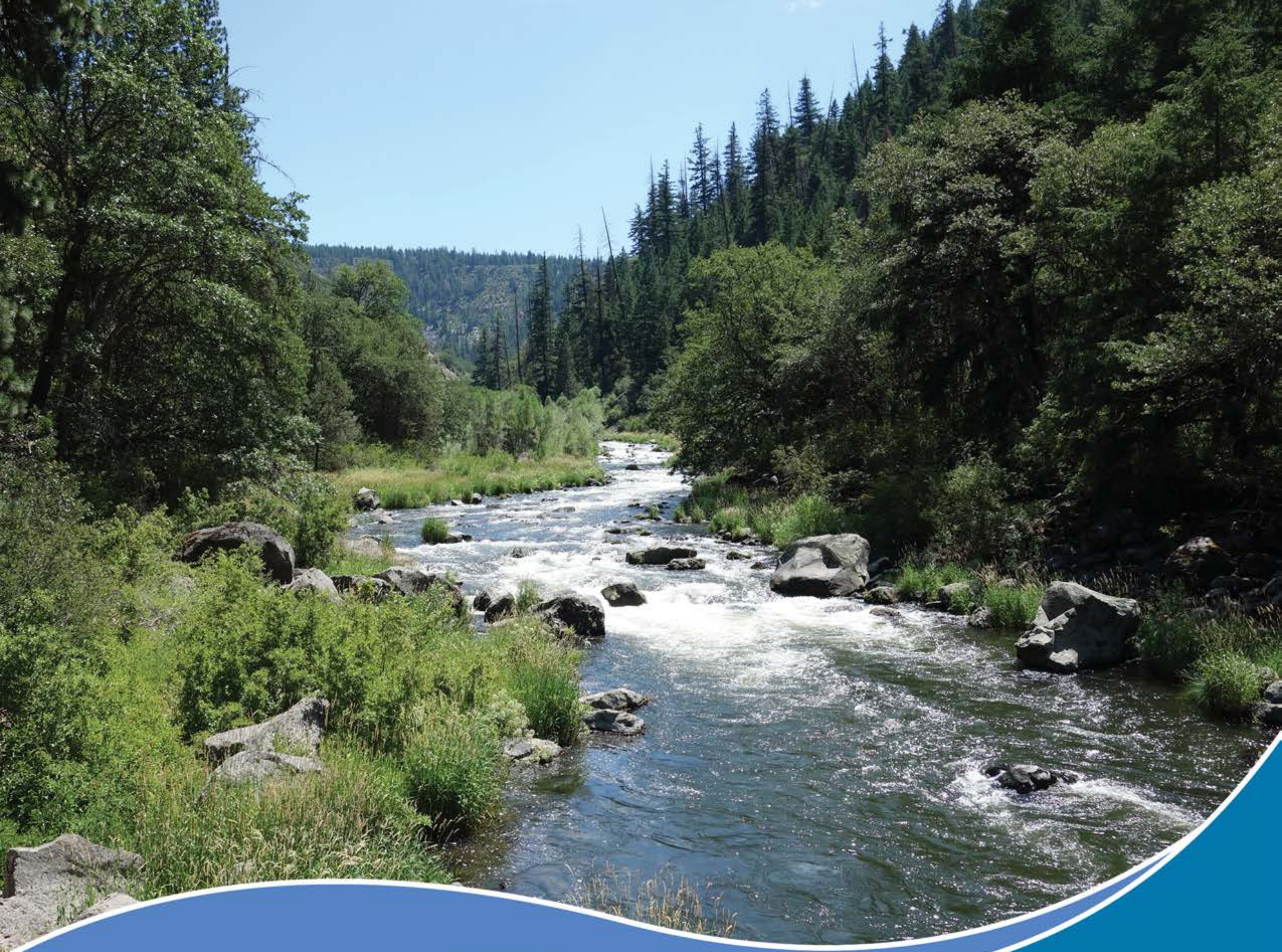

Definite Plan for the Lower Klamath Project

Appendix E – Reservoir Rim Stability Evaluation

KLAMATH
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CORPORATION

June 2018

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Acronyms and Abbreviations

DEM	Digital Elevation Model
EM	Engineering Manual
ICU-TX	Isotopically Consolidated Undrained Tri-Axial Strength Test
KRRC	Klamath River Renewal Corporation
MC	Modified California Sampler
pcf	Pounds-Force per Cubic Foot
psf	Pounds-Force per Square Foot
SPT	Standard Penetration Test
USACE	United States Army Corp of Engineers

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Chapter 1: Introduction

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1. INTRODUCTION

The purpose of this evaluation is to summarize relevant geologic background information, recent field reconnaissance and explorations, and any assessments or analyses completed to assess reservoir rim stability at J.C. Boyle, Copco No.1 and Iron Gate reservoirs.

When discussing reservoir rim stability during drawdown at the various reservoir locations, it is important to differentiate between the potential for deep-seated large landslides, which could impact residences and other resources adjacent to the rim, and shallower slides of material beneath the current water surface, which would only impact resources within the local limited slide footprint. The methodology used and amount of data available for the current analyses does not allow for the prediction of exactly where and how many of these shallow slides may occur. This evaluation largely discusses the potential for deep-seated landslides, which have the greatest potential to cause large impacts to resource areas. The methodology KRRC used for evaluation of reservoir rim stability included the following steps:

1. A desktop geologic study of the reservoir rims including a literature review of previous geologic studies of the area and a review of available aerial photography.
2. A geologic reconnaissance along the reservoir rims
3. Field investigations and laboratory testing of soil samples in areas with potential instabilities.
4. Analysis of cross-sections and material properties based on available data, geotechnical field investigations, and laboratory testing.
5. Rapid drawdown and other slope stability analyses. The rapid drawdown analysis assumed instantaneous drawdown unless determined that transient analysis was needed.
6. Develop a map showing areas of identified potential impacts.

Based on the United States Army Corp of Engineers (USACE) Slope Stability Engineering Manual (EM-110-2-1902) (USACE, 2003), Table 1-1 shows criteria developed for factors of safety. The following sections summarize geologic conditions and evaluations of the reservoir rims behind J.C. Boyle, Copco No. 1, and Iron Gate dams for potential instability during reservoir drawdown.

Table 1-1 Slope Stability Criteria

Case	Minimum Factor of Safety
Existing Conditions	1.11
Rapid Drawdown	1.15
Long-Term (post drawdown)	1.5
Historical Drawdown	1.11

Notes:

1. Case used as a check of the model. Anything over a factor of safety of 1.1 would be considered acceptable.

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Chapter 2: J.C. Boyle Reservoir

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2. J.C. BOYLE RESERVOIR

KRRC based the assessment presented in this section on preliminary bathymetric data. KRRC will perform additional geologic mapping and interpretation once recently collected bathymetric data is finalized.

2.1 Previous Investigations

Previous investigations are the subsurface geologic data related to J.C. Boyle Dam (Black & Veatch, 1998) and sediment sampling (Shannon & Wilson, 2006). Neither of these investigations were deep enough to provide useful information concerning rim stability. However, based on KRRC's 2017 geologic site reconnaissance and review of existing materials, KRRC determined no additional exploratory borings were required.

2.2 Geologic Characterization

The following discussion of geologic conditions at J.C. Boyle Reservoir is excerpted from PanGEO (2008). Topography for the area around the reservoir is gently sloping (less than 10%) to rolling terrain without many steep slopes other than on stratovolcanoes that are scattered around the region. Upstream and downstream of the dam, the Klamath River has cut a series of deep canyons into the volcanic rocks that mantle this part of northeastern California and southeastern Oregon. These canyons have slopes up to about 60 degrees. Bands of 30 and 40 degree slopes form NW-SE-oriented lineations in the topography; one of these bands forms the upstream boundary of the topographic bowl that the reservoir is located within.

Bedrock geology in the J.C. Boyle area is complex, characterized by inter-fingered volcanic deposits from a variety of sources less than 5 million years old that are part of the High Cascade stratovolcanic deposits. Common lithologies include hard, resistant basalt and basaltic andesite and less resistant volcaniclastic deposits. The area is characterized by several stratovolcanoes (Mount McLoughlin, Chase, Hamaker, Buck, and Surveyor Mountains) as well as dozens of smaller vents that erupted lavas and volcaniclastic materials. Younger alluvium and colluvium (at least 18,000 years old) are present on some of the slopes and as gently sloped terraces around the margins of the reservoir. An outcrop of very light grayish tan diatomite is present along the margin of the reservoir on the north side of the river by the prominent eastward bend. The outcrop is at least 10 feet high and located at the foot of a rounded hill mapped as glacial material. The diatomite is underlain by black sand and is possibly interbedded with volcaniclastic material.

Faulting is prominent in the J.C. Boyle Reservoir area. The faulting appears to display a normal sense of offset associated with the extensional tectonics of the Basin Range geomorphic province. The bowl topography of the reservoir area likely owes its configuration, in part, to being within a down-dropped basin. One prominent fault system is a fault that trends northwest through the northeast corner of the reservoir extent. The fault is down-dropped to the southwest, and the fault forms the southwest boundary of the hard rock canyon located upstream of the reservoir. To the northwest of the dam site, another fault system exists along the east side and through the middle of a prominent hill. This fault appears to mark the west side of the down-dropped block that forms the reservoir basin, as the fault is down to the northeast.

Review of topographic data and reconnaissance of the reservoir slopes indicate that no landslides are present adjacent to the reservoir. Furthermore, the land surface surrounding the J.C. Boyle Reservoir is generally low gradient and underlain by competent materials.

2.3 Conclusions

The geologic reconnaissance of the J.C. Boyle Reservoir rim did not reveal obvious stability problems. Based on the results of the geologic reconnaissance, the historic performance of the slopes above the reservoir level, and the bathymetry, KRRC concluded that deep-seated large landslides are less likely. Therefore, stability analyses for the rim of J.C. Boyle Reservoir are deemed not required to support the preliminary design. Shallower slides could occur in the surficial soil deposits around the reservoir rim and on the reservoir slopes that are currently below the reservoir surface.

Chapter 3: Copco No. 1 Reservoir

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3. COPCO NO. 1 RESERVOIR

Copco No. 1 Dam and reservoir are mostly underlain by volcanic and volcaniclastic rock of the Western Cascades Volcanics group. Younger volcanic rock of the High Cascades Volcanics group is present at the dam site and at the western end of reservoir, as well as on parts of the canyon rim. Quaternary fluvio-lacustrine diatomaceous deposits are present around much of the reservoir rim and in the reservoir bed as terrace deposits with surfaces both above and below the modern reservoir level.

PanGEO (2006) suggests the slight possibility of drawdown-induced block sliding where hard strong volcanic flow rocks are underlain by saturated tuffaceous beds and bedding dips into the valley. Hammond (1983) reports several low to moderate dip angles of volcaniclastic beds into the valley, but there is no evidence of previous slope instability at these locations.

3.1 Historical Investigations and Reservoir Drawdowns

3.1.1 Historical Investigations

The available subsurface geologic data is limited to only the recent reservoir sediment sampling (Shannon & Wilson, 2006). For the investigation, Shannon & Wilson used a barge mounted CME-45 to continuously sample the reservoir sediments using either a pushed piston sampler or a driven MC sampler. No drilling was used to clean the hole between samples and casing was used when needed in a few locations. Twelve explorations were completed in the reservoir, which showed reservoir sediments ranging from 0.5 to 10 feet in thickness. These borings were examined and used to define the sediment thickness in the analysis profiles when applicable. No other useful investigations for rim stability were found.

3.1.2 Historical Reservoir Drawdowns

Copco No. 1 reservoir levels between November 1, 1978, and December 31, 2016, were reviewed by the KRRC for historical occurrences of reservoir drawdown. The three most significant drawdown events occurred in 1982, 2014, and 2015 (see Figure 3-1).

The maximum daily drawdown rate of 2 feet per day occurred in 2014 when the reservoir was drawn down nearly 14 feet. Based on inquiries made to PacifiCorp, slope failures were not observed in connection with the three reservoir drawdown events, although there was no specific effort made to determine whether slope failures occurred (email with Demian Ebert August 2, 2017).

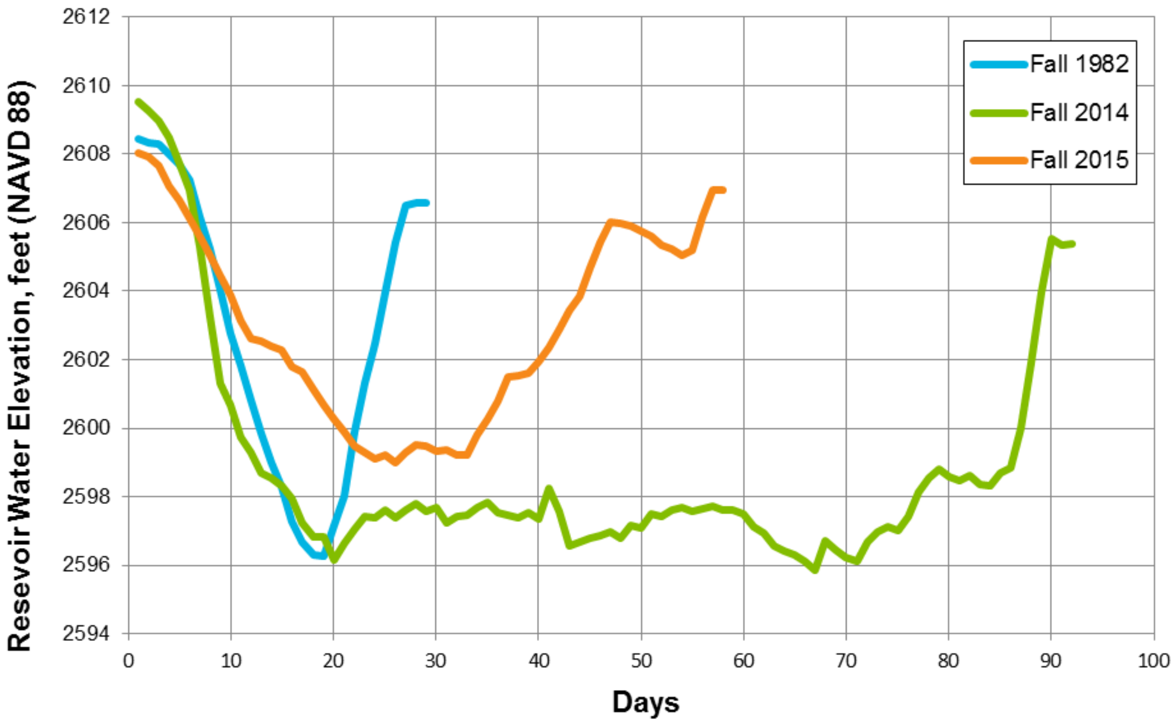

Figure 3-1 Copco Lake Maximum Historical Drawdown Events (1978 to 2016)

3.2 Project Investigations and Laboratory Testing

KRRC performed geologic mapping and a subsurface investigation with lab testing at Copco No. 1 reservoir to characterize and analyze the stability of the fluvio-lacustrine terrace deposits present around much of the rim of the reservoir and within the reservoir bed.

Access to the overland shoreline surfaces was not available, so KRRC performed drilling over water from a small platform barge using a CME-45 drill rig. Ten rotary wash borings were advanced into the reservoir bed between February 1 and 14, 2018, by Taber Drilling of West Sacramento. The boring depths ranged from 12 to 97 feet. Boring locations are shown on the geologic map (Figure 3-2). Table 3-1 summarizes the exploratory boring data, including depth and elevation of volcanic bedrock, where encountered. Boring logs are presented in Attachment B and a summary of the subsurface conditions are presented in Section 3.2.1.

KRRC obtained soil samples using standard penetration test (SPT) and 2.5-inch I.D. modified California (MC) drive samplers and 3-inch diameter thin-walled Shelby tubes. The tubes were advanced by direct push or with a hydraulically activated piston sampler (Osterberg). KRRC recorded blow counts at 6-inch intervals for drive samples and hydraulic gage down pressure necessary to advance Shelby tubes was noted.

Table 3-1 Summary of Exploratory Boring Data

Boring Id No.	Total Depth (feet)	Northing	Easting	Elevation (feet)	Depth to Rock (feet)
BC-01	30.4	2608898	6476516	2593.1	27.5
BC-02	64.6	2608331	6476958	2596.3	63
BC-02	96.5	2606643	6474657	2580.8	>96.5
BC-04	73.5	2604812	6472949	2593.1	69.5
BC-05	20.5	2604139	6474515	2597.8	17.5
BC-06	15.4	2605112	6476050	2574.9	7.5
BC-07	15.9	2605439	6477039	2577.8	15.5
BC-08	11.5	2605190	6480346	2582.4	-
BC-08a	85.2	2605249	6480346	2579.8	83.5
BC-09	70.5	2602526	6483561	2598.2	>71.5
BC-10	43	2604959	6472871	2575.1	39

KRRC sent samples to Cooper Testing Laboratory in Palo Alto, California. Lab testing performed included:

- Moisture Content (ASTM D2216)
- Moisture and Density (ASTM D7263B)
- Atterberg Limits (ASTM D4318)
- Grain Size Analyses with and without Hydrometer (ASTM D6913 & ASTM D7928)
- Percent Fines (ASTM D1140)
- Unconsolidated Undrained Triaxial Strength Test (ASTM D2850)
- Consolidated Undrained Triaxial Strength Test (ASTM D4767m)

The laboratory test results are provided in Attachment C and a summary of the laboratory test results received at the time of writing this report are shown in Section 3.4.1.

3.2.1 Summary of Subsurface Conditions from Borings

Borings encountered between 1 and 11 feet of very soft, recent lake sediments typically consisting of organic rich clayey sand to sandy clay/silt occasionally with coarse sand and small gravel clasts of weak, friable diatomite. The diatomite gravel was encountered at near shore borings and likely was derived from relatively recent bluff erosion along the shoreline.

Below the recent reservoir sediment, all the borings except BC-01 encountered alluvial terrace deposits and/or colluvium consisting of soft/loose to dense/stiff gravels, sands, and clays between 3 feet and 14 feet thick. Cobbles were observed in gravelly layers with a layer primarily of cobbles observed in BC-03.

Below the alluvial terrace deposits/colluvium or recent reservoir sediments, various forms of diatomite or diatomaceous clays were observed in all but borings BC-06 and BC-07, with thicknesses ranging from 6.5 feet in BC-09 to greater than 86 feet in BC-03. The various forms of diatomite encountered included diatomite rock, clayey diatomite, diatomaceous clay, and weakly cemented diatomite pieces.

Finally, below the diatomite or alluvial terrace deposits, volcanic bedrock was encountered consisting of basalt, andesite, cinders, volcaniclastic sandstone, and volcaniclastic/intrusive bedrock of various weathering and strength. While the strength of the volcanic bedrock varied, it was all considerably stronger than the materials above; no coring was performed to retrieve samples for strength testing since failure surfaces during reservoir drawdown are not likely to pass through the bedrock.

3.3 Geologic Characterization

3.3.1 Previous Mapping

Previously published mapping around Copco reservoir include:

- *Volcanic Formations Along the Klamath River Near Copco Lake, Siskiyou County,* PAUL E. HAMMOND, Department of Geology, Portland State University, Portland, Oregon; California Geology, May 1983.
- *Geology of the Macdoel Quadrangle,* HOWEL WILLIAMS , California Division of Mines and Geology Bulletin 151, November, 1949
- *Circular Soil Structures in Northeastern California*, PETER H. MASSON, California Division of Mines and Geology Bulletin 151, November, 1949
- *Geotechnical Report, Klamath River Dam Removal Project, California and Oregon, Project No. 07-153,* PanGEO Incorporated, prepared for Philip Williams & Associates, Ltd. And California State Coastal Conservancy, August, 2008
- *Geologic Map of the Weed Quadrangle,* D. L. Wagner and G. J. Saucedo, California Division of Mines and Geology, 1987)

These maps primarily show bedrock units, with surficial deposits typically not differentiated. Williams shows terrace deposits around Copco reservoir as diatomite and suggests it may have economic value. Wagner and Saucedo show the terrace deposits around Copco reservoir as lacustrine in origin. Hammond provides the most detailed descriptions of volcanic bedrock, but the area covered extends west only to the upstream end of Iron Gate reservoir, and mapping does not differentiate surficial deposits. Hammond also reports a maximum age for Copco basalt of 0.14 million years, based on Potassium/Argon isotope analysis of one sample. No other published ages of the Copco basalt are available.

3.3.2 Geologic and Surficial Mapping

Geologic reconnaissance along public right of ways and at Copco No. 1 dam site was performed several times during summer and fall of 2017. KRRC performed reconnaissance of the reservoir shoreline on October 4, 2017 using a boat and, to a lesser extent, during subsurface investigations in February, 2018.

KRRC used observations made during field investigations, preliminary results of subsurface investigation, and previously published maps to develop a geologic surficial map of Copco reservoir (Figure 3-2). Surficial deposits and landforms were identified on high-resolution topographic (LiDAR, 2010) and bathymetric (GMA, 2018) surface data for the shoreline and reservoir bed areas, respectively. This mapping focused on identifying the full extent of the quaternary lacustrine terrace deposits along the shoreline and any large, deep seated landslides or other areas of potential instability within the shoreline slopes.

Figure 3-2: Geologic Overview of Copco Lake (Attachment A)

Surficial Deposits

Previously undifferentiated surficial deposits around much of Copco reservoir include talus and rockfall debris, colluvium, alluvium and alluvial fans associated with tributary drainages, and older, likely Quaternary, fluvio-lacustrine terrace deposits, described below.

No large-scale landslides have been identified in either the terrestrial or submarine slopes around Copco reservoir by this or previous studies. PanGEO (2008) identified two small to medium-size inactive landslides on the north shore and concluded that these are not likely to be reactivated by reservoir lowering, due to their position above the reservoir rim. One notable feature is a large alluvial fan on the north side of the reservoir, just west of Spannus Gulch. PanGEO (2008) states that the location of this fan between tributary drainages suggests that the feature could be colluvial or landslide related, but if this is the case, the feature is likely ancient and inactive. Additionally, there is a notch in the bedrock at the head of this fan suggesting that the fan was once associated with Spannus Gulch, which now flows down a steeper, bedrock channel to the east. To confirm this interpretation, boring BC-09 was located offshore of the feature and results indicate it is a relatively thin alluvial fan deposit overlying Quaternary lacustrine deposits. For this study, KRRC identified one medium size slide deposit just above the reservoir level on the south shore. This feature appears rocky and is interpreted as a rock slide/fall deposit. Based on the limited extent below the water, low submarine relief and rocky nature of the deposit, it is very unlikely that this feature will be affected by reservoir drawdown.

Surficial deposits and landforms mapped during this study and shown on Figure 3-2 include:

- Active channel alluvium associated with pre-dam Klamath river (Qac)
- Flood plain deposits associated with the pre-dam Klamath river (Qfp)
- Alluvial fans (Qaf)
- Undifferentiated alluvium, usually associated with tributary drainages (Qa)
- Local accumulations of colluvium (Qc)

- Talus deposits (Qtl)
- Landslide deposits (Qls)
- Debris flow deposits (Qdf)
- Fluvio-lacustrine terrace deposits (Qtg, Qt, and Qtl), described below

Fluvio-Lacustrine Terrace Deposits

Fluvio-lacustrine terrace deposits surround much of the shoreline of Copco reservoir, extending to approximately 40 feet above the current reservoir level. These consist of diatomite, fine-grained diatomaceous reservoir sediment and dense, coarse-grained alluvial deposits. The terrestrial (onshore) extent of these deposits has been mapped (see Figure 3-2) by KRRC on modern topography and aerial imagery, based on field reconnaissance and modified from previous mapping by Williams (1949), Hammond (1983), and PanGEO (2008). The diatomite and lacustrine sediments were presumably deposited in a freshwater lake setting formed by volcanic damming of the Klamath River at or near the Copco No. 1 dam site by the 0.14 million-year-old Copco basalt.

Coarse-grained alluvial deposits were encountered on submarine terrace surfaces in borings (BC-03, BC-08/8a, and BC-10) and observed in shoreline deposits in the upstream half of the reservoir, occasionally interbedded with fine-grained lacustrine deposits. In the borings, these deposits ranged from 3 to 8 feet thick, likely representing river deposits after a partial volcanic dam breach with base level several tens of feet higher than that of the modern Klamath River. The degree of weathering and thickness of overlying soil suggest these deposits are geologically old, perhaps as little as a few thousand years younger than the emplacement of the Copco basalt. Upstream alluvial deposits, locally interbedded with diatomaceous lake sediments, are likely of similar age; however, surficial coarse-grained deposits may be much younger.

The most extensive on-shore deposits of diatomite are along the downstream south shore and along the Beaver Creek arm of the reservoir on the north shore where the deposits form a flat-lying to gently dipping surface, into which steep shoreline bluffs have been formed by modern shoreline erosion. Along much of the rest of the shoreline, the diatomite is present as a relatively thin wedge or prism, often with a modern colluvial/alluvial depositional capping layer. In this case, the maximum extent of the deposits was based on elevation and morphology. In other areas, bedrock was exposed at the shoreline and the diatomite was not observed on the slopes, presumably due to wave and/or hillslope and tributary channel erosion. The diatomite along the shoreline and at shallow depths in borings is generally a light gray to light tan colored material which is low density and weak to very weak. In the more extensive deposits, near-vertical bluffs have formed in the diatomaceous deposits as a result of undercutting due to wave erosion and failure of the weak material. In some places, this erosion has exposed volcanic bedrock at the base of the bluffs, indicated with thick black line on Figure 3-2.

Where the toe of the terrestrial diatomite terrace deposit lies above the current high lake level, the response of the slope to rapid drawdown are determined by the properties and geometry of the underlying volcanic and volcaniclastic strata. Where the toe of the terrestrial diatomite terrace deposit lies below the current high lake level, the response of the slope to rapid reservoir drawdown are determined by the properties of the diatomite deposits, the thickness of the diatomite deposits, and the properties of the underlying material. Lacustrine diatomite deposits also exist completely below the current range of reservoir levels, and appear as prominent benches in the bathymetry. Along the south shore, this bench is mostly continuous and ranges between 100 and 300 feet wide. Along the north shore, the terrace bench is wider, with large peninsulas extending to the south with very steep to near vertical side slopes.

Mapped terrace deposits include:

- Quaternary alluvial terrace deposits, with gravels (Qtg)
- Quaternary fluvio-lacustrine terrace deposits, undifferentiated (Qt)
- Quaternary lacustrine deposits (Qtl)

The thickness of lacustrine diatomaceous sediments in borings further from the shoreline indicate that this material is likely present beneath surficial terrace and alluvial fan deposits in the upstream part of the reservoir bed and shoreline areas.

High Cascade Volcanics

Copco Basalt (Qb), a 0.14 million years old intracanyon flow unit (Hammond 1983), outcrops at the west end of the reservoir and likely underlies some of the western (downstream) submarine terrace deposits. This unit erupted from vents on both sides of the Klamath River, damming the river to form a lake that was approximately 35-40 feet higher than the modern reservoir (Hammond 1983). Other Quaternary basalt lava flows (QTb) unconformably overlie the older volcanics of the Western Cascades Group to form the generally flat-lying rim rock at the topo of the slopes around much of Copco No. 1 reservoir, but more prominent to the north.

Western Cascade Volcanics

Volcanic and volcaniclastic bedrock of the Western Cascade Volcanics around the rim include Spannus Ranch Andesite, undifferentiated intrusives, and several members of the Bogus Mountain volcaniclastic beds.

The Spannus Ranch Andesite consists mainly of pyroxene andesite flows with interbeds of lithic breccia (PanGEO 2008).

The Bogus Mountain Beds consist of interstratified tuff-breccia, volcaniclastic sandstone and tuffs, with thinner interbedded andesite flows. The strata tend to be greenish gray, and the tuffs and sandstones are fine to medium grained. One of the basal members of the Bogus Mountain Beds has been dated at roughly 23 million years old (Hammond, 1983).

For this mapping effort, the Western Cascade volcanics are not differentiated and are presented at Tertiary Volcanics (Tv)

3.4 Stability Analyses

This section presents the current results from material characterization, segment and cross section selection, and slope stability analyses. KRRC is still completing analyses and will update this evaluation once they are finalized. KRRC completed the following steps for the analyses:

1. Develop material properties
2. Complete generalized slope stability models assuming diatomite slopes with different slope heights and angles
3. Produce a map highlighting potential areas of instability using a Graphical Information System (GIS) model
4. Select segments
5. Create and analyze a conservatively representative cross section in segments with areas of potential instability

The section s below discuss further details of the analyses.

3.4.1 Material Characterization

Based on blow count data, field descriptions of soils, and laboratory test results, KRRC divided the subsurface materials into three layers, as summarized below. Attachment C provides the laboratory results and Table 3-2 shows the chosen analysis parameters . Attachment B provides blow counts and soil descriptions on the boring logs.

Diatomite

The diatomite consists of a low density material that is significantly weaker than the underlying bedrock materials. In addition, the material has a low permeability (about $1x10^{-6}$ cm/s) and will behave as an undrained material during reservoir drawdown, regardless of the drawdown rate. Several different types of diatomite were observed including a rock like diatomite (referred to as diatomite in the boring logs), diatomite that had more of an elastic silt like behavior (referred to as diatomite with elastic silt in the boring logs), and a weakly cemented diatomite. Properties of the diatomite with elastic silt were chosen to represent all the types of diatomite since it was the most common type observed. Table 3-2 and Figure 3-3 summarize strength testing of the diatomite.

Fluvio-Lacustrine Terrace Deposit with Gravel

In general, the fluvio-lacustrine terrace deposit with gravel is a relatively dense layer of alluvium, colluvium, or lacustrine deposit with significant amounts of gravel. The material generally has a relatively high permeability and will likely behave as a drained material during rapid drawdown. KRRC chose material properties based on lab data (as summarized in Table 3-2 below), blow counts, and material descriptions.

Recent Reservoir Sediments

The recent reservoir sediments generally consist of very soft silt, sand, or clay, which have been deposited since Copco Dam was constructed. KRRC chose material properties based on lab data (as summarized in Table 3-2 below), blow counts, material description, and testing of similar material from other reservoirs.

Volcanic Bedrock

Bedrock was encountered in eight of the ten borings completed. The rock consisted of basalt, andesite, volcanic sandstone, and volcanic cinder from the Copco/Quarternary Basalt and Bogus Mountain Beds formations. The rock is significantly stronger than the diatomite, fluvio-lacustrine terrace deposits, and recent reservoir sediments. The properties of the bedrock were chosen based on field descriptions and laboratory testing of two rock cores completed in Iron Gate Reservoir (see Section 4), and previous experience with similar rock. The strength parameters were calculated using Hoek-Brown (Hoek et. al., 2002) procedures.

Table 3-2 Summary of Material Properties for Slope Stability Analyses

Material	Mositure (%)	Dry Unit Weight (pcf)	Gravel (%)	Sand (%)	Fines (%)	LL	PI
Diatomite[1]	μ: 116.7 N: 22 σ: 40.3	μ: 43.1 N: 17 σ: 15.3	μ: 0.0 N: 7 σ: 0.0	μ: 0.6 N: 7 σ: 0.4	μ: 99.4 N: 7 σ: 0.4	μ: 111 N: 7 σ: 15	μ: 51 N: 7 σ: 40
Fluvio-Lacustrine Terrace Deposit with Gravel	μ: 30.3 N: 3 σ: 4.5	μ: 121.4 N: 2 σ: 5.4	μ: 42.2 N: 3 σ: 37.3	μ: 33.4 N: 3 σ: 27.8	μ: 24.4 N: 3 σ: 34.9	μ: 111 N: 2 σ: 2.8	μ: 51 N: 2 σ: 2.8
Recent Lake Sediments[2]	μ: 38.9 N: 2 σ: 5.9	μ: NA N: 0 σ: NA	μ: 3.5 N: 3 σ: 0.7	μ: 40.3 N: 3 σ: 10.6	μ: 56.1 N: 3 σ: 11.2	μ: 41 N: 2 σ: 10.6	μ: 16 N: 2 σ: 10.6

μ = Mean
N = Number of data points
σ = Standard deviation

1. Does not include weakly cemented diatomite gravel
2. One sample (BC-02, S-01) was removed from statistics due to it being an outlier (more gravelly than others)

Table 3-3 Summary of Material Properties for Slope Stability Analyses

Layer	Unit Weight (pcf)	Undrained (Total) Strength Parameters		Drained (Effective) Strength Parameters	
		Φ (deg.)	C (psf)	Φ' (deg.)	C' (psf)
Recent Reservoir Sediments	90	0	100	-	-
Fluvio-Lacustrine Terrace Deposits with Gravel (Qtg)	120	-	-	35	0
Diatomite (Lacustrine Terrace Deposits, Ql)	82	19.9	660	35.3	150
Volcanic Bedrock	135	-	-	34	1110

Notes:
Φ = friction angle
C = cohesion

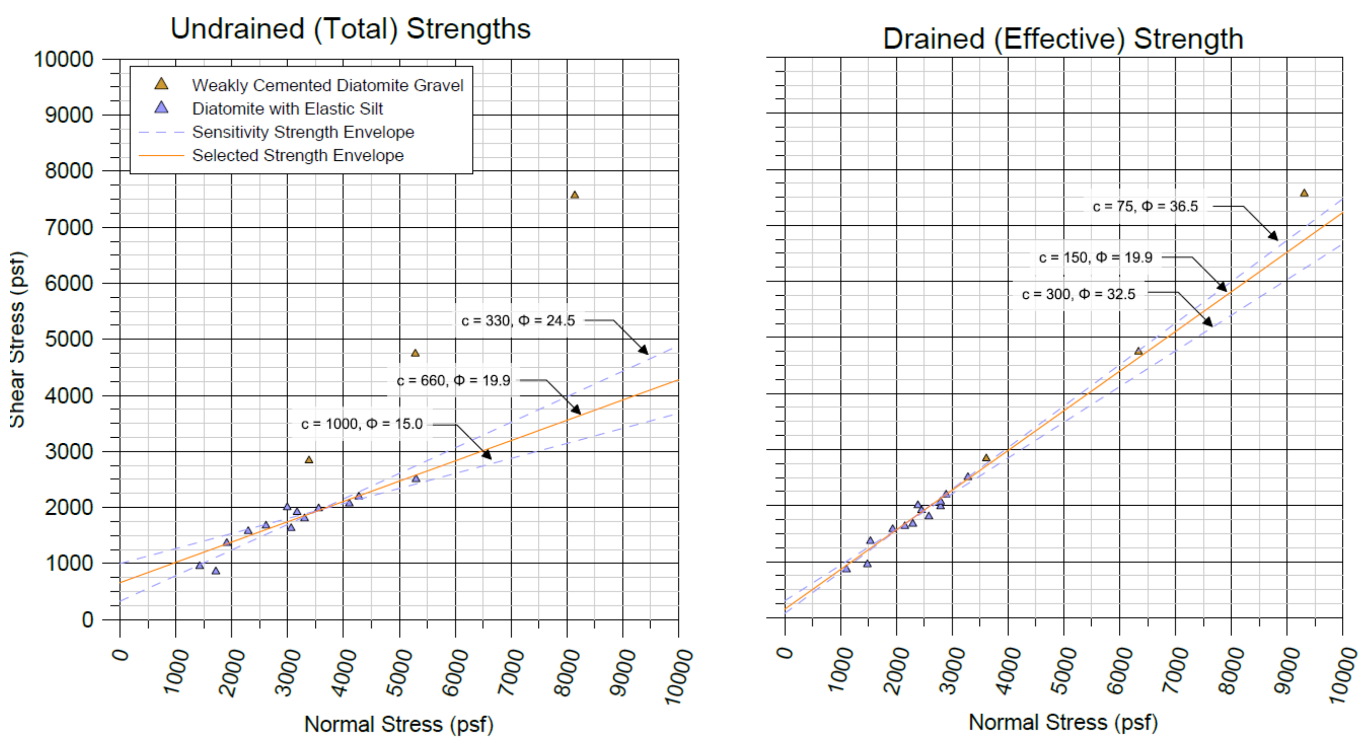

Figure 3-3 Selected Strength Envelopes

3.4.2 Segment and Cross Section Selection

To facilitate the rim stability analysis, KRRC separated the slopes within and around the reservoir rim into segments. Each segment is separated from the previous or following segment by a change in condition that could significantly change the slope stability analysis results. Some changes include a flattening or steepening of the slope, an increase in the slope height, or the mapped extent of the diatomite limiting the slope.

To aid in segment and cross section selection, KRRC performed a GIS analysis using results from a generalized slope stability analysis using the strength parameters in Table 3-3 and the methodology described in Section 3.4.3. In the generalized analysis, KRRC evaluated diatomite slopes of various heights and inclinations, providing a set of slope heights and inclinations that had a potential for instability (factor of safety less than 1.15). KRRC used the slope heights and inclinations in the GIS analysis to produce a map highlighting areas of potential concern, which was then used in segment and cross section selection.

After completing the GIS analysis and selecting segments, cross sections were selected at the most critical portion of each segment, as appropriate. KRRC created cross sections mostly for segments that the GIS analysis showed to be potentially unstable, and KRRC chose a few locations where the GIS analysis showed segments as stable to confirm those results.

Table 3-4 provides a list of the segments selected and some general information about them along with the results of the GIS analysis. Figure 3-4 shows a plan view of the segments and the status of the segment after slope stability analyses, as discussed below.

Table 3-4 Segment Description and GIS Assessment Summary

Segment	Segment Summary				GIS Analysis Result
	Approximate Length (feet)	Average Height (feet)	Average Slope (Horz:Vert)	Segment Differentiation	
N1	2,200	12.5 (range = 0 to 27)	5.2:1 (steepest = 1.2:1)	At downstream edge: by the start of the slope (at the edge of the diatomite) At upstream edge: by a decrease in the slope angle	Stable
N2	2,115	44.8 (range = 20 to 56)	2.5:1 (steepest = 0.3:1)	At downstream edge: by the start of the slope At upstream edge: by a decrease in the slope angle and increase in the slope height	Further Analysis Req.
N3	1340	18.0 (range = 1 to 40)	2.5:1 (steepest = 0.6:1)	At downstream edge by a decrease in the slope height At upstream edge by an increase in the slope height	Stable
N4	1,145	52.0 (range = 33 to 60)	2.8:1 (steepest = 0.3:1)	At downstream edge by a decrease in the slope angle and an increase in the slope height At upstream edge by an increase in the slope angle	Further Analysis Req.
N5	805	49.6 (range = 36 to 54)	2.0:1 (steepest = 0.7:1)	At downstream edge by an increase in the slope angle At upstream edge by a decrease in the slope height	Further Analysis Req.
N6	565	23.9 (range = 6 to 37)	2.7:1 (steepest = 1.1:1)	At downstream edge by a decrease in the slope height At upstream edge by the end of the slope	Stable
N7	400	-	-	At downstream edge by the start of the slope At upstream edge by an increase in the slope height	Not Completed (Further Analysis Required)
N8	2,030	40.0 (range = 11 to 52)	3.4:1 (steepest = 0.5:1)	At downstream edge an increase in the slope height At upstream edge by a decrease in the slope angle	Stable
N9	2,245	37.6 (range = 11 to 51)	3.8:1 (steepest = 1.2:1)	At downstream edge a decrease in the slope angle At upstream edge by an decrease in the slope angle	Stable
N10	2,420	19.8 (range = 9 to 28)	3.3:1 (steepest = 0.7:1)	At downstream edge a decrease in the slope angle At upstream edge by an increase in the slope angle	Not Completed (Further Analysis Required)
N11	925	-	-	At downstream edge an increase in the slope angle At upstream edge by an increase in the slope height	Not Completed (Further Analysis Required)
N12	2,665	28.6 (range = 6 to 43)	2.9:1 (steepest = 0.7:1)	At downstream edge an increase in the slope height At upstream edge by the end of the slope (decrease in the slope angle)	Not Fully Completed (Further Analysis Required)
N13	1,445	20.1 (range = 3 to 28)	3.2:1 (steepest = 1.5:1)	At downstream edge the start of the slope At upstream edge by an increase in the slope angle	Stable

Segment	Segment Summary				GIS Analysis Result
	Approximate Length (feet)	Average Height (feet)	Average Slope (Horz:Vert)	Segment Differentiation	
N14	505	37.6 (range = 1 to 45)	2.4:1 (steepest = 0.2:1)	At downstream edge an increase in the slope angle At upstream edge by a decrease in the slope height (at the edge of the diatomite)	Further Analysis Req.
N15	970	5.6 (range = 0 to 18)	4.5:1 (steepest = 1.8:1)	At downstream edge by a decrease in the slope height (at the edge of the diatomite) At upstream edge by an increase in the slope height (at the edge of the diatomite)	Stable
N16	370	52.0 (range = 16 to 59)	2.4:1 (steepest = 0.9:1)	At downstream edge by an increase in the slope height (at the edge of the diatomite) At upstream edge by a decrease in the slope angle and decrease in the slope height	Further Analysis Req.
N17	1,210	22.7 (range = 2 to 45)	3.7:1 (steepest = 1.1:1)	At downstream edge by a decrease in the slope angle and decrease in the slope height At upstream edge by an increase in the slope height (at the edge of the diatomite)	Stable
N18	1,455	-	-	At downstream edge by the start of the slope (increase in the slope angle) At upstream edge by the end of the slope (decrease in the slope angle)	Not Completed (Further Analysis Required)
N19	985	24.9 (range = 17 to 40)	3.8:1 (steepest = 1.1:1)	At downstream edge by the start of the slope (increase in slope angle) At upstream edge by an increase in the slope angle	Stable
N20	1,015	35.3 (range = 11 to 44)	3.0:1 (steepest = 0.6:1)	At downstream edge by an increase in the slope angle At upstream edge by a decrease in the slope height (edge of the diatomite)	Further Analysis Required
N21	670	9.0 (range = 0 to 15)	5.1:1 (steepest = 0.9:1)	At downstream edge by a decrease in the slope height (edge of the diatomite) At upstream edge by the end of the slope (edge of the diatomite)	Stable
S1	665	70.5 (range = 46 to 87)	3.8:1 (steepest = 0.8:1)	At downstream edge by the start of the slope (at the edge of the diatomite) At upstream edge by a decrease in the slope height (due to an intermediate plateau)	Further Analysis Req.

Segment	Segment Summary				GIS Analysis Result
	Approximate Length (feet)	Average Height (feet)	Average Slope (Horz:Vert)	Segment Differentiation	
S2	555	41.8 (range = 29 to 52)	3.7:1 (steepest = 0.6:1)	At downstream edge by a decrease in the slope height (due to an intermediate plateau) At upstream edge by a decrease in the slope height	Stable
S3	1,020	47.6 (range = 22 to 55)	2.4:1 (steepest = 0.6:1)	At downstream edge by a decrease in the slope height (due to an intermediate plateau) At upstream edge by a decrease in the slope height	Further Analysis Req.
S4	1,190	23.5 (range = 6 to 39)	2.9:1 (steepest = 0.4:1)	At downstream edge by a decrease in the slope height At upstream edge by the end of the slope (decrease in the slope angle)	Further Analysis Req.
S5	445	16.0 (range = 3 to 28)	3.0:1 (steepest = 1.2:1)	At downstream edge by a decrease in the slope height At upstream edge by the end of the slope (decrease in the slope angle)	Stable
S6	1,080	23.5 (range = 5 to 31)	3.0:1 (steepest = 1:1)	At downstream edge by the start of the slope (increase in slope angle) At upstream edge by an increase in the slope height	Stable
S7	350	49.2 (range = 31 to 66)	2.3:1 (steepest = 0.7:1)	At downstream edge by an increase in the slope height At upstream edge by a decrease in the slope angle	Further Analysis Req.
S8	1,410	48.8 (range = 36 to 59)	3.5:1 (steepest = 0.9:1)	At downstream edge by a decrease in the slope angle At upstream edge by a decrease in the slope height	Stable
S9	1,365	28.2 (range = 3 to 51)	2.4:1 (steepest = 0.4:1)	At downstream edge by a decrease in the slope height At upstream edge by an increase in the slope height	Further Analysis Req.
S10	670	66.0 (range = 42 to 79)	2.4:1 (steepest = 0.6:1)	At downstream edge by an increase in the slope height At upstream edge by the edge of observed bedrock along the shoreline	Further Analysis Req.
S11	765	70.0 (range = 32 to 82)	3.6:1 (steepest = 0.8:1)	At downstream edge by the edge of observed bedrock along the shoreline At upstream edge by the start of an intermediate plateau (decrease in slope height)	Further Analysis Req.

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Segment	Segment Summary				GIS Analysis Result
	Approximate Length (feet)	Average Height (feet)	Average Slope (Horz:Vert)	Segment Differentiation	
S12	2,445	16.7 (range = 4 to 42)	3.7:1 (steepest = 0.9:1)	At downstream edge by the start of an intermediate plateau (decrease in slope height) At upstream edge by the end of an intermediate plateau (increase in slope height)	Stable
S13	640	20.5 (range = 7 to 29)	2.7:1 (steepest = 1.3:1)	At downstream edge by the start of an intermediate plateau (decrease in slope height) At upstream edge by an increase in the slope angle	Stable
S14	1,945	39.5 (range = 28 to 51)	2.1:1 (steepest = 0.2:1)	At downstream edge by an increase in the slope angle At upstream edge by the end of an intermediate plateau (increase in slope height)	Further Analysis Req.
S15	460	56.3 (range = 10 to 64)	1.9:1 (steepest = 0.2:1)	At downstream edge by the end of an intermediate plateau (increase in slope height) At upstream edge by a decrease in the slope angle	Further Analysis Req.
S16	1,105	35.5 (range = 6 to 44)	2.9:1 (steepest = 1:1)	At downstream edge by a decrease in the slope angle At upstream edge by a decrease in the slope height	Stable
S17	950	12.5 (range = 3 to 19)	3.6:1 (steepest = 1.3:1)	At downstream edge by a decrease in the slope height At upstream edge by the end of the slope (decrease in slope angle)	Stable
S18	1,565	20.7 (range = 5 to 29)	2.8:1 (steepest = 0.2:1)	At downstream edge by the start of the slope (increase in slope height) At upstream edge by a decrease in the slope height (edge of the diatomite)	Further Analysis Req.
S19	1,945	7.3 (range = 0 to 16)	4.5:1 (steepest = 1.2:1)	At downstream edge by the end of the slope (decrease in the slope height) At upstream edge by the end of the slope (decrease in slope angle)	Stable
S20	3,370	18.7 (range = 0 to 30)	3.7:1 (steepest = 0.2:1)	At downstream edge by the start of the slope (increase in slope angle) At upstream edge by the end of the slope (edge of the diatomite)	Stable

3.4.3 Slope Stability Analysis Methodology

The slope stability of individual sections (and the initial generalized analyses) was analyzed using the software SLOPE/W (GeoStudio 2018) and Morgenstern-Price's procedure (with a half-sine function) for the calculation of factor of safety. KRRC used a circular slip surface without optimization for the analyses unless otherwise noted.

The different analyses performed for the sections are discussed below. The rapid drawdown analyses were performed for every section analyzed, while the other existing conditions, long-term (post drawdown), and historical drawdown analyses were only performed on sections that had a factor of safety less than 1.15, to confirm the validity of the model.

Rapid Drawdown

Rapid drawdown analyses were performed using a staged rapid drawdown analysis approach proposed by Duncan et. al. (1990). During rapid drawdown, the stabilizing effect of the reservoir on the slope is absent but the pore water pressures within the slope remain high in materials with low permeability. The high pore pressures in combination with the lack of the stabilizing effect from the reservoir can lead to significantly reduced slope stability.

The diatomite was modeled with undrained shear strength parameters in the analysis. This model approach is reasonable considering the fact that the diatomite would take long time to drain because it has a very low permeability of about $1x10^{-6}$ cm/s. The recent reservoir sediment was also modelled in a similar fashion, although that choice is inconsequential to the stability of the slope overall since it makes up only a small percentage of the slope.

The groundwater was initially set as a horizontal line at Elevation +2,605 feet (the same as the existing conditions) and then drawn down to a horizontal line at the existing thalweg ground surface.

Historical Drawdown

Based on the historical drawdown information shown in Figure 3-1, KRRC performed a rapid drawdown analysis using the same method as the rapid drawdown analyses above but with a water level drop from Elevation +2,610 to +2,596. KRRC used this analysis to verify the model due to the fact that no landslides were observed during any of the previous drawdown events.

Existing Conditions

KRRC performed the existing condition analyses to assess the current stability of the slope. This analysis serves as verification of the model since there are no reported active slope instabilities around Copco No. 1 reservoir. These analyses used the drained (effective) strength parameters for all materials and the groundwater was set as a horizontal line at Elevation +2,605 feet based on the water level in the reservoir at the time of drilling.

Long-Term (Post Drawdown)

KRRC performed the long-term analyses to assess the stability of the slope after all the excess pore pressures from drawdown have dissipated. This analysis was also done to validate the model since the slopes, particularly those submerged in the reservoir, were at least semi-stable before the reservoir was filled. These analyses used drained (effective) strength parameters for the diatomite and groundwater was set as a horizontal line at the existing thalweg ground surface.

3.4.4 Slope Stability Analysis Results

A summary of the results of the slope stability analyses are presented below. KRRC used a factor of safety of 1.15 as the pass/fail criteria due to the critical nature of some areas and the lack of specific data at most of these locations. Figure 3-4 shows a plan view of the current analysis results, and Figure 3-5 shows cross section results for the rapid drawdown analyses.

Sensitivity Analyses

The shear strength of the diatomite is the parameter that has the greatest influence on the slope stability analysis results. Therefore, sensitivity analyses will be performed by assuming different interpretations of the laboratory strength test results for samples of diatomite, as shown in Figure 3-3 and summarized in Table 3-5. Using the strengths shown, any sections with factors of safety between 1.15 and 1.3 will be analyzed and included in the final report.

Table 3-5 Summary of Strength Parameters of Diatomite Used for Sensitivity Analysis

Strength Type	Selected Strength		Lower Cohesion Fit		Lower Friction Angle Fit	
	C (psf)	Φ (degrees)	C (psf)	Φ (degrees)	C (psf)	Φ (degrees)
Drained (effective) Strengths	150	35.3	75	36.5	300	32.5
Undrained (total) Strengths	660	19.9	330	24.5	1000	15

Figure 3-4 Summary of Segment Extents and Current Results (Attachment A)

Figure 3-5 Rapid Drawdown Analysis Cross Sections (Attachment A)

Table 3-6 Stability Analysis Summary

Segment	GIS Analysis Result	Cross Section Details		Slope Stability Analysis Results			
		Maximum Slope (H:V)	Slope Height (feet)	Rapid Drawdown	Historical Drawdown	Existing Conditions	Long-Term Conditions
N2	Further Analysis Req.	In Progress					
N4	Further Analysis Req.	In Progress					
N5	Further Analysis Req.	In Progress					
N7	Not Completed (Further Analysis Req.)	In Progress					
N9	Stable (GIS Analysis Check)	In Progress					
N10	Not Completed (Further Analysis Req.)	1.8:1	65	2.01	-	-	-
N11	Not Completed (Further Analysis Req.)	1.1:1	54	1.71	-	-	-
N12	Not Fully Completed (Further Analysis Req.)	In Progress					
N14	Further Analysis Req.	In Progress					
N16	Further Analysis Req.	In Progress					
N18	Not Completed (Further Analysis Req.)	In Progress					
N20	Further Analysis Req.	In Progress					
S1	Further Analysis Req.	1.9:1 (0.4:1 bluff)	163 (97 from water level)	1.09	1.66	1.53	2.26
S2	Stable (GIS Analysis Check)	In Progress					
S3	Further Analysis Req.	1.6:1	53	1.0	2.87	2.87	1.75
S4	Further Analysis Req.	In Progress					
S7	Further Analysis Req.	In Progress					
S8	Stable (GIS Analysis Check)	In Progress					
S9	Further Analysis Req.	In Progress					
S10	Further Analysis Req.	1.1:1	72	1.03	2.56	2.68	1.62

Segment	GIS Analysis Result	Cross Section Details		Slope Stability Analysis Results			
		Maximum Slope (H:V)	Slope Height (feet)	Rapid Drawdown	Historical Drawdown	Existing Conditions	Long-Term Conditions
S11	Further Analysis Req.	1.9:1	159 (81 from water level)	0.99	1.89	1.38	2.18
S14	Further Analysis Req.	In Progress					
S15	Further Analysis Req.	In Progress					
S18	Further Analysis Req.	0.7:1	29	1.39	-	-	-

3.4.5 Future Analyses and Investigations

While the analyses discussed above are still preliminary, the results indicate that certain areas or segments may have the potential for slope instability as a result of the project activities. Some of these segments are below the current reservoir water surface, and slope failures within these segments would not impact existing roads or private property/structures. KRRC does not propose additional field investigations for these segments.

For other segments, slope failure could result in impacts to existing roads or private property/structures. For each of these segments, KRRC will complete a boring or borings during the summer of 2018. KRRC will use boring logs and laboratory data to update the stability analyses completed to date to better understand the potential for slope failure and any project actions that may be required to offset the impact.

In addition to field investigations above, KRRC may complete additional analyses along certain segments, as appropriate, including:

- Deformation analysis of select profiles, as necessary, to assess the impact area of potential slope failures
- Sensitivity analyses of the impact of variations in the strength of the diatomite on the slope stability analysis results (as mentioned above)
- Analyses of possible engineered solutions (retaining wall, etc.), as appropriate

3.5 Conclusions

When discussing reservoir rim stability during drawdown, it is important to differentiate between the potential for deep-seated large landslides along the reservoir rim that could impact roads or property, and slides of material beneath the current water surface, which would only impact resources within the local limited slide footprint.

Minor, shallow slides of existing material beneath the existing reservoir water surfaces are possible during drawdown. These minor slides would not extend outside of the current reservoir footprint and would only potentially impact resources within the limited slide footprint (e.g. cultural resources). Some larger deeper slides are also possible within Copco No. 2 reservoir where submerged higher bluffs exist along the original Klamath River channel. These shallow slides and potential slides along the river channel pose no threat to roads or private property; however, KRRC will monitor these areas during and post-drawdown to assess any potential impact to existing cultural resources.

The geologic assessment and slope stability analysis summarized above indicate that certain segments along the Copco No. 1 reservoir rim have a potential for slope failure that could impact existing roads and/or private property. In some areas, the impact could be relatively minor, while in other areas the impact could be greater. Based on the referenced analysis, approximately 3,700 linear feet of slopes along Copco Road (north shore segments S4, S9, S11 and S15), and approximately 2,800 linear feet of slope adjacent to private property (along south shore – segments N9, N14, N16and N14) require additional field investigation and analysis to gain a more refined understanding of slope stability in those areas. Up to eight parcels along the referenced segments appear to have existing habitable structures that could potentially be impacted.

Additional field geologic data is required to confirm the potential for slope failure along the referenced reservoir rim segments. KRRC will complete the additional field investigation in July and August of 2018, followed by completion of a series of material property laboratory tests. KRRC will use results from the field investigation and laboratory testing to update stability assessments in the rim segments of concern in fall 2018. Should additional study determine that there is a high probability of slope failure in any of these areas, KRRC will consider the following actions to offset potential impacts:

1. For segments along Copco Road:
    a) Re-align of road segment away from rim slope
    b) Engineer structural slope improvements (e.g. drilled shafts or other structural elements that could be installed to resist slope movement)
2. For segments adjacent to property or structure:
    a) Move structure or purchase property
    b) Engineer structural slope improvements (e.g. drilled shafts or other structural elements that could be installed to resist slope movement)

Based on the low permeability of the diatomite, changing the drawdown rate would have minimal impact on the rapid drawdown stability analysis results. Therefore, KRRC is not proposing to limit the drawdown rate for drawdown of Copco No. 1 reservoir.

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Chapter 4: Iron Gate Reservoir

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4. IRON GATE RESERVOIR

4.1 Historical Investigations and Drawdowns

4.1.1 Historical Investigations

Historic subsurface geologic data at Iron Gate reservoir includes sediment sampling completed in 2006 (Shannon & Wilson, 2006). None of the borings for this previous investigation were deep enough to provide information useful for reservoir rim stability analysis.

4.1.2 Historical Drawdowns

Iron Gate Reservoir levels between January 1, 1979, and December 31, 2016, KRRC reviewed for historical occurrences of reservoir drawdown. The four most significant drawdown events occurred in the falls of 2004, 2014, 2015, and 2016 (see Figure 4-1).

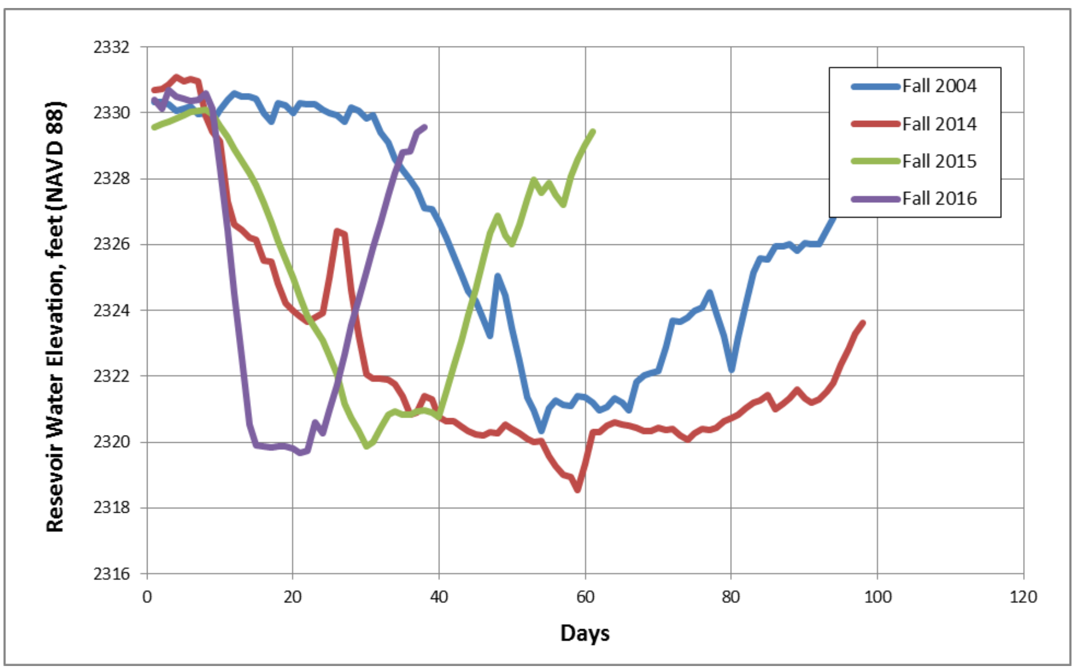

Figure 4-1 Iron Gate Reservoir Maximum Historical Drawdown Events (1979 to 2016)

The magnitude of the drawdowns ranged from about 9 feet to 14.5 feet. The maximum daily drawdown rate of 2 feet per day occurred in 2014. Based on inquiries made to PacifiCorp, there were no reported slope failures resulting from these drawdowns (email with Demian Ebert August 2, 2017).

4.2 Project Investigations

KRRC performed geologic mapping and subsurface investigations at Iron Gate Reservoir to characterize past landslides and for design of the replacement Yreka waterline.

Drilling within the reservoir area was performed over water from a small platform barge using a CME-45 drill rig for borings BI-01 and BI-03. Land-based drilling was performed with a truck-mounted CME-75 drill rig for BI-02. Taber Drilling of West Sacramento advanced the three rotary wash borings between February 20 and 23, 2018. The boring depths ranged from 22.2 to 67 feet. Figure 4-2 shows boring locations. Table 4-1 summarizes the exploratory boring data, including depth and elevation of volcanic bedrock, where encountered. Attachment A provides boring logs. KRRC obtained soil samples using standard penetration test (SPT) and 2.5-inch I.D. modified California (MC) drive samplers. KRRC recorded blow counts at 6-inch intervals for drive samples.

Table 4-1 Summary of Exploratory Boring Data (Iron Gate Reservoir)

Boring Name	Total Depth (feet)	Northing	Easting	Elevation (feet)	Depth to Rock (feet)
BI-01	22.2	2600814	6450534	2315.1	11.5
BI-02	67	2602024	6461383	2326.7	17.5
BI-03	35.1	2601812	6461399	2302.2	3.8

4.2.1 Summary of Subsurface Conditions

Boring BI-01 was completed to assess the rim stability around Iron Gate Reservoir. The boring encountered approximately 2 feet of recent lake sediment consisting of lean clay with organics which overlay approximately 9.5 feet of colluvium/residual soil consisting of lean clay. Below the colluvium/residual soil the boring encountered volcanic bedrock consisting of basalt and volcaniclastics.

Borings BI-02 and BI-03 were advanced as part of the design of the replacement Yreka waterline. While not directly related to rim stability, the results of these explorations were useful to develop estimates of rock strength for the analyses around Copco No. 1 reservoir. The two borings showed approximately 3.8 (BI-03) to 17.5 (BI-02) feet of alluvium (older and younger) consisting of lean clay with varying amounts of sand and gravel, clayey sand with gravel, and poorly graded gravel. Volcanic bedrock consisting of tuff breccia underlay the alluvium.

4.3 Geologic Characterization

4.3.1 Previous Mapping

Previously published geologic mapping of the Iron Gate Dam and lake area include:

- *Volcanic Formations Along the Klamath River Near Copco Lake, Siskiyou County,* PAUL E. HAMMOND, Department of Geology, Portland State University, Portland, Oregon; California Geology, May 1983.
- *Geology of the Macdoel Quadrangle,* HOWEL WILLIAMS , California Division of Mines and Geology Bulletin 151, November, 1949
- *Geotechnical Report, Klamath River Dam Removal Project, California and Oregon, Project No. 07-153,* PanGEO Incorporated, prepared for Philip Williams & Associates, Ltd. And California State Coastal Conservancy, August, 2008.
- *Geologic Map of the Weed Quadrangle,* D. L. Wagner and G. J. Saucedo, California Division of Mines and Geology, 1987)

PanGEO (2008) provide a thorough description of regional and local geology for Iron Gate area, including a geologic map compiled from Williams (1949) and Hammond (1983) that includes structural data from site reconnaissance in a 2008 Geotechnical Report for this project. Pertinent data is included in this evaluation.

4.3.2 Geologic and Surficial Mapping

Iron Gate Dam and its reservoir lie entirely within the Western Cascades geologic province. Hammond (1983) suggests that the volcaniclastic formation that he informally named the Beds of Bogus Mountain extends into the Iron Gate area (PanGEO 2008). Bedrock units include tuffaceous siltstones and sandstones, bouldery volcaniclastics and volcanic breccia, rhyolite tuff and tuff breccia, and pyroxene flow rocks. Geologic reconnaissance indicates generally shallow bedrock with a thin soil mantle. Surficial geologic units including landslide and alluvial deposits are not differentiated from the underlying volcanic rocks in previously published mapping.

PanGEO (2008) identified three possible landslide related features on the south rim of the reservoir (Figure 4-2), and characterized these as “weakly suggestive of old landslides ranging from small slumps only a few meters in size up to possible slides covering several square miles”. These existing features are considerations in the rim stability conclusions described in Section 4.4.

For this study, the KRRC reviewed the 2010 LiDAR-derived terrestrial digital elevation model (DEM), recently acquired high-resolution bathymetric survey data (GMA, 2018), and pre-dam stereoscopic aerial photographs (1944 and 1951) for the entire lake area. KRRC used these data to develop a detailed surficial geologic map (Figure 4-2). While some bedrock and structural data is included in this mapping, the primary intent is to identify larger surficial deposits along the lakeshore and in lake bed that could become unstable during drawdown. In addition to DEM and photo review, KRRC performed site reconnaissance along public roadways around the reservoir during the week of June 5, 2017, and the week of July 24, 2017. KRRC performed additional reconnaissance of the lake shoreline on October 5, 2017 using a small powered row boat. Based on preliminary reconnaissance, before bathymetric surveys were performed, boring BI-01 was located to investigate the toe zone of a possible landslide identified by PanGEO (2008). As noted in Section 4.2.1, the results of this boring did not indicate a slide deposit and encountered volcanic bedrock approximately 10 feet below the pre-dam surface.

Features previously identified by PanGEO as well as several other features with possible landslide morphology identified by the KRRC are delineated as shown on Figure 4-2. These features appear unchanged from 1944 and 1951 historical aerial photographs, and do not show indications of recent activity on the LiDAR/Bathymetric DEM. The morphology of the two larger features appears more consistent with differential erosion of different volcanic/volcaniclastic bedrock units or in the case of the western feature, possible volcanic flow collapse during or immediately after emplacement. The third, smallest potential landslide identified by PanGEO (2008) may represent a small, dormant slide, but the narrow width indicates a rather shallow slide surface that, if reactivated, does not pose a significant hazard.

The reservoir slopes in the area downstream of Jenny Creek exhibit some degree of bench and scarp morphology, sometimes associated with large, deep-seated landslides. The prevalence of outcrops with variable volcanic rock lithologies, the lack of indications recent activity, and consistent appearance on historic aerial photographs suggests that this morphology is most likely the result of bedrock structure, including volcanic flow rock emplacement, and differential weathering. Some of the bench surfaces may also be the result of past fluvial erosion.

One larger, likely landslide was identified along Copco Road within the peninsula between the east and west arms of the reservoir. KRRC based the identification on the presence of a subdued, 10- to 20-foot high break in slope that may represent the head scarp of a dormant, block-slide type feature. This feature does not have any indication of recent slope movement and is unchanged in historic aerial photos. As KRRC interprets the toe of this feature to lie in a small tributary drainage above the reservoir rim, it is very unlikely to be affected by drawdown.

Figure 4-2: Geologic Overview of Iron Gate Reservoir (Attachment A)

4.4 Conclusions

Much of the bedrock mapped around the rim of Iron Gate Reservoir consists of volcanic flow rock, rhyolite tuff and tuff breccia. The extent and morphology of these outcrops and general lack of surficial deposits suggest a shallow weathering profile that is interpreted to form generally stable reservoir slopes under drawdown conditions. Existing structural data (PanGEO 2008) and reconnaissance performed by the KRRC are in line with this interpretation.

Beds of Bogus Mountain are mapped at the very upstream end of the reservoir, but the outcrop pattern and structural measurements indicate the beds strike normal to the slope and dip gently to the east. PanGEO (2008) mapped volcaniclastic beds on the northwest arm of the reservoir, to the north and east of Juniper Point, dipping gently to the west. On the west facing, eastern slope of the reservoir, this orientation has the potential for structural block slide slope failure, however, the gentle slope, lack of historical movement and very low submarine relief indicate this type of failure is very unlikely in this area.

Shallower slides are likely to occur in the shallow surficial deposits around the reservoir rim and on the reservoir slopes that are currently below the reservoir surface. Small, shallow soil failures in the more deeply weathered volcaniclastic beds and in colluvial deposits present a minor hazard to Copco Road where the road is immediately adjacent to the shore. These slope failures are likely to be shallow and local, but may possibly require minor repair to maintain full use of the roadway. Minor repair may include installation of riprap on slope adjacent to Copco Road and/or road surface rehabilitation.

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Chapter 5: References

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Attachment A Figures

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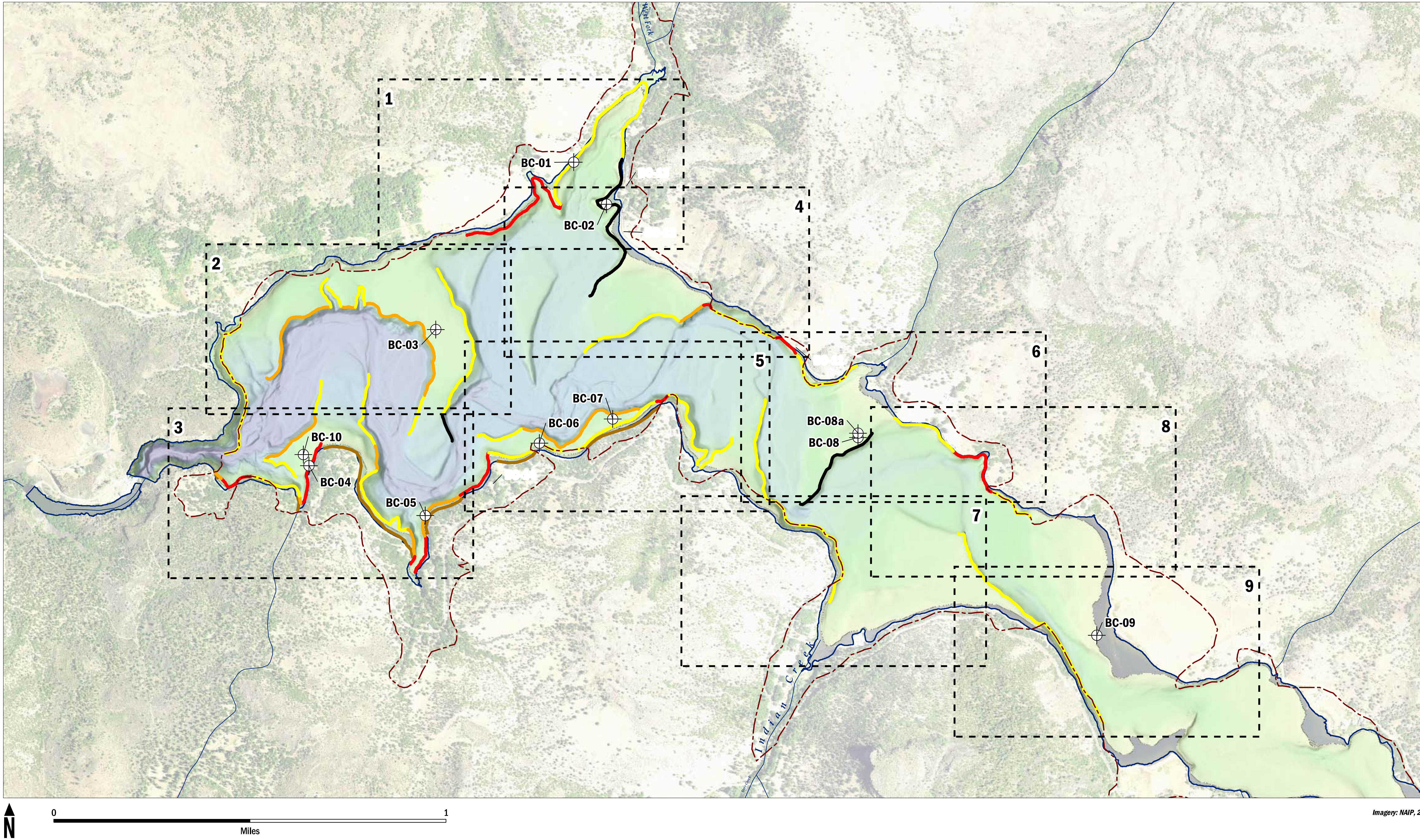
FIGURE 3-2
Geologic Overview of Copco Lake



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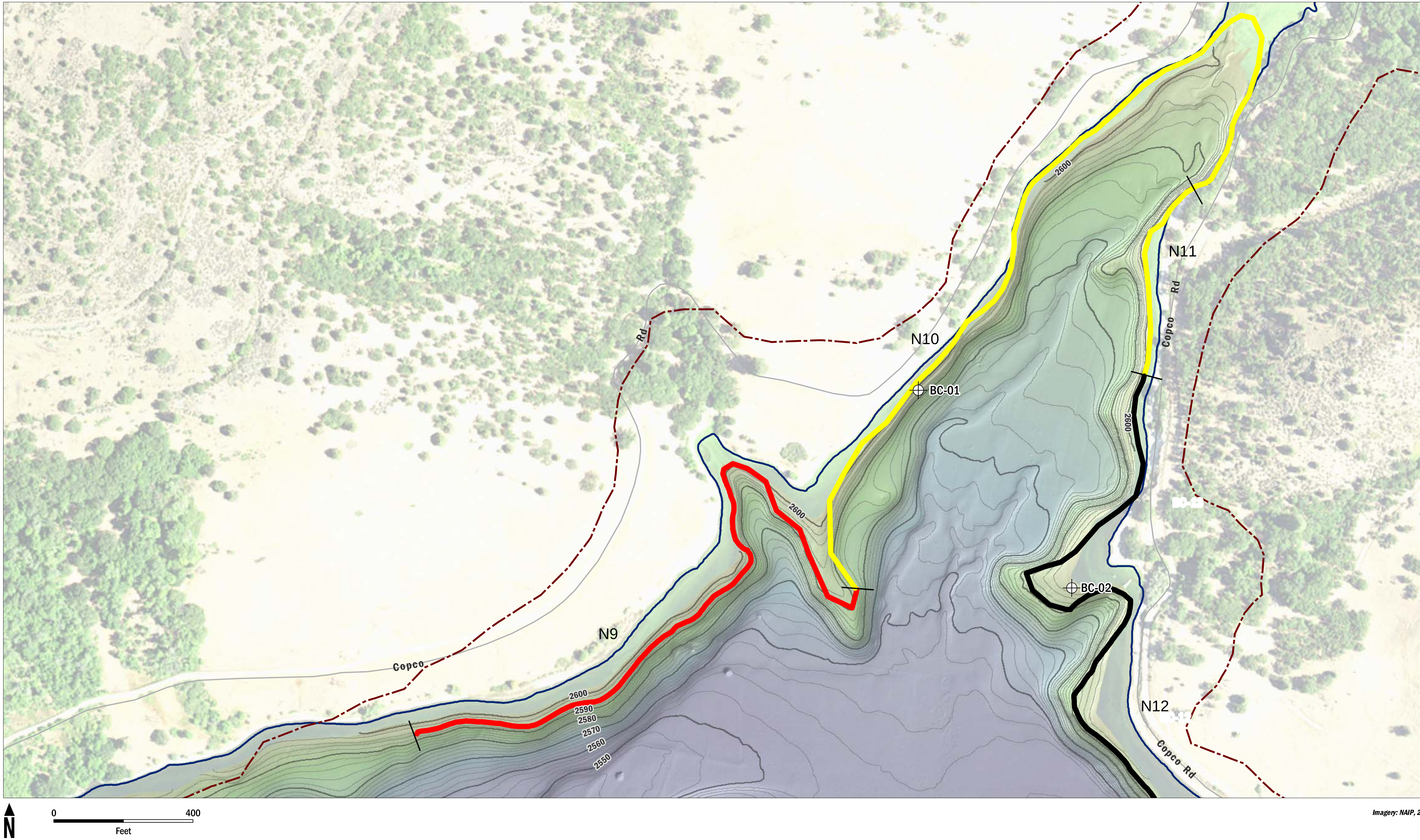
Borings
Mapbook Sheet Extent
Extent of Fluvio-Lacustrine Deposits
Volcanic Rock Exposed in Shoreline Notch
Current Reservoir Shoreline

Slope Failure Analysis Features
Incomplete Analysis
Stable Slope
Potentially Unstable Slope (failure contained within reservoir)
Potentially Unstable Slope

FIGURE 3-4
Copco Dam - Slope Failure Analysis
Overview Map



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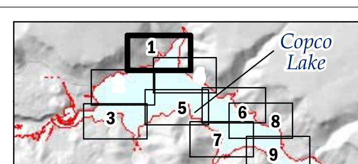


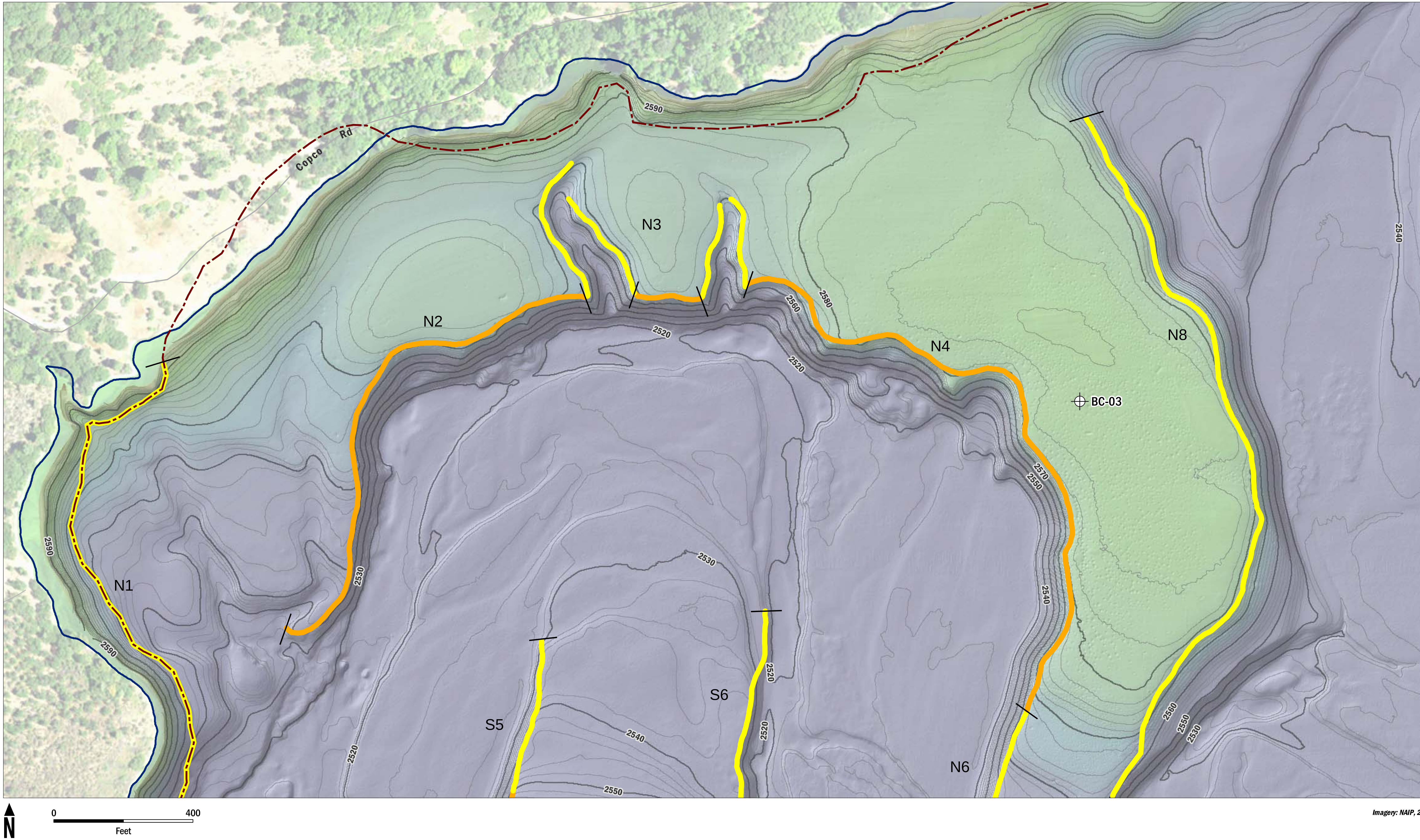
Borings
Extent of Fluvio-Lacustrine Deposits
Current Reservoir Shoreline

Slope Failure Analysis Features
Incomplete Analysis
Stable Slope
Potentially Unstable Slope

Bathymetric Contours
2 ft.
10 ft.

Segment Information
Segment Extents
N1 Segment Names

FIGURE 3-4
Copco Dam - Slope Failure Analysis
Sheet 1 of 9



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Borings
Extent of Fluvio-Lacustrine Deposits
Current Reservoir Shoreline

Slope Failure Analysis Features
Incomplete Analysis
Stable Slope
Potentially Unstable Slope (failure contained within reservoir)

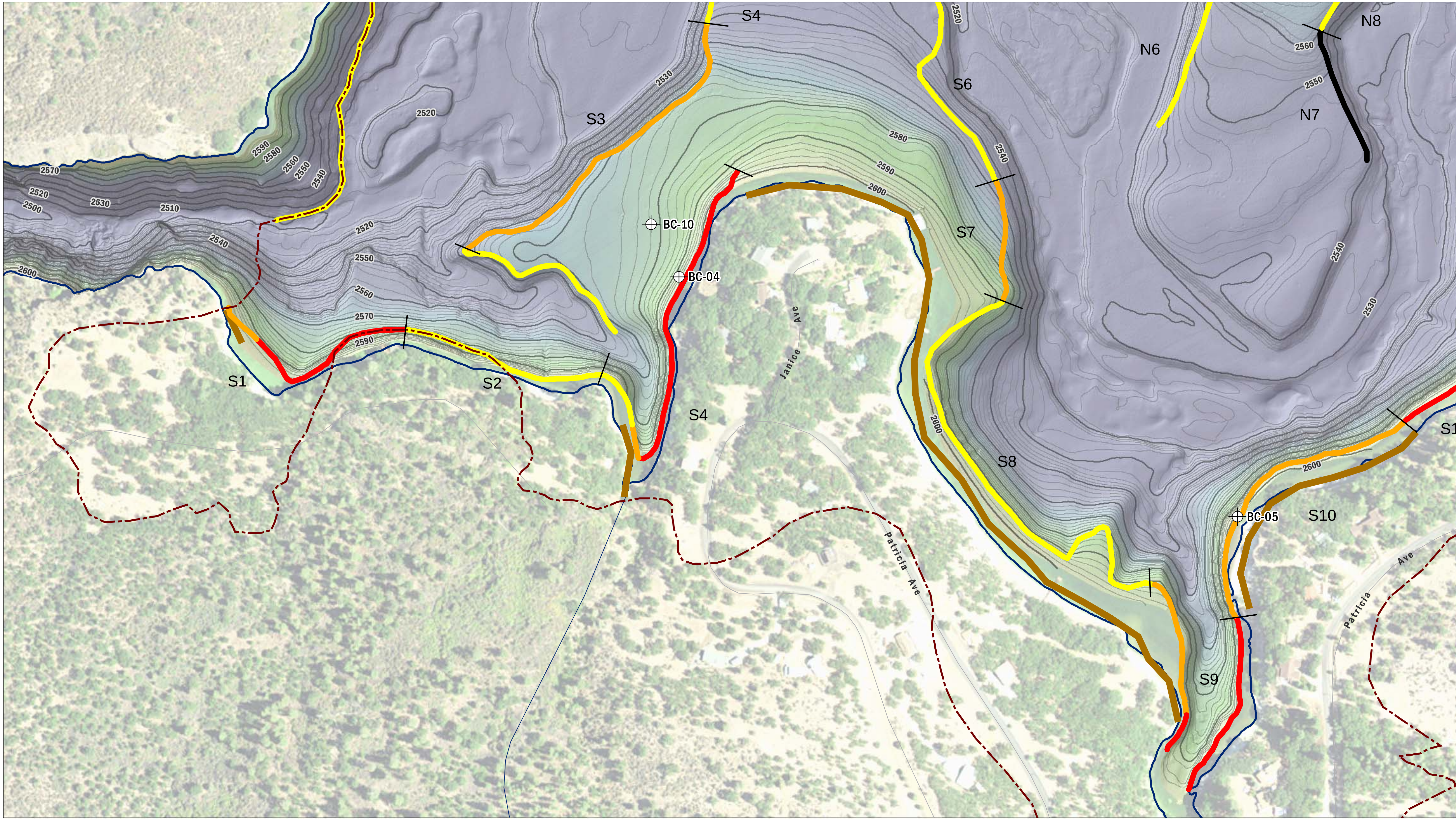
Bathymetric Contours
2 ft.
10 ft.

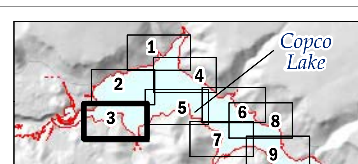
Segment Information
Segment Extents
N1 Segment Names

FIGURE 3-4

Copco Dam - Slope Failure Analysis

Sheet 2 of 9





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Borings

Extent of Fluvio-Lacustrine Deposits

Volcanic Rock Exposed in Shoreline Notch

Current Reservoir Shoreline

Slope Failure Analysis Features

Incomplete Analysis

Stable Slope

Potentially Unstable Slope (failure contained within reservoir)

Potentially Unstable Slope

Bathymetric Contours

2 ft.

10 ft.

Segment Information

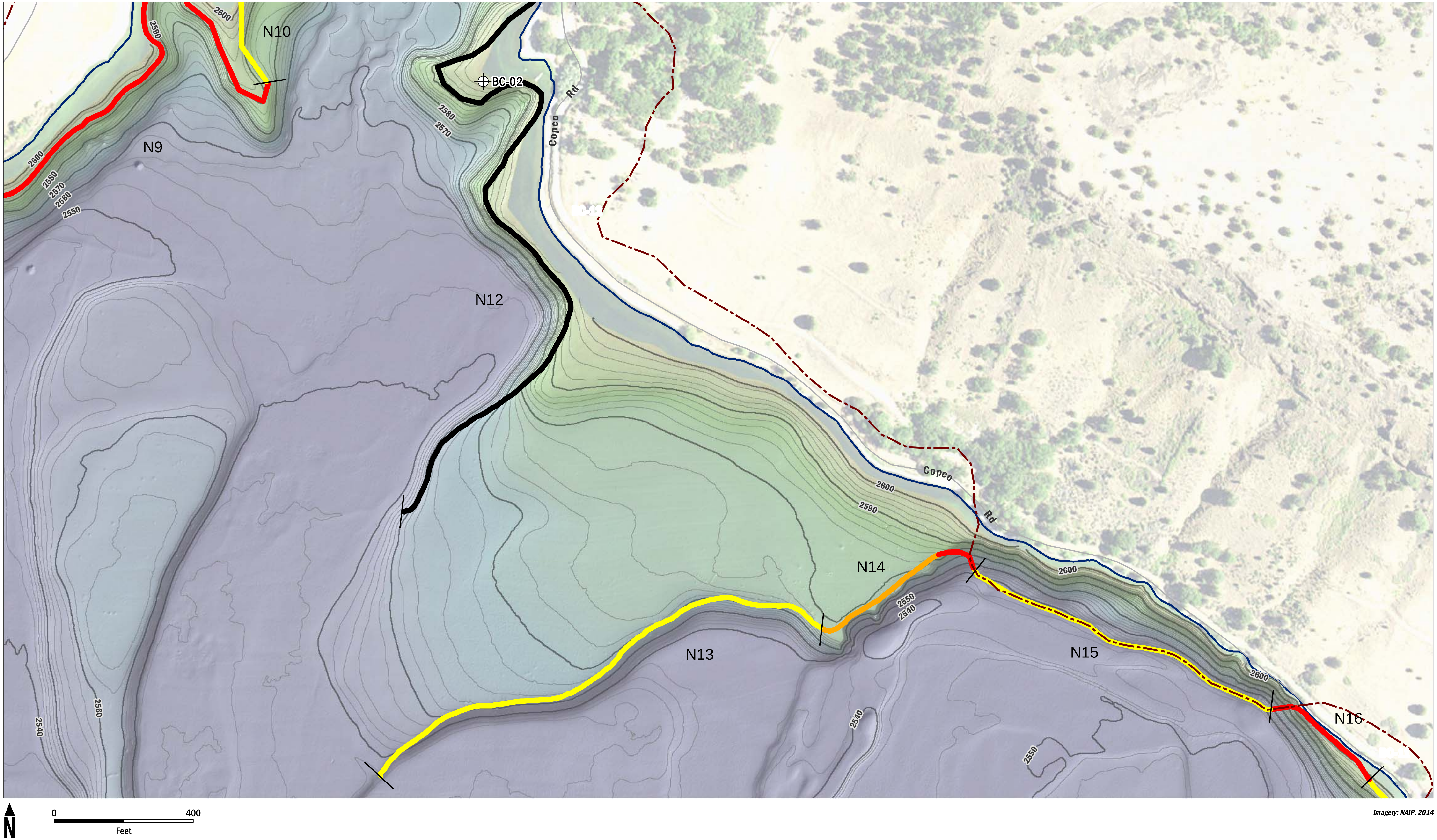
Segment Extents

N1 Segment Names

FIGURE 3-4

Copco Dam - Slope Failure Analysis

Sheet 3 of 9



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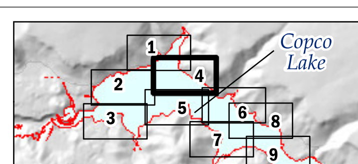


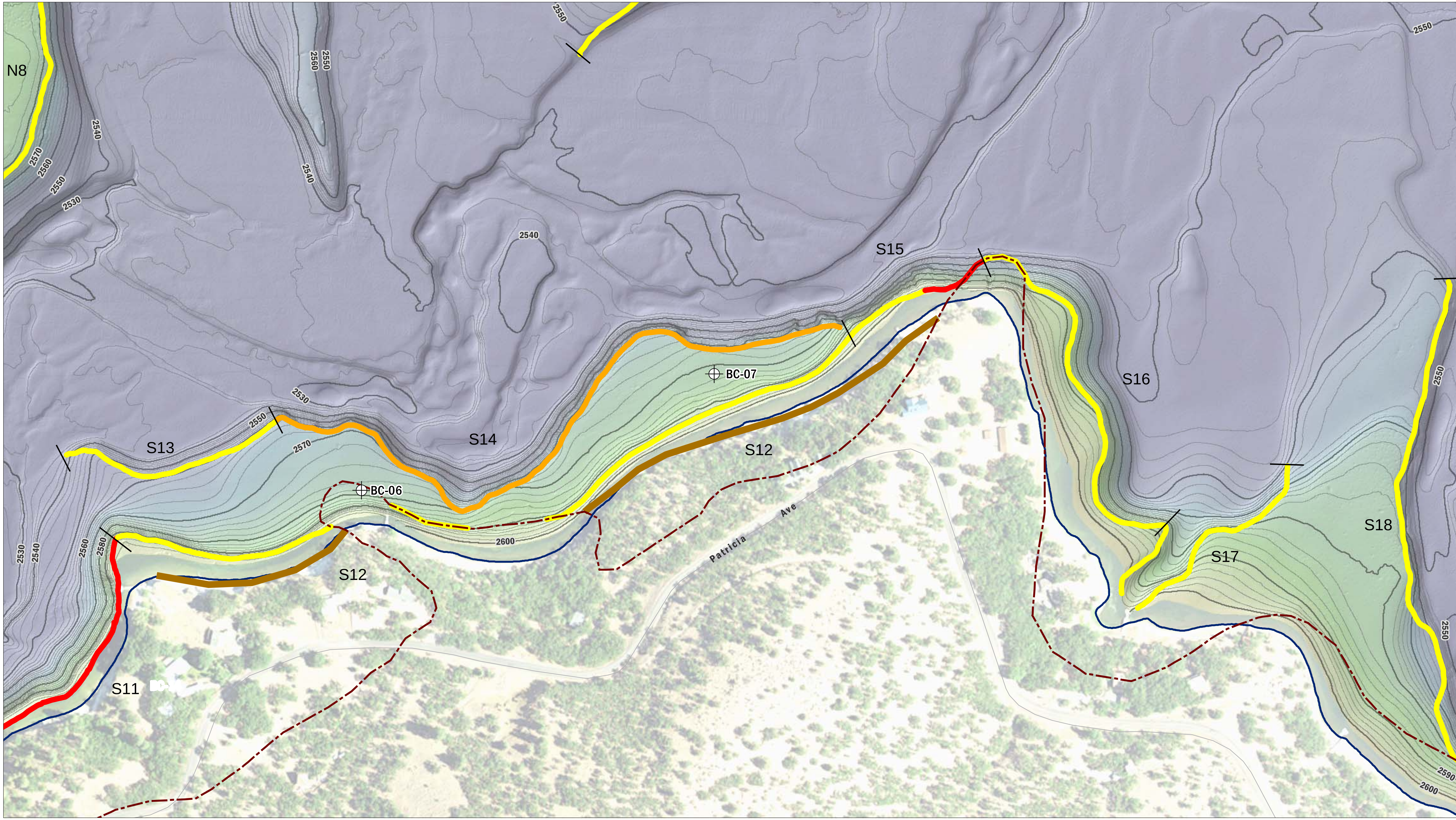
Borings
Extent of Fluvio-Lacustrine Deposits
Current Reservoir Shoreline

Slope Failure Analysis Features
- Incomplete Analysis
- Stable Slope
- Potentially Unstable Slope (failure contained within reservoir)
- Potentially Unstable Slope

Bathymetric Contours
- 2 ft.
- 10 ft.

Segment Information
- Segment Extents
- N1 Segment Names

FIGURE 3-4
Copco Dam - Slope Failure Analysis
Sheet 4 of 9



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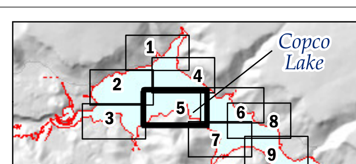


Borings

Extent of Fluvio-Lacustrine Deposits

Volcanic Rock Exposed in Shoreline Notch

Current Reservoir Shoreline

Slope Failure Analysis Features

Stable Slope

Potentially Unstable Slope (failure contained within reservoir)

Potentially Unstable Slope

Bathymetric Contours

2 ft.

10 ft.

Segment Information

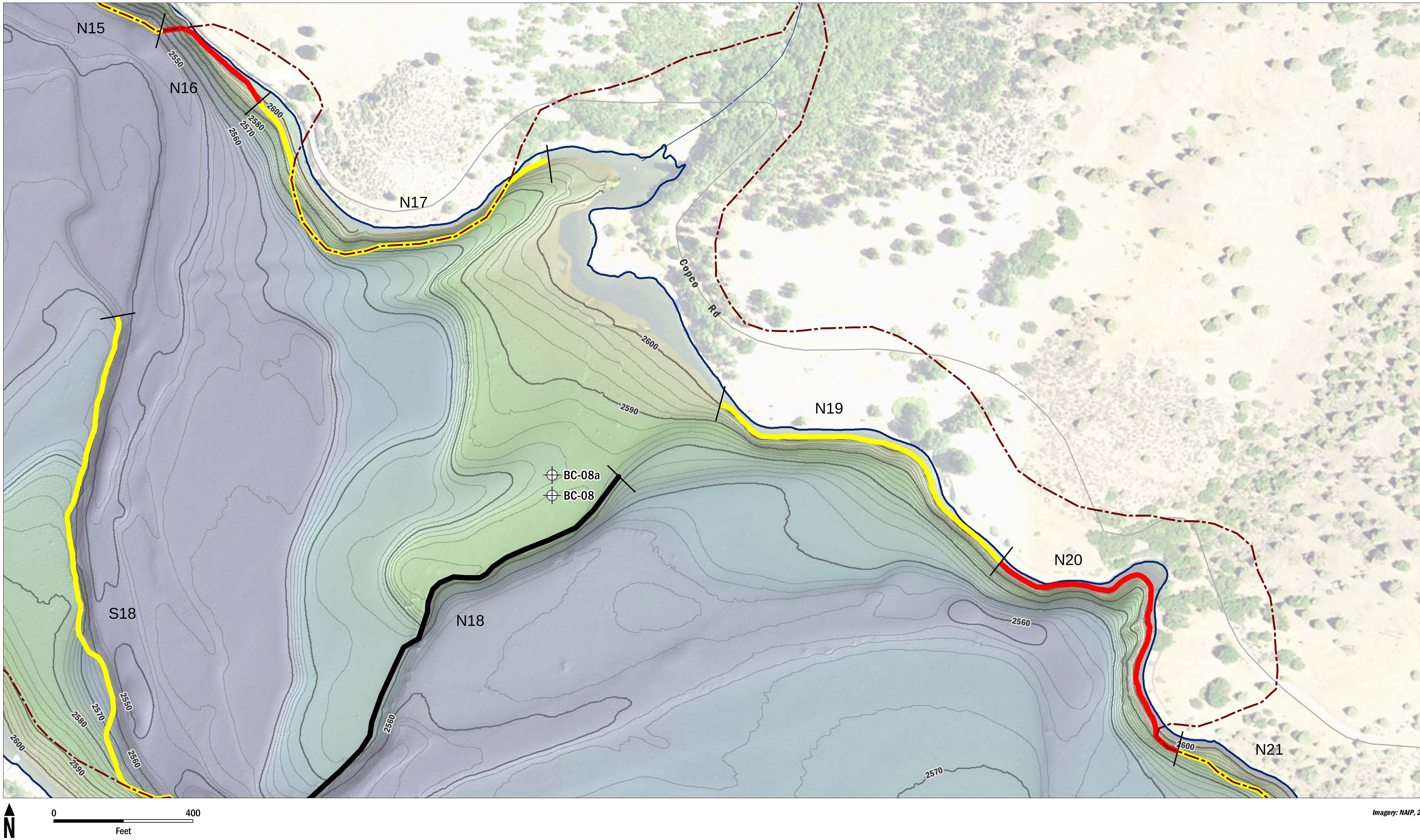
Segment Extents

N1 Segment Names

FIGURE 3-4

Copco Dam - Slope Failure Analysis

Sheet 5 of 9



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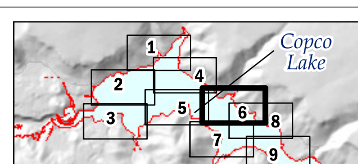


Borings
Extent of Fluvio-Lacustrine Deposits
Current Reservoir Shoreline

Slope Failure Analysis Features
Incomplete Analysis
Stable Slope
Potentially Unstable Slope

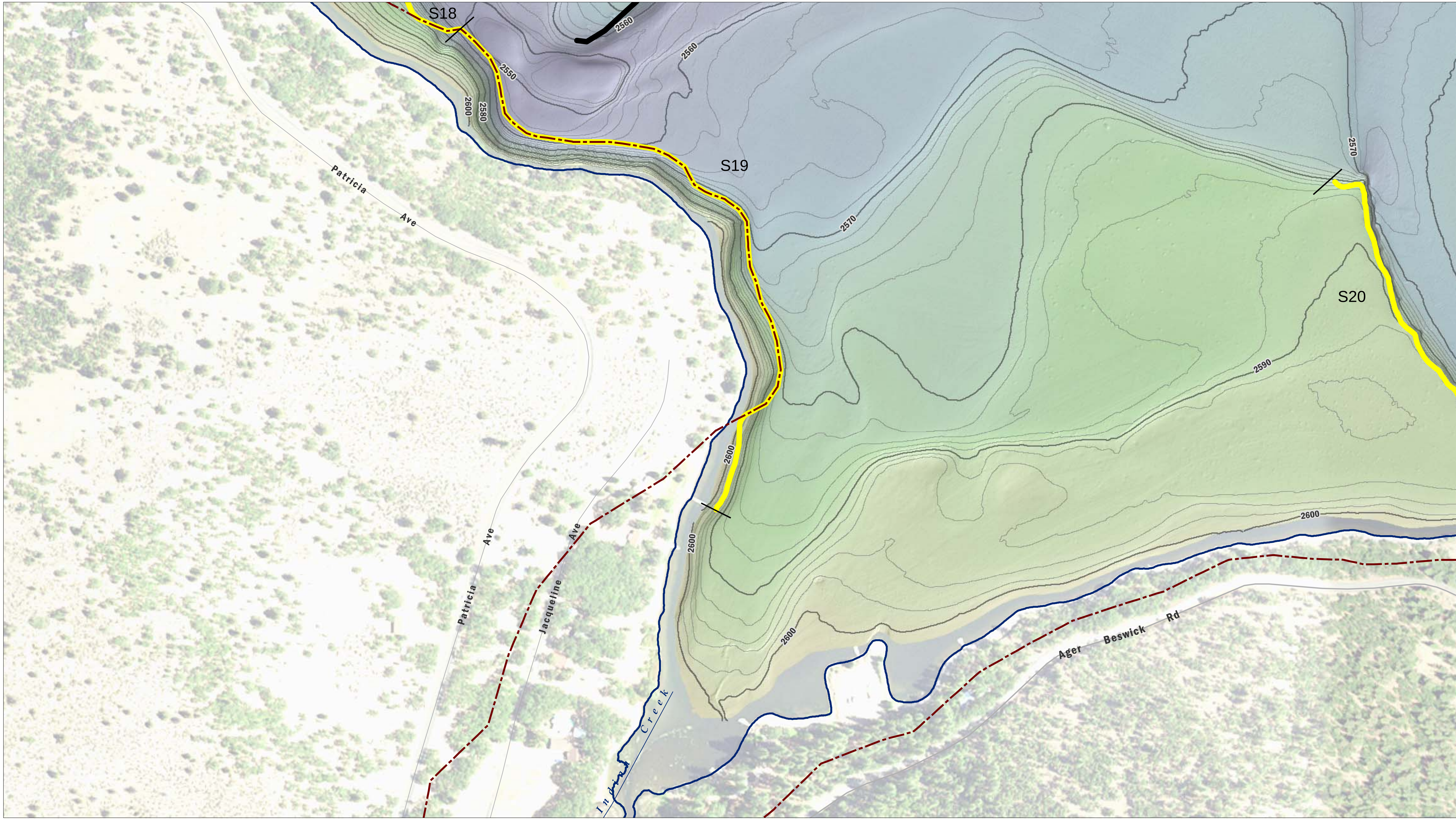
Bathymetric Contours
2 ft.
10 ft.

Segment Information
Segment Extents
N1 Segment Names

FIGURE 3-4

Copco Dam - Slope Failure Analysis

Sheet 6 of 9



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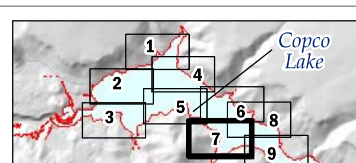


Extent of Fluvio-Lacustrine Deposits
Current Reservoir Shoreline

Slope Failure Analysis Features
Incomplete Analysis
Stable Slope

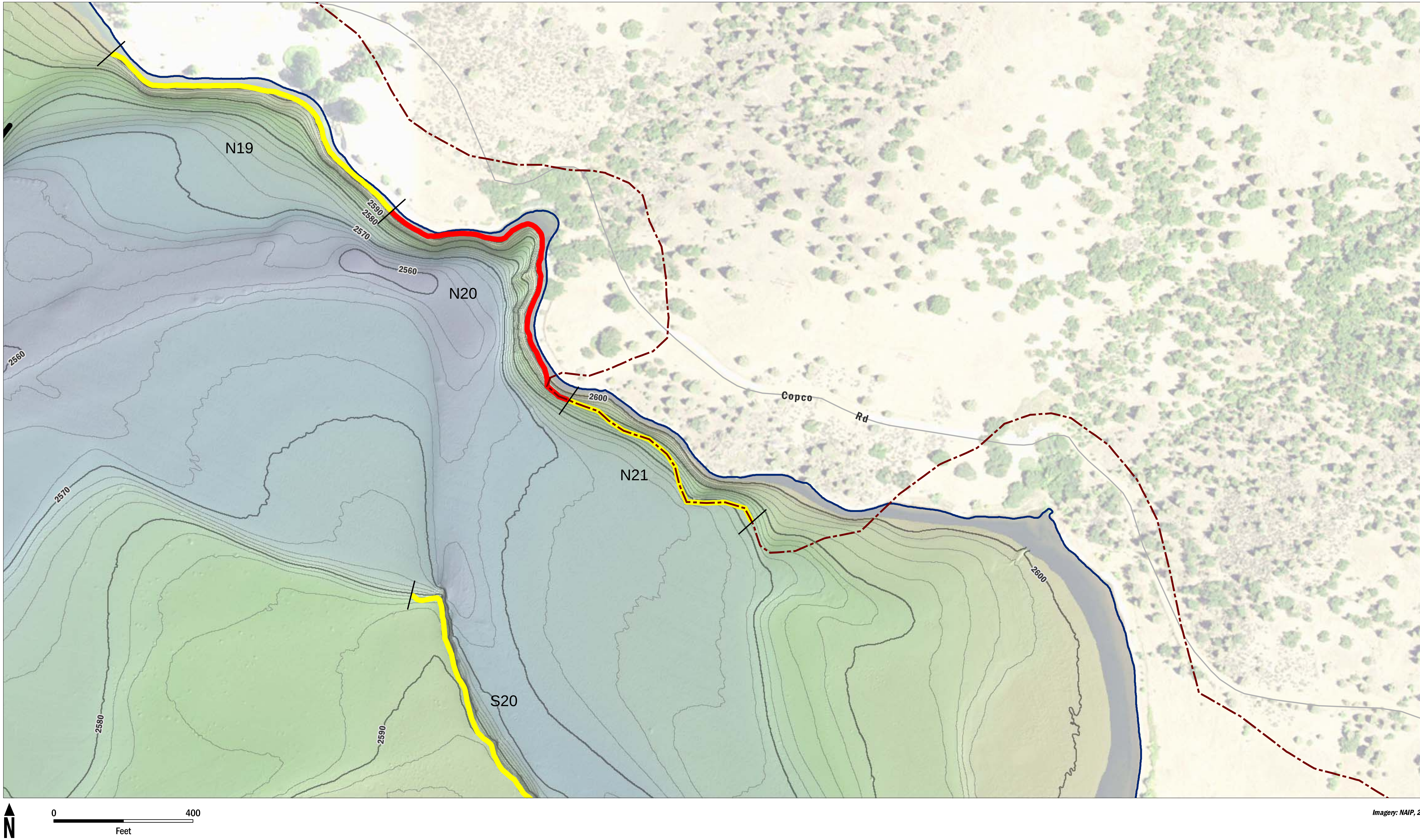
Bathymetric Contours
2 ft.
10 ft.

Segment Information
Segment Extents
N1 Segment Names

FIGURE 3-4

Copco Dam - Slope Failure Analysis

Sheet 7 of 9



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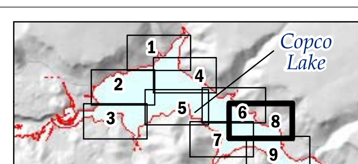


Extent of Fluvio-Lacustrine Deposits
Current Reservoir Shoreline

Slope Failure Analysis Features
Incomplete Analysis
Stable Slope
Potentially Unstable Slope

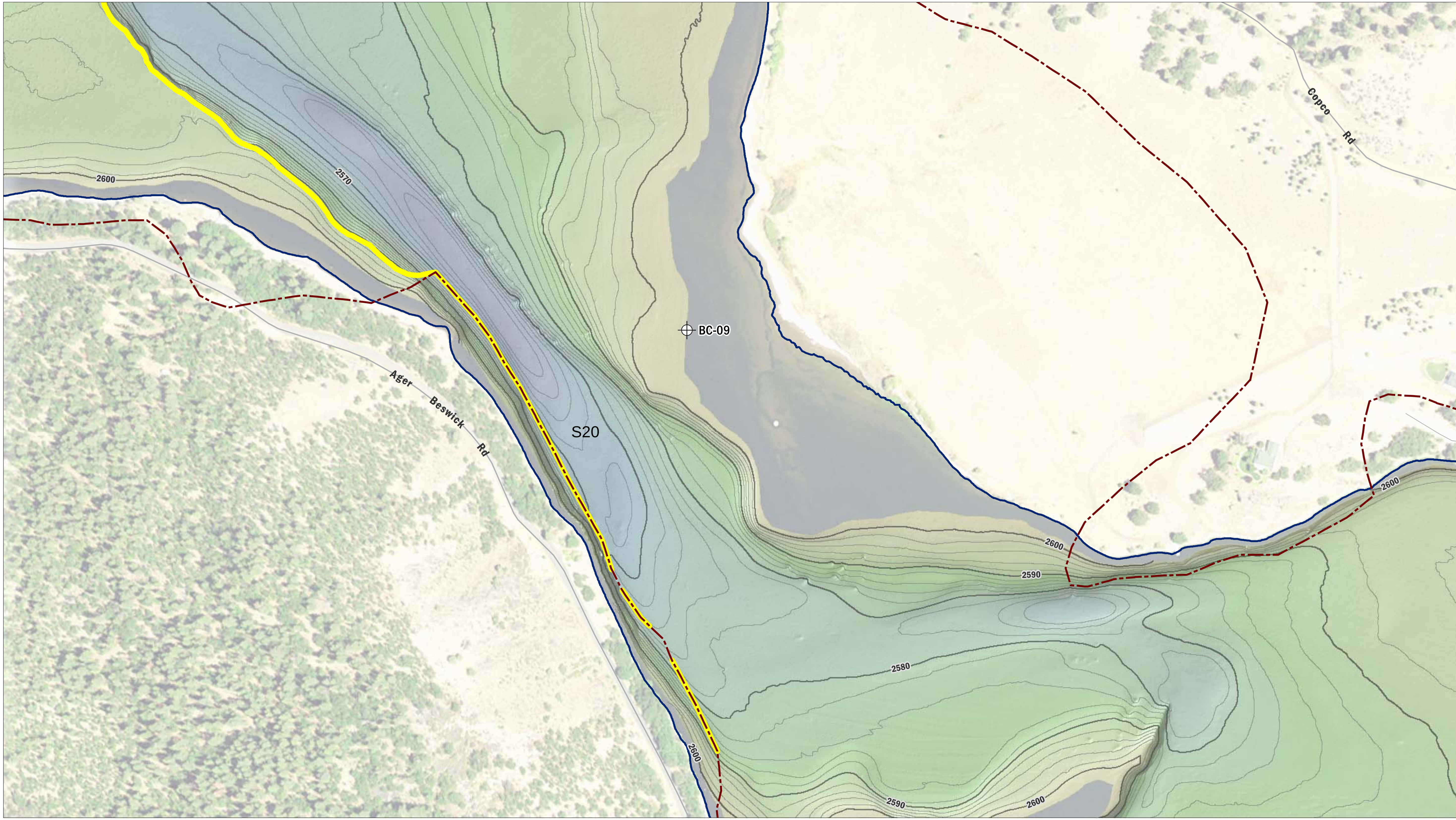
Bathymetric Contours
2 ft.
10 ft.

Segment Information
Segment Extents
N1 Segment Names

FIGURE 3-4

Copco Dam - Slope Failure Analysis

Sheet 8 of 9



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Feet

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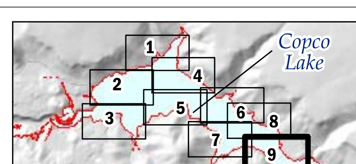


Borings

Extent of Fluvio-Lacustrine Deposits

Current Reservoir Shoreline

Slope Failure Analysis Features

Stable Slope

Bathymetric Contours

2 ft.

10 ft.

Segment Information

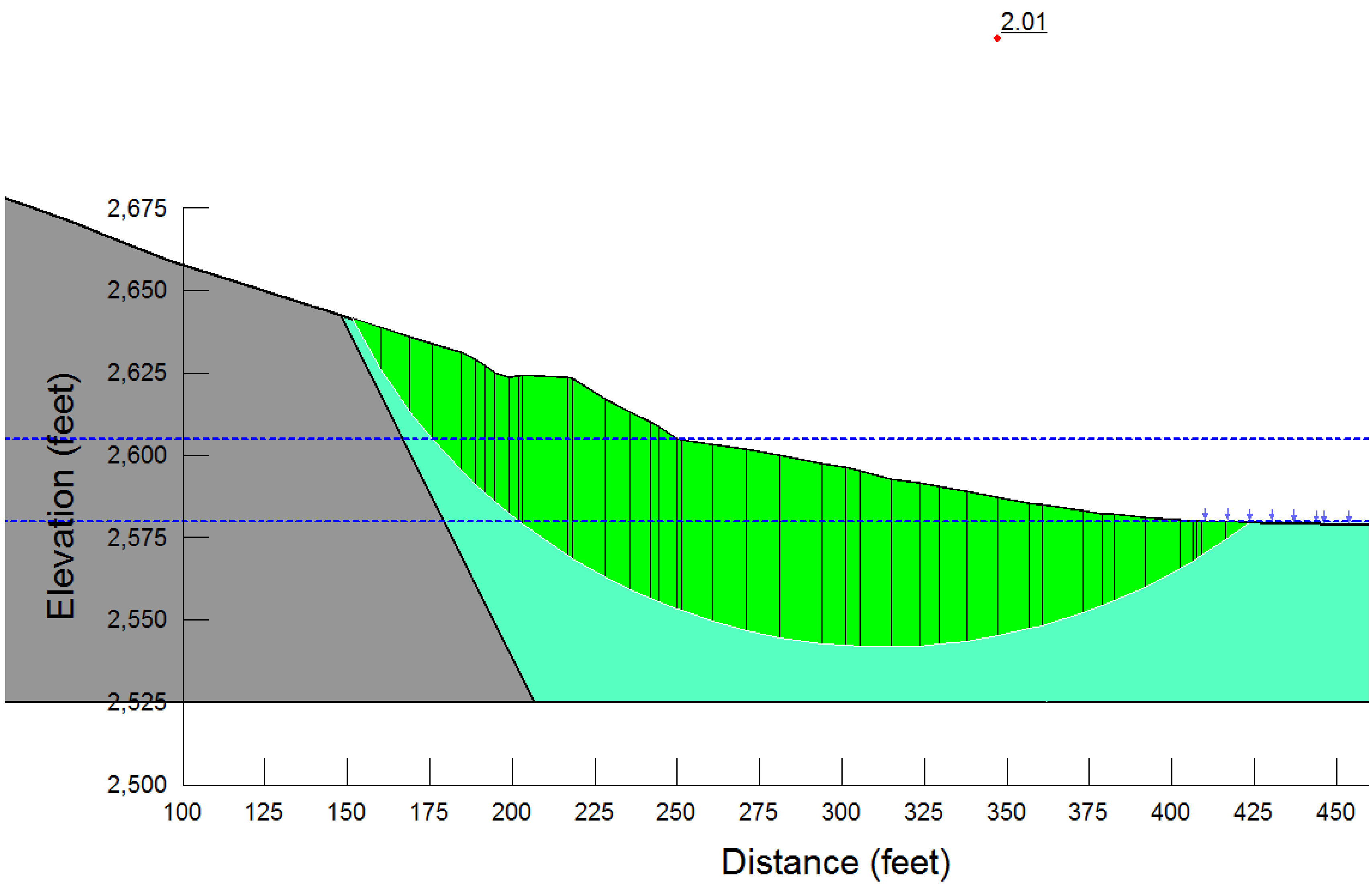
Segment Extents

N1 Segment Names

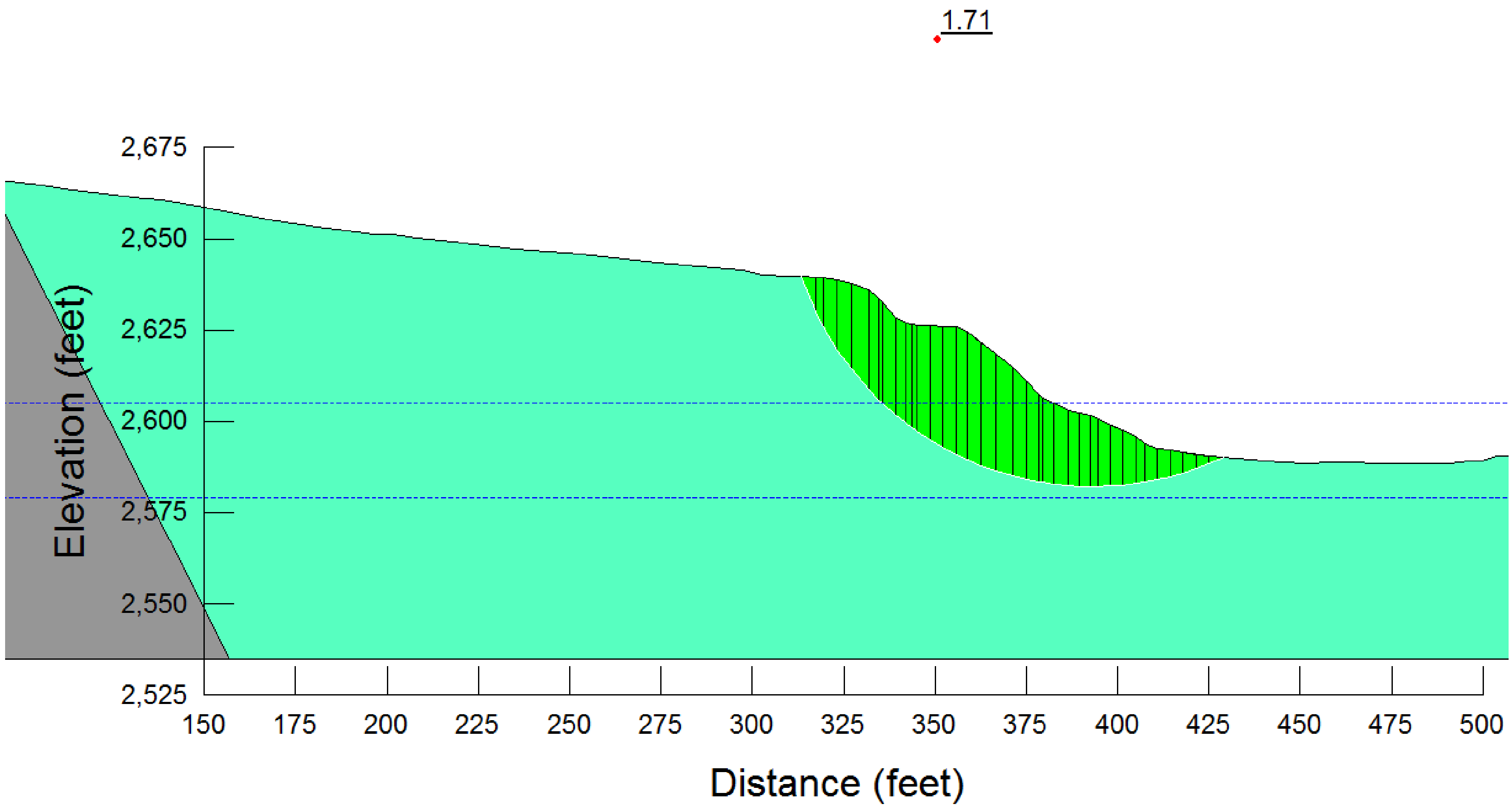
FIGURE 3-4

Copco Dam - Slope Failure Analysis

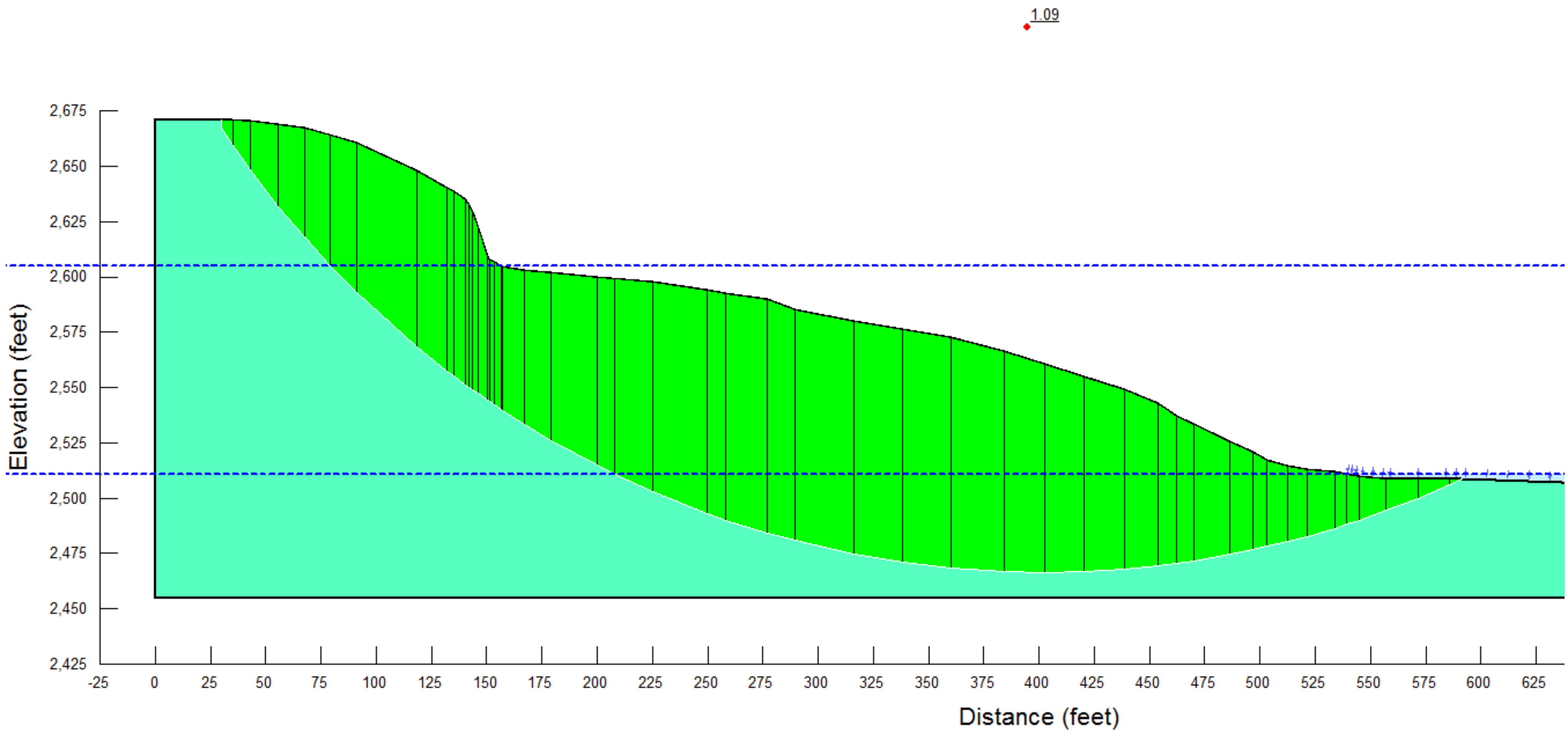
Sheet 9 of 9



Klamath River Renewal Corporation	Copco Reservoir Slope Stability Segment N10, Section 1 Rapid Drawdown Analysis	Figure 3-5a
AECOM		



Klamath River Renewal Corporation	Copco Reservoir Slope Stability Segment N11, Section 1 Rapid Drawdown Analysis	Figure 3-5b
AECOM		



Klamath River Renewal Corporation	Copco Reservoir Slope Stability Segment S1, Section 1 Rapid Drawdown Analysis	Figure 3-5c
AECOM		

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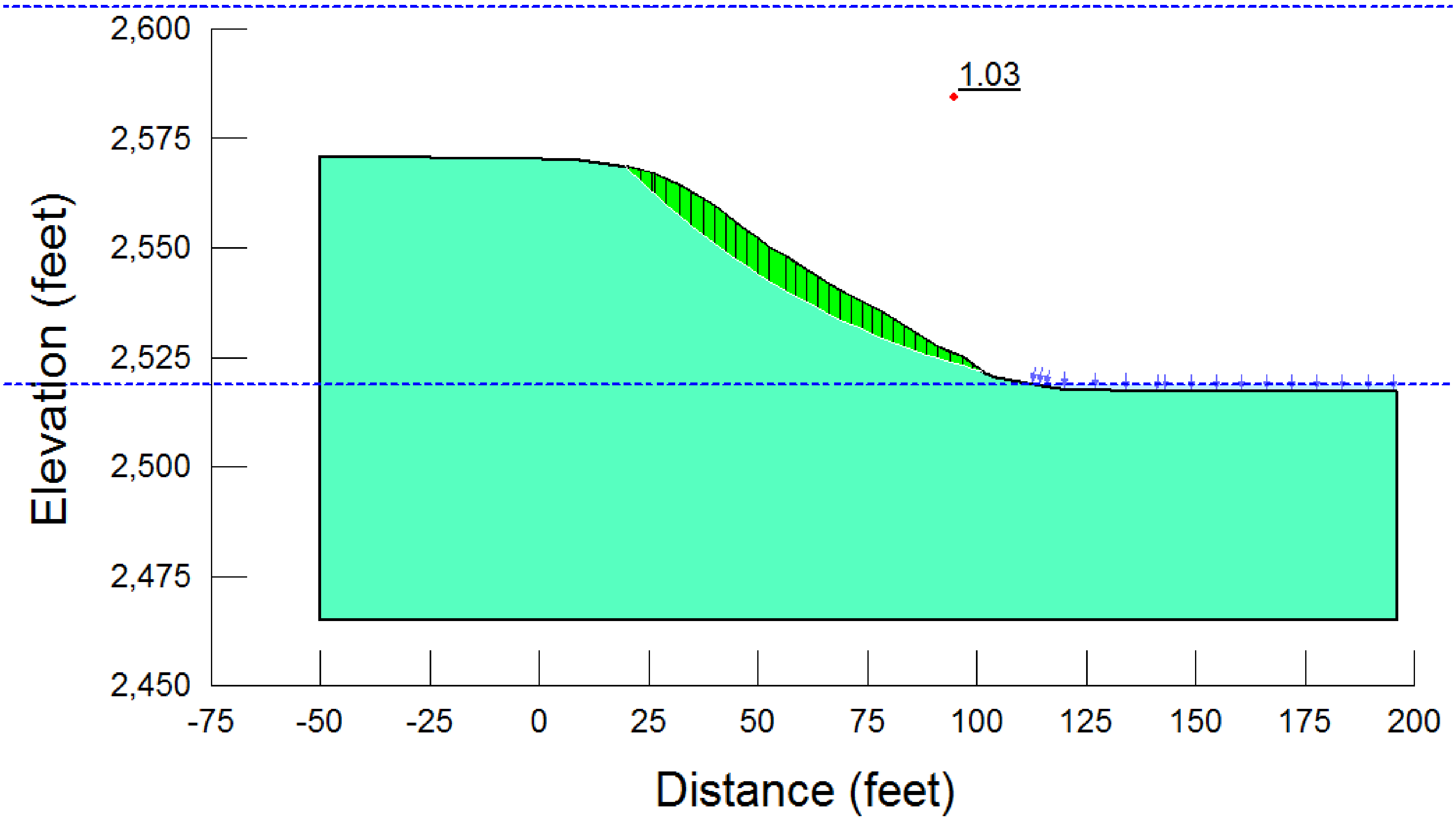
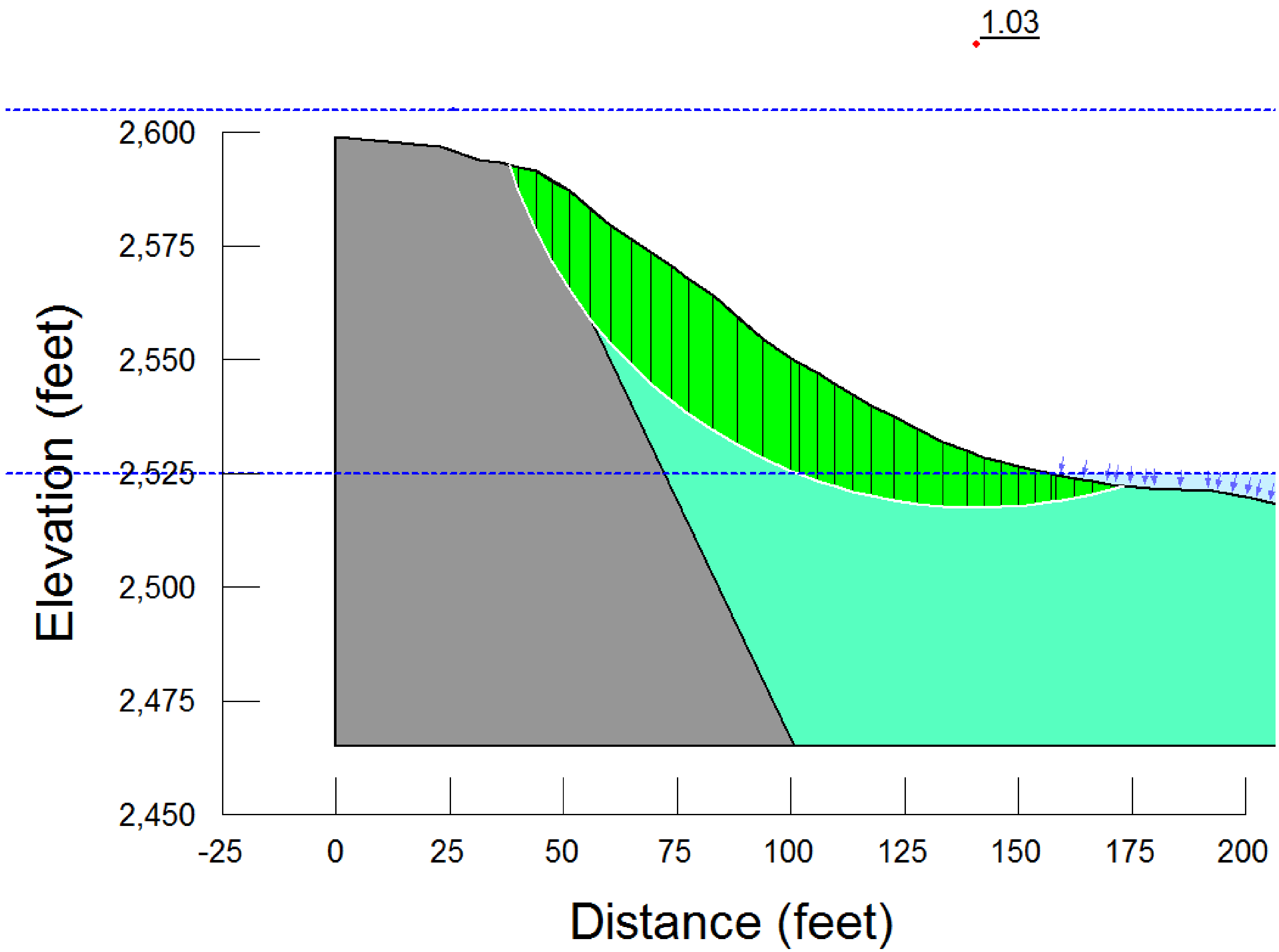
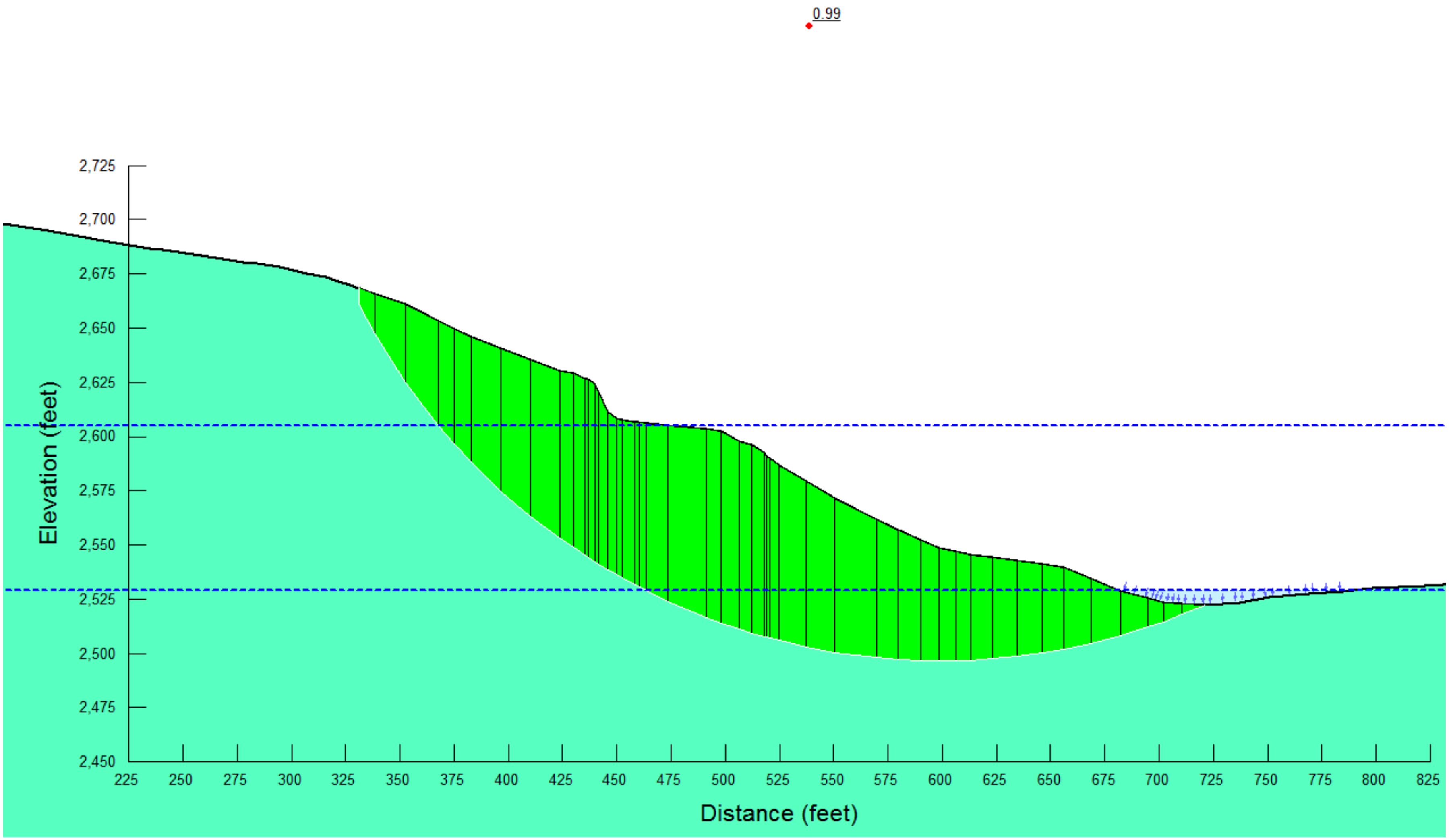


Klamath River Renewal Corporation	Copco Reservoir Slope Stability Segment S3, Section 1 Rapid Drawdown Analysis	Figure 3-5d
AECOM		



Klamath River Renewal Corporation AECOM	Copco Reservoir Slope Stability Segment S10, Section 1 Rapid Drawdown Analysis	Figure 3-5e



Klamath River Renewal Corporation

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Copco Reservoir Slope Stability
Segment S11, Section 1
Rapid Drawdown Analysis

Figure 3-5f

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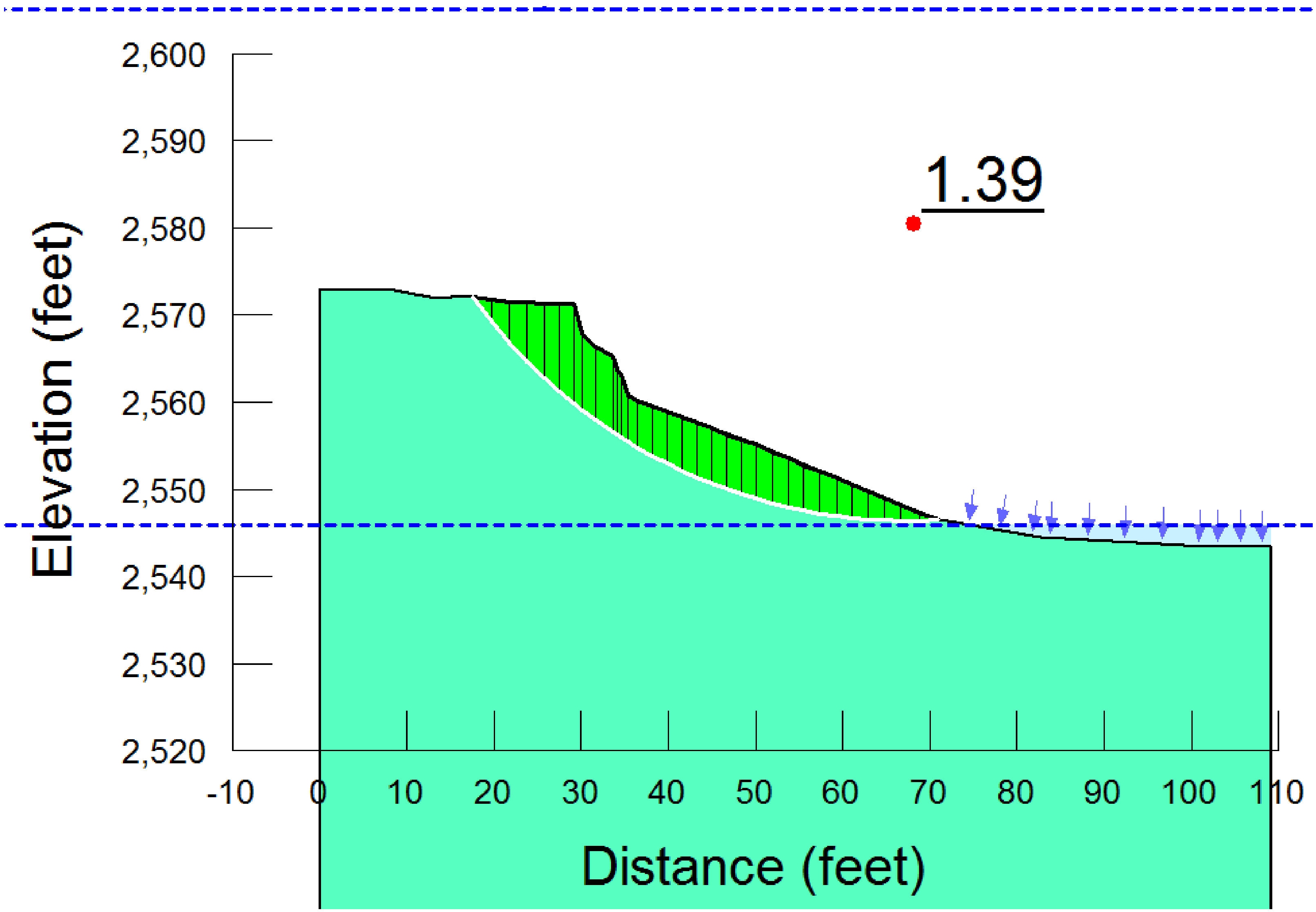

Klamath River Renewal Corporation	Copco Reservoir Slope Stability Segment S18, Section 1 Rapid Drawdown Analysis	Figure 3-5g
AECOM		

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FIGURE 4-2
Geologic Overview of Iron Gate Reservoir

Attachment B Boring Logs

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Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance blows/6-in.	Recovery (inches)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight (pcf)	Fines Content (% <200 Sieve)	REMARKS AND OTHER TESTS
1	2	3	4	5	6	7	8	9	10	11	12

COLUMN DESCRIPTIONS

1. **Elevation:** Elevation in feet referenced to specified datum.
2. **Depth:** Depth in feet below the ground surface.
3. **Sample Type:** Type of soil sample collected at depth interval shown; sampler symbols are explained below.
4. **Sample Number:** Sample identification number.
5. **Sampling Resistance:** Number of blows required to advance driven sampler 12 inches beyond first 6-inch interval, or distance noted, using a 140-lb hammer with a 30-inch drop; or down-pressure for pushed sampler.
6. **Recovery:** Percentage of driven or pushed sample length recovered; "NA" indicates data not recorded.
7. **Graphic Log:** Graphic depiction of subsurface material encountered; typical symbols are explained below.
8. **Material Description:** Description of material encountered; may include density/consistency, moisture, color, and grain size.
9. **Water Content:** Water content of soil sample measured in laboratory, expressed as percentage of dry weight of specimen.
10. **Dry Unit Weight:** Density of soil as measured in the laboratory, in pounds per cubic foot
11. **Fines Content** Percentage passing the #200 sieve as measured in the laboratory
12. **Remarks and Other Tests:** Comments and observations regarding drilling or sampling made by driller or field personnel.

TYPICAL MATERIAL GRAPHIC SYMBOLS

- Diatomite
- Diatomite with Elastic Silt
- Weakly Cemented Diatomite
- Fat Clay with varying amounts of sand and gravel; diatomaceous in some areas
- Lean Clay with varying amounts of sand and gravel; diatomaceous in some areas
- Organic Silt
- Clayey Sand
- Silty Sand with varying amounts of sand and gravel
- Clayey Gravel with varying amounts of sand
- Well Graded Gravel with varying amounts of sand
- Volcanic Clastics
- Volcanic Cinder
- Volcanic Sandstone
- Andesite
- Basalt

TYPICAL SAMPLER GRAPHIC SYMBOLS

- Modified California Sampler (2.5-inch outer diameter)
- Standard Penetration Test
- Shelby tube (thin walled 3-inch outer diameter)

OTHER GRAPHIC SYMBOLS

GENERAL NOTES

KEY TO DESCRIPTIVE TERMS USED ON CORE LOGS

DISCONTINUITY DESCRIPTORS

a Dip of discontinuity, measured relative to a plane normal to the core axis.

b **Discontinuity Type:**

- F - Fault
- J - Joint
- Sh - Shear
- Fo - Foliation
- V - Vein
- B - Bedding

c **Aperture (inches):**

- W - Wide (0.5-2.0)
- MW - Moderately Wide (0.1-0.5)
- N - Narrow (0.05-0.1)
- VN - Very Narrow (<0.05)
- T - Tight (0)

d **Type of Infilling:**

- Bi - Biotite
- Cl - Clay
- Ca - Calcite
- Ch - Chlorite
- Ep - Epidote
- Fe - Iron Oxide
- H - Healed
- My - Mylonite
- CR - Crushed Rock
- Mn - Manganese
- No - None
- Py - Pyrite
- Qz - Quartz
- Sd - Sand
- Se - Serpentine
- Si - Silty
- Uk - Unknown

e **Amount of Infilling:**

- Su - Surface Stain
- Sp - Spotty
- Pa - Partially Filled
- Fi - Filled
- No - None

f **Surface Shape of Joint:**

- Pl - Planar
- Wa - Wavy
- St - Stepped
- Ir - Irregular

g **Roughness of Surface:**

- Slk - Slickensided [surface has smooth, glassy finish with visual evidence of striations]
- S - Smooth [surface appears smooth and feels so to the touch]
- SR - Slightly Rough [asperities on discontinuity surfaces are distinguishable and can be felt]
- R - Rough [ridges and side-angle steps are evident; asperities are clearly visible; surface feels very abrasive]
- VR - Very Rough [near-vertical steps and ridges occur on discontinuity surface]

ROCK FRACTURING

Description	Recognition
Intensely Fractured	Fractures spaced less than 2 inches apart
Highly Fractured	Fractures spaced 2 inches to 1 foot apart
Moderately Fractured	Fractures spaced 1 foot to 3 feet apart
Slightly Fractured	Fractures spaced 3 feet to 10 feet apart
Massive	Fracture spacing greater than 10 feet

ROCK WEATHERING / ALTERATION

Description	Recognition
Residual Soil	Original minerals of rock have been entirely decomposed to secondary minerals, and original rock fabric is not apparent; material can be easily broken by hand
Completely Weathered/Altered	Original minerals of rock have been almost entirely decomposed to secondary minerals, although original fabric may be intact; material can be granulated by hand
Highly Weathered/Altered	More than half of the rock is decomposed; rock is weakened so that a minimum 2-inch-diameter sample can be broken readily by hand across rock fabric
Moderately Weathered/Altered	Rock is discolored and noticeably weakened, but less than half is decomposed; a minimum 2-inch-diameter sample cannot be broken readily by hand across rock fabric
Slightly Weathered/Altered	Rock is slightly discolored, but not noticeably lower in strength than fresh rock
Fresh/Unweathered	Rock shows no discoloration, loss of strength, or other effect of weathering/alteration

ROCK STRENGTH

Description	Recognition	Approximate Uniaxial Compressive Strength (psi)
Extremely Weak Rock	Can be indented by thumbnail	35 - 150
Very Weak Rock	Can be peeled by pocket knife	150 - 700
Weak Rock	Can be peeled with difficulty by pocket knife	700 - 3,600
Moderately Strong Rock	Can be indented 5 mm with sharp end of pick	3,600 - 7,200
Strong Rock	Requires one hammer blow to fracture	7,200 - 14,500
Very Strong Rock	Requires many hammer blows to fracture	14,500 - 36,000
Extremely Strong Rock	Can only be chipped with hammer blows	>36,000

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Project: Klamath River Dam Removal Project **Project Location: Klamath River** **Project Number: 60537920**	**Log of Boring BC-01** Sheet 1 of 2

Date(s) Drilled	**2/5/2018 - 2/6/2018**	Logged By	**B. Kozlowicz**	Checked By	**D. Simpson**
Drilling Method	**Rotary Wash**	Drill Bit Size/Type	**4-inch Tricone**	Total Depth of Borehole	**30.4 feet**
Drill Rig Type	**Barge Mounted CME-45**	Drilling Contractor	**Taber Drilling**	Surface Elevation	**2597.1**
Groundwater Level(s)	**12.3 feet above ground surface (2/5 at 15:15)**	Sampling Method(s)	**2.5-inch ID Mod Cal, SPT**	Hammer Data	**Auto hammer (140 lb, 30-inch drop)**
Borehole Backfill	**Bentonite cement grout to 10 feet bgs**	Location		Coordinates	**N 2608898** **E 6476516**

Elevation feet	Depth, feet	SAMPLES Type	SAMPLES Number	SAMPLES Sampling Resistance	SAMPLES Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Fines Content (%<#200 Sieve)	Dry Density, pcf	REMARKS AND OTHER TESTS
	0		S01	1 1 0 (1)	1.8		SILT WITH SAND AND GRAVEL (ML), very soft, very dark gray to black (2.5Y 3/1 to 2.5/1), fine to coarse grained sand, subangular to rounded gravel, sand and gravel consists of diatomite clasts. [Recent Lake Sediment]				Sampler fell 18 inches on last blow
2595											Advance 6-inch casing to 6 feet with hammer (hard/stiff at about 3.5 feet)
	5										Advance 6-inch casing to 8 feet with hammer LL = 33 PL = 25 PI = 8
2590			S02	4 3 4 (7)	1.5		Becomes soft, dark olive brown (2.5Y 3/3) to very dark grayish brown (2.5Y 3/2) with trace gravel	43			
	10						DIATOMITE, light olive brown (2.5Y 5/4), highly weathered, extremely weak, highly fractured, friable [Lacustrine Diatomaceous Terrace (Ql)]				
2585			S03	7 6 6 (12)	1.2			99		46	2/5/18 16:45 EOD 2/6/18 8:30 BOD Advance 6-inch casing to 11 feet with hammer
	15										
2580											
	20										
2575			S04	3 2 5 (7)	1.4		Becomes soft with iron staining on irregular subvertical fractures	93	99		LL = 85 PL = 51 PI = 34 1% Sand 99% Fines
	25										

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Project: Klamath River Dam Removal Project
Project Location: Klamath River
Project Number: 60537920

Log of Boring BC-01

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Fines Content (%<#200 Sieve)	Dry Density, pcf	REMARKS AND OTHER TESTS
	25										
2570											
							BASALT, black (10Y 2.5/1), highly to completely weathered, friable				Cuttings become dark greenish gray sandy clay; slower drilling
			S05	31 50/6"	0.6						
	30		S06	50/5"	0.4						
							TOTAL DEPTH = 30.4 FEET				
2565											
	35										
2560											
	40										
2555											
	45										
2550											
	50										
2545											

AECOM

Project: Klamath River Dam Removal Project	**Log of Boring BC-02**
Project Location: Klamath River	Sheet 1 of 3
Project Number: 60537920	

Date(s) Drilled	**2/5/2018**	Logged By	**B. Kozlowicz**	Checked By	**D. Simpson**
Drilling Method	**Rotary Wash**	Drill Bit Size/Type	**4-inch Tricone**	Total Depth of Borehole	**64.6 feet**
Drill Rig Type	**Barge Mounted CME-45**	Drilling Contractor	**Taber Drilling**	Surface Elevation	**2599.6**
Groundwater Level(s)	**9.4 feet above ground surface (2/5 at 9:00)**	Sampling Method(s)	**2.5-inch ID Mod Cal, SPT, 3-inch Shelby Tube**	Hammer Data	**Auto hammer (140 lb, 30-inch drop)**
Borehole Backfill	**Bentonite cement grout to 10 feet bgs**	Location		Coordinates	**N 2608331 E 6476958**

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Fines Content (%<#200 Sieve)	Dry Density, pcf	REMARKS AND OTHER TESTS
	0		S01	2 10 12 (22)	1.7		SANDY LEAN CLAY (CL), very soft, very dark gray (2.5Y 3/1) to black (2.5Y 2.5/1), trace fine rounded gravel [Recent Lake Sediment]				Drove sampler for extra 6 inches (last three blowcounts reported)
							CLAYEY GRAVEL WITH SAND (GC), stiff/medium dense, very dark grayish brown (10YR 3/2), subangular to rounded fine to coarse gravel up to 2 inches in diameter, fine to coarse sand [Fluvio-Lacustrine Terrace Deposit with Gravel (Qtg)]		28		52% Gravel 20% Sand 28% Fines Advanced 6-inch casing to 3.8 feet with hammer
2595	5		S02	5 5 10 (15)	0.2		Black angular basalt cobble				
			S03	18 10 10 (20)	1.2		DIATOMITE, olive to olive yellow (5Y 4/3 to 2.5Y 6/6), moderately to highly weathered, extremely weak, highly fractured, with sub-horizontal bedding and irregular sub-vertical fractures, friable [Lacustrine Diatomaceous Terrace (Ql)]				Drove sampler for extra 6 inches (last three blowcounts reported) Advanced 6-inch casing to 8.8 feet with hammer
2590	10		S04	11 9 9 (18)	0.8						
							Becomes light yellowish brown (2.5Y 6/4), extremely weak/clayey, moderately fractured				
2585	15		S05	4 4 6 (10)	1.2			84	99		LL = 105 PL = 59 PI = 46 1% Sand 99% Fines
							DIATOMITE WITH ELASTIC SILT, greenish gray (10Y 5/1), soft to extremely weak, highly fractured, friable [Lacustrine Diatomaceous Terrace (Ql)]				
2580	20		S06	200 psi	2.3			148		32	About 50% WCR TX-ICU
2575	25			3							

Project: Klamath River Dam Removal Project
Project Location: Klamath River
Project Number: 60537920

Log of Boring BC-02

Elevation feet	Depth, feet	Type (SAMPLES)	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Fines Content (%<#200 Sieve)	Dry Density, pcf	REMARKS AND OTHER TESTS
	25		S07	2 3 (5)	1.4						
											About 25% to 50% WCR
2570	30										
2565	35		S08	200 to 500 psi	2.1			149		33	TX-ICU
2560	40										Cuttings become very dark gray
							Increase in plasticity, soft, olive (5Y 5/3) and very dark gray to black (2.5Y 2.5/1 to 2.5Y 3/1) in ~2.5-inch beds, sub-horizontal bedding				
2555	45		S09	3 3 4 (7)	1.5			178	100		LL = 187 PL = 85 PI = 102 1% Sand 99% Fines
2550	50										

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Fines Content (%<#200 Sieve)	Dry Density, pcf	REMARKS AND OTHER TESTS
2545	55		S10	2 3 5 (8)	1.5			171		30	
2540	60										
							BASALT, black (10Y 2.5/1), slightly weathered, strong; recovered as angular gravel up to 1-inch in diameter [Copco/Quaternary Basalt (Qb)]				Harder drilling, small black basalt chips in cuttings
2535	65		S11	50/3"	0.3		**TOTAL DEPTH = 64.6 FEET**				
2530	70										
2525	75										
2520	80										

Project: Klamath River Dam Removal Project
Project Location: Klamath River
Project Number: 60537920

Log of Boring BC-03

Date(s) Drilled	**2/6/2018 - 2/7/2018**	Logged By	**B. Kozlowicz**	Checked By	**D. Simpson**
Drilling Method	**Rotary Wash**	Drill Bit Size/Type	**4-inch Tricone**	Total Depth of Borehole	**96.5 feet**
Drill Rig Type	**Barge Mounted CME-45**	Drilling Contractor	**Taber Drilling**	Surface Elevation	**2584.6**
Groundwater Level(s)	**24.3 feet above ground surface (2/6 at 12:00)**	Sampling Method(s)	**2.5-inch ID Mod Cal, SPT, 3-inch Shelby Tube, HQ Core Barrel**	Hammer Data	**Auto hammer (140 lb, 30-inch drop)**
Borehole Backfill	**Bentonite cement grout to 10 feet bgs**	Location		Coordinates	**N 2606643 E 6474657**

Elevation feet	Depth, feet	SAMPLES Type	SAMPLES Number	SAMPLES Sampling Resistance	SAMPLES Recovery (feet)	MATERIAL DESCRIPTION	Water Content, %	Fines Content (%<#200 Sieve)	Dry Density, pcf	REMARKS AND OTHER TESTS
	0					ORGANIC SILT WITH SAND (OL), very soft, very dark grayish brown (2.5Y 3/2) [Recent Lake Sediment]	35	67		
			S01	1 2 3 (5)	2	LEAN CLAY WITH SAND (CL), soft, black (5Y 2.5/2), fine grained sand, trace rounded gravel, small angular rock fragements, and fine rootlets [Colluvium/Resdiual Soil]				Sampler settled to 1-foot; drove sampler for extra 6 inches (last three blowcounts reported) LL = 48 PL = 25 PI = 23
2580	5					Without gravel				3% Gravel 29% Sand 68% Fines
			S02	4 3 2 (5)	0.6		25		80	Advanced 6-inch casing to 4 feet (stiff from 3 feet)
						Subrounded gravel up to 2.5-inch in diameter with clayey infill [Fluvio-lacustrine Terrace Deposits with Gravel (Qtg)]				Hard chattering drilling Switch to rock core bit with SPT sampler
2575	10		R1		0.1					
						DIATOMITE, olive brown to dark grayish brown (2.5Y 4/3 to 2.5Y 4/2), massive, extremely weak, bedding/fractures not present [Lacustrine Diatomaceous Terrace (Ql)]				Faster drilling from 10.5 to 11.5 feet
			S03	6 3 2 (5)	0.1					Return fluid becomes olive
2570	15		R2		0.2					Advanced 6-inch casing to 14 feet with hammer
			S04	6 4 5 (9)	1					Switch back to tricone bit
2565	20									
						DIATOMITE WITH ELASTIC SILT, dark grayish brown (2.5Y 4/2), massive/soft to very soft [Lacustrine Diatomaceous Terrace (Ql)]				
2560	25			3			80	100		LL = 69

Project: Klamath River Dam Removal Project Project Location: Klamath River Project Number: 60537920	Log of Boring BC-03 Sheet 2 of 4

Elevation feet	Depth, feet	Samples: Type	Samples: Number	Samples: Sampling Resistance	Samples: Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Fines Content (%<#200 Sieve)	Dry Density, pcf	REMARKS AND OTHER TESTS
	25		S05	3 4 (7)	1.3						PL = 59 PI = 10 100% Fines
2555	30										
2550	35										
2545	40		S06	200 to 400 psi	2.5			85 90		27 25	TX-ICU TX-ICU
							Increase in plasticity, soft, dark greenish gray (10Y 4/1), 1 to 2-inch beds/lenses of very dark gray to black clay				
2540	45										Cutting very dark greenish gray
2535	50										

Elevation feet	Depth, feet	Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Fines Content (%<#200 Sieve)	Dry Density, pcf	REMARKS AND OTHER TESTS
2530	55										
2525	60										
2520	65		S07	5 5 7 (12)	1.5						2/6/18 16:25 EOD 2/7/18 8:30 BOD Cuttings greenish black
2515	70										
2510	75										
2505	80		S08	100 psi	0						

Project: Klamath River Dam Removal Project	**Log of Boring BC-03**
Project Location: Klamath River	Sheet 4 of 4
Project Number: 60537920	

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Fines Content (%<#200 Sieve)	Dry Density, pcf	REMARKS AND OTHER TESTS
2500	85		S09		0.25						
2495	90		S10		1			120		16	TX-ICU
2490	95		S11	7 5 5 (10)	0.3						Driller out of rods
							TOTAL DEPTH = 96.5 FEET				
2485	100										
2480	105										
2475	110										

Project: Klamath River Dam Removal Project
Project Location: Klamath River
Project Number: 60537920

Log of Boring BC-04

Date(s) Drilled	**2/1/2018**	Logged By	**B. Kozlowicz**	Checked By	**D. Simpson**
Drilling Method	**Rotary Wash**	Drill Bit Size/Type	**4-inch Tricone**	Total Depth of Borehole	**73.5 feet**
Drill Rig Type	**Barge Mounted CME-45**	Drilling Contractor	**Taber Drilling**	Surface Elevation	**2595.1**
Groundwater Level(s)	**11.8 feet above ground surface (2/1)**	Sampling Method(s)	**2.5-inch ID Mod Cal, SPT, 3-inch Shelby Tube**	Hammer Data	**Auto hammer (140 lb, 30-inch drop)**
Borehole Backfill	**Bentonite cement grout to 10 feet bgs**	Location		Coordinates	**N 2604812 E 6472949**

Elevation feet	Depth, feet	SAMPLES Number	Sampling Resistance	Recovery (feet)	MATERIAL DESCRIPTION	Water Content, %	Fines Content (%<#200 Sieve)	Dry Density, pcf	REMARKS AND OTHER TESTS
2595	0				SILTY SAND (SM), very loose, very dark brown (10YR 2/2), trace subangular diatomite gravel up to 0.75 inches in diameter [Recent Lake Sediment]				6-inch casing settles to 1.5 feet
							44		5% Gravel 51% Sand 44% Fines
		S01	1 0 1 (1)	2	Becomes organic rich and softer/looser with increased nonplasctic fines				Sampler advanced 1 foot on first blow and 2.5 feet on second blow
2590	5								Advanced 6-inch casing to 5.5 feet with hammer
					SANDY LEAN CLAY (CL), very loose/very soft, very dark brown (10YR 2/2), trace fine gravel and coarse organics [Recent Lake Sediment]				
							58		3% Gravel 39% Sand 58% Fines
		S02	2 3 3 (6)	2					Drove sampler for extra 6 inches (last three blowcounts reported)
2585	10								Advanced 6-inch casing to 11 feet (resistance at 11 feet)
		S03	4 11 18 (29)	1.3	WEAKLY CEMENTED DIATOMITE GRAVEL, medium dense, light olive brown (2.5Y 5/4), angular diatomite gravel, weakly cemented and friable with sub-horizontal bedding and sub-vertical fractures [Lacustrine Diatomaceous Terrace (Ql)]		41		Advanced 6-inch casing to 12.5 feet with hammer 9% Gravel 50% Sand 41% Fines
		S04	400 psi	2		61		59	TX-ICU
						54		65	TX-ICU
2580	15								
									100 percent WCR
		S05	400 psi	2.5					
						105		42	TX-ICU
2575	20								
					DIATOMITE WITH ELASTIC SILT, soft to completely weathered, light greenish gray (5GY 7/1) [Lacustrine Diatomaceous Terrace (Ql)]				
		S06	200 to 400 psi	2.5		155		32	TX-ICU
	25								

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Project: Klamath River Dam Removal Project
Project Location: Klamath River
Project Number: 60537920

Log of Boring BC-04

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Fines Content (%<#200 Sieve)	Dry Density, pcf	REMARKS AND OTHER TESTS
2570	25										Lost circulation to 27.5 feet
							Becomes mottled with very pale brown (10YR 8/3) and light greenish gray (5GY 7/1) with 10 degree bedding				
			S07	2 3 5 (8)	1.8						Drove sampler for extra 6 inches (last three blowcounts reported) About 50% WCR
2565	30										
			S08	200 to 500 psi	1.5			117	99	37	TX-ICU LL = 60 PL = 24 PI = 36 1% Sand 99% Fines About 75% WCR
2560	35										
							Becomes with 0.25-inch very dark gray (5Y 3/1) 10-degree beds (varves?) and vertical dark gray (5Y 4/1) stained fractures				
2555	40										
			S09	1 1 1 (2)	2						About 50% to 75% WCR
2550	45										
2545	50										
			S10	200 to 400 psi	2.5			161		31	TX-UU

Project: Klamath River Dam Removal Project
Project Location: Klamath River
Project Number: 60537920

Log of Boring BC-04

Elevation feet	Depth, feet	Samples: Type	Samples: Number	Samples: Sampling Resistance	Samples: Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Fines Content (%<#200 Sieve)	Dry Density, pcf	REMARKS AND OTHER TESTS
2540	55							154		32	TX-ICU
2535	60						DIATOMITE, highly to completely weathered, pale yellow to olive yellow (2.5Y 6/6 to 2.5Y 8/4) with orange oxidation stain/mottling; fine grained vitreous gypsum xtals along very dark gray (5Y 3/1) sub-vertical fractures [Lacustrine Diatomaceous Terrace (Ql)]				
			S11	2 2 2 (4)							
2530	65										
2525	70						ANDESITE(?); moderatly to highly weathered, medium strong, fine to medium grained [Bogus Mountain Beds]				Hard drilling, very dark gray to black volcanic fragments in cuttings
			S12	30 50/5"							
							TOTAL DEPTH = 73.5 FEET				
2520	75										
2515	80										

Project: Klamath River Dam Removal Project	Log of Boring BC-05
Project Location: Klamath River	Sheet 1 of 1
Project Number: 60537920	

Date(s) Drilled	2/2/2018, 2/8/2018	Logged By	B. Kozlowicz	Checked By	D. Simpson
Drilling Method	Rotary Wash	Drill Bit Size/Type	4-inch Tricone	Total Depth of Borehole	20.5 feet
Drill Rig Type	Barge Mounted CME-45	Drilling Contractor	Taber Drilling	Surface Elevation	2601.1
Groundwater Level(s)	8.2 feet (2/2 at 11:00) and 6.6 (2/8 at 12:15) feet above ground surface	Sampling Method(s)	2.5-inch ID Mod Cal, SPT, 3-inch Shelby Tube	Hammer Data	Auto hammer (140 lb, 30-inch drop)
Borehole Backfill	Bentonite cement grout to 10 feet bgs	Location		Coordinates	N 2604139 E 6474515

Elevation feet	Depth, feet	Samples: Type	Samples: Number	Samples: Sampling Resistance	Samples: Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Fines Content (%<#200 Sieve)	Dry Density, pcf	REMARKS AND OTHER TESTS
	0		S01	0 0 0 (0)	0.7		SILTY SAND WITH GRAVEL (SM), very loose, very dark grayish brown (2.5Y 3/2), greenish gray clayey diatomite gravel clasts up to 1-inch in diameter, nonplastic fines [Recent Lake Sediment]				Sampler advanced 2 feet under hammer weight Advanced 6-inch casing to 5 feet with hammer
2600											
2595	5										
			S02	4 10 20 (30)			Clayey gravel made up of mostly Diatomite clasts up to 0.75 inches in diameter LEAN CLAY (CL), very stiff, very dark gray to very dark greenish gray (10Y 3/1 to 2.5Y 3/1), low to medium plasticity fines, trace highly to completely weathered clasts of diatomite [Fluvio-Lacustrine Terrace Deposit with Gravel (Qtg)]				Drove sampler for extra 6 inches (last three blowcounts reported) Advanced 6-inch casing to 8.5 feet (refusal) 2/2/18 EOD 2/8/18 BOD
2590	10		S03	2 1 1 (2)	1.5		DIATOMITE WITH ELASTIC SILT, extremely weak/very soft, greenish gray (5GY 6/1), 20-degree bedding and 90-degree fractures [Lacustrine Diatomaceous Terrace (Ql)] Fine roots				
2585	15		S04	200 to 400 psi	2.2		Becomes medium stiff to stiff with olive yellow (2.5Y 6/6) with angular clasts, friable	135		35	TX-ICU
								30		93	TX-ICU Harder drilling with yellowish to reddish brown rock chips in cuttings
							VOLCANIC SANDSTONE, yellowish brown(10YR 5/6), highly to completely weathered, very weak, locally clayey				
	20		S05	32 50/5"							
2580							TOTAL DEPTH = 20.5 FEET				
	25										

AECOM

Project: Klamath River Dam Removal Project Project Location: Klamath River Project Number: 60537920	**Log of Boring BC-06** Sheet 1 of 1

Date(s) Drilled	**2/2/2018**	Logged By	**B. Kozlowicz**	Checked By	**D. Simpson**
Drilling Method	**Rotary Wash**	Drill Bit Size/Type	**4-inch Tricone**	Total Depth of Borehole	**15.4 feet**
Drill Rig Type	**Barge Mounted CME-45**	Drilling Contractor	**Taber Drilling**	Surface Elevation	**2577.8**
Groundwater Level(s)	**29.2 feet above ground surface (2/2 at 13:00)**	Sampling Method(s)	**2.5-inch ID Mod Cal, SPT**	Hammer Data	**Auto hammer (140 lb, 30-inch drop)**
Borehole Backfill	**Bentonite cement grout to 10 feet bgs**	Location		Coordinates	**N 2605112 E 6476050**

Elevation feet	Depth, feet	SAMPLES Type	SAMPLES Number	SAMPLES Sampling Resistance	SAMPLES Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Fines Content (%<#200 Sieve)	Dry Density, pcf	REMARKS AND OTHER TESTS
	0						[Recent Lake Sediment]				Advanced 6-inch casing to 5 feet with hammer from 2 to 5 feet
2575							LEAN CLAY WITH SAND (CL), stiff, olive gray to dark olive gray (5Y 4/2 to 5Y 3/2), fine grained sand, low to medium plasticity fines, trace fine angular volcanic gravel and wood debris/roots [Colluvium]				
	5		S01	5 9 14 (23)	1.5						
2570							VOLCANIC SANDSTONE, dark greenish gray to black (5GY 4/1 to GLEY1 2.5/N), moderately to slightly weathered [Bogus Mountain Beds]				Harder drilling with gravelly cuttings
	10		S02	50/4"	0.3						Hard, slow drilling
2565											
	15		S03	50/4"							
							TOTAL DEPTH = 15.4 FEET				
2560											
	20										
2555											
	25										

AECOM

Report: GEO_10B1_OAK; File: BORING LOGS.GPJ; 6/21/2018 BC-06

Project: Klamath River Dam Removal Project
Project Location: Klamath River
Project Number: 60537920

Log of Boring BC-07

Date(s) Drilled	**2/2/2018 - 2/3/2018**	Logged By	**B. Kozlowicz**	Checked By	**D. Simpson**
Drilling Method	**Rotary Wash**	Drill Bit Size/Type	**4-inch Tricone**	Total Depth of Borehole	**15.9 feet**
Drill Rig Type	**Barge Mounted CME-45**	Drilling Contractor	**Taber Drilling**	Surface Elevation	**2581.3**
Groundwater Level(s)	**26.2 feet above ground surface (2/2 at 15:30)**	Sampling Method(s)	**2.5-inch ID Mod Cal**	Hammer Data	**Auto hammer (140 lb, 30-inch drop)**
Borehole Backfill	**Bentonite cement grout to 10 feet bgs**	Location		Coordinates	**N 2605439 E 6477039**

Elevation feet	Depth, feet	Samples: Type	Samples: Number	Samples: Sampling Resistance	Samples: Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Fines Content (%<#200 Sieve)	Dry Density, pcf	REMARKS AND OTHER TESTS
	0						[Recent Lake Sediments]				
2580			S01	0 0 0 (0)	2		FAT CLAY WITH SAND (CH), medium stiff, very dark gray (10YR 3/1), fine to medium grained sand, medium to high plasticity fines, trace rootlets [Colluvium/Residual Soil]				Sampler advanced 2 feet under weight of hammer Advanced 6-inch casing to 2 feet
			S02	5 7 8 (15)	1		← Wood/roots up to 1-inch in size	34	65	88	LL = 60 PL = 24 PI = 36
	5										15% Gravel 20% Sand 65% Fines 2/2/18 16:15 EOD 2/3/18 8:30 BOD Advanced 6-inch casing to 5 feet with hammer
2575											
			S03	2 5 4 (9)	0.6		CLAYEY SAND (SC), loose, very dark grayish brown (10YR 3/2), medium to coarse grained sand; medium plasticity fines; trace fine gravel with some diatomite clasts [Colluvium/Residual Soil]				Angular diatomite gravel and wood fibers in cutting to about 13 feet Advanced 6-inch casing to 10 feet with hammer
	10										
2570							POORLY GRADED SAND WITH SILT (SP-SM), loose to medium dense, coarse grained sand, dark greenish gray (10Y 4/1) subrounded to rounded diatomite gravel up to 1-inch in diameter in shoe [Colluvium/Residual Soil]				
			S04	9 9 7 (16)	1.5				8		27% Gravel 65% Sand 8% Fines
	15		S05	20 50/4"			With shell hash				Hole caving; advanced 6-inbch casing to 14 feet with hammer
2565							VOLCANIC SANDSTONE, very weak, light olive brown to strong brown (2.5Y 5/4 to 7.5YR 5/8), highly to completely weathered, with irregular 5 to 10-degree bedding [Bogus Mountain Beds]				
							TOTAL DEPTH = 15.9 FEET				
	20										
2560											
	25										

AECOM

Project: Klamath River Dam Removal Project	Log of Boring BC-08
Project Location: Klamath River	Sheet 1 of 1
Project Number: 60537920	

Date(s) Drilled	2/3/2018	Logged By	B. Kozlowicz	Checked By	D. Simpson
Drilling Method	Rotary Wash	Drill Bit Size/Type	4-inch Tricone	Total Depth of Borehole	11.5 feet
Drill Rig Type	Barge Mounted CME-45	Drilling Contractor	Taber Drilling	Surface Elevation	2586.2
Groundwater Level(s)	22.2 feet above ground surface (2/3 at 14:00)	Sampling Method(s)	2.5-inch ID Mod Cal, SPT	Hammer Data	Auto hammer (140 lb, 30-inch drop)
Borehole Backfill	Bentonite cement grout to 10 feet bgs	Location		Coordinates	N 2605190 E 6480346

Elevation feet	Depth, feet	SAMPLES Type	SAMPLES Number	SAMPLES Sampling Resistance	SAMPLES Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Fines Content (%<#200 Sieve)	Dry Density, pcf	REMARKS AND OTHER TESTS
	0						ORGANIC SILT TO ORGANIC CLAY (OL/OH), very soft, dark olive gray (5Y 3/2) with coarse organic debris				Advanced 6-inch casing to 3 feet with hammer past 1 foot
2585							FAT CLAY WITH SAND, stiff, black (5Y 2.5/2), fine grained sand, medium plasticity fines, trace angular to subrounded gravel up to 1.5 inches in diameter [Colluvium/Residual Soil]				
			S01	4 8 11 (19)	1.3			31			LL = 56 PL = 24 PI = 32
	5						WELL GRADED GRAVEL WITH SAND (GW), very dense, very dark grayish brown to black (10YR 3/2 to 10YR 2/1), broken rounded gravel up to 1.5 inches in diameter, medium to coarse grained sand, trace low plasticity fines [Fluvio-Lacustrine Terrace Deposit with Gravel (Qtg)]				Very hard drilling with volcanic rock chips in cuttings; switched to 2 7/8-inch drag but Blow counts affected by large particles
2580											
			S02	22 29 37 (66)	0.7						
	10										
2575							**TOTAL DEPTH = 11.5 FEET**				
	15										
2570											
	20										
2565											
	25										

AECOM

Project: Klamath River Dam Removal Project Project Location: Klamath River Project Number: 60537920	**Log of Boring BC-08a** Sheet 1 of 4

Date(s) Drilled	**2/14/18**	Logged By	**B. Kozlowicz**	Checked By	**D. Simpson**
Drilling Method	**Rotary Wash**	Drill Bit Size/Type	**4-inch Tricone**	Total Depth of Borehole	**85.2 feet**
Drill Rig Type	**Barge Mounted CME-45**	Drilling Contractor	**Taber Drilling**	Surface Elevation	**2583.5**
Groundwater Level(s)	**25.3 feet above ground surface (2/14 at 10:00)**	Sampling Method(s)	**2.5-inch ID Mod Cal, SPT**	Hammer Data	**Auto hammer (140 lb, 30-inch drop)**
Borehole Backfill	**Bentonite cement grout to 10 feet bgs**	Location		Coordinates	**N 2605249 E 6480346**

Elevation feet	Depth, feet	SAMPLES Type	SAMPLES Number	SAMPLES Sampling Resistance	SAMPLES Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Fines Content (%<#200 Sieve)	Dry Density, pcf	REMARKS AND OTHER TESTS
	0						ORGANIC SILT (OL), very soft, very dark brown (10YR 2/2) [Recent Lake Sediment]				
2580											Sampler sank to 4 feet; drove sampler for extra 18 inches (last three blowcounts reported, previous blows were 2-2-7)
	5		S01	9 20 50/4" (70/10")	2		CLAYEY SAND TO SANDY LEAN CLAY, loose/medium dense, black (10YR 2/1), fine to medium grained sand, medium plasticity fines, trace fine rounded gravel [Colluvium/Residual Soil]				
			S02	50/5"	0.4		CLAYEY GRAVEL WITH SAND (GC), very dense, dark yellowish brown to very dark gray (10YR 4/6 to 10YR 3/1), subangular to rounded gravel and cobbles up to 3 inches in diameter in a sandy lean clay to clayey sand matrix [Fluvio-Lacustrine Terrace Deposit with Gravel (Qtg)]				Hard chattering drilling from 7 to 11 feet Advanced 6-inch casing to 8 feet with hammer
2575	10										
							DIATOMITE, light yellowish brown (2.5Y 6/4), extremely weak, with irregular 45 to 90-degree fractures with some iron staining and 0 to 15-degree fractures [Lacustrine Diatomaceous Terrace (Ql)]				Fast smooth drilling with olive brown diatomite cuttings
2570	15										Advanced casing to 15 feet with hammer
2565			S03	3 4 5 (9)	1.2						
	20										
2560	25										

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Fines Content (%<#200 Sieve)	Dry Density, pcf	REMARKS AND OTHER TESTS
	25										
2555											
	30										
							DIATOMITE WITH ELASTIC SILT; olive gray (5Y 4/2) and greenish black (10Y 2.5/1), very soft/extremely weak, 0.25 to 0.5-inch alternating beds [Lacustrine Diatomaceous Terrace (Ql)]				Cuttings become greenish gray
2550			S04	2 4 4 (8)	0						
	35										
2545											
	40										
2540											
	45										
2535											Cuttings become olive gray and greenish gray
	50										
2530											

Project: Klamath River Dam Removal Project
Project Location: Klamath River
Project Number: 60537920

Log of Boring BC-08a

Elevation feet	Depth, feet	Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Fines Content (%<#200 Sieve)	Dry Density, pcf	REMARKS AND OTHER TESTS
	55		S05	2 2 3 (5)	1.5			179	99		LL = 200 PL = 88 PI = 112 1% Sand 99% Fines
2525											
	60										
2520											
	65										
2515											
	70										
2510											
	75		S06	1 2 4 (6)							
2505											
	80										

AECOM

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Fines Content (%<#200 Sieve)	Dry Density, pcf	REMARKS AND OTHER TESTS
2500											Harder drilling
	85		S07	50/3"	0.1		BASALT, black (10Y 2.5/1), slightly weathered, strong; recovered as angular gravel up to 1-inch in diameter [Copco/Quaternary Basalt (Qb)]				Tricone refusal
							TOTAL DEPTH = 85.2 FEET				
2495	90										
2490	95										
2485	100										
2480	105										
2475	110										

Project: Klamath River Dam Removal Project	Log of Boring BC-09
Project Location: Klamath River	Sheet 1 of 3
Project Number: 60537920	

Date(s) Drilled	2/13/2018	Logged By	B. Kozlowicz	Checked By	D. Simpson
Drilling Method	Rotary Wash	Drill Bit Size/Type	4-inch Tricone	Total Depth of Borehole	70.5 feet
Drill Rig Type	Barge Mounted CME-45	Drilling Contractor	Taber Drilling	Surface Elevation	2601.7
Groundwater Level(s)	5.8 feet above ground surface (2/13 at 9:00)	Sampling Method(s)	2.5-inch ID Mod Cal, SPT, 3-inch Shelby Tube, HQ Core Barrel	Hammer Data	Auto hammer (140 lb, 30-inch drop)
Borehole Backfill	Bentonite cement grout to 10 feet bgs	Location		Coordinates	N 2602526 E 6483561

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Fines Content (%<#200 Sieve)	Dry Density, pcf	REMARKS AND OTHER TESTS
	0						[Recent Lake Sediment]				Sampler advanced 2 feet under weight of hammer
2600			S01	0 0 0 (0)	1		FAT CLAY WITH SAND (CH), medium stiff, brown (10YR 4/3) [Alluvium/Residual Soil]				
			R01		1.4		CLAYEY GRAVEL (GC), dark gray (10YR 4/1) and yellowish brown (10YR 5/6), cored and wash subrounded to rounded basalt gravel and cobbles; some clayey sand matrix observed [Fluvio-Lacustrine Terrace Deposit with Gravel (Qtg)]				Set casing to 2 feet; hard driving at 2 feet (casing bouncing); switched to core bit
			R02		0						
	5		S02	4 2 7 (9)	1		DIATOMITE WITH ELASTIC SILT, medium stiff/weak, dark yellowish brown (10YR 4/4), trace fine grained sand [Lacustrine Diatomaceous Deposit (Ql)]				
2595											Advanced 6-inch casing to 4.5 feet
			S03	9 9 7 (16)	1						
	10										
2590							Becomes greenish gray (10Y 5/1), extremely weak/soft				
			S04	3 3 4 (7)	1.2						
	15										
2585											
	20										
2580											
								76	100	54	TX-UU
			S05	200 psi	1.7						LL = 74 PL = 53 PI = 21
	25							80		52	

Project: Klamath River Dam Removal Project
Project Location: Klamath River
Project Number: 60537920

Log of Boring BC-09

Elevation, feet	Depth, feet	Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Fines Content (%<#200 Sieve)	Dry Density, pcf	REMARKS AND OTHER TESTS
	25										100% Fines TX-ICU
2575											
	30										
2570											
			S06	3 3 4 (7)	0						
	35										
2565											
			S07	3 3 5 (8)	1.8						Sampler advanced an additional 6 inches by pushing
	40										
2560											
	45										
2555											
	50										
2550											

AECOM

Project: Klamath River Dam Removal Project
Project Location: Klamath River
Project Number: 60537920

Log of Boring BC-09

Elevation feet	Depth, feet	Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Fines Content (%<#200 Sieve)	Dry Density, pcf	REMARKS AND OTHER TESTS
		■	S08	200 psi	0						
	55										
2545											
	60										
2540											
	65										
2535											
		■	S09	200 to 400 psi	2.5			92		47	TX-ICU
	70							96		46	TX-ICU
							TOTAL DEPTH = 70.5 FEET				
2530											
	75										
2525											
	80										
2520											

AECOM

Project: Klamath River Dam Removal Project **Project Location: Klamath River** **Project Number: 60537920**	**Log of Boring BC-10** Sheet 1 of 2

Date(s) Drilled	**2/7/2018 - 2/8/2018**	Logged By	**B. Kozlowicz**	Checked By	**D. Simpson**
Drilling Method	**Rotary Wash**	Drill Bit Size/Type	**4-inch Tricone**	Total Depth of Borehole	**43.0 feet**
Drill Rig Type	**Barge Mounted CME-45**	Drilling Contractor	**Taber Drilling**	Surface Elevation	**2578.2**
Groundwater Level(s)	**29.3 feet above ground surface (2/7 at 14:40)**	Sampling Method(s)	**2.5-inch ID Mod Cal, SPT, 3-inch Shelby Tube**	Hammer Data	**Auto hammer (140 lb, 30-inch drop)**
Borehole Backfill	**Bentonite cement grout to 10 feet bgs**	Location		Coordinates	**N 2604959 E 6472871**

Elevation feet	Depth, feet	SAMPLES Type	SAMPLES Number	SAMPLES Sampling Resistance	SAMPLES Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Fines Content (%<#200 Sieve)	Dry Density, pcf	REMARKS AND OTHER TESTS
	0						[Recent Lake Sediment]				Set 6-inch casing to 4 feet (very soft to 2.5 feet)
2575							WELL GRADED GRAVEL WITH SAND (GW), dense, dark brown (10YR 3/3), subangular to rounded gravel up to 3 inches in diameter consisting of various volcanic lithologies [Fluvio-Lacustrine Terrace Deposit with Gravel (Qtg)]				
	5										Hard, chattering drilling
2570											
	10		S01	25 26 19 (45)	1.5				1		85% Gravel 15% Sand Advanced 6-inch casing to 9 feet with hammer
2565											Tricone bit refusal; rock core barrel used to advance
	15		S02	10 5 5 (10)	0.4		DIATOMITE WITH ELASTIC SILT, olive (5Y 5/3), medium stiff/extremely weak, with trace oxidation [Lacustrine Diatomaceous Terrace (Ql)]				Clayey diatomite curring; switched back to tricone bit Advanced 6-inch casing to 14 feet with hammer
2560											
	20										
2555											
	25			5			Becomes light olive brown (2.5Y 5/4) and olive brown (5Y 5/3)				

AECOM

Report: GEO_10B1_OAK; File: BORING LOGS.GPJ; 6/21/2018 BC-10

Project: Klamath River Dam Removal Project Project Location: Klamath River Project Number: 60537920	Log of Boring BC-10 Sheet 2 of 2

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Fines Content (%<#200 Sieve)	Dry Density, pcf	REMARKS AND OTHER TESTS
	25		S03	4 6 (10)	1.3		with 0.1 to 0.5 inch 10-degree bedding and some oxidation stains				
2550	30										
2545	35										
2540							VOLCANIC CINDER, very dark brown (10YR 2/2), very weak/dense to very dense, medium to coarse grained weakly welded sand, friable with corestones and weakly expressed 10 to 15-degree bedding [Bogus Mountain Beds]				Harder drilling
	40		S04	200 to 400 psi	0.9						
			S05	6 20 37 (57)	1.5		ANDESITE/TUFF, reddish brown (5YR 5/3), strong brown (7.5YR 5/6), and dusky purple, highly to completely weathered, very weak, coarse grained [Bogus Mountain Beds]				
2535							**TOTAL DEPTH = 43.0 FEET**				
	45										
2530	50										
2525											

AECOM

Project: Klamath River Dam Removal Project **Project Location: Klamath River** **Project Number: 60537920**	**Log of Boring BI-01** Sheet 1 of 1

Date(s) Drilled	**2/20/2018**	Logged By	**K. Zeiger**	Checked By	**B. Kozlowicz**
Drilling Method	**Rotary Wash**	Drill Bit Size/Type	**4-inch Tricone**	Total Depth of Borehole	**22.2 feet**
Drill Rig Type	**Barge Mounted CME-45**	Drilling Contractor	**Taber Drilling**	Surface Elevation	
Groundwater Level(s)	**11.8 feet above ground surface (2/20)**	Sampling Method(s)	**2.5-inch ID Mod Cal, SPT**	Hammer Data	**Auto hammer (140 lb, 30-inch drop)**
Borehole Backfill	**Neat cement grout to the ground surface**	Location		Coordinates	**N 2600814** **E 6450534**

Elevation feet	Depth, feet	SAMPLES Type	SAMPLES Number	SAMPLES Sampling Resistance	SAMPLES Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Fines Content (%<#200 Sieve)	Dry Density, pcf	REMARKS AND OTHER TESTS
	0						LEAN CLAY WITH ORGANICS (CL), very soft, wet, dark red brown (5YR 3/4), twigs and roots [Recent Lake Sediment]				
			S-1	0 0 0 (0)	2		LEAN CLAY (CL), stiff, dry, dark red brown (5YR 3/4), trace rootlets, CaCO3 ribbons, developed soil texture [Colluvium/Residual Soil]				
	5										
			S-2	4 7 8 (15)	1.5						
	10		S-3	6 8 13 (21)	1						
			S-4	50/4"	0.3		BASALT, dark red brown (5YR 2.5/2), fresh, strong [QUARTERNARY VOLCANICS]				
	15										
			S-5	50/3"	0.1		VOLCANIC CLASTICS, mottled dark gray (2.5Y 4/1) and light yellow brown (2.5Y 6/4), slightly weathered, moderately strong, coarse grained with quartz phenocrysts [MIOCENE VOLCANICS]				
	20										
			S-6	50/3"	0.2						
							TOTAL DEPTH = 22.2 FEET				
	25										

AECOM

Project: Klamath River Dam Removal Project **Project Location: Copco and Iron Gate Reservoirs** **Project Number: 60537920**	**Log of Boring BI-02** Sheet 1 of 5

Date(s) Drilled	**2/22/2018 - 2/23/2018**	Logged By	**K. Zeiger**	Checked By	**B. Kozlowicz**
Drilling Method	**Rotary Wash, HQ-3 Rock Core**	Drill Bit Size/Type	**4-inch solid stem auger, 3-7/8 inch tricone, 4-inch #2 diamond coring bit**	Total Depth of Borehole	**67.0 feet**
Drill Rig Type	**Truck mounted CME 75**	Drilling Contractor	**Taber Drilling**	Approx. Ground Surface Elevation	**2334.3 NAVD 88**
Groundwater Level	**4.8 feet (15:00 2/22)**	Sampling Methods	**2.5-inch ID Mod Cal, Rock Core**	Hammer Data	**Auto hammer (140 lbs, 30-inches)**
Borehole Backfill	**Neat cement to ground surface**	Borehole Location	**Iron Gate Reservoir**	Coordinate Location	**N 2602023 E 6461382**

Elevation, feet	Depth, feet	ROCK CORE: Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES: Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	0								FAT CLAY WITH SAND (CH), stiff, very dark brown (7.5YR 2.5/3), moist, low plasticity fines, 10 percent rounded gravel up to 1-inch in diameter [Alluvium]						4-inch solid stem auger
2334	1														
2332	2														
	3														
2330	4								∇						
	5										S-1	6 8 13	1.3	14:30	LL = 78 PL = 28 PI = 50 11% Gravel 21% Sand 68% Fines
2328	6								← 2-inch rounded clasts with trace decomposed rootlets						
	7														
2326	8														
	9														
2324	10								SANDY FAT CLAY (CH), stiff, dry, brown (7.5YR 4/3), low plasticity fines, fine grained sand, trace rounded gravel up to 0.25 inches in diameter, CaCO3 ribbons [Older Alluvium/Residual Soil]		S-2	5 7 12	1.5	14:40	LL = 58 PL = 28 PI = 30 5% Gravel 33% Sand 62% Fines
	11														
2322	12														
	13														

Log of Boring BI-02

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	MATERIAL DESCRIPTION	Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	13													
	14													
2320														First water at 14.0 feet; after 20 minutes at 4.8 feet
	15							SANDY FAT CLAY (CH), loose, brown (7.5YR 5/4), fine grained sand, low plascticity fines, trace rounded gravel up to 1-inch in diameter [Older Alluvium]		S-3	6, 6, 7	1.5	15:00	LL = 51 PL = 27 PI = 24 8% Gravel 40% Sand 53% Fines 4-inch casing to 14 feet Switch to rotary wash
	16													
2318														
	17													
		1	1	18	NA	0	1, 2	TUFF BRECCIA, green gray (10Y 6/1), highly to completely weathered, extremely weak, intensely fractured with angular breccia clasts up to 1-inch, fine to medium grained matrix [Miocene Volcanics - Bogus Mountian Beds]					1549	Refusal with tricone bit; switched to HQ rock core
	18				NA									
2316								1: 60, J, N, No, No, Pl, SR 2: 10, J, MW, No, No, Wa, SR						
	19				NA		NR						[21]	Clayey volcanics cuttings
	20				NA									100% fluid return
2314														
	21				NA								1601	
		2		100		48*	1	Becomes moderately to slightly weathered, moderately strong, moderately fractured Rough, irregular fractures likely mechanical along weathered contacts of breccia clasts 1: 10, J, T, No, No, Wa, SR 2: 20-80, J, N, No, No, Ir-St, R 3: 10, J, MW, No, No, Wa, SR					1610	
2312	22				2		2, 3, 3, 1							
	23				3								[22]	*Does not meet soundness criteria for RQD calculation
	24						4	4: 20, J, N, No, No, Wa, SR						
2310					1		m	Run break					1618	
		3		100		100	1	1: 30, J, N, No, No, Wa, SR					1622	
	25				2		2, 1	2: 5, J, T, H + ?, Pa, Wa, ?					[21]	
	26				1		1							
2308														
	27						m	Run break					1629	
					1								1634	
	28						1	1: 5, J, N, No, No, Wa, SR						
2306					0		m							
	29													

Project: Klamath River Dam Removal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Boring BI-02

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Number	Lithology	MATERIAL DESCRIPTION	Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	29	4		100	1	100	2		TUFF BRECCIA, green gray (10Y 6/1), moderately to slightly weathered, moderately strong, moderately fractured with angular breccia clasts up to 1-inch, medium grained matrix [Miocene Volcanics - Bogus Mountian Beds] (continued) 2: 10-15, J, N, No, No, Wa-St, R					[30]	Broken while placing in the box
2304	30				1		2								100% fluid return
	31				0										
2302	32				1		m 1		1: 10, J, N, No, No, Wa, SR					1644 1647	
	33				2		1								
2300	34	5	2	100	1	96	2 3		2: 40, J, N, No, No, St, SR 3: 30, J, T, H+?, No, No, Wa?					[31]	
	35				1		4		4: 10, J, N, No, No, Wa-St, SR						
2298	36				0										
	37				1		1		1: 10, J, N, No, No, Wa-St, R					1657 1701	
2296	38				1		1								
	39	6		100	1	100	2		2: 15, J, T, No, No, Wa, SR					[26]	
2294	40				1										
	41				0		3		3: 30, J, N, No, No, Wa-Pl, SR						
2292	42				1		1		1: 10, J, N, No, No, Wa, SR					1712 1206	EOD 2/22/2018 BOD2/23/2018
	43				4		2		2: 10-30, J, T, No, No, Wa, SR						
2290	44	7		100	1	96	1							[43]	
	45														

Project: Klamath River Dam Removal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Boring BI-02

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Number	Lithology	MATERIAL DESCRIPTION	Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	45				1		3		TUFF BRECCIA, green gray (10Y 6/1), moderately to slightly weathered, moderately strong, moderately fractured, angular breccia clasts up to 1-inch, fine to medium grained matrix [Miocene Volcanics - Bogus Mountian Beds] (continued) 3: 10-30, J, MW, No, No, Wa-Ir, SR-R						100% fluid return
2288	46		3		1		4		4: 30, J, N, No, No, Wa-Pl, SR					1213	
	47				0				Becomes strong, slightly fractured					1216	
2286	48				0										
	49	8		100	1	100	1 2		1: 20, J, MW, H+Ca, F, Wa, ? 2: 15, J, N, No, No, Wa-St, R					[25]	
2284	50				0										
	51				1		2							1228	
2282	52				0									1232	
	53				0										
2280	54	9		100	1	98	1		1: 30, J, N, No, No, St, R					[23]	
	55				0		m								Mechanical fractures from placing in box
2278	56				1		m 2		2: 20, J, N, No, No, Wa-St, SR					1245	
	57				1		1		1: 20, J, N, No, No, Wa, SR					1250	
2276	58				0										
	59	10		100	1	96	2		2: 10, J, N, No, No, Wa-St, R					[20]	
2274	60				0										100% fluid return
	61														

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Number	Lithology	MATERIAL DESCRIPTION	Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	61		4		1		m, m, 3		TUFF BRECCIA, green gray (10Y 6/1), moderately to slightly weathered, strong, slightly fractured, angular breccia clasts up to 1-inch, fine to medium grained matrix [Miocene Volcanics - Bogus Mountian Beds] (continued) 3: 6, J, N, No, No, Wa, SR					1305	
2272	62				0									1311	Mechanically broken from placement in box
	63				1		1		1: 30, V, N-T, H+Ca, Fi, Wa, ?						
							2		2: 10, J, N, No, No, Wa-St, SR-R						
2270	64	11		100	0	72								[19]	
	65				1		3		3: 60, J/V, MW, Ca, Pa, Wa-Pl, SR						
2268	66				3		4, 4, m		4: 60-70, J/V, N, H+Ca, Fi, Wa, ?					1327	
	67								**TOTAL DEPTH = 67.0 FEET**						
2266	68														
	69														
2264	70														
	71														
2262	72														
	73														
2260	74														
	75														
2258	76														
	77														

Project: Klamath River Dam Removal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Boring BI-03

Date(s) Drilled	**2/21/2018**	Logged By	**K. Zeiger**	Checked By	**B. Kozlowicz**
Drilling Method	**Rotary Wash, HQ-3 Rock Core**	Drill Bit Size/Type	**4-inch solid stem auger, 3-7/8 inch tricone, 4-inch #2 diamond coring bit**	Total Depth of Borehole	**35.1 feet**
Drill Rig Type	**Barge mounted CME 45**	Drilling Contractor	**Taber Drilling**	Approx. Ground Surface Elevation	**2302.2 NAVD 88**
Groundwater Level	**25.3 feet above ground surface (2/21)**	Sampling Methods	**2.5-inch ID Mod Cal, Rock Core**	Hammer Data	**Auto hammer (140 lbs, 30-inches)**
Borehole Backfill	**Neat cement to ground surface**	Borehole Location	**Iron Gate Reservoir**	Coordinate Location	**N 2601812 E 6461399**

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	MATERIAL DESCRIPTION	Soil Sample Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
2302	0							POORLY GRADED GRAVEL WITH CLAY (GP-GC), dark green gray (N 4/1), wet, loose, subangular to subrounded gravel up to 0.25-inch in diameter [Alluvium]						Advanced 5-inch casing to 3 feet
	1													
2300	2													
	3													
2298	4							TUFF BRECCIA, green gray (5G 6/1). highly weathered, weak to very weak, fine to medium grained matrix with angular to subrounded clasts up to 0.75 inches [Miocene Volcanics - Bogus Mountian Beds]		S-1	12 50/2.5"	0.7	10:10	LL = 51 PL = 27 PI = 24 61% Gravel 30% Sand 9% Fines Advanced 5-inch casing to 4 feet
	5													
		1		4	6+	0	1 2	Becomes moderately weathered, weak, intensely fractured to locally crushed. Most rough, irregular fractures likely mechanical due to weathering on clasts/matrix boundaries					1059	Refusal with tricone bit; switched to HQ-3
2296	6				6+		3 4 2 5 4 4	1: 60, J, N, No, No, St, R 2: 40, J, T, No, No, St, R 3: 50-60, J, T, No, No, St, R 4: 30, J, MW, No, No, St, R 5: 10, J, N, No, No, St, R						
	7				6+								[13]	
2294	8				6+		6 4 7	6: 40, J, N, No, No, Wa, SR 7: 70, J, T, No, No, Wa, SR						
	9				NA		5							
2292	10	2		5	NA	14*	1	1: ~10, J, N, No, No, Wa, SR					1120 1143	LL = 58 PL = 28 PI = 30 5% Gravel 33% Sand 62% Fines
	11				4		2 3 3	2: 30, J, N-T, No, No, Wa-St, SR 3: 40-50, J, N, No, No, Wa-St, SR-R						
2290	12				5		4 3 4 2	4: 20, J, MW, No, Wa, St, SR-R					[19]	Does not meet soundness criteria for RQD calculation
	13													

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Number	Lithology	MATERIAL DESCRIPTION	Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	13–14				5		5, 2, 2		TUFF BRECCIA, green gray (5G 6/1), moderately weathered, weak, intensely fractured to locally crushed, fine to medium grained matrix with angular to subrounded clasts up to 0.75 inches [Miocene Volcanics - Bogus Mountian Beds] (continued)						
2288	14–15				5		1, 2, 2		5: 30, J, N, No, No, Wa-Pl, SR						
	15–16	3	5		3	100*	1		1: 35, J, N, No, No, St, R Becomes slightly fractured, moderately strong					1159 1215	LL = 51 PL = 27 PI = 24 8% Gravel 40% Sand 53% Fines Packer test #1 from 15.1 to 35.1
2286	16–17				0										
	17–18				1		2		2: 30, J, N, No, No, Wa, SR					[23]	Does not meet soundness criteria for RQD calculation
2284	18–19				1		3		3: 20, J, T, No, No, Wa, SR						
	19–20				0										
2282	20–21	4	5		3	86*	1, 2, 3		Becomes highly fractured 1: 10, J, MW, No, No, Wa, SR 2: 25, J, T, No, No, Wa-St, SR-R 3: 10, J, MW, No, No, Wa, SR-R					1228 1239	
	21–22				2		3, 2		Becomes moderately fractured						
2280	22–23				1		3							[18]	
	23–24				0										
2278	24–25				1		3								
	25–26	5	5		0	48*								1256 1301	
2276	26–27				5		1, 2, 3, 3		Moderately to highly weathered, weak to very weak, fractures 1, 2, 3 are likely mechanical						Clayey coating 26.5-27.2 is from when return hose got disconnected during run
	27–28				5		3, 3, 4, 5		1: 15, J, T, No, No, Wa, SR 2: 40, J, T, No, No, Wa-St, SR 3: 5-10, J, MW, No, No, Wa, SR 4: 80, J, N, No, No, Wa-Ir, SR 5: 30, J/V, T, Ca, Pa, Pl-Wa, SR					[15]	
2274	28–29				6+		6		Crushed zone 6: 65, J, MW, Sd, Pa, Wa, SR						

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	29				0				TUFF BRECCIA, green gray (5G 6/1), moderately weathered, moderately strong, moderately fractured, fine to medium grained matrix with angular to subrounded clasts up to 0.75 inches [Miocene Volcanics - Bogus Mountian Beds] (continued)						
2272	30				2		1, 1		Becomes intensely fractured 1: 5, J, N, No, No, Pl-Wa, SR					1321 1327	
	31				4		2, 2, 3, 1		2: 20, J, N-MW, No, No, Wa, SR 3: 35, J, N, Ca+Sd, Pl, S						
2270	32	6		5	0	54*								[15]	
	33				3		4, 3		4: 30, J, N, No, No, Pl, SR						Does not meet soundness criteria for RQD calculation
2268	34				4		5, 6		Becomes highly weathered, weak, crushed along a fracture? 5: 65, J, MW-W, Fe+Sd, Su+Pa, Pl, SR-R with ~0.75-inch Fe stained highly weathered rind 6: 10-20, J, T, No, No, Wa-Lr, SR					1347	
	35								**TOTAL DEPTH = 35.1 FEET**						
2266	36														
	37														
2264	38														
	39														
2262	40														
	41														
2260	42														
	43														
2258	44														
	45														

Attachment C Laboratory Testing Results

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Moisture-Density-Porosity Report

Cooper Testing Labs, Inc. (ASTM D7263b)

CTL Job No: 020-251a **Project No.** 60537920 **By:** RU

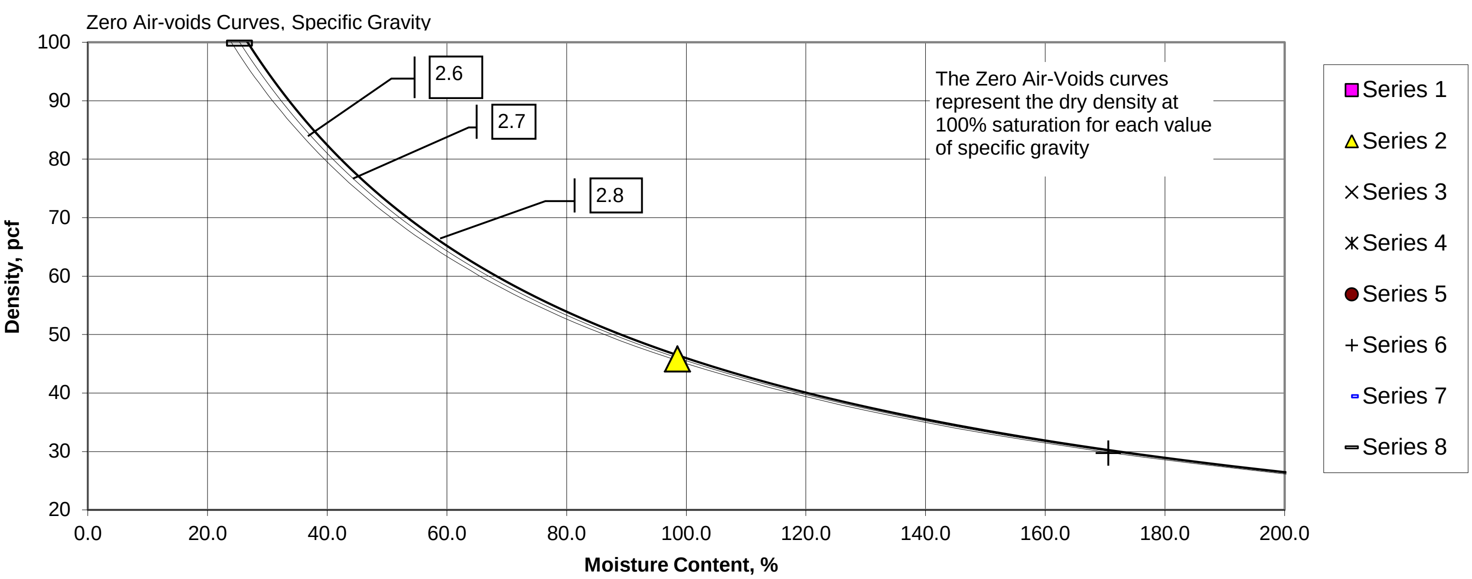
Client: AECOM **Date:** 06/13/18

Project Name: Klamath River Dam Removal Project **Remarks:**

Boring:	BC-01	BC-01	BC-01	BC-02	BC-02	BC-02	BC-03	BC-03
Sample:	S-02	S-03	S04	S05	S09	S10	S-01	S-02
Depth, ft:	6.5	12.5-13	21.5	14.5	44.5	54.8-55.3	1	5.5-6.0
Visual Description:	Dark Olive Gray Sandy SILT	Light Yellowish Brown Sandy CLAY	Gray Elastic SILT	Gray Elastic SILT	Gray Elastic SILT	Black CLAY	Dark Olive Brown Sandy Lean CLAY	Dark Olive Brown Sandy CLAY w/ Gravel
Actual G_s								
Assumed G_s		2.70				2.70		2.70
Moisture, %	43.1	98.6	92.9	83.7	177.8	170.6	34.7	25.4
Wet Unit wt, pcf		91.0				80.3		125.2
Dry Unit wt, pcf		45.8				29.7		99.9
Dry Bulk Dens.pb, (g/cc)		0.73				0.48		1.60
Saturation, %		99.3				98.3		99.4
Total Porosity, %		72.8				82.4		40.8
Volumetric Water Cont,Θw,%		72.3				81.0		40.6
Volumetric Air Cont., Θa,%		0.5				1.4		0.2
Void Ratio		2.68				4.68		0.69
Series	1	2	3	4	5	6	7	8

Note: All reported parameters are from the as-received sample condition unless otherwise noted. If an assumed specific gravity (Gs) was used then the saturation, porosities, and void ratio should be considered approximate.

Moisture-Density



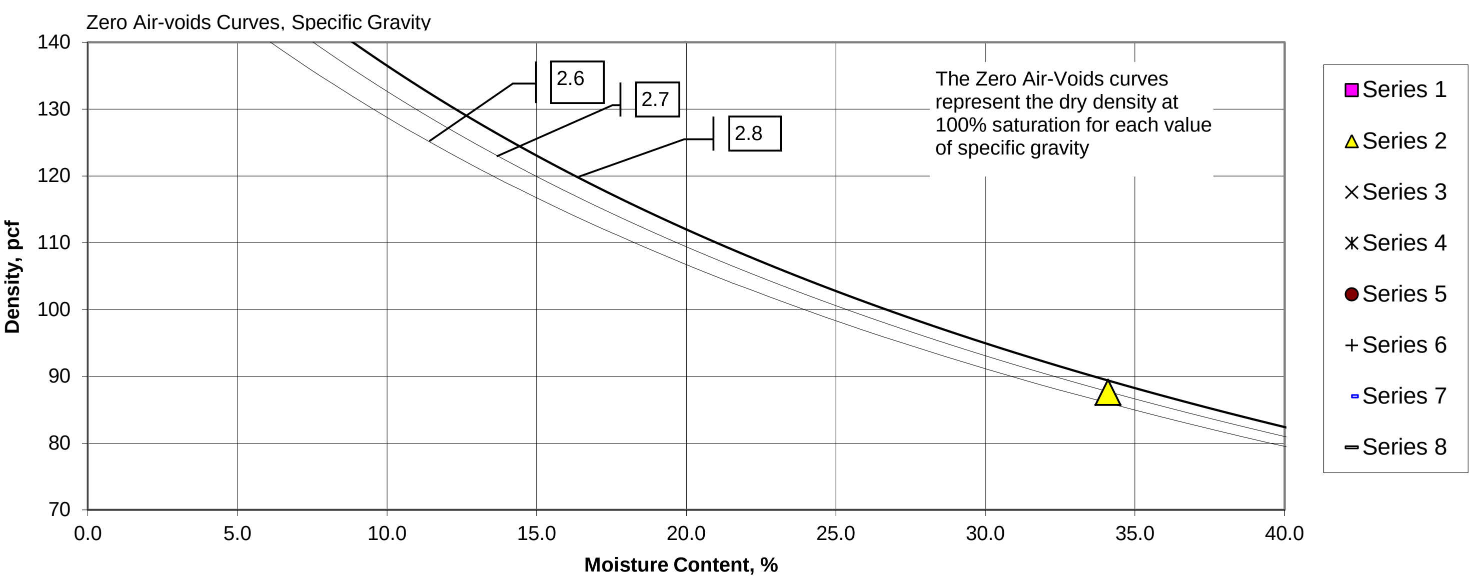
Moisture-Density-Porosity Report
Cooper Testing Labs, Inc. (ASTM D7263b)

CTL Job No:	020-251b	**Project No.**	60537920	**By:**	RU
Client:	AECOM	**Date:**	06/13/18		
Project Name:	Klamath River Dam Removal Project	**Remarks:**			

Boring:	BC-03	BC-07	BC-08	BC-08A	BI-02	BI-02	BI-02	BI-03
Sample:	S05	S-02	S-01	S05	S1	S2	S3	S-1
Depth, ft:	24.5	4-4.5	3	54	5	10	15	3.5
Visual Description:	Light Olive Brown Elastic SILT	Very Dark Olive Brown Sandy Fat CLAY w/ Gravel	Dark Reddish Brown Sandy Fat CLAY	Light Olive Brown Elastic SILT	Dark Reddish Brown Sandy Fat CLAY	Yellowish Brown Sandy Fat CLAY	Yellowish Brown Sandy Fat CLAY	Olive Gray Poorly Graded GRAVEL w/ Silt & Sand
Actual G_s								
Assumed G_s		2.70						
Moisture, %	80.3	34.1	31.4	178.6	27.8	28.7	38.4	12.0
Wet Unit wt, pcf		117.5						
Dry Unit wt, pcf		87.6						
Dry Bulk Dens.pb, (g/cc)		1.40						
Saturation, %		99.5						
Total Porosity, %		48.1						
Volumetric Water Cont,Θw,%		47.8						
Volumetric Air Cont., Θa,%		0.2						
Void Ratio		0.93						
Series	1	2	3	4	5	6	7	8

Note: All reported parameters are from the as-received sample condition unless otherwise noted. If an assumed specific gravity (Gs) was used then the saturation, porosities, and void ratio should be considered approximate.

Moisture-Density



#200 Sieve Wash Analysis
ASTM D 1140

COOPER TESTING LABORATORY

Job No.: 020-251 **Project No.:** 60537920 **Run By:** MD
Client: AECOM **Date:** 6/14/2018 **Checked By:** DC
Project: Klamath River Dam Removal Project

Boring:	BC-02	BC-03	BC-04	BC-04				
Sample:	S-01	S-01	S-01	S02				
Depth, ft.:	1-2	1	1.5	7				
Soil Type:	Dark Olive Brown Clayey GRAVEL w/ Sand	Dark Olive Brown Sandy Lean CLAY	Dark Olive Brown Clayey SAND	Dark Olive Brown Sandy CLAY				
Wt of Dish & Dry Soil, gm	1247.4	707.6	696.3	656.3				
Weight of Dish, gm	175.6	175.8	172.4	173.0				
Weight of Dry Soil, gm	1071.8	531.8	523.9	483.3				
Wt. Ret. on #4 Sieve, gm	556.7	16.7	22.3	15.6				
Wt. Ret. on #200 Sieve, gm	774.5	177.4	291.7	205.6				
% Gravel	**51.9**	**3.1**	**4.3**	**3.2**				
% Sand	**20.3**	**30.2**	**51.4**	**39.3**				
% Silt & Clay	**27.7**	**66.6**	**44.3**	**57.5**				

Remarks: As an added benefit to our clients, the gravel fraction may be included in this report. Whether or not it is included is dependent upon both the technician's time available and if there is a significant enough amount of gravel. The gravel is always included in the percent retained on the #200 sieve but may not be weighed separately to determine the percentage, especially if there is only a trace amount, (5% or less).

COOPER TESTING LABORATORY

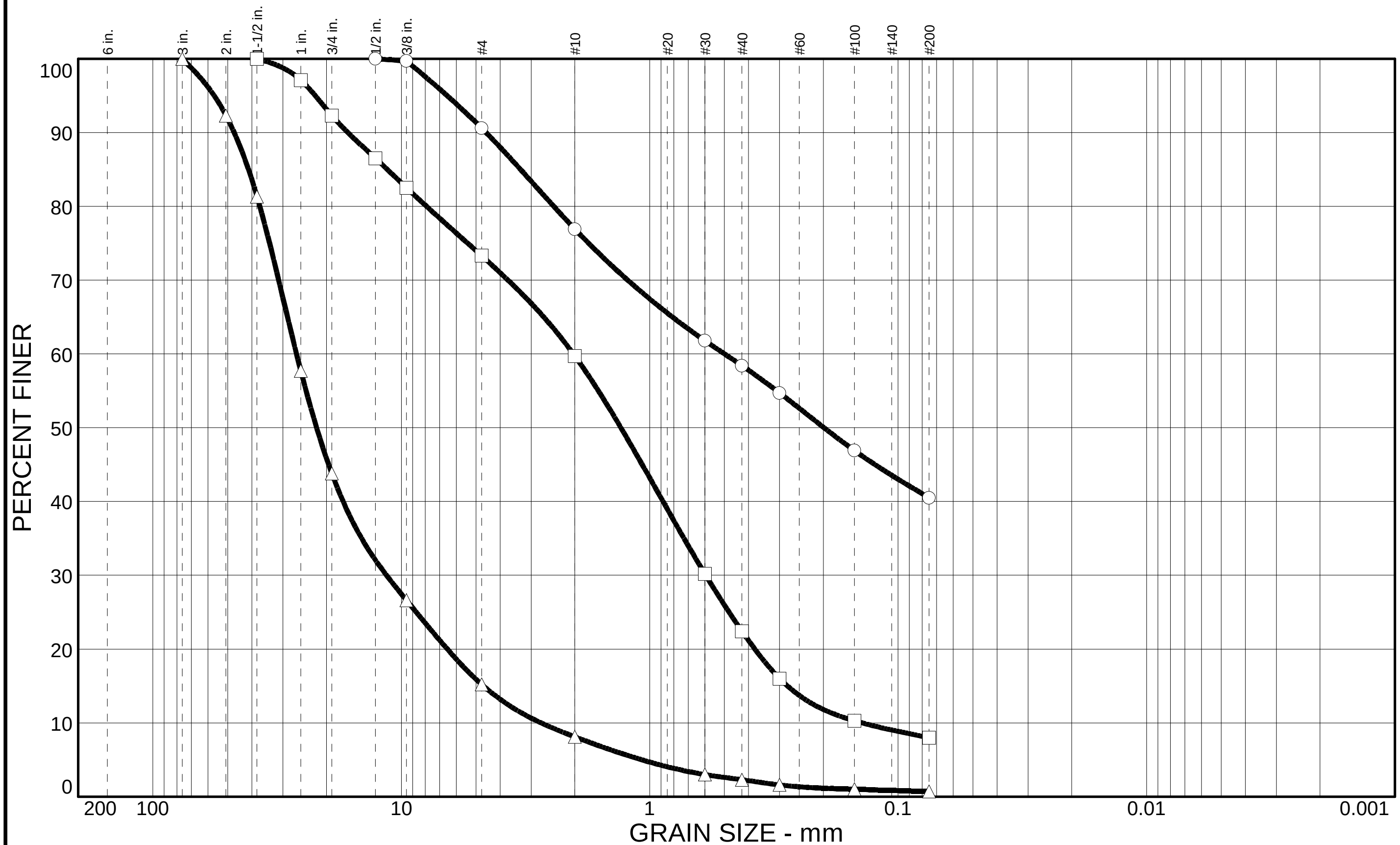
#200 Bulk Sieve Wash Analysis
ASTM D 1140m

Job No.: 020-251 **Project No.:** 60537920 **Run By:** MD
Client: AECOM **Date:** 6/14/2018 **Checked By:** DC
Project: Klamath River Dam Removal Project

Boring:	BC-07							
Sample:	S-02							
Depth, ft.:	4-4.5							
Soil Type:	Very Dark Olive Brown Sandy Fat CLAY w/ Gravel							
Bulk Sample wt. lb.	218.0							
Wt of Dish & Dry Soil <#4,gm	389.5							
Weight of Dish, gm	171.0							
Weight of Dry Soil <#4, gm	218.5							
Wt. Ret. on #4 Sieve, lb	33.1							
Wt. Ret. on #200 Sieve, gm	52.3							
% Gravel	**15.2**							
% Sand	**20.3**							
% Silt & Clay	**64.5**							

Remarks: As an added benefit to our clients, the gravel fraction may be included in this report. Whether or not it is included is dependent upon both the technician's time available and if there is a significant enough amount of gravel. The gravel is always included in the percent retained on the #200 sieve but may not be weighed separately to determine the percentage, especially if there is only a trace amount, (5% or less).

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		9.4	50.1	40.5					
□		26.7	65.3	8.0					
△		84.8	14.5	0.7					

SIEVE inches size	PERCENT FINER ○	□	△
3			100.0
2			92.3
1.5"		100.0	81.3
1"		97.1	57.7
3/4"		92.3	43.8
1/2"	100.0	86.5	
3/8"	99.7	82.5	26.6
	GRAIN SIZE		
D_{60}	0.500	2.03	26.4
D_{30}		0.595	11.5
D_{10}		0.139	2.74
	COEFFICIENTS		
C_c		1.25	1.82
C_u		14.56	9.65

SIEVE number size	PERCENT FINER ○	□	△
#4	90.6	73.3	15.2
#10	76.9	59.7	8.1
#30	61.8	30.2	3.0
#40	58.4	22.4	2.3
#50	54.7	16.0	1.6
#100	46.9	10.3	1.0
#200	40.5	8.0	0.7

SOIL DESCRIPTION

○ Reddish Brown Clayey SAND

□ Dark Olive Brown Well-Graded SAND w/ Silt & Gravel

△ Dark Olive Brown Well-Graded GRAVEL

REMARKS:

○

□ Due to the small sample size, relative to the largest particle size, this data should be considered to be approximate.

△

○ Source: BC-04 Sample No.: S-03 Elev./Depth: 11-12.5'

□ Source: BC-07 Sample No.: S-04 Elev./Depth: 13'

△ Source: BC-10 Sample No.: S-01 Elev./Depth: 9.5'

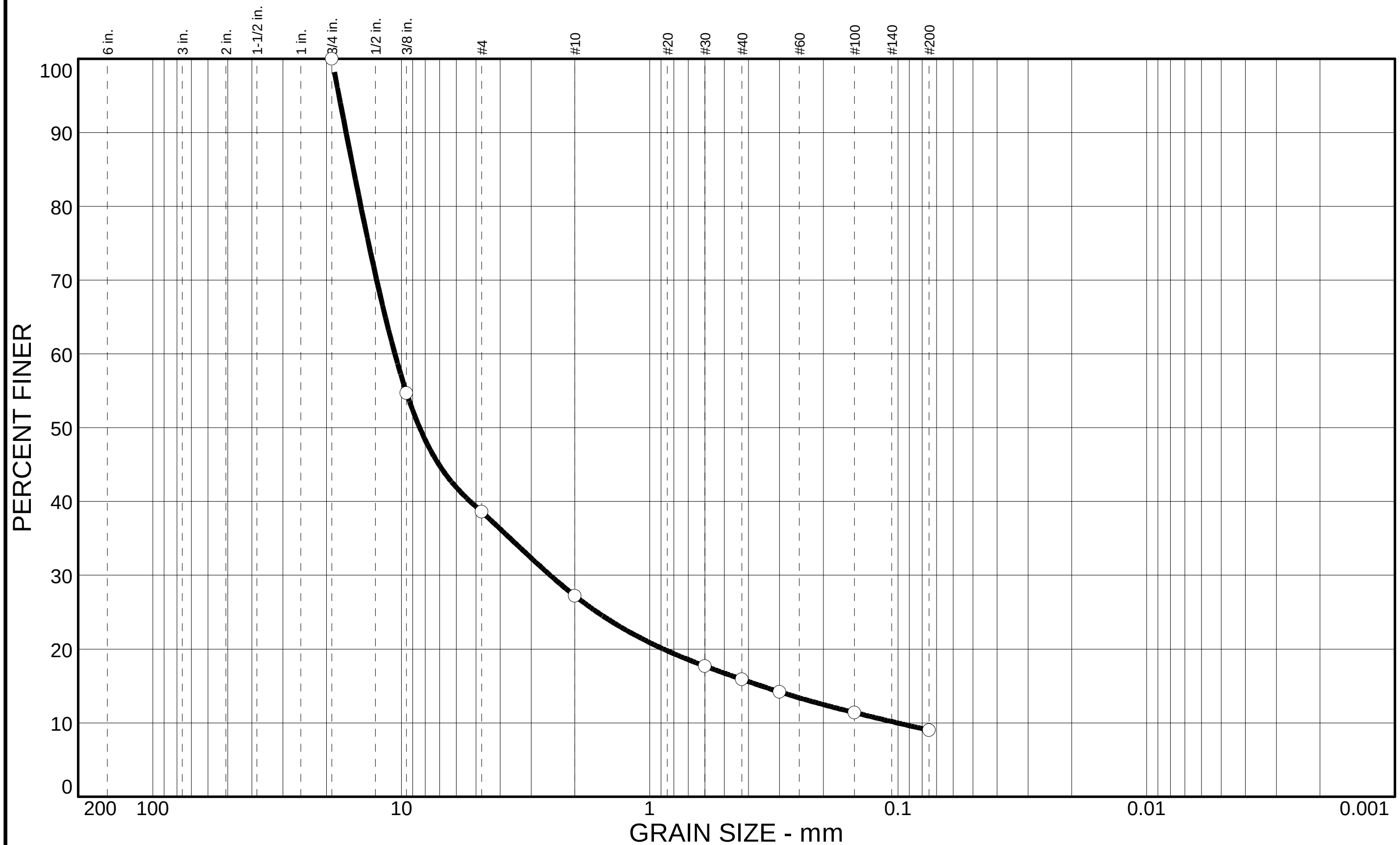
COOPER TESTING LABORATORY

Client: AECOM

Project: Klamath River Dam Removal Project - 60537920

Project No.: 020-251 Figure

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		61.4	29.6	9.0		GP-GM		26	41

SIEVE inches size	PERCENT FINER ○		
3/4"	100.0		
3/8"	54.7		
	GRAIN SIZE		
D_{60}	10.6		
D_{30}	2.52		
D_{10}	0.101		
	COEFFICIENTS		
C_c	5.92		
C_u	105.44		

SIEVE number size	PERCENT FINER ○		
#4	38.6		
#10	27.2		
#30	17.7		
#40	15.9		
#50	14.2		
#100	11.4		
#200	9.0		

SOIL DESCRIPTION

○ Olive Gray Poorly Graded GRAVEL w/ Silt & Sand

REMARKS:

○

○ Source: BI-03 Sample No.: S-01 Elev./Depth: 3.5'

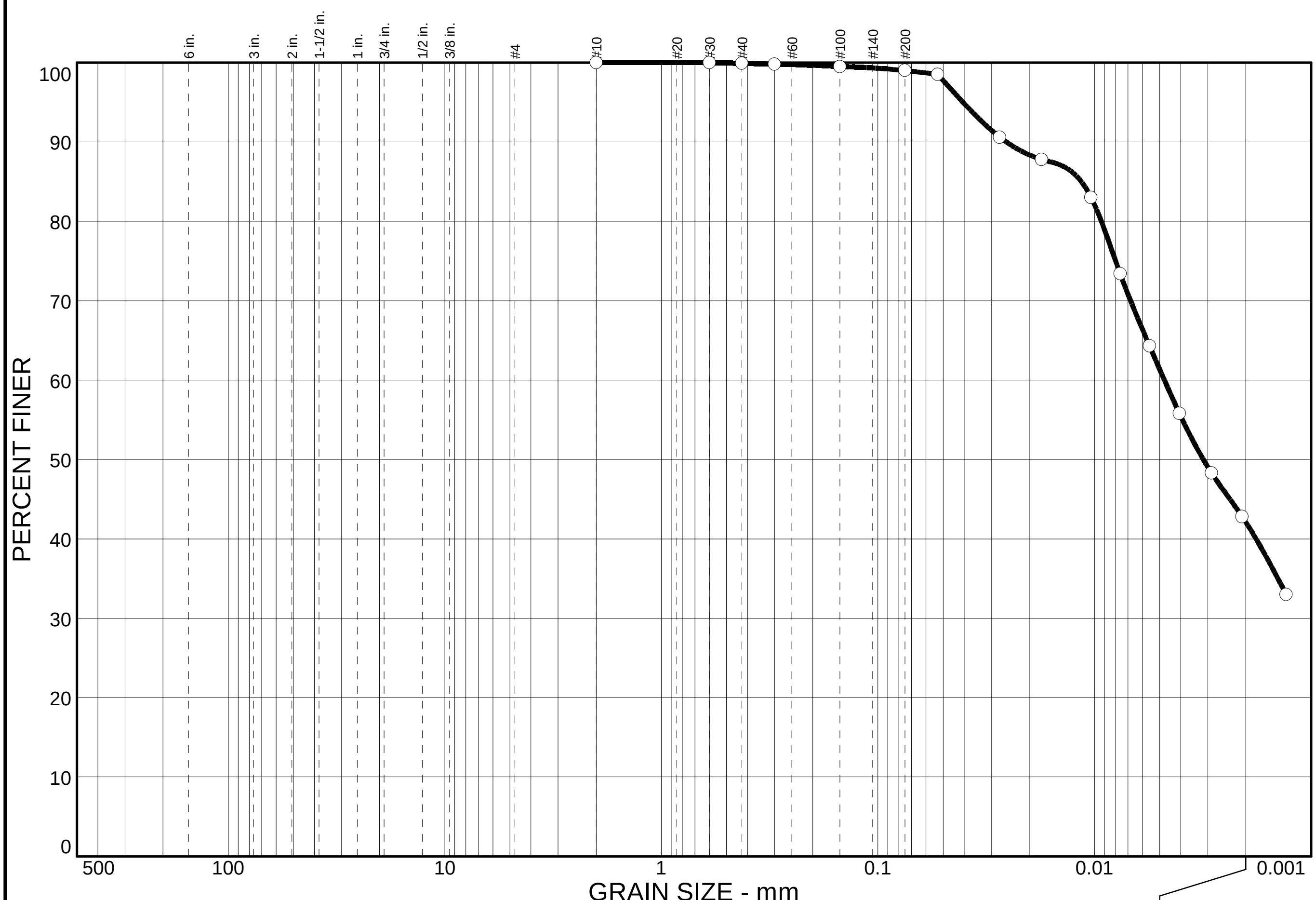
COOPER TESTING LABORATORY

Client: AECOM

Project: Klamath River Dam Removal Project - 60537920

Project No.: 020-251 Figure

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	1.0	56.9	42.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#30	100.0		
#40	99.9		
#50	99.8		
#100	99.5		
#200	99.0		
#270	98.5		
0.0274 mm.	90.6		
0.0176 mm.	87.8		
0.0104 mm.	83.0		
0.0076 mm.	73.4		
0.0056 mm.	64.3		
0.0041 mm.	55.8		
0.0029 mm.	48.3		
0.0021 mm.	42.8		
0.0013 mm.	33.0		

* (no specification provided)

Soil Description

Olive Gray Elastic SILT

Atterberg Limits

PL= 51 LL= 85 PI= 34

Coefficients

D_{85}= 0.0115 D_{60}= 0.0048 D_{50}= 0.0031
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= MH AASHTO=

Remarks

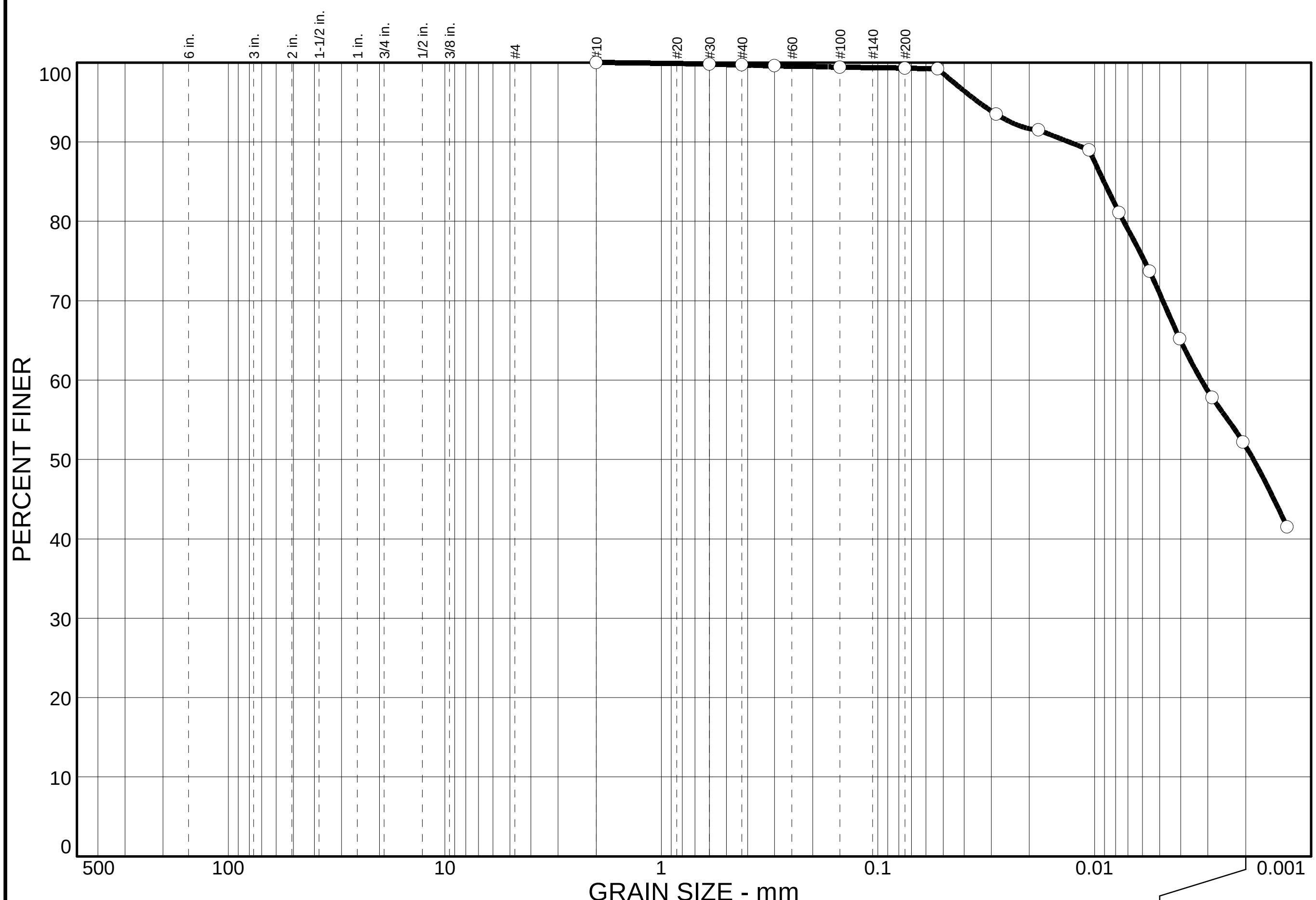
Sample No.: S-04 **Source of Sample:** BC-01 **Date:** 6/5/18
Location: **Elev./Depth:** 21.5'

COOPER TESTING LABORATORY

Client: AECOM
Project: Klamath River Dam Removal Project - 60537920

Project No: 020-251 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	0.7	47.7	51.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#30	99.8		
#40	99.7		
#50	99.6		
#100	99.4		
#200	99.3		
#270	99.2		
0.0285 mm.	93.5		
0.0182 mm.	91.5		
0.0106 mm.	89.0		
0.0077 mm.	81.1		
0.0056 mm.	73.7		
0.0040 mm.	65.2		
0.0029 mm.	57.8		
0.0021 mm.	52.2		
0.0013 mm.	41.5		

* (no specification provided)

Soil Description

Gray Elastic SILT

Atterberg Limits

PL= 59 LL= 105 PI= 46

Coefficients

D_{85}= 0.0090 D_{60}= 0.0032 D_{50}= 0.0018
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= MH AASHTO=

Remarks

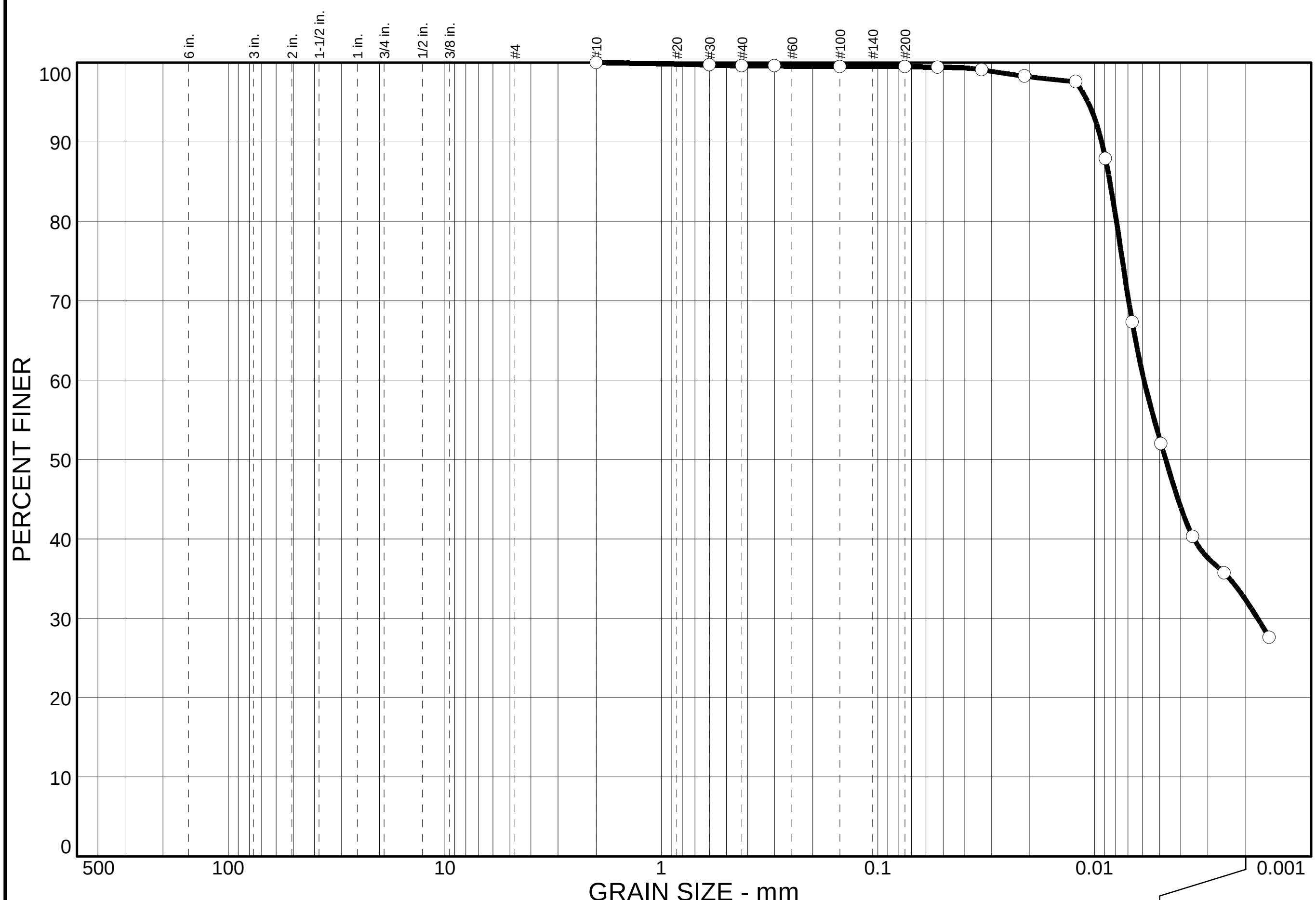
Sample No.: S-05 **Source of Sample:** BC-02 **Date:** 6/5/18
Location: **Elev./Depth:** 14.5'

COOPER TESTING LABORATORY

Client: AECOM
Project: Klamath River Dam Removal Project - 60537920

Project No: 020-251 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	0.5	67.2	32.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#30	99.7		
#40	99.6		
#50	99.6		
#100	99.5		
#200	99.5		
#270	99.4		
0.0331 mm.	99.1		
0.0210 mm.	98.3		
0.0122 mm.	97.6		
0.0089 mm.	87.9		
0.0067 mm.	67.3		
0.0049 mm.	52.0		
0.0035 mm.	40.3		
0.0025 mm.	35.7		
0.0016 mm.	27.6		

* (no specification provided)

Soil Description

Gray Elastic SILT

Atterberg Limits

PL= 85 LL= 187 PI= 102

Coefficients

D_{85}= 0.0085 D_{60}= 0.0059 D_{50}= 0.0047
D_{30}= 0.0018 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= MH AASHTO=

Remarks

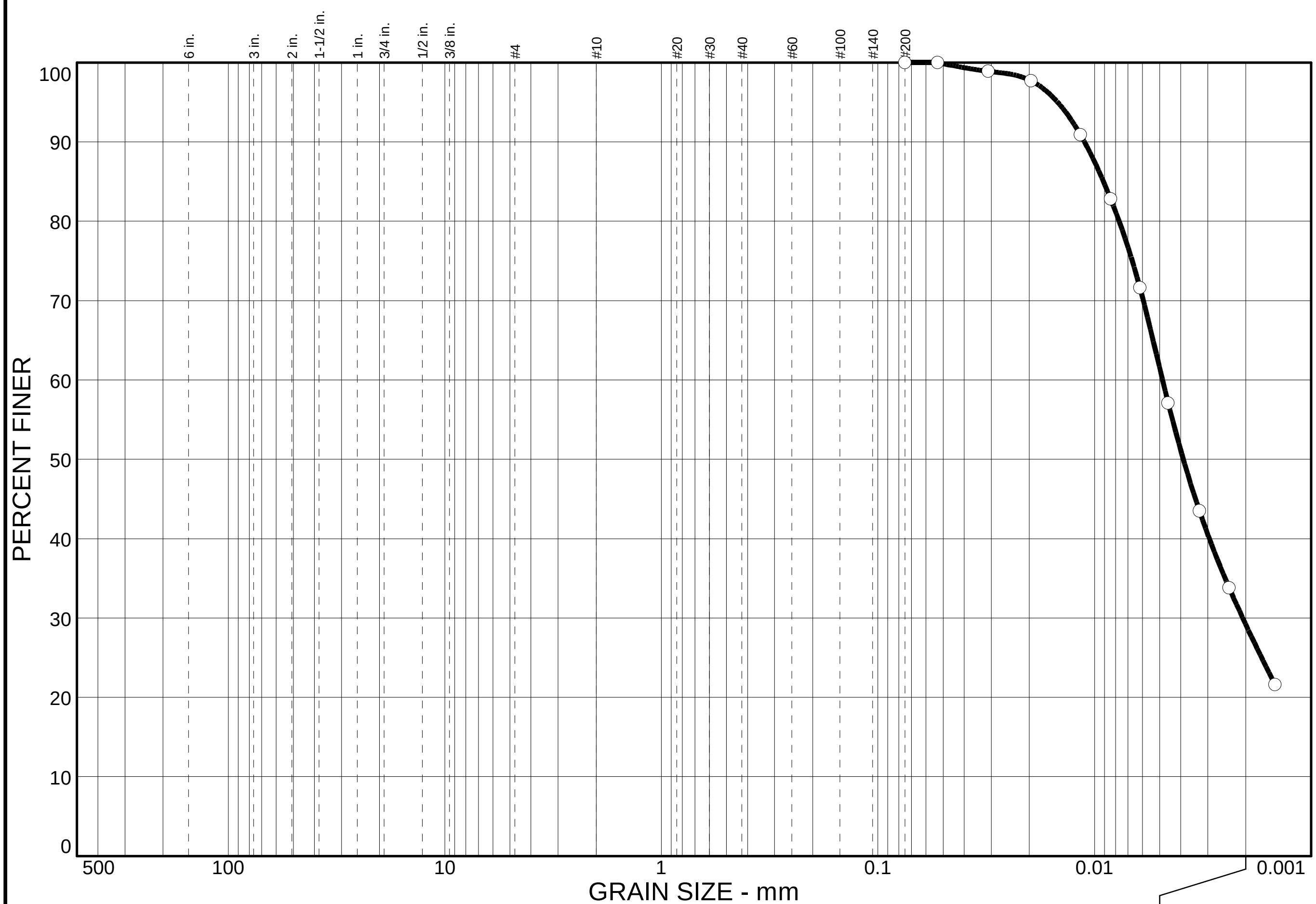
Sample No.: S-09 **Source of Sample:** BC-02 **Date:** 6/5/18
Location: **Elev./Depth:** 44.5'

COOPER TESTING LABORATORY

Client: AECOM
Project: Klamath River Dam Removal Project - 60537920

Project No: 020-251 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	0.0	70.9	29.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	100.0		
#270	100.0		
0.0309 mm.	98.9		
0.0196 mm.	97.7		
0.0116 mm.	90.9		
0.0084 mm.	82.8		
0.0062 mm.	71.6		
0.0046 mm.	57.1		
0.0033 mm.	43.5		
0.0024 mm.	33.8		
0.0015 mm.	21.6		

* (no specification provided)

Soil Description

Light Olive Brown Elastic SILT

Atterberg Limits

PL= 59 LL= 69 PI= 10

Coefficients

D_{85}= 0.0091 D_{60}= 0.0049 D_{50}= 0.0039
D_{30}= 0.0021 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= MH AASHTO=

Remarks

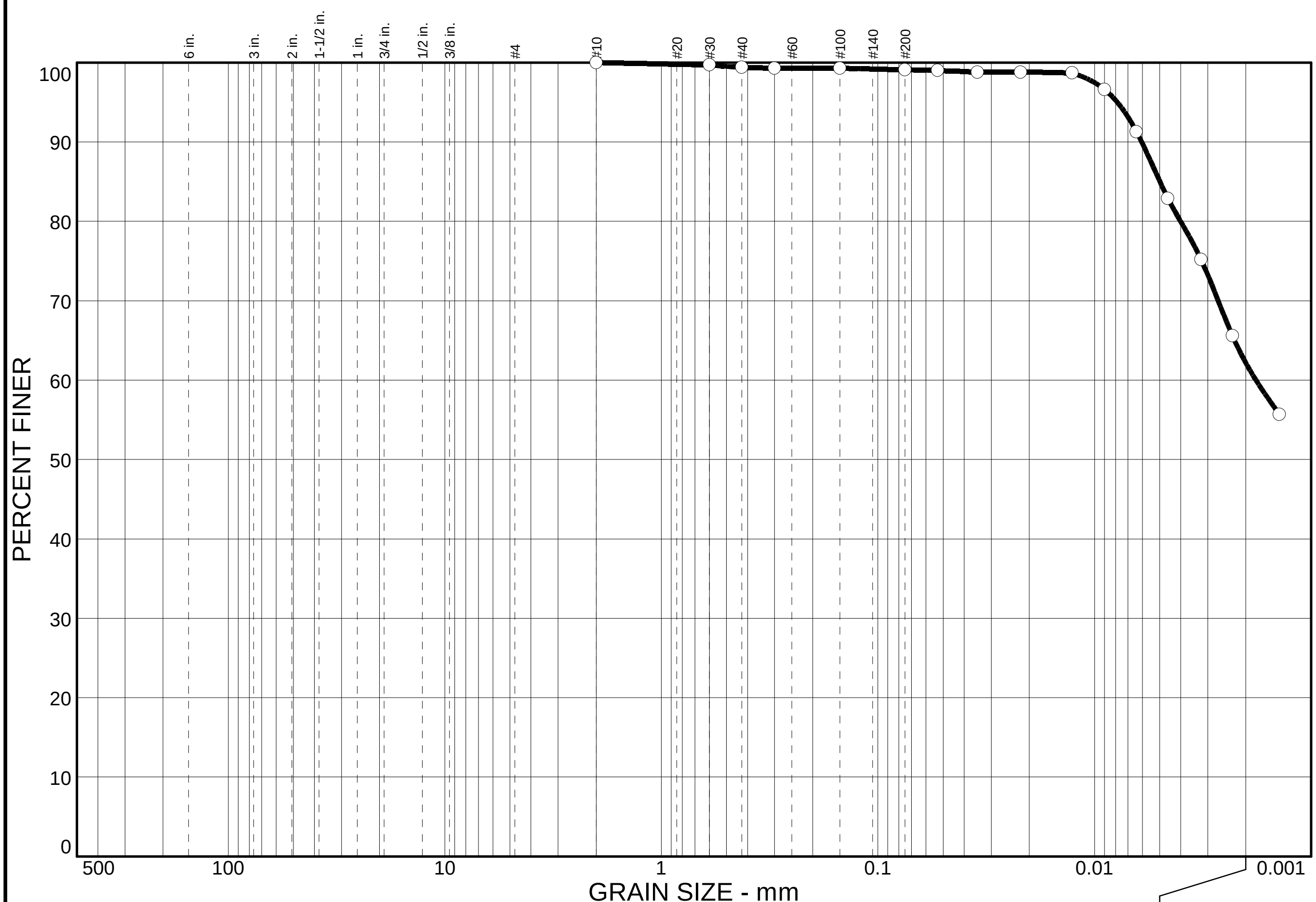
Sample No.: S-05 **Source of Sample:** BC-03 **Date:** 6/5/18
Location: **Elev./Depth:** 24.5'

COOPER TESTING LABORATORY

Client: AECOM
Project: Klamath River Dam Removal Project - 60537920

Project No: 020-251 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	0.9	37.0	62.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#30	99.7		
#40	99.4		
#50	99.3		
#100	99.3		
#200	99.1		
#270	99.0		
0.0347 mm.	98.8		
0.0219 mm.	98.8		
0.0127 mm.	98.7		
0.0090 mm.	96.6		
0.0064 mm.	91.3		
0.0046 mm.	82.9		
0.0032 mm.	75.2		
0.0023 mm.	65.6		
0.0014 mm.	55.7		

* (no specification provided)

Soil Description

Pale Brown Mottled Gray Elastic SILT

Atterberg Limits

PL= 85 LL= 120 PI= 35

Coefficients

D_{85}= 0.0050 D_{60}= 0.0018 D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= MH AASHTO=

Remarks

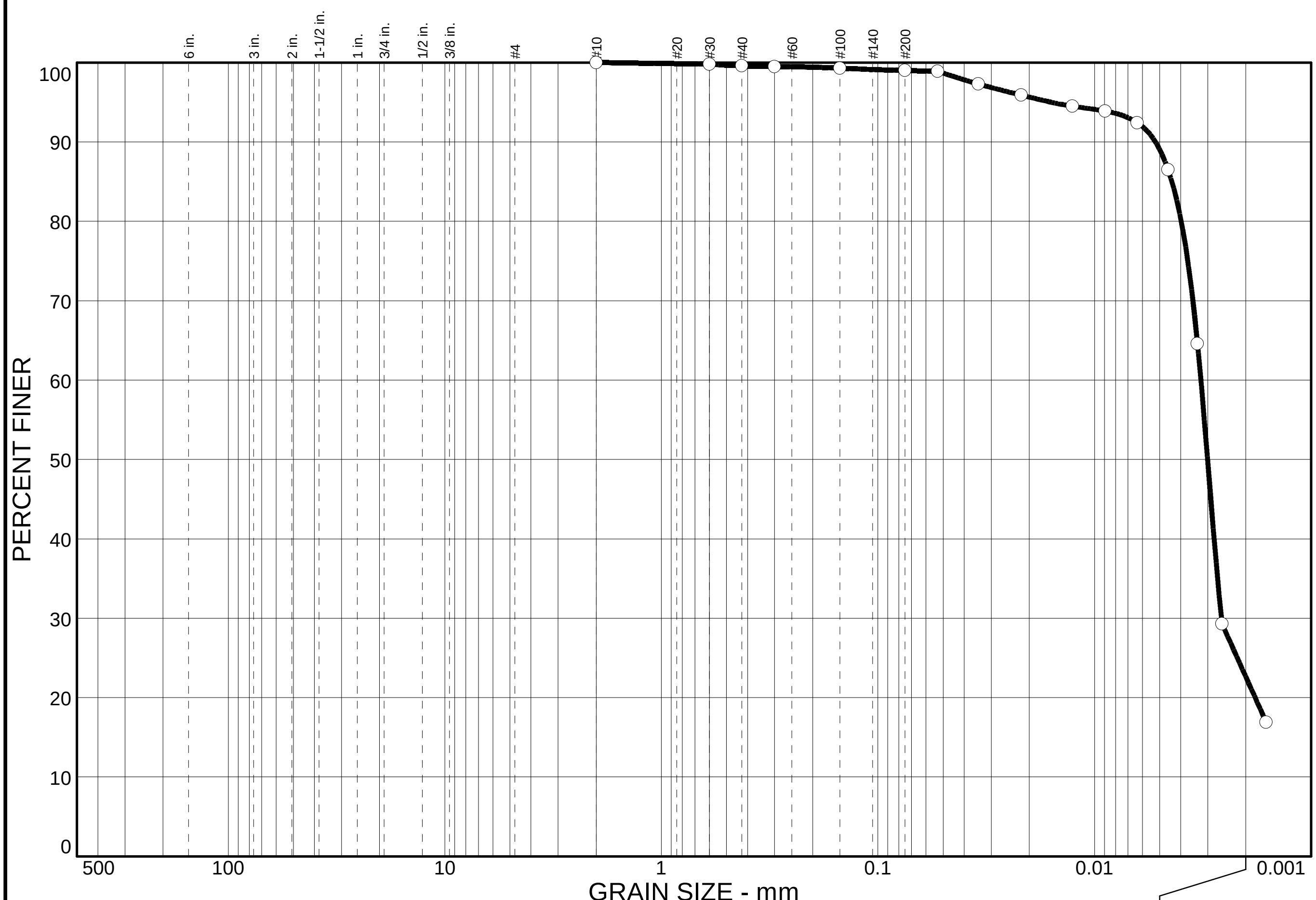
Sample No.: S-08 **Source of Sample:** BC-04 **Date:** 5/16/18
Location: **Elev./Depth:** 32.5(Tip-16")

COOPER TESTING LABORATORY

Client: AECOM
Project: Klamath River Dam Removal Project - 60537920

Project No: 020-251 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	1.0	76.4	22.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#30	99.8		
#40	99.6		
#50	99.5		
#100	99.3		
#200	99.0		
#270	98.9		
0.0343 mm.	97.3		
0.0218 mm.	95.9		
0.0126 mm.	94.5		
0.0089 mm.	93.9		
0.0063 mm.	92.4		
0.0046 mm.	86.5		
0.0034 mm.	64.6		
0.0026 mm.	29.3		
0.0016 mm.	16.9		

* (no specification provided)

Soil Description

Light Olive Brown Elastic SILT

Atterberg Limits

PL= 88 LL= 200 PI= 112

Coefficients

D_{85}= 0.0044 D_{60}= 0.0032 D_{50}= 0.0030
D_{30}= 0.0026 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= MH AASHTO=

Remarks

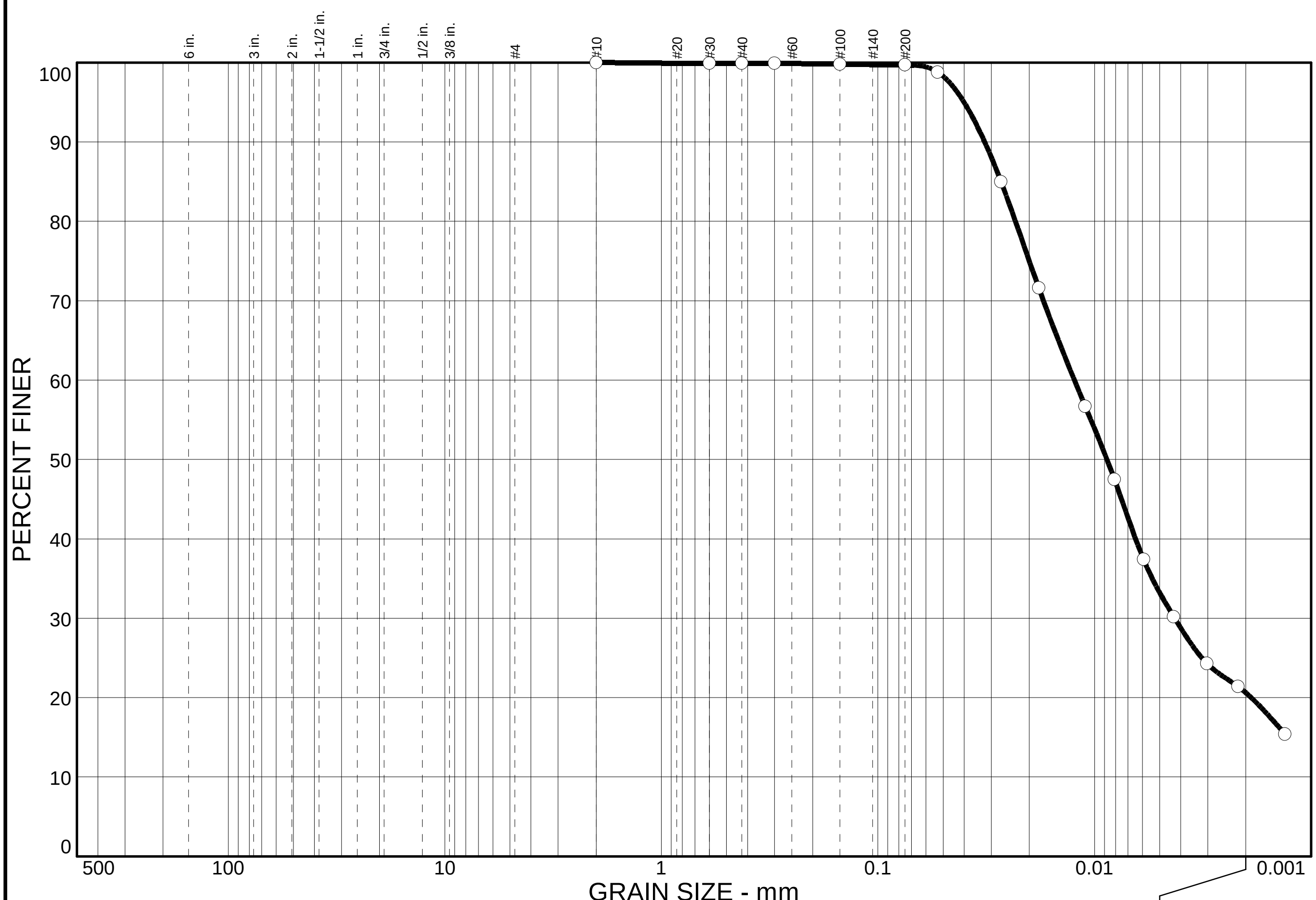
Sample No.: S-05 **Source of Sample:** BC-08A **Date:** 6/5/18
Location: **Elev./Depth:** 54'

COOPER TESTING LABORATORY

Client: AECOM
Project: Klamath River Dam Removal Project - 60537920

Project No: 020-251 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	0.3	79.1	20.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#30	99.9		
#40	99.9		
#50	99.9		
#100	99.8		
#200	99.7		
#270	98.8		
0.0270 mm.	85.0		
0.0181 mm.	71.6		
0.0110 mm.	56.7		
0.0081 mm.	47.5		
0.0059 mm.	37.4		
0.0043 mm.	30.2		
0.0030 mm.	24.3		
0.0022 mm.	21.4		
0.0013 mm.	15.4		

* (no specification provided)

Soil Description

Dark Gray Elastic SILT

Atterberg Limits

PL= 53 LL= 74 PI= 21

Coefficients

D_{85}= 0.0270 D_{60}= 0.0124 D_{50}= 0.0088
D_{30}= 0.0043 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= MH AASHTO=

Remarks

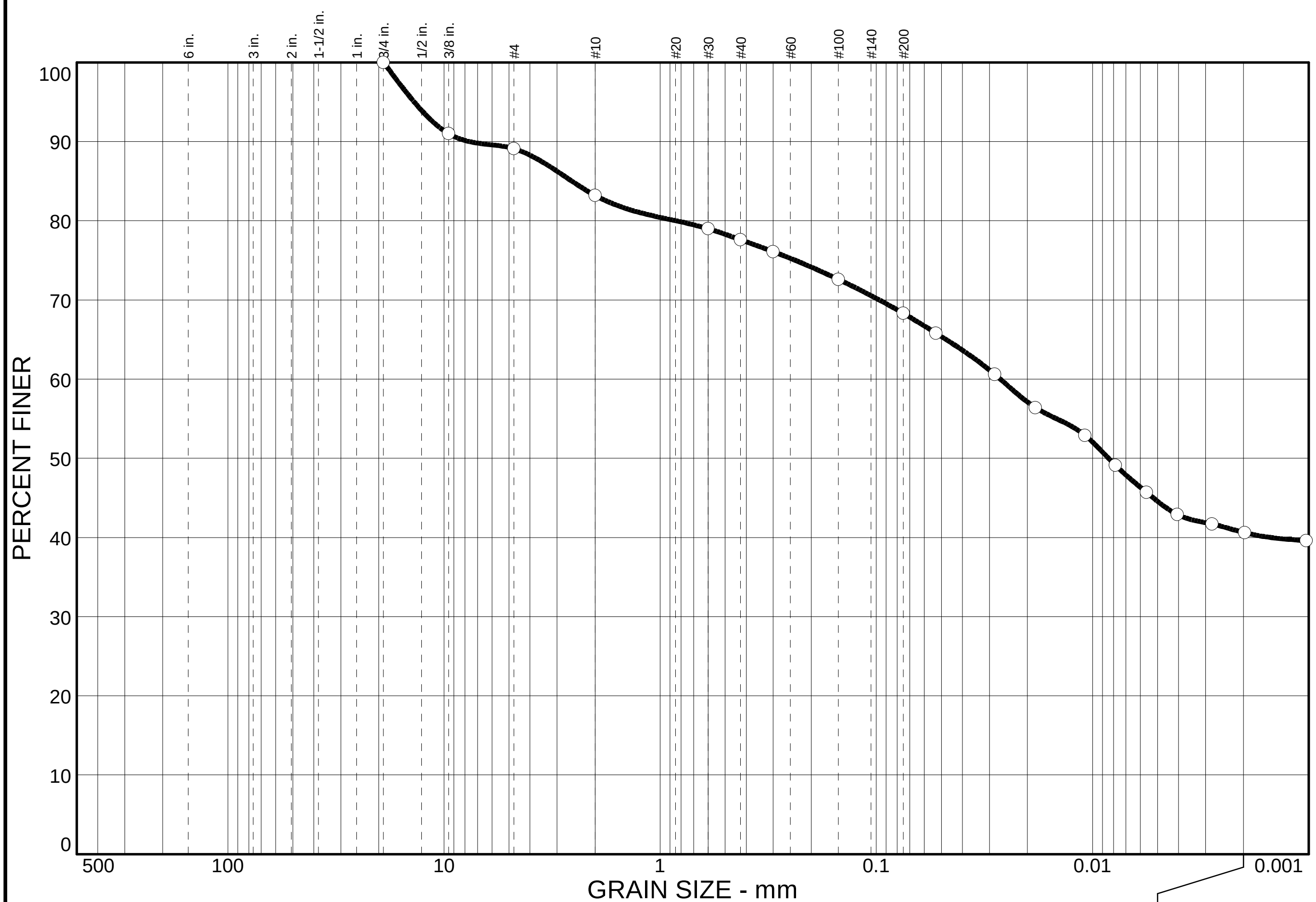
Sample No.: S-05 **Source of Sample:** BC-09 **Date:** 6/5/18
Location: **Elev./Depth:** 23(Tip-5")

COOPER TESTING LABORATORY

Client: AECOM
Project: Klamath River Dam Removal Project - 60537920

Project No: 020-251 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	10.9	20.8	27.7	40.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4 in.	100.0		
3/8 in.	91.0		
#4	89.1		
#10	83.2		
#30	79.0		
#40	77.6		
#50	76.1		
#100	72.6		
#200	68.3		
#270	65.8		
0.0284 mm.	60.6		
0.0184 mm.	56.4		
0.0108 mm.	52.9		
0.0078 mm.	49.1		
0.0056 mm.	45.7		
0.0041 mm.	42.9		
0.0028 mm.	41.7		
0.0020 mm.	40.6		
0.0010 mm.	39.6		

* (no specification provided)

Soil Description

Dark Reddish Brown Sandy Fat CLAY

Atterberg Limits

PL= 28 LL= 78 PI= 50

Coefficients

D_{85}= 2.56 D_{60}= 0.0267 D_{50}= 0.0084
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CH AASHTO=

Remarks

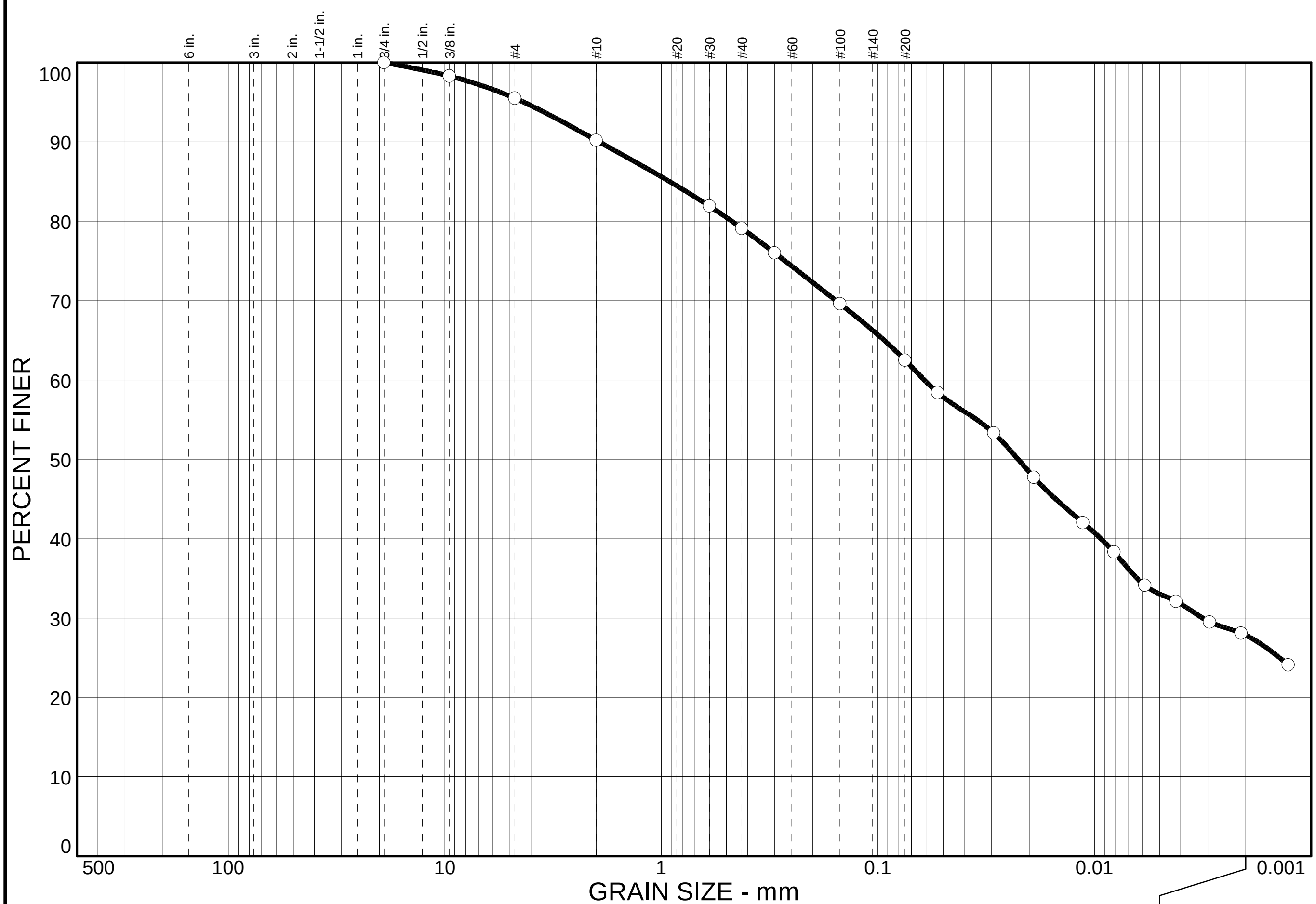
Sample No.: S-01 **Source of Sample:** BI-02 **Date:** 6/6/18
Location: **Elev./Depth:** 5'

COOPER TESTING LABORATORY

Client: AECOM
Project: Klamath River Dam Removal Project - 60537920

Project No: 020-251 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	4.5	33.0	34.7	27.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4 in.	100.0		
3/8 in.	98.3		
#4	95.5		
#10	90.2		
#30	81.9		
#40	79.1		
#50	76.0		
#100	69.6		
#200	62.5		
#270	58.4		
0.0292 mm.	53.3		
0.0190 mm.	47.7		
0.0113 mm.	42.0		
0.0081 mm.	38.3		
0.0059 mm.	34.1		
0.0042 mm.	32.1		
0.0029 mm.	29.5		
0.0021 mm.	28.1		
0.0013 mm.	24.1		

* (no specification provided)

Soil Description

Yellowish Brown Sandy Fat CLAY

Atterberg Limits

PL= 28 LL= 58 PI= 30

Coefficients

D_{85}= 0.917 D_{60}= 0.0612 D_{50}= 0.0226
D_{30}= 0.0032 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CH AASHTO=

Remarks

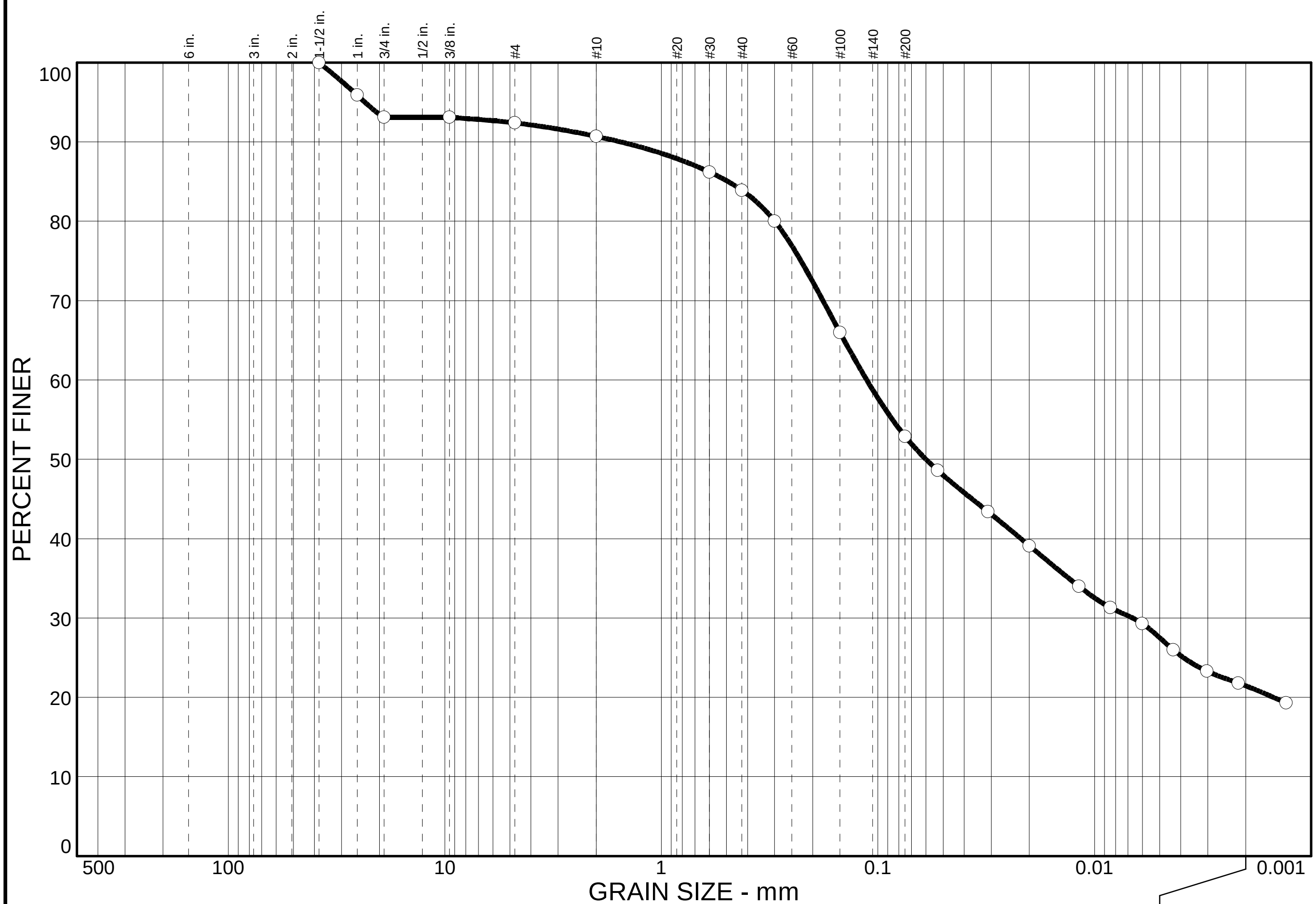
Sample No.: S-02 **Source of Sample:** BI-02 **Date:** 6/6/18
Location: **Elev./Depth:** 10'

COOPER TESTING LABORATORY

Client: AECOM
Project: Klamath River Dam Removal Project - 60537920

Project No: 020-251 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	7.6	39.5	31.5	21.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5 in.	100.0		
1 in.	95.9		
3/4 in.	93.1		
3/8 in.	93.1		
#4	92.4		
#10	90.7		
#30	86.2		
#40	83.9		
#50	80.0		
#100	66.0		
#200	52.9		
#270	48.6		
0.0311 mm.	43.4		
0.0200 mm.	39.1		
0.0118 mm.	34.0		
0.0084 mm.	31.3		
0.0060 mm.	29.3		
0.0043 mm.	26.0		
0.0030 mm.	23.3		
0.0022 mm.	21.8		
0.0013 mm.	19.3		

* (no specification provided)

Soil Description

Yellowish Brown Sandy Fat CLAY

Atterberg Limits

PL= 27 LL= 51 PI= 24

Coefficients

D_{85}= 0.492 D_{60}= 0.113 D_{50}= 0.0601
D_{30}= 0.0067 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CH AASHTO=

Remarks

Due to the small sample size, relative to the largest particle size, this data should be considered to be approximate.

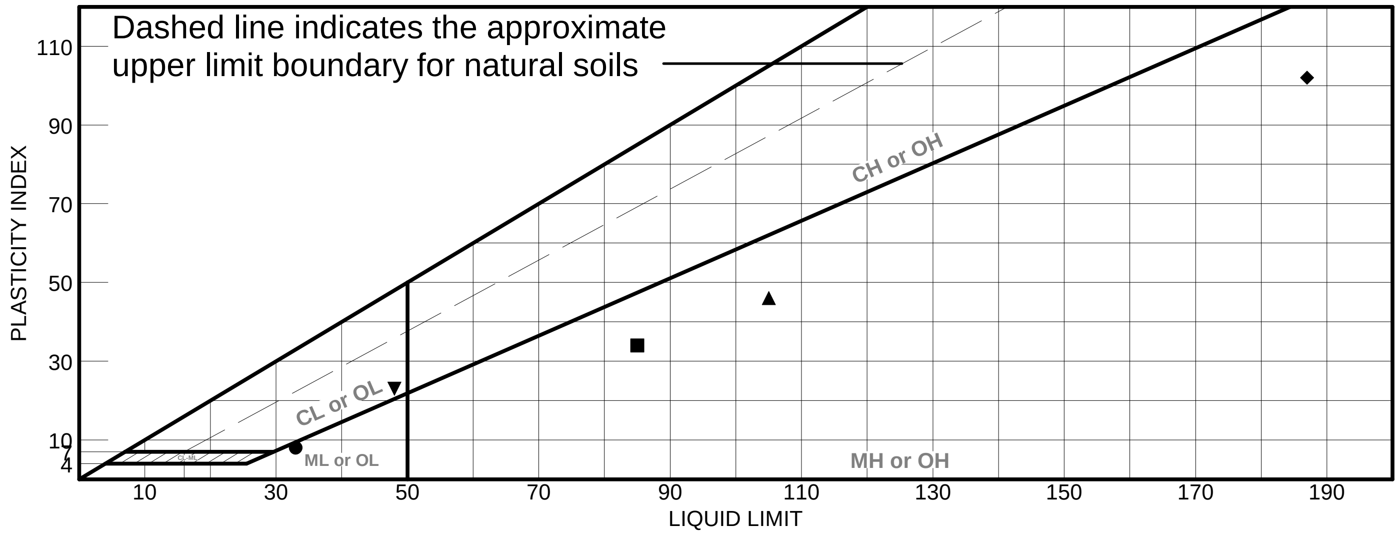
Sample No.: S-03 **Source of Sample:** BI-02 **Date:** 6/6/18
Location: **Elev./Depth:** 15'

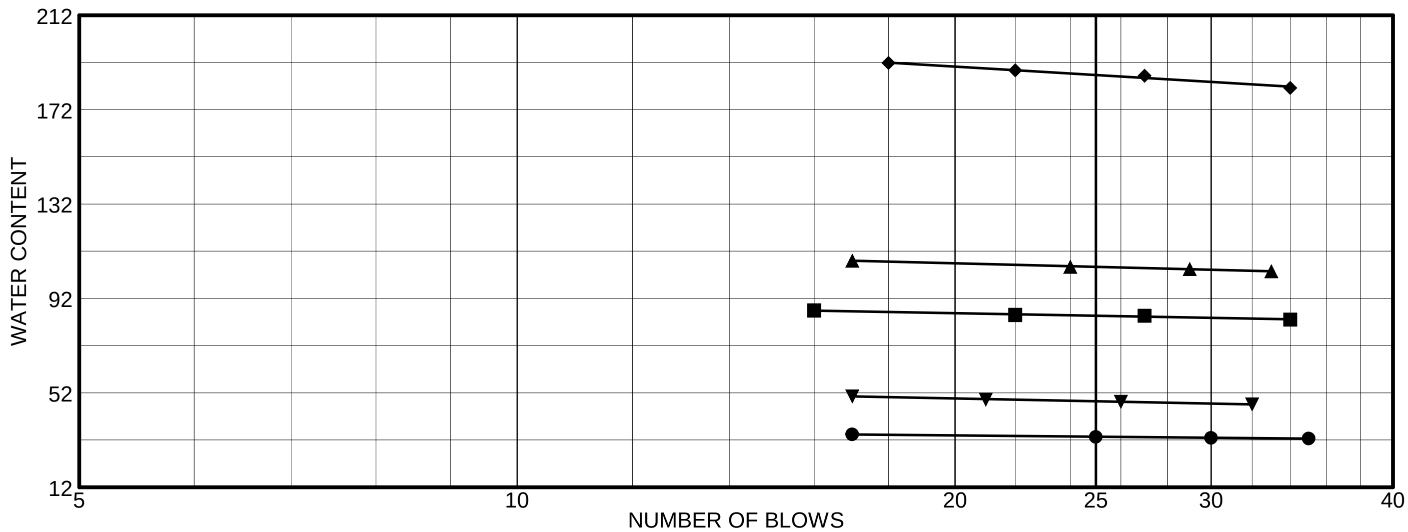
COOPER TESTING LABORATORY

Client: AECOM
Project: Klamath River Dam Removal Project - 60537920

Project No: 020-251 **Figure**

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Dark Olive Gray Sandy SILT	33	25	8			
■	Olive Gray Elastic SILT	85	51	34	99.9	99.0	MH
▲	Gray Elastic SILT	105	59	46	99.7	99.3	MH
◆	Gray Elastic SILT	187	85	102	99.6	99.5	MH
▼	Dark Olive Brown Sandy Lean CLAY	48	25	23			

Project No. 020-251 **Client:** AECOM

Project: Klamath River Dam Removal Project - 60537920

● **Source:** BC-01	**Sample No.:** S-02	**Elev./Depth:** 6.5'
■ **Source:** BC-01	**Sample No.:** S-04	**Elev./Depth:** 21.5'
▲ **Source:** BC-02	**Sample No.:** S-05	**Elev./Depth:** 14.5'
◆ **Source:** BC-02	**Sample No.:** S-09	**Elev./Depth:** 44.5'
▼ **Source:** BC-03	**Sample No.:** S-01	**Elev./Depth:** 1'

Remarks:

●

■

▲

◆

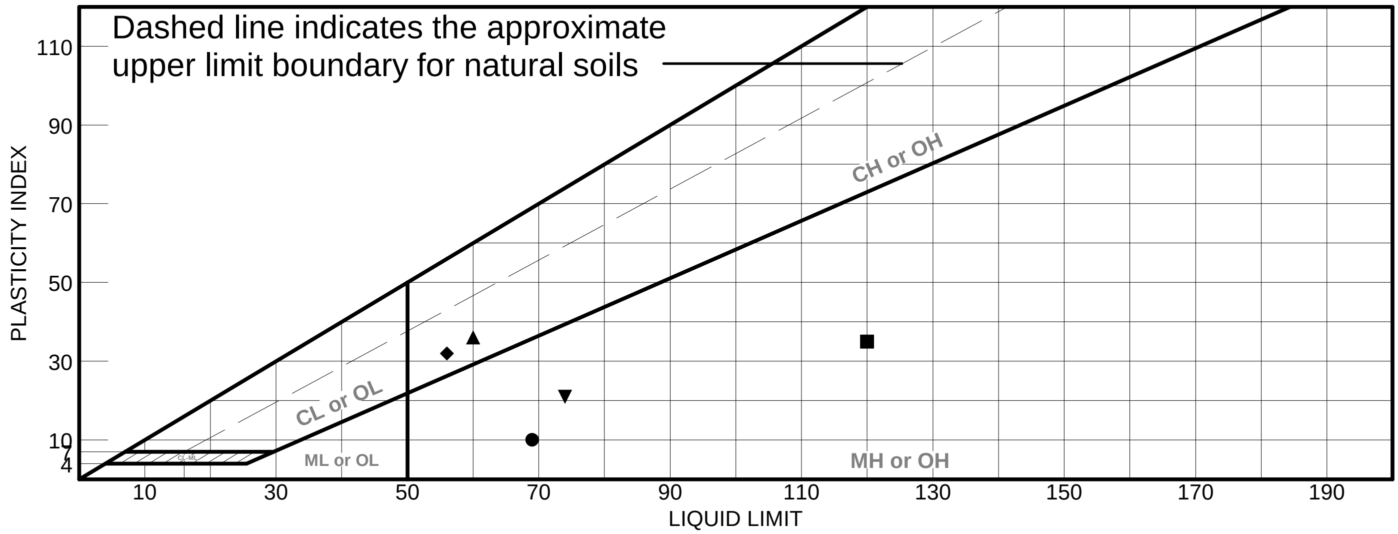
▼

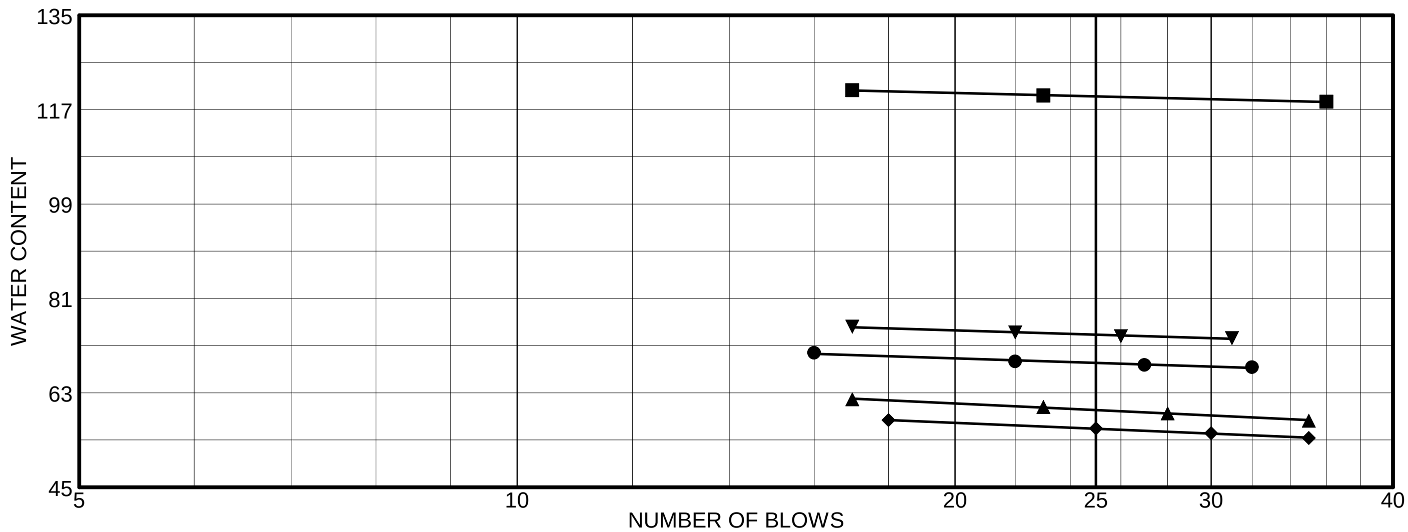
LIQUID AND PLASTIC LIMITS TEST REPORT

COOPER TESTING LABORATORY

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Light Olive Brown Elastic SILT	69	59	10	100.0	100.0	MH
■	Pale Brown Mottled Gray Elastic SILT	120	85	35	99.4	99.1	MH
▲	Very Dark Olive Brown Sandy Fat CLAY w/ Gravel	60	24	36			
◆	Dark Reddish Brown Sandy Fat CLAY	56	24	32			
▼	Dark Gray Elastic SILT	74	53	21	99.9	99.7	MH

Project No. 020-251 **Client:** AECOM

Project: Klamath River Dam Removal Project - 60537920

● **Source:** BC-03 **Sample No.:** S-05 **Elev./Depth:** 24.5'
■ **Source:** BC-04 **Sample No.:** S-08 **Elev./Depth:** 32.5(Tip-16")
▲ **Source:** BC-07 **Sample No.:** S02 **Elev./Depth:** 4-4.5'
◆ **Source:** BC-08 **Sample No.:** S-01 **Elev./Depth:** 3.0'
▼ **Source:** BC-09 **Sample No.:** S-05 **Elev./Depth:** 23(Tip-5")

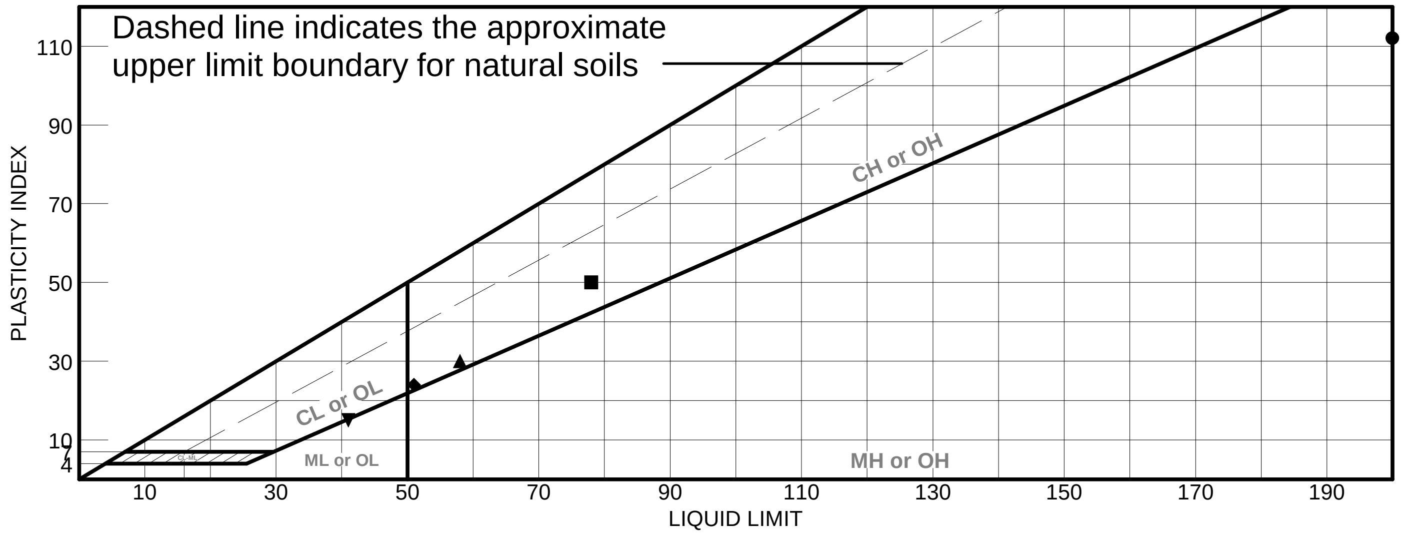
Remarks:
●
■
▲
◆
▼

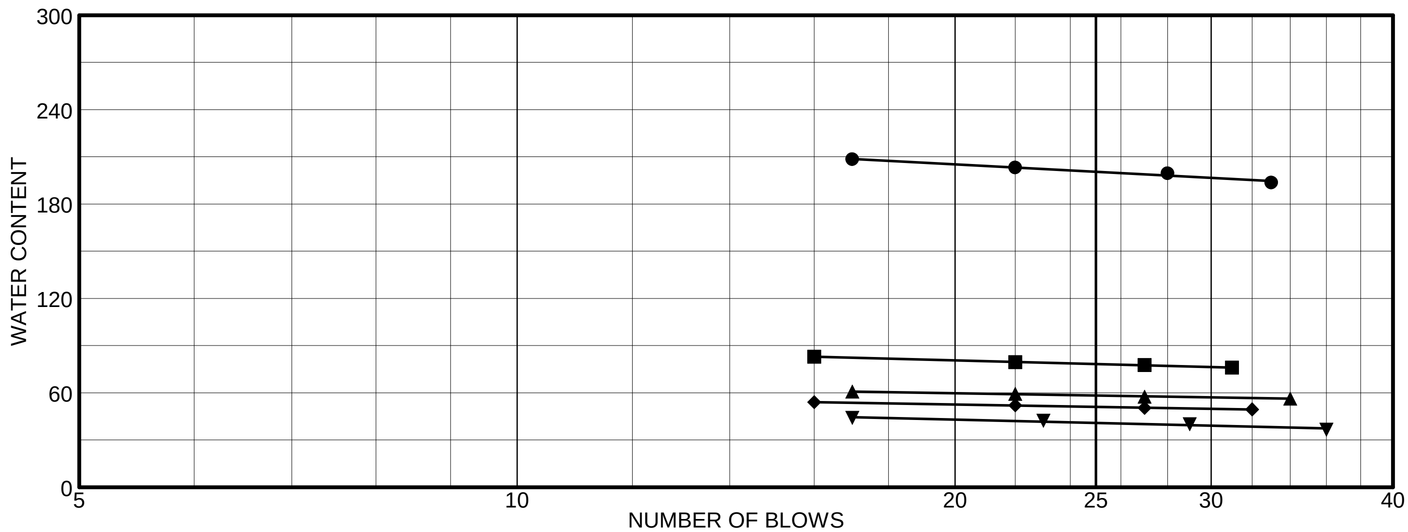
LIQUID AND PLASTIC LIMITS TEST REPORT

COOPER TESTING LABORATORY

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Light Olive Brown Elastic SILT	200	88	112	99.6	99.0	MH
■	Dark Reddish Brown Sandy Fat CLAY	78	28	50	77.6	68.3	CH
▲	Yellowish Brown Sandy Fat CLAY	58	28	30	79.1	62.5	CH
◆	Yellowish Brown Sandy Fat CLAY	51	27	24	83.9	52.9	CH
▼	Olive Gray Poorly Graded GRAVEL w/ Silt & Sand	41	26	15	15.9	9.0	GP-GM

Project No. 020-251 **Client:** AECOM

Project: Klamath River Dam Removal Project - 60537920

● **Source:** BC-08A **Sample No.:** S-05 **Elev./Depth:** 54'
■ **Source:** BI-02 **Sample No.:** S-01 **Elev./Depth:** 5'
▲ **Source:** BI-02 **Sample No.:** S-02 **Elev./Depth:** 10'
◆ **Source:** BI-02 **Sample No.:** S-03 **Elev./Depth:** 15'
▼ **Source:** BI-03 **Sample No.:** S-01 **Elev./Depth:** 3.5'

Remarks:
●
■
▲
◆
▼

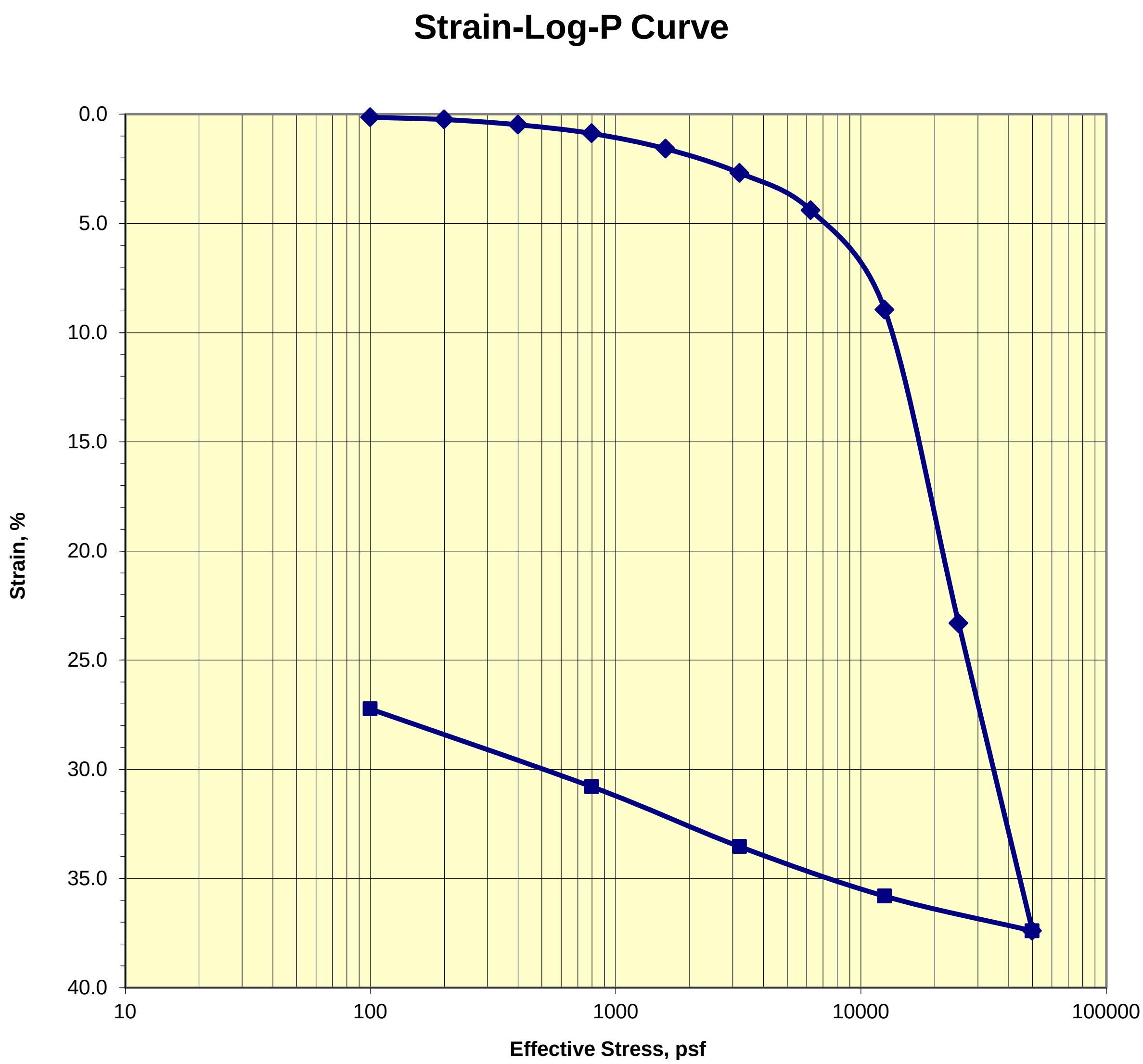
LIQUID AND PLASTIC LIMITS TEST REPORT

COOPER TESTING LABORATORY

Figure

Consolidation Test
ASTM D2435

Job No.:	020-251	**Boring:**	BC-04	**Run By:**	MD
Client:	AECOM	**Sample:**	S-08	**Reduced:**	PJ
Project:	60537920	**Depth, ft.:**	32.5(Tip-2")	**Checked:**	PJ/DC
Soil Type:	Pale Brown Mottled Gray Elastic SILT			**Date:**	6/1/2018



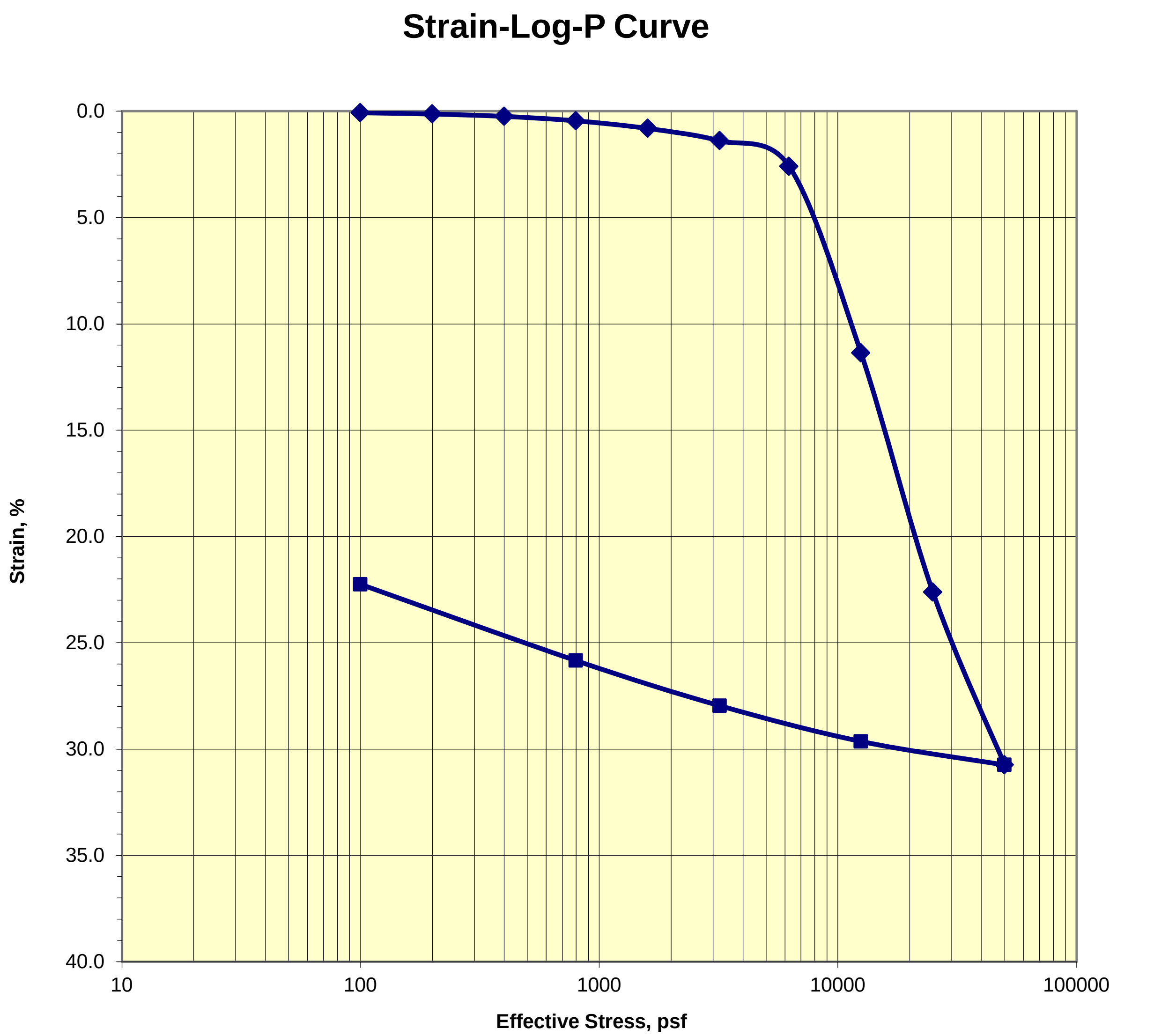
Assumed Gs 2.6	**Initial**	**Final**
Moisture %:	149.5	104.4
Dry Density, pcf:	32.1	43.7
Void Ratio:	4.058	2.715
% Saturation:	95.8	100.0

Remarks:

Consolidation Test
ASTM D2435

COOPER TESTING LABORATORY

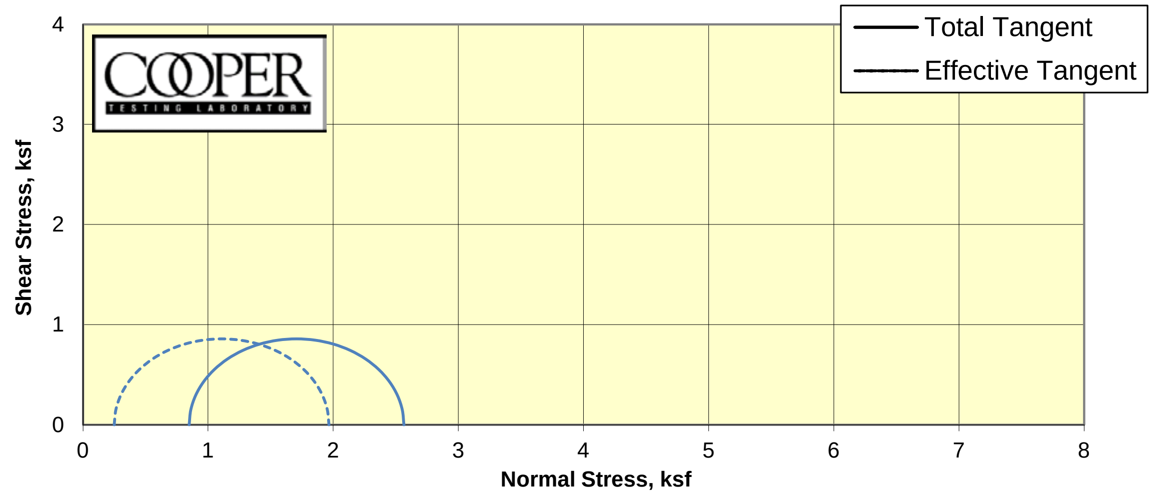
Job No.:	020-251	**Boring:**	BC-09	**Run By:**	MD
Client:	AECOM	**Sample:**	S-09	**Reduced:**	PJ
Project:	60537920	**Depth, ft.:**	68-70.5(Tip-20")	**Checked:**	PJ/DC
Soil Type:	Dark Greenish Gray CLAY (Silty)			**Date:**	6/1/2018

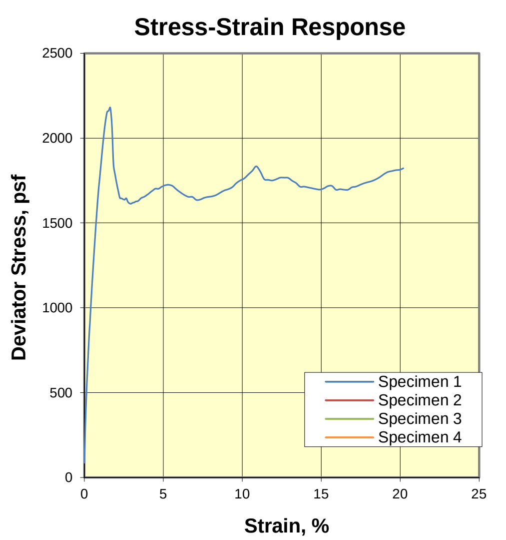


Assumed Gs 2.6	**Initial**	**Final**
Moisture %:	88.4	60.3
Dry Density, pcf:	48.6	63.2
Void Ratio:	2.340	1.568
% Saturation:	98.2	100.0

Remarks:

Consolidated Undrained Triaxial Compression with Pore Pressure
ASTM D4767

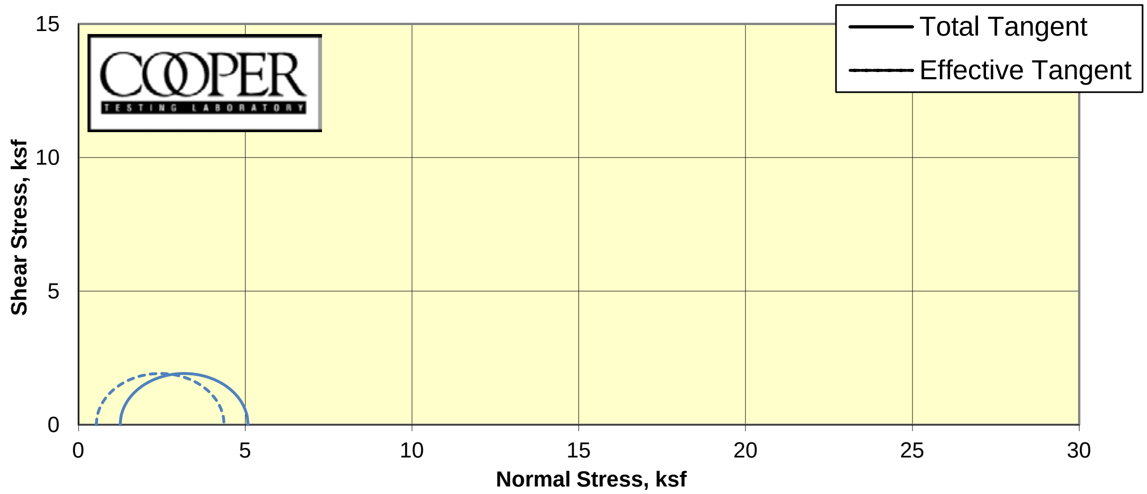


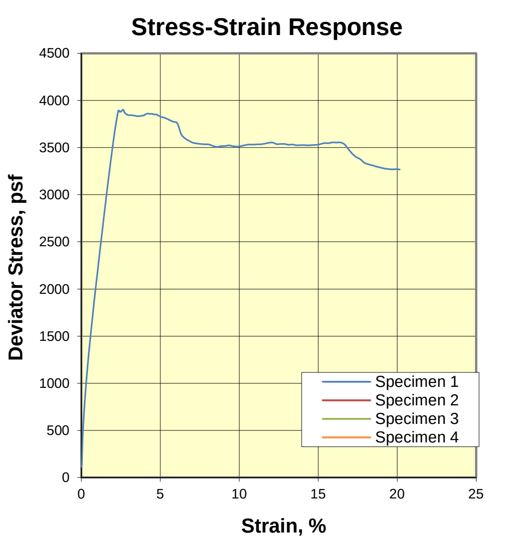


CTL Number:	020-251		
Client Name:	AECOM		
Project Name:	Klamath River Dam Removal Project		
Project Number:	60537920		
Date:	5/30/2018	By:	MD/DC
Total C	#DIV/0!	ksf	
Total phi	#DIV/0!	degrees	
Eff. C	#DIV/0!	ksf	
Eff. Phi	#DIV/0!	degrees	©

Specimen	1	2	3	4
Boring	BC-02			
Sample	S-06			
Depth	19.5(Tip-2")			
Visual Description	Gray CLAY (Silty)			
MC (%)	147.5			
Dry Density (pcf)	31.6			
Saturation (%)	92.6			
Void Ratio	4.139			
Diameter (in)	2.86			
Height (in)	6.07			
	Final			
MC (%)	147.6			
Dry Density (pcf)	33.6			
Saturation (%)	100.0			
Void Ratio	3.838			
Diameter (in)	2.79			
Height (in)	6.02			
Cell Pressure (psi)	86.4			
Back Pressure (psi)	80.5			
	Effective Stresses At:			
Strain (%)	5.0			
Deviator (ksf)	1.716			
Excess PP (psi)	4.2			
Sigma 1 (ksf)	1.966			
Sigma 3 (ksf)	0.250			
P (ksf)	1.108			
Q (ksf)	0.858			
Stress Ratio	7.869			
Rate (in/min)	0.0005			

Consolidated Undrained Triaxial Compression with Pore Pressure
ASTM D4767

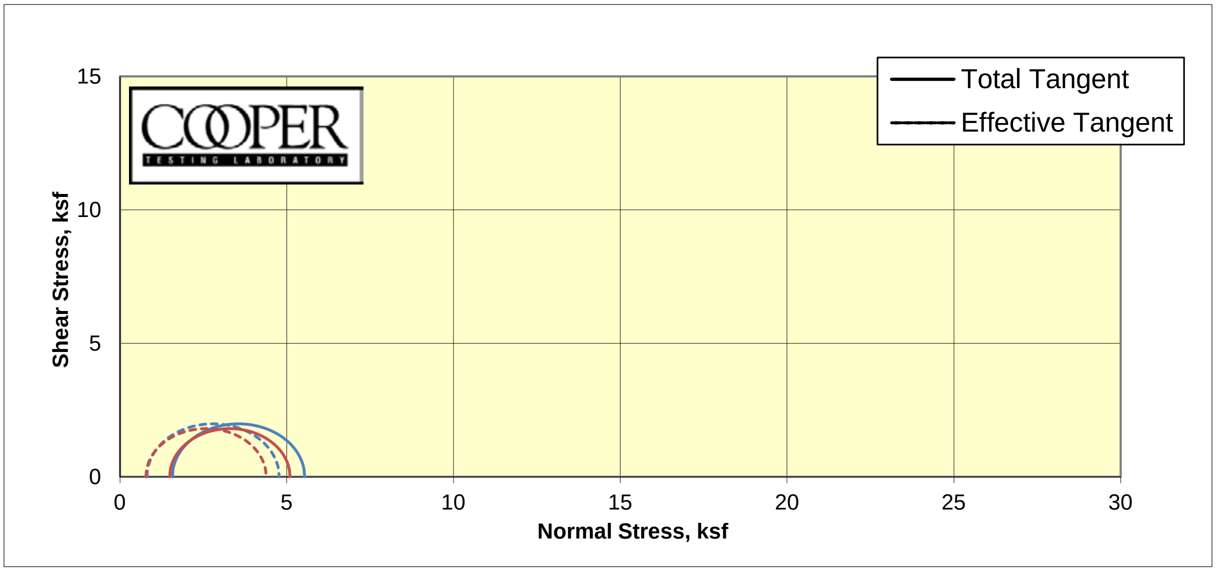


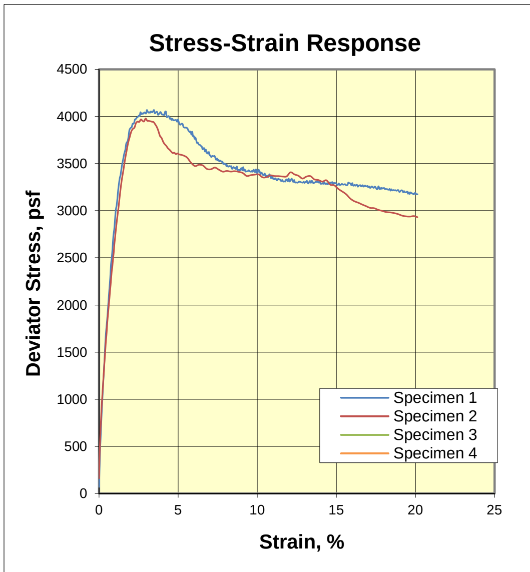


Specimen	1	2	3	4
Boring	BC-02			
Sample	S-08			
Depth	34.5(Tip-6")			
Visual Description	Pale Brown CLAY (Silty)			
MC (%)	148.8			
Dry Density (pcf)	32.7			
Saturation (%)	96.6			
Void Ratio	4.158			
Diameter (in)	2.87			
Height (in)	6.07			
	Final			
MC (%)	148.5			
Dry Density (pcf)	33.6			
Saturation (%)	100.0			
Void Ratio	4.010			
Diameter (in)	2.84			
Height (in)	6.02			
Cell Pressure (psi)	88.8			
Back Pressure (psi)	80.1			
	Effective Stresses At:			
Strain (%)	5.0			
Deviator (ksf)	3.832			
Excess PP (psi)	5.0			
Sigma 1 (ksf)	4.368			
Sigma 3 (ksf)	0.536			
P (ksf)	2.452			
Q (ksf)	1.916			
Stress Ratio	8.153			
Rate (in/min)	0.0005			

CTL Number:	020-251		
Client Name:	AECOM		
Project Name:	Klamath River Dam Removal Project		
Project Number:	60537920		
Date:	5/14/2018	By:	MD/DC
Total C	#DIV/0!	ksf	
Total phi	#DIV/0!	degrees	
Eff. C	#DIV/0!	ksf	
Eff. Phi	#DIV/0!	degrees	©

Consolidated Undrained Triaxial Compression with Pore Pressure
ASTM D4767

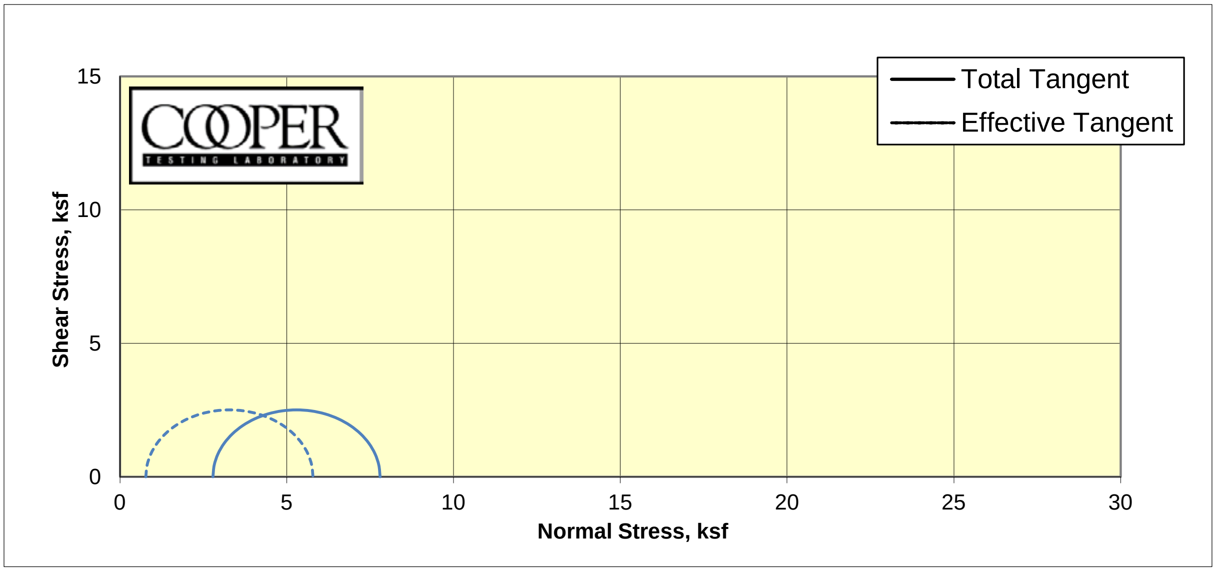


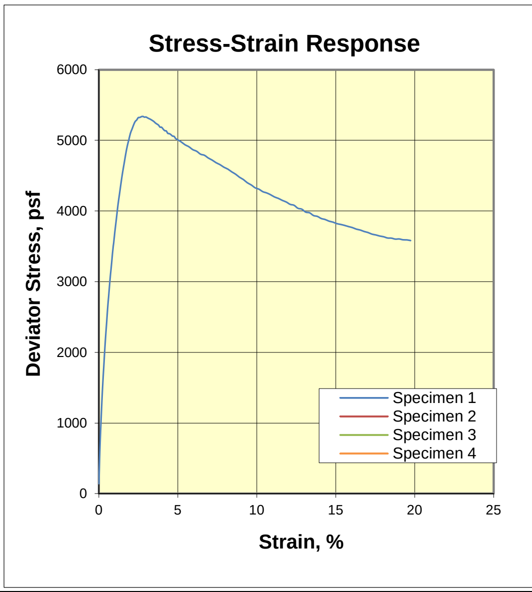


CTL Number:	020-251
Client Name:	Klamath River Dam Removal Project
Project Name:	60537920
Project Number:	43237
Date:	5/17/2018 By: MD/DC
Total C	#DIV/0! ksf
Total phi	#DIV/0! degrees
Eff. C	#DIV/0! ksf
Eff. Phi	#DIV/0! degrees ©

Specimen	1	2	3	4
Boring	BC-03	BC-03		
Sample	S-06	S-06		
Depth	39.5-42(Tip-11")	39.5-42(Tip-4")		
Visual Description	Dark Gray CLAY (Silty)	Dark Gray CLAY		
MC (%)	84.9	90.1		
Dry Density (pcf)	50.2	47.7		
Saturation (%)	99.0	97.6		
Void Ratio	2.230	2.402		
Diameter (in)	2.87	2.87		
Height (in)	6.06	6.08		
Final				
MC (%)	83.0	87.9		
Dry Density (pcf)	51.4	49.4		
Saturation (%)	100.0	100.0		
Void Ratio	2.158	2.285		
Diameter (in)	2.85	2.83		
Height (in)	6.02	6.04		
Cell Pressure (psi)	90.5	91.6		
Back Pressure (psi)	79.5	81.2		
Effective Stresses At:				
Strain (%)	5.0	5.0		
Deviator (ksf)	3.966	3.607		
Excess PP (psi)	5.3	5.0		
Sigma 1 (ksf)	4.775	4.386		
Sigma 3 (ksf)	0.809	0.779		
P (ksf)	2.792	2.582		
Q (ksf)	1.983	1.804		
Stress Ratio	5.901	5.632		
Rate (in/min)	0.0005	0.0005		

Consolidated Undrained Triaxial Compression with Pore Pressure
ASTM D4767

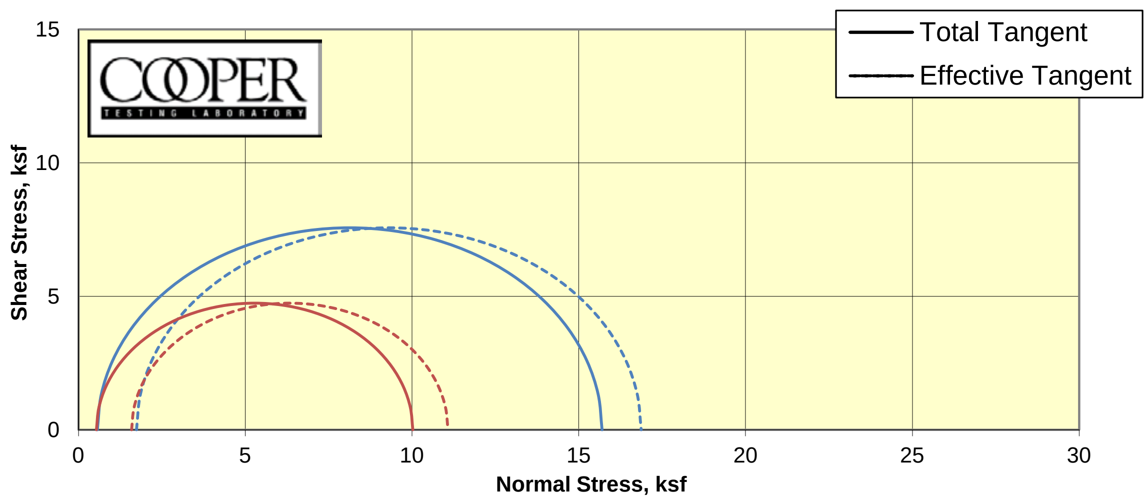


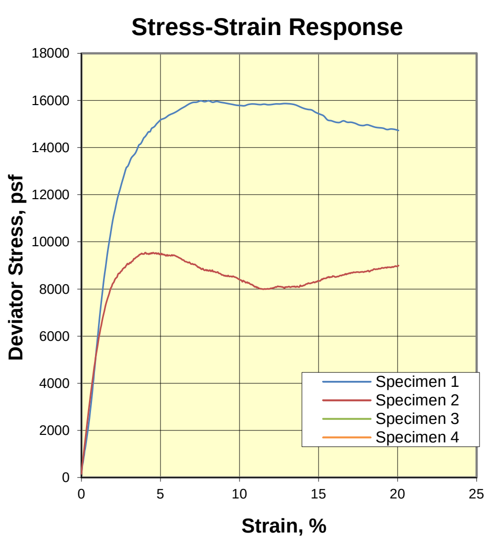


CTL Number:	020-251		
Client Name:	AECOM		
Project Name:	Klamath River Dam Removal Project		
Project Number:	60537920		
Date:	5/21/2018	By:	MD/DC
Total C	#DIV/0!	ksf	
Total phi	#DIV/0!	degrees	
Eff. C	#DIV/0!	ksf	
Eff. Phi	#DIV/0!	degrees	©

Specimen	1	2	3	4
Boring	BC-03			
Sample	S-10			
Depth	90(Tip-13")			
Visual Description	Dark Gray CLAY			
MC (%)	119.8			
Dry Density (pcf)	35.8			
Saturation (%)	88.1			
Void Ratio	3.533			
Diameter (in)	2.87			
Height (in)	6.08			
	Final			
MC (%)	116.3			
Dry Density (pcf)	40.3			
Saturation (%)	100.0			
Void Ratio	3.023			
Diameter (in)	2.69			
Height (in)	6.16			
Cell Pressure (psi)	99.9			
Back Pressure (psi)	80.5			
	Effective Stresses At:			
Strain (%)	5.0			
Deviator (ksf)	5.012			
Excess PP (psi)	14.0			
Sigma 1 (ksf)	5.788			
Sigma 3 (ksf)	0.777			
P (ksf)	3.283			
Q (ksf)	2.506			
Stress Ratio	7.452			
Rate (in/min)	0.0005			

Consolidated Undrained Triaxial Compression with Pore Pressure
ASTM D4767

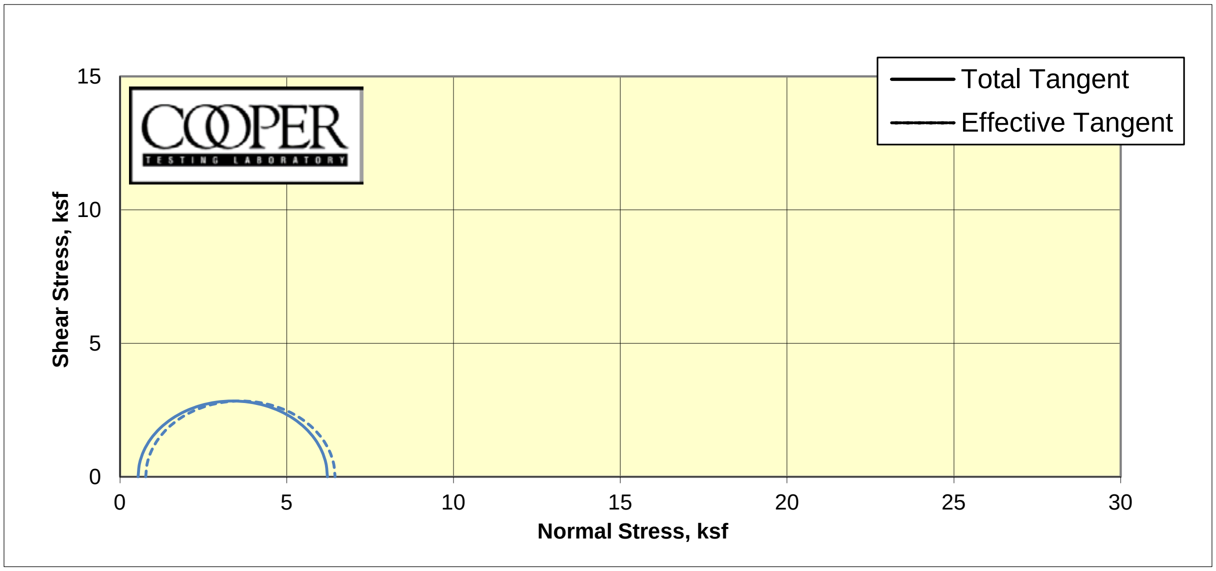


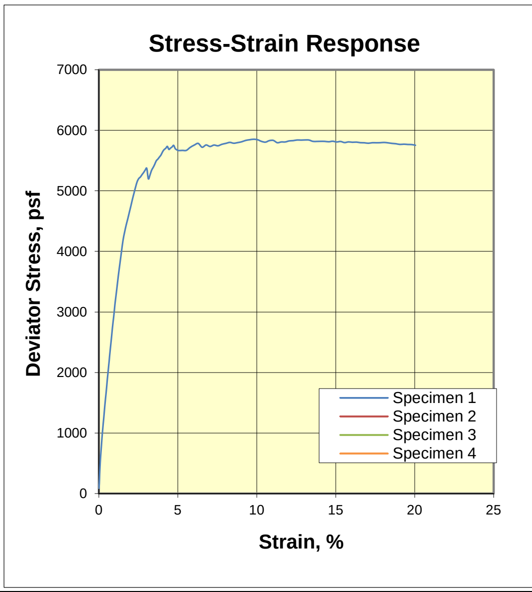


CTL Number:	020-251
Client Name:	AECOM
Project Name:	Klamath River Dam Removal Project
Project Number:	60537920
Date:	6/6/2018 By: MD/DC
Total C	#DIV/0! ksf
Total phi	#DIV/0! degrees
Eff. C	#DIV/0! ksf
Eff. Phi	#DIV/0! degrees ©

Specimen	1	2	3	4
Boring	BC-04	BC-04		
Sample	S-04	S-04		
Depth	12.5-14(Tip-15")	12.5-14.5(Tip-4")		
Visual Description	Brown Weathered Rock	Dark Brown Clayey GRAVEL (Weathered Rock)		
MC (%)	60.8	53.9		
Dry Density (pcf)	59.2	65.0		
Saturation (%)	90.8	93.7		
Void Ratio	1.740	1.497		
Diameter (in)	2.87	2.86		
Height (in)	6.06	6.06		
Final				
MC (%)	61.4	54.7		
Dry Density (pcf)	62.5	67.0		
Saturation (%)	100.0	100.0		
Void Ratio	1.597	1.422		
Diameter (in)	2.80	2.82		
Height (in)	6.04	6.04		
Cell Pressure (psi)	83.2	82.9		
Back Pressure (psi)	79.2	79.1		
Effective Stresses At:				
Strain (%)	5.0	5.0		
Deviator (ksf)	15.130	9.485		
Excess PP (psi)	-8.1	-7.3		
Sigma 1 (ksf)	16.872	11.080		
Sigma 3 (ksf)	1.741	1.594		
P (ksf)	9.306	6.337		
Q (ksf)	7.565	4.743		
Stress Ratio	9.688	6.949		
Rate (in/min)	0.0005	0.0005		

Consolidated Undrained Triaxial Compression with Pore Pressure
ASTM D4767

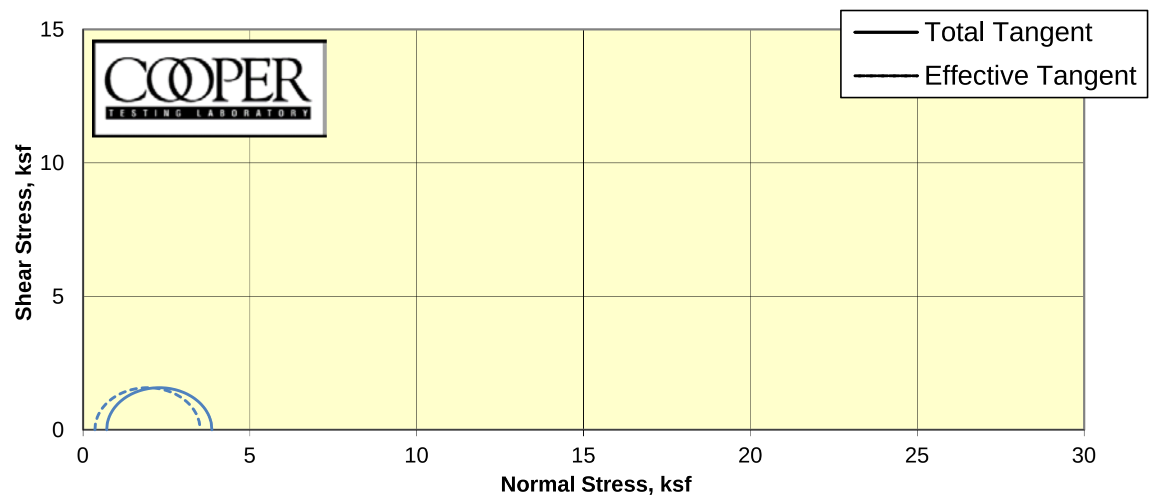


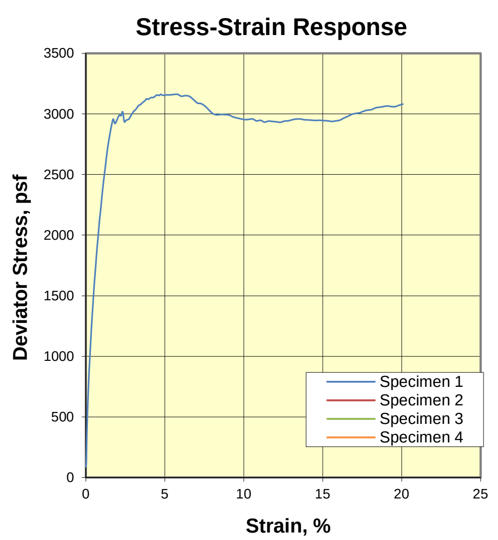


CTL Number:	020-251			
Client Name:	AECOM			
Project Name:	Klamath River Dam Removal Project			
Project Number:	60537920			
Date:	5/14/2018	By:	MD/DC	
Total C	#DIV/0!	ksf		
Total phi	#DIV/0!	degrees		
Eff. C	#DIV/0!	ksf		
Eff. Phi	#DIV/0!	degrees	©	

Specimen	1	2	3	4
Boring	BC-04			
Sample	S-5			
Depth	17.5(Tip-6")			
Visual Description	Light Gray CLAY			
MC (%)	104.7			
Dry Density (pcf)	42.1			
Saturation (%)	94.2			
Void Ratio	3.000			
Diameter (in)	2.87			
Height (in)	6.08			
	Final			
MC (%)	105.4			
Dry Density (pcf)	43.8			
Saturation (%)	100.0			
Void Ratio	2.846			
Diameter (in)	2.82			
Height (in)	6.07			
Cell Pressure (psi)	84.0			
Back Pressure (psi)	80.2			
	Effective Stresses At:			
Strain (%)	5.0			
Deviator (ksf)	5.677			
Excess PP (psi)	-1.6			
Sigma 1 (ksf)	6.450			
Sigma 3 (ksf)	0.774			
P (ksf)	3.612			
Q (ksf)	2.838			
Stress Ratio	8.336			
Rate (in/min)	0.0005			

Consolidated Undrained Triaxial Compression with Pore Pressure
ASTM D4767

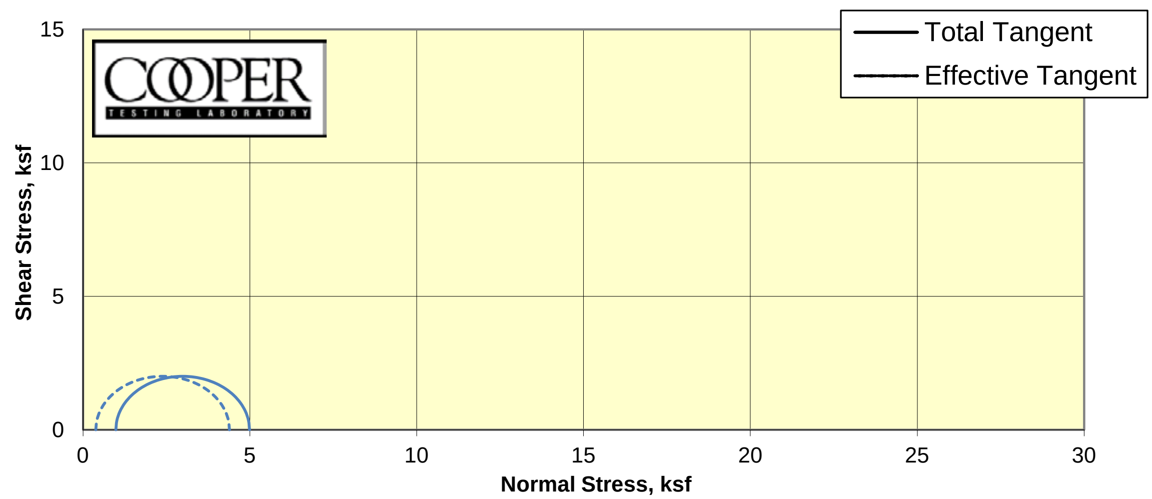


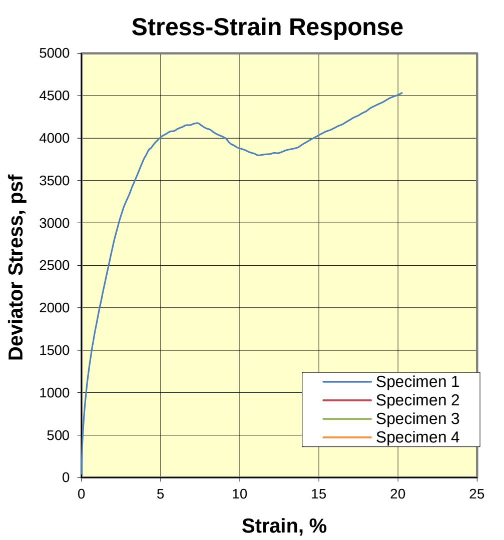


Specimen	1	2	3	4
Boring	BC-04			
Sample	S-06			
Depth	22.5(Tip-2")			
Visual Description	Greenish Gray CLAY (Silty)/ SILT (slightly plastic)			
MC (%)	154.6			
Dry Density (pcf)	31.7			
Saturation (%)	97.4			
Void Ratio	4.127			
Diameter (in)	2.87			
Height (in)	6.07			
	Final			
MC (%)	152.8			
Dry Density (pcf)	32.6			
Saturation (%)	100.0			
Void Ratio	3.974			
Diameter (in)	2.83			
Height (in)	6.05			
Cell Pressure (psi)	85.0			
Back Pressure (psi)	80.1			
	Effective Stresses At:			
Strain (%)	5.0			
Deviator (ksf)	3.153			
Excess PP (psi)	2.5			
Sigma 1 (ksf)	3.511			
Sigma 3 (ksf)	0.358			
P (ksf)	1.935			
Q (ksf)	1.576			
Stress Ratio	9.796			
Rate (in/min)	0.0005			

CTL Number:	020-251		
Client Name:	AECOM		
Project Name:	Klamath River Dam Removal Project		
Project Number:	60537920		
Date:	5/30/2018	By:	MD/DC
Total C	#DIV/0!	ksf	
Total phi	#DIV/0!	degrees	
Eff. C	#DIV/0!	ksf	
Eff. Phi	#DIV/0!	degrees	©

Consolidated Undrained Triaxial Compression with Pore Pressure
ASTM D4767

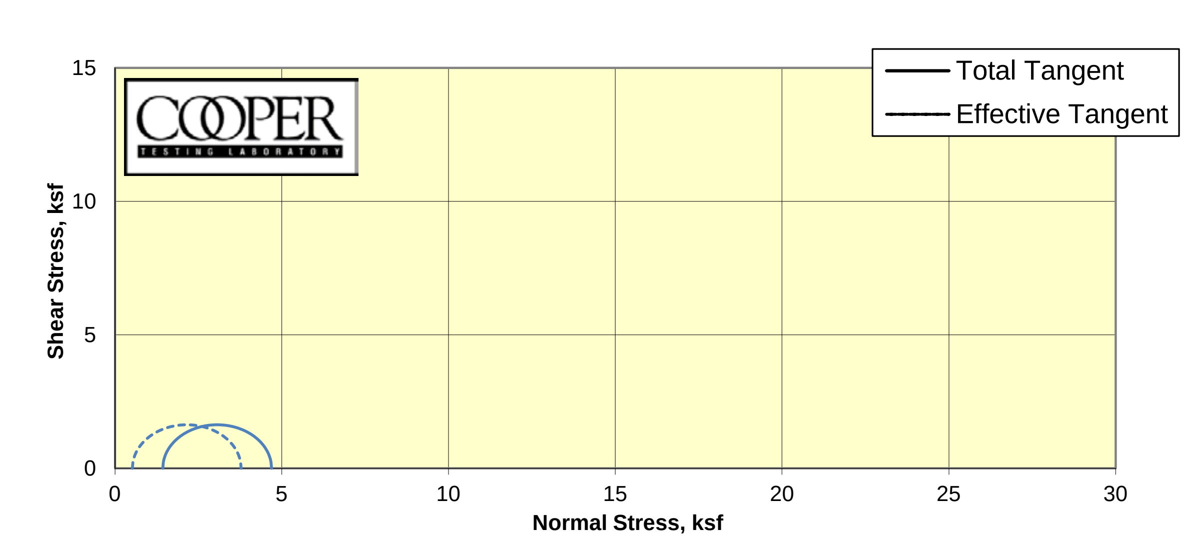


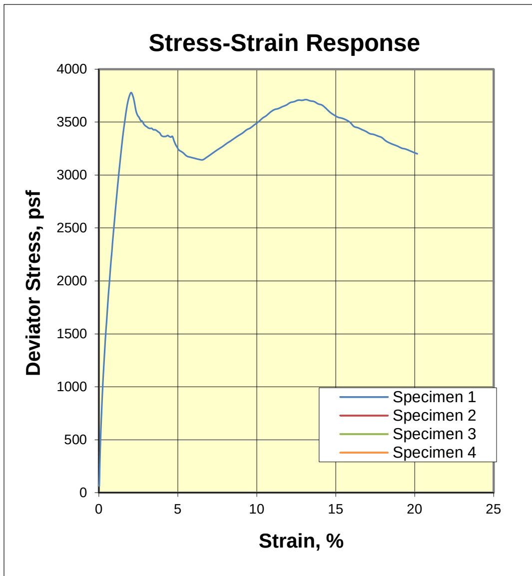


CTL Number:	020-251
Client Name:	AECOM
Project Name:	Klamath River Dam Removal Project
Project Number:	60537920
Date:	5/17/2018 By: MD/DC
Total C	#DIV/0! ksf
Total phi	#DIV/0! degrees
Eff. C	#DIV/0! ksf
Eff. Phi	#DIV/0! degrees ©

Specimen	**1**	**2**	**3**	**4**
Boring	BC-04			
Sample	S-08			
Depth	32.5(Tip-10")			
Visual Description	Pale Brown Mottled Gray Elastic SILT			
MC (%)	117.2			
Dry Density (pcf)	36.9			
Saturation (%)	89.7			
Void Ratio	3.397			
Diameter (in)	2.87			
Height (in)	6.08			
	Final			
MC (%)	115.5			
Dry Density (pcf)	40.5			
Saturation (%)	100.0			
Void Ratio	3.004			
Diameter (in)	2.76			
Height (in)	6.01			
Cell Pressure (psi)	86.8			
Back Pressure (psi)	80.0			
	Effective Stresses At:			
Strain (%)	5.0			
Deviator (ksf)	4.005			
Excess PP (psi)	4.2			
Sigma 1 (ksf)	4.390			
Sigma 3 (ksf)	0.385			
P (ksf)	2.388			
Q (ksf)	2.003			
Stress Ratio	11.403			
Rate (in/min)	0.0005			

Consolidated Undrained Triaxial Compression with Pore Pressure
ASTM D4767

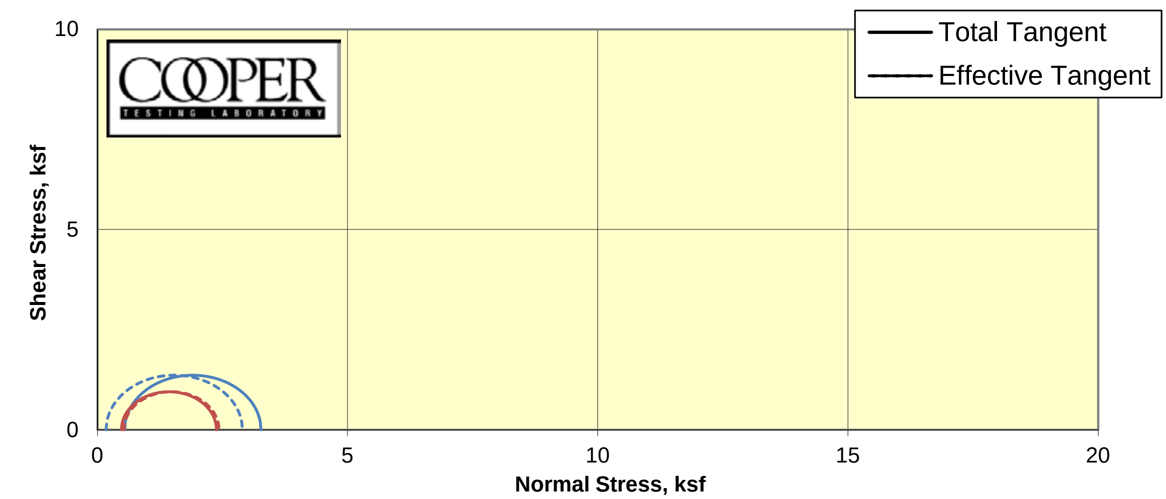


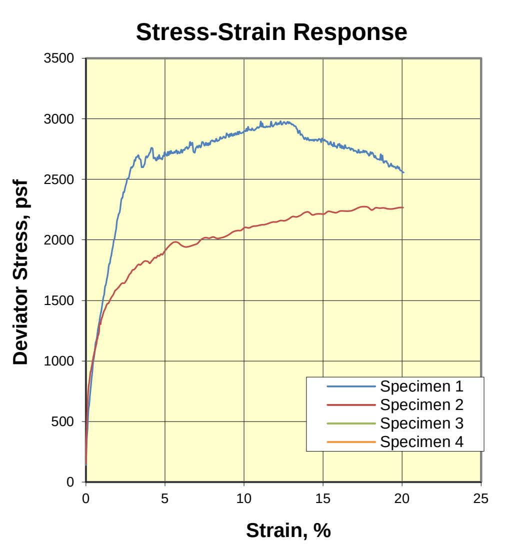


CTL Number:	020-251		
Client Name:	AECOM		
Project Name:	Klamath River Dam Removal Project		
Project Number:	60537920		
Date:	5/25/2018	By:	MD/DC
Total C	#DIV/0!	ksf	
Total phi	#DIV/0!	degrees	
Eff. C	#DIV/0!	ksf	
Eff. Phi	#DIV/0!	degrees	©

Specimen	1	2	3	4
Boring	BC-04			
Sample	S-10			
Depth	52.5(Tip-4")			
Visual Description	Bluish Gray CLAY (Silty)/ SILT (slightly plastic)			
MC (%)	153.6			
Dry Density (pcf)	32.1			
Saturation (%)	97.9			
Void Ratio	4.156			
Diameter (in)	2.87			
Height (in)	6.08			
	Final			
MC (%)	151.2			
Dry Density (pcf)	33.0			
Saturation (%)	100.0			
Void Ratio	4.007			
Diameter (in)	2.84			
Height (in)	6.03			
Cell Pressure (psi)	90.6			
Back Pressure (psi)	80.6			
	Effective Stresses At:			
Strain (%)	5.0			
Deviator (ksf)	3.260			
Excess PP (psi)	6.3			
Sigma 1 (ksf)	3.784			
Sigma 3 (ksf)	0.523			
P (ksf)	2.154			
Q (ksf)	1.630			
Stress Ratio	7.229			
Rate (in/min)	0.0005			

Consolidated Undrained Triaxial Compression with Pore Pressure
ASTM D4767

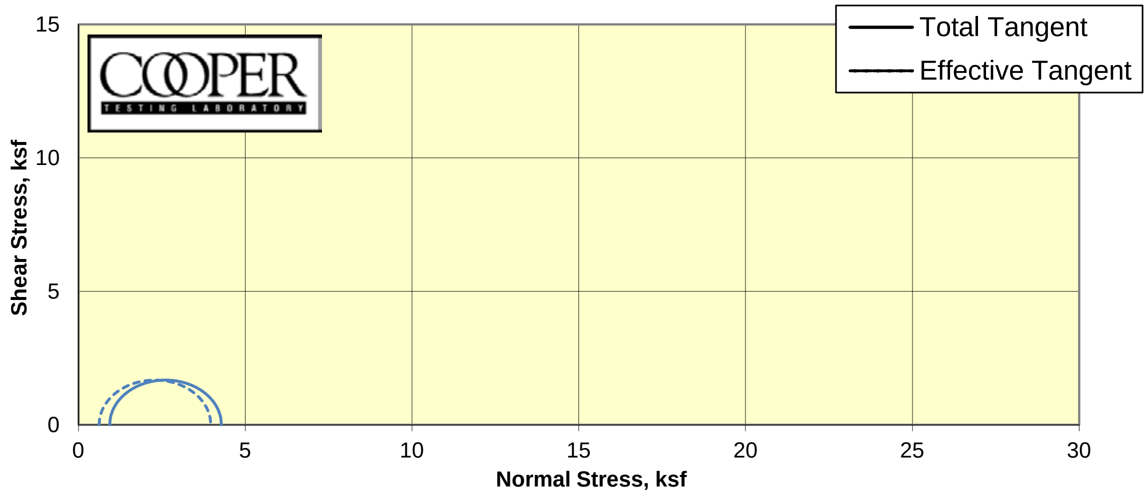


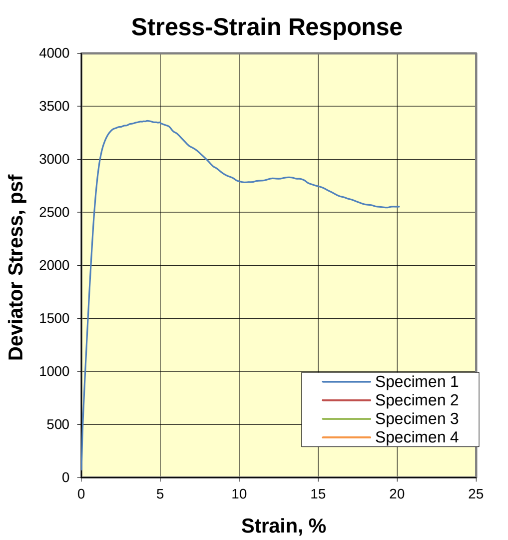


CTL Number:	020-251		
Client Name:	AECOM		
Project Name:	Klamath River Dam Removal Project		
Project Number:	60537920		
Date:	5/24/2018	By:	MD/DC
Total C	#DIV/0!	ksf	
Total phi	#DIV/0!	degrees	
Eff. C	#DIV/0!	ksf	
Eff. Phi	#DIV/0!	degrees	©

Specimen	**1**	**2**	**3**	**4**
Boring	BC-05	BC-05		
Sample	S-04	S-04		
Depth	14.5(Tip-16")	14.5(Tip-1")		
Visual Description	Olive CLAY (Silty)/SILT (slightly plastic)	Olive Mottled Yellow Clayey SAND/ Sandy CLAY		
MC (%)	135.1	30.0		
Dry Density (pcf)	35.4	92.8		
Saturation (%)	97.0	99.2		
Void Ratio	3.760	0.816		
Diameter (in)	2.87	2.87		
Height (in)	5.83	6.09		
	Final			
MC (%)	135.4	29.8		
Dry Density (pcf)	36.2	93.4		
Saturation (%)	100.0	100.0		
Void Ratio	3.656	0.805		
Diameter (in)	2.85	2.87		
Height (in)	5.80	6.07		
Cell Pressure (psi)	84.2	84.1		
Back Pressure (psi)	80.4	80.8		
	Effective Stresses At:			
Strain (%)	5.0	5.0		
Deviator (ksf)	2.725	1.900		
Excess PP (psi)	2.6	-0.4		
Sigma 1 (ksf)	2.899	2.431		
Sigma 3 (ksf)	0.173	0.531		
P (ksf)	1.536	1.481		
Q (ksf)	1.363	0.950		
Stress Ratio	16.726	4.577		
Rate (in/min)	0.0005	0.0005		

Consolidated Undrained Triaxial Compression with Pore Pressure
ASTM D4767





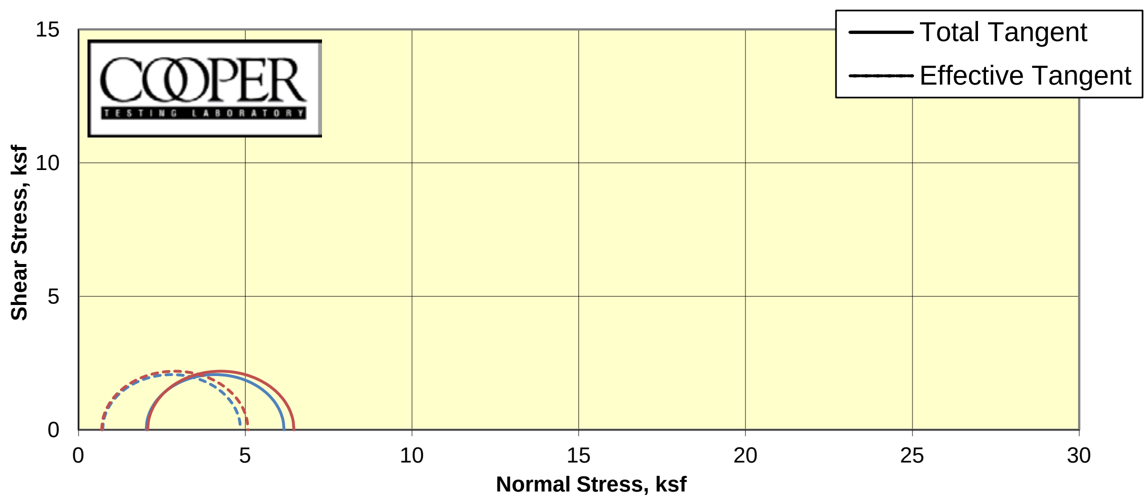
CTL Number:	020-251
Client Name:	AECOM
Project Name:	Klamath River Dam Removal Project
Project Number:	60537920
Date:	5/30/2018 By: MD/DC

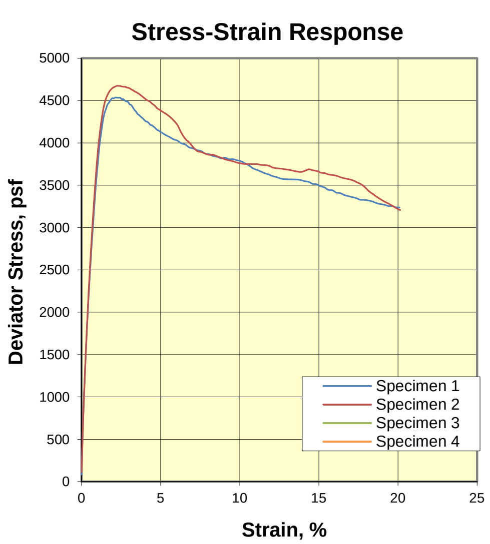
Total C	#DIV/0!	ksf
Total phi	#DIV/0!	degrees
Eff. C	#DIV/0!	ksf
Eff. Phi	#DIV/0!	degrees

©

Specimen	1	2	3	4
Boring	BC-09			
Sample	S-05			
Depth	23(Tip-5")			
Visual Description	Dark Gray Elastic SILT			
MC (%)	79.5			
Dry Density (pcf)	51.9			
Saturation (%)	97.1			
Void Ratio	2.130			
Diameter (in)	2.87			
Height (in)	6.07			
	Final			
MC (%)	79.4			
Dry Density (pcf)	53.0			
Saturation (%)	100.0			
Void Ratio	2.065			
Diameter (in)	2.85			
Height (in)	6.04			
Cell Pressure (psi)	86.8			
Back Pressure (psi)	80.3			
	Effective Stresses At:			
Strain (%)	5.0			
Deviator (ksf)	3.348			
Excess PP (psi)	2.2			
Sigma 1 (ksf)	3.969			
Sigma 3 (ksf)	0.621			
P (ksf)	2.295			
Q (ksf)	1.674			
Stress Ratio	6.396			
Rate (in/min)	0.0005			

Consolidated Undrained Triaxial Compression with Pore Pressure
ASTM D4767

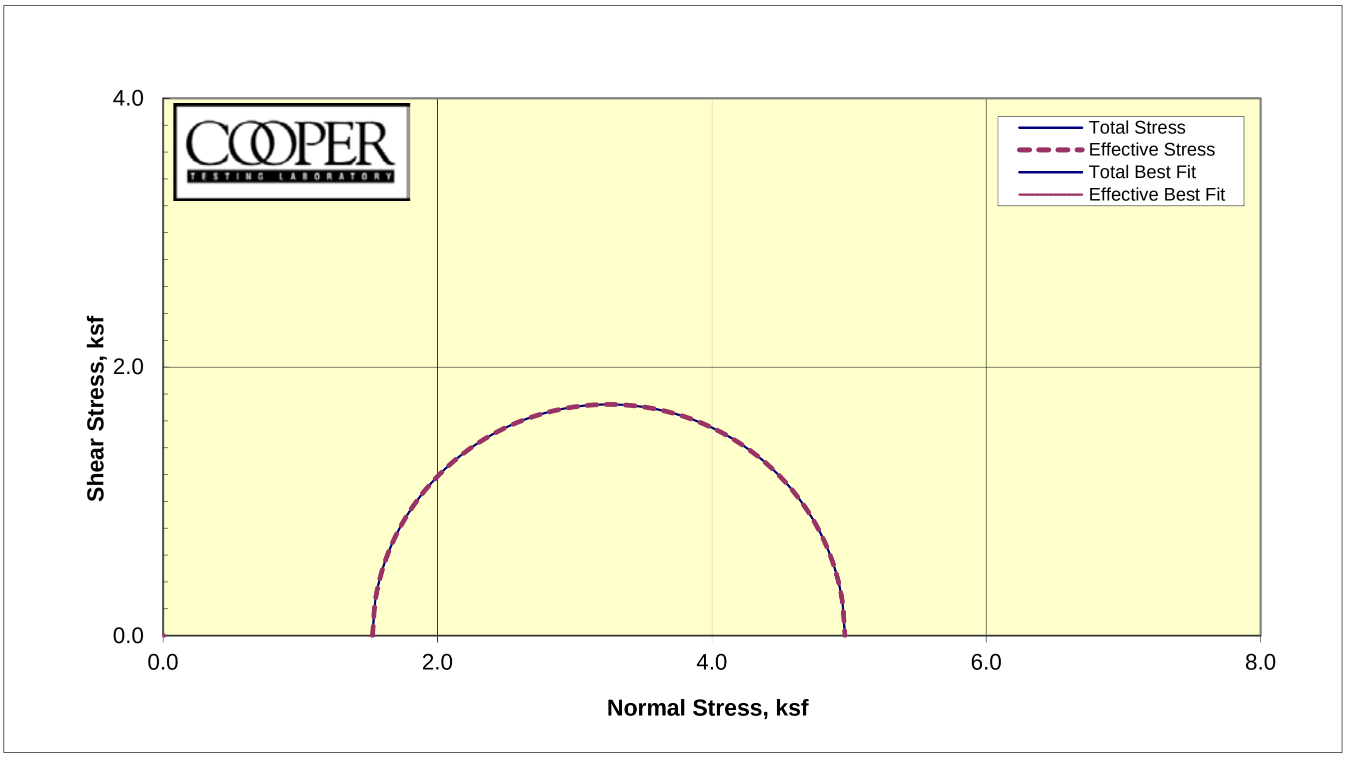


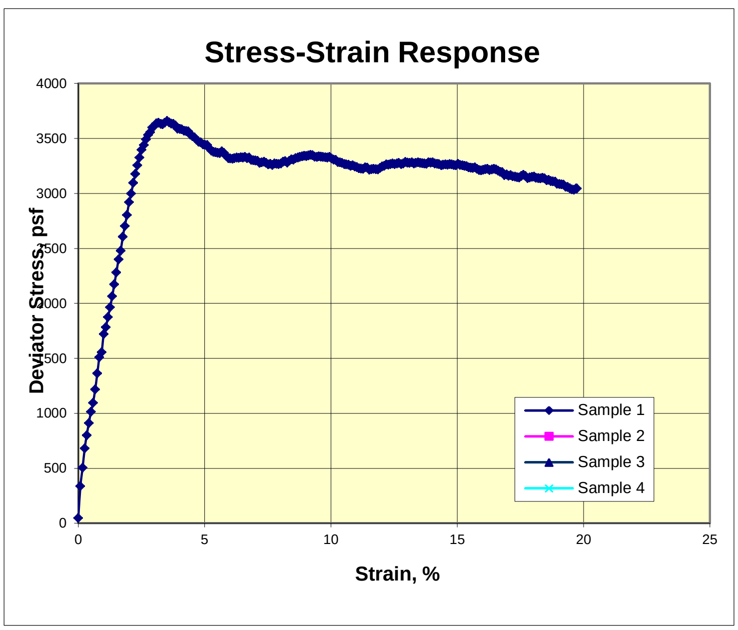


CTL Number:	020-251
Client Name:	AECOM
Project Name:	Klamath River Dam Removal Project
Project Number:	60537920
Date:	6/6/2018 By: MD/DC
Total C	#DIV/0! ksf
Total phi	#DIV/0! degrees
Eff. C	#DIV/0! ksf
Eff. Phi	#DIV/0! degrees ©

Specimen	1	2	3	4
Boring	BC-09	BC-09		
Sample	S-09	S-09		
Depth	68-70.5(Tip-10")	68-70.5(Tip-4")		
Visual Description	Dark Greenish Gray CLAY (Silty)/ SILT (slightly plastic)	Dark Greenish Gray CLAY (Silty)/ SILT (slightly plastic)		
MC (%)	92.0	95.5		
Dry Density (pcf)	47.2	46.1		
Saturation (%)	98.2	98.5		
Void Ratio	2.436	2.520		
Diameter (in)	2.87	2.87		
Height (in)	6.06	6.06		
	Final			
MC (%)	90.6	93.7		
Dry Density (pcf)	48.4	47.2		
Saturation (%)	100.0	100.0		
Void Ratio	2.355	2.436		
Diameter (in)	2.84	2.85		
Height (in)	6.03	6.02		
Cell Pressure (psi)	94.2	94.1		
Back Pressure (psi)	80.1	79.7		
	Effective Stresses At:			
Strain (%)	5.0	5.0		
Deviator (ksf)	4.134	4.387		
Excess PP (psi)	9.1	9.6		
Sigma 1 (ksf)	4.860	5.084		
Sigma 3 (ksf)	0.726	0.697		
P (ksf)	2.793	2.891		
Q (ksf)	2.067	2.194		
Stress Ratio	6.693	7.293		
Rate (in/min)	0.0005	0.0005		

Triaxial Unconsolidated-Undrained
(ASTM D2850m)





Sample:	1	2	3	4
MC, %	160.5			
Dry Dens, pcf	30.5			
Sat. %	95.9			
Void Ratio	4.519			
Diameter in	2.87			
Height, in	6.08			
	Final			
MC, %	163.5			
Dry Dens, pcf	31.1			
Sat. %	100.0			
Void Ratio	4.414			
Diameter, in	2.84			
Height, in	6.08			
Cell, psi	49.1			
BP, psi	38.5			
	Effective Stresses At:			
Strain, %	5.0			
Deviator ksf	3.444			
Excess PP	0.000			
Sigma 1	4.970			
Sigma 3	1.526			
P, ksf	3.248			
Q, ksf	1.722			
Stress Ratio	3.256			
Rate in/min	0.0588			
Total C	N/A	ksf		
Total Phi	N/A	Degrees		
Eff. C	N/A	ksf		
Eff. Phi	N/A	Degrees		

Job No.: 020-251 **Date:** 5/24/2018

Client: AECOM BY:MD/DC

Project: 60537920

Sample 1) BC-04_S-10 @ 52.5(Tip-18") Bluish Gray CLAY (Silty)

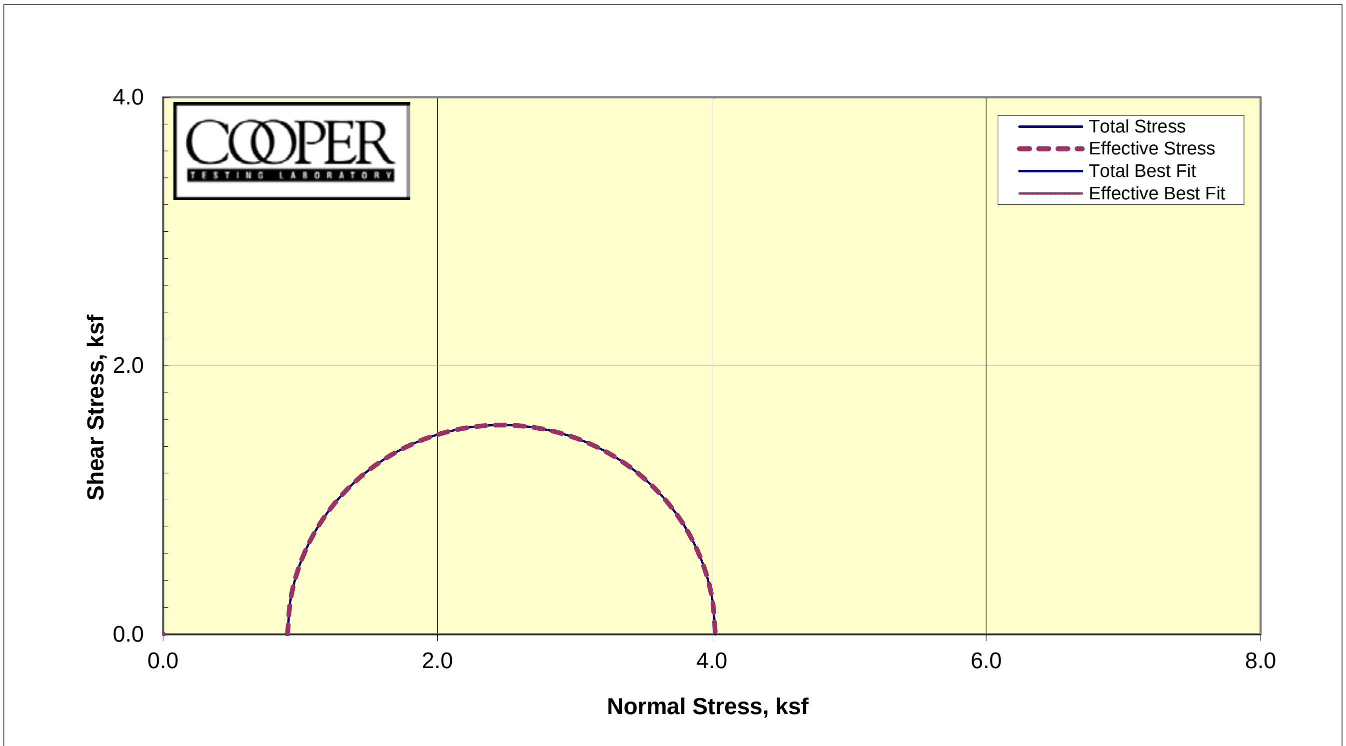
Sample 2)

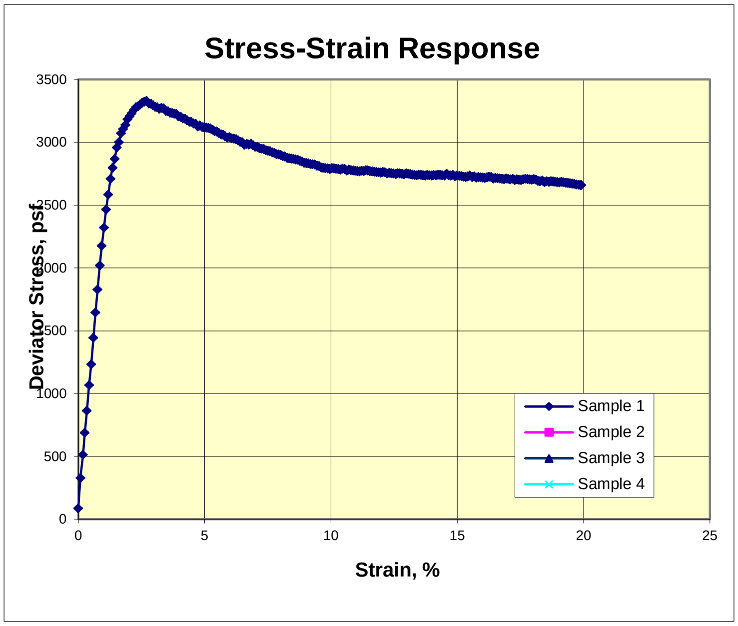
Sample 3)

Sample 4)

REMARKS: Strengths picked at 5% strain.
*Sample was back-pressure saturated prior to shear.

Triaxial Unconsolidated-Undrained
(ASTM D2850m)





Sample:	1	2	3	4
MC, %	76.3			
Dry Dens, pcf	54.0			
Sat. %	97.1			
Void Ratio	2.121			
Diameter in	2.87			
Height, in	6.05			
	Final			
MC, %	76.6			
Dry Dens, pcf	54.9			
Sat. %	100.0			
Void Ratio	2.068			
Diameter, in	2.85			
Height, in	6.03			
Cell, psi	54.8			
BP, psi	48.5			
	Effective Stresses At:			
Strain, %	5.0			
Deviator ksf	3.118			
Excess PP	0.000			
Sigma 1	4.025			
Sigma 3	0.907			
P, ksf	2.466			
Q, ksf	1.559			
Stress Ratio	4.437			
Rate in/min	0.0588			
Total C	N/A	ksf		
Total Phi	N/A	Degrees		
Eff. C	N/A	ksf		
Eff. Phi	N/A	Degrees		

Job No.: 020-251 **Date:** 5/25/2018

Client: AECOM BY:MD/DC

Project: 60537920

Sample 1) BC-09_S-05 @ 23(Tip-13") Dark Gray Elastic SILT

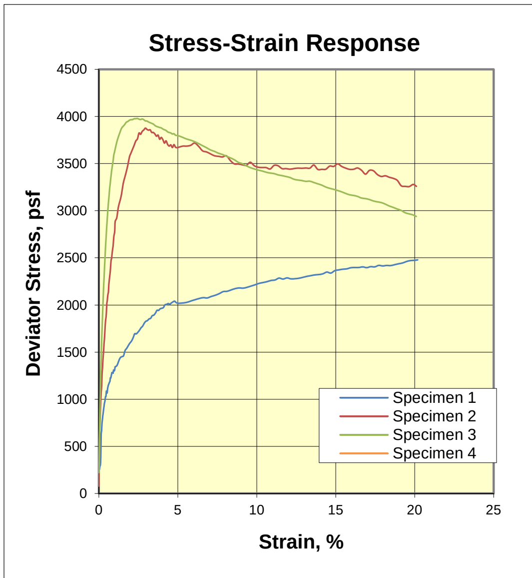
Sample 2)

Sample 3)

Sample 4)

REMARKS: Strengths picked at 5% strain.
*Sample was back-pressure saturated prior to shear.

Consolidated Undrained Triaxial Compression with Pore Pressure
ASTM D4767



CTL Number:	020-232		
Client Name:	AECOM		
Project Name:	Klamath		
Project Number:	60537920		
Date:	9/25/2017	By:	MD/DC
Total C	**0.470**	**ksf**	
Total phi	**17.2**	**degrees**	
Eff. C	**0.470**	**ksf**	
Eff. Phi	**28.4**	**degrees**	©

Remarks: The sample was delivered as singular 13" x 16" block. The specimens were trimmed into a brass tube 2" x 4". The orientation of the outcrop block was unknown. All samples were trimmed in the same approximate orientation. The material is highly structured and cemented. It disperses when exposed to water. All three specimens behaved differently during shear.

Specimen	**1**	**2**	**3**	**4**
Boring	Outcrop #1	Outcrop #1	Outcrop #1	
Sample				
Depth				
Visual Description	Pale Brown Siltstone (Diatomite)	Pale Brown Siltstone (Diatomite)	Pale Brown Siltstone (Diatomite)	
MC (%)	8.2	7.1	5.9	
Dry Density (pcf)	53.1	56.9	58.0	
Saturation (%)	10.2	9.7	8.4	
Void Ratio	2.176	1.961	1.907	
Diameter (in)	1.86	1.86	1.85	
Height (in)	4.00	4.00	4.00	
	Final			
MC (%)	78.4	73.5	71.9	
Dry Density (pcf)	54.1	56.5	57.3	
Saturation (%)	100.0	100.0	100.0	
Void Ratio	2.116	1.984	1.942	
Diameter (in)	1.85	1.87	1.87	
Height (in)	3.96	3.98	3.98	
Cell Pressure (psi)	124.0	135.0	144.9	
Back Pressure (psi)	119.7	119.8	120.4	
	Effective Stresses At:			
Strain (%)	2.0	2.0	2.0	
Deviator (ksf)	1.596	3.571	3.959	
Excess PP (psi)	3.5	10.2	14.0	
Sigma 1 (ksf)	1.708	4.282	5.488	
Sigma 3 (ksf)	0.111	0.712	1.529	
P (ksf)	0.909	2.497	3.509	
Q (ksf)	0.798	1.785	1.980	
Stress Ratio	15.338	6.018	3.589	
Rate (in/min)	0.0003	0.0003	0.0003	

POINT LOAD TEST RESULTS
BI-02 and BI-03

Test Number	Test Order	Depth of Test	Boring Number	Date	Depth Interval Bottom	Depth Interval Top	Rock Type[1]	Diameter (D) (mm)	Diameter (D) (in)	Distance Between Contact Points (cm)	Distance Between Contact Points (in)	Length - Contact Points to End of Sample, L (in)	L/D[2]	Test Type[3]	Failure Load, P (kN)[4]	Uncorrected Point Load, I_S (Mpa)[5]	Size Correction Factor, F[6]	Point Load, $I_{S(50)}$ (MPa)[7]	Uniaxial Compressive Strength, s_c (Mpa)[8]	Uniaxial Compressive Strength, psi	Weathering	Notes
BI02-1-22.1	1	22.1	BI-02	4/11/2018	22.6	21.9	Volcanic Breccia	59.94	2.36	6.00	2.36	1.97	0.83	d	0.51	0.14	1.09	0.15	3	504	MW/SW	Bottom 3.5" broke on preexisting fracture plane prior to test. Sample broke on preexisting fracture plane during testing.
BI02-2-28.2	2	28.2	BI-02	4/11/2018	28.6	27.9	Volcanic Breccia	59.94	2.36	6.00	2.36	3.54	1.50	d	1.99	0.55	1.09	0.60	14	1968	MW/SW	Fractured between platens (see photo)
BI02-3-32.8	3	32.8	BI-02	4/11/2018	33.4	32.2	Volcanic Breccia	59.94	2.36	6.00	2.36	7.01	2.97	d	2.59	0.72	1.09	0.78	18	2561	MW/SW	Fractured between platens (see photo). Other breaks from rock core falling on table after testing.
BI02-4-37.4	4	37.4	BI-02	4/11/2018	37.7	37.2	Volcanic Breccia	59.94	2.36	6.00	2.36	2.68	1.13	d	2.53	0.70	1.09	0.76	17	2502	MW/SW	Fractured between platens (see photo)
BI02-5-42.8	5	42.8	BI-02	4/11/2018	43.1	42.5	Volcanic Breccia	59.94	2.36	6.00	2.36	3.86	1.63	d	2.00	0.56	1.09	0.60	14	1978	MW/SW	Fractured between platens (see photo). 1" long fracture propagated along the length of sample from the point load application.
BI02-7-55	7	55.0	BI-02	4/11/2018	55.4	54.7	Volcanic Breccia	59.94	2.36	6.00	2.36	3.74	1.58	d	1.41	0.39	1.09	0.43	10	1394	MW/SW	Fractured between platens (see photo). Platen penetrated into rock 3mm at failure.
BI02-8-57.3	8	57.3	BI-02	4/11/2018	57.6	57.0	Volcanic Breccia	59.94	2.36	6.00	2.36	3.23	1.37	d	1.5-2.0		1.09				MW/SW	Peak load not recorded. One of the broken halfs was retested in test BI02-9-57.1.
BI02-9-57.1	9	57.1	BI-02	4/11/2018	57.6	57.0	Volcanic Breccia	59.94	2.36	6.00	2.36	1.69	0.72	d	1.80	0.50	1.09	0.54	12	1780	MW/SW	Fractured between platens (see photo)
BI02-10-64.2	10	64.2	BI-02	4/11/2018	64.7	63.7	Volcanic Breccia	59.94	2.36	6.00	2.36	6.10	2.59	d	1.05	0.29	1.09	0.32	7	1038	MW/SW	Fractured between platens (see photo)
BI03-11-10.3	11	10.3	BI-03	4/11/2018	10.5	10.1	Volcanic Breccia	59.94	2.36	6.00	2.36	2.17	0.92	d	0.60	0.17	1.09	0.18	4	593	MW	Fractured between platens (see photo)
BI03-12-17.2	12	17.2	BI-03	4/11/2018	17.4	17.0	Volcanic Breccia	59.94	2.36	6.00	2.36	2.17	0.92	d	0.56	0.16	1.09	0.17	4	554	MW	Fractured between platens (see photo)
BI03-13-21.3	13	21.3	BI-03	4/11/2018	21.5	21.0	Volcanic Breccia	59.94	2.36	6.00	2.36	2.56	1.08	d	0.76	0.21	1.09	0.23	5	752	MW	Fractured between platens (see photo)
BI03-14-29.8	14	29.8	BI-03	4/11/2018	30.1	29.5	Volcanic Breccia	59.94	2.36	6.00	2.36	3.54	1.50	d	0.73	0.20	1.09	0.22	5	722	MW	Fractured between platens (see photo)
BI03-15-32.7	15	32.7	BI-03	4/11/2018	33.5	32.0	Volcanic Breccia	59.94	2.36	6.00	2.36	8.58	3.64	d	0.77	0.21	1.09	0.23	5	761	MW	Fractured between platens (see photo)

Notes:

1 Based on Drill Logs
2 ASTM D5731 calls for L/D > 0.5 for diametral test.
3 d = diametral, a = axial, b = block, ir = irregular lump
4 Reading from testing apparatus
5 $I_S = P/D^2$ (ASTM D5731 - for diametral test)
6 $F = (D/50)^{0.45}$ (ASTM D5731 - for diametral test)
7 $I_{S(50)} = I_S \times F$ (ASTM D5731)
8 $s_c = I_S \times K$; I_s is uncorrected point load index; K=24.5 for ~60 mm diameter cores (ASTM D5731)

F	Fresh
SW	Slightly Weathered
MW	Moderately Weathered
HW	Highly Weathered
CW	Completely Weathered

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Project Name	Klamath River Dam Removal
Location	Klamath River
Client	Klamath River Renewal Corporation
Client Project No.	60537920
Registry No.	2018-22
Report No.	2018-22-1
Report Date	5/17/2018
Drill Hole and Depth	BI-02; 48.9-50.3 ft
Rock Type	Volcanic Breccia
Geologic Unit	N/A
Moisture Condition	As-received

Date Received: 4/24/2018	Date Opened: 4/24/2018	Date Tested: 4/30/2018

Distance, D		Load, P		Corrected Point Load Index $(D/50)^{0.45}$ P/D^2		Direction of Loading	
mm	in	kN	lbf	MPa	psi	A	B
60.86	2.40	0.74	166.352	0.22	31.66	1	
62.20	2.45	1.65	370.92	0.47	68.24		1
47.58	1.87	0.98	220.304	0.42	61.40	1	
79.15	3.12	3.23	726.104	0.63	91.95		1
82.44	3.25	3.00	674.4	0.55	80.18		1
39.71	1.56	0.86	193.328	0.49	71.31	1	

Average Point Load Strength in Direction A	0.38 MPa	54.79 psi
Average Point Load Strength in Direction B	0.55 MPa	80.12 psi

Point Load Strength Anisotropy Index
1.46

A = Parallel to core axis

B = Orthogonal to core axis

Performed by: Dr. Fulvio Tonon, P.E., Ph.D.

Checked by: Gloria Tonon-Kozma, P.E.

2028 E Ben White BLVD #240-2660
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Uniaxial Compression Test without Stress-Strain Curves and Moduli
ASTM D7012 - 14e1

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Project Name	Klamath River Dam Removal
Location	Klamath River
Client	Klamath River Renewal Corporation
Client Project No.	60537920
Registry No.	2018-22
Report No.	2018-22-1-1
Report Date	5/17/2018
Drill hole and Depth	BI-02; 27-27.9 ft
Rock Type	Volcanic Breccia
Geologic Unit	N/A
Moisture Condition	As-received

Stress Rate	0.5 MPa/s	
Diameter of Specimen	60.54 mm	2.38 in
Height of Specimen	97.72 mm	3.85 in
Load at Peak	16.69 kN	3,752 lbf
Unconfined Compressive Strength	5.80 MPa	841 psi
Type of Failure	Non-Structural	

Note: The provided sample had a height-to-diameter ratio less than 2

Date Received : 4/24/2018	Date Opened : 4/24/2018	Date Tested: 4/30/2018

Photo Before Test	Photo After Test
	

Tested by: Dr. Fulvio Tonon, P.E., Ph.D.

Checked by: Gloria Tonon-Kozma, P.E.

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Picture of the sample upon arrival at Tonon USA Laboratory: no core piece allowed preparation of a specimen with a height-to-diameter ratio between 2 and 2.5.

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Project Name	Klamath River Dam Removal
Location	Klamath River
Client	Klamath River Renewal Corporation
Client Project No.	60537920
Registry No.	2018-22
Report No.	2018-22-1-2
Report Date	5/17/2018
Drill hole and Depth	BI-02; 48.9-50.3 ft
Rock Type	Volcanic Breccia
Geologic Unit	N/A
Moisture Condition	As-received

Stress Rate	0.5 MPa/s	
Diameter of Specimen	60.85 mm	2.40 in
Height of Specimen	127.87 mm	5.03 in
Load at Peak	34.80 kN	7,823 lbf
Unconfined Compressive Strength	11.97 MPa	1,736 psi
Type of Failure	Non-Structural	

Date Received : 4/24/2018	Date Opened : 4/24/2018	Date Tested: 4/30/2018

Photo Before Test

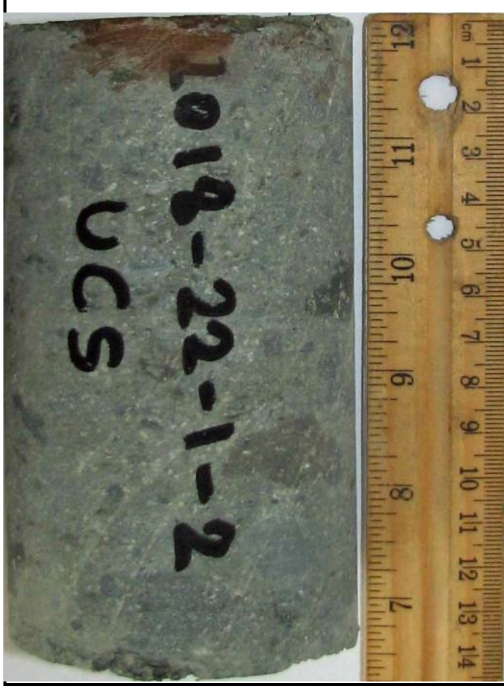

Photo After Test

Tested by: Dr. Fulvio Tonon, P.E., Ph.D.

Checked by: Gloria Tonon-Kozma, P.E.

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Web: tononeng.com

Project Name	Klamath River Dam Removal
Location	Klamath River
Client	Klamath River Renewal Corporation
Client Project No.	60537920
Registry No.	2018-22
Report No.	2018-22-1-3
Report Date	5/17/2018
Drill hole and Depth	BI-02; 55.4-56.3 ft
Rock Type	Volcanic Breccia
Geologic Unit	N/A
Moisture Condition	As-received

Stress Rate	0.5 MPa/s	
Diameter of Specimen	60.68 mm	2.39 in
Height of Specimen	128.33 mm	5.05 in
Load at Peak	45.59 kN	10,248 lbf
Unconfined Compressive Strength	15.77 MPa	2,288 psi
Type of Failure	Non-Structural	

Date Received : 4/24/2018	Date Opened : 4/24/2018	Date Tested: 4/30/2018

Photo Before Test

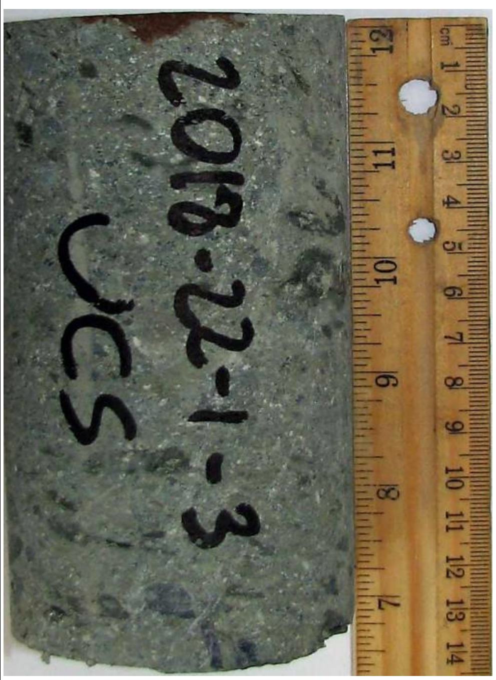
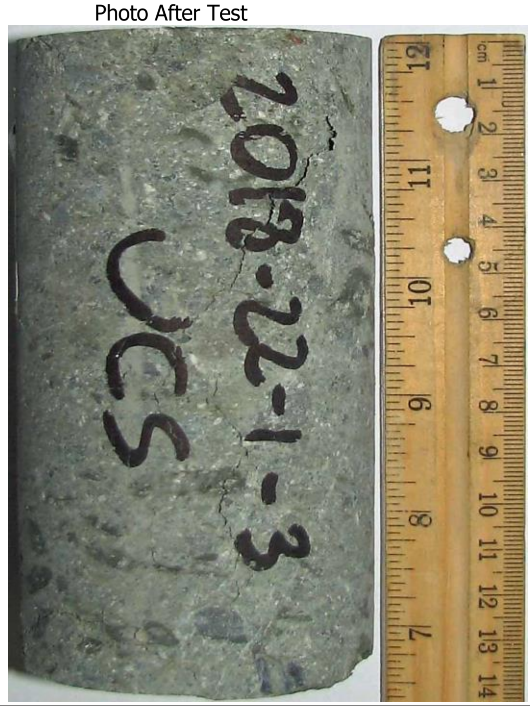


Photo After Test



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Project Name	Klamath River Dam Removal
Location	Klamath River
Client	Klamath River Renewal Corporation
Client Project No.	60537920
Registry No.	2018-22
Report No.	2018-22-1-4
Report Date	5/17/2018
Drill hole and Depth	BI-03; 17.4-18.4 ft
Rock Type	Volcanic Breccia
Geologic Unit	N/A
Moisture Condition	As-received

Stress Rate	0.5 MPa/s	
Diameter of Specimen	60.59 mm	2.39 in
Height of Specimen	129.81 mm	5.11 in
Load at Peak	4.39 kN	987 lbf
Unconfined Compressive Strength	1.52 MPa	221 psi
Type of Failure	Non-Structural	

Date Received : 4/24/2018	Date Opened : 4/24/2018	Date Tested: 5/4/2018

Photo Before Test

Photo After Test

Tested by: Dr. Fulvio Tonon, P.E., Ph.D.

Checked by: Gloria Tonon-Kozma, P.E.

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Tonon USA:
Engineering, Measuraments and Testing, LLC

Web: tononeng.com

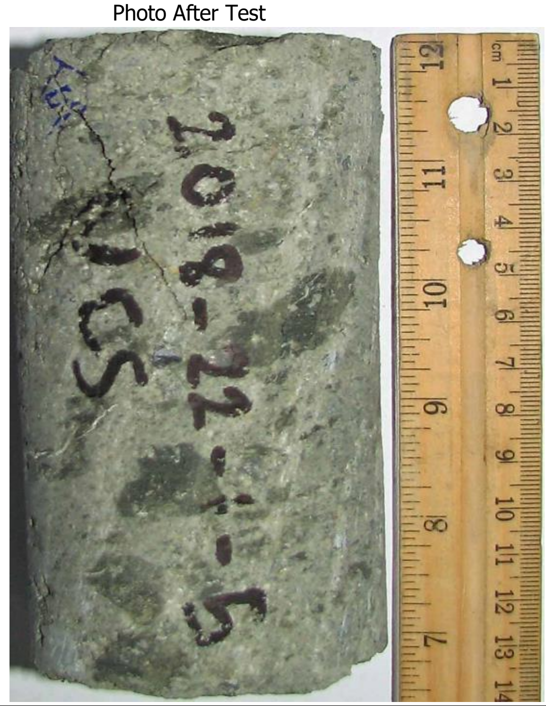
Project Name	Klamath River Dam Removal
Location	Klamath River
Client	Klamath River Renewal Corporation
Client Project No.	60537920
Registry No.	2018-22
Report No.	2018-22-1-5
Report Date	5/17/2018
Drill hole and Depth	BI-03; 21.5-22.9 ft
Rock Type	Volcanic Breccia
Geologic Unit	N/A
Moisture Condition	As-received

Stress Rate	0.5 MPa/s	
Diameter of Specimen	60.58 mm	2.39 in
Height of Specimen	125.67 mm	4.95 in
Load at Peak	6.99 kN	1,571 lbf
Unconfined Compressive Strength	2.43 MPa	352 psi
Type of Failure	Non-Structural	

Date Received : 4/24/2018	Date Opened : 4/24/2018	Date Tested: 4/30/2018

Photo Before Test

Photo After Test



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Project Name	Klamath River Dam Removal	Rate of loading (0.05-0.35 MPa/s or 500-3,000 psi/min)	0.11 MPa/sec	957 psi/min
Location	Klamath River	Diameter (D)	60.94 mm	2.40 in
Client	Klamath River Renewal Corporation	Thickness (t)	22.88 mm	0.90 in
Client Project No.	60537920	Maximum Load (P)	6.53 kN	1,468 lbf
Registry No.	2018-22	Tensile strength (flat platens) $\sigma_t = 2P/\pi tD$	N/A	N/A
Report No.	2018-22-2-1	Tensile strength (curved platens) $\sigma_t = 1.272P/\pi tD$	1.90 MPa	275 psi
Report Date	5/17/2018	Direction of Loading	Orthogonal to the Borehole Axis	
Drill Hole and Depth	BI-02; 47-48.9 ft	Type of Failure	Non-Structural	
Rock Type	Volcanic Breccia	Conformance to dimensional Requirements $0.2 \le \frac{t}{D} \le 0.75$	$\frac{t}{D} =$ 0.38	OK
Geologic Unit	N/A			
Moisture Condition	As-received			

Date Received : 4/24/2018	Date Opened : 4/24/2018	Date Tested: 4/30/2018

Photo Before Test

Photo After Test

Tested by: Dr. Fulvio Tonon, P.E., Ph.D.

Checked by: Gloria Tonon-Kozma, P.E.

Project Name	Klamath River Dam Removal
Location	Klamath River
Client	Klamath River Renewal Corporation
Client Project No.	60537920
Registry No.	2018-22
Report No.	2018-22-2-2
Report Date	5/17/2018
Drill Hole and Depth	BI-02; 52-54.7 ft
Rock Type	Volcanic Breccia
Geologic Unit	N/A
Moisture Condition	As-received

Rate of loading (0.05-0.35 MPa/s or 500-3,000 psi/min)	0.11 MPa/sec	957 psi/min
Diameter (D)	60.84 mm	2.40 in
Thickness (t)	24.67 mm	0.97 in
Maximum Load (P)	5.25 kN	1,180 lbf
Tensile strength (flat platens) $\sigma_t = 2P/\pi tD$	N/A	N/A
Tensile strength (curved platens) $\sigma_t = 1.272P/\pi tD$	1.42 MPa	206 psi
Direction of Loading	Orthogonal to the Borehole Axis	
Type of Failure	Non-Structural	
Conformance to dimensional Requirements $0.2 \le \frac{t}{D} \le 0.75$	$\frac{t}{D} =$ 0.41	OK

Date Received : 4/24/2018	Date Opened : 4/24/2018	Date Tested: 4/30/2018

Photo Before Test

Photo After Test

Tested by: Dr. Fulvio Tonon, P.E., Ph.D.

Checked by: Gloria Tonon-Kozma, P.E.

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Project Name	Klamath River Dam Removal
Location	Klamath River
Client	Klamath River Renewal Corporation
Client Project No.	60537920
Registry No.	2018-22
Report No.	2018-22-2-3
Report Date	5/17/2018
Drill Hole and Depth	BI-03; 18.4-20.1 ft
Rock Type	Volcanic Breccia
Geologic Unit	N/A
Moisture Condition	As-received

Rate of loading (0.05-0.35 MPa/s or 500-3,000 psi/min)	0.11 MPa/sec	957 psi/min
Diameter (D)	60.74 mm	2.39 in
Thickness (t)	26.84 mm	1.06 in
Maximum Load (P)	1.51 kN	339 lbf
Tensile strength (flat platens) $\sigma_t = 2P/\pi tD$	N/A	N/A
Tensile strength (curved platens) $\sigma_t = 1.272P/\pi tD$	0.38 MPa	54 psi
Direction of Loading	Orthogonal to the Borehole Axis	
Type of Failure	Non-Structural	
Conformance to dimensional Requirements $0.2 \le \frac{t}{D} \le 0.75$	$\frac{t}{D} =$ 0.44	OK

Date Received : 4/24/2018	Date Opened : 4/24/2018	Date Tested: 4/30/2018

Photo Before Test

Photo After Test

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Project Name	Klamath River Dam Removal	Rate of loading (0.05-0.35 MPa/s or 500-3,000 psi/min)	0.11 MPa/sec	957 psi/min
Location	Klamath River	Diameter (D)	60.26 mm	2.37 in
Client	Klamath River Renewal Corporation	Thickness (t)	33.83 mm	1.33 in
Client Project No.	60537920	Maximum Load (P)	0.55 kN	124 lbf
Registry No.	2018-22	Tensile strength (flat platens) $\sigma_t = 2P/\pi tD$	N/A	N/A
Report No.	2018-22-2-4	Tensile strength (curved platens) $\sigma_t = 1.272P/\pi tD$	0.11 MPa	16 psi
Report Date	5/17/2018	Direction of Loading	Orthogonal to the Borehole Axis	
Drill Hole and Depth	BI-03; 22.9-24.2 ft	Type of Failure	Non-Structural	
Rock Type	Volcanic Breccia	Conformance to dimensional Requirements $0.2 \le \frac{t}{D} \le 0.75$	$\frac{t}{D} =$ 0.56	OK
Geologic Unit	N/A			
Moisture Condition	As-received			

Date Received : 4/24/2018	Date Opened : 4/24/2018	Date Tested: 4/30/2018

Photo Before Test

Photo After Test

Tested by: Dr. Fulvio Tonon, P.E., Ph.D.

Checked by: Gloria Tonon-Kozma, P.E.

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Tonon USA
Engineering, Measurements and Testing, LLC

Web: tononeng.com

Project Name	Klamath River Dam Removal
Location	Klamath River
Client	Klamath River Renewal Corporation
Client Project No.	60537920
Registry No.	2018-22
Report No.	2018-22-3-1
Report Date	5/17/2018
Drill Hole and Depth (ft)	BI-02; 27-27.9 ft
Rock Type	Volcanic Breccia
Geologic Unit	N/A
Moisture Condition	As-received

Date Received: 4/24/2018	Date Opened: 4/24/2018	Date Tested: 4/30/2018

Diameter	Length	Weight	Bulk Density	Bulk Density
(mm)	(mm)	(g)	(kN/m^3)	(pcf)
60.54	97.72	637.28	22.22	141.42

Performed by: Dr. Fulvio Tonon, P.E., Ph.D.   Checked by: Gloria Tonon-Kozma, P.E.

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Project Name	Klamath River Dam Removal
Location	Klamath River
Client	Klamath River Renewal Corporation
Client Project No.	60537920
Registry No.	2018-22
Report No.	2018-22-3-2
Report Date	5/17/2018
Drill Hole and Depth (ft)	BI-02; 48.9-50.3 ft
Rock Type	Volcanic Breccia
Geologic Unit	N/A
Moisture Condition	As-received

Date Received: 4/24/2018	Date Opened: 4/24/2018	Date Tested: 4/30/2018

Diameter	Length	Weight	Bulk Density	Bulk Density
(mm)	(mm)	(g)	(kN/m^3)	(pcf)
60.85	127.87	891.59	23.51	149.67

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Project Name	Klamath River Dam Removal
Location	Klamath River
Client	Klamath River Renewal Corporation
Client Project No.	60537920
Registry No.	2018-22
Report No.	2018-22-3-3
Report Date	5/17/2018
Drill Hole and Depth (ft)	BI-02; 55.4-56.3 ft
Rock Type	Volcanic Breccia
Geologic Unit	N/A
Moisture Condition	As-received

Date Received: 4/24/2018	Date Opened: 4/24/2018	Date Tested: 4/30/2018

Diameter	Length	Weight	Bulk Density	Bulk Density
(mm)	(mm)	(g)	(kN/m^3)	(pcf)
60.68	128.33	882.58	23.32	148.46

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Project Name	Klamath River Dam Removal
Location	Klamath River
Client	Klamath River Renewal Corporation
Client Project No.	60537920
Registry No.	2018-22
Report No.	2018-22-3-4
Report Date	5/17/2018
Drill Hole and Depth (ft)	BI-03; 17.4-18.4 ft
Rock Type	Volcanic Breccia
Geologic Unit	N/A
Moisture Condition	As-received

Date Received: 4/24/2018	Date Opened: 4/24/2018	Date Tested: 4/30/2018

Diameter	Length	Weight	Bulk Density	Bulk Density
(mm)	(mm)	(g)	(kN/m^3)	(pcf)
60.59	129.81	830.07	21.75	138.44

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Project Name	Klamath River Dam Removal
Location	Klamath River
Client	Klamath River Renewal Corporation
Client Project No.	60537920
Registry No.	2018-22
Report No.	2018-22-3-5
Report Date	5/17/2018
Drill Hole and Depth (ft)	BI-03; 21.5-22.9 ft
Rock Type	Volcanic Breccia
Geologic Unit	N/A
Moisture Condition	As-received

Date Received: 4/24/2018	Date Opened: 4/24/2018	Date Tested: 4/30/2018

Diameter	Length	Weight	Bulk Density	Bulk Density
(mm)	(mm)	(g)	(kN/m^3)	(pcf)
60.58	125.67	783.13	21.20	134.96

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Project Name	Klamath River Dam Removal
Location	Klamath River
Client	Klamath River Renewal Corporation
Client Project No.	60537920
Registry No.	2018-22
Report No.	2018-22-4-1
Report Date	5/17/2018
Drill Hole and Depth	BI-02; 27-27.9 ft
Rock Type	Volcanic Breccia
Geologic Unit	N/A
Moisture Condition	As-received

Date Received: 4/24/2018	Date Opened: 4/24/2018	Date Tested: 4/27-30/2018

Method A: Caliper

Diameter (mm)	Length (mm)	Initial Weight (g)	Dry Weight (g)
		202.50	193.13

Moisture Content (%)	**Unit Weight (kN/m^3)**	**Unit Weight (pcf)**	**Dry Unit Weight (kN/m^3)**	**Dry Unit Weight (pcf)**
4.85				

Method B: Buoyancy

Weight (g)	Saturated Weight (g)	Suspended Weight (g)	Dry Weight (g)

Moisture Content (%)	**Unit Weight (kN/m^3)**	**Unit Weight (pcf)**	**Dry Unit Weight (kN/m^3)**	**Dry Unit Weight (pcf)**

Performed by: Dr. Fulvio Tonon, P.E., Ph.D.

Checked by: Gloria Tonon-Kozma, P.E.

2028 E Ben White BLVD #240-2660
Austin, TX 78741

Laboratory Director: Dr. Fulvio Tonon, P.E., Ph.D.
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COMPANY WITH QUALITY SYSTEM CERTIFIED BY DNV GL = ISO 9001 =

Tonon USA
Engineering, Measurements and Testing, LLC

Web: tononeng.com

Project Name	Klamath River Dam Removal
Location	Klamath River
Client	Klamath River Renewal Corporation
Client Project No.	60537920
Registry No.	2018-22
Report No.	2018-22-4-2
Report Date	5/17/2018
Drill Hole and Depth	BI-02; 48.9-50.3 ft
Rock Type	Volcanic Breccia
Geologic Unit	N/A
Moisture Condition	As-received

Date Received: 4/24/2018	Date Opened: 4/24/2018	Date Tested: 4/27-30/2018

Method A: Caliper

Diameter (mm)	Length (mm)	Initial Weight (g)	Dry Weight (g)
		180.47	169.63

Moisture Content (%)	**Unit Weight (kN/m^3)**	**Unit Weight (pcf)**	**Dry Unit Weight (kN/m^3)**	**Dry Unit Weight (pcf)**
6.39				

Method B: Buoyancy

Weight (g)	Saturated Weight (g)	Suspended Weight (g)	Dry Weight (g)

Moisture Content (%)	**Unit Weight (kN/m^3)**	**Unit Weight (pcf)**	**Dry Unit Weight (kN/m^3)**	**Dry Unit Weight (pcf)**

Performed by: Dr. Fulvio Tonon, P.E., Ph.D.

Checked by: Gloria Tonon-Kozma, P.E.

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Project Name	Klamath River Dam Removal
Location	Klamath River
Client	Klamath River Renewal Corporation
Client Project No.	60537920
Registry No.	2018-22
Report No.	2018-22-4-3
Report Date	5/17/2018
Drill Hole and Depth	BI-02; 55.4-56.3 ft
Rock Type	Volcanic Breccia
Geologic Unit	N/A
Moisture Condition	As-received

Date Received: 4/24/2018	Date Opened: 4/24/2018	Date Tested: 4/27-30/2018

Method A: Caliper

Diameter (mm)	Length (mm)	Initial Weight (g)	Dry Weight (g)
		175.36	165.73

Moisture Content (%)	**Unit Weight (kN/m^3)**	**Unit Weight (pcf)**	**Dry Unit Weight (kN/m^3)**	**Dry Unit Weight (pcf)**
5.81				

Method B: Buoyancy

Weight (g)	Saturated Weight (g)	Suspended Weight (g)	Dry Weight (g)

Moisture Content (%)	**Unit Weight (kN/m^3)**	**Unit Weight (pcf)**	**Dry Unit Weight (kN/m^3)**	**Dry Unit Weight (pcf)**

Performed by: Dr. Fulvio Tonon, P.E., Ph.D.

Checked by: Gloria Tonon-Kozma, P.E.

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COMPANY WITH QUALITY SYSTEM CERTIFIED BY DNV GL = ISO 9001 =

Tonon USA
Engineering, Measurements and Testing, LLC

Web: tononeng.com

Project Name	Klamath River Dam Removal
Location	Klamath River
Client	Klamath River Renewal Corporation
Client Project No.	60537920
Registry No.	2018-22
Report No.	2018-22-4-4
Report Date	5/17/2018
Drill Hole and Depth	BI-03; 17.4-18.4 ft
Rock Type	Volcanic Breccia
Geologic Unit	N/A
Moisture Condition	As-received

Date Received: 4/24/2018	Date Opened: 4/24/2018	Date Tested: 4/27-30/2018

Method A: Caliper

Diameter (mm)	Length (mm)	Initial Weight (g)	Dry Weight (g)
		84.27	74.93

Moisture Content (%)	**Unit Weight (kN/m^3)**	**Unit Weight (pcf)**	**Dry Unit Weight (kN/m^3)**	**Dry Unit Weight (pcf)**
12.46				

Method B: Buoyancy

Weight (g)	Saturated Weight (g)	Suspended Weight (g)	Dry Weight (g)

Moisture Content (%)	**Unit Weight (kN/m^3)**	**Unit Weight (pcf)**	**Dry Unit Weight (kN/m^3)**	**Dry Unit Weight (pcf)**

Performed by: Dr. Fulvio Tonon, P.E., Ph.D.

Checked by: Gloria Tonon-Kozma, P.E.

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COMPANY WITH QUALITY SYSTEM CERTIFIED BY DNV GL = ISO 9001 =

Tonon USA
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Project Name	Klamath River Dam Removal
Location	Klamath River
Client	Klamath River Renewal Corporation
Client Project No.	60537920
Registry No.	2018-22
Report No.	2018-22-4-5
Report Date	5/17/2018
Drill Hole and Depth	BI-03; 21.5-22.9 ft
Rock Type	Volcanic Breccia
Geologic Unit	N/A
Moisture Condition	As-received

Date Received: 4/24/2018	Date Opened: 4/24/2018	Date Tested: 4/27-30/2018

Method A: Caliper

Diameter (mm)	Length (mm)	Initial Weight (g)	Dry Weight (g)
		177.06	160.77

Moisture Content (%)	**Unit Weight (kN/m^3)**	**Unit Weight (pcf)**	**Dry Unit Weight (kN/m^3)**	**Dry Unit Weight (pcf)**
10.13				

Method B: Buoyancy

Weight (g)	Saturated Weight (g)	Suspended Weight (g)	Dry Weight (g)

Moisture Content (%)	**Unit Weight (kN/m^3)**	**Unit Weight (pcf)**	**Dry Unit Weight (kN/m^3)**	**Dry Unit Weight (pcf)**

Performed by: Dr. Fulvio Tonon, P.E., Ph.D.

Checked by: Gloria Tonon-Kozma, P.E.

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Tonon USA:
Engineering, Measurements and Testing, LLC

Web: tononeng.com

Project Name	Klamath River Dam Removal
Location	Klamath River
Client	Klamath River Renewal Corporation
Client Project No.	60537920
Registry No.	2018-22
Report No.	2018-22-5-1
Report Date	5/17/2018
Drill Hole and Depth	BI-02; 51.3-51.7 ft
Rock Type	Volcanic Breccia
Formation	N/A
Surface Condition	Cut by Slab Saw

Apparatus, Pin R.-H.	West Cerchar, 55/56	
Direction of Scratch	Perpendicular to Core Axis	
Pin Wear (mm)	0.156	0.145
	0.142	0.124
	0.144	0.133
	0.162	0.129
	0.150	0.140
Average (mm)	0.143	
CAIs	**1.43**	
CAI	**1.89**	
Classification	**Medium Abrasiveness**	

Date Received : 4/24/2018	Date Opened : 4/24/2018	Date Tested: 4/30/2018

Photo After Test

Tested by: Dr. Fulvio Tonon, P.E., Ph.D.

Checked by: Gloria Tonon-Kozma, P.E.

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Project Name	Klamath River Dam Removal
Location	Klamath River
Client	Klamath River Renewal Corporation
Client Project No.	60537920
Registry No.	2018-22
Report No.	2018-22-5-2
Report Date	5/17/2018
Drill Hole and Depth	BI-03; 25.1-26.1 ft
Rock Type	Volcanic Breccia
Formation	N/A
Surface Condition	Cut by Slab Saw

Apparatus, Pin R.-H.	West Cerchar, 55/56	
Direction of Scratch	Perpendicular to Core Axis	
Pin Wear (mm)	0.046	0.037
	0.083	0.069
	0.104	0.090
	0.087	0.098
	0.100	0.093
Average (mm)	0.081	
CAIs	**0.81**	
CAI	**1.28**	
Classification	**Medium Abrasiveness**	

Date Received : 4/24/2018	Date Opened : 4/24/2018	Date Tested: 4/30/2018

Photo After Test

Tested by: Dr. Fulvio Tonon, P.E., Ph.D.

Checked by: Gloria Tonon-Kozma, P.E.

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Project Name	Klamath River Dam Removal
Project location	Klamath River
Client	Klamath River Renewal Corporation
Client's Project No.	60537920
Registry No.	2018-22
Report No.	2018-22-7-1
Report Date	5/17/2018
Borehole and Depth	BI-02; 51.7-52 ft
Studied by	Lidia Scavo and Fulvio Tonon
Reviewed by	Gloria Tonon-Kozma

Date Received : 4/24/2018	Date Opened : 4/24/2018	Date Tested: 5/17/2018

A sample from borehole BI-02; 51.7-52 ft was analyzed under the polarized microscope to determine its mineralogical composition from a 25 X 40 mm (0.9 X 1.58 in) thin section.

Visual inspection of the sample suggests an igneous origin.

ROCK NAME: **BRECCIATED-ALTERED BASALT** (according to EN 12670).

Fig. 1 - Aspect of the studied sample (hand specimen).

Hand specimen – Visual inspection: It is a mafic, greenish and dusty material with a very weak behavior. It is composed of a dark and very fine groundmass with phenocrysts that are millimetric in size, and light to dark colored.

According to the Rock-Color Chart of the Geological Society of America, the groundmass color is Grayish Green (5G 5/2), and the phenocrysts are Grayish Green (10G 4/2) to Light Bluish Gray (5B 7/1).

The rock fizzes under hydrochloric acid, and it can be scratched by a metal tip.

Probable Origin: It is an altered Plagioclase-rich basaltic rock.

Mineralogy: Plagioclase, Clay Minerals, Olivine, Opaque Minerals, Volcanic Glass, Carbonates

Textures: The rock has a porphyric texture with a very fine and dark groundmass, in which there are Plagioclase crystals, rare Olivine crystals, Opaque Minerals, and many alteration Clay Minerals (predominantly Phyllosilicates such as Chlorite).
Plagioclase is the most common mineral phase: crystals are quite large and well zoned. Because of their golden color, clay minerals can be hardly distinguished from the groundmass, except for Chlorite that can be locally seen in amorphous greenish individuals.
Opaque Minerals are mainly made up of Oxides of the Hematite group.
Spotted Carbonates may be also identified.

Alteration and Mineral Suturing Condition: The rock is highly altered: even the largest phenocrysts show traces of intense alteration acted upon by clayey minerals; Plagioclase crystals are intensively fractured. These fractures are commonly filled with secondary clayey material in a "quasi-stylolithic" pattern.

Discontinuities: The rock shows a very pervasive fracture system: many of these fractures have not been filled with secondary mineralization, and they predominantly cross the groundmass. Fractures crossing phenocrysts are instead filled with clay minerals.

Description of Individual Minerals:

Minerals	Mineral Content (%)	Mohs Hardness	Grain Size (mm)	Description and Comments
Plagioclase	33.3	6	1.10	As individual crystals
Chlorite	1.67	2.5	0.05	Very variable in size, alteration single crystals
Oxides	6.67	5.5	0.02-0.8	Spotted Hematite individuals
Glass	50	5	Sub-micrometric	Makes up the groundmass
Clay	8.33	4	Sub-micrometric	Phyllosilicates, unresolvable at a microscopic scale
Weighted Average:		4.2	-	

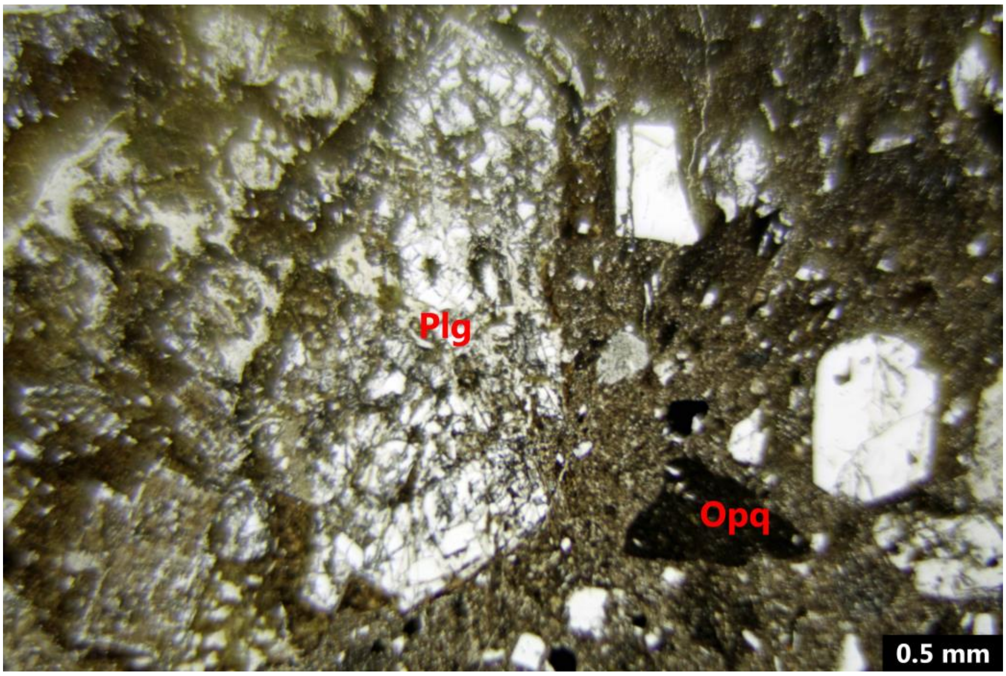

Fig. 2 - Plane polarized light. Field of view = 4 mm wide (magnification 4X). A view of the studied sample, showing an altered Plagioclase (Plg) crystal near to a big Hematite crystal (Opq).

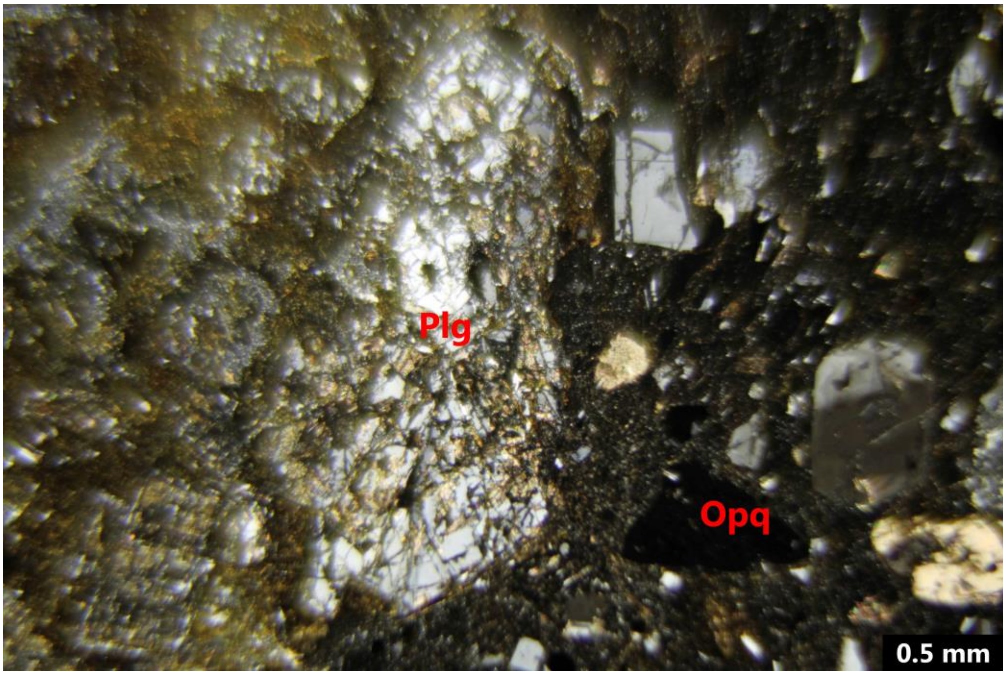

Fig. 3 - Cross polarized light. Field of view = 4 mm wide (magnification 4X). Same as Figure 2, but under crossed polars.

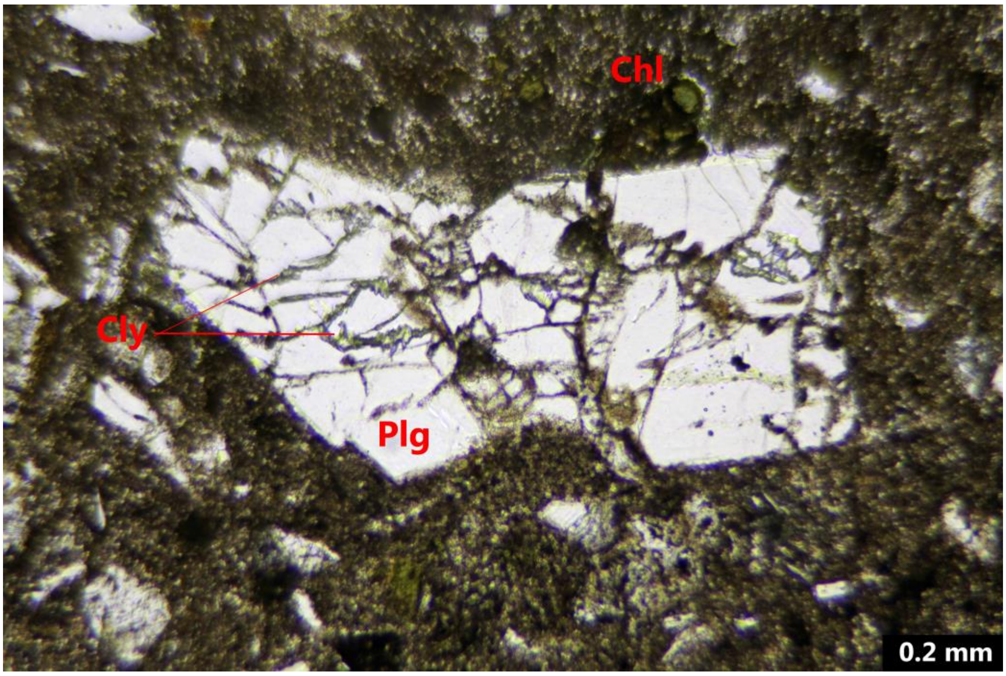

Fig. 4 - Plane polarized light. Field of view = 1.7 mm wide (magnification 10X). A detail of a Plagioclase grain, crossed by many fractures, all filled with Clay Minerals (Cly). Some Chlorite individuals (Chl) may be identified in the upper part of the picture.

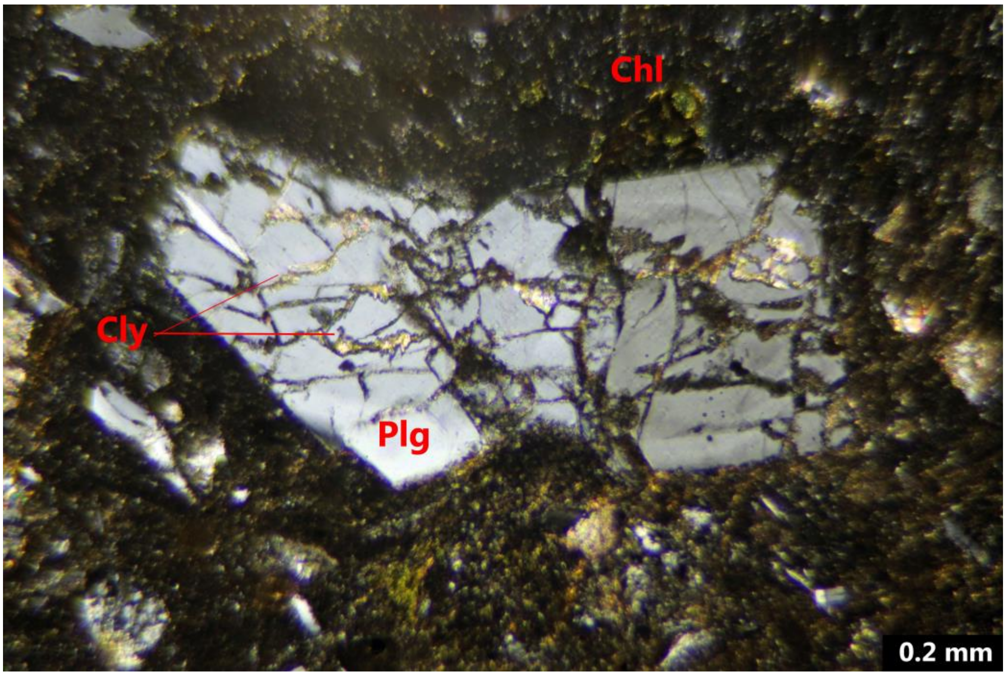

Fig. 5 - Cross polarized light. Field of view = 1.7 mm wide (magnification 10X). Same as Figure 4, but under crossed polars.

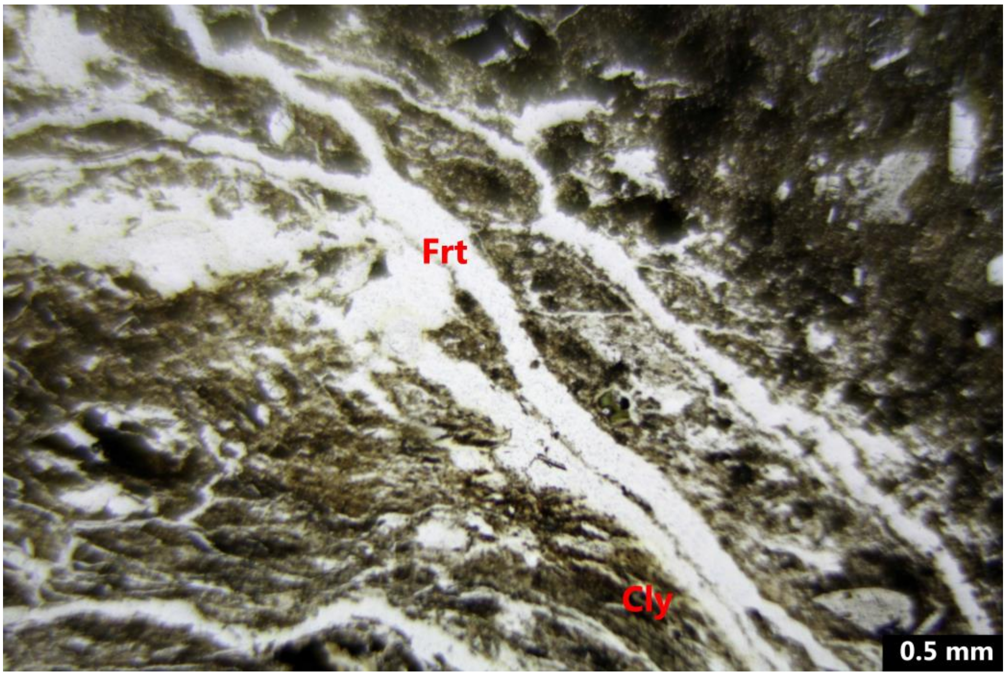

Fig. 6 - Plane polarized light. Field of view = 4 mm wide (magnification 4X). A selected area of the section with a well-developed fracture system (Frt).

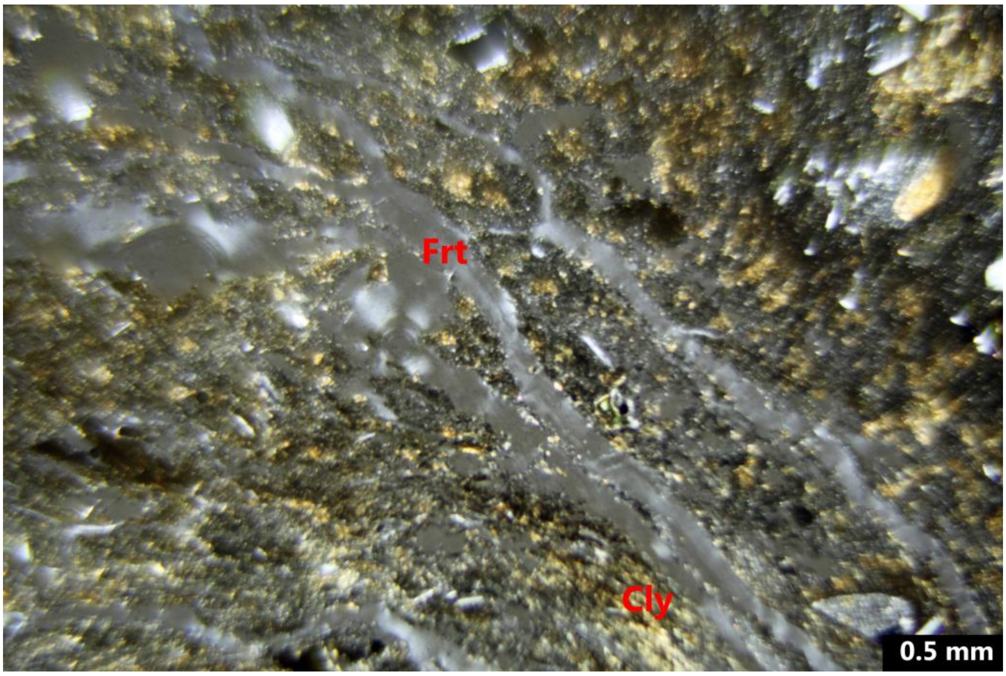

Fig. 7 - Cross polarized light. Field of view = 4 mm wide (magnification 4X). Same as Figure 6, but under crossed polars.

Project Name	Klamath River Dam Removal
Project location	Klamath River
Client	Klamath River Renewal Corporation
Client's Project No.	60537920
Registry No.	2018-22
Report No.	2018-22-7-2
Report Date	5/17/2018
Borehole and Depth	BI-03; 20.8-21 ft
Studied by	Lidia Scavo and Fulvio Tonon
Reviewed by	Gloria Tonon-Kozma

Date Received : 4/24/2018	Date Opened : 4/24/2018	Date Tested: 5/17/2018

A sample from borehole BI-03; 20.8-21 ft was analyzed under the polarized microscope to determine its mineralogical composition from a 25 X 40 mm (0.9 X 1.58 in) thin section.

Visual inspection of the sample suggests an igneous origin.

ROCK NAME: **ALTERED VOLCANIC BRECCIA** (according to EN 12670).

Fig. 1 - Aspect of the studied sample (hand specimen).

Hand specimen – Visual inspection: It is a greenish mafic rock. It appears to be very weak, and it shows a dusty appearance. It is composed of a dark green groundmass with spotted whitish to bluish phenocrysts.

According to the Rock-Color Chart of the Geological Society of America, the groundmass color is Grayish Green (5G 5/2); clasts have colors ranging from Dark Greenish Gray (4G 4/1) to Light Bluish Gray (5B 7/1). The matter also shows alterations that are Dark Greenish Yellow (10Y 6/6).

The rock fizzes under hydrochloric acid, and it can be scratched by a metal tip.

Probable Origin: It is an altered volcanic breccia.

Mineralogy: Plagioclase, Volcanic Glass, Pyroxene, Chlorite, Clay Minerals, Opaque Minerals, Carbonates.

Textures: It is a mafic porphyritic rock with a chaotic structure: no preferred orientation may be identified.
Plagioclase is the most common constituent mineral: its crystals range from sub-millimetric in size to glassy and are usually well shaped. Zonation is irregular.
Some of the clasts are made up of extraneous volcanic clasts; they can be easily identified because of their color variation when compared to the rest of the thin section: these clasts display a different mafic content.
Secondary mineral phases are made up of rare Augite-Pyroxene, Chlorite, Carbonates and Opaque Minerals.
Very common, but not resolvable at a microscopic observation scale, are Volcanic Glass and Clay Minerals. Clay Minerals also represent the main alteration substance of the rock, which affects both the groundmass and the clasts.

Alteration and Mineral Suturing Condition: The sample shows a substaintial clayey alteration, with clear Chlorite individuals associated with very fine-grained Clay Minerals. Spotted secondary Carbonates can be found as fracture filling material.
Crystals in this thin section have well defined rims, but they are also affected by pervasive fractures both within the crystals and all around their boundaries.

Discontinuities: The rock is heavily fractured, with two classes of discontinuities: a first one made up of empty cracks crossing the groundmass and the crystals, and a second one made up of Carbonate-filled fractures, sometimes surrounding single crystals or clasts.

Description of Individual Minerals:

Minerals	Mineral Content (%)	Mohs Hardness	Grain Size (mm)	Description and Comments
Plagioclase	28.33	6	0.6	As single individuals or as the main part of many external clast groundmass
Chlorite	1.67	2	0.3	As individuals of secondary crystallization
Opaque Minerals	5	5.5	0.1	Spotted individuals of Hematite
Glass	41.67	5	Sub-micrometric	Makes up the groundmass
Pyroxene	1.67	5.5	0.2	Rare sub-euhedral crystals
Carbonates	5	4	0.06	As fracture filling material
Clay Minerals	16.67	2	Sub-micrometric	Phyllosilicates of secondary alteration
Weighted Average:		4.3	-	

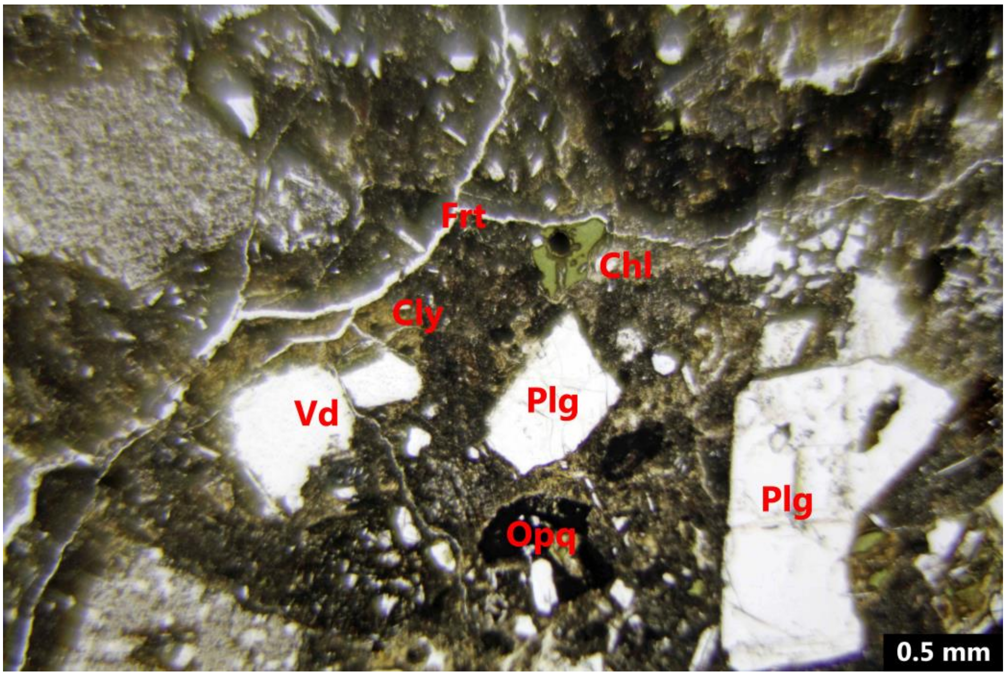

Fig. 2 - Plane polarized light. Field of view = 4 mm wide (magnification 4X). A view of the studied sample. The most common minerals are: Plagioclase (Plg), Clay Minerals (Cly), Opaque Minerals (Opq), and Chlorite (Chl). Also highlighted here are some structural features, such as fractures (Frt) and voids (Vd).

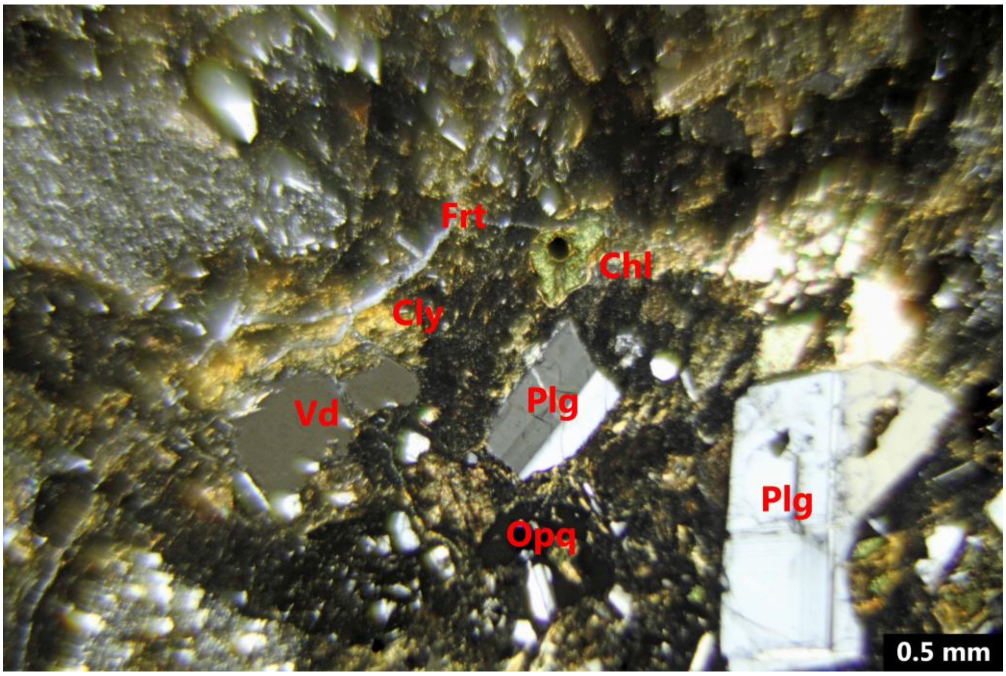

Fig. 3 - Cross polarized light. Field of view = 4 mm wide (magnification 4X). Same as Figure 2, but under crossed polars.

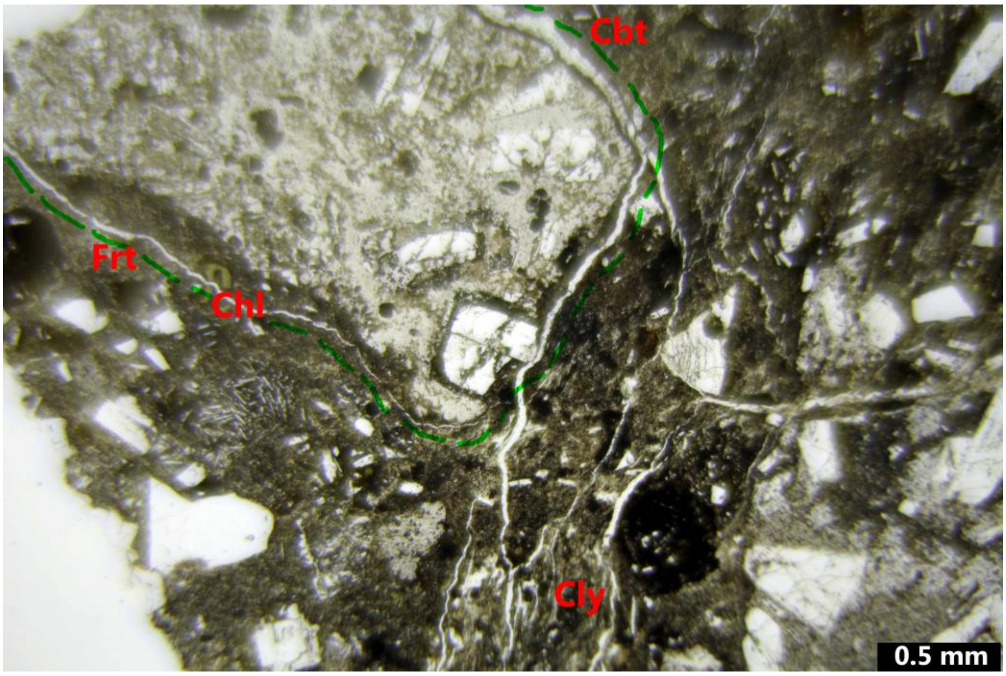

Fig. 4 - Plane polarized light. Field of view = 4 mm wide (magnification 4X). A view of a volcanic clast. A common feature of all the clasts in this thin section is the presence of fractures surrounding clast boundaries (follow the green dashed line). In this case the fracture is filled with secondary Carbonates (Cbt).

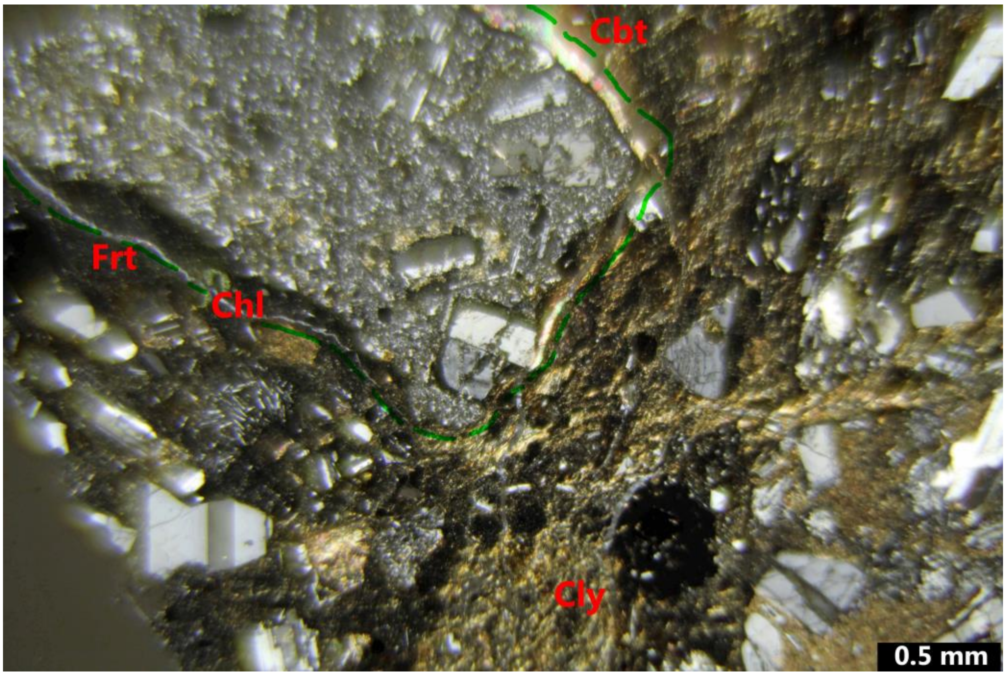

Fig. 5 - Cross polarized light. Field of view = 4 mm wide (magnification 4X). Same as Figure 4, but under crossed polars.

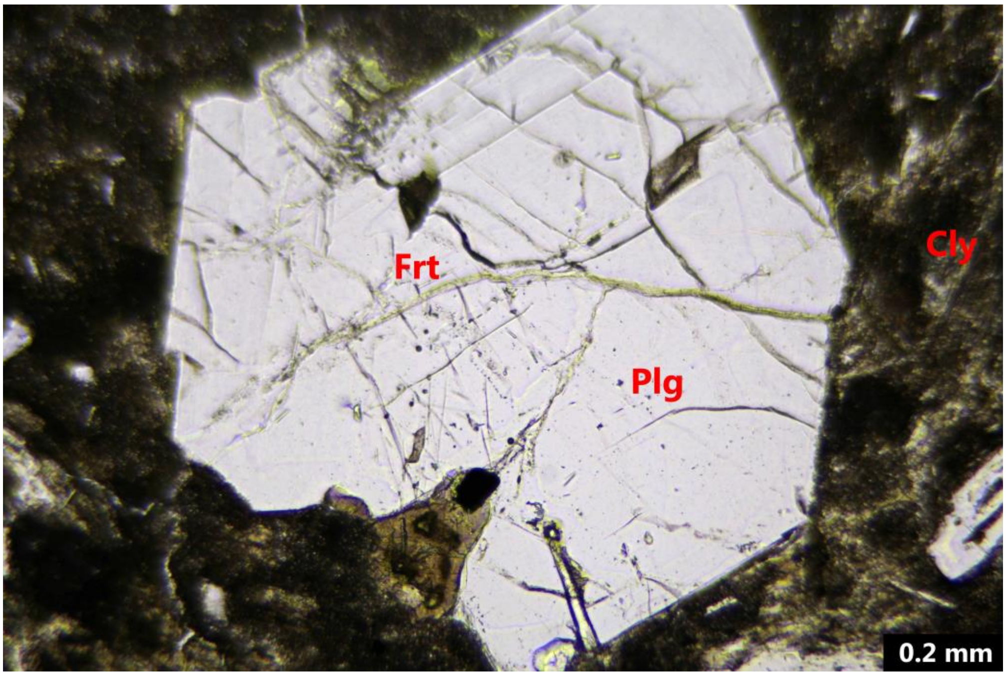

Fig. 6 - Plane polarized light. Field of view = 1.7 mm wide (magnification 10X). A detail of a Plagioclase crystal, showing grain alteration and suturing features: fractures cross the crystal and are also filled with Clay Minerals.

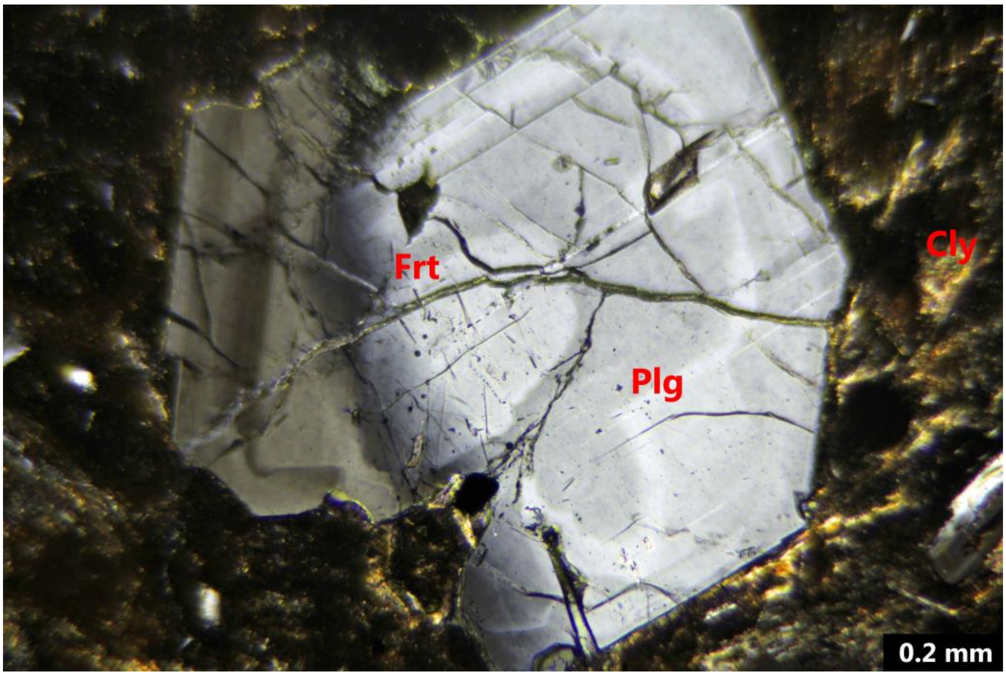

Fig. 7 - Cross polarized light. Field of view = 1.7 mm wide (magnification 10X). Same as Figure 6, but under crossed polars.

COMPANY WITH QUALITY SYSTEM CERTIFIED BY DNV GL = ISO 9001 =

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Project Name	Klamath River Dam Removal
Location	Klamath River
Client	Klamath River Renewal Corporation
Client Project No.	60537920
Registry No.	2018-22
Report No.	2018-22-8-1
Report Date	5/17/2018
Drill Hole and Depth	BI-02; 27-27.9 ft
Rock Type	Volcanic Breccia
Geologic Unit	N/A
Moisture Condition	As-received

Date received : 4/24/2018	Date Opened : 4/24/2018	Date Tested: 4/24/2018

Mohs Hardness
3

Performed by: Dr. Fulvio Tonon, P.E., Ph.D.

Checked by: Gloria Tonon-Kozma, P.E.

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Web: tononeng.com

Project Name	Klamath River Dam Removal
Location	Klamath River
Client	Klamath River Renewal Corporation
Client Project No.	60537920
Registry No.	2018-22
Report No.	2018-22-8-2
Report Date	5/17/2018
Drill Hole and Depth	BI-02; 48.9-50.3 ft
Rock Type	Volcanic Breccia
Geologic Unit	N/A
Moisture Condition	As-received

Date received : 4/24/2018	Date Opened : 4/24/2018	Date Tested: 4/24/2018

Mohs Hardness
3

Performed by: Dr. Fulvio Tonon, P.E., Ph.D.

Checked by: Gloria Tonon-Kozma, P.E.

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COMPANY WITH QUALITY SYSTEM CERTIFIED BY DNV GL = ISO 9001 =

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Engineering, Measurements and Testing, LLC

Web: tononeng.com

Project Name	Klamath River Dam Removal
Location	Klamath River
Client	Klamath River Renewal Corporation
Client Project No.	60537920
Registry No.	2018-22
Report No.	2018-22-8-3
Report Date	5/17/2018
Drill Hole and Depth	BI-02; 55.4-56.3 ft
Rock Type	Volcanic Breccia
Geologic Unit	N/A
Moisture Condition	As-received

Date received : 4/24/2018	Date Opened : 4/24/2018	Date Tested: 4/24/2018

Mohs Hardness
3

Performed by: Dr. Fulvio Tonon, P.E., Ph.D.

Checked by: Gloria Tonon-Kozma, P.E.

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Project Name	Klamath River Dam Removal
Location	Klamath River
Client	Klamath River Renewal Corporation
Client Project No.	60537920
Registry No.	2018-22
Report No.	2018-22-8-4
Report Date	5/17/2018
Drill Hole and Depth	BI-03; 17.4-18.4 ft
Rock Type	Volcanic Breccia
Geologic Unit	N/A
Moisture Condition	As-received

Date received : 4/24/2018	Date Opened : 4/24/2018	Date Tested: 4/24/2018

Mohs Hardness
3

Performed by: Dr. Fulvio Tonon, P.E., Ph.D.

Checked by: Gloria Tonon-Kozma, P.E.

2028 E Ben White BLVD #240-2660
Austin, TX 78741

Laboratory Director:Dr. Fulvio Tonon, P.E., Ph.D.
Phone: +1-512-200-3051
E-mail: fulvio@tononeng.com

COMPANY WITH QUALITY SYSTEM CERTIFIED BY DNV GL = ISO 9001 =

Tonon USA
Engineering, Measurements and Testing, LLC

Web: tononeng.com

Project Name	Klamath River Dam Removal
Location	Klamath River
Client	Klamath River Renewal Corporation
Client Project No.	60537920
Registry No.	2018-22
Report No.	2018-22-8-5
Report Date	5/17/2018
Drill Hole and Depth	BI-03; 21.5-22.9 ft
Rock Type	Volcanic Breccia
Geologic Unit	N/A
Moisture Condition	As-received

Date received : 4/24/2018	Date Opened : 4/24/2018	Date Tested: 4/24/2018

Mohs Hardness
3

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Project Name	Klamath River Dam Removal	Penetration rate	0.001 in/sec			
Location	Klamath River	Diameter of specimen	60.65	mm	2.39	in
Client	Klamath River Renewal Corporation	Height of specimen	64.62	mm	2.54	in
Client Project No.	60537920	Load at peak	27.81	kN	6,251	lbf
Registry No.	2018-22	45 Degree (Standard) Index	175			
Report No.	2018-22-8-1	Peak Slope Index	39			
Report Date	5/17/2018					
Drill Hole and Depth	BI-02; 50.3-51.3 ft					
Rock Type	Volcanic Breccia					
Geologic Unit	N/A					
Moisture Condition	As-received					

Date Received : 4/24/2018	Date Opened : 4/24/2018	Date Tested: 5/4/2018

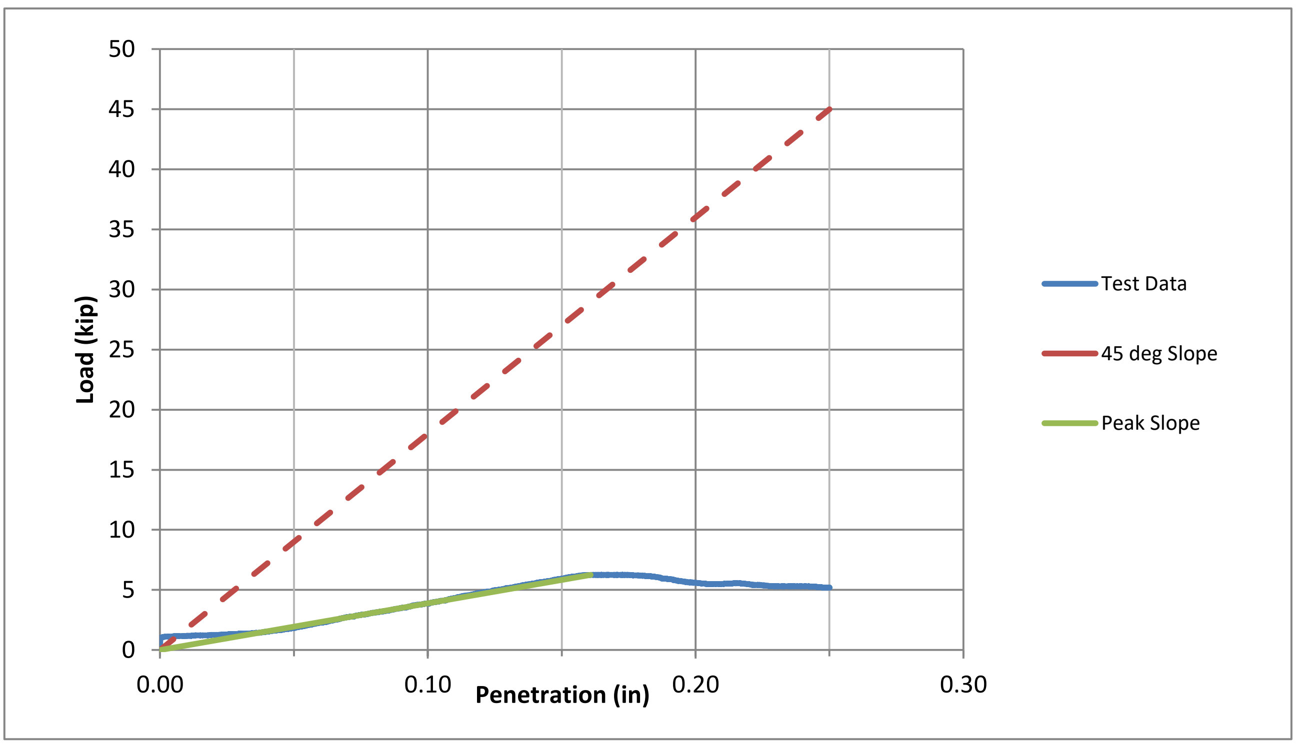

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Photo After Test

Performed by: Dr. Fulvio Tonon, P.E., Ph.D.

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Project Name	Klamath River Dam Removal	Penetration rate	0.001 in/sec			
Location	Klamath River	Diameter of specimen	60.4	mm	2.38	in
Client	Klamath River Renewal Corporation	Height of specimen	67.53	mm	2.66	in
Client Project No.	60537920	Load at peak	19.46	kN	4,373	lbf
Registry No.	2018-22	45 Degree (Standard) Index	175			
Report No.	2018-22-8-2	Peak Slope Index	18			
Report Date	5/17/2018					
Drill Hole and Depth	BI-03; 24.2-25.1 ft					
Rock Type	Volcanic Breccia					
Geologic Unit	N/A					
Moisture Condition	As-received					

Date Received : 4/24/2018	Date Opened : 4/24/2018	Date Tested: 5/4/2018

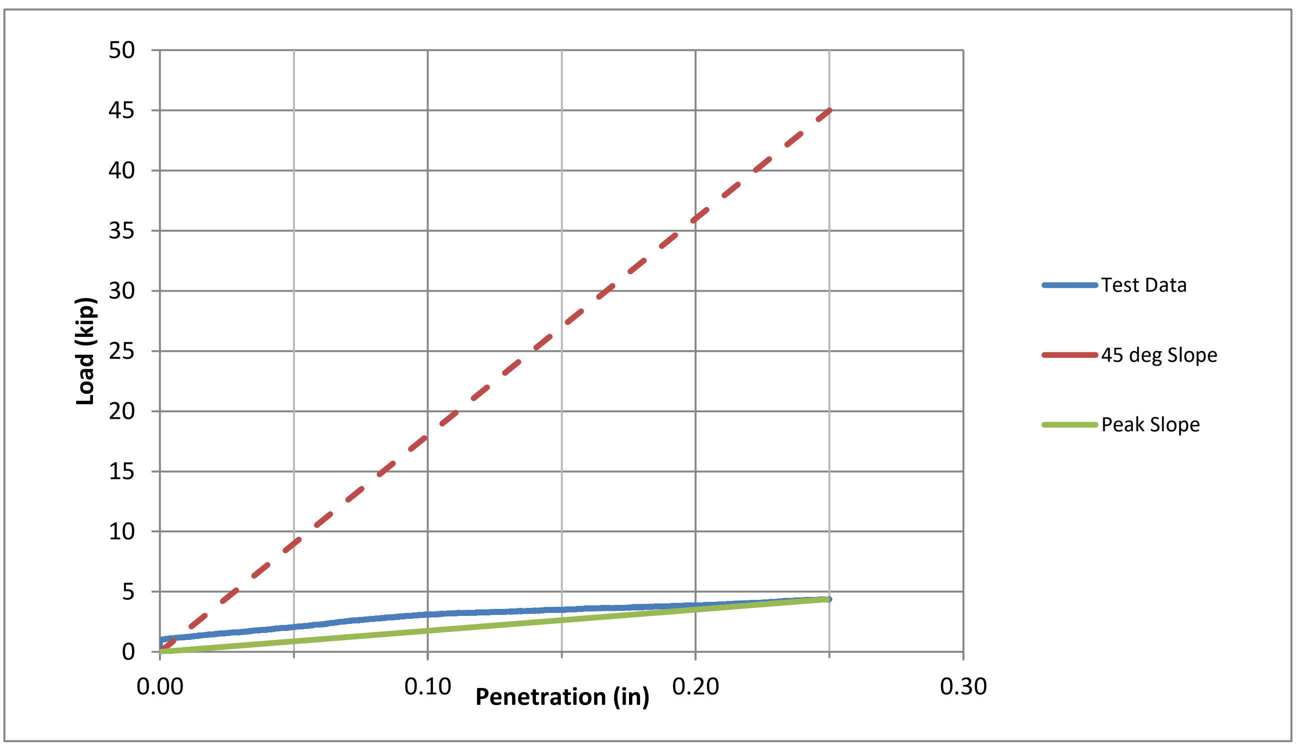

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Photo After Test

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www.klamathrenewal.org