APPENDIX E

Preliminary Services Diversion Tunnel Inspection

(Pages E-1 to E-56)

Knight Piésold CONSULTING

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Mr. Nick Drury
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Dear Nick,

RE: Klamath River Renewal Project – Iron Gate and Copco No. 1 Diversion Tunnel Geotechnical Inspection

1.0 INTRODUCTION

As part of the design of the Klamath River Renewal Project (KRRP), consideration is being given to utilizing the existing diversion tunnels at the Iron Gate and Copco No. 1 facilities to draw down the reservoirs prior to dam removal. Geotechnical inspections of the downstream (non-flooded) sections of the Iron Gate and Copco No. 1 diversion tunnels have been undertaken by Knight Piésold Ltd. (KP) to help evaluate this option. The Iron Gate diversion tunnel is 967.5 ft-long and is located at the right bank of the river valley. The Copco No. 1 diversion tunnel is approximately 300 ft-long and is located at the left dam abutment.

This report describes the findings of the inspections, characterizes the existing ground conditions, and discusses possible additional investigation work if the use of these tunnels is to be pursued.

2.0 DESK STUDY

2.1 GENERAL

A desk study was undertaken of relevant geotechnical and construction data. The information reviewed included regional published geology maps and memoirs, drawings pertaining to drilling investigations and design and construction of the tunnels, AECOM's Geotechnical Data report for the KRRP (KRRC, 2019), and a memo by AECOM summarizing the findings of their tunnel inspections undertaken in February 2018 at the Copco No. 1 and Iron Gate facilities (AECOM, 2018).

2.2 GEOLOGY

The 1:250,000 scale geology map of the Weed Quadrangle (Wagner & Saucedo, 1987) published by the United States Geological Survey (USGS) shows the regional bedrock geology comprises Miocene-age rocks that belong to the Western Cascade Volcanics (Figure 1). The published map indicates the Western Cascade Volcanics predominantly comprise andesite with some basalt and dacite. Younger Pleistocene-age volcanic rocks, belonging to the High Cascade Volcanics, are mapped in the areas of higher terrain at the west end of Copco Lake. The map indicates the High Cascade Volcanics comprise andesite, basalt, dacite and pyroclastic deposits. Volcanic cones are mapped on both the north and south sides of the Klamath River at the west end of Copco Lake. It is interpreted the river valley was 'dammed' by Pleistocene-age volcanic eruptions creating a larger lake at the same site as the existing Copco reservoir. The 'volcanic dam' was breached and the outburst flood eroded a steep-sided canyon into the bedrock; this steep-sided

buried bedrock canyon at the site of the Copco No. 1 Dam is shown on a ground investigation drawing (Drawing F-1109 in Appendix A) from the original construction (KRRC, 2018). As stated in the KRRC Definite Plan, 'the river gravel was found to be over 100 feet deep at the dam site and was excavated and then backfilled with concrete.' The bedrock profile significantly reduces the lateral cover locally along the Copco No. 1 Diversion Tunnel alignment.

Hammond (1983) presents the findings of detailed geological mapping undertaken in the vicinity of Copco Lake and describes the regional geological setting as well as the detailed stratigraphy. The Western Cascade Series dips towards the east. The regional geological faults trend towards the west-northwest and northwest. Hammond (1983) describes the bedrock geology around Copco Lake as comprising the 'Beds of Bogus Mountain'. The geology map presented in the memoir shows the bedrock in the vicinity of the downstream portal of the Copco No. 1 Diversion Tunnel comprises 'Member D' of the 'Beds of Bogus Mountain'. The stratigraphic column presented in the memoir shows that this member comprises dark grey andesite lava flows up to approximately 30 ft thick, with volcanic breccias occurring at the margins between flows.

Approximately thirty drillholes were undertaken at the site of the Iron Gate Dam at the time of construction (Drawing A-33834 in Appendix A). The basic geological findings of these drillholes were summarized on geological cross-sections and presented on Drawings AA-33833 and A-33835 copies of which are presented in Appendix A. The geological sections show the bedrock in the vicinity of the Iron Gate Diversion Tunnel comprises jointed basalt.

2.3 DIVERSION TUNNELS

KRRC's preliminary design Drawing C161 (Appendix A) shows the existing concrete plug at the Copco No. 1 Diversion Tunnel is approximately 200 feet upstream from the downstream portal. The tunnel profile indicates that approximately 100 feet from the downstream portal there is an abrupt rise in the elevation of the invert.

KRRC's preliminary design Drawing C260 (Appendix A) shows a reinforced concrete portal structure extending upstream for 24.1 ft from the downstream outlet of the Iron Gate Diversion Tunnel. This is followed by an approximately 353.5 ft unlined section, a 120.6 ft section with a concrete invert, an upstream concrete ring, and a blind flange sealing off the upstream portion of the tunnel. The drawing shows there to be a 325.5 ft-long section of the tunnel on the upstream side of the blind flange with a 'plain concrete lining' and an approximately 18.5 ft-long reinforced concrete liner adjacent to the submerged intake structure.

In 2007, a rehabilitation project was completed for the Iron Gate Diversion Tunnel (PacifiCorp, 2008). The intent of the project was to allow safe underwater inspection of the gate and to determine the cause of observed leaks. The rehabilitation works were designed by Black and Veatch, and included:

- Scaling of the tunnel crown and walls and replacement of degraded timber supports with tensioned rock bolts and shotcrete with welded wire mesh along the first 125 ft section of the tunnel starting immediately upstream from the downstream concrete liner. The details of the tunnel stabilization works are shown on Drawing 108369, Sheet 7 (Appendix A). The rock bolts are 10 ft-long and 1-inch diameter and were installed at spacings of 5 ft in the tunnel crown. A 4-inch-thick layer of steel fibre reinforced shotcrete was extended down to the Spring Line.
- Stabilizing the rock slopes adjacent to the downstream portal by scaling loose rock and installing rock fall netting. The details of the tunnel stabilization works are shown on Drawing 108369, Sheet 6 (Appendix A).

- Removal of talus from past rockslides that blocked the channel at the downstream portal.
- Construction of a new transition structure (blind flange with a steel reinforced concrete ring).
- Installation of a new 12-inch diameter ventilation pipe along the tunnel crown.
- Construction of a new weir structure at the downstream portal.

A photo presented in the Pacificorp letter report (2008) shows talus covering the full width of the channel immediately in front of the tunnel portal, and another photo indicates that 1,100 cubic yards of talus were removed. This quantity possibly represents the amount of rockslide debris combined with the amount of material scaled from the adjacent rock slope. PacifiCorp concluded that aside from ongoing annual monitoring of the condition of the blind flange from the downstream end, no further action was needed with respect to the low-level outlet.

AECOM inspected the Iron Gate and Copco No. 1 Diversion Tunnels in February 2018 (AECOM, 2018). AECOM described a pile of rubble at approximately 300 ft from the Iron Gate Diversion Tunnel portal and interpreted the blocks to comprise debris from the construction of the weir and shotcrete. AECOM observed the tunnel walls to be rough with areas of 'loose' and very fractured rock. AECOM observed a small pile of submerged rock fall debris immediately downstream of the portal of the Copco No. 1 Diversion Tunnel. Seepage was identified close to the concrete plug at the Copco No. 1 Diversion Tunnel and water flow was also observed from the top of the plug, which was noted to be coming through a grout pipe remaining from construction.

3.0 FIELDWORK

KP inspected the Iron Gate Diversion Tunnel on the July 9, 2019 and the Copco No. 1 Diversion Tunnel on July 10, 2019. JR Merit provided KP personnel with confined space training to undertake the work, developed a site-specific Health and Safety Plan, obtained the Confined Space Entry Permits, coordinated lock-out / tag-out procedures with PacifiCorp, undertook air quality monitoring, and provided an entry supervisor, attendant, and rescue team. An inflatable raft was used to access the tunnel portals and to traverse the Iron Gate Diversion Tunnel. The inspections were undertaken from the tunnel portals to the plugs. A 100 metre (328.1 ft) long tape was used to establish chainage along the tunnels during the inspections. Chainage stations were measured from the downstream portals.

The key objective of the geotechnical inspections was to collect data to facilitate a characterization of the rock mass quality with respect to Barton's Q System (1974). Geotechnical descriptions of the rock mass were made, evidence of previous tunnel instability (e.g. wedge failures) was noted, and seepage locations were recorded and described. The Rock Quality Designation (RQD) was evaluated in two ways:

- Measuring the total length of intact rock blocks greater than 100 mm (3.9 in) in length over a 1 m (3.28 ft) length (these measurements were taken vertically, parallel to the tunnel alignment and, where possible, perpendicular to the tunnel alignment).
- Taking systematic measurements of joint set spacing so that an RQD value could be derived from the volumetric joint count (Jv).

Discontinuity data surveys were undertaken in accordance with the ISRM Suggested Methods for the Quantitative Description of Discontinuities in Rock Masses (ISRM, 1978). Schmidt hammer testing was performed to obtain an indication of the compressive strength of the encountered bedrock units. Measurements were taken of the tunnel widths, the dimensions of the concrete-lined sections, and the water depths. Observations were made of seepage and additional support measures installed.

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4.0 FINDINGS OF INSPECTION

4.1 IRON GATE DIVERSION TUNNEL

4.1.1 GENERAL

The downstream portal of the Iron Gate Diversion Tunnel (Photo 1, Appendix B) has an outer concrete wing wall. A concrete wing wall extends from the tunnel portal at the Left Bank. The first 19.4 ft of the tunnel extending from the downstream portal has a 1.3 ft-thick reinforced concrete liner with an internal diameter of approximately 15.7 ft (Photo 2, Appendix B). The left wall of the concrete lining was measured to be approximately 2.1 foot-thick at its upstream end (Photo 3, Appendix B).

From STA. 19.4 ft to STA. 140.4 ft the tunnel crown and upper walls are covered with shotcrete and welded wire mesh (Photos 4 and 5, Appendix B). Possible rock bolts were identified from the presence of local bulges in the shotcrete (Photo 6, Appendix B). An unlined section of the tunnel extends from STA. 140.4 ft to STA. 516.7 ft. The unlined tunnel is approximately 22.3 ft wide in the vicinity of STA. 515 ft. A concrete liner with an internal diameter of approximately 15.1 ft extends from STA 516.7 ft to STA. 577.6 ft and a blind flange is located at approximately STA. 577.6 ft (Photo 7, Appendix B), which restricts access to the upstream portion of the tunnel. The concrete liner was measured to be approximately 4.4 ft wide at the right wall (looking downstream), as shown on Photo 14 (Appendix B).

The water within the tunnel was approximately 3.3 to 4.6 ft-deep at the time of the inspection (Photo 8, Appendix B) and was flowing relatively fast. These factors limited the extent of data collection that could be undertaken. Suspended sediment was visible, locally, in the tunnel water.

A rubble pile was observed in the centre portion of the tunnel invert at STA 286.4 ft (Photo 9, Appendix B). There is no obvious source zone for a wedge failure in the tunnel crown above the rubble pile. However, an approximately 3-ft sized rock block has detached from the left wall at this location. The rubble pile predominantly comprises bedrock blocks but also includes some blocks of concrete.

4.1.2 ROCK MASS CHARACTERIZATION

The unlined portion of the Iron Gate Diversion Tunnel is described as medium brownish to orangish grey, fine grained, and slightly weathered basalt. Schmidt Hammer testing indicates the compressive strength of the rock is in the range of 100 to 130 MPa (2,000 to 2,700 ksf), i.e. strong rock. The joints generally have a surface staining of haematite. Four dominant joint sets were identified:

1. Dips 80° to 89° towards the west-northwest and east-southeast, slightly rough, slightly undulating with reddish brown haematite staining, open to moderately wide aperture, closely spaced, low to medium persistence (5 to 15 ft).
2. Dips 80° to 89° towards the south-southwest and north-northeast, slightly rough, slightly undulating with red brown haematite staining, wide aperture, closely spaced, medium persistence (5 to 30 ft). =
3. Dips 10 to 40° towards the east, slightly rough, slightly undulating with red brown haematite staining, open to moderately wide aperture, closely spaced, very low persistence (1.5 to 3 ft). =
4. Dips 30° to 60° towards the east-southeast, slightly rough, slightly undulating with red brown haematite staining, closely spaced, low to medium persistence (7 to 13 ft).

The tunnel was is developed along a subvertical Set 1 Joint at STA 252.6 ft (Photo 10, Appendix B). At STA. 253.6 ft, a Set 2 Joint was identified as having 1/16 to 1/4-inch of sandy clay infill (Photo 11, Appendix

B). An approximately 10 to 15 ft-wide zone of volcanic breccia with extremely to very closely spaced fractures was identified at STA 214.2 ft. No geological faults were identified.

The field data sheets for the discontinuity survey are presented in Table C.1 in Appendix C. A declination correction has not been applied to the dip direction values presented in the table. The dip and dip direction measurements collected in the field have been plotted as 'poles-to-planes' on a stereonet (Figure 2). A 14.3° declination correction was applied to the plotted data. The stereonet confirms the presence of four joint sets.

The vertical RQD values obtained from tunnel mapping are generally in the range of 85 to 90%. The horizontal RQD values measured are highly variable ranging from approximately 20% to 100%. The discontinuity spacing measurements are summarized in Table C.1 (Appendix C) and are summarized in Table 4.1 with respect to the different joint sets.

Table 4.1 Summary of Joint Set Spacings for Iron Gate Diversion Tunnel

Joint Set	Range of Values (ft)	General Range of Values (ft)
1	0.1 to 2	0.3 to 1.3
2	0.1 to 2.6	0.3 to 2.3
3	0.1 to 1.6	0.1 to 1.3
4	0.1 to 1.3	0.3 to 0.7

The general ranges of spacings for the four joint sets were used to determine lower- and upper-bound Jv values and to interpret lower- and upper-bound equivalent RQD values using the following formula:

$$RQD = 115 – (3.3xJv)$$

The calculated lower- and upper-bound equivalent RQD values for the Iron Gate Diversion Tunnel are 0% and 77%, respectively.

Slight seepage (approximately 1 drop every 2 seconds) was observed in the tunnel crown at STA. 453.7 ft (Photo 12, Appendix B) and STA. 509.5 ft (Photo 13, Appendix B). Seepage was also observed around the upstream concrete liner (Photo 14, Appendix B).

Wedge failures were observed in the tunnel crown at STA. 30.5 ft (6.5 ft x 6.5 ft x 2.3 ft), STA. 104.3 ft (approximately 35 ft^3), STA 380.6 ft (approximately 53 ft^3) (Photo 15, Appendix B), STA. 421.6 ft (10 foot-long wedge failure in crown with water seepage), and STA 454.4 ft (approximately 53 ft^3). The wedge failures generally occurred in the area of intersection between the tunnel walls and the crown and resulted from the intersection of the low angle Set 3 joints with the very steep Set 1 and Set 2 joints. An approximately 3-ft sized rock block has detached from the left wall at STA 286.4 ft.

Set 4 joints have formed the failure surface for at least two relatively small-scale (less than 1,750 ft^3) rockslides in the rock cut outside of the tunnel and adjacent to the spillway (Photo 16, Appendix B). Joints belonging to this set may have acted as a failure surface for the previous rockslide that covered the channel immediately downstream of the portal and was removed in 2007 as part of the rehabilitation project. The draped rock slope netting that has been installed on the rock cut in this area (Photo 17, Appendix B) will be effective in controlling the fall of rock blocks with a volume in the order of 35 ft^3.

4.2 COPCO 1 DIVERSION TUNNEL

4.2.1 GENERAL

The Copco No. 1 Diversion Tunnel is unlined from its downstream portal to the tunnel plug, which is located at approximately STA. 176.5 ft. The tunnel has a diameter of approximately 18.4 ft at the portal, 18 feet at STA. 108.3 ft and STA. 150.9 ft, and 15.1 ft at STA. 176.5 ft. There is an abrupt rise in the elevation of the tunnel invert at approximately STA. 109.3 ft and the water depth is generally shallower upstream of this point. Concentrated water flow (10 to 20 gallons per min.) was observed from the central portion of the tunnel crown at the concrete plug (Photo 18, Appendix B). The flow appeared to be channeled through a grout tube left in place in the upper plug. Water was also flowing from the valve in the lower portion of the plug and seeping from a recessed central portion of the plug that marks the location of the 'manway' (Photo 19, Appendix B). The depth of water in the tunnel at the time of the inspection ranged from about 0.6 to 2.3 ft. Suspended sediment was observed in the tunnel water.

4.2.2 ROCK MASS CHARACTERIZATION

The rock mass at the Copco No. 1 Diversion Tunnel is described as greenish dark grey, equi-granular, fine grained, and slightly to moderately weathered andesite. Schmidt hammer testing indicates the compressive strength of the rock is in the range of 29 to 45 MPa (600 to 950 ksf), i.e. Medium Strong Rock. The bedrock has a visible susceptibility to slaking; if a sample is left under a running tap, small (less than 1/16-inch in diameter) fragments start to detach after a few seconds. Three dominant joint sets were identified:

1. Dips 80° to 89° towards the west-northwest and east-southeast, rough, undulating with iron staining, open aperture (locally very wide with infill comprising weak to medium strong gravel size rock fragments and trace to some clayey sand), widely to very widely spaced with localized moderately closely spaced sections, medium to high persistence, localized seepage.
2. Dips 80° to 89° towards the north-northeast and south-southwest, rough, undulating with iron staining, open aperture (locally very wide with infill comprising weak to medium strong gravel size rock fragments, some soft clay, and a 8 to 12 inch-thick differentially weathered zone comprising weak to medium strong, moderately weathered rock), widely to very widely spaced, medium to high persistence, localized seepage.
3. Dips 10° to 20° towards the northeast, rough, undulating with iron staining, open aperture (locally very wide with infill comprising weak to medium strong gravel size rock fragments), widely to very widely spaced, medium to high persistence, localized seepage.

The contacts between lava flows can be seen in the bedrock outcrop above and adjacent to the downstream portal (Photos 20 and 21, Appendix B). The contacts between lava flows dip towards the northeast and have spacings ranging from approximately 6 to 23 feet. A contact was identified at the elevation of the tunnel, which is very wide with infill comprising weak, moderately weathered, gravel size rock fragments (Photo 21, Appendix B).

The field data sheets for the discontinuity survey are presented in Table C.2 of Appendix C. A declination correction has not been applied to the dip direction values presented in the table. The dip and dip direction measurements collected in the field have been plotted as 'poles-to-planes' on a stereonet (Figure 3). A 14.3° declination correction was applied to the plotted data. The stereonet confirms the presence of three joint sets.

The discontinuity spacing measurements are included in Table C.2 (Appendix C) and are summarized in Table 4.2 with respect to the different joint sets.

Table 4.2 Summary of Joint Set Spacings for Copco No. 1 Diversion Tunnel

Joint Set	Range of Values (ft)	General Range of Values (ft)
1	0.8 to 6.5	1 to 6.5
2	4 to 33	4 to 16.4
3	4.9 to 16.4	4.9 to 16.4

The general ranges of spacings of the three joint sets were used to determine lower- and upper-bound Jv values and to interpret lower- and upper-bound equivalent RQD values using the following formula:

$$RQD = 115 – (3.3xJv)$$

The interpreted RQD value is 100% for the Copco No.1 Diversion Tunnel rock mass.

The Set 1 and 2 joints are both characterized by a high persistence. Highly persistent joints belonging to these two sets can be seen in the bedrock outcrop above the downstream portal (Photo 22, Appendix B). There are at least two Set 1 joints that can be traced from reservoir level to the bedrock surface above the tunnel. A gully in the bedrock exposure above the downstream portal has developed along highly persistent Set 2 joints. In the outcrop, individual joints can be traced for approximately 50 to 65 ft and intersections of joints belonging to the two highly persistent joint sets were observed. Such high persistence leads to longer potential seepage pathways (up to approximately 115 ft).

Seepage was observed at 12 locations along the Copco No. 1 tunnel (e.g. Photos 23 and 24, Appendix B). The seepage locations were in the walls as well as the crown and were generally from highly persistent discontinuities (Photo 25, Appendix B). Water flow along the discontinuities has locally developed very wide, soil filled discontinuities with differentially weathered zones in the wall rock. The soil infill is generally up to 1 inch-thick and comprises weak to medium strong gravel size rock fragments with trace to some sand and trace clay (Photo 26, Appendix B). At STA. 105 ft, a Set 2 joint with approximately 3/4 to 2 inches of soil infill comprising weak to medium strong gravel size rock fragments with some soft clay was identified (Photo 27, Appendix B); there is an approximately 8 to 12 inch-wide differentially weathered zone adjacent to the joint comprising weak to medium strong, moderately weathered material.

The tunnel crown shows evidence of possible significant overbreak for approximately the first 15 ft heading upstream from the downstream portal (Photo 28, Appendix B).

4.3 ASSESSMENT OF Q VALUE PARAMETERS

Table 4.3 presents interpreted ranges of the input parameters from which estimations of appropriate Q values can be made.

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Table 4.3 Interpreted Ranges of Q Value Parameters

	Iron Gate	Copco No. 1
RQD	0 to 75%	80 to 100%
Joint Set Number (Jn)	15 (1)	9 (1)
Joint Roughness Number (Jr)	2	3
Joint Alteration Number (Ja)	1	3 to 1
Joint Water Reduction (Jw)	1	0.66 to 1.0
Stress Reduction Factor (SRF)	2.5	1 (2.5 (2))

NOTES:
1. FOR PORTALS USE 2.0 X JN.
2. SRF OF 2.5 TO BE APPLIED AT PORTALS AND POSSIBLY IN ANY LOCALIZED AREAS OF LIMITED LATERAL COVER.

The data in Table 4.3 can be used to asses ranges of Q value for the two tunnels. A lower-bound RQD of 80% was assumed from qualitative observations at the Copco No. 1 Diversion Tunnel in order to account for potential less favorable localized ground conditions.

As noted in Table 4.3, increased Jn and SRF values should be applied for the portal areas. Typically, these increased values are applied for approximately 15 to 33 ft from the portal face. There may also be sections of the tunnels with limited side cover that would justify the use of an increased SRF value. The tunnel walls show signs of disturbance, including irregular surfaces and open discontinuities; this is especially the case for the Iron Gate Diversion Tunnel. It is likely the disturbance can be attributed to methods used to excavate the tunnel. This disturbance can be accounted for in design by using an increased SRF of 2.5 for the entire length of the Iron Gate Diversion Tunnel.

The interpreted Jw values are based upon observations of groundwater seepage into the tunnel. The Jw values included in Table 4.3 are applicable for determining the temporary support requirement with respect to construction worker safety, however, the Jw values will not provide a realistic indication of the need for a water-proofing liner or the erosion potential of tunnel walls when affected by the full pressure head of the reservoirs.

5.0 DISCUSSION

5.1 IRON GATE DIVERSION TUNNEL

The rock mass at the Iron Gate Diversion Tunnel is characterized by closely spaced, open joints. The rock mass comprising the tunnel walls is heavily disturbed and exhibits a ‘loose’ condition. This is likely attributable to the original construction methods. Wedge-type failures resulting from the intersection of low angle and steeply inclined joints have occurred in the tunnel crown especially in the area of intersection between the tunnel walls and the crown. In 2007, additional stabilization works were installed along the first 125 feet of the tunnel. It is possible that the derived Q value parameters for the Iron Gate Diversion Tunnel will highlight the need for additional support measures, particularly in the remaining un-supported section; this would be consistent with the observation of past wedge failures in the tunnel crown in this area. It is recommended that a SRF of 2.5 be applied along the full length of the Iron Gate Diversion Tunnel to account for the disturbed nature of the rock mass. This value is based upon engineering judgement and a level of uncertainty should be assumed.

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5.2 COPCO NO. 1 DIVERSION TUNNEL

The rock mass at the Copco No. 1 Diversion Tunnel is characterized by highly persistent joints that are conduits for groundwater seepage. The intact rock material is weaker at the Copco No. 1 Diversion Tunnel compared to the Iron Gate Diversion Tunnel (medium strong compared to strong). The bedrock at the Copco No. 1 Diversion Tunnel has a visible susceptibility to slaking; if a sample is left under a running tap, small (less than 1/16-inch in diameter) fragments start to detach after a few seconds. This property of the rock material has potential implications with respect to the erosion potential of the tunnel walls. Erosion potential can be investigated further by undertaking slaking tests. It is possible that the Q value parameters derived in this study for the Copco No. 1 Diversion Tunnel will highlight the need for temporary support measures with respect to worker safety. This is especially the case in the vicinity of the downstream portal where there is no existing support and evidence of possible 'overbreak' has been observed.

The site inspection of the Copco No. 1 Diversion Tunnel noted pervasive weathering along the highly persistent discontinuities as a result of water seepage. Locally, this has resulted in the development of soil filled discontinuities. The high to very high persistence of the steeply inclined joints at the Copco No. 1 Diversion Tunnel means individual joints can yield a direct flow path from the bedrock surface into the tunnel over considerable distances. These characteristics result in significant uncertainty with respect to the interpreted ground conditions in the submerged section of the tunnel upstream of the plug. Highly persistent discontinuities that extend from the tunnel to the bedrock surface could be conduits of water flow into the tunnel under the full reservoir head and there is potential for a cyclic process whereby water flow along the discontinuities results in a progressive deterioration of rock mass quality and increases water flows into the tunnel. This process could be exacerbated by the bedrock being susceptible to slaking and erosion from running water. The apertures of the joints could progressively widen leading to increasing water flow. It would be challenging to develop a rigorous Lugeon testing program for the upstream section of the tunnel in order to investigate the connectivity of the highly persistent joints between the bedrock surface and the tunnel and the extent of deterioration of their condition.

5.3 TUNNEL PRESSURIZATION

Another design consideration will be the potential for water flow from the pressurized tunnel into the adjacent rock mass. The Jw values presented above will not provide a realistic indication of this. This geotechnical consideration could be addressed by undertaking arrays of lugeon tests within the tunnels.

Please do not hesitate to contact the undersigned with any questions regarding this letter report.

Yours truly,
Knight Piésold

Prepared: James Haley

Prepared: For: Jessica Galavan

Reviewed: Salina Yong

Approval that this document adheres to the Knight Piésold Quality System:

Attachments:

Figure 1 Rev A	Copco and Iron Gate Reservoirs – Published Geology
Figure 2 Rev A	Diversion Tunnel Structural Analysis – Iron Gate Structures
Figure 3 Rev A	Diversion Tunnel Structural Analysis – Copco No. 1 Structures
Appendix A	Reference Drawings (F-1109, A-33834, A-33833, AA-33835, C161, C260, 108369)
Appendix B	Photos (1 – 28)
Appendix C	Tables (C.1 to C.3)

References:

AECOM. (2018). Klamath River Renewal Project – Diversion Tunnel Visual Inspections, Iron Gate and Copco No. 1.

Barton, N., Lien, R. and Lunde, J. (1974). Engineering Classification of Rock Masses for the Design of Tunnel Support, NGI Publication 106, Oslo, *Rock Mechanics* 6: No. 4: 189 – 236.

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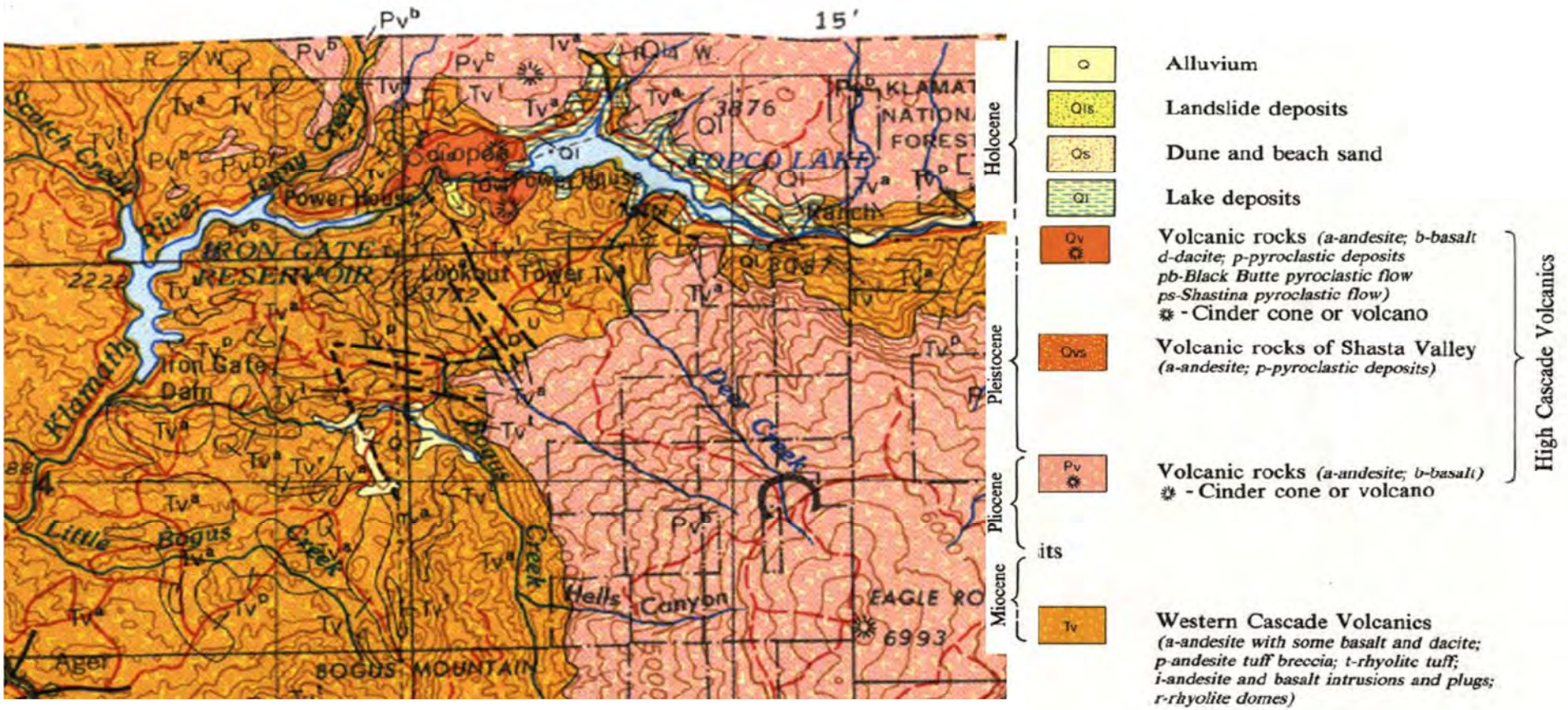
Wagner & Saucedo. (1987). Source Map: Geological Map of the Weed Quadrangle, scale 1:250,000.



NOTES:

1. NOT TO SCALE.
2. SOURCE MAP: GEOLOGICAL MAP OF THE WEED QUADRANGLE, CALIFORNIA, 1:250,000 (WAGNER AND SAUCEDO, 1987).

REV	DATE	DESCRIPTION	PREP'D	RVW'D
A	31JUL'19	ISSUED WITH REPORT	JAG	JEH

KIEWIT INFRASTRUCTURE WEST CO.

KLAMATH RIVER RENEWAL PROJECT

DIVERSION TUNNEL GEOTECHNICAL INSPECTION
COPCO AND IRON GATE RESERVOIRS
PUBLISHED GEOLOGY

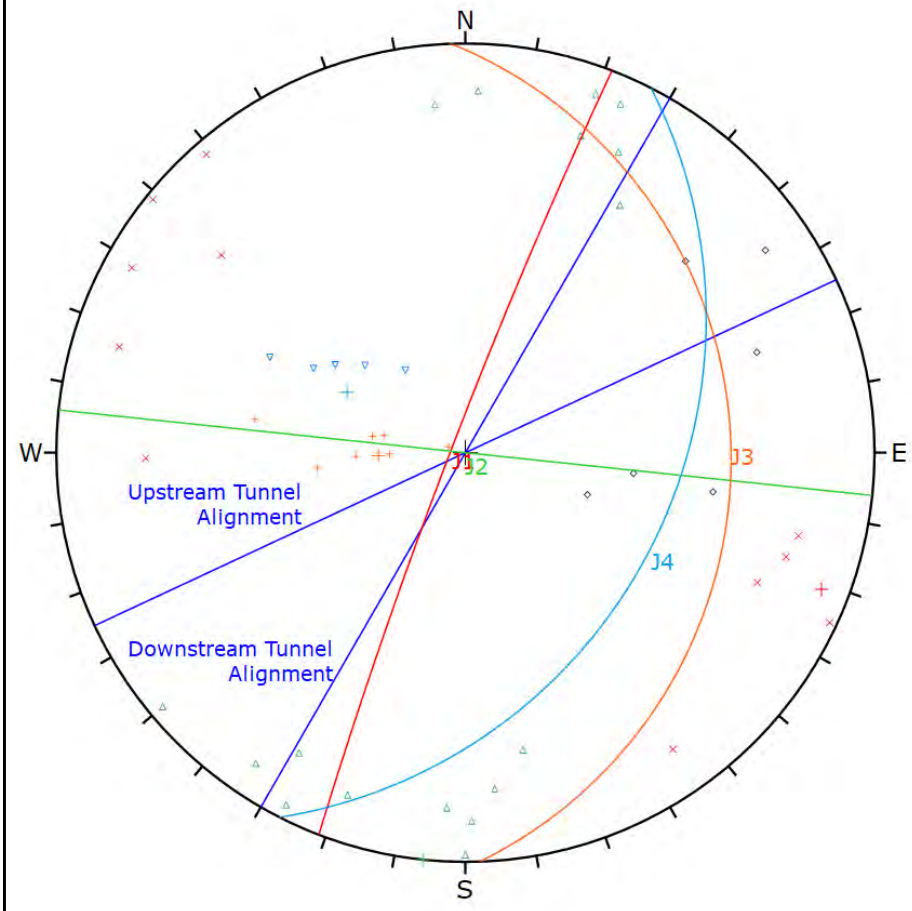
Knight Piésold CONSULTING

P/A NO. VA103-640/01

REF. NO. VA19-01344

FIGURE 1

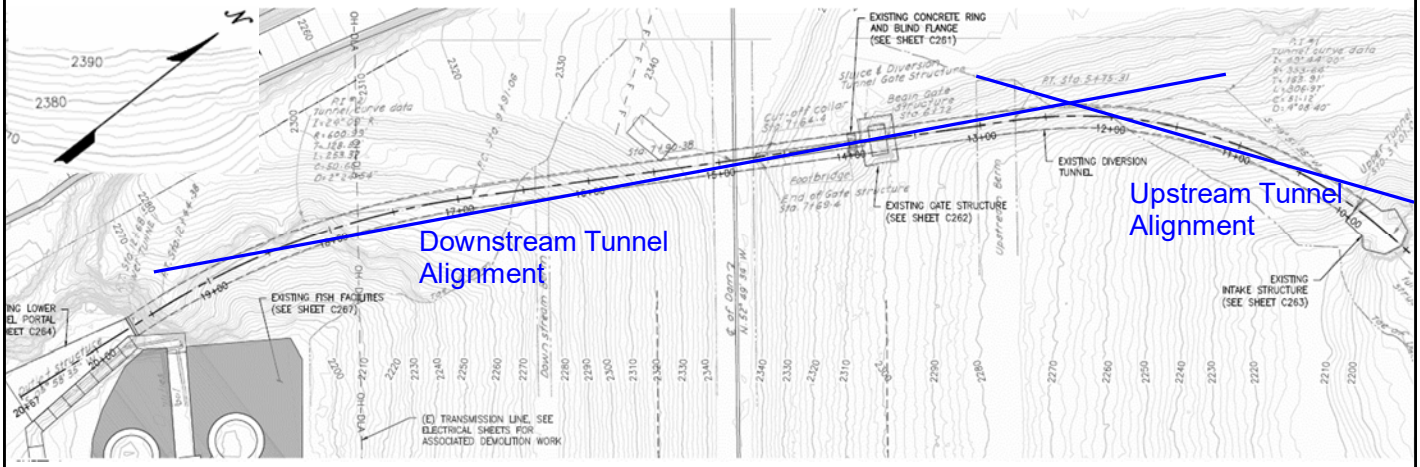
REV A



Symbol	SET #	Quantity
◇	-	6
×	1	11
△	2	17
+	3	7
▽	4	5

	Color	Dip	Dip Direction	Label
User Planes				
1		90	120	US Tunnel
2		90	155	DS Tunnel
Mean Set Planes				
1m		86	291	J1
2m		90	6	J2
3m		24	88	J3
4m		36	117	J4

Plot Mode	Pole Vectors
Vector Count	46 (46 Entries)
Hemisphere	Lower
Projection	Equal Angle



NOTES:
1. MAGNETIC DECLINATION OF 14.3 DEGREES APPLIED TO PLOT.
2. TUNNEL ALIGNMENT PLANES ARE APPROXIMATE AND CAPTURE THE DOMINANT TUNNEL ORIENTATIONS.

REV	DATE	DESCRIPTION	PREP'D	RVW'D
A	31JUL'19	ISSUED WITH REPORT	JAG	JEH

KIEWIT INFRASTRUCTURE WEST CO.

KLAMATH RIVER RENEWAL PROJECT

DIVERSION TUNNEL GEOTECHNICAL INSPECTION STRUCTURAL ANALYSIS IRON GATE

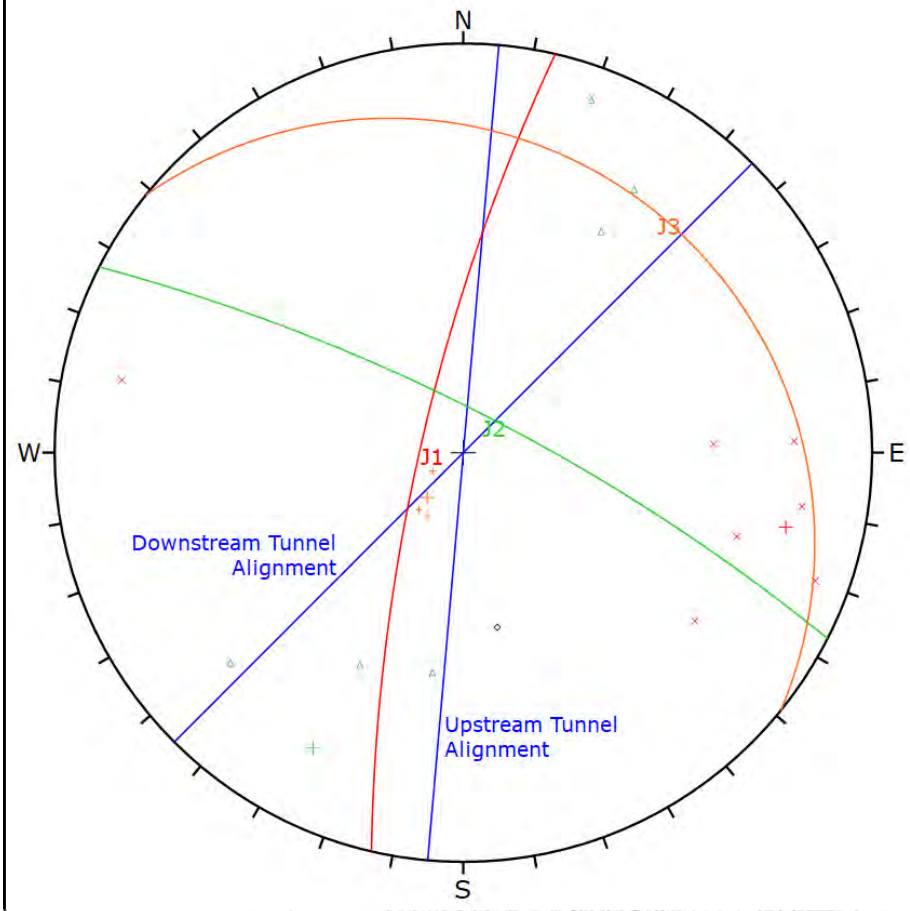
Knight Piésold CONSULTING

P/A NO. VA103-640/01

REF. NO. VA19-01344

FIGURE 2

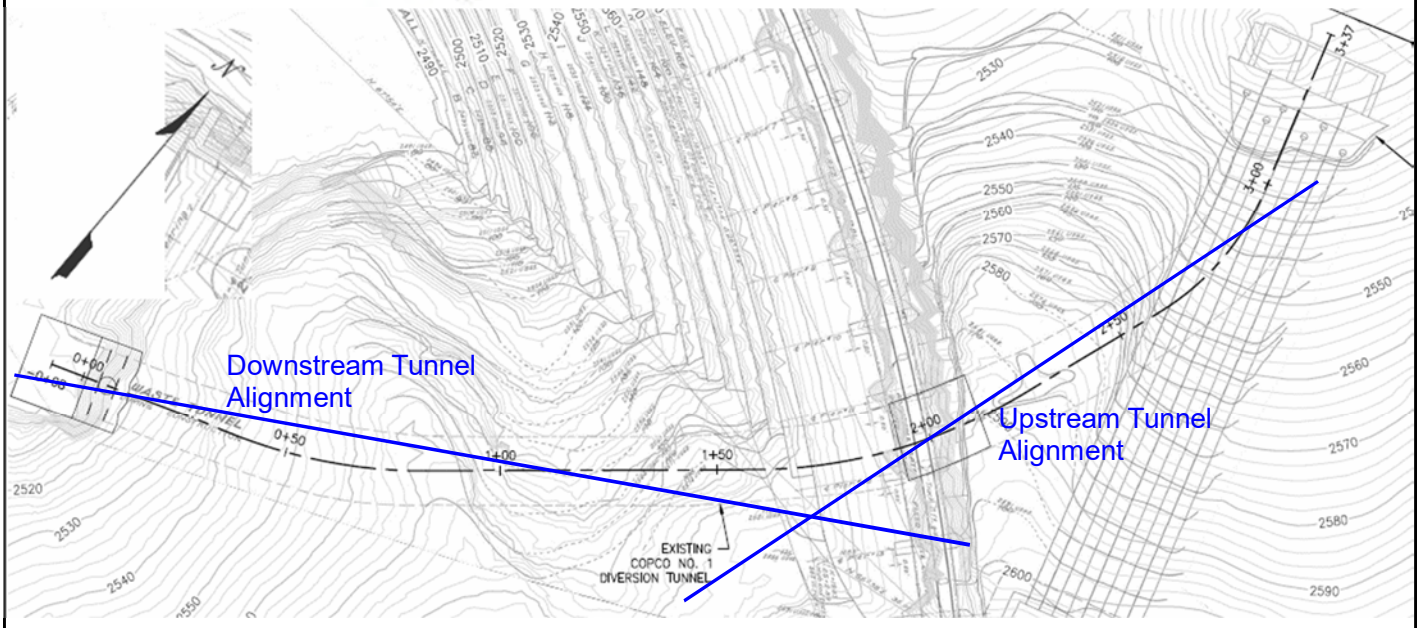
REV A



Symbol	SET #	Quantity
◇	-	1
×	1	7
△	2	6
+	3	3

	Color	Dip	Dip Direction	Label
User Planes				
1		90	315	US Tunnel
2		90	275	DS Tunnel
Mean Set Planes				
1m		78	283	J1
2m		78	27	J2
3m		16	39	J3

Plot Mode	Pole Vectors
Vector Count	17 (17 Entries)
Hemisphere	Lower
Projection	Equal Angle



NOTES:
1. MAGNETIC DECLINATION OF 14.3 DEGREES APPLIED TO PLOT.
2. TUNNEL ALIGNMENT PLANES ARE APPROXIMATE AND CAPTURE THE DOMINANT TUNNEL ORIENTATIONS.

KIEWIT INFRASTRUCTURE WEST CO.

KLAMATH RIVER RENEWAL PROJECT

DIVERSION TUNNEL GEOTECHNICAL INSPECTION STRUCTURAL ANALYSIS COPCO NO. 1

Knight Piésold CONSULTING

P/A NO. VA103-640/01

REF. NO. VA19-01344

FIGURE 3

REV A

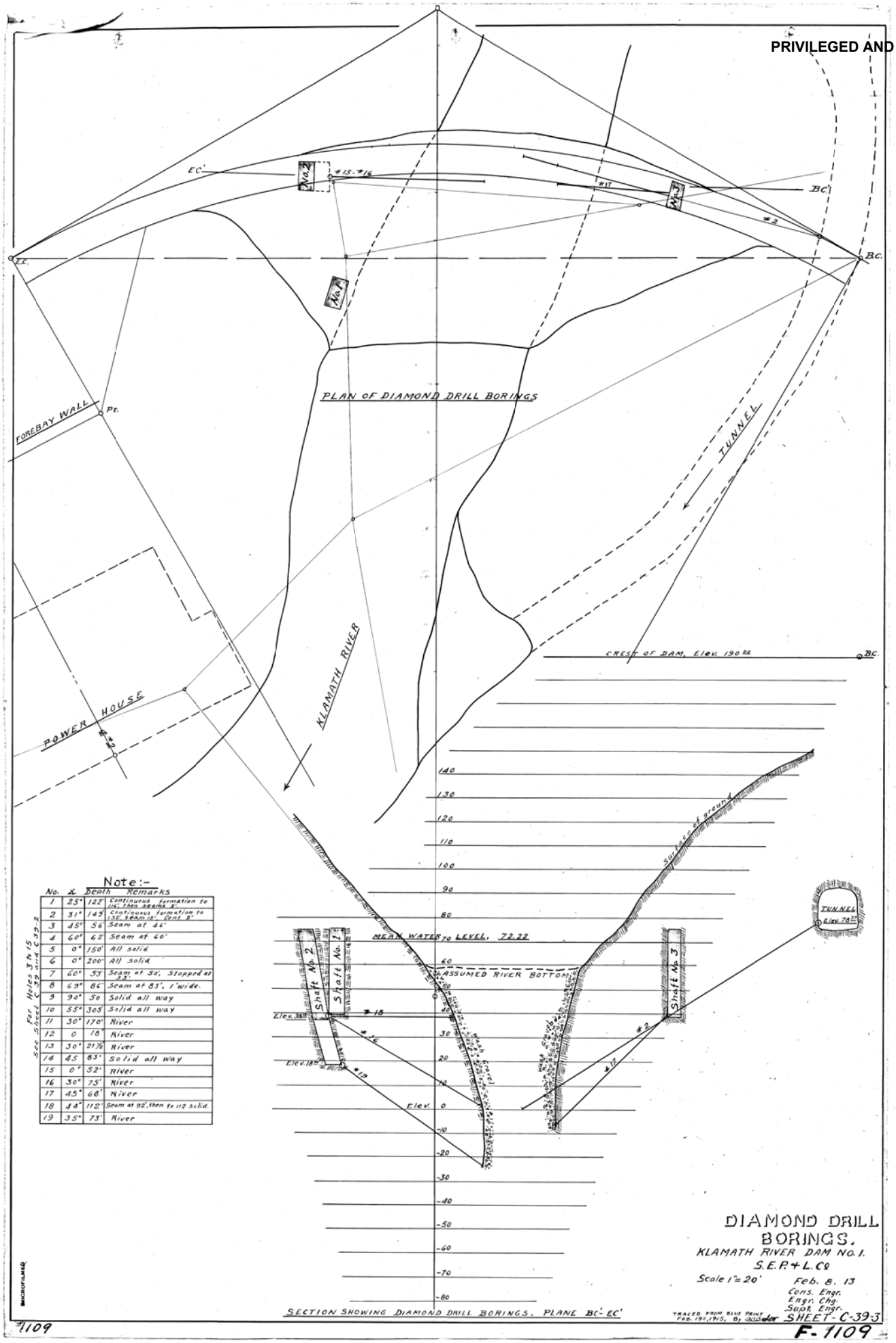
REV	DATE	DESCRIPTION	PREP'D	RVW'D
A	31JUL'19	ISSUED WITH REPORT	JAG	JEH

Knight Piésold CONSULTING

APPENDIX A

Reference Drawings

(Pages A-1 to A-8)



Note:-

For Holes 3 to 15 see Sheet C-39-2

No.	∠	Depth	Remarks
1	25°	122'	Continuous formation to 114', then seams ∠
2	31°	149'	Continuous formation to 132', seam is ∠ Cont. 2'
3	45°	56'	Seam at 46'
4	60°	62'	Seam at 60'
5	0°	150'	All solid
6	0°	200'	All solid
7	60°	53'	Seam at 50'; Stopped at 53'
8	69°	86'	Seam at 83', 1' wide.
9	90°	50'	Solid all way
10	55°	303'	Solid all way
11	30°	170'	River
12	0	18'	River
13	30°	21½	River
14	45°	83'	Solid all way
15	0°	52'	River
16	30°	75'	River
17	45°	68'	River
18	44°	112'	Seam at 92', then to 112 solid.
19	35°	75'	River

SECTION SHOWING DIAMOND DRILL BORINGS, PLANE BC-EC'

DIAMOND DRILL BORINGS.
KLAMATH RIVER DAM NO. 1.
S.E.P.+L.Co
Scale 1"=20' Feb. 8, 13
Cons. Engr.
Engr. Chg.
Supt. Engr.
SHEET-C-39-3

TRACED FROM BLUE PRINT Feb. 19?, 1915, By [illegible]

MICROFILMED

#1109

F-1109

COPCO 1
F-1109-01
DIAMOND DRILLS BORINGS

EXHIBIT J

IFC_Daggett_Bridge_Specifications(June2022)(Part10of13)(CEII)
(pages E17 to 23 of 56)

CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION (CEII)

PAGES REDACTED IN ENTIRETY

The redacted material qualifies as CEII pursuant to the Commission's rules because it contains sensitive dam safety and construction information that (a) relates details about the production, generation, transmission, or distribution of energy, (b) could be useful to a person planning an attack on critical infrastructure, (c) is exempt from mandatory disclosure under the Freedom of Information Act, and (d) gives strategic information beyond the location of the critical infrastructure. Accordingly, the Renewal Corporation has requested confidential treatment of this material pursuant to 18 C.F.R. § 388.113.

Knight Piésold CONSULTING

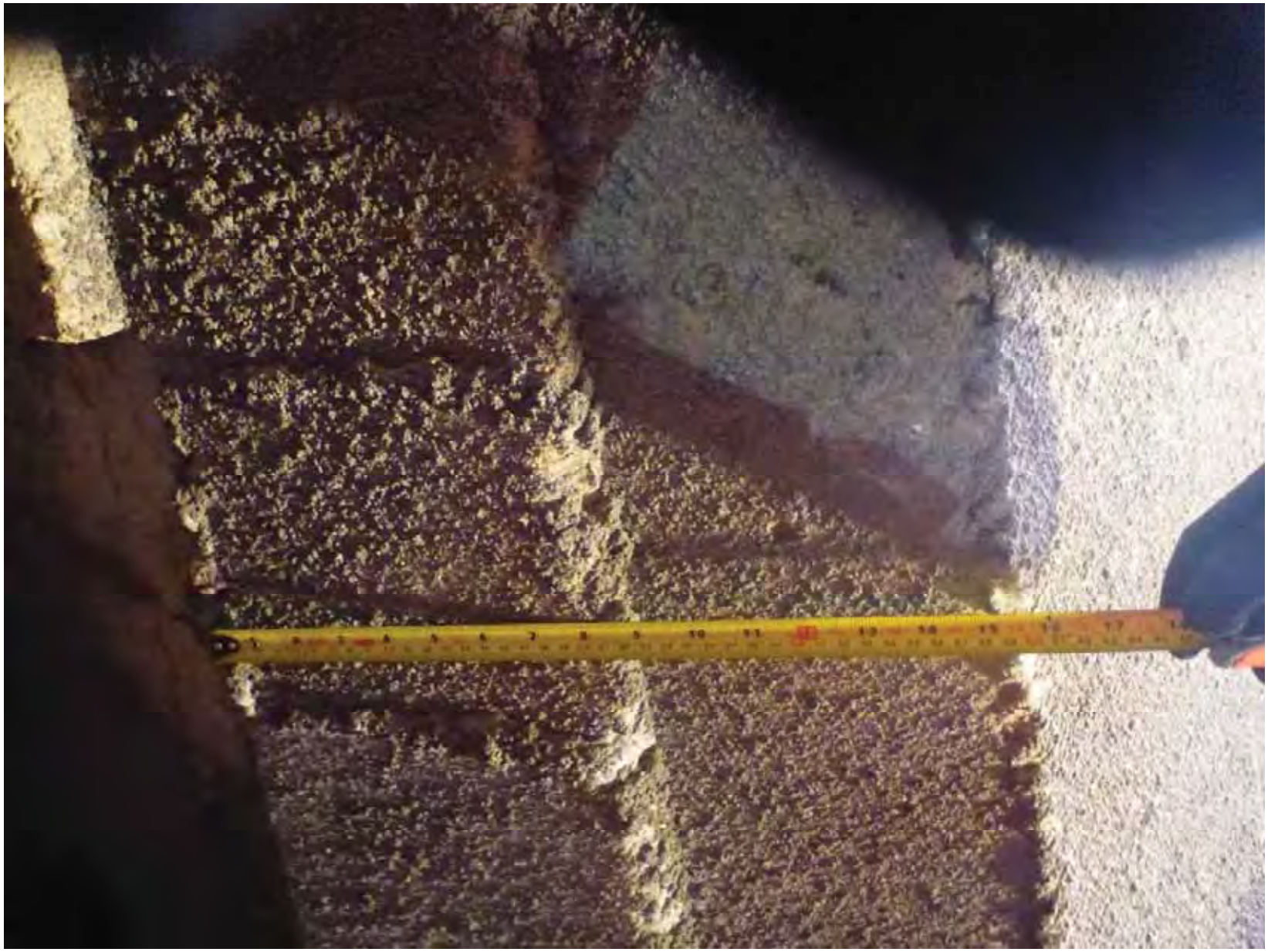
APPENDIX B

Photographs

(Pages B-1 to B-28)

Concrete Lining and Ventilation Pipe at Downstream Portal

Downstream Concrete Liner and Ventilation Pipe

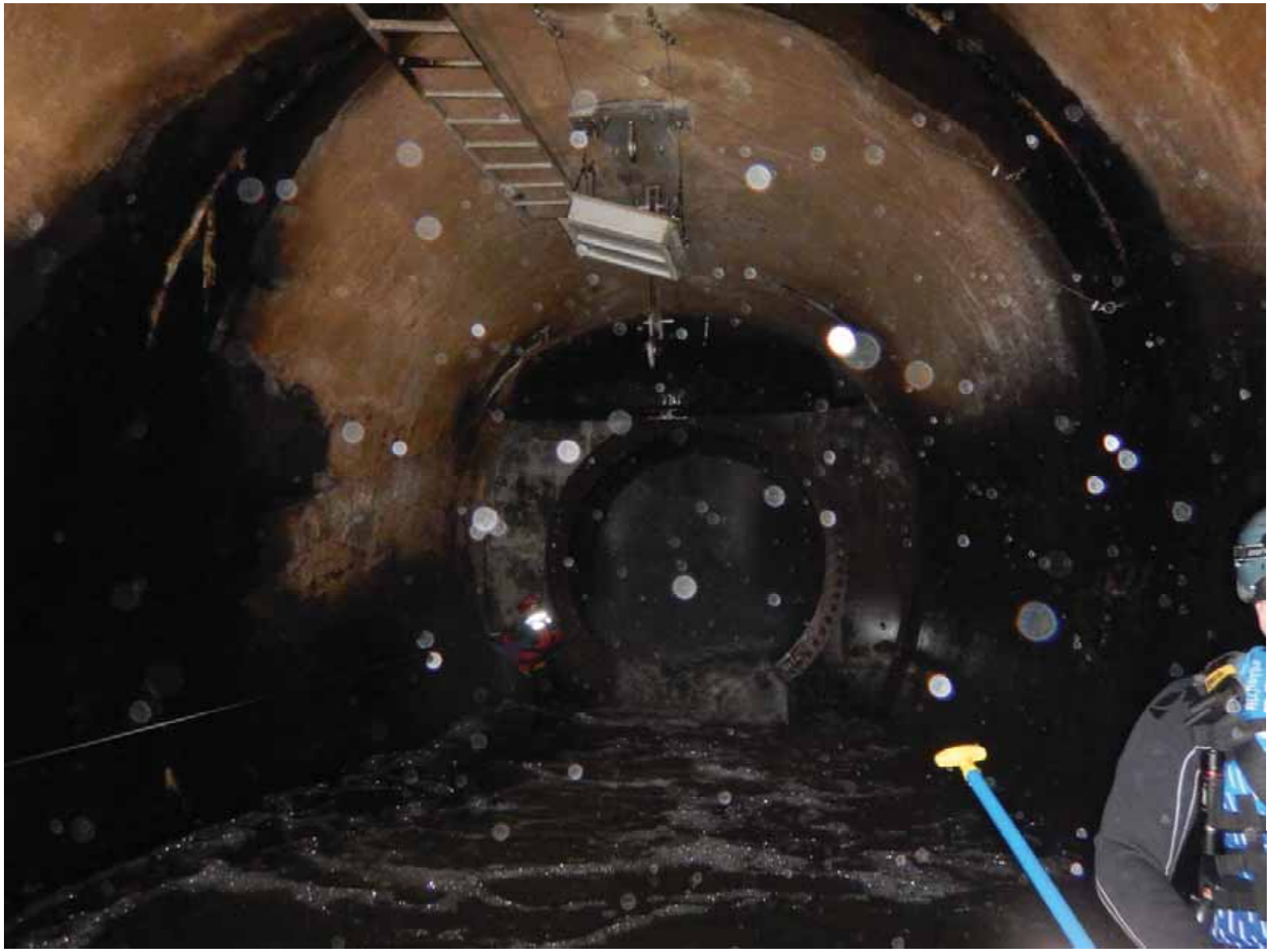


Profile of Left Wall of Downstream Concrete Liner

Profile of the tunnel crown in the shotcreted section is locally highly irregular suggesting the presence of a 'loose' closely jointed rock mass with previous crown instability

Right Wall of Downstream Concrete Liner

Shotcreted section with welded wire mesh and possible spot bolts



STA. 577.6 ft - Concrete Ring and Blind Flange

Water Level at Iron Gate Weir

STA. 286.4 ft - 'Rubble Pile' includes concrete as well as rock fragments. No obvious evidence of a rock fall from the tunnel crown at this location

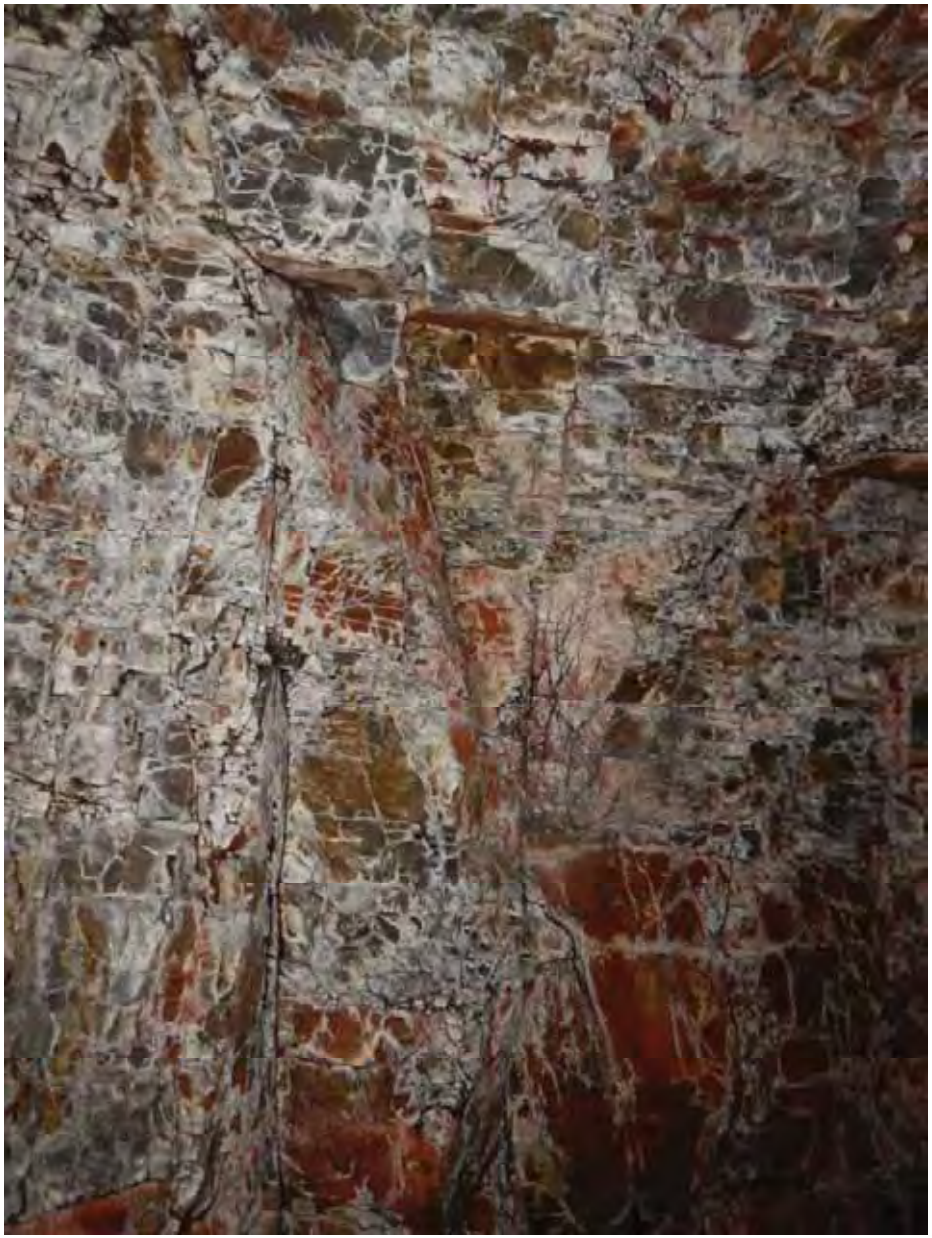
STA. 252.6 ft - Tunnel wall is developed along sub-vertical Set 1 Joint

STA. 253.6 ft – Very Steep Set 2 Joint with 1/16 to 1/4-inch of sandy clay infill

STA 453.7 ft – 9.8 ft long triangular wedge failure at crown/wall interface formed by intersection of Set 1 and Set 3 Joint. Note water seepage.

STA 509.5 ft – Seepage in Tunnel Crown

STA. 516.7 ft – Seepage observed around Upstream Concrete Liner



STA 380.6 ft - Triangular 53 ft3 wedge failure at crown/wall interface in area with very closely to closely spaced joints. The wedge was formed by the intersection of low angle Set 3 Joint with steep joints

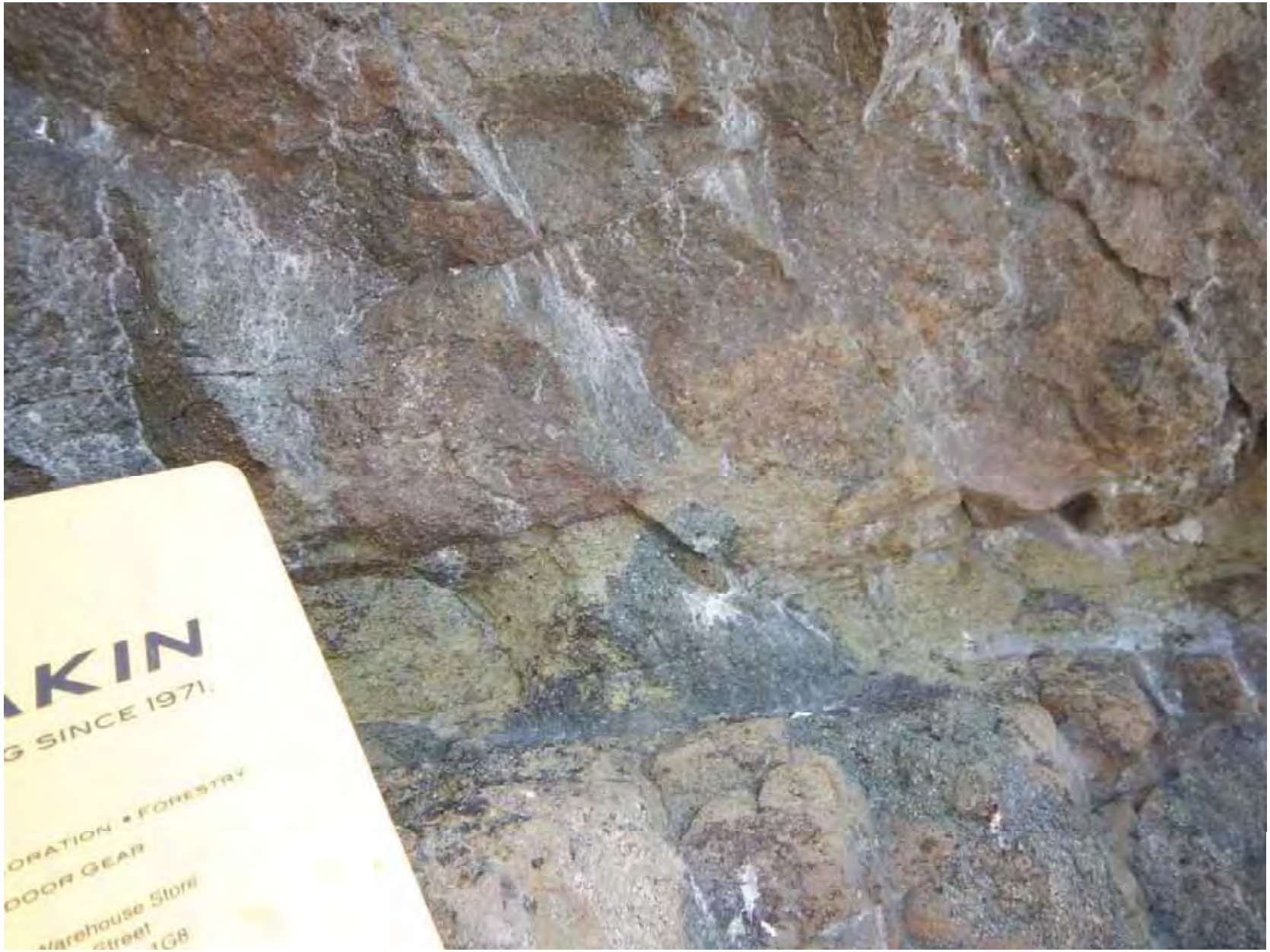
Rock Slides have occurred in the Rock Cut above the Spillway

Drape Wire Mesh installed at the Downstream Portal

STA 176.5 ft - Tunnel Plug - Water flow at tunnel crown and from valve

STA 176.5 ft - Tunnel Plug - Water flow at tunnel crown and seepage from top of recessed area of concrete

Copco No. 1 Diversion Tunnel – Downstream Portal



Contact between Lava Flows exposed in bedrock outcrop adjacent to the Downstream Portal

Knight Piésold CONSULTING

Klamath River Renewal Project
Findings of Tunnel Mapping
Copco No. 1 Tunnel

Photo 22

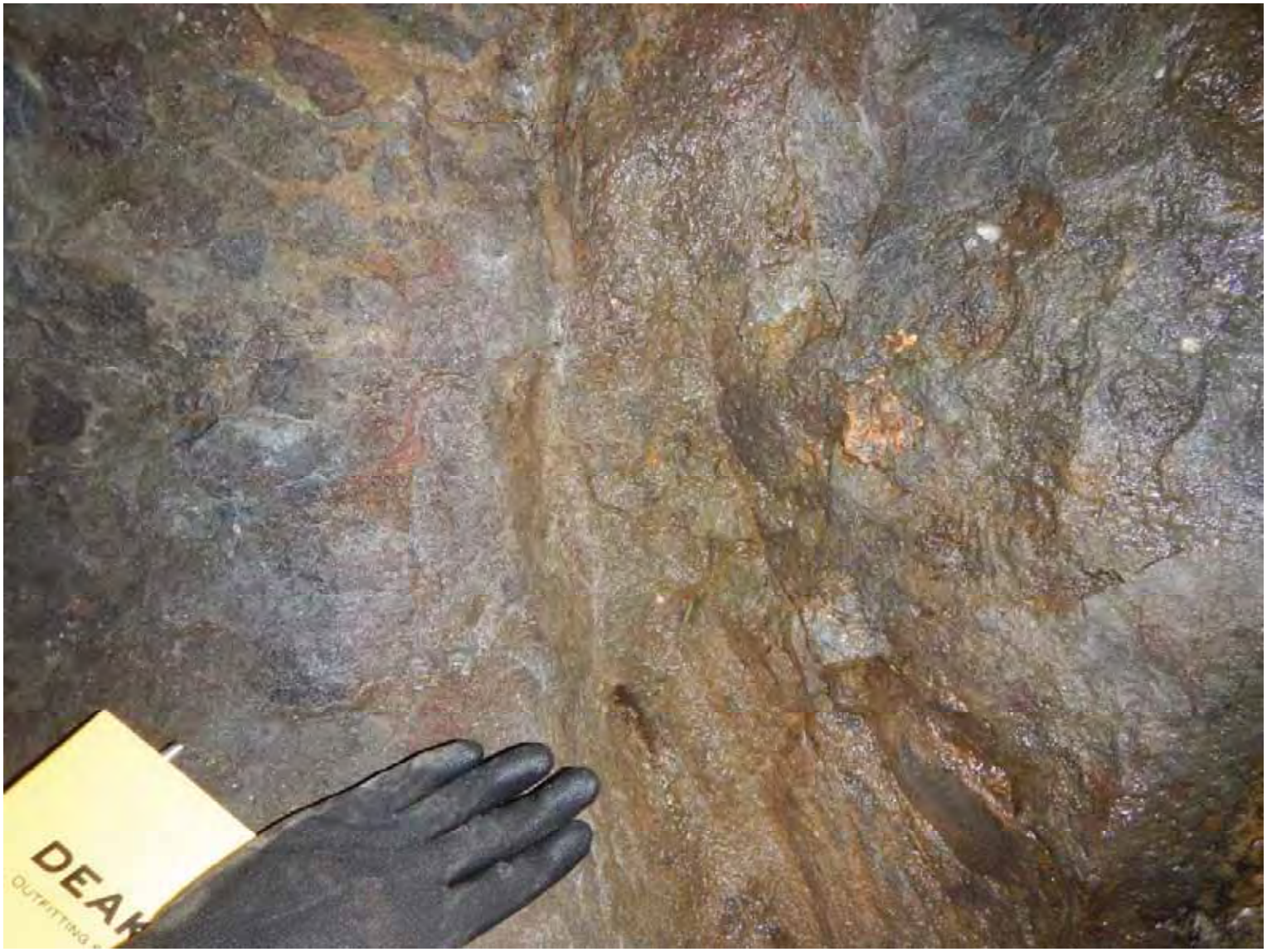
Date: July 10, 2019

STA. 108.3 ft – Seepage from Low angle Set 3 Discontinuity

STA. 144.4 ft – Seepage from Set 1 Joint

STA 44.6 to STA 49.2 ft - Highly persistent (up to 65 ft Set 1 Joint slightly oblique to tunnel alignment showing seepage. This joint possibly extends to the ground surface.

STA. 124.7 to 145.0 ft - Highly persistent Set 1 Joint, 1-inch wide with soil infill comprising weak to medium strong gravel size rock fragments with trace to some sand and trace clay



STA.105 ft Set 2 Joint, 1/16 to 1/4-inch wide with soil infill (weak to medium strong gravel size rock fragments with some soft clay), seepage. Differentially weathered zone is 8 to 12 inch-wide and comprises weak to medium strong material.

Overbreak observed in the first 15 ft of the Tunnel Crown from the Portal.

Knight Piésold CONSULTING

APPENDIX C

Tables

(Tables C.1 to C.3)

Knight Piésold CONSULTING

TABLE C.1

KIEWIT INFRASTRUCTURE WEST CO.
KLAMATH RIVER RENEWAL PROJECT

DIVERSION TUNNEL GEOTECHNICAL INSPECTION
IRON GATE STRUCTURAL MAPPING DATA

Location	Set Number	Dip	Dip Direction[1]	Type	Persistence Rating	Aperture Rating	Nature of Infill	Strength of Infill	Surface Roughness Rating	Surface Shape Rating	Water Flow Rating	Spacing Rating	Spacing (cm)	Remarks
Tunnel Chainage 19.4 ft	2	83	168	2	-	4	2	-	1 - 2	2 - 3	2	2 - 3	5 - 15	Hematite
Tunnel Chainage 19.4 ft	-	45	263	2	-	3	2	-	1 - 2	2 - 3	2	3 - 4	15 - 30	Hematite
Tunnel Chainage 19.4 ft	-	74	237	2	-	3	2	-	1 - 2	2 - 3	2	2 - 3	5 - 15	Hematite
Tunnel Chainage 145.3 ft	2	86	190	2	-	4	2	-	1 - 2	2 - 3	2	3 - 4	7, 6, 9, 50	Hematite + calcite
Tunnel Chainage 145.3 ft	3	5	95	2	-	3 - 4	2	-	1 - 2	2 - 3	2	3 - 4	9, 20, 40, 50	Hematite
Tunnel Chainage 145.3 ft	-	63	265	2	-	-	2	-	1 - 2	2 - 3	2	2 - 3	5 - 15	Local Fe staining
Tunnel Chainage 253.6 ft	1	86	105	2	2 - 3	-	-	-	-	-	-	-	-	Left wall formed along joint
Tunnel Chainage 253.6 ft	4	42	110	2	2	3 - 4	2	-	1 - 2	2 - 3	2	3 - 4	15 - 40	Hematite
Tunnel Chainage 253.6 ft	1	76	75	2	2	4	2, 3	-	1 - 2	2 - 3	2	3	15	Hematite, local silt infill
Tunnel Chainage 253.6 ft	2	80	15	2	-	5	2, 4	-	1 - 2	2 - 3	2	3 - 4	15 - 50	Hematite, localy with 1/16" - 1/4" of sandy clay infill
Tunnel Chainage 385.5 ft	-	71	215	2	2	4 - 7	2, 3	-	1 - 2	2 - 3	2	3 - 5	15, 30, 80, 150	Hematite, generally open, locally infilled with weak gravel sized fragments, some fines
Tunnel Chainage 385.5 ft	2	73	335	2	-	4	2	-	1 - 2	2 - 3	2	4 - 5	40, 70, 80	Hematite
Tunnel Chainage 385.5 ft	4	46	105	2	-	3 - 4	2	-	1 - 2	3	2	3 - 4	3 - 50, most 10 - 20	Hematite
Tunnel Chainage 508.9 ft	1	75	115	2	2	-	2	-	1 - 2	2 - 3	2	2 - 3	2 - 15, most 2 - 7	Hematite
Tunnel Chainage 508.9 ft	-	35	275	2	-	-	2	-	1 - 2	2 - 3	2	4	20 - 50	Hematite
Tunnel Chainage 508.9 ft	2	85	20	2	-	-	2	-	1 - 2	2 - 3	2	4	30 - 50	Hematite
Cut slope above portal	2	81	161	2	2 - 3	4 - 5	2	-	1 - 2	2 - 3	2	2 - 4	5 - 60	Hematite, joints dilated by blasting and freeze/thaw
Cut slope above portal	2	83	5	2	2 - 3	4 - 5	2	-	1 - 2	2 - 3	2	2 - 4	5 - 60	Hematite, joints dilated by blasting and freeze/thaw
Cut slope above portal	2	79	193	2	2 - 3	4 - 5	2	-	1 - 2	2 - 3	2	2 - 4	5 - 60	Hematite, joints dilated by blasting and freeze/thaw
Cut slope above portal	2	89	346	2	2 - 3	4 - 5	2	-	1 - 2	2 - 3	2	2 - 4	5 - 60	Hematite, joints dilated by blasting and freeze/thaw
Cut slope above portal	2	88	36	2	2 - 3	4 - 5	2	-	1 - 2	2 - 3	2	2 - 4	5 - 60	Hematite, joints dilated by blasting and freeze/thaw
Cut slope above portal	2	84	345	2	2 - 3	4 - 5	2	-	1 - 2	2 - 3	2	2 - 4	5 - 60	Hematite, joints dilated by blasting and freeze/thaw
Cut slope above portal	2	86	186	2	2 - 3	4 - 5	2	-	1 - 2	2 - 3	2	2 - 4	5 - 60	Hematite, joints dilated by blasting and freeze/thaw
Cut slope above portal	1	89	281	2	2 - 3	4 - 5	2	-	1 - 2	2 - 3	2	3 - 4	15 - 40	Hematite
Cut slope above portal	1	83	311	2	2 - 3	4 - 5	2	-	1 - 2	2 - 3	2	3 - 4	15 - 40	Hematite
Cut slope above portal	1	79	274	2	2 - 3	4 - 5	2	-	1 - 2	2 - 3	2	3 - 4	15 - 40	Hematite
Cut slope above portal	1	89	115	2	2 - 3	4 - 5	2	-	1 - 2	2 - 3	2	3 - 4	15 - 40	Hematite
Cut slope above portal	1	76	280	2	2 - 3	4 - 5	2	-	1 - 2	2 - 3	2	3 - 4	15 - 40	Hematite
Cut slope above portal	1	88	125	2	2 - 3	4 - 5	2	-	1 - 2	2 - 3	2	3 - 4	15 - 40	Hematite
Cut slope above portal	3	40	70	2	1	3	2	-	1 - 2	3	2	2 - 4	3 - 50	Hematite
Cut slope above portal	3	55	85	2	1	3	2	-	1 - 2	3	2	2 - 4	3 - 50	Hematite
Cut slope above portal	4	36	117	2	1	3	2	-	1 - 2	3	2	2 - 4	3 - 50	Hematite
Cut slope above portal	3	26	86	2	1	3	2	-	1 - 2	3	2	2 - 4	3 - 50	Hematite
Right bank downstream from portal	1	83	93	2	2 - 3	4 - 5	2	-	1 - 2	2 - 3	2	4	20 - 60	Iron staining
Right bank downstream from portal	1	80	270	2	2 - 3	4 - 5	2	-	1 - 2	2 - 3	2	4	20 - 60	Iron staining
Right bank downstream from portal	3	21	75	2	1	3 - 4	2	-	1 - 2	2 - 3	2	2 - 3	2 - 20	Local occurance only
Right bank downstream from portal	3	23	88	2	1	3 - 4	2	-	1 - 2	2 - 3	2	2 - 3	2 - 20	Local occurance only
Right bank downstream from portal	3	30	74	2	1	3 - 4	2	-	1 - 2	2 - 3	2	2 - 3	2 - 20	Local occurance only
Right bank downstream from portal	2	82	349	2	1 - 2	-	2	-	1 - 2	2 - 3	2	3	10 - 20	Hematite
Right bank downstream from portal	2	88	13	2	1 - 2	-	2	-	1 - 2	2 - 3	2	3	10 - 20	Hematite
Right bank downstream from portal	2	79	341	2	1 - 2	-	2	-	1 - 2	2 - 3	2	3	10 - 20	Hematite
Right bank downstream from portal	2	79	186	2	1	4	2	-	1 - 2	2 - 3	2	4	30 - 60	Locally iron stained
Right bank downstream from portal	4	28	130	2	1 - 2	-	2	-	1 - 2	2 - 3	2	2 - 3	5 - 20	Locally iron stained
Right bank downstream from portal	4	56	102	2	1 - 2	-	2	-	1 - 2	2 - 3	2	2 - 3	5 - 20	Locally iron stained
Right bank downstream from portal	-	83	222	2	2	4	2	-	1 - 2	2 - 3	2	3 - 4	20	Iron staining
Right bank downstream from portal	2	71	198	2	2	4	2	-	1 - 2	2 - 3	2	3 - 4	20	Iron staining

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NOTES:
1. REPORTED DIP DIRECTIONS HAVE NOT BEEN CORRECTED FOR SITE-SPECIFIC MAGNETIC DECLINATION.
2. THE ISRM (1978) LENGEND FOR STRUCTURAL MAPPING DATA IS PROVIDED IN TABLE C.3.

REV	DATE	DESCRIPTION	PREP'D	RVW'D
A	21AUG'19	ISSUED WITH REPORT VA103-640/01-VA19-01344	JAG	JEH

TABLE C.2

KIEWIT INFRASTRUCTURE WEST CO.
KLAMATH RIVER RENEWAL PROJECT

DIVERSION TUNNEL GEOTECHNICAL INSPECTION
COPCO NO. 1 STRUCTURAL MAPPING DATA

Location	Set Number	Dip	Dip Direction[1]	Type	Persistence Rating	Aperture Rating	Nature of Infill	Strength of Infill	Surface Roughness Rating	Surface Shape Rating	Water Flow Rating	Spacing Rating	Spacing (cm)	Remarks
Tunnel Chainage 5.9 ft	1	80	265	2	3	4 - 5	2	-	1	2	2	-	-	
Tunnel Chainage 16.1 ft	2	75	34	2	-	5	2	-	1	2	4	-	-	Minor Fe staining
Tunnel Chainage 0 - 52.5 ft	1	70	292	2	4	-	2	-	1	2	4	-	-	Fe staining
Tunnel Chainage 27.2 ft	2	60	12	2	3	-	2	-	1	2	2	5	120	
Tunnel Chainage 40.0 ft	2	65	198	2	3	-	2	-	1	2	2	-	-	Fe staining
Tunnel Chainage 40.0 - 85.3 ft	1	70	273	2	4	5 - 7	2, 8+	R2, R3	1	2	3	-	-	Gravel sized rock fragments
Tunnel Chainage 50.5 ft	1	85	276	2	-	-	2	-	1	2	2	5	80 - 120	
Tunnel Chainage 42.7 - 57.7 ft	3	20	16	9	3	-	2	-	1	2	2	-	-	
Tunnel Chainage 105.0 ft	2	85	186	2	3 - 4	7	2, 8+	R2, R3	1	2	8	-	-	medium strong to weak gravel sized rock fragments, some soft clay. Weathered zone is 8-12" wide (moderately weathered, weak to medium strong)
Tunnel Chainage 131.2 ft	1	81	88	2	2 - 3	4	2	-	1	2	2	-	-	Some Fe staining
Tunnel Chainage 124.7 - 145.0 ft	1	63	254	2	4 - 5	7	2, 8+	R2, R3	1	2	8	5 - 6	200	Weak to medium strong gravel sized rock fragments, trace to some clayey sand
Tunnel Chainage 149 ft	3	10	45	9	3	-	2	-	1	2	4	5	150	
Tunnel Chainage 142.7 ft	2	75	199	2	3 - 4	7	2, 8+	R2, R3	1	2	7	6 - 7	500 - 1000	Weak to medium strong gravel sized rock fragmetns
Right bank outside of portal	3	20	24	9	3	7	8+	R2	1	2	7	5 - 6	> 200	waek gravel sized fragments (moderately weathered), Fe stained
Right bank outside of portal	-	47	335	2	3 - 4	3 - 4	2	-	1	2	2	-	-	
Right bank outside of portal	1	78	254	2	2	-	2	-	1	2	2	4 - 5	25, 30, 65	
Right bank outside of portal	2	57	354	2	-	-	2	-	1	2	2	5 - 6	200	

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NOTES:
1. REPORTED DIP DIRECTIONS HAVE NOT BEEN CORRECTED FOR SITE-SPECIFIC MAGNETIC DECLINATION.
2. THE ISRM (1978) LENGEND FOR STRUCTURAL MAPPING DATA IS PROVIDED IN TABLE C.3.

REV	DATE	DESCRIPTION	PREP'D	RVW'D
A	21AUG'19	ISSUED WITH REPORT VA103-640/01-VA19-01344	JAG	JEH

Knight Piésold CONSULTING

TABLE C.3

KIEWIT INFRASTRUCTURE WEST CO.
KLAMATH RIVER RENEWAL PROJECT

DIVERSION TUNNEL GEOTECHNICAL INSPECTION
IRSM STRUCTURAL MAPPING LEGEND

Print Aug/27/19 9:12:20

Type	Persistence	Aperture/width	Nature of filling	Compressive strength of infilling (MPa)	Water flow (open)	Water flow (filled)
0. Fault zone	1. Very low persistence <1 m	1. Very tight (<0.1 mm)	1. Clean	S1 Very soft clay <0.025	0. The discontinuity is very tight and dry; water flow along it does not appear possible.	6. The filling materials are heavily consolidated and dry; significant flow appears unlikely due to very low permeability.
1. Fault	2. Low persistence 1-3 m	2. Tight (0.1-0.25 mm)	2. Surface staining	S2 Soft clay 0.025-0.05	1. The discontinuity is dry with no evidence of water flow.	7. The filling materials are damp, but no free water is present.
2. Joint	3. Medium persistence 3-10 m	3. Partly open (0.25-0.5 mm)	3. Non-cohesive	S3 Firm clay 0.05-0.10	2. The discontinuity is dry but shows evidence of water flow. i.e. rust staining, etc.	8. The filling materials are wet; occasional drops of water.
3. Cleavage	4. High persistence 10-20 m	4. Open (0.5-2.5 mm)	4. Inactive clay or clay matrix	S4 Stiff clay 0.10-0.25	3. The discontinuity is damp but no free water is present.	9. The filling materials show signs of outwash, continuos flow of water (estimate litres/minute).
4. Schistosity	5. Very high persistence >20 m	5. Moderately wide (2.5-10 mm)	5. Swelling clay or clay matrix	S5 Very stiff clay 0.25-0.50	4. The discontinuity shows seepage, occasional drops of water, but no continuous flow.	10. The filling materials are washed out locally; considerable water flow along out-wash channels (estimate litres/minute and describe pressure, i.e. low, medium, high).
5. Shear		6. Wide (>10 mm)	6. Cemented	S6 Hard clay >0.50	5. The discontinuity shows a continuous flow of water (Estimate 1/mm and describe pressure, i.e. low medium, high).	
6. Fissure		7. Very wide (1-10 cm)	7. Chlorite, talc or gypsum	R0 Extremely weak rock 0.25-1.0		
7. Tension Crack		8. Extremely wide (10-100 cm)	8. Other - specify	R1 Very weak rock 1.0-5.0		
8. Foliation		9. Cavernous (>1 m)		R2 Weak rock 5.0-25		
9. Bedding				R3 Medium strong rock 25-50		
				R4 Strong rock 50-100		
				R5 Very strong rock 100-250		
				R6 Extremely strong rock >250		

Surface shape	Surface roughness	Spacing
1. Stepped	1. Rough	1. Extremely close spacing <20 mm
2. Undulating	2. Smooth	2. Very close spacing 20 - 60 mm
3. Planar	3. Polished	3. Close spacing 60 - 200 mm
	4. Slickensided	4. Moderate spacing 200 - 600 mm
		5. Wide spacing 600 - 2000 mm
		6. Very wide spacing 2000 - 6000 mm
		7. Extremely wide spacing >6000 mm

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NOTES:

1. TABLE AFTER ISRM (1978).

REV	DATE	DESCRIPTION	PREP'D	RVW'D
A	21AUG'19	ISSUED WITH REPORT VA103-640/01-VA19-01344	JAG	JEH

APPENDIX F

Preliminary Services J.C. Boyle Scour Hole Inspection

(Pages F-1 to F-5)

APPENDIX F
PRELIMINARY SERVICES J.C. BOYLE SCOUR HOLE INSPECTION

1.0 INTRODUCTION

The Klamath River Renewal Project comprises the removal of four hydroelectric facilities on the Klamath River in southern Oregon and northern California. A 'Scour Hole' developed at the forebay area of the J.C. Boyle Hydroelectric Facility and is located on a terrace approximately 200 ft above the Klamath River. It is approximately 170 ft wide with very steep back slopes extending from the terrace platform at approximately 3,760 ft Elevation (EL.) to approximately 3,620 ft EL. The Scour Hole is located at the inside bend and the upstream end of a pronounced meander of the Klamath River. The J.C. Boyle Powerhouse Road is located behind the back slopes of the Scour Hole. The Scour Hole developed by water discharging along a short concrete-lined chute into the bypass reach of the Klamath River. This occurs following any load rejection at the powerhouse. The removal design involves backfilling the Scour Hole with concrete rubble and a topping layer of rock fill in order to create natural-looking topography.

Knight Piésold undertook an engineering geological inspection of the Scour Hole on July 8, 2019. Safety considerations restricted access to the toe and precluded close inspection of the geological materials exposed in the back slopes. Instead, observations were made from behind the safety fence located on the terrace. This approach limited the level and accuracy of mapping that could be reasonably undertaken. This appendix describes the findings of the engineering geological inspection of the Scour Hole.

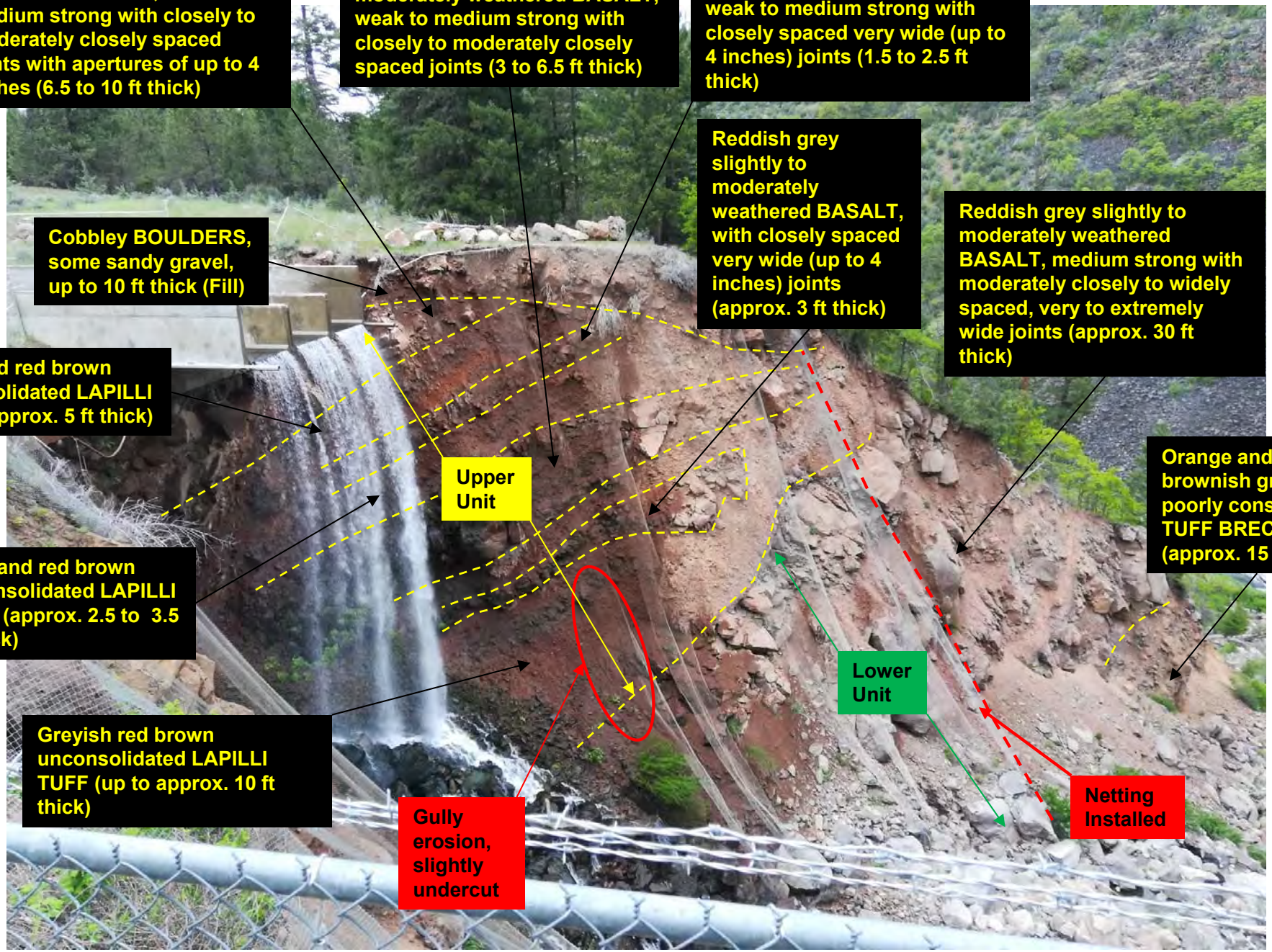
2.0 DESK STUDY

The regional bedrock geology is shown on the 1:500,000 scale geology map of Oregon published by the USGS (Walker and Macleod, 1981) and local mapping undertaken for the Spencer Creek 7.5-foot Quadrangle at a scale of 1:24,000 (Mertzman, 2008). The published mapping shows the bedrock at the site of the Scour Hole comprises the Lower Pleistocene age 'Basalt of Buck Lake' and shows northwest-southeast oriented geological faults.

3.0 FINDINGS OF INSPECTION

The field observations are presented on Figures F1 and F2, which include photos of the north and south faces of the Scour Hole, respectively. There is a surficial layer of fill on the terrace, which is up to approximately 10 ft thick and comprises cobbly boulders with some sandy gravel. The geological succession exposed in the back slopes can broadly be subdivided into an upper and a lower unit. On the north face of the Scour Hole, the upper unit predominantly comprises unconsolidated lapilli tuff inter-layered with gently dipping bands of (weak to medium strong) basalt and closely to moderately spaced joints. The joints are open with apertures up to approximately 4 inches. The lapilli tuff layers are approximately 5 ft to 10 ft thick and the basalt layers are between approximately 3 ft and 10 ft thick. On the south face, the upper unit predominantly comprises an approximately 30 ft to 40 ft thick layer of unconsolidated agglomerate underlying an approximately 10 ft to 13 ft thick layer of lapilli tuff. The lower unit is evident on the north face of the Scour hole. It predominantly comprises an approximately 30 ft to 40 ft thick band of (medium strong)

basalt with moderately spaced joints and apertures up to approximately 7 inches. There is a possible band of poorly consolidated tuff breccia at the toe of the north face of the Scour Hole.

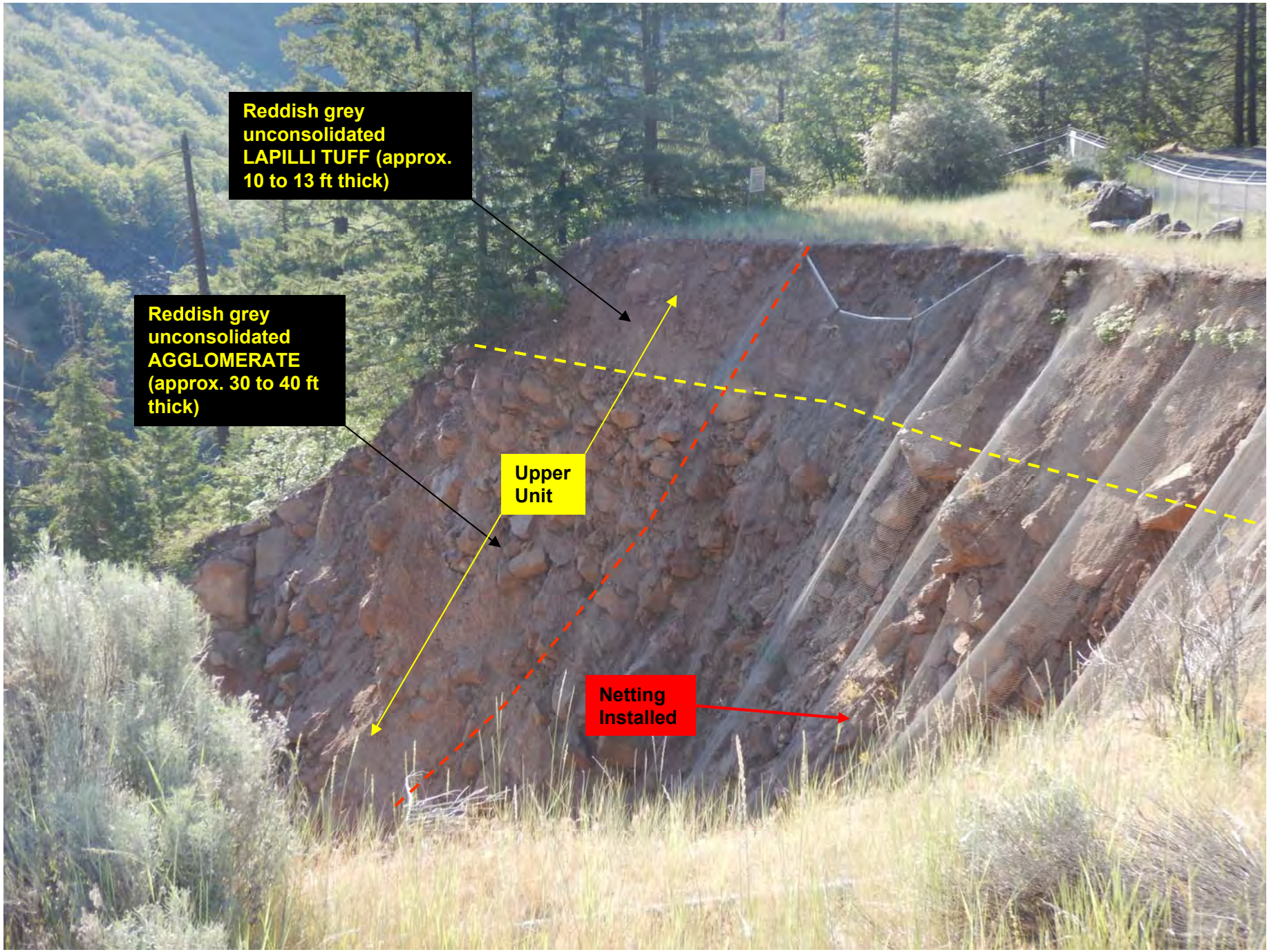


Knight Piésold CONSULTING

Klamath River Renewal Project
JC Boyle Hydroelectric Facility – Engineering Geological Inspection of Scour Hole – Observations (North Face)

Figure **F1**

Date: SEPT. 09, 2019



Knight Piésold CONSULTING

Klamath River Renewal Project
JC Boyle Hydroelectric Facility – Engineering Geological Inspection of Scour Hole – Observations (South Face)

Figure F2

Date: SEPT. 09, 2019

There is an abundance of boulder sized rock blocks at the toe of the escarpment extending out on the valley floor to the active channel of the Klamath River. It is interpreted that blocks were detached from the slopes during previous operational flow release events. The agglomerate at the South Face seems to be unconsolidated with voids being visible between the blocks. It is interpreted this slope segment is prone to boulder falls. The basalt layers exposed in both the upper and lower units are characterized by joints with very large apertures, and this likely renders the slopes to be inherently prone to rock fall. The basalt layers in the upper part of the succession generally protrude from the adjacent layers of lapilli tuff. There is a local development of gully erosion in the lowest band of lapilli tuff. It is interpreted that enhanced erosion of the lapilli tuff horizons undermines the basalt layers in the upper part of the succession contributing to the occurrence of rock falls. Draped wire mesh has been installed on the back slopes of the Scour Hole to mitigate the boulder fall and rock fall hazards.

4.0 DISCUSSION

It is interpreted the local volcanic activity that created the Basalt of Buck Lake came from northwest oriented fissures and that in the area of the meander bend, magma interacted with groundwater associated with the Klamath River to create explosive eruptions possibly creating a ‘tuff cone’. In these types of explosive eruptions, solidified magma is broken up into tiny fragments. These fragments fall back around the vent to form fine-grained layers of tuff. It is interpreted that cobble-sized and boulder-sized ‘volcanic bombs’ or ‘volcanic blocks’ (that did not break up) were ejected yielding layers of lapilli tuff, tuff breccia and agglomerate dependent upon the relative proportion of cobble-sized and boulder-sized clasts. It is interpreted these explosive interruptions were interspersed with non-explosive lava flows that yielded the basalt horizons.

The field inspection highlighted the existence of pronounced boulder fall and rock fall hazards in the back slopes of the Scour Hole. The geological materials exposed in the slopes have been broadly subdivided into an upper and lower unit, the former unit being more prone to erosion. It is recommended the remedial works at the Scour Hole be specifically designed to limit the exposure of workers to the identified hazards. A construction management plan should be developed to mitigate the risk to workers engaged in the remedial work. There is room to relocate the JC Boyle Powerhouse Road further away from the back slopes of the Scour Hole. This would allow the back slopes of the scour Hole to be benched downwards from the top of the terrace downwards thereby mitigating the boulder fall and rock fall risks to workers.

5.0 REFERENCES

Mertzman, S.A. 2008. Preliminary geologic map of the Spencer Creek 7.5’ Quadrangle, Klamath County, Oregon, Oregon Department of Geology and Mineral Industries Open File Report O-08-01.

Walker and Macleod. 1981. Geological Map of Oregon, scale 1:500,000 (USGS).

APPENDIX G

Preliminary Services Test Pit Program

Appendix G1 Test Pit Site Investigation Summary
Appendix G2 Test Pit Location Figures
Appendix G3 Test Pit Logs
Appendix G4 Test Pit Photographs
Appendix G5 Test Pit Lab Testing Summary Tables
Appendix G6 Test Pit Lab Testing Data

APPENDIX G1

Test Pit Site Investigation Summary

(Pages G1-1 to G1-6)

APPENDIX G1
TEST PIT SITE INVESTIGATION SUMMARY

1.0 INTRODUCTION

A test pit program was completed in January and February of 2020 by Knight Piésold (KP) to characterize soil geotechnical properties in support of the preliminary design of disposal sites at J.C. Boyle, Copco No. 1 and Iron Gate. The program also investigated potential borrow sources at Copco No. 1 and at Copco No. 2 and assessed the depth of fill material at the J.C. Boyle forebay. The test pit program comprised test pit excavation, hand-collected grab sampling, soil logging, and laboratory testing of select soil samples.

The proposed test pit locations were assessed, adjusted, and approved in the field by a PacifiCorp representative prior to excavation. This was completed at the California sites (Copco No. 1, Copco No. 2, and Iron Gate) on January 28 and at the Oregon sites (J.C. Boyle) on February 19, 2020. Test pit locations at the California sites were also adjusted in the field with input from an AECOM cultural resources monitor and a KP engineer to ensure that the excavation locations complied with cultural resources constraints and Occupational Health and Safety requirements. A cultural resource monitor did not assess the Oregon sites as archeological investigations had already been completed by BLM personnel at the J.C. Boyle forebay The J.C. Boyle disposal area did not require cultural resource monitoring.

Eleven test pits were excavated at the California sites from January 29 to 30, 2020. Seven test pits were excavated at the Oregon sites on February 20, 2020.

2.0 SITE INVESTIGATION

Test pits were excavated using a John Deere 120C excavator operated by Carlson's Construction Inc. Test pit depths ranged from 5.5 ft to 15 ft and were terminated due to either pit wall instability or refusal on boulders, bedrock, or compact soil material. The exposed soils in the pit walls and spoil piles were logged and photographed. Representative samples were collected in sealed, plastic bags for laboratory testing. All test pits were backfilled, and the surface was recontoured upon completion. A summary of the test pit data and samples collected are presented in Table 2.1. The locations of the test pits are presented in Appendix G2. The test pit and grab sample logs and photographs are included in Appendix G3 and G4, respectively.

Table 2.1 Summary of Test Pit and Grab Sample Site Investigations

Test Pit/Grab Sample ID	Easting[1] (ft)	Northing[1] (ft)	Elevation (ft)	Total Depth (ft)
TP-CO1-A	6,469,960.54	2,604,853.14	2,670.40	6.1
TP-CO1-B	6,469,746.47	2,604,699.08	2,662.59	7.7
TP-CO1-C	6,470,386.66	2,604,865.89	2,706.00	5.5
TP-CO1-D	6,469,659.79	2,604,743.01	2,660.72	11.0
TP-CO1-E	6,470,149.00	2,605,036.06	2,705.45	7.5
TP-CO2-A	6,464,465.72	2,603,234.11	2,382.47	5.8
TP-CO2-B	6,464,549.10	2,603,191.92	2,419.52	11.0
TP-IG-A	6,444,966.76	2,588,035.37	2,500.53	5.9
TP-IG-B	6,445,058.97	2,588,602.34	2,522.82	15.0
TP-IG-C	6,445,711.48	2,588,371.03	2,543.00	5.6
TP-IG-D	6,445,868.17	2,589,369.19	2,535.85	12.7
GRB01	6,470,033.30	2,605,107.59	2,712.59	Surface
GRB02	6,470,053.13	2,605,244.55	2,771.89	Surface
GRB03	6,464,276.26	2,603,438.29	2,349.00	0.8
GRB04	6,464,336.04	2,603,360.79	2,354.65	1.0
GRB05	6,464,382.57	2,603,387.09	2,370.15	1.0
TP-JCB-A	6,547,250.98	2,657,844.63	3,854.39	15.0
TP-JCB-B	6,547,577.95	2,657,886.72	3,850.55	14.0
TP-JCB-C	6,547,574.04	2,657,702.26	3,852.00	13.3
TP-JCB-D	6,548,010.63	2,657,751.97	3,847.17	9.0
TP-JCB-E	6,544,408.33	2,647,757.56	3,783.28	6.7
TP-JCB-F	6,544,345.47	2,647,918.34	3,796.19	9.0
TP-JCB-G	6,544,697.73	2,647,443.55	3,774.26	9.1

NOTES:

1. COORDINATES OF TEST PIT AND GRAB SAMPLE LOCATIONS MEASURED USING HANDHELD GPS AFTER TEST PIT BACKFILLING.
2. DATUM IS NAD 83 HARN, CALIFORNIA STATE PLAN, ZONE 1.
3. ELEVATIONS OF TEST PITS TAKEN FROM EXISTING LIDAR SURVEY.

2.1 LABORATORY TESTING

Laboratory testing is required to verify the soil descriptions presented in the geotechnical logs and to support civil design of the potential disposal sites and borrow source. Samples were selected to provide a range of index testing from the test pits within the areas of interest. Select samples were also tested to assess the chemical composition and durability of the proposed borrow material. The range of tests completed on a variety of samples from the site investigation locations are as follows:

- Particle Size Analysis (PSA) – ASTM D6913
- Hydrometers – ASTM D7928
- Atterberg Limits – ASTM D4318
- Moisture Content – ASTM D2216

- Modified Proctor – ASTM D1557
- Specific Gravity – ASTM D854, C127
- L.A. Abrasion – ASTM C131
- Slake Durability – ASTM D4644
- Modified Acid Base Accounting (ABA)
- Synthetic Precipitate Leaching Procedure (SPLP) – EPA 1312

Not all samples selected in the field were sent to the laboratories for testing, and not all tests were completed on every sample sent for testing. Samples were sent to the KP Soils laboratory in Denver, Colorado, the ACZ Laboratories in Steamboat Springs, Colorado, and Kumar and Associates in Denver, Colorado.

Laboratory testing results are provided in Appendix G5 and G6.

3.0 GEOTECHNICAL CHARACTERIZATION

Geotechnical site characterizations have been completed based on field observations for the study areas assessed during the test pit program and based on laboratory testing results.

3.1 J.C. BOYLE DISPOSAL SITE

Four test pits were excavated at the proposed J.C. Boyle disposal site as shown on Figure 1 in Appendix G2. The disposal site area has been previously disturbed, including recently by public vehicular traffic.

The four tests pits completed (TP-JCB-A through TP-JCB-D) were located at the eastern, northern, southern, and western disposal site area limits, respectively. The test pits ranged in depth between 9 and 15 ft, and were excavated from surface elevations ranging between El. 3,847 ft and 3,854 ft. The overburden encountered in the test pits was predominately silt. The poorly graded silt was stratified in layers ranging between approximately 2 and 8 feet thick that typically comprised silt combined with varying amounts of clay and sand. The surficial 2 to 3 ft was found to typically have higher sand content, a low plasticity, and was compact to dense. The surficial layer was underlaid by silt and clay, or silt and sand layers. Higher sand content in a layer corresponded with a lower plasticity, while layers with higher clay content were found to be highly plastic. The majority of layers were typically found to be firm to stiff with only the top 7 ft of TP-JCB-C were classified as soft to firm. All test pits except for TP-JCB-D intercepted a silt and clay layer that was highly plastic, grey, and firm to stiff. The high content clay layer was 2 to 6 ft thick and was located between elevations 3,848 ft and 3,836 ft. The bottom layer of each test pit was found to comprise silt and sand or predominately sand. All test pits were terminated between El. 3,840 and 3,836 ft.

The water table was encountered in TP-JCB-B, TP-JCB-C and TP-JCB-D approximately between El. 3,839 ft and 3,836 ft. TP-JCB-A extended to approximately El. 3,839 ft but did not encounter the water table.

3.2 J.C. BOYLE FOREBAY AREA

Three test pits were excavated at the J.C. Boyle forebay as shown on Figure 2 in Appendix G2. The test pits indicated a sand and gravel surface layer with increased silt and clay content observed in the surface material at the northernmost pit (TP-JCB-F).

Test pits TP-JCB-E and TP-JCB-G were observed to have similar material characteristics. The test pits were excavated from surface elevation 3,774 and 3,796 ft, respectively. The surficial 6 ft of both test pits was observed to comprise sand and gravel and included some subangular cobbles and is interpreted to be fill material. The sand and gravel was fine to coarse, and the gravel was rounded to subangular. The material was observed to be well graded, non-plastic, loose to compact, and dry to moist. The silt, clay and boulder content increased in the layer with depth, and the fines content plasticity was observed to increase from non-plastic to low plasticity. Both test pits terminated in a 1 to 2 ft thick gravel layer that is located approximately 6 ft below the surface. This layer comprised fine to coarse, angular gravel, and included some fine to coarse sand, some silt, some angular cobbles and boulders, and trace clay. The material was observed to be well graded, had low to medium plasticity, was firm, and was moist. TP-JCB-E and TP-JCB-G were terminated at 6.7 ft and 9.1 ft, respectively, after intercepting large boulders.

Test pit TP-JCB-F also comprised a surface sandy gravel layer that extended 6.0 ft below the surface that was interpreted to be fill. This layer was fine- to coarse-grained, rounded to subangular, and included some silt, some subangular cobbles and boulders, and trace clay. The material was observed to be well graded, have low to medium plasticity fines content, was loose to compact, and was moist. This layer was underlain by a silt and clay layer with some angular to subangular cobbles and boulders, and trace fine sand. The material was observed to be well graded, have medium plasticity, was firm, and moist. TP-JCB-F hit refusal at 9 ft after excavation was obstructed by large boulders.

The three test pits indicate a minimum surficial cap of 6 ft of sand and gravel fill material throughout the forebay site.

3.3 COPCO NO. 1 DISPOSAL SITE

Three test pits (TP-CO1-A, TP-CO1-B, and TP-CO1-D) were excavated at the proposed Copco No. 1 disposal site and one test pit (TP-CO1-C) was excavated east of the disposal site as shown on Figure 3 in Appendix G2.

The three test pits located at the proposed disposal site were generally observed to comprise a silty sand and gravel surface layer ranging from 3 ft to 5 ft thick. Underlying the upper surficial layer is a sand and gravel layer with cobbles and boulders that increase in frequency with depth. The silt and clay material in the upper layer was found to be medium to highly plastic, stiff to hard, and moist. The underlying sand and gravel layer had a lower fines content than the surficial layer. The underlying layer was found to be non-plastic, compact to dense and dry. TP-CO1-A and TP-CO1-B terminated in either bedrock or large boulders, at El. 2,664 ft and El. 2,655 ft, respectively. TP-CO1-D terminated due to instability of the excavated walls. The bedrock surface appears to slope to the west. Observations of the geological conditions at TP-CO1-C, located to the east of the borrow area, were similar to those of the three test pits located within the disposal site.

3.4 COPCO NO. 1 BORROW SOURCE

One test pit (TP-CO1-E) was excavated near the proposed Copco No. 1 borrow source along with the collection of two grab samples (GRB-01, GRB-02) as shown on Figure 3 in Appendix G2. The proposed borrow source has been previously used as a borrow source for the construction works at Copco No. 1 and Copco No. 2 facilities. The completed test pit was located approximately 50 ft south of the proposed borrow source due to access constraints and was situated in previously disturbed ground (as the site had been

historically used for railway infrastructure that has been demolished and buried). The soils encountered at TP-CO1-E are not a good representation of the material that is being proposed to be used for construction.

TP-CO1-E comprised a surficial sand and gravel layer approximately 2 ft deep and underlain by a 3 ft thick sand with silt and clay, which is underlain by a silty gravel with sand layer. The surface sand and gravel layer was observed to consist of rounded to subangular particles and to be fine- to coarse-grained, well graded, low to medium plasticity, included some subangular cobbles, and was moist. The sand with silt and clay layer was observed to be fine- to coarse-grained, well graded, included some subangular cobbles and boulders, had low to medium plasticity, was compact, and was moist. The silty gravel with sand layer was observed to comprise rounded to subangular (fine to coarse) particles, was well graded with some cobbles and boulders, had low plasticity, was compact, and moist. Inclusions of wood material, possibly from historic structure demolitions, were uncovered in the lower sand and gravel layer.

Grab samples from hand excavated pits were collected at the borrow source for classification and laboratory testing as excavator access to the borrow area was limited. The two hand samples comprised of a sand and gravel material that was observed to be angular, medium coarse to coarse, contained trace angular cobbles, was poorly graded, non-plastic, loose, and was dry.

3.5 COPCO NO. 2 POWERHOUSE BORROW SOURCE

Two test pits (TP-CO2-A, TP-CO2-B) were excavated at the Copco No. 2 penstocks and three grab samples were excavated at the proposed powerhouse borrow source, as shown on Figure 4 in Appendix G2. The two test pits were located to the south of the penstocks and powerhouse, while the three grab samples were collected from the area north of the penstocks and powerhouse.

The two test pits indicated the presence of a sand and gravel material at surface with layer thickness varying spatially. TP-CO2-A was excavated to an approximate depth of 6 ft and mostly consisted of the sand and gravel material with increased fines observed in the final six inches of the excavation. The sand and gravel layer was observed to range from poorly- to well graded with silt, and some cobbles and boulders observed with depth, had low plasticity, was compact to dense, and was moist.

TP-CO2-B comprised 1 ft of sand with silt and clay underlain by more than 9 ft of a sand and gravel material. The sand and gravel layer was observed to be typically subangular to angular, fine- to medium-grained, poorly to well graded with increased cobbles and boulders observed with increased depth, low plasticity, was compact, and dry.

The excavator could not reach the north side of the powerhouse where the majority of the proposed borrow material is located. Three grab samples were collected for classification and laboratory testing as a result. The three hand samples comprised of silty sand and sandy silt with clay materials observed to be fine- to coarse grained, poorly to well graded, had no to high plasticity, was compact, and was moist.

3.6 IRON GATE DISPOSAL SITE

Four test pits were excavated at the proposed Iron Gate disposal site as shown on Figure 5 in Appendix G2. The disposal site area has been previously disturbed as it was a borrow source for the original construction of the dam.

The two western test pits (TP-IG-A, TP-IG-B) comprised a surficial silt and clay layer approximately 2 ft to 3 ft thick that overlaid a sand and gravel unit. The two eastern test pits (TP-IG-C, TP-IG-D) solely comprised sand and gravel material.

The silt and clay layer ranged from well to poorly graded, low to high plasticity, and was moist. Grass root inclusions were observed in the first foot below the surface. The lateral extent of this silt and clay layer was not determined.

The sand and gravel layer was typically observed to be subangular to angular, ranged from poorly to well graded, was compact to very dense, and dry. This material was found in all four test pits and is likely characteristic of the historic borrow site.

4.0 CONCLUSION

This appendix provides geotechnical logs from the test pit program completed at Copco No.1, Copco No. 2, Iron Gate, and J.C. Boyle. Laboratory testing has been used to adjust and confirm the observations made in the field and is included in Appendix G5 and G6.

APPENDIX G2

Test Pit Location Figures

(Pages G2-1 to G2-5)

ATTACHMENT J

IFC_Daggett_Bridge_Specifications(June2022)(Part10of13)(CEII) (pages G2-1 to G2-5 of 5)

CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION (CEII)

PAGES REDACTED IN ENTIRETY

The redacted material qualifies as CEII pursuant to the Commission's rules because it contains sensitive dam safety and construction information that (a) relates details about the production, generation, transmission, or distribution of energy, (b) could be useful to a person planning an attack on critical infrastructure, (c) is exempt from mandatory disclosure under the Freedom of Information Act, and (d) gives strategic information beyond the location of the critical infrastructure. Accordingly, the Renewal Corporation has requested confidential treatment of this material pursuant to 18 C.F.R. § 388.113.

APPENDIX G3

Test Pit Logs

(Pages G3-1 to G3-30)

Contractor	Carlsons Construction	**Test Pit No**	**TP-CO1-A**	**Page**	1 of 1
Location	Copco No. 1 Disposal Area	**Equipment Used**	120C Deere Excavator	**Date Completed**	29/Jan/2020
Coordinates	6469960.344E, 2604853.612N	**Total Depth**	6.1 ft	**Logged By**	GOJ
Coordinate System	California State Plane Zone 1	**Elevation**	2670.4 ft	**Reviewed By**	CAV

DEPTH - (FT)	ELEVATION - (FT)	SAMPLE TYPE	SAMPLE NO	GRAPHIC LOG	MATERIAL DESCRIPTION	NOTES
0	2670				**SILTY GRAVEL** (0 to 4.8 ft) Silty GRAVEL, subangular to angular, fine to medium coarse, some sand, fine to coarse, some clay, trace subangular cobbles, trace boulders, gap-graded, low to medium plasticity, brown, massive, moist.	Cylindrical metal bar uncovered during excavation.
1	2669					
2	2668					
3	2667	GB	TP-CO1-A01			G: 41.3%, S:14.2%, Si: 31.1%, C:13.4% PL: 21, LL: 55, PI: 34 MC: 20.4%
4	2666					
5	2665				**SAND** (4.8 to 6.1 ft) SAND, subangular to angular, fine to medium coarse, some subangular cobbles, some subangular boulders, trace clay and silt, gap-graded, low plasticity, compact, light brown, massive, dry to moist.	Extended hole southwest to try to excavate deeper. Bedrock appears to slope downwards towards the southwest.
6						
	2664				End of Test Pit: 6.1 ft Bedrock/large boulders	

GENERAL REMARKS:

KIEWIT INFRASTRUCTURE WEST CO.
KLAMATH RIVER RESTORATION PROJECT

Knight Piésold CONSULTING

P/A NO.	REF. NO.	REV
VA103-00640/01	VA103-640/1-2	C

FIGURE G3-1

Contractor	Carlsons Construction	**Test Pit No**	**TP-CO1-B**	**Page**	1 of 1
Location	Copco No. 1 Disposal Area	**Equipment Used**	120C Deere Excavator	**Date Completed**	29/Jan/2020
Coordinates	6469746.473E, 2604699.08N	**Total Depth**	7.7 ft	**Logged By**	GOJ
Coordinate System	California State Plane Zone 1	**Elevation**	2662.6 ft	**Reviewed By**	CAV

DEPTH - (FT)	ELEVATION - (FT)	SAMPLE TYPE	SAMPLE NO	GRAPHIC LOG	MATERIAL DESCRIPTION	NOTES
1	2662				**SAND** (0 to 2.3 ft) SAND, fine to coarse, some gravel, some silt and clay, some rounded to subangular cobbles, poorly graded, medium to high plasticity, brown, root inclusions, massive, moist.	Cut through an old wire at surface (within 2 ft of surface).
2	2661					
3	2660				**SAND AND GRAVEL** (2.3 to 4 ft) SAND and GRAVEL, subangular, medium coarse, non-plastic, poorly graded, compact to dense, light brown, massive, dry.	
4	2659	GB	TP-CO1-B01		**SAND** (4 to 7.7 ft) SAND, fine to medium coarse, some silt and clay, low plasticity, poorly graded, compact to dense, light brown, massive, dry.	
5	2658					
6	2657					
7	2656	GB	TP-CO1-B02			G: 0.0%, S: 80.8%, Si and C: 19.2% PL: 39, LL: 52, PI: 13 MC: 29.9%
	2655				End of Test Pit: 7.7 ft Bedrock/large boulders	

GENERAL REMARKS:

KIEWIT INFRASTRUCTURE WEST CO.
KLAMATH RIVER RESTORATION PROJECT

Knight Piésold CONSULTING

P/A NO.	REF. NO.	REV
VA103-00640/01	VA103-640/1-2	C

FIGURE G3-2

Contractor	Carlsons Construction	**Test Pit No**	**TP-CO1-C**	**Page**	1 of 1
Location	Copco No. 1 Disposal Area	**Equipment Used**	120C Deere Excavator	**Date Completed**	29/Jan/2020
Coordinates	6470386.656E, 2604865.891N	**Total Depth**	5.5 ft	**Logged By**	GOJ
Coordinate System	California State Plane Zone 1	**Elevation**	2706 ft	**Reviewed By**	CAV

DEPTH - (FT)	ELEVATION - (FT)	SAMPLE TYPE	SAMPLE NO	GRAPHIC LOG	MATERIAL DESCRIPTION	NOTES
1	2705				**SILT AND GRAVEL** (0 to 2.1 ft) SILT and GRAVEL, fine to coarse, subangular, some sand, fine to coarse, some cobbles, some clay, well graded, low plasticity, dark brown, root inclusions, massive, moist.	
2	2704	GB	TP-CO1-C01			G: 33.2%, S:15.3%, Si: 34.0%, C: 14.8% PL: 22, LL: 38, PI: 16 MC: 22.6%
3	2703	GB	TP-CO1-C02		**SILT AND CLAY** (2.1 to 3.3 ft) SILT and CLAY, some gravel and cobbles, fine to coarse, subangular, trace sand, fine, well graded, medium to high plasticity, light red brown, massive, moist.	
4	2702	GB	TP-CO1-C03		**SAND AND GRAVEL** (3.3 to 4.6 ft) SAND and GRAVEL, medium coarse to coarse, angular, some angular cobbles, some silt and clay, well graded, low plasticity, compact, light red brown, massive, dry to moist.	
5	2701	GB	TP-CO1-C04		**SAND AND GRAVEL** (4.6 to 5.5 ft) SAND and GRAVEL, fine to coarse, angular, some angular cobbles, trace silt and clay, poorly graded, non-plastic, compact, darker brown than previous layer, massive, dry.	G: 53.4%, S: 40.3%, Si: 5.6%, C: 0.7% PL: NP, LL: NP, PI: NP MC: 5.2%
					End of Test Pit: 5.5 ft Material too compact to excavate/large boulders obstructing excavation	

GENERAL REMARKS:

KIEWIT INFRASTRUCTURE WEST CO.
KLAMATH RIVER RESTORATION PROJECT

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P/A NO.	REF. NO.	REV
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FIGURE G3-3

Contractor	Carlsons Construction	**Test Pit No**	**TP-CO1-D**	**Page**	1 of 2
Location	Copco No. 1 Disposal Site	**Equipment Used**	120C Deere Excavator	**Date Completed**	29/Jan/2020
Coordinates	6469659.788E, 2604743.011N	**Total Depth**	8.8 ft	**Logged By**	GOJ
Coordinate System	California State Plane Zone 1	**Elevation**	2660.7 ft	**Reviewed By**	CAV

DEPTH - (FT)	ELEVATION - (FT)	SAMPLE TYPE	SAMPLE NO	GRAPHIC LOG	MATERIAL DESCRIPTION	NOTES
0	2660				**SAND AND GRAVEL** (0 to 2.9 ft) SAND and GRAVEL, some silt and clay, subangular, well graded, low plasticity, dark brown, massive, moist.	Trace boulders observed at 2.33 ft below surface.
1						
2	2659					Attempted shear vane test with smallest vane at 3.33 ft - apparatus unable to rotate due to hardness of soil.
	2658					
3		GB	TP-CO1-D01		**CLAYEY SILT** (2.9 to 4.6 ft) Clayey SILT, poorly graded, medium to highly plastic, dark brown, stratified with underlying sand and gravel material with increased depth, hard, moist.	G: 3.8%, S: 10.6%, Si: 51.4%, C: 34.2% PL: 22, LL: 63, PI: 41 MC: 27.3%
4	2657					Some angular cobbles observed at 5.25 ft below surface. Overhangs in the pit walls and tension cracks on the ground around the pit developed during excavation between 7.5 ft to 8.58 ft. Boulders 17" across observed at 8.75 ft below surface.
	2656				**SILT** (4.6 to 11 ft) SILT, some clay, some sand, trace gravel, poorly graded, low plasticity, compact, light brown, moist.	
5		GB	TP-CO1-D02			G: 1.2%, S: 14.3%, Si: 61.3%, C: 23.2% PL: 41, LL: 59, PI: 18 MC: 30.1%
	2655					

GENERAL REMARKS:

KIEWIT INFRASTRUCTURE WEST CO.
KLAMATH RIVER RESTORATION PROJECT

Knight Piésold CONSULTING

P/A NO.	REF. NO.	REV
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FIGURE G3-4

Contractor	Carlsons Construction	**Test Pit No**	**TP-CO1-D**	**Page**	2 of 2
Location	Copco No. 1 Disposal Site	**Equipment Used**	120C Deere Excavator	**Date Completed**	29/Jan/2020
Coordinates	6469659.788E, 2604743.011N	**Total Depth**	8.8 ft	**Logged By**	GOJ
Coordinate System	California State Plane Zone 1	**Elevation**	2660.7 ft	**Reviewed By**	CAV

DEPTH - (FT)	ELEVATION - (FT)	SAMPLE TYPE	SAMPLE NO	GRAPHIC LOG	MATERIAL DESCRIPTION	NOTES
7	2654				**SILT** (4.6 to 11 ft) SILT, some clay, some sand, trace gravel, poorly graded, low plasticity, compact, light brown, moist.	Some angular cobbles observed at 5.25 ft below surface. Overhangs in the pit walls and tension cracks on the ground around the pit developed during excavation between 7.5 ft to 8.58 ft. Boulders 17" across observed at 8.75 ft below surface.
8	2653					
	2652					
9					End of Test Pit: 8.8 ft Terminated due to unstable ground	
10	2651					
	2650					
11						
	2649					

GENERAL REMARKS:

KIEWIT INFRASTRUCTURE WEST CO.
KLAMATH RIVER RESTORATION PROJECT

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P/A NO.	REF. NO.	REV
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FIGURE G3-4

Contractor	Carlsons Construction	**Test Pit No**	**TP-CO1-E**	**Page**	1 of 1
Location	Copco Borrow Site	**Equipment Used**	120C Deere Excavator	**Date Completed**	29/Jan/2020
Coordinates	6470149.001E, 2605036.055N	**Total Depth**	8 ft	**Logged By**	GOJ
Coordinate System	California State Plane Zone 1	**Elevation**	2705.5 ft	**Reviewed By**	CAV

DEPTH - (FT)	ELEVATION - (FT)	SAMPLE TYPE	SAMPLE NO	GRAPHIC LOG	MATERIAL DESCRIPTION	NOTES
0	2705				**SAND AND GRAVEL** (0 to 2 ft) SAND and GRAVEL, rounded to subangular, fine to coarse, some clay and silt, some subangular cobbles, well graded, low to medium plasticity, light brown, massive, moist.	
1						
	2704	GB	TP-CO1-E01			
2					**SAND** (2 to 5 ft) SAND, fine to medium coarse, some subangular cobbles and boulders, some silt and clay, well graded, low to medium plasticity, compact, light brown, massive, moist.	Overhangs forming and walls begin sloughing into pit at approximately 4.17 ft below surface
	2703					
3		GB	TP-CO1-E02			
	2702					
4						Angular boulders up to 17" across observed at approximately 5.42 ft below surface. Unable to approach pit close enough to lower in a measuring tape: depth measurements taken using the length of the excavator arm. Some boulders greater than 25" across observed at approximately 7.5 ft (depth approximated using excavator arm).
	2701					
5					**SILTY GRAVEL** (5 to 7.5 ft) Silty GRAVEL, fine to coarse, rounded to subangular, some sand, some cobbles and boulders, trace clay, well graded, low plasticity, compact, dark brown, inclusions of wood, massive, moist.	
	2700					
6						
	2699					
7		GB	TP-CO1-E03			G: 50.6%, S: 22.0%, Si: 23.0%, C: 4.4% PL: 24, LL: 30, PI: 6 MC: 16.9%
	2698					
8					End of Test Pit: 8 ft Terminated due to unstable ground	

GENERAL REMARKS:

KIEWIT INFRASTRUCTURE WEST CO.
KLAMATH RIVER RESTORATION PROJECT

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P/A NO.	REF. NO.	REV
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FIGURE G3-5

Contractor	Carlsons Construction	**Test Pit No**	**TP-CO2-A**	**Page**	1 of 1
Location	Copco No. 2 Penstock	**Equipment Used**	120C Deere Excavator	**Date Completed**	30/Jan/2020
Coordinates	6464465.716E, 2603234.113N	**Total Depth**	5.8 ft	**Logged By**	GOJ
Coordinate System	California State Plane Zone 1	**Elevation**	2382.5 ft	**Reviewed By**	CAV

DEPTH - (FT)	ELEVATION - (FT)	SAMPLE TYPE	SAMPLE NO	GRAPHIC LOG	MATERIAL DESCRIPTION	NOTES
0	2382				**SAND AND GRAVEL** (0 to 5.3 ft) SAND and GRAVEL, fine to coarse, trace angular cobbles, some silt, trace clay, well graded, low plasticity, compact to dense, dark brown, root inclusions, massive, moist.	
1	2381					
2	2380					
3		GB	TP-CO2-A01			G:39.9%, S: 34.8%, Si: 18.0%, C: 7.3% PL: 25, LL: 31, PI: 6 MC: 13.7%
	2379					
4	2378					
5	2377				**SAND** (5.3 to 5.8 ft) SAND, fine to coarse, some angular gravel and cobbles, some angular boulders up to 34", some silt and clay, well graded, low plasticity, compact to dense, dark brown, root inclusions, massive, moist.	
6					End of Test Pit: 5.8 ft Bedrock/large boulders	

GENERAL REMARKS:

KIEWIT INFRASTRUCTURE WEST CO.
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P/A NO.	REF. NO.	REV
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FIGURE G3-6

Contractor	Carlsons Construction	**Test Pit No**	**TP-CO2-B**	**Page**	1 of 2
Location	Copco No. 2 Penstocks	**Equipment Used**	120C Deere Excavator	**Date Completed**	30/Jan/2020
Coordinates	6464549.104E, 2603191.915N	**Total Depth**	11 ft	**Logged By**	GOJ
Coordinate System	California State Plane Zone 1	**Elevation**	2419.5 ft	**Reviewed By**	CAV

DEPTH - (FT)	ELEVATION - (FT)	SAMPLE TYPE	SAMPLE NO	GRAPHIC LOG	MATERIAL DESCRIPTION	NOTES
1	2419				**SAND** (0 to 1.3 ft) SAND, fine to coarse, some subangular to angular gravel, some silt and clay, trace subangular to angular cobbles, low to medium plasticity, well graded, dark brown, root inclusions, massive, moist	Metal drill rod uncovered during excavation.
		GB	TP-CO2-B01			
2	2418				**SANDY SILTY GRAVEL** (1.3 to 5 ft) Sandy silty GRAVEL, medium coarse, angular, some angular cobbles, trace angular boulders, trace clay, well graded, low plasticity, compact, light brown, root inclusions, massive, dry.	
3	2417					
4	2416	GB	TP-CO2-B02			G: 38.3%, S: 24.3%, Si: 20.0%, C: 5.7% PL: 21, LL: 33, PI: 12 MC: 7.0%
5	2415				**SAND AND GRAVEL** (5 to 11 ft) SAND and GRAVEL, fine to medium, angular, some angular cobbles, trace angular boulders, gap-graded, non-plastic, compact, light brown, root inclusions, massive, dry.	
	2414					

GENERAL REMARKS:

KIEWIT INFRASTRUCTURE WEST CO.
KLAMATH RIVER RESTORATION

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P/A NO.	REF. NO.	REV
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FIGURE G3-7

Contractor	Carlsons Construction	**Test Pit No**	**TP-CO2-B**	**Page**	2 of 2
Location	Copco No. 2 Penstocks	**Equipment Used**	120C Deere Excavator	**Date Completed**	30/Jan/2020
Coordinates	6464549.104E, 2603191.915N	**Total Depth**	11 ft	**Logged By**	GOJ
Coordinate System	California State Plane Zone 1	**Elevation**	2419.5 ft	**Reviewed By**	CAV

DEPTH - (FT)	ELEVATION - (FT)	SAMPLE TYPE	SAMPLE NO	GRAPHIC LOG	MATERIAL DESCRIPTION	NOTES
0	2413				**SAND AND GRAVEL** (5 to 11 ft) SAND and GRAVEL, fine to medium, angular, some angular cobbles, trace angular boulders, gap-graded, non-plastic, compact, light brown, root inclusions, massive, dry.	
7	2412					
8	2411					
9	2410					
10	2409					
11	2408				End of Test Pit: 11 ft Terminated due to unstable ground	

GENERAL REMARKS:

KIEWIT INFRASTRUCTURE WEST CO.
KLAMATH RIVER RESTORATION

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P/A NO.	REF. NO.	REV
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FIGURE G3-7

Contractor	Carlsons Construction	**Test Pit No**	**TP-IG-A**	**Page**	1 of 1
Location	Iron Gate Disposal Site	**Equipment Used**	120C Deere Excavator	**Date Completed**	30/Jan/2020
Coordinates	6444966.758E, 2588035.37N	**Total Depth**	5.9 ft	**Logged By**	GOJ
Coordinate System	California State Plane Zone 1	**Elevation**	2500.5 ft	**Reviewed By**	CAV

DEPTH - (FT)	ELEVATION - (FT)	SAMPLE TYPE	SAMPLE NO	GRAPHIC LOG	MATERIAL DESCRIPTION	NOTES
1	2500				**SILTY CLAY** (0 to 2.1 ft) Silty CLAY, some sand, fine to coarse, trace gravel, poorly graded, medium to high plasticity, stiff to hard, dark brown, root inclusions, massive, moist.	
2	2499	GB	TP-IG-A01			G: 10.3%, S: 18.0%, Si: 24.8%, C: 46.9% PL: 20, LL: 71, PI: 51 MC: 28.9%
3	2498				**SAND AND GRAVEL** (2.1 to 5.9 ft) SAND and GRAVEL, angular, medium coarse, uniformly graded, non-plastic, dense to very dense, light greyish brown, massive, dry.	
4	2497					
5	2496	GB	TP-IG-A02			
6	2495				End of Test Pit: 5.9 ft Compact material obstructing excavation	

GENERAL REMARKS:

KIEWIT INFRASTRUCTURE WEST CO.
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P/A NO.	REF. NO.	REV
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FIGURE G3-8

Contractor	Carlsons Construction	**Test Pit No**	**TP-IG-B**	**Page**	1 of 2
Location	Iron Gate Disposal Site	**Equipment Used**	120C Deere Excavator	**Date Completed**	30/Jan/2020
Coordinates	6445058.969E, 2588602.336N	**Total Depth**	15 ft	**Logged By**	GOJ
Coordinate System	California State Plane Zone 1	**Elevation**	2522.8 ft	**Reviewed By**	CAV

DEPTH - (FT)	ELEVATION - (FT)	SAMPLE TYPE	SAMPLE NO	GRAPHIC LOG	MATERIAL DESCRIPTION	NOTES
0	2522				**CLAY** (0 to 3.3 ft) CLAY, some sand, fine to coarse, some silt, trace gravel, fine to coarse, poorly graded, medium to high plasticity, compact to dense, brown, massive, moist.	
1						
2	2521					
3	2520	GB	TP-IG-B01			G: 3.4%, S: 13.3%, Si: 16.0%, C: 67.3% PL: 21, LL: 80, PI: 59 MC: 25.8%
4	2519				**GRAVELLY SANDY SILT** (3.3 to 15 ft) Gravelly sandy SILT, fine to coarse, subangular, fine to coarse, some clay, well graded, highly plastic, compact to dense, pale gray, massive, dry.	
5	2518	GB	TP-IG-B02			G: 26.1%, S: 25.3%, Si: 31.2%, C: 17.4% PL: 22, LL: 62, PI: 40 MC: 7.4%
6	2517					
7	2516					
	2515					

GENERAL REMARKS:

KIEWIT INFRASTRUCTURE WEST CO.
KLAMATH RIVER RESTORATION PROJECT

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P/A NO.	REF. NO.	REV
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FIGURE G3-9

Contractor	Carlsons Construction	**Test Pit No**	**TP-IG-B**	**Page**	2 of 2
Location	Iron Gate Disposal Site	**Equipment Used**	120C Deere Excavator	**Date Completed**	30/Jan/2020
Coordinates	6445058.969E, 2588602.336N	**Total Depth**	15 ft	**Logged By**	GOJ
Coordinate System	California State Plane Zone 1	**Elevation**	2522.8 ft	**Reviewed By**	CAV

DEPTH - (FT)	ELEVATION - (FT)	SAMPLE TYPE	SAMPLE NO	GRAPHIC LOG	MATERIAL DESCRIPTION	NOTES
9	2514				**GRAVELLY SANDY SILT** (3.3 to 15 ft) Gravelly sandy SILT, fine to coarse, subangular, fine to coarse, some clay, well graded, highly plastic, compact to dense, pale gray, massive, dry.	
10	2513					
11	2512					
12	2511					
13	2510					
14	2509					
15	2508				End of Test Pit: 15 ft Terminated due to maximum reach of excavator	
	2507					

GENERAL REMARKS:

KIEWIT INFRASTRUCTURE WEST CO.
KLAMATH RIVER RESTORATION PROJECT

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P/A NO.	REF. NO.	REV
VA103-00640/01	VA103-640/1-2	C

FIGURE G3-9

Contractor	Carlsons Construction	**Test Pit No**	**TP-IG-C**	**Page**	1 of 1
Location	Iron Gate Disposal Site	**Equipment Used**	120C Deere Excavator	**Date Completed**	30/Jan/2020
Coordinates	6445711.477E, 2588371.028N	**Total Depth**	5.6 ft	**Logged By**	GOJ
Coordinate System	California State Plane Zone 1	**Elevation**	2543 ft	**Reviewed By**	CAV

DEPTH - (FT)	ELEVATION - (FT)	SAMPLE TYPE	SAMPLE NO	GRAPHIC LOG	MATERIAL DESCRIPTION	NOTES
					ORGANICS (0 to 0.5 ft) Dark topsoil, grasses, roots.	
1	2542				**SAND** (0.5 to 4 ft) SAND, medium to coarse, some gravel, subangular to angular, poorly graded, non-plastic, compact to dense, pale gray, massive, dry.	
2	2541					
3	2540					
4	2539				**SAND** (4 to 5.6 ft) SAND, medium to coarse, some gravel and cobbles, subangular to angular, trace boulders, poorly graded, non-plastic, dense to very dense, pale gray, massive, dry.	Hard excavation.
5	2538	GB	TP-IG-C01			
					End of Test Pit: 5.6 ft Compact material obstructing excavation	

GENERAL REMARKS:

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KLAMATH RIVER RESTORATION PROJECT

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P/A NO.	REF. NO.	REV
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FIGURE G3-10

Contractor	Carlsons Construction	**Test Pit No**	**TP-IG-D**	**Page**	1 of 2
Location	Iron Gate Disposal Site	**Equipment Used**	120C Deere Excavator	**Date Completed**	30/Jan/2020
Coordinates	6445868.17E, 2589369.193N	**Total Depth**	12.7 ft	**Logged By**	GOJ
Coordinate System	California State Plane Zone 1	**Elevation**	2535.9 ft	**Reviewed By**	CAV

DEPTH - (FT)	ELEVATION - (FT)	SAMPLE TYPE	SAMPLE NO	GRAPHIC LOG	MATERIAL DESCRIPTION	NOTES
1	2535				**SAND AND GRAVEL** (0 to 9 ft) SAND and GRAVEL, medium coarse, rounded to subangular, some cobbles, well graded, non-plastic, compact to dense, light yellow brown, massive, dry.	
2	2534	GB	TP-IG-D01			
3	2533					Increased number of cobbles observed with depth from 2.67 ft.
4	2532					
5	2531					
6	2530					
	2529					

GENERAL REMARKS:

KIEWIT INFRASTRUCTURE WEST CO.
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P/A NO.	REF. NO.	REV
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FIGURE G3-11

Contractor	Carlsons Construction	**Test Pit No**	**TP-IG-D**	**Page**	2 of 2
Location	Iron Gate Disposal Site	**Equipment Used**	120C Deere Excavator	**Date Completed**	30/Jan/2020
Coordinates	6445868.17E, 2589369.193N	**Total Depth**	12.7 ft	**Logged By**	GOJ
Coordinate System	California State Plane Zone 1	**Elevation**	2535.9 ft	**Reviewed By**	CAV

DEPTH - (FT)	ELEVATION - (FT)	SAMPLE TYPE	SAMPLE NO	GRAPHIC LOG	MATERIAL DESCRIPTION	NOTES
8	2528				**SAND AND GRAVEL** (0 to 9 ft) SAND and GRAVEL, medium coarse, rounded to subangular, some cobbles, well graded, non-plastic, compact to dense, light yellow brown, massive, dry.	Increased number of cobbles observed with depth from 2.67 ft.
9	2527				**SILT AND SAND** (9 to 12.7 ft) SILT and SAND, medium to coarse, some clay, trace gravel, fine to coarse, poorly graded, low to medium plasticity, compact to dense, light yellow brown, massive, dry.	Wall sloughing observed at depth 12.17 ft.
10	2526					
11	2525					
12	2524	GB	TP-IG-D02			G: 8.1%, S: 37.6%, Si: 41.0%, C: 13.3% PL: 25, LL: 49, PI: 24 MC: 19.6%
13	2523				End of Test Pit: 12.7 ft Compact material obstructing excavation	
	2522					

GENERAL REMARKS:

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KLAMATH RIVER RESTORATION PROJECT

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P/A NO.	REF. NO.	REV
VA103-00640/01	VA103-640/1-2	C

FIGURE G3-11

Contractor	NA	**Test Pit No**	**GRB-01**	**Page**	1 of 1
Location	Copco No. 1 Borrow Site	**Equipment Used**	Shovel	**Date Completed**	29/Jan/2020
Coordinates	6470033.303E, 2605107.59N	**Total Depth**	0.5 ft	**Logged By**	GOJ
Coordinate System	California State Plane Zone 1	**Elevation**	2712.6 ft	**Reviewed By**	CAV

DEPTH - (FT)	ELEVATION - (FT)	SAMPLE TYPE	SAMPLE NO	GRAPHIC LOG	MATERIAL DESCRIPTION	NOTES
		GB	GRB01		**SAND AND GRAVEL** (0 to 0.5 ft) SAND and GRAVEL, fine to coarse, angular, fine to coarse, trace angular cobbles, poorly graded, light gray, loose, dry.	G: 33.1%, S: 64.2%, Si and C: 1.5% PL: NP, LL: NP, PI: NP MC: 13.0%
	2712					
1					End of Test Pit: 1 ft	
	2711					

GENERAL REMARKS:

KIEWIT INFRASTRUCTURE WEST CO.
KLAMATH RIVER RESTORATION PROJECT

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P/A NO.	REF. NO.	REV
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FIGURE G3-12

Contractor	NA	**Test Pit No**	**GRB-02**	**Page**	1 of 1
Location	Copco No. 1 Borrow Site	**Equipment Used**	Shovel	**Date Completed**	29/Jan/2020
Coordinates	6470053.134E, 2605244.551N	**Total Depth**	0.5 ft	**Logged By**	GOJ
Coordinate System	California State Plane Zone 1	**Elevation**	2771.9 ft	**Reviewed By**	CAV

DEPTH - (FT)	ELEVATION - (FT)	SAMPLE TYPE	SAMPLE NO	GRAPHIC LOG	MATERIAL DESCRIPTION	NOTES
		GB	GRB02		**GRAVELLY SAND** (0 to 0.5 ft) Gravelly SAND, fine to coarse, angular, fine to coarse, trace angular cobbles, trace silt and clay, poorly graded, light gray, loose, dry.	G: 27.8%, S: 67.7%, Si and C: 4.5% PL: NP, LL: NP, PI: NP MC: 11.7%
1	2771 2770				End of Test Pit: 0.5 ft	

GENERAL REMARKS:

KIEWIT INFRASTRUCTURE WEST CO.
KLAMATH RIVER RESTORATION PROJECT

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FIGURE G3-13

Contractor	NA	**Test Pit No**	**GRB-03**	**Page**	1 of 1
Location	North of Copco No. 2 Penstocks	**Equipment Used**	Shovel	**Date Completed**	30/Jan/2020
Coordinates	6464276.255E, 2603438.293N	**Total Depth**	0.83 ft	**Logged By**	GOJ
Coordinate System	California State Plane Zone 1	**Elevation**	2349 ft	**Reviewed By**	CAV

DEPTH - (FT)	ELEVATION - (FT)	SAMPLE TYPE	SAMPLE NO	GRAPHIC LOG	MATERIAL DESCRIPTION	NOTES
					SILT AND SAND (0 to 0.8 ft) SILT and SAND, fine to coarse, trace gravel, trace clay, well graded, non-plastic, light yellowy brown, compact, moist.	
		GB	GRB03			G: 9.2%, S: 51.1%, Si: 36.3%, C: 3.4% PL: NP, LL: NP, PI: NP MC: 17.9%
1	2348				End of Test Pit: 0.8 ft	

GENERAL REMARKS:

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KLAMATH RIVER RESTORATION PROJECT

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P/A NO.	REF. NO.	REV
VA103-00640/01	VA103-640/1-2	C

FIGURE G3-14

Contractor	NA	**Test Pit No**	**GRB-04**	**Page**	1 of 1
Location	North of Copco No. 2 Penstocks	**Equipment Used**	Shovel	**Date Completed**	30/Jan/2020
Coordinates	6464335.851E, 2603361.273N	**Total Depth**	1 ft	**Logged By**	GOJ
Coordinate System	California State Plane Zone 1	**Elevation**	2354.7 ft	**Reviewed By**	CAV

DEPTH - (FT)	ELEVATION - (FT)	SAMPLE TYPE	SAMPLE NO	GRAPHIC LOG	MATERIAL DESCRIPTION	NOTES
					SANDY SILT (0 to 1 ft) Sandy SILT, fine to medium coarse, some clay, trace gravel, well graded, low to medium plasticity, light brown and gray, compact, moist.	
	2354	GB	GRB04			G: 7.9%, S: 25.9%, Si: 47.4%, C: 18.8% PL: 25, LL: 54, PI: 29 MC: 24.1%
1					End of Test Pit: 1 ft	
	2353					

GENERAL REMARKS:

KIEWIT INFRASTRUCTURE WEST CO.
KLAMATH RIVER RESTORATION PROJECT

Knight Piésold CONSULTING

P/A NO.	REF. NO.	REV
VA103-00640/01	VA103-640/1-2	C

FIGURE G3-15

Contractor	NA	**Test Pit No**	**GRB-05**	**Page**	1 of 1
Location	North of Copco No. 2 Penstocks	**Equipment Used**	Shovel	**Date Completed**	30/Jan/2020
Coordinates	6464382.568E, 2603387.092N	**Total Depth**	1 ft	**Logged By**	GOJ
Coordinate System	California State Plane Zone 1	**Elevation**	2370.2 ft	**Reviewed By**	CAV

DEPTH - (FT)	ELEVATION - (FT)	SAMPLE TYPE	SAMPLE NO	GRAPHIC LOG	MATERIAL DESCRIPTION	NOTES
	2370				**SANDY SILT** (0 to 1 ft) Sandy SILT, fine to coarse, some clay, trace gravel, poorly graded, medium plasticity, brown, compact, moist.	
		GB	GRB05			G: 3.4%, S: 31.3%, Si: 45.5%, C: 19.8% PL: 20, LL: 61, PI: 41 MC: 30.4%
1	2369				End of Test Pit: 1 ft	

GENERAL REMARKS:

KIEWIT INFRASTRUCTURE WEST CO.
KLAMATH RIVER RESTORATION PROJECT

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P/A NO.	REF. NO.	REV
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FIGURE G3-16

Contractor	Carlson's Construction	**Test Pit No**	**TP-JCB-A**	**Page**	1 of 2
Location	J.C. Boyle Disposal Area	**Equipment Used**	120C Deere Excavator	**Date Completed**	20/Feb/2020
Coordinates	6547250.981E, 2657844.634N	**Total Depth**	15 ft	**Logged By**	GOJ
Coordinate System	California State Plane Zone 1	**Elevation**	3854.4 ft	**Reviewed By**	CAV

DEPTH - (FT)	ELEVATION - (FT)	SAMPLE TYPE	SAMPLE NO	GRAPHIC LOG	MATERIAL DESCRIPTION	NOTES
0	3854				**SILT AND CLAY** (0 to 1.58 ft) SILT and CLAY, some fine to coarse sand, poorly graded, low plasticity, light to dark brown, firm, massive with some lenses of light yellow clayey material at 18", trace roots, moist.	Top three inches of soil frozen
1	3853	GB	TP-JCB-A01			
2	3852				**SILT AND SAND** (1.58 to 8.33 ft) SILT and SAND, fine to medium coarse, trace clay, poorly graded, non-plastic, dark brown, firm to stiff, varved with gray sandy material and light yellow clayey material, moist.	Some subangular cobbles after 2.5 ft
3	3851					
4	3850					
5	3849	GB	TP-JCB-A02			G: 0.0%, S: 58.8%, Si: 36.6, C: 4.6% PL: NP, LL: NP, PI: NP MC: 43.8%
6	3848					
7	3847					

GENERAL REMARKS:

KIEWIT INFRASTRUCTURE WEST CO.
KLAMATH RIVER RENEWAL PROJECT

Knight Piésold CONSULTING

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FIGURE G3-17

Contractor	Carlson's Construction	**Test Pit No**	**TP-JCB-A**	**Page**	2 of 2
Location	J.C. Boyle Disposal Area	**Equipment Used**	120C Deere Excavator	**Date Completed**	20/Feb/2020
Coordinates	6547250.981E, 2657844.634N	**Total Depth**	15 ft	**Logged By**	GOJ
Coordinate System	California State Plane Zone 1	**Elevation**	3854.4 ft	**Reviewed By**	CAV

DEPTH - (FT)	ELEVATION - (FT)	SAMPLE TYPE	SAMPLE NO	GRAPHIC LOG	MATERIAL DESCRIPTION	NOTES
	3846				**SILT AND SAND** (1.58 to 8.33 ft) SILT and SAND, fine to medium coarse, trace clay, poorly graded, non-plastic, dark brown, firm to stiff, varved with gray sandy material and light yellow clayey material, moist.	Some subangular cobbles after 2.5 ft
9		GB	TP-JCB-A03		**SILT AND CLAY** (8.33 to 9.5 ft) SILT and CLAY, some angular cobbles up to 10" diameter, trace fine sand, poorly graded, medium to high plasticity, light gray and brown, firm to stiff, massive, moist.	
	3845					
10					**SILT** (9.5 to 15 ft) SILT, some sand, fine to medium coarse, some clay, trace angular cobbles, poorly graded, low plasticity, gray blue, firm to stiff, massive, moist.	
	3844					
11		GB	TP-JCB-A04			G: 0.0%, S: 17.1%, Si: 68.5%, C: 14.4% PL: 34, LL: 41, PI: 7 MC: 54.9%
	3843					
12						
	3842					
13						
	3841					
14						Laminated clayey blocks observed from 14 to 15 ft
	3840					
15					End of Test Pit: 15 ft Terminated due to maximum reach of excavator.	
	3839					

GENERAL REMARKS:

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FIGURE G3-17

Contractor	Carlson's Construction	**Test Pit No**	**TP-JCB-B**	**Page**	1 of 2
Location	J.C. Boyle Disposal Area	**Equipment Used**	120C Deere Excavator	**Date Completed**	20/Feb/2020
Coordinates	6547577.951E, 2657886.717N	**Total Depth**	14 ft	**Logged By**	GOJ
Coordinate System	California State Plane Zone 1	**Elevation**	3850.6 ft	**Reviewed By**	CAV

DEPTH - (FT)	ELEVATION - (FT)	SAMPLE TYPE	SAMPLE NO	GRAPHIC LOG	MATERIAL DESCRIPTION	NOTES
0	3850				**SAND** (0 to 2 ft) SAND, fine to medium coarse, some silt and clay, trace gravel, fine to coarse, subangular to rounded, poorly graded, non-plastic, light brown, compact to dense, massive, some root inclusions, moist.	
1						
2	3849				**SILT AND CLAY** (2 to 6.67 ft) SILT and CLAY, some sand, medium to coarse, trace gravel, medium to coarse, subangular, poorly graded, low to medium plasticity, light brown, compact to stiff, massive, moist.	Increased laminated clayey blocks observed with depth
3	3848					
4	3847	GB	TP-JCB-B01			
5	3846					
6	3845					
7	3844				**SILT AND CLAY** (6.67 to 12 ft) SILT and CLAY, trace sand, fine, poorly graded, high plasticity, blue gray, firm to stiff, massive with lenses of previous logged material, moist.	
	3843	GB	TP-JCB-B02			

GENERAL REMARKS:

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FIGURE G3-18

Contractor	Carlson's Construction	**Test Pit No**	**TP-JCB-B**	**Page**	2 of 2
Location	J.C. Boyle Disposal Area	**Equipment Used**	120C Deere Excavator	**Date Completed**	20/Feb/2020
Coordinates	6547577.951E, 2657886.717N	**Total Depth**	14 ft	**Logged By**	GOJ
Coordinate System	California State Plane Zone 1	**Elevation**	3850.6 ft	**Reviewed By**	CAV

DEPTH - (FT)	ELEVATION - (FT)	SAMPLE TYPE	SAMPLE NO	GRAPHIC LOG	MATERIAL DESCRIPTION	NOTES
9	3842				**SILT AND CLAY** (6.67 to 12 ft) SILT and CLAY, trace sand, fine, poorly graded, high plasticity, blue gray, firm to stiff, massive with lenses of previous logged material, moist.	
10	3841					
11	3840					
12	3839					
13	3838	GB	TP-JCB-B03		**SILTY SAND** (12 to 14 ft) Silty SAND, fine to coarse, trace gravel, fine, trace clay, poorly graded, low plasticity, blue gray, stiff, lenses of silt and clay with some gravel and sand at 13 ft, moist.	Drier than previously logged soil material.
14	3837	GB	TP-JCB-B04			G: 4.0%, S: 58.3%, Si: 32.9%, C: 4.8% PL: 41, LL: 48, PI: 7 MC: 56.0%
15	3836				End of Test Pit: 14 ft Reached the water table.	
	3835					

GENERAL REMARKS:

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KLAMATH RIVER RENEWAL PROJECT

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P/A NO.	REF. NO.	REV
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FIGURE G3-18

Contractor	Carlson's Construction	**Test Pit No**	**TP-JCB-C**	**Page**	1 of 2
Location	J.C. Boyle Disposal Area	**Equipment Used**	120C Deere Excavator	**Date Completed**	20/Feb/2020
Coordinates	6547574.043E, 2657702.295N	**Total Depth**	13.33 ft	**Logged By**	GOJ
Coordinate System	California State Plane Zone 1	**Elevation**	3852 ft	**Reviewed By**	CAV

DEPTH - (FT)	ELEVATION - (FT)	SAMPLE TYPE	SAMPLE NO	GRAPHIC LOG	MATERIAL DESCRIPTION	NOTES
1	3851				**SILT AND CLAY** (0 to 3.67 ft) SILT and CLAY, some sand, fine to medium coarse, trace gravel, fine, angular, poorly graded, low plasticity, light brown and gray, soft to firm, stratified with silty clayey sand, moist.	
2	3850					
3	3849					
4	3848	GB	TP-JCB-C01		**SILT AND CLAY** (3.67 to 6.83 ft) SILT and CLAY, poorly graded, medium to high plasticity, light brown and gray, soft to firm, massive, moist.	
5	3847					
6	3846					
7	3845				**SILT AND SAND** (6.83 to 10.42 ft) SILT and SAND, fine to coarse, some clay, poorly graded, low to medium plasticity, light gray, firm, massive, moist.	

GENERAL REMARKS:

Entire pit was very easy to excavate (material not observed to be dense).

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FIGURE G3-19

Contractor	Carlson's Construction	**Test Pit No**	**TP-JCB-C**	**Page**	2 of 2
Location	J.C. Boyle Disposal Area	**Equipment Used**	120C Deere Excavator	**Date Completed**	20/Feb/2020
Coordinates	6547574.043E, 2657702.295N	**Total Depth**	13.33 ft	**Logged By**	GOJ
Coordinate System	California State Plane Zone 1	**Elevation**	3852 ft	**Reviewed By**	CAV

DEPTH - (FT)	ELEVATION - (FT)	SAMPLE TYPE	SAMPLE NO	GRAPHIC LOG	MATERIAL DESCRIPTION	NOTES
9	3843	GB	TP-JCB-C02		**SILT AND SAND** (6.83 to 10.42 ft) SILT and SAND, fine to coarse, some clay, poorly graded, low to medium plasticity, light gray, firm, massive, moist.	G: 0.0%, S: 43.5%, Si: 37.8%, C: 18.7% PL: 34, LL: 58, PI: 24 MC: 51.3%
10	3842					
11	3841				**SAND** (10.42 to 13.33 ft) SAND, some silt and clay, medium to coarse, poorly graded, non-plastic, reddish brown, firm, massive, moist.	Small seepage noted through one wall at approximately 11 ft
12	3840					
13	3839					Increased water seepage through both walls noted at 13.33 ft
14	3838				End of Test Pit: 13.33 ft Reached the water table.	
15	3837					

GENERAL REMARKS:

Entire pit was very easy to excavate (material not observed to be dense).

KIEWIT INFRASTRUCTURE WEST CO.
KLAMATH RIVER RESTORATION PROJECT

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P/A NO.	REF. NO.	REV
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FIGURE G3-19

Contractor	Carlson's Construction	**Test Pit No**	**TP-JCB-D**	**Page**	1 of 1
Location	J.C. Boyle Disposal Area	**Equipment Used**	120C Deere Excavator	**Date Completed**	20/Feb/2020
Coordinates	6548010.633E, 2657751.973N	**Total Depth**	9 ft	**Logged By**	GOJ
Coordinate System	California State Plane Zone 1	**Elevation**	3847.2 ft	**Reviewed By**	CAV

DEPTH - (FT)	ELEVATION - (FT)	SAMPLE TYPE	SAMPLE NO	GRAPHIC LOG	MATERIAL DESCRIPTION	NOTES
0	3847				**SAND** (0 to 3.33 ft) SAND, fine to coarse, some silt and gravel, fine to coarse, rounded to subangular, trace cobbles, subangular, trace clay, well graded, low plasticity, reddish brown, compact to dense, stratified with trace gray clayey material, some root inclusions, moist.	
1	3846					
2	3845	GB	TP-JCB-D01			G: 11.1%, S: 68.0%, Si: 14.1%, C: 6.8% PL: 43, LL: 49: PI: 6 MC: 39.3%
3	3844					
3.33		GB	TP-JCB-D02		**SILT AND CLAY** (3.33 to 6.67 ft) SILT and CLAY, some fine to medium coarse sand, poorly graded, low plasticity, light brown, firm to stiff, massive, moist to wet.	Slow seepage observed through one of the pit walls at 3.67 ft
4	3843					
5	3842					
6	3841					
6.67					**SAND** (6.67 to 9 ft) SAND, coarse, some gravel, fine, subangular, some silt and clay, trace cobbles, subangular, well graded, non-plastic, light to dark brown, compact to dense, massive, moist to wet.	
7	3840	GB	TP-JCB-D03			
8	3839					
9	3838				End of Test Pit: 9 ft Reached the water table.	

GENERAL REMARKS:

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FIGURE G3-20

Contractor	Carlson's Construction	**Test Pit No**	**TP-JCB-E**	**Page**	1 of 1
Location	J.C. Boyle Forebay Area	**Equipment Used**	120C Deere Excavator	**Date Completed**	20/Feb/2020
Coordinates	6544408.33E, 2647757.563N	**Total Depth**	6.67 ft	**Logged By**	GOJ
Coordinate System	California State Plane Zone 1	**Elevation**	3783.3 ft	**Reviewed By**	CAV

DEPTH - (FT)	ELEVATION - (FT)	SAMPLE TYPE	SAMPLE NO	GRAPHIC LOG	MATERIAL DESCRIPTION	NOTES
0	3783				**SAND AND GRAVEL** (0 to 2.92 ft) SAND and GRAVEL, fine to coarse, subangular to angular, some cobbles, angular, trace silt and clay, well graded, non-plastic, reddish brown, loose to compact, massive, dry to moist.	
1	3782					
2	3781					Boulder approximately 42" across uncovered at depth 2 ft.
3	3780				**SAND AND GRAVEL** (2.92 to 5.83 ft) SAND and GRAVEL, medium to coarse, angular, some silt and clay, some cobbles and boulders, angular, well graded, low plasticity, reddish brown, loose to compact, massive, trace root inclusions, moist.	Weak pit walls sloughing into hole and overhangs forming from approximately 4 to 6 ft. Sample bag broke and soil material lost for this layer.
4	3779					
5	3778					
6	3777	GB	TP-JCB-E01		**GRAVEL** (5.83 to 6.67 ft) GRAVEL, fine to coarse, angular, some sand, fine to coarse, some silt, some cobbles and boulders, angular, trace clay, well graded, low plasticity, light brown, firm, massive, moist.	G: 51.0%, S: 17.3%, Si: 17.8%, C: 4.8% PL: 24, LL: 31, PI: 7 MC: 15.3%
7	3776				End of Test Pit: 6.67 ft Refusal (large boulders).	

GENERAL REMARKS:

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FIGURE G3-21

Contractor	Carlson's Construction	**Test Pit No**	**TP-JCB-F**	**Page**	1 of 1
Location	J.C. Boyle Forebay Area	**Equipment Used**	120C Deere Excavator	**Date Completed**	20/Feb/2020
Coordinates	6544345.474E, 2647918.34N	**Total Depth**	9 ft	**Logged By**	GOJ
Coordinate System	California State Plane Zone 1	**Elevation**	3796.2 ft	**Reviewed By**	CAV

DEPTH - (FT)	ELEVATION - (FT)	SAMPLE TYPE	SAMPLE NO	GRAPHIC LOG	MATERIAL DESCRIPTION	NOTES
0	3796				**SANDY GRAVEL** (0 to 6 ft) Sandy GRAVEL, fine to coarse, rounded to subangular, fine to coarse, some silt, some cobbles and boulders, subangular, trace clay, well graded, non-plastic, reddish brown, loose to compact, massive, root and rusty nail inclusions, moist.	
1	3795					
2	3794					
3	3793	GB	TP-JCB-F			G: 43.1%, S: 25.4%, Si: 17.7%, C: 3.4% PL: NP, LL: NP, PI: NP MC: 20.3%
4	3792					
5	3791					
6	3790				**SILT AND CLAY** (6 to 9 ft) SILT and CLAY, some cobbles and boulders, angular to subangular, trace sand, fine, well graded, medium plasticity, reddish brown, firm, massive, some root inclusions, moist.	Overhangs and significant sloughing observed once excavation reached depth 6.33 ft.
7	3789					
8	3788					
9	3787				End of Test Pit: 9 ft Refusal (large boulders).	

GENERAL REMARKS:

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FIGURE G3-22

Contractor	Carlson's Construction	**Test Pit No**	**TP-JCB-G**	**Page**	1 of 1
Location	J.C. Boyle Forebay Area	**Equipment Used**	120C Deere Excavator	**Date Completed**	20/Feb/2020
Coordinates	6544697.732E, 2647443.547N	**Total Depth**	9.08 ft	**Logged By**	GOJ
Coordinate System	California State Plane Zone 1	**Elevation**	3774.3 ft	**Reviewed By**	CAV

DEPTH - (FT)	ELEVATION - (FT)	SAMPLE TYPE	SAMPLE NO	GRAPHIC LOG	MATERIAL DESCRIPTION	NOTES
0	3774				**SANDY GRAVEL** (0 to 4.83 ft) Sandy GRAVEL, fine to coarse, rounded to angular, fine to coarse, some cobbles, subangular, trace silt and clay, well graded, non-plastic, reddish dark brown, loose to compact, massive, moist.	Metal cylinder bar uncovered at depth 12". Lens of gray clayey material at approximately 4.58 ft. Increase in size and quantity of boulders with increased depth.
1	3773					
2	3772	GB	TP-JCB-G01			G: 58.6%, S: 33.0%, Si: 7.2%, C: 1.2% PL: NP, LL: NP, PI: NP MC: 14.2%
3	3771					
4	3770					
5	3769	GB	TP-JCB-G02		**SAND AND GRAVEL** (4.83 to 6.58 ft) SAND and GRAVEL, coarse, subangular, fine to coarse, some cobbles and boulders, angular, some silt and clay, well graded, low plasticity, brown, compact, massive, moist.	Boulder approximately 4 ft across uncovered at approximate depth 5.5 ft.
6	3768					
7	3767				**GRAVEL** (6.58 to 9.08 ft) GRAVEL, fine to coarse, angular, some sand, some silt, some cobbles and boulders, angular, trace clay, well graded, low to medium plasticity, light brown, firm, some lenses of gray clayey material, moist.	Overhangs forming from 5 ft and down. Increased boulders with depth. Sheepsfoot compactor used to fill-in the pit.
8	3766	GB	TP-JCB-G03			G: 31.2%, S: 22.5%, Si: 25.0%, C: 5.7% PL: 26, LL: 31, PI: 5 MC: 19.8%
9	3765				End of Test Pit: 9.08 ft Refusal (large boulders).	

GENERAL REMARKS:

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FIGURE G3-23