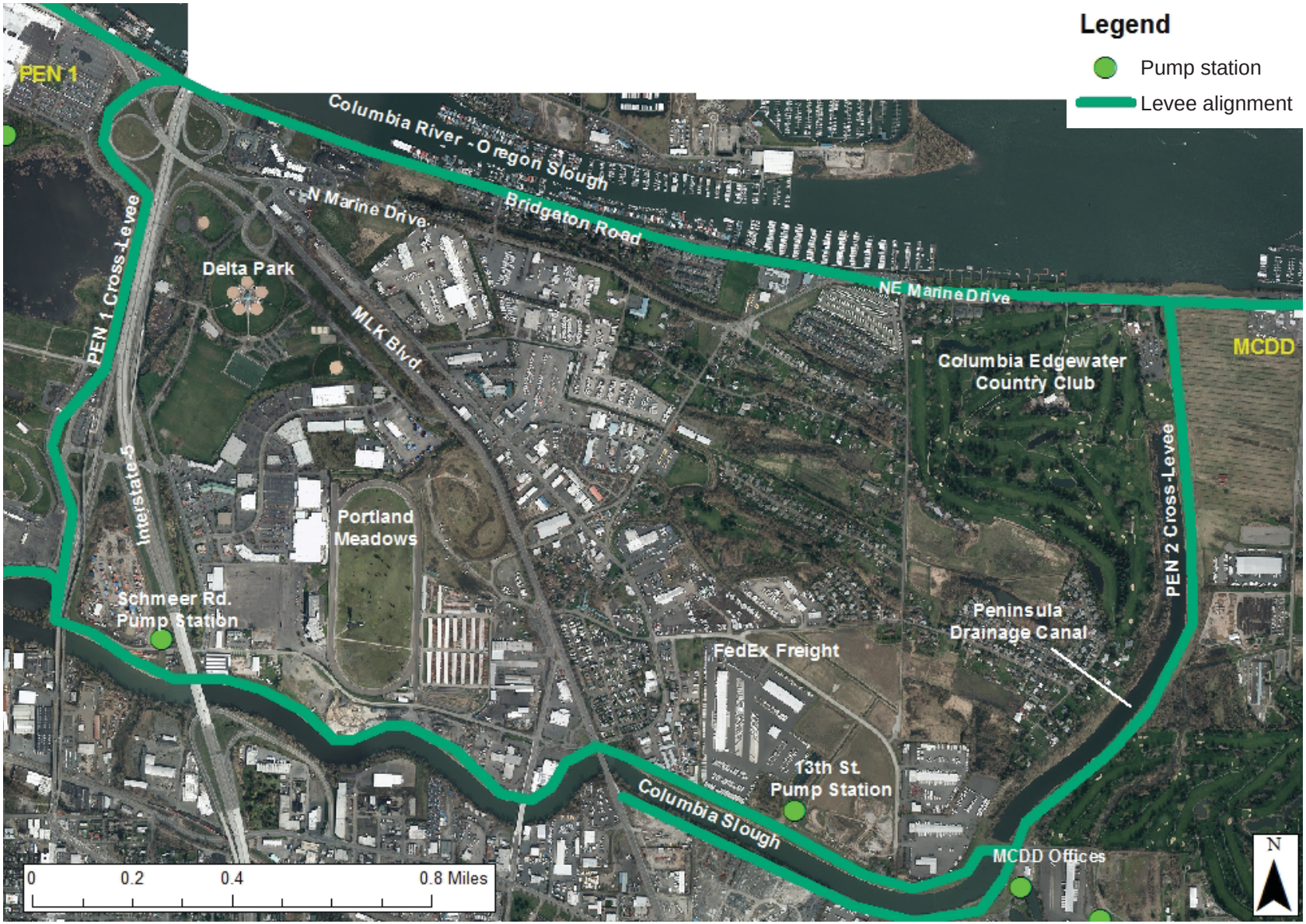
The Summary Boring Logs are our opinion of the subsurface conditions revealed by periodic sampling of the ground as the borings progressed. The soil descriptions and interfaces between strata are interpretive and actual changes may be gradual.

The boring logs and related information depict subsurface conditions only at these specific locations and at the particular time designated on the logs. Soil conditions at other locations may differ from conditions occurring at these boring locations. Also, the passage of time may result in a change in the soil conditions at these boring locations.

Groundwater levels often vary seasonally. Groundwater levels reported on the boring logs or in the body of the report are factual data only for the dates shown.

Unanticipated soil conditions are commonly encountered on construction sites and cannot be fully anticipated by merely taking soil samples, borings or test pits. Such unexpected conditions frequently require that additional expenditures be made to attain a properly constructed project. It is recommended that the Owner consider providing a contingency fund to accommodate such potential extra costs.

This firm cannot be responsible for any deviation from the intent of this report including, but not restricted to, any changes to the scheduled time of construction, the nature of the project or the specific construction methods or means indicated in this report; nor can our firm be responsible for any construction activity on sites other than the specific site referred to in this report.



BASE MAP CREATED BY MCDD.

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2320/01.AI NAU

VICINITY MAP

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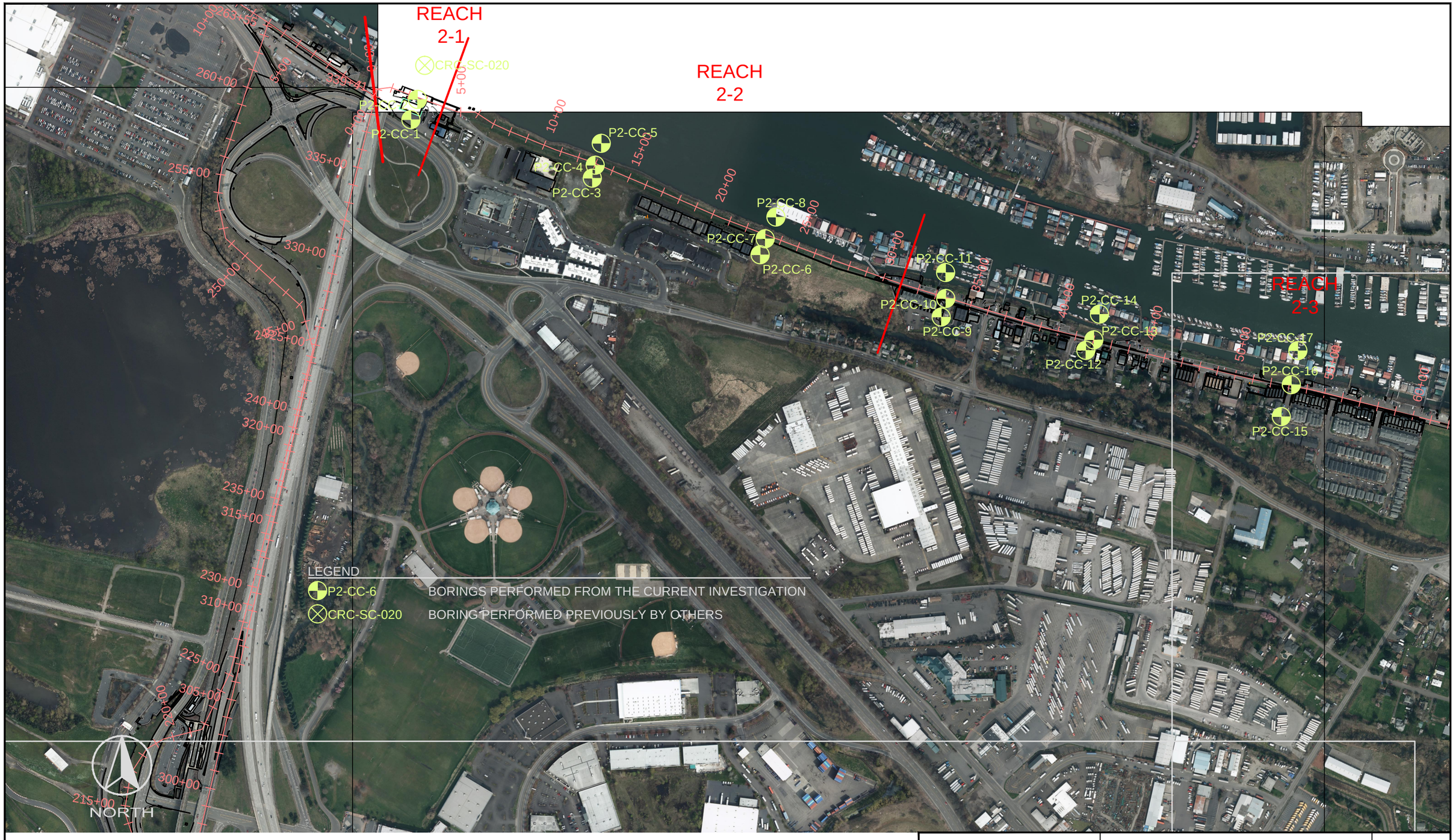
PROJ. 2320

FIG. 1



0 500 1,000

SCALE IN FEET

BASE MAP CREATED BY MCDD, DATED 8/14/2014.

PEN 2-Cornforth 8.14.2014.dwg NAU

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SITE PLAN

PENINSULA 2 LEVEE ASSESSMENT
PORTLAND, OREGON

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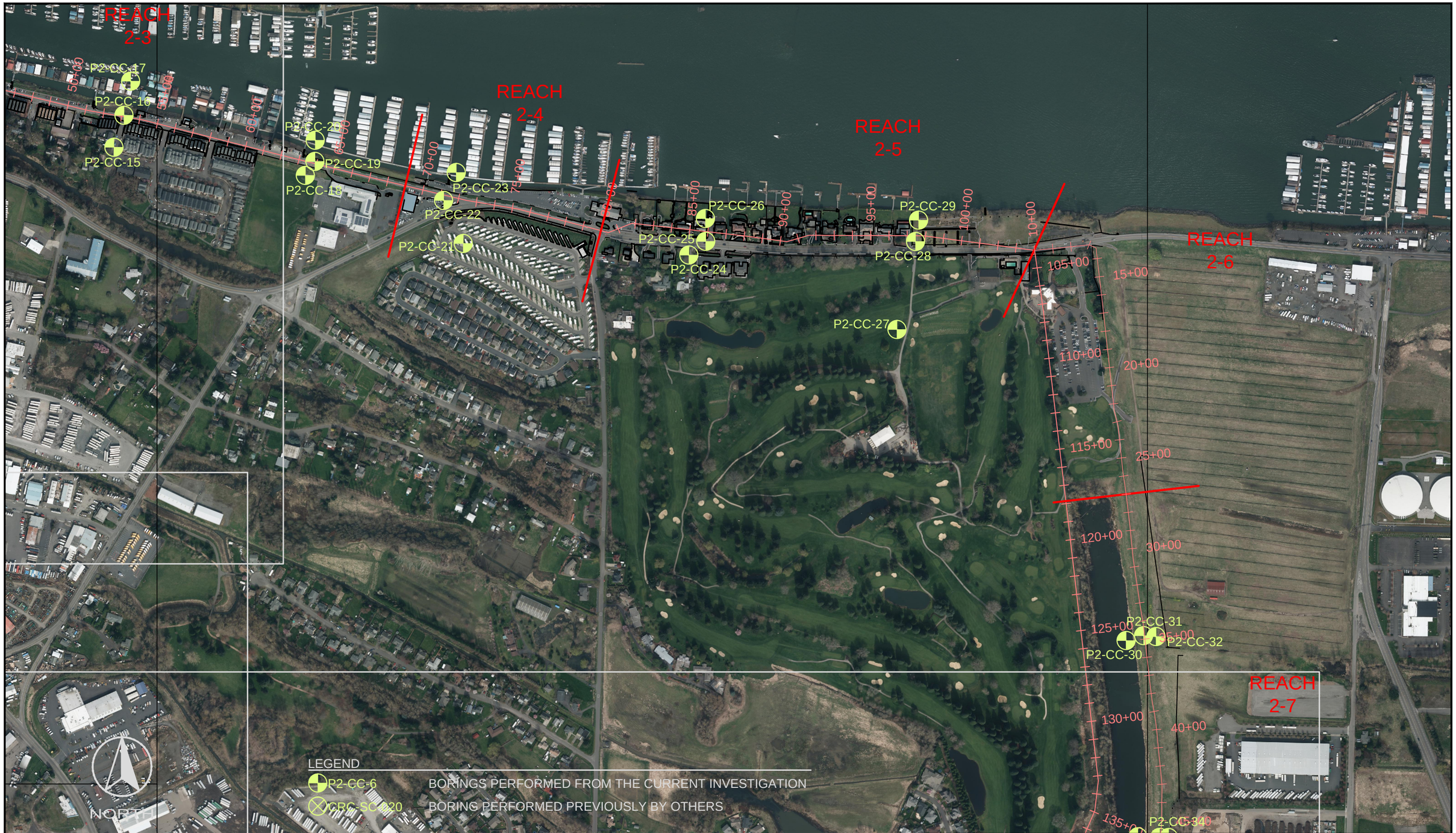
PROJ. 2320

FIG. 2A



0 500 1,000

SCALE IN FEET

BASE MAP CREATED BY MCDD, DATED 8/14/2014.

PEN 2-Cornforth 8.14.2014.dwg NAU

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SITE PLAN

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FIG. 2B

0 500 1,000

SCALE IN FEET

BASE MAP CREATED BY MCDD, DATED 8/14/2014.

PEN 2-Cornforth 8.14.2014.dwg NAU

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FIG. 2C

0 500 1,000

SCALE IN FEET

BASE MAP CREATED BY MCDD, DATED 8/14/2014.

PEN 2-Cornforth 8.14.2014.dwg NAU

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FIG. 2D

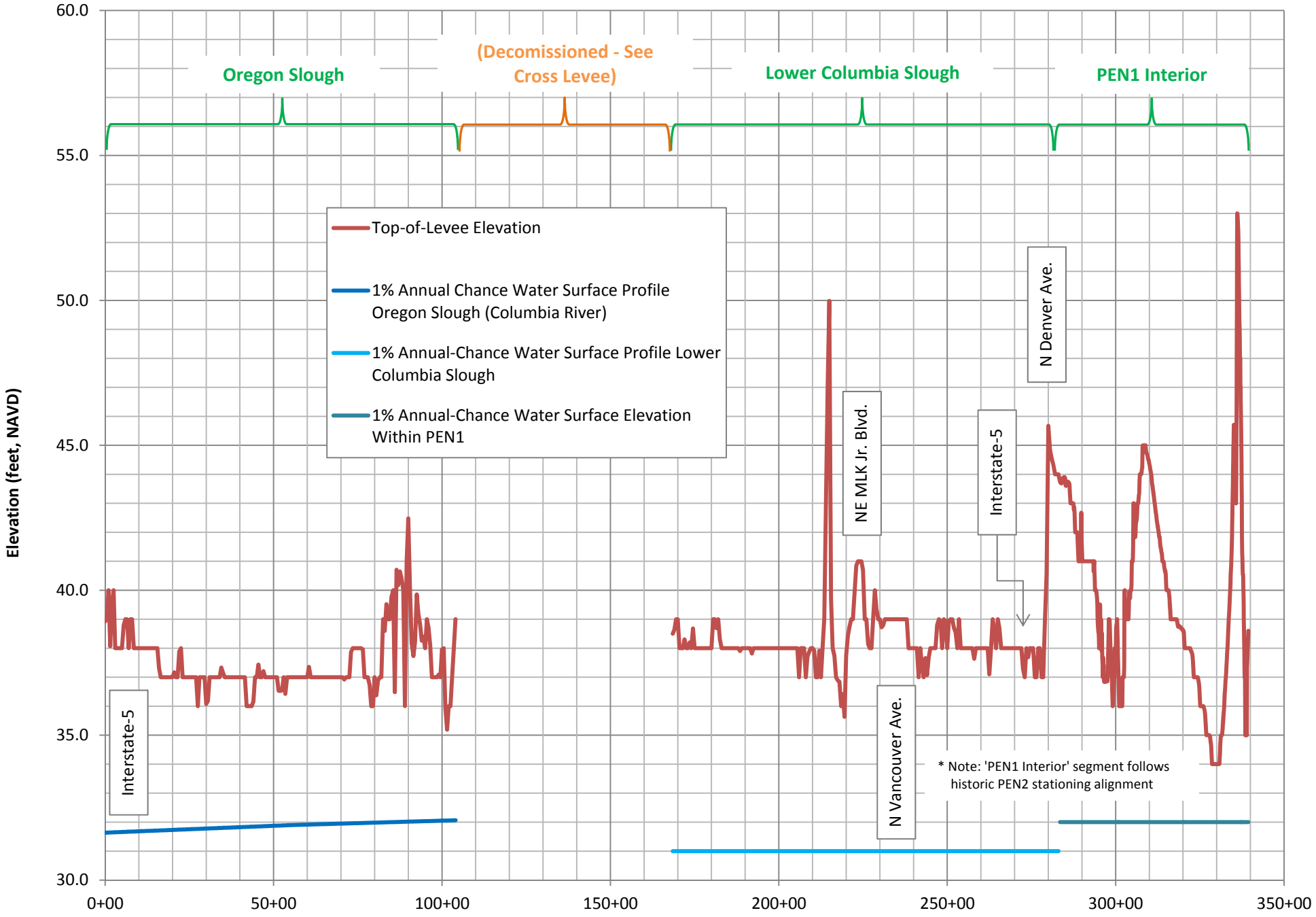


Figure 3 - PEN 2 Levee Crest and 1% Annual-Chance Water Surface Elevations

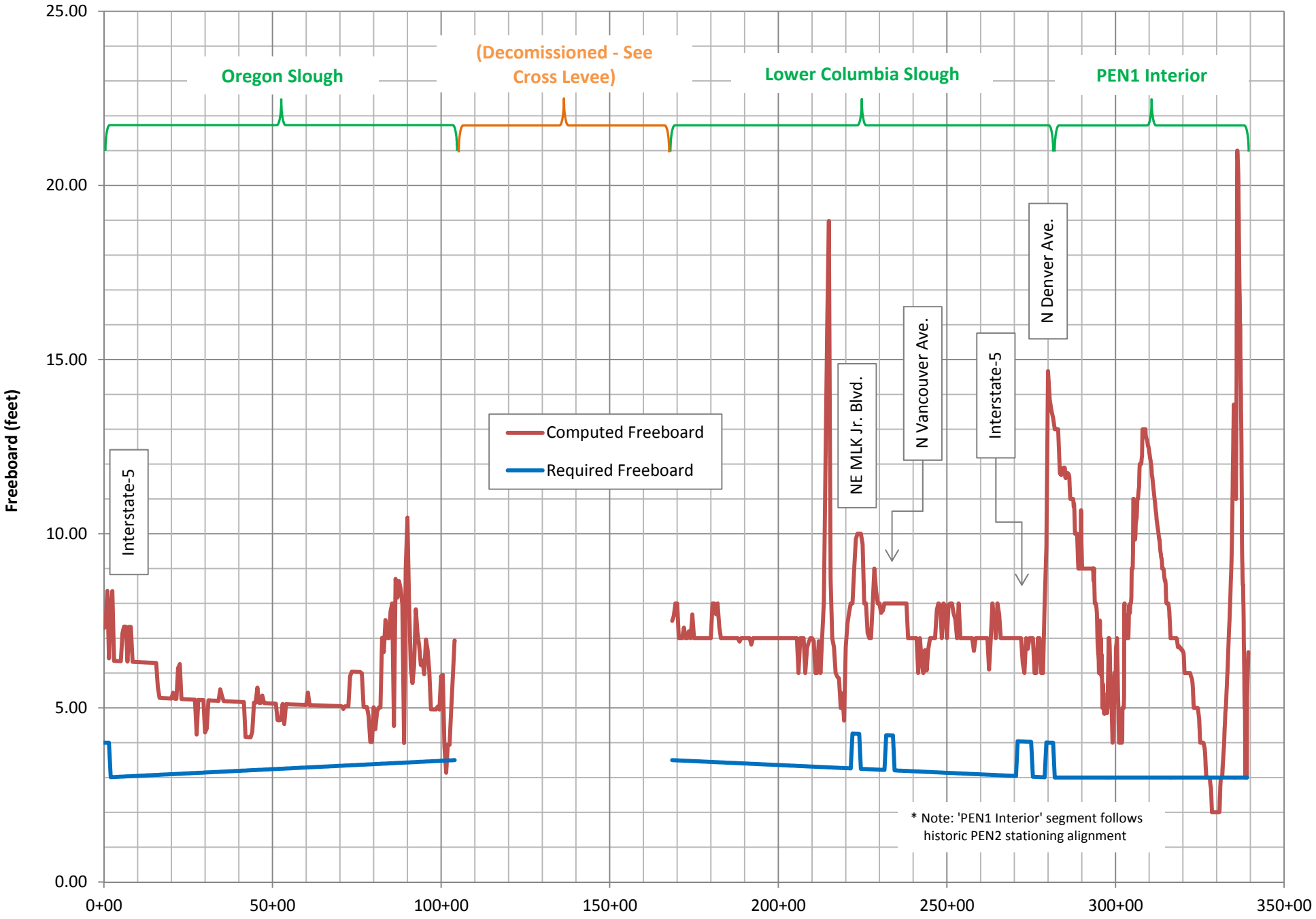


Figure 4 - PEN 2 Computed Versus Required Freeboard

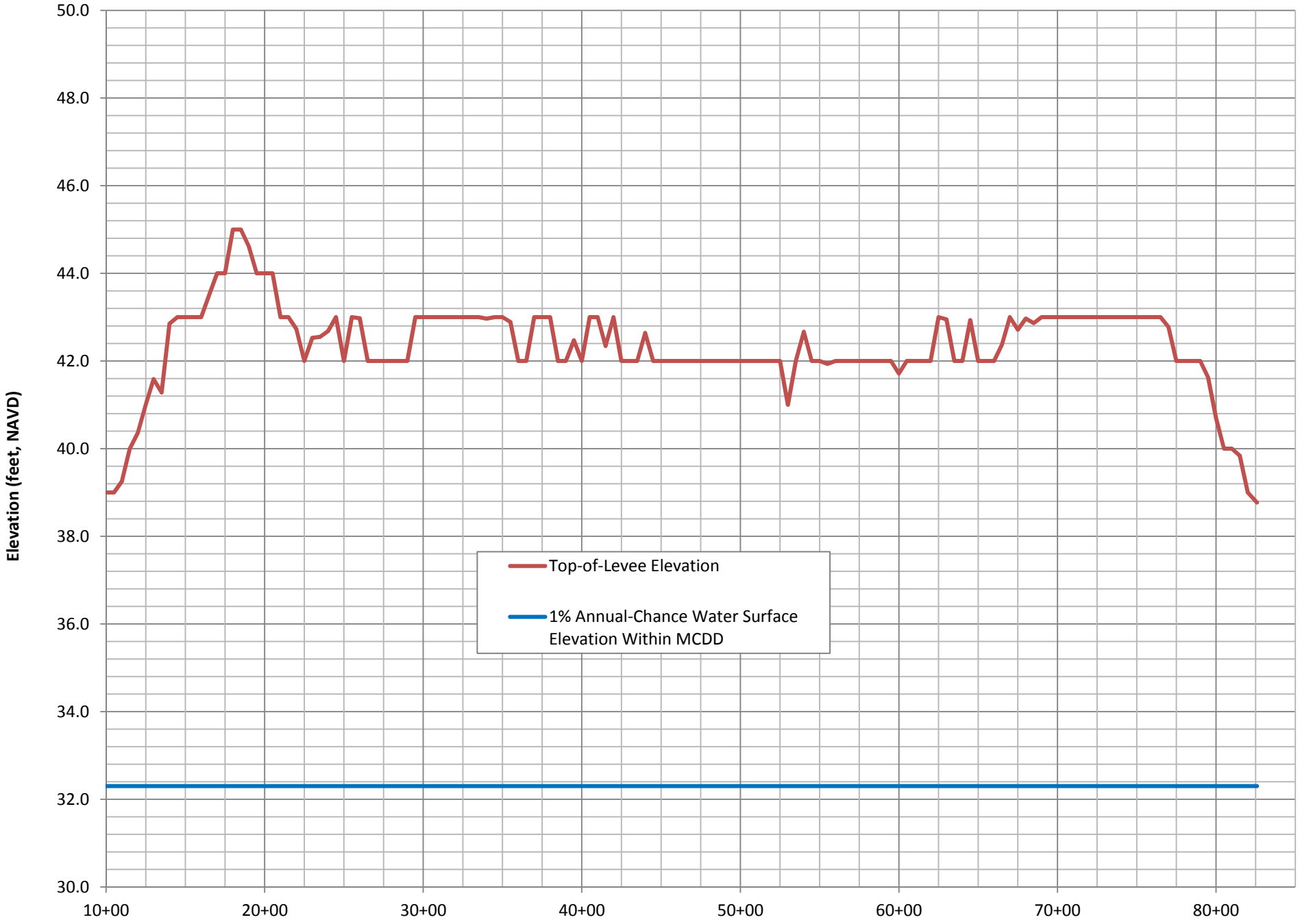


Figure 5 - PEN 2 Peninsula Drainage Canal Levee Crest Elevation and 1% Annual-Chance Water Surface Elevation

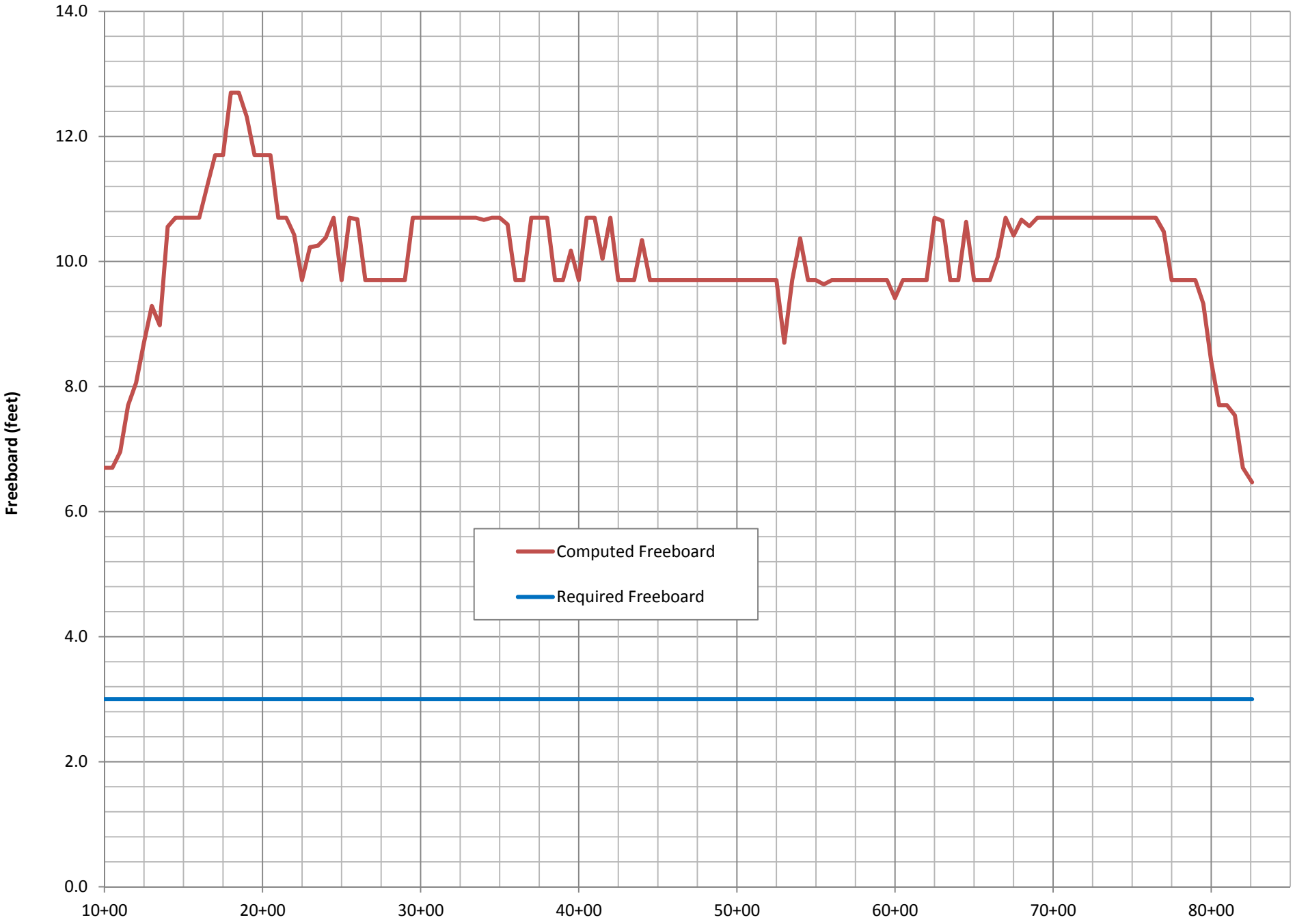


Figure 6 - PEN 2 Peninsula Drainage Canal Levee - Computed Versus Required Freeboard

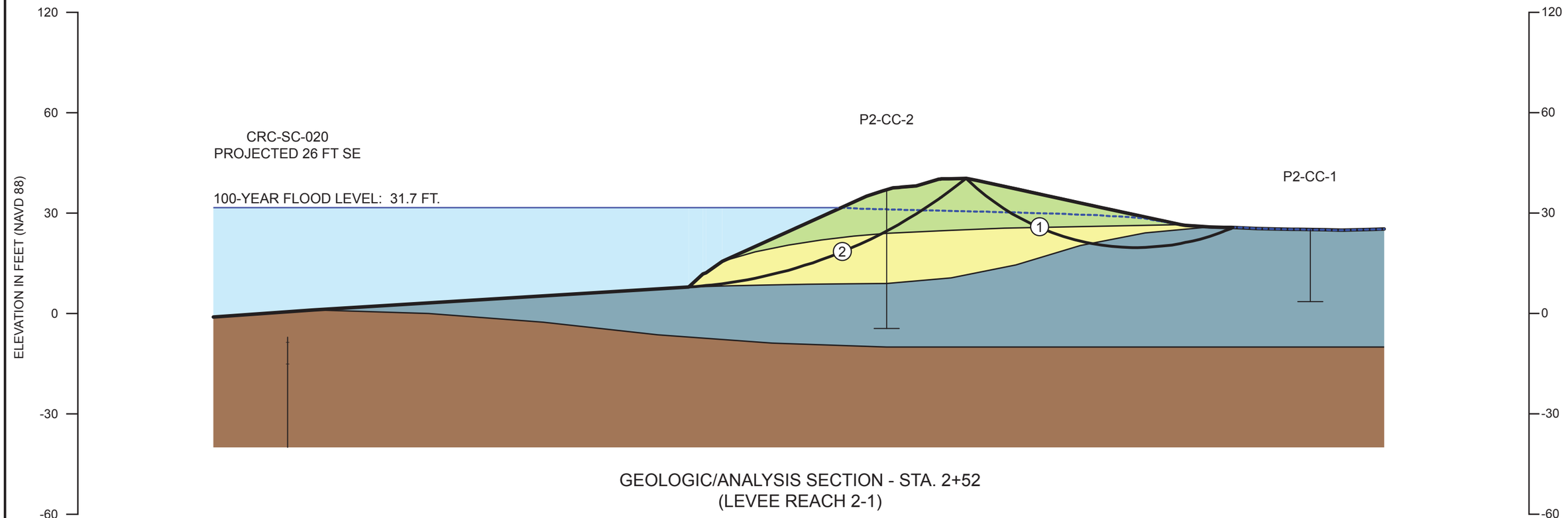
Embankment	Soft, slightly clayey to clayey SILT
Embankment	Loose, silty SAND to sandy SILT
Foundation	Loose, silty SAND and sandy SILT (Alluvium)
Foundation	Soft, clayey SILT to silty CLAY (Alluvium)

SLIP SURFACE	CALCULATED FS	MEETS REQUIRED FS*
1	2.17	YES
2	1.56	YES

*MINIMUM ALLOWABLE FS=1.4, USACE, EM 1110-2-1913

CALCULATED EXIT GRADIENT AT TOE OF LANDWARD SLOPE = 0.1**

**RECOMMENDED MAXIMUM EXIT GRADIENT = 0.5, USACE, EM 1110-2-1913



GEOLOGIC/ANALYSIS SECTION - STA. 2+52
(LEVEE REACH 2-1)

2320/ Sec-2+51.67.AI NAU

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FIG. 7

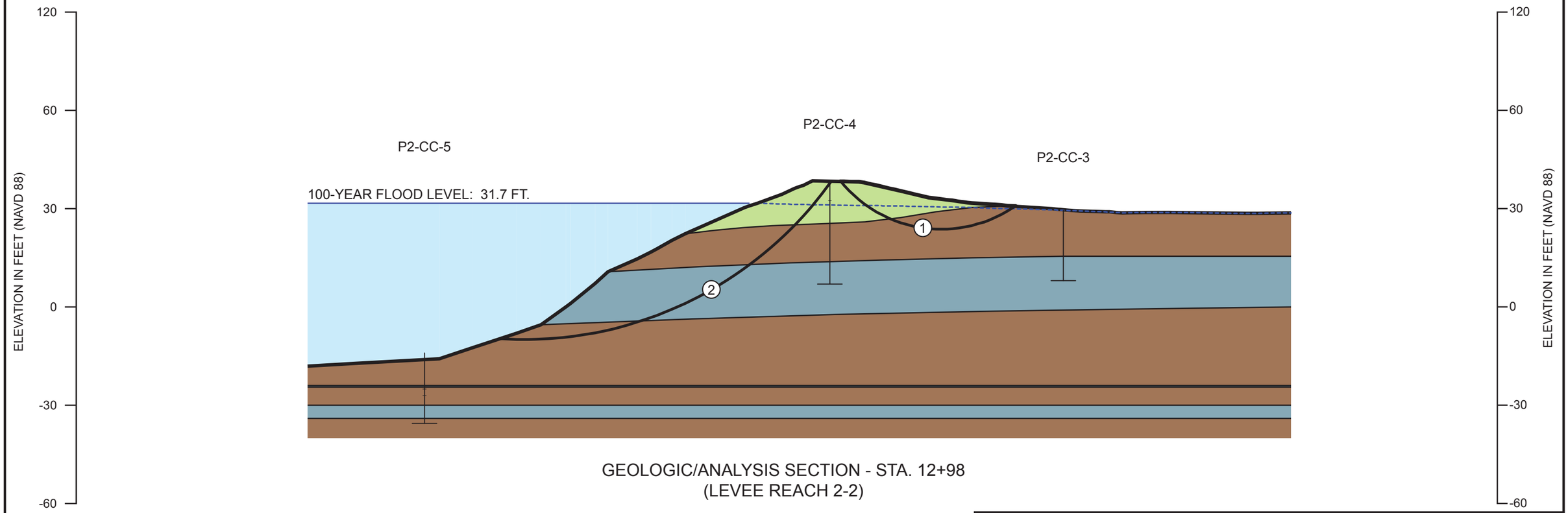
Embankment	Soft, slightly clayey to clayey SILT
Embankment	Loose, silty SAND to sandy SILT
Foundation	Loose, silty SAND and sandy SILT (Alluvium)
Foundation	Soft, clayey SILT to silty CLAY (Alluvium)

SLIP SURFACE	CALCULATED FS	MEETS REQUIRED FS*
1	3.41	YES
2	1.41	YES

*MINIMUM ALLOWABLE FS=1.4, USACE, EM 1110-2-1913

CALCULATED EXIT GRADIENT AT TOE OF LANDWARD SLOPE = 0.0**

**RECOMMENDED MAXIMUM EXIT GRADIENT = 0.5, USACE, EM 1110-2-1913



GEOLOGIC/ANALYSIS SECTION - STA. 12+98
(LEVEE REACH 2-2)

2320/Sec-12+98.37.AI NAU

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GEOLOGIC/ANALYSIS CROSS SECTION

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FIG. 8

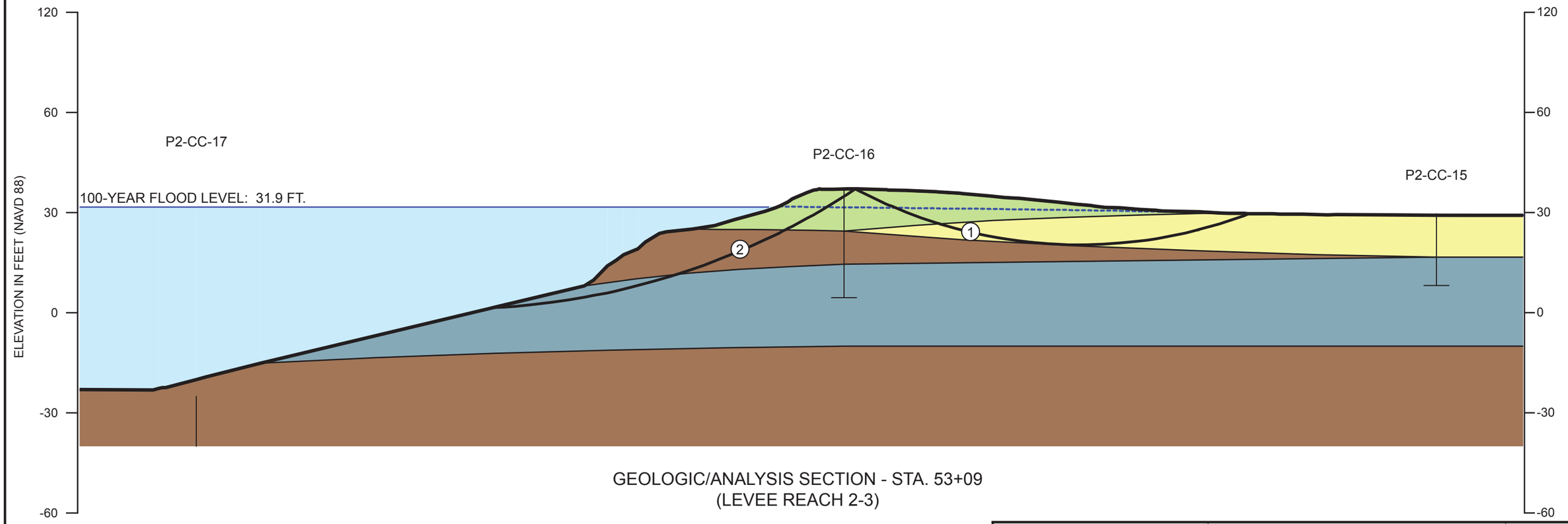
Embankment	Soft, slightly clayey to clayey SILT
Embankment	Loose, silty SAND to sandy SILT
Foundation	Loose, silty SAND and sandy SILT (Alluvium)
Foundation	Soft, clayey SILT to silty CLAY (Alluvium)

SLIP SURFACE	CALCULATED FS	MEETS REQUIRED FS*
1	5.39	YES
2	1.79	YES

*MINIMUM ALLOWABLE FS=1.4, USACE, EM 1110-2-1913

CALCULATED EXIT GRADIENT AT TOE OF LANDWARD SLOPE = 0.0**

**RECOMMENDED MAXIMUM EXIT GRADIENT = 0.5, USACE, EM 1110-2-1913



GEOLOGIC/ANALYSIS SECTION - STA. 53+09
(LEVEE REACH 2-3)

2320/Sec-53+08.72.AI NAU

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GEOLOGIC/ANALYSIS CROSS SECTION

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FIG. 9

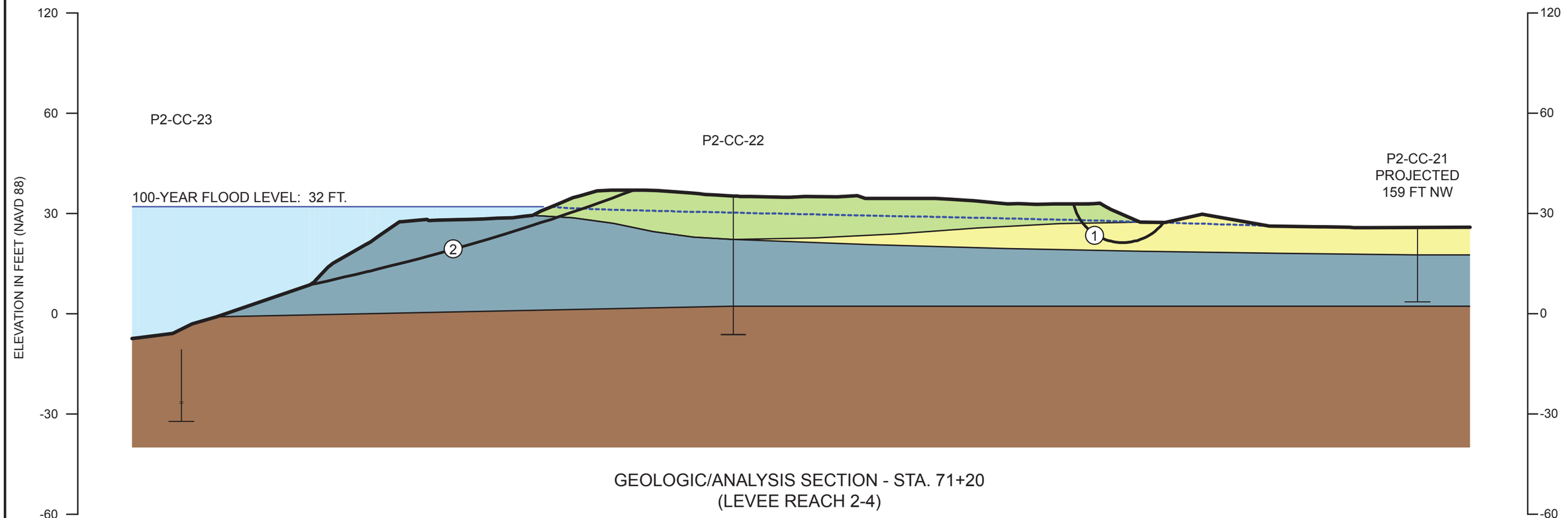
Embankment	Soft, slightly clayey to clayey SILT
Embankment	Loose, silty SAND to sandy SILT
Foundation	Loose, silty SAND and sandy SILT (Alluvium)
Foundation	Soft, clayey SILT to silty CLAY (Alluvium)

SLIP SURFACE	CALCULATED FS	MEETS REQUIRED FS*
1	2.38	YES
2	2.30	YES

*MINIMUM ALLOWABLE FS=1.4, USACE, EM 1110-2-1913

CALCULATED EXIT GRADIENT AT TOE OF LANDWARD SLOPE = 0.0**

**RECOMMENDED MAXIMUM EXIT GRADIENT = 0.5, USACE, EM 1110-2-1913



GEOLOGIC/ANALYSIS SECTION - STA. 71+20
(LEVEE REACH 2-4)

0 30 60
SCALE IN FEET

2320/Sec-71+19.84.AI NAU

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GEOLOGIC/ANALYSIS CROSS SECTION

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PORTLAND, OREGON

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FIG. 10

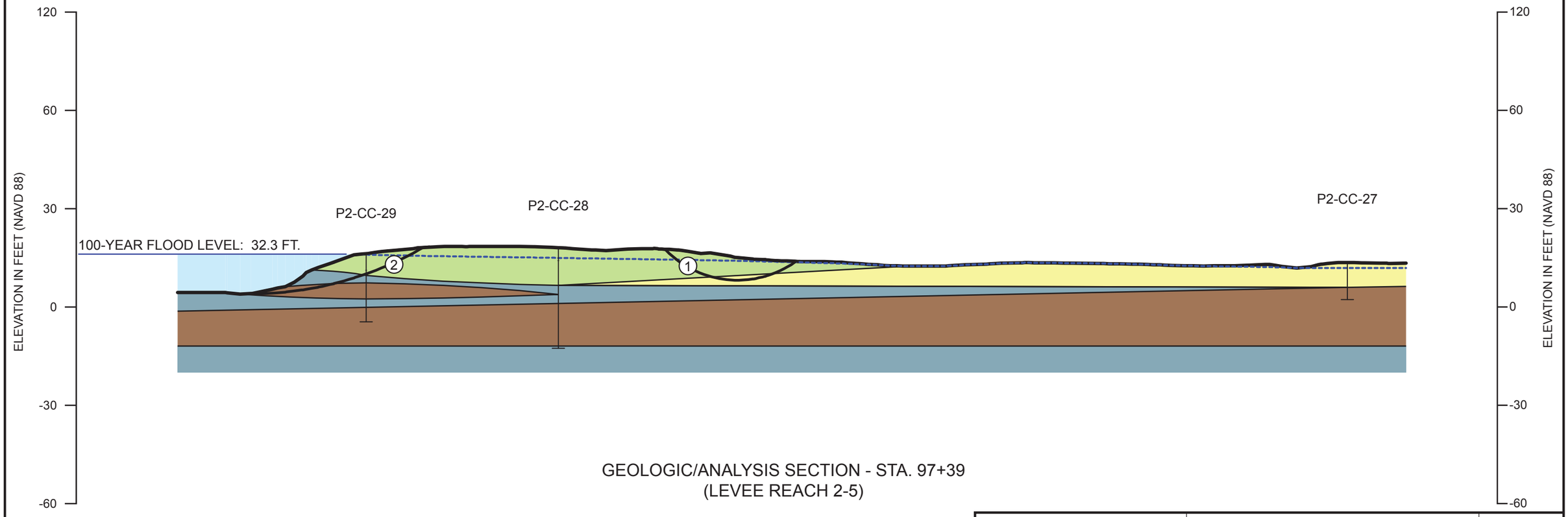
Embankment	Soft, slightly clayey to clayey SILT
Embankment	Loose, silty SAND to sandy SILT
Foundation	Loose, silty SAND and sandy SILT (Alluvium)
Foundation	Soft, clayey SILT to silty CLAY (Alluvium)

SLIP SURFACE	CALCULATED FS	MEETS REQUIRED FS*
1	4.35	YES
2	2.29	YES

*MINIMUM ALLOWABLE FS=1.4, USACE, EM 1110-2-1913

CALCULATED EXIT GRADIENT AT TOE OF LANDWARD SLOPE = 0.1**

**RECOMMENDED MAXIMUM EXIT GRADIENT = 0.5, USACE, EM 1110-2-1913



GEOLOGIC/ANALYSIS SECTION - STA. 97+39
(LEVEE REACH 2-5)

2320/Sec-97+38.74.AI NAU

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GEOLOGIC/ANALYSIS CROSS SECTION

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FIG. 11

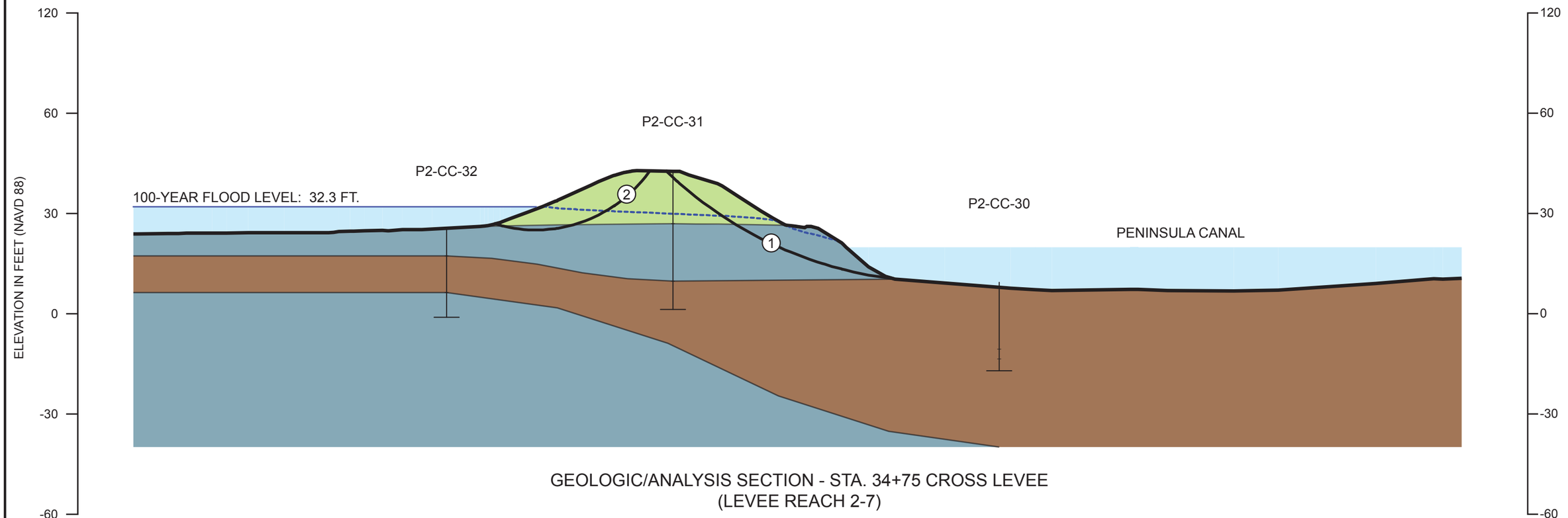
Embankment	Soft, slightly clayey to clayey SILT
Embankment	Loose, silty SAND to sandy SILT
Foundation	Loose, silty SAND and sandy SILT (Alluvium)
Foundation	Soft, clayey SILT to silty CLAY (Alluvium)

SLIP SURFACE	CALCULATED FS	MEETS REQUIRED FS*
1	0.99	NO
2	1.75	YES

*MINIMUM ALLOWABLE FS=1.4, USACE, EM 1110-2-1913

CALCULATED EXIT GRADIENT AT TOE OF LANDWARD SLOPE = 0.1**

**RECOMMENDED MAXIMUM EXIT GRADIENT = 0.5, USACE, EM 1110-2-1913



GEOLOGIC/ANALYSIS SECTION - STA. 34+75 CROSS LEVEE
(LEVEE REACH 2-7)

2320/ Sec-125+38.69.AI NAU

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FIG. 12

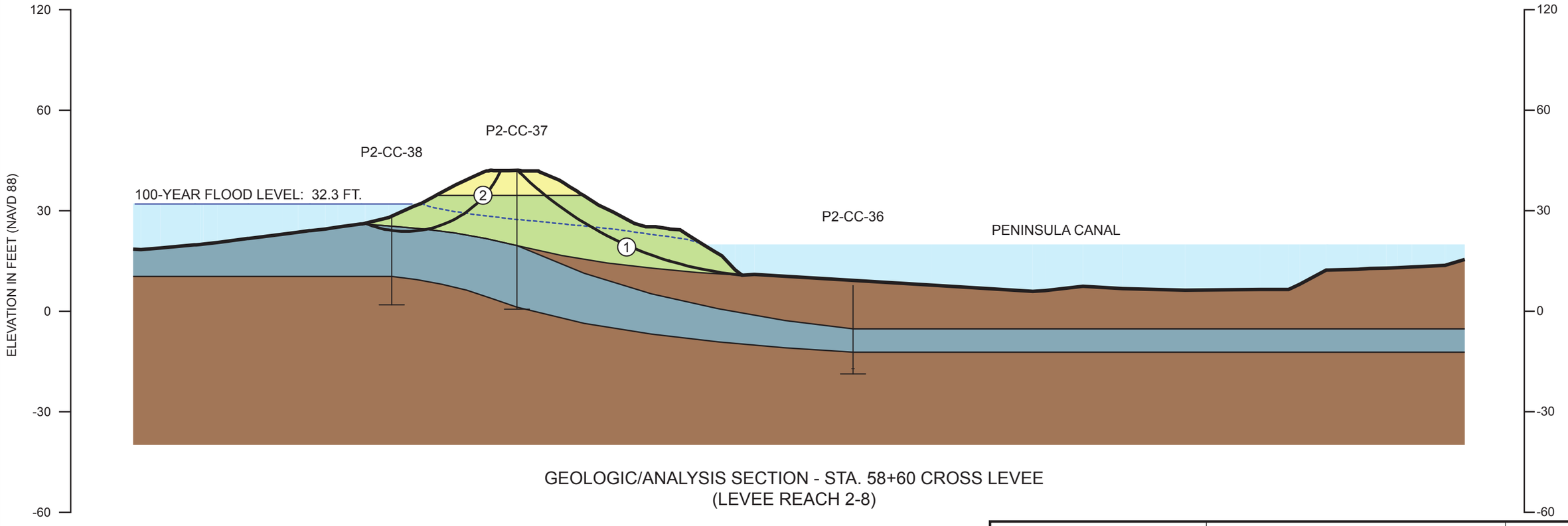
Embankment	Soft, slightly clayey to clayey SILT
Embankment	Loose, silty SAND to sandy SILT
Foundation	Loose, silty SAND and sandy SILT (Alluvium)
Foundation	Soft, clayey SILT to silty CLAY (Alluvium)

SLIP SURFACE	CALCULATED FS	MEETS REQUIRED FS*
1	1.09	NO
2	1.61	YES

*MINIMUM ALLOWABLE FS=1.4, USACE, EM 1110-2-1913

CALCULATED EXIT GRADIENT AT TOE OF LANDWARD SLOPE = 0.1**

**RECOMMENDED MAXIMUM EXIT GRADIENT = 0.5, USACE, EM 1110-2-1913



GEOLOGIC/ANALYSIS SECTION - STA. 58+60 CROSS LEVEE
(LEVEE REACH 2-8)

2320/Sec-146+09.03.AI NAU

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FIG. 13

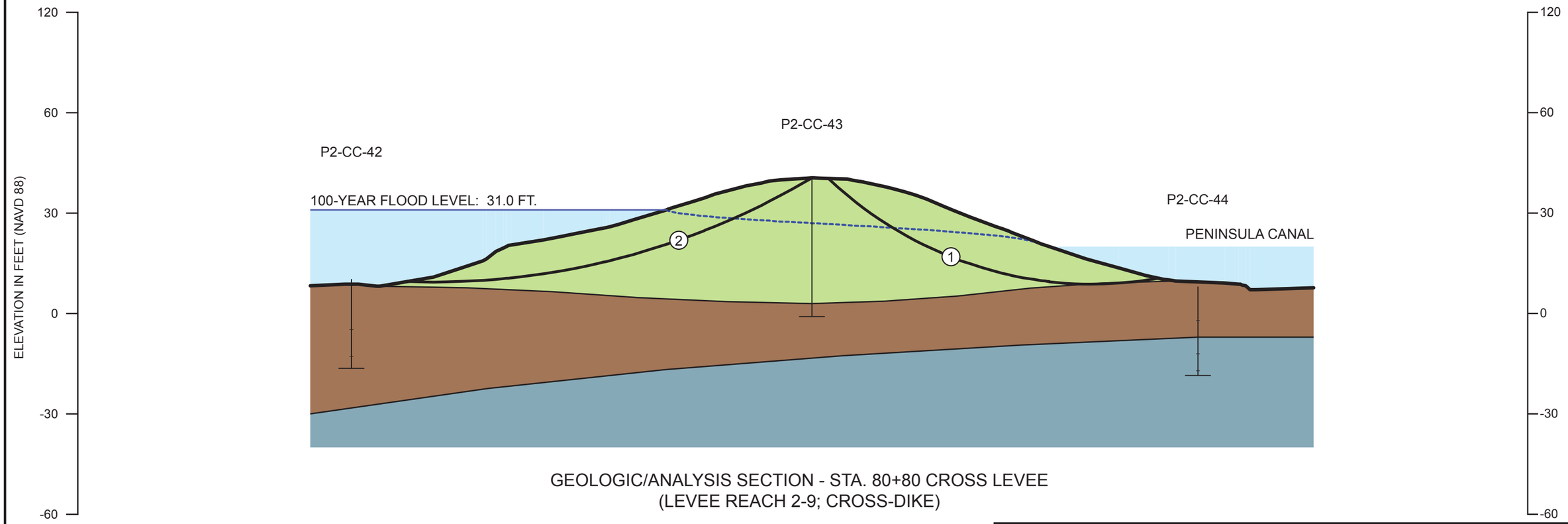
Embankment	Soft, slightly clayey to clayey SILT
Embankment	Loose, silty SAND to sandy SILT
Foundation	Loose, silty SAND and sandy SILT (Alluvium)
Foundation	Soft, clayey SILT to silty CLAY (Alluvium)

SLIP SURFACE	CALCULATED FS	MEETS REQUIRED FS*
1	1.50	YES
2	2.42	YES

*MINIMUM ALLOWABLE FS=1.4, USACE, EM 1110-2-1913

CALCULATED EXIT GRADIENT AT TOE OF LANDWARD SLOPE = 0.2**

**RECOMMENDED MAXIMUM EXIT GRADIENT = 0.5, USACE, EM 1110-2-1913



GEOLOGIC/ANALYSIS SECTION - STA. 80+80 CROSS LEVEE
(LEVEE REACH 2-9; CROSS-DIKE)

2320/Sec-168+63.97.AI NAU

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FIG. 14

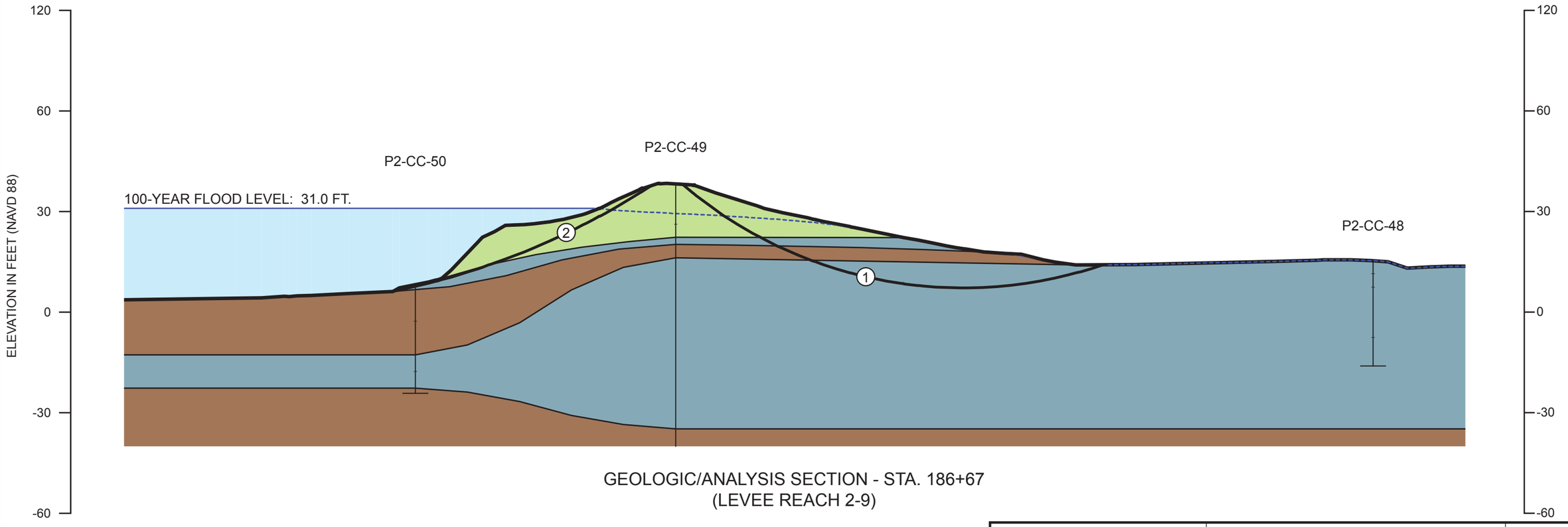
Embankment	Soft, slightly clayey to clayey SILT
Embankment	Loose, silty SAND to sandy SILT
Foundation	Loose, silty SAND and sandy SILT (Alluvium)
Foundation	Soft, clayey SILT to silty CLAY (Alluvium)

SLIP SURFACE	CALCULATED FS	MEETS REQUIRED FS*
1	1.73	YES
2	1.63	YES

*MINIMUM ALLOWABLE FS=1.4, USACE, EM 1110-2-1913

CALCULATED EXIT GRADIENT AT TOE OF LANDWARD SLOPE = 0.3**

**RECOMMENDED MAXIMUM EXIT GRADIENT = 0.5, USACE, EM 1110-2-1913



GEOLOGIC/ANALYSIS SECTION - STA. 186+67
(LEVEE REACH 2-9)

2320/Sec-186+67.36.AI NAU

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GEOLOGIC/ANALYSIS CROSS SECTION

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FIG. 15

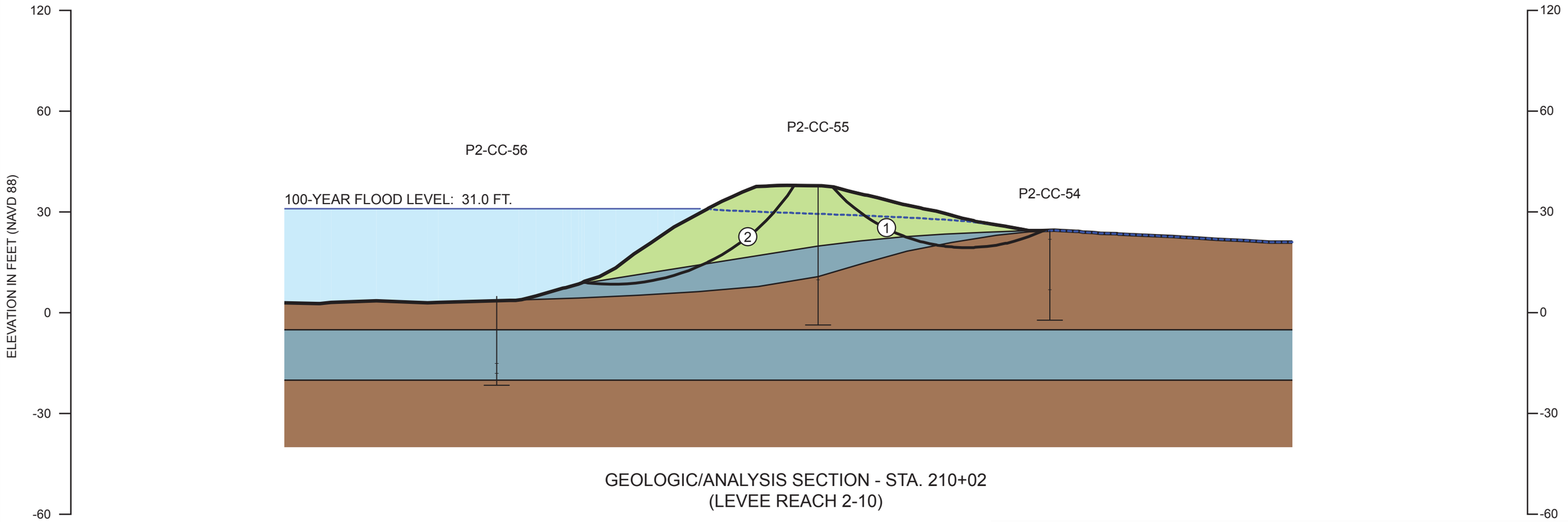
Embankment	Soft, slightly clayey to clayey SILT
Embankment	Loose, silty SAND to sandy SILT
Foundation	Loose, silty SAND and sandy SILT (Alluvium)
Foundation	Soft, clayey SILT to silty CLAY (Alluvium)

SLIP SURFACE	CALCULATED FS	MEETS REQUIRED FS*
1	2.15	YES
2	1.40	YES

*MINIMUM ALLOWABLE FS=1.4, USACE, EM 1110-2-1913

CALCULATED EXIT GRADIENT AT TOE OF LANDWARD SLOPE = 0.1**

**RECOMMENDED MAXIMUM EXIT GRADIENT = 0.5, USACE, EM 1110-2-1913



GEOLOGIC/ANALYSIS SECTION - STA. 210+02
(LEVEE REACH 2-10)

2320/Sec-210+02.47.AI NAU

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GEOLOGIC/ANALYSIS CROSS SECTION

PENINSULA 2 LEVEE ASSESSMENT
PORTLAND, OREGON

OCT 2014
PROJ. 2320
FIG. 16

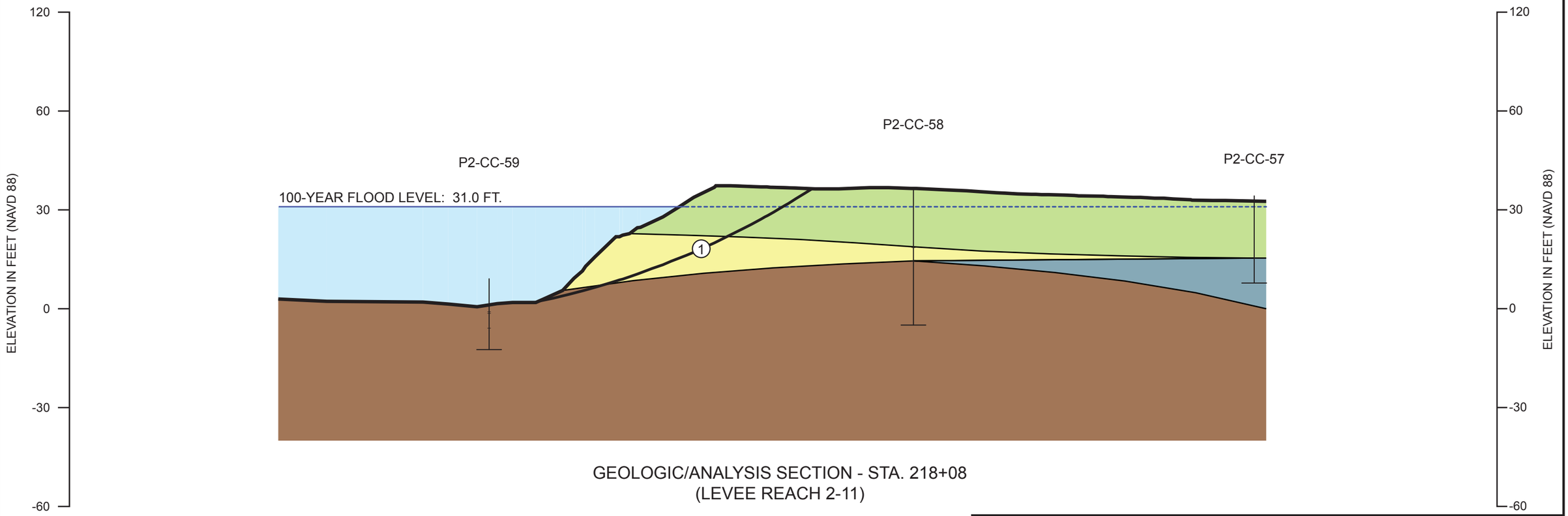
Embankment	Soft, slightly clayey to clayey SILT
Embankment	Loose, silty SAND to sandy SILT
Foundation	Loose, silty SAND and sandy SILT (Alluvium)
Foundation	Soft, clayey SILT to silty CLAY (Alluvium)

SLIP SURFACE	CALCULATED FS	MEETS REQUIRED FS*
1	1.44	YES

*MINIMUM ALLOWABLE FS=1.4, USACE, EM 1110-2-1913

CALCULATED EXIT GRADIENT AT TOE OF LANDWARD SLOPE = 0.0**

**RECOMMENDED MAXIMUM EXIT GRADIENT = 0.5, USACE, EM 1110-2-1913



GEOLOGIC/ANALYSIS SECTION - STA. 218+08
(LEVEE REACH 2-11)

2320/Sec-218+08.46.AI NAU

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GEOLOGIC/ANALYSIS CROSS SECTION

PENINSULA 2 LEVEE ASSESSMENT
PORTLAND, OREGON

OCT 2014
PROJ. 2320
FIG. 17

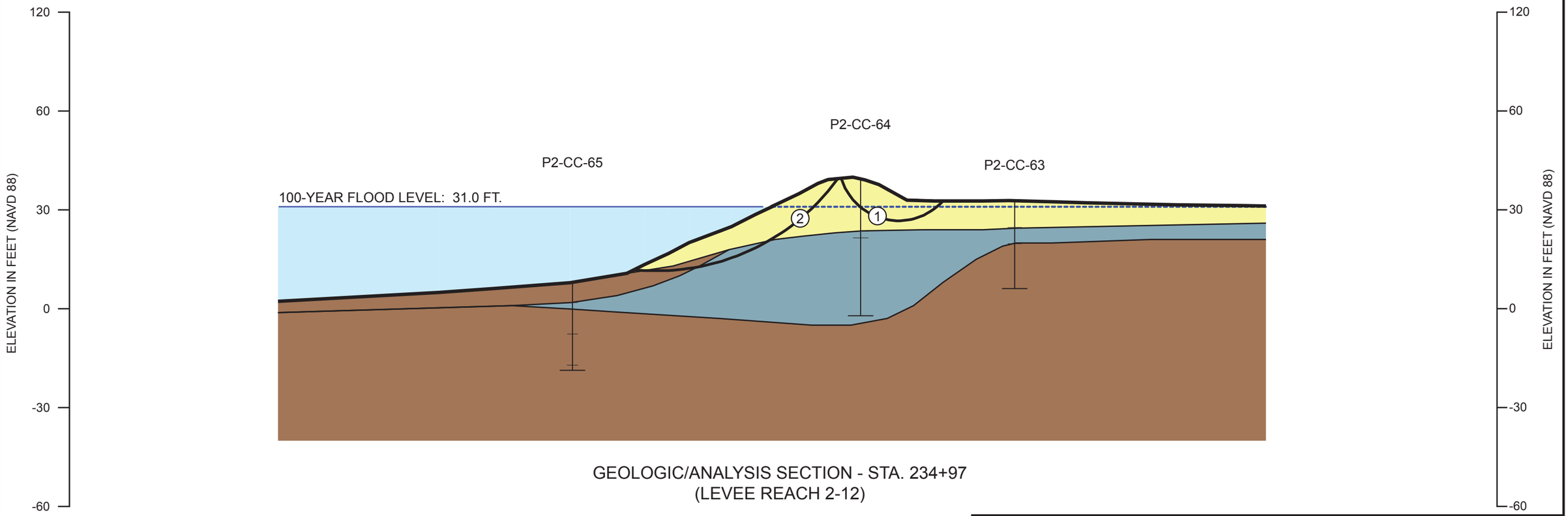
Embankment	Soft, slightly clayey to clayey SILT
Embankment	Loose, silty SAND to sandy SILT
Foundation	Loose, silty SAND and sandy SILT (Alluvium)
Foundation	Soft, clayey SILT to silty CLAY (Alluvium)

SLIP SURFACE	CALCULATED FS	MEETS REQUIRED FS*
1	2.71	YES
2	1.41	YES

*MINIMUM ALLOWABLE FS=1.4, USACE, EM 1110-2-1913

CALCULATED EXIT GRADIENT AT TOE OF LANDWARD SLOPE = 0.0**

**RECOMMENDED MAXIMUM EXIT GRADIENT = 0.5, USACE, EM 1110-2-1913



GEOLOGIC/ANALYSIS SECTION - STA. 234+97
(LEVEE REACH 2-12)

2320/Sec-234+97.30.AI NAU

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GEOLOGIC/ANALYSIS CROSS SECTION

PENINSULA 2 LEVEE ASSESSMENT
PORTLAND, OREGON

OCT 2014
PROJ. 2320
FIG. 18

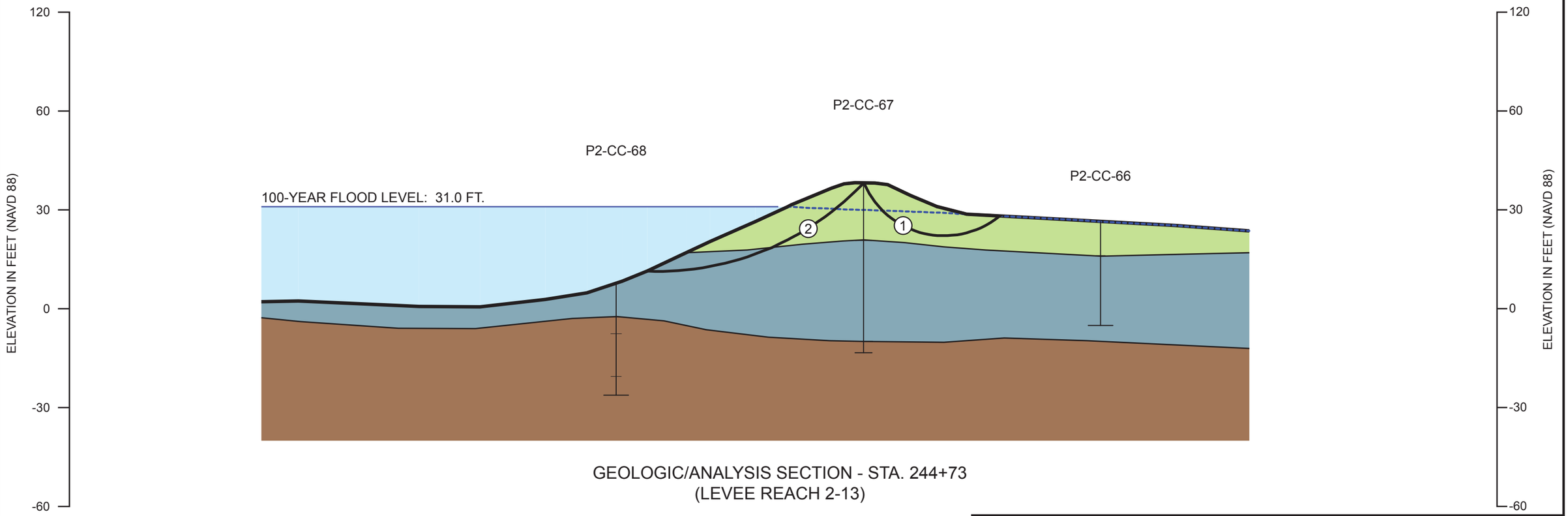
Embankment	Soft, slightly clayey to clayey SILT
Embankment	Loose, silty SAND to sandy SILT
Foundation	Loose, silty SAND and sandy SILT (Alluvium)
Foundation	Soft, clayey SILT to silty CLAY (Alluvium)

SLIP SURFACE	CALCULATED FS	MEETS REQUIRED FS*
1	2.00	YES
2	1.53	YES

*MINIMUM ALLOWABLE FS=1.4, USACE, EM 1110-2-1913

CALCULATED EXIT GRADIENT AT TOE OF LANDWARD SLOPE = 0.0**

**RECOMMENDED MAXIMUM EXIT GRADIENT = 0.5, USACE, EM 1110-2-1913



GEOLOGIC/ANALYSIS SECTION - STA. 244+73
(LEVEE REACH 2-13)

2320/Sec-244+72.66.AI NAU

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GEOLOGIC/ANALYSIS CROSS SECTION

PENINSULA 2 LEVEE ASSESSMENT
PORTLAND, OREGON

OCT 2014
PROJ. 2320
FIG. 19

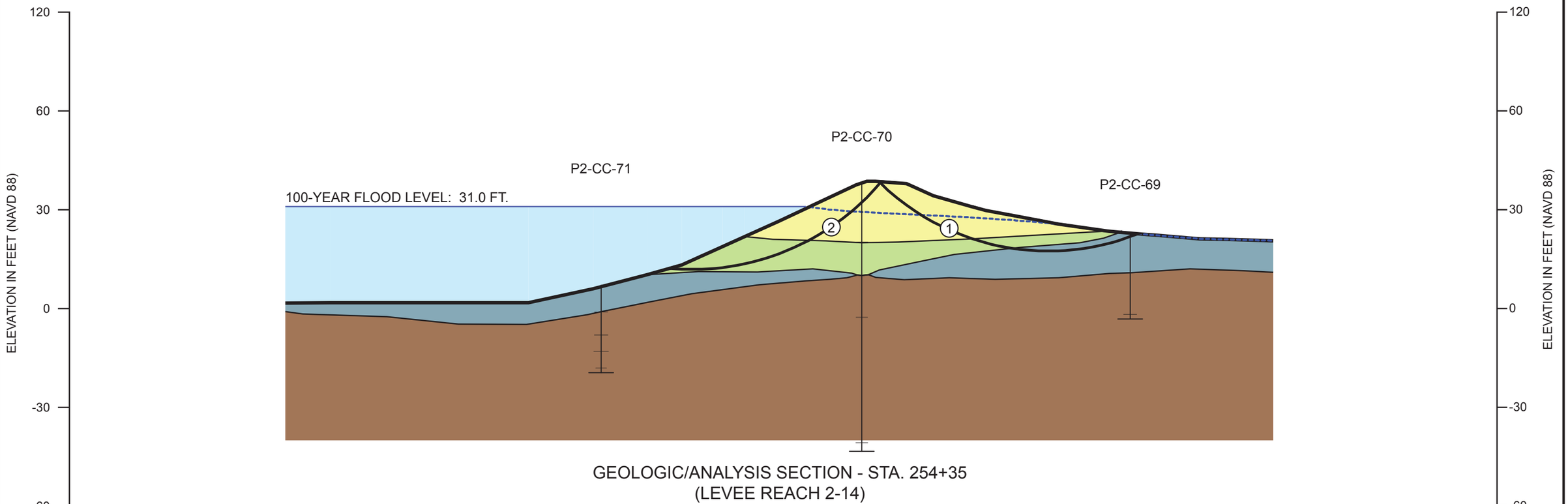
Embankment	Soft, slightly clayey to clayey SILT
Embankment	Loose, silty SAND to sandy SILT
Foundation	Loose, silty SAND and sandy SILT (Alluvium)
Foundation	Soft, clayey SILT to silty CLAY (Alluvium)

SLIP SURFACE	CALCULATED FS	MEETS REQUIRED FS*
1	1.88	YES
2	1.49	YES

*MINIMUM ALLOWABLE FS=1.4, USACE, EM 1110-2-1913

CALCULATED EXIT GRADIENT AT TOE OF LANDWARD SLOPE = 0.1**

**RECOMMENDED MAXIMUM EXIT GRADIENT = 0.5, USACE, EM 1110-2-1913



GEOLOGIC/ANALYSIS SECTION - STA. 254+35
(LEVEE REACH 2-14)

2320/Sec-254+35.37AI NAU

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GEOLOGIC/ANALYSIS CROSS SECTION

PENINSULA 2 LEVEE ASSESSMENT
PORTLAND, OREGON

OCT 2014
PROJ. 2320
FIG. 20

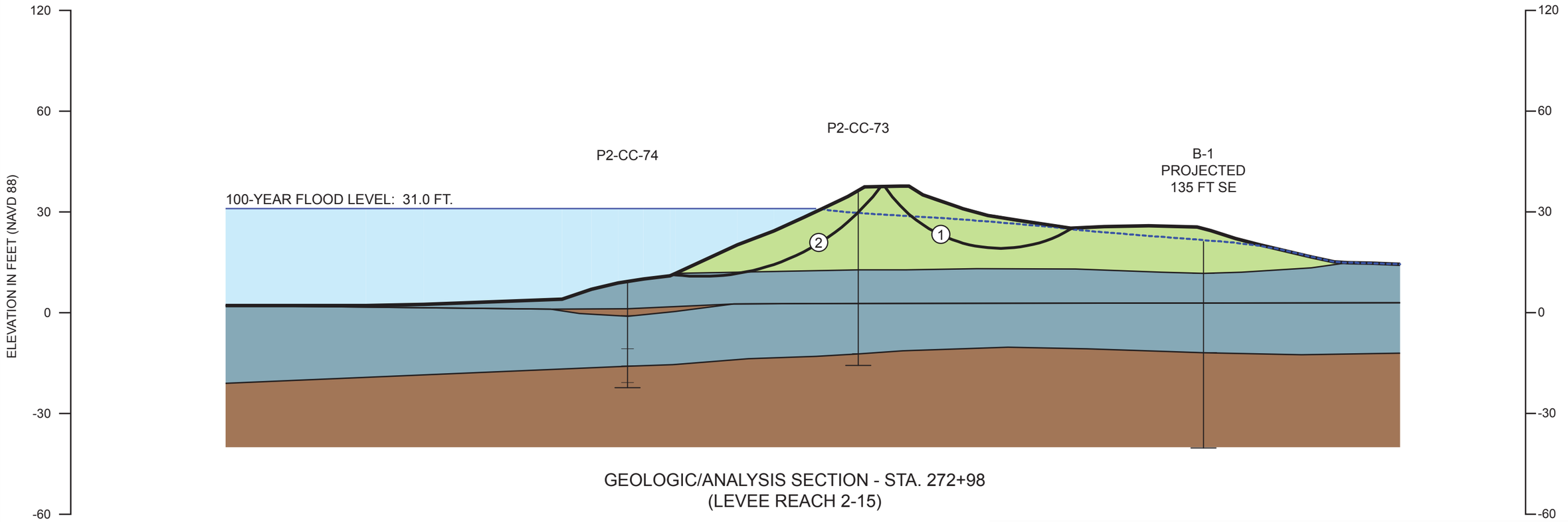
Embankment	Soft, slightly clayey to clayey SILT
Embankment	Loose, silty SAND to sandy SILT
Foundation	Loose, silty SAND and sandy SILT (Alluvium)
Foundation	Soft, clayey SILT to silty CLAY (Alluvium)

SLIP SURFACE	CALCULATED FS	MEETS REQUIRED FS*
1	1.71	YES
2	1.97	YES

*MINIMUM ALLOWABLE FS=1.4, USACE, EM 1110-2-1913

CALCULATED EXIT GRADIENT AT TOE OF LANDWARD SLOPE = 0.2**

**RECOMMENDED MAXIMUM EXIT GRADIENT = 0.5, USACE, EM 1110-2-1913



GEOLOGIC/ANALYSIS SECTION - STA. 272+98
(LEVEE REACH 2-15)

2320/Sec-272+98.45AI NAU

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GEOLOGIC/ANALYSIS CROSS SECTION

PENINSULA 2 LEVEE ASSESSMENT
PORTLAND, OREGON

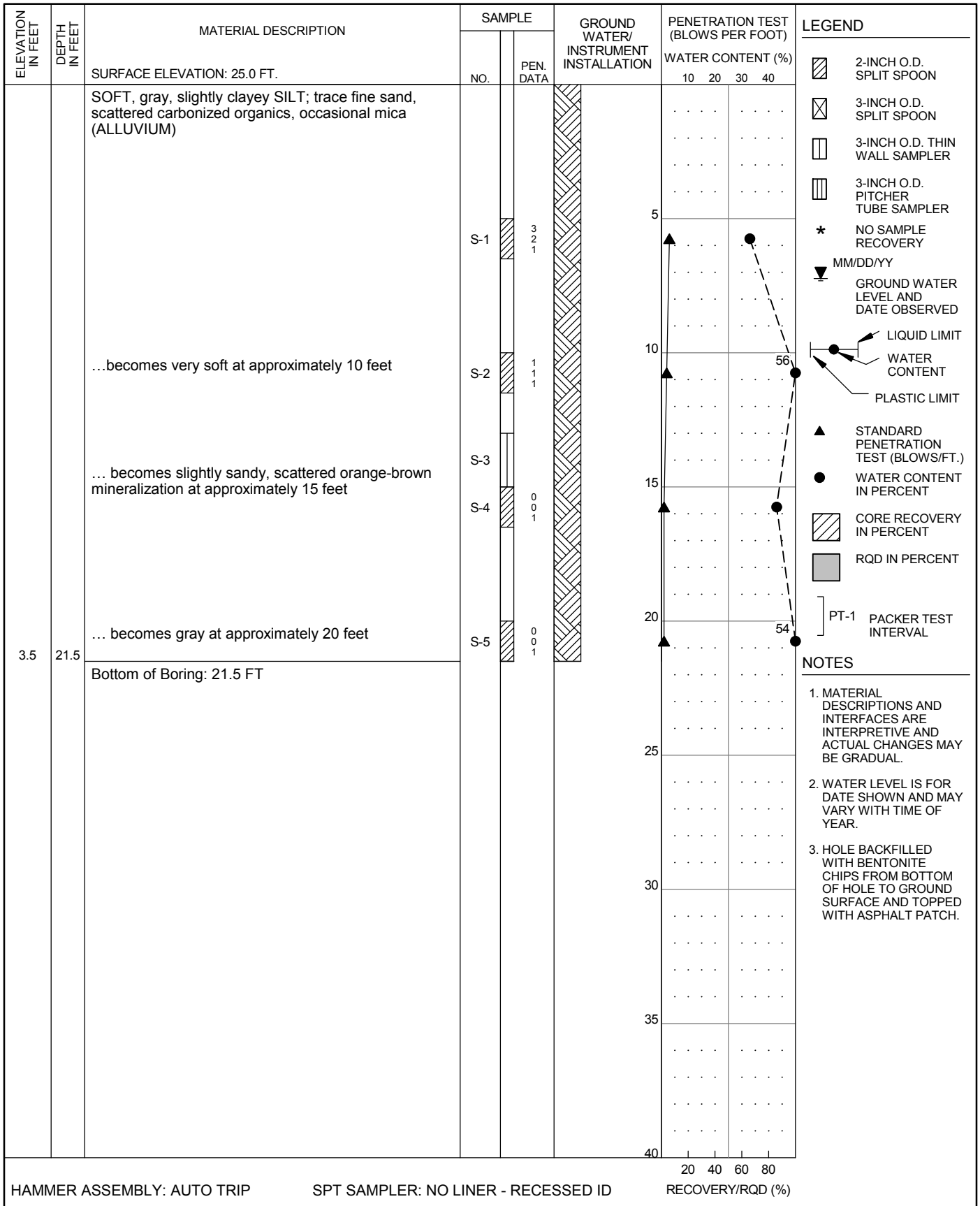
OCT 2014
PROJ. 2320
FIG. 21

APPENDIX A

SUMMARY BORING LOGS
(Current Study)

Appendix A – Table of Contents

Appendix A – Table of Contents (Cont.)



HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 3 7/8"

DRILLER: WESTERN STATES
DATE START: 4/11/2014 FINISH: 4/11/2014
DRILLING TECHNIQUE: MUD ROTARY

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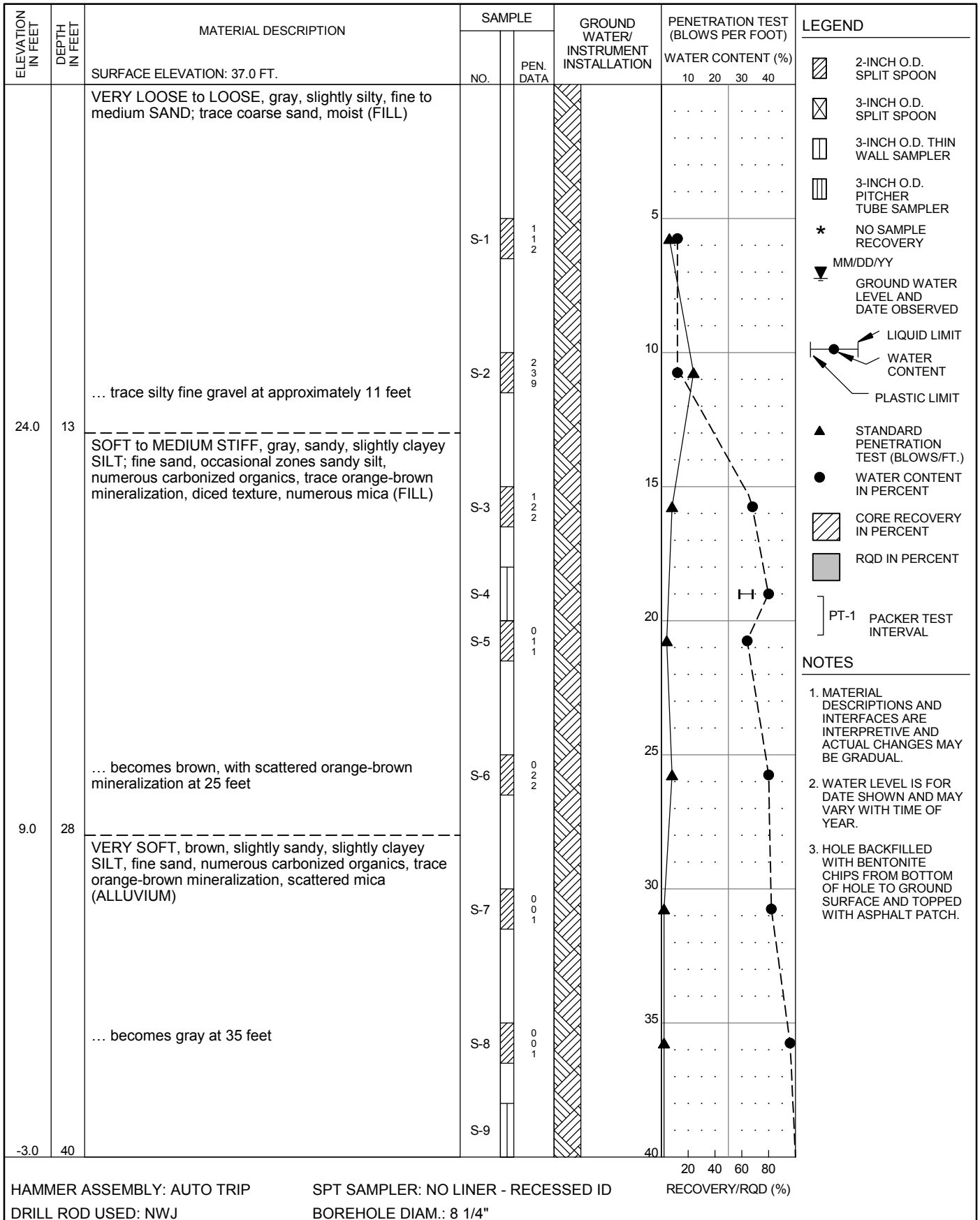
SUMMARY BORING LOG P2-CC-1

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014
PROJ 2320
FIG. A1



HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 4/14/2014 FINISH: 4/14/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-2 (1 of 2)

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014
PROJ 2320
FIG. A2

ELEVATION IN FEET	DEPTH IN FEET	MATERIAL DESCRIPTION	SAMPLE NO.	SAMPLE PEN. DATA	GROUND WATER/ INSTRUMENT INSTALLATION	PENETRATION TEST (BLOWS PER FOOT) WATER CONTENT (%) 10 20 30 40
		SURFACE ELEVATION: 37.0 FT.				
-4.5	41.5	(continued from previous page)	S-10	0 0 1		61
		Bottom of Boring: 41.5 FT				

45 50 55 60 65 70 75 80

20 40 60 80
RECOVERY/RQD (%)

LEGEND

- 2-INCH O.D. SPLIT SPOON
- 3-INCH O.D. SPLIT SPOON
- 3-INCH O.D. THIN WALL SAMPLER
- 3-INCH O.D. PITCHER TUBE SAMPLER
- * NO SAMPLE RECOVERY
- MM/DD/YY GROUND WATER LEVEL AND DATE OBSERVED
- LIQUID LIMIT, WATER CONTENT, PLASTIC LIMIT
- STANDARD PENETRATION TEST (BLOWS/FT.)
- WATER CONTENT IN PERCENT
- CORE RECOVERY IN PERCENT
- RQD IN PERCENT
- PT-1 PACKER TEST INTERVAL

NOTES

1. MATERIAL DESCRIPTIONS AND INTERFACES ARE INTERPRETIVE AND ACTUAL CHANGES MAY BE GRADUAL.
2. WATER LEVEL IS FOR DATE SHOWN AND MAY VARY WITH TIME OF YEAR.
3. HOLE BACKFILLED WITH BENTONITE CHIPS FROM BOTTOM OF HOLE TO GROUND SURFACE AND TOPPED WITH ASPHALT PATCH.

HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ
SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 4/14/2014 FINISH: 4/14/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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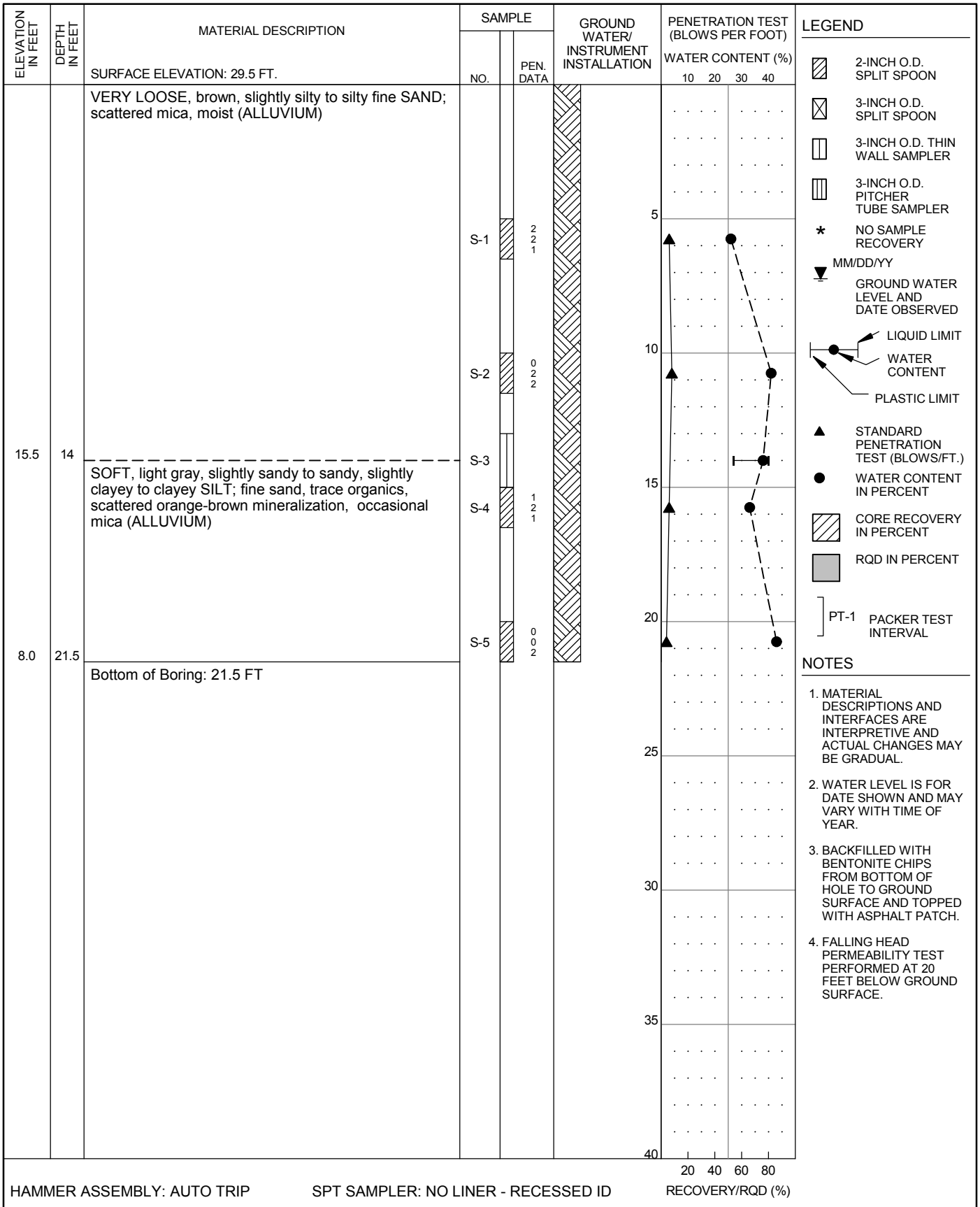
SUMMARY BORING LOG P2-CC-2 (2 of 2)

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014

PROJ 2320

FIG. A2



HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ
SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 4/15/2014 FINISH: 4/15/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-3

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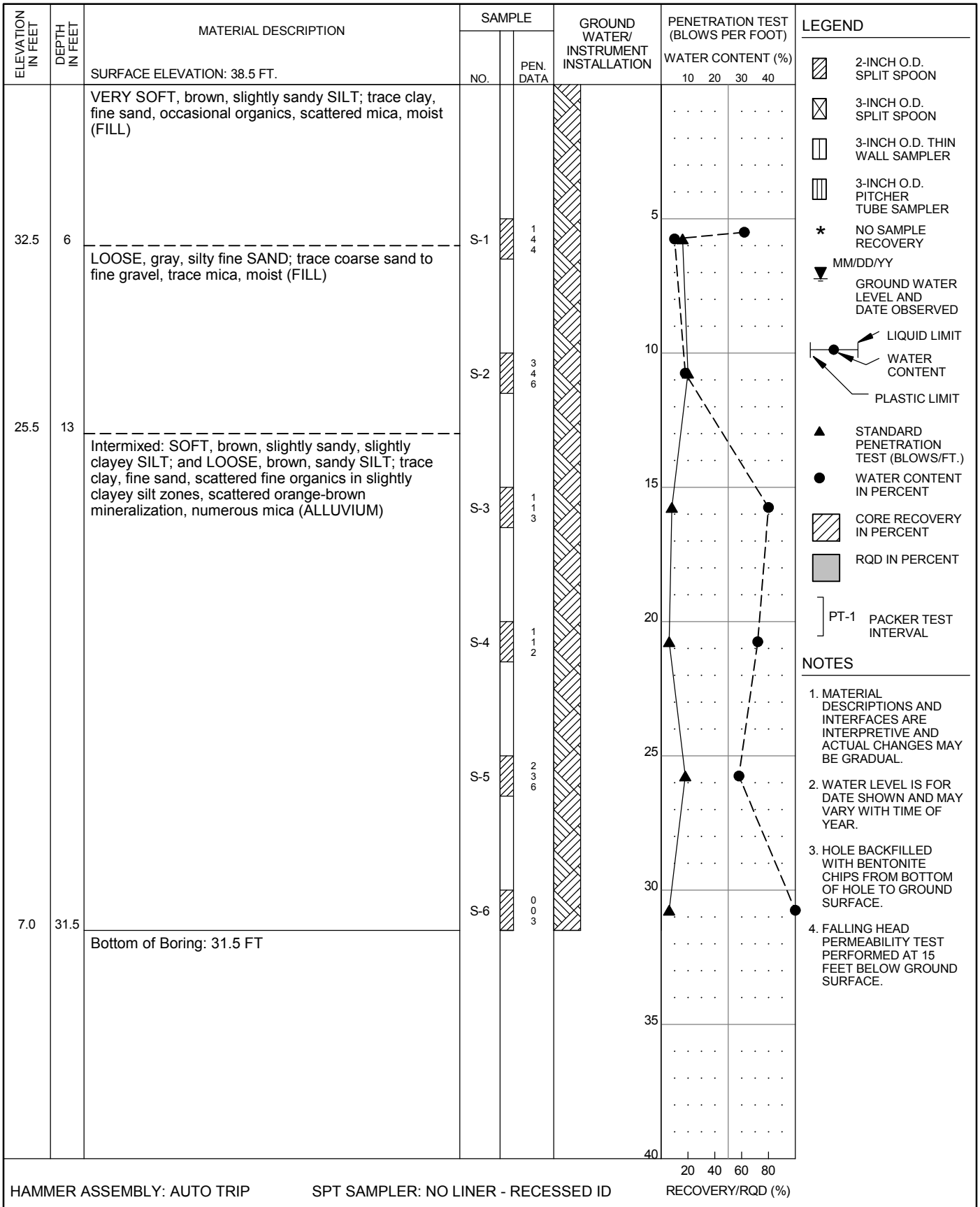
FIG. A3



HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 4/10/2014 FINISH: 4/10/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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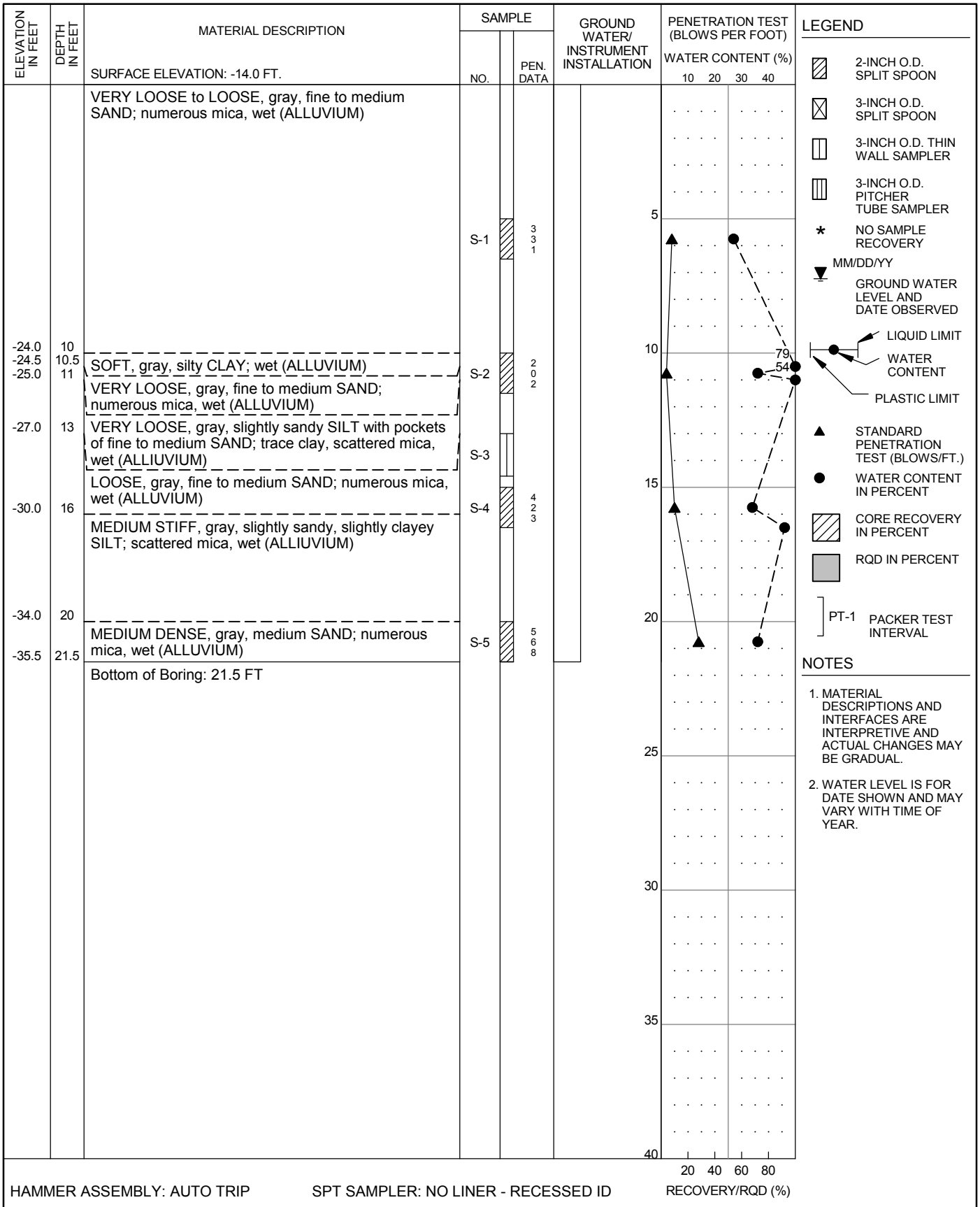
SUMMARY BORING LOG P2-CC-4

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014
PROJ 2320
FIG. A4



HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 3 7/8"

DRILLER: WESTERN STATES
DATE START: 5/14/2014 FINISH: 5/14/2014
DRILLING TECHNIQUE: MUD ROTARY

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SUMMARY BORING LOG P2-CC-5

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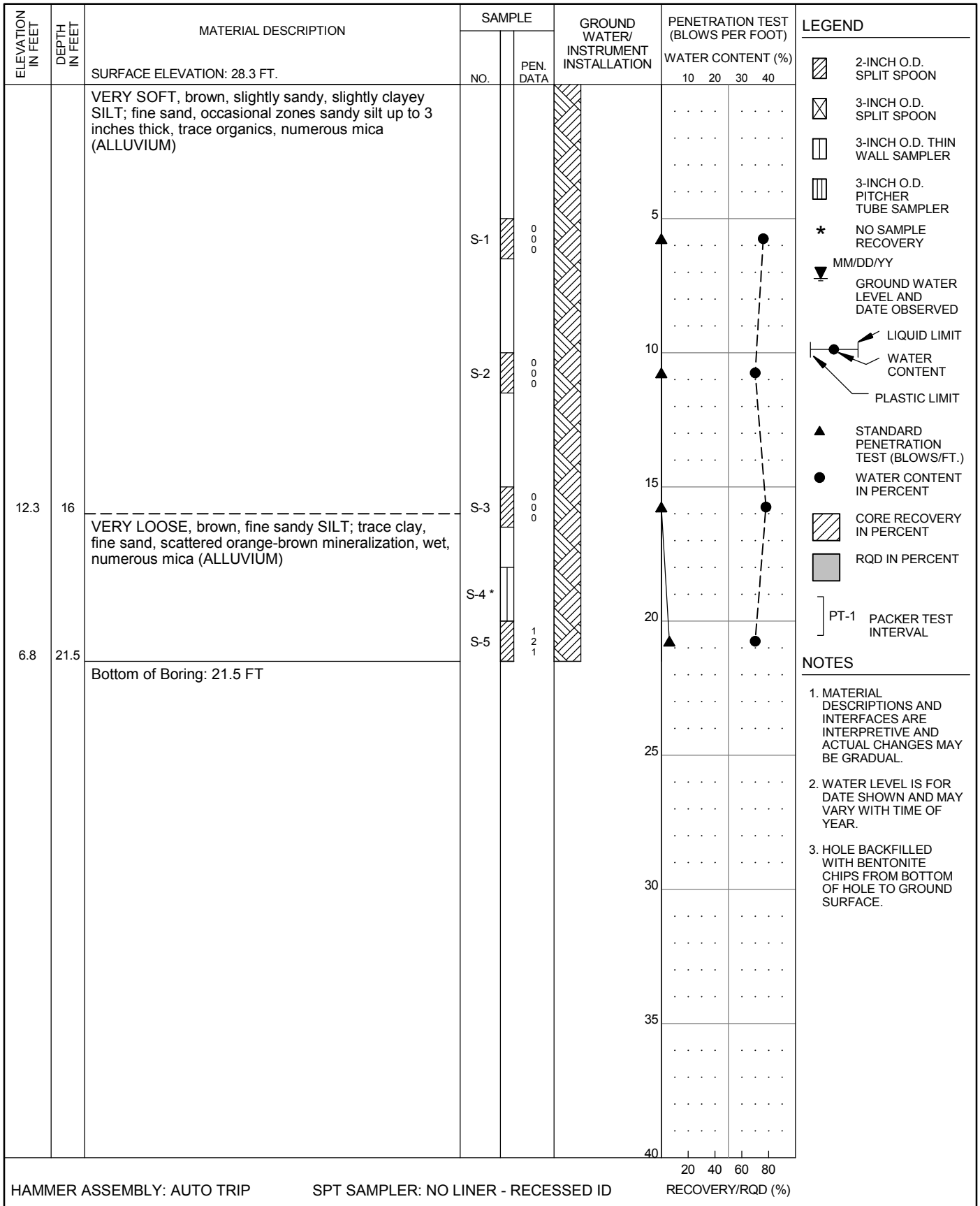
PORTLAND, OR

SEP 2014
PROJ 2320
FIG. A5



HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 3 7/8"

DRILLER: WESTERN STATES
DATE START: 4/11/2014 FINISH: 4/11/2014
DRILLING TECHNIQUE: MUD ROTARY

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SUMMARY BORING LOG P2-CC-6

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014
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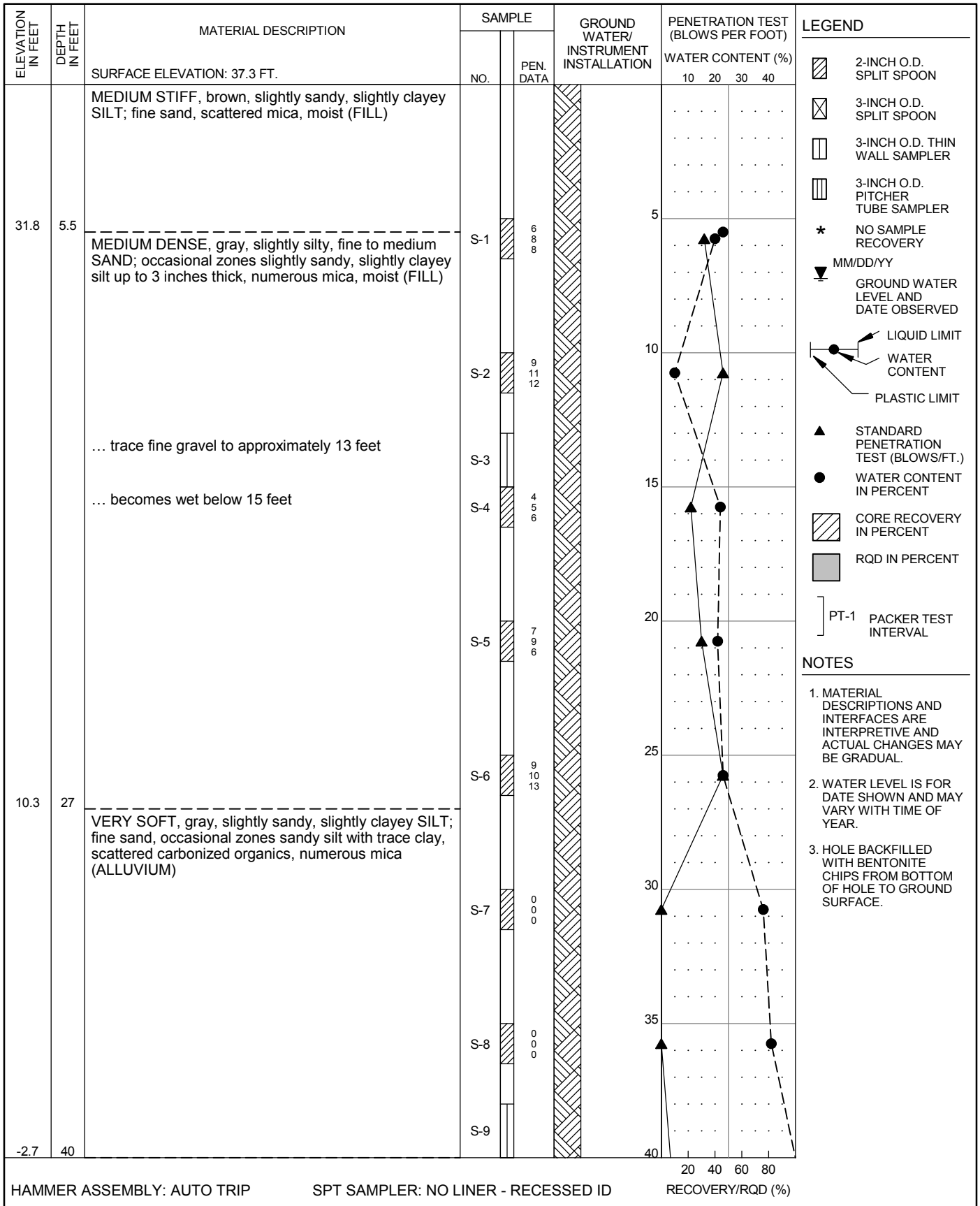
FIG. A6



HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 4/10/2014 FINISH: 4/10/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-7 (1 of 2)

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014

PROJ 2320

FIG. A7

ELEVATION IN FEET	DEPTH IN FEET	MATERIAL DESCRIPTION	SAMPLE NO.	SAMPLE PEN. DATA	GROUND WATER/ INSTRUMENT INSTALLATION	PENETRATION TEST (BLOWS PER FOOT) WATER CONTENT (%)
		SURFACE ELEVATION: 37.3 FT.				10 20 30 40
-4.2	41.5	(continued from previous page)	S-10	0 2 2		57
		Bottom of Boring: 41.5 FT				

45 50 55 60 65 70 75 80

20 40 60 80
RECOVERY/RQD (%)

LEGEND

- 2-INCH O.D. SPLIT SPOON
- 3-INCH O.D. SPLIT SPOON
- 3-INCH O.D. THIN WALL SAMPLER
- 3-INCH O.D. PITCHER TUBE SAMPLER
- * NO SAMPLE RECOVERY
- MM/DD/YY GROUND WATER LEVEL AND DATE OBSERVED
- LIQUID LIMIT, WATER CONTENT, PLASTIC LIMIT
- STANDARD PENETRATION TEST (BLOWS/FT.)
- WATER CONTENT IN PERCENT
- CORE RECOVERY IN PERCENT
- RQD IN PERCENT
- PT-1 PACKER TEST INTERVAL

NOTES

1. MATERIAL DESCRIPTIONS AND INTERFACES ARE INTERPRETIVE AND ACTUAL CHANGES MAY BE GRADUAL.
2. WATER LEVEL IS FOR DATE SHOWN AND MAY VARY WITH TIME OF YEAR.
3. HOLE BACKFILLED WITH BENTONITE CHIPS FROM BOTTOM OF HOLE TO GROUND SURFACE.

HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ

SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 4/10/2014 FINISH: 4/10/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-7 (2 of 2)

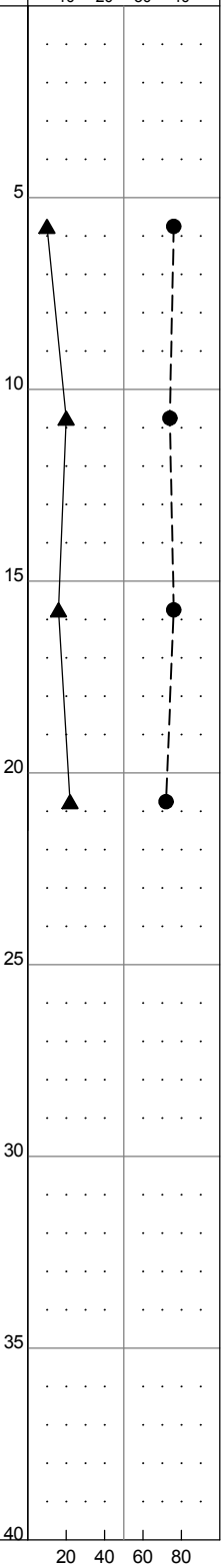
PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014

PROJ 2320

FIG. A7

ELEVATION IN FEET	DEPTH IN FEET	MATERIAL DESCRIPTION	SAMPLE NO.	SAMPLE PEN. DATA	GROUND WATER/ INSTRUMENT INSTALLATION
		SURFACE ELEVATION: -27.3 FT.			
		LOOSE to MEDIUM DENSE, gray, fine to medium SAND; numerous mica, wet (ALLUVIUM)	S-1	6 3 2	
		… 3-inch layer of silty fine sand at approximately 11 feet	S-2	2 4 6	
			S-3	2 4 4	
			S-4	4 5 6	
-48.8	21.5	Bottom of Boring: 21.5 FT			



LEGEND

- 2-INCH O.D. SPLIT SPOON
- 3-INCH O.D. SPLIT SPOON
- 3-INCH O.D. THIN WALL SAMPLER
- 3-INCH O.D. PITCHER TUBE SAMPLER
- * NO SAMPLE RECOVERY
- MM/DD/YY GROUND WATER LEVEL AND DATE OBSERVED
- LIQUID LIMIT, WATER CONTENT, PLASTIC LIMIT
- STANDARD PENETRATION TEST (BLOWS/FT.)
- WATER CONTENT IN PERCENT
- CORE RECOVERY IN PERCENT
- RQD IN PERCENT
- PT-1 PACKER TEST INTERVAL

NOTES

1. MATERIAL DESCRIPTIONS AND INTERFACES ARE INTERPRETIVE AND ACTUAL CHANGES MAY BE GRADUAL.
2. WATER LEVEL IS FOR DATE SHOWN AND MAY VARY WITH TIME OF YEAR.

HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ
SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 3 7/8"

DRILLER: WESTERN STATES
DATE START: 5/14/2014 FINISH: 5/14/2014
DRILLING TECHNIQUE: MUD ROTARY

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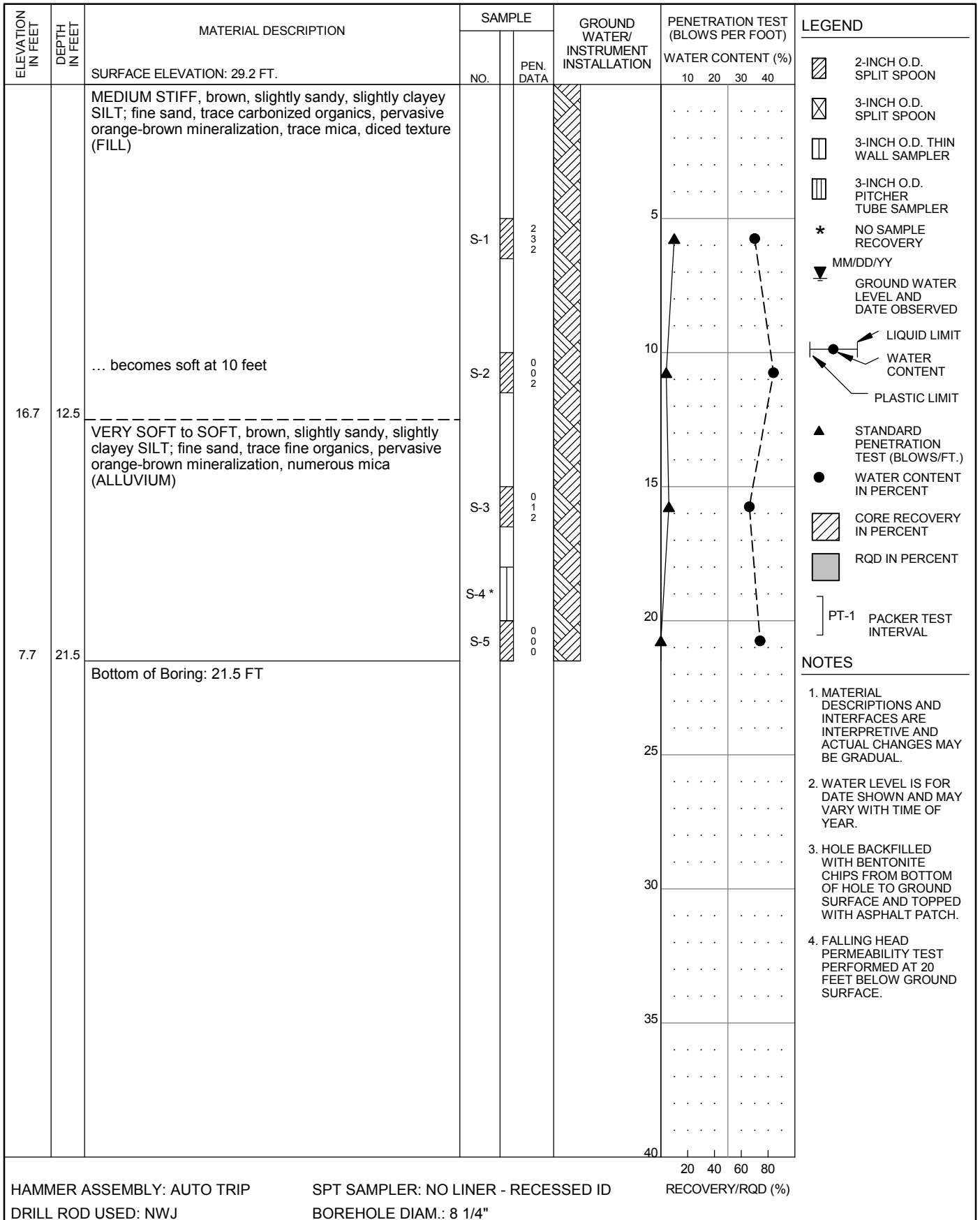
SUMMARY BORING LOG P2-CC-8

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014
PROJ 2320
FIG. A8



HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ
SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 4/7/2014 FINISH: 4/7/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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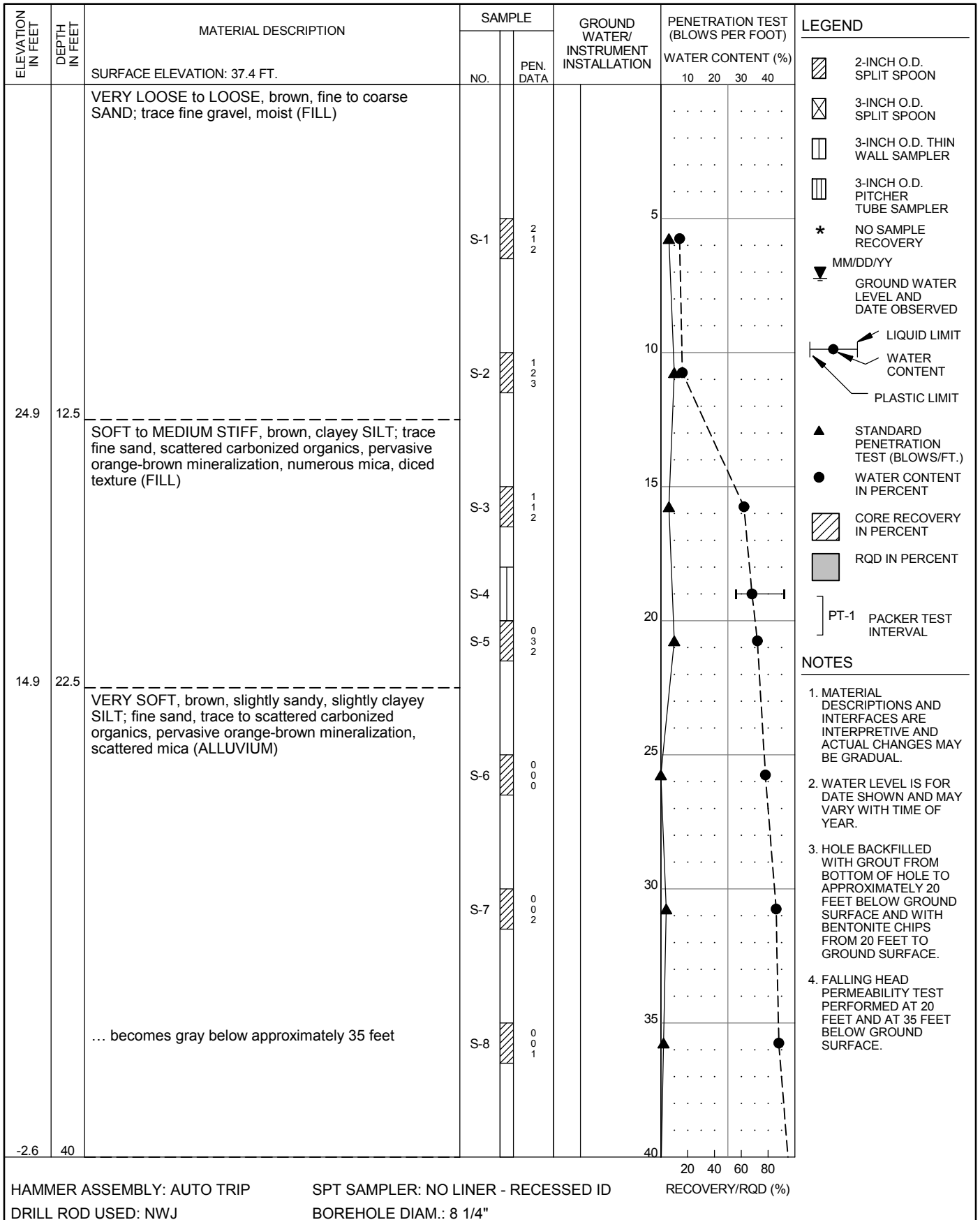
SUMMARY BORING LOG P2-CC-9

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014
PROJ 2320
FIG. A9



NOTES

1. MATERIAL DESCRIPTIONS AND INTERFACES ARE INTERPRETIVE AND ACTUAL CHANGES MAY BE GRADUAL.
2. WATER LEVEL IS FOR DATE SHOWN AND MAY VARY WITH TIME OF YEAR.
3. HOLE BACKFILLED WITH GROUT FROM BOTTOM OF HOLE TO APPROXIMATELY 20 FEET BELOW GROUND SURFACE AND WITH BENTONITE CHIPS FROM 20 FEET TO GROUND SURFACE.
4. FALLING HEAD PERMEABILITY TEST PERFORMED AT 20 FEET AND AT 35 FEET BELOW GROUND SURFACE.

HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 4/8/2014 FINISH: 4/8/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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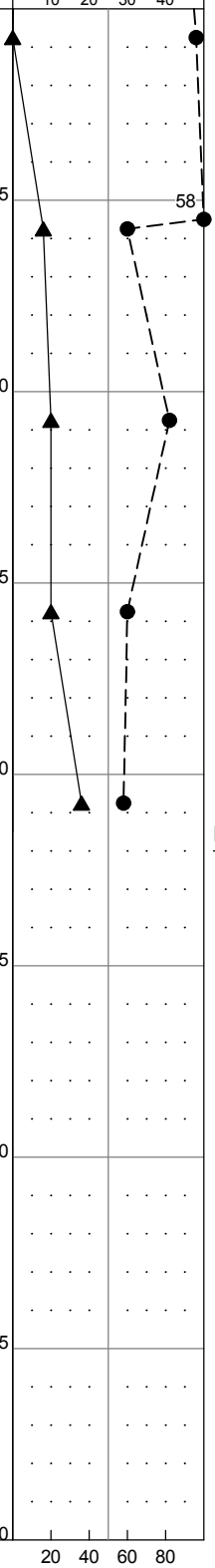
SUMMARY BORING LOG P2-CC-10 (1 of 2)

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014
PROJ 2320
FIG. A10

ELEVATION IN FEET	DEPTH IN FEET	MATERIAL DESCRIPTION	SAMPLE NO.	SAMPLE PEN. DATA	GROUND WATER/ INSTRUMENT INSTALLATION
		SURFACE ELEVATION: 37.4 FT.			
		(continued from previous page)	S-9	0 0 0	
			S-10		
-8.1	45.5	LOOSE, gray, fine SAND; trace silt, trace fine organics, numerous mica, wet (ALLUVIUM)	S-11	1 3 5	
			S-12	1 4 6	
			S-13	5 4 6	
-24.1	61.5	… becomes medium dense below approximately 60 feet	S-14	13 9 9	
		Bottom of Boring: 61.5 FT			



LEGEND

- 2-INCH O.D. SPLIT SPOON
- 3-INCH O.D. SPLIT SPOON
- 3-INCH O.D. THIN WALL SAMPLER
- 3-INCH O.D. PITCHER TUBE SAMPLER
- * NO SAMPLE RECOVERY
- MM/DD/YY GROUND WATER LEVEL AND DATE OBSERVED
- LIQUID LIMIT
- WATER CONTENT
- PLASTIC LIMIT
- STANDARD PENETRATION TEST (BLOWS/FT.)
- WATER CONTENT IN PERCENT
- CORE RECOVERY IN PERCENT
- RQD IN PERCENT
- PT-1 PACKER TEST INTERVAL

NOTES

1. MATERIAL DESCRIPTIONS AND INTERFACES ARE INTERPRETIVE AND ACTUAL CHANGES MAY BE GRADUAL.
2. WATER LEVEL IS FOR DATE SHOWN AND MAY VARY WITH TIME OF YEAR.
3. HOLE BACKFILLED WITH GROUT FROM BOTTOM OF HOLE TO APPROXIMATELY 20 FEET BELOW GROUND SURFACE AND WITH BENTONITE CHIPS FROM 20 FEET TO GROUND SURFACE.
4. FALLING HEAD PERMEABILITY TEST PERFORMED AT 20 FEET AND AT 35 FEET BELOW GROUND SURFACE.

HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ
SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 4/8/2014 FINISH: 4/8/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-10 (2 of 2)

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014

PROJ 2320

FIG. A10

ELEVATION IN FEET	DEPTH IN FEET	MATERIAL DESCRIPTION	SAMPLE NO.	SAMPLE PEN. DATA
		SURFACE ELEVATION: -11.6 FT.		
		LOOSE, gray, fine SAND; numerous mica, wet (ALLUVIUM)	S-1	4 4 3
-21.6	10	MEDIUM DENSE, gray, fine to medium SAND; numerous mica, wet (ALLUVIUM)	S-2	4 9 7
			S-3	5 8 9
			S-4	6 8 10
-33.1	21.5	Bottom of Boring: 21.5 FT		

GROUND WATER/ INSTRUMENT INSTALLATION

PENETRATION TEST (BLOWS PER FOOT)

WATER CONTENT (%)

10 20 30 40

5 10 15 20 25 30 35 40

20 40 60 80

RECOVERY/RQD (%)

LEGEND

- 2-INCH O.D. SPLIT SPOON
- 3-INCH O.D. SPLIT SPOON
- 3-INCH O.D. THIN WALL SAMPLER
- 3-INCH O.D. PITCHER TUBE SAMPLER
- * NO SAMPLE RECOVERY
- MM/DD/YY GROUND WATER LEVEL AND DATE OBSERVED
- LIQUID LIMIT
- WATER CONTENT
- PLASTIC LIMIT
- STANDARD PENETRATION TEST (BLOWS/FT.)
- WATER CONTENT IN PERCENT
- CORE RECOVERY IN PERCENT
- RQD IN PERCENT
- PT-1 PACKER TEST INTERVAL

NOTES

1. MATERIAL DESCRIPTIONS AND INTERFACES ARE INTERPRETIVE AND ACTUAL CHANGES MAY BE GRADUAL.
2. WATER LEVEL IS FOR DATE SHOWN AND MAY VARY WITH TIME OF YEAR.

HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ

SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 3 7/8"

DRILLER: WESTERN STATES
DATE START: 5/16/2014 FINISH: 5/16/2014
DRILLING TECHNIQUE: MUD ROTARY

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SUMMARY BORING LOG P2-CC-11

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

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FIG. A11

ELEVATION IN FEET	DEPTH IN FEET	MATERIAL DESCRIPTION	SAMPLE NO.	SAMPLE PEN. DATA
		SURFACE ELEVATION: 30.6 FT.		
		VERY LOOSE, brown, very silty fine SAND; numerous mica, moist (FILL)	S-1	0 0 0
20.6	10	MEDIUM STIFF, brown, slightly clayey SILT; trace fine sand, trace fine organics, pervasive orange-brown mineralization, scattered mica (ALLUVIUM)	S-2	1 2 3
			S-3	2 2 2
9.1	21.5	… becomes very soft, wet below approximately 20 feet	S-4	0 0 1
		Bottom of Boring: 21.5 FT		

GROUND WATER/ INSTRUMENT INSTALLATION

PENETRATION TEST (BLOWS PER FOOT)

WATER CONTENT (%)

10 20 30 40

5 10 15 20 25 30 35 40

20 40 60 80

RECOVERY/RQD (%)

LEGEND

- 2-INCH O.D. SPLIT SPOON
- 3-INCH O.D. SPLIT SPOON
- 3-INCH O.D. THIN WALL SAMPLER
- 3-INCH O.D. PITCHER TUBE SAMPLER
- * NO SAMPLE RECOVERY
- MM/DD/YY GROUND WATER LEVEL AND DATE OBSERVED
- LIQUID LIMIT
- WATER CONTENT
- PLASTIC LIMIT
- STANDARD PENETRATION TEST (BLOWS/FT.)
- WATER CONTENT IN PERCENT
- CORE RECOVERY IN PERCENT
- RQD IN PERCENT
- PT-1 PACKER TEST INTERVAL

NOTES

1. MATERIAL DESCRIPTIONS AND INTERFACES ARE INTERPRETIVE AND ACTUAL CHANGES MAY BE GRADUAL.
2. WATER LEVEL IS FOR DATE SHOWN AND MAY VARY WITH TIME OF YEAR.
3. HOLE BACKFILLED WITH BENTONITE CHIPS FROM BOTTOM OF HOLE TO GROUND SURFACE.

HAMMER ASSEMBLY: AUTO TRIP

DRILL ROD USED: NWJ

SPT SAMPLER: NO LINER - RECESSED ID

BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES

DATE START: 4/8/2014 FINISH: 4/8/2014

DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-12

PENINSULA DISTRICT 2 LEVEE
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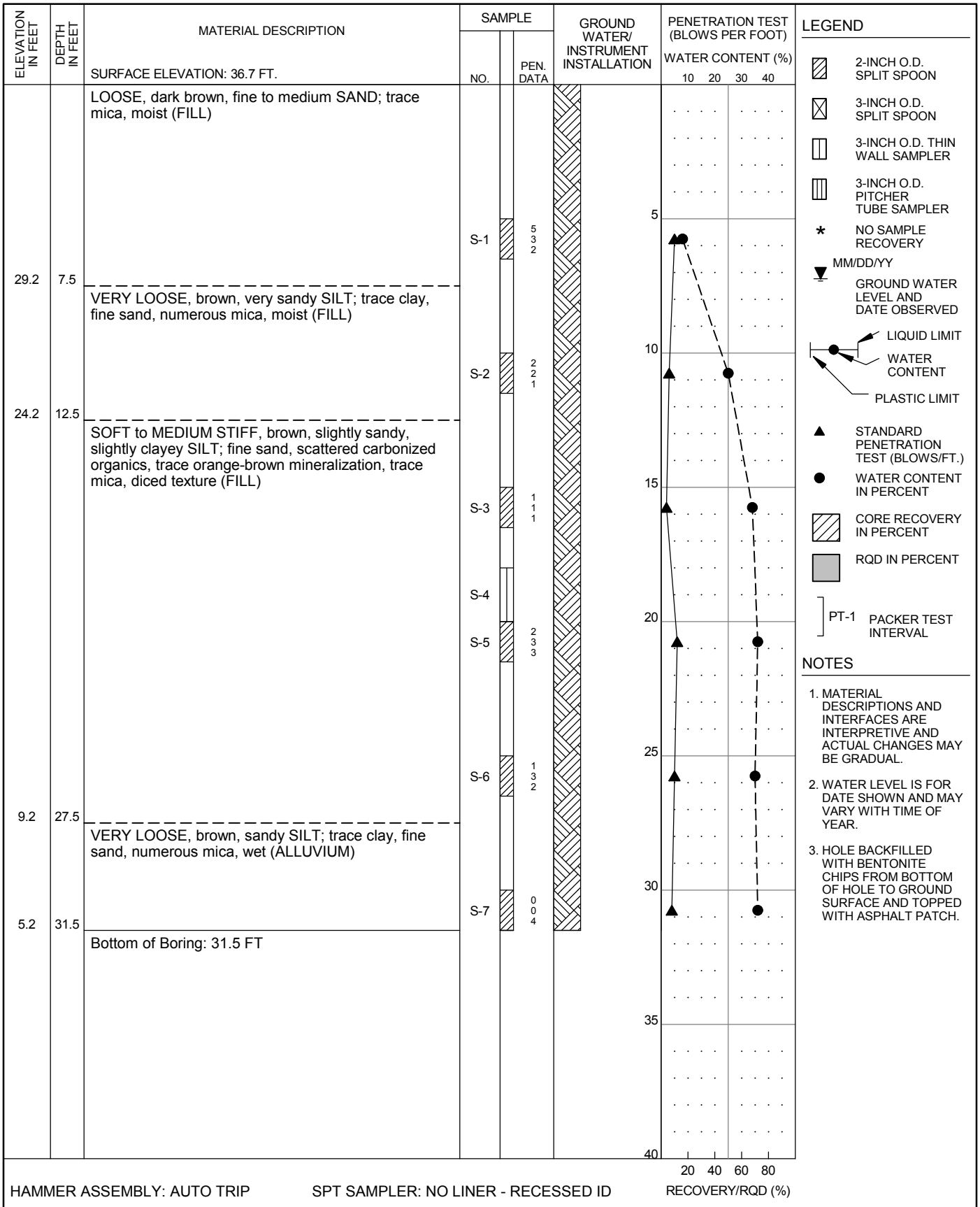
FIG. A12



NOTES

1. MATERIAL DESCRIPTIONS AND INTERFACES ARE INTERPRETIVE AND ACTUAL CHANGES MAY BE GRADUAL.
2. WATER LEVEL IS FOR DATE SHOWN AND MAY VARY WITH TIME OF YEAR.
3. HOLE BACKFILLED WITH BENTONITE CHIPS FROM BOTTOM OF HOLE TO GROUND SURFACE AND TOPPED WITH ASPHALT PATCH.

HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ
SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 4/7/2014 FINISH: 4/7/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-13

PENINSULA DISTRICT 2 LEVEE
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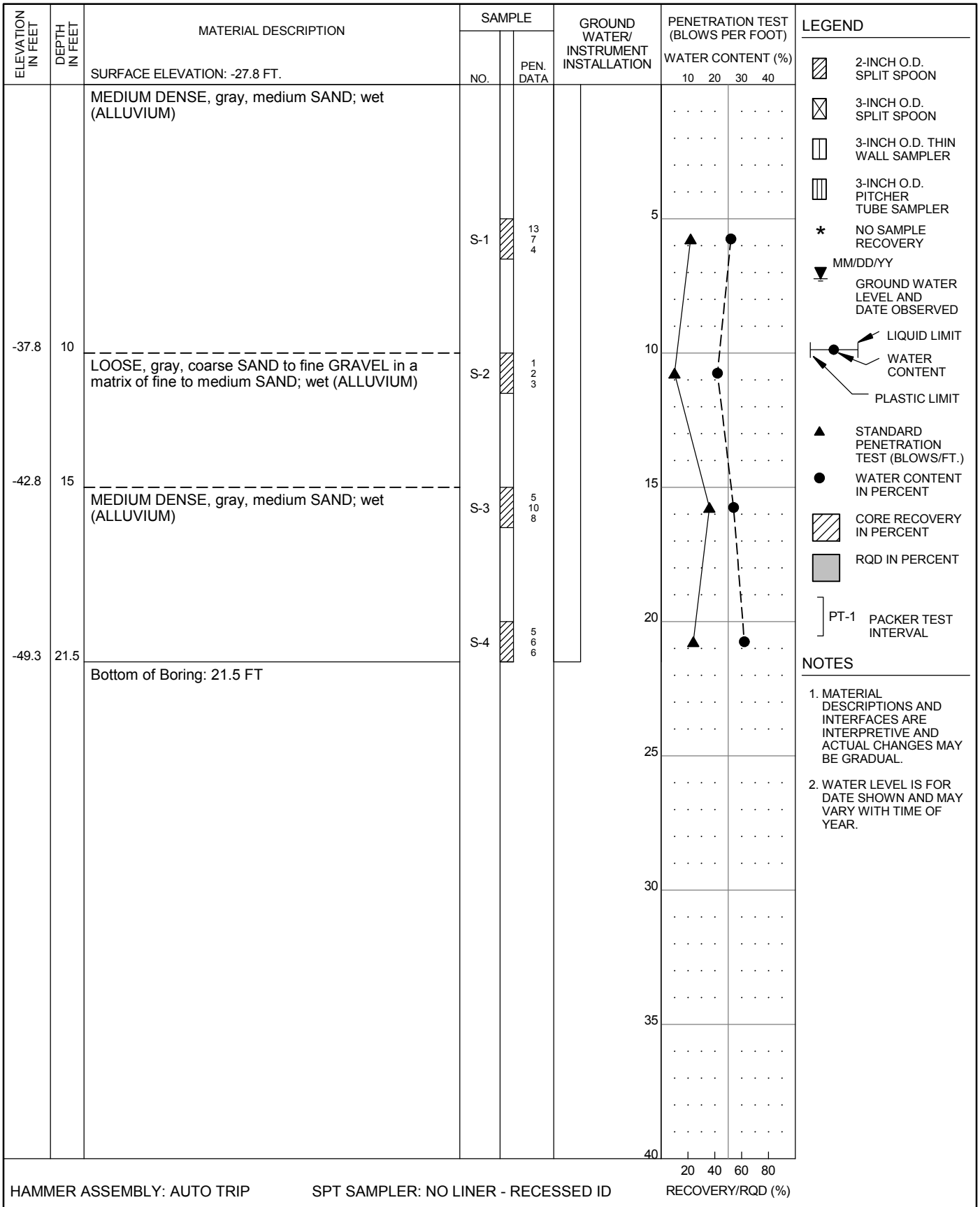
FIG. A13



HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ
SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 3 7/8"

DRILLER: WESTERN STATES
DATE START: 5/13/2014 FINISH: 5/13/2014
DRILLING TECHNIQUE: MUD ROTARY

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SUMMARY BORING LOG P2-CC-14

PENINSULA DISTRICT 2 LEVEE
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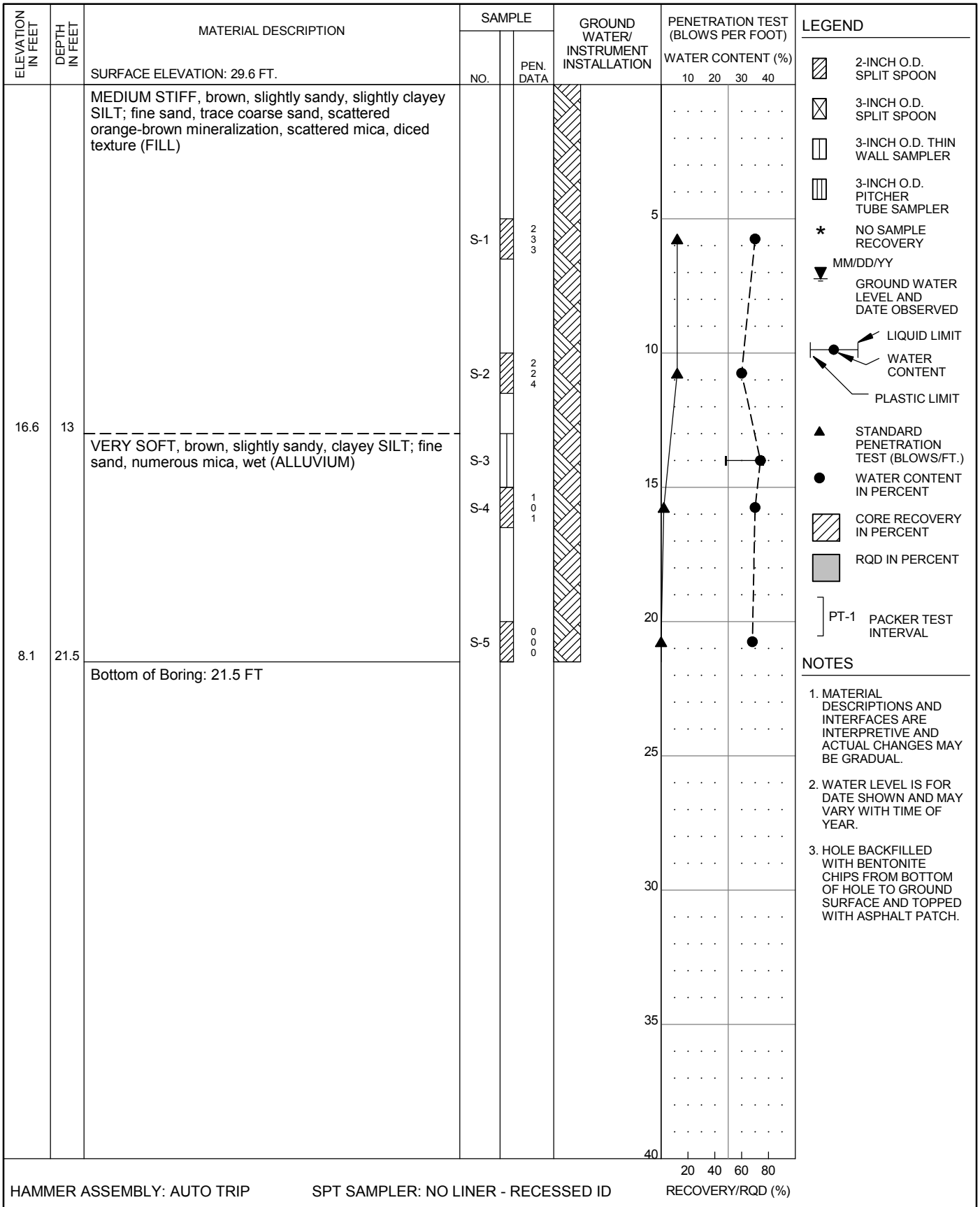
FIG. A14



HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 4/7/2014 FINISH: 4/7/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-15

PENINSULA DISTRICT 2 LEVEE
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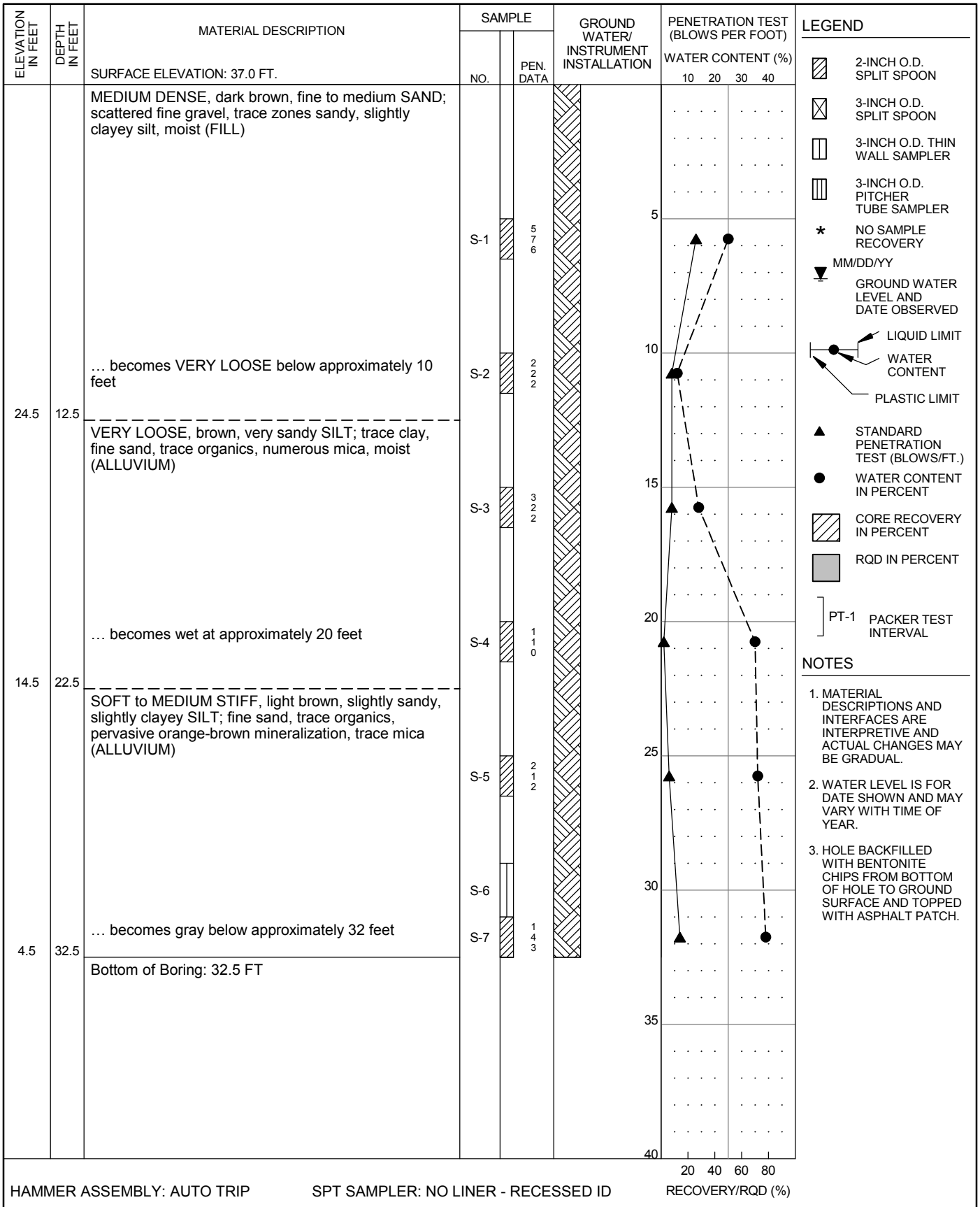
FIG. A15



HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ
SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 4/9/2014 FINISH: 4/9/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-16

PENINSULA DISTRICT 2 LEVEE
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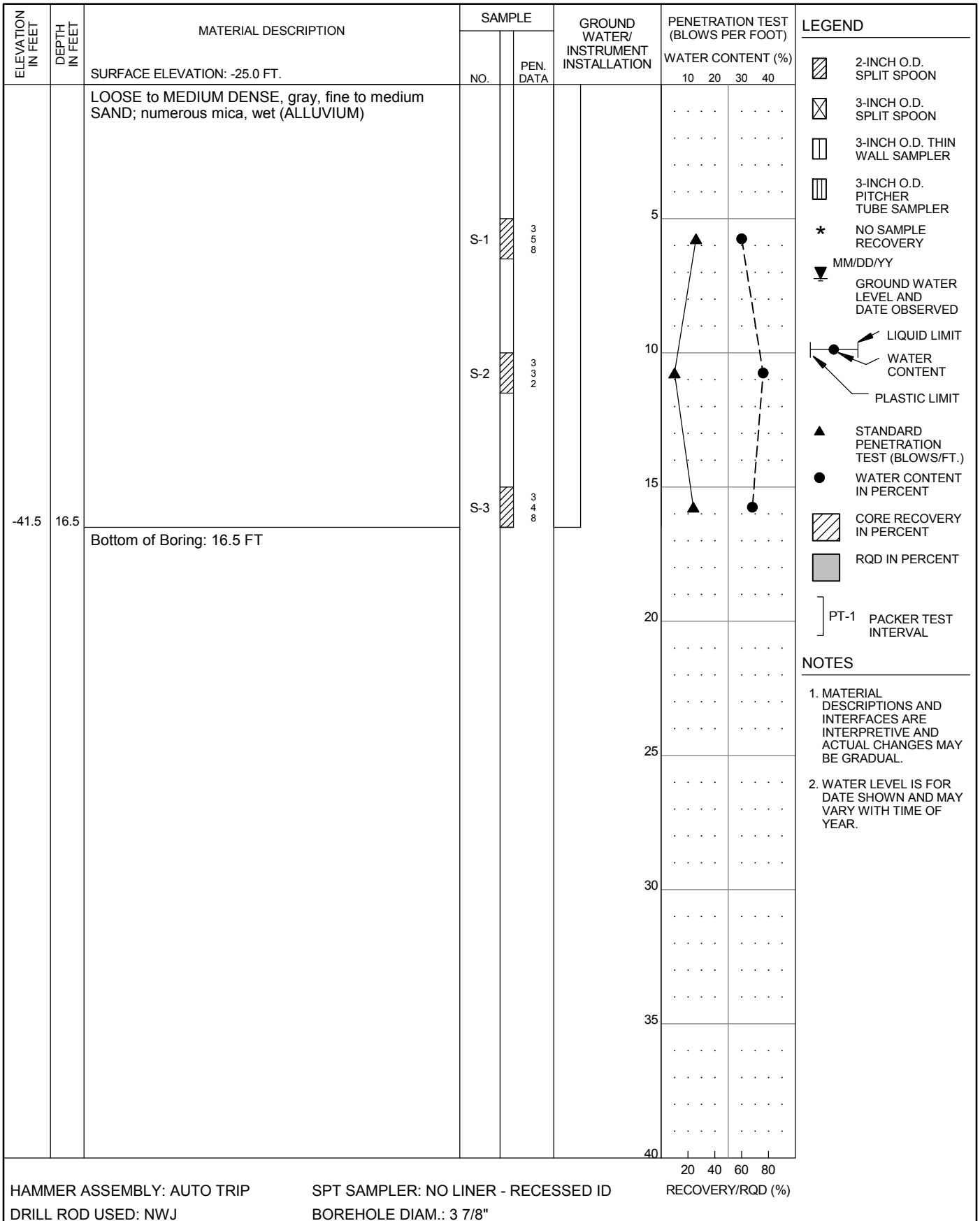
FIG. A16



HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ
SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 3 7/8"

DRILLER: WESTERN STATES
DATE START: 5/13/2014 FINISH: 5/13/2014
DRILLING TECHNIQUE: MUD ROTARY

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SUMMARY BORING LOG P2-CC-17

PENINSULA DISTRICT 2 LEVEE
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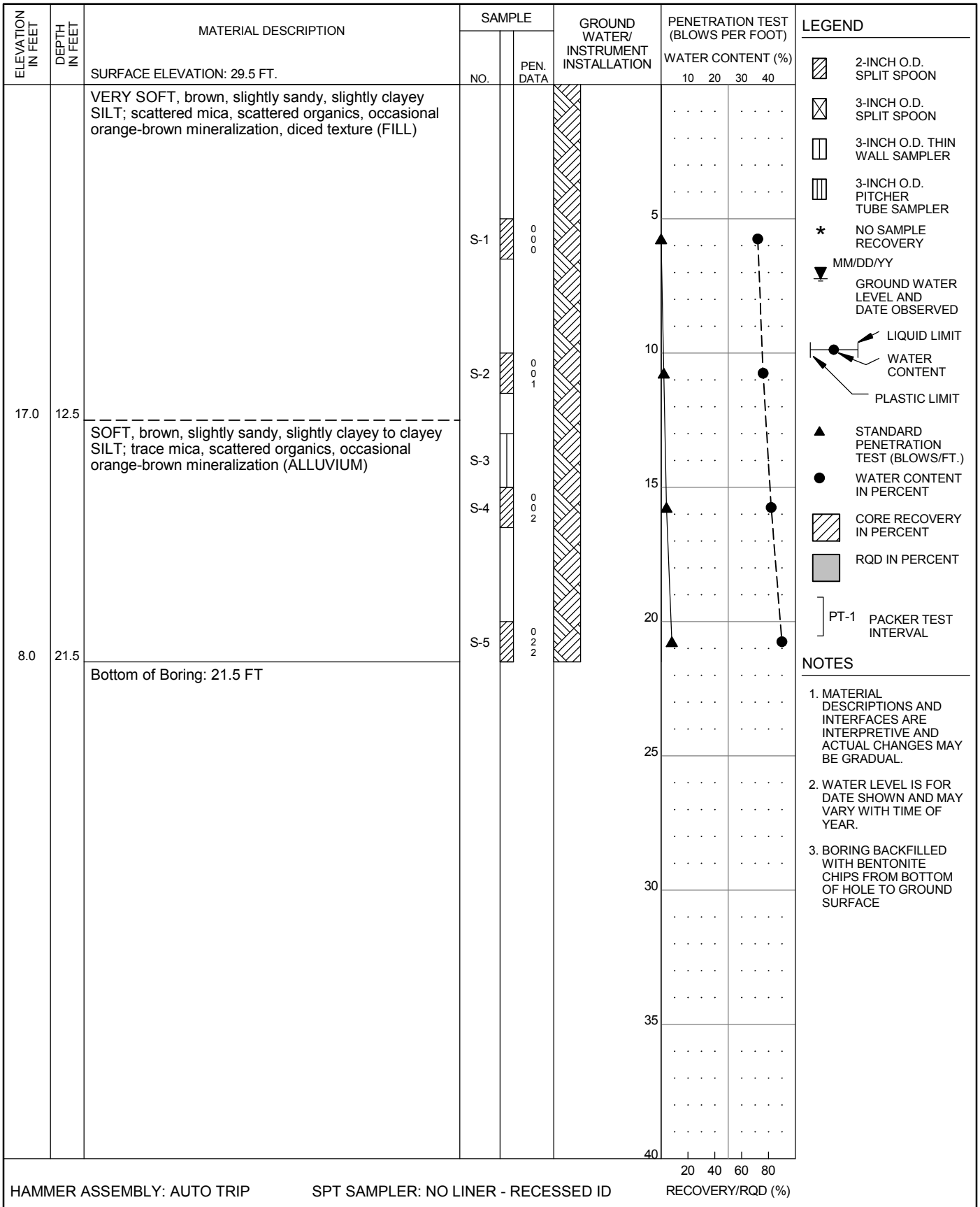
FIG. A17



HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ
SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 4 7/8"

DRILLER: WESTERN STATES
DATE START: 4/2/2014 FINISH: 4/2/2014
DRILLING TECHNIQUE: MUD ROTARY

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SUMMARY BORING LOG P2-CC-18

PENINSULA DISTRICT 2 LEVEE
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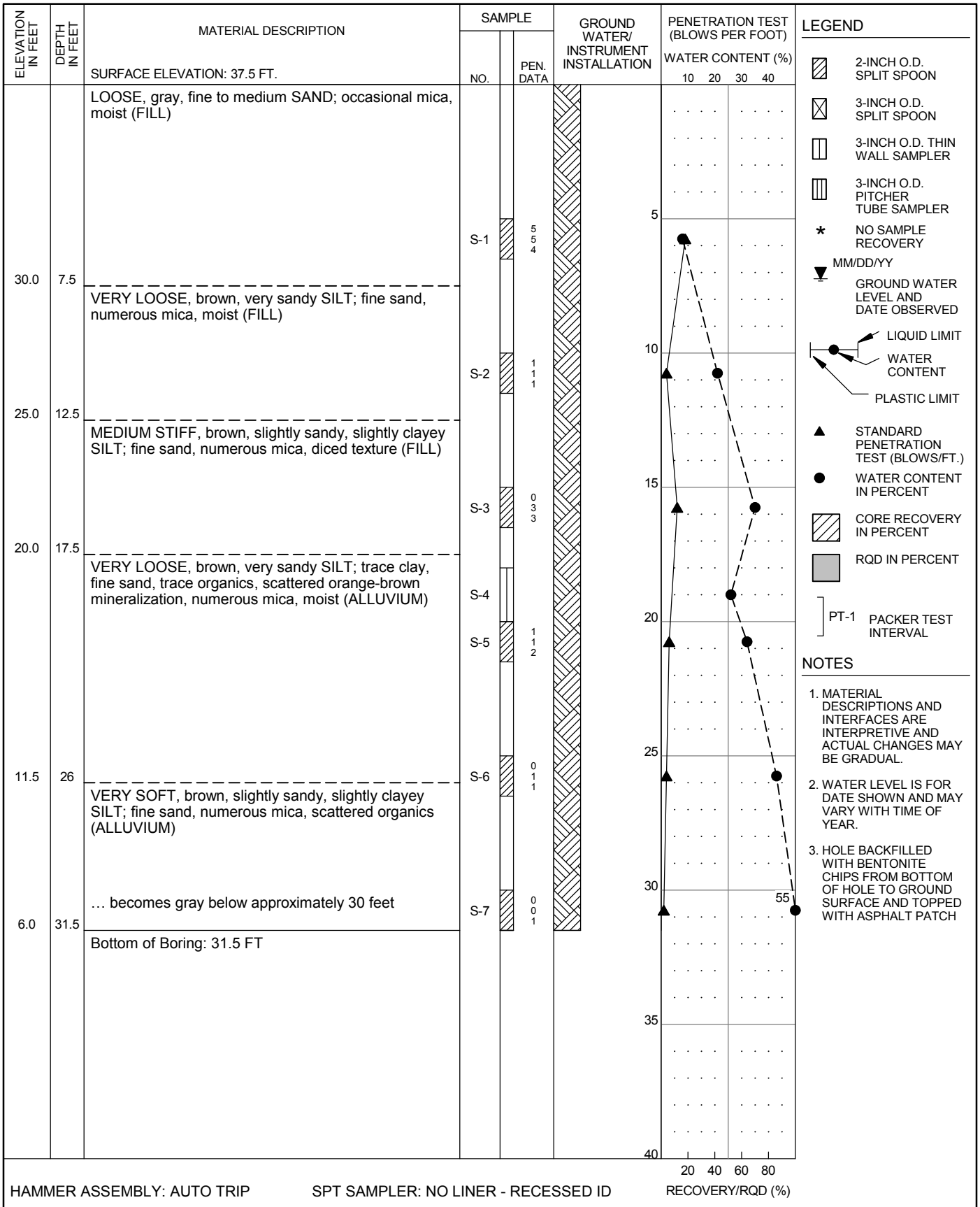
FIG. A18



HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 4/9/2014 FINISH: 4/9/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-19

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

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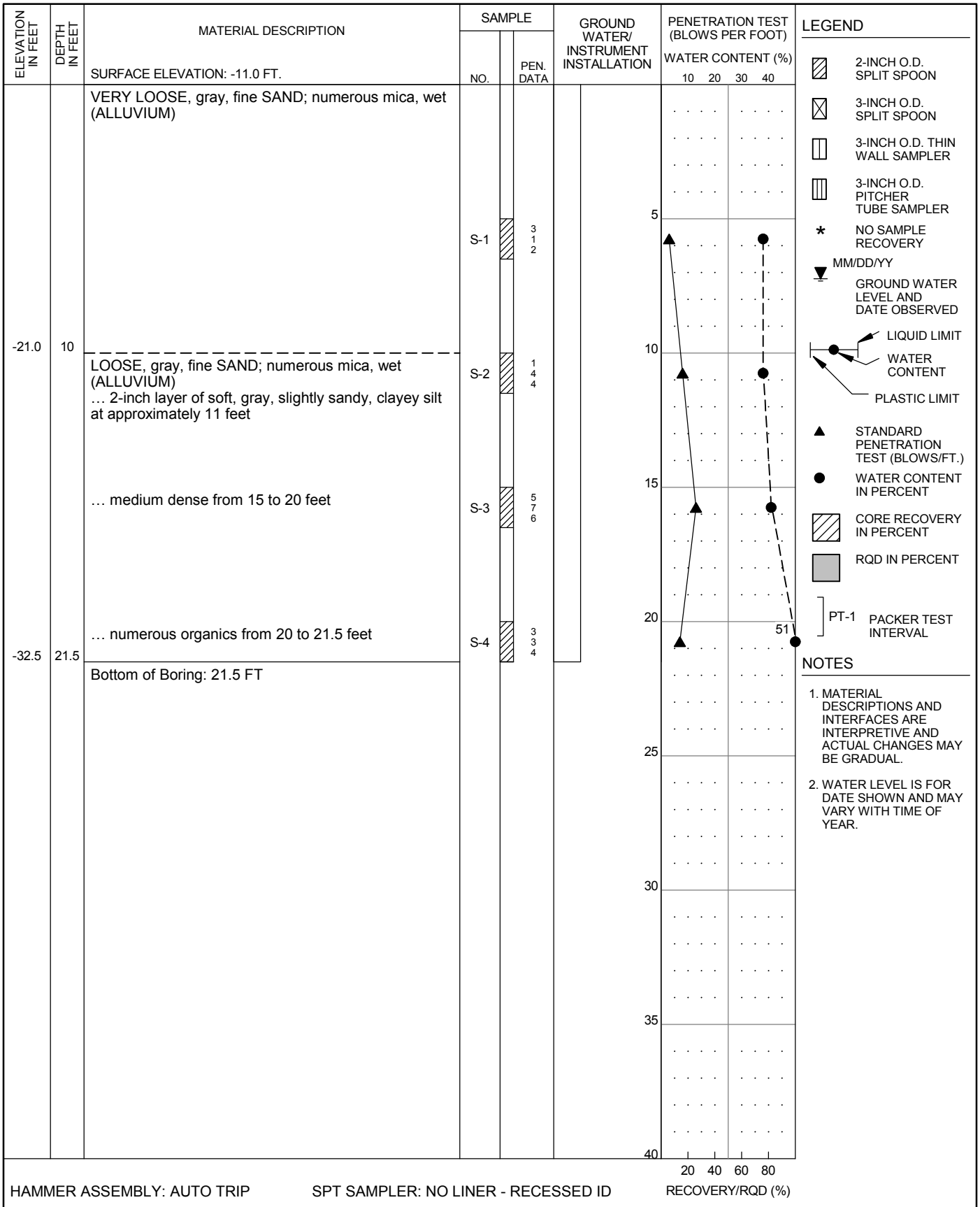
FIG. A19



HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ
SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 3 7/8"

DRILLER: WESTERN STATES
DATE START: 5/15/2014 FINISH: 5/15/2014
DRILLING TECHNIQUE: MUD ROTARY

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SUMMARY BORING LOG P2-CC-20

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014
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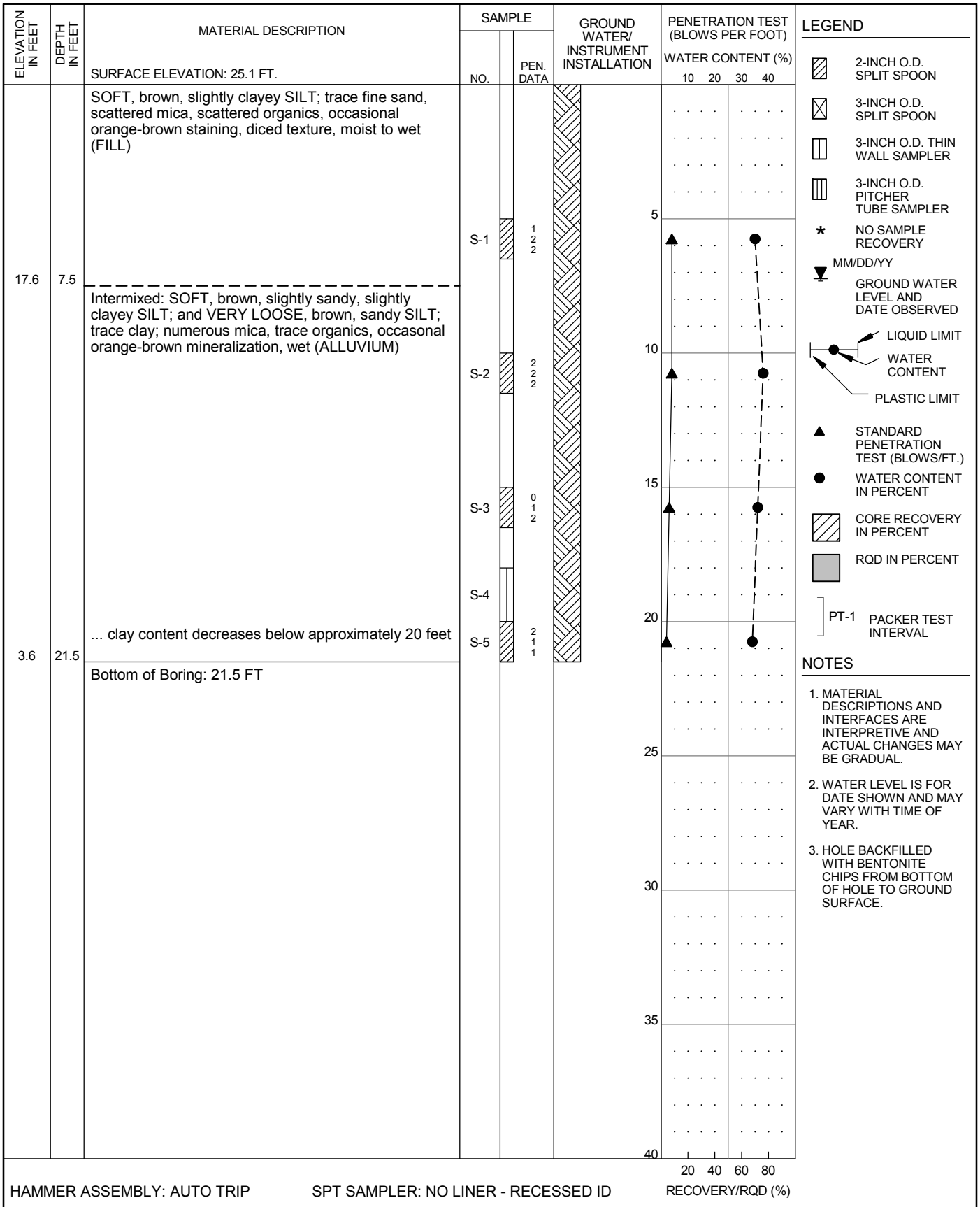
FIG. A20



HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ
SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 4 7/8"

DRILLER: WESTERN STATES
DATE START: 4/2/2014 FINISH: 4/2/2014
DRILLING TECHNIQUE: MUD ROTARY

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SUMMARY BORING LOG P2-CC-21

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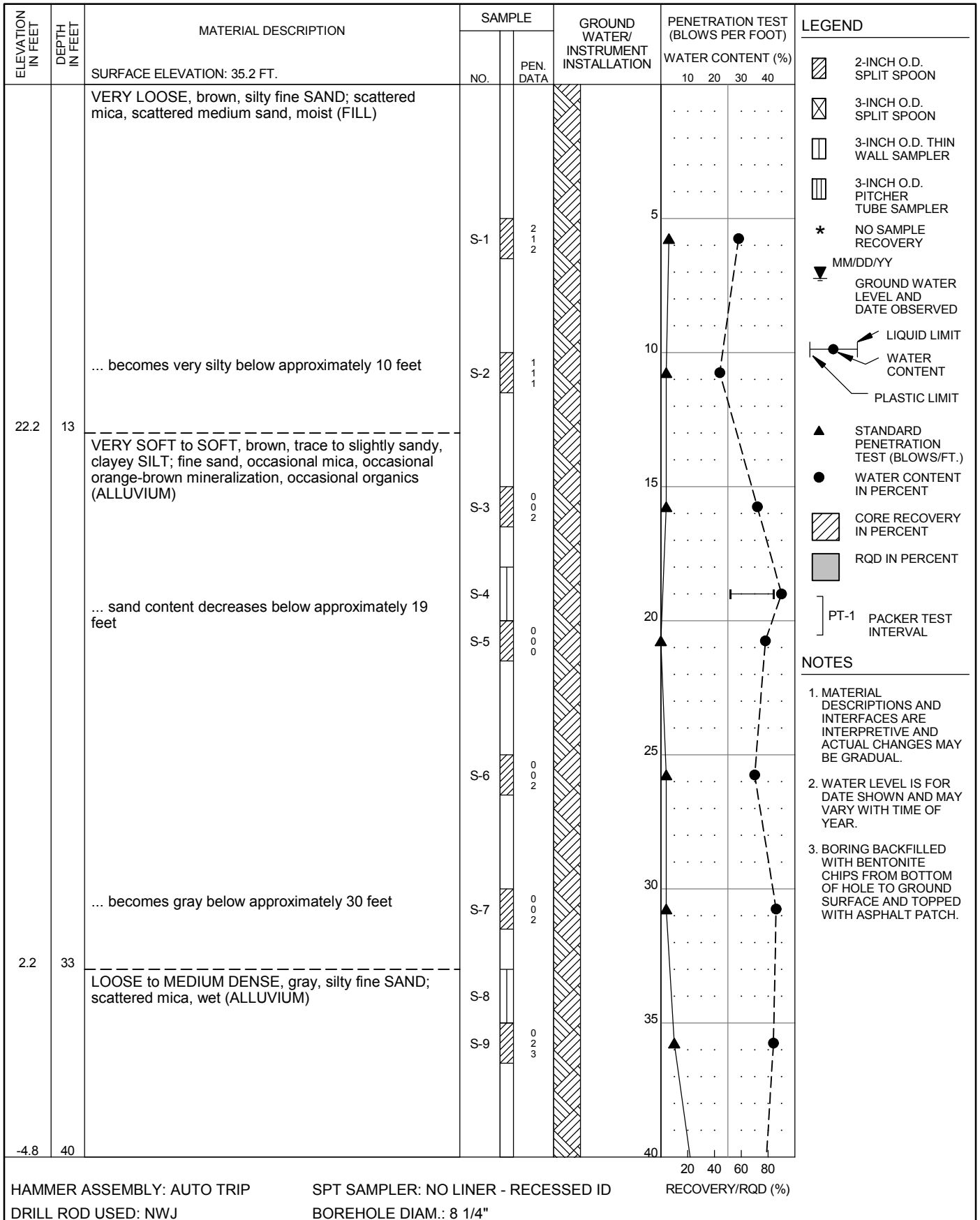
FIG. A21



HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 4/2/2014 FINISH: 4/2/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-22 (1 of 2)

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

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PROJ 2320
FIG. A22

ELEVATION IN FEET	DEPTH IN FEET	MATERIAL DESCRIPTION	SAMPLE NO.	SAMPLE PEN. DATA	GROUND WATER/ INSTRUMENT INSTALLATION
		SURFACE ELEVATION: 35.2 FT.			
-6.3	41.5	(continued from previous page)	S-10	6 5 7	
		Bottom of Boring: 41.5 FT			

PENETRATION TEST (BLOWS PER FOOT)
WATER CONTENT (%)
10 20 30 40

45 50 55 60 65 70 75 80

20 40 60 80
RECOVERY/RQD (%)

LEGEND

- 2-INCH O.D. SPLIT SPOON
- 3-INCH O.D. SPLIT SPOON
- 3-INCH O.D. THIN WALL SAMPLER
- 3-INCH O.D. PITCHER TUBE SAMPLER
- * NO SAMPLE RECOVERY
- MM/DD/YY GROUND WATER LEVEL AND DATE OBSERVED
- LIQUID LIMIT
- WATER CONTENT
- PLASTIC LIMIT
- STANDARD PENETRATION TEST (BLOWS/FT.)
- WATER CONTENT IN PERCENT
- CORE RECOVERY IN PERCENT
- RQD IN PERCENT
- PT-1 PACKER TEST INTERVAL

NOTES

1. MATERIAL DESCRIPTIONS AND INTERFACES ARE INTERPRETIVE AND ACTUAL CHANGES MAY BE GRADUAL.
2. WATER LEVEL IS FOR DATE SHOWN AND MAY VARY WITH TIME OF YEAR.
3. BORING BACKFILLED WITH BENTONITE CHIPS FROM BOTTOM OF HOLE TO GROUND SURFACE AND TOPPED WITH ASPHALT PATCH.

HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ
SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 4/2/2014 FINISH: 4/2/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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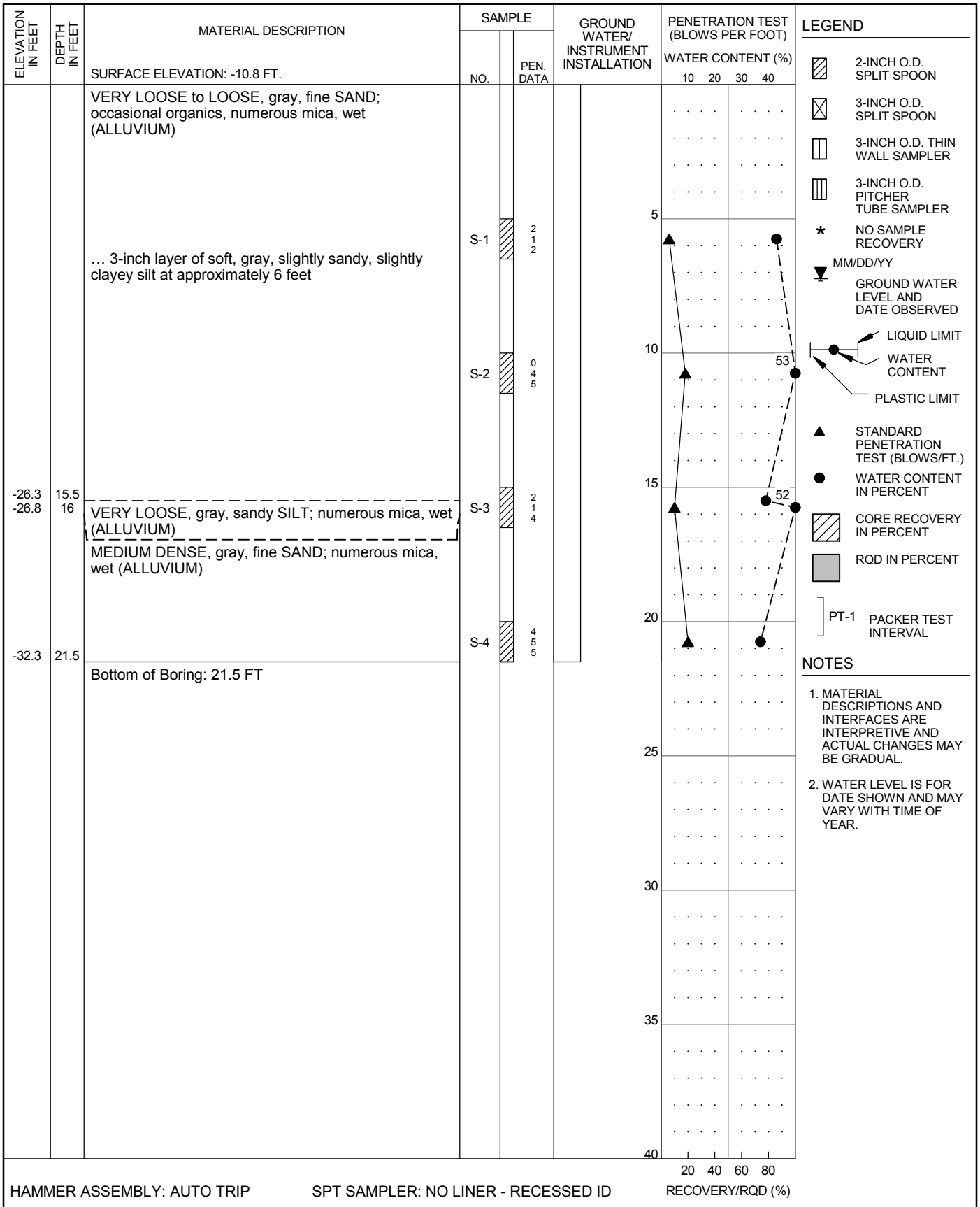
SUMMARY BORING LOG P2-CC-22 (2 of 2)

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014
PROJ 2320
FIG. A22



HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ
SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 3 7/8"

DRILLER: WESTERN STATES
DATE START: 5/15/2014 FINISH: 5/15/2014
DRILLING TECHNIQUE: MUD ROTARY

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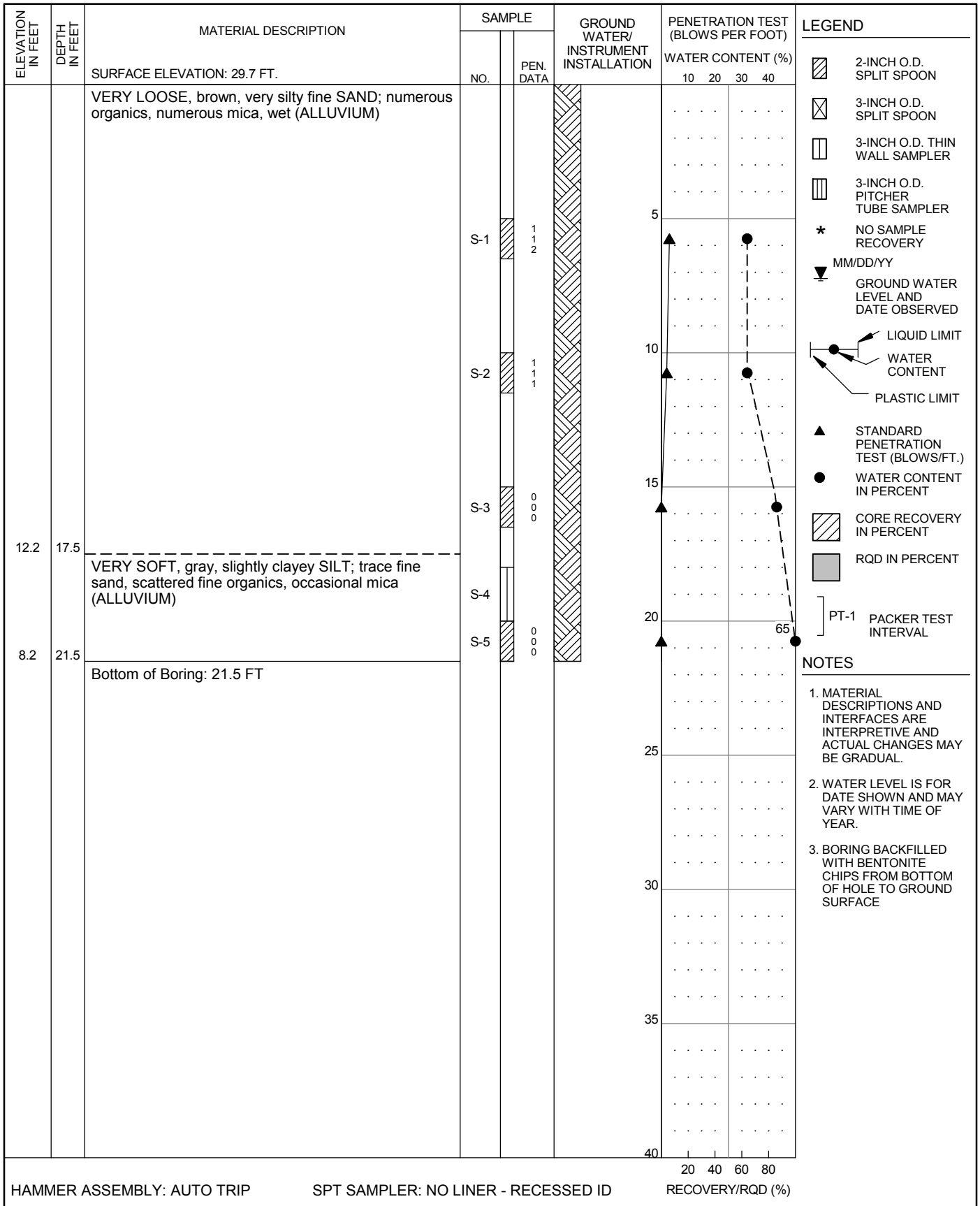
SUMMARY BORING LOG P2-CC-23

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014
PROJ 2320
FIG. A23



HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ
SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 3 7/8"

DRILLER: WESTERN STATES
DATE START: 4/14/2014 FINISH: 4/14/2014
DRILLING TECHNIQUE: MUD ROTARY

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SUMMARY BORING LOG P2-CC-24

PENINSULA DISTRICT 2 LEVEE
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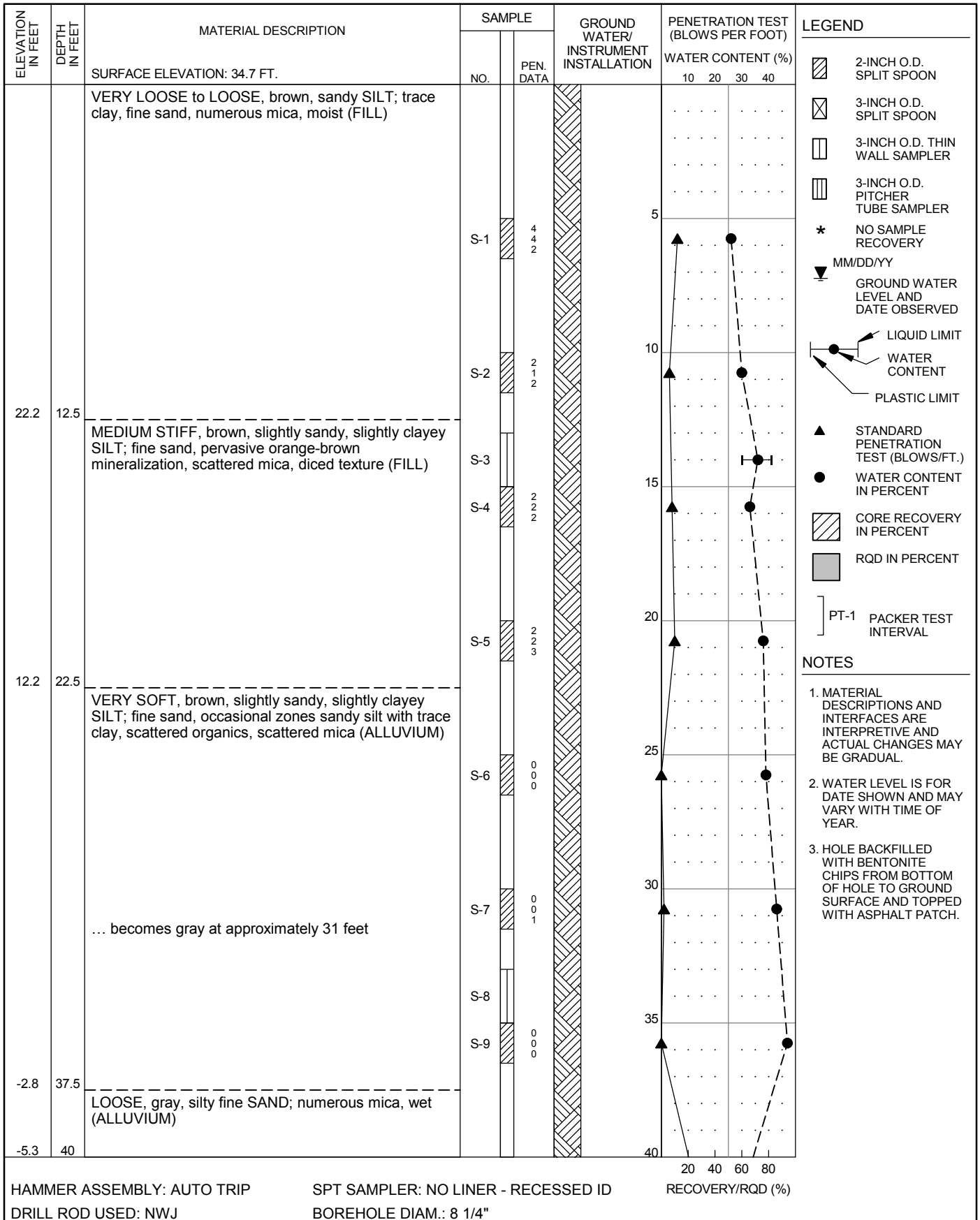
FIG. A24



HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 4/16/2014 FINISH: 4/16/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-25 (1 of 2)

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014
PROJ 2320
FIG. A25

ELEVATION IN FEET	DEPTH IN FEET	MATERIAL DESCRIPTION	SAMPLE NO.	SAMPLE PEN. DATA	GROUND WATER/ INSTRUMENT INSTALLATION
		SURFACE ELEVATION: 34.7 FT.			
-6.8	41.5	(continued from previous page)	S-10	6 6 6	
		Bottom of Boring: 41.5 FT			

PENETRATION TEST (BLOWS PER FOOT)

WATER CONTENT (%)

10 20 30 40

45 50 55 60 65 70 75 80

20 40 60 80

RECOVERY/RQD (%)

LEGEND

- 2-INCH O.D. SPLIT SPOON
- 3-INCH O.D. SPLIT SPOON
- 3-INCH O.D. THIN WALL SAMPLER
- 3-INCH O.D. PITCHER TUBE SAMPLER
- * NO SAMPLE RECOVERY
- MM/DD/YY GROUND WATER LEVEL AND DATE OBSERVED
- LIQUID LIMIT
- WATER CONTENT
- PLASTIC LIMIT
- STANDARD PENETRATION TEST (BLOWS/FT.)
- WATER CONTENT IN PERCENT
- CORE RECOVERY IN PERCENT
- RQD IN PERCENT
- PT-1 PACKER TEST INTERVAL

NOTES

1. MATERIAL DESCRIPTIONS AND INTERFACES ARE INTERPRETIVE AND ACTUAL CHANGES MAY BE GRADUAL.
2. WATER LEVEL IS FOR DATE SHOWN AND MAY VARY WITH TIME OF YEAR.
3. HOLE BACKFILLED WITH BENTONITE CHIPS FROM BOTTOM OF HOLE TO GROUND SURFACE AND TOPPED WITH ASPHALT PATCH.

HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ

SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 4/16/2014 FINISH: 4/16/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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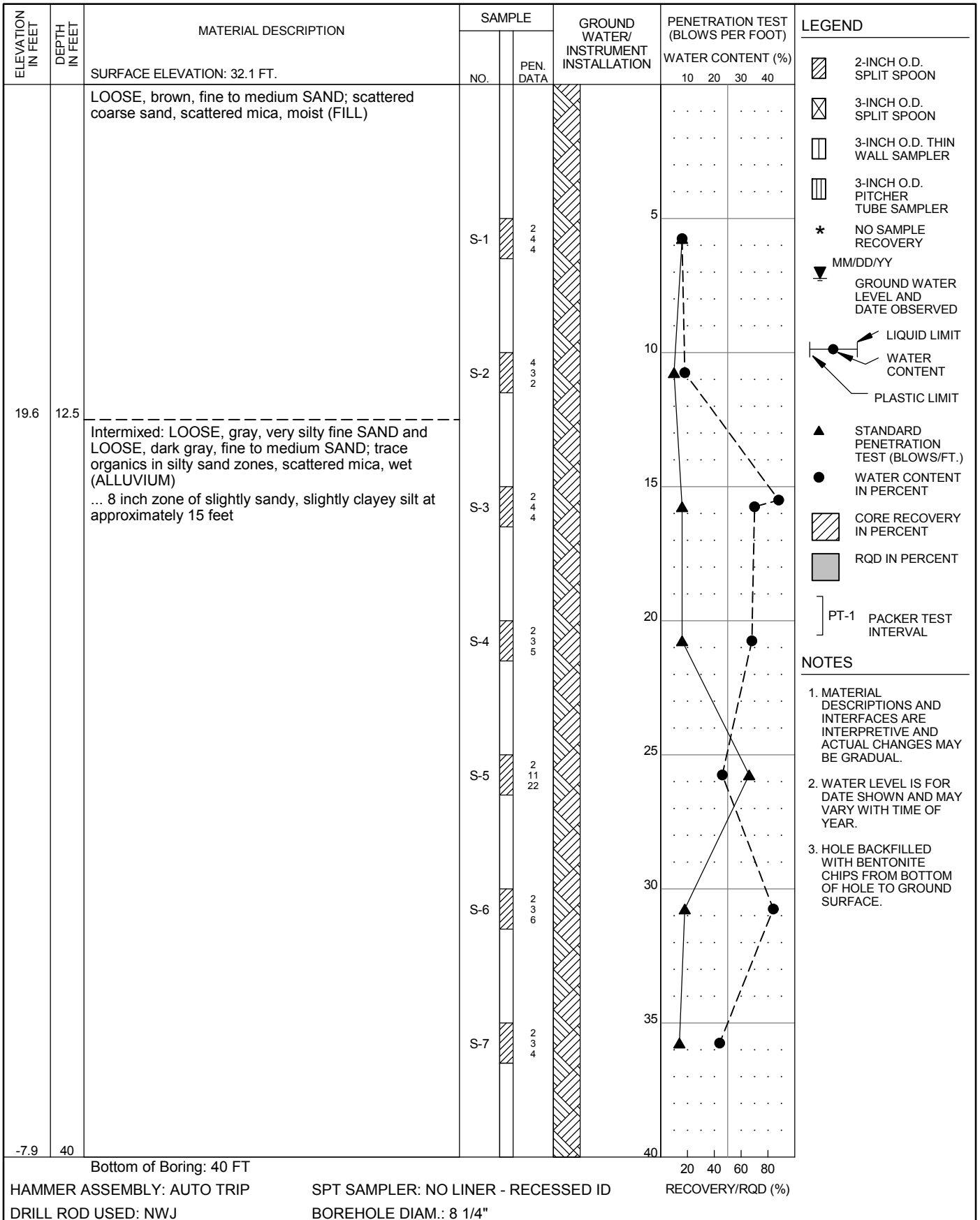
SUMMARY BORING LOG P2-CC-25 (2 of 2)

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014

PROJ 2320

FIG. A25



HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 4/3/2014 FINISH: 4/3/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-26

PENINSULA DISTRICT 2 LEVEE
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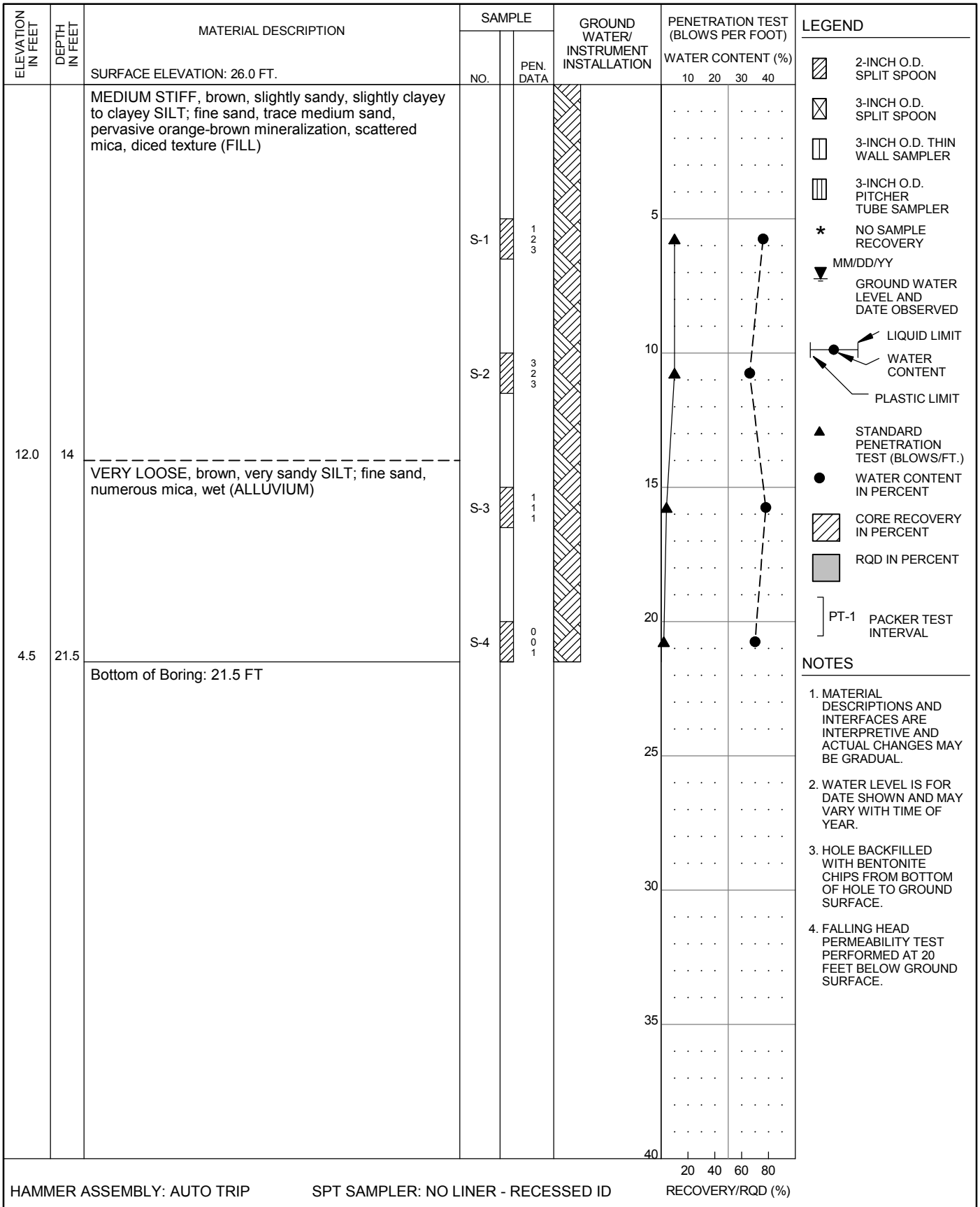
FIG. A26



HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 4/15/2014 FINISH: 4/15/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-27

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

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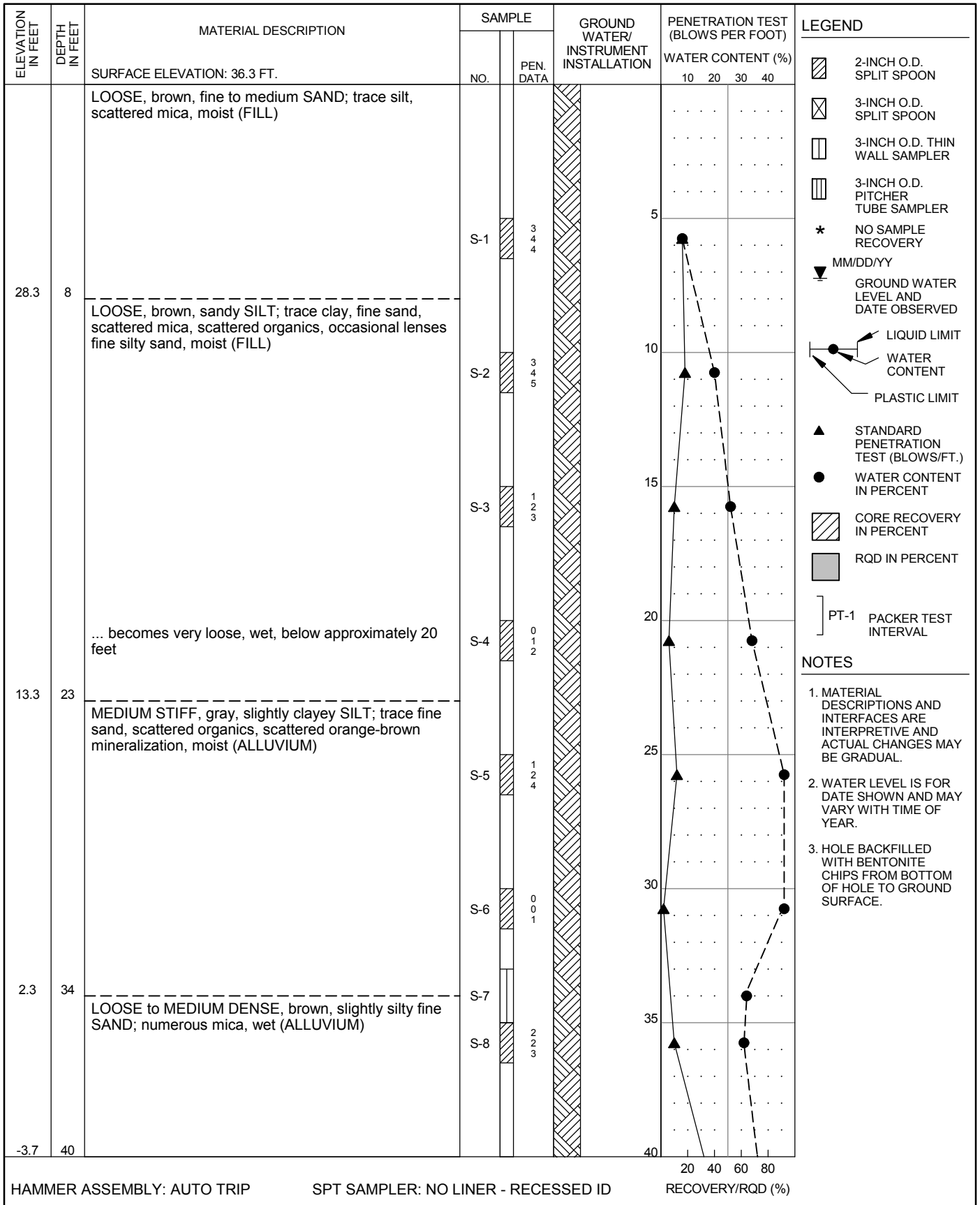
FIG. A27



HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 3/11/2014 FINISH: 3/11/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-28 (1 of 2)

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

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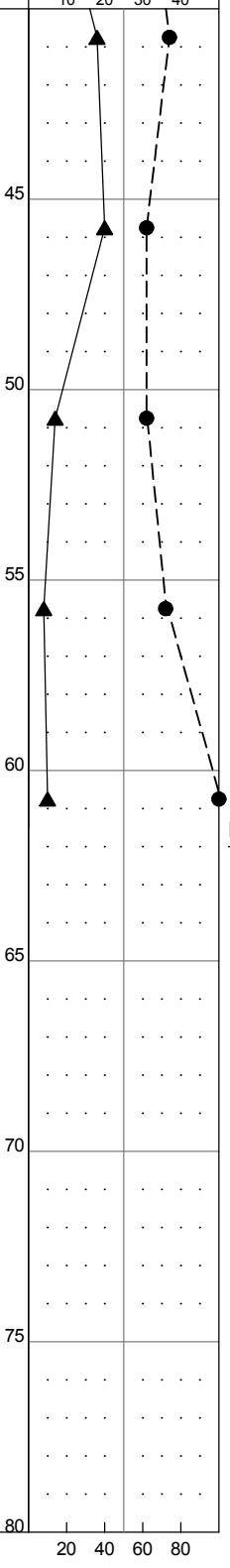
FIG. A28

ELEVATION IN FEET	DEPTH IN FEET	MATERIAL DESCRIPTION	SAMPLE NO.	SAMPLE PEN. DATA	GROUND WATER/ INSTRUMENT INSTALLATION
		SURFACE ELEVATION: 36.3 FT.			
		(continued from previous page)			
		… becomes gray below 40 feet	S-9	5 8 10	
		... becomes slightly silty below approximately 45 feet	S-10	6 9 11	
			S-11	3 3 4	
			S-12	3 1 3	
-23.7	60				
-25.2	61.5	MEDIUM STIFF, gray, slightly sandy, slightly clayey SILT; numerous mica, occasional fine organics (ALLUVIUM)	S-13	1 2 3	
		Bottom of Boring: 61.5 FT			



LEGEND

- 2-INCH O.D. SPLIT SPOON
- 3-INCH O.D. SPLIT SPOON
- 3-INCH O.D. THIN WALL SAMPLER
- 3-INCH O.D. PITCHER TUBE SAMPLER
- * NO SAMPLE RECOVERY
- MM/DD/YY GROUND WATER LEVEL AND DATE OBSERVED
- LIQUID LIMIT
- WATER CONTENT
- PLASTIC LIMIT
- STANDARD PENETRATION TEST (BLOWS/FT.)
- WATER CONTENT IN PERCENT
- CORE RECOVERY IN PERCENT
- RQD IN PERCENT
- PT-1 PACKER TEST INTERVAL

NOTES

1. MATERIAL DESCRIPTIONS AND INTERFACES ARE INTERPRETIVE AND ACTUAL CHANGES MAY BE GRADUAL.
2. WATER LEVEL IS FOR DATE SHOWN AND MAY VARY WITH TIME OF YEAR.
3. HOLE BACKFILLED WITH BENTONITE CHIPS FROM BOTTOM OF HOLE TO GROUND SURFACE.

HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ
SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 3/11/2014 FINISH: 3/11/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-28 (2 of 2)

PENINSULA DISTRICT 2 LEVEE
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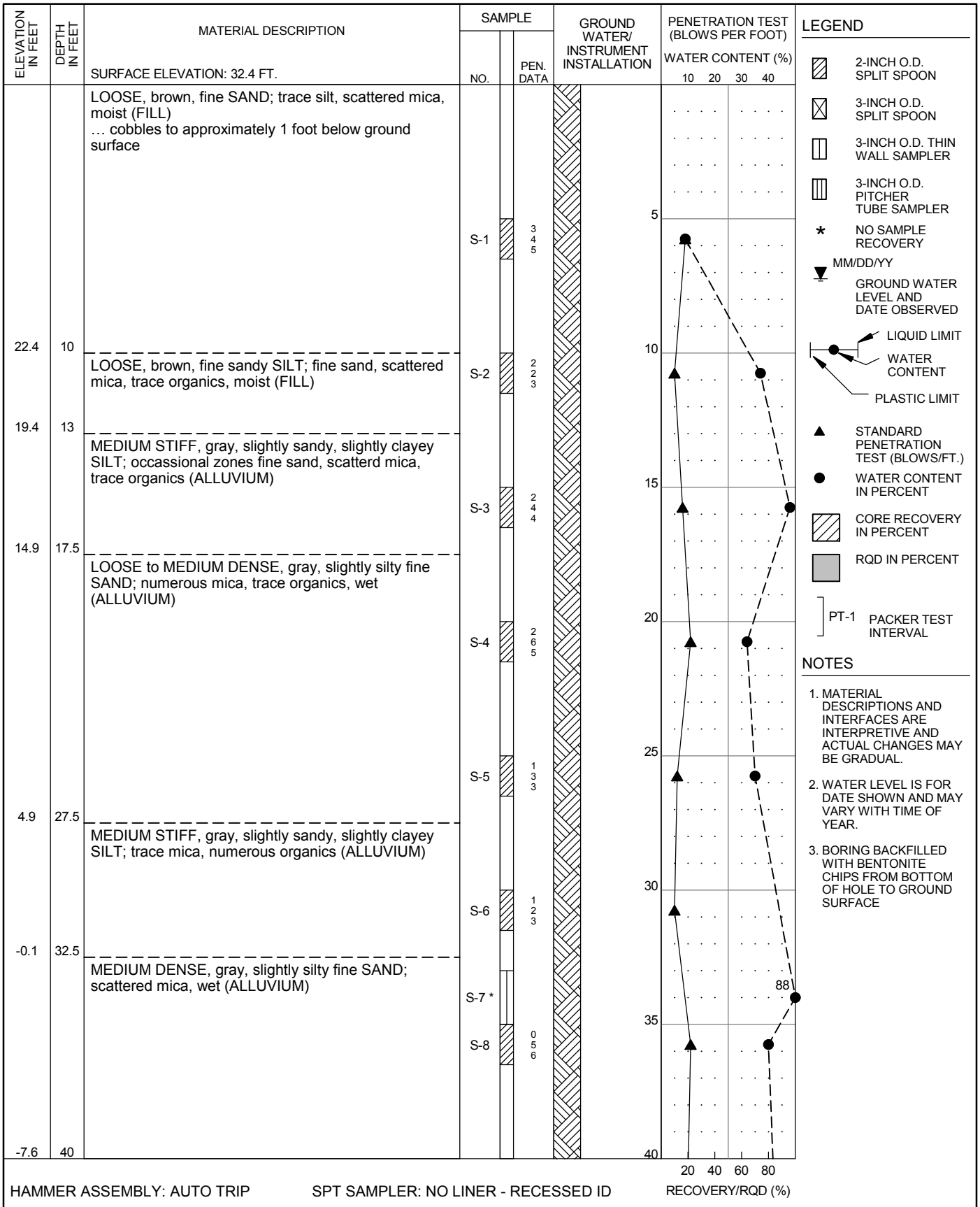
FIG. A28



NOTES

1. MATERIAL DESCRIPTIONS AND INTERFACES ARE INTERPRETIVE AND ACTUAL CHANGES MAY BE GRADUAL.
2. WATER LEVEL IS FOR DATE SHOWN AND MAY VARY WITH TIME OF YEAR.
3. BORING BACKFILLED WITH BENTONITE CHIPS FROM BOTTOM OF HOLE TO GROUND SURFACE

HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 3/12/2014 FINISH: 3/12/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-29 (1 of 2)

PENINSULA DISTRICT 2 LEVEE
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FIG. A29

ELEVATION IN FEET	DEPTH IN FEET	MATERIAL DESCRIPTION	SAMPLE NO.	SAMPLE PEN. DATA	GROUND WATER/ INSTRUMENT INSTALLATION	PENETRATION TEST (BLOWS PER FOOT) WATER CONTENT (%)
		SURFACE ELEVATION: 32.4 FT.				10 20 30 40
-9.1	41.5	(continued from previous page)	S-9	3 5 5		
		Bottom of Boring: 41.5 FT				

45 50 55 60 65 70 75 80

20 40 60 80
RECOVERY/RQD (%)

LEGEND

- 2-INCH O.D. SPLIT SPOON
- 3-INCH O.D. SPLIT SPOON
- 3-INCH O.D. THIN WALL SAMPLER
- 3-INCH O.D. PITCHER TUBE SAMPLER
- * NO SAMPLE RECOVERY
- MM/DD/YY GROUND WATER LEVEL AND DATE OBSERVED
- LIQUID LIMIT
- WATER CONTENT
- PLASTIC LIMIT
- STANDARD PENETRATION TEST (BLOWS/FT.)
- WATER CONTENT IN PERCENT
- CORE RECOVERY IN PERCENT
- RQD IN PERCENT
- PT-1 PACKER TEST INTERVAL

NOTES

1. MATERIAL DESCRIPTIONS AND INTERFACES ARE INTERPRETIVE AND ACTUAL CHANGES MAY BE GRADUAL.
2. WATER LEVEL IS FOR DATE SHOWN AND MAY VARY WITH TIME OF YEAR.
3. BORING BACKFILLED WITH BENTONITE CHIPS FROM BOTTOM OF HOLE TO GROUND SURFACE

HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ

SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 3/12/2014 FINISH: 3/12/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-29 (2 of 2)

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

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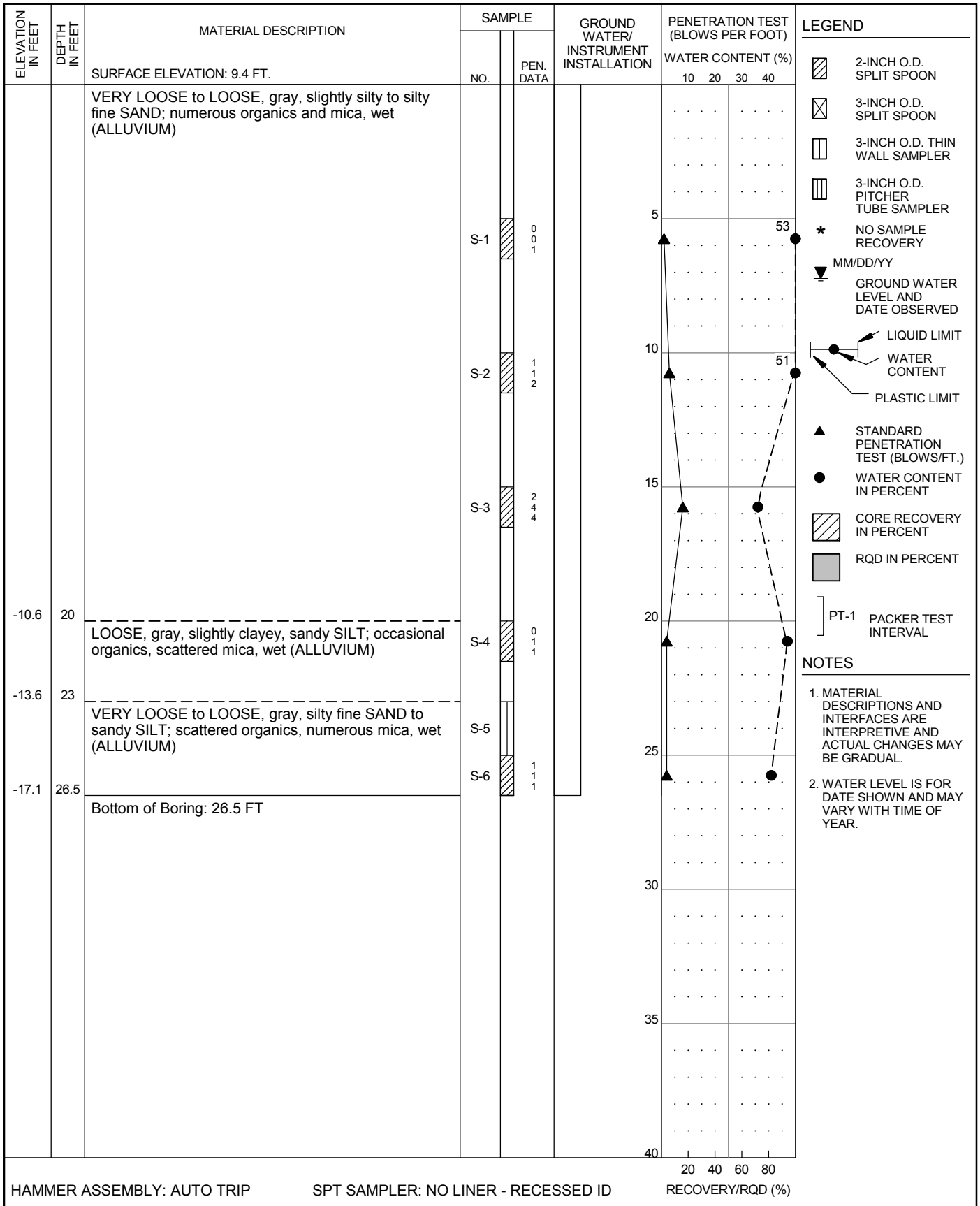
FIG. A29



HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 3 7/8"

DRILLER: WESTERN STATES
DATE START: 4/24/2014 FINISH: 4/24/2014
DRILLING TECHNIQUE: MUD ROTARY

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SUMMARY BORING LOG P2-CC-30

PENINSULA DISTRICT 2 LEVEE
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FIG. A30

ELEVATION IN FEET	DEPTH IN FEET	MATERIAL DESCRIPTION	SAMPLE NO.	SAMPLE PEN. DATA
		SURFACE ELEVATION: 42.8 FT.		
		VERY LOOSE to LOOSE, brown, slightly to very silty fine SAND; scattered to numerous mica, moist (FILL)	S-1	1 2 2
			S-2	1 1 2
27.0	15.8		S-3	1 2 3
		VERY SOFT to MEDIUM STIFF, mottled red-brown to gray, slightly clayey to clayey SILT; trace fine sand, occasional organics, occasional mica, moist (ALLUVIUM)	S-4	
			S-5	1 2 2
			S-6	2 3 5
			S-7	0 1 2
9.8	33			
		VERY LOOSE to LOOSE, mottled red-brown to brown, sandy SILT; trace clay, fine sand, occasional to scattered mica, moist to wet (ALLUVIUM)	S-8	0 0 0
			S-9 *	

GROUND WATER/ INSTRUMENT INSTALLATION

PENETRATION TEST (BLOWS PER FOOT)

WATER CONTENT (%)

10 20 30 40

5 10 15 20 25 30 35 40

20 40 60 80

RECOVERY/RQD (%)

LEGEND

- 2-INCH O.D. SPLIT SPOON
- 3-INCH O.D. SPLIT SPOON
- 3-INCH O.D. THIN WALL SAMPLER
- 3-INCH O.D. PITCHER TUBE SAMPLER
- * NO SAMPLE RECOVERY
- MM/DD/YY GROUND WATER LEVEL AND DATE OBSERVED
- LIQUID LIMIT
- WATER CONTENT
- PLASTIC LIMIT
- STANDARD PENETRATION TEST (BLOWS/FT.)
- WATER CONTENT IN PERCENT
- CORE RECOVERY IN PERCENT
- RQD IN PERCENT
- PT-1 PACKER TEST INTERVAL

NOTES

1. MATERIAL DESCRIPTIONS AND INTERFACES ARE INTERPRETIVE AND ACTUAL CHANGES MAY BE GRADUAL.
2. WATER LEVEL IS FOR DATE SHOWN AND MAY VARY WITH TIME OF YEAR.
3. BORING BACKFILLED WITH BENTONITE CHIPS FROM BOTTOM OF HOLE TO GROUND SURFACE

HAMMER ASSEMBLY: AUTO TRIP

SPT SAMPLER: NO LINER - RECESSED ID

DRILL ROD USED: NWJ

BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES

DATE START: 3/13/2014 FINISH: 3/13/2014

DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-31 (1 of 2)

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014

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FIG. A31

ELEVATION IN FEET	DEPTH IN FEET	MATERIAL DESCRIPTION	SAMPLE NO.	SAMPLE	SAMPLE PEN. DATA	GROUND WATER/ INSTRUMENT INSTALLATION	PENETRATION TEST (BLOWS PER FOOT) WATER CONTENT (%) 10 20 30 40
		SURFACE ELEVATION: 42.8 FT.					
1.3	41.5	(continued from previous page) ... sand content increases below approximately 40 feet	S-10		0 2 3		
		Bottom of Boring: 41.5 FT					

45
50
55
60
65
70
75
80

20 40 60 80
RECOVERY/RQD (%)

LEGEND

- 2-INCH O.D. SPLIT SPOON
- 3-INCH O.D. SPLIT SPOON
- 3-INCH O.D. THIN WALL SAMPLER
- 3-INCH O.D. PITCHER TUBE SAMPLER
- * NO SAMPLE RECOVERY
- MM/DD/YY GROUND WATER LEVEL AND DATE OBSERVED
- LIQUID LIMIT
- WATER CONTENT
- PLASTIC LIMIT
- STANDARD PENETRATION TEST (BLOWS/FT.)
- WATER CONTENT IN PERCENT
- CORE RECOVERY IN PERCENT
- RQD IN PERCENT
- PT-1 PACKER TEST INTERVAL

NOTES

1. MATERIAL DESCRIPTIONS AND INTERFACES ARE INTERPRETIVE AND ACTUAL CHANGES MAY BE GRADUAL.
2. WATER LEVEL IS FOR DATE SHOWN AND MAY VARY WITH TIME OF YEAR.
3. BORING BACKFILLED WITH BENTONITE CHIPS FROM BOTTOM OF HOLE TO GROUND SURFACE

HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ

SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 3/13/2014 FINISH: 3/13/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-31 (2 of 2)

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014

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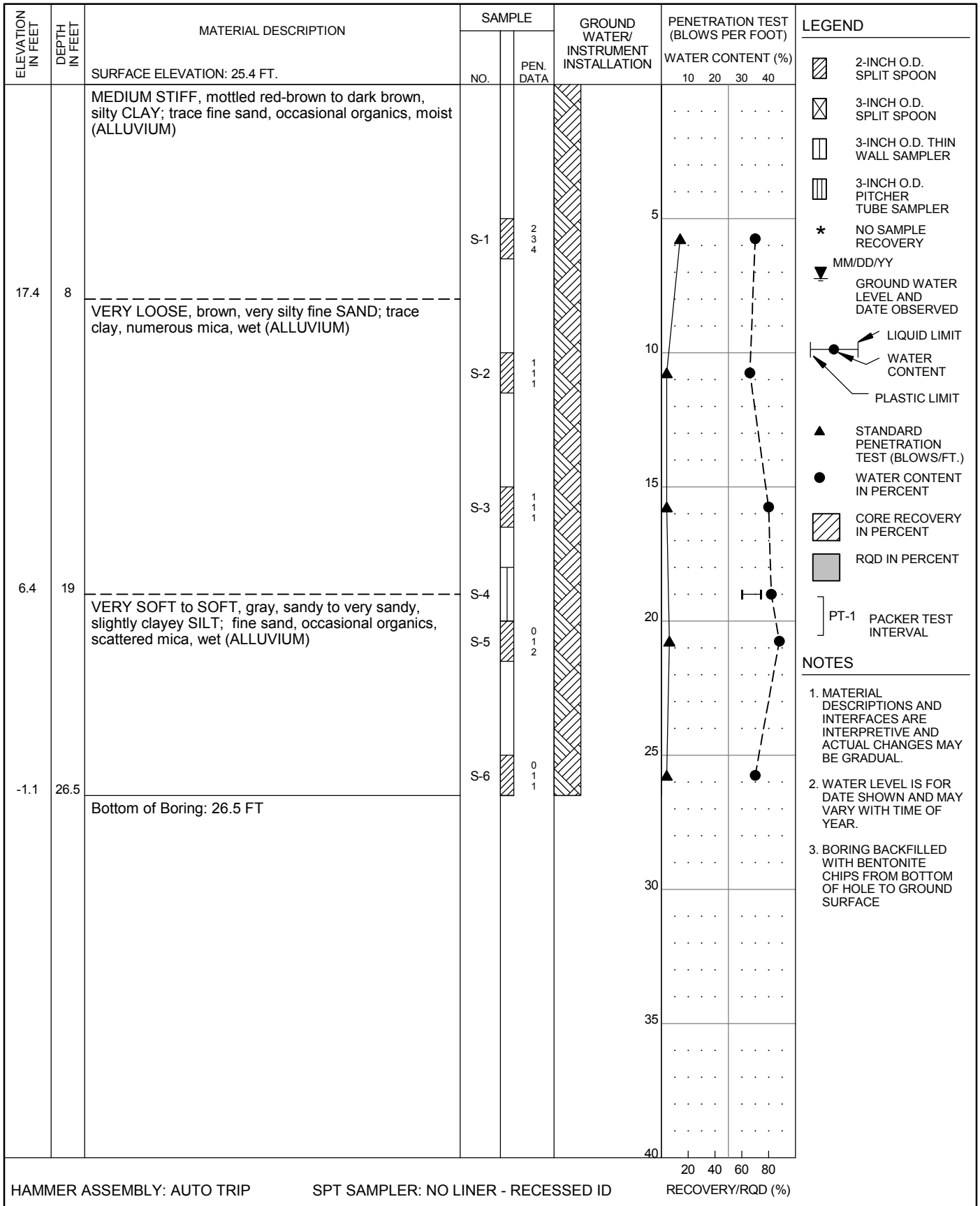
FIG. A31



HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 3/11/2014 FINISH: 3/11/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-32

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014

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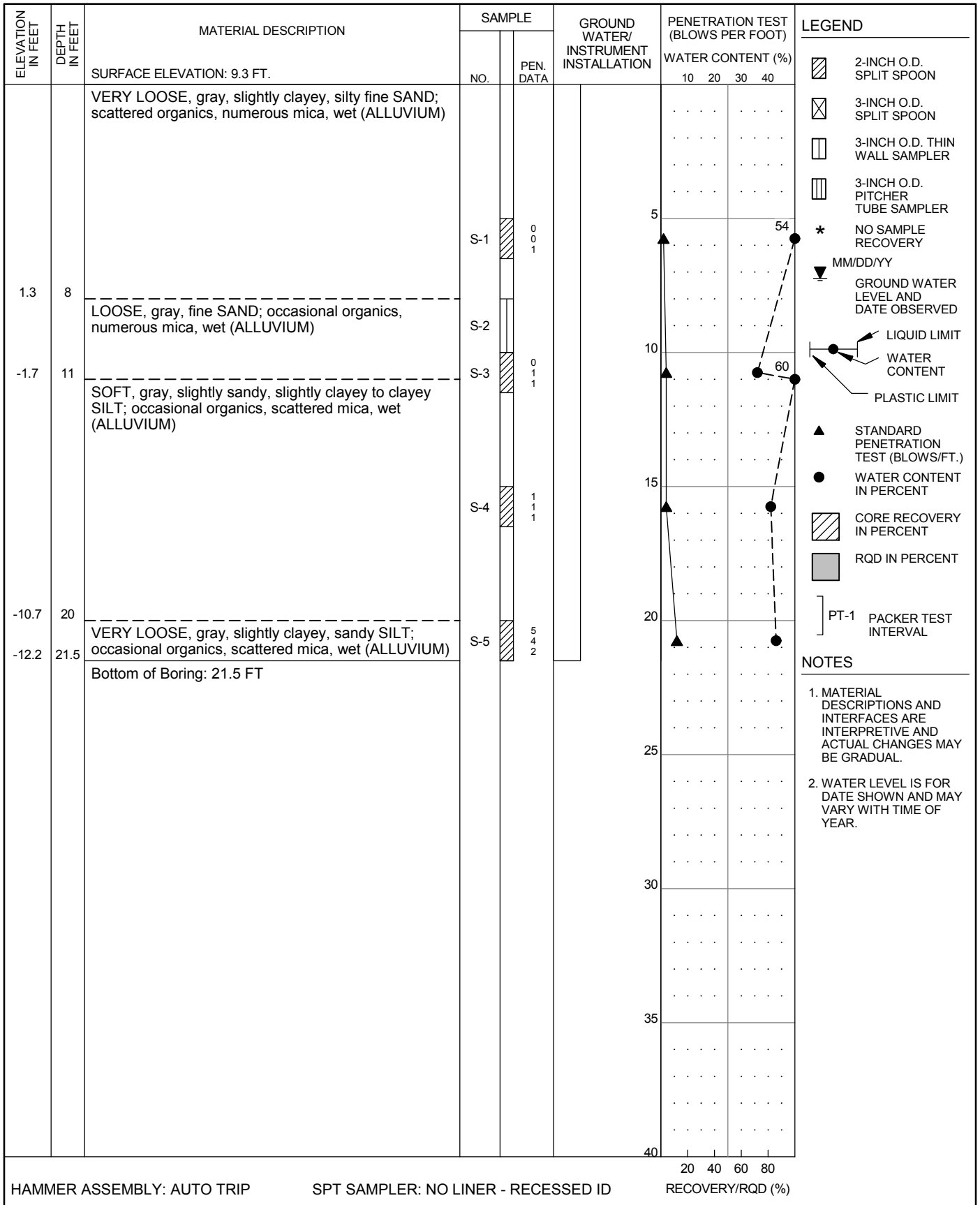
FIG. A32



HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ
SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 3 7/8"

DRILLER: WESTERN STATES
DATE START: 4/25/2014 FINISH: 4/25/2014
DRILLING TECHNIQUE: MUD ROTARY

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SUMMARY BORING LOG P2-CC-33

PENINSULA DISTRICT 2 LEVEE
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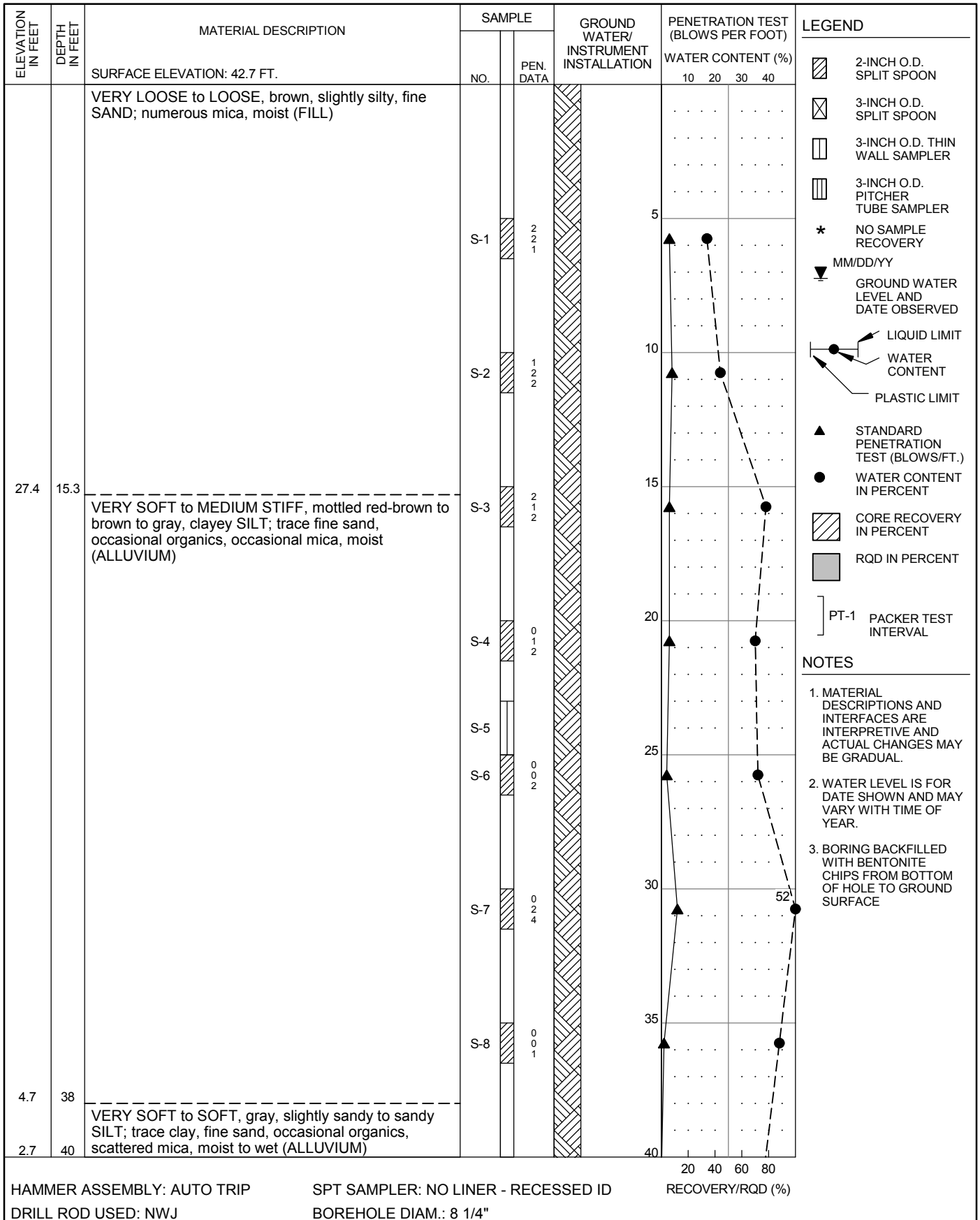
FIG. A33



HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 3/12/2014 FINISH: 3/12/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-34 (1 of 2)

PENINSULA DISTRICT 2 LEVEE
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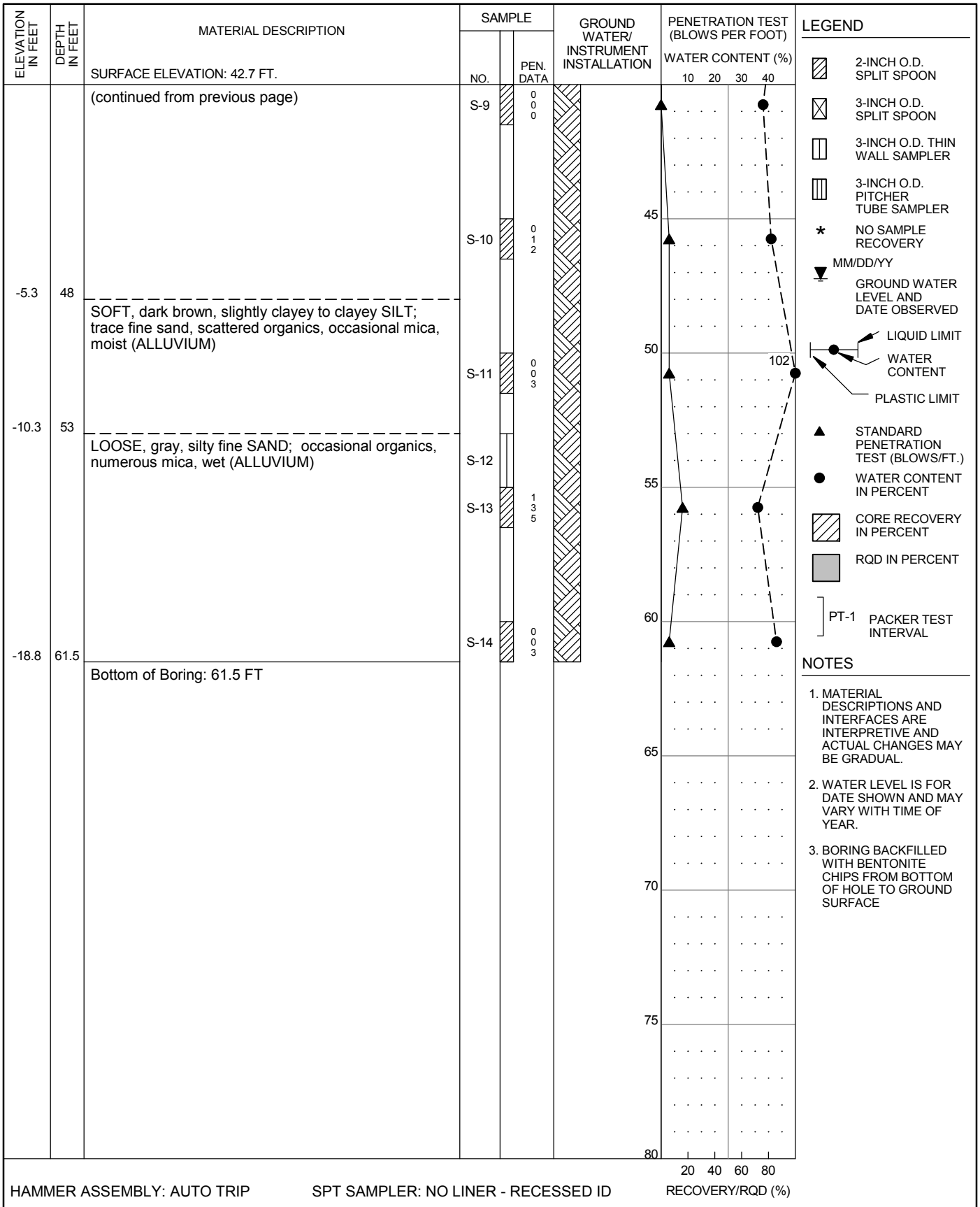
FIG. A34



HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 3/12/2014 FINISH: 3/12/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-34 (2 of 2)

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

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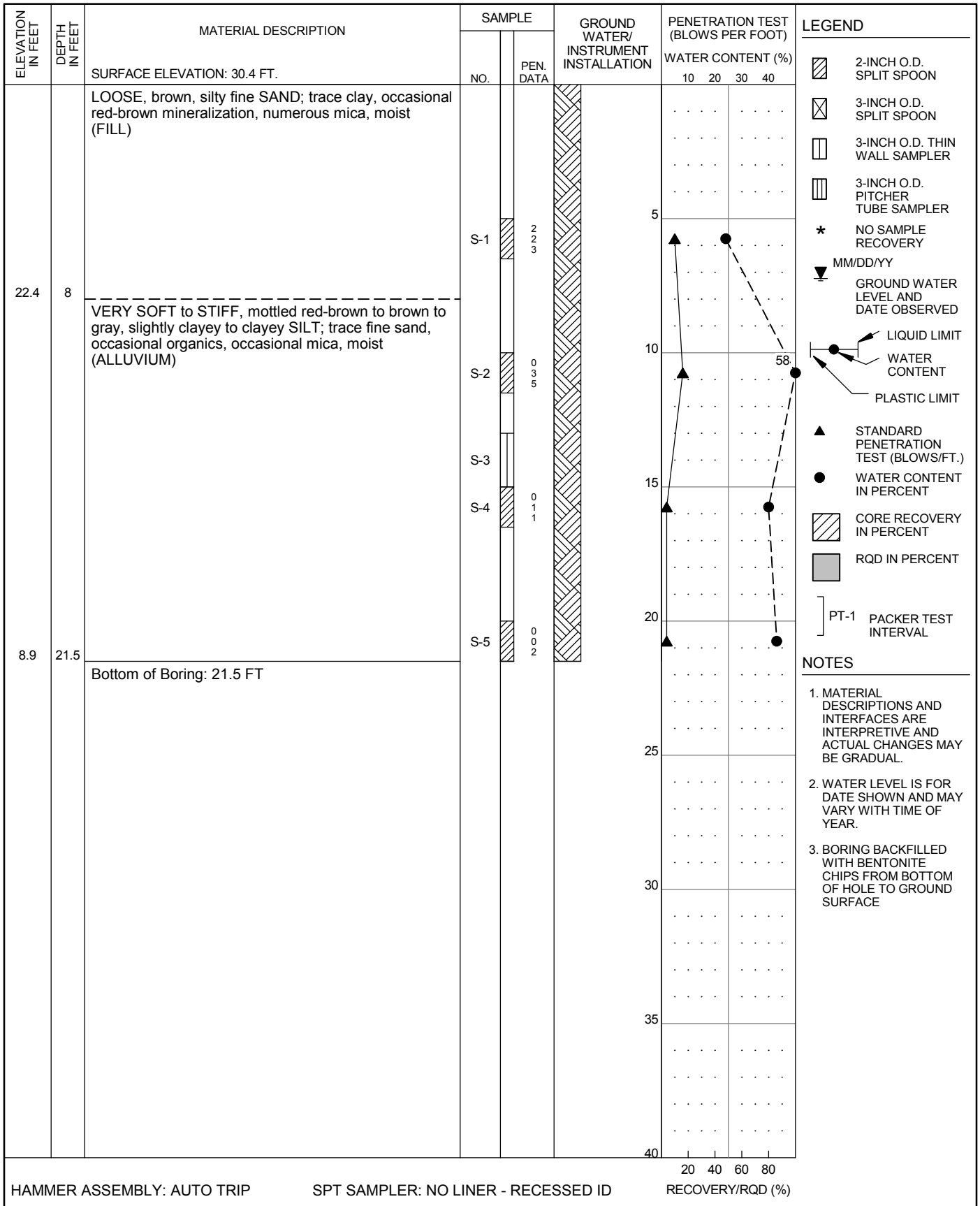
FIG. A34



HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 3/12/2014 FINISH: 3/12/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-35

PENINSULA DISTRICT 2 LEVEE
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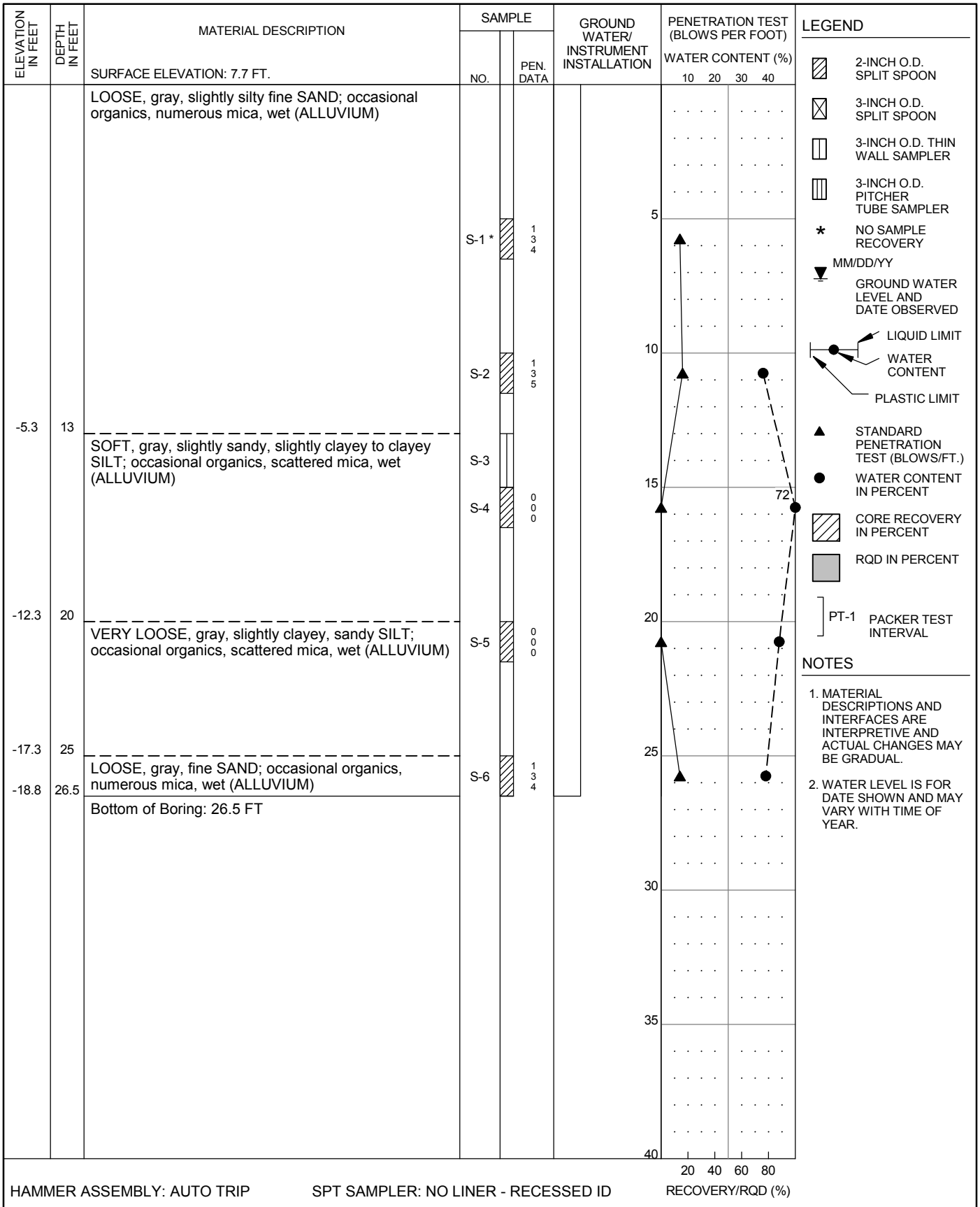
FIG. A35



HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ
SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 3 7/8"

DRILLER: WESTERN STATES
DATE START: 4/24/2014 FINISH: 4/24/2014
DRILLING TECHNIQUE: MUD ROTARY

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SUMMARY BORING LOG P2-CC-36

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

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FIG. A36

ELEVATION IN FEET	DEPTH IN FEET	MATERIAL DESCRIPTION	SAMPLE NO.	SAMPLE PEN. DATA
		SURFACE ELEVATION: 42.1 FT.		
		STIFF, brown, slightly clayey SILT; trace fine sand, occasional organics, occasional mica, diced texture, moist (FILL)	S-1	3 5 5
34.6	7.5			
		Intermixed: SOFT, brown, slightly clayey to clayey SILT; and VERY LOOSE, brown, silty fine SAND; scattered red-brown mineralization, occasional mica, moist (FILL)	S-2	1 1 1
			S-3	1 2 2
			S-4	
			S-5	0 0 0
19.6	22.5			
		SOFT, brown to gray, slightly clayey SILT; trace fine sand, scattered red-brown mottling, occasional lenses silty fine sand up to 6" thick, occasional mica, moist (ALLUVIUM)	S-6	0 2 3
			S-7	
			S-8	0 1 2
			S-9	0 1 2
2.1	40			

GROUND WATER/ INSTRUMENT INSTALLATION

PENETRATION TEST (BLOWS PER FOOT)

WATER CONTENT (%)

10 20 30 40

5 10 15 20 25 30 35 40

20 40 60 80

RECOVERY/RQD (%)

LEGEND

- 2-INCH O.D. SPLIT SPOON
- 3-INCH O.D. SPLIT SPOON
- 3-INCH O.D. THIN WALL SAMPLER
- 3-INCH O.D. PITCHER TUBE SAMPLER
- * NO SAMPLE RECOVERY
- MM/DD/YY GROUND WATER LEVEL AND DATE OBSERVED
- LIQUID LIMIT
- WATER CONTENT
- PLASTIC LIMIT
- STANDARD PENETRATION TEST (BLOWS/FT.)
- WATER CONTENT IN PERCENT
- CORE RECOVERY IN PERCENT
- RQD IN PERCENT
- PT-1 PACKER TEST INTERVAL

NOTES

1. MATERIAL DESCRIPTIONS AND INTERFACES ARE INTERPRETIVE AND ACTUAL CHANGES MAY BE GRADUAL.
2. WATER LEVEL IS FOR DATE SHOWN AND MAY VARY WITH TIME OF YEAR.
3. BORING BACKFILLED WITH BENTONITE CHIPS FROM BOTTOM OF HOLE TO GROUND SURFACE

HAMMER ASSEMBLY: AUTO TRIP

SPT SAMPLER: NO LINER - RECESSED ID

DRILL ROD USED: NWJ

BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES

DATE START: 3/11/2014 FINISH: 3/11/2014

DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-37 (1 of 2)

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014

PROJ 2320

FIG. A37

ELEVATION IN FEET	DEPTH IN FEET	MATERIAL DESCRIPTION	SAMPLE NO.	SAMPLE PEN. DATA	GROUND WATER/ INSTRUMENT INSTALLATION	PENETRATION TEST (BLOWS PER FOOT) WATER CONTENT (%)
		SURFACE ELEVATION: 42.1 FT.				10 20 30 40
		(continued from previous page)				
0.6	41.5	... 6" thick lens of gray fine sand at approximately 41 feet	S-10	1 2 7		
		Bottom of Boring: 41.5 FT				

45 50 55 60 65 70 75 80

20 40 60 80
RECOVERY/RQD (%)

LEGEND

- 2-INCH O.D. SPLIT SPOON
- 3-INCH O.D. SPLIT SPOON
- 3-INCH O.D. THIN WALL SAMPLER
- 3-INCH O.D. PITCHER TUBE SAMPLER
- * NO SAMPLE RECOVERY
- MM/DD/YY GROUND WATER LEVEL AND DATE OBSERVED
- LIQUID LIMIT
- WATER CONTENT
- PLASTIC LIMIT
- STANDARD PENETRATION TEST (BLOWS/FT.)
- WATER CONTENT IN PERCENT
- CORE RECOVERY IN PERCENT
- RQD IN PERCENT
- PT-1 PACKER TEST INTERVAL

NOTES

1. MATERIAL DESCRIPTIONS AND INTERFACES ARE INTERPRETIVE AND ACTUAL CHANGES MAY BE GRADUAL.
2. WATER LEVEL IS FOR DATE SHOWN AND MAY VARY WITH TIME OF YEAR.
3. BORING BACKFILLED WITH BENTONITE CHIPS FROM BOTTOM OF HOLE TO GROUND SURFACE

HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ
SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 3/11/2014 FINISH: 3/11/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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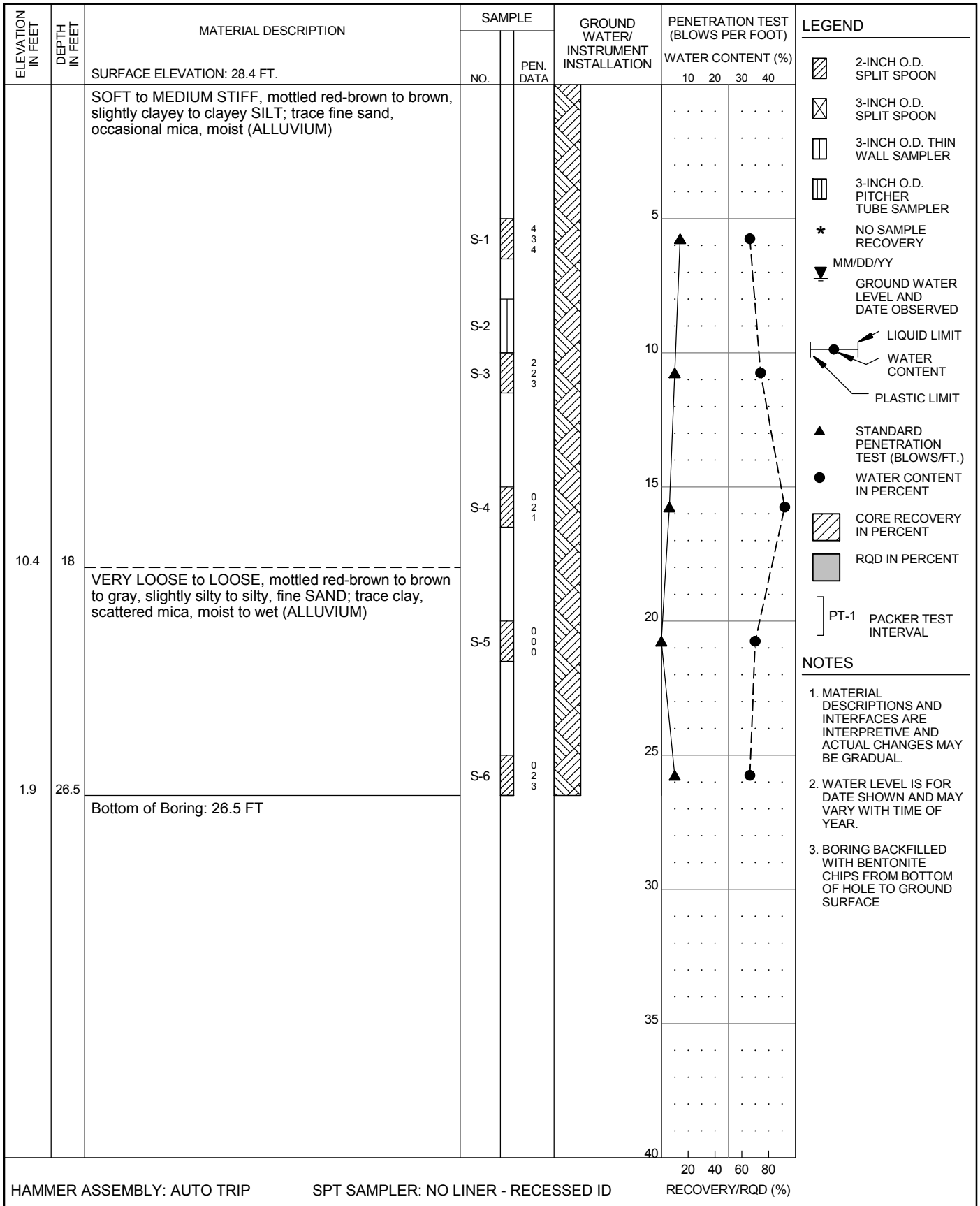
SUMMARY BORING LOG P2-CC-37 (2 of 2)

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014
PROJ 2320
FIG. A37



HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 3/11/2014 FINISH: 3/11/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-38

PENINSULA DISTRICT 2 LEVEE
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FIG. A38

ELEVATION IN FEET	DEPTH IN FEET	MATERIAL DESCRIPTION	SAMPLE NO.	SAMPLE PEN. DATA
		SURFACE ELEVATION: 5.3 FT.		
		VERY LOOSE to LOOSE, gray, slightly silty to silty fine SAND; occasional organics, numerous mica, wet (ALLUVIUM)	S-1	1 1 1
			S-2	1 2 3
-9.7	15			
		LOOSE, gray, slightly clayey, sandy SILT; occasional organics, scattered mica, wet (ALLUVIUM)	S-3	2 3 4
-12.7	18			
		VERY LOOSE, gray, fine SAND; occasional organics, numerous mica, wet (ALLUVIUM)	S-4	
			S-5	0 1 2
-16.2	21.5			
		Bottom of Boring: 21.5 FT		

GROUND WATER/ INSTRUMENT INSTALLATION

PENETRATION TEST (BLOWS PER FOOT)

WATER CONTENT (%)

10 20 30 40

5 10 15 20 25 30 35 40

20 40 60 80

RECOVERY/RQD (%)

LEGEND

- 2-INCH O.D. SPLIT SPOON
- 3-INCH O.D. SPLIT SPOON
- 3-INCH O.D. THIN WALL SAMPLER
- 3-INCH O.D. PITCHER TUBE SAMPLER
- * NO SAMPLE RECOVERY
- MM/DD/YY GROUND WATER LEVEL AND DATE OBSERVED
- LIQUID LIMIT
- WATER CONTENT
- PLASTIC LIMIT
- STANDARD PENETRATION TEST (BLOWS/FT.)
- WATER CONTENT IN PERCENT
- CORE RECOVERY IN PERCENT
- RQD IN PERCENT
- PT-1 PACKER TEST INTERVAL

NOTES

1. MATERIAL DESCRIPTIONS AND INTERFACES ARE INTERPRETIVE AND ACTUAL CHANGES MAY BE GRADUAL.
2. WATER LEVEL IS FOR DATE SHOWN AND MAY VARY WITH TIME OF YEAR.

HAMMER ASSEMBLY: AUTO TRIP

DRILL ROD USED: NWJ

SPT SAMPLER: NO LINER - RECESSED ID

BOREHOLE DIAM.: 3 7/8"

DRILLER: WESTERN STATES

DATE START: 4/23/2014 FINISH: 4/23/2014

DRILLING TECHNIQUE: MUD ROTARY

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SUMMARY BORING LOG P2-CC-39

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014

PROJ 2320

FIG. A39

ELEVATION IN FEET	DEPTH IN FEET	MATERIAL DESCRIPTION	SAMPLE NO.	SAMPLE PEN. DATA
		SURFACE ELEVATION: 43.2 FT.		
		SOFT to MEDIUM STIFF, red-brown to brown, sandy, slightly clayey to clayey SILT; occasional organics, occasional mica, moist (FILL)	S-1	1 2 2
			S-2	0 1 2
			S-3	
27.4	15.8		S-4	1 2 2
		SOFT, gray, silty CLAY; trace fine sand, scattered organics, trace mica, moist (ALLUVIUM)		
25.2	18			
		VERY LOOSE to LOOSE, mottled red-brown to brown to gray, trace to slightly clayey, slightly sandy to very sandy SILT; fine sand, occasional organics, scattered mica, moist to wet (ALLUVIUM)	S-5	1 2 2
			S-6	1 2 2
			S-7	0 1 1
			S-8	
			S-9	1 2 2
5.2	38			
		VERY LOOSE, gray, slightly silty to silty, fine SAND; scattered mica, occasional organics, wet (ALLUVIUM)		
3.2	40			

GROUND WATER/ INSTRUMENT INSTALLATION

PENETRATION TEST (BLOWS PER FOOT)

WATER CONTENT (%)

10 20 30 40

5 10 15 20 25 30 35 40

20 40 60 80

RECOVERY/RQD (%)

LEGEND

- 2-INCH O.D. SPLIT SPOON
- 3-INCH O.D. SPLIT SPOON
- 3-INCH O.D. THIN WALL SAMPLER
- 3-INCH O.D. PITCHER TUBE SAMPLER
- * NO SAMPLE RECOVERY
- MM/DD/YY GROUND WATER LEVEL AND DATE OBSERVED
- LIQUID LIMIT
- WATER CONTENT
- PLASTIC LIMIT
- STANDARD PENETRATION TEST (BLOWS/FT.)
- WATER CONTENT IN PERCENT
- CORE RECOVERY IN PERCENT
- RQD IN PERCENT
- PT-1 PACKER TEST INTERVAL

NOTES

1. MATERIAL DESCRIPTIONS AND INTERFACES ARE INTERPRETIVE AND ACTUAL CHANGES MAY BE GRADUAL.
2. WATER LEVEL IS FOR DATE SHOWN AND MAY VARY WITH TIME OF YEAR.
3. BORING BACKFILLED WITH BENTONITE CHIPS FROM BOTTOM OF HOLE TO GROUND SURFACE

HAMMER ASSEMBLY: AUTO TRIP

SPT SAMPLER: NO LINER - RECESSED ID

DRILL ROD USED: NWJ

BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES

DATE START: 3/10/2014 FINISH: 3/10/2014

DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-40 (1 of 2)

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014

PROJ 2320

FIG. A40

ELEVATION IN FEET	DEPTH IN FEET	MATERIAL DESCRIPTION	SAMPLE NO.	SAMPLE PEN. DATA	GROUND WATER/ INSTRUMENT INSTALLATION
		SURFACE ELEVATION: 43.2 FT.			
1.7	41.5	(continued from previous page)	S-10	1 1 1	
		Bottom of Boring: 41.5 FT			

PENETRATION TEST (BLOWS PER FOOT)

WATER CONTENT (%)

10 20 30 40

45 50 55 60 65 70 75 80

20 40 60 80

RECOVERY/RQD (%)

LEGEND

- 2-INCH O.D. SPLIT SPOON
- 3-INCH O.D. SPLIT SPOON
- 3-INCH O.D. THIN WALL SAMPLER
- 3-INCH O.D. PITCHER TUBE SAMPLER
- * NO SAMPLE RECOVERY
- MM/DD/YY GROUND WATER LEVEL AND DATE OBSERVED
- LIQUID LIMIT
- WATER CONTENT
- PLASTIC LIMIT
- STANDARD PENETRATION TEST (BLOWS/FT.)
- WATER CONTENT IN PERCENT
- CORE RECOVERY IN PERCENT
- RQD IN PERCENT
- PT-1 PACKER TEST INTERVAL

NOTES

1. MATERIAL DESCRIPTIONS AND INTERFACES ARE INTERPRETIVE AND ACTUAL CHANGES MAY BE GRADUAL.
2. WATER LEVEL IS FOR DATE SHOWN AND MAY VARY WITH TIME OF YEAR.
3. BORING BACKFILLED WITH BENTONITE CHIPS FROM BOTTOM OF HOLE TO GROUND SURFACE

HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ

SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 3/10/2014 FINISH: 3/10/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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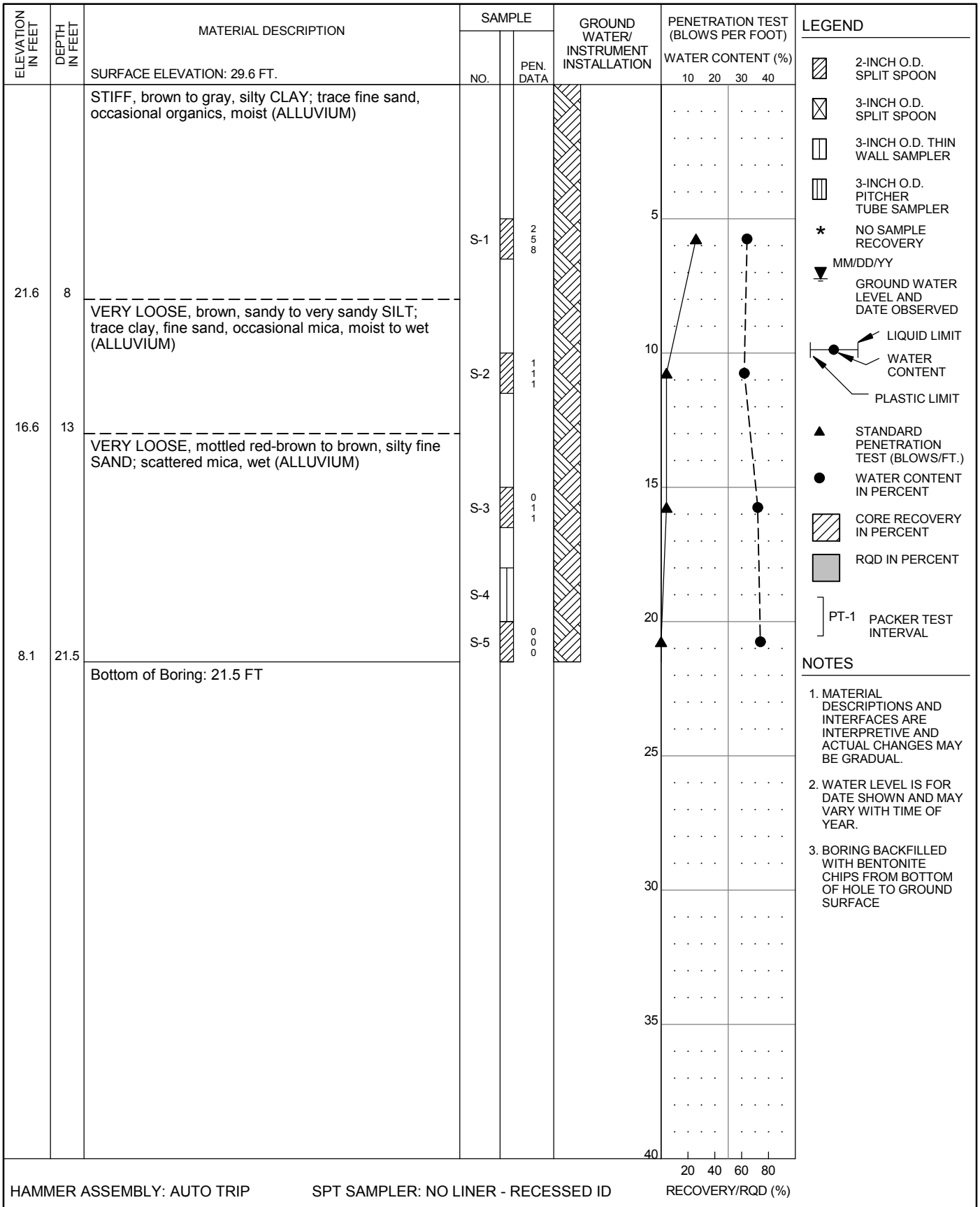
SUMMARY BORING LOG P2-CC-40 (2 of 2)

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014

PROJ 2320

FIG. A40



NOTES

1. MATERIAL DESCRIPTIONS AND INTERFACES ARE INTERPRETIVE AND ACTUAL CHANGES MAY BE GRADUAL.
2. WATER LEVEL IS FOR DATE SHOWN AND MAY VARY WITH TIME OF YEAR.
3. BORING BACKFILLED WITH BENTONITE CHIPS FROM BOTTOM OF HOLE TO GROUND SURFACE

HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 3/10/2014 FINISH: 3/10/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-41

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

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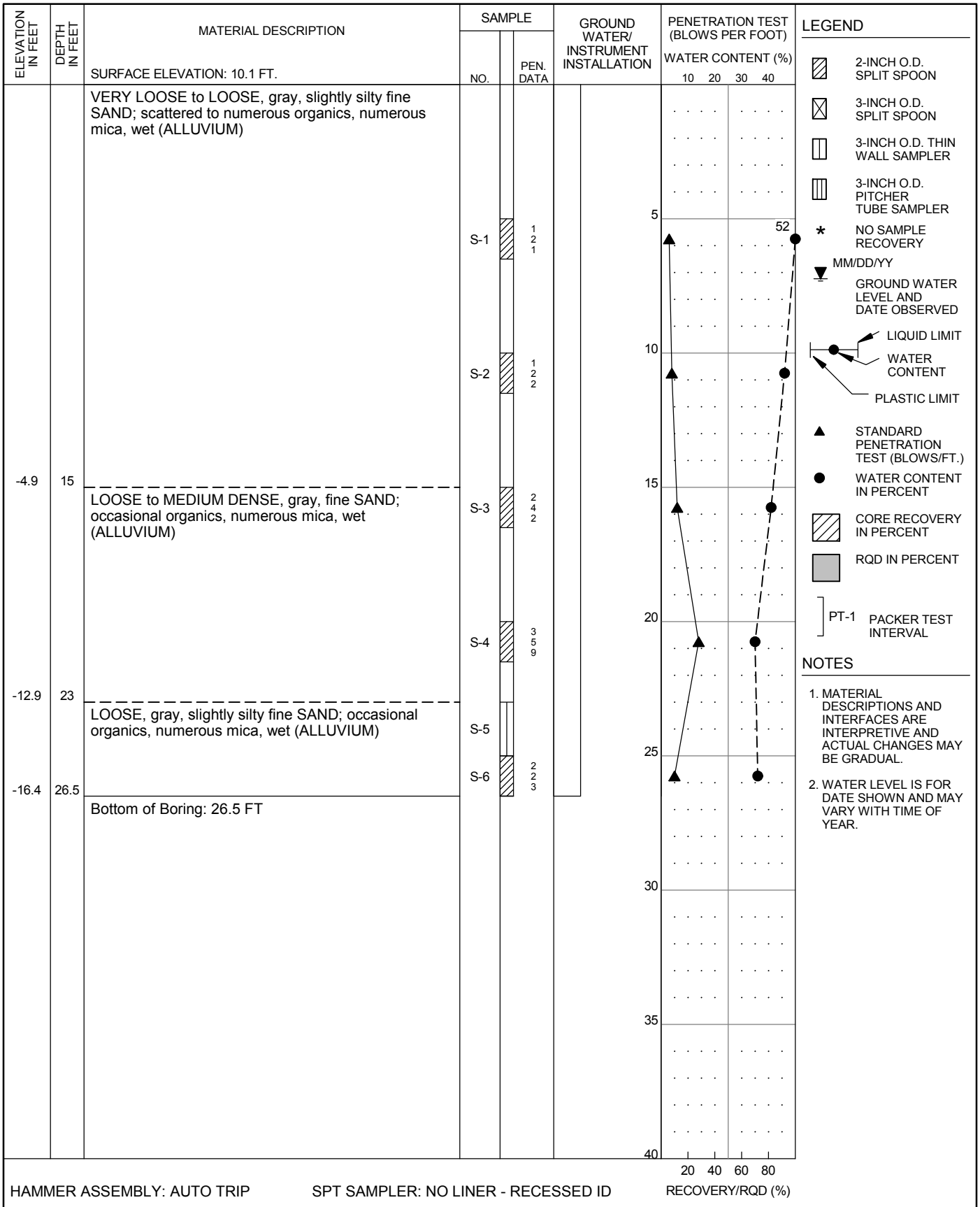
FIG. A41



HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 3 7/8"

DRILLER: WESTERN STATES
DATE START: 4/23/2014 FINISH: 4/23/2014
DRILLING TECHNIQUE: MUD ROTARY

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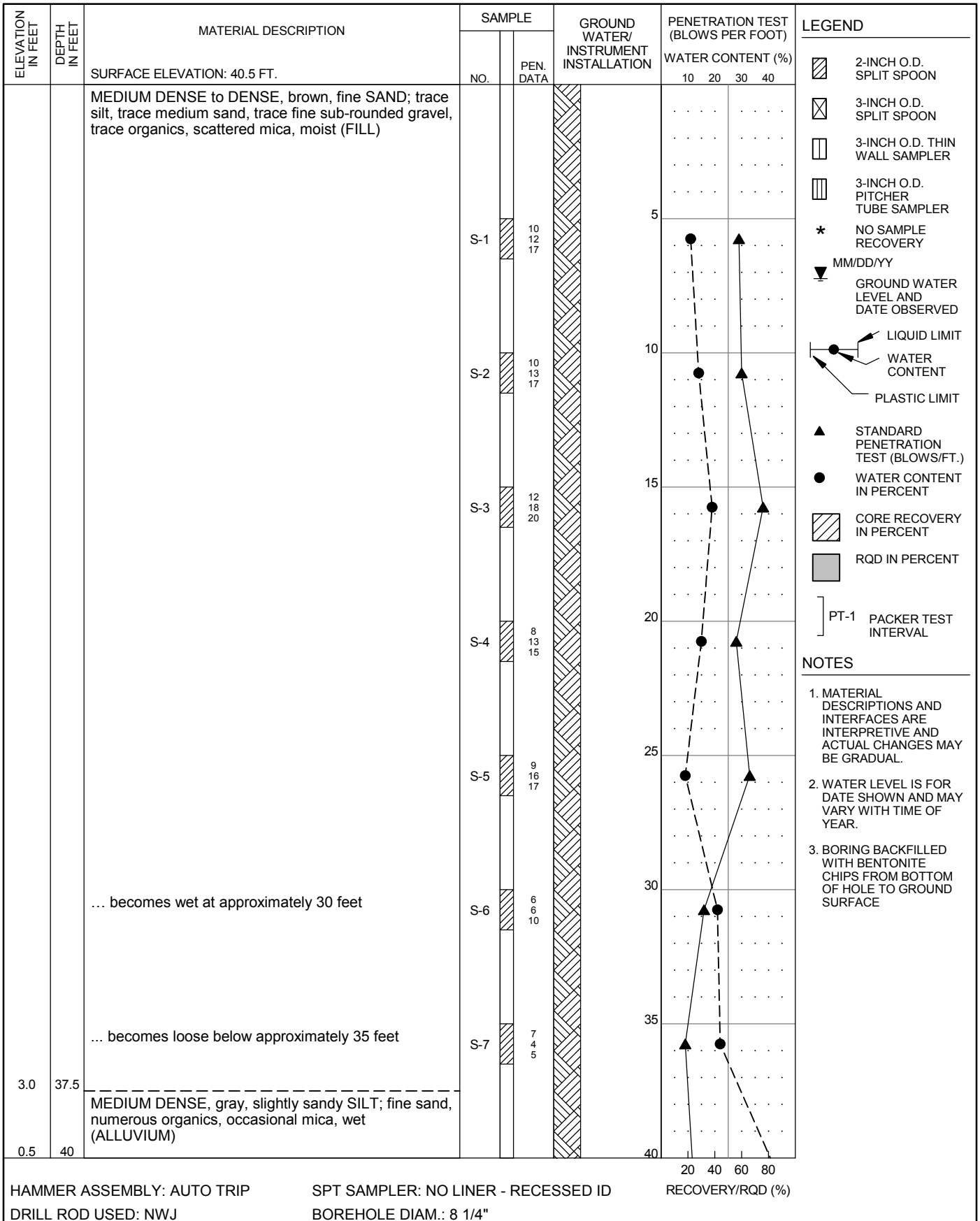
SUMMARY BORING LOG P2-CC-42

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014
PROJ 2320
FIG. A42



HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 3/10/2014 FINISH: 3/10/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-43 (1 of 2)

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014
PROJ 2320
FIG. A43

ELEVATION IN FEET	DEPTH IN FEET	MATERIAL DESCRIPTION	SAMPLE NO.	SAMPLE PEN. DATA	GROUND WATER/ INSTRUMENT INSTALLATION
		SURFACE ELEVATION: 40.5 FT.			
-1.0	41.5	(continued from previous page)	S-8	5 5 7	
		Bottom of Boring: 41.5 FT			

PENETRATION TEST (BLOWS PER FOOT)
WATER CONTENT (%)
10 20 30 40

45 50 55 60 65 70 75 80

20 40 60 80
RECOVERY/RQD (%)

LEGEND

- 2-INCH O.D. SPLIT SPOON
- 3-INCH O.D. SPLIT SPOON
- 3-INCH O.D. THIN WALL SAMPLER
- 3-INCH O.D. PITCHER TUBE SAMPLER
- * NO SAMPLE RECOVERY
- MM/DD/YY GROUND WATER LEVEL AND DATE OBSERVED
- LIQUID LIMIT
- WATER CONTENT
- PLASTIC LIMIT
- STANDARD PENETRATION TEST (BLOWS/FT.)
- WATER CONTENT IN PERCENT
- CORE RECOVERY IN PERCENT
- RQD IN PERCENT
- PT-1 PACKER TEST INTERVAL

NOTES

1. MATERIAL DESCRIPTIONS AND INTERFACES ARE INTERPRETIVE AND ACTUAL CHANGES MAY BE GRADUAL.
2. WATER LEVEL IS FOR DATE SHOWN AND MAY VARY WITH TIME OF YEAR.
3. BORING BACKFILLED WITH BENTONITE CHIPS FROM BOTTOM OF HOLE TO GROUND SURFACE

HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ
SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 3/10/2014 FINISH: 3/10/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-43 (2 of 2)

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

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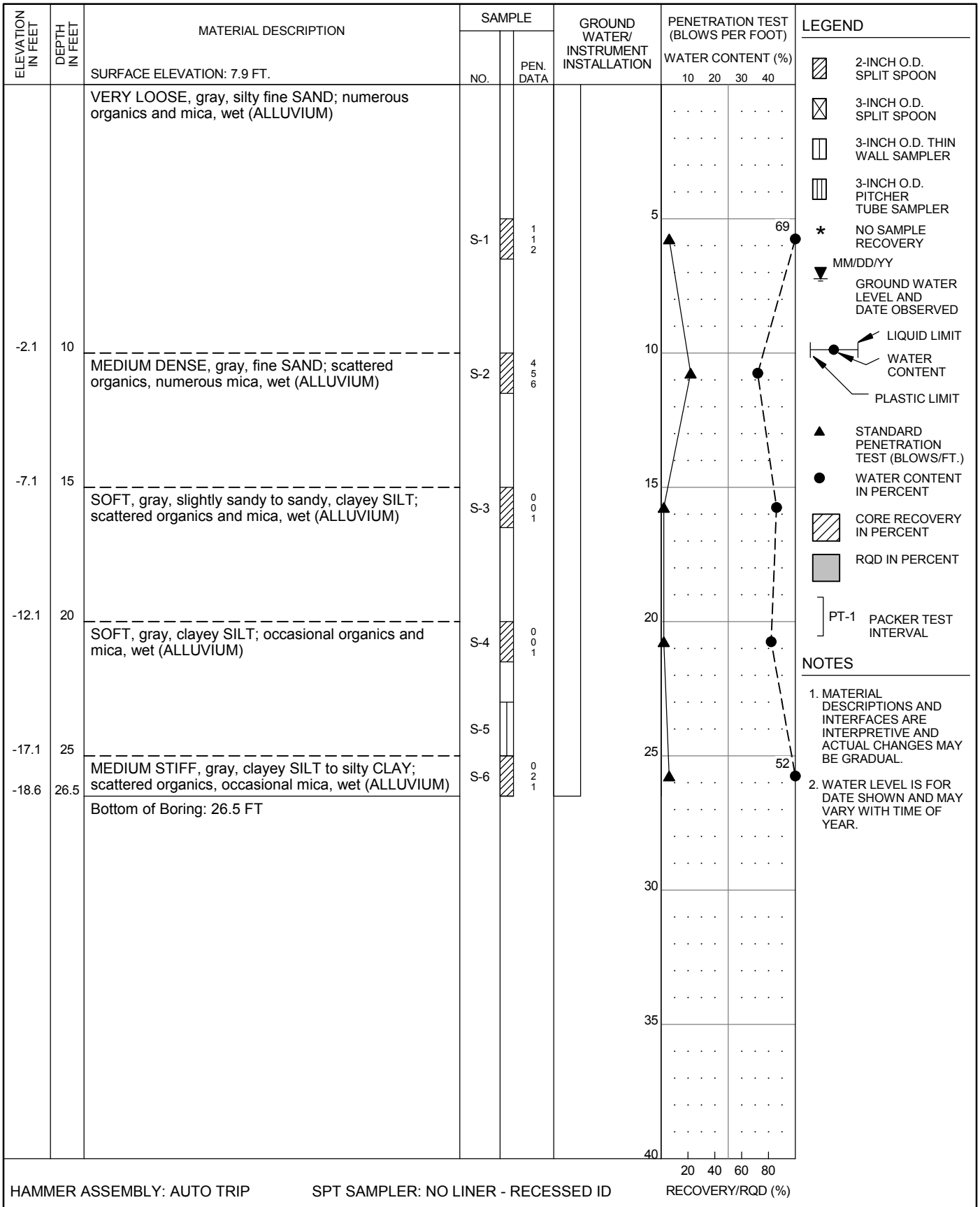
FIG. A43



HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ
SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 3 7/8"

DRILLER: WESTERN STATES
DATE START: 4/29/2014 FINISH: 4/29/2014
DRILLING TECHNIQUE: MUD ROTARY

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SUMMARY BORING LOG P2-CC-44

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

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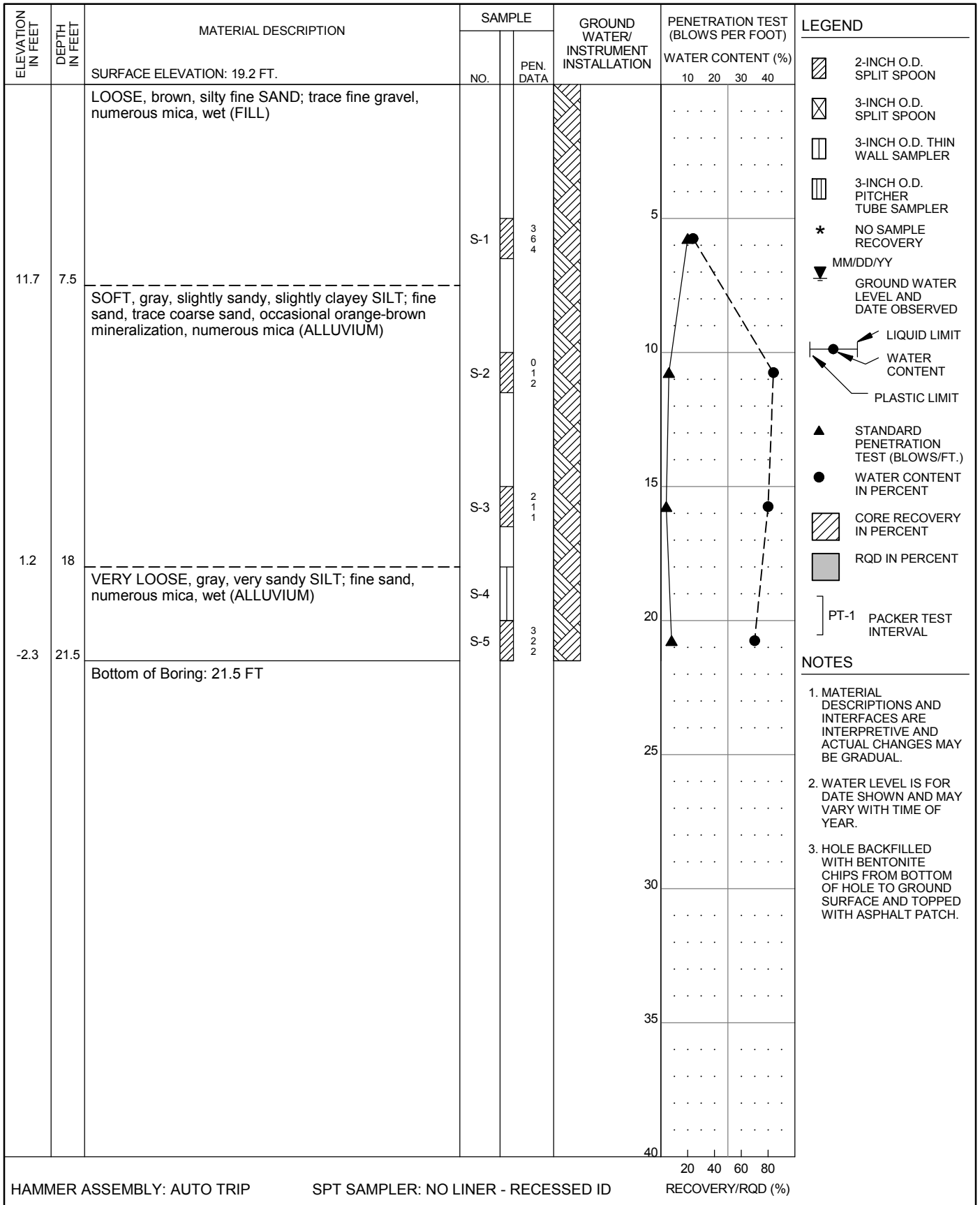
FIG. A44



NOTES

1. MATERIAL DESCRIPTIONS AND INTERFACES ARE INTERPRETIVE AND ACTUAL CHANGES MAY BE GRADUAL.
2. WATER LEVEL IS FOR DATE SHOWN AND MAY VARY WITH TIME OF YEAR.
3. HOLE BACKFILLED WITH BENTONITE CHIPS FROM BOTTOM OF HOLE TO GROUND SURFACE AND TOPPED WITH ASPHALT PATCH.

HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 3 7/8

DRILLER: WESTERN STATES
DATE START: 4/15/2014 FINISH: 4/15/2014
DRILLING TECHNIQUE: MUD ROTARY

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SUMMARY BORING LOG P2-CC-45

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014

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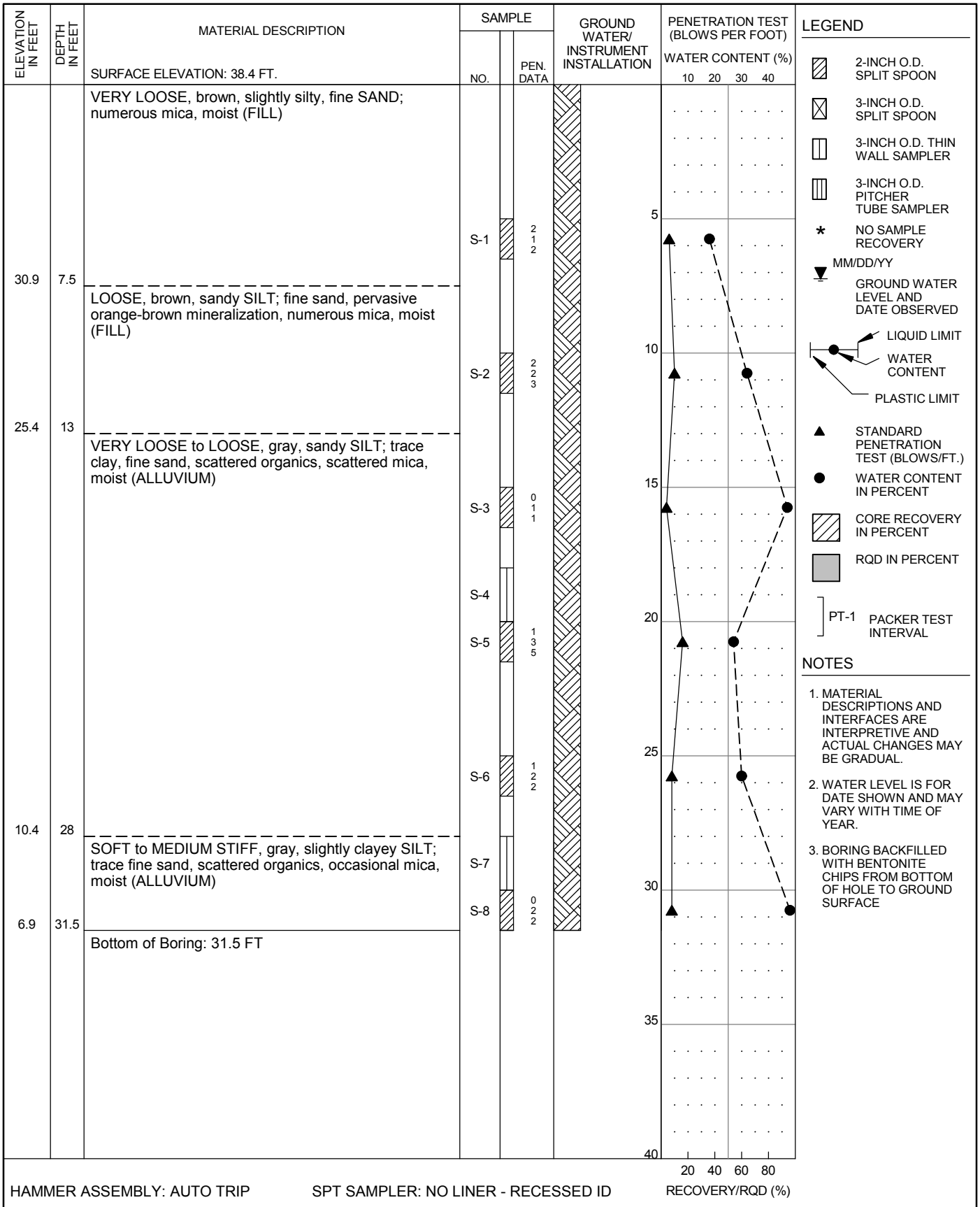
FIG. A45



HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 3/13/2014 FINISH: 3/13/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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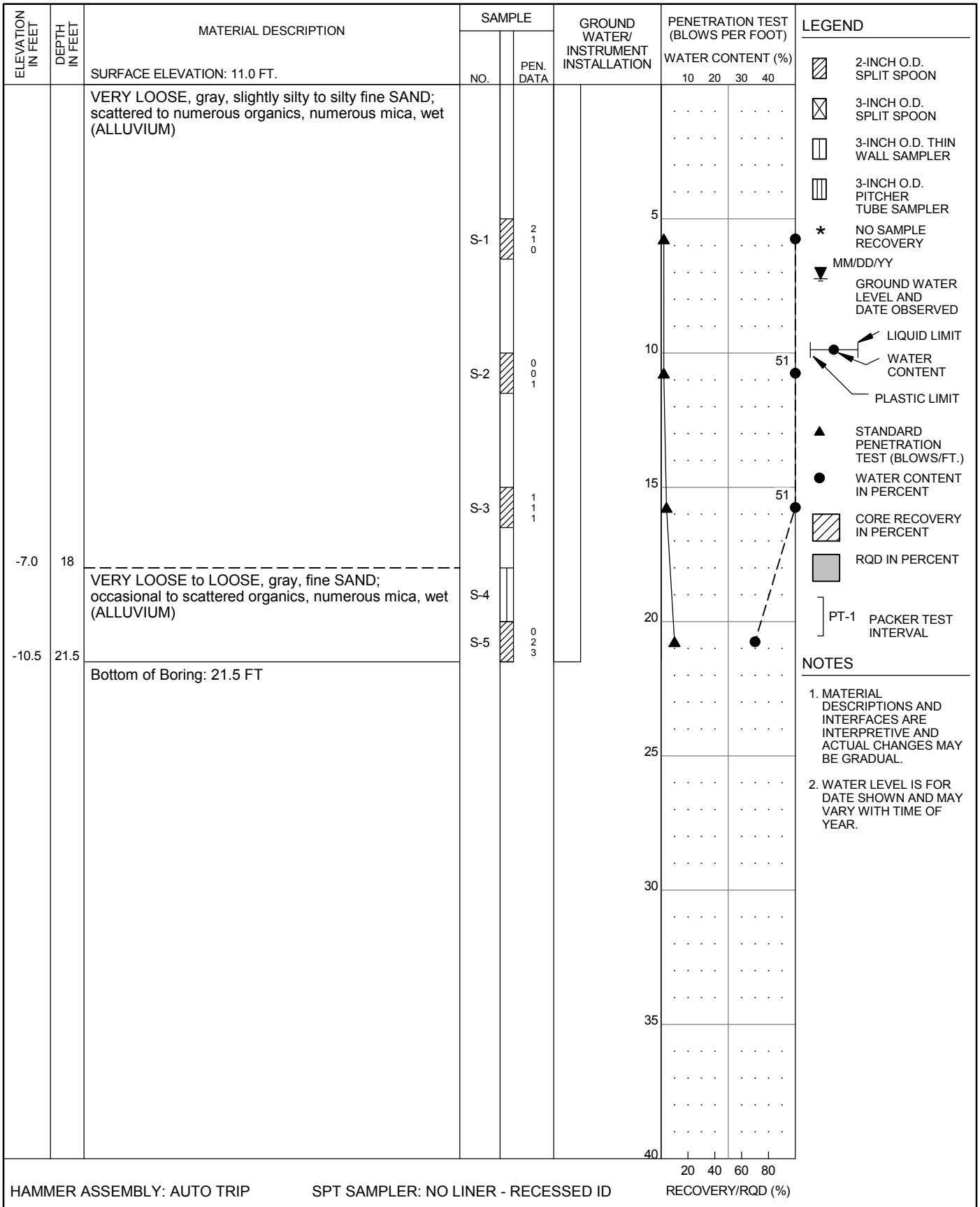
SUMMARY BORING LOG P2-CC-46

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014
PROJ 2320
FIG. A46



HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 3 7/8

DRILLER: WESTERN STATES
DATE START: 4/29/2014 FINISH: 4/29/2014
DRILLING TECHNIQUE: MUD ROTARY

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SUMMARY BORING LOG P2-CC-47

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014

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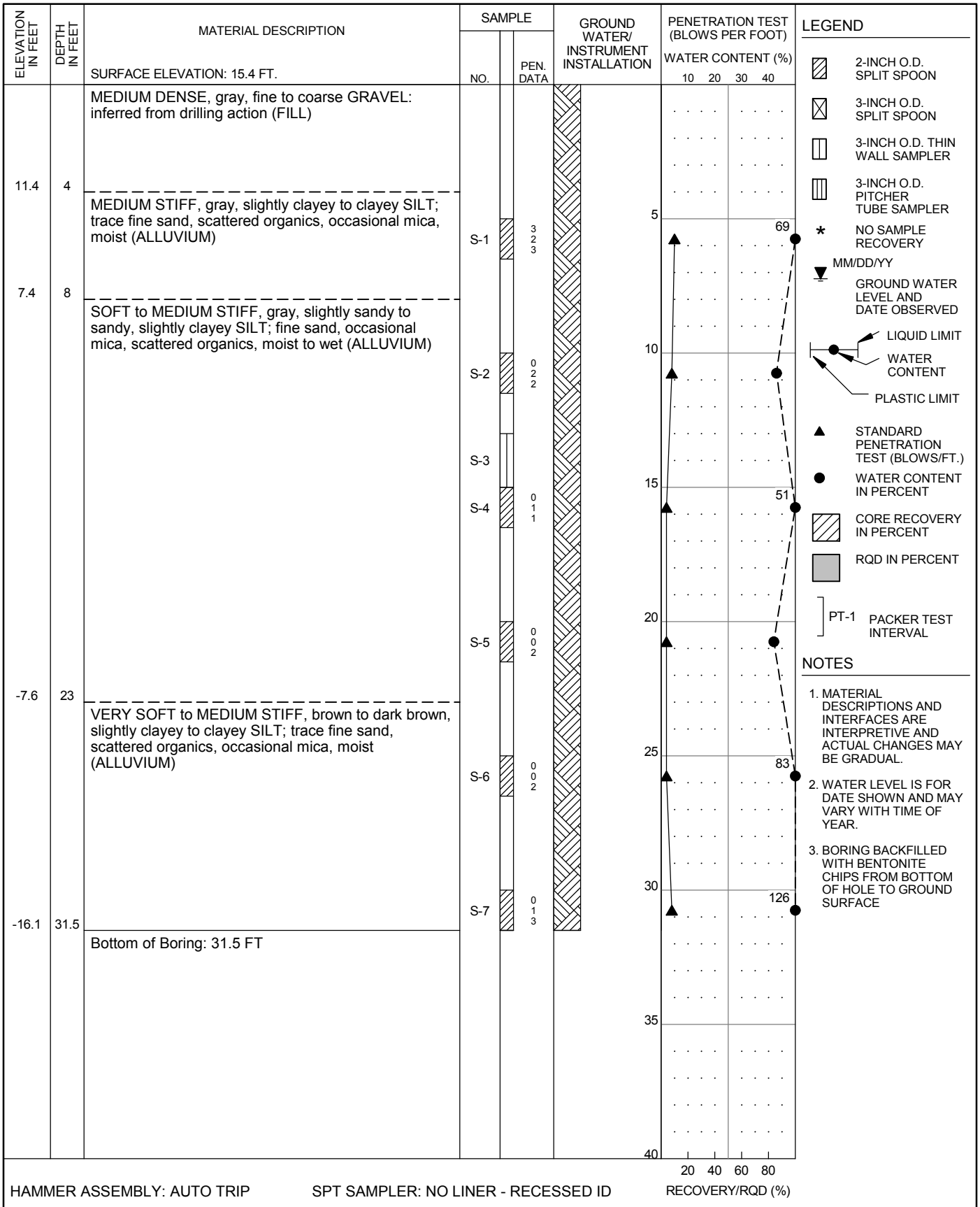
FIG. A47



HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 3/18/2014 FINISH: 3/18/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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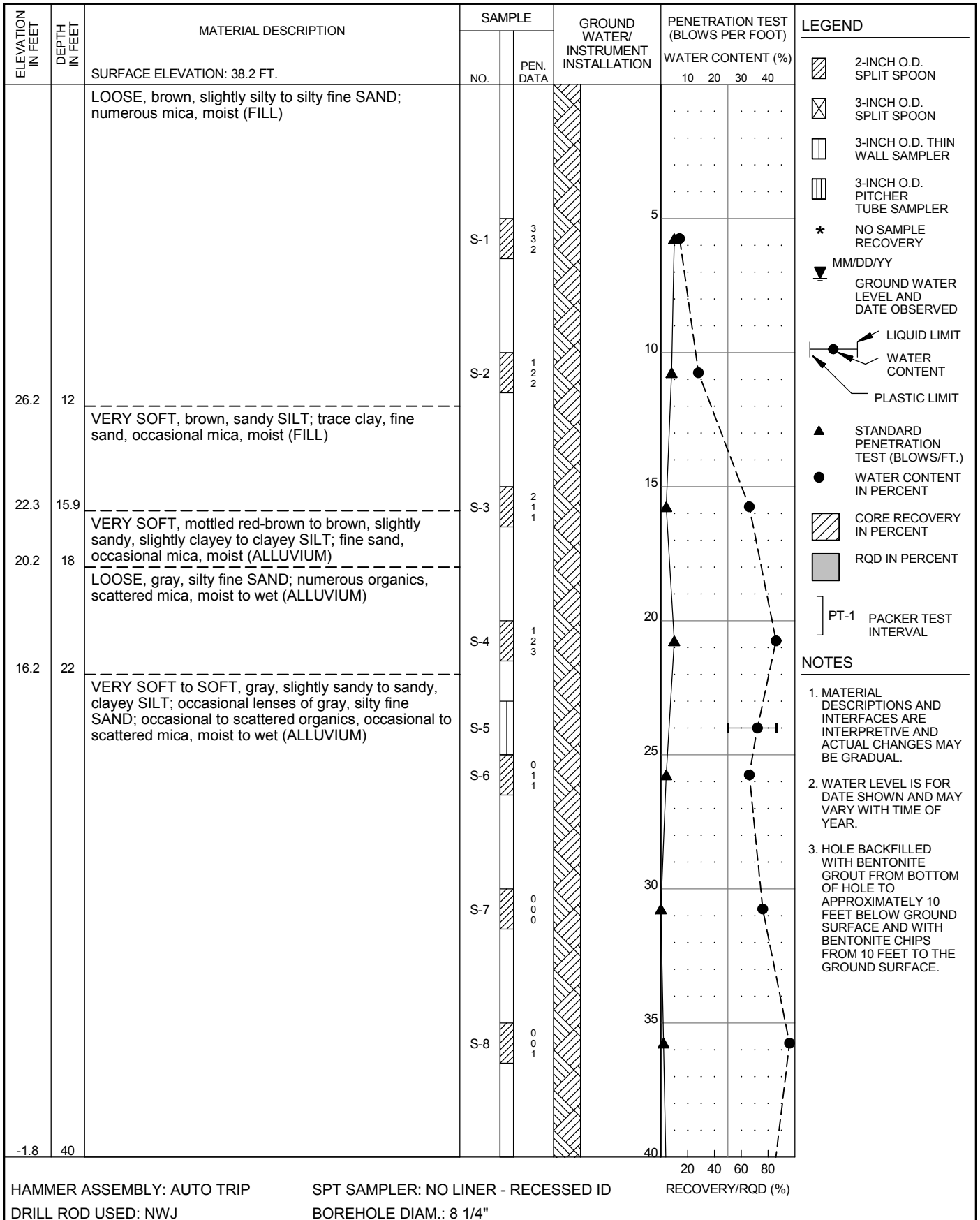
SUMMARY BORING LOG P2-CC-48

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014
PROJ 2320
FIG. A48



NOTES

1. MATERIAL DESCRIPTIONS AND INTERFACES ARE INTERPRETIVE AND ACTUAL CHANGES MAY BE GRADUAL.
2. WATER LEVEL IS FOR DATE SHOWN AND MAY VARY WITH TIME OF YEAR.
3. HOLE BACKFILLED WITH BENTONITE GROUT FROM BOTTOM OF HOLE TO APPROXIMATELY 10 FEET BELOW GROUND SURFACE AND WITH BENTONITE CHIPS FROM 10 FEET TO THE GROUND SURFACE.

HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 3/17/2014 FINISH: 3/17/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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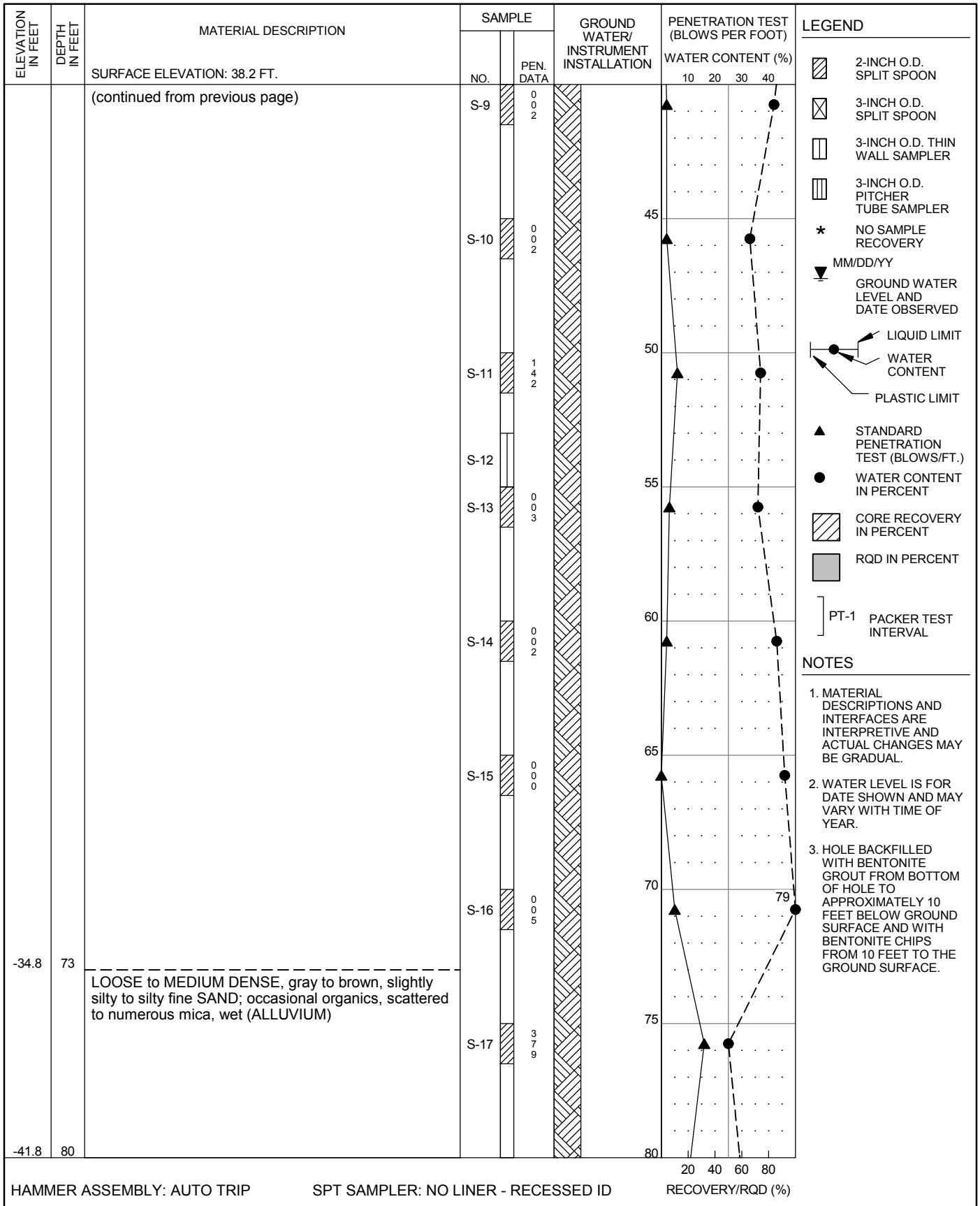
SUMMARY BORING LOG P2-CC-49 (1 of 3)

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014

PROJ 2320

FIG. A49



HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 3/17/2014 FINISH: 3/17/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-49 (2 of 3)

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014

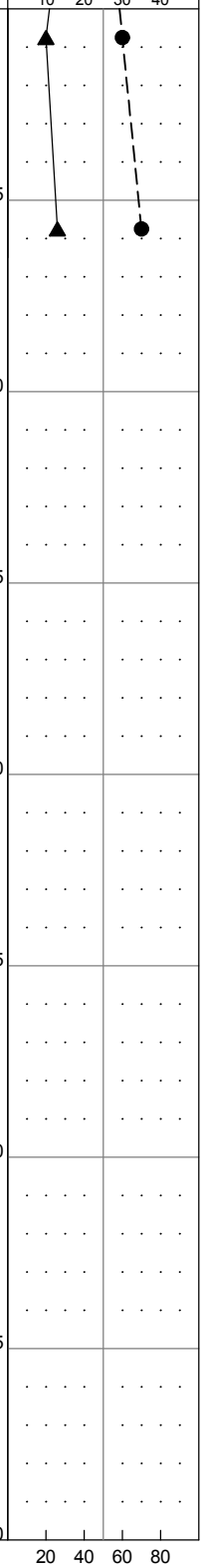
PROJ 2320

FIG. A49

ELEVATION IN FEET	DEPTH IN FEET	MATERIAL DESCRIPTION	SAMPLE NO.	SAMPLE PEN. DATA	GROUND WATER/ INSTRUMENT INSTALLATION
		SURFACE ELEVATION: 38.2 FT.			
		(continued from previous page)	S-18	0 3 7	
			S-19	4 7 6	
-48.3	86.5	Bottom of Boring: 86.5 FT			

PENETRATION TEST (BLOWS PER FOOT)

WATER CONTENT (%)



LEGEND

- 2-INCH O.D. SPLIT SPOON
- 3-INCH O.D. SPLIT SPOON
- 3-INCH O.D. THIN WALL SAMPLER
- 3-INCH O.D. PITCHER TUBE SAMPLER
- * NO SAMPLE RECOVERY
- MM/DD/YY GROUND WATER LEVEL AND DATE OBSERVED
- LIQUID LIMIT
- WATER CONTENT
- PLASTIC LIMIT
- STANDARD PENETRATION TEST (BLOWS/FT.)
- WATER CONTENT IN PERCENT
- CORE RECOVERY IN PERCENT
- RQD IN PERCENT
- PT-1 PACKER TEST INTERVAL

NOTES

1. MATERIAL DESCRIPTIONS AND INTERFACES ARE INTERPRETIVE AND ACTUAL CHANGES MAY BE GRADUAL.
2. WATER LEVEL IS FOR DATE SHOWN AND MAY VARY WITH TIME OF YEAR.
3. HOLE BACKFILLED WITH BENTONITE GROUT FROM BOTTOM OF HOLE TO APPROXIMATELY 10 FEET BELOW GROUND SURFACE AND WITH BENTONITE CHIPS FROM 10 FEET TO THE GROUND SURFACE.

HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ

SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 3/17/2014 FINISH: 3/17/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-49 (3 of 3)

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014

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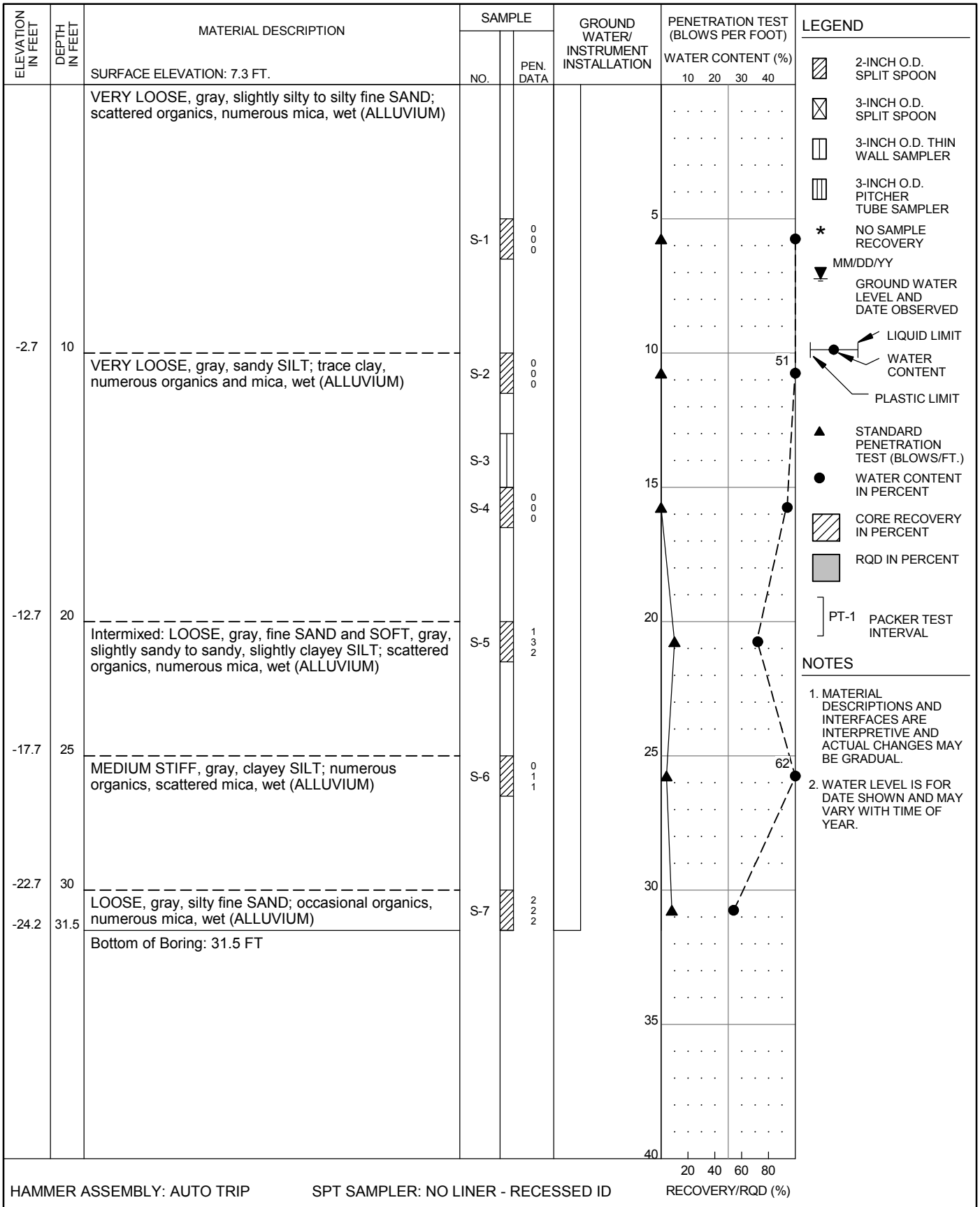
FIG. A49



HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ
SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 3 7/8"

DRILLER: WESTERN STATES
DATE START: 4/29/2014 FINISH: 4/29/2014
DRILLING TECHNIQUE: MUD ROTARY

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SUMMARY BORING LOG P2-CC-50

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

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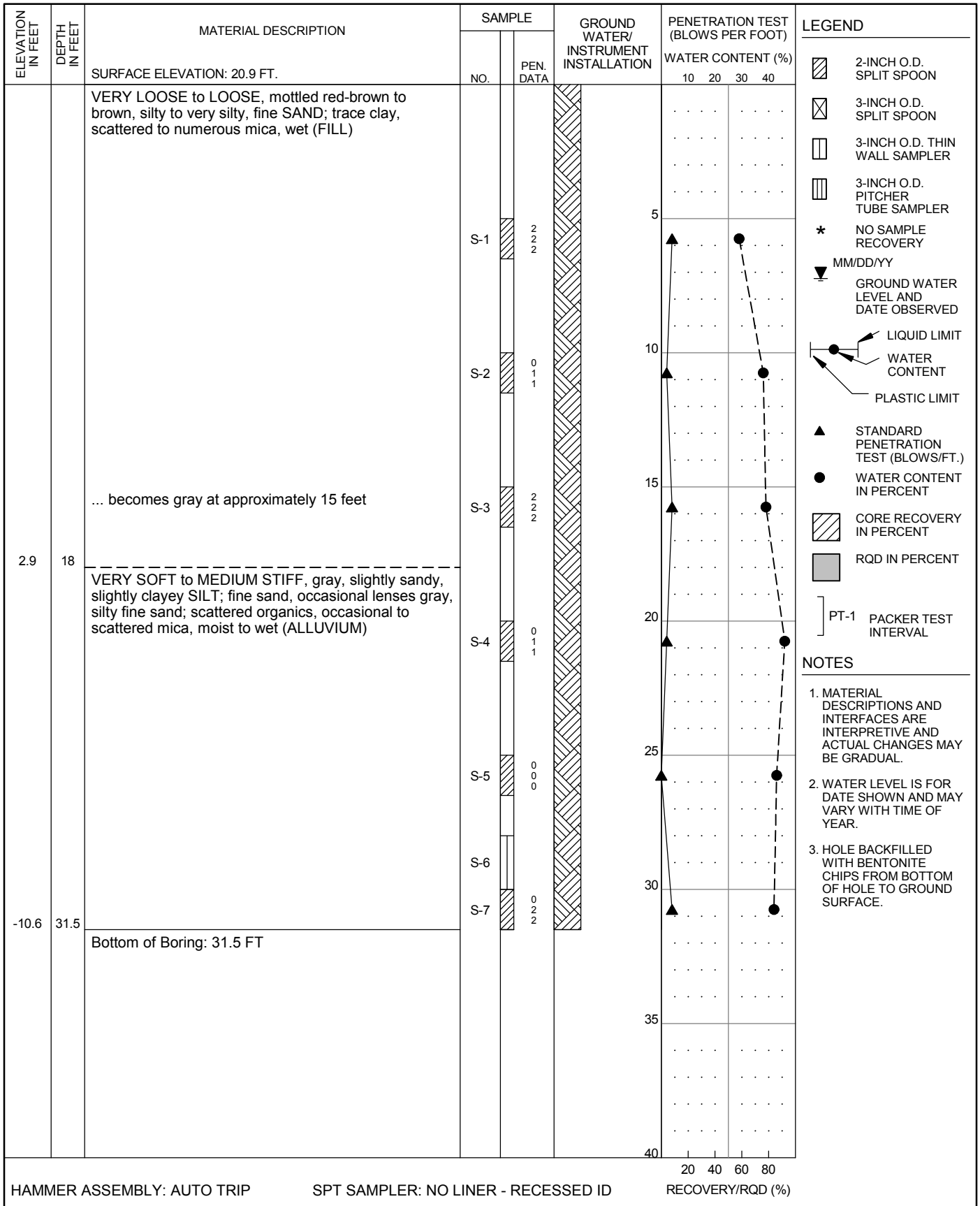
PROJ 2320

FIG. A50



HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ
SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 3/14/2014 FINISH: 3/14/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-51

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014
PROJ 2320
FIG. A51

ELEVATION IN FEET	DEPTH IN FEET	MATERIAL DESCRIPTION	SAMPLE NO.	SAMPLE PEN. DATA
		SURFACE ELEVATION: 38.5 FT.		
		VERY LOOSE, brown, very silty, fine SAND; trace clay, scattered mica, moist (FILL)		
32.6	5.9	VERY SOFT, mottled red-brown to brown, slightly clayey to clayey SILT; trace fine sand, occasional mica, moist (FILL)	S-1	1 2 3
			S-2	0 0 0
			S-3	
24.5	14	MEDIUM STIFF, brown, sandy SILT; trace clay, fine sand, scattered mica, moist to wet (FILL)	S-4	0 2 3
			S-5	2 3 3
15.5	23	VERY LOOSE to LOOSE, gray, slightly silty to silty, fine SAND; occasional organics, occasional red-brown mineralization, numerous mica,wet (FILL)	S-6	1 3 3
			S-7	0 0 1
			S-8	0 0 1
0.5	38	VERY LOOSE to LOOSE, gray, silty fine SAND; occasional to numerous organics, occasional to scattered mica, moist to wet (ALLUVIUM)		

GROUND WATER/ INSTRUMENT INSTALLATION

PENETRATION TEST (BLOWS PER FOOT)

WATER CONTENT (%)

10 20 30 40

5 10 15 20 25 30 35 40

20 40 60 80

RECOVERY/RQD (%)

LEGEND

- 2-INCH O.D. SPLIT SPOON
- 3-INCH O.D. SPLIT SPOON
- 3-INCH O.D. THIN WALL SAMPLER
- 3-INCH O.D. PITCHER TUBE SAMPLER
- * NO SAMPLE RECOVERY
- MM/DD/YY GROUND WATER LEVEL AND DATE OBSERVED
- LIQUID LIMIT
- WATER CONTENT
- PLASTIC LIMIT
- STANDARD PENETRATION TEST (BLOWS/FT.)
- WATER CONTENT IN PERCENT
- CORE RECOVERY IN PERCENT
- RQD IN PERCENT
- PT-1 PACKER TEST INTERVAL

NOTES

1. MATERIAL DESCRIPTIONS AND INTERFACES ARE INTERPRETIVE AND ACTUAL CHANGES MAY BE GRADUAL.
2. WATER LEVEL IS FOR DATE SHOWN AND MAY VARY WITH TIME OF YEAR.
3. HOLE BACKFILLED WITH BENTONITE CHIPS FROM BOTTOM OF HOLE TO GROUND SURFACE.

HAMMER ASSEMBLY: AUTO TRIP

SPT SAMPLER: NO LINER - RECESSED ID

DRILL ROD USED: NWJ

BOREHOLE DIAM.: 8 1/4

DRILLER: WESTERN STATES

DATE START: 3/14/2014 FINISH: 3/14/2014

DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-52 (1 of 2)

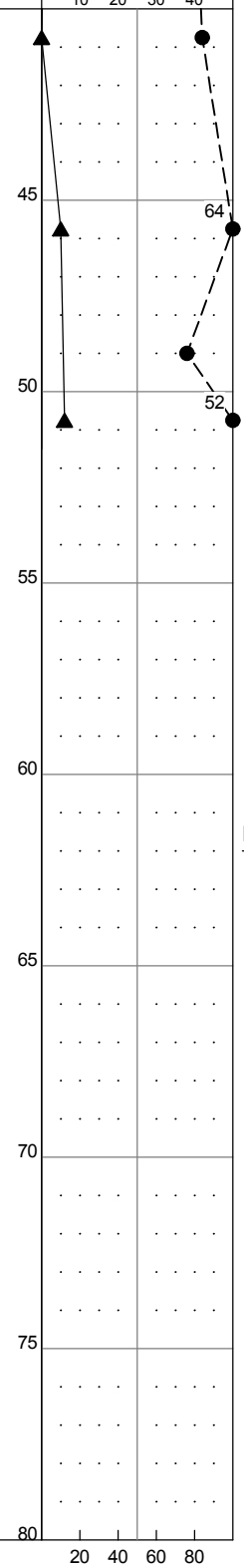
PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014

PROJ 2320

FIG. A52

ELEVATION IN FEET	DEPTH IN FEET	MATERIAL DESCRIPTION	SAMPLE NO.	SAMPLE PEN. DATA	GROUND WATER/ INSTRUMENT INSTALLATION
		SURFACE ELEVATION: 38.5 FT.			
		(continued from previous page)	S-9	0 0 0	
			S-10	0 2 3	
			S-11		
			S-12	2 2 4	
-13.0	51.5	Bottom of Boring: 51.5 FT			



LEGEND

- 2-INCH O.D. SPLIT SPOON
- 3-INCH O.D. SPLIT SPOON
- 3-INCH O.D. THIN WALL SAMPLER
- 3-INCH O.D. PITCHER TUBE SAMPLER
- * NO SAMPLE RECOVERY
- MM/DD/YY GROUND WATER LEVEL AND DATE OBSERVED
- LIQUID LIMIT
- WATER CONTENT
- PLASTIC LIMIT
- STANDARD PENETRATION TEST (BLOWS/FT.)
- WATER CONTENT IN PERCENT
- CORE RECOVERY IN PERCENT
- RQD IN PERCENT
- PT-1 PACKER TEST INTERVAL

NOTES

1. MATERIAL DESCRIPTIONS AND INTERFACES ARE INTERPRETIVE AND ACTUAL CHANGES MAY BE GRADUAL.
2. WATER LEVEL IS FOR DATE SHOWN AND MAY VARY WITH TIME OF YEAR.
3. HOLE BACKFILLED WITH BENTONITE CHIPS FROM BOTTOM OF HOLE TO GROUND SURFACE.

HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ
SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 8 1/4

DRILLER: WESTERN STATES
DATE START: 3/14/2014 FINISH: 3/14/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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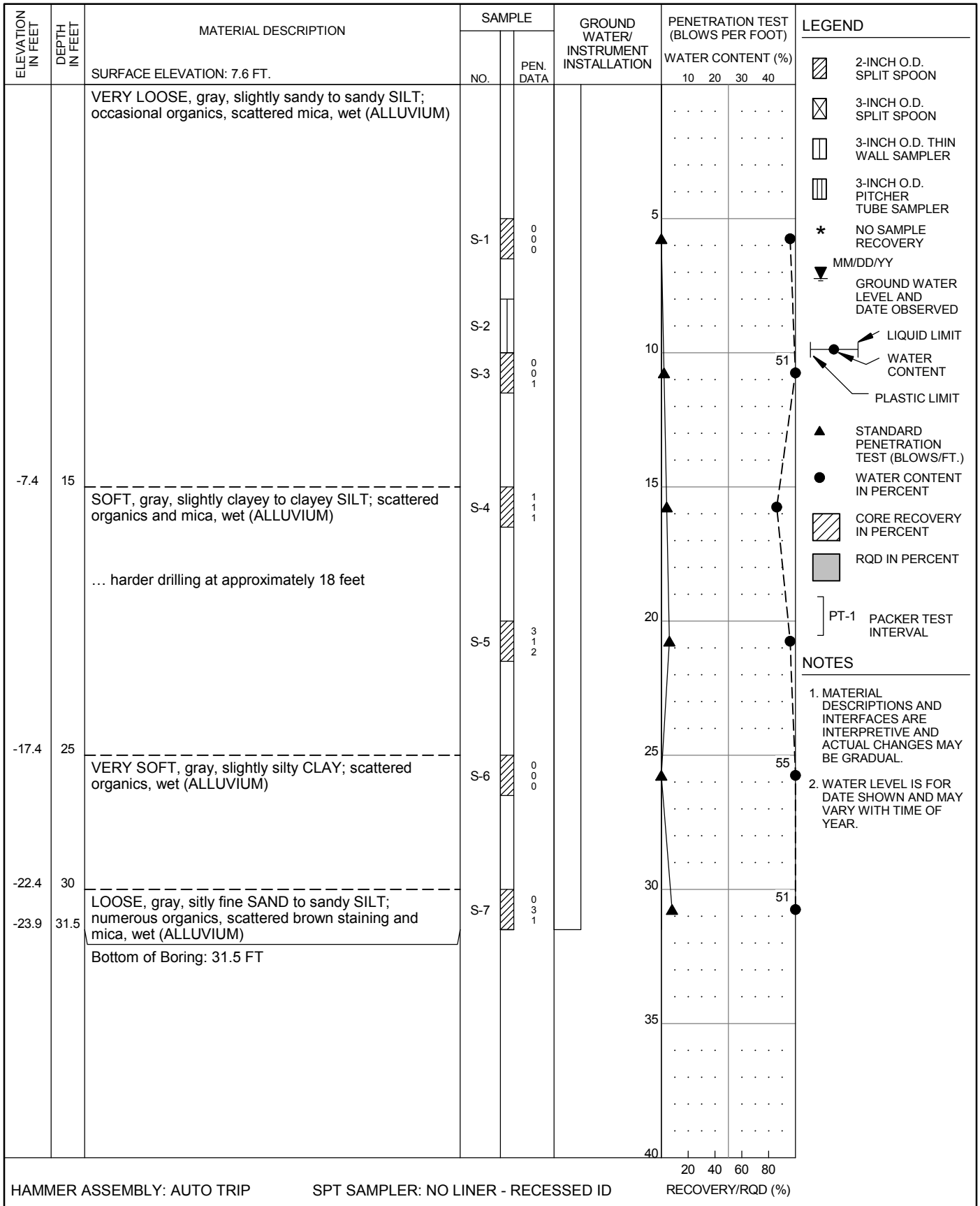
SUMMARY BORING LOG P2-CC-52 (2 of 2)

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014

PROJ 2320

FIG. A52



HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ
SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 3 7/8"

DRILLER: WESTERN STATES
DATE START: 4/30/2014 FINISH: 4/30/2014
DRILLING TECHNIQUE: MUD ROTARY

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SUMMARY BORING LOG P2-CC-53

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

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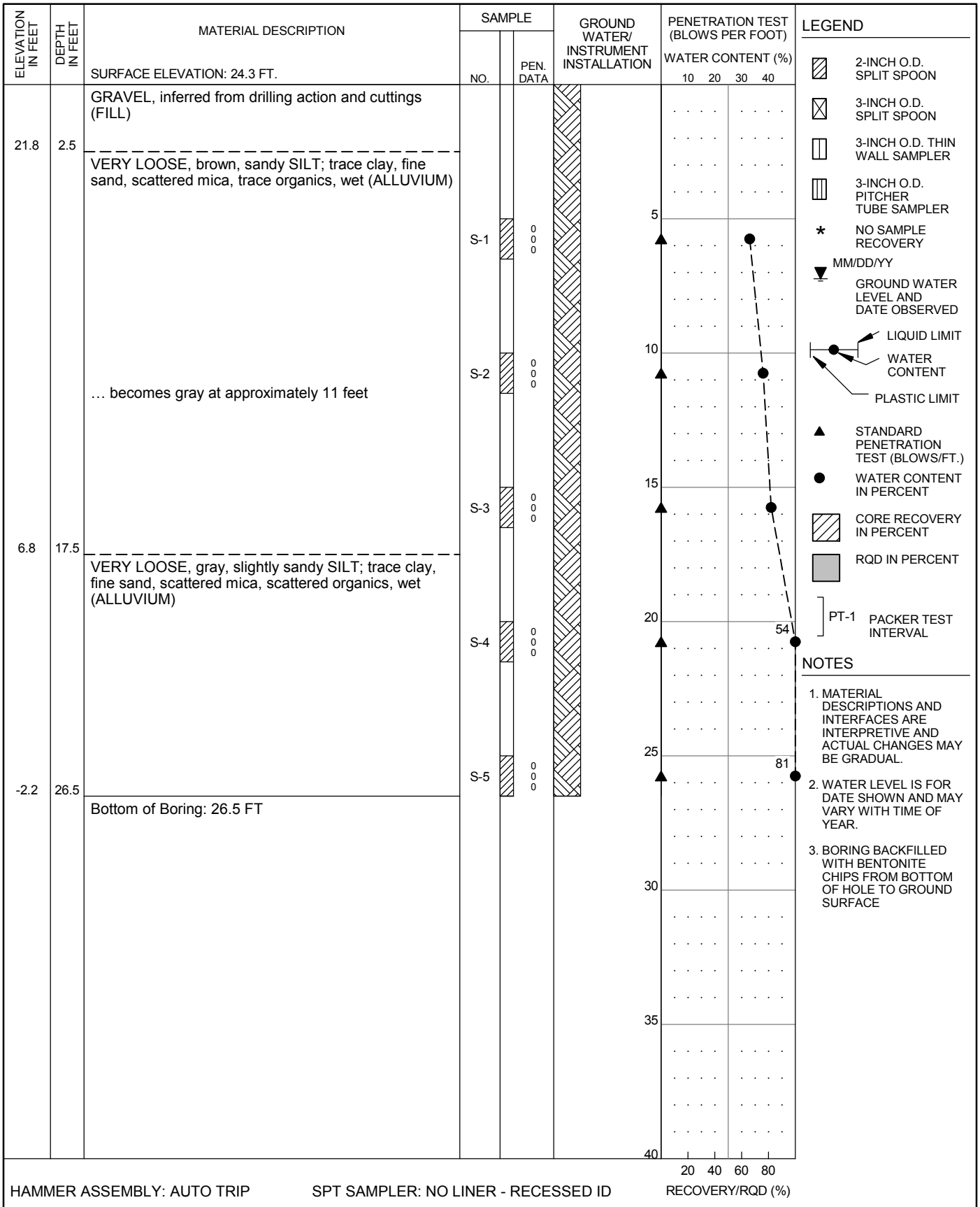
PROJ 2320
FIG. A53



HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 4 7/8"

DRILLER: WESTERN STATES
DATE START: 3/14/2014 FINISH: 3/14/2014
DRILLING TECHNIQUE: MUD ROTARY

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SUMMARY BORING LOG P2-CC-54

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

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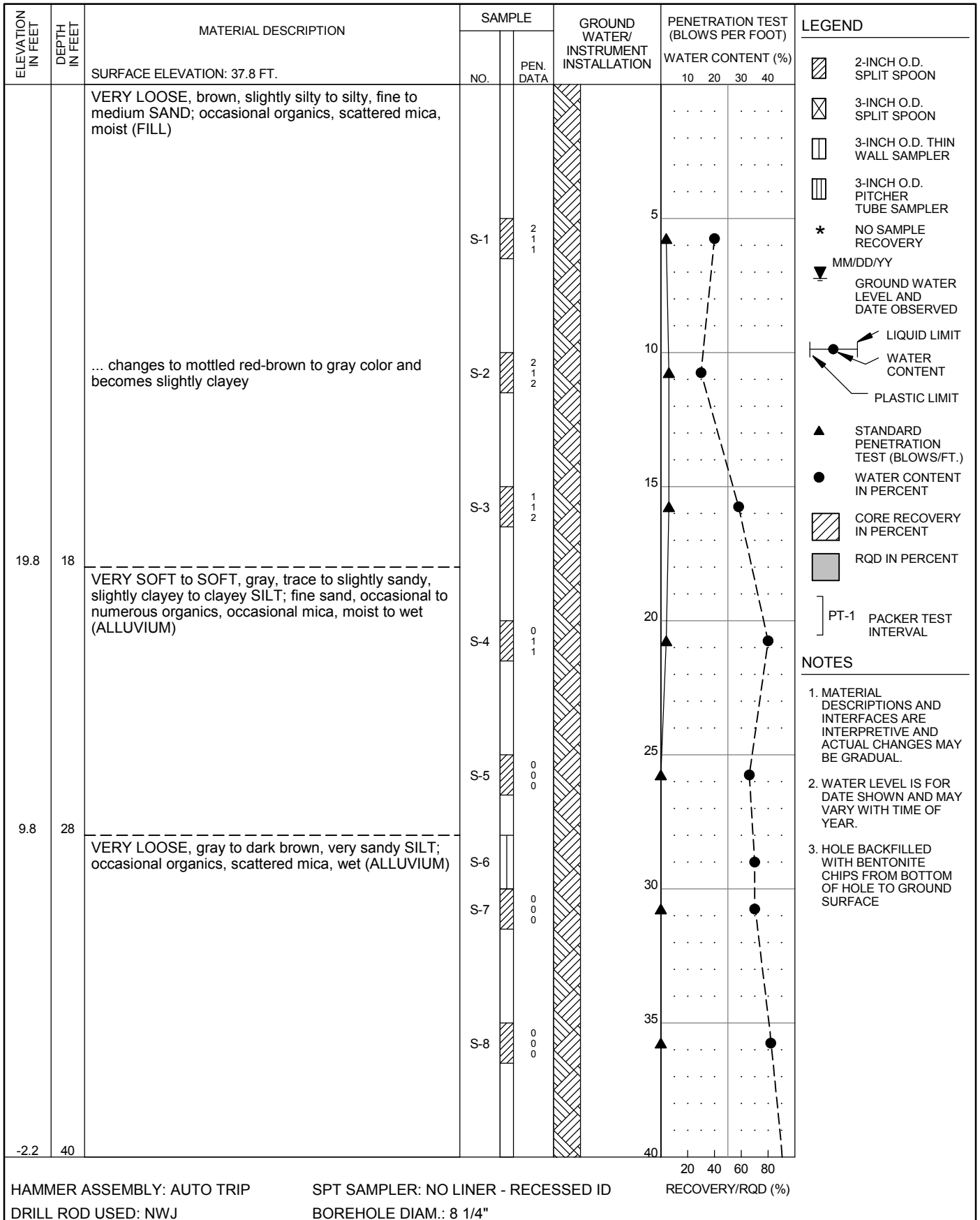
FIG. A54



HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 3/18/2014 FINISH: 3/18/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-55 (1 of 2)

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014
PROJ 2320
FIG. A55

ELEVATION IN FEET	DEPTH IN FEET	MATERIAL DESCRIPTION	SAMPLE NO.	SAMPLE PEN. DATA	GROUND WATER/ INSTRUMENT INSTALLATION
		SURFACE ELEVATION: 37.8 FT.			
		(continued from previous page)	S-9	0 0 0	
-3.7	41.5	Bottom of Boring: 41.5 FT			

PENETRATION TEST (BLOWS PER FOOT)

WATER CONTENT (%)

10 20 30 40

45 50 55 60 65 70 75 80

20 40 60 80

RECOVERY/RQD (%)

LEGEND

- 2-INCH O.D. SPLIT SPOON
- 3-INCH O.D. SPLIT SPOON
- 3-INCH O.D. THIN WALL SAMPLER
- 3-INCH O.D. PITCHER TUBE SAMPLER
- * NO SAMPLE RECOVERY
- MM/DD/YY GROUND WATER LEVEL AND DATE OBSERVED
- LIQUID LIMIT
- WATER CONTENT
- PLASTIC LIMIT
- STANDARD PENETRATION TEST (BLOWS/FT.)
- WATER CONTENT IN PERCENT
- CORE RECOVERY IN PERCENT
- RQD IN PERCENT
- PT-1 PACKER TEST INTERVAL

NOTES

1. MATERIAL DESCRIPTIONS AND INTERFACES ARE INTERPRETIVE AND ACTUAL CHANGES MAY BE GRADUAL.
2. WATER LEVEL IS FOR DATE SHOWN AND MAY VARY WITH TIME OF YEAR.
3. HOLE BACKFILLED WITH BENTONITE CHIPS FROM BOTTOM OF HOLE TO GROUND SURFACE

HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ

SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 3/18/2014 FINISH: 3/18/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-55 (2 of 2)

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

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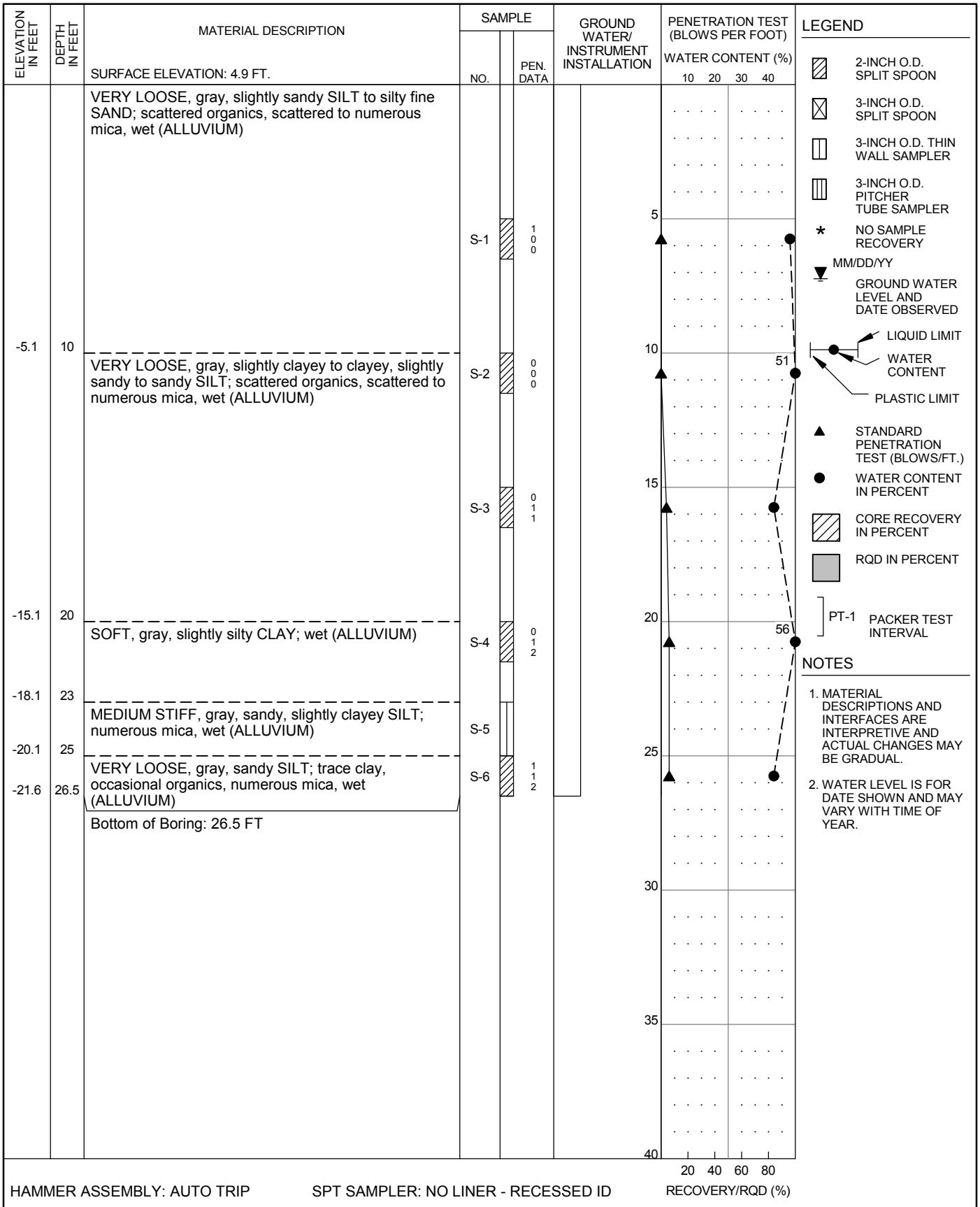
FIG. A55



HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ
SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 3 7/8"

DRILLER: WESTERN STATES
DATE START: 4/30/2014 FINISH: 4/30/2014
DRILLING TECHNIQUE: MUD ROTARY

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SUMMARY BORING LOG P2-CC-56

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

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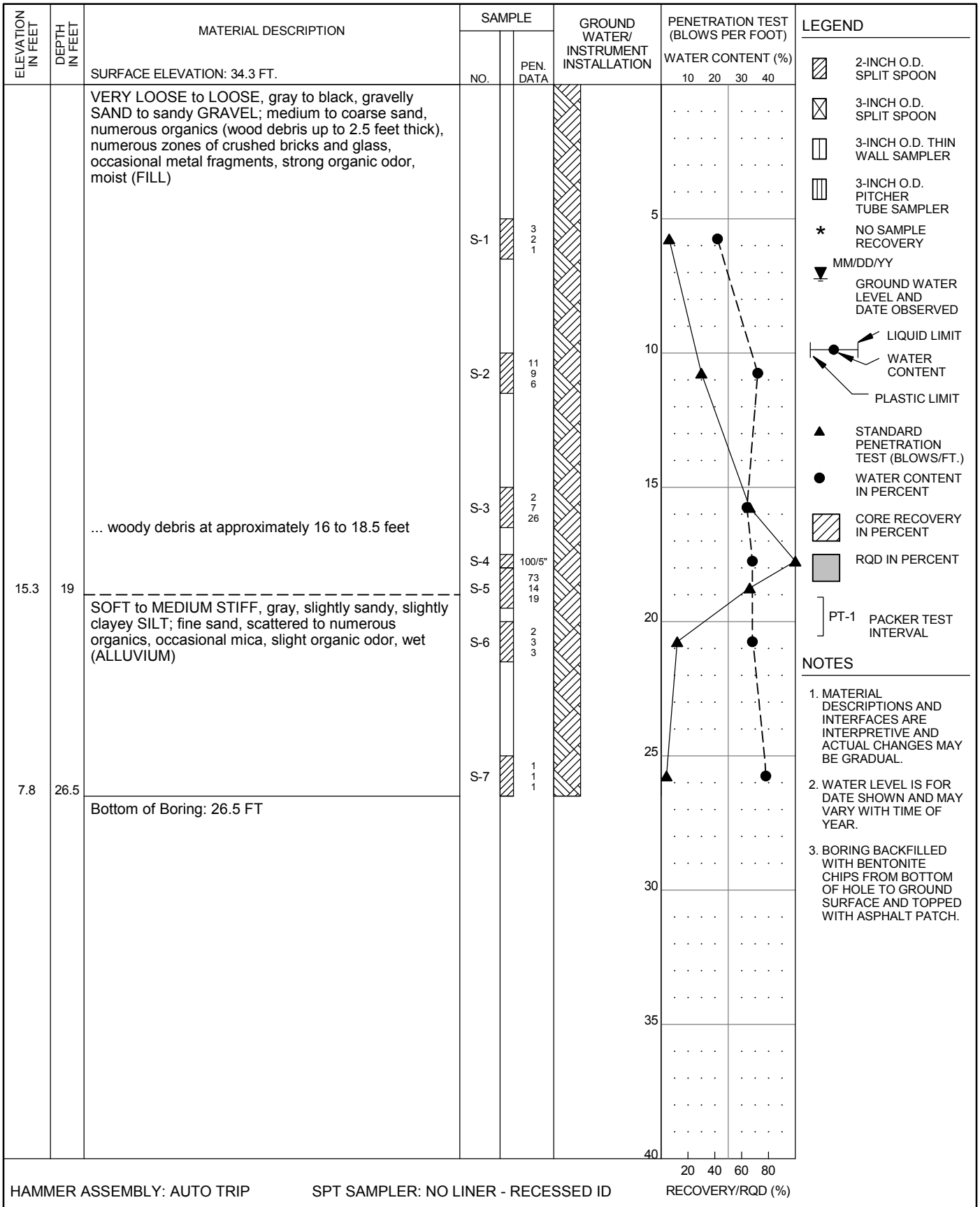
FIG. A56



HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED:
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 3/31/2014 FINISH: 3/31/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-57

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

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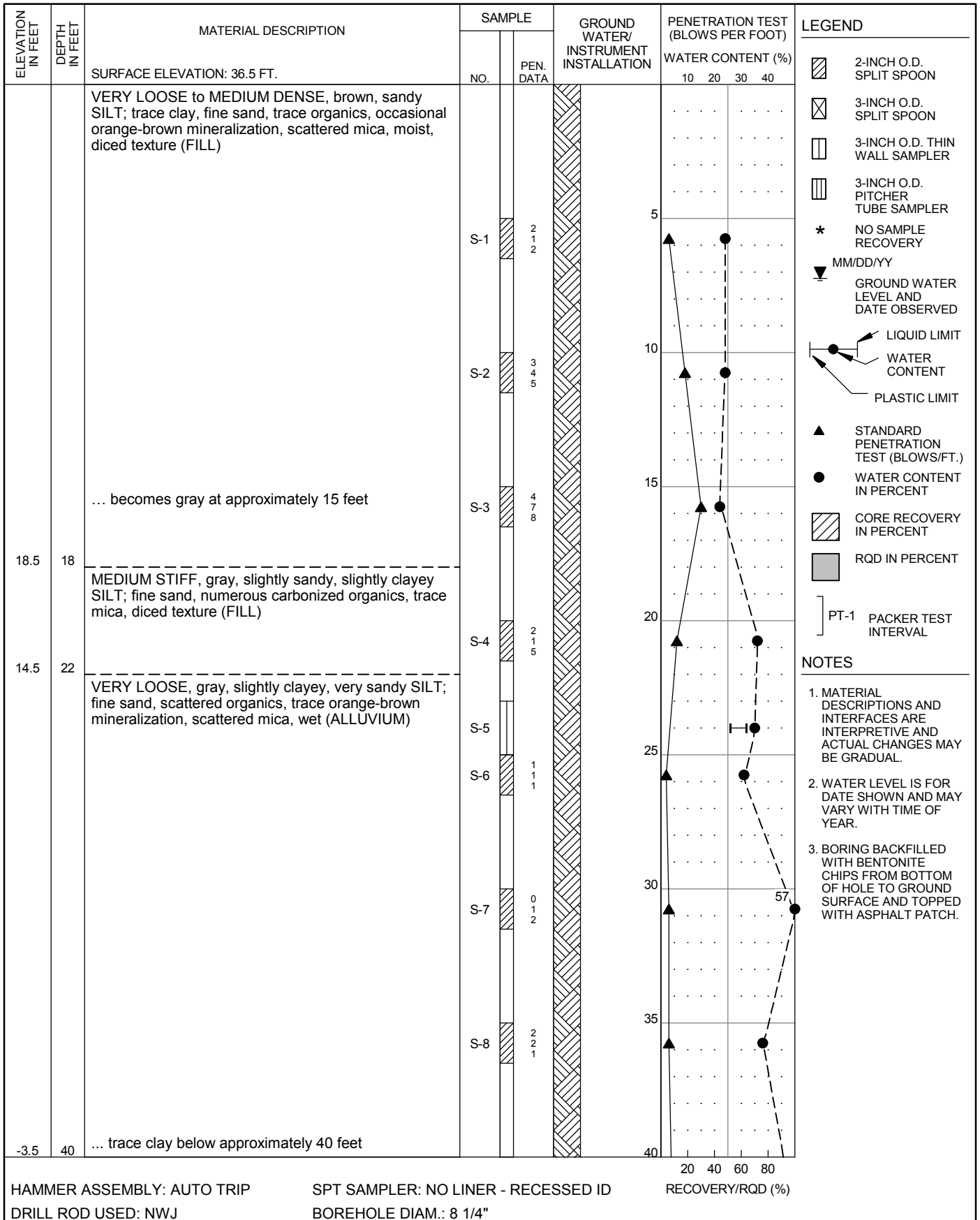
FIG. A57



HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 3/31/2014 FINISH: 3/31/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-58 (1 of 2)

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014

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FIG. A58

ELEVATION IN FEET	DEPTH IN FEET	MATERIAL DESCRIPTION	SAMPLE NO.	SAMPLE PEN. DATA	GROUND WATER/ INSTRUMENT INSTALLATION
		SURFACE ELEVATION: 36.5 FT.			
-5.0	41.5	(continued from previous page)	S-9	2 2 2	
		Bottom of Boring: 41.5 FT			

PENETRATION TEST (BLOWS PER FOOT)

WATER CONTENT (%)

10 20 30 40

45 50 55 60 65 70 75 80

20 40 60 80

RECOVERY/RQD (%)

LEGEND

- 2-INCH O.D. SPLIT SPOON
- 3-INCH O.D. SPLIT SPOON
- 3-INCH O.D. THIN WALL SAMPLER
- 3-INCH O.D. PITCHER TUBE SAMPLER
- * NO SAMPLE RECOVERY
- MM/DD/YY GROUND WATER LEVEL AND DATE OBSERVED
- LIQUID LIMIT
- WATER CONTENT
- PLASTIC LIMIT
- STANDARD PENETRATION TEST (BLOWS/FT.)
- WATER CONTENT IN PERCENT
- CORE RECOVERY IN PERCENT
- RQD IN PERCENT
- PT-1 PACKER TEST INTERVAL

NOTES

1. MATERIAL DESCRIPTIONS AND INTERFACES ARE INTERPRETIVE AND ACTUAL CHANGES MAY BE GRADUAL.
2. WATER LEVEL IS FOR DATE SHOWN AND MAY VARY WITH TIME OF YEAR.
3. BORING BACKFILLED WITH BENTONITE CHIPS FROM BOTTOM OF HOLE TO GROUND SURFACE AND TOPPED WITH ASPHALT PATCH.

HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ

SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 3/31/2014 FINISH: 3/31/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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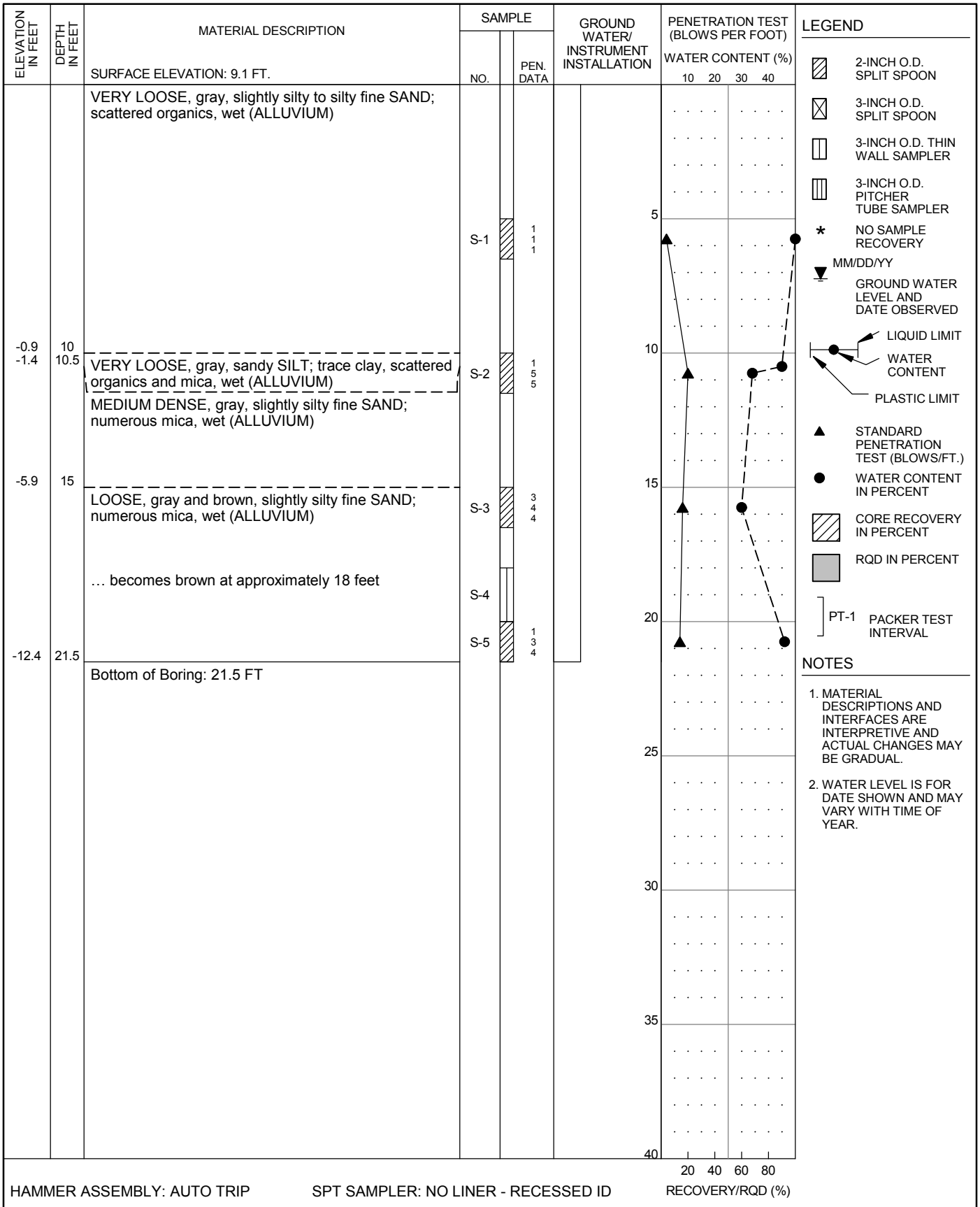
SUMMARY BORING LOG P2-CC-58 (2 of 2)

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014

PROJ 2320

FIG. A58



HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ
SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 3 7/8"

DRILLER: WESTERN STATES
DATE START: 4/30/2014 FINISH: 4/30/2014
DRILLING TECHNIQUE: MUD ROTARY

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SUMMARY BORING LOG P2-CC-59

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014

PROJ 2320

FIG. A59

ELEVATION IN FEET	DEPTH IN FEET	MATERIAL DESCRIPTION	SAMPLE NO.	SAMPLE PEN. DATA
		SURFACE ELEVATION: 33.2 FT.		
		MEDIUM STIFF to STIFF, gray, slightly sandy, slightly clayey SILT; fine sand, trace medium sand, numerous organics, diced texture (FILL)		
		… occasional gravel and cobbles to 8 feet below ground surface (inferred from drilling action)	S-1	3 6 4
			S-2	3 4 4
20.2	13	LOOSE, gray, silty fine SAND; scattered mica, wet (ALLUVIUM)	S-3	4 4 5
			S-4	
		… becomes brown at approximately 22 feet	S-5	3 3 2
9.7	23.5	Bottom of Boring: 23.5 FT		

GROUND WATER/ INSTRUMENT INSTALLATION

PENETRATION TEST (BLOWS PER FOOT)

WATER CONTENT (%)

10 20 30 40

5 10 15 20 25 30 35 40

20 40 60 80

RECOVERY/RQD (%)

LEGEND

- 2-INCH O.D. SPLIT SPOON
- 3-INCH O.D. SPLIT SPOON
- 3-INCH O.D. THIN WALL SAMPLER
- 3-INCH O.D. PITCHER TUBE SAMPLER
- * NO SAMPLE RECOVERY
- MM/DD/YY GROUND WATER LEVEL AND DATE OBSERVED
- LIQUID LIMIT
- WATER CONTENT
- PLASTIC LIMIT
- STANDARD PENETRATION TEST (BLOWS/FT.)
- WATER CONTENT IN PERCENT
- CORE RECOVERY IN PERCENT
- RQD IN PERCENT
- PT-1 PACKER TEST INTERVAL

NOTES

1. MATERIAL DESCRIPTIONS AND INTERFACES ARE INTERPRETIVE AND ACTUAL CHANGES MAY BE GRADUAL.
2. WATER LEVEL IS FOR DATE SHOWN AND MAY VARY WITH TIME OF YEAR.
3. BORING BACKFILLED WITH BENTONITE CHIPS FROM BOTTOM OF HOLE TO GROUND SURFACE AND TOPPED WITH ASPHALT PATCH.

HAMMER ASSEMBLY: AUTO TRIP

DRILL ROD USED: NWJ

SPT SAMPLER: NO LINER - RECESSED ID

BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES

DATE START: 4/1/2014 FINISH: 4/1/2014

DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-60

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014

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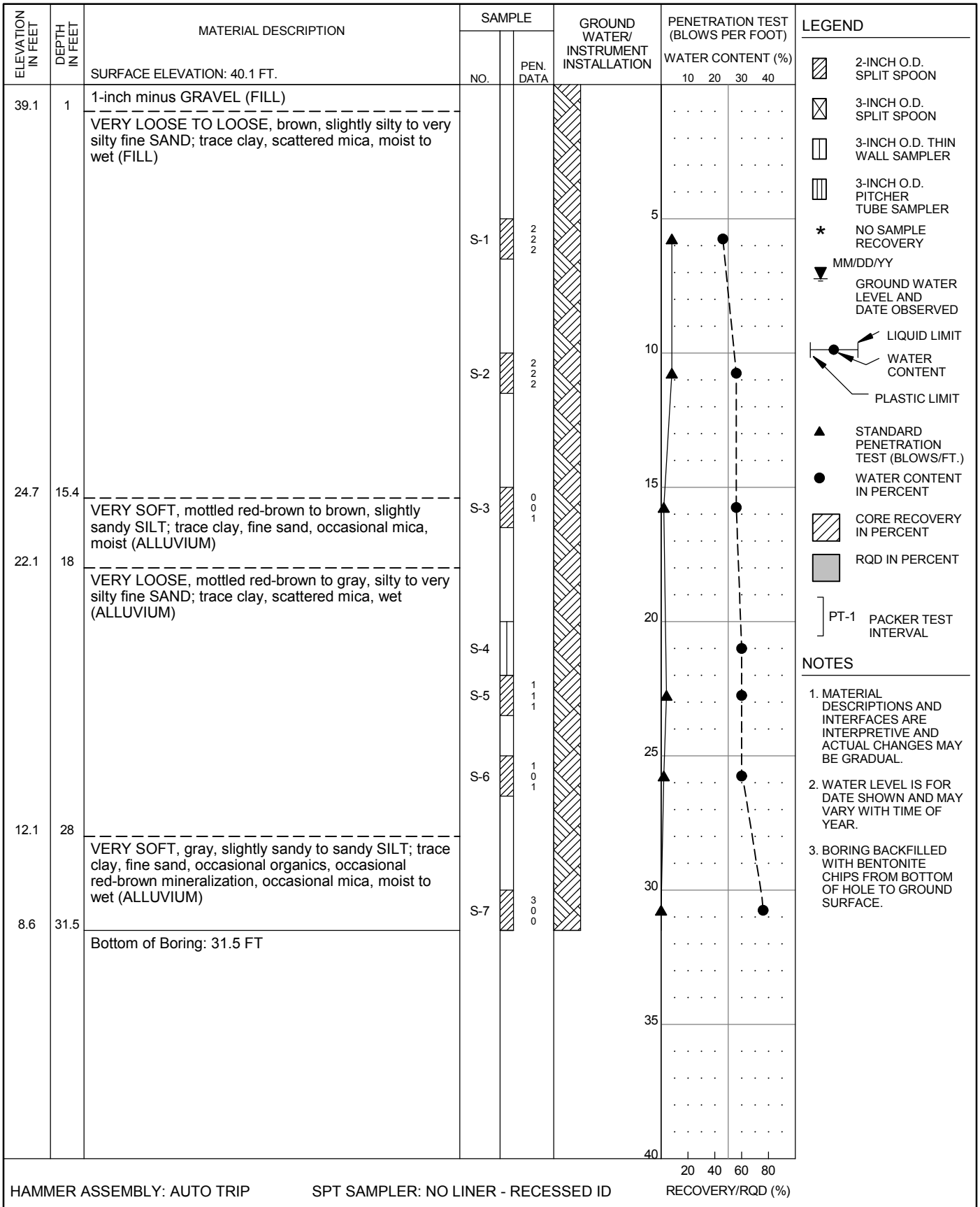
FIG. A60



HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 3/19/2014 FINISH: 3/19/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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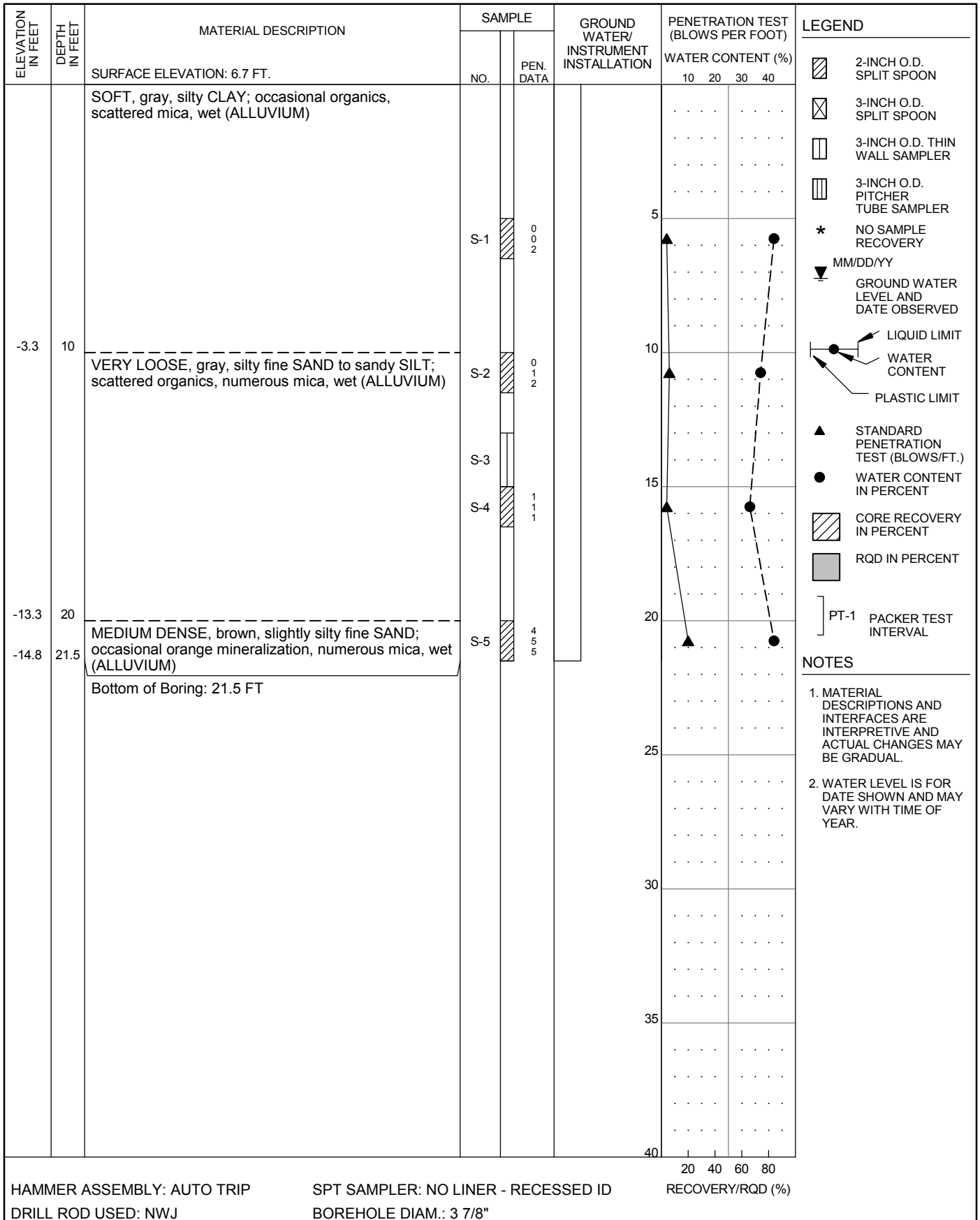
SUMMARY BORING LOG P2-CC-61

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014
PROJ 2320
FIG. A61



HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ
SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 3 7/8"

DRILLER: WESTERN STATES
DATE START: 5/1/2014 FINISH: 5/1/2014
DRILLING TECHNIQUE: MUD ROTARY

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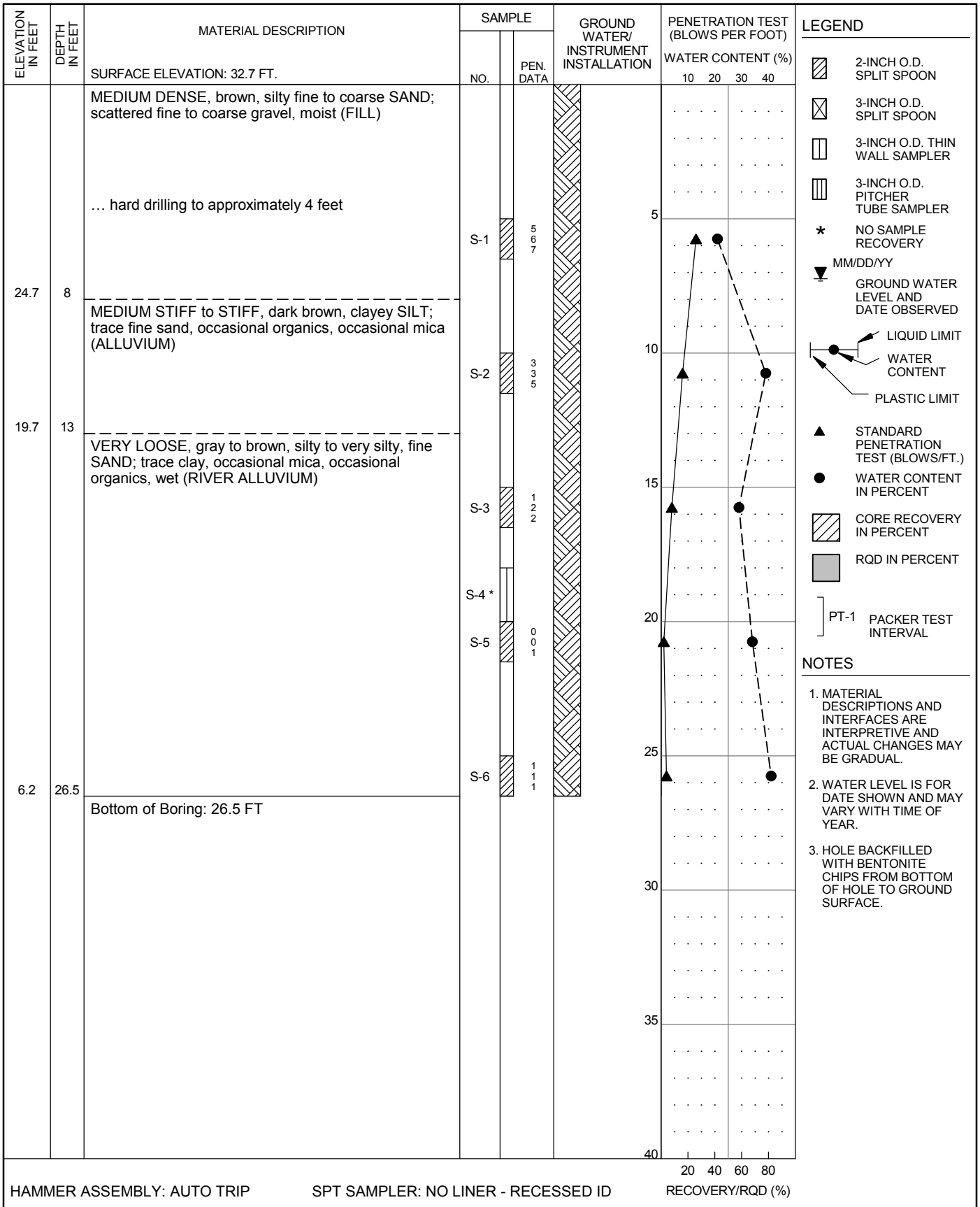
SUMMARY BORING LOG P2-CC-62

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014
PROJ 2320
FIG. A62



HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 3/21/2014 FINISH: 3/21/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-63

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

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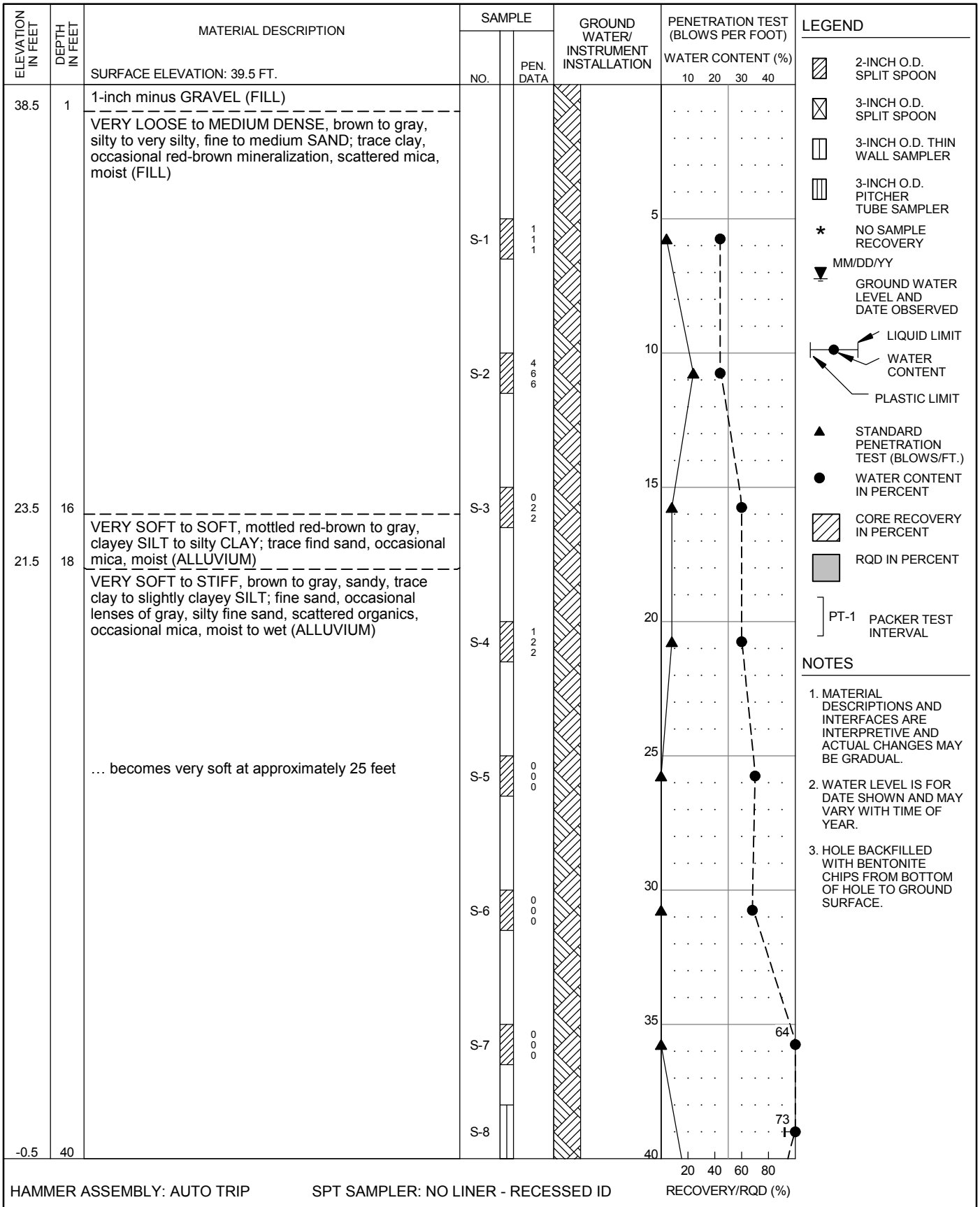
PROJ 2320
FIG. A63



HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 3/19/2014 FINISH: 3/19/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-64 (1 of 2)

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014
PROJ 2320
FIG. A64

ELEVATION IN FEET	DEPTH IN FEET	MATERIAL DESCRIPTION	SAMPLE NO.	SAMPLE PEN. DATA	GROUND WATER/ INSTRUMENT INSTALLATION
		SURFACE ELEVATION: 39.5 FT.			
		(continued from previous page)			
-2.0	41.5	… becomes stiff at approximately 40 feet	S-9	4 4 5	
		Bottom of Boring: 41.5 FT			

PENETRATION TEST (BLOWS PER FOOT)

WATER CONTENT (%)

10 20 30 40

45 50 55 60 65 70 75 80

20 40 60 80

RECOVERY/RQD (%)

LEGEND

- 2-INCH O.D. SPLIT SPOON
- 3-INCH O.D. SPLIT SPOON
- 3-INCH O.D. THIN WALL SAMPLER
- 3-INCH O.D. PITCHER TUBE SAMPLER
- * NO SAMPLE RECOVERY
- MM/DD/YY GROUND WATER LEVEL AND DATE OBSERVED
- LIQUID LIMIT
- WATER CONTENT
- PLASTIC LIMIT
- STANDARD PENETRATION TEST (BLOWS/FT.)
- WATER CONTENT IN PERCENT
- CORE RECOVERY IN PERCENT
- RQD IN PERCENT
- PT-1 PACKER TEST INTERVAL

NOTES

1. MATERIAL DESCRIPTIONS AND INTERFACES ARE INTERPRETIVE AND ACTUAL CHANGES MAY BE GRADUAL.
2. WATER LEVEL IS FOR DATE SHOWN AND MAY VARY WITH TIME OF YEAR.
3. HOLE BACKFILLED WITH BENTONITE CHIPS FROM BOTTOM OF HOLE TO GROUND SURFACE.

HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ

SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 3/19/2014 FINISH: 3/19/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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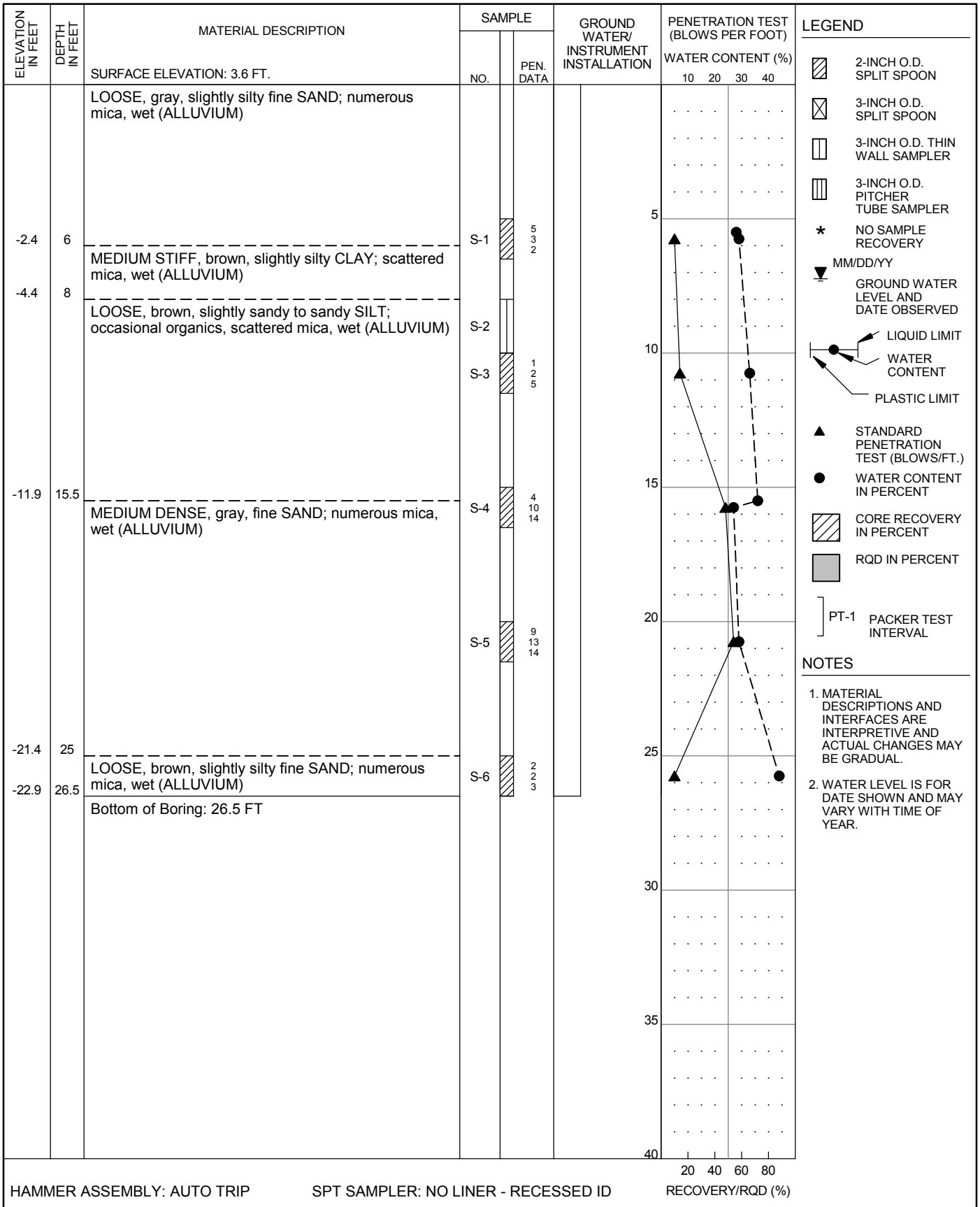
SUMMARY BORING LOG P2-CC-64 (2 of 2)

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014

PROJ 2320

FIG. A64



HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 3 7/8"

DRILLER: WESTERN STATES
DATE START: 5/1/2014 FINISH: 5/1/2014
DRILLING TECHNIQUE: MUD ROTARY

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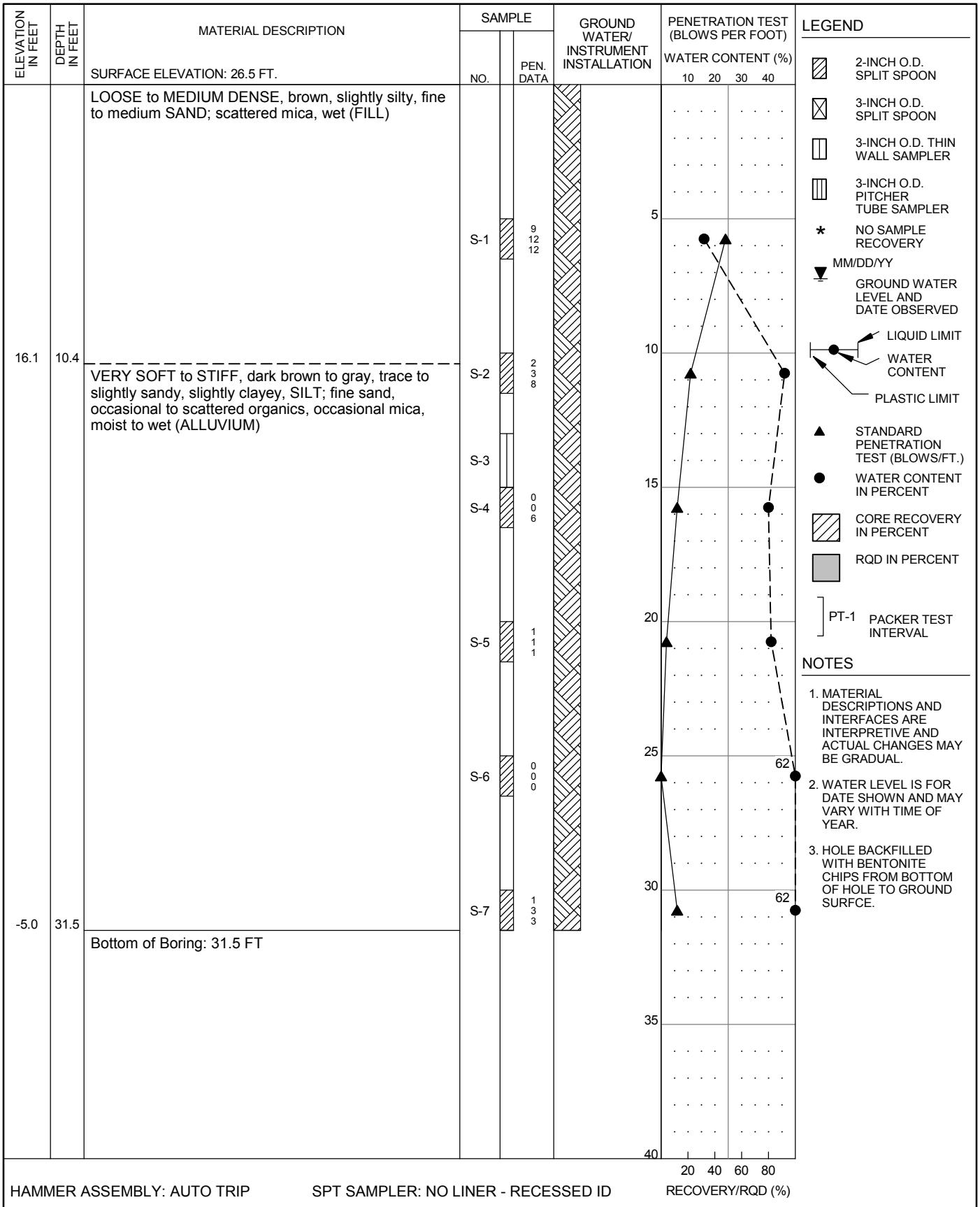
SUMMARY BORING LOG P2-CC-65

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014

PROJ 2320

FIG. A65



HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ
SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 3/21/2014 FINISH: 3/21/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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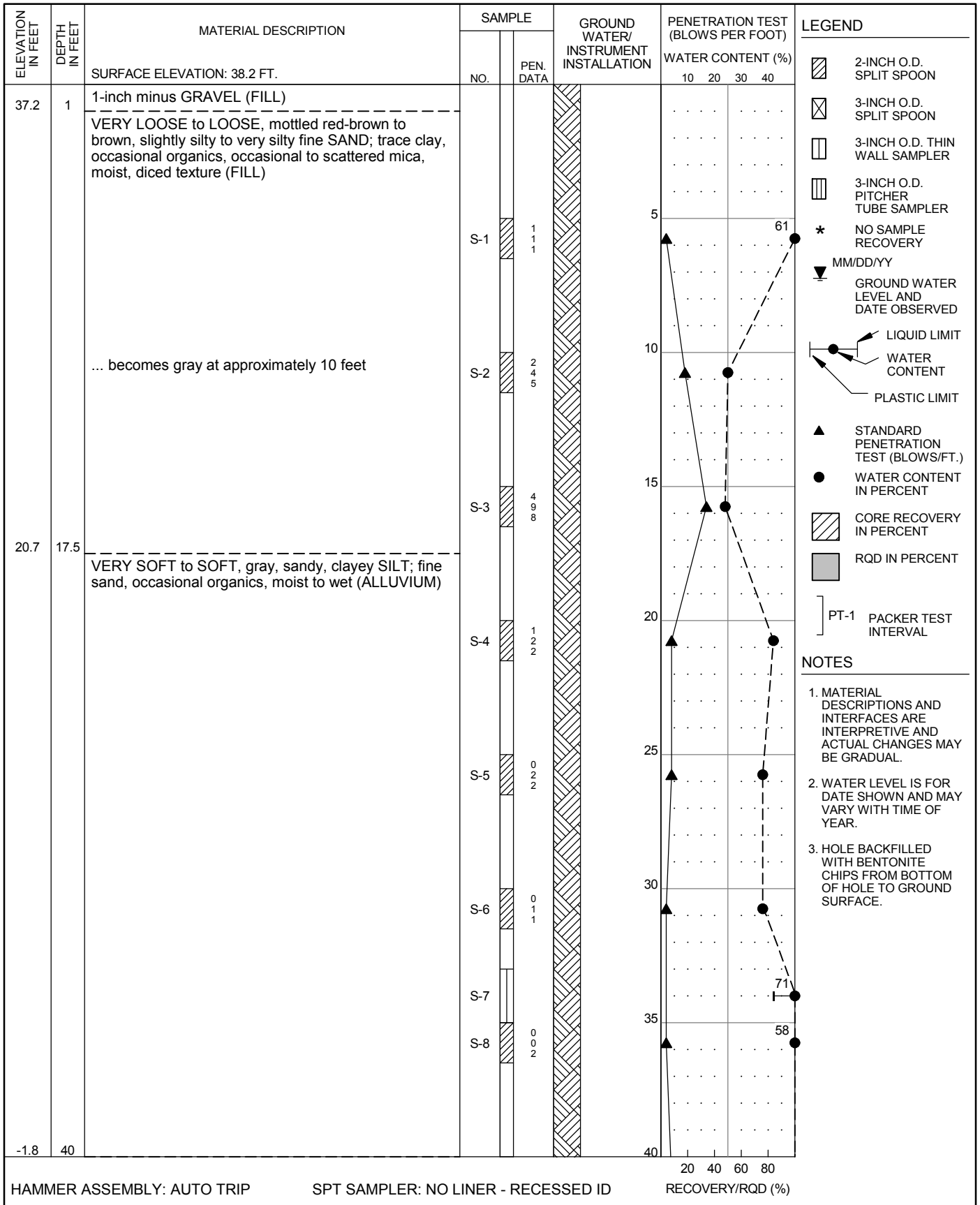
SUMMARY BORING LOG P2-CC-66

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014

PROJ 2320

FIG. A66



HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ
SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 3/19/2014 FINISH: 3/20/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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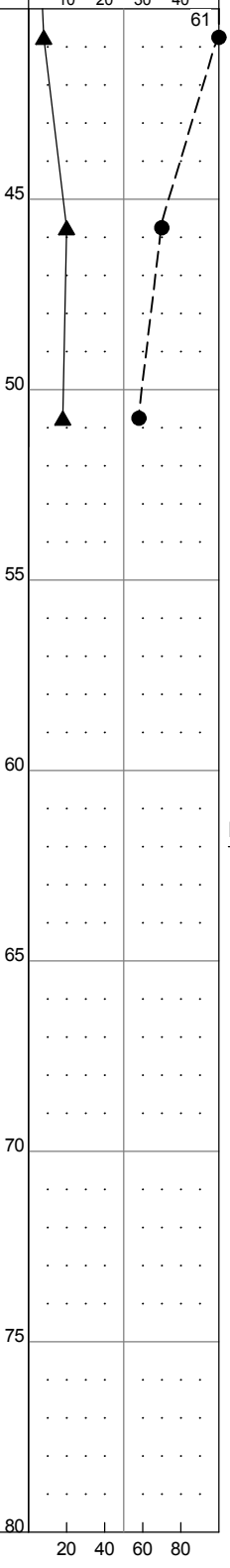
SUMMARY BORING LOG P2-CC-67 (1 of 2)

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014
PROJ 2320
FIG. A67

ELEVATION IN FEET	DEPTH IN FEET	MATERIAL DESCRIPTION	SAMPLE NO.	SAMPLE PEN. DATA	GROUND WATER/ INSTRUMENT INSTALLATION
		SURFACE ELEVATION: 38.2 FT.			
		(continued from previous page)	S-9	0 1 3	
		... becomes stiff at appproximately 45 feet	S-10	5 4 6	
-9.8	48	LOOSE, gray, silty to very silty, fine SAND; occasional organics, scattered mica, wet (ALLUVIUM)	S-11	3 3 6	
-13.3	51.5	Bottom of Boring: 51.5 FT			



LEGEND

- 2-INCH O.D. SPLIT SPOON
- 3-INCH O.D. SPLIT SPOON
- 3-INCH O.D. THIN WALL SAMPLER
- 3-INCH O.D. PITCHER TUBE SAMPLER
- * NO SAMPLE RECOVERY
- MM/DD/YY GROUND WATER LEVEL AND DATE OBSERVED
- LIQUID LIMIT
- WATER CONTENT
- PLASTIC LIMIT
- STANDARD PENETRATION TEST (BLOWS/FT.)
- WATER CONTENT IN PERCENT
- CORE RECOVERY IN PERCENT
- RQD IN PERCENT
- PT-1 PACKER TEST INTERVAL

NOTES

1. MATERIAL DESCRIPTIONS AND INTERFACES ARE INTERPRETIVE AND ACTUAL CHANGES MAY BE GRADUAL.
2. WATER LEVEL IS FOR DATE SHOWN AND MAY VARY WITH TIME OF YEAR.
3. HOLE BACKFILLED WITH BENTONITE CHIPS FROM BOTTOM OF HOLE TO GROUND SURFACE.

HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 3/19/2014 FINISH: 3/20/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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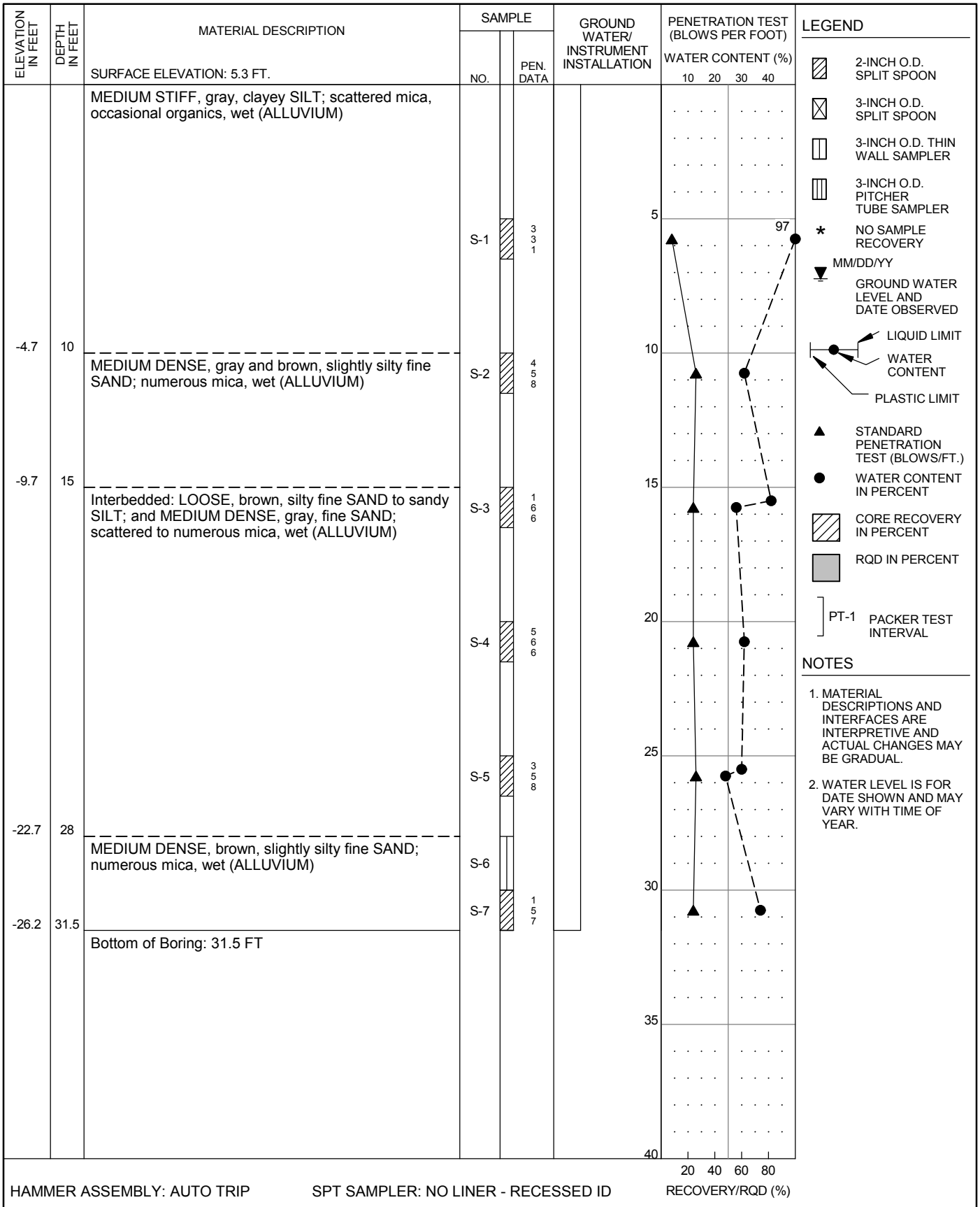
SUMMARY BORING LOG P2-CC-67 (2 of 2)

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014
PROJ 2320
FIG. A67



HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ
SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 3 7/8"

DRILLER: WESTERN STATES
DATE START: 5/1/2014 FINISH: 5/1/2014
DRILLING TECHNIQUE: MUD ROTARY

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SUMMARY BORING LOG P2-CC-68

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014
PROJ 2320
FIG. A68

ELEVATION IN FEET	DEPTH IN FEET	MATERIAL DESCRIPTION	SAMPLE NO.	SAMPLE PEN. DATA
		SURFACE ELEVATION: 23.3 FT.		
		VERY SOFT, brown, slightly sandy, slightly clayey SILT; fine sand, scattered organics, occasional orange-brown mineralization, scattered mica, moist (ALLUVIUM)	S-1	1 2 1
		…becomes wet at approximately 10 feet	S-2	0 0 0
10.8	12.5			
		VERY LOOSE, gray, slightly sandy SILT; trace clay, fine sand, scattered fine organics, scattered mica, wet (ALLUVIUM)	S-3	0 0 0
			S-4	0 0 0
			S-5	
-1.7	25			
		LOOSE, blue-gray, silty fine SAND; scattered mica, wet (ALLUVIUM)	S-6	1 2 3
-3.2	26.5	Bottom of Boring: 26.5 FT		

GROUND WATER/ INSTRUMENT INSTALLATION

PENETRATION TEST (BLOWS PER FOOT)

WATER CONTENT (%)

10 20 30 40

5 10 15 20 25 30 35 40

60

20 40 60 80

RECOVERY/RQD (%)

LEGEND

- 2-INCH O.D. SPLIT SPOON
- 3-INCH O.D. SPLIT SPOON
- 3-INCH O.D. THIN WALL SAMPLER
- 3-INCH O.D. PITCHER TUBE SAMPLER
- * NO SAMPLE RECOVERY
- MM/DD/YY GROUND WATER LEVEL AND DATE OBSERVED
- LIQUID LIMIT
- WATER CONTENT
- PLASTIC LIMIT
- STANDARD PENETRATION TEST (BLOWS/FT.)
- WATER CONTENT IN PERCENT
- CORE RECOVERY IN PERCENT
- RQD IN PERCENT
- PT-1 PACKER TEST INTERVAL

NOTES

1. MATERIAL DESCRIPTIONS AND INTERFACES ARE INTERPRETIVE AND ACTUAL CHANGES MAY BE GRADUAL.
2. WATER LEVEL IS FOR DATE SHOWN AND MAY VARY WITH TIME OF YEAR.
3. BORING BACKFILLED WITH BENTONITE CHIPS FROM BOTTOM OF HOLE TO GROUND SURFACE.
4. FALLING HEAD PERMEABILITY TEST PERFORMED AT 25 FEET BELOW GROUND SURFACE.

HAMMER ASSEMBLY: AUTO TRIP

DRILL ROD USED: NWJ

SPT SAMPLER: NO LINER - RECESSED ID

BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES

DATE START: 4/1/2014 FINISH: 4/1/2014

DRILLING TECHNIQUE: HOLLOW STEM AUGER

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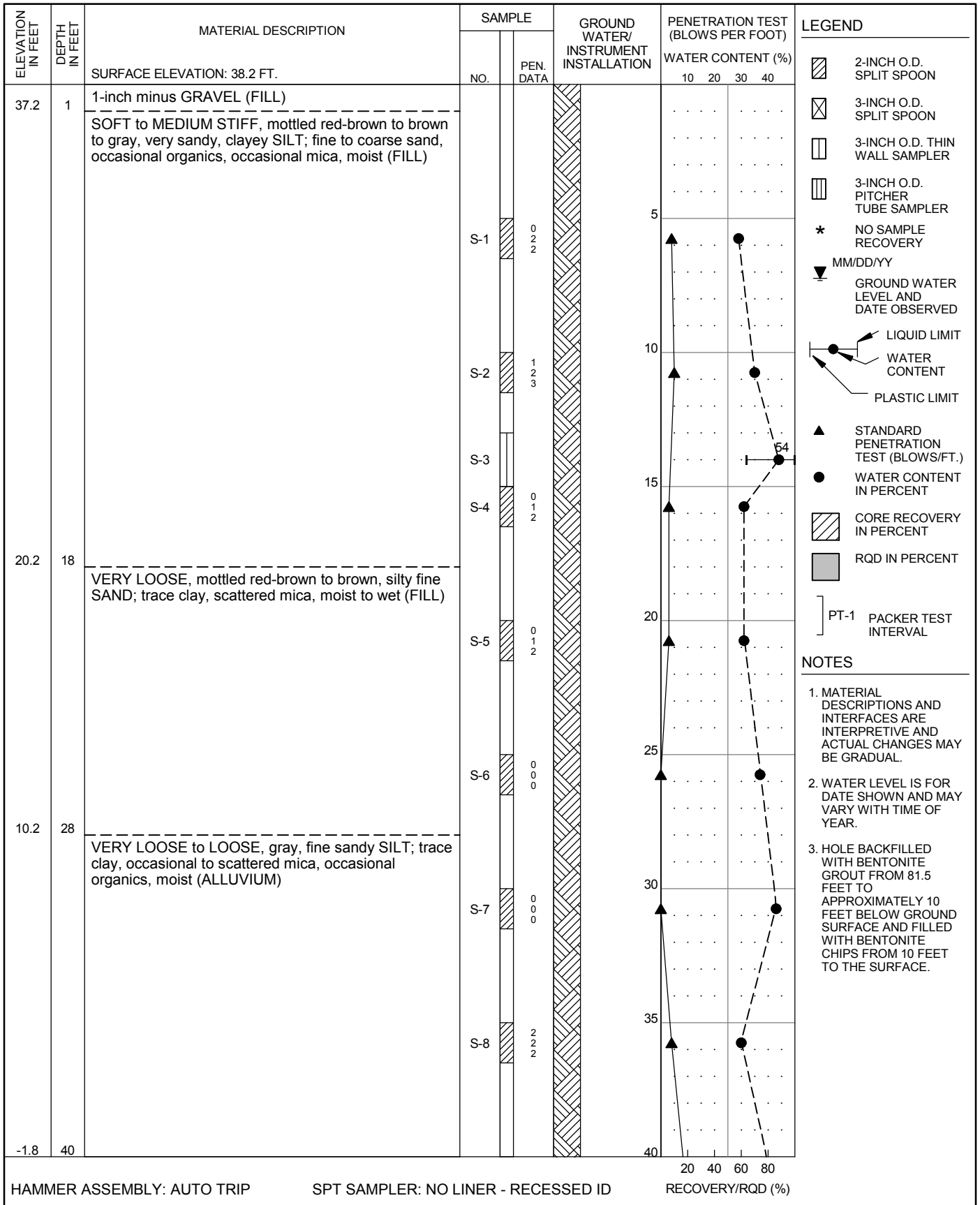
SUMMARY BORING LOG P2-CC-69

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014

PROJ 2320

FIG. A69



NOTES

1. MATERIAL DESCRIPTIONS AND INTERFACES ARE INTERPRETIVE AND ACTUAL CHANGES MAY BE GRADUAL.
2. WATER LEVEL IS FOR DATE SHOWN AND MAY VARY WITH TIME OF YEAR.
3. HOLE BACKFILLED WITH BENTONITE GROUT FROM 81.5 FEET TO APPROXIMATELY 10 FEET BELOW GROUND SURFACE AND FILLED WITH BENTONITE CHIPS FROM 10 FEET TO THE SURFACE.

HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ
SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 3/20/2014 FINISH: 3/20/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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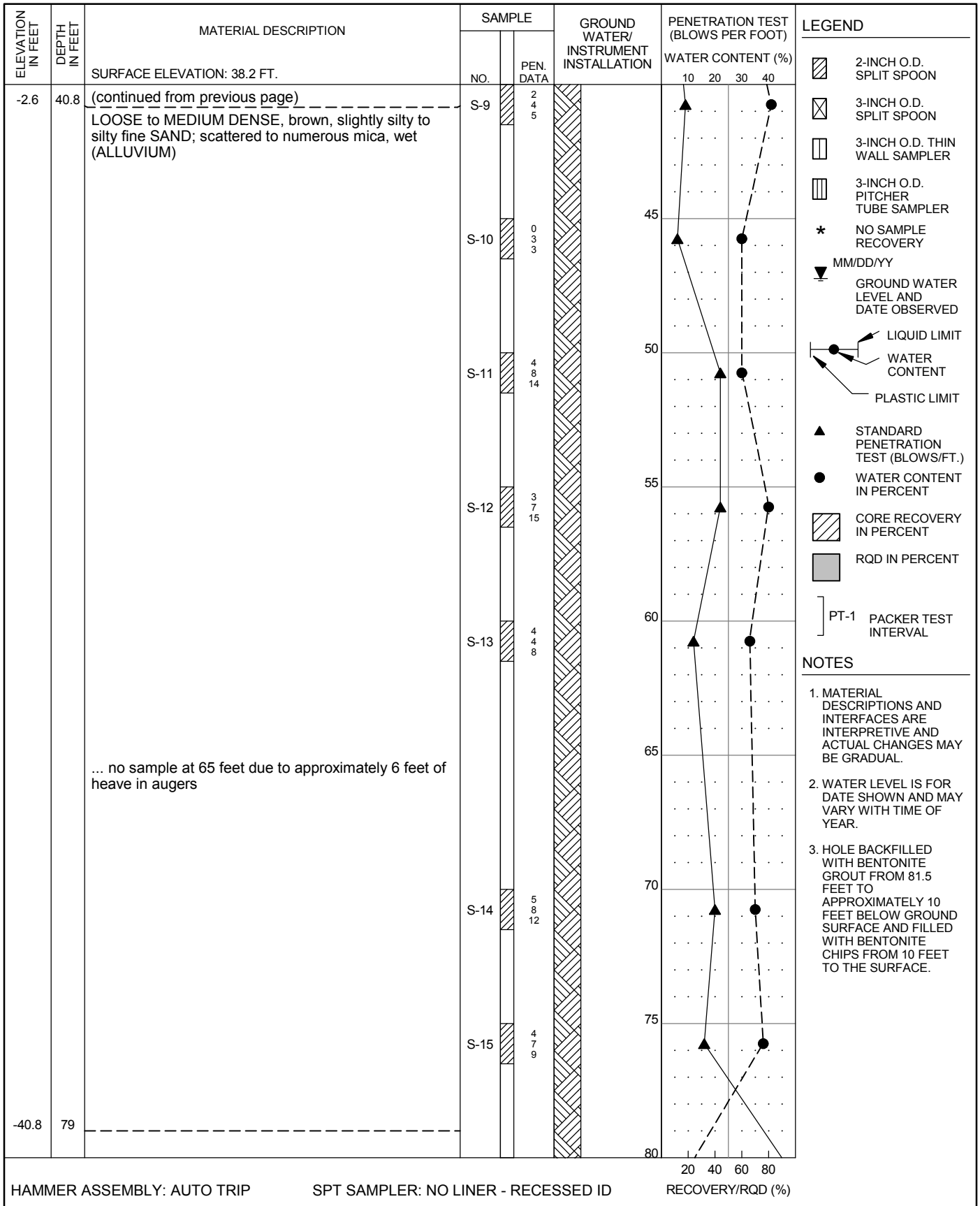
SUMMARY BORING LOG P2-CC-70 (1 of 3)

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014

PROJ 2320

FIG. A70



HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 3/20/2014 FINISH: 3/20/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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SUMMARY BORING LOG P2-CC-70 (2 of 3)

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014
PROJ 2320
FIG. A70

ELEVATION IN FEET	DEPTH IN FEET	MATERIAL DESCRIPTION	SAMPLE NO.	SAMPLE PEN. DATA	GROUND WATER/ INSTRUMENT INSTALLATION
		SURFACE ELEVATION: 38.2 FT.			
-43.3	81.5	VERY DENSE, brown to gray, sandy GRAVEL; well-graded with fine to coarse sand and gravel clasts, rounded gravel clasts up to 1.5 inches in diameter, wet (TROUTDALE FORMATION)	S-16	50/5"	
		Bottom of Boring: 81.5 FT			

PENETRATION TEST (BLOWS PER FOOT)

WATER CONTENT (%)

10 20 30 40

85 90 95 100 105 110 115 120

20 40 60 80

RECOVERY/RQD (%)

LEGEND

- 2-INCH O.D. SPLIT SPOON
- 3-INCH O.D. SPLIT SPOON
- 3-INCH O.D. THIN WALL SAMPLER
- 3-INCH O.D. PITCHER TUBE SAMPLER
- * NO SAMPLE RECOVERY
- MM/DD/YY GROUND WATER LEVEL AND DATE OBSERVED
- LIQUID LIMIT
- WATER CONTENT
- PLASTIC LIMIT
- STANDARD PENETRATION TEST (BLOWS/FT.)
- WATER CONTENT IN PERCENT
- CORE RECOVERY IN PERCENT
- RQD IN PERCENT
- PT-1 PACKER TEST INTERVAL

NOTES

1. MATERIAL DESCRIPTIONS AND INTERFACES ARE INTERPRETIVE AND ACTUAL CHANGES MAY BE GRADUAL.
2. WATER LEVEL IS FOR DATE SHOWN AND MAY VARY WITH TIME OF YEAR.
3. HOLE BACKFILLED WITH BENTONITE GROUT FROM 81.5 FEET TO APPROXIMATELY 10 FEET BELOW GROUND SURFACE AND FILLED WITH BENTONITE CHIPS FROM 10 FEET TO THE SURFACE.

HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ
SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 3/20/2014 FINISH: 3/20/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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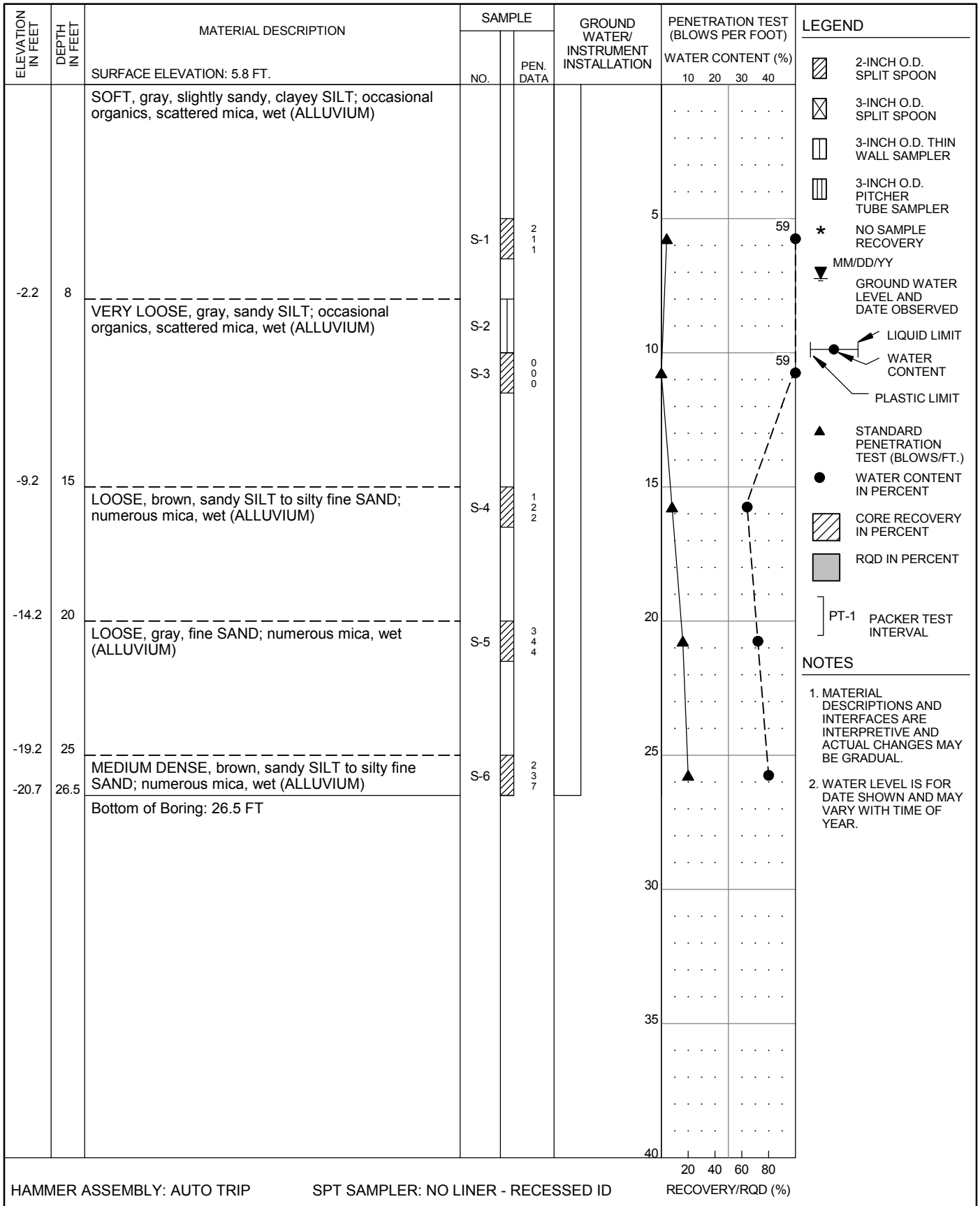
SUMMARY BORING LOG P2-CC-70 (3 of 3)

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014

PROJ 2320

FIG. A70



HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ
SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 3 7/8"

DRILLER: WESTERN STATES
DATE START: 5/2/2014 FINISH: 5/2/2018
DRILLING TECHNIQUE: MUD ROTARY

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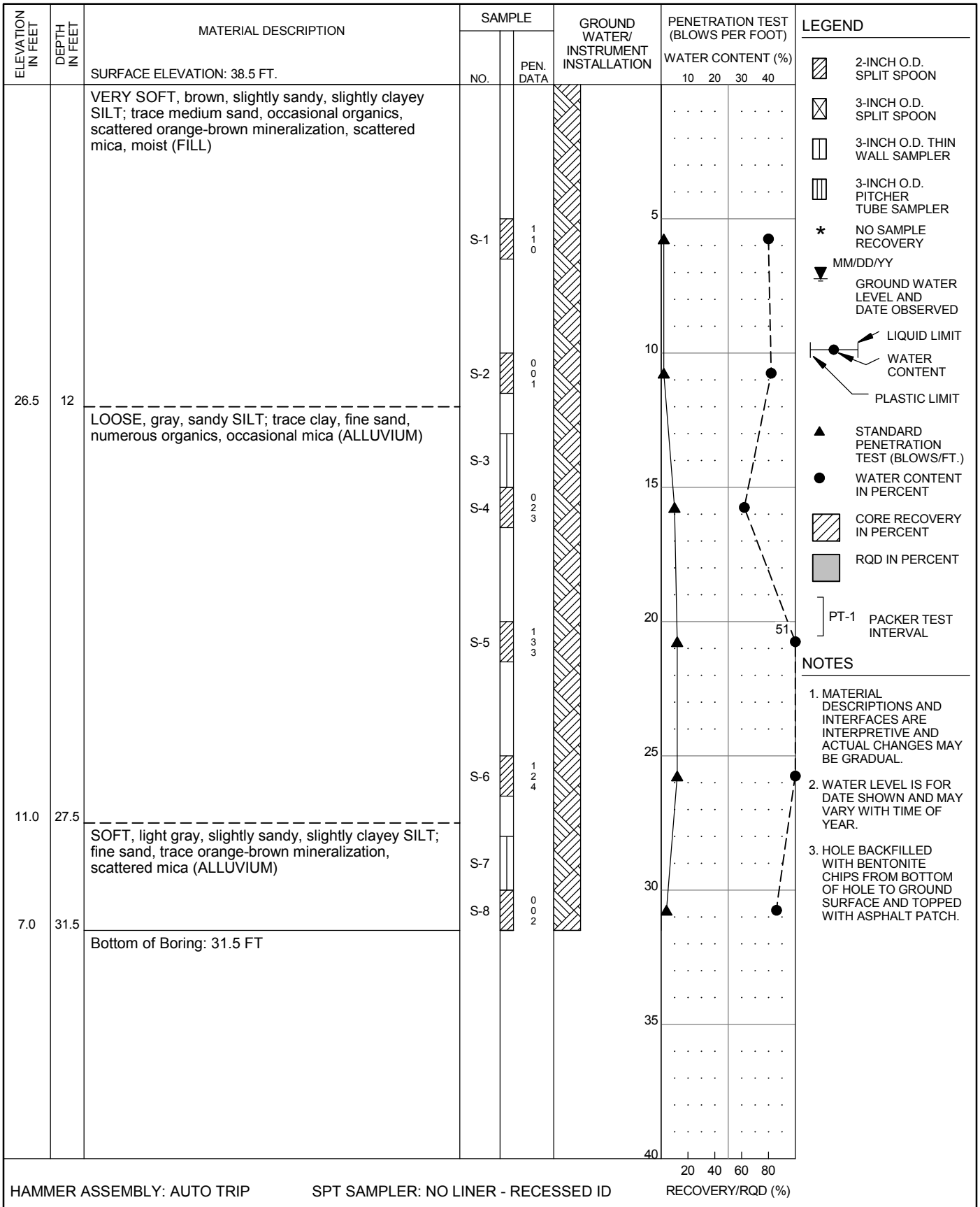
SUMMARY BORING LOG P2-CC-71

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014
PROJ 2320
FIG. A71



HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 4/1/2014 FINISH: 4/1/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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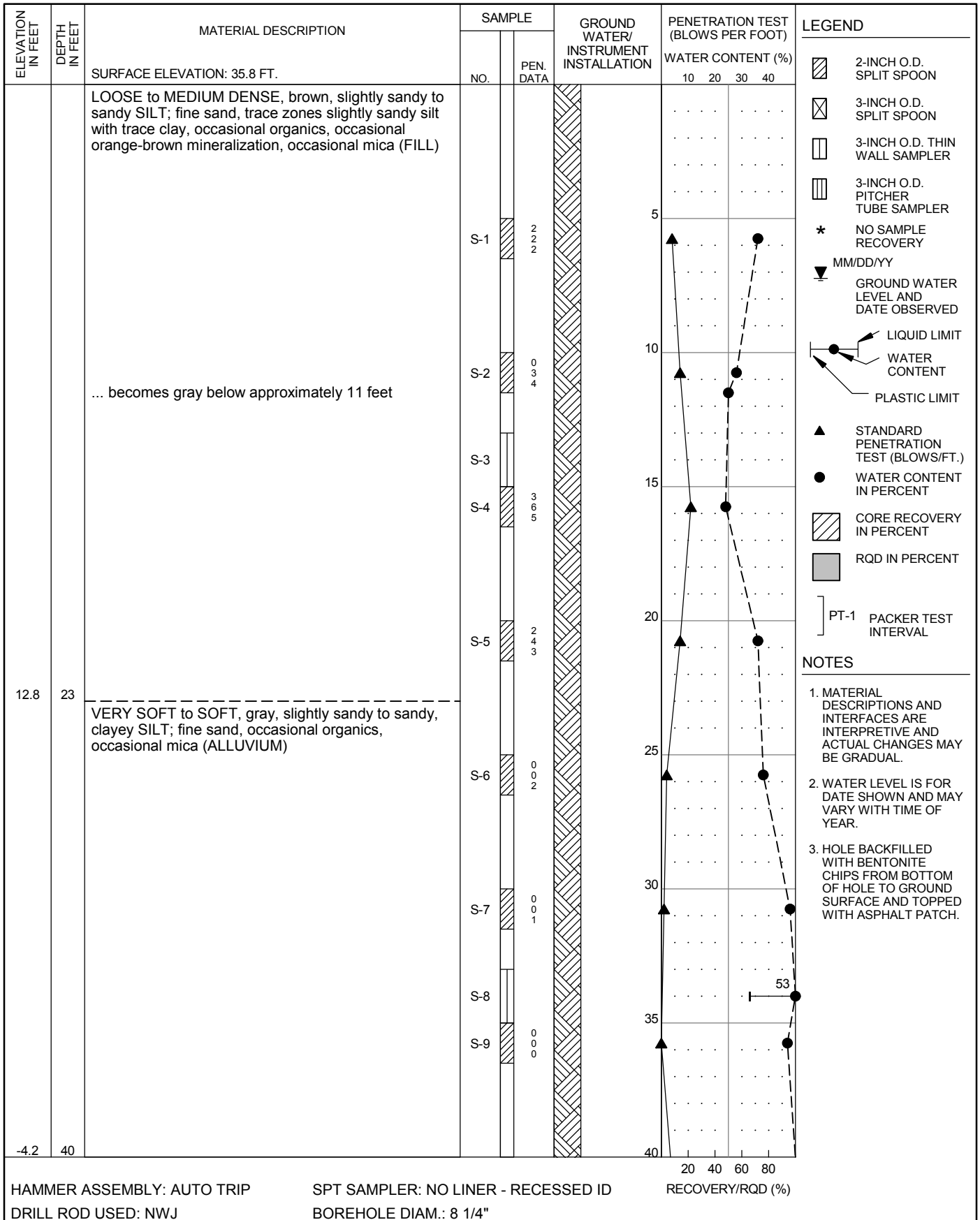
SUMMARY BORING LOG P2-CC-72

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014
PROJ 2320
FIG. A72



HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 3/10/2014 FINISH: 3/10/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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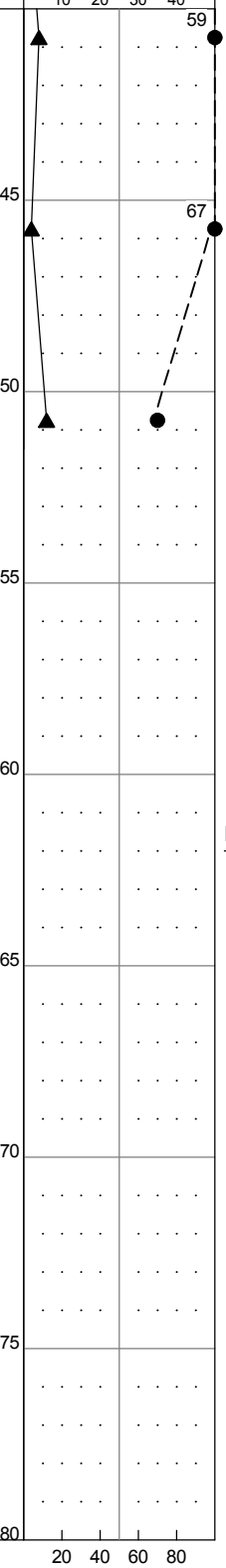
SUMMARY BORING LOG P2-CC-73 (1 of 2)

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014
PROJ 2320
FIG. A73

ELEVATION IN FEET	DEPTH IN FEET	MATERIAL DESCRIPTION	SAMPLE NO.	SAMPLE PEN. DATA	GROUND WATER/ INSTRUMENT INSTALLATION
		SURFACE ELEVATION: 35.8 FT.			
		(continued from previous page)	S-10	0 1 3	
		... trace sand below approximately 45 feet	S-11	0 0 2	
-12.2	48	Interbedded: LOOSE, gray, sandy SILT; trace clay, and LOOSE, gray, silty fine SAND; silt beds 3 to 6-inches thick, sand beds 4 to 5-inches thick, fine sand, trace organics in silt, trace mica, wet (ALLUVIUM)	S-12	2 2 4	
-15.7	51.5	Bottom of Boring: 51.5 FT			



LEGEND

- 2-INCH O.D. SPLIT SPOON
- 3-INCH O.D. SPLIT SPOON
- 3-INCH O.D. THIN WALL SAMPLER
- 3-INCH O.D. PITCHER TUBE SAMPLER
- * NO SAMPLE RECOVERY
- MM/DD/YY GROUND WATER LEVEL AND DATE OBSERVED
- LIQUID LIMIT
- WATER CONTENT
- PLASTIC LIMIT
- STANDARD PENETRATION TEST (BLOWS/FT.)
- WATER CONTENT IN PERCENT
- CORE RECOVERY IN PERCENT
- RQD IN PERCENT
- PT-1 PACKER TEST INTERVAL

NOTES

1. MATERIAL DESCRIPTIONS AND INTERFACES ARE INTERPRETIVE AND ACTUAL CHANGES MAY BE GRADUAL.
2. WATER LEVEL IS FOR DATE SHOWN AND MAY VARY WITH TIME OF YEAR.
3. HOLE BACKFILLED WITH BENTONITE CHIPS FROM BOTTOM OF HOLE TO GROUND SURFACE AND TOPPED WITH ASPHALT PATCH.

HAMMER ASSEMBLY: AUTO TRIP
SPT SAMPLER: NO LINER - RECESSED ID
DRILL ROD USED: NWJ
BOREHOLE DIAM.: 8 1/4"

DRILLER: WESTERN STATES
DATE START: 3/10/2014 FINISH: 3/10/2014
DRILLING TECHNIQUE: HOLLOW STEM AUGER

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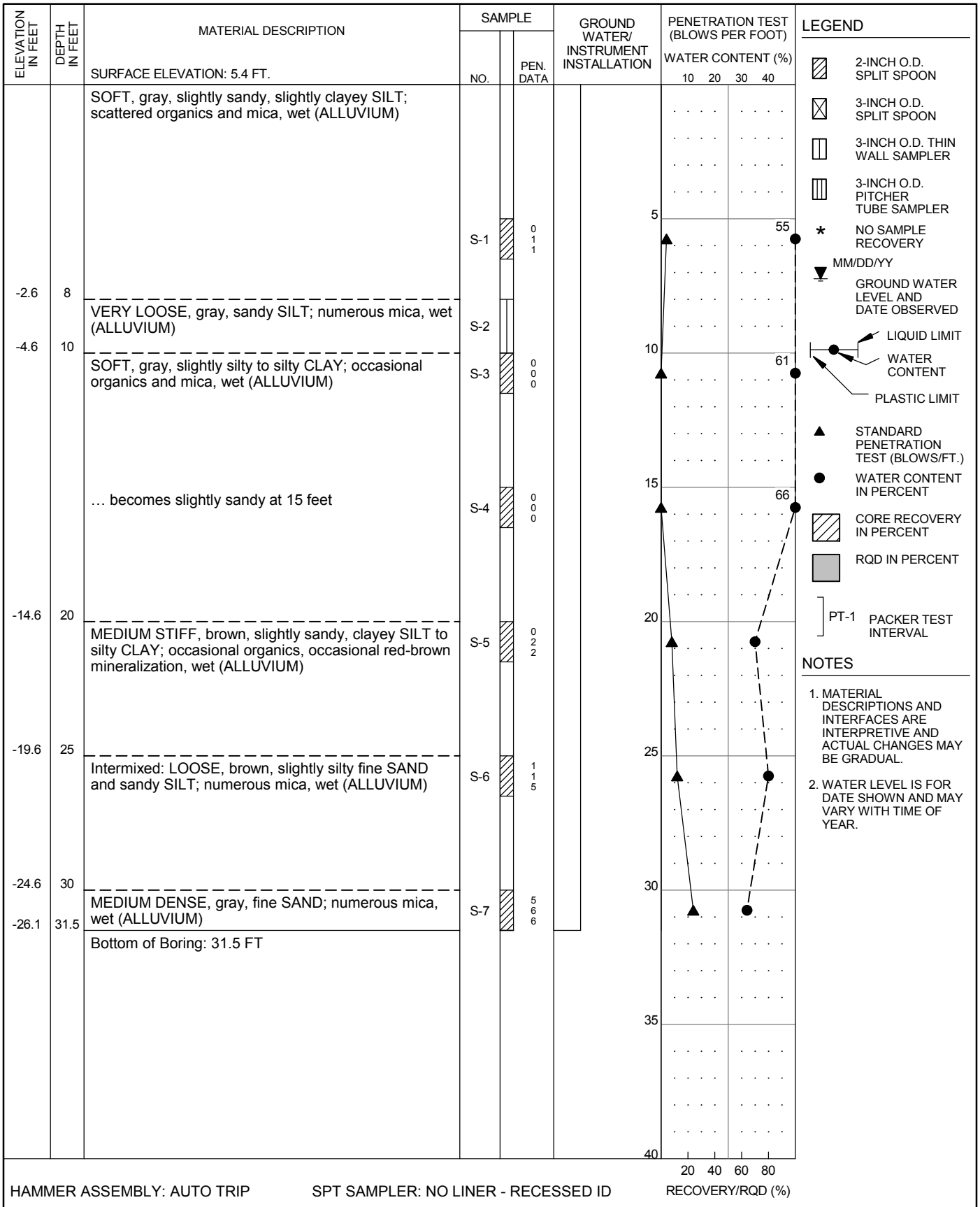
SUMMARY BORING LOG P2-CC-73 (2 of 2)

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014
PROJ 2320
FIG. A73



HAMMER ASSEMBLY: AUTO TRIP
DRILL ROD USED: NWJ
SPT SAMPLER: NO LINER - RECESSED ID
BOREHOLE DIAM.: 3 7/8"

DRILLER: WESTERN STATES
DATE START: 5/2/2014 FINISH: 5/2/2014
DRILLING TECHNIQUE: MUD ROTARY

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SUMMARY BORING LOG P2-CC-74

PENINSULA DISTRICT 2 LEVEE
PORTLAND, OR

SEP 2014
PROJ 2320
FIG. A74

APPENDIX B

SUMMARY BORING LOGS
(By Others)

Appendix B – Table of Contents

Report References

(a) Summary Boring Log from – I-5: Columbia River Crossing – North Portland Harbor, report prepared by Shannon & Wilson, Inc., November 2011.

(b) Summary Boring Log from – I-5: Victory Boulevard to Lombard Section, report prepared by GeoDesign, Inc., October 2006.

(c) Summary Boring Log from – OR99W: N. Victory Blvd. – N. Argyle St., report prepared by Shannon & Wilson, Inc., October 2013.

Total Depth:	189.7 ft.	Northing:	107,311 ft.	Drilling Method:	Mud Rotary	Hole Diam.:	4 7/8 in.
Top Elevation:	-7.1 ft.	Easting:	1,082,186 ft.	Drilling Company:	Hardcore Drilling	Rod Type:	NWJ
Vert. Datum:	NAVD88	Station:		Drill Rig Equipment:	CME 75 (YEAA627)	Hammer Type:	Automatic
Horiz. Datum:	CRC Project	Offset:		Other Comments:			

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 soil types, and the transitions may be gradual.

Loose brown GRAVEL with sand; wet; fine subangular gravel. (GP)
-8.6 / 1.5
FILL

Loose gray SAND; wet; medium to coarse sand; occasional wood debris. (SP)
SAND ALLUVIUM 1

-15.1 / 8.0

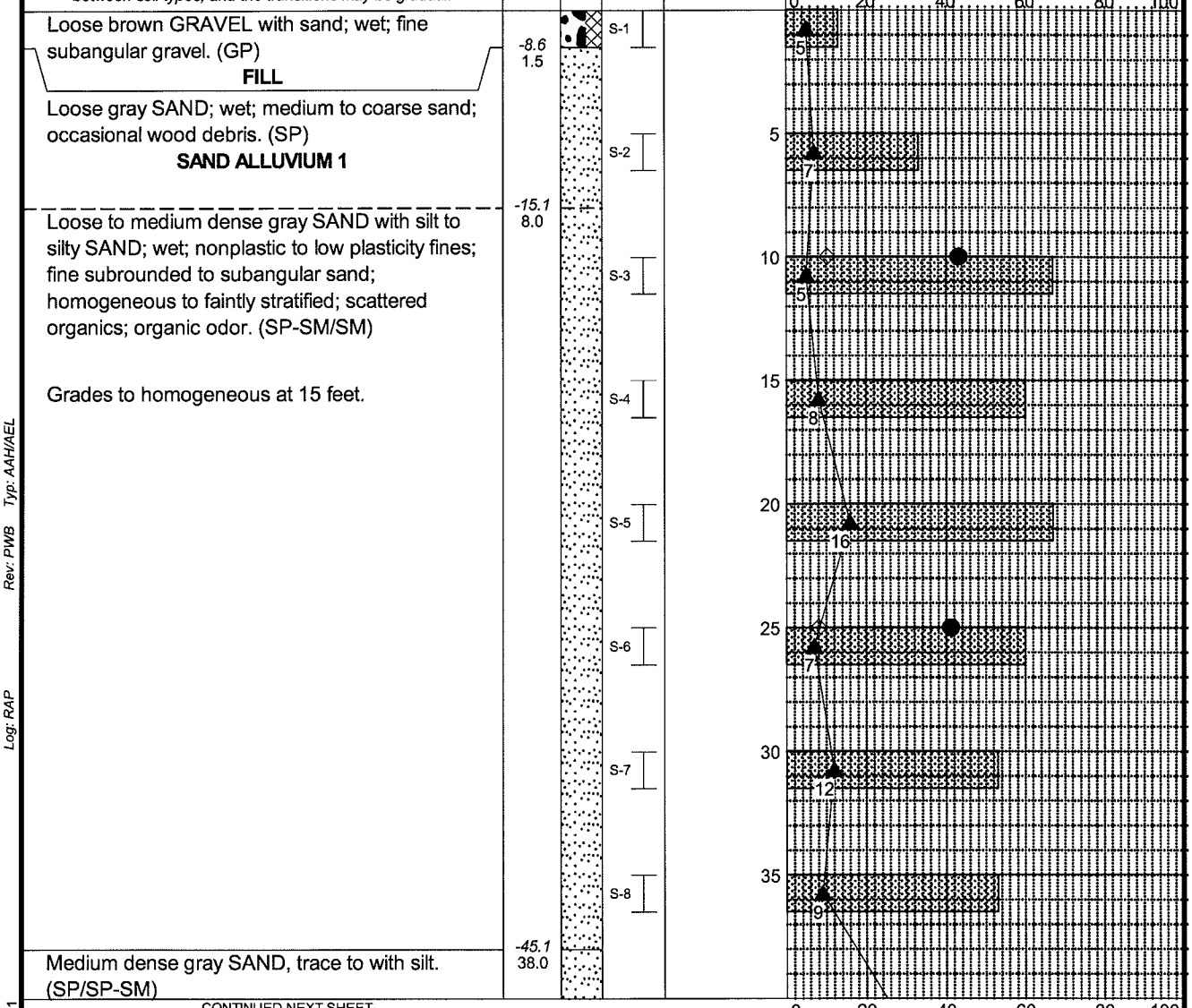
Loose to medium dense gray SAND with silt to silty SAND; wet; nonplastic to low plasticity fines; fine subrounded to subangular sand; homogeneous to faintly stratified; scattered organics; organic odor. (SP-SM/SM)

Grades to homogeneous at 15 feet.

-45.1 / 38.0

Medium dense gray SAND, trace to with silt. (SP/SP-SM)

CONTINUED NEXT SHEET



LEGEND

* Sample Not Recovered

Standard Penetration Test

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 and elevation should be considered approximate.
5. Energy-corrected blow counts are not provided for non-standard samplers.

I-5 Columbia River Crossing
North Portland Harbor
Portland, Oregon / Vancouver, Washington

LOG OF BORING CRC-SC-020

November 2011 24-1-03595-010

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A22
Sheet 1 of 5

REV 3
FIG. B1

MASTER LOG E NE 24 1 03595.GPJ SHAN WILGDT 11/15/11 Log: RAP Rev: PWB Typ: AAH/AEL

Total Depth:	189.7 ft.	Northing:	107,311 ft.	Drilling Method:	Mud Rotary	Hole Diam.:	4 7/8 in.
Top Elevation:	-7.1 ft.	Easting:	1,082,186 ft.	Drilling Company:	Hardcore Drilling	Rod Type:	NWJ
Vert. Datum:	NAVD88	Station:		Drill Rig Equipment:	CME 75 (YEAA627)	Hammer Type:	Automatic
Horiz. Datum:	CRC Project	Offset:		Other Comments:			

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 soil types, and the transitions may be gradual.

Elev. Depth (ft.) | Symbol | Samples | Ground Water | Depth, ft.

PENETRATION RESISTANCE, N (blows/ft.)

▲ Energy-Corrected Field Blow Count [5], N_E

Hammer Wt. & Drop: 140 lbs / 30 inches

Continued:

Medium dense gray SAND with silt; wet; nonplastic fines; fine to medium sand; stratified; micaceous; occasional silt lenses. (SP-SM)

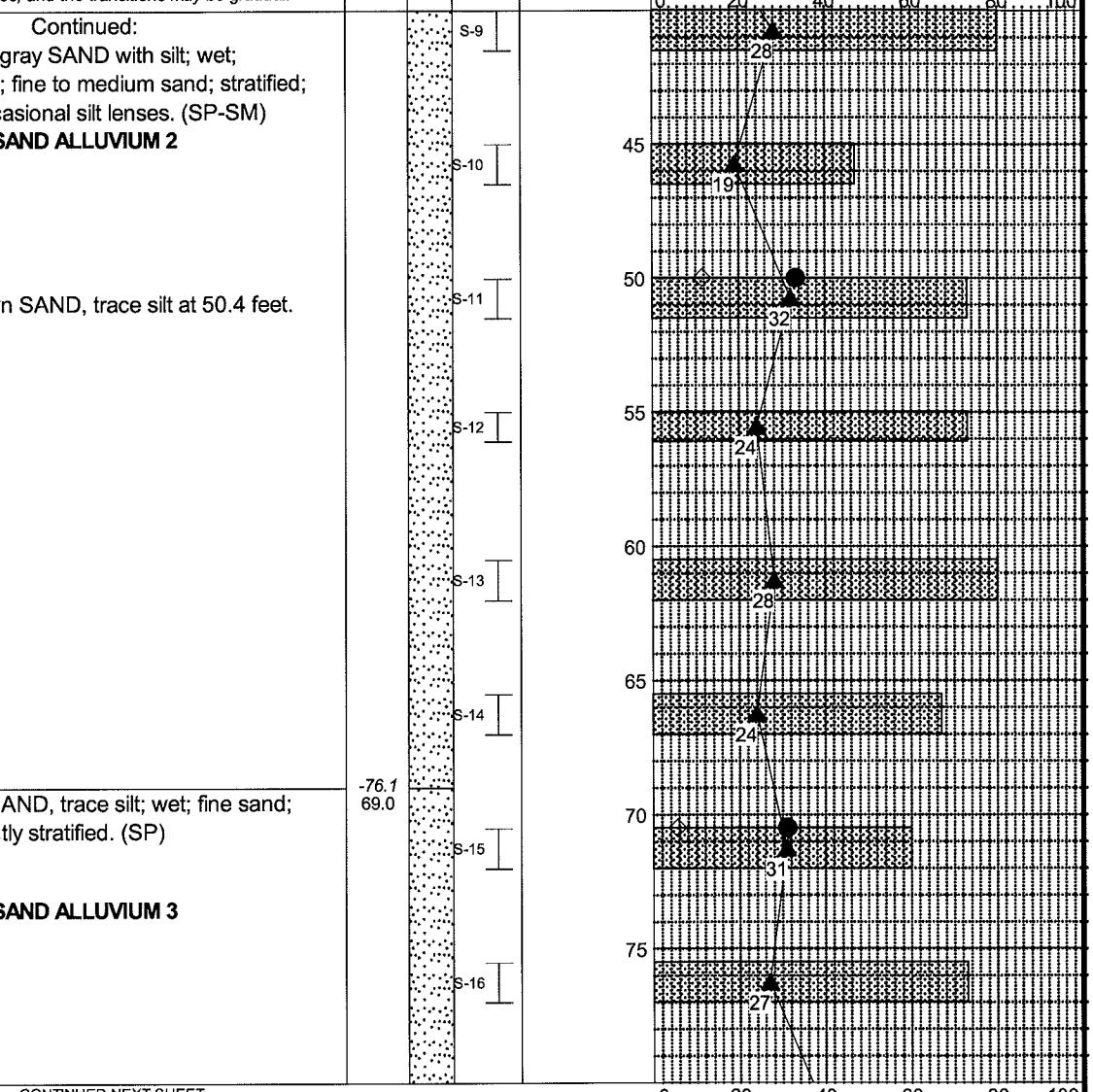
SAND ALLUVIUM 2

Grades to brown SAND, trace silt at 50.4 feet. (SP)

-76.1
69.0

Dense brown SAND, trace silt; wet; fine sand; micaceous; faintly stratified. (SP)

SAND ALLUVIUM 3



CONTINUED NEXT SHEET

LEGEND

* Sample Not Recovered

Standard Penetration Test

Recovery (%)

◇ % Fines (<0.075mm)

● % Water Content

Plastic Limit ⊢—⊣ Liquid Limit

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 and elevation should be considered approximate.
5. Energy-corrected blow counts are not provided for non-standard samplers.

I-5 Columbia River Crossing
North Portland Harbor
Portland, Oregon / Vancouver, Washington

LOG OF BORING CRC-SC-020

November 2011 24-1-03595-010

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A22
Sheet 2 of 5

REV 3

FIG. B1

MASTER LOG E NE 24 1 03595.GPJ SHAN WIL.GDT 11/15/11 Log: RAP Rev: PWB Typ: AAH/AEL

Total Depth:	189.7 ft.	Northing:	107,311 ft.	Drilling Method:	Mud Rotary	Hole Diam.:	4 7/8 in.
Top Elevation:	-7.1 ft.	Easting:	1,082,186 ft.	Drilling Company:	Hardcore Drilling	Rod Type:	NWJ
Vert. Datum:	NAVD88	Station:		Drill Rig Equipment:	CME 75 (YEAA627)	Hammer Type:	Automatic
Horiz. Datum:	CRC Project	Offset:		Other Comments:			

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 soil types, and the transitions may be gradual.

Elev. Depth (ft.) | Symbol | Samples | Ground Water | Depth, ft.

PENETRATION RESISTANCE, N (blows/ft.)

▲ Energy-Corrected Field Blow Count [5], N_E

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

Continued:

Dense brown SAND, trace silt; wet; fine sand; micaceous; faintly stratified. (SP)

SAND ALLUVIUM 3

S-17 (39)

S-18 (35)

S-19 (32)

-102.6
95.5

S-20 (88/10")

Very dense yellow-brown to gray sandy GRAVEL with cobbles, trace silt; wet; coarse rounded to subrounded gravel; occasional boulders. (GP)

GRAVEL ALLUVIUM

BOULDER at 99 feet.

-107.1
100.0

S-21 (50/1st 4")

Mud loss: 60 gallons, 102.5 to 103 feet.

Mud loss: 150 gallons, 108.5 feet.

S-22 (50/1st 4.25")

0 20 40 60 80 100

85 90 95 100 105 110 115

CONTINUED NEXT SHEET

LEGEND

* Sample Not Recovered

Standard Penetration Test

Recovery (%)

◇ % Fines (<0.075mm)

● % Water Content

Plastic Limit ⊢—⊣ Liquid Limit

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 and elevation should be considered approximate.
5. Energy-corrected blow counts are not provided for non-standard samplers.

I-5 Columbia River Crossing
North Portland Harbor
Portland, Oregon / Vancouver, Washington

LOG OF BORING CRC-SC-020

November 2011 24-1-03595-010

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A22
Sheet 3 of 5

REV 3

FIG. B1

MASTER LOG E NE 24 1 03595.GPJ SHAN WILGDT 11/15/11 Log: RAP Rev: PWB Typ: AAH/AEL

Total Depth:	189.7 ft.	Northing:	107,311 ft.	Drilling Method:	Mud Rotary	Hole Diam.:	4 7/8 in.
Top Elevation:	-7.1 ft.	Easting:	1,082,186 ft.	Drilling Company:	Hardcore Drilling	Rod Type:	NWJ
Vert. Datum:	NAVD88	Station:		Drill Rig Equipment:	CME 75 (YEAA627)	Hammer Type:	Automatic
Horiz. Datum:	CRC Project	Offset:		Other Comments:			

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 soil types, and the transitions may be gradual.

Elev. Depth (ft.) | Symbol | Samples | Ground Water | Depth, ft.

PENETRATION RESISTANCE, N (blows/ft.)

▲ Energy-Corrected Field Blow Count [5], N_E

Hammer Wt. & Drop: 140 lbs / 30 inches

0 20 40 60 80 100

Continued:

Very dense yellow-brown to gray sandy GRAVEL with cobbles, trace silt; wet; coarse rounded to subrounded gravel; occasional boulders. (GP)

GRAVEL ALLUVIUM

S-23 — 50/1st 3.5"

125

S-24 — 50/1st 2.5"

130

135

S-25 — 50/1st 5"

140

BOULDER from 145 to 146.5 feet.
Hole caving at 145 feet; added qwik-gel and grout to stabilize.

-153.6
146.5

145

S-26 * — 50/1st 1"

150

BOULDER from 151.2 to 152.5 feet.

-159.6
152.5

BOULDER from 155 to 157 feet.

155

Mud loss at 157 feet.

-164.1
157.0

0 20 40 60 80 100

CONTINUED NEXT SHEET

LEGEND

* Sample Not Recovered

I Standard Penetration Test

Recovery (%)

◇ % Fines (<0.075mm)

● % Water Content

Plastic Limit ⊢—⊣ Liquid Limit

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 and elevation should be considered approximate.
5. Energy-corrected blow counts are not provided for non-standard samplers.

I-5 Columbia River Crossing
North Portland Harbor
Portland, Oregon / Vancouver, Washington

LOG OF BORING CRC-SC-020

November 2011 24-1-03595-010

SHANNON & WILSON, INC.
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FIG. A22
Sheet 4 of 5

REV 3

FIG. B1

MASTER LOG E_NE 24 1 03595.GPJ SHAN WIL.GDT 11/15/11 Log: RAP Rev: PWB Typ: AAH/AEL

Total Depth:	189.7 ft.	Northing:	107,311 ft.	Drilling Method:	Mud Rotary	Hole Diam.:	4 7/8 in.
Top Elevation:	-7.1 ft.	Easting:	1,082,186 ft.	Drilling Company:	Hardcore Drilling	Rod Type:	NWJ
Vert. Datum:	NAVD88	Station:		Drill Rig Equipment:	CME 75 (YEAA627)	Hammer Type:	Automatic
Horiz. Datum:	CRC Project	Offset:		Other Comments:			

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 soil types, and the transitions may be gradual.

Elev. Depth (ft.) | Symbol | Samples | Ground Water | Depth, ft.

PENETRATION RESISTANCE, N (blows/ft.)

▲ Energy-Corrected Field Blow Count [5], N_E

Hammer Wt. & Drop: 140 lbs / 30 inches

0 20 40 60 80 100

Continued:

Very dense yellow-brown to gray sandy GRAVEL with cobbles, trace silt; wet; coarse rounded to subrounded gravel; occasional boulders. (GP)

GRAVEL ALLUVIUM

S-27 50/1st 5.5"

165

170

S-28 50/1st 5.5"

175

S-29 50/1st 5.5"

Grades to with yellow-green alteration minerals at 178.2 feet.

S-29: Recovery not recorded.

180

185

190

-196.8

Abandoned due to caving - November 16, 2010

189.7

195

0 20 40 60 80 100

LEGEND

* Sample Not Recovered

Standard Penetration Test

Recovery (%)

◇ % Fines (<0.075mm)

● % Water Content

Plastic Limit ——— Liquid Limit

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 and elevation should be considered approximate.
5. Energy-corrected blow counts are not provided for non-standard samplers.

I-5 Columbia River Crossing
North Portland Harbor
Portland, Oregon / Vancouver, Washington

LOG OF BORING CRC-SC-020

November 2011 24-1-03595-010

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A22
Sheet 5 of 5

REV 3

FIG. B1

MASTER LOG E_NE_24_1_03595.GPJ SHAN_WIL.GDT 11/15/11 Log: RAP Rev: PWB Typ: AAH/AEL

DRAFT

DRILL LOG

OREGON DEPARTMENT OF TRANSPORTATION

		Hole No. **TB12076-03**
Project **I-5: Victory Boulevard to Lombard Section**	Purpose **Col. Sl. Bridge Bent**	E.A. No. **PE000474**
Highway **001**	County **Multnomah**	Key No. **12076**
Hole Location Northing: **15,482.66** Easting: **0.00**		Start Card No.
Equipment **Prosonic SR118**	Driller **Prosonic**	Bridge No.
Project Geologist **Taylor/Hay/Gullixson/Clough**	Recorder **Taylor**	Ground Elev. **3.58 ft**
Start Date **June 25, 2006** End Date **June 25, 2006**	Total Depth **37.00 ft**	Tube Height

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

Rock Abbreviations

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

Typical Drilling Abbreviations

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

Lab Acronyms
CON - Consolidation Test
DS - Direct Shear
P200 - P200 Test
HYD - Hydrometer Gradation
SIEVE - Sieve Gradation
DD - Dry Density
ATT - Atterberg Limits Test

Depth (ft)	Test Type, No.	Percent Recovery	Soil: Driving Resistance / Rock: Discontinuity Data Or RQD%	Percent Natural Moisture	Material Description (SOIL: Soil Name, USCS, Color, Plasticity, Moisture, Consistency/Relative Density, Texture, Cementation, Structure, Origin; ROCK: Rock Name, Color, Weathering, Hardness, Discontinuity Spacing, Joint Filling, Core Recovery, Formation Name.)	Unit Description	Graphic Log	Drilling Methods, Size and Remarks / Water Level/ Date	Backfill/ Instrumentation
0	C1	100			C- 1 (0.00-5.50) Sandy SILT with some Organics; ML; Gray; Low plasticity; Wet; Very loose. Organics include wood, coniferous needles etc.	**0.00 - 7.00 Sandy SILT to Silty SAND; ML/SM; (Alluvium)**		Top of borehole is 9.5 feet below water level (Columbia Slough). Slough depth at hole: 9.5 feet	
5	C2	100			C- 2 (5.50-15.50) (a) 5.5' - 7.0': Silty SAND, trace to some Organics; SM; Gray; Nonplastic; Wet; Very loose.				
					(7.00) (b) 7' - 12': Clayey SILT to SILT with some Clay; MH-ML; Gray; Medium plasticity; Moist; Very soft (Sample at 9 ft).	**7.00 - 12.00 Clayey SILT to SILT; ML/MH; (Alluvium)**			
10									
					(12.00) (c) 12' - 15.5': Clayey SILT to Silty SAND with some Organics; ML; Gray; Nonplastic to low plasticity; Moist to wet; Very soft 0.1- to 0.3-foot-thick peaty horizons every 0.5 foot.	**12.00 - 15.50 SILT and SAND with Organics; ML, SM, OH; (Alluvium)**			
15	N1	100	0-0-0		N- 1 (15.50-17.00) Clayey SILT to SILT with some Clay; MH-ML; Variegated tan and brown with some gray; Medium plasticity; Moist to wet; Very soft. Faint laminations and thin bedding.	**15.50 - 23.50 SILT; ML/MH; (Alluvium)**		ATT at 15.0 feet; HYD; SIEVE N-1 - Weight of hammer dropped SPT easily at 15.5 feet	
	C3	100			C- 3 (17.00-25.50) Clayey SILT, trace Sand; MH; Gray; Medium plasticity; Moist to wet; Very soft. 20% sticks and other woody Organics from 23.5 to 25.5 feet.				
20									

ODOT DRILL LOG DEA-69-01-B1-30.GPJ ODOT_MAN.GDT 10/5/06

FIG. B2

Depth (ft)	Test Type, No.	Percent Recovery	Soil / Rock: Driving Resistance / Discontinuity Data Or RQD%	Percent Natural Moisture	Material Description (SOIL: Soil Name, USCS, Color, Plasticity, Moisture, Consistency/Relative Density, Texture, Cementation, Structure, Origin. ROCK: Rock Name, Color, Weathering, Hardness, Discontinuity Spacing, Joint Filling, Core Recovery, Formation Name.)	Unit Description	Graphic Log	Drilling Methods, Size and Remarks / Water Level/ Date	Backfill/ Instrumentation
20									
						23.50 - 25.50 SILT with Organics; MH/OH; (Alluvium)			
25	N3	100	6-9-9	26	N- 3 (25.50-27.00) SILT with some Sand; ML; Gray; Nonplastic; Moist-wet; Medium dense. Fine-grained Sand.	**25.50 - 27.00 SILT; ML; (Alluvium)**		P200	
	C4	100			C- 4 (27.00-35.50) (a) 27' - 31.5': SAND, trace Silt; SP; Yellow to orange-brown; Nonplastic; Wet; Medium dense. (Upper 0.5 foot is gray).	**27.00 - 31.50 SAND; SP; (Alluvium)**			
30									
					(31.50) (b) 31.5' - 32.5': Silty, Sandy GRAVEL with some Cobbles; GM; Brown. Fine- to coarse-grained Gravel and Sand. Gravel and Cobbles subrounded to rounded. Cobbles to +0.5-foot diameter. (32.50) (c) 32.5' - 35.5': Sandy GRAVEL with some Cobbles; GP; Gray-brown; Nonplastic; Moist; Very dense. Fine- to coarse-grained Gravel with Cobbles, subrounded to rounded. Medium- to coarse-grained Sand. Cobbles to +0.5-foot diameter.	**31.50 - 37.00 GRAVEL; GP, GM; (Alluvium)**			
35	N4	0	30-34-31		N- 4 (35.50-37.00) GRAVEL like above (No Recovery).				
								BOH @ 37.0 feet	
40									
45									
50									

ODOT DRILL LOG DEA-69-01-B1-30.GPJ ODOT_MAN.GDT 10/5/06

FIG. B2

DRAFT

DRILL LOG

OREGON DEPARTMENT OF TRANSPORTATION

			Hole No. **TB12076-22**
Project **I-5: Victory Boulevard to Lombard Section**		Purpose **Col. Sl. Bridge Bent**	E.A. No. **PE000474**
Highway **001**		County **Multnomah**	Key No. **12076**
Hole Location Northing: **15,247.54**	Easting: **0.00**		Start Card No.
Equipment **Minisonic**		Driller **BOART**	Bridge No.
Project Geologist **Taylor/Hay/Gullixson/Clough**		Recorder **Taylor/Hay**	Ground Elev. **24.24 ft**
Start Date **August 22, 2006**	End Date **August 25, 2006**	Total Depth **110.30 ft**	Tube Height

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

Rock Abbreviations

Discontinuity	Shape	Surface Roughness
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HYD - Hydrometer Gradation
SIEVE - Sieve Gradation
DD - Dry Density
ATT - Atterberg Limits Test

Depth (ft)	Test Type, No.	Percent Recovery	Soil Driving Resistance / Rock Discontinuity Data Or RQD%	Percent Natural Moisture	Material Description (SOIL: Soil Name, USCS, Color, Plasticity, Moisture, Consistency/Relative Density, Texture, Cementation, Structure, Origin. ROCK: Rock Name, Color, Weathering, Hardness, Discontinuity Spacing, Joint Filling, Core Recovery, Formation Name.)	Unit Description	Graphic Log	Drilling Methods, Size and Remarks / Water Level/ Date	Backfill/ Instrumentation
0	C1	100			C- 1 (0.00-2.50) Sandy GRAVEL; GP; Brown; Nonplastic; Damp; Medium dense; Subrounded Gravel, fine to coarse-grained sand	**0.00 - 20.00 Sandy GRAVEL, Gravelly SAND, SILT to Clayey SILT; GP, SP, ML, MH; (Fill)**		Material used for backfill not readily known.	
	N1	73	11-12-8		N- 1 (2.50-4.00) GRAVEL as in C-1				
	C2	100			C- 2 (4.00-5.00) GRAVEL as in C-1				
5	N2	60	9-10-10		N- 2 (5.00-6.50) Gravelly SAND; SP; Brown; Nonplastic; Damp; Medium dense; Fine- to coarse-grained, subrounded Gravel. Fill				
	C3	100			C- 3 (6.50-7.50) SAND as in N-2				
	N3	67	10-9-9		N- 3 (7.50-9.00) SAND as in N-2				
	C4	100			C- 4 (9.00-10.00) SAND as in N-2, Moist				
10	N4	73	8-4-6		N- 4 (10.00-11.50) a) 10.0 - 11.1 SAND as in N-2, Moist				
	C5	50			(11.10) b) 11.1 - 11.5 SILT with some Clay; ML; Gray; Low plasticity; Moist; Stiff. Fill C- 5 (11.50-13.00) SILT with some Clay and trace sand; ML; Brown and Gray; Low plasticity; Moist; Very Soft; Fine- to medium-grained Sand; Homogeneous. Fill			8/28/06 ▽	
	U1	100		38	U- 1 (13.00-15.00) SILT as in C-5			DD; DS	
15	N5	100	0-0-0		N- 5 (15.00-16.50) SILT as in C-5				
	C6	100			C- 6 (16.50-17.50) Clayey SILT with trace sand and Gravel; MH; Brown and Gray; Medium plasticity; Moist; Very Soft; Fine-grained, rounded Gravel; Homogeneous. Fill				
	N6	33	0-0-0		N- 6 (17.50-19.00) SILT as in C-6				
	C7	100			C- 7 (19.00-20.00) a) 19.0 - 19.5 SILT as in C-6				
20					(19.50) b) 19.5 - 20.0				

ODOT DRILL LOG DEA-69-01-B1-30.GPJ ODOT_MAN.GDT 10/5/06

FIG. B3

Depth (ft)	Test Type, No.	Percent Recovery	Soil / Rock: Driving Resistance / Discontinuity Data Or RQD%	Percent Natural Moisture	Material Description (SOIL: Soil Name, USCS, Color, Plasticity, Moisture, Consistency/Relative Density, Texture, Cementation, Structure, Origin. ROCK: Rock Name, Color, Weathering, Hardness, Discontinuity Spacing, Joint Filling, Core Recovery, Formation Name.)	Unit Description	Graphic Log	Drilling Methods, Size and Remarks / Water Level/ Date	Backfill/ Instrumentation
20	N7	100	2-2-2		Gravelly Sandy SILT; ML; Brown and Gray; Low plasticity; Moist; Very Soft; Fine rounded Gravel, fine to medium-grained sand; Homogeneous. Fill N- 7 (20.00-21.50) Silty CLAY; CL; Dark Gray; Low plasticity; Moist; Homogeneous. Alluvium	**20.00 - 34.00 Silty CLAY to SILT; CL, ML; (Alluvium)**			
	C8	100			C- 8 (21.50-25.00) SILT with some Clay and trace Sand; ML; Dark Gray; Low plasticity; Moist; Very Soft; Fine-grained Sand; Homogeneous. Alluvium				
25	U2	100		40	U- 2 (25.00-27.00) SILT as in C-8			DD	
	N8	100	4-5-6		N- 8 (27.00-29.50) SILT with some Sand; ML; Brown and Gray mottled; Low plasticity; Wet; Stiff; Fine-grained Sand; Homogeneous. Alluvium				
	C9	100			C- 9 (29.50-35.00) a) 29.5 - 34.0 SILT as in N-8				
30									
					(34.00) b) 34.0 - 35.0 SAND; SP; Dark Gray; Nonplastic; Moist; Loose to medium dense; Uncemented; Homogeneous. Alluvium	**34.00 - 61.00 SAND, SILT with some SAND to SAND with trace Gravel; SP, ML; (Alluvium)**			
35	N9	100	2-3-4		N- 9 (35.00-36.50) SAND as in C-9b, Loose				
	C10	66			C- 10 (36.50-40.00) a) 36.5 - 39.0 SAND as in C-9b				
					(39.00) b) 39.0 - 39.5 SILT with some Sand; ML; Light Brown; Nonplastic; Wet; Medium stiff; Fine-grained Sand; Homogeneous.				
40	N10	50	10-7-4		(39.50) c) 39.5 - 40.0 SAND; SP; Dark Gray; Nonplastic; Wet; Medium dense; Uncemented; Homogeneous. Alluvium N- 10 (40.00-41.50) SAND as in C-10c				
	C11	0			C- 11 (41.50-45.00) NR in SAND				
45	N11	100	4-15-17		N- 11 (45.00-46.50) SAND as in C-10c, Dense				
	C12	100			C- 12 (46.50-50.00) SAND with trace Gravel; SP; Dark gray; Nonplastic; Wet; Dense; Fine-grained, rounded Gravel; Uncemented; Homogeneous. Alluvium				
50									

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ODOT DRILL LOG DEA-69-01-B1-30.GPJ ODOT_MAN.GDT 10/5/06

FIG. B3

Depth (ft)	Test Type, No.	Percent Recovery	Soil / Rock: Driving Resistance / Discontinuity Data Or RQD%	Percent Natural Moisture	Material Description (SOIL: Soil Name, USCS, Color, Plasticity, Moisture, Consistency/Relative Density, Texture, Cementation, Structure, Origin. ROCK: Rock Name, Color, Weathering, Hardness, Discontinuity Spacing, Joint Filling, Core Recovery, Formation Name.)	Unit Description	Graphic Log	Drilling Methods, Size and Remarks / Water Level/ Date	Backfill/ Instrumentation
50	N12	100	4-5-9		N- 12 (50.00-51.50) SAND; SP; Dark Gray; Nonplastic; Wet; Medium dense; Fine grained; Uncemented; Homogeneous. Alluvium				
	C13	82			C- 13 (51.50-60.00) SAND as in N-12				
55									
60	N13	100	16-24-26		N- 13 (60.00-61.50) a) 60.0 - 61.0 SAND as in N-12				
	C14	100			(61.00) b) 61.0 - 61.5 Silty, Sandy GRAVEL; GM; Dark Gray; Nonplastic; Wet; Very dense; Fine-grained, subrounded Gravel; Uncemented; Homogeneous. Alluvium C- 14 (61.50-70.00) Sandy GRAVEL with some Cobbles and trace Silt; GP; Gray-brown; Nonplastic; Moist; Dense to Very Dense; Subrounded to rounded Gravel, Fine- to coarse-grained Sand.	**61.00 - 108.00 Silty GRAVEL, Sandy GRAVEL to Gravelly SAND; GM, GP, SP; (Alluvium)**			
65									
70	N14	100	50/0.4'		N- 14 (70.00-70.40) GRAVEL as in C-14				
	C15	100			C- 15 (70.40-80.00) Sandy Cobbly GRAVEL with trace Silt; GP; Gray to Brown; Nonplastic; Wet; Very Dense; Subrounded Gravel, fine to coarse-grained sand.				
75									
80									

ODOT DRILL LOG DEA-69-01-B1-30.GPJ ODOT_MAN.GDT 10/5/06

DRAFT

FIG. B3

Depth (ft)	Test Type, No.	Percent Recovery	Soil / Rock: Driving Resistance / Discontinuity Data Or RQD%	Percent Natural Moisture	Material Description (SOIL: Soil Name, USCS, Color, Plasticity, Moisture, Consistency/Relative Density, Texture, Cementation, Structure, Origin. ROCK: Rock Name, Color, Weathering, Hardness, Discontinuity Spacing, Joint Filling, Core Recovery, Formation Name.)	Unit Description	Graphic Log	Drilling Methods, Size and Remarks / Water Level/ Date	Backfill/ Instrumentation
80	N15	80	8-32-32		N- 15 (80.00-81.50) Sandy GRAVEL; GP; Yellow-brown; Nonplastic; Wet; Very Dense; Subrounded to rounded Gravel, Fine- to coarse-grained Sand.				
	C16	100			C- 16 (81.50-90.00) a) 81.5 - 86.0 GRAVEL as in N-15				
85					(86.00) b) 86.0 - 89.0 Gravelly SAND; SP; Yellow-brown; Nonplastic; Moist; Dense; Fine- to coarse-grained, subrounded to rounded Gravel, Medium-grained sand				
					(89.00) c) 89.0 - 90.0 GRAVEL as in N-15				
90	N16	40	1-2-2		N- 16 (90.00-91.50) SAND (Slough?); SP; Yellow-brown; Nonplastic; Wet; Loose; Fine to medium-grained.			Heaving sand and gravel from 90.0 to 100.0 feet.	
	C17	62			C- 17 (91.50-95.00) Silty GRAVEL with some Sand (Slough?); GM; Dark Gray; Nonplastic; Moist; Loose; Fine to coarse rounded Gravel; Uncemented; Homogeneous. Alluvium				
95	C18	60			C- 18 (95.00-100.00) Silty GRAVEL with trace Sand (Slough?); GM; Dark Gray; Nonplastic; Moist to Wet; Loose; Fine- to coarse-grained, rounded Gravel; Uncemented; Homogeneous. Alluvium				
100	N17	100	50/0.1'		N- 17 (100.00-100.10) Sandy Gravel; GP; Yellow-brown; Nonplastic; Wet; Very Dense; Fine- to coarse-grained Sand; Uncemented; Homogeneous. Alluvium				
	C19	87			C- 19 (100.10-108.00) Cobbly, silty GRAVEL; GM; Dark Gray; Nonplastic; Wet; Very Dense; Fine- to coarse-grained, subrounded to rounded Gravel and Cobbles; Uncemented; Homogeneous. Alluvium				
105									
					(108.00-110.00) Sandy GRAVEL; GP; Yellow-brown; Nonplastic; Wet; Very Dense; Subrounded to rounded Gravel, Fine- to coarse-grained Sand; Weakly cemented; Homogeneous. Troutdale Formation	**108.00 - 110.30 Sandy GRAVEL; GP; (Troutdale Formation)**			
110									

ODOT DRILL LOG DEA-69-01-B1-30.GPJ ODOT_MAN.GDT 10/5/06

DRAFT

FIG. B3

Depth (ft)	Test Type, No.	Percent Recovery	Soil / Rock: Driving Resistance / Discontinuity Data Or RQD%	Percent Natural Moisture	Material Description (SOIL: Soil Name, USCS, Color, Plasticity, Moisture, Consistency/Relative Density, Texture, Cementation, Structure, Origin. ROCK: Rock Name, Color, Weathering, Hardness, Discontinuity Spacing, Joint Filling, Core Recovery, Formation Name.)	Unit Description	Graphic Log	Drilling Methods, Size and Remarks / Water Level/ Date	Backfill/ Instrumentation
110	N18	100	50/0.3'		N- 18 (110.00-110.30) Sandy GRAVEL; GP; Yellow-brown; Nonplastic; Wet; Very Dense; Subrounded to rounded Gravel, Fine- to coarse-grained Sand; Weakly cemented; Homogeneous. Troutdale Formation			BOH @ 110.3 feet	
115									
120									
125									
130									
135									
140									

ODOT DRILL LOG DEA-69-01-B1-30.GPJ ODOT_MAN.GDT 10/5/06

DRAFT

FIG. B3

Total Depth:	61.5 ft.	Northing:	~	Drilling Method:	Mud Rotary	Hole Diam.:	4 in.
Top Elevation:	~	Easting:	~	Drilling Company:	Subsurface Technologies	Rod Type:	NWJ
Vert. Datum:		Station:	~	Drill Rig Equipment:	Diedrich D-50 Track	Hammer Type:	Automatic
Horiz. Datum:		Offset:	~	Other Comments:	Hammer Efficiency = 70.9%		

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 soil types, and the transitions may be gradual.

Gray, *Poorly Graded Gravel with Sand (GP)*; dry; coarse, angular gravel; fine sand.

Loose grading to medium dense, gray-brown, *Poorly Graded Sand (SP)*; moist; fine sand.

FILL

Medium dense, brown, *Silty Sand (SM)*; moist; trace coarse, rounded gravel; medium to coarse, subrounded to subangular sand; nonplastic fines.

SAND ALLUVIUM

Medium stiff/stiff grading to soft/very soft, green-gray to green, *Silt (ML)*; moist; slow dilatancy, medium plasticity.

FINE-GRAINED ALLUVIUM

Medium stiff, green grading to yellow, *Sandy Silt (ML)*; wet; fine sand; rapid dilatancy, low plasticity.

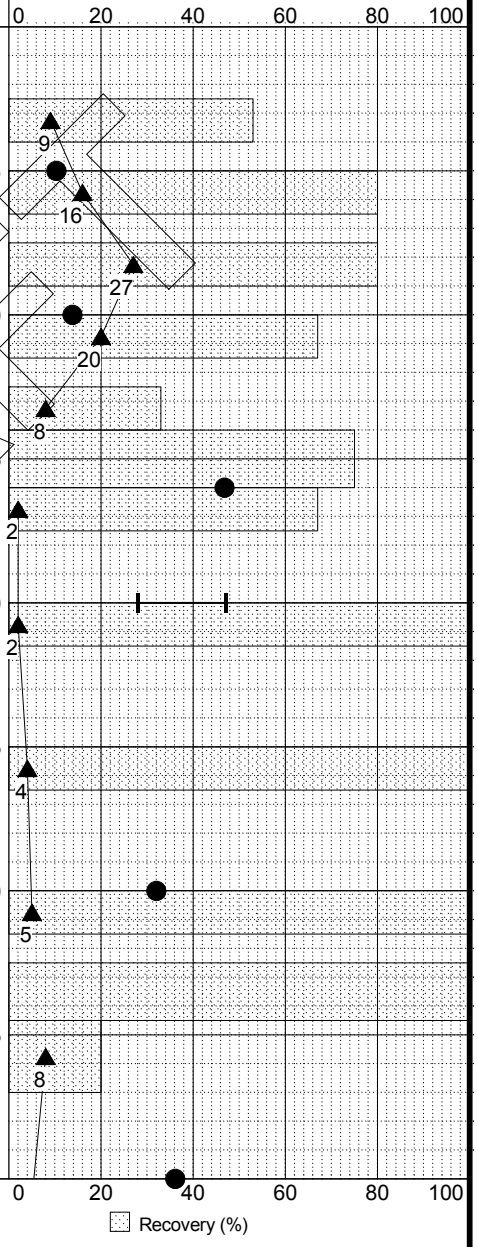
Loose, brown, *Poorly Graded Sand with Silt (SP-SM)*; wet; fine sand; nonplastic fines; micaceous.

SAND ALLUVIUM

Elev. Depth (ft.)	Symbol	Samples	Ground Water	Depth, ft.
2.0		S-1		5
		S-2		
		S-3		10
9.5		S-4		
12.0		S-5		15
		U-1		
		S-6		
		S-7		20
		S-8		25
28.5		S-9a S-9b		30
33.0		U-2		35
		S-10		
38.5				

PENETRATION RESISTANCE, N (blows/ft.)

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



Recovery (%)

● % Water Content

Plastic Limit ⊢—⊣ Liquid Limit

CONTINUED NEXT SHEET

LEGEND

* Sample Not Recovered

Standard Penetration Test

3" O.D. Shelby Tube

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. Group symbol is based on visual-manual identification and selected lab testing.
4. The hole location and elevation should be considered approximate.

OR99W: N. Victory Blvd - N. Argyle St
Portland, Oregon

LOG OF BORING B-1

September 2013 24-1-03778-604

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FIG. B2
Sheet 1 of 2

REV 2

FIG. B4

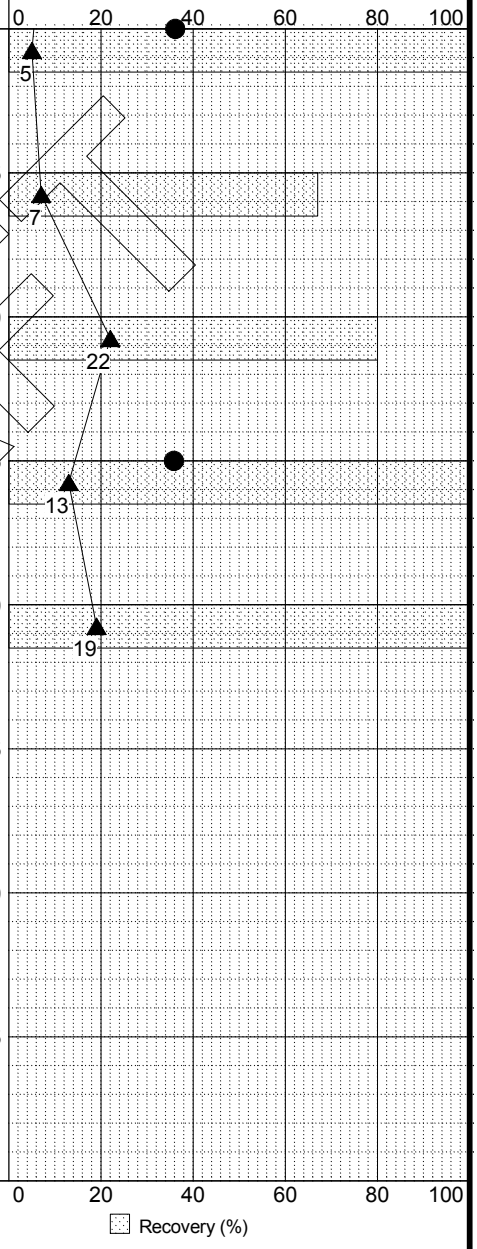
MASTER_LOG_E 24-1-03778.GPJ SHAN_WIL.GDT 9/27/13 Log: EJOF Rev: KE/AH Typ: MAS/ATH

Total Depth:	61.5 ft.	Northing:	~	Drilling Method:	Mud Rotary	Hole Diam.:	4 in.
Top Elevation:	~	Easting:	~	Drilling Company:	Subsurface Technologies	Rod Type:	NWJ
Vert. Datum:		Station:	~	Drill Rig Equipment:	Diedrich D-50 Track	Hammer Type:	Automatic
Horiz. Datum:		Offset:	~	Other Comments:	Hammer Efficiency = 70.9%		

SOIL DESCRIPTION	Elev. Depth (ft.)	Symbol	Samples	Ground Water	Depth, ft.
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 soil types, and the transitions may be gradual.					
Continued: Loose, gray, *Poorly Graded Sand (SP)*; wet; fine sand; trace fines; nonplastic fines; micaceous. **SAND ALLUVIUM**			S-11		
			S-12		
Medium dense, gray, *Poorly Graded Sand (SP)*; wet; fine, subangular sand.	48.5		S-13		
Medium dense, brown, *Poorly Graded Sand (SP)*; wet; fine sand; trace nonplastic fines; micaceous.	53.5		S-14		
Medium dense, olive, *Silt (ML)*; wet; trace fine sand; rapid dilatancy, nonplastic.	58.5		S-15a		
Medium dense, gray, *Poorly Graded Sand (SP)*; wet; fine, subangular sand.	60.3		S-15b		
Completed - August 8, 2013	61.5				

PENETRATION RESISTANCE, N (blows/ft.)

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



LEGEND

* Sample Not Recovered

Standard Penetration Test

3" O.D. Shelby Tube

● % Water Content

Plastic Limit ⊢—⊣ Liquid Limit

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. Group symbol is based on visual-manual identification and selected lab testing.
4. The hole location and elevation should be considered approximate.

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Portland, Oregon

LOG OF BORING B-1

September 2013 24-1-03778-604

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FIG. B2
Sheet 2 of 2

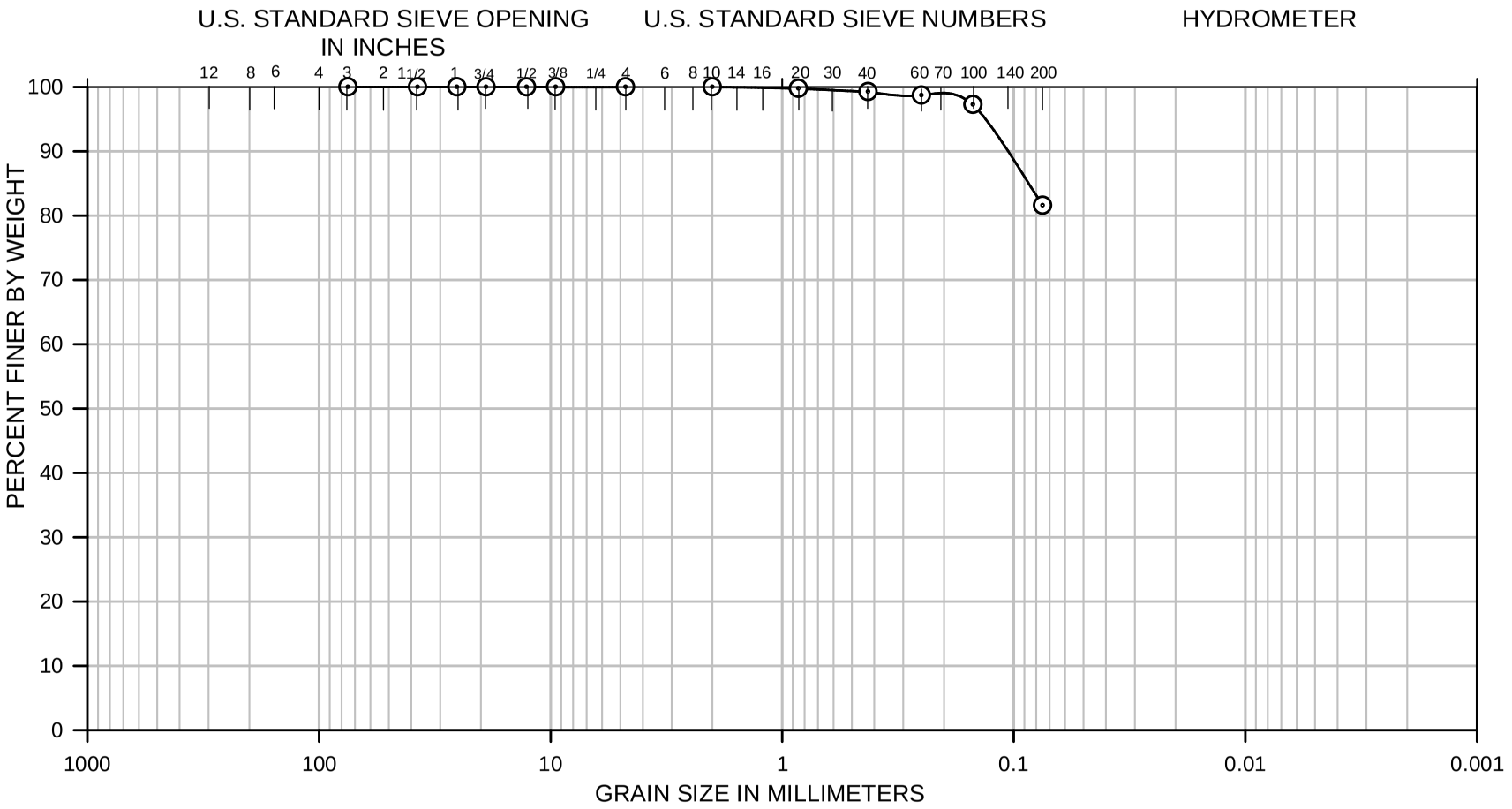
REV 2

FIG. B4

APPENDIX C

LABORATORY TEST RESULTS

Appendix C – Table of Contents



COBBLES	GRAVEL		SAND			FINES	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Boring No.	Sample No.	Depth, Ft.	Classification	Nat W%	LL	PL	PI
⊙ P2-CC-40	S-3	15	sandy SILT	35	--	--	--

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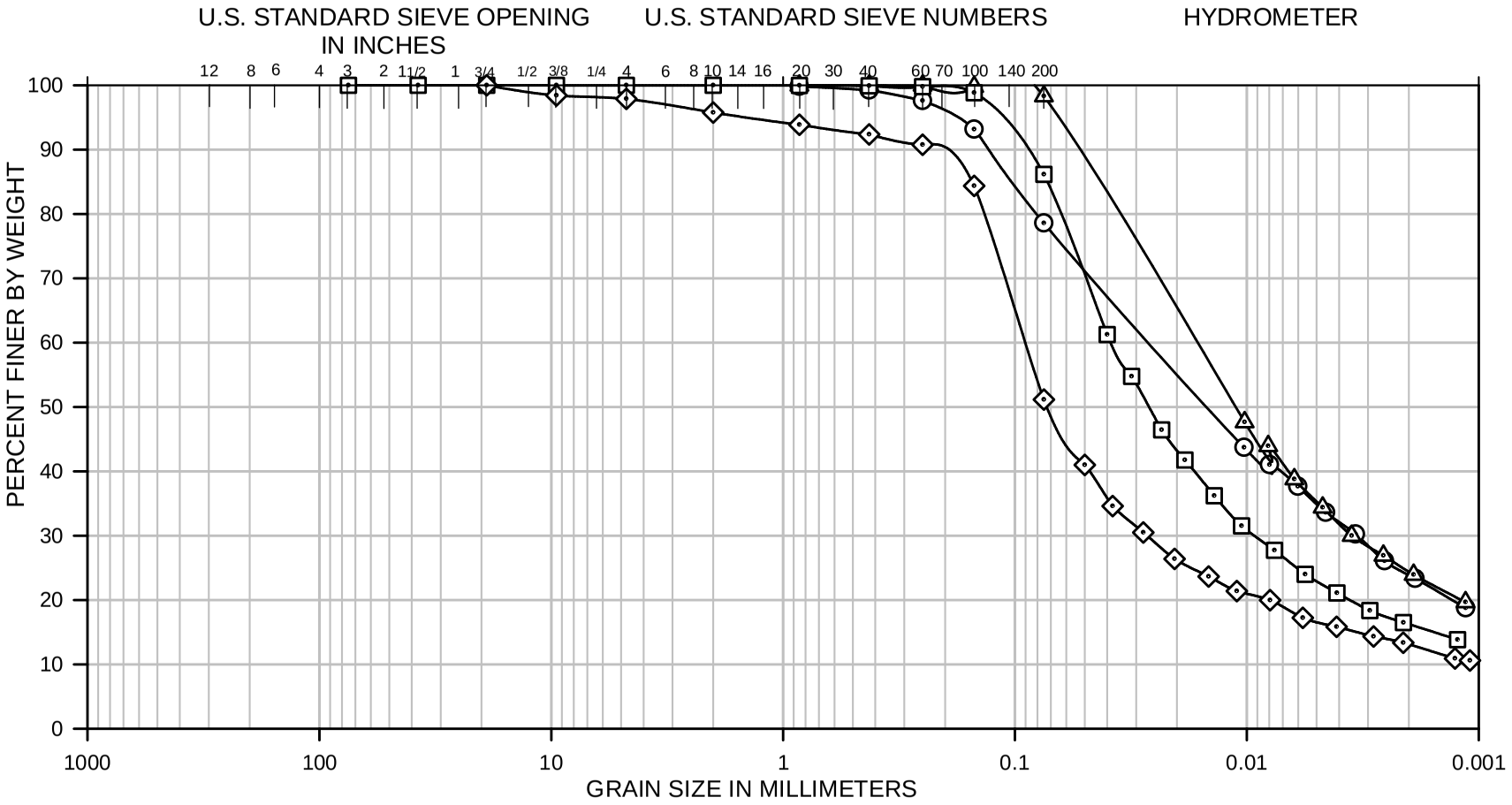
GRADATION GRAPH
EMBANKMENT (1 of 2)
PENINSULA 2 LEVEE EVALUATION
PORTLAND, OR

SEP 2014
PROJ. 2320
FIG. C1



COBBLES	GRAVEL		SAND			FINES	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Boring No.	Sample No.	Depth, Ft.	Classification	Nat W%	LL	PL	PI
⊙ P2-CC-02	S-4	20	sandy, slightly clayey SILT	40	34	29	5
△ P2-CC-10	S-4	20	clayey SILT; trace fine sand	34	46	28	18
⊡ P2-CC-25	S-3	15	slightly sandy, slightly clayey SILT	36	41	30	11
◇ P2-CC-70	S-3	15	very sandy, clayey SILT	44	54	32	22

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GRADATION GRAPH
EMBANKMENT (2 of 2)

PENINSULA 2 LEVEE EVALUATION
PORTLAND, OR

FIG. C2

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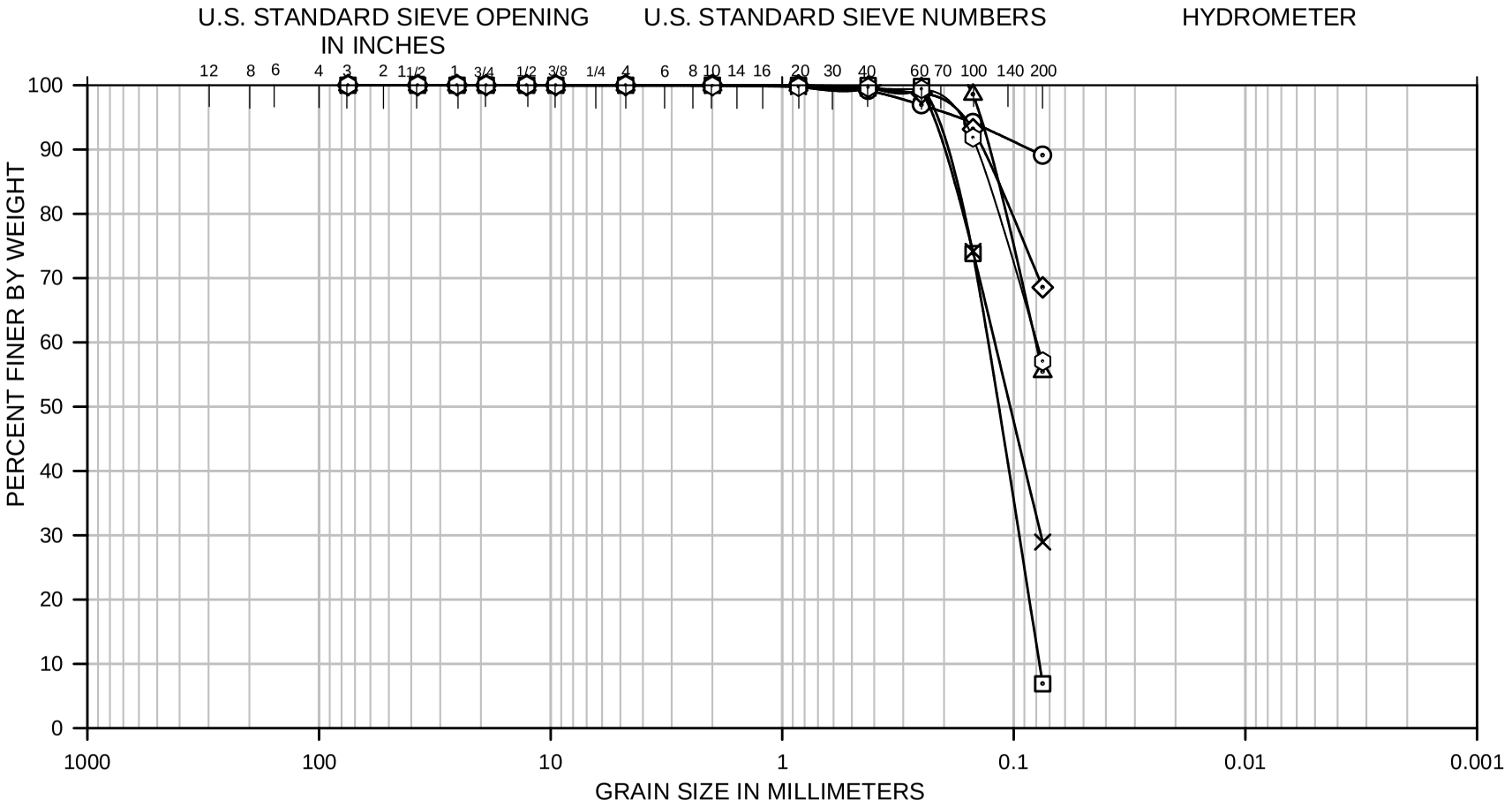
SEP 2014



COBBLES	GRAVEL		SAND			FINES	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Boring No.	Sample No.	Depth, Ft.	Classification	Nat W%	LL	PL	PI
⊙ P2-CC-03	S-3	15	slightly sandy, clayey SILT	38	40	27	13
△ P2-CC-19	S-4	20	very sandy SILT	26	--	--	--
⊡ P2-CC-28	S-7	35	slightly silty fine SAND	32	--	--	--
◇ P2-CC-32	S-4	20	sandy, slightly clayey SILT	41	37	30	7
× P2-CC-52	S-11	50	silty fine SAND	38	--	--	--
⬡ P2-CC-55	S-6	30	very sandy SILT	35	--	--	--

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GRADATION GRAPH FOUNDATION (1 of 3)

PENINSULA 2 LEVEE EVALUATION
PORTLAND, OR

FIG. C3

PROJ. 2320

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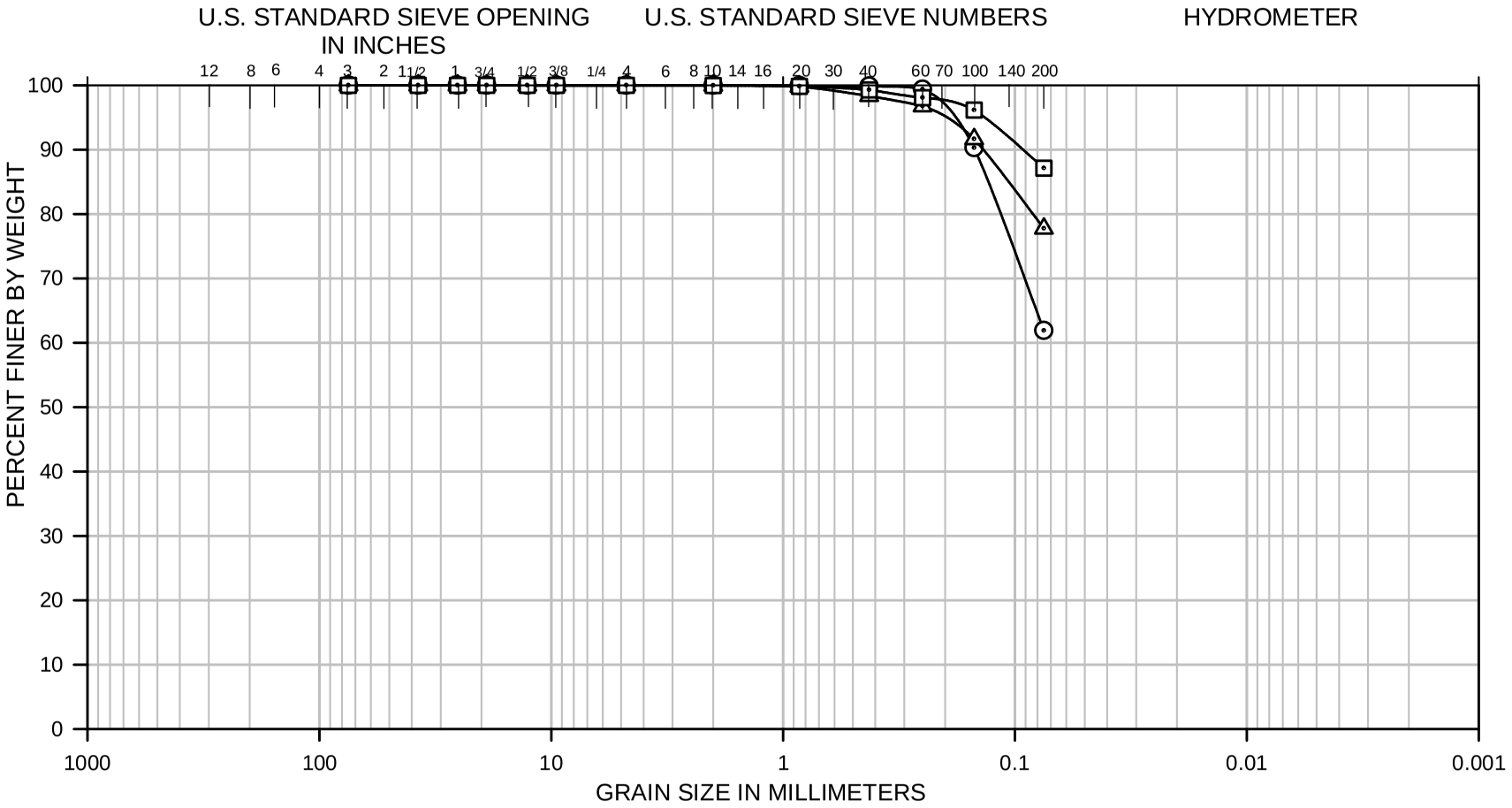

COBBLES	GRAVEL		SAND			FINES	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Boring No.	Sample No.	Depth, Ft.	Classification	Nat W%	LL	PL	PI
⊙ P2-CC-58	S-5	25	slightly clayey, very sandy SILT	33	32	26	6
△ P2-CC-64	S-8	40	sandy, slightly clayey SILT	73	58	46	12
⊡ P2-CC-67	S-7	35	sandy, clayey SILT	71	75	42	33

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GRADATION GRAPH FOUNDATION (2 of 3)

PENINSULA 2 LEVEE EVALUATION
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FIG. C4

PROJ. 2320

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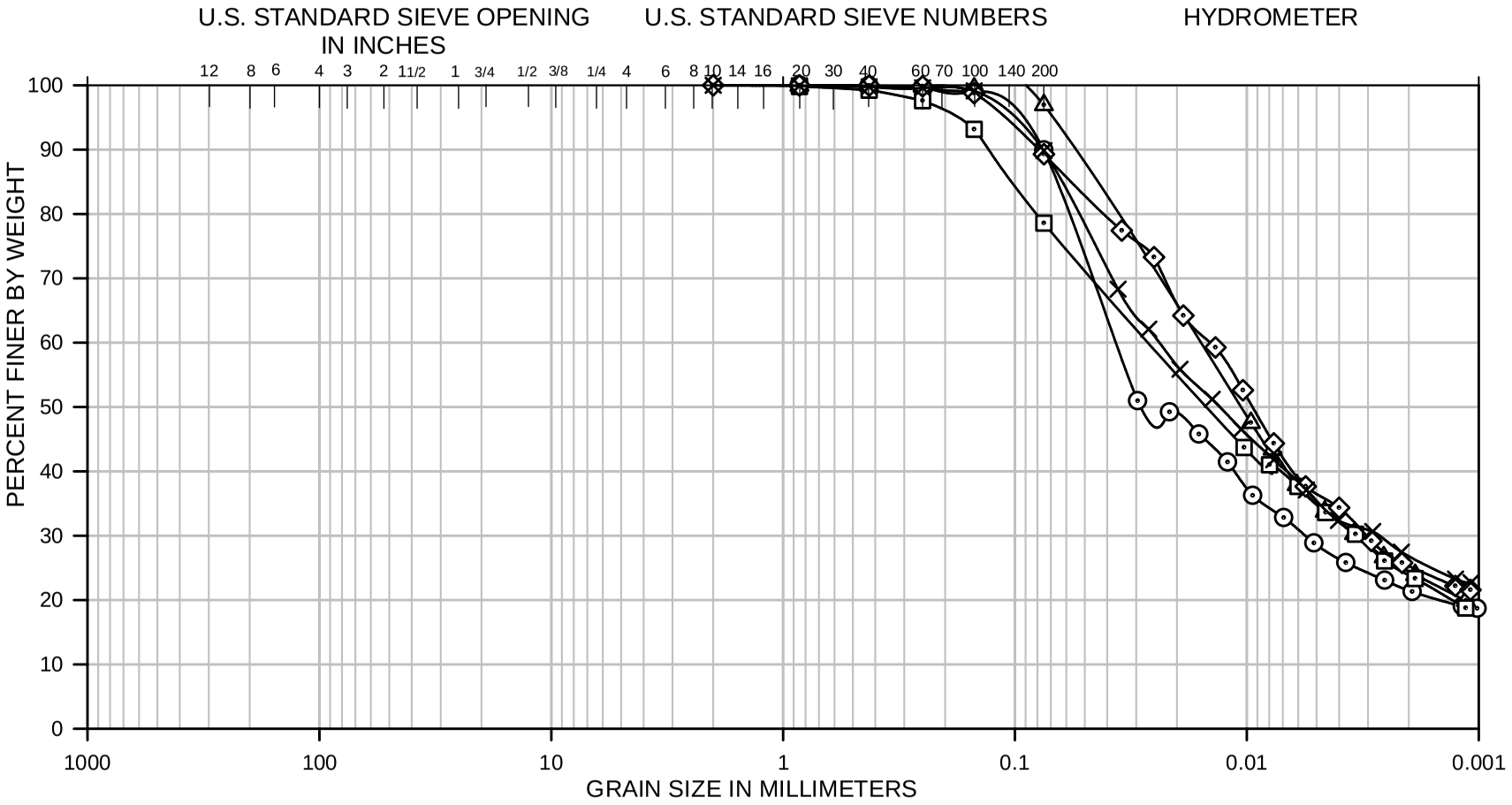

COBBLES	GRAVEL		SAND			FINES	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Boring No.	Sample No.	Depth, Ft.	Classification	Nat W%	LL	PL	PI
⊙ P2-CC-15	S-3	15	slightly sandy, clayey SILT	37	38	24	14
△ P2-CC-22	S-4	20	slightly sandy, clayey SILT	45	42	26	16
⊡ P2-CC-37	S-4	20	sandy, clayey SILT	33	38	26	12
◇ P2-CC-49	S-5	25	slightly sandy, clayey SILT	36	43	25	18
× P2-CC-73	S-8	35	sandy, clayey SILT	53	54	33	21

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FOUNDATION (3 of 3)

PENINSULA 2 LEVEE EVALUATION
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FIG. C5

PROJ. 2320

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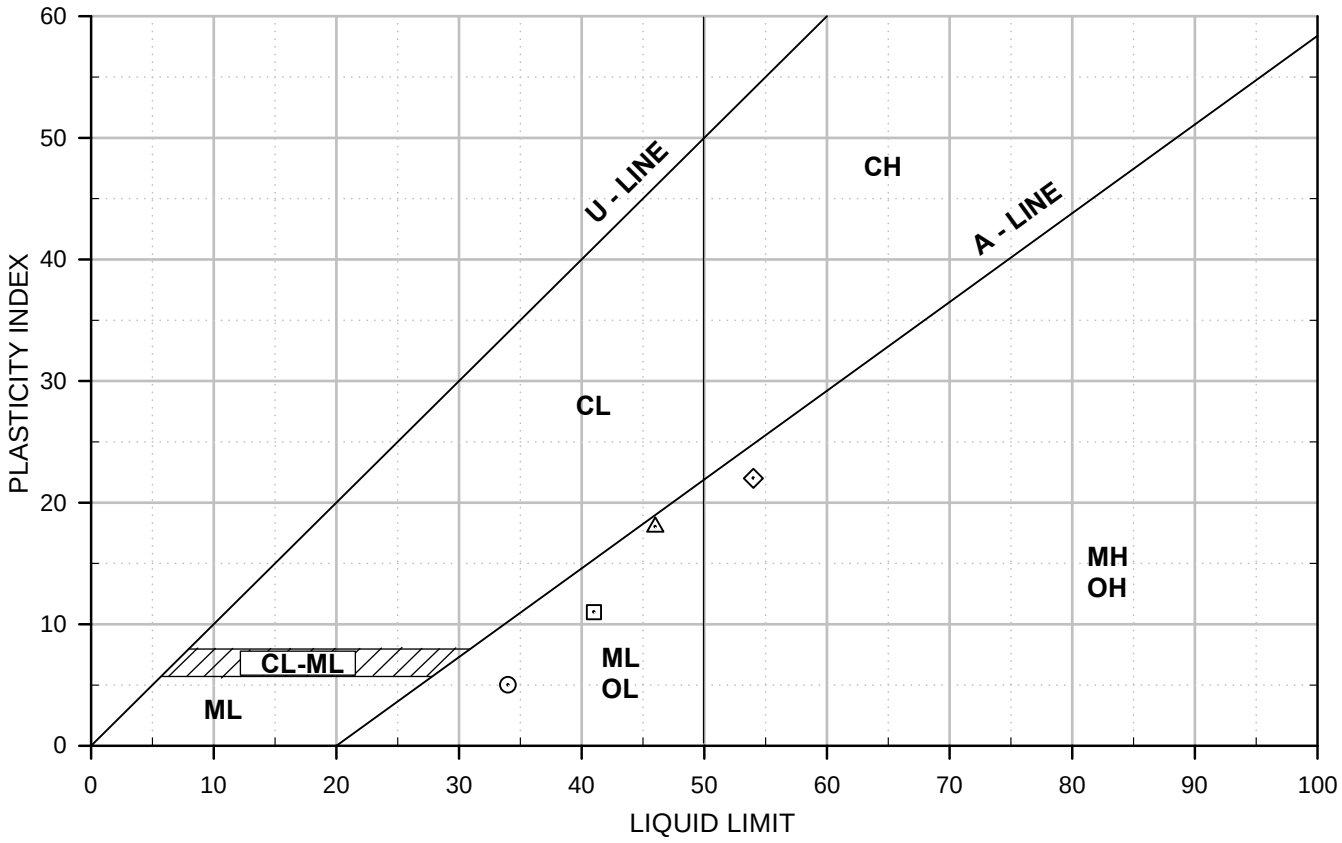

Boring No.	Sample No.	Depth (ft)
⊙ P2-CC-02	S-4	20
△ P2-CC-10	S-4	20
⊡ P2-CC-25	S-3	15
◇ P2-CC-70	S-3	15

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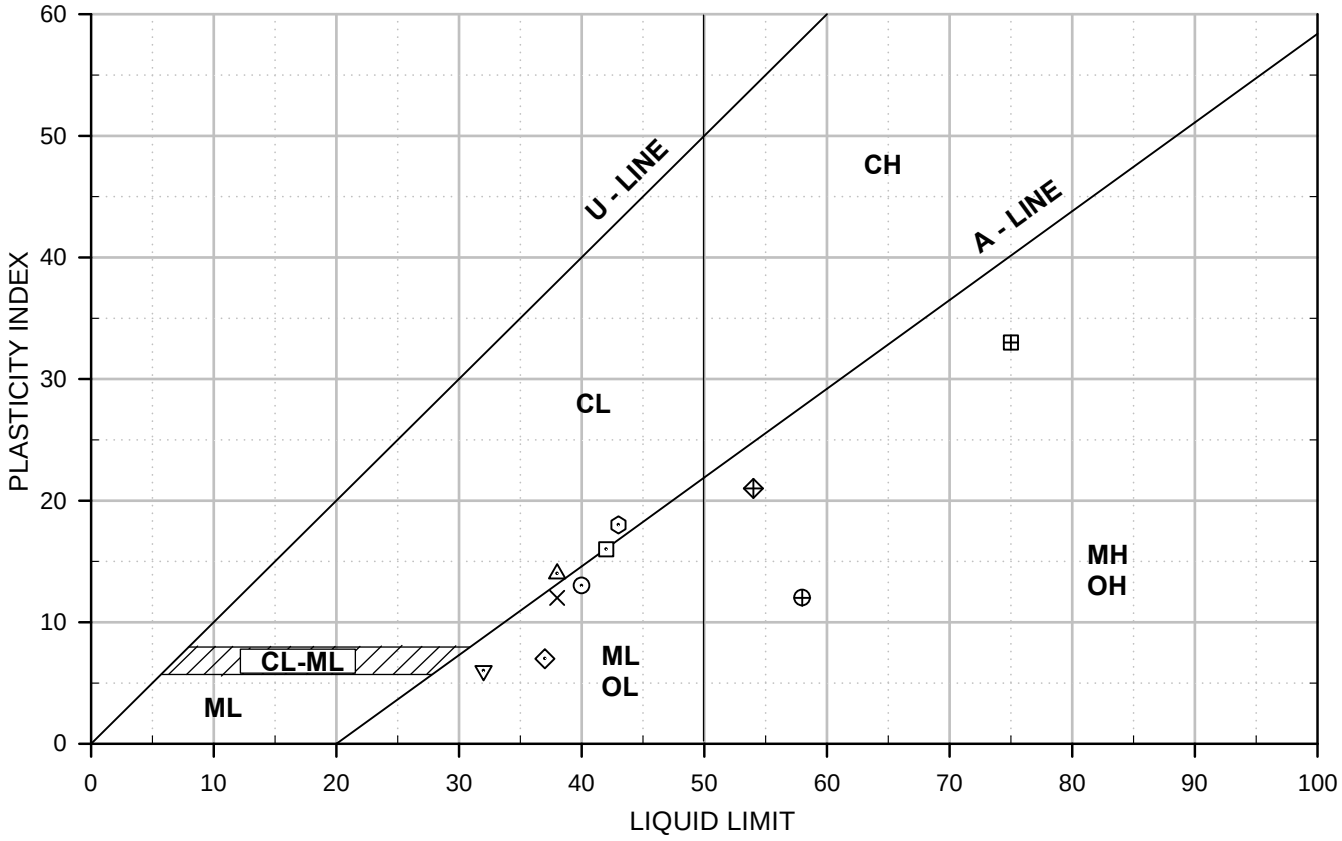
PLASTICITY CHART EMBANKMENT SAMPLES

PENINSULA 2 LEVEE EVALUATION
PORTLAND, OREGON

SEP 2014
PROJ. 2320
FIG. C6



Boring No.	Sample No.	Depth (ft)
⊙ P2-CC-03	S-3	15
△ P2-CC-15	S-3	15
⊡ P2-CC-22	S-4	20
◇ P2-CC-32	S-4	20
× P2-CC-37	S-4	20
⬡ P2-CC-49	S-5	25
▽ P2-CC-58	S-5	25
⊕ P2-CC-64	S-8	40
⊞ P2-CC-67	S-7	35
◈ P2-CC-73	S-8	35

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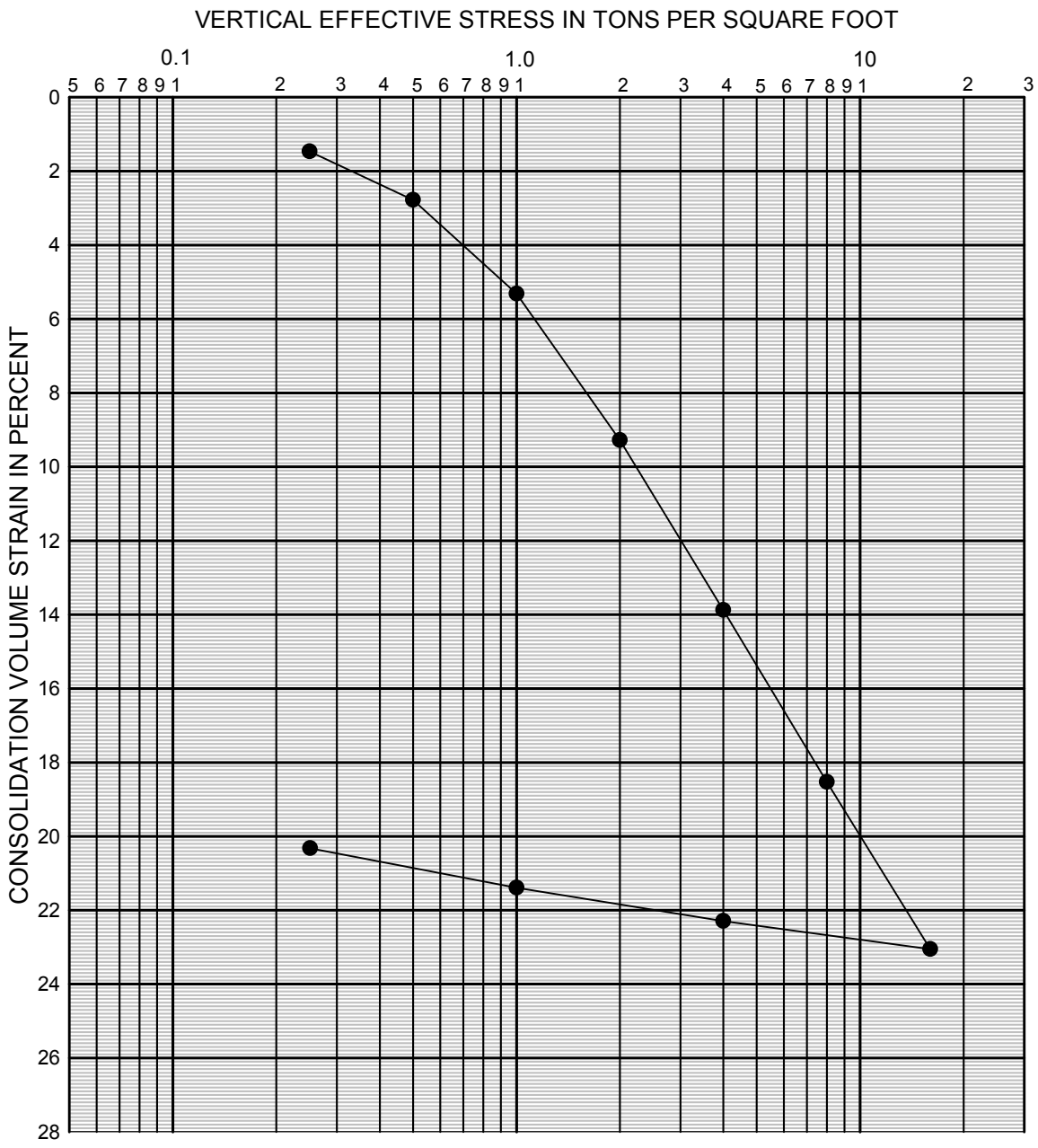
PLASTICITY CHART FOUNDATION SAMPLES

PENINSULA 2 LEVEE EVALUATION
PORTLAND, OREGON

SEP 2014
PROJ. 2320
FIG. C7



* Saturated with water

P_o Existing overburden stress

P_p Estimated preconsolidation stress

Boring No. P2-CC-15 Sample No. S-3 Depth of Sample 13 to 15 ft.

Soil Description: VERY SOFT, brown, slightly sandy, clayey SILT; fine sand, numerous mica, wet (ALLUVIUM)

☒ Undisturbed ☐ Re-compacted

Initial Conditions: Height 0.75 inches Wet Density 101 lb/ft^3

Diameter 2.50 inches Water Content 37 %

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CONSOLIDATION TEST

PENINSULA 2 LEVEE EVALUATION
PORTLAND, OREGON

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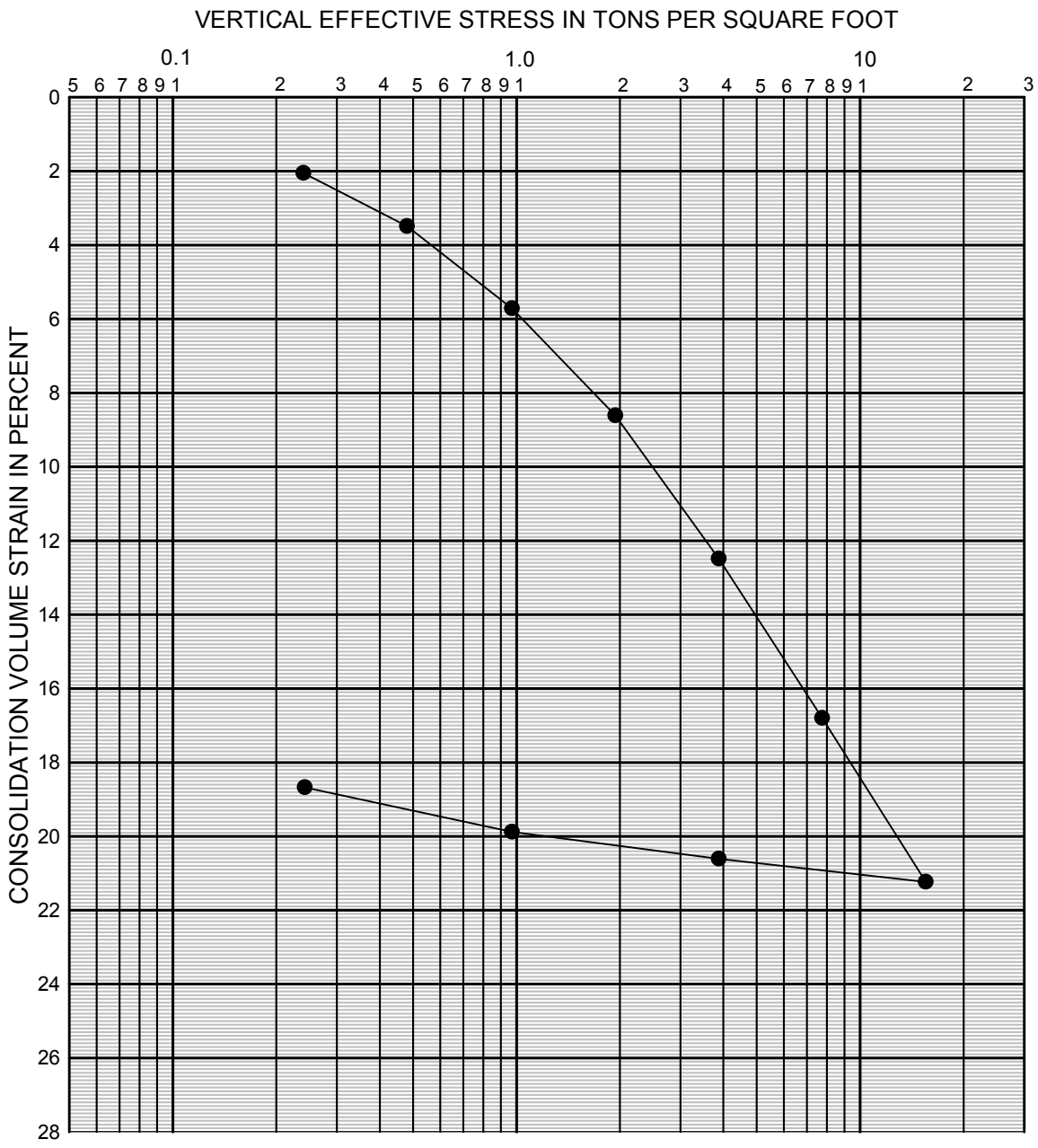
PROJ. 2320

FIG. C8



* Saturated with water

P_o Existing overburden stress

P_p Estimated preconsolidation stress

Boring No. P2-CC-32 Sample No. S-4 Depth of Sample 18 to 20 ft.

Soil Description: SOFT, gray, sandy, slightly clayey SILT; fine sand, occasional organics, scattered mica, wet (ALLUVIUM)

☒ Undisturbed ☐ Re-compacted

Initial Conditions: Height 0.75 inches Wet Density 97 lb/ft^3

Diameter 2.50 inches Water Content 41 %

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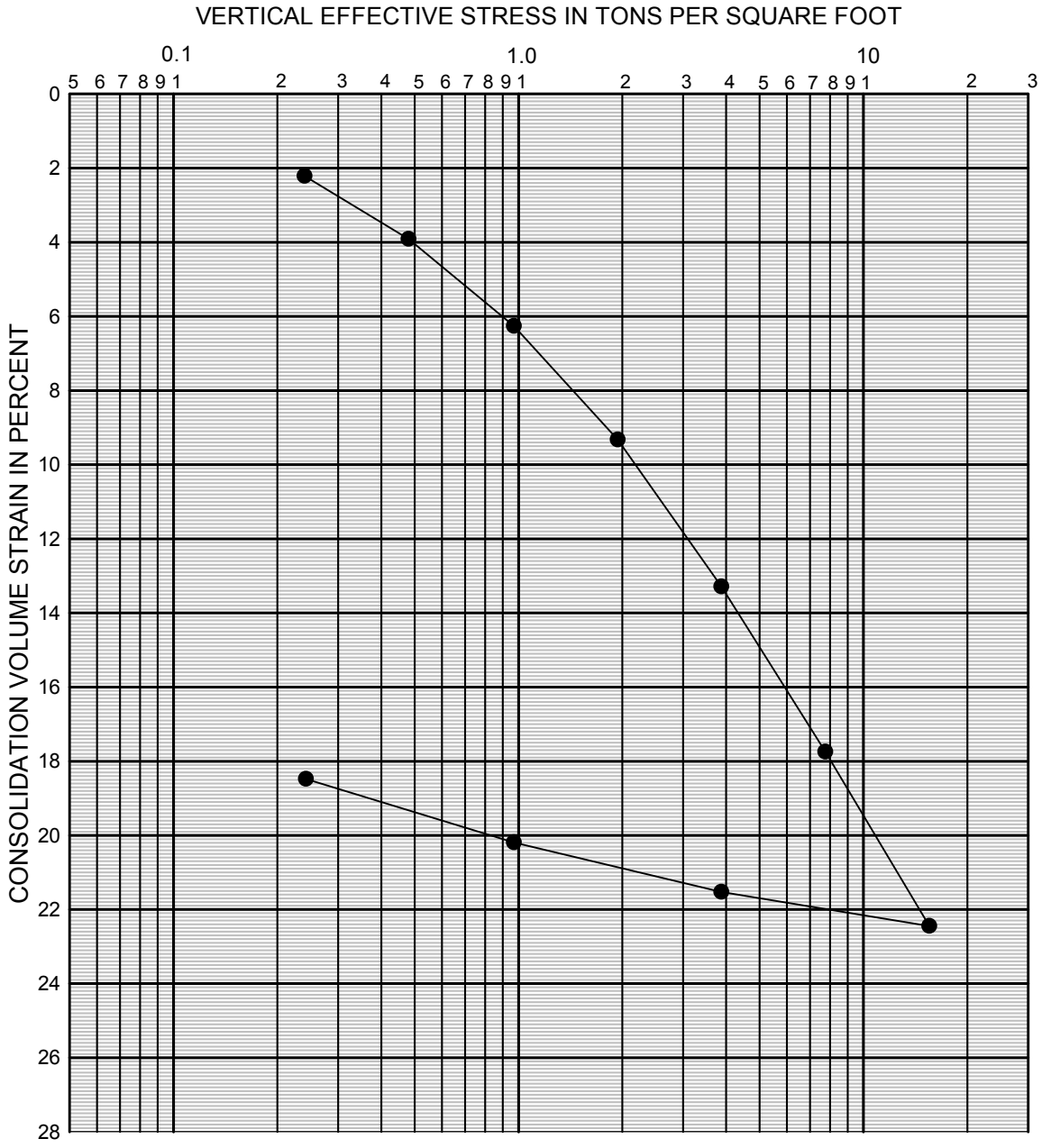
FIG. C9



* Saturated with water

P_o Existing overburden stress

P_p Estimated preconsolidation stress

Boring No. P2-CC-70 Sample No. S-3 Depth of Sample 13 to 15 ft.

Soil Description: SOFT to MEDIUM STIFF, mottled red-brown to gray, very sandy, clayey SILT; fine to coarse sand, occasional organics, occasional mica, moist (FILL)

☒ Undisturbed ☐ Re-compacted

Initial Conditions: Height 0.75 inches Wet Density 95 lb/ft^3

Diameter 2.50 inches Water Content 44 %

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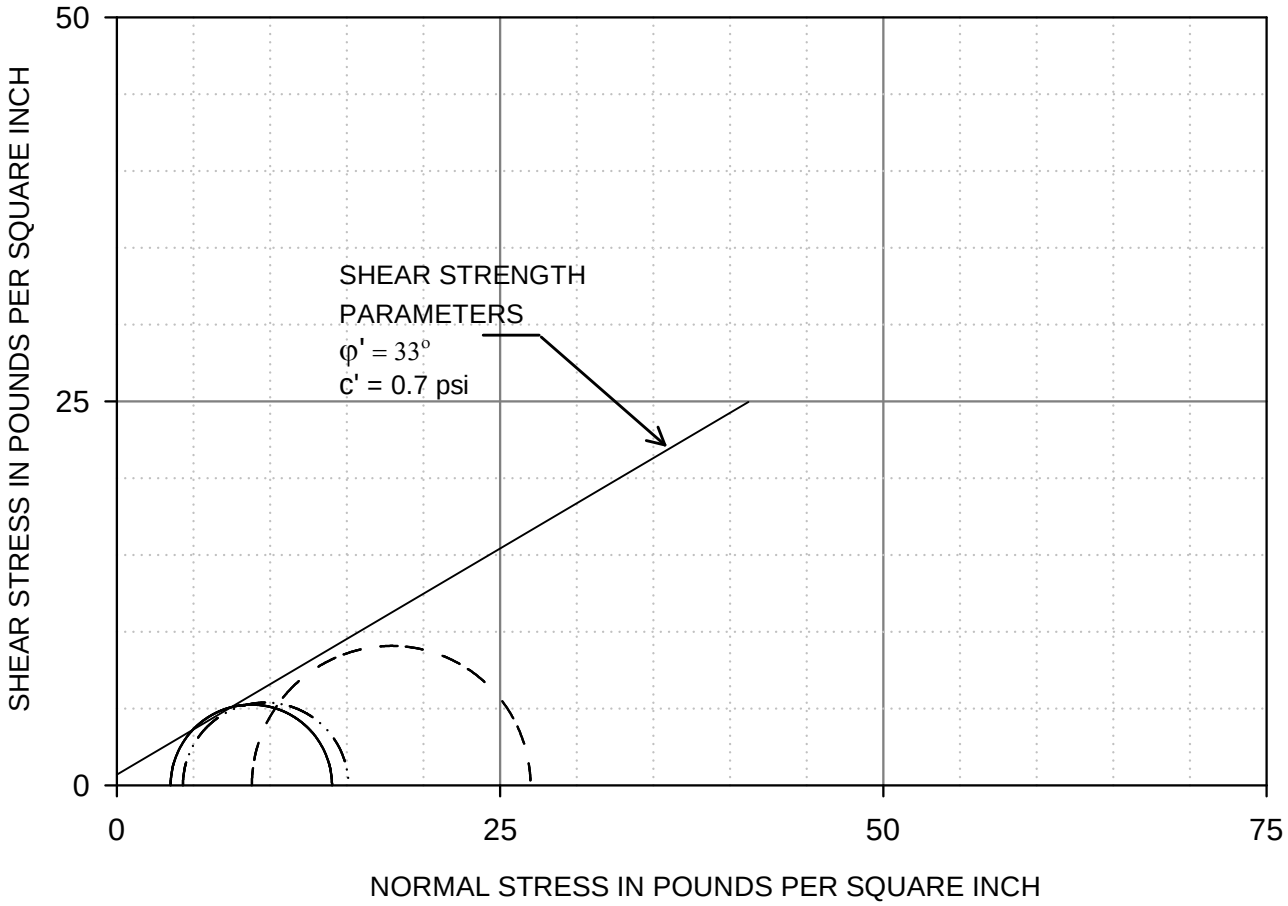
CONSOLIDATION TEST

PENINSULA 2 LEVEE EVALUATION
PORTLAND, OREGON

SEP 2014

PROJ. 2320

FIG. C10



LEGEND Confining Stress (psi)

———	7
—·—·—·—	14
– – – – – –	28

☒ Undisturbed ☐ Re-compacted

Type of Test Consolidated Undrained Triaxial

Boring No. P2-CC-15 Sample No. S-3 Depth of Sample 13 to 15 ft.

Soil Description: VERY SOFT, brown, slightly sandy, clayey SILT; fine sand, numerous mica, wet (ALLUVIUM)

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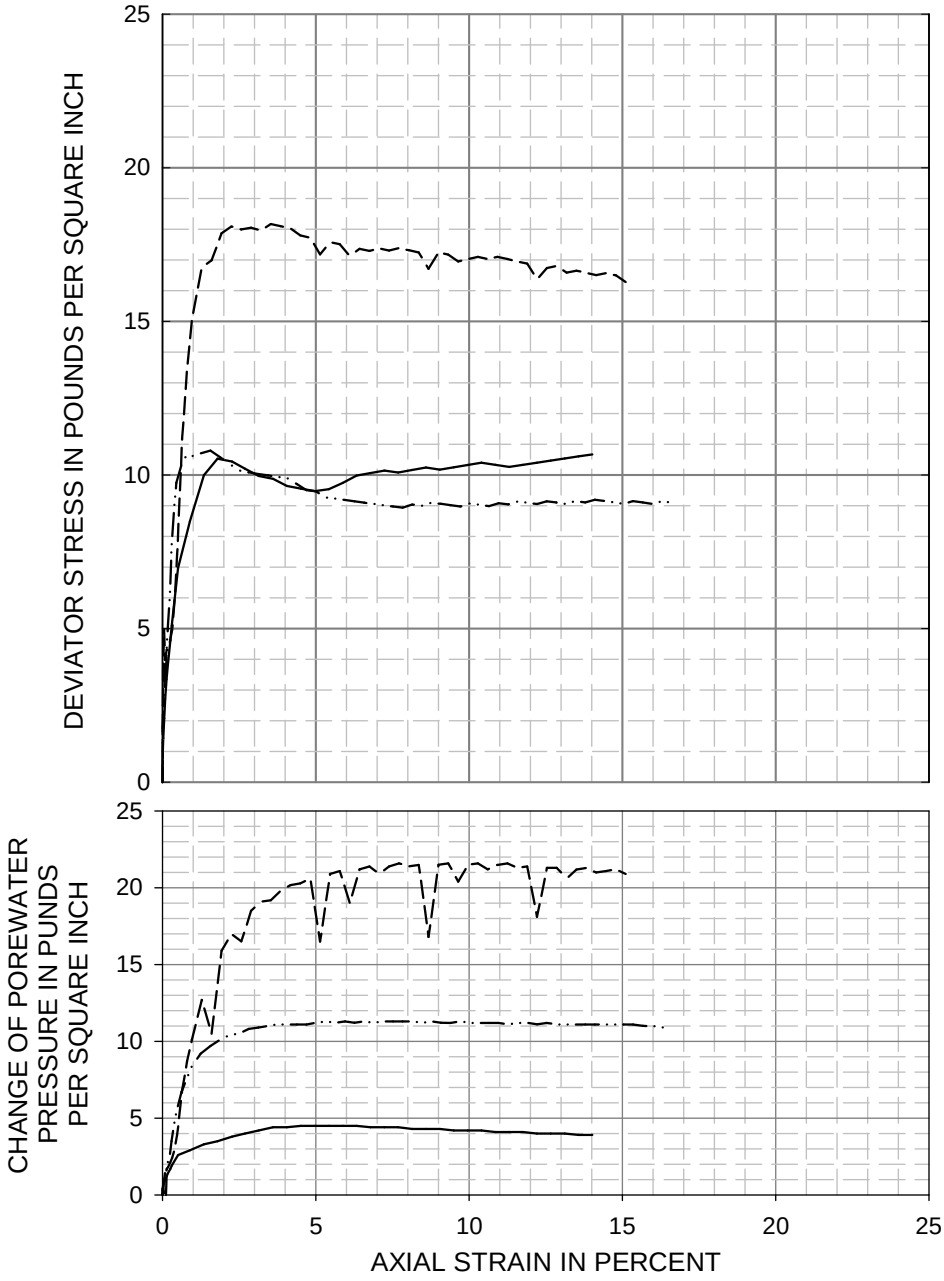
CONSOLIDATED UNDRAINED TRIAXIAL TEST DATA PLOTS

PENINSULA 2 LEVEE EVALUATION
PORTLAND, OREGON

SEP 2014
PROJ. 2320
FIG. C11



Boring No. P2-CC-15

Sample No. S-3

Depth of Sample 13 - 15 ft.

☒ Undisturbed

☐ Re-compacted

Soil Description: VERY SOFT, brown, slightly sandy, clayey SILT; fine sand, numerous mica, wet (ALLUVIUM)

	Confining Stress σ'	Length (in)	Diameter (in)	Strain Rate (%/hr)	w_c (%)	Wet Density (pcf)	Peak Stress (psi)
———	7	6.00	2.83	0.95	33	112.2	10.5
—·—·—	14	5.79	2.83	0.99	34	107.8	10.8
– – –	28	5.71	2.83	0.96	32	108.0	18.2

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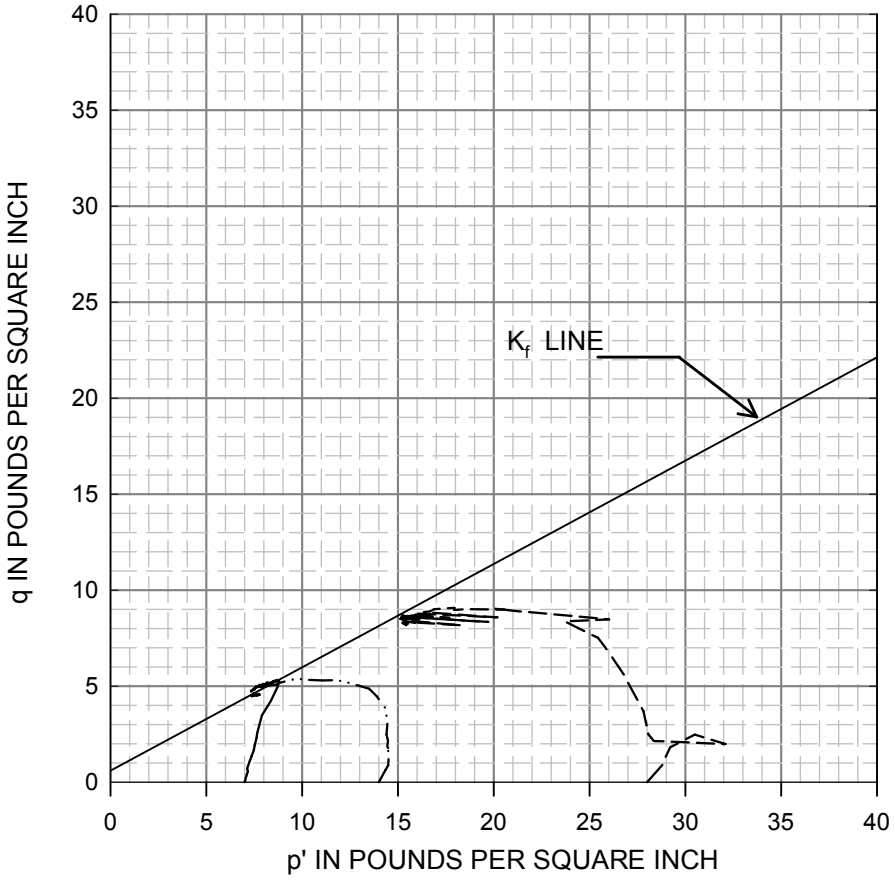
CONSOLIDATED UNDRAINED TRIAXIAL TEST DATA PLOTS

PENINSULA 2 LEVEE EVALUATION
PORTLAND, OREGON

SEP 2014

PROJ. 2320

FIG. C12



Boring No. P2-CC-15

Sample No. S-3

Depth of Sample 13 - 15 ft.

☒ Undisturbed

☐ Re-compacted

Test Type: Consolidated Undrained Triaxial

Soil Description: VERY SOFT, brown, slightly sandy, clayey SILT; fine sand, numerous mica, wet (ALLUVIUM)

Confining Stress (psi)	Length (in)	Diameter (in)	Strain Rate (%/hr)	w_C (%)	Wet Density (pcf)	Peak Stress (psi)
7	6.02	2.83	0.95	33	112.2	10.5
14	5.79	2.83	0.99	34	107.8	10.8
28	5.71	2.83	0.96	32	108.0	18.2

* failed on sand seam noted during sample preparation

K_f STRENGTH PARAMETERS:

0.04 ton/ft.^{2}

28.3 degrees

CALCULATED MOHR DIAGRAM STRENGTH PARAMETERS:

c = 0.05 ton/ft.^{2}

' 32.6 degrees

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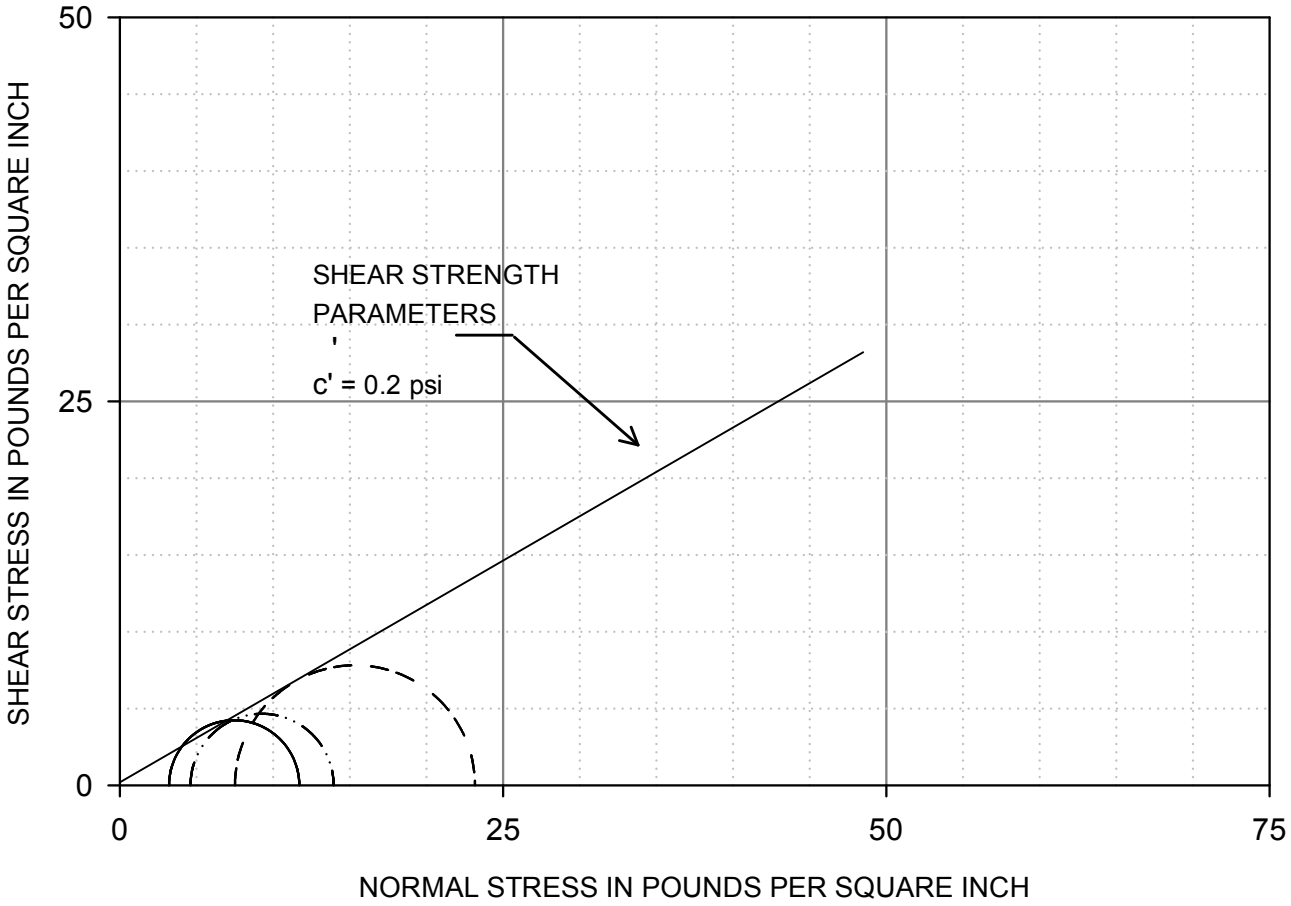
CONSOLIDATED UNDRAINED TRIAXIAL TEST DATA PLOTS

PENINSULA 2 LEVEE EVALUATION
PORTLAND, OREGON

SEP 2014

PROJ. 2320

FIG. C13



LEGEND Confining Stress (psi)

———	7
—·—·—·—	14
– – – – –	28

* failed on sand seam noted during sample preparation

☒ Undisturbed ☐ Re-compacted

Type of Test Consolidated Undrained Triaxial

Boring No. P2-CC-25 Sample No. S-3 Depth of Sample 13 to 15 ft.

Soil Description: MEDIUM STIFF, brown, slightly sandy, slightly clayey SILT; trace clay, fine sand, numerous mica, moist (FILL)

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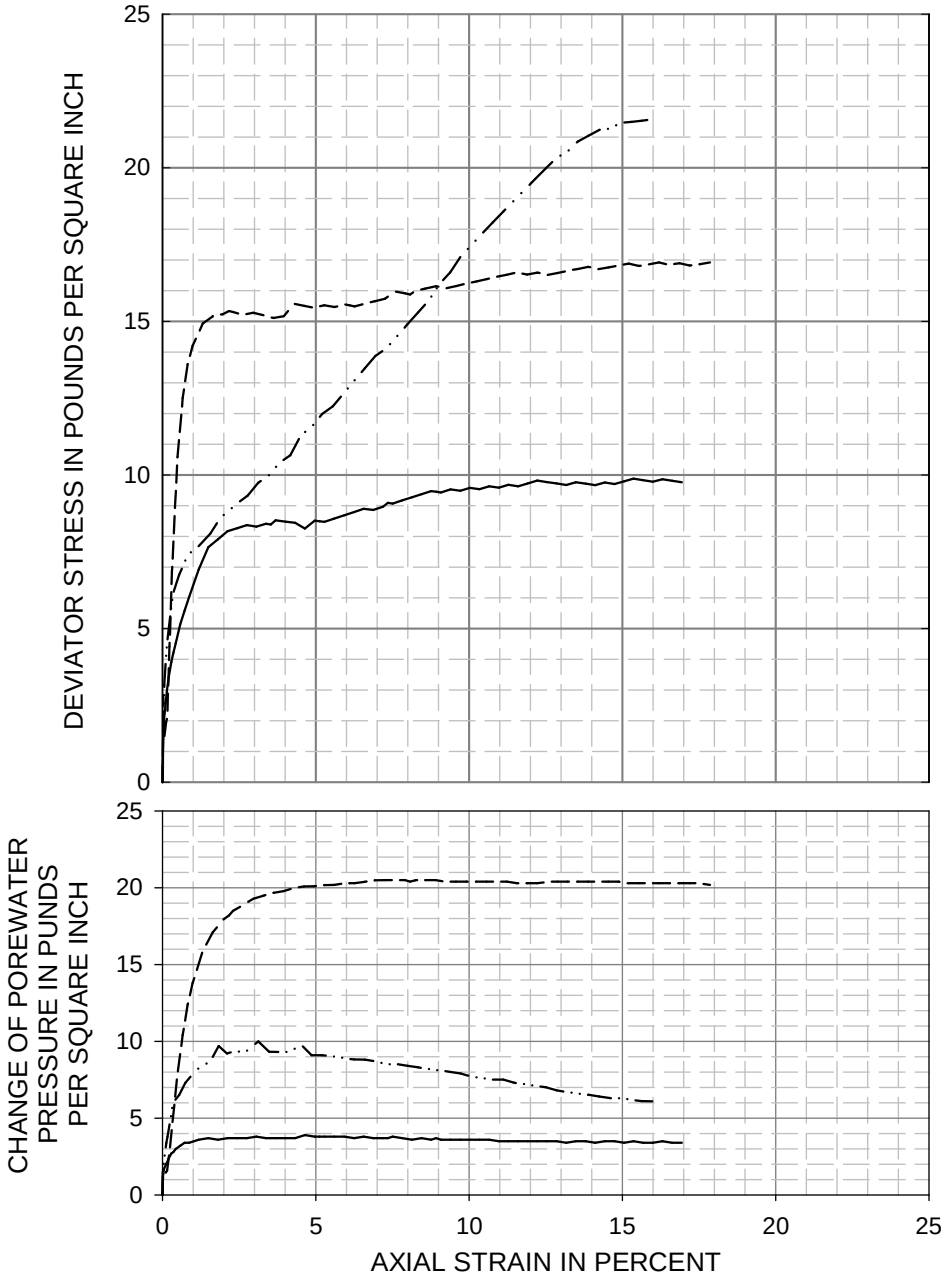
CONSOLIDATED UNDRAINED TRIAXIAL TEST DATA PLOTS

PENINSULA 2 LEVEE EVALUATION
PORTLAND, OREGON

SEP 2014
PROJ. 2320
FIG. C14



Boring No. P2-CC-25

Sample No. S-3

Depth of Sample 13 - 15 ft.

☒ Undisturbed

☐ Re-compacted

Soil Description: MEDIUM STIFF, brown, slightly sandy, slightly clayey SILT; trace clay, fine sand, numerous mica, moist (FILL)

	Confining Stress σ'	Length (in)	Diameter (in)	Strain Rate (%/hr)	w_c (%)	Wet Density (pcf)	Peak Stress (psi)
———	7	5.74	2.85	0.99	33	112.0	8.4
—·—·—	14	5.23	2.79	1.09	31	116.3	10.0
– – –	28	5.52	2.83	1.04	32	111.8	15.6

* failed on sand seam noted during sample preparation

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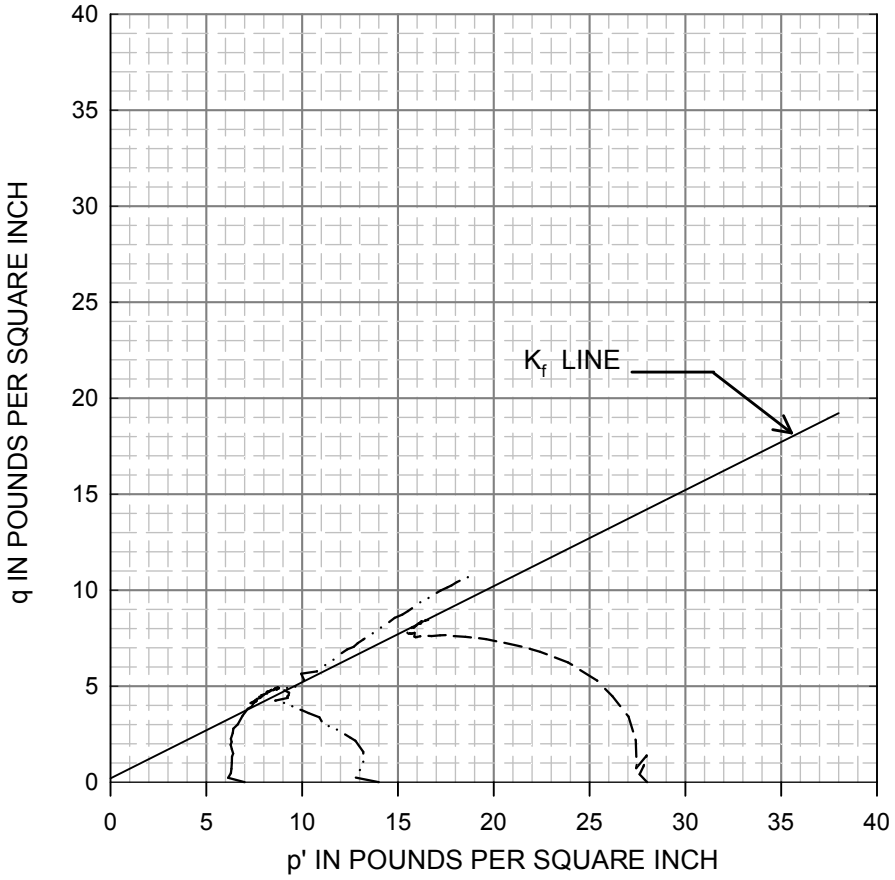
CONSOLIDATED UNDRAINED TRIAXIAL TEST DATA PLOTS

PENINSULA 2 LEVEE EVALUATION
PORTLAND, OREGON

SEP 2014

PROJ. 2320

FIG. C15



Boring No. P2-CC-25

Sample No. S-3

Depth of Sample 13 - 15 ft.

☒ Undisturbed

☐ Re-compacted

Test Type: Consolidated Undrained Triaxial

Soil Description: MEDIUM STIFF, brown, slightly sandy, slightly clayey SILT; trace clay, fine sand, numerous mica, moist (FILL)

Confining Stress (psi)	Length (in)	Diameter (in)	Strain Rate (%/hr)	w_C (%)	Wet Density (pcf)	Peak Stress (psi)
——— 7	5.74	2.85	0.99	33	112.0	8.4
—·—·— 14	5.23	2.79	1.09	XX	116.3	10.0
– – – 28	5.52	2.83	1.04	32	111.8	15.6

* failed on sand seam noted during sample preparation

K_f STRENGTH PARAMETERS:

0.01 ton/ft.^{2}

30 degrees

CALCULATED MOHR DIAGRAM STRENGTH PARAMETERS:

c = 0.02 ton/ft.^{2}

' 30.1 degrees

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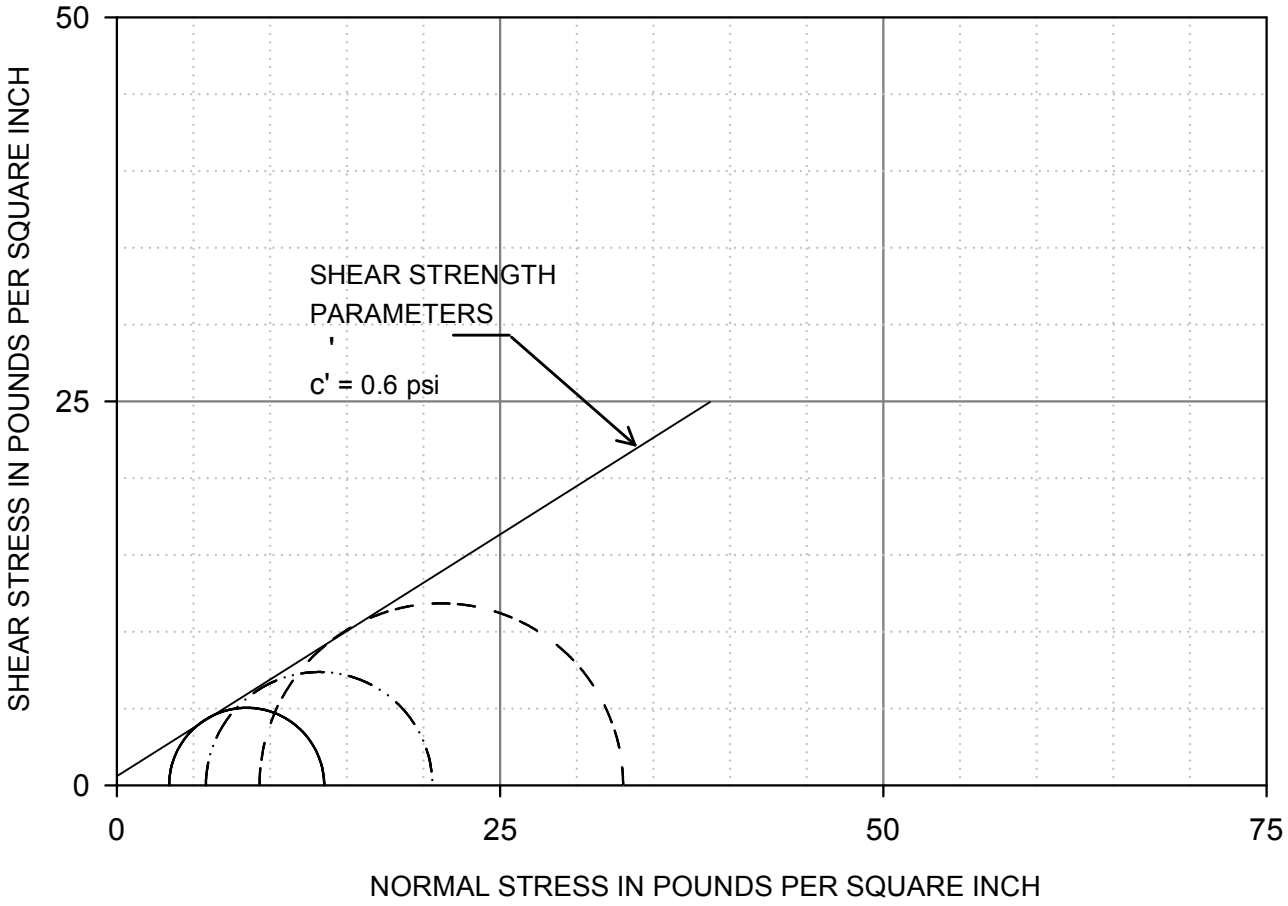
CONSOLIDATED UNDRAINED TRIAXIAL TEST DATA PLOTS

PENINSULA 2 LEVEE EVALUATION
PORTLAND, OREGON

SEP 2014

PROJ. 2320

FIG. C16



LEGEND Confining Stress (psi)

———	7
—·—·—·—	14
– – – – –	28

☒ Undisturbed ☐ Re-compacted

Type of Test Consolidated Undrained Triaxial

Boring No. P2-CC-70 Sample No. S-3 Depth of Sample 13 to 15 ft.

Soil Description: SOFT to MEDIUM STIFF, mottled red-brown to gray, very sandy, clayey SILT; fine to coarse sand, occasional organics, occasional mica, moist (FILL)

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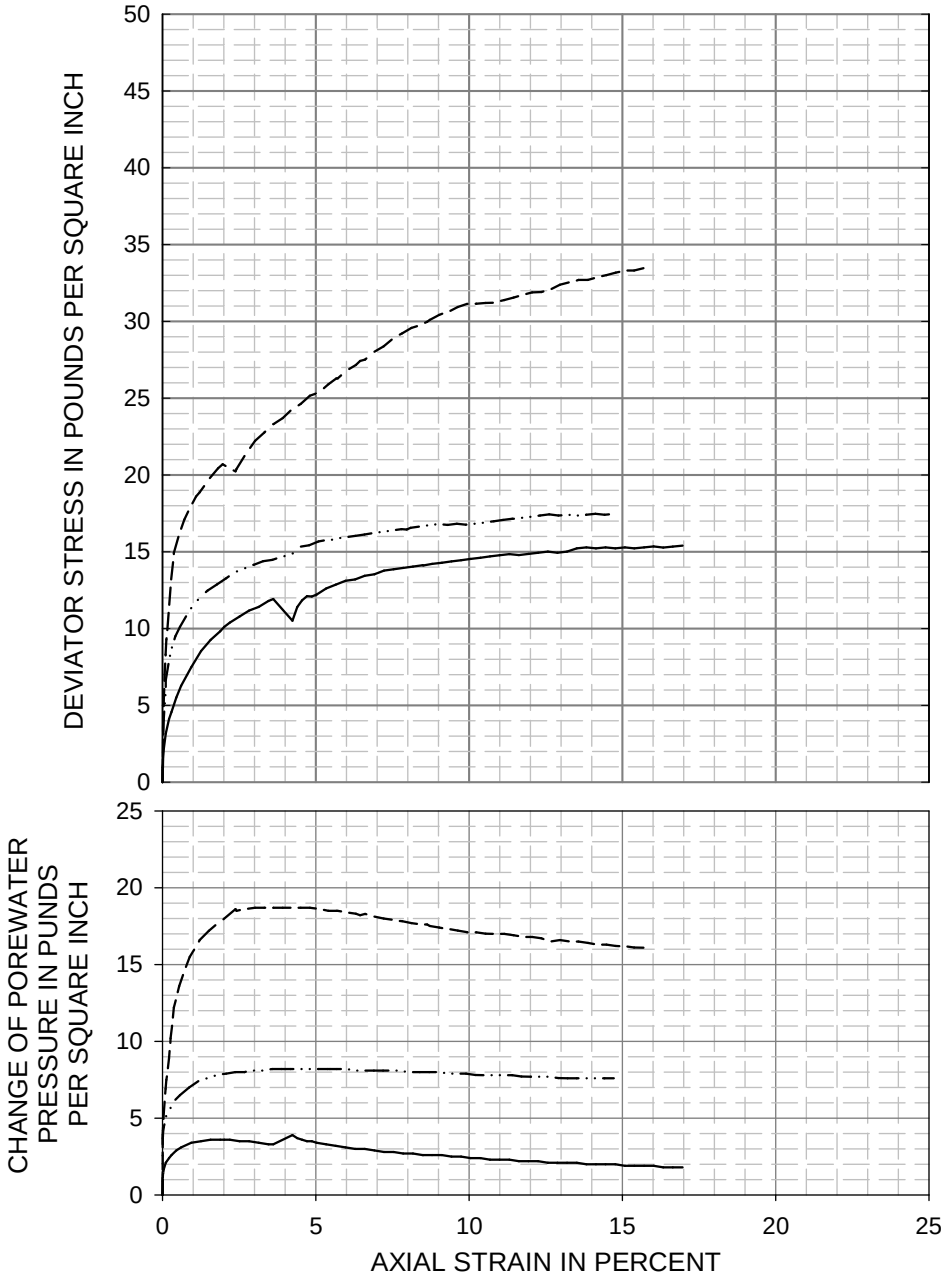
PENINSULA 2 LEVEE EVALUATION
PORTLAND, OREGON

SEP 2014
PROJ. 2320
FIG. C17



Boring No. P2-CC-70

Sample No. S-3

Depth of Sample 13 - 15 ft.

☒ Undisturbed

☐ Re-compacted

Soil Description: SOFT to MEDIUM STIFF, mottled red-brown to gray, very sandy, clayey SILT; fine to coasre sand, occasional organics, occasional mica, moist (FILL)

	Confining Stress σ'	Length (in)	Diameter (in)	Strain Rate (%/hr)	w_c (%)	Wet Density (pcf)	Peak Stress (psi)
———	7	5.77	2.85	0.99	44	109.5	10.1
—·—·—	14	6.04	2.83	0.95	37	112.3	14.8
– – –	28	6.02	2.83	0.95	33	115.3	23.7

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PENINSULA 2 LEVEE EVALUATION
PORTLAND, OREGON

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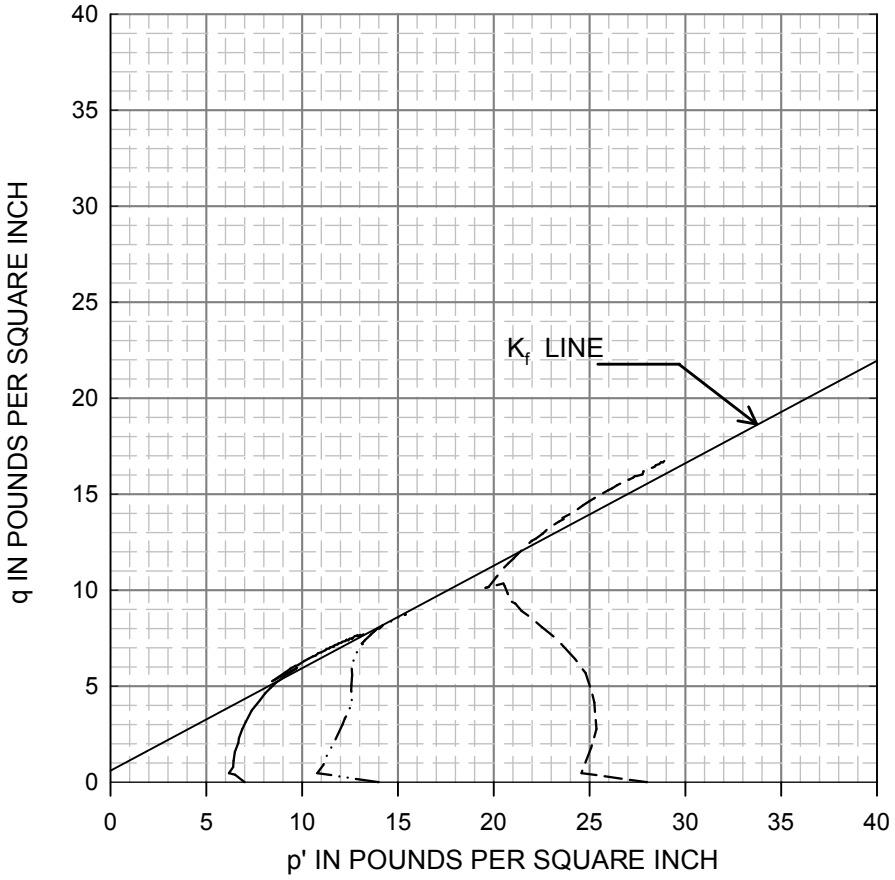
PROJ. 2320

FIG. C18



Boring No. P2-CC-70

Sample No. S-3

Depth of Sample 13 - 15 ft.

☒ Undisturbed

☐ Re-compacted

Test Type: Consolidated Undrained Triaxial

Soil Description: SOFT to MEDIUM STIFF, mottled red-brown to gray, very sandy, clayey SILT; fine to coarse sand, occasional organics, occasional mica, moist (FILL)

Confining Stress (psi)	Length (in)	Diameter (in)	Strain Rate (%/hr)	w_C (%)	Wet Density (pcf)	Peak Stress (psi)
7	5.77	2.85	0.99	44	109.5	10.1
14	6.04	2.83	0.95	37	112.3	14.8
28	6.02	2.83	0.95	33	115.3	23.7

* failed on sand seam noted during sample preparation

K_f STRENGTH PARAMETERS:

0.04 ton/ft.^{2}

28.1 degrees

CALCULATED MOHR DIAGRAM STRENGTH PARAMETERS:

c = 0.05 ton/ft.^{2}

' 32.2 degrees

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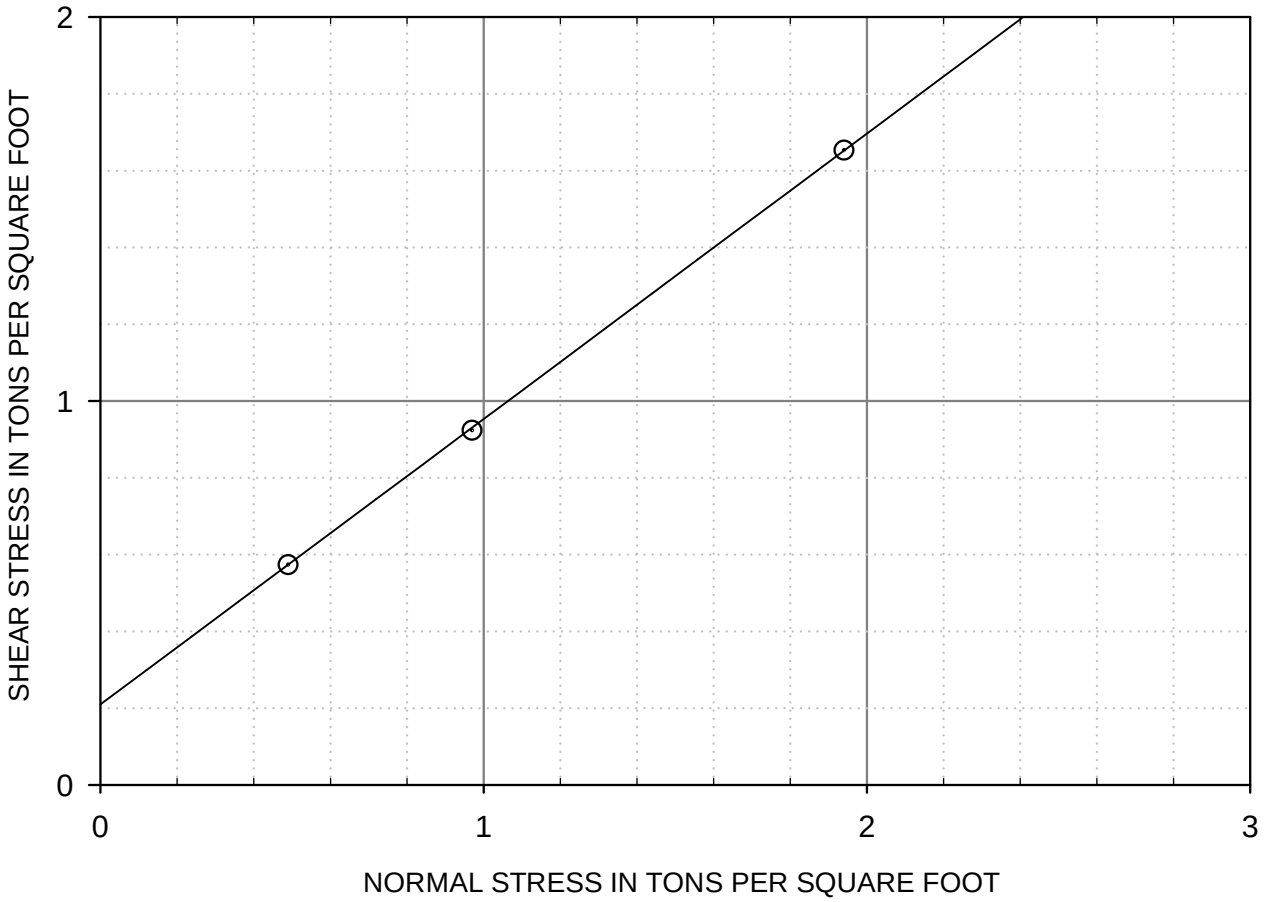
CONSOLIDATED UNDRAINED TRIAXIAL TEST DATA PLOTS

PENINSULA 2 LEVEE EVALUATION
PORTLAND, OREGON

SEP 2014

PROJ. 2320

FIG. C19



Boring No. P2-CC-32 Sample No. S-4 Depth of Sample 18.5 to 19.1 ft.

Soil Description: SOFT, gray, sandy, slightly clayey SILT; fine sand, occasional organics, scattered mica, wet (ALLUVIUM)

☒ Undisturbed ☐ Compacted ☒ Consolidated ☐ Unconsolidated

Liquid Limit: 37 Plastic Limit: 30

RESULTS:

Normal Stress (ton/ft.^{2})	0.49	0.97	1.94
⊙ Peak Stress (ton/ft.^{2})	0.57	0.92	1.65

PEAK STRENGTH PARAMETERS:

c = 0.21 ton/ft.^{2}

ϕ' = 37 degrees

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DIRECT SHEAR TEST

PENINSULA 2 LEVEE EVALUATION
PORTLAND, OREGON

SEP 2014
PROJ. 2320
FIG. C20

APPENDIX D

GROUP MACKENZIE CONSULTANTS

PEN 2 LEVEE – As-Built Maps

October 2014

PEN 2 LEVEE RECERTIFICATION
AS-BUILT MAPS

Vicinity Map

NOT TO SCALE

CLIENT

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PORTLAND, OR 97211
PHONE: 503.281.5675
CONTACT: SARA MORRISSEY

CIVIL ENGINEER

MACKENZIE
1515 SE WATER AVE.
P.O. BOX 14310
PORTLAND, OR 97293
PHONE: 503.224.9560
CONTACT: TIM MCGUIRE, P.E.

GEOTECHNICAL ENGINEER

CORNFORTH CONSULTANTS
10250 SW GREENBURG RD., SUITE 111
PORTLAND, OR 97223
PHONE: 503.452.1100
CONTACT: MIKE MEYER

SURVEYOR

GIBBS & OLSON
1405 17TH AVE., SUITE 300
LONGVIEW, WA 98632
PHONE: 360.425.0991
CONTACT: RICH WILLIAMS

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COVER SHEET

DATE:

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SHEET:
T1.0

JOB NO:
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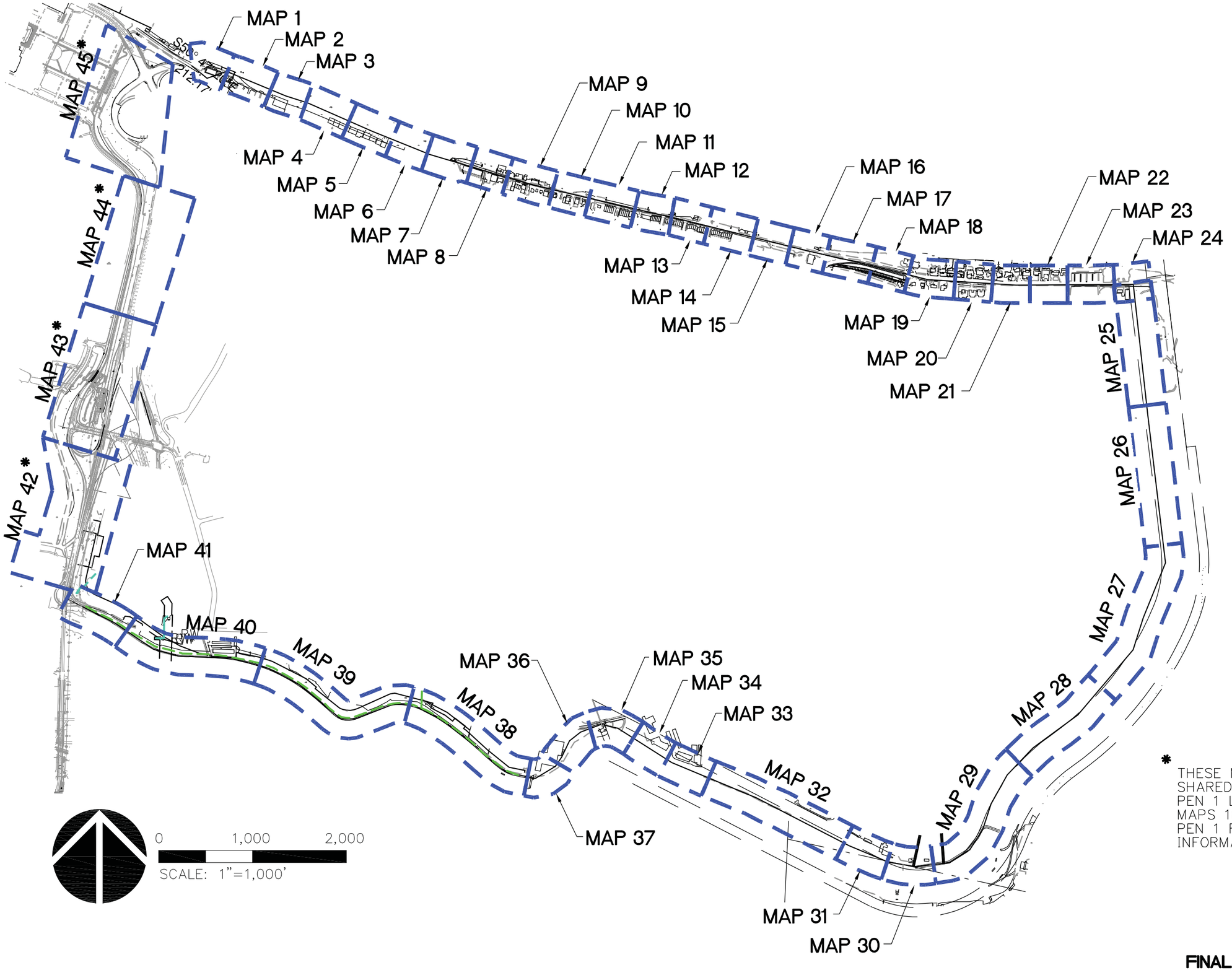

* THESE MAPS ARE PART OF A SHARED BOUNDARY WITH THE PEN 1 LEVEE. SEE AS-BUILT MAPS 16, 17, 18, & 19 FOR PEN 1 FOR DUPLICATE INFORMATION.

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RECERTIFICATION

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KEY MAP

DATE:

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RVS

SHEET:
T1.1

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LEGEND

LEVEE CENTERLINE/CONTROL LINE

APPROXIMATE TOE OF LEVEE

EXISTING GUARDRAIL

GRAVEL

EXISTING FENCE

EXISTING FLOOD WALL

EXISTING WALL

EXISTING STORM LINE — STM

EXISTING WATER LINE — WAT

EXISTING GAS LINE — G

EXISTING TELEPHONE LINE — T

EXISTING SANITARY SEWER — SS

EXISTING POWER LINE — P

EXISTING PGE UNDERGROUND — E

EXISTING POLES YARD LIGHT

EXISTING GUARD POSTS

EXISTING HDYRANTS 3 PORT

EXISTING WATER METERS

EXISTING VALVES GATE FL

EXISTING WATER VAULTS — W

EXISTING MISC. MAIL BOX

EXISTING MISC. SIGN

EXISTING VEGETATION CONIFER TREE

EXISTING VEGETATION DECIDUOUS TREE

PROPOSED VEGETATION DECIDUOUS TREE

EXISTING CONTROL ANGLE POINT

EXISTING CONTROL BENCH MARK

EXISTING CONTROL SPOT ELEV.

EXISTING GAS METER

EXISTING RELIEF WELL

EXISTING GAS VALVE

EXISTING POWER POLE

EXISTING POWER POLE ANCHOR

EXISTING POWER TOWER

EXISTING POWER TRANSFORMER

EXISTING POWER VAULT — P

EXISTING SEWER CLEANOUT

EXISTING SEWER MH

EXISTING STORM CULVERT

EXISTING STORM GENERIC MH

EXISTING TELEPHONE POLE

EXISTING TELEPHONE POLE ANCHOR

EXISTING TELEPHONE RISER

EXISTING TELEPHONE VAULT — T

CORNFORTH CONSULTANTS BORING (2014) — P2-CC-7

PREVIOUS BORINGS BY OTHERS — CRC-SC-011

DATUM/BENCHMARK

GIBBS & OLSON POINT #DEA1540
D.EVANS & ASSOC. COLUMBIA CROSSING POINT #1540
HELD FOR VERTICAL
HORIZONTAL COORDINATES ARE OREGON NORTH NAD 83
N: 710717.082
E: 7642333.849
VERTICAL ARE NAVD88
ELEVATION: 39.288

GIBBS & OLSON POINT #DEA3406
D.EVANS & ASSOC. COLUMBIA CROSSING POINT #3406
HELD FOR VERTICAL
HORIZONTAL COORDINATES ARE OREGON NORTH NAD 83
N: 714703.056
E: 7643154.604
VERTICAL ARE NAVD88
ELEVATION: 35.113

GIBBS & OLSON POINT #DEA1326
D.EVANS & ASSOC. COLUMBIA CROSSING POINT #1326
HELD FOR VERTICAL
HORIZONTAL COORDINATES ARE OREGON NORTH NAD 83
N: 710304.592
E: 7647508.466
VERTICAL ARE NAVD88
ELEVATION: 17.940

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LEGEND + NOTES

DATE:

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SHEET:
T1.2

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CRC–SC–020

OREGON SLOUGH
COLUMBIA RIVER

2+50.00

10

20

30

TOE OF LEVEE

0+00

339+29

339+00

1+00

2+00

P2–CC–2

3+00

4+00

I–5

N. PIER 99 ST.

SDMH #2546
RIM=30.86

SDCB #2257 (2.9' x 2.4' GRATE)
GRATE=25.79

RIVERS WEST

P2–CC–1

0 30 60
SCALE: 1"=30'

MATCHLINE - SEE SHEET 2

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MAP 1

DATE:

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RVS

SHEET:
1

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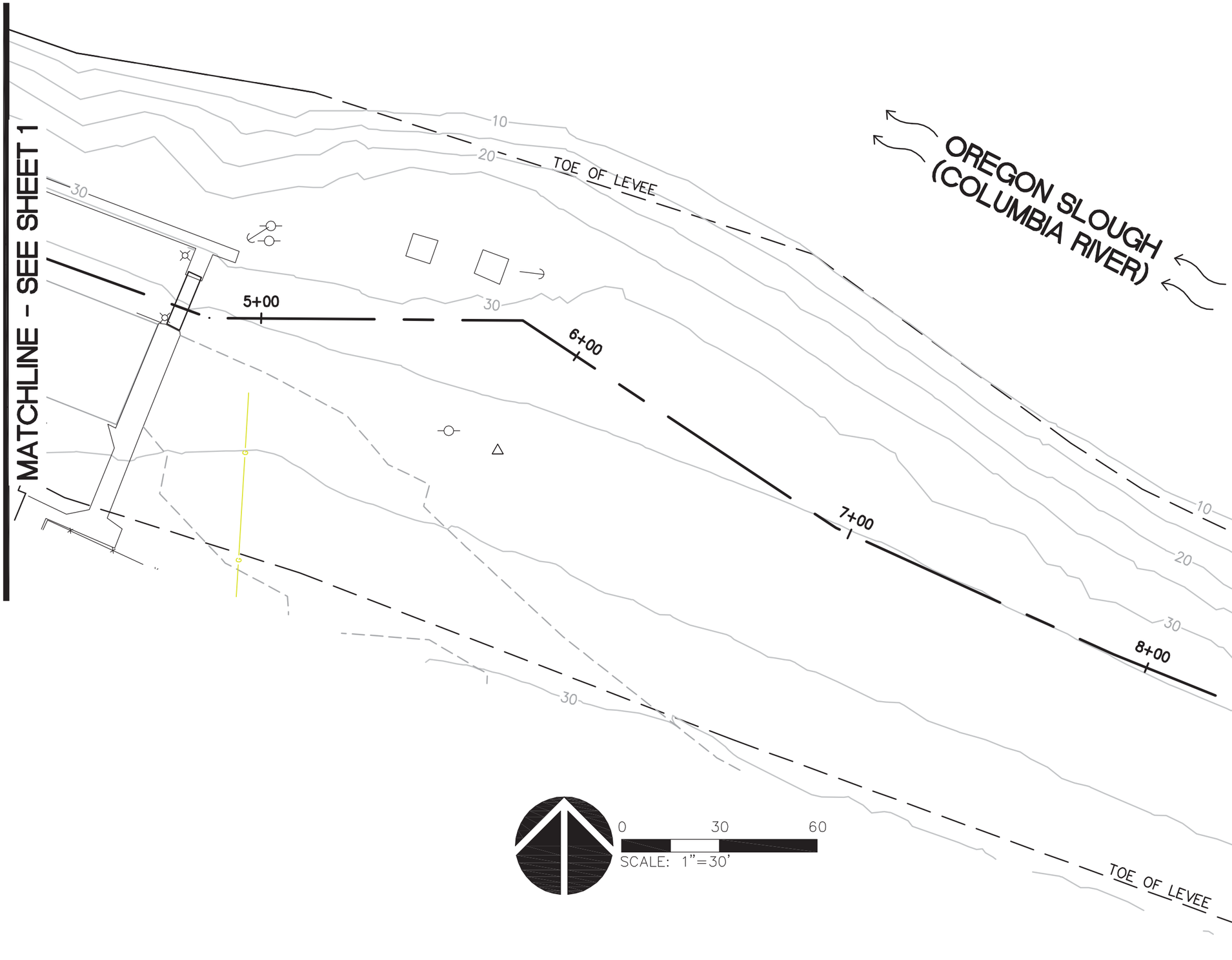

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SHEET:
2

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2140170.01

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MATCHLINE - SEE SHEET 2

OREGON SLOUGH
(COLUMBIA RIVER)

P2-CC-5

10+00

11+00

12+00

13+00

13+10.0

TOE OF LEVEE

TOE OF LEVEE

10

15

20

25

30

35

10

20

30

35

30

30

MARRIOT GARAGE
FF ELEV=26.7±

COURTYARD MARRIOT

P2-CC-4

P2-CC-3

0 30 60

SCALE: 1"=30'

MATCHLINE - SEE SHEET 4

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SHEET TITLE:
MAP 3

DATE:

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BTS
CHECKED BY:
RVS

SHEET:
3

JOB NO:
2140170.01

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FINAL CONTENT - 10.03.2014

214017000\CIVIL\P2-03.DWG BTS 07/28/14 07:59 1:30.00

MATCHLINE - SEE SHEET 3

OREGON SLOUGH
(COLUMBIA RIVER)

TOE OF LEVEE

TOE OF LEVEE

14+00

15+00

16+00

17+00

18+00

10

20

30

30

10

20

30

30

SDMH #2379
RIM=30.28

G

0 30 60
SCALE: 1"=30'

MATCHLINE - SEE SHEET 5

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SHEET TITLE:
MAP 4

DATE:

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SHEET:
4

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214017000\CIVIL\P2-04.DWG BTS 07/29/14 12:49 1:30.00

MATCHLINE - SEE SHEET 4

OREGON SLOUGH
(COLUMBIA RIVER)

10

19+00

TOE OF LEVEE

10

20

20+00

30

TOE OF LEVEE

21+00

22+00

VEGETATION

30

0 30 60

SCALE: 1"=30'

MATCHLINE - SEE SHEET 6

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MAP 5

DATE:

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SHEET:
5

JOB NO:
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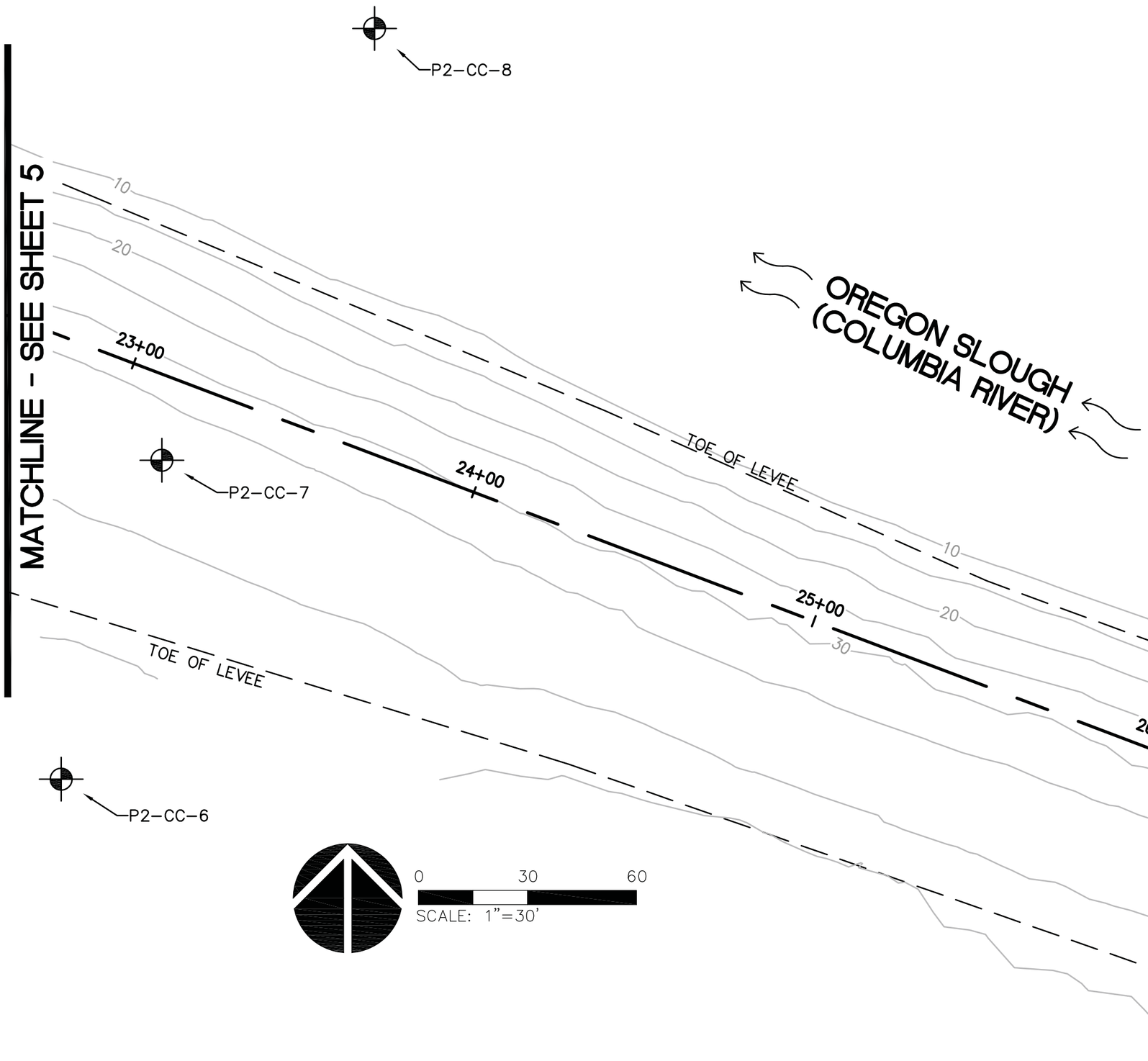

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MATCHLINE - SEE SHEET 7

PROJECT:
PEN 2 LEVEE RECERTIFICATION

SHEET TITLE:
MAP 6

DATE:

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SHEET:
6

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0 30 60
SCALE: 1"=30'

MATCHLINE - SEE SHEET 6

MATCHLINE - SEE SHEET 8

OREGON SLOUGH
(COLUMBIA RIVER)

N. BRIDGETON RD.

TOE OF LEVEE

TOE OF LEVEE

10
20
30
28+00
29+00
30+00
31+00
35

SDCB 2.75' x 2.3' WITH OIL TRAP #2590
GRATE=35.46
I.E. OUT=31.96 SIZE" TYPE (S)

SDCB TYPE ? #2594
GRATE=35.95
I.E. OUT=33.60 8" TYP

CDMH #2595
RIM=35.74

STM

PROJECT:
PEN 2 LEVEE RECERTIFICATION

SHEET TITLE:
MAP 7

DATE:

DRAWN BY:
BTS
CHECKED BY:
RVS

SHEET:
7

JOB NO:
2140170.01

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214017000 C:\TEMP\ACPUBLISH_3276\P2-07.DWG RVS 09/26/14 15:01 1:30.00

MATCHLINE - SEE SHEET 7

33+00.00

P2-CC-11

OREGON SLOUGH
(COLUMBIA RIVER)

34+75.00

TOE OF LEVEE

32+00

33+00

P2-CC-10

N. BRIDGETON RD.

34+00

35+00

36+00

SDCB TYPE ? #2737
GRATE=36.25
I.E. OUT=33.45

SDMH #2757
RIM=35.72

N HAIGHT AVE.

SDCB TYPE 2 #2747
GRATE=28.36

P2-CC-9

#328

#322

#318

#310

TOE OF LEVEE

N GANTENBEIN AVE.

MATCHLINE - SEE SHEET 9

0 30 60

SCALE: 1"=30'

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214017000\CIVIL\P2-08.DWG RVS 09/26/14 15:03 1:30.00

M.
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PROJECT:
PEN 2 LEVEE
RECERTIFICATION

SHEET TITLE:
MAP 8

DATE:

DRAWN BY:
BTS
CHECKED BY:
RVS

SHEET:
8

JOB NO:
2140170.01

MATCHLINE - SEE SHEET 8

37+75.00

OREGON SLOUGH
(COLUMBIA RIVER)

TOE OF LEVEE

N. BRIDGETON RD.

37+00

38+00

39+00

40+00

N. VANCOUVER AVE.

TOE OF LEVEE

MATCHLINE - SEE SHEET 10

0 30 60

SCALE: 1"=30'

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PROJECT:
PEN 2 LEVEE RECERTIFICATION

SHEET TITLE:
MAP 9

DATE:

DRAWN BY:
BTS
CHECKED BY:
RVS

SHEET:
9

JOB NO:
2140170.01

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214017000\CIVIL\P2-09.DWG RVS 09/26/14 15:05 1:30.00

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MATCHLINE – SEE SHEET 9

MATCHLINE – SEE SHEET 11

P2–CC–14

OREGON SLOUGH
(COLUMBIA RIVER)

TOE OF LEVEE

43+80.00

STEEL
STAIRS
EL.=34.49

P2–CC–13

41+00

42+00

43+00

44+00

N. MOORE AVE.

N. BRIDGETON RD.

N. WILLIAMS AVE.

DECK

#11020

P2–CC–12

30

20

10

TOE OF LEVEE

#8

#20

FF ELEV=29.27

SSMH #3566
RIM=28.87

SSMH #3569
RIM=28.42

UPPER FLOOR
FF ELEV=36.86

#28

WAT

G

W

0 30 60
SCALE: 1"=30'

PROJECT:
PEN 2 LEVEE RECERTIFICATION

SHEET TITLE:
MAP 10

DATE:

DRAWN BY:
BTS
CHECKED BY:
RVS

SHEET:
10

JOB NO:
2140170.01

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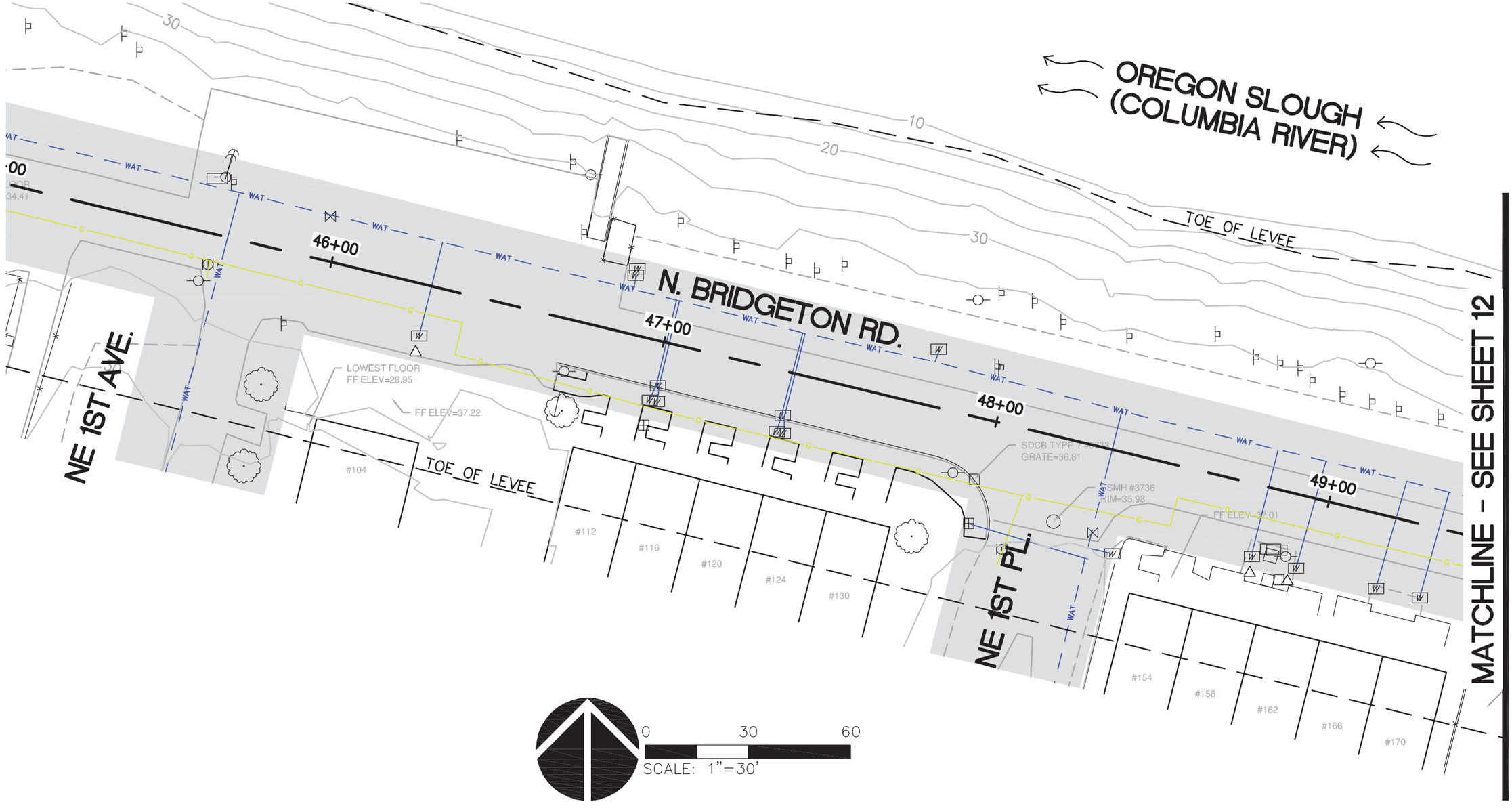
FINAL CONTENT – 10.03.2014

214017000\CIVIL\P2–10.DWG RVS 08/08/14 14:21 1:30.00

MATCHLINE - SEE SHEET 10



0 30 60

SCALE: 1"=30'

MATCHLINE - SEE SHEET 12

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SHEET TITLE:
MAP 11

DATE:

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BTS
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RVS

SHEET:
11

JOB NO:
2140170.01

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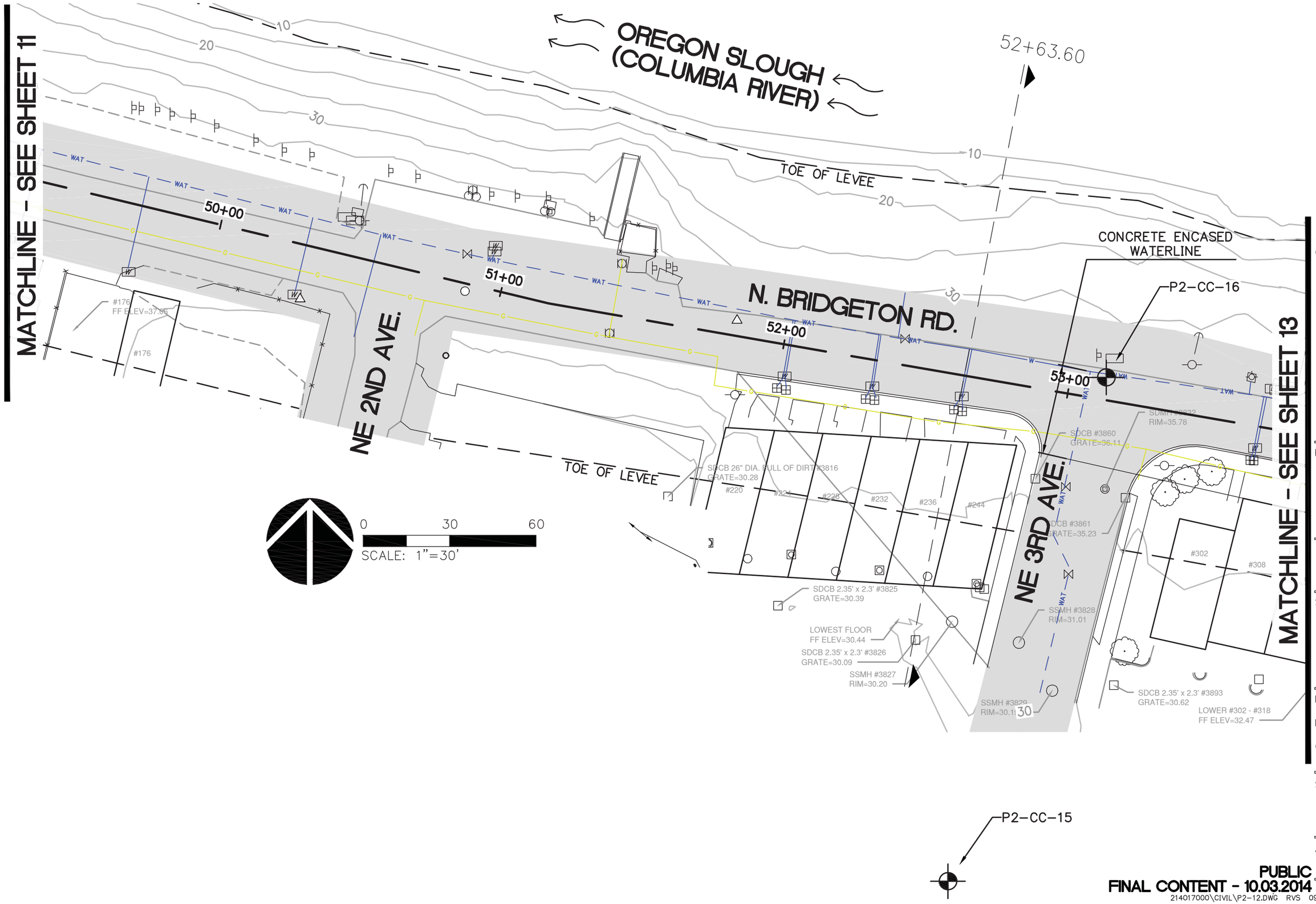
214017000\CIVIL\P2-11.DWG BTS 07/28/14 11:43 1:30.00



MATCHLINE - SEE SHEET 13

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SHEET TITLE:
MAP 12

DATE:

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BTS
CHECKED BY:
RVS

SHEET:
12

JOB NO:
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214017000\CIVIL\P2-12.DWG RVS 09/26/14 15:06 1:30.00

MATCHLINE - SEE SHEET 12

MATCHLINE - SEE SHEET 14

NE BRIDGETON RD.

NE 4TH AVE.

OREGON SLOUGH (COLUMBIA RIVER)

TOE OF LEVEE

TOE OF LEVEE

56+50.00

54+00

55+00

56+00

57+00

58+00

10

20

30

#321

#314

#318

#324

#330

#336

#340

#400

#406

#412

#418

#424

#430

#436

#442

#448

#405

SHEDS

GARAGES
FF ELEV. =28.59

UPPER #302 - #318
FF ELEV=37.36

UPPER #324 - #340
FF ELEV=37.70

UPPER #400 - #424
FF ELEV=37.64

UPPER FLOOR
FF ELEV. =36.44

UPPER #430 - #448
FF ELEV=37.77

LOWER #324 - #340
FF ELEV=33.73

LOWER #400 - #424
FF ELEV=33.69

LOWER #430 - #448
FF ELEV=32.99

SSMH #3884
RIM=33.24

SSMH #3883
RIM=33.37

SSMH #3975
RIM=33.33

SSMH #3976
RIM=33.28

SSMH #3958
RIM=36.12

SDCB #3960
GRATE=35.56

SDCB #3951
GRATE=35.65

SSMH #3951
RIM=32.17

SSMH #3962
RIM=31.24

0 30 60

SCALE: 1"=30'

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SHEET TITLE:
MAP 13

DATE:

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CHECKED BY:
RVS

SHEET:
13

JOB NO:
2140170.01

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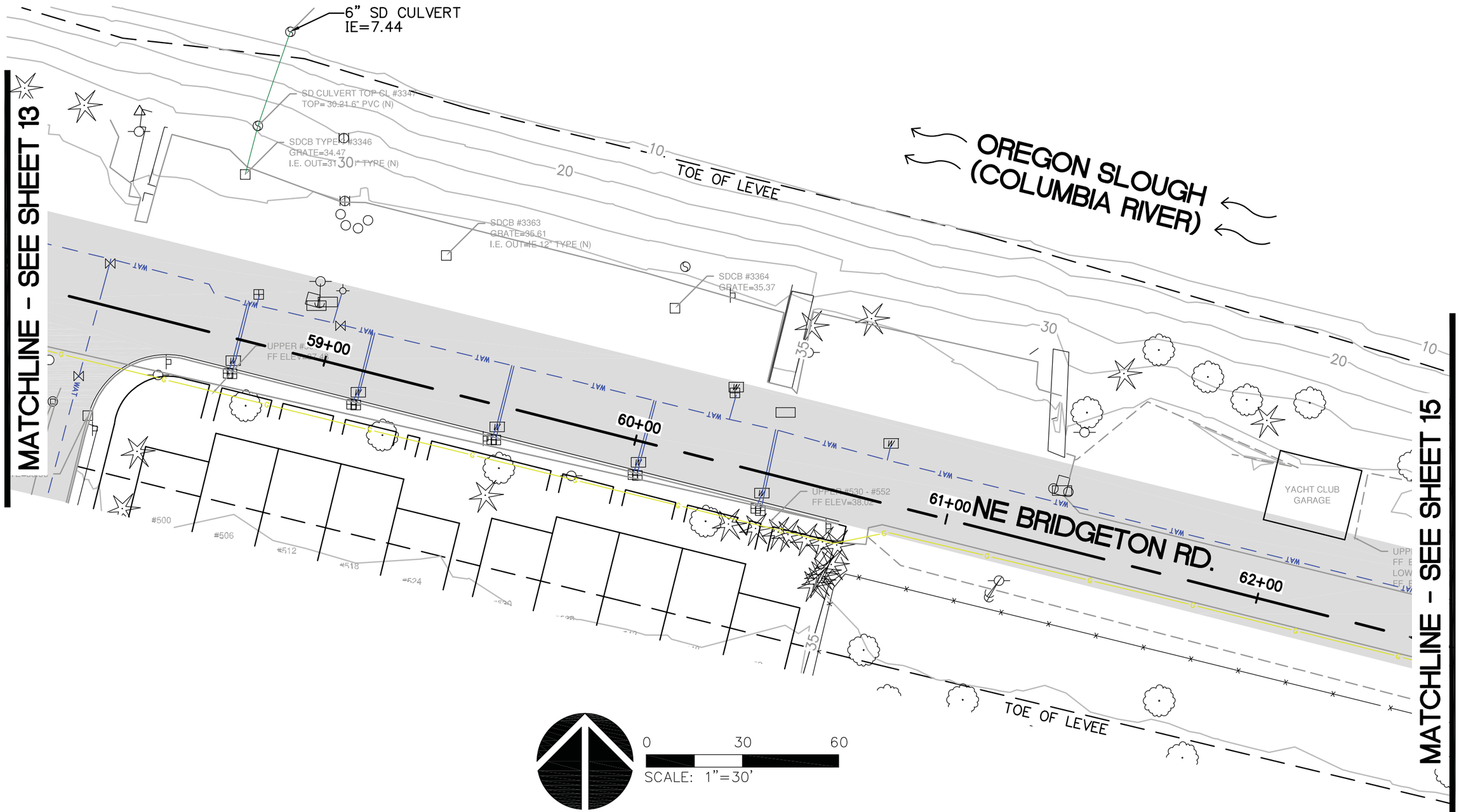
FINAL CONTENT - 10.03.2014

214017000\CIVIL\P2-13.DWG RVS 09/26/14 15:08 1:30.00



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PROJECT:
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SHEET TITLE:
MAP 14

DATE:

DRAWN BY:
BTS
CHECKED BY:
RVS

SHEET:
14

JOB NO:
2140170.01

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214017000\CIVIL\P2-14.DWG RVS 07/29/14 16:16 1:30.00

MATCHLINE – SEE SHEET 14

P2–CC–20

OREGON SLOUGH
(COLUMBIA RIVER)

TOE OF LEVEE

P2–CC–19

NE BRIDGETON RD.

63+00

64+00

65+00

66+00

TOE OF LEVEE

P2–CC–18

SDCB #3500
GRATE=29.36

SDCB #3499
GRATE=29.18

0 30 60
SCALE: 1"=30'

MATCHLINE – SEE SHEET 16

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SHEET TITLE:
MAP 15

DATE:

DRAWN BY:
BTS
CHECKED BY:
RVS

SHEET:
15

JOB NO:
214017.01

PUBLIC
FINAL CONTENT – 10.03.2014

214017000\CIVIL\P2–15.DWG RVS 08/08/14 14:25 1:30.00

MATCHLINE - SEE SHEET 15

MATCHLINE - SEE SHEET 17

OREGON SLOUGH
(COLUMBIA RIVER)

NE BRIDGETON RD.

TOE OF LEVEE

TOE OF LEVEE

67+00

68+00

69+00

70+00

71+00

10

20

30

WAT

G

SEED OIL TANK

0 30 60

SCALE: 1"=30'

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SHEET TITLE:
MAP 16

DATE:

DRAWN BY:
BTS
CHECKED BY:
RVS

SHEET:
16

JOB NO:
2140170.01

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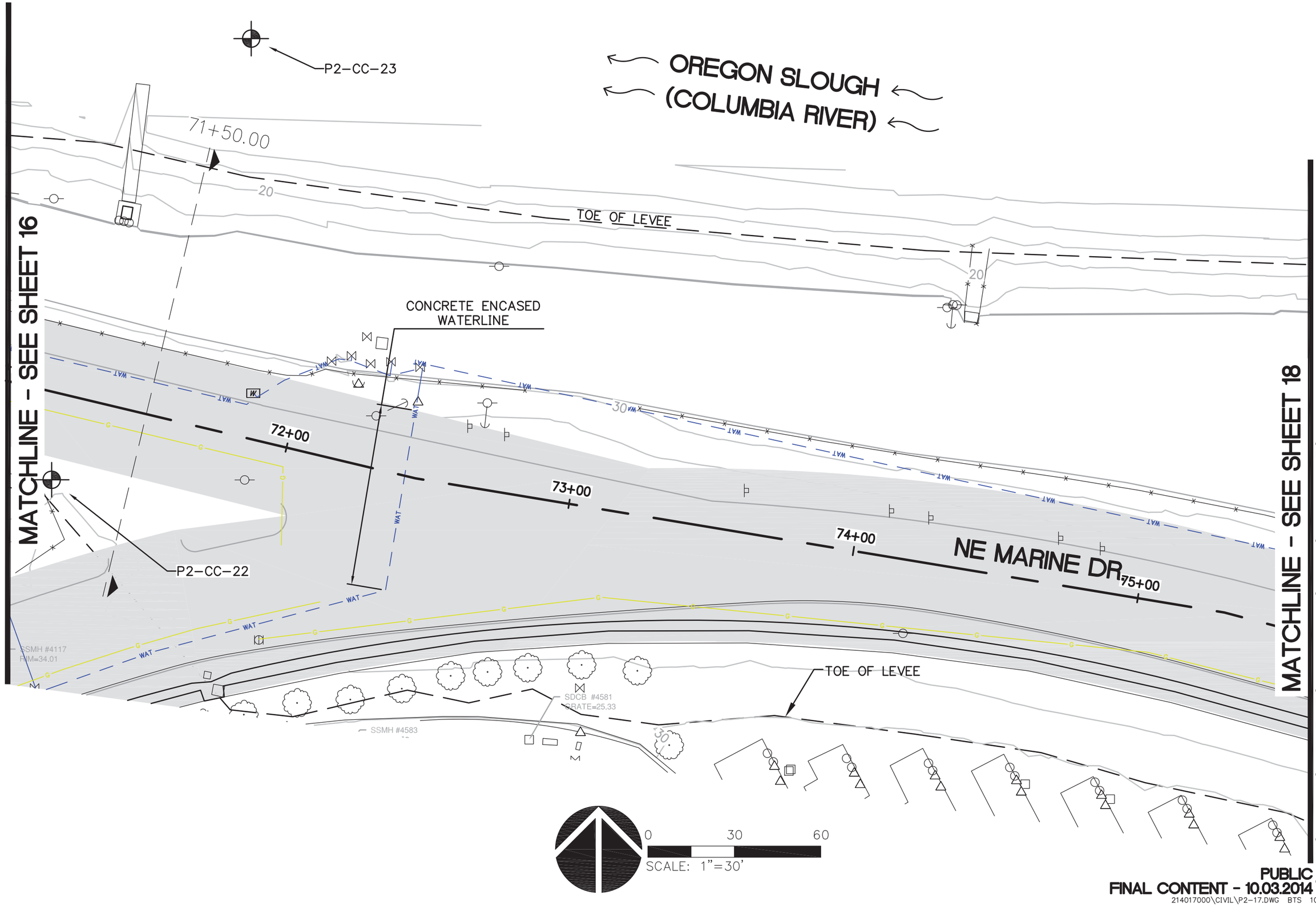
FINAL CONTENT - 10.03.2014



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SHEET TITLE:
MAP 17

DATE:

DRAWN BY:
BTS
CHECKED BY:
RVS

SHEET:
17

JOB NO:
2140170.01

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FINAL CONTENT - 10.03.2014

OREGON SLOUGH
(COLUMBIA RIVER)

0 30 60
SCALE: 1"=30'

TOE OF LEVEE

20

30

PORTLAND
YACHT
CLUB

CONCRETE ENCASED
WATERLINE

SSCO #4264
TOP=35.95

SSMH #4265
RIM=35.50

76+00 77+00 78+00 79+00 80

NE MARINE DR.

WAT

SD

SS

SSCO #4469
TOP=26.06

SSCO #4470

TOE OF LEVEE

MATCHLINE - SEE SHEET 17

MATCHLINE - SEE SHEET 19

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SHEET TITLE:
MAP 18

DATE:

DRAWN BY:
BTS
CHECKED BY:
RVS

SHEET:
18

JOB NO:
2140170.01

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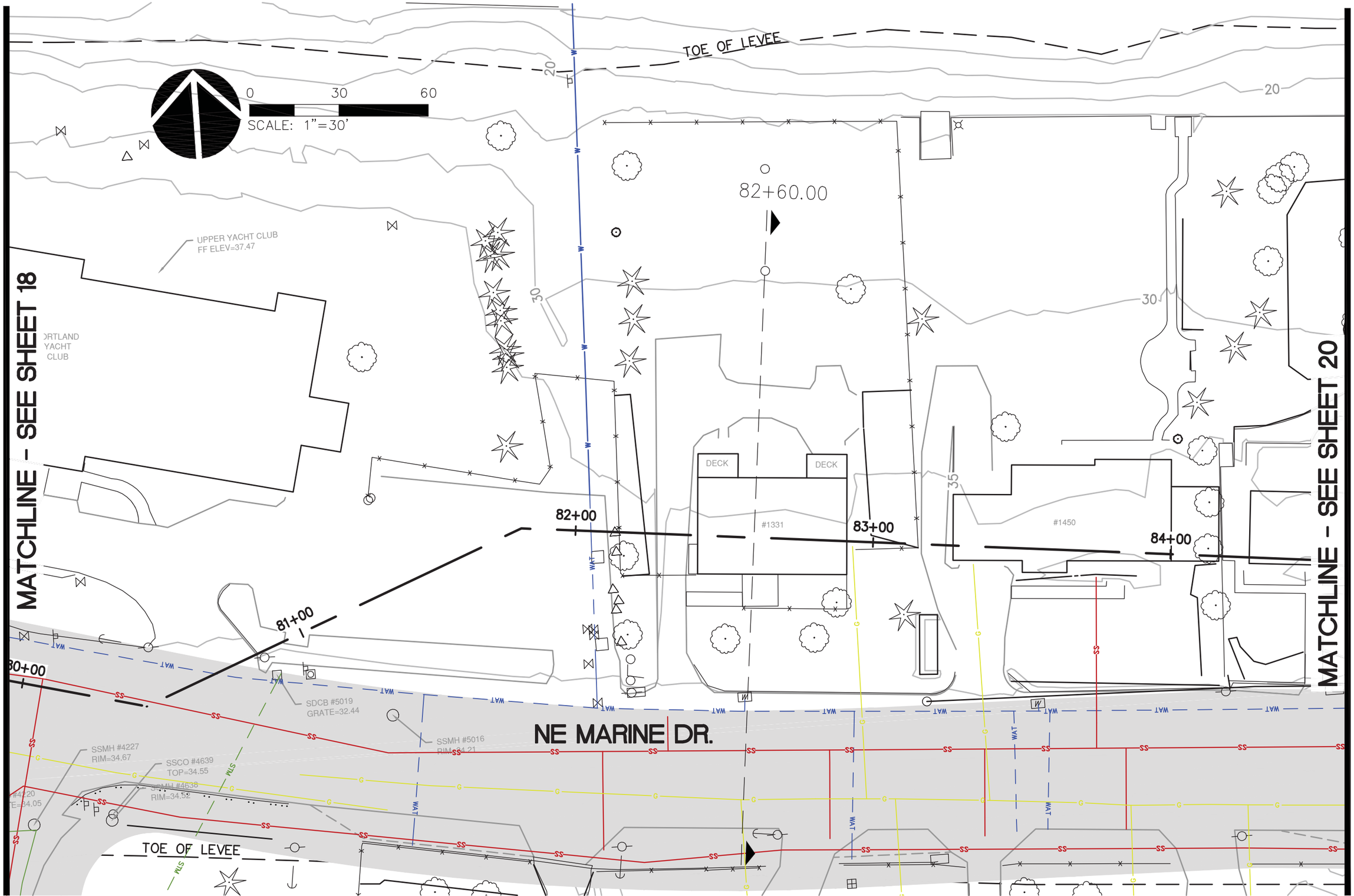
FINAL CONTENT - 10.03.2014
214017000\CIVIL\P2-18.DWG BTS 10/03/14 08:31 1:30.00



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SHEET TITLE:
MAP 19

DATE:

DRAWN BY:
BTS
CHECKED BY:
RVS

SHEET:
19

JOB NO:
2140170.01

PUBLIC
FINAL CONTENT - 10.03.2014

214017000\CIVIL\P2-19.DWG BTS 10/03/14 08:37 1:30.00

TOE OF LEVEE

25 20 25

25 85+80.00 30

P2-CC-26

SDCB #5008
GRATE=32.58

LOWER #1427
FF ELEV=32.34

PATIO
DECK

DECK

#1427

UPPER #1427
FF ELEV=39.48

85+00 86+00 87+00 88+00

LOWER #1515
FF ELEV=33.13

DECK

#1515

LOWEST #1525
FF ELEV=28.69

30

DECK

DECK
HOUSE

SHOP
FF ELEV=32.86

DECK HOUSE
FF ELEV=34.42

#1525

#1611

UPPER #1515
FF ELEV=41.00

0 30 60
SCALE: 1"=30'

MATCHLINE - SEE SHEET 19

MATCHLINE - SEE SHEET 21

SDCB #5427
GRATE=33.81

SDMH #5424
RIM=34.87

SDMH #5423
RIM=34.29

SDCB #5416
GRATE=34.23

P2-CC-25

NE MARINE DR.

EXISTING SANITARY SEWER LINE
ELEVATION INFORMATION NOT AVAILABLE

BORING P2-CC-24 IS
PRESENT, BUT LOCATED
OUTSIDE OF THE EXTENTS
OF THIS MAP

SSCO #4719
TOP=34.77

TOE OF LEVEE

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214017000\CIVIL\P2-20.DWG BTS 10/03/14 08:39 1:30.00

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SHEET TITLE:
MAP 20

DATE:

DRAWN BY:
BTS
CHECKED BY:
RVS

SHEET:
20

JOB NO:
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M.

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SHEET TITLE:
MAP 21

DATE:

DRAWN BY: BTS

CHECKED BY: RVS

SHEET:
21

JOB NO:
2140170.01

PUBLIC
FINAL CONTENT - 10.03.2014

214017000\CIVIL\P2-21.DWG BTS 10/03/14 08:40 1:30.00

TOE OF LEVEE

93+90.00

LOWEST #1825
FF ELEV=33.19

LOWER #1801
FF ELEV=32.46

LOWER PATIO

CAR PORT

#1825

#1839

SSCO #5556
TOP=37.53

LOWER #1909
FF ELEV=31.54

LOWEST #1917
FF ELEV=35.08

DECK

#1917

#1909

UPPER #1917
FF ELEV=38.63

UPPER #1801
FF ELEV=39.33

94+00

95+00

96+00

97+00

SDCB #5442
GRATE=34.34

SDMH #5443
RIM=34.65

SSMH #5444
RIM=35.02

SDCB #5445
GRATE=33.87

SSMH #5453
RIM=34.35

SDCB #5457
GRATE=33.67

NE MARINE DR.

TOE OF LEVEE

0 30 60

SCALE: 1"=30'

MATCHLINE - SEE SHEET 21

MATCHLINE - SEE SHEET 23

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SHEET TITLE:
MAP 22

DATE:

DRAWN BY:
BTS
CHECKED BY:
RVS

SHEET:
22

JOB NO:
2140170.01

PUBLIC
FINAL CONTENT - 10.03.2014

214017000\CIVIL\P2-22.DWG BTS 10/03/14 08:49 1:30.00

SD CULVERT
IE=12.90

TOE OF LEVEE

20

30

97+50.00

P2-CC-29

VEGETATION

MATCHLINE - SEE SHEET 22

98+00

99+00

100+00

101+00

P2-CC-28

STM

WAT

SS

G

W

NE MARINE DR.

30

TOE OF LEVEE

MATCHLINE - SEE SHEET 24

0 30 60

SCALE: 1"=30'

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SHEET TITLE:
MAP 23

DATE:

DRAWN BY:
BTS
CHECKED BY:
RVS

SHEET:
23

JOB NO:
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214017000\CIVIL\P2-23.DWG BTS 10/03/14 09:28 1:30.00

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SHEET TITLE:
MAP 24

DATE:

DRAWN BY:
BTS
CHECKED BY:
RVS

SHEET:
24

JOB NO:
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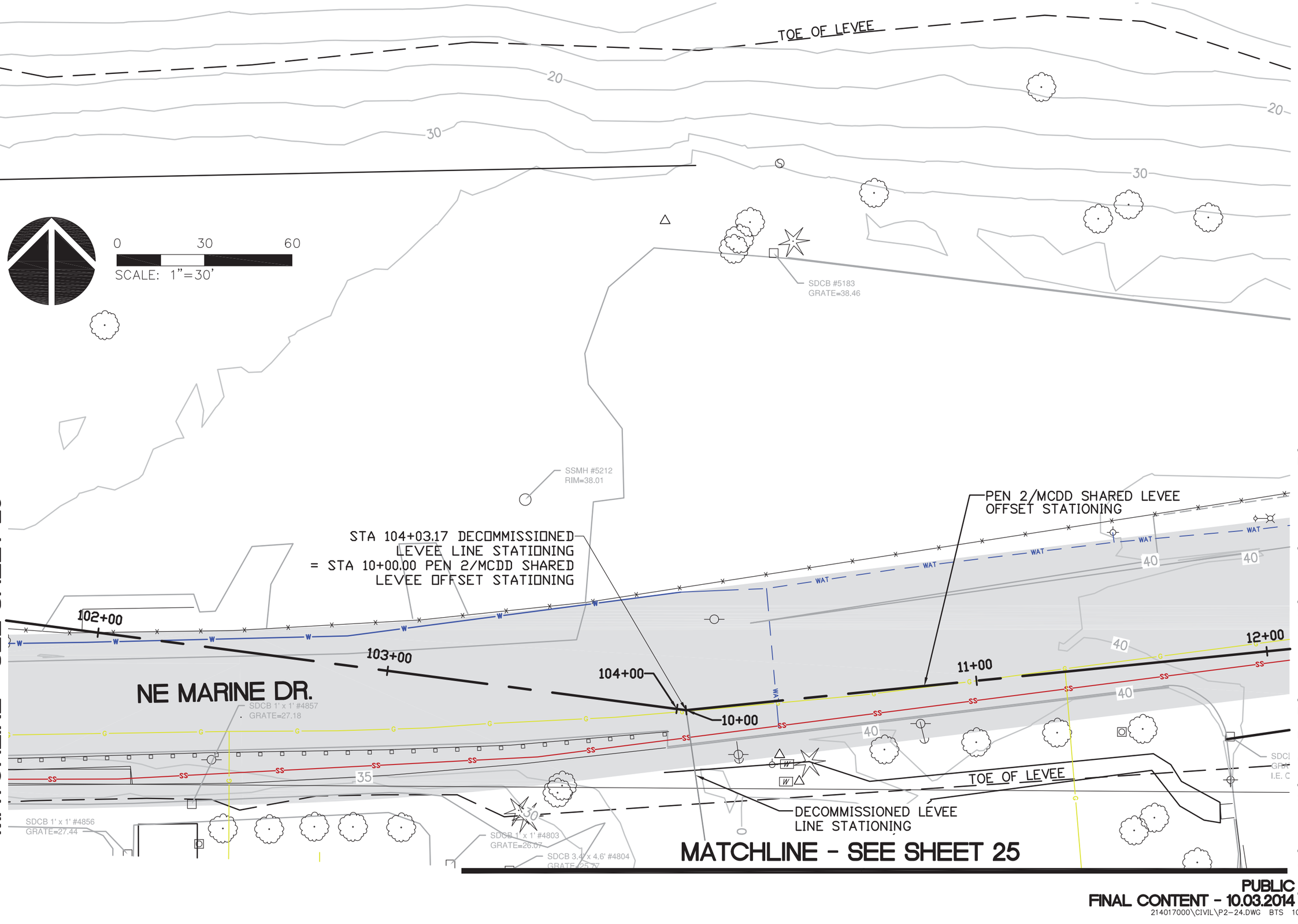

PUBLIC
FINAL CONTENT - 10.03.2014

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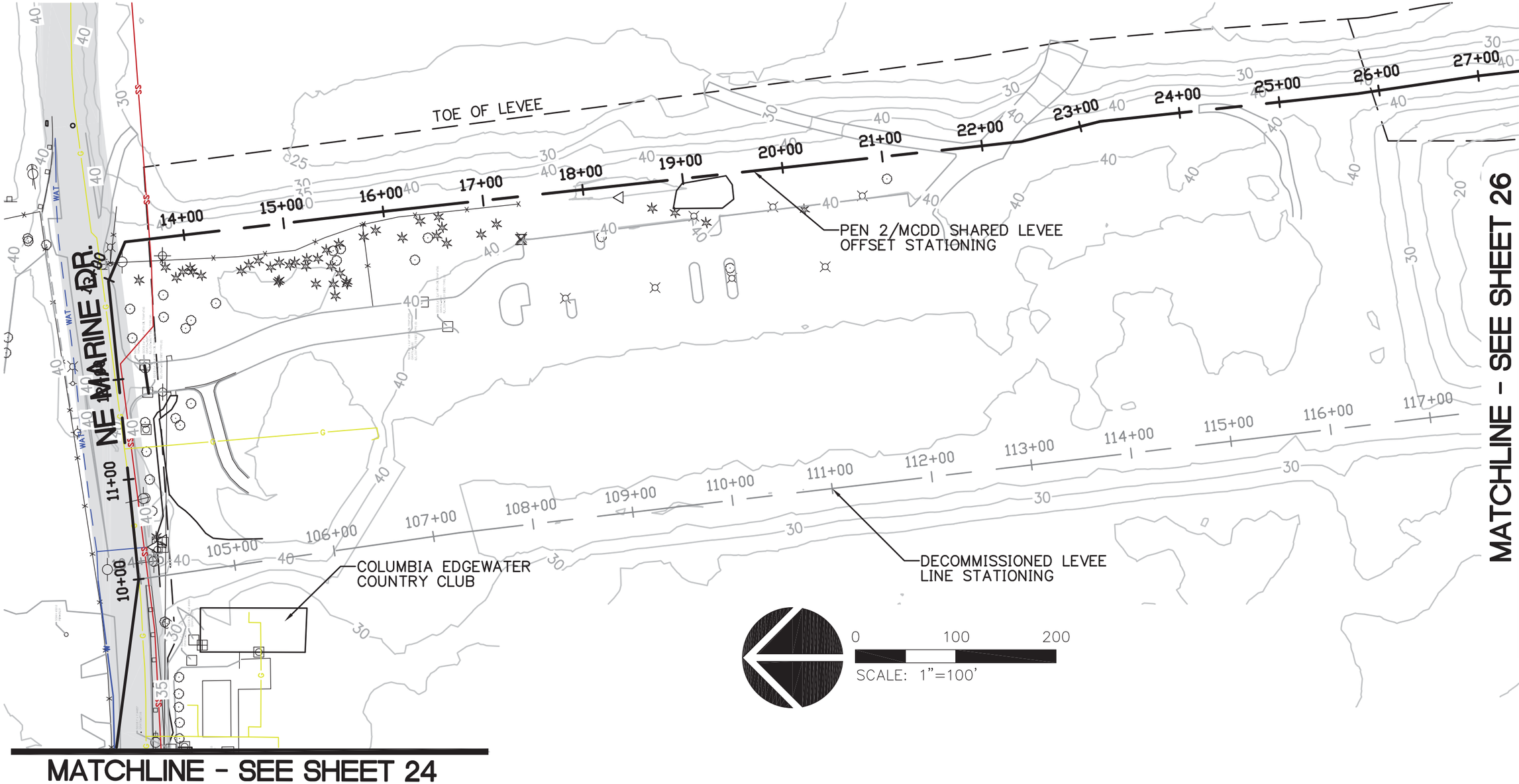

MATCHLINE - SEE SHEET 24

MATCHLINE - SEE SHEET 26

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PROJECT:
PEN 2 LEVEE RECERTIFICATION

SHEET TITLE:
MAP 25

DATE:

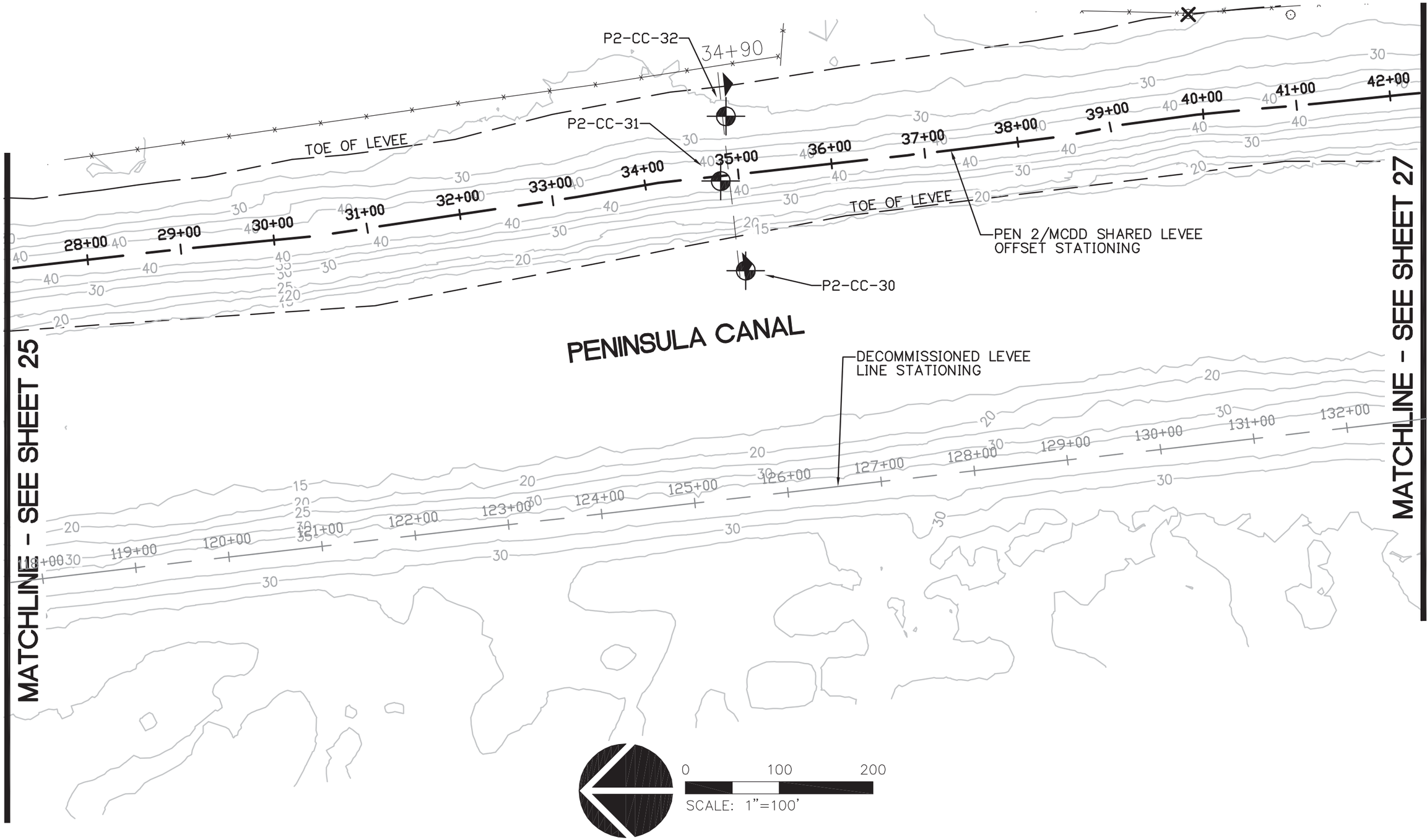
DRAWN BY:
BTS
CHECKED BY:
RVS

SHEET:
25

JOB NO:
2140170.01

PUBLIC
FINAL CONTENT - 10.03.2014

214017000\CIVIL\P2-25.DWG BTS 10/03/14 09:06 1:100.00



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SHEET TITLE:
MAP 26

DATE:

DRAWN BY:
BTS
CHECKED BY:
RVS

SHEET:
26

JOB NO:
2140170.01

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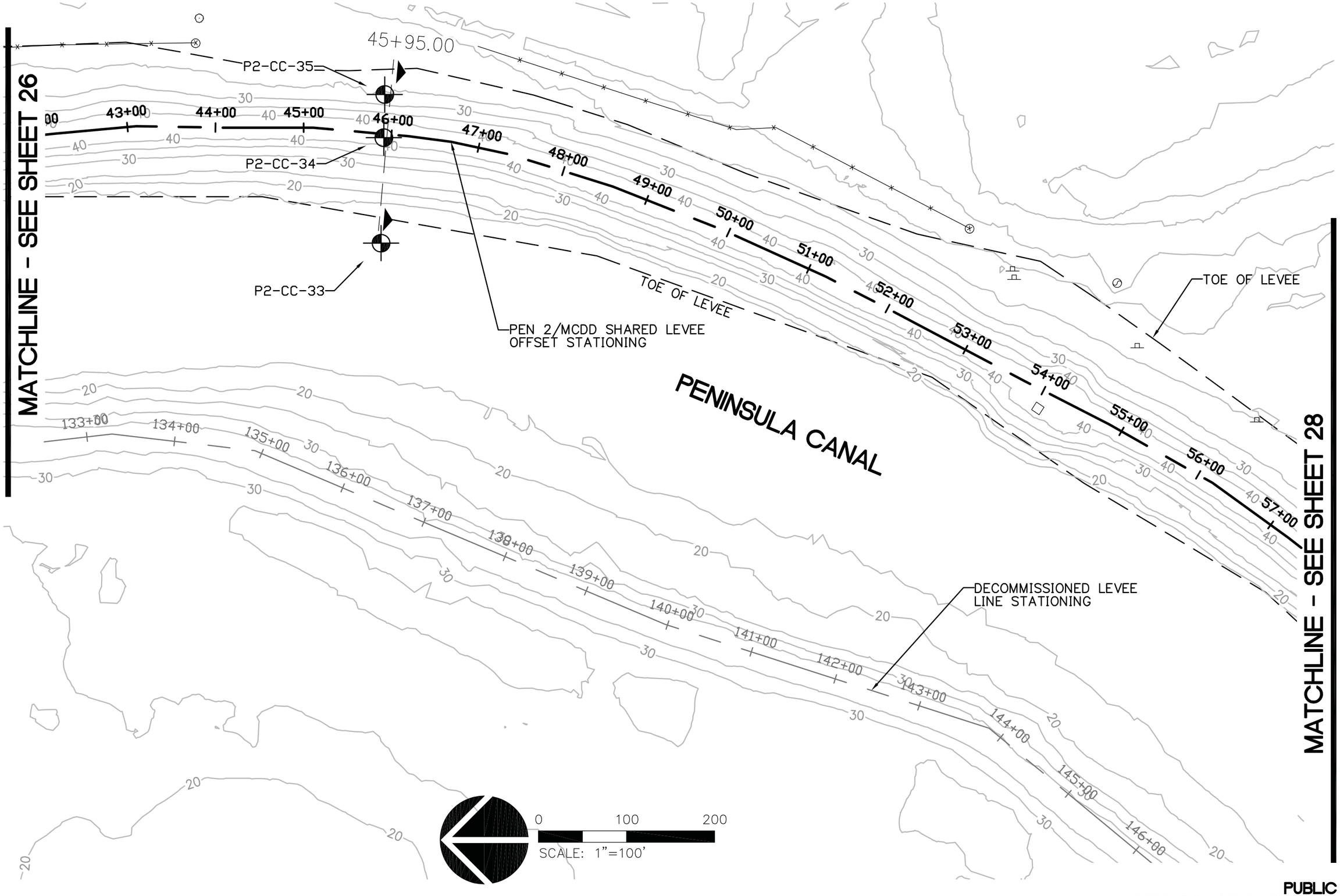

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SHEET TITLE:
MAP 27

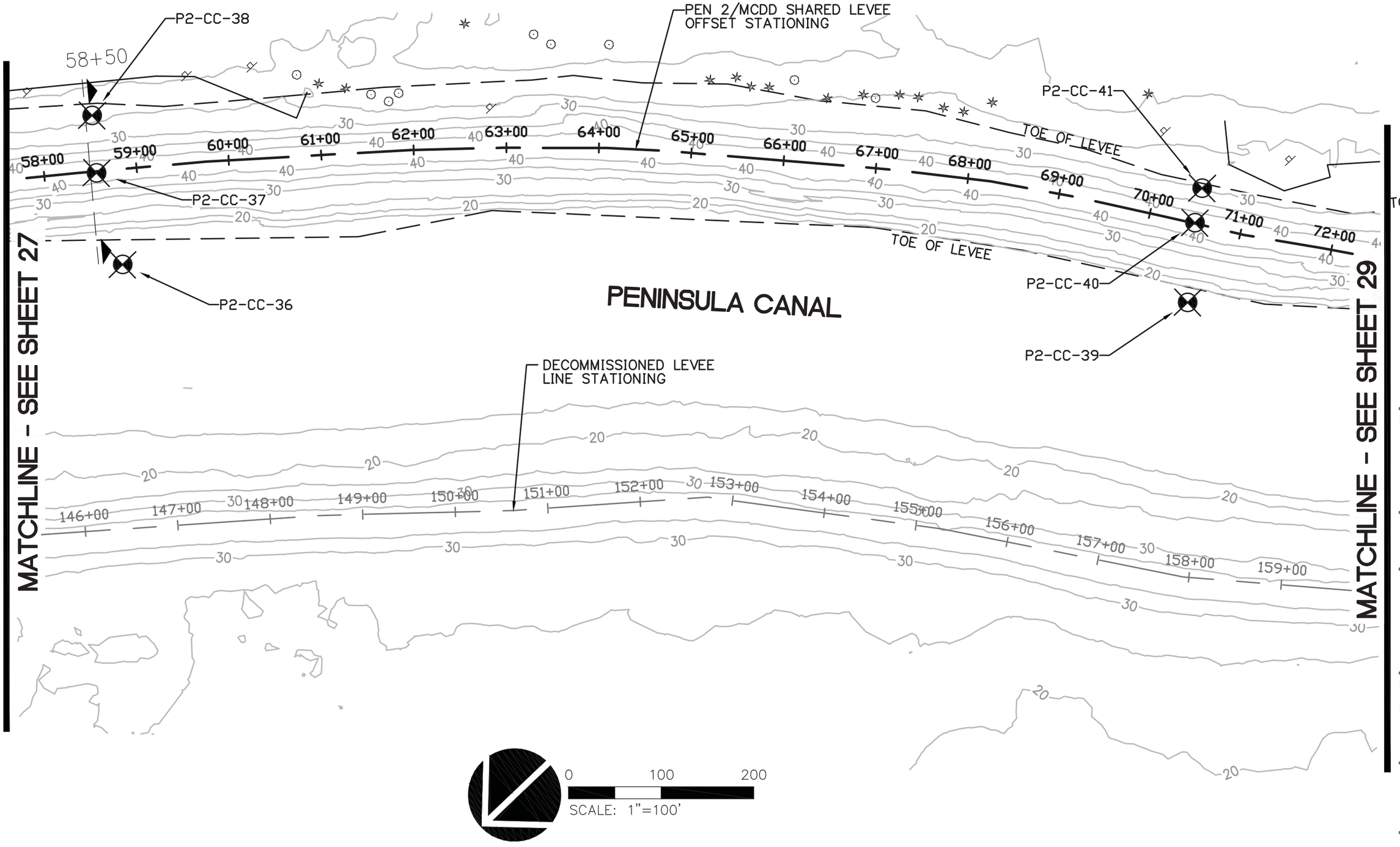
DATE:

DRAWN BY:
BTS
CHECKED BY:
RVS

SHEET:
27

JOB NO:
2140170.01

PUBLIC
FINAL CONTENT - 10.03.2014



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SHEET TITLE:
MAP 28

DATE:

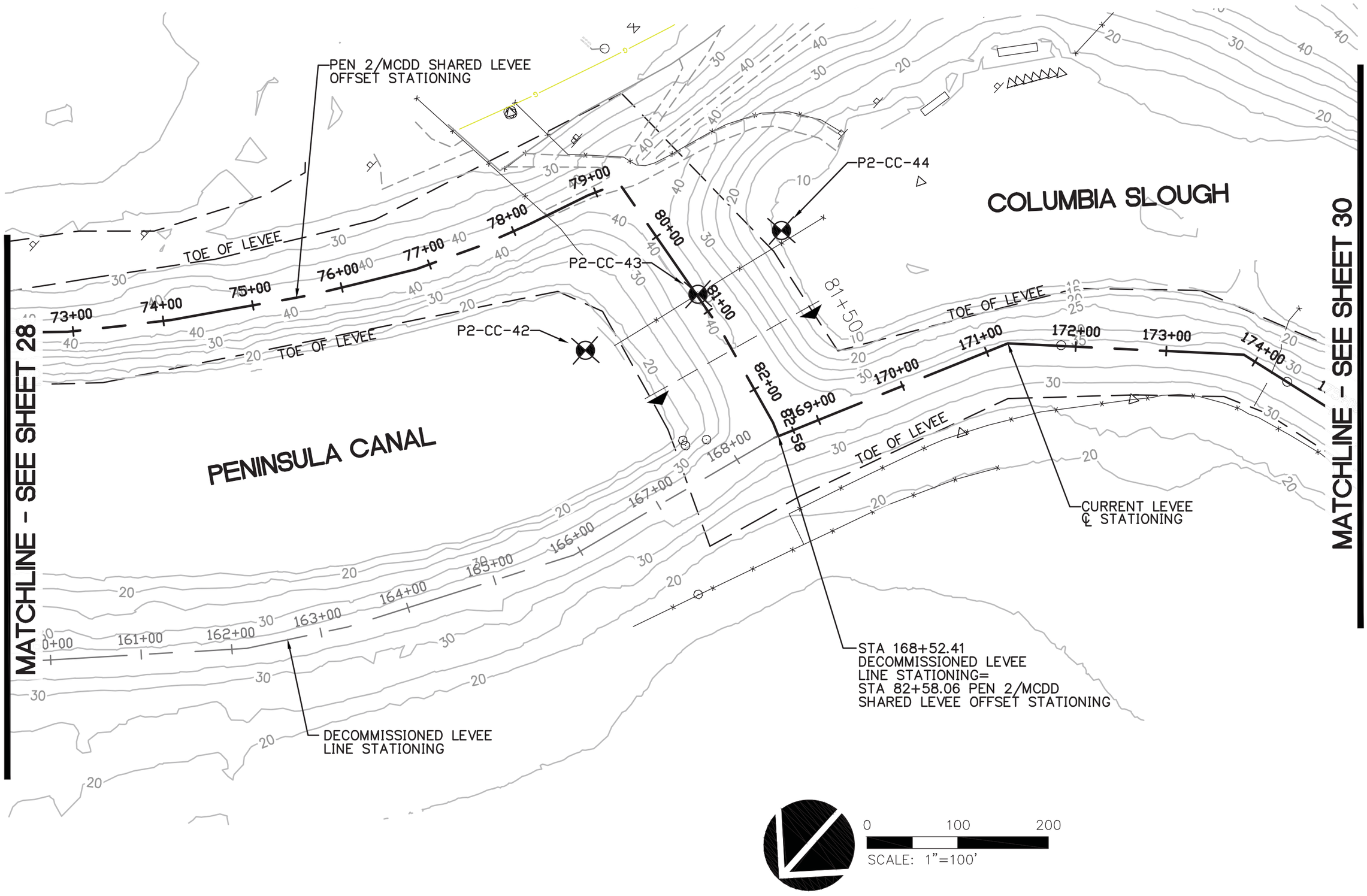
DRAWN BY:
BTS
CHECKED BY:
RVS

SHEET:
28

JOB NO:
2140170.01

PUBLIC
FINAL CONTENT - 10.03.2014

214017000\CIVIL\P2-28.DWG RVS 08/21/14 10:48 1:100.00



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PROJECT:
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SHEET TITLE:
MAP 29

DATE:

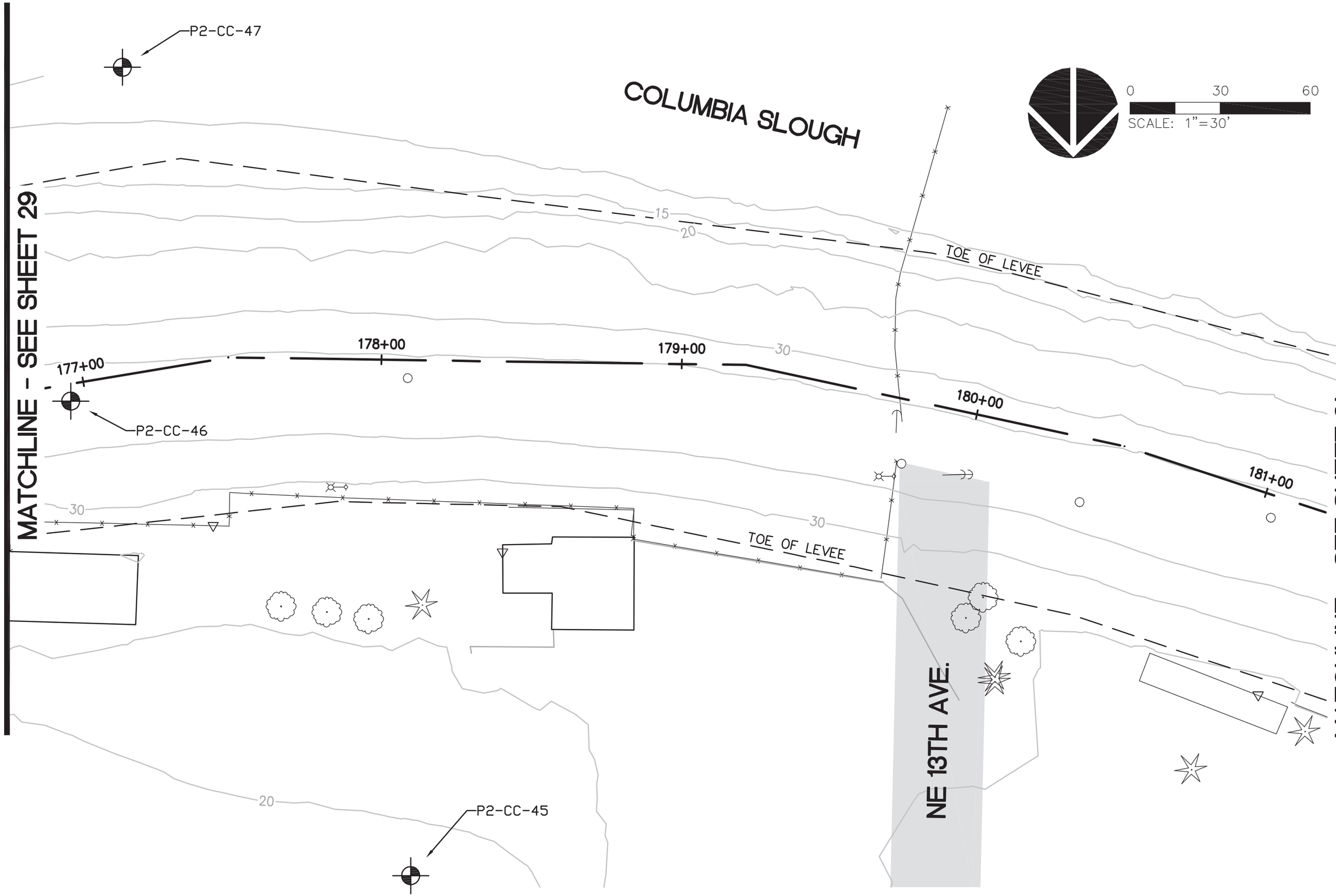
DRAWN BY:
BTS
CHECKED BY:
RVS

SHEET:
29

JOB NO:
2140170.01

PUBLIC
FINAL CONTENT - 10.03.2014

214017000\CIVIL\P2-29.DWG RVS 08/21/14 10:50 1:100.00



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SHEET TITLE:
MAP 30

DATE:

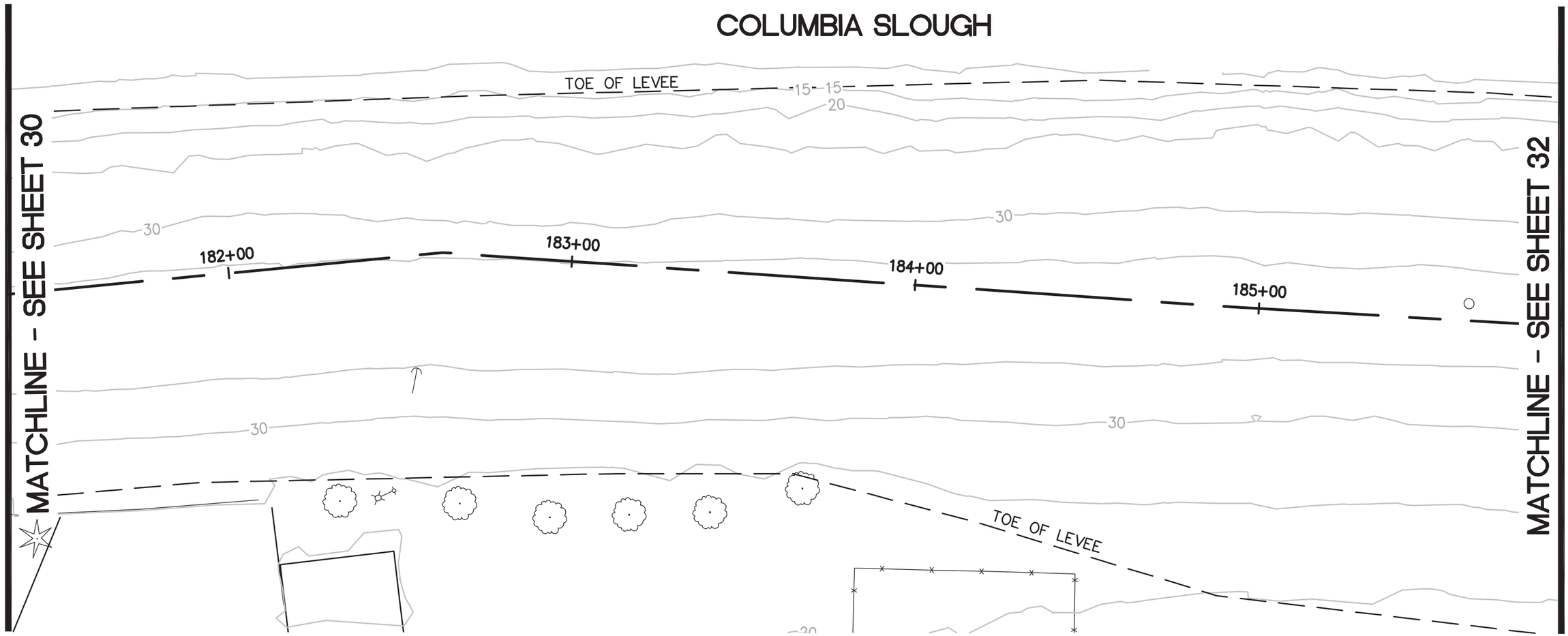
DRAWN BY:
BTS
CHECKED BY:
RVS

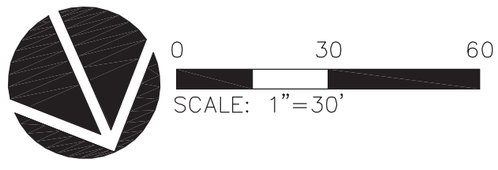
SHEET:
30

JOB NO:
2140170.01

PUBLIC
FINAL CONTENT - 10.03.2014

214017000\CIVIL\P2-30.DWG BTS 07/28/14 10:44 1:30.00





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CLIENT:
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PROJECT:
PEN 2 LEVEE RECERTIFICATION

SHEET TITLE:
MAP 31

DATE:

DRAWN BY:
BTS
CHECKED BY:
RVS

SHEET:
31

JOB NO:
2140170.01

PUBLIC
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MATCHLINE - SEE SHEET 31

MATCHLINE - SEE SHEET 33

COLUMBIA SLOUGH

186+65.00 P2-CC-50

TOE OF LEVEE

187+00 188+00 189+00 190+00 191+00 192+00 193+00 194+00 195+00 196+00 197+00 198+00 199+00 200+00

P2-CC-49

P2-CC-48

PUMP STATION OUTFALL

PUMP STATION OUTFALL

SD CULVERT
TOP ELEV.=36.95

SD CULVERT
TOP ELEV.=36.98

SD CULVERT
TOP ELEV.=36.90

STM

PEN 2
PUMP STATION

199+20.00 P2-CC-53

P2-CC-52

TOE OF LEVEE

P2-CC-51

0 100 200

SCALE: 1"=100'

CLIENT:
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PROJECT:
PEN 2 LEVEE
RECERTIFICATION

SHEET TITLE:
MAP 32

DATE:

DRAWN BY:
BTS
CHECKED BY:
RVS

SHEET:
32

JOB NO:
2140170.01

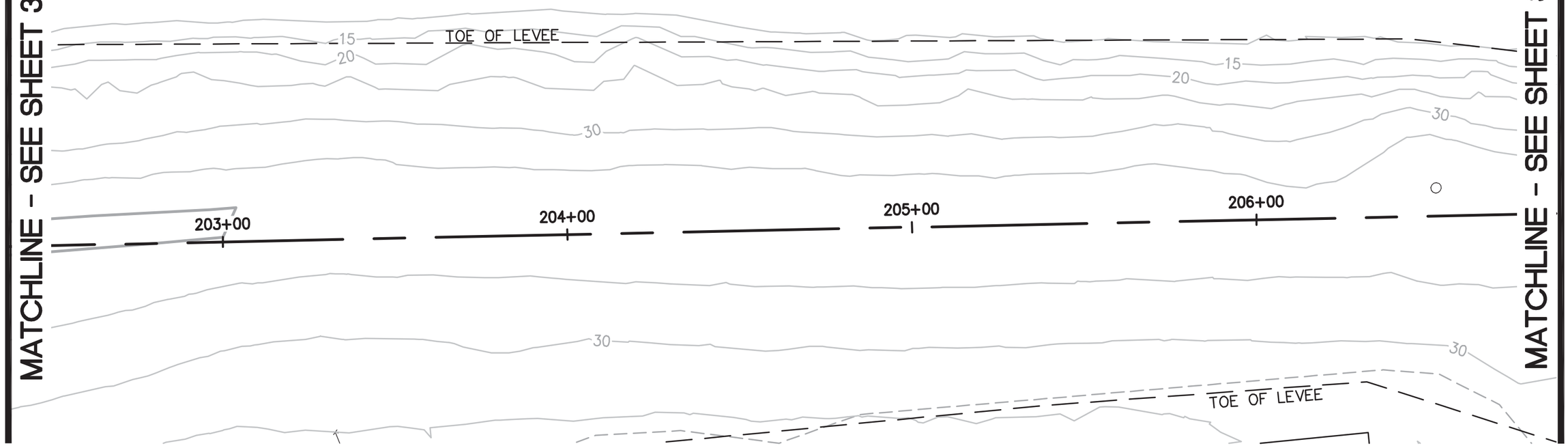
PUBLIC
FINAL CONTENT - 10.03.2014

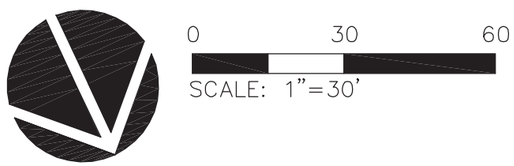
214017000\CIVIL\P2-32.DWG BTS 08/11/14 13:10 1:100.00

COLUMBIA SLOUGH

MATCHLINE - SEE SHEET 32

MATCHLINE - SEE SHEET 34





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PROJECT:
PEN 2 LEVEE RECERTIFICATION

SHEET TITLE:
MAP 33

DATE:

DRAWN BY:
BTS
CHECKED BY:
RVS

SHEET:
33

JOB NO:
2140170.01

PUBLIC
FINAL CONTENT - 10.03.2014

214017000\CIVIL\P2-33.DWG BTS 07/28/14 09:03 1:30.00

MATCHLINE - SEE SHEET 33

MATCHLINE - SEE SHEET 35

209+33.00

COLUMBIA SLOUGH

P2-CC-56

TOE OF LEVEE

20

15

20

30

207+00

208+00

209+00

210+00

211+00

P2-CC-55

30

TOE OF LEVEE

VANCOUVER PARTNERS LLC
8910 NE VANCOUVER WAY
FF=24.5±

P2-CC-54

0 30 60

SCALE: 1"=30'

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PROJECT:
PEN 2 LEVEE RECERTIFICATION

SHEET TITLE:
MAP 34

DATE:

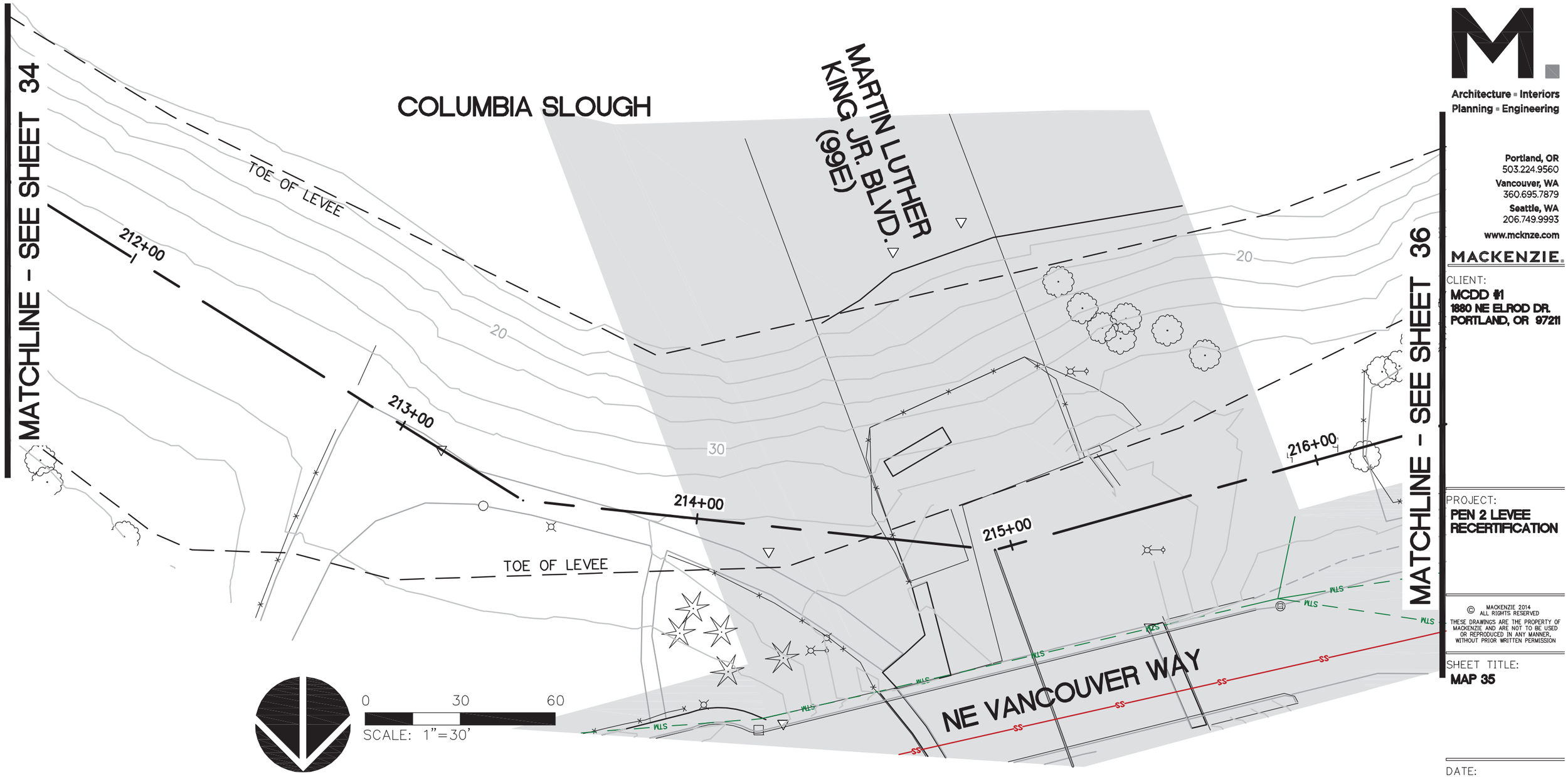
DRAWN BY:
BTS
CHECKED BY:
RVS

SHEET:
34

JOB NO:
2140170.01

PUBLIC
FINAL CONTENT - 10.03.2014

214017000\CIVIL\P2-34.DWG RVS 08/08/14 14:59 1:30.00



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PROJECT:
PEN 2 LEVEE RECERTIFICATION

SHEET TITLE:
MAP 35

DATE:

DRAWN BY:
BTS
CHECKED BY:
RVS

SHEET:
35

JOB NO:
2140170.01

PUBLIC
FINAL CONTENT - 10.03.2014

MATCHLINE - SEE SHEET 35

MATCHLINE - SEE SHEET 37

TOE OF LEVEE

20

30

218+10.00

220+35.00

COLUMBIA SLOUGH

P2-CC-59

15-15

20

30

25

217+00

218+00

219+00

TOE OF LEVEE

220+00

P2-CC-58

WLS

WLS

WLS

WLS

WLS

NE VANCOUVER WAY

P2-CC-57

SDMH #1720
RIM=39.9±

PRICE MART
TRUE VALUE
8700 N VANCOUVER AVE.
FF=39.0±

0 30 60

SCALE: 1"=30'

PUBLIC
FINAL CONTENT - 10.03.2014

214017000\CIVIL\P2-36.DWG BTS 07/29/14 08:38 1:30.00

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PROJECT:
PEN 2 LEVEE RECERTIFICATION

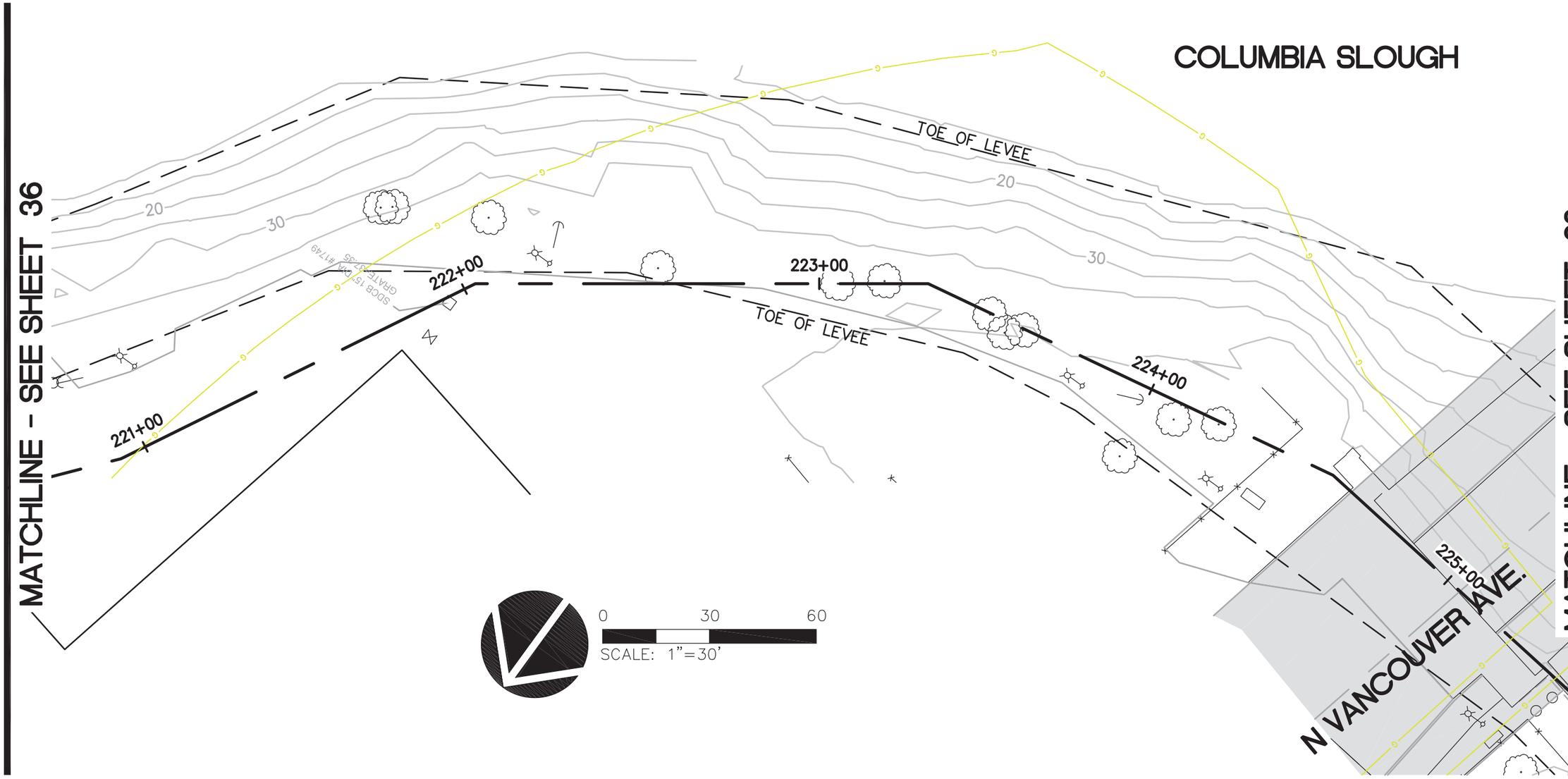
SHEET TITLE:
MAP 36

DATE:

DRAWN BY:
BTS
CHECKED BY:
RVS

SHEET:
36

JOB NO:
2140170.01



0 30 60

SCALE: 1"=30'

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PROJECT:
PEN 2 LEVEE RECERTIFICATION

SHEET TITLE:
MAP 37

DATE:

DRAWN BY:
BTS
CHECKED BY:
RVS

SHEET:
37

JOB NO:
2140170.01

PUBLIC
FINAL CONTENT - 10.03.2014

214017000\CIVIL\P2-37.DWG BTS 10/03/14 09:12 1:30.00

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PROJECT:
PEN 2 LEVEE RECERTIFICATION

SHEET TITLE:
MAP 38

DATE:

DRAWN BY:
BTS
CHECKED BY:
RVS

SHEET:
38

JOB NO:
2140170.01

MATCHLINE - SEE SHEET 37

MATCHLINE - SEE SHEET 39

COLUMBIA SLOUGH

229+00.00 P2-CC-62

234+90.00 P2-CC-65

APPROXIMATE LOCATION OF LEVEE TOE DRAIN

TOE OF LEVEE

TOE OF LEVEE

TOE DRAIN

<227+00 228+00 229+00 230+00 231+00 232+00 233+00 234+00 235+00 236+00 237+00 238+00 239+00 240+00 241+00

P2-CC-61

P2-CC-64

P2-CC-63

P2-CC-60

N. VANCOUVER AVE.

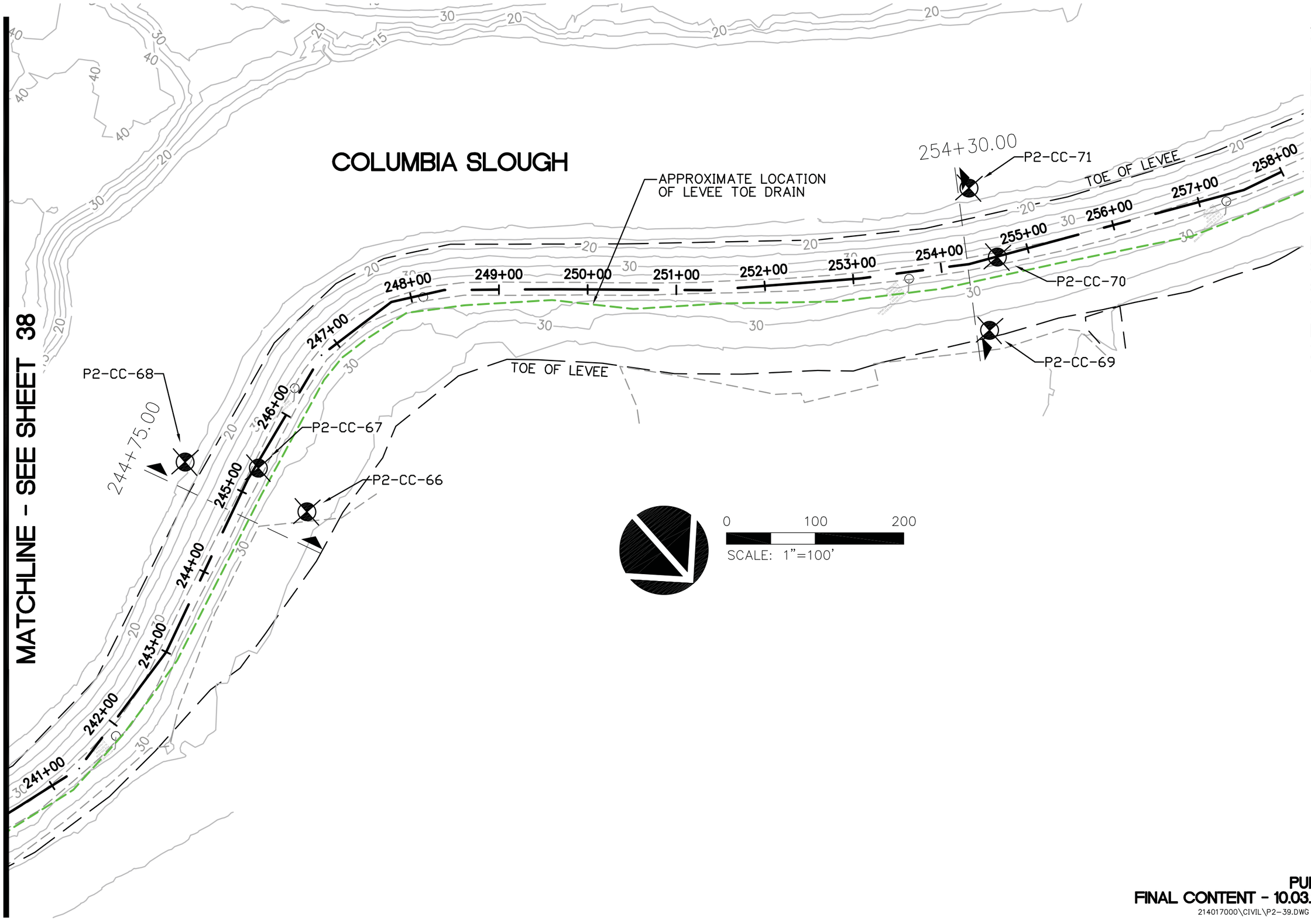
N. SCHMEER RD.

0 100 200

SCALE: 1"=100'

PUBLIC
FINAL CONTENT - 10.03.2014

214017000\CIVIL\P2-38.DWG BTS 08/11/14 13:12 1:100.00



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PROJECT:
PEN 2 LEVEE RECERTIFICATION

SHEET TITLE:
MAP 39

DATE:

DRAWN BY:
BTS
CHECKED BY:
RVS

SHEET:
39

JOB NO:
2140170.01

PUBLIC
FINAL CONTENT - 10.03.2014

214017000\CIVIL\P2-39.DWG RVS 08/08/14 15:05 1:100.00

MATCHLINE - SEE SHEET 39

MATCHLINE - SEE SHEET 41

COLUMBIA SLOUGH

TB-3

263+00.00

APPROXIMATE LOCATION OF LEVEE TOE DRAIN

P2-CC-72

PUMP STATION OUTFALL

TOE OF LEVEE

260+00

261+00

262+00

263+00

264+00

265+00

266+00

267+00

268+00

269+00

270+00

271+00

272+00

273+00

P2-CC-74

FF=27.0±

TB-22

RELIEF WELLS AND OUTFALL

TOE OF LEVEE

N SCHMEER RD.

P2-CC-73

B-1

PEN 2
PUMP STATION

STM

0 100 200

SCALE: 1"=100'

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PROJECT:
PEN 2 LEVEE
RECERTIFICATION

SHEET TITLE:
MAP 40

DATE:

DRAWN BY:
BTS

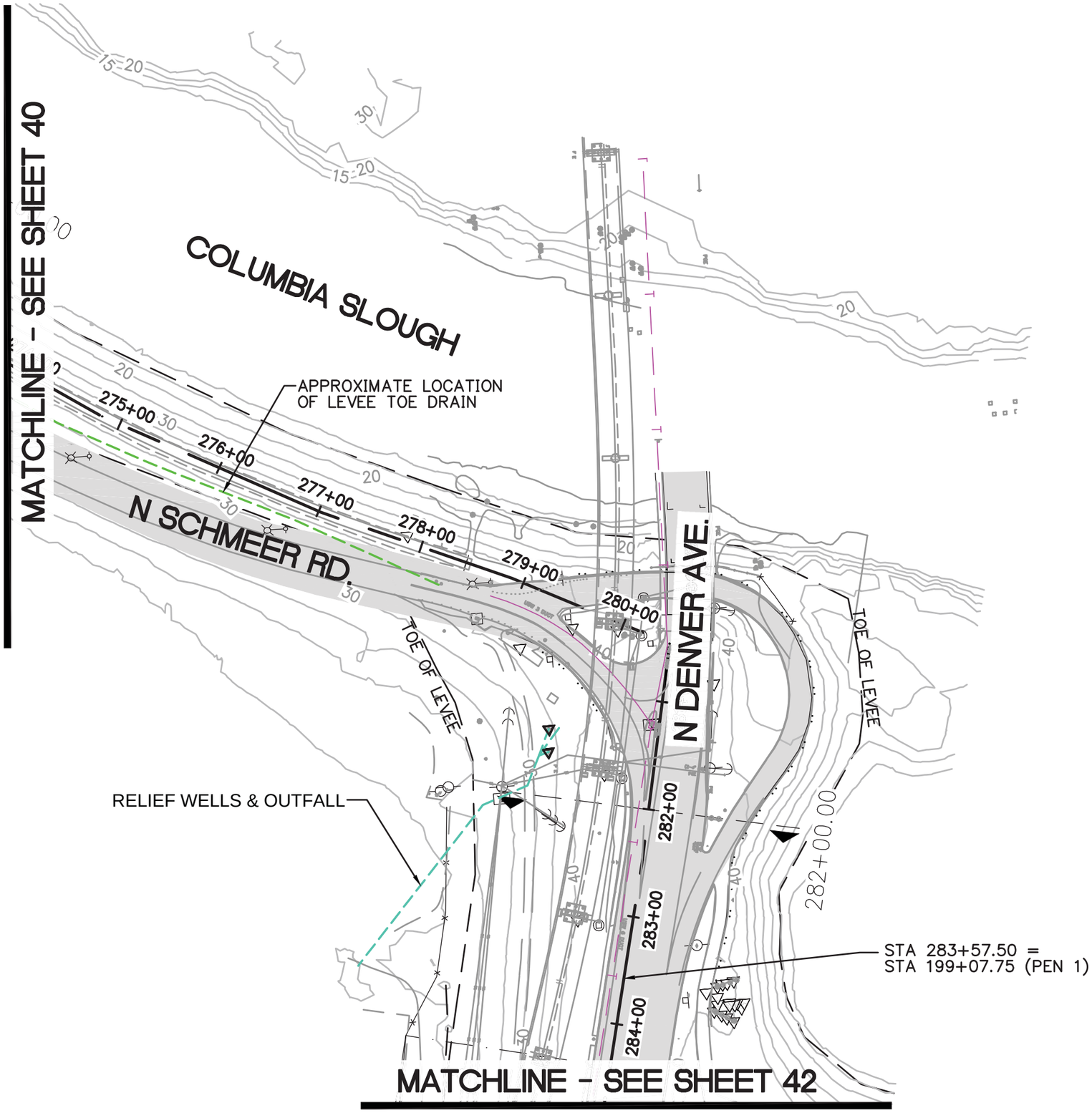
CHECKED BY:
RVS

SHEET:
40

JOB NO:
2140170.01

PUBLIC
FINAL CONTENT - 10.03.2014

2140170.00 \CIVIL\P2-40.DWG BTS 08/11/14 13:24 1:100.00



0 100 200

SCALE: 1"=100'

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PROJECT:
PEN 2 LEVEE RECERTIFICATION

SHEET TITLE:
MAP 41

DATE:

DRAWN BY:
BTS
CHECKED BY:
RVS

SHEET:
41

JOB NO:
2140170.01

PUBLIC
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214017000\CIVIL\P2-41.DWG BTS 08/11/14 13:35 1:100.00

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CLIENT:
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0 100 200
SCALE: 1"=100'

MATCHLINE - SEE PEN 1

PORTLAND INTERNATIONAL RACEWAY

SD CULVERT
IE=34.37

CURRENT LEVEE
℄ STATIONING

P1-CC-54

205+00.00

DH-111

212+00
211+00
210+00
209+00
208+00
207+00
206+00
205+00
204+00
203+00
202+00
201+00
200+00
199+22
199+00
198+00
197+00

N DENVER AVE.

12" SD CULVERT
IE=28.26

C-23

P1-CC-55

HISTORIC DISTRICT
BOUNDARY LINE

EXISTING STORM DRAIN
NO ELEVATION DATA AVAILABLE

STA:199+22.32 CURRENT LEVEE
= STA 199+25.21 HISTORIC DISTRICT
BOUNDARY LINE

MATCHLINE - SEE SHEET 41

MATCHLINE - SEE SHEET 43

PROJECT:
PEN 2 LEVEE RECERTIFICATION

SHEET TITLE:
MAP 42

DATE:

DRAWN BY:
BTS
CHECKED BY:
RVS

SHEET:
42

JOB NO:
2140170.01

PUBLIC
FINAL CONTENT - 10.03.2014

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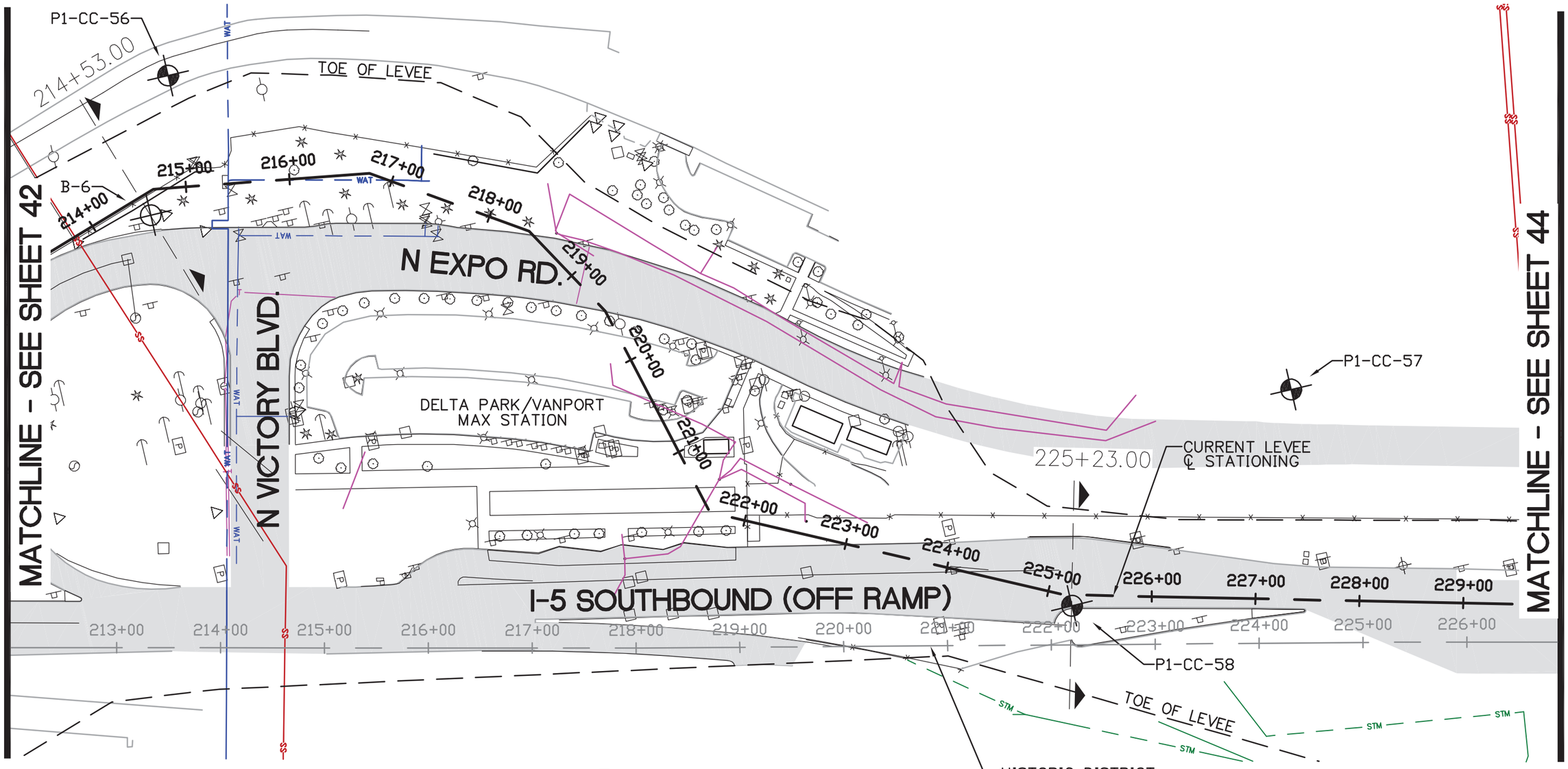

0 100 200

SCALE: 1"=100'

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PROJECT:
PEN 2 LEVEE RECERTIFICATION

SHEET TITLE:
MAP 43

DATE:

DRAWN BY:
BTS
CHECKED BY:
RVS

SHEET:
43

JOB NO:
2140170.01

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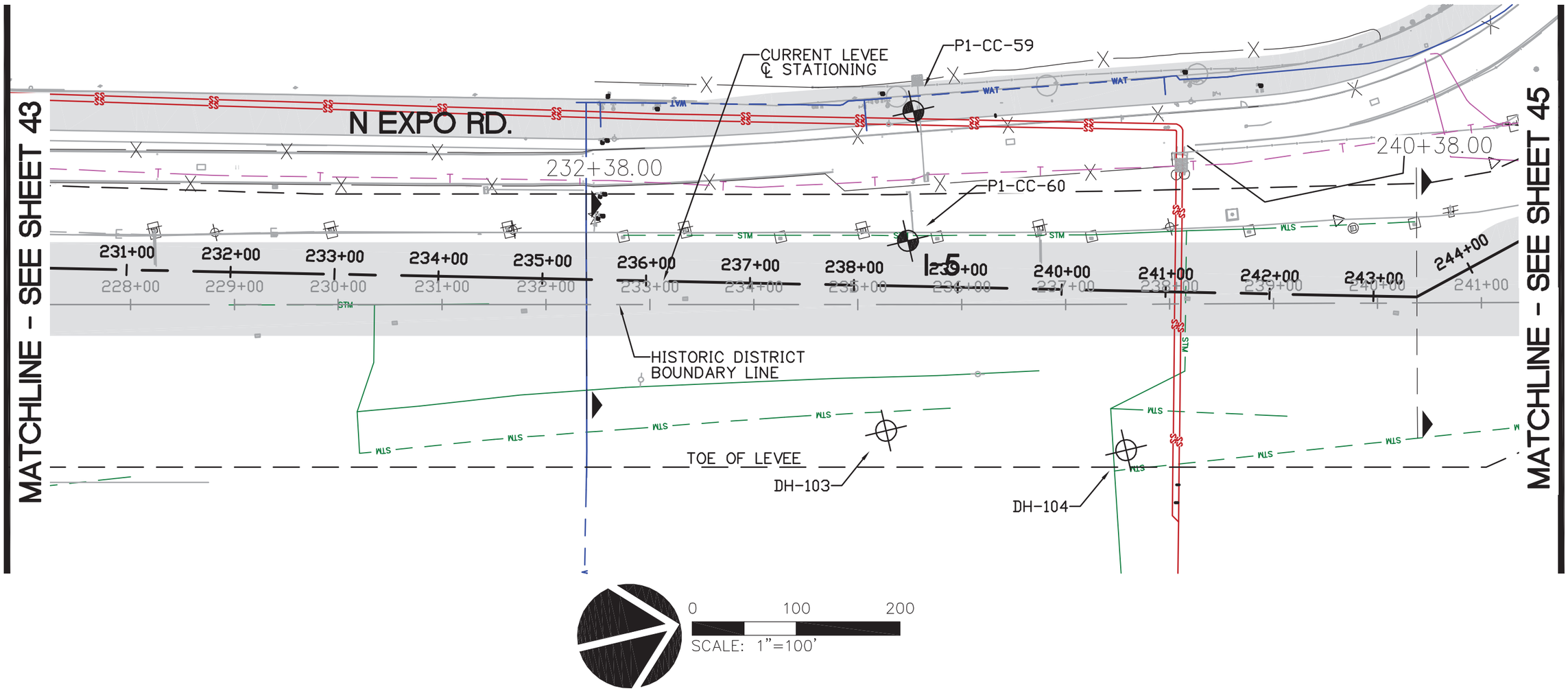
FINAL CONTENT - 10.03.2014



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CLIENT:
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PROJECT:
PEN 2 LEVEE RECERTIFICATION

SHEET TITLE:
MAP 44

DATE:

DRAWN BY:
BTS
CHECKED BY:
RVS

SHEET:
44

JOB NO:
2140170.01

PUBLIC
FINAL CONTENT - 10.03.2014

P1-CC-61

EXPO CENTER

CURRENT LEVEE
℄ STATIONING

N. EXPO RD.

N MARINE DR.

P1-CC-62

CRC-MD-006

CRC-SC-011

P1-CC-1

TOE OF LEVEE

252+36.00

2+10.00

5+00.00

MATCHLINE - SEE SHEET 44

HISTORIC DISTRICT
BOUNDARY LINE

0 100 200
SCALE: 1"=100'

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PROJECT:
PEN 2 LEVEE RECERTIFICATION

SHEET TITLE:
MAP 45

DATE:

DRAWN BY:
BTS
CHECKED BY:
RVS

SHEET:
45

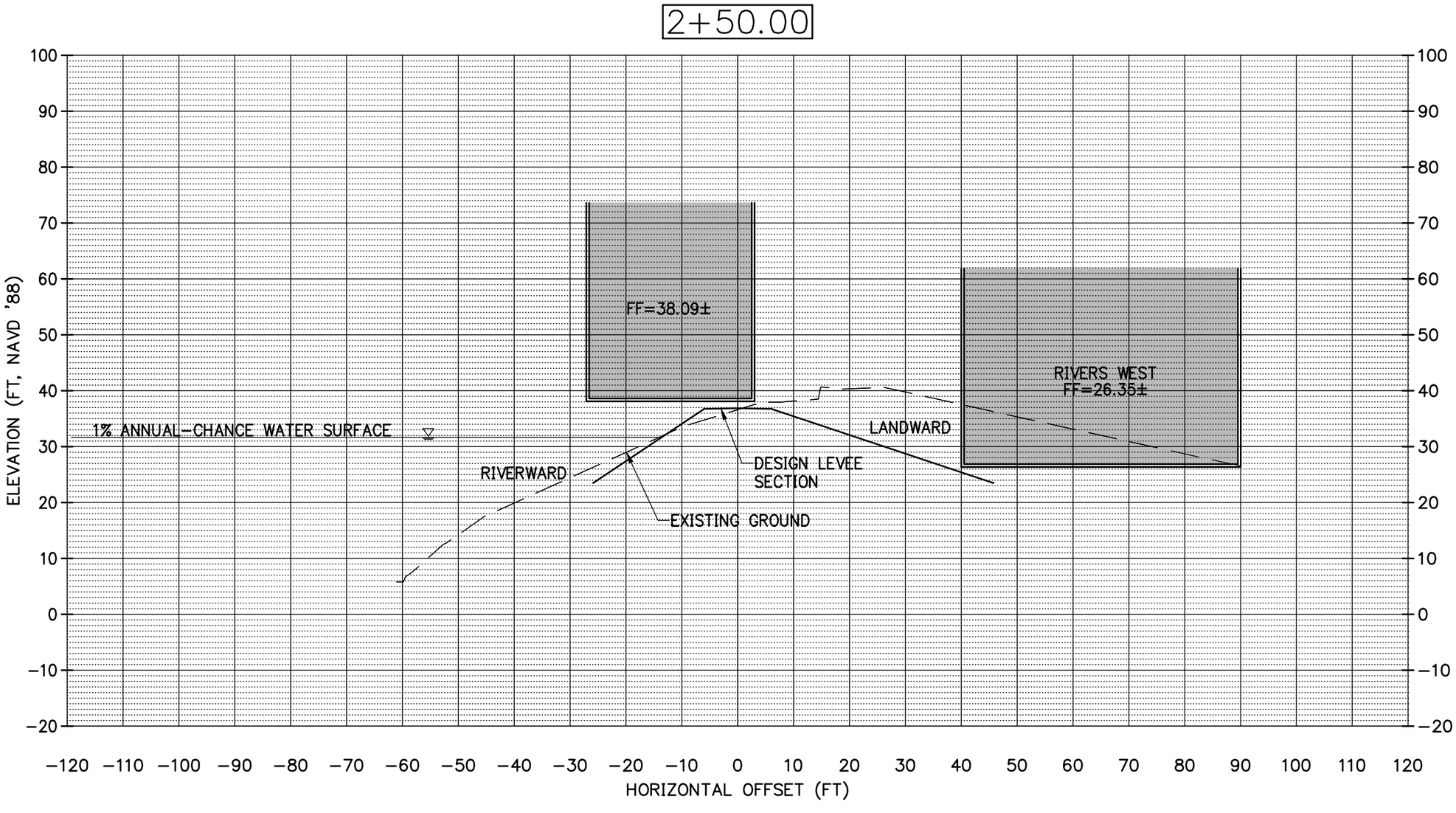
JOB NO:
2140170.01

APPENDIX E

GROUP MACKENZIE CONSULTANTS

PEN 2 LEVEE – As-Built Cross-Sections

October 2014



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PROJECT:
PEN 2 LEVEE RECERTIFICATION

SHEET TITLE:
SECTION 2+50

DATE:

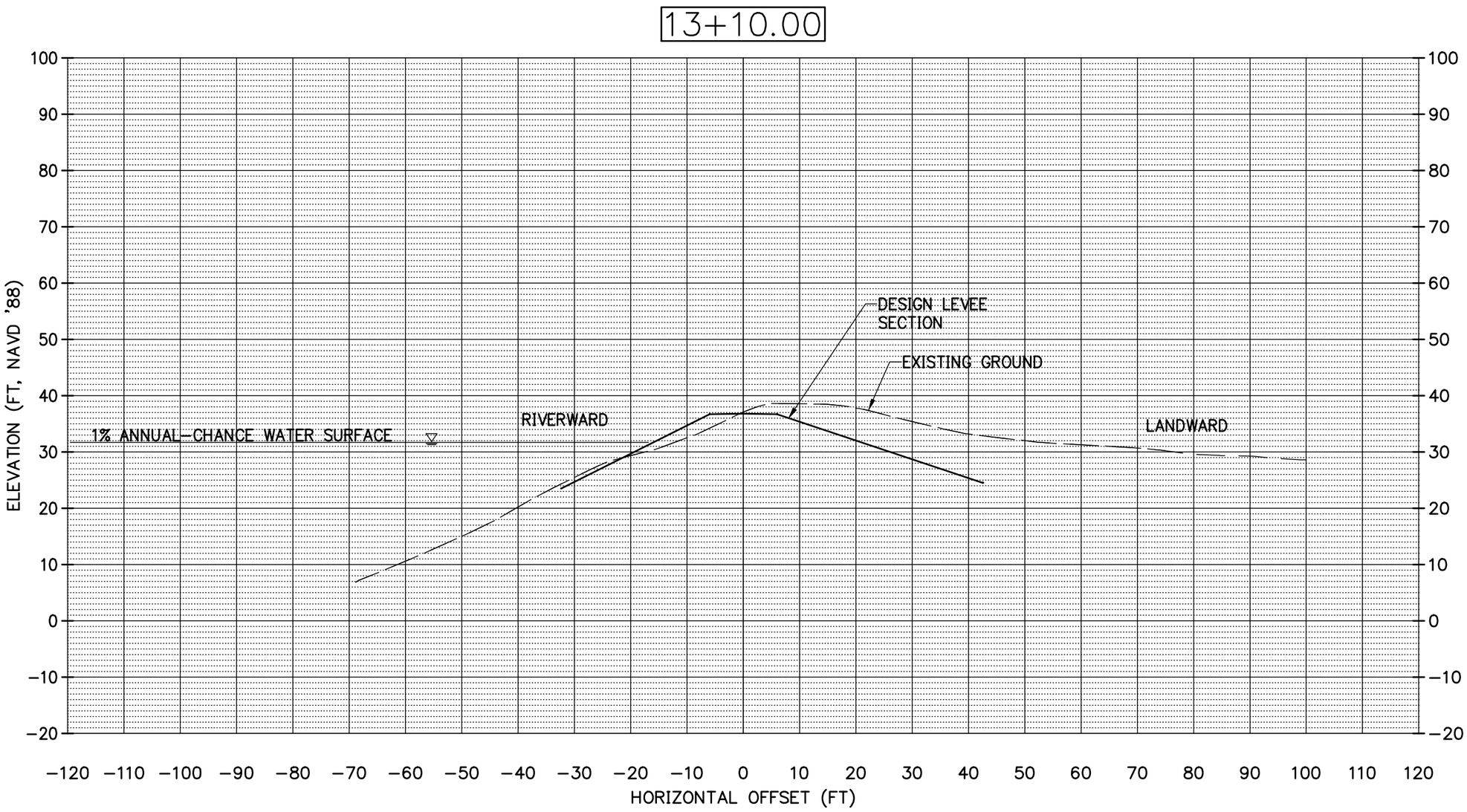
DRAWN BY:

CHECKED BY:

SHEET:

JOB NO:
2140170.01

PUBLIC
FINAL CONTENT - 10.03.2014



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PROJECT:
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SHEET TITLE:
SECTION 13+10

DATE:

DRAWN BY:

CHECKED BY:

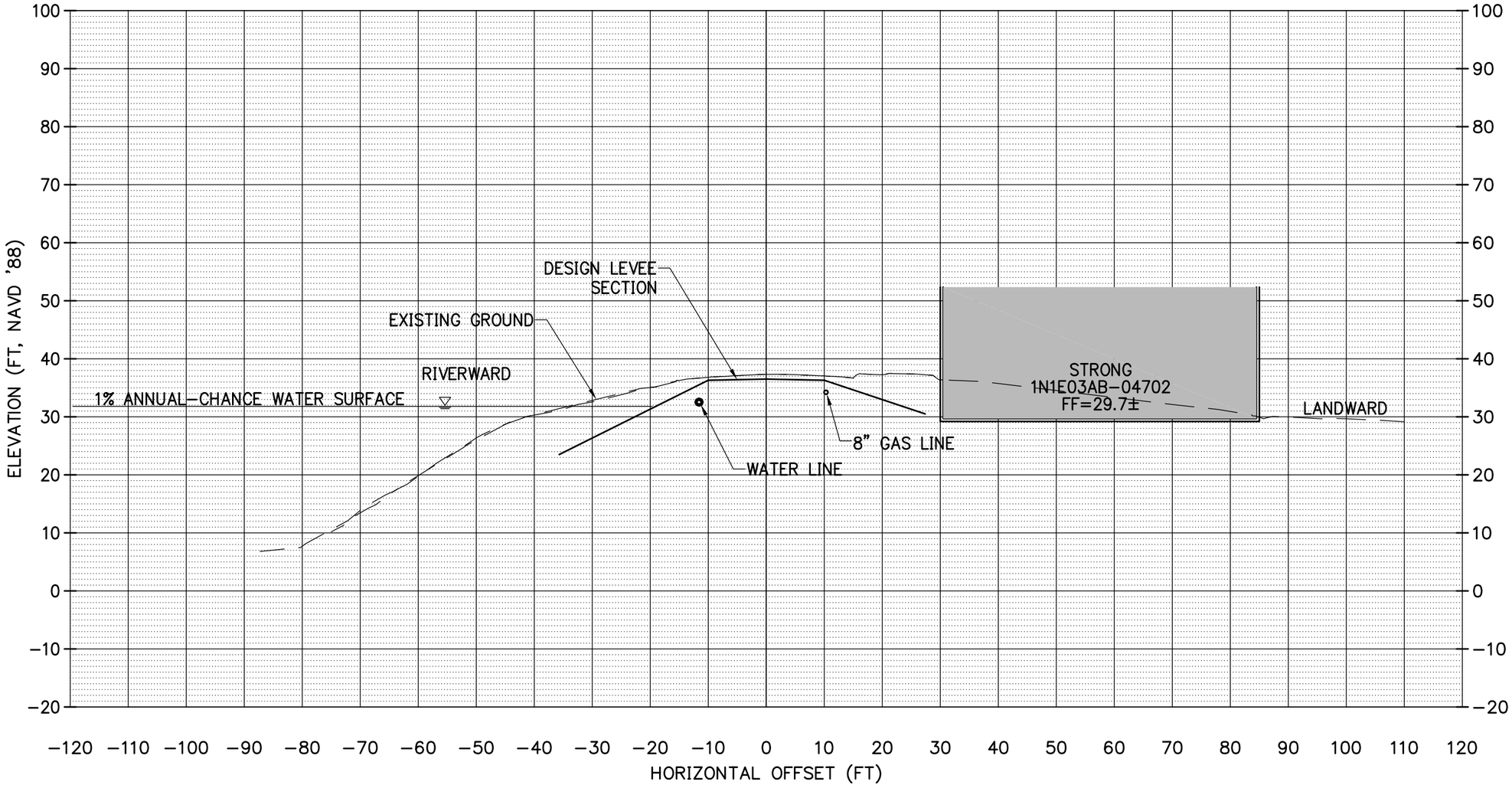
SHEET:

JOB NO:
2140170.01

PUBLIC
FINAL CONTENT - 10.03.2014

214017000\CIVIL\170PSITE-PEN2.DWG BTS 07/29/14 11:58 1:20.00

33+00.00



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SHEET TITLE:
SECTION 33+00

DATE:

DRAWN BY:

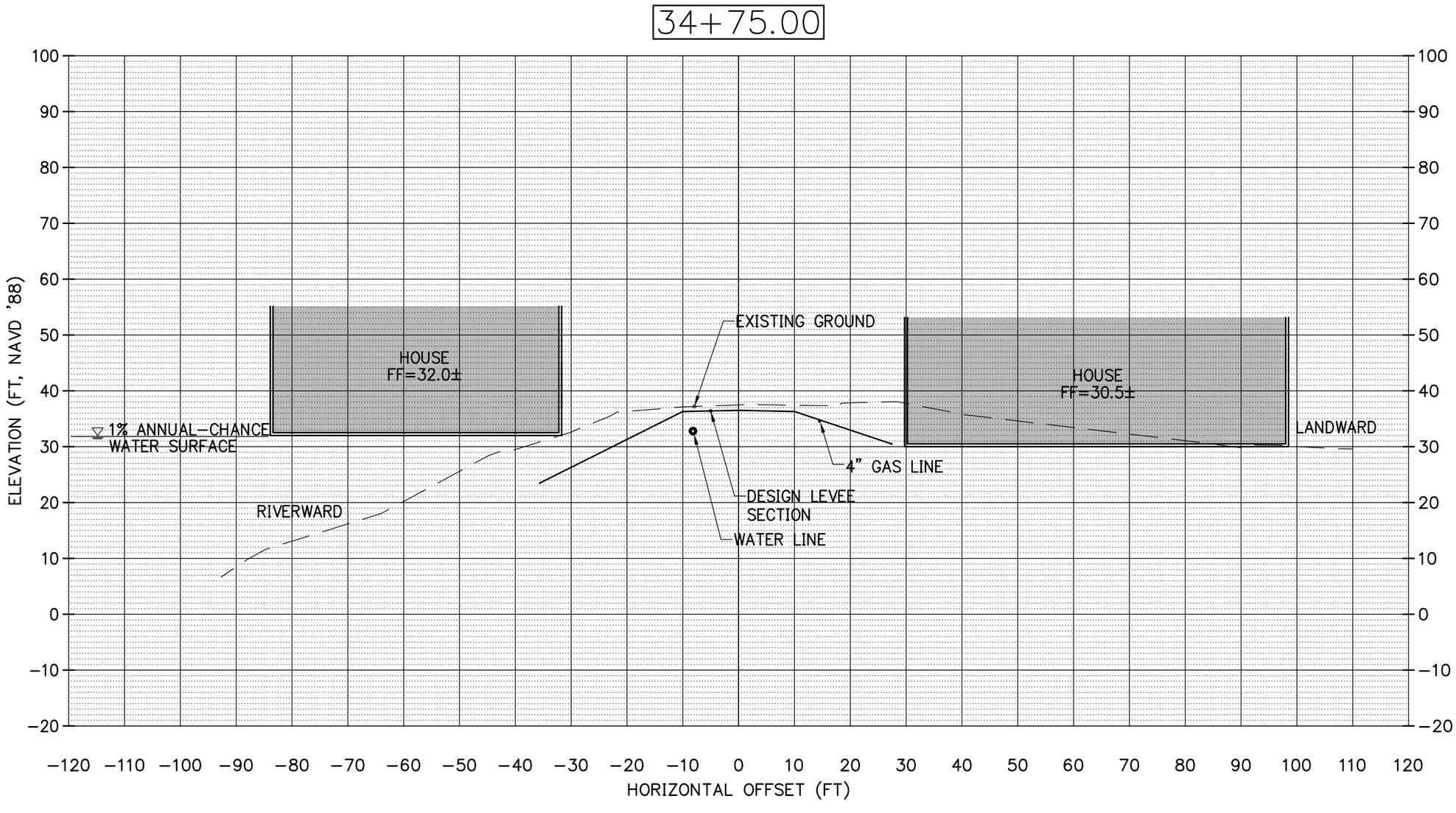
CHECKED BY:

SHEET:

JOB NO:
2140170.01

PUBLIC
FINAL CONTENT - 10.03.2014

214017000\CIVIL\170PSITE-PEN2.DWG BTS 10/03/14 09:37 1:20.00



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PROJECT:
PEN 2 LEVEE RECERTIFICATION

SHEET TITLE:
SECTION 34+75

DATE:

DRAWN BY:

CHECKED BY:

SHEET:

JOB NO:
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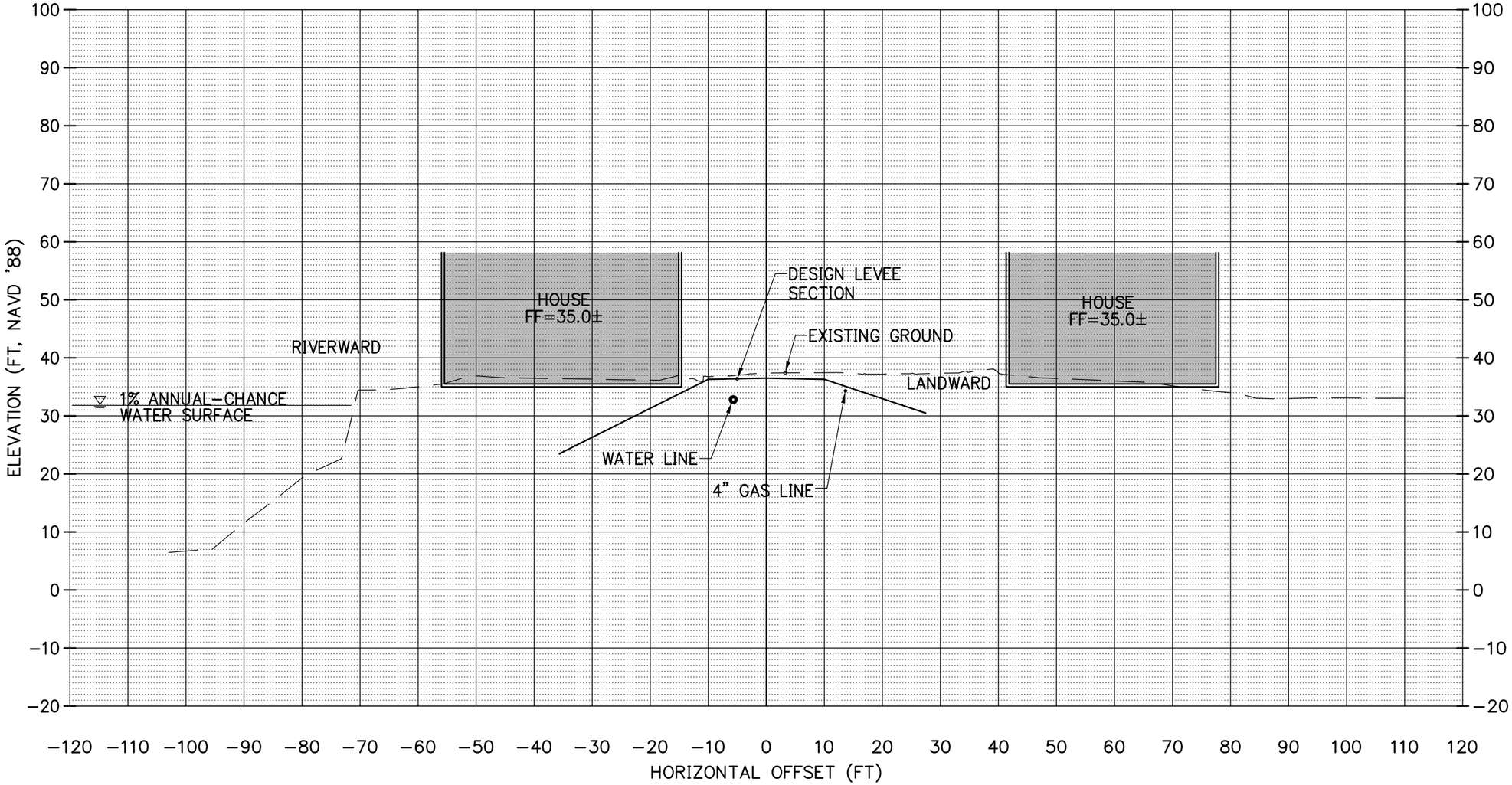
FINAL CONTENT - 10.03.2014

214017000\CIVIL\170PSITE-PEN2.DWG RVS 09/29/14 15:33 1:20.00

37+75.00



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SHEET TITLE:
SECTION 37+75

DATE:

DRAWN BY:

CHECKED BY:

SHEET:

JOB NO:
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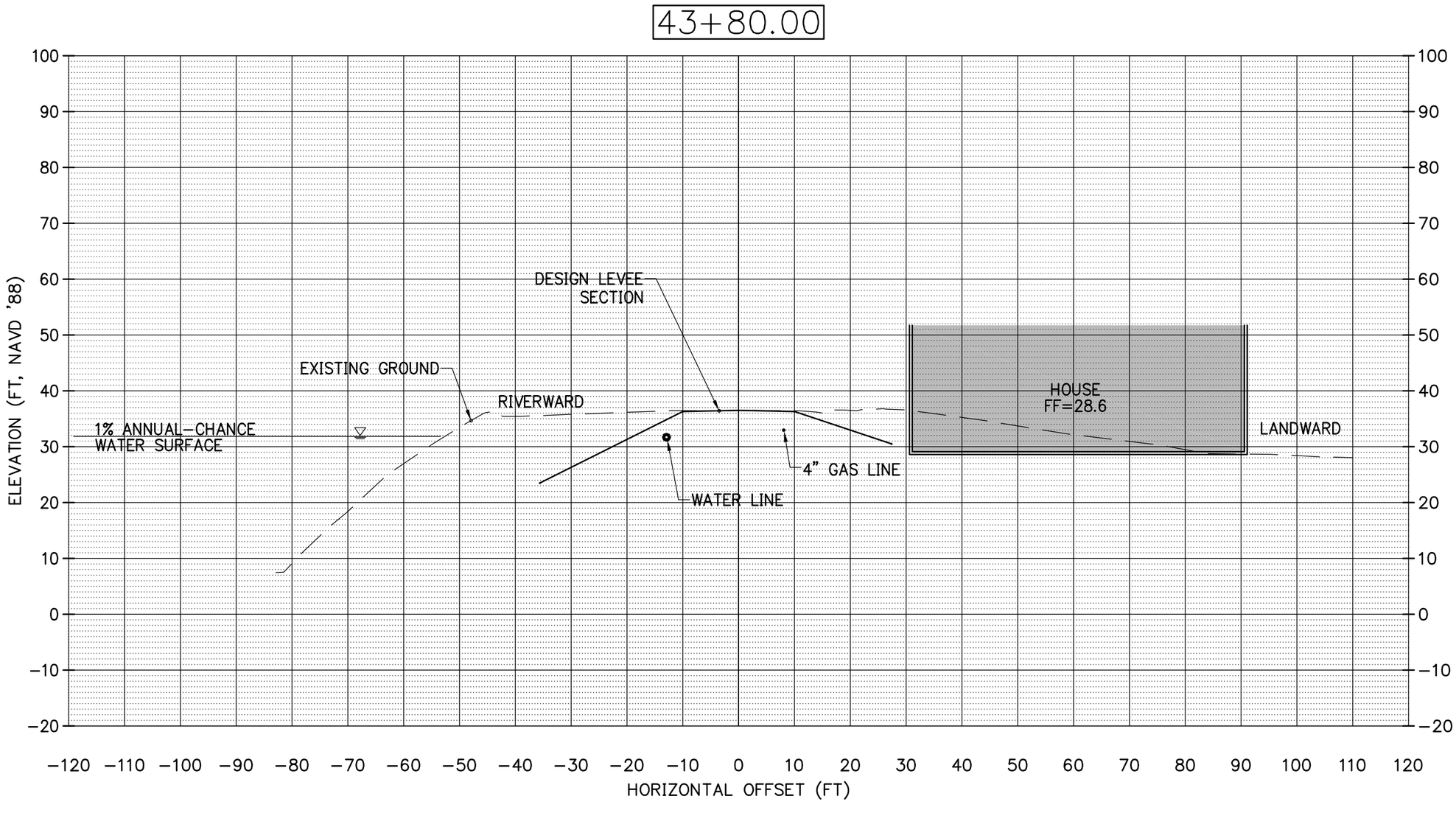
FINAL CONTENT - 10.03.2014

214017000\CIVIL\170PSITE-PEN2.DWG RVS 09/29/14 15:33 1:20.00



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PROJECT:
PEN 2 LEVEE RECERTIFICATION

SHEET TITLE:
SECTION 43+80

DATE:

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SHEET:

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2140170.01

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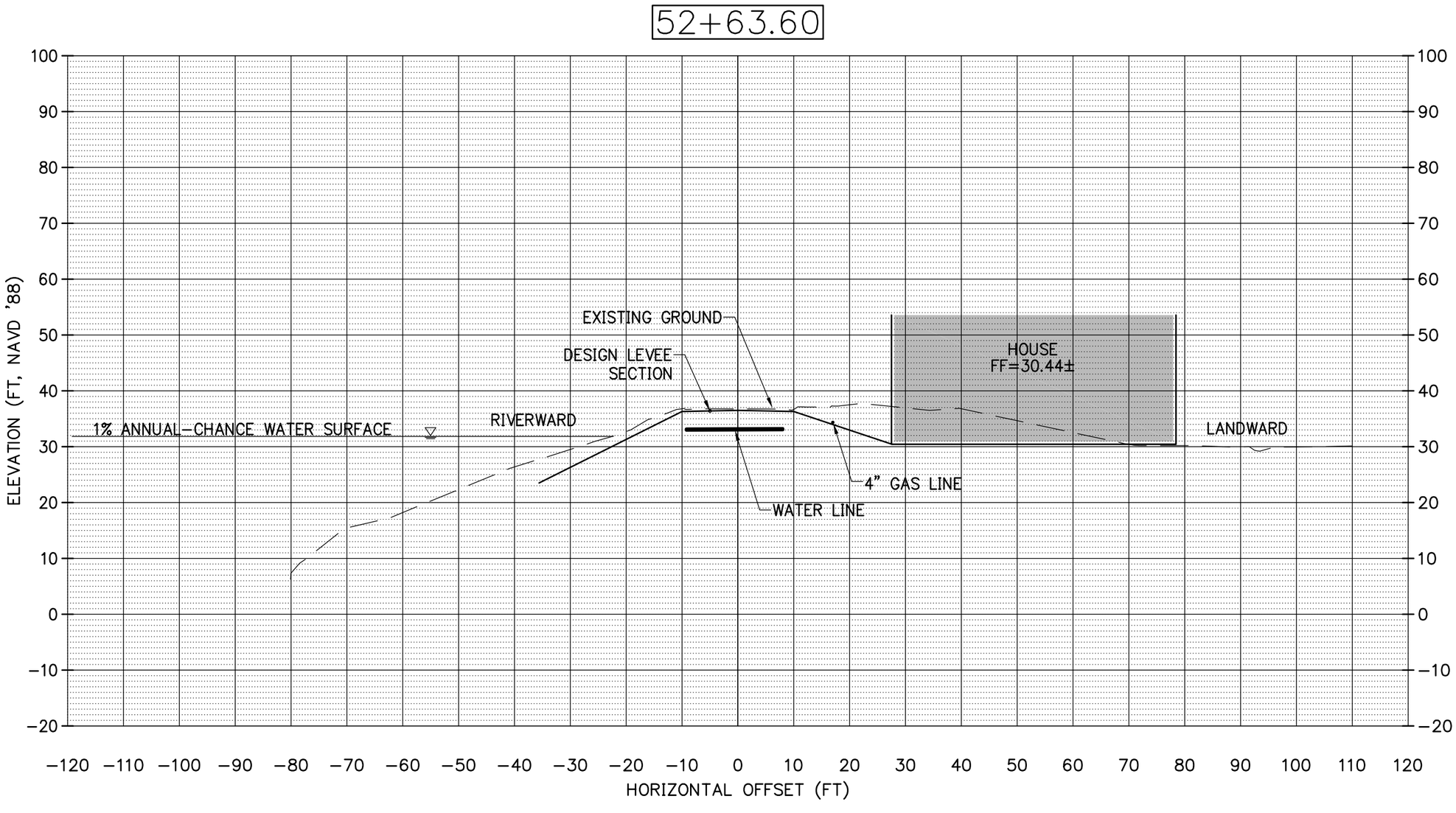
FINAL CONTENT - 10.03.2014
214017000\CIVIL\170PSITE-PEN2.DWG RVS 09/29/14 15:35 1:20.00



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PROJECT:
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SHEET TITLE:
SECTION 52+63.60

DATE:

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FINAL CONTENT - 10.03.2014
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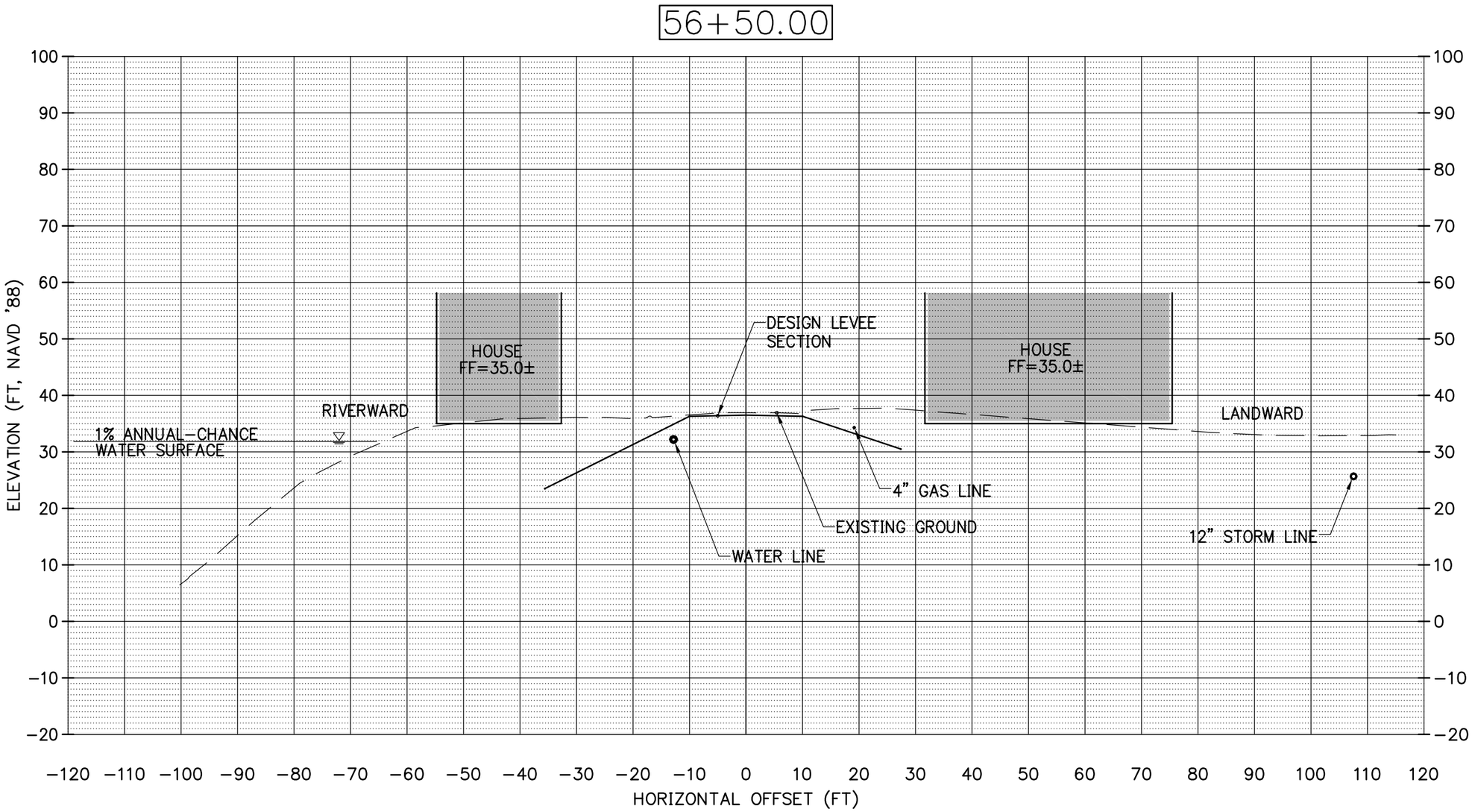

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SHEET TITLE:
SECTION 56+50

DATE:

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214017000\CIVIL\170PSITE-PEN2.DWG RVS 09/29/14 15:36 1:20.00

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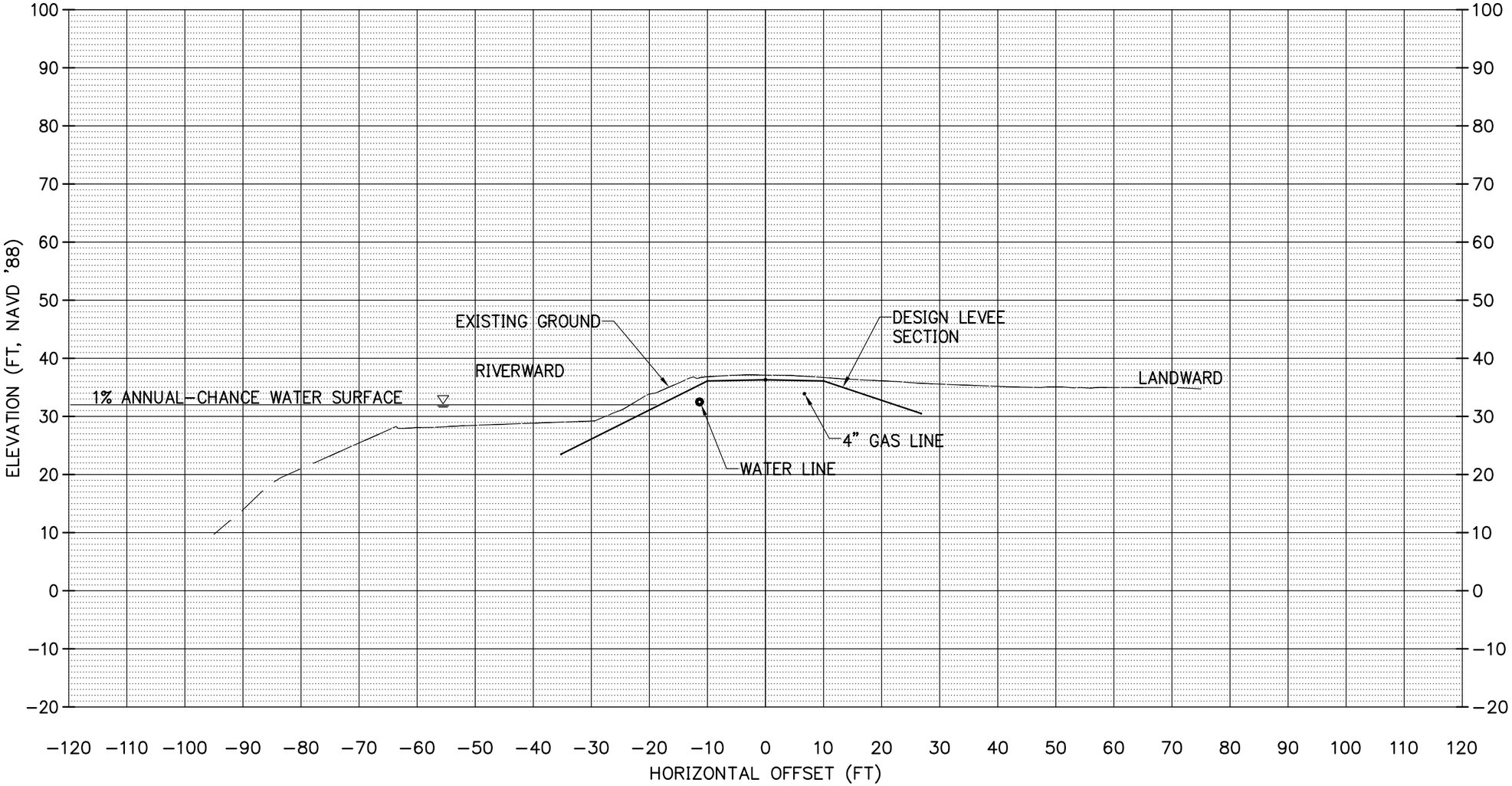
71+50.00



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SHEET TITLE:
SECTION 71+50

DATE:

DRAWN BY:

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SHEET:

JOB NO:
2140170.01

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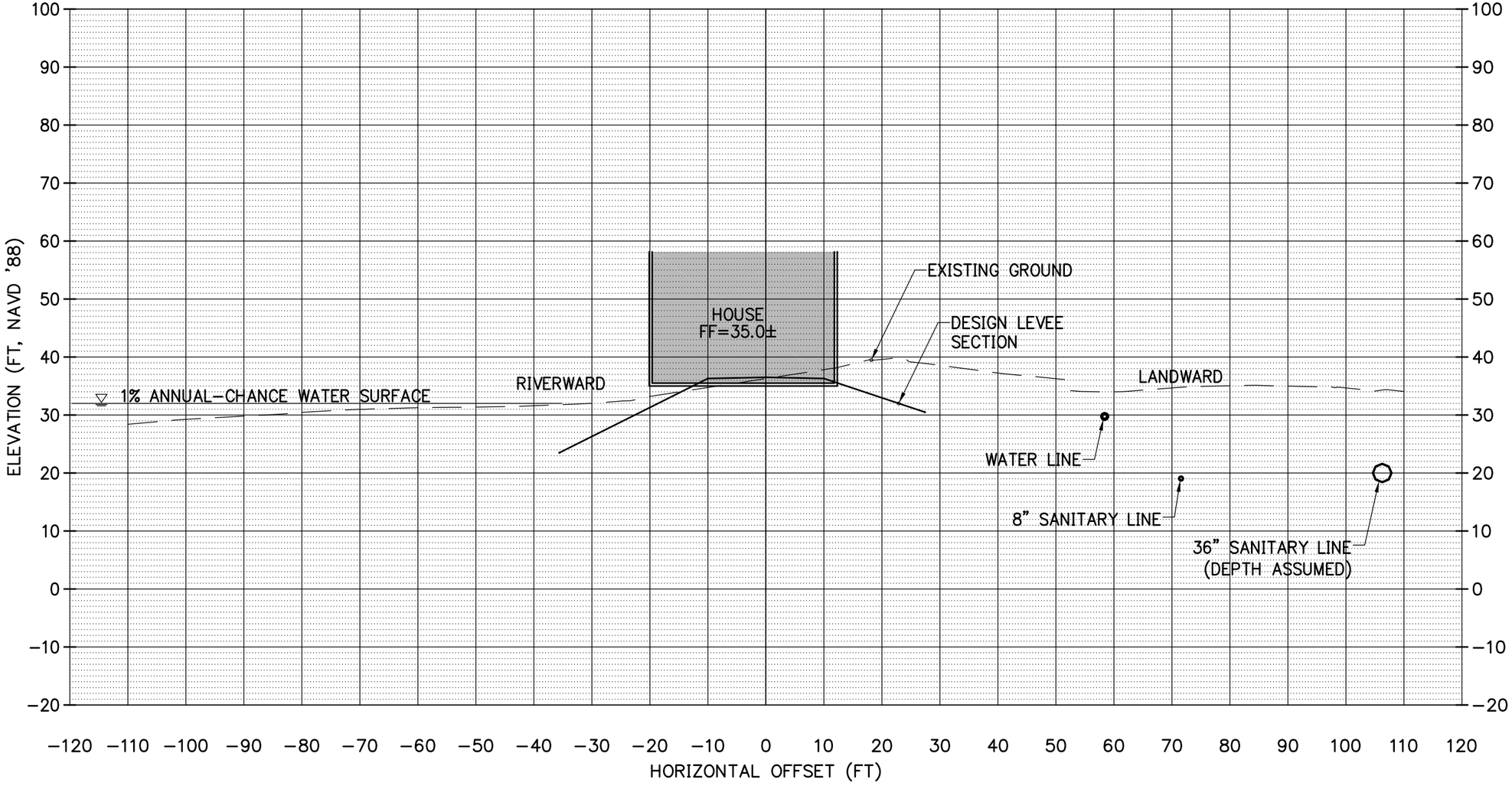
FINAL CONTENT - 10.03.2014

82+60.00



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SHEET TITLE:
SECTION 82+60

DATE:

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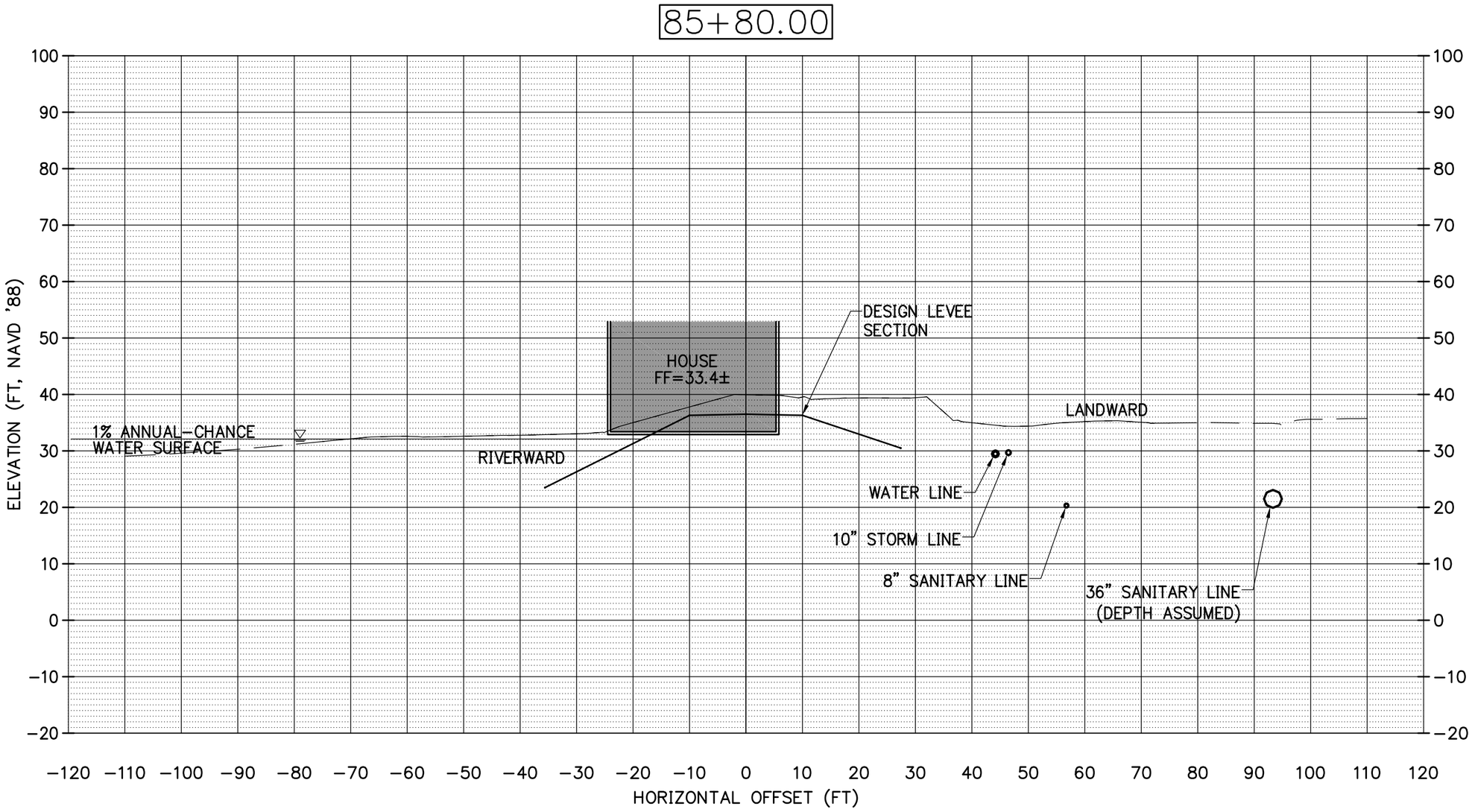

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SHEET TITLE:
SECTION 85+80

DATE:

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JOB NO:
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FINAL CONTENT - 01.03.2014

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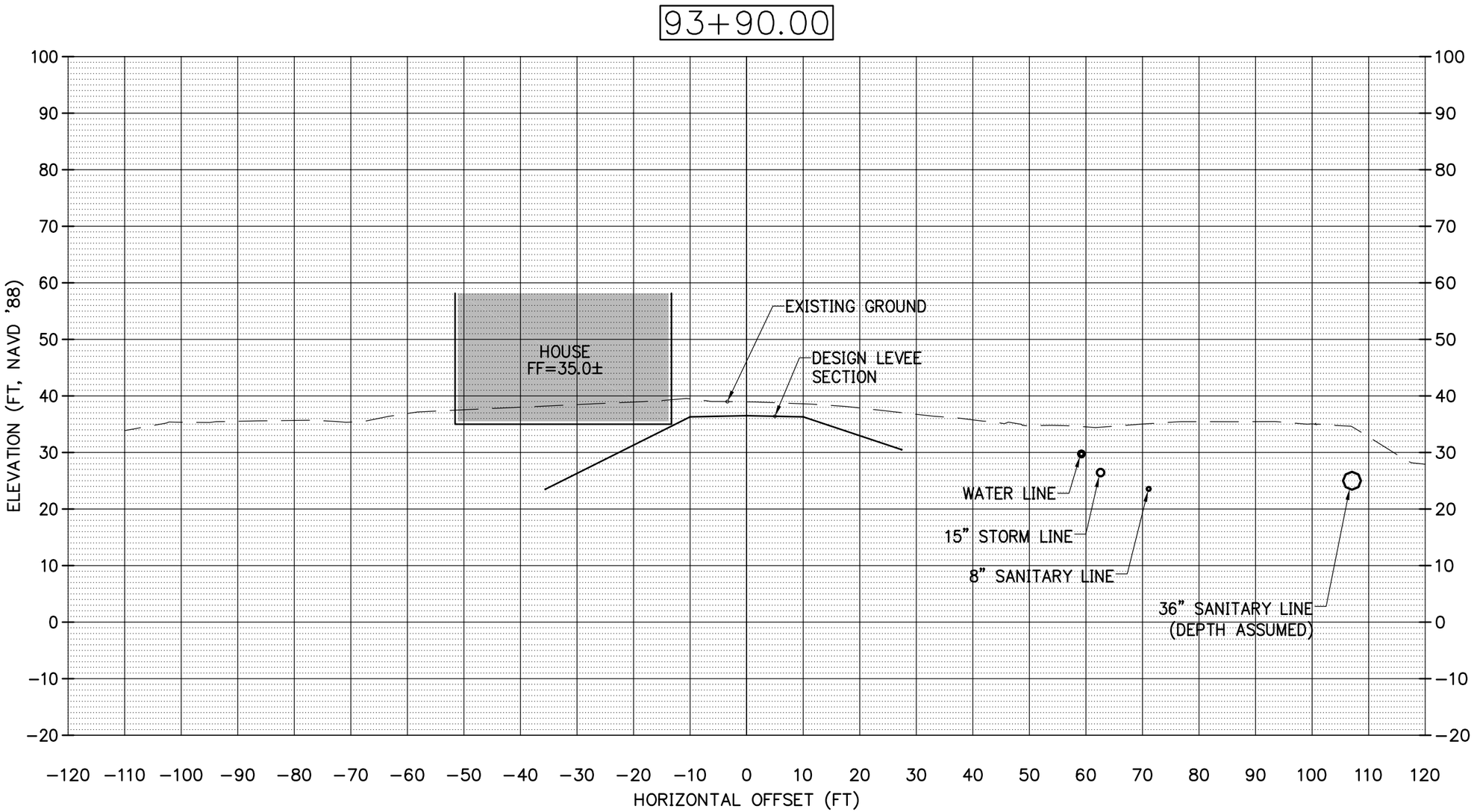

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SHEET TITLE:
SECTION 93+90

DATE:

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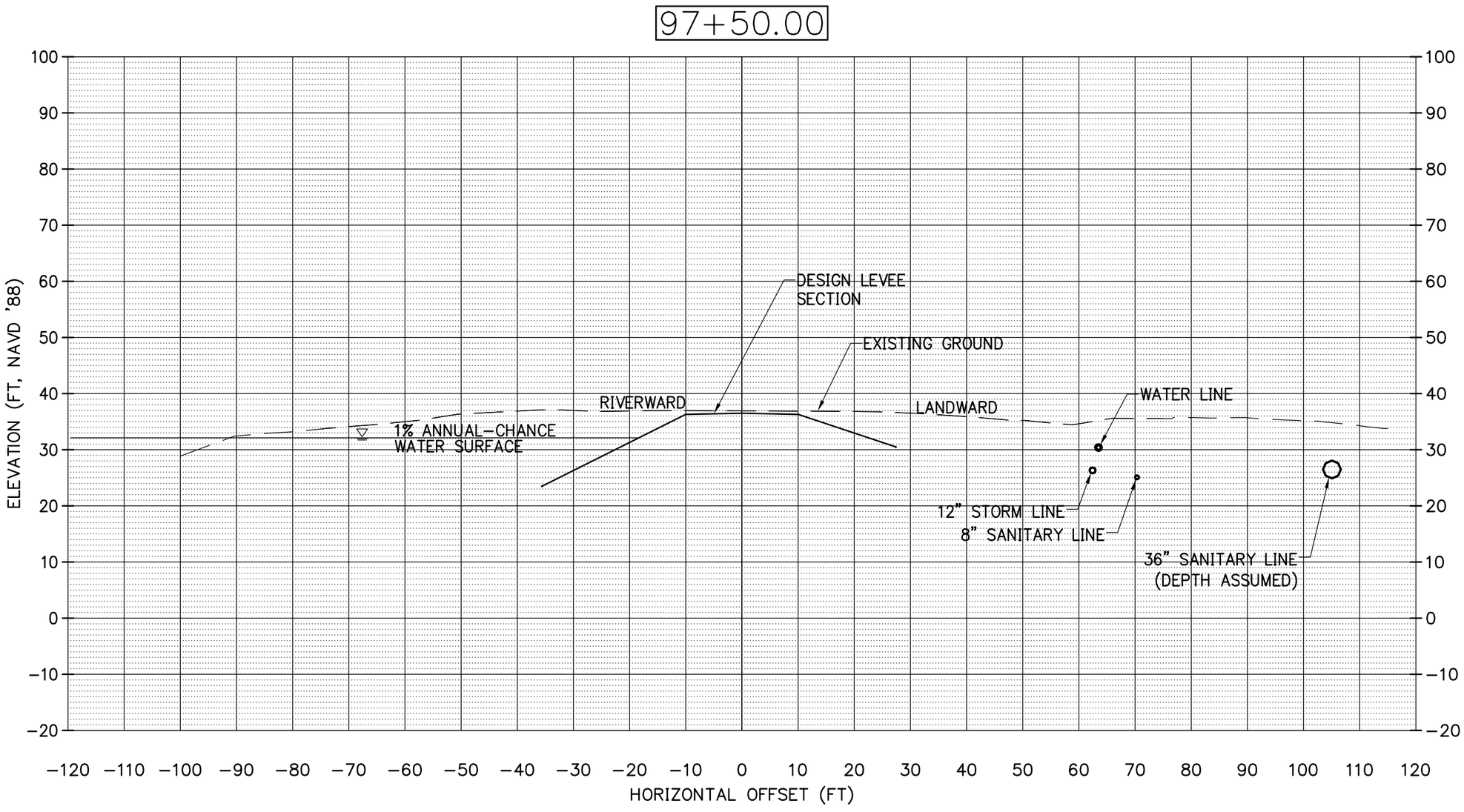
FINAL CONTENT - 01.03.2014



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SHEET TITLE:
SECTION 97+50

DATE:

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JOB NO:
2140170.01

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FINAL CONTENT - 10.03.2014
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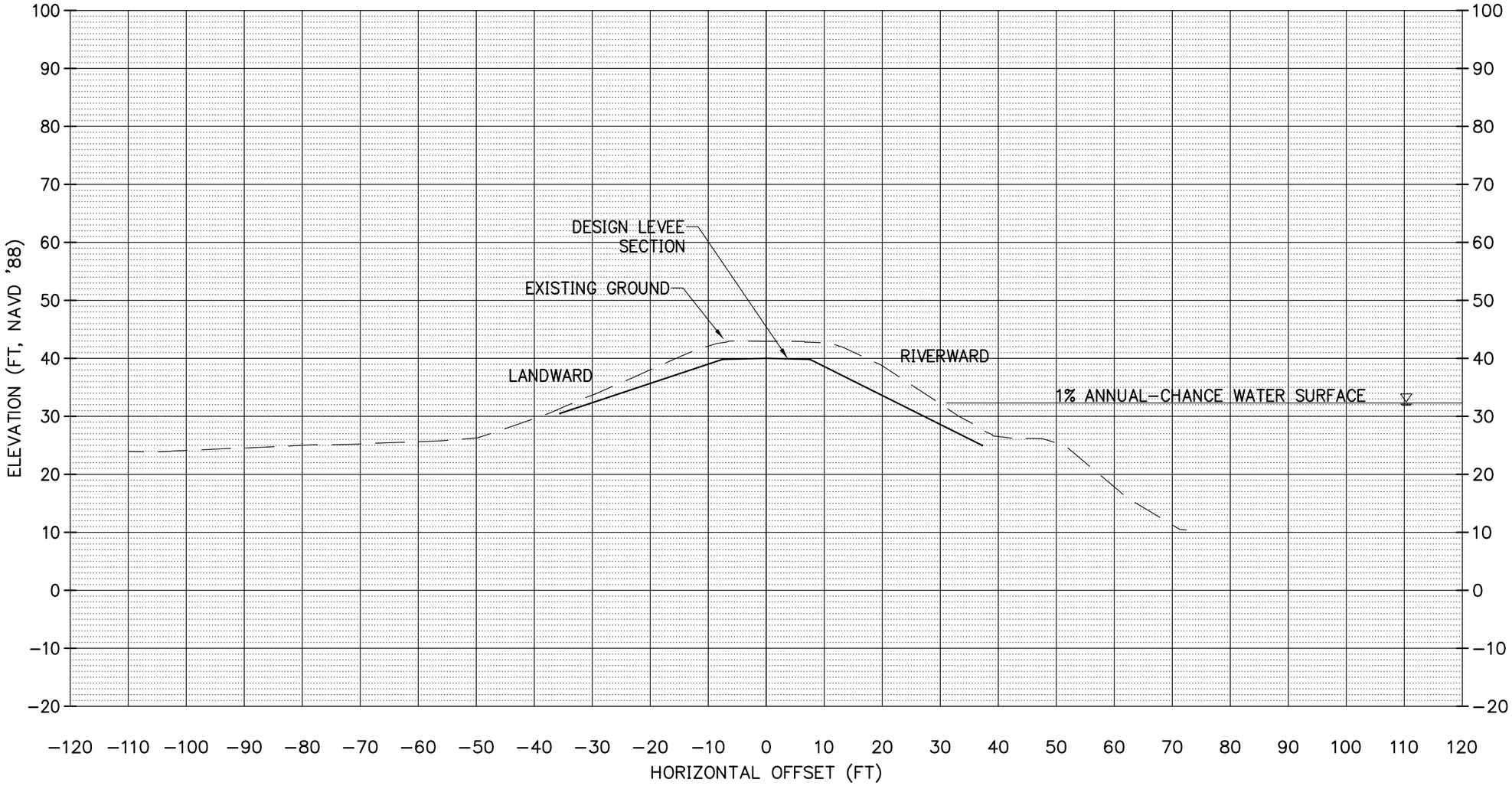
34+90.00
CROSS–LEVEE



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SHEET TITLE:
SECTION 34+90

DATE:

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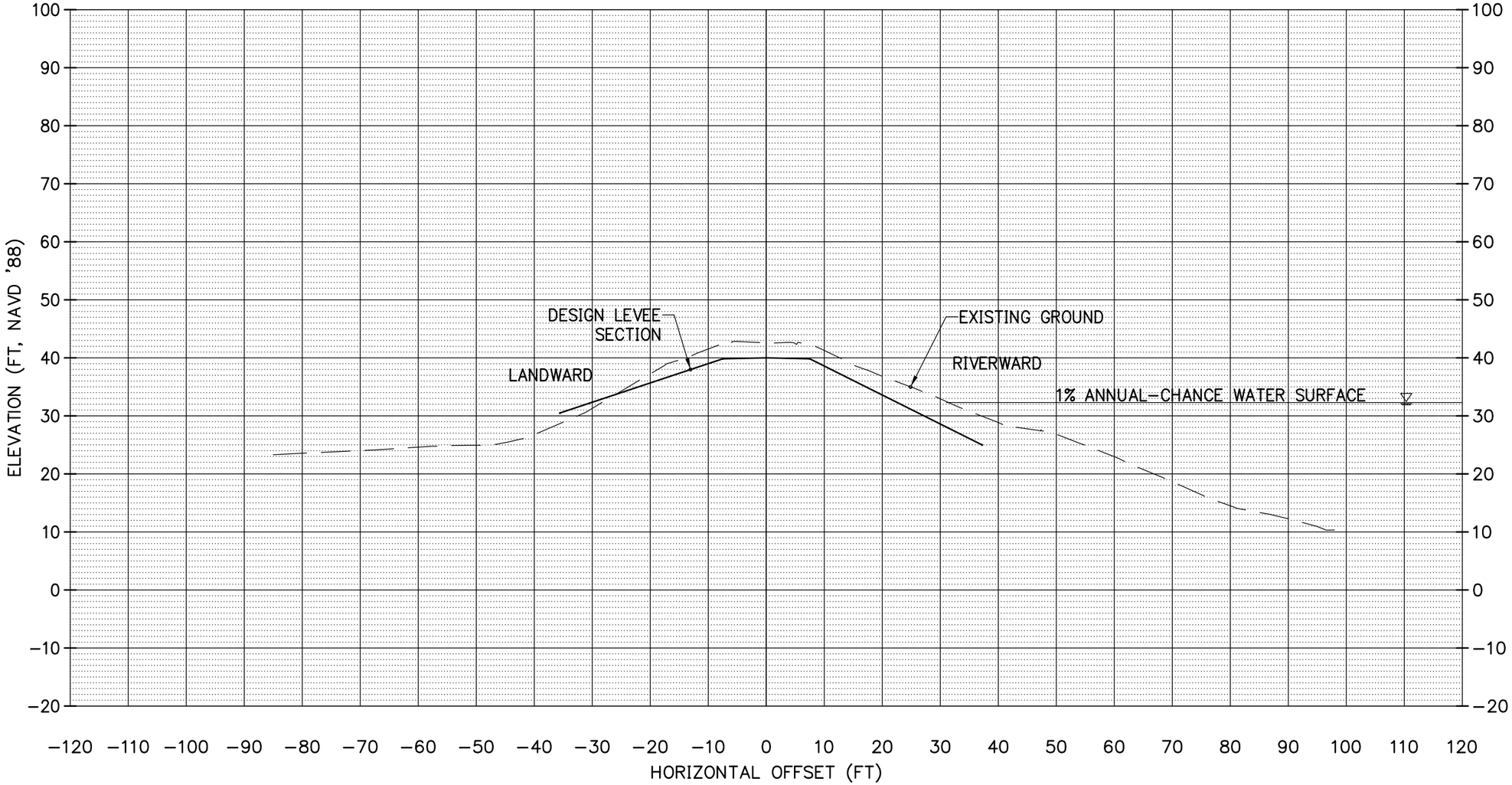
FINAL CONTENT - 10.03.2014

214017000\CIVIL\170PSITE–PEN2.DWG RVS 07/29/14 13:47 1:20.00

45+95.00
CROSS–LEVEE



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SECTION 45+95

DATE:

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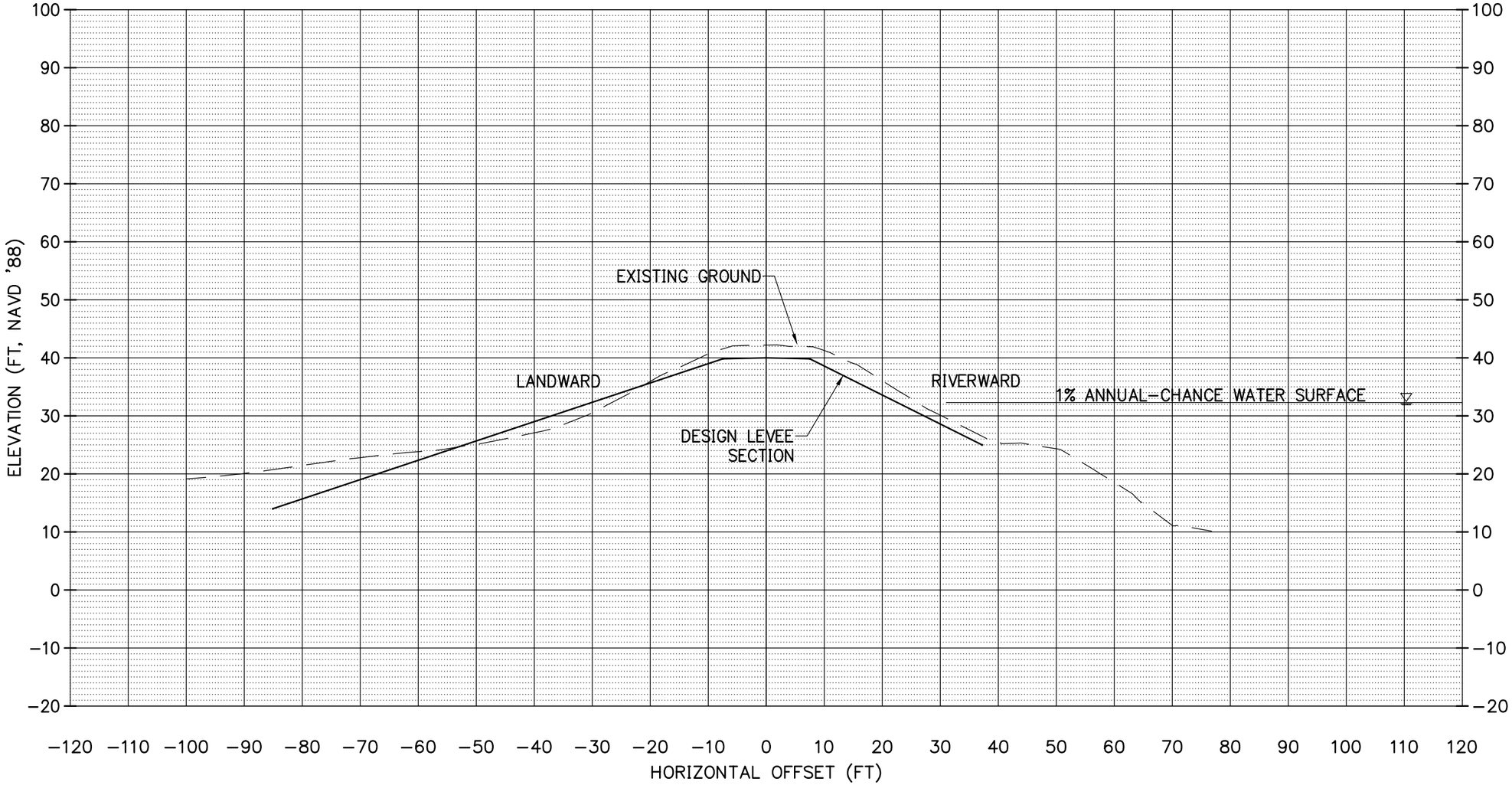
58+50.00
CROSS–LEVEE



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SECTION 58+50

DATE:

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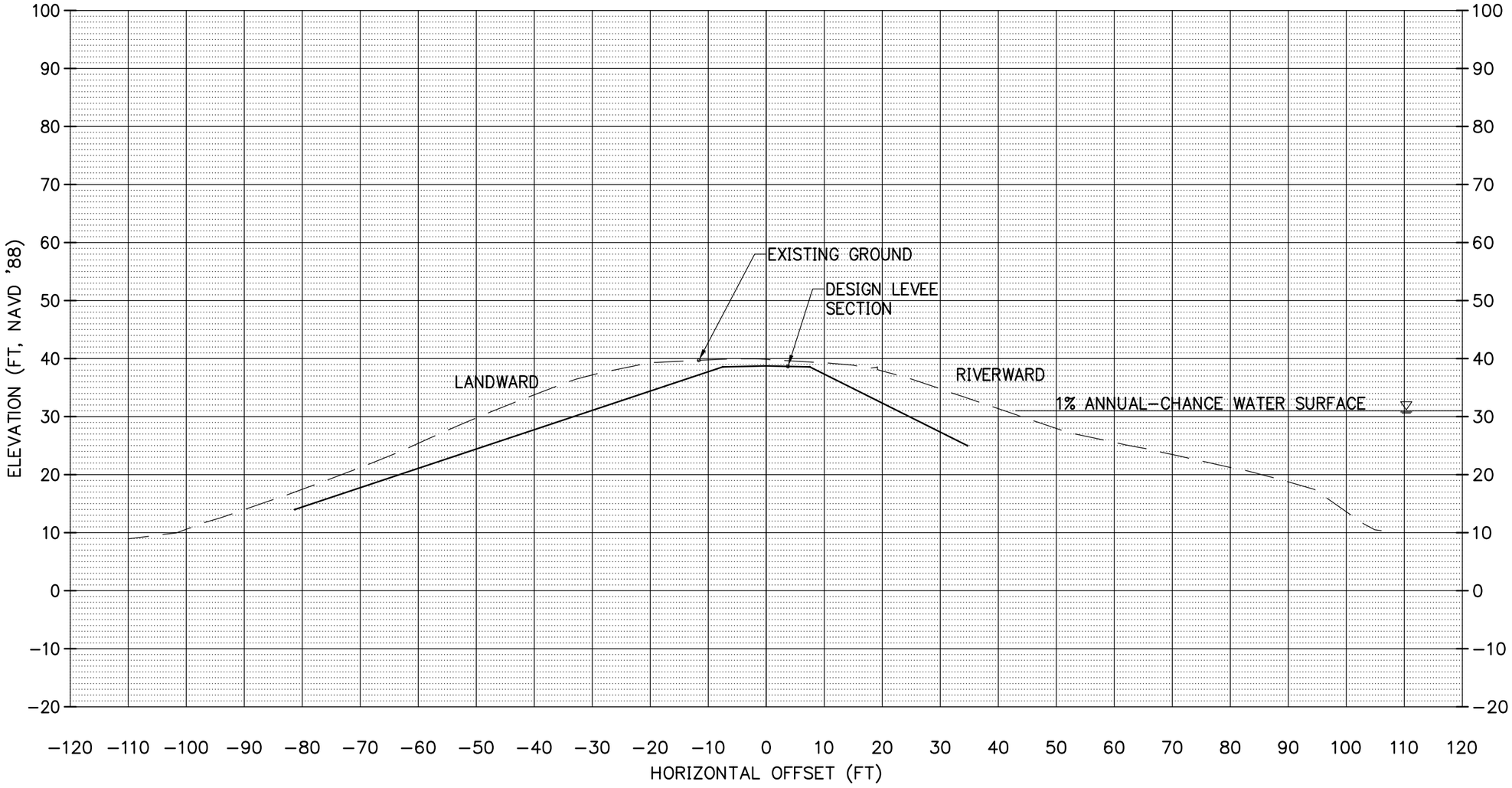
81+50.00
CROSS–LEVEE



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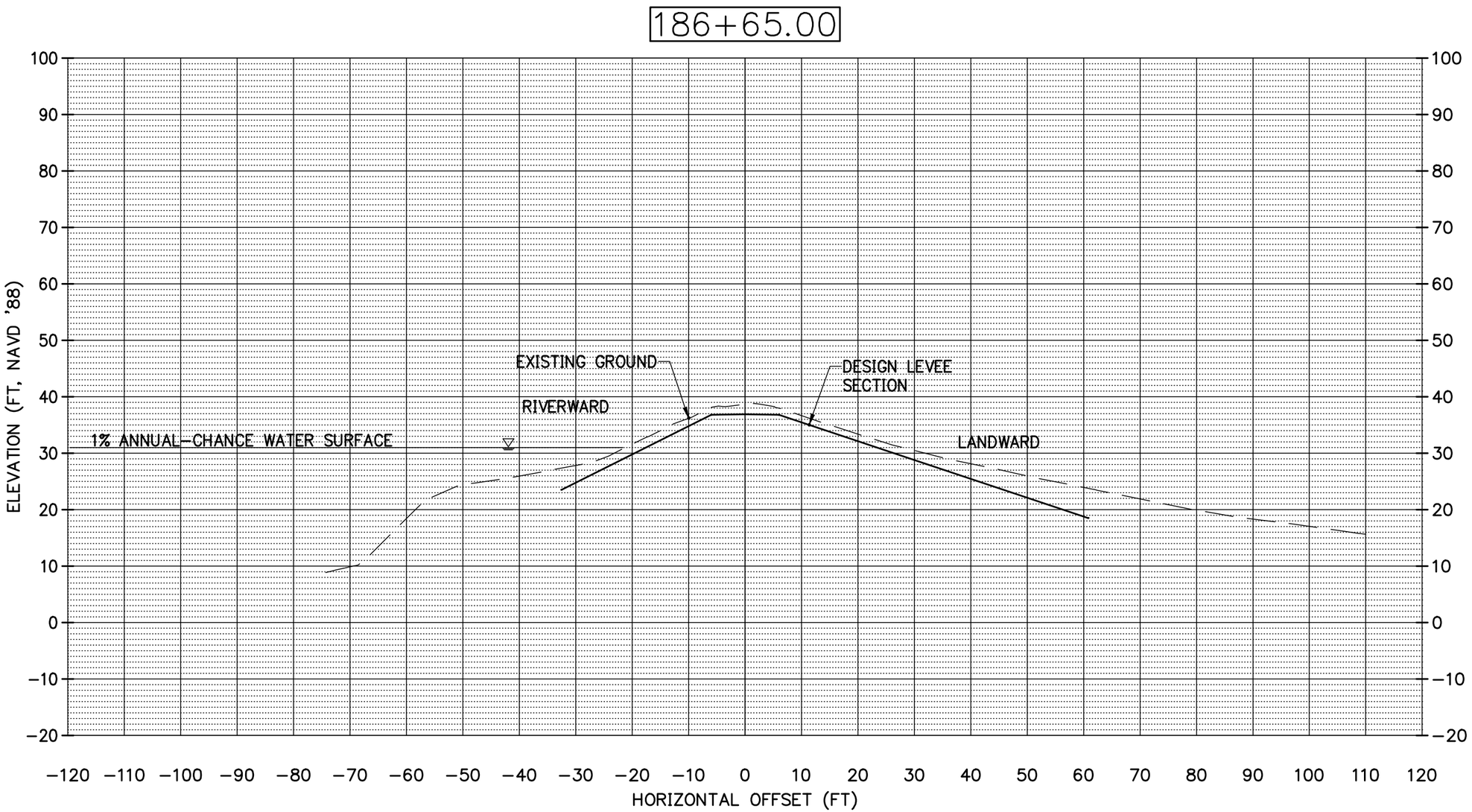

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SECTION 186+65

DATE:

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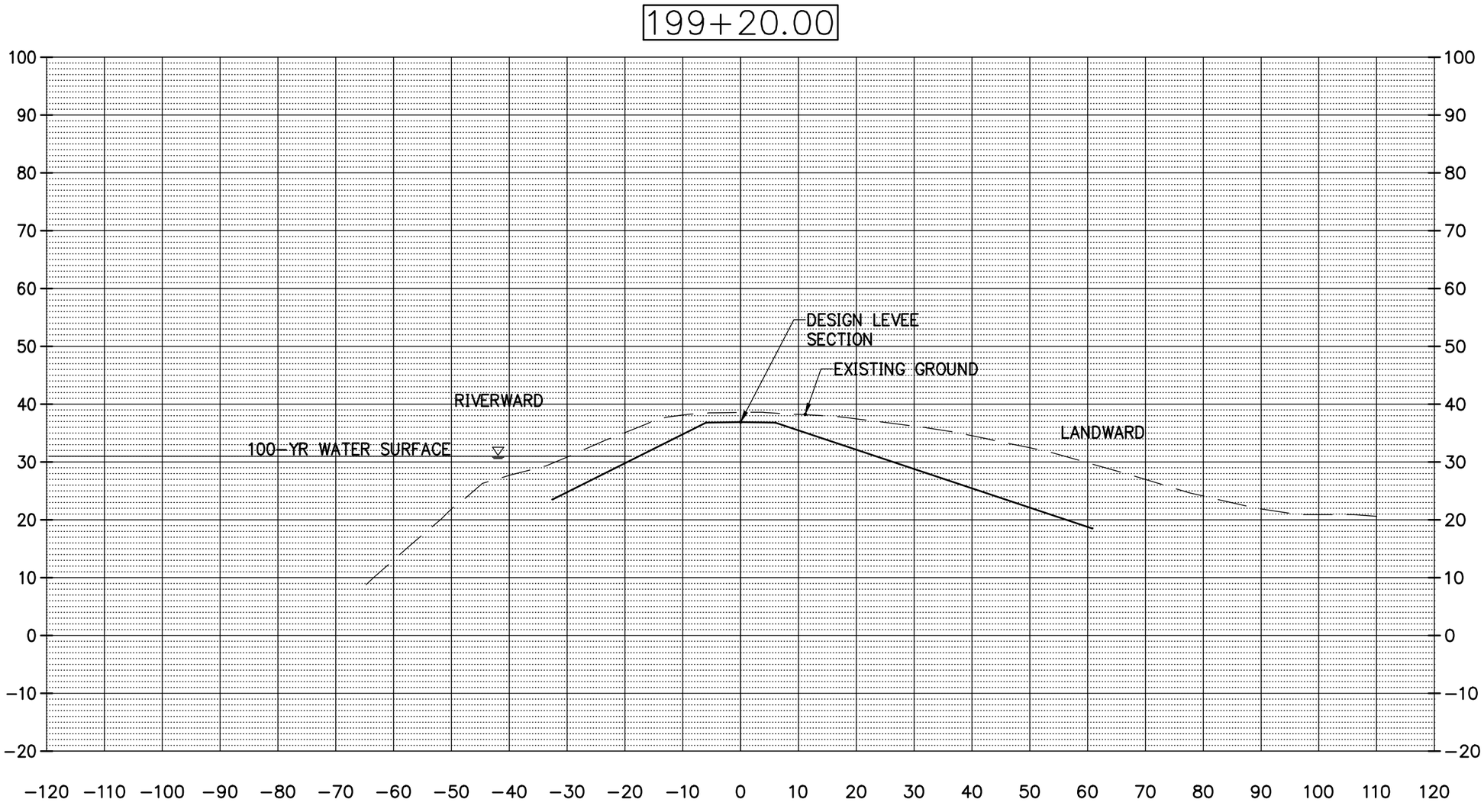

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SECTION 199+20

DATE:

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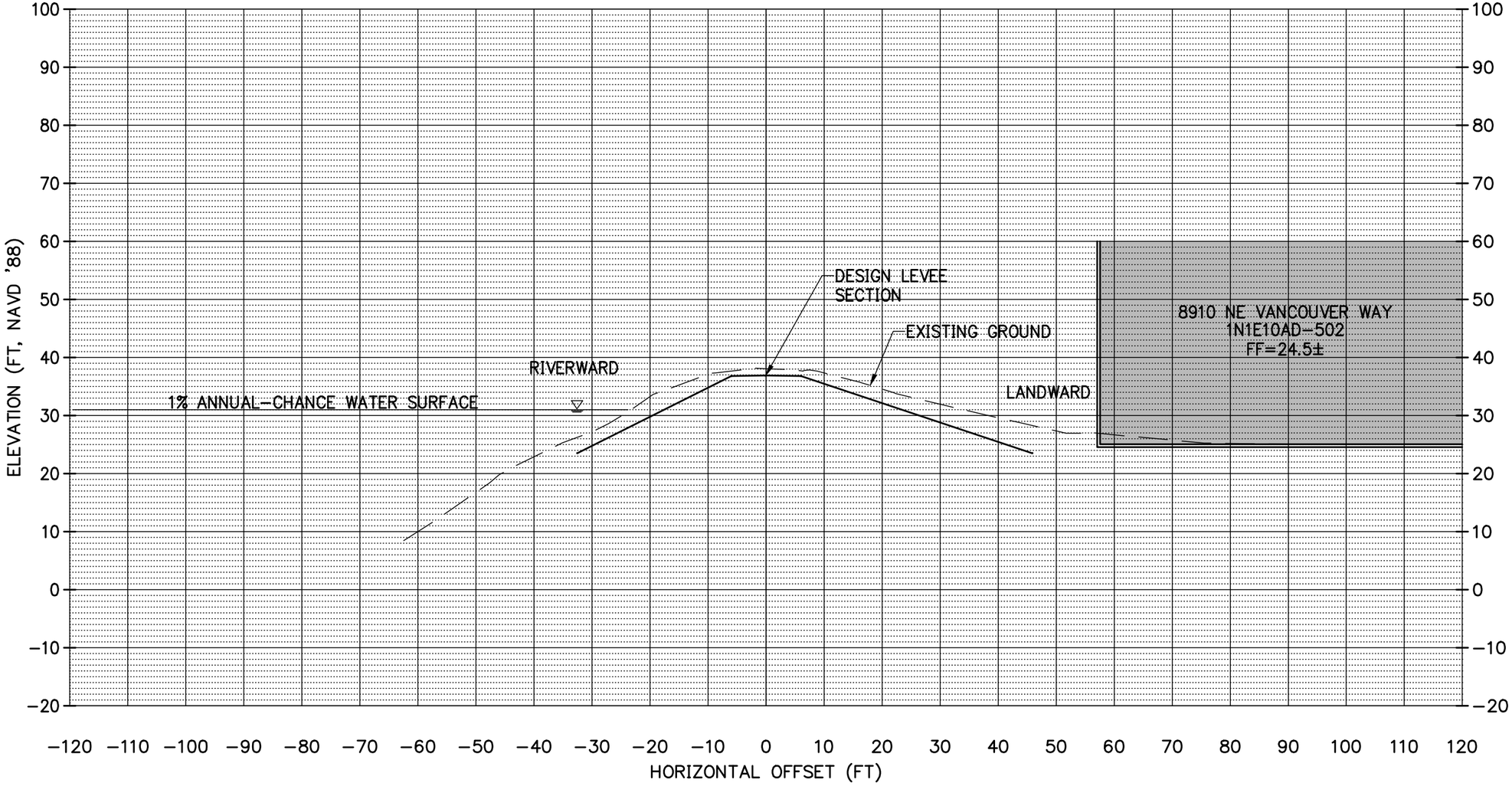
FINAL CONTENT - 10.03.2014

2140170\CIVIL\170PSITE-PEN2.DWG BTS 07/25/14 15:26 1:20.00

209+33.00



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SECTION 209+33

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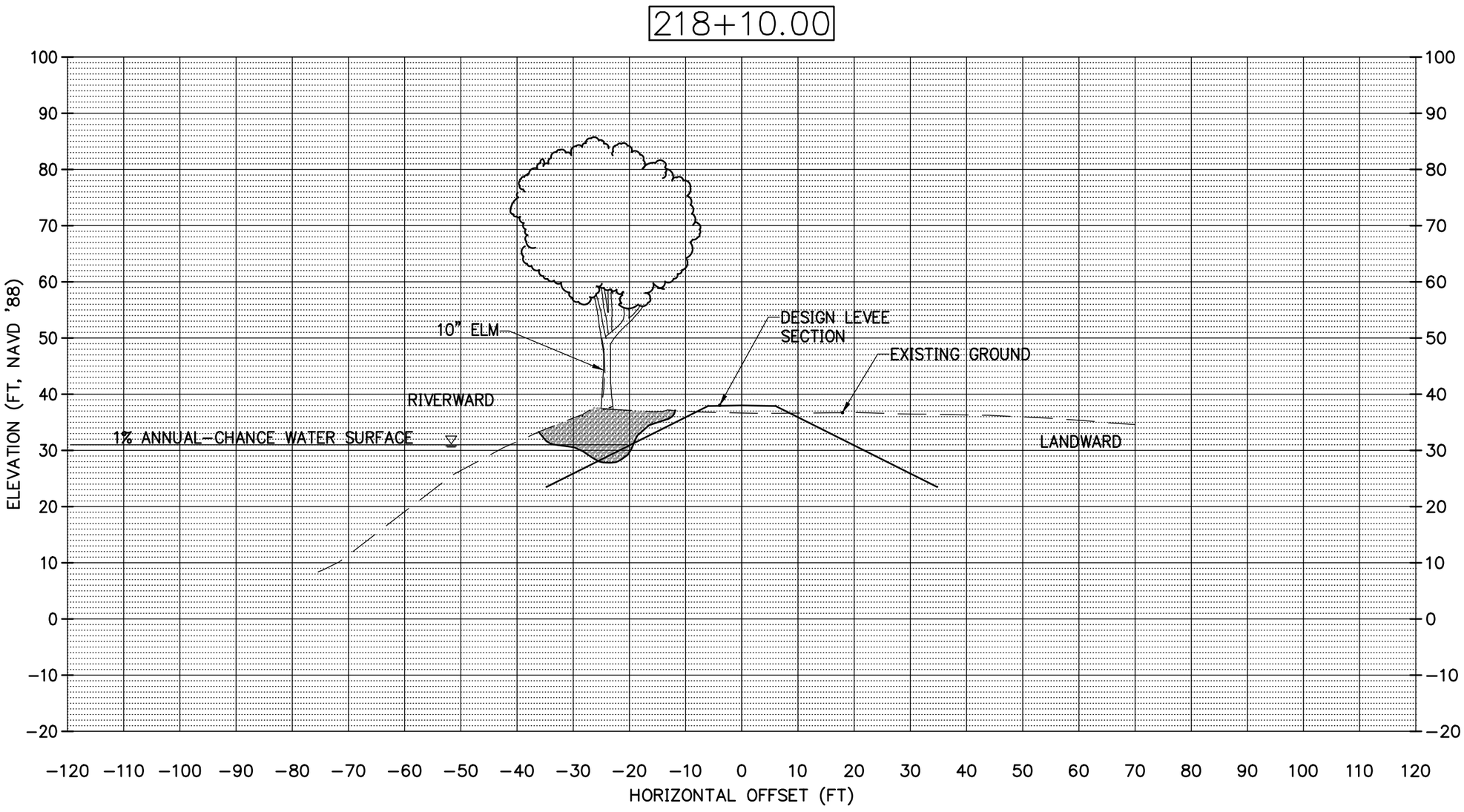

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SECTION 218+10

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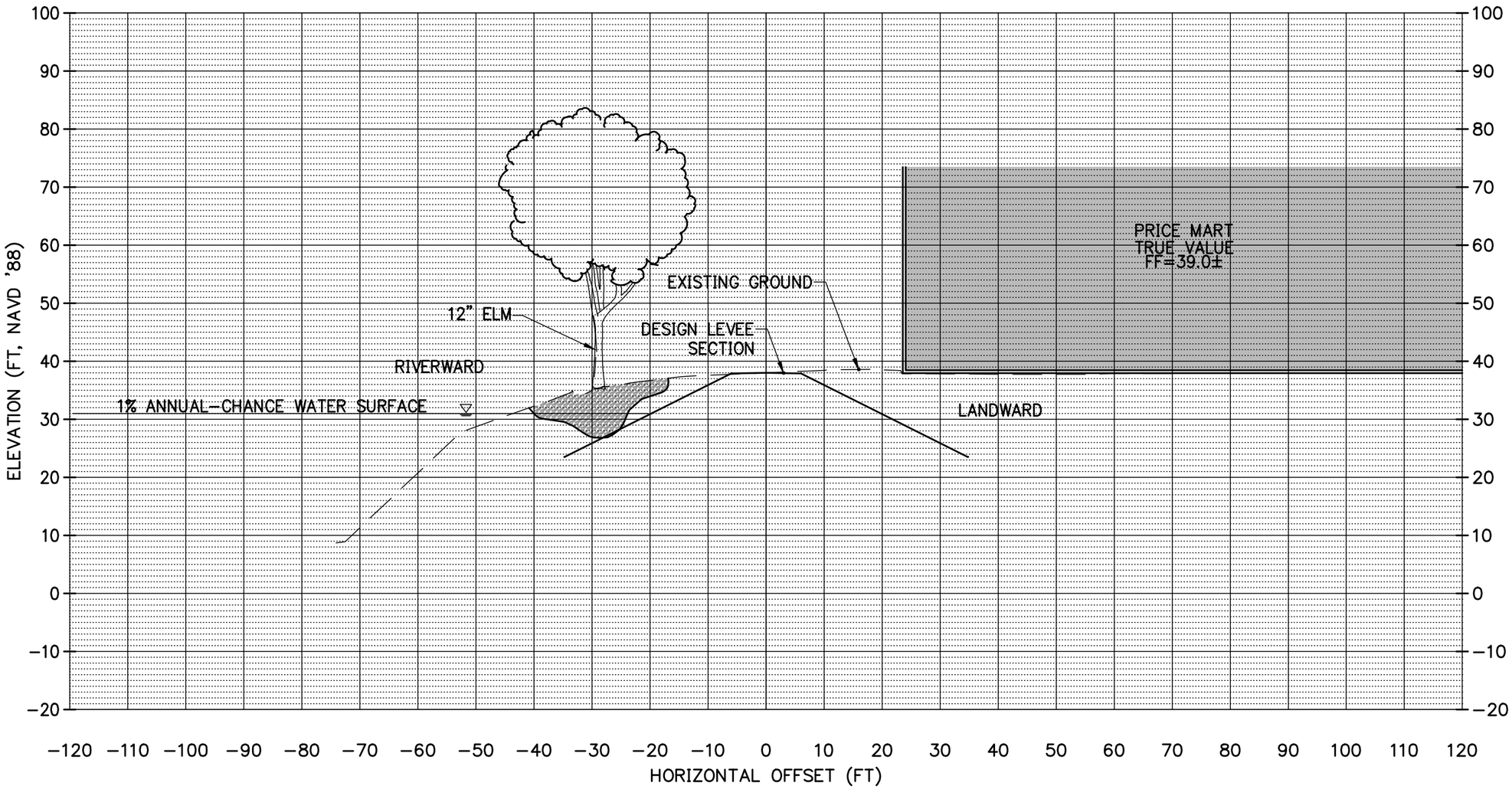
220+35.00



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SECTION 220+35

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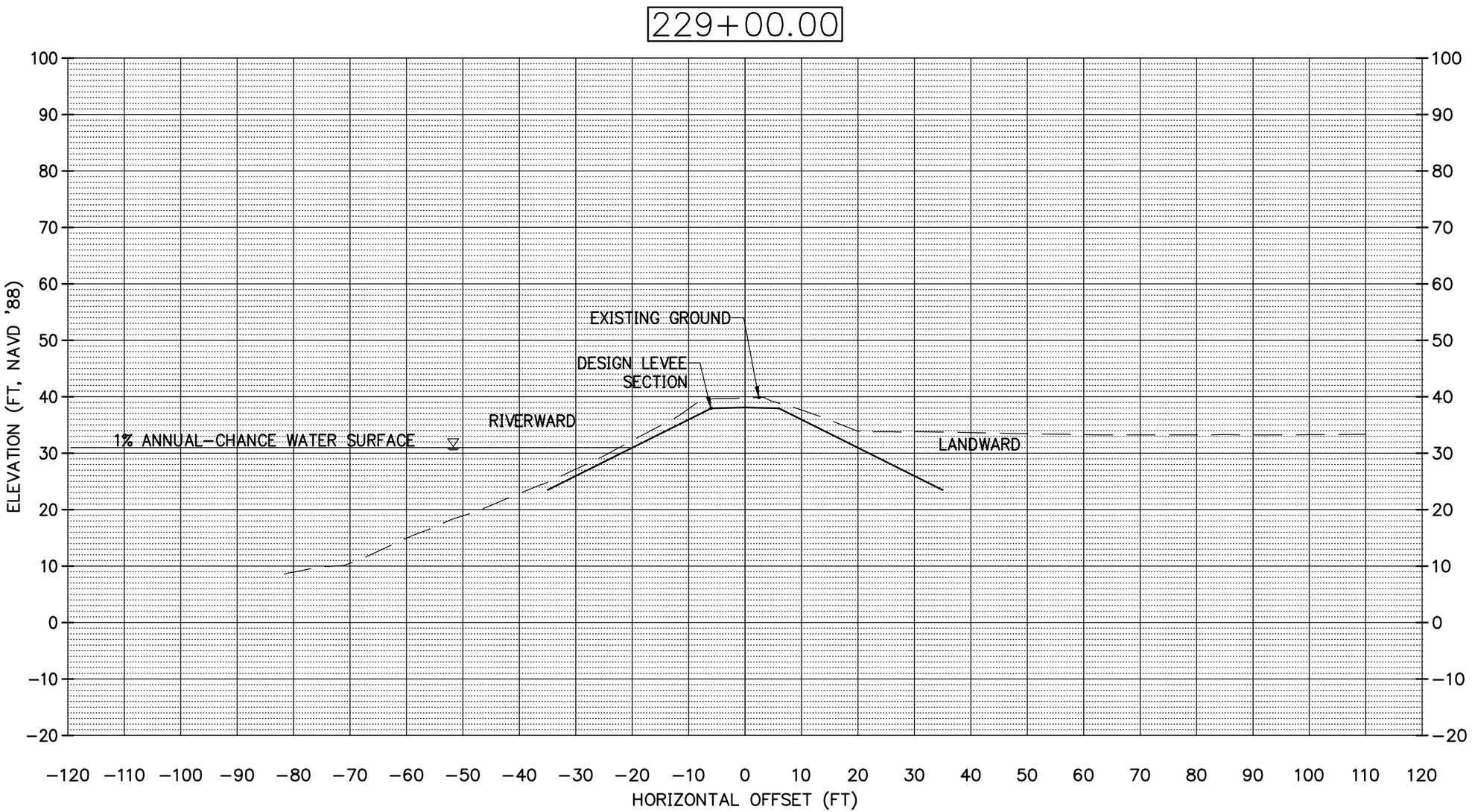

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SHEET TITLE:
SECTION 229+00

DATE:

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JOB NO:
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FINAL CONTENT - 10.03.2014
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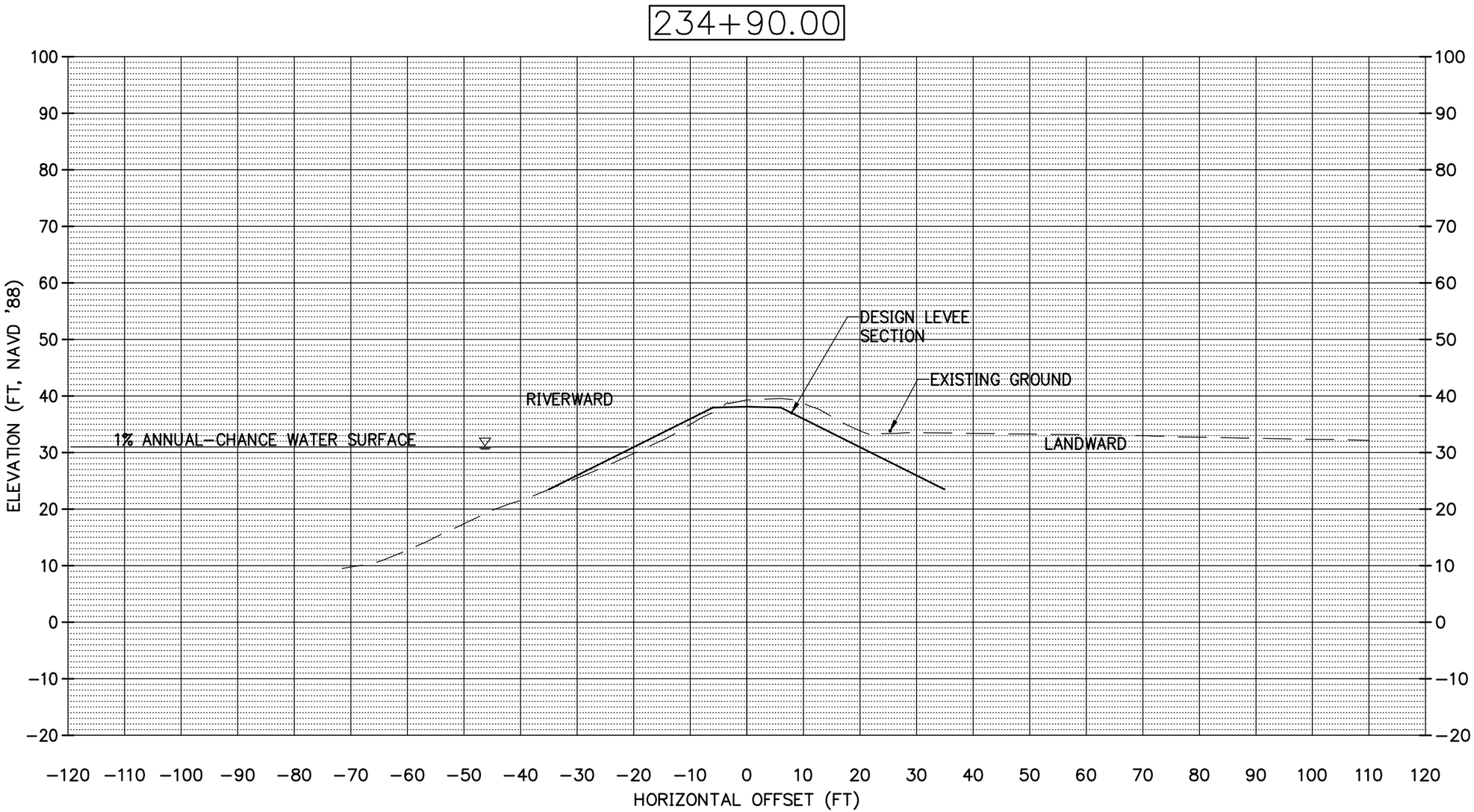

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SHEET TITLE:
SECTION 234+90

DATE:

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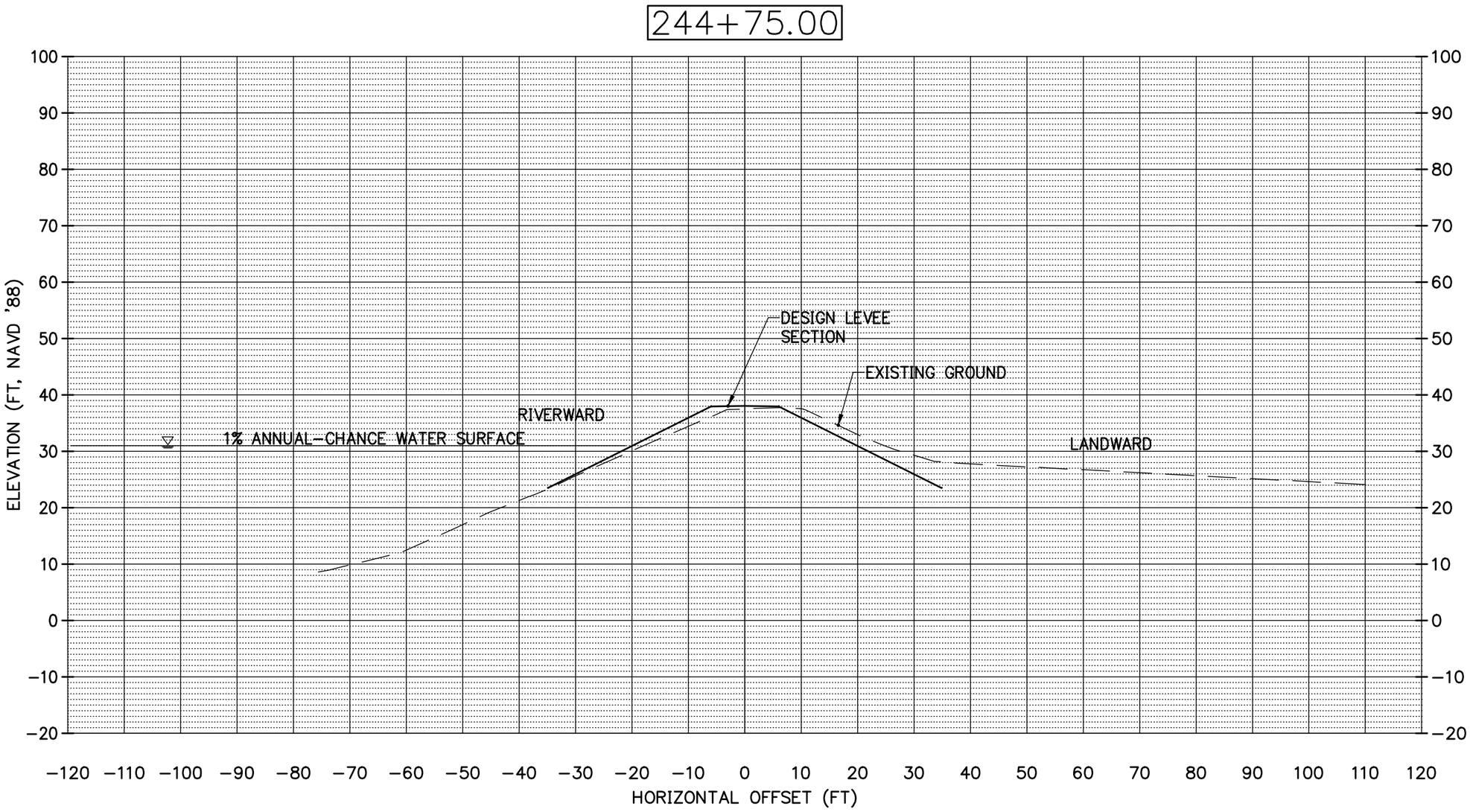

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SECTION 244+75

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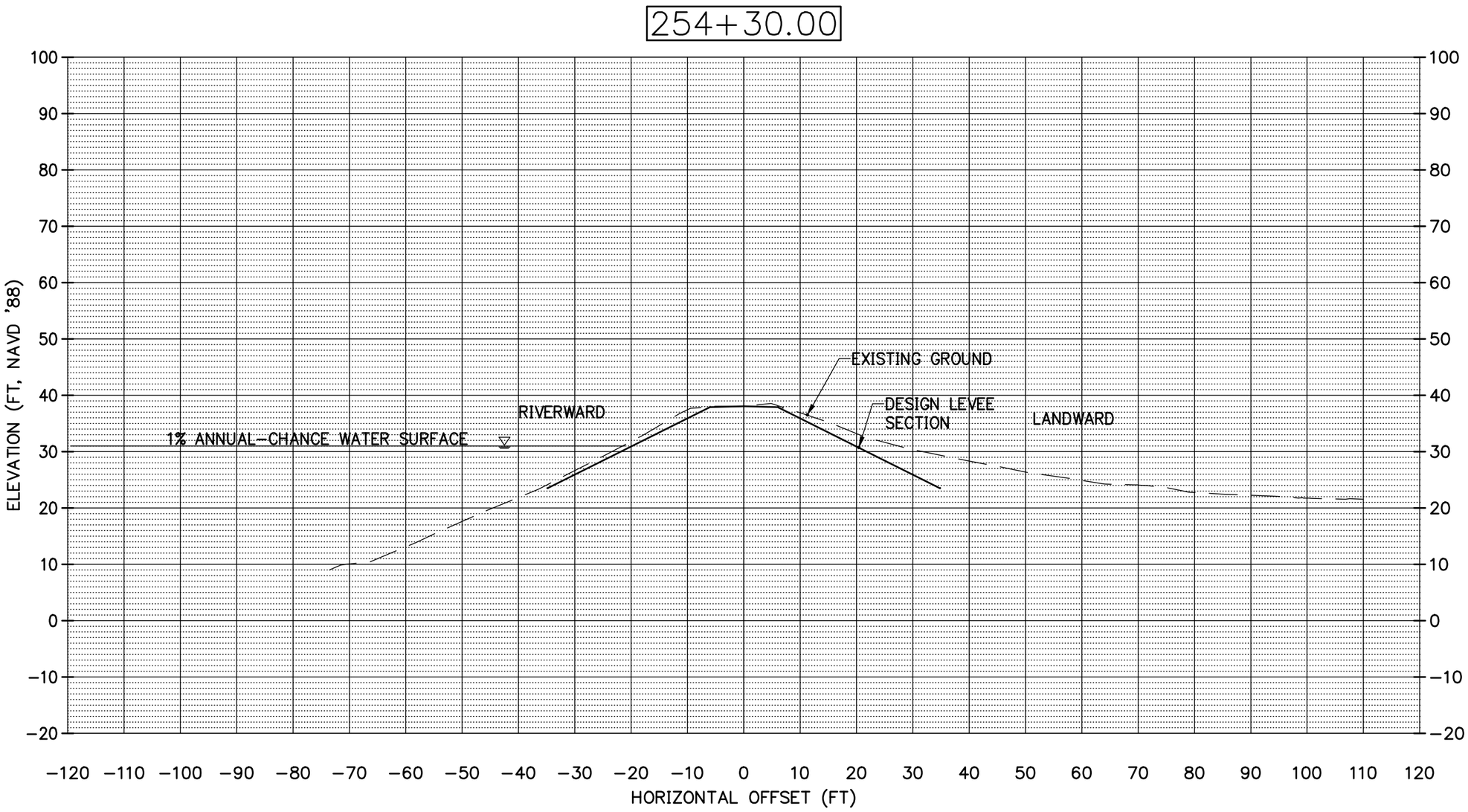
214017000\CIVIL\170PSITE-PEN2.DWG BTS 07/29/14 12:25 1:20.00



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SECTION 254+30

DATE:

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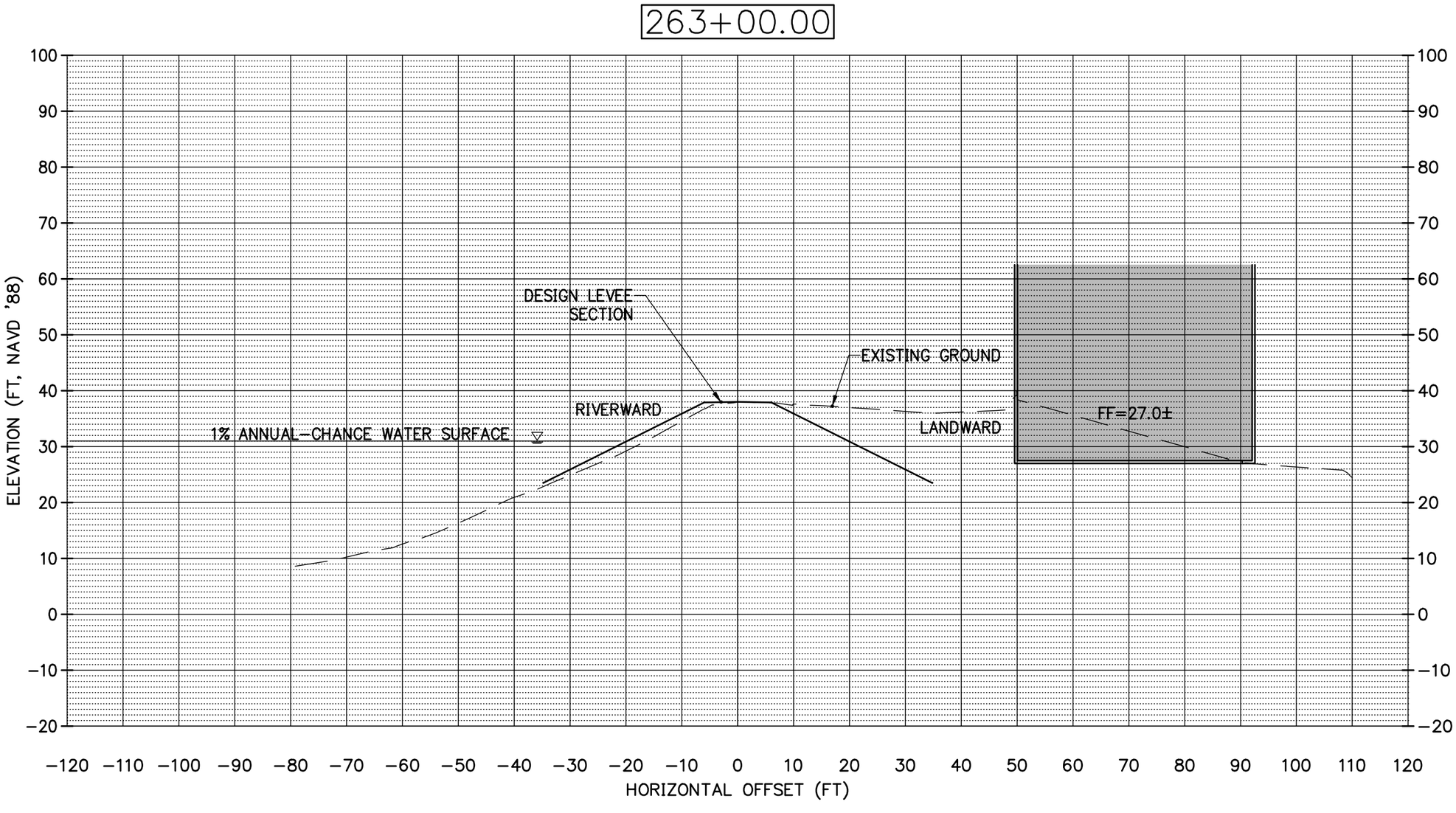

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SECTION 263+00

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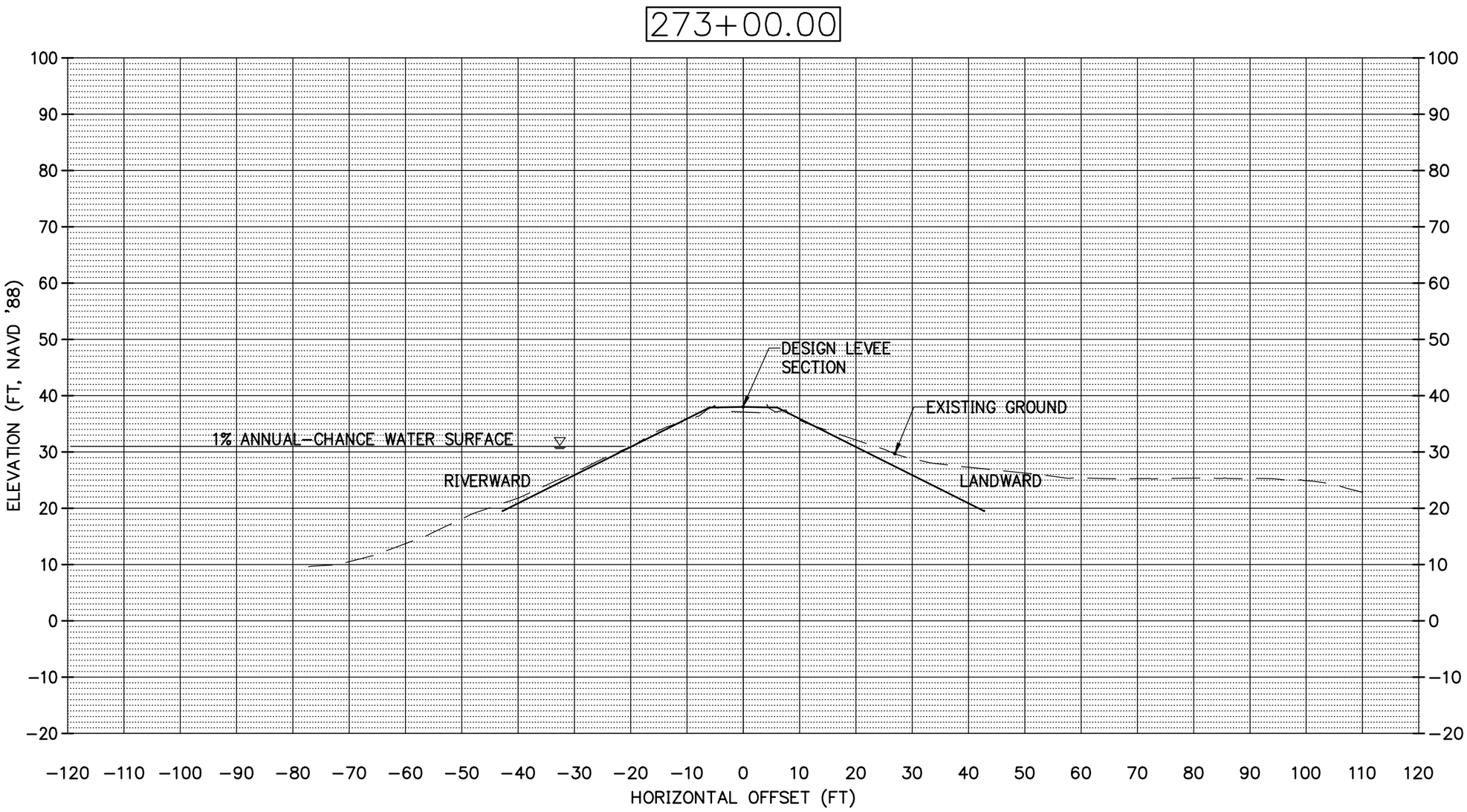

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SECTION 273+00

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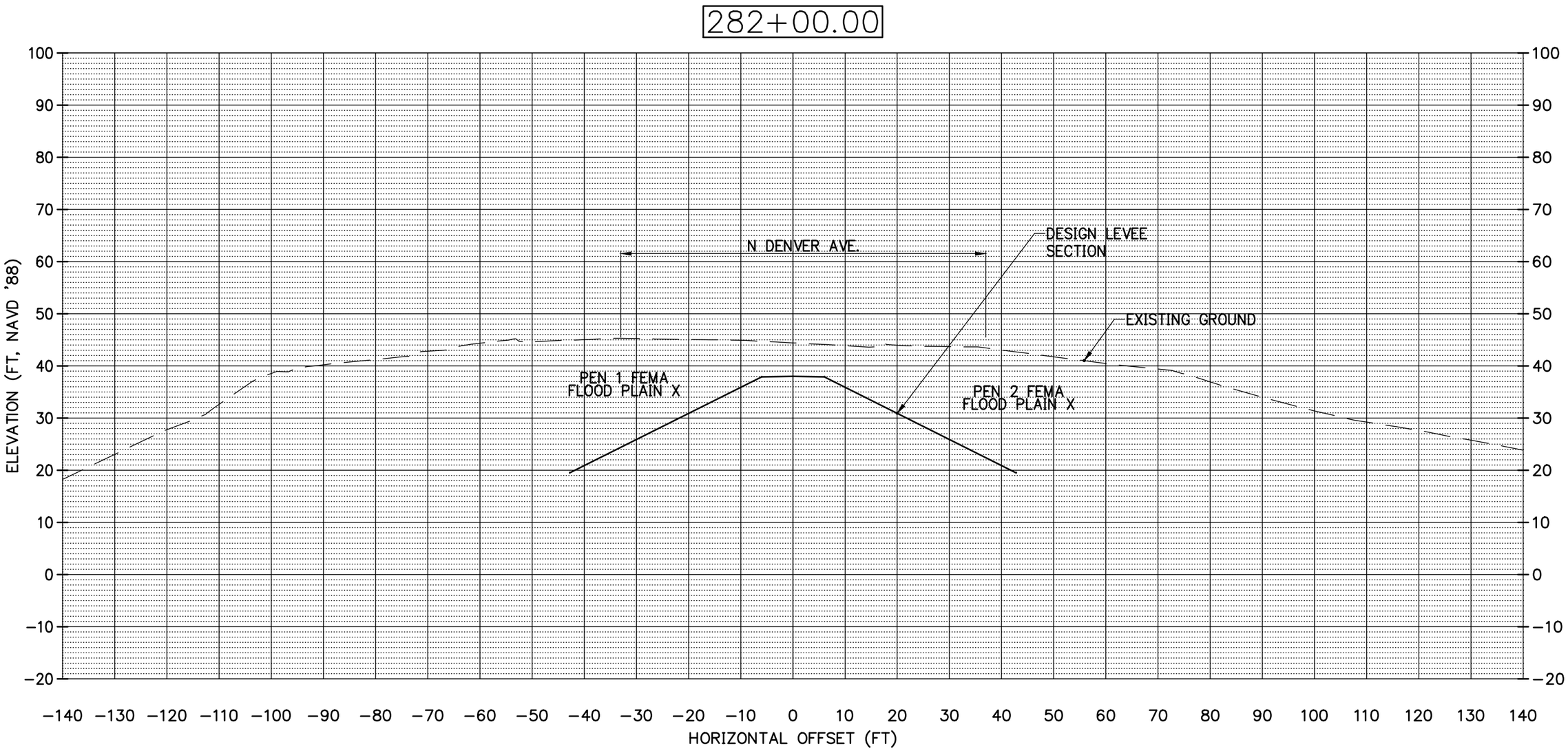

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