SUBMITTED TO:
Oregon Zoo Train Track Restoration Team
Oregon Zoo
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Portland, Oregon 97221

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DRAFT

PRELIMINARY GEOTECHNICAL ENGINEERING REPORT

Oregon Zoo Train Track Restoration

PORTLAND, OREGON

SHANNON & WILSON

December 2023

Shannon & Wilson No: 107736

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Submitted To: Oregon Zoo Train Track Restoration Team
Oregon Zoo
4001 SW Canyon Road
Portland, Oregon 97221
Attn: Kathy Goeddel

Subject: DRAFT PRELIMINARY GEOTECHNICAL ENGINEERING REPORT, OREGON ZOO TRAIN TRACK RESTORATION, PORTLAND, OREGON

Shannon & Wilson prepared this report and participated in this project as a consultant to the Oregon Zoo. Our scope of services was specified in our proposal that was executed on September 29, 2021. This report was prepared by the undersigned and presents the results of our field reconnaissance and discussion of conceptual landslide mitigation alternatives. Shannon & Wilson previously prepared a draft report for the project dated November 2021. The purpose of the revised report is to update cost estimates associated with the conceptual mitigation alternatives included in the November 2021 report to account for cost escalations. This report supersedes our November 2021 draft report.

We appreciate the opportunity to be of service to you on this project. If you have questions concerning this report, or we may be of further service, please contact us.

Sincerely,

SHANNON & WILSON, INC.

Neal D.J. McCulloch
Vice President

Elliott Mecham, PE
Senior Associate | Engineer

KJW:RAW:ECM:NJM/myw

EXECUTIVE SUMMARY

Shannon & Wilson performed a site reconnaissance in October 2021. This section provides a summary of our observations and conclusions. Detailed discussions are provided in the proceeding sections. Overall, in our opinion the tracks are in good condition. In addition to geotechnical considerations presented in this report, the railroad would benefit from removal of ivy and other vegetation that has taken over since the railroad has been out of service. Track ballast would be beneficial along most of the alignment to help hold the track in place.

We understand that the railroad only operates during daylight hours and when the weather is favorable. The train runs slow enough that the operator can stop if a tree is on the tracks or damage to the track has occurred. The risk of landslides or retaining wall failure occurring during the summer months and during periods of dry weather when trains would be running is very low.

We identified two areas that are currently preventing the train from running and several areas that should be budgeted for and addressed in a long-term maintenance plan. Geotechnical issues which need to be addressed before operations can resume are as follows:

- Crib Wall Number 3 (STA 16+65 to 17+07) has failed as a result of uncontrolled drainage during a storm and is not retaining the track shoulder. A new retaining wall is required at this location before operations can resume. For planning purposes, we assume a 10-foot tall by 40-foot-long solider pile wall will be required. We recommend final design for the structure be performed. As an alternative a short bridge could be evaluated during design. Estimated design and construction cost was $150,000 in 2021 dollars. If the construction cost escalations experienced over the last 5 years (2019-2023) continue, the cost of construction to complete the design concept in 2026 may be $225,000.
- A slide from an adjacent bluff at Station 56+00 has covered the track with slide debris and trees and needs to be cleared. We estimate the volume of the slide debris at around 300 cubic yards. After removing the debris, we recommend performing an assessment of that portion of the track and adjacent retaining wall. For slide debris removal and cleanup, we recommended a budget of $40,000 in 2021 dollars. If the construction cost escalations experienced over the last 5 years (2019-2023) continue, the cost of construction to complete the debris removal in 2026 may be $60,000.

After re-opening the line to trains, there are areas that should be addressed as part of a long-term maintenance plan, as required by inspection and as budget allows. These locations are described in the report and include retaining walls, culverts, and areas of slope instability.

Construction cost estimates for most of these locations are presented in Table 1 and include some budget for design and mobilization. Shannon & Wilson does not employee professional estimators or economists. Our understanding of cost is based on available historic bids, and conversations with railroad contractors. Cost estimates were developed based on the 2021 design concept.

Costs presented in Table 1 by Shannon & Wilson are approximate in nature and based on conceptual design. Additionally, projected costs may not fully capture future escalation (or may overpredict future escalation) and should be considered approximate.

In an effort to account for future escalation, we reviewed the National Highway Construction Cost Index (NHCCI) prepared by the Federal Highway Administration. The index indicates cost escalations of approximately 50 percent over the past five years. In an effort to account for escalation we have applied a factor of 1.5 to the 2021 construction costs to project anticipated costs in 2026.

We recommend that the zoo budget for an annual reconnaissance of the line to identify changes over time and to prioritize areas for maintenance. The reconnaissance could take place in the spring prior to reopening of the line each season.

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1 INTRODUCTION

This report summarizes our recent desktop study, site reconnaissance, and conceptual slope stabilization alternatives for the Oregon Zoo Train in Portland, Oregon. The general location of the project is shown on the Vicinity Map, Figure 1.

For our evaluation, we performed the following tasks:

- Reviewing available documentation related to the existing landslides and impacts to existing infrastructure at the rail alignment;
- Performing site reconnaissance to collect field information on the slope instability and infrastructure impacts;
- Reviewing and summarizing site geologic information;
- Reviewing existing data and logs for soil borings performed by others;
- Providing discussion of conceptual slope stabilization alternatives and estimated construction costs for conceptual alternatives, and;
- Preparing this report.

2 PROJECT UNDERSTANDING

The following information is based on our experience in the area, email and phone correspondence with the project team, and review of two previous geotechnical studies performed by others at the site from 2014 and 2015.

The railway is located in Washington Park and consists of an approximately 2-mile extension that operated during the summer between the Rose Garden and the Zoo grounds. We understand that a small slide and at least one drainage problem partially eroded a small patch of earth outside of the railroad ballast. As a result, Oregon Metro opted to shut down the extension around 2013. Site reconnaissance efforts were conducted by others in 2014 and twelve subsurface explorations were performed by others in 2015. Subsurface explorations and observations of existing infrastructure were documented in a Geotechnical Data Report prepared by others in May 2015.

2.1 Document Review

We reviewed the following documents related to this project:

- GeoDesign, Inc. 2014, Draft Memorandum, Geological and Geotechnical Engineering Services and Civil Engineering, Zoo Railroad Track, Oregon Zoo, Portland, Oregon, dated August 8, 2014.
- GeoDesign, Inc. 2015, Draft Memorandum "Site Specific Explorations and Geotechnical Wall Data Report", Zoo Train Track, Oregon Zoo, Portland, Oregon, dated May 8, 2015.
- Shannon & Wilson, Inc., Geotechnical Engineering Report, Train Alignment and Structures, Oregon Zoo, New Elephant Habitat, Metro Contract No. 930986, Portland, Oregon, August 2012
- Shannon & Wilson, Inc., Geotechnical Data Report, Oregon Zoo New Elephant Habitat Project, Oregon Zoo, Metro Contract No. 930986, Portland, Oregon, June 2012
- Parsons Binkerhoff, Quade & Douglas, Inc., and Landslide Technology, Washington Park Landslide Stabilization Task M Phase III Summary Report, September 1997
- Shannon & Wilson, Inc., Spring 2021 Instrumentation Monitoring, Washington Park Station, Portland, Oregon.

3 GEOLOGIC SETTING

3.1 Regional Geology

The Oregon Zoo is located on the east side of the Tualatin Mountains, a northwest trending mountain range that separates the Portland Basin from the Tualatin Basin. The Tualatin Mountains, known locally as the Portland Hills or West Hills, were created by complex folding and faulting of the bedrock units. Above the ancient sedimentary rocks, at depths more relevant to the project, the bedrock consists of a several-hundred-foot-thick sequence of lava flows known as the Columbia River Basalt Group (CRBG). These CRBG lavas flowed into the area between about 17 million and 15 million years ago (Walsh and others, 2011).

In the vicinity of the Oregon Zoo, the CRBG is overlain by various layers of sediment. Near the project site, Walsh and others (2011) have divided these sediments into several units, including Younger Loess, Older Loess, and Slope or Landslide Deposits. The Younger Loess, commonly referred to as Portland Hills Silt, is a blanket of micaceous, wind-blown silt deposited in the hills above the Portland Basin, above elevation 400 feet, between about 700,000 and 10,000 years ago. It was deposited on top of the Older Loess, which includes mostly older Portland Hills Silt equivalent wind-blown silt, but may also include some scattered fine-grained fluvial sediments and laterite formed from deep weathering of the underlying CRBG flows. The Older Loess unit is generally brown-gray to red-brown and may contain small clasts of weathered basalt.

In extensive areas underlying the Oregon Zoo and surrounding area, ancient landslides and mass wasting processes deposited substantial landslide disturbed materials between the Older Loess and residual soil weathered from the CRBG bedrock. Smaller, shallow slope failures within the Younger Loess have also been documented in the West Hills. The Slope or Landslide Deposits unit includes Younger Loess, Older Loess, and/or residual soil that have been disturbed or reworked by landslide activity.

3.2 Ancient Landslides

Decades of work by numerous engineers and geologists has led to reasonable definition of the limits of the 125-acre ancient landslide mass we call the Zoo Highlands Landslide Complex (Shannon & Wilson 2012). The Zoo Highlands Landslide Complex (ZHLC) encompasses the majority of the Oregon Zoo and a portion of the train tracks inside of the fence line of the zoo. Inside the ZHLC there is the potential for slow, deep-seated ground movement known as creep. Various monitoring programs documented the location and rates of movement including more than 50 years of inclinometer monitoring. The historic data shows that movements have successfully slowed as a result of two major and numerous minor stability improvements (Shannon & Wilson 2012). To date, the Zoo has operated for more than 50 years with slow, deep-seated ground movement at rates termed as "creep."

A second massive landslide complex, the Washington Park Landslide, is located on the northern portion of the train alignments. Stations of 50+40 to 62+00 are located within the Washington Park Landslide. The Washington Park slide is an ancient slide mass triggered into activity in 1994 by excavation of city of Portland Reservoirs #3 and #4 (Shannon & Wilson 2012). During design of the Washington Park Lift Station, a slip plane of the ancient slide plane was identified 80 feet below the ground surface (Parsons Brinkerhoff 1997). Inclinometer readings performed over a 13-month period between 1993 and 1994 indicated an average annual slip rate of 0.06 inches/year. However, the slipping occurred almost entirely during the winter months when groundwater levels rose and stopped in the dry summer months when the groundwater levels dropped. Consequently, the Tri-County Metropolitan Transportation District of Oregon (now TRIMET) decided to design the structures to accommodate up to 2 inches of movement, while simultaneously installing horizontal and vertical drains to try and slow the sliding. On-going monitoring is being performed at select locations in the Washington Park slide by Shannon & Wilson. Measurements performed at 13 different inclinometer locations between 1996 and 2020 range between less than approximately 0.1 inches to up to approximately 0.25 inches.

Within the larger Washington Park and Oregon Zoo Landslide Complex, numerous smaller slides and localized instability exists. The slope instability observed during our site

reconnaissance is a result of localized instability and not a result of movement of the larger landslide complex. A detailed review of the Washington Park Landslide complex was outside of the scope of this study. Numerous historic landslides have also occurred along the interface of the basalt rock and the overlying silt in the Portland West hills during periods of extended rainfall. The focus of our report is to address localized instability that resulted in the closure of the Oregon Zoo Train. However, we acknowledge the potential slow long-term creep within the deep-seated, Washington Park Landslide that may not be addressed by the mitigation measures for the shallow landslides discussed in this letter.

4 EXPLORATIONS BY OTHERS

Twelve geotechnical explorations were performed by GeoDesign in 2015. The approximate location of the explorations are shown on Figure 2. The borings were advanced to depths ranging between 2.5 and 17.5 feet and terminated in materials described as gravel colluvium or weathered or decomposed basalt. The boring logs from the GeoDesign Data Report are included in Appendix A, Existing Explorations by Others.

5 SITE RECONNAISSANCE AND RECOMMENDATIONS

Site reconnaissance efforts have previously been performed by others in 2014 (GeoDesign, 2014). The previous site reconnaissance included notes and observations regarding the key features along the existing track alignment. Shannon and Wilson completed a site reconnaissance trip on October 6, 2021 to document the current condition of some of the key features noted in the previous site reconnaissance.

A Shannon & Wilson engineer approximated the location of relevant site features using a handheld GPS device. Existing surface conditions were observed, including historical landslides and possible landslides, and other key surficial features of concern were also documented. Photos and notes were taken at these key features. A log of the photos is provided in Appendix B. A summary of observations made at specific key features is provided in the following sections.

Note that the stationing presented is based on previous reconnaissance activities performed by others along the alignment with station 0+00 starting at culvert 0.

5.1 Crib Wall 1 and Culvert 3 (STA 7+05 to 7+72)

Previous observations indicate that crib wall 1 has an exposed wall height of 1.3 to 7.5 feet and spans over an incised drainage area. Culvert 3 is a corrugated metal pipe (CMP) culvert

that collects drainage upslope of the tracks and then directs it below the lowest point of crib wall 1. Previous notes indicate that culvert 3 has a rusted bottom allowing water to saturate the timber members which promotes rot.

Previous notes indicate that the wall face is covered with fern and vine growth. During the current site reconnaissance, fern and vine growth is still observed covering the face of the wall. However, large trees were also observed growing behind crib wall 1 as seen in Exhibit 5-1.

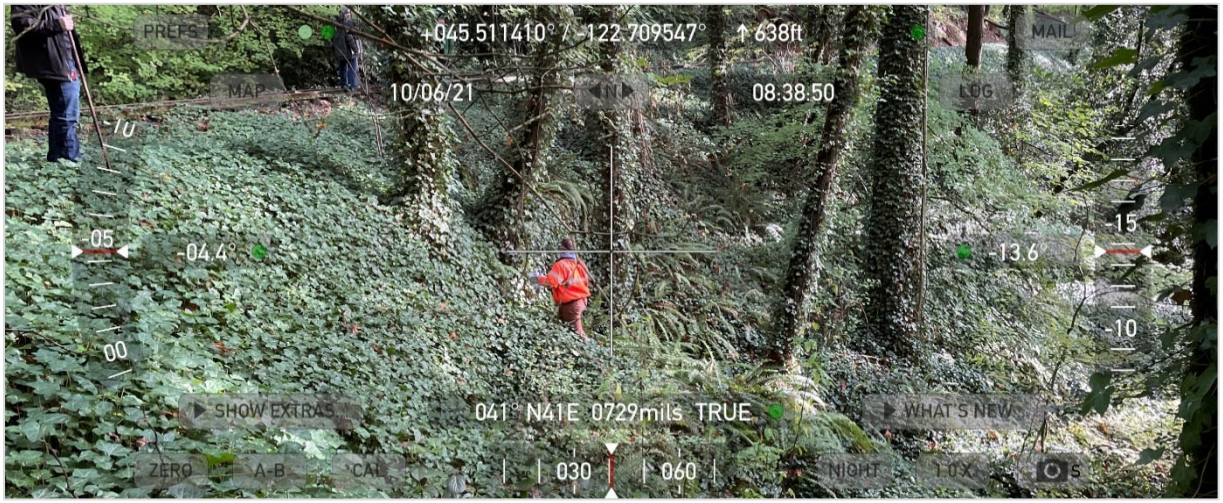


Exhibit 5-1: Trees and underbrush growing over existing crib wall 1

Previous notes also indicated rotting of the wall timbers, which was equated to age and poor or inadequate drainage conditions behind and within the wall. Slumping of the track subgrade and outward rotation of the wall face were not observed previously. However, the previous site reconnaissance noted some downward expression of the wall at butting locations.

We did not observe slumping of track subgrade or outward rotation of the wall. We recommend cutting the trees growing in the wall to prevent them from causing further damage. In our opinion, the risk of sudden, catastrophic failure of the wall is low unless the culvert is blocked during a period of heavy rain. We recommend the wall be monitored to determine if additional wall deformation is occurring and to confirm Culvert 3 remains clear and able to drain. We also recommend that wall replacement be included as part of a long-term maintenance plan.

5.2 Crib Wall 2 (STA 13+62 to 15+93)

Crib wall 2 supports the "Texas" gulch area of the existing alignment. Previous notes indicate that bulging of the wall near its northern extent was observed. Current observations did not note bulging in the wall, however heavy vegetation impeded visual

observation. No disruption to the track structure or alignment was observed. A photo of the wall and vegetation is provided in Exhibit 5-2.

Exhibit 5-2: Heavy vegetation covering crib wall 2

Zoo staff indicated that the track within this portion of the alignment has required surfacing to accommodate settlement in the past. Continued track settlement is likely related to heavy rainfall and displacements of crib wall 2. We recommend continued monitoring of the wall.

5.3 Crib Wall 3 and Culvert 6 (STA 16+65 to 17+07)

As described in previous reports, crib wall 3 overlies culvert 6 which was to be replaced to correct drainage upslope of the track. During the replacement of culvert 6, a failure of crib wall 3 occurred due to rotting of the timbers and saturated ground conditions caused by uncontrolled drainage allowing water to collect behind wall. After the failure a replacement culvert was installed consisting of a 10-inch diameter corrugated HDPE pipe as shown in Exhibit 5-3. Current observations indicate that the inlet of culvert (Culvert No. 6) may be partially clogged and needs to be cleaned out. The current wall also needs to be replaced. A new soldier pile wall is likely the most feasible mitigation option. As an alternative, a short bridge could be installed to span the erosion area.

Exhibit 5-3: Replacement pipe installed at culvert 6

5.4 Crib Wall 4 (STA 17+80 to 19+07)

The edge of crib wall number 4 is located between 4 and 7 feet from the track. The wall is approximately 5 feet high and located on the approach to the "Texas Curve" when traveling from the Zoo. Because of the long-term settlement reportedly observed in the Texas Curve, the steepness of the slope, and the proximity of the tracks to the wall, we recommend a monitoring program be implemented to identify movement of the wall over time so that corrective measures can be performed if movement is detected.

5.5 Crib Wall 5 (STA 28+35 to 28+65) and Surrounding Culverts

Crib Wall 5 is mapped at the location of a historic slide that occurred in 1997. In January of 1997 a total of 7.77 inches of rain fell in 15 days, which triggered several slides in the Portland area. No remnants of the mapped wall were observed during our site visit, either because they were obscured by vegetation or because they are no longer present. The existing ballast is over-steepened on the track shoulder. Long term support of the ballast should be considered to minimize settlement. A short soldier pile wall would provide support of the track shoulder to retain ballast along the end of ties.

Three corrugated metal pipe culverts are located in the vicinity of the slide, including Culvert 12, and two unnamed culverts. The culverts should be cleaned and inspected to maintain conveyance of water beneath the tracks.

5.6 Crib Wall 7 (STA 40+80 to 41+00)

Crib Wall Number 7 is an approximately 20-foot-long timber crib wall located in a curve. Because of the location and steepness of the slope, we recommend monitoring the wall for

displacement over time so that remedial measures can be performed if movement is detected.

5.7 Culvert 1 (STA 3+25)

Culvert 1 is a 10-inch diameter corrugated metal pipe (CMP). During a site reconnaissance performed by others in 2014, it was noted that water flow is rarely observed. During our 2021 site reconnaissance we were unable to confirm that the culvert is clear and able to convey flow. We recommend that the culvert be located, cleaned out and inspected.

5.8 Culvert 8a and 8b (STA 20+80)

Culvert (8a) consists of a 12-inch CMP originally intended to be the primary culvert. The inlet of culvert 8a has been covered by erosion of uplsope material and currently appears to be blocked. A secondary culvert (8b) is located above culvert 8A and is in relatively good condition. We recommend grouting Culvert 8a and grading the inlet area to direct water into culvert 8b. This work can be performed as part of a maintenance plan for the alignment.

5.9 Historic and Potential Landsliding

5.9.1 Potential Slump (Appr. STA 4+00 to 4+65)

Based on LiDAR and a review of previous reports, there is a potential, slow moving slump on the steep hillside north of the tracks, approximately between stations 4+00 to 4+65. The ground deformation does not extend to the tracks and we did not observe bare, exposed earth during our site visit that indicate recent movement. We recommend observing the potential slump and drainage channel, to monitor for signs of movement or blockage in the drainage channel so corrective action can be taken if future movement occurs.

5.9.2 Potential Slump (Appr. STA 12+00 to 13+30)

Based on LiDAR and a review of previous reports, there is a potential, slow moving slump on the steep hillside north of the tracks, approximately between stations 12+00 to 13+30. The ground deformation does not extend to the tracks and we did not observe bare, exposed earth during our site visit that indicates recent movement. We recommend observing the potential slump and drainage channel, to monitor for signs of movement or blockage in the drainage channel so corrective action can be taken if future movements occur.

5.9.3 Historical Slide (Appr. STA 28+50 to 29+10)

A landslide occurred between the approximate stations of 28+50 to 29+10 in 1997 after a period of extended rainfall. The slide buried the railroad track and culvert and removed the original Crib Wall 5. We recommend on-going monitoring of the slide be performed and that the culvert drainage system be maintained to prevent the accumulation of water that could negatively affect the slope stability.

5.9.4 Historical Slide (Appr. STA 54+80 to 57+10)

A landslide occurred between the approximate stations of 54+80 to 57+10 in 1997 after a period of extended rainfall. Information from historic reports indicates the slide was buttressed and repaired with a crib wall. During our October site reconnaissance, the railroad tracks were covered with an estimated 20 foot by 10 foot by 40-foot-wide volume of slide debris originating from above the crib wall. It is unclear if the recent slide caused damage to the wall or simply overtopped the wall. The landslide debris should be cleared from the tracks and damage to the wall evaluated. This area will continue to require clean up following slides caused by heavy rainfall, however, as long as the train is only operated during summer months and when the weather is dry, the risk of sliding during these times is very low. We recommend on-going monitoring of the slide area be performed.

6 CONCEPTUAL RETAINING WALL ALTERNATIVES

Support of railroad ballast and replacement of rotting retaining walls can be achieved through construction of new retaining walls. Retaining wall alternatives previously discussed in the 2014 GeoDesign Report included:

- Soil nail retaining walls;
- Soldier pile with tie-back anchor walls; and
- Cantilever soldier pile walls.

Given the height of the existing walls that will eventually need to be replaced, soldier pile and lagging retaining walls are the most feasible. A photo of a similar retaining wall that we have designed for railroad purposes is presented below:

Exhibit 6-1: Installation of a soldier pile wall used for railroad embankment support on steep slope on a rail alignment in California

The proposed soldier pile and lagging retaining walls should be designed to resist lateral earth pressures acting from the retained soil and train or vehicle surcharge loading adjacent to the wall. The walls will mobilize passive resistance against the embedded length of pile sections. The anticipated failure plane for future slope instability is likely to occur at the interface of the soil and the underlying rock. For conceptual design purposes, we recommend that the soldier piles be embedded into the basalt bedrock. Previous explorations B-6 and B-7 were performed near the north and south ends of Crib Wall 3, respectively. Decomposed basalt was encountered at a depth of 10 feet in B-7. Boring B-6 was terminated at a depth of 11.5 feet in gravel/cobble material.

To support final design of Crib Wall 3, we recommend supplementing the existing explorations by performing a minimum of one geotechnical boring to a depth 25 feet (and a minimum of 5 feet into bedrock), to characterize the rock for design and bidding purposes. The explorations will be used to support a detailed internal and global stability analysis of the wall for final design.

Table 1 presents estimated replacement cost for each wall along the alignment. The cost estimates presented in Table 1 include some allowance for mobilization and final design.

7 LIMITATIONS

Our geologic interpretations and conclusions are based on a desktop study including review of publicly available information prepared by others and a field reconnaissance. No explorations were performed by Shannon & Wilson to evaluate subsurface conditions and make interpretations of the subsurface geology.

Within the limitations of scope, schedule, and budget, the conclusions presented in this report were prepared in accordance with generally accepted professional geotechnical engineering principles and practice in this area at the time this report was prepared. Shannon & Wilson makes no other warranty, either express or implied. These conclusions were based on Shannon & Wilson's understanding of the project as described in this report and the site conditions as observed at the time of our field reconnaissance.

This report was prepared for the exclusive use of the Oregon Zoo Track Restoration Team and the Oregon Zoo related to the restoration of the Oregon Zoo Train in Portland, Oregon. The scope of Shannon & Wilson's present work did not include environmental assessments or evaluations regarding the presence or absence of wetlands, or hazardous or toxic substances in the soil, surface water, groundwater, or air, on or below or around this site, or for the evaluation or disposal of contaminated soils or groundwater should any be encountered.

Shannon & Wilson has prepared "Important Information About Your Geotechnical/Environmental Report" to assist you and others in understanding the use and limitations of our reports and is attached at the end of this report.

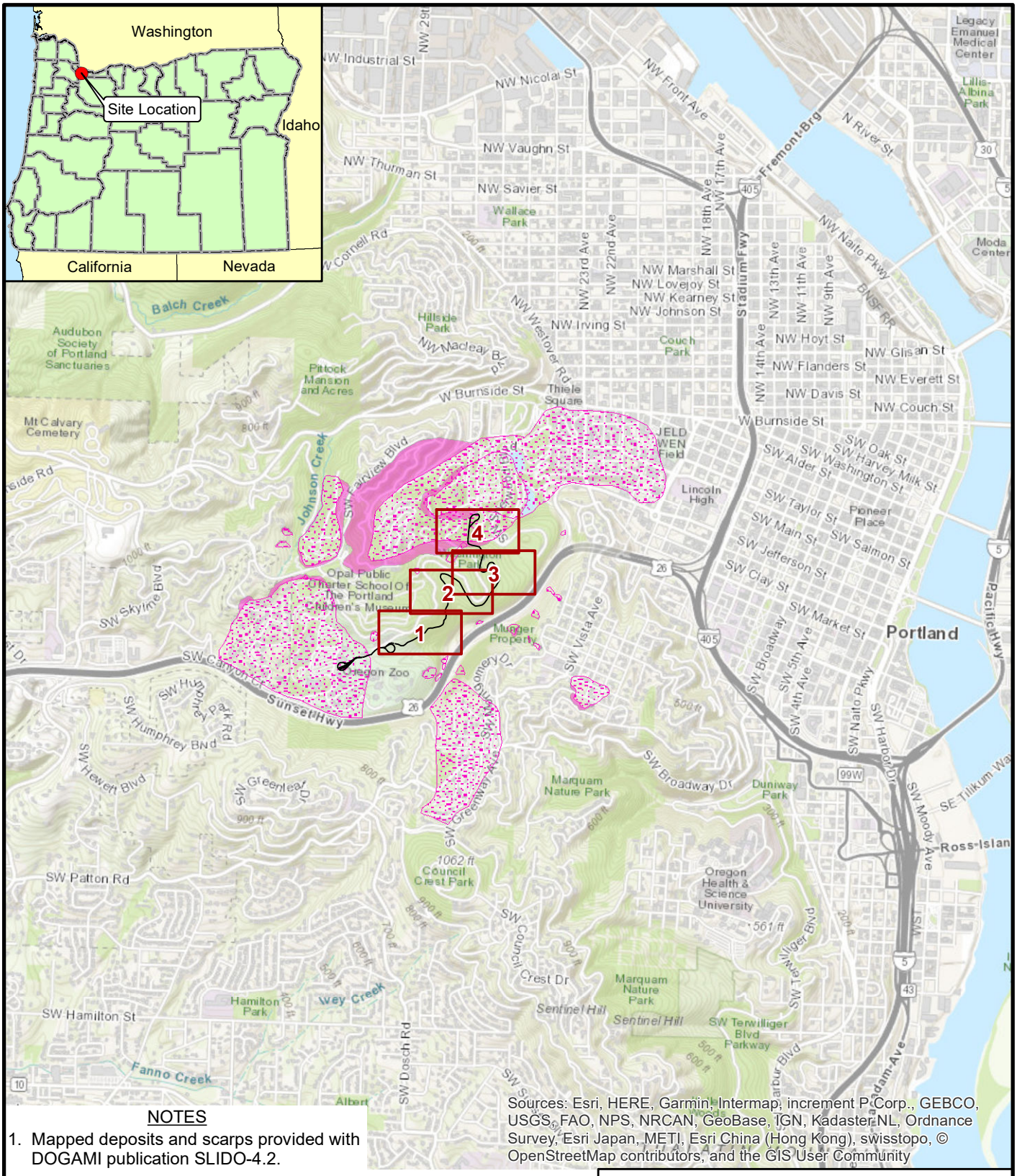
8 REFERENCES

Walsh, K., Peterson, G.L., Beeson, M.H., Wells, R.E., Fleck, R.J., Evarts, R.C., Duvall, A., Blakely, R.J., and Burns, S., 2011, A Tunnel Runs Through It – An Inside View of the Tualatin Mountain, Oregon: U.S. Geological Survey Scientific Investigations Map 3144.

Table 1 - Summary of Mitigation / Monitoring Costs

Existing Feature ID / Recommended Action	Approximate Beginning Station	Approximate Ending Station	Approximate Overall Wall Length (feet)	Approximate Average Exposed Wall Height (feet)	Estimated Cost[1,2,3]	Replacement Priority
Crib Wall 1	7+05	7+72	67	5 to 6	$150,000	Low
Crib Wall 2	13+62	15+93	231	5	$450,000	Low
Crib Wall 3	16+65	17+07	42	10	$150,000	High
Crib Wall 4	17+80	19+07	127	4 to 5	$250,000	Low
Crib Wall 5	28+35	28+65	30	4 to 8	$100,000	Low
Crib Wall 6A	36+00	37+00	100	<5	$200,000	Low
Crib Wall 6B	40+50	40+80	30	<5	$100,000	Low
Crib Wall 7	40+80	41+00	20	<5	$75,000	Low
Crib Wall 8	59+10	59+30	20	<5	$75,000	Low
Landslide debris near 56+00	N/A	N/A	N/A	N/A	$40,000	N/A
Annual Monitoring	N/A	N/A	N/A	N/A	$5,000	N/A

NOTES:
1 Estimated cost for the existing crib walls is for replacement of the existing wall and includes final design and construction mobilization.
2 Estimated cost for the landslide debris includes debris removal and cleanup.
3 Estimated annual monitoring cost includes an annual site walk to observe current conditions and a letter report summarizing the observations.



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

NOTES

1. Mapped deposits and scarps provided with DOGAMI publication SLIDO-4.2.

0 0.25 0.5 1

Scale in Miles

N

LEGEND

- 1 Figure 2 Sheet
- Mapped Landslide Deposit
- Mapped Scarp Flank

Oregon Zoo Train Track Restoration
Portland, Oregon

VICINITY MAP

December 2023 107736

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FIG. 1

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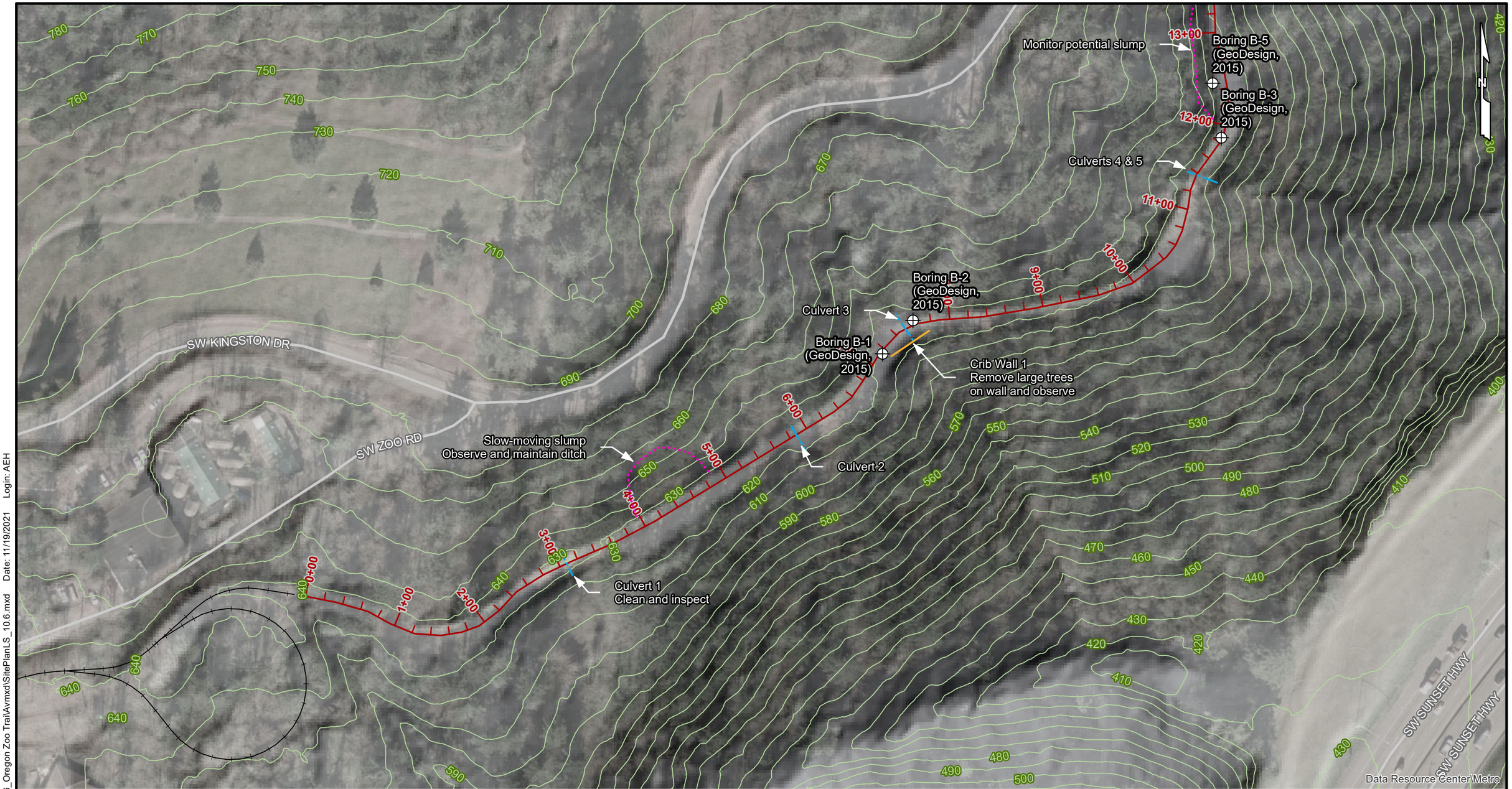

LEGEND

- Approximate Location of Exploration Performed by Others
- Retaining Wall
- Culvert
- Slide or Historic Slide Feature
- Slump or Potential Slump Feature

0 50 100 200

Scale in Feet

NOTES

1. 2005 leaf-off aerial imagery obtained through Metro RLIS.
2. Hillshade and contours created from 2014 LiDAR obtained through DOGAMI.
3. Slide and slump features are based on site reconnaissance and locations are approximate.
4. Train alignment, stationing, and feature locations are approximate.

Oregon Zoo Train Track Restoration
Portland, Oregon

SITE PLAN

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FIG. 2
Sheet 1 of 4

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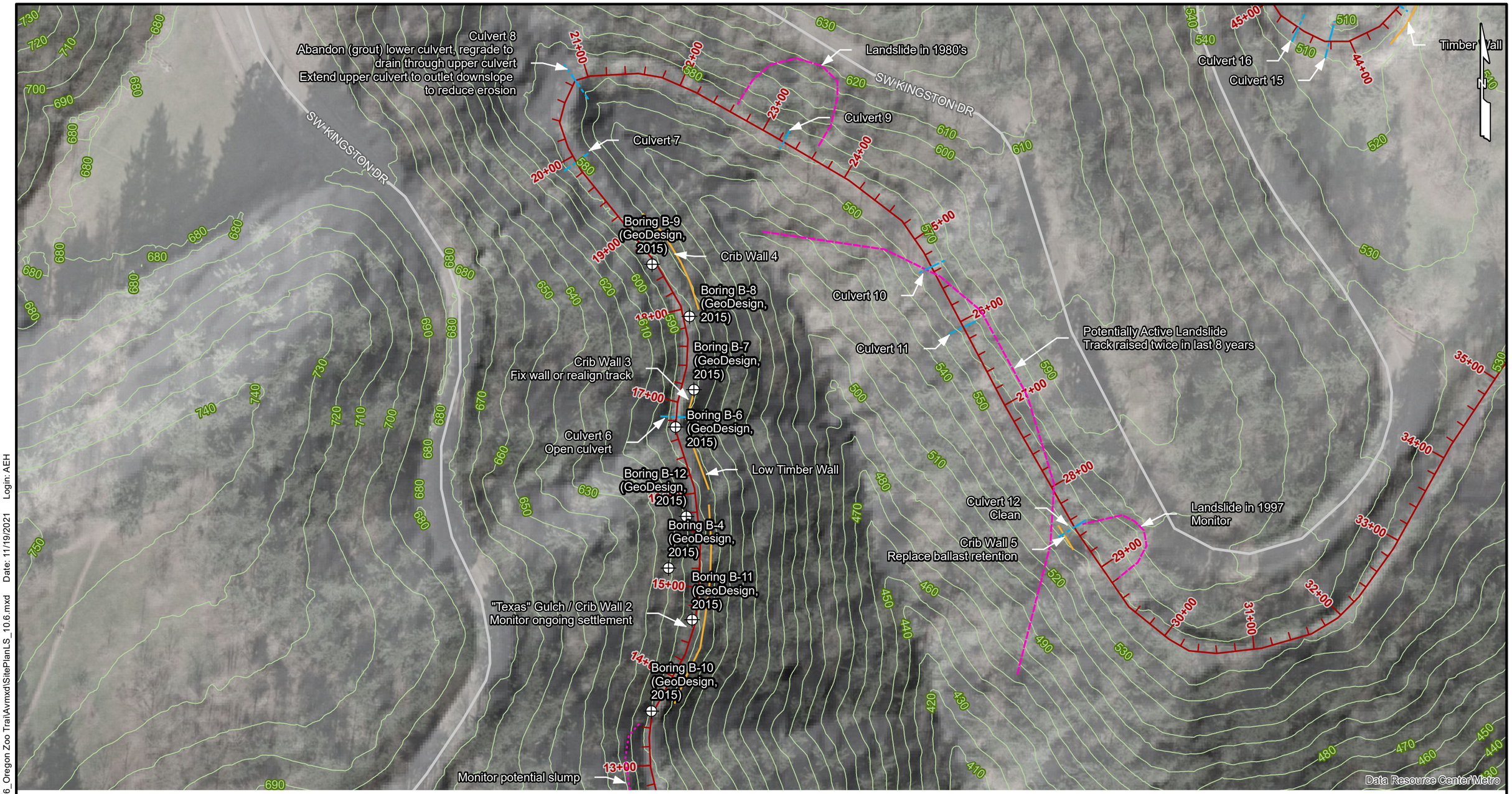

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Portland, Oregon

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Decmeber 2023 107736

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FIG. 2
Sheet 2 of 4

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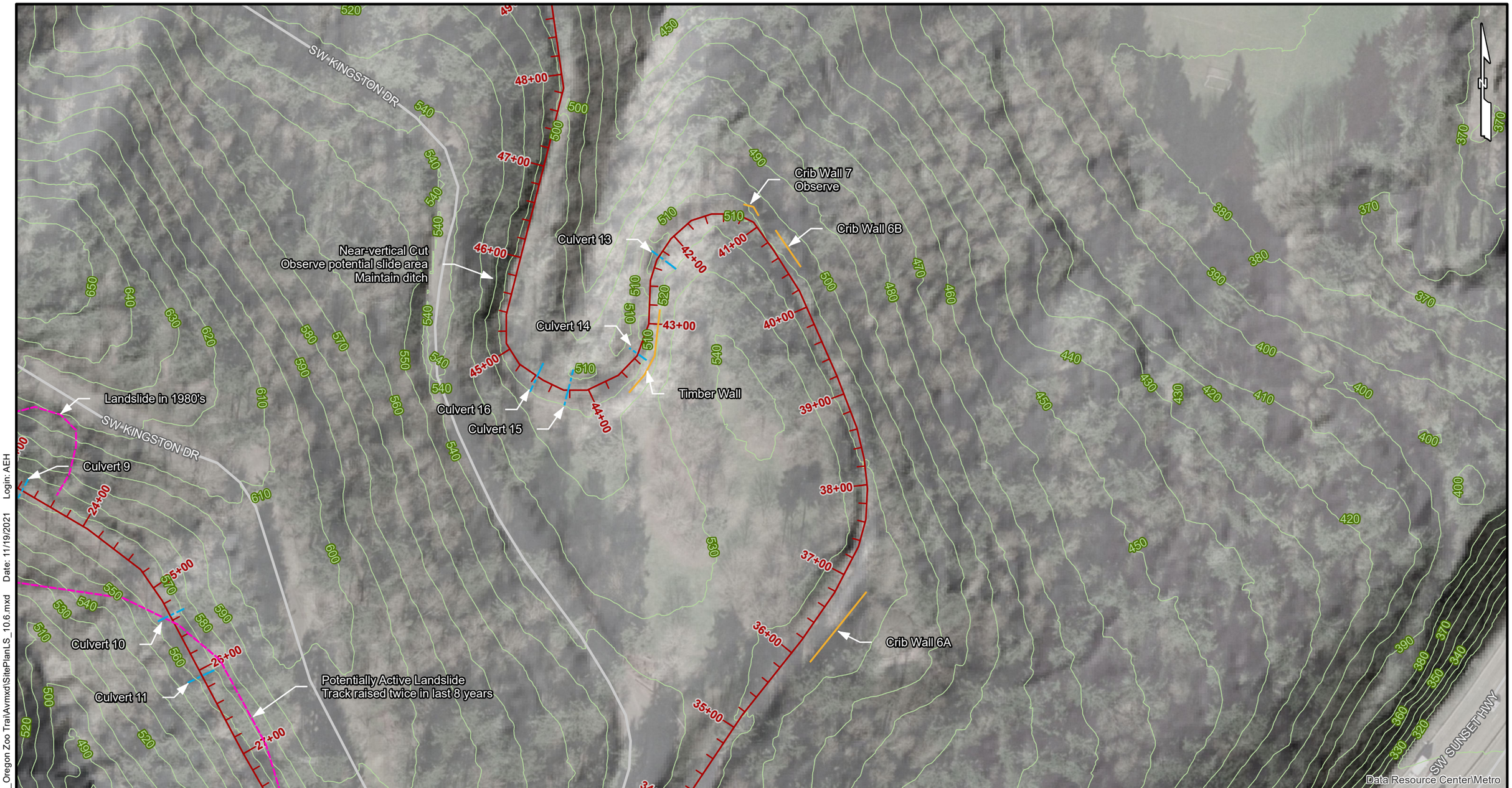

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December 2023 107736

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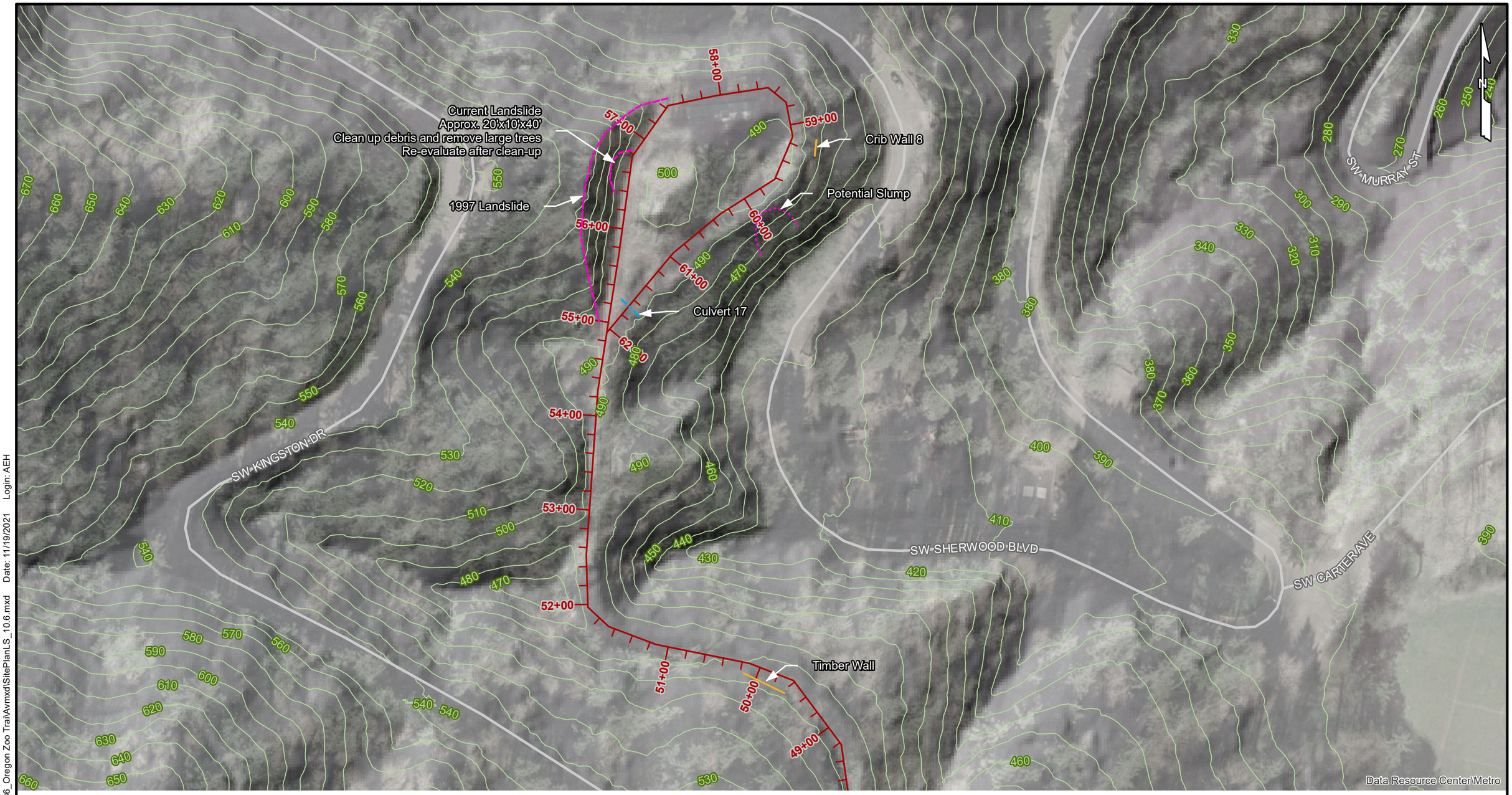
FIG. 2
Sheet 3 of 4

Filename: T:\Projects\PDX\107000s\107736_Oregon Zoo TrailAvmxd\SitePlanLS_10.6.mxd Date: 11/19/2021 Login: AEH



LEGEND

- Approximate Location of Exploration Performed by Others
- Retaining Wall
- Culvert
- Slide or Historic Slide Feature
- Slump or Potential Slump Feature

0 50 100 200

Scale in Feet

NOTES

1. 2005 leaf-off aerial imagery obtained through Metro RLIS.
2. Hillshade and contours created from 2014 LiDAR obtained through DOGAMI.
3. Slide and slump features are based on site reconnaissance and locations are approximate.
4. Train alignment, stationing, and feature locations are approximate.

Oregon Zoo Train Track Restoration
Portland, Oregon

SITE PLAN

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FIG. 2
Sheet 4 of 4

Filename: T:\Projects\PDX\107000s\107736_Oregon Zoo Trail\Avmxd\SitePlanLS_10.6.mxd Date: 11/19/2021 Login: AEH

Appendix A

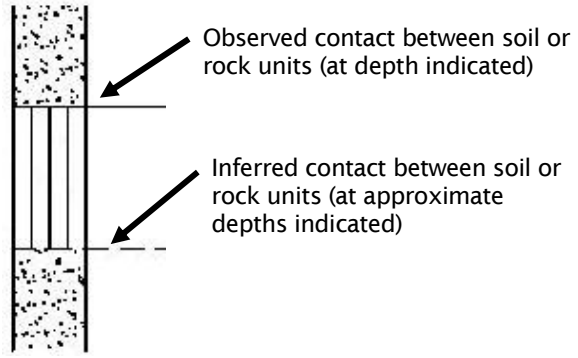
Existing Explorations by Others

APPENDIX A: EXISTING EXPLORATIONS BY OTHERS

CONTENTS

SYMBOL	SAMPLING DESCRIPTION
	Location of sample obtained in general accordance with ASTM D 1586 Standard Penetration Test with recovery
	Location of sample obtained using thin-wall Shelby tube or Geoprobe® sampler in general accordance with ASTM D 1587 with recovery
	Location of sample obtained using Dames & Moore sampler and 300-pound hammer or pushed with recovery
	Location of sample obtained using Dames & Moore and 140-pound hammer or pushed with recovery
	Location of sample obtained using 3-inch-O.D. California split-spoon sampler and 140-pound hammer
	Location of grab sample
	Rock coring interval
	Water level during drilling
	Water level taken on date shown

Graphic Log of Soil and Rock Types



GEOTECHNICAL TESTING EXPLANATIONS

ATT	Atterberg Limits	PP	Pocket Penetrometer
CBR	California Bearing Ratio	P200	Percent Passing U.S. Standard No. 200 Sieve
CON	Consolidation		
DD	Dry Density	RES	Resilient Modulus
DS	Direct Shear	SIEV	Sieve Gradation
HYD	Hydrometer Gradation	TOR	Torvane
MC	Moisture Content	UC	Unconfined Compressive Strength
MD	Moisture-Density Relationship	VS	Vane Shear
OC	Organic Content	kPa	Kilopascal
P	Pushed Sample		

ENVIRONMENTAL TESTING EXPLANATIONS

CA	Sample Submitted for Chemical Analysis	ND	Not Detected
P	Pushed Sample	NS	No Visible Sheen
PID	Photoionization Detector Headspace Analysis	SS	Slight Sheen
		MS	Moderate Sheen
ppm	Parts per Million	HS	Heavy Sheen

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EXPLORATION KEY

TABLE A-1

RELATIVE DENSITY - COARSE-GRAINED SOILS

Relative Density	Standard Penetration Resistance	Dames & Moore Sampler (140-pound hammer)	Dames & Moore Sampler (300-pound hammer)
Very Loose	0 – 4	0 - 11	0 - 4
Loose	4 – 10	11 - 26	4 - 10
Medium Dense	10 – 30	26 - 74	10 - 30
Dense	30 – 50	74 - 120	30 - 47
Very Dense	More than 50	More than 120	More than 47

CONSISTENCY - FINE-GRAINED SOILS

Consistency	Standard Penetration Resistance	Dames & Moore Sampler (140-pound hammer)	Dames & Moore Sampler (300-pound hammer)	Unconfined Compressive Strength (tsf)
Very Soft	Less than 2	Less than 3	Less than 2	Less than 0.25
Soft	2 - 4	3 – 6	2 - 5	0.25 - 0.50
Medium Stiff	4 - 8	6 – 12	5 - 9	0.50 - 1.0
Stiff	8 - 15	12 – 25	9 - 19	1.0 - 2.0
Very Stiff	15 - 30	25 – 65	19 – 31	2.0 - 4.0
Hard	More than 30	More than 65	More than 31	More than 4.0

PRIMARY SOIL DIVISIONS			GROUP SYMBOL	GROUP NAME
COARSE-GRAINED SOILS (more than 50% retained on No. 200 sieve)	GRAVEL (more than 50% of coarse fraction retained on No. 4 sieve)	CLEAN GRAVELS (< 5% fines)	GW or GP	GRAVEL
		GRAVEL WITH FINES (≥ 5% and ≤ 12% fines)	GW-GM or GP-GM	GRAVEL with silt
			GW-GC or GP-GC	GRAVEL with clay
		GRAVELS WITH FINES (> 12% fines)	GM	silty GRAVEL
			GC	clayey GRAVEL
			GC-GM	silty, clayey GRAVEL
	SAND (50% or more of coarse fraction passing No. 4 sieve)	CLEAN SANDS (<5% fines)	SW or SP	SAND
		SANDS WITH FINES (≥ 5% and ≤ 12% fines)	SW-SM or SP-SM	SAND with silt
			SW-SC or SP-SC	SAND with clay
		SANDS WITH FINES (> 12% fines)	SM	silty SAND
			SC	clayey SAND
			SC-SM	silty, clayey SAND
FINE-GRAINED SOILS (50% or more passing No. 200 sieve)	SILT AND CLAY	Liquid limit less than 50	ML	SILT
			CL	CLAY
			CL-ML	silty CLAY
			OL	ORGANIC SILT or ORGANIC CLAY
		Liquid limit 50 or greater	MH	SILT
			CH	CLAY
			OH	ORGANIC SILT or ORGANIC CLAY
HIGHLY ORGANIC SOILS			PT	PEAT

MOISTURE CLASSIFICATION

Term	Field Test
dry	very low moisture, dry to touch
moist	damp, without visible moisture
wet	visible free water, usually saturated

ADDITIONAL CONSTITUENTS

Secondary granular components or other materials such as organics, man-made debris, etc.

Percent	Silt and Clay In: Fine-Grained Soils	Silt and Clay In: Coarse-Grained Soils	Percent	Sand and Gravel In: Fine-Grained Soils	Sand and Gravel In: Coarse-Grained Soils
< 5	trace	trace	< 5	trace	trace
5 – 12	minor	with	5 – 15	minor	minor
> 12	some	silty/clayey	15 – 30	with	with
			> 30	sandy/gravelly	Indicate %

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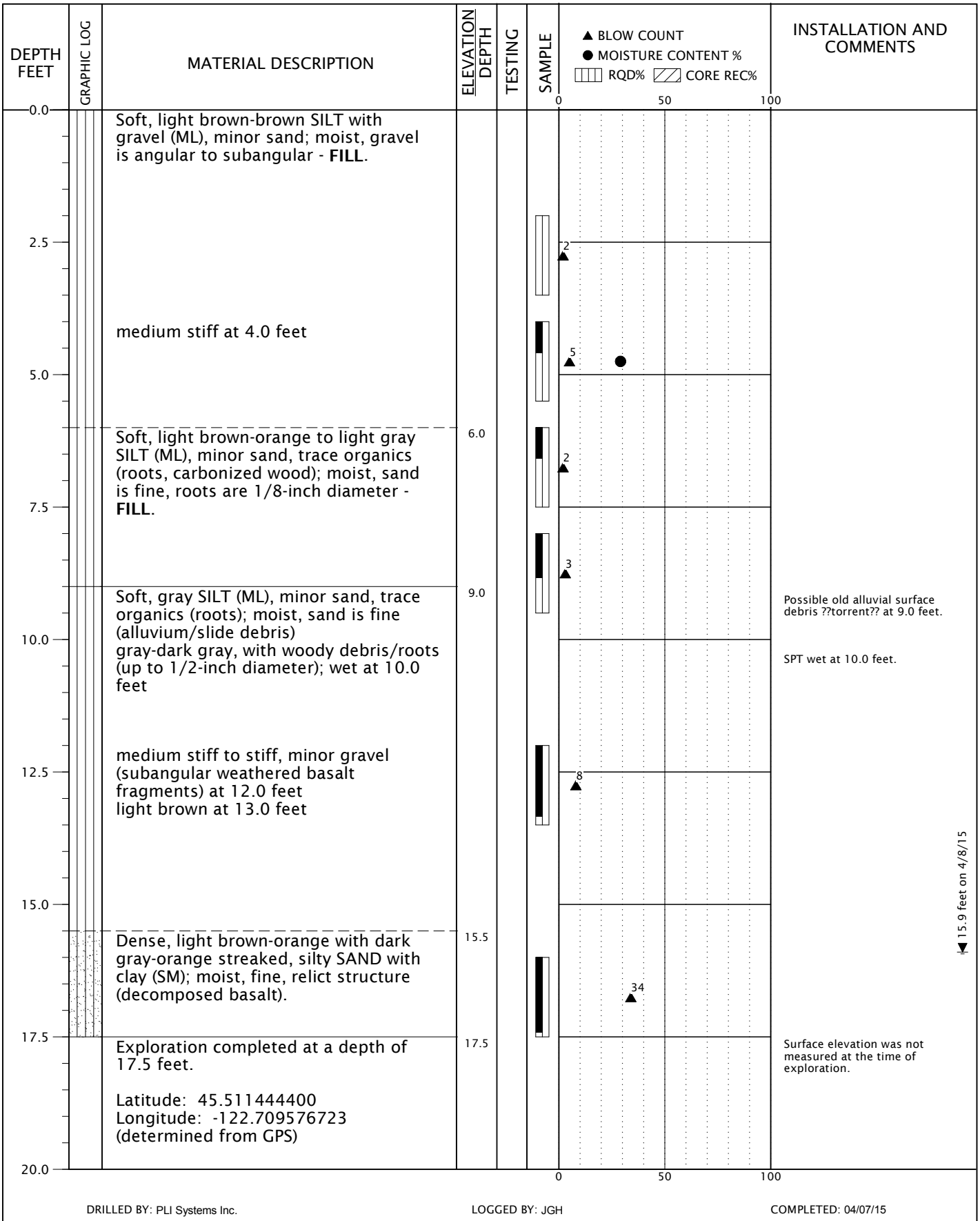
SOIL CLASSIFICATION SYSTEM

TABLE A-2



DRILLED BY: PLI Systems Inc. LOGGED BY: JGH COMPLETED: 04/07/15

BORING METHOD: solid-stem auger (see document text) BORING BIT DIAMETER: 4 inches

BORING LOG OREGONZOO-8-02-B1_12.GPJ GEODESIGN.GDT PRINT DATE: 5/8/15:KT

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OREGONZOO-8-02

BORING B-1

MAY 2015

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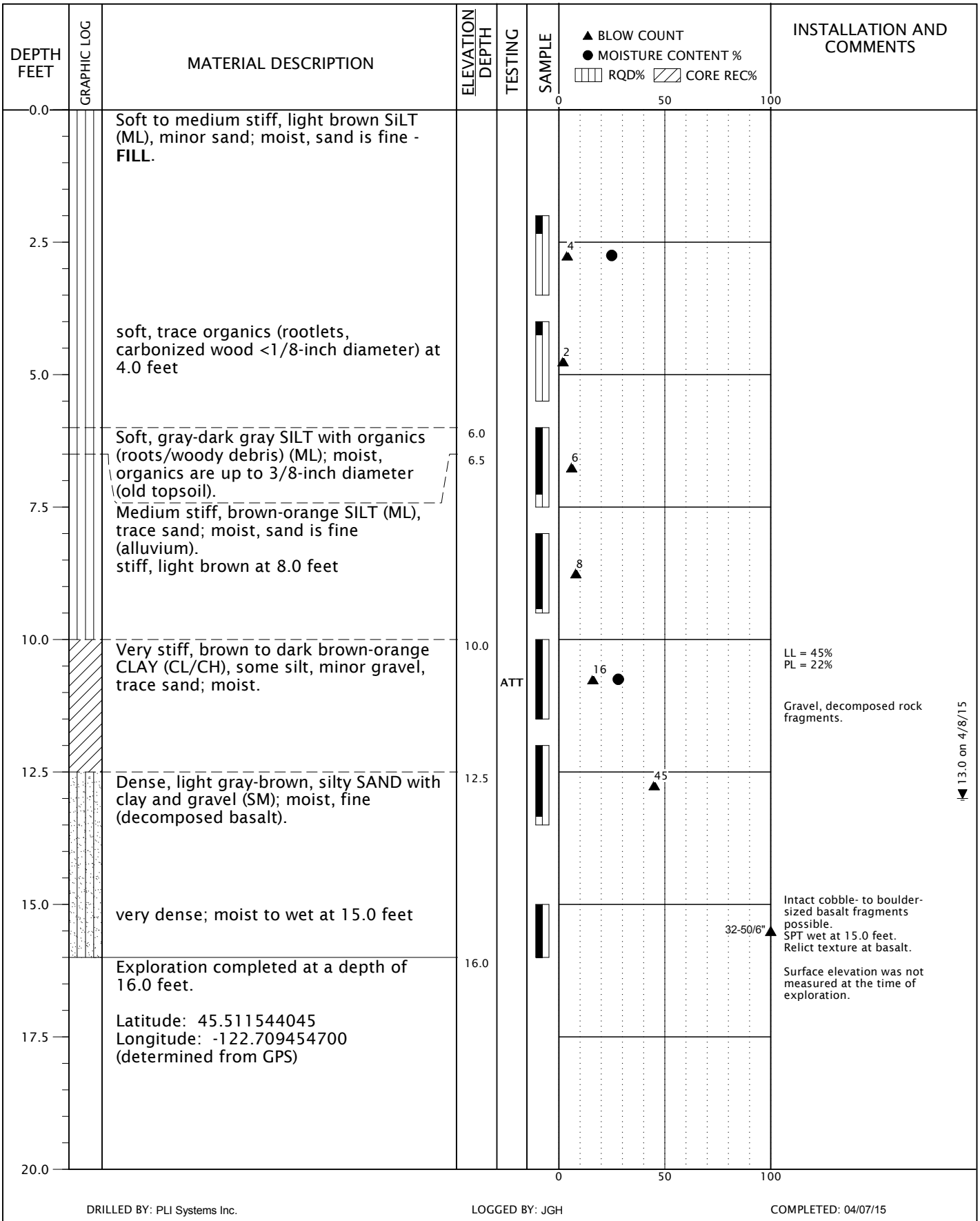
FIGURE A-1



DRILLED BY: PLI Systems Inc. LOGGED BY: JGH COMPLETED: 04/07/15

BORING METHOD: solid-stem auger (see document text) BORING BIT DIAMETER: 4 inches

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BORING B-2

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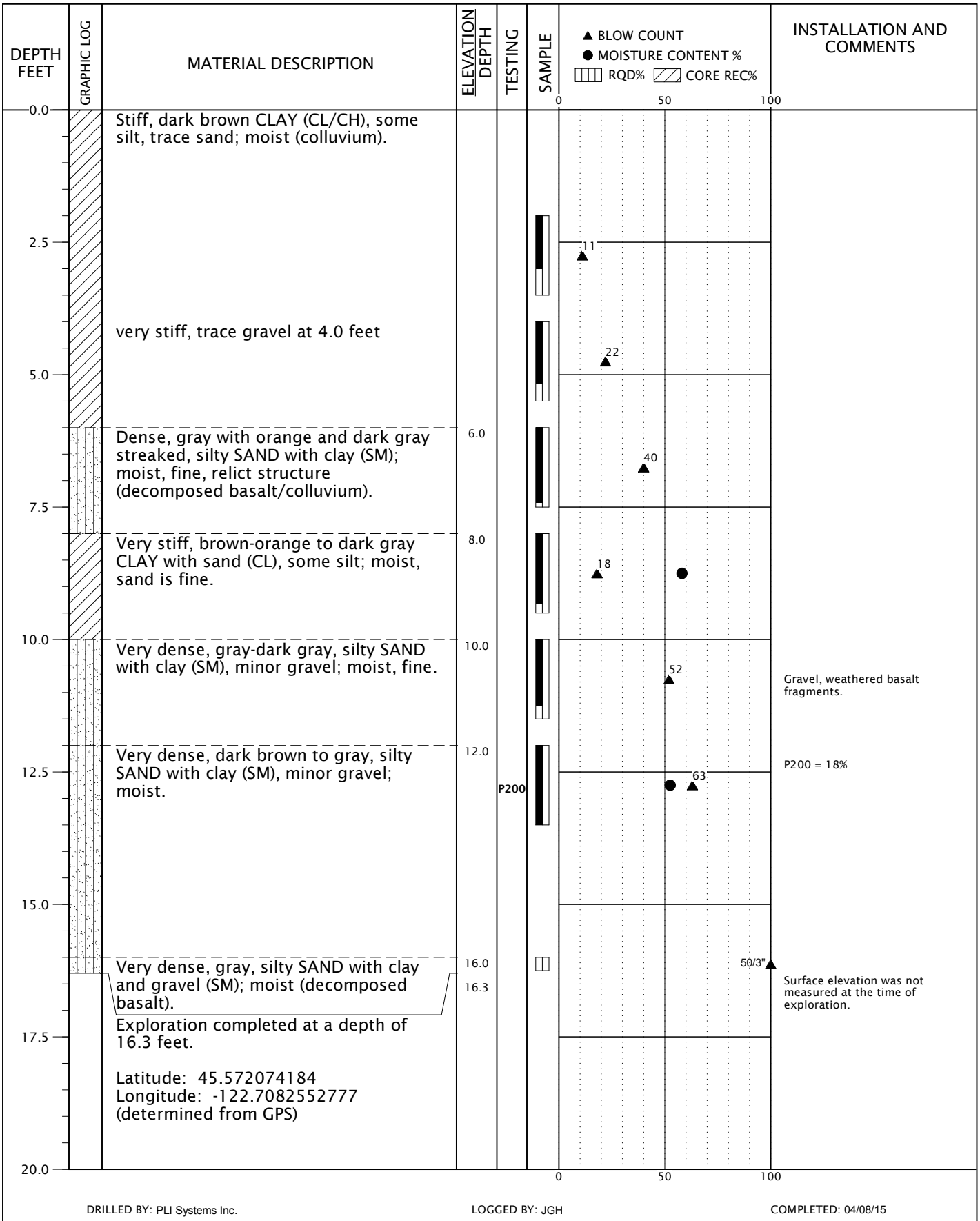
FIGURE A-2

BORING LOG OREGONZOO-8-02-B1_12.GPJ GEODESIGN.GDT PRINT DATE: 5/8/15:KT



DRILLED BY: PLI Systems Inc.

LOGGED BY: JGH

COMPLETED: 04/08/15

BORING METHOD: solid-stem auger (see document text)

BORING BIT DIAMETER: 4 inches

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BORING B-3

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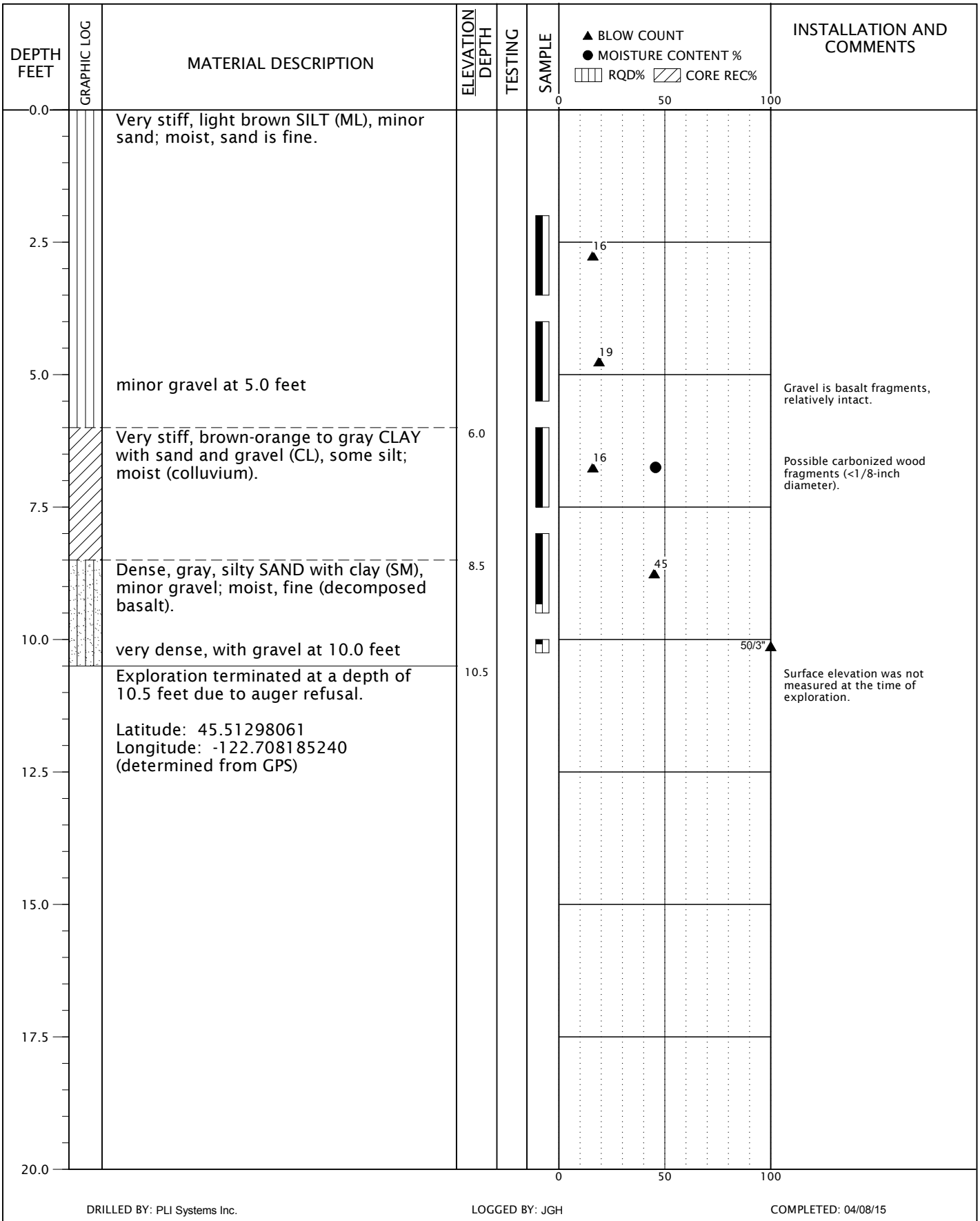
FIGURE A-3

BORING LOG OREGONZOO-8-02-B1_12.GPJ GEODESIGN.GDT PRINT DATE: 5/8/15:KT



DRILLED BY: PLI Systems Inc. LOGGED BY: JGH COMPLETED: 04/08/15

BORING METHOD: solid-stem auger (see document text) BORING BIT DIAMETER: 4 inches

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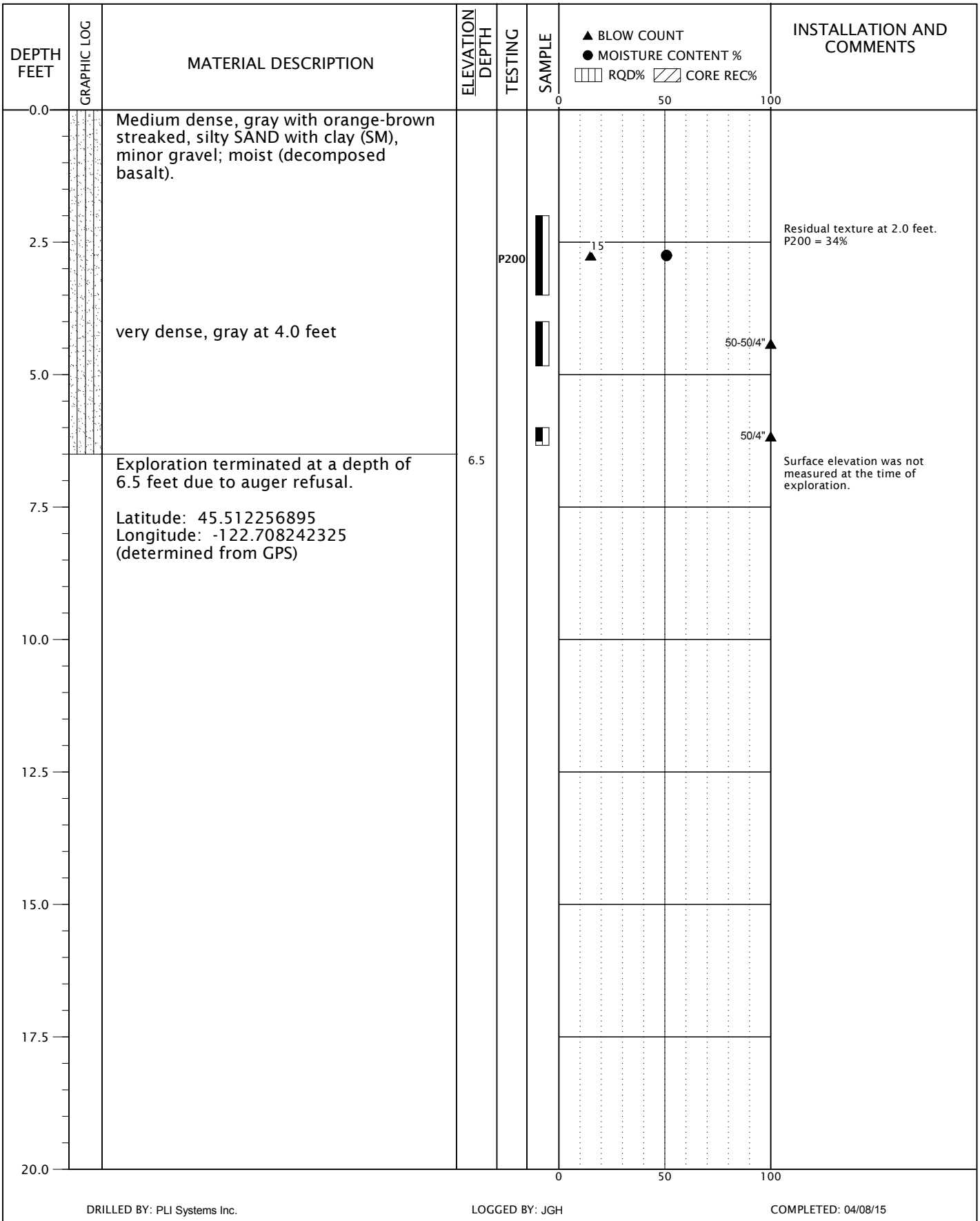
FIGURE A-4



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OREGONZOO-8-02

BORING B-5

MAY 2015

ZOO TRAIN TRACK
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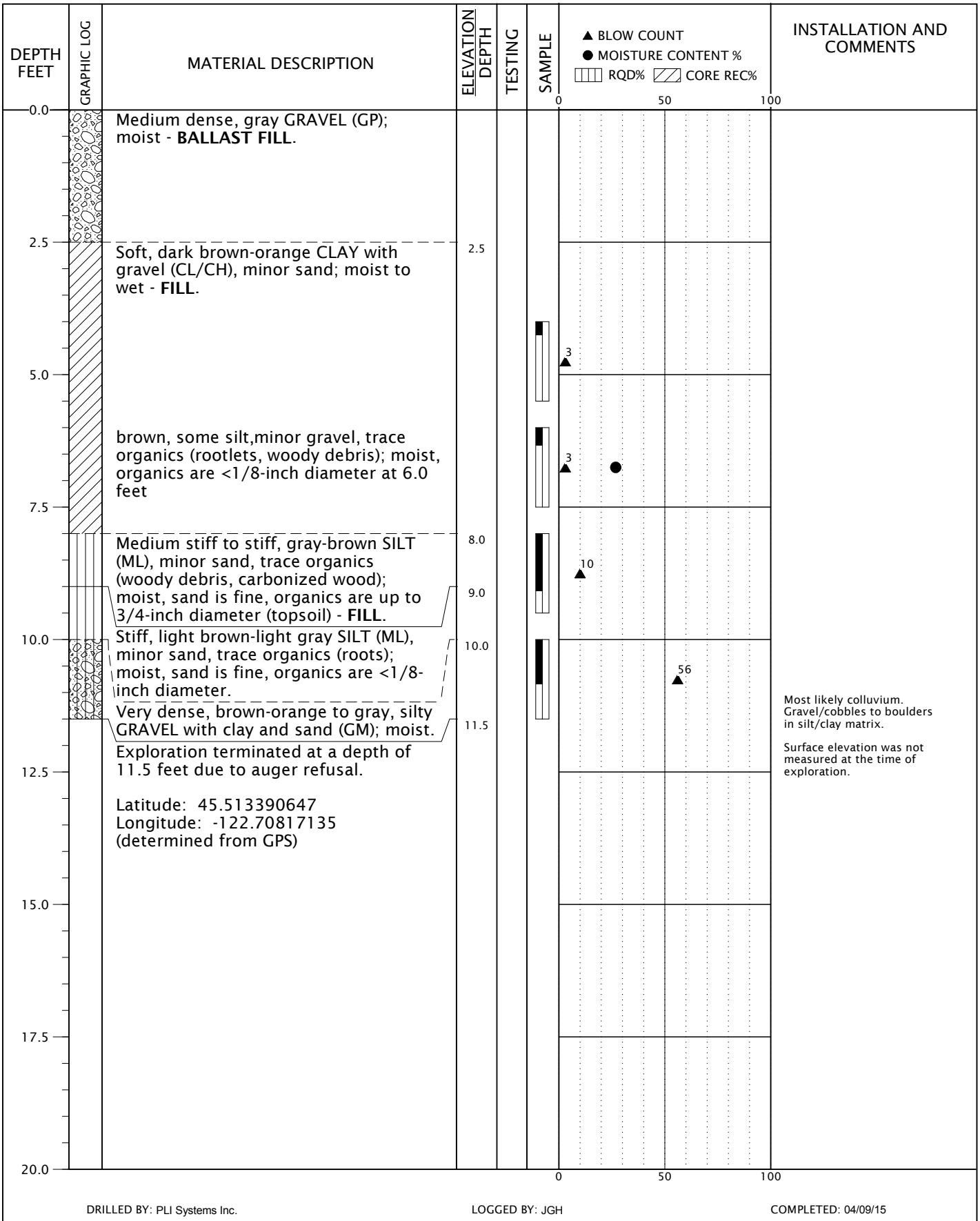
FIGURE A-5



DRILLED BY: PLI Systems Inc. LOGGED BY: JGH COMPLETED: 04/09/15

BORING METHOD: solid-stem auger (see document text) BORING BIT DIAMETER: 4 inches

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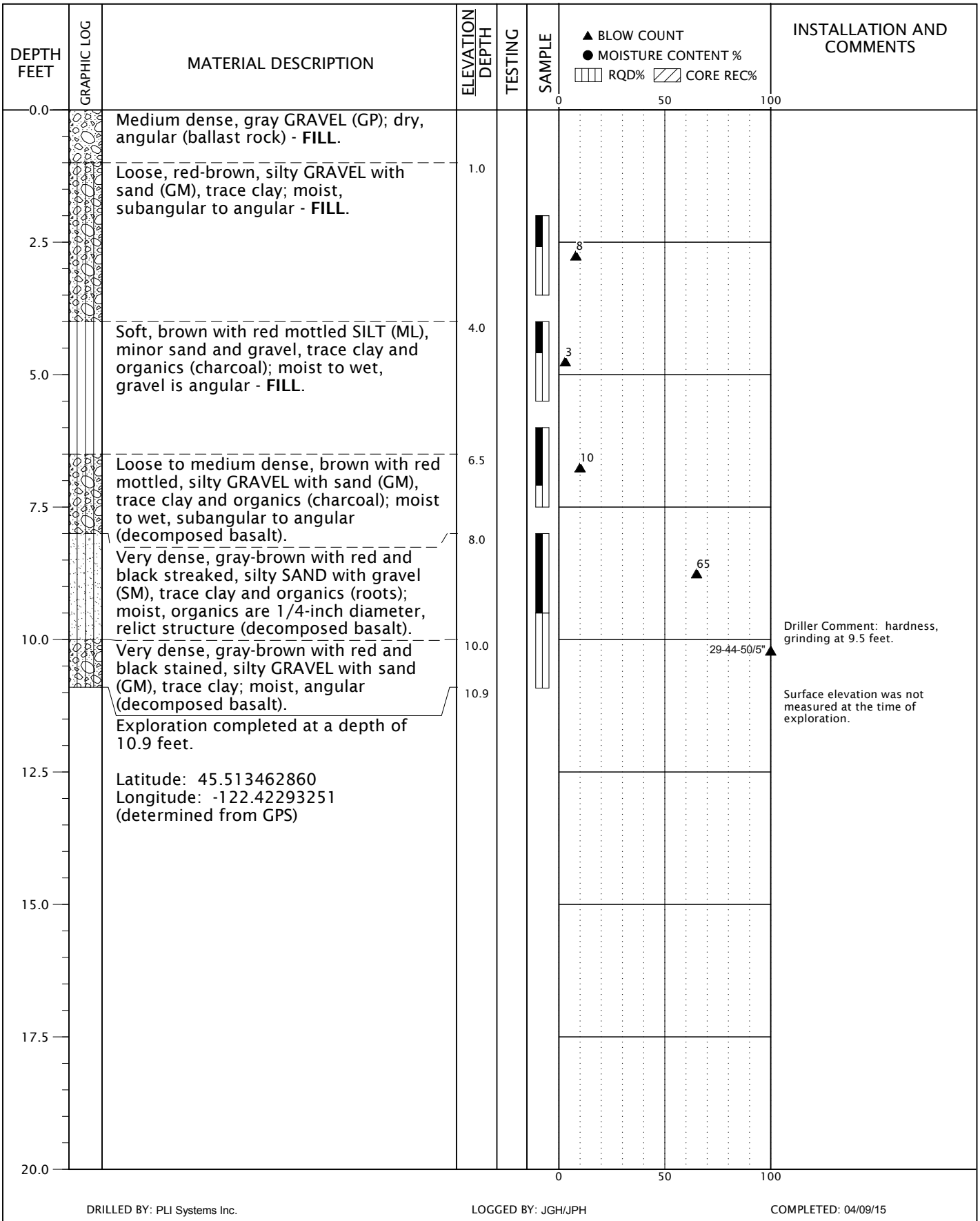
FIGURE A-6

BORING LOG OREGONZOO-8-02-B1_12.GPJ GEODESIGN.GDT PRINT DATE: 5/8/15:KT



DRILLED BY: PLI Systems Inc.

LOGGED BY: JGH/JPH

COMPLETED: 04/09/15

BORING METHOD: solid-stem auger (see document text)

BORING BIT DIAMETER: 4 inches

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OREGONZOO-8-02

BORING B-7

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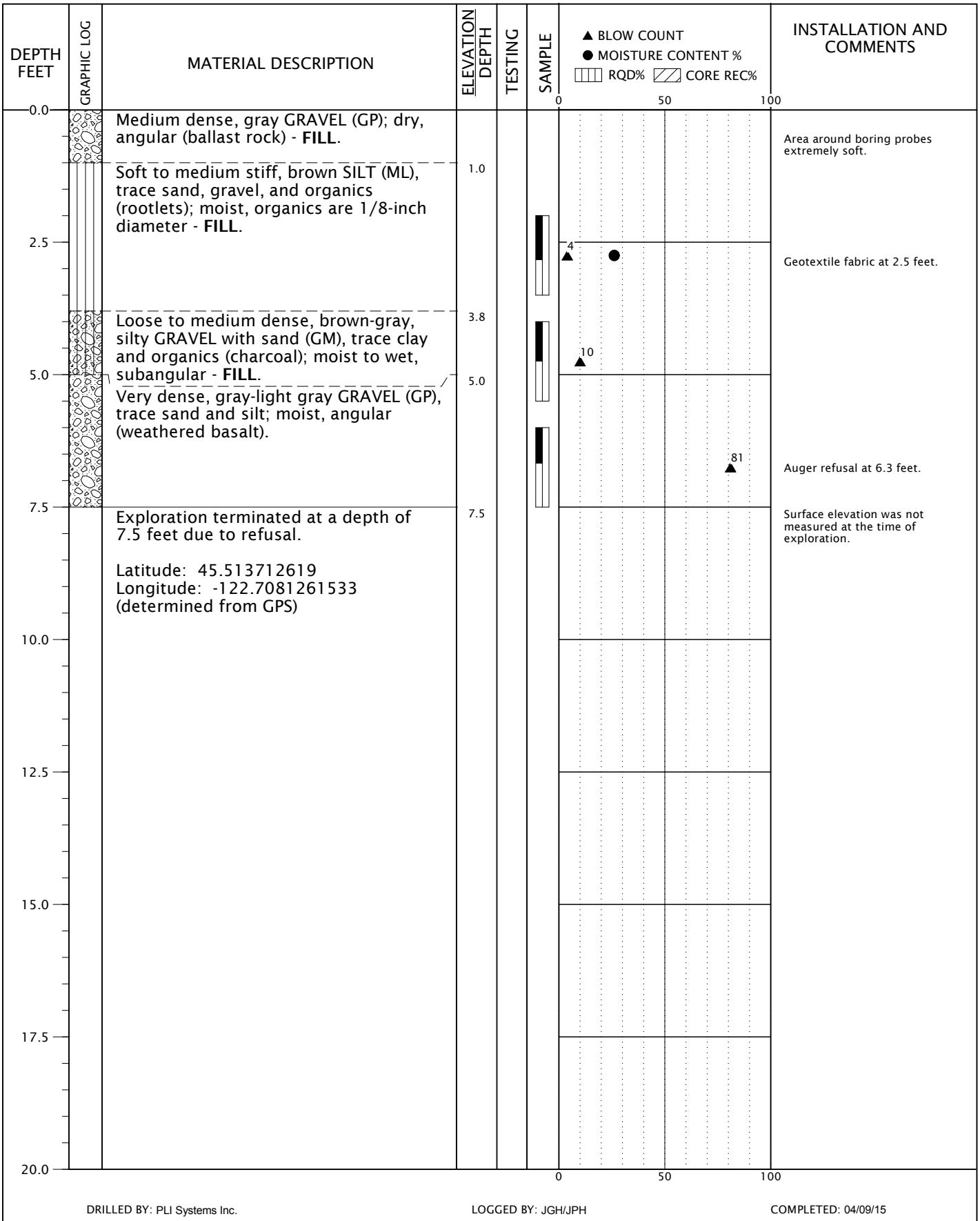
FIGURE A-7

BORING LOG OREGONZOO-8-02-B1_12.GPJ GEODESIGN.GDT PRINT DATE: 5/8/15:KT



DRILLED BY: PLI Systems Inc.

LOGGED BY: JGH/JPH

COMPLETED: 04/09/15

BORING METHOD: solid-stem auger (see document text)

BORING BIT DIAMETER: 4 inches

BORING LOG OREGONZOO-8-02-B1_12.GPJ GEODESIGN.GDT PRINT DATE: 5/8/15:KT

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OREGONZOO-8-02

BORING B-8

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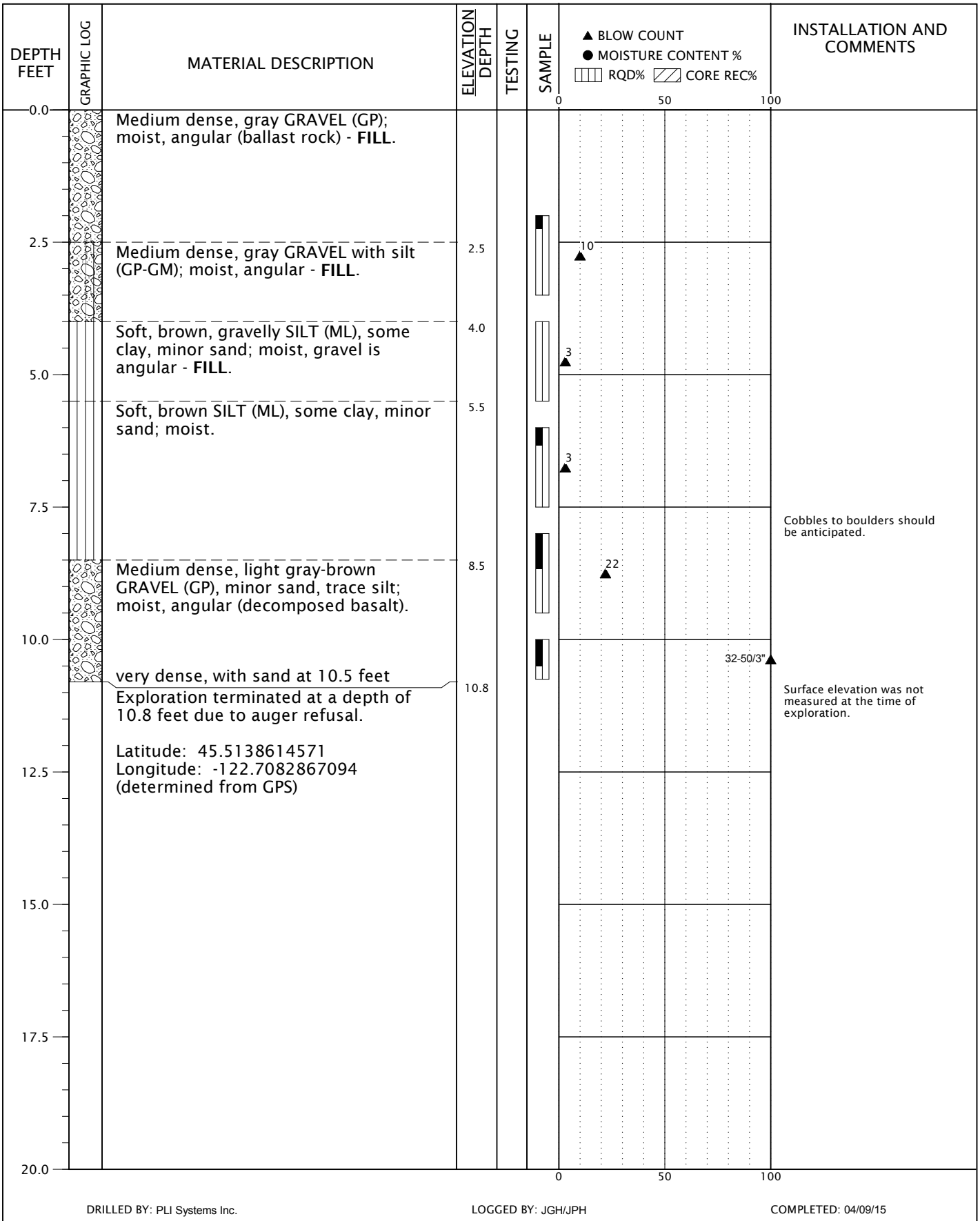
FIGURE A-8



DRILLED BY: PLI Systems Inc.

LOGGED BY: JGH/JPH

COMPLETED: 04/09/15

BORING METHOD: solid-stem auger (see document text)

BORING BIT DIAMETER: 4 inches

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BORING B-9

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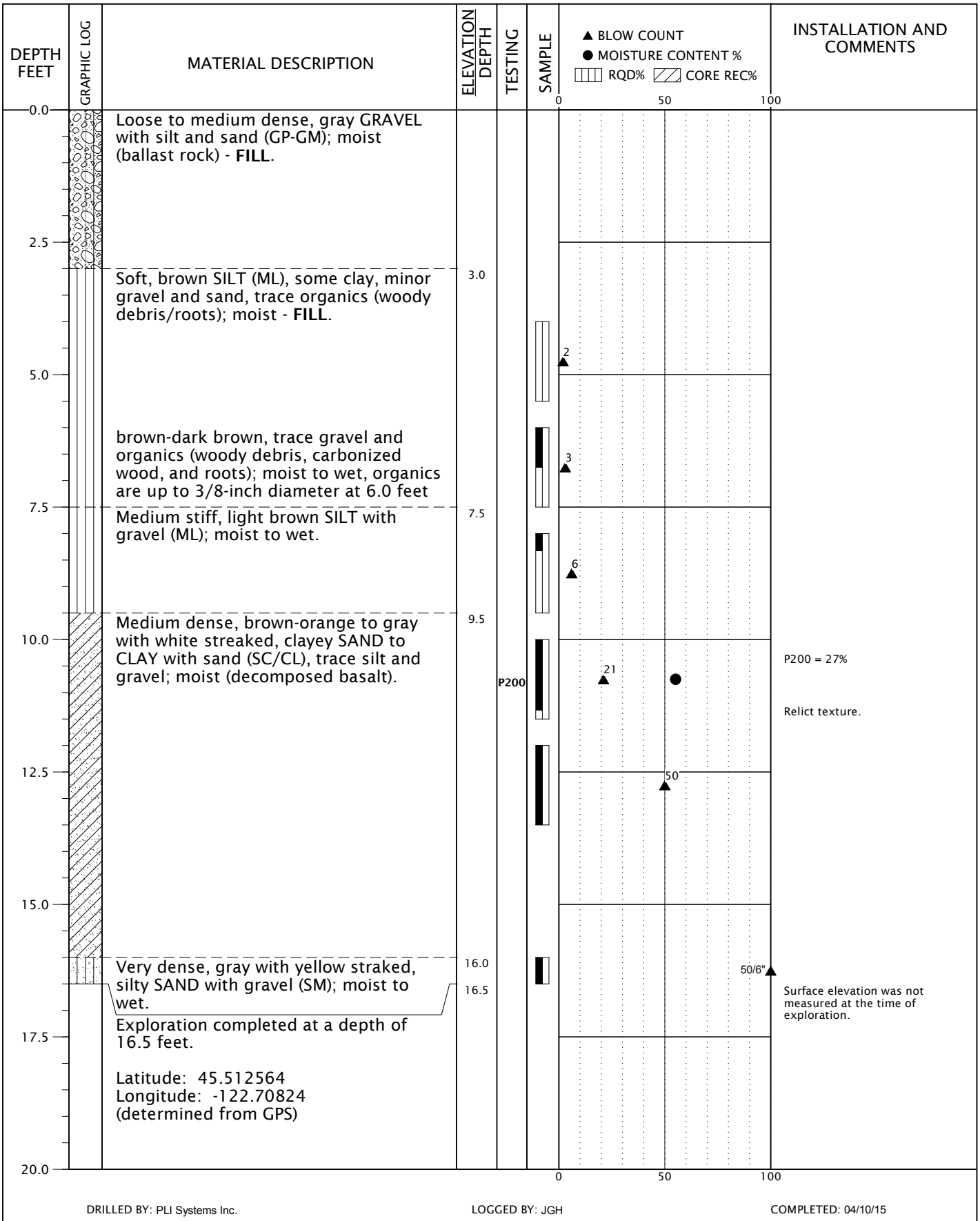
FIGURE A-9

BORING LOG OREGONZOO-8-02-B1_12.GPJ GEODESIGN.GDT PRINT DATE: 5/8/15:KT



DRILLED BY: PLI Systems Inc. LOGGED BY: JGH COMPLETED: 04/10/15

BORING METHOD: solid-stem auger (see document text) BORING BIT DIAMETER: 4 inches

BORING LOG OREGONZOO-8-02-B1_12.GPJ GEODESIGN.GDT PRINT DATE: 5/8/15:KT

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OREGONZOO-8-02

BORING B-10

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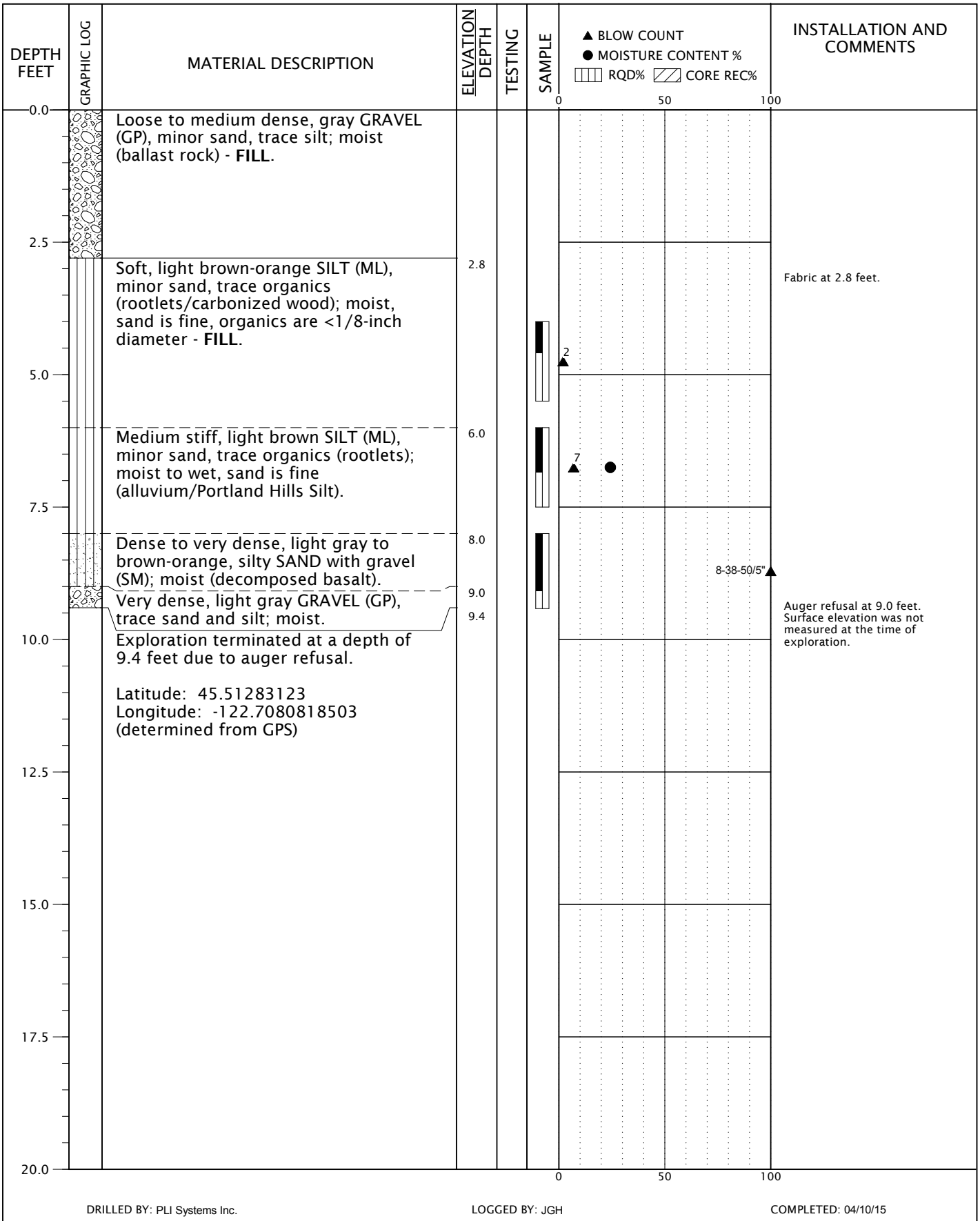
FIGURE A-10



DRILLED BY: PLI Systems Inc. LOGGED BY: JGH COMPLETED: 04/10/15

BORING METHOD: solid-stem auger (see document text) BORING BIT DIAMETER: 4 inches

BORING LOG OREGONZOO-8-02-B1_12.GPJ GEODESIGN.GDT PRINT DATE: 5/8/15:KT

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BORING B-11

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FIGURE A-11

DEPTH FEET	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	SAMPLE	▲ BLOW COUNT ● MOISTURE CONTENT % RQD% CORE REC%	INSTALLATION AND COMMENTS
0.0		Loose to medium dense, gray GRAVEL (GP), minor sand, trace silt; moist (ballast rock) - **FILL**.					
		Very dense, gray to brown GRAVEL with clay (GP-GC), trace silt; moist (weathered basalt).	1.5				Decomposed basalt beneath ballast (hand dug out cobble).
2.5		Exploration terminated at a depth of 2.9 feet due to refusal.	2.9			24-50/5" ▲	Surface elevation was not measured at the time of exploration.
		Latitude: 45.51313208 Longitude: -122.7081167 (determined from GPS)					
5.0							
7.5							
10.0							
12.5							
15.0							
17.5							
20.0							

0 50 100

0 50 100

DRILLED BY: PLI Systems Inc. LOGGED BY: JGH COMPLETED: 04/10/15

BORING METHOD: solid-stem auger (see document text) BORING BIT DIAMETER: 4 inches

BORING LOG OREGONZOO-8-02-B1_12.GPJ GEODESIGN.GDT PRINT DATE: 5/8/15:KT

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BORING B-12

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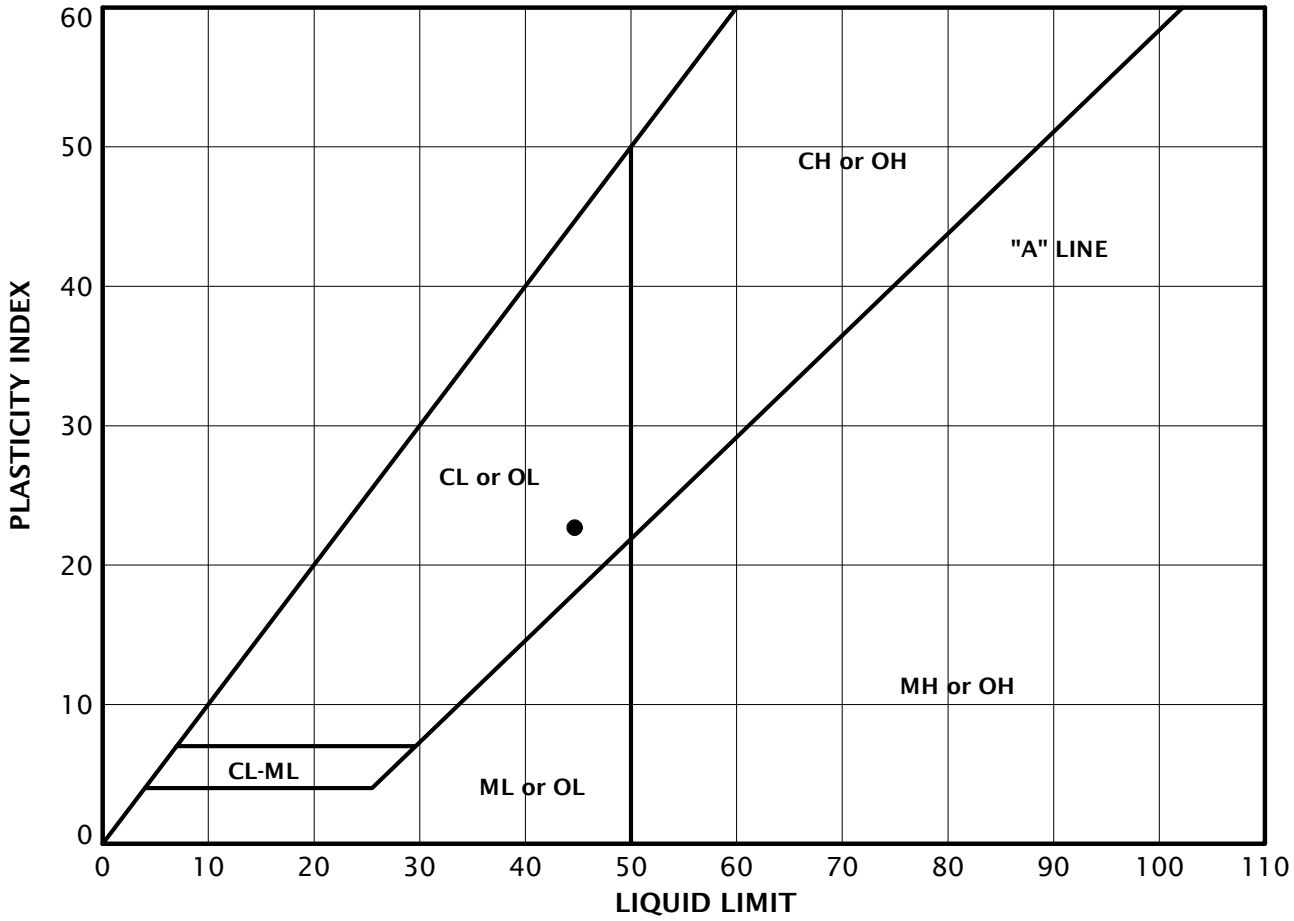
FIGURE A-12



KEY	EXPLORATION NUMBER	SAMPLE DEPTH (FEET)	MOISTURE CONTENT (PERCENT)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
●	B-2	10.0	28	45	22	23

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ATTERBERG LIMITS TEST RESULTS

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FIGURE A-13

SAMPLE INFORMATION			MOISTURE CONTENT (PERCENT)	DRY DENSITY (PCF)	SIEVE			ATTERBERG LIMITS		
EXPLORATION NUMBER	SAMPLE DEPTH (FEET)	ELEVATION (FEET)			GRAVEL (PERCENT)	SAND (PERCENT)	P200 (PERCENT)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
B-1	4.0		29							
B-2	2.0		25							
B-2	10.0		28					45	22	23
B-3	8.0		58							
B-3	12.0		53				18			
B-4	6.0		46							
B-5	2.0		51				34			
B-6	6.0		27							
B-8	2.0		26							
B-10	10.0		55				27			
B-11	6.0		24							

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OREGONZOO-8-02

SUMMARY OF LABORATORY DATA

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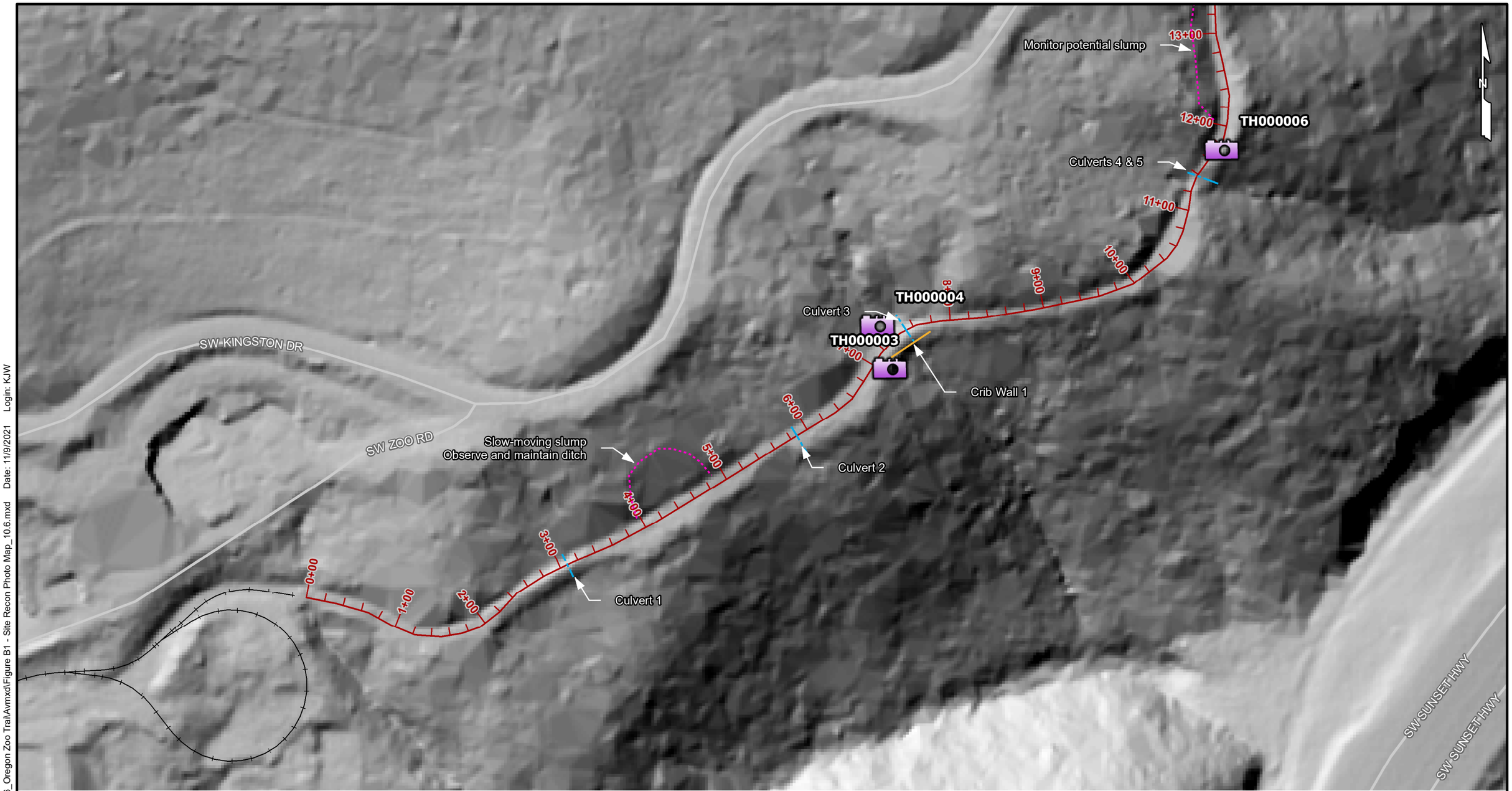
FIGURE A-14

Appendix B

Site Reconnaissance Photo Log

APPENDIX B: SITE RECONNAISSANCE PHOTO LOG

CONTENTS



LEGEND

- Retaining Wall
- Culvert
- Slide or Historic Slide Feature
- Slump or Potential Slump Feature
- Mapped Landslide Deposit
- Mapped Scarp Flank
- Approximate Location of Site Reconnaissance Photos

0 50 100 200

Scale in Feet

NOTES

1. 2005 leaf-off aerial imagery obtained through Metro RLIS.
2. Hillshade and contours created from 2014 LiDAR obtained through DOGAMI.
3. Mapped landslide deposits and scarp flanks provided with DOGAMI publication SLIDO-4.2.
4. Train alignment, stationing, and feature locations are approximate.

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SITE RECONNAISSANCE PHOTO MAP

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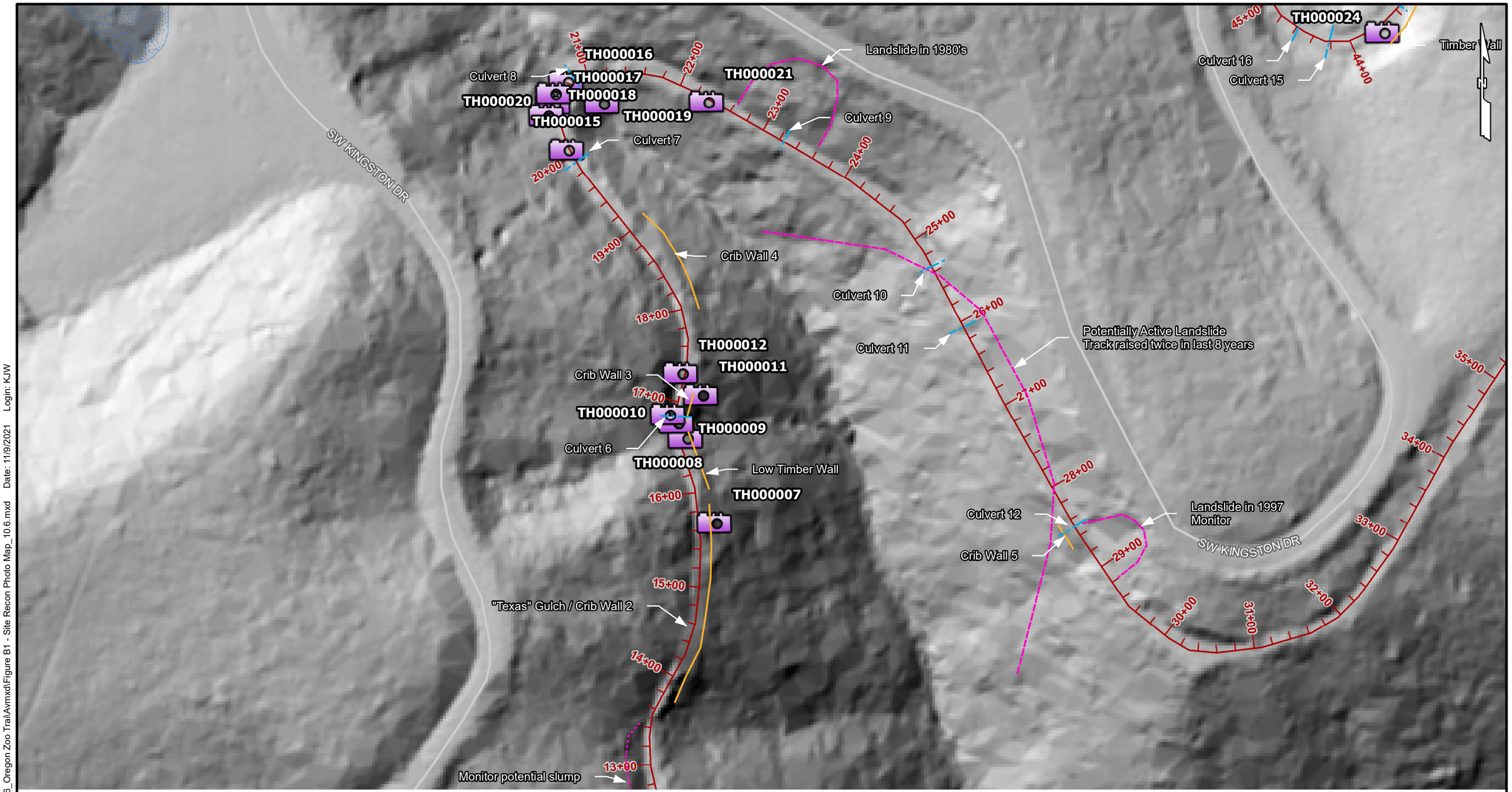
FIG. B1
Sheet 1 of 4

Filename: T:\Projects\PDX\107000s\107736_Oregon Zoo Trail\Avmxd\Figure B1 - Site Recon Photo Map_10.6.mxd Date: 11/9/2021 Login: KJW



LEGEND

- Retaining Wall
- Culvert
- Slide or Historic Slide Feature
- Slump or Potential Slump Feature
- Mapped Landslide Deposit
- Mapped Scarp Flank
- Approximate Location of Site Reconnaissance Photos

0 50 100 200

Scale in Feet

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2. Hillshade and contours created from 2014 LiDAR obtained through DOGAMI.
3. Mapped landslide deposits and scarp flanks provided with DOGAMI publication SLIDO-4.2.
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Portland, Oregon

SITE RECONNAISSANCE PHOTO MAP

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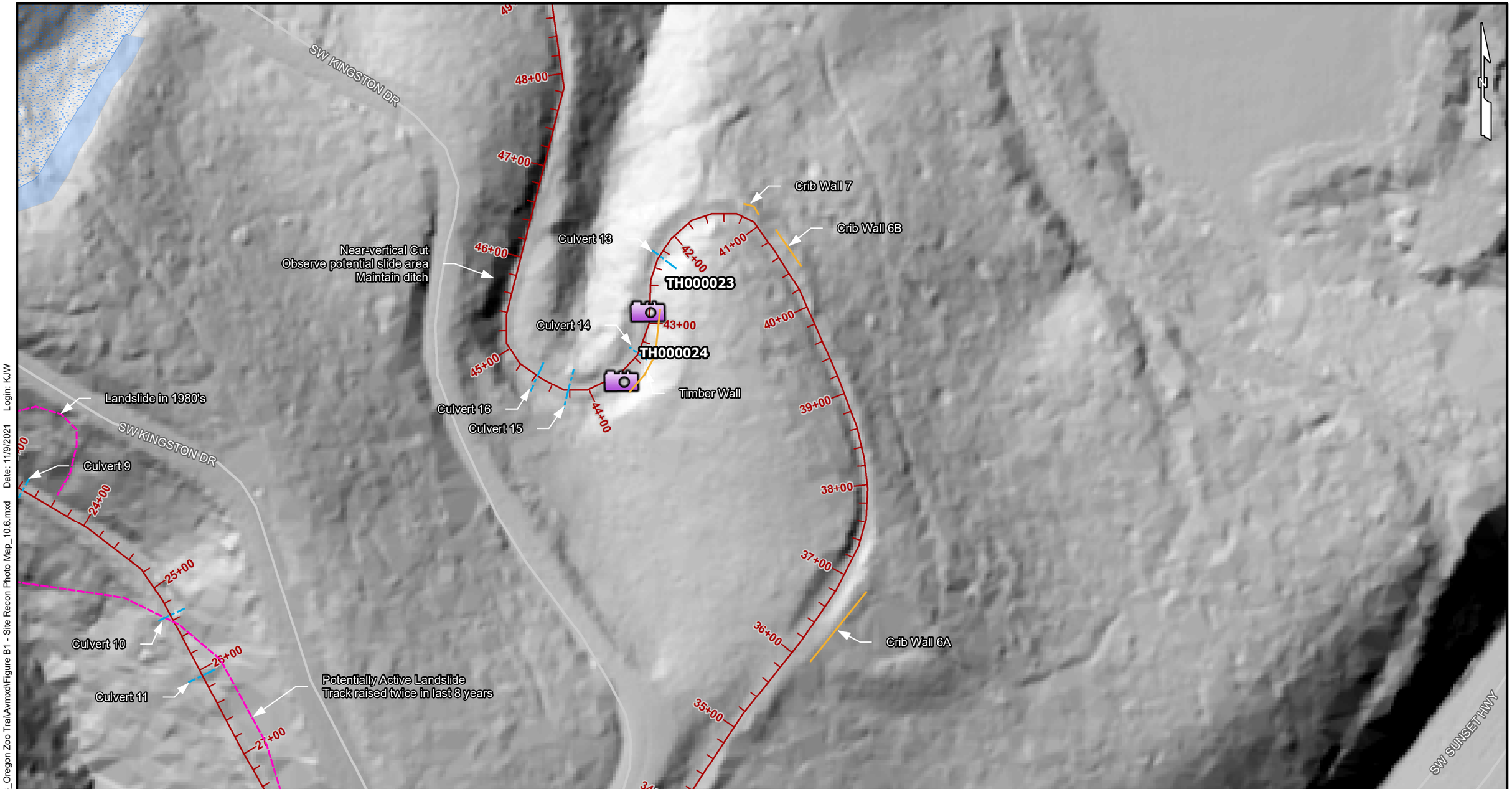
FIG. B1
Sheet 2 of 4

Filename: T:\Projects\PDX\107000s\107736_Oregon Zoo Trail\Avmxd\Figure B1 - Site Recon Photo Map_10.6.mxd Date: 11/9/2021 Login: KJW



LEGEND

- Retaining Wall
- Culvert
- Slide or Historic Slide Feature
- Slump or Potential Slump Feature
- Mapped Landslide Deposit
- Mapped Scarp Flank
- Approximate Location of Site Reconnaissance Photos

0 50 100 200

Scale in Feet

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SITE RECONNAISSANCE PHOTO MAP

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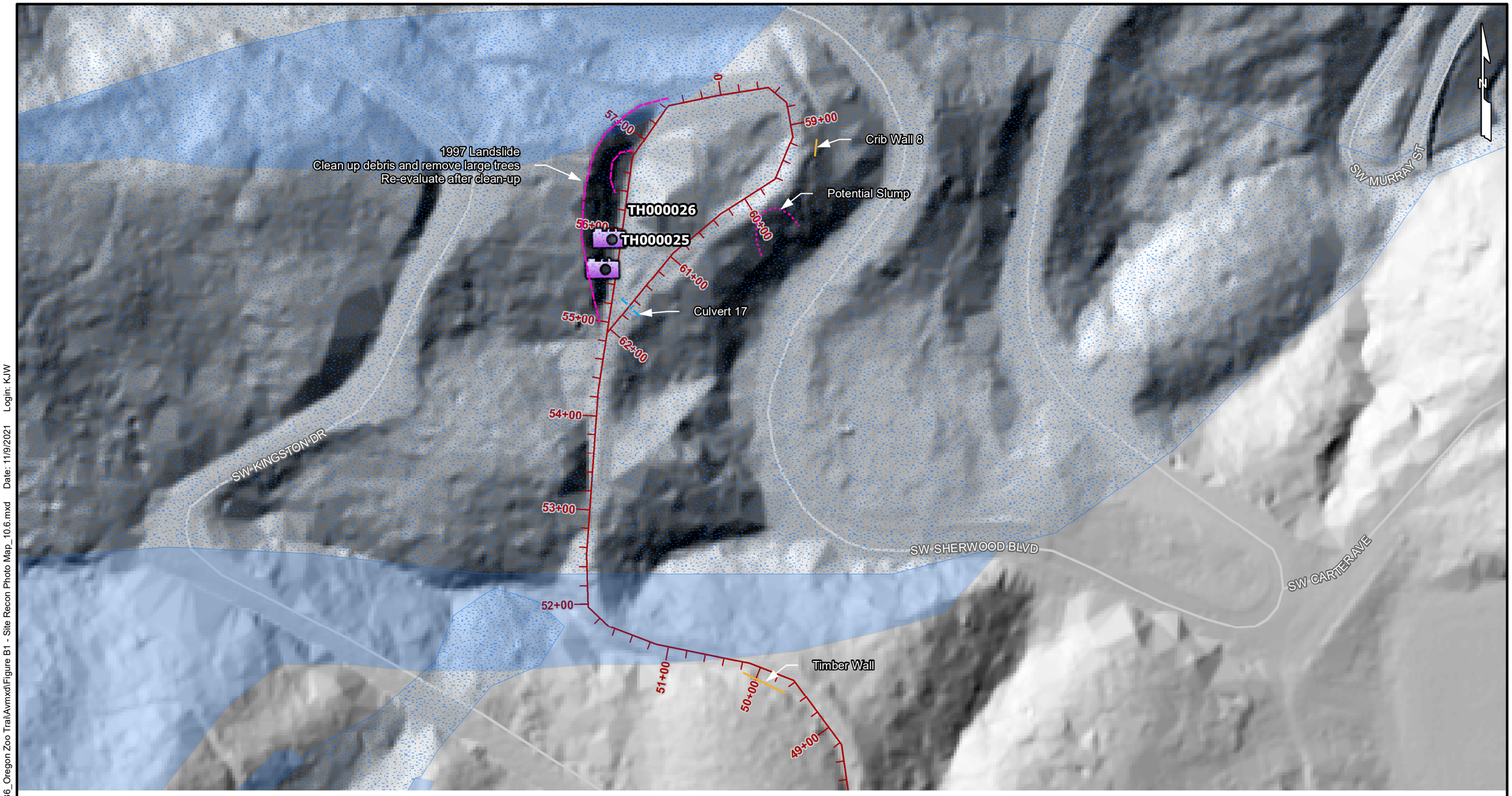
FIG. B1
Sheet 3 of 4

Filename: T:\Projects\PDX\107000s\107736_Oregon Zoo Trail\Avmxd\Figure B1 - Site Recon Photo Map_10.6.mxd Date: 11/9/2021 Login: KJW



LEGEND

- Retaining Wall
- Culvert
- Slide or Historic Slide Feature
- Slump or Potential Slump Feature
- Mapped Landslide Deposit
- Mapped Scarp Flank
- Approximate Location of Site Reconnaissance Photos

0 50 100 200

Scale in Feet

NOTES

1. 2005 leaf-off aerial imagery obtained through Metro RLIS.
2. Hillshade and contours created from 2014 LiDAR obtained through DOGAMI.
3. Mapped landslide deposits and scarp flanks provided with DOGAMI publication SLIDO-4.2.
4. Train alignment, stationing, and feature locations are approximate.

Oregon Zoo Train Track Restoration
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SITE RECONNAISSANCE PHOTO MAP

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FIG. B1
Sheet 4 of 4

Filename: T:\Projects\PDX\107000s\107736_Oregon Zoo Trail\Avmxd\Figure B1 - Site Recon Photo Map_10.6.mxd Date: 11/9/2021 Login: KJW

Photo TH000003: Crib Wall 1 looking northeast

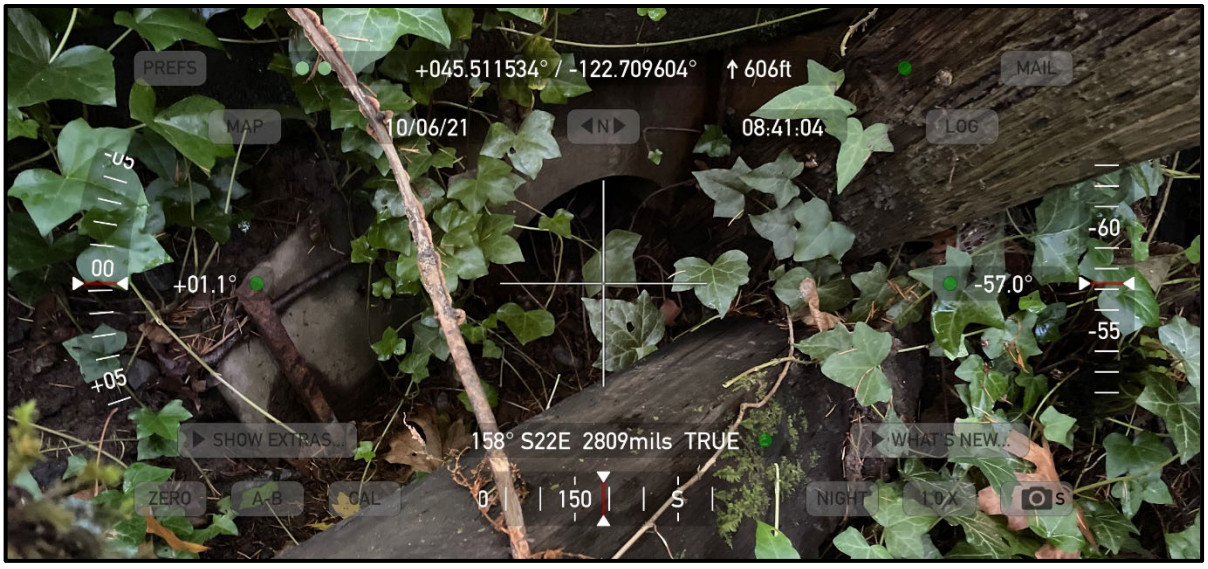

Photo TH000004: Culvert 3

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Photo TH000006: Potential slump west of tracks looking north

Photo TH000007: Crib Wall 2 / "Texas" Gulch looking south

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FIG. B3

Photo TH000008: Culvert 6 looking north

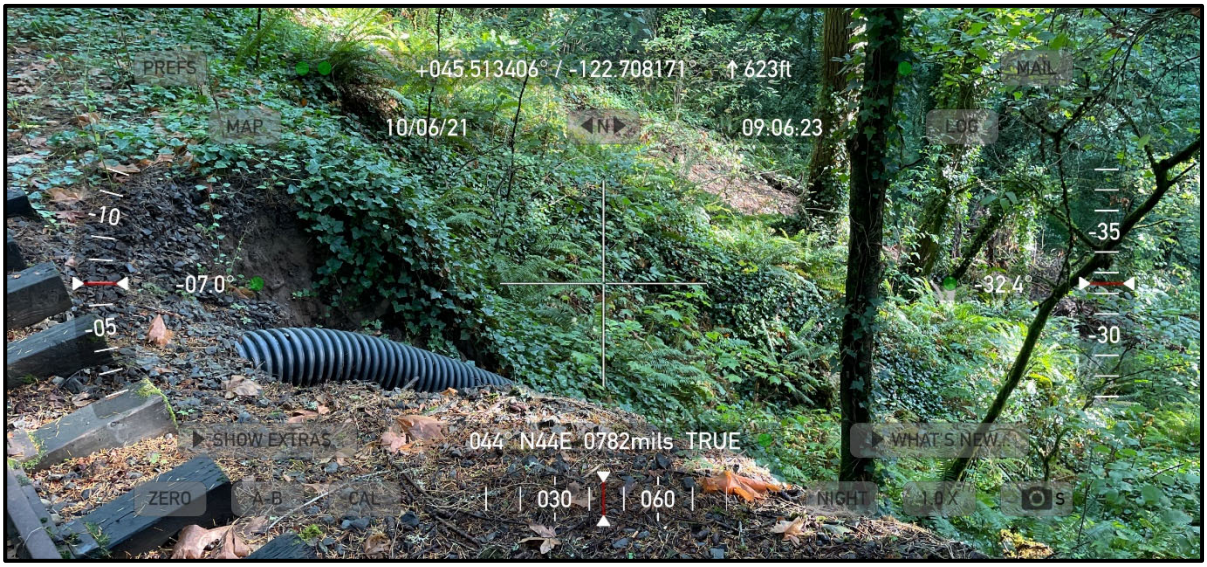

Photo TH000009: Culvert 6 looking north

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FIG. B4

Photo TH000010: Culvert 6 underlying wood timbers

Photo TH000011: Crib Wall 3 looking south

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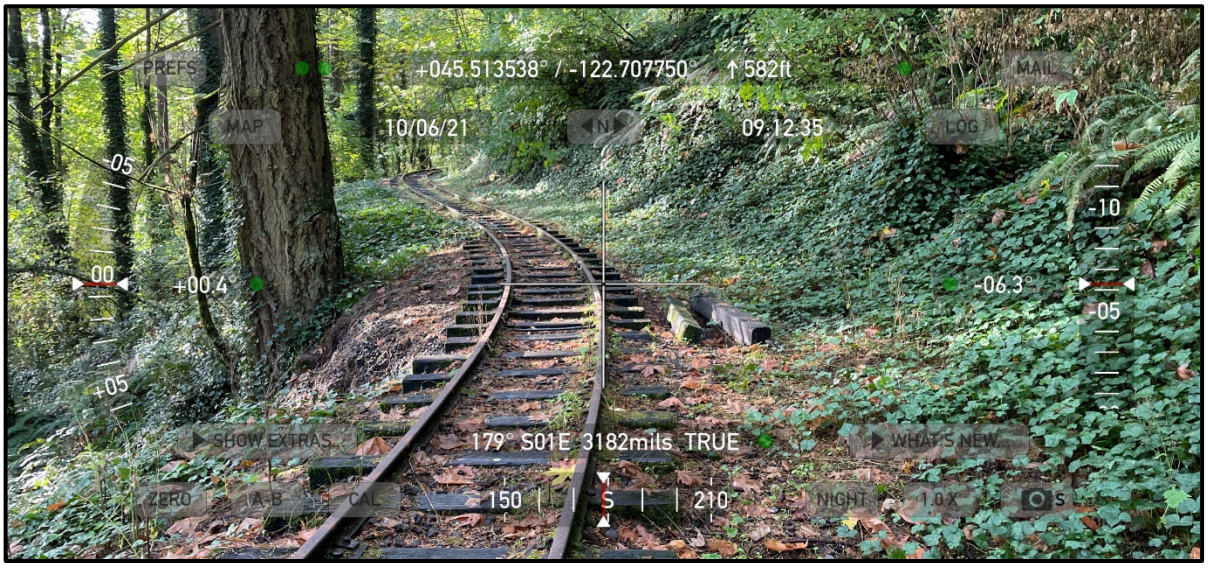

Photo TH000012: Alignment near Crib Wall 3 and Culvert 6 looking south

Photo TH000015: Culvert 8 looking north

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Photo TH000016: Culvert 8 looking southeast

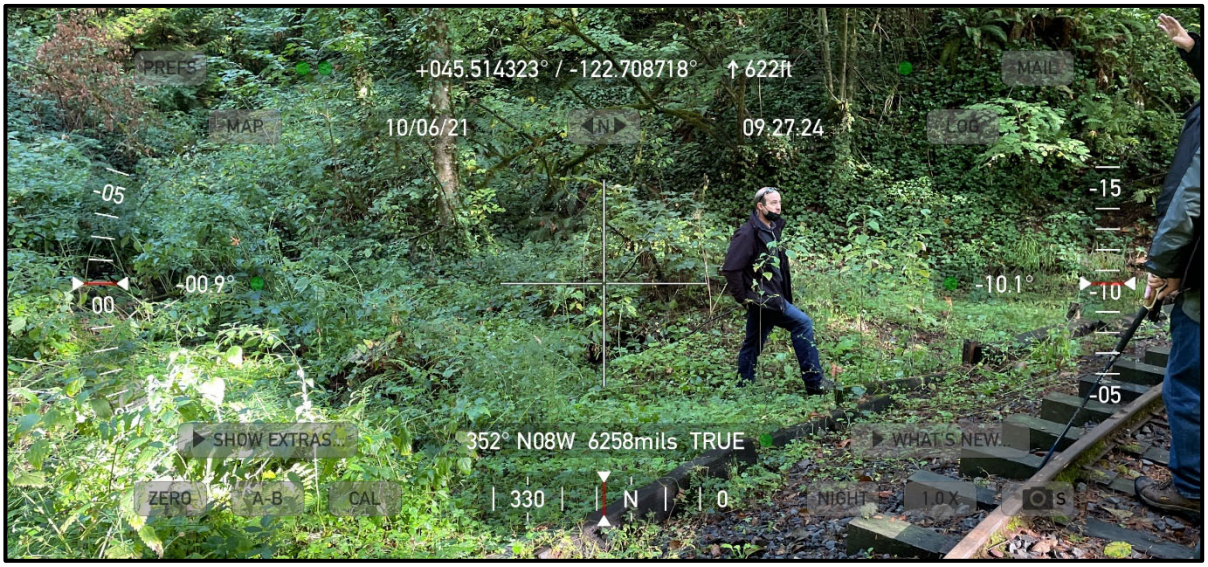

Photo TH000017: Area near Culvert 8 looking northeast

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FIG. B7

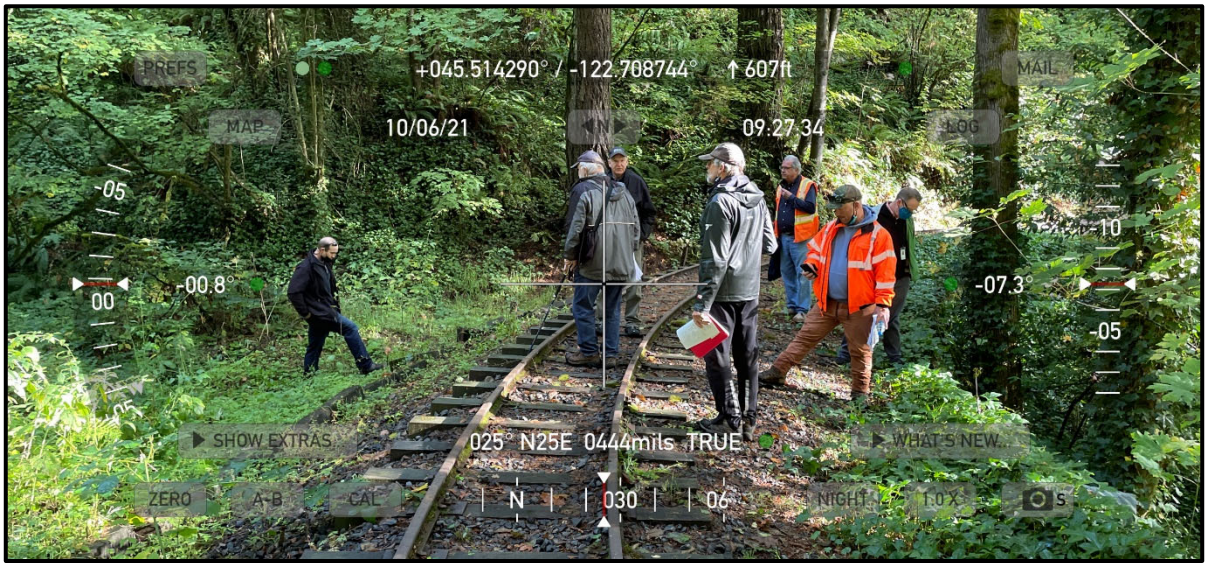

Photo TH000018: Alignment at Culvert 8 looking east

Photo TH000019: Culvert 8 looking southeast

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Photo TH000020: Inlet for Culvert 8

Photo TH000021: Area near 1980's landslide and Culvert 9 looking southeast

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FIG. B9

Photo TH000023: Timber Wall east of tracks near Culvert 14 looking southwest

Photo TH000024: Timber Wall east of tracks near Culvert 14 looking northeast

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FIG. B10

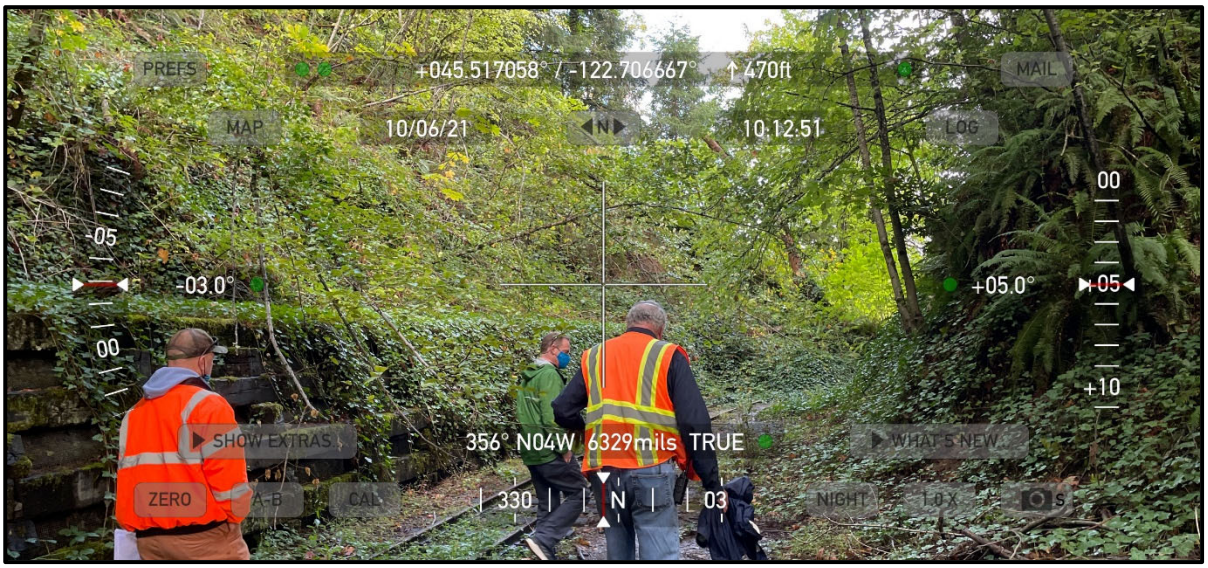

Photo TH000025: Area near 1997 landslide looking north (appr. STA 56+00 to 57+00)

Photo TH000026: Area near 1997 landslide looking north (appr. STA 56+00 to 57+00)

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FIG. B11

Important Information

About Your Geotechnical Report

IMPORTANT INFORMATION

IMPORTANT INFORMATION

CONSULTING SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND FOR SPECIFIC CLIENTS.

Consultants prepare reports to meet the specific needs of specific individuals. A report prepared for a civil engineer may not be adequate for a construction contractor or even another civil engineer. Unless indicated otherwise, your consultant prepared your report expressly for you and expressly for the purposes you indicated. No one other than you should apply this report for its intended purpose without first conferring with the consultant. No party should apply this report for any purpose other than that originally contemplated without first conferring with the consultant.

THE CONSULTANT'S REPORT IS BASED ON PROJECT-SPECIFIC FACTORS.

A geotechnical/environmental report is based on a subsurface exploration plan designed to consider a unique set of project-specific factors. Depending on the project, these may include the general nature of the structure and property involved; its size and configuration; its historical use and practice; the location of the structure on the site and its orientation; other improvements such as access roads, parking lots, and underground utilities; and the additional risk created by scope-of-service limitations imposed by the client. To help avoid costly problems, ask the consultant to evaluate how any factors that change subsequent to the date of the report may affect the recommendations. Unless your consultant indicates otherwise, your report should not be used (1) when the nature of the proposed project is changed (for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one, or chemicals are discovered on or near the site); (2) when the size, elevation, or configuration of the proposed project is altered; (3) when the location or orientation of the proposed project is modified; (4) when there is a change of ownership; or (5) for application to an adjacent site. Consultants cannot accept responsibility for problems that may occur if they are not consulted after factors that were considered in the development of the report have changed.

SUBSURFACE CONDITIONS CAN CHANGE.

Subsurface conditions may be affected as a result of natural processes or human activity. Because a geotechnical/environmental report is based on conditions that existed at the time of subsurface exploration, construction decisions should not be based on a report whose adequacy may have been affected by time. Ask the consultant to advise if additional tests are desirable before construction starts; for example, groundwater conditions commonly vary seasonally.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes, or groundwater fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical/environmental report. The consultant should be kept apprised of any such events and should be consulted to determine if additional tests are necessary.

MOST RECOMMENDATIONS ARE PROFESSIONAL JUDGMENTS.

Site exploration and testing identifies actual surface and subsurface conditions only at those points where samples are taken. The data were extrapolated by your consultant, who then applied judgment to render an opinion about overall subsurface conditions. The actual interface between materials may be far more gradual or abrupt than your report indicates. Actual conditions in areas not sampled may differ from those predicted in your report. While nothing can be done to prevent such situations, you and your consultant can work together to help reduce their impacts. Retaining

IMPORTANT INFORMATION

your consultant to observe subsurface construction operations can be particularly beneficial in this respect.

A REPORT'S CONCLUSIONS ARE PRELIMINARY.

The conclusions contained in your consultant's report are preliminary, because they must be based on the assumption that conditions revealed through selective exploratory sampling are indicative of actual conditions throughout a site. Actual subsurface conditions can be discerned only during earthwork; therefore, you should retain your consultant to observe actual conditions and to provide conclusions. Only the consultant who prepared the report is fully familiar with the background information needed to determine whether or not the report's recommendations based on those conclusions are valid and whether or not the contractor is abiding by applicable recommendations. The consultant who developed your report cannot assume responsibility or liability for the adequacy of the report's recommendations if another party is retained to observe construction.

THE CONSULTANT'S REPORT IS SUBJECT TO MISINTERPRETATION.

Costly problems can occur when other design professionals develop their plans based on misinterpretation of a geotechnical/environmental report. To help avoid these problems, the consultant should be retained to work with other project design professionals to explain relevant geotechnical, geological, hydrogeological, and environmental findings, and to review the adequacy of their plans and specifications relative to these issues.

BORING LOGS AND/OR MONITORING WELL DATA SHOULD NOT BE SEPARATED FROM THE REPORT.

Final boring logs developed by the consultant are based upon interpretation of field logs (assembled by site personnel), field test results, and laboratory and/or office evaluation of field samples and data. Only final boring logs and data are customarily included in geotechnical/environmental reports. These final logs should not, under any circumstances, be redrawn for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process.

To reduce the likelihood of boring log or monitoring well misinterpretation, contractors should be given ready access to the complete geotechnical engineering/environmental report prepared or authorized for their use. If access is provided only to the report prepared for you, you should advise contractors of the report's limitations, assuming that a contractor was not one of the specific persons for whom the report was prepared, and that developing construction cost estimates was not one of the specific purposes for which it was prepared. While a contractor may gain important knowledge from a report prepared for another party, the contractor should discuss the report with your consultant and perform the additional or alternative work believed necessary to obtain the data specifically appropriate for construction cost estimating purposes. Some clients hold the mistaken impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes that aggravate them to a disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY.

Because geotechnical/environmental engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims

being lodged against consultants. To help prevent this problem, consultants have developed a number of clauses for use in their contracts, reports, and other documents. These responsibility clauses are not exculpatory clauses designed to transfer the consultant's liabilities to other parties; rather, they are definitive clauses that identify where the consultant's responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your report, and you are encouraged to read them closely. Your consultant will be pleased to give full and frank answers to your questions.

The preceding paragraphs are based on information provided by the ASFE/Association of Engineering Firms Practicing in the Geosciences, Silver Spring, Maryland