KLAMATH RIVER RENEWAL CORPORATION

Klamath River Renewal Project

City of Yreka Waterline Modification Project—Technical Specifications

Issued for Construction Submittal

REV 1

McMILLEN JACOBS ASSOCIATES

June 2022

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The technical material and data contained in this document were prepared under the supervision and direction of the undersigned, whose seals, as professional engineers/architects licensed to practice as such, are affixed on the following pages

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CITY OF YREKA WATERLINE MODIFICATION
TECHNICAL SPECIFICATIONS

IFC REDESIGN
TABLE OF CONTENTS

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SECTION 01 11 00 - SUMMARY OF WORK

PART 1 -- GENERAL

1.1 SUMMARY

A. The WORK to be performed under this Contract shall consist of furnishing tools, equipment, materials, supplies, and manufactured articles, and furnishing all labor, transportation, and services, including fuel, power, water, and essential communications, and performing all work or other operations required for the fulfillment of the Contract in strict accordance with the Contract Documents. The WORK shall be complete, and all work, materials, and services not expressly indicated or called for in the Contract Documents which may be necessary for the complete and proper construction of the WORK in good faith shall be provided by the CONTRACTOR as though originally so indicated, at no increase in cost to the OWNER.

1.2 WORK COVERED BY CONTRACT DOCUMENTS

A. The WORK of this Contract is comprised of the demolition of the existing 24-inch diameter steel pipe that is minimally buried in the Iron Gate Reservoir bed and the construction of a new 25 diameter steel pipe along the Daggett Road and supported along the new Daggett Bridge across the Klamath River.

B. The WORK is located in Siskiyou County northeast of Iron Gate Dam near Hornbrook, California. The Project is located near the intersection of Copco Road and Daggett Road southwest of the Daggett Road Bridge crossing the Klamath Reservoir.

1.3 WORK SEQUENCE

A. The construction work sequence proposed in the steps that follow are intended to inform the CONTRACTOR on the ENGINEER's design development process. This shall not dictate the CONTRACTOR's means and methods. Construction activities shall be scheduled and sequenced to ensure continuous operation of the OWNER's raw waterline to the greatest extent possible. Short outages are allowed with approval from the OWNER and Engineer. The OWNER has stated that the waterline outage is allowed for up to 20 hours in the months of May through October, and an outage is allowed for up to 60 hours in the months of November through April. CONTRACTOR shall submit construction work sequence and outage plan for OWNER and ENGINEER approval.

1. CONSTRUCT NEW DAGGETT BRIDGE AND NEW YREKA WATERLINE SUPPORTED BELOW THE DAGGETT BRIDGE DECK (SEE DRAWING C105). THE DAGGETT BRIDGE DESIGN AND BRIDGE PIPE SUPPORTS ARE NOT INCLUDED IN THIS PACKAGE. PLEASE REFER TO THE DAGGETT BRIDGE DESIGN PACKAGE PREPARED BY MCMILLEN JACOBS.

2. CONSTRUCT NEW 25" BURIED PIPELINE UPSTREAM AND DOWNSTREAM OF DAGGETT BRIDGE CROSSING EXCLUDING CONNECTIONS TO THE EXISTING YREKA WATERLINE.

3. 48 HR PRESSURE TEST NEW PIPELINE AT 375 PSIG WITH BLIND FLANGES OR APPORVED EQUAL ON EACH END OF PIPELINE. DISINFECT WATERLINE. SEE SPECIFICATION SECTION 01 74 30.

4. CONNECT TO EXISTING WATERLINE AT UPSTREAM AND DOWNSTREAM CONNECTION POINTS (SEE DWG C200 AND 201).

5. START UP THE NEW WATERLINE SYSTEM AND OPERATE. ENSURE SYSTEM OPERATING PROPERLY FOR MINIMUM 30 DAYS.

6. AFTER 30 DAYS OF PROPER SYSTEM OPERATION AND OWNER APPROVAL, PERFORM DEMOLITION AND REMOVAL OF EXISTING RIVER CROSSING PIPELINE (SEE DRAWING D101).

1.4 CONTRACTOR USE OF SITE

A. The CONTRACTOR's use of the Site shall be limited to its construction operations, including on-Site storage of materials, on-Site fabrication facilities, and field offices.

1.5 OUTAGE PLAN AND REQUESTS

A. Unless the Contract Documents indicate otherwise, the CONTRACTOR shall not remove from service, de-energize, or modify settings for any existing operating tank, pipeline, pump, valve, channel, equipment, structure, road, or any other facility without permission from the OWNER.

B. Where the WORK requires modifications to existing facilities or construction of new facilities and connection of new facilities to existing facilities, the CONTRACTOR shall submit a detailed outage plan and schedule for the ENGINEER'S approval a minimum of two (2) weeks in advance of the time that such outage is planned.

C. A completed System Outage Request form shall accompany each outage plan. The outage plans shall be coordinated with the construction schedule and shall meet the restrictions and conditions of the Contract Documents. The outage plan shall describe the CONTRACTOR's estimated length of time required to complete said operation; any necessary temporary power, controls, instrumentation or alarms required to maintain control, monitoring, and alarms for the processes; and the manpower and equipment which the CONTRACTOR will furnish. All costs for preparing and implementing the outage plans shall be at no increase in cost to the OWNER.

D. The ENGINEER shall be notified in writing at least one week in advance of the required outage if the schedule for performing the work has changed or if revisions to the outage plan are required.

E. The CONTRACTOR shall provide written confirmation of the shutdown date and time two (2) working days prior to the actual shutdown.

1.6 PROJECT MEETINGS

A. **Preconstruction Conference**

1. Prior to the commencement of WORK at the Site, a preconstruction conference will be held at a mutually agreed time and place. The conference shall be attended by the CONTRACTOR'S Project Manager, its superintendent, and its subcontractors as the CONTRACTOR deems appropriate. Other attendees will be:

   a. ENGINEER and the Resident Project Representative.

   b. Representatives of OWNER.

   c. Governmental representatives as appropriate.

   d. Others as requested by CONTRACTOR, OWNER, or ENGINEER.

2. The CONTRACTOR shall bring the preconstruction conference submittals in accordance with KRRP Project Submittals. The following submittals are required at a minimum.

   a. SWPPP in accordance with Specification 31 25 00 (Erosion and Sedimentation Control) and Contract Drawing EC100 (Erosion and Sediment Control Plan)

   b. Testing and Disinfection Plan in accordance with Specification 01 74 30 (Pressure Pipeline Testing and Disinfection)

   c. Site Condition Assessment in accordance with Specification 02 22 00 (Site Condition Assessment)

   d. Demolition, Salvage, and Rehabilitation plan in accordance with Specification 02 41 00 (Demolition, Salvage, and Rehabilitation)

   e. Earthwork and Trench Backfill Materials in accordance with Specification 31 00 00 (Earthwork)

   f. CLSM Mixture in accordance with Specification 31 23 00 (Controlled Low Strength Material)

   g. Dewatering Plan in accordance with Specification 31 23 19 (Dewatering)

   h. A.C. Pavement and Base in accordance with Specification Section 32 11 13 (A.C. Pavement and Base)

   i. Precast Manholes, Vaults, Hatches, Steps, Ladders, and Penetrations in accordance with Specification 33 05 00 (Precast Concrete Manholes and Vaults)

   j. Steel Pipe, Specials, Coatings, Linings, Appurtenances and Fittings in accordance with Specification 33 11 11(Steel Pipe, Specials and Fittings - AWWA C200) and/or 40 23 15 (Steel Pipe - ASTM A53-A106)

   k. General Piping in accordance with Specification 40 23 00 (Piping General)

   l. Piping Identification in accordance with Specification 40 23 01 (Piping Identification)

m. General Valves in accordance with Specification 43 25 00 (Valves, General)

3. The purpose of the conference is to designate responsible personnel and establish a working relationship. Matters requiring coordination will be discussed and procedures for handling such matters established. The complete agenda will be furnished to the CONTRACTOR prior to the meeting date. However, the CONTRACTOR should be prepared to discuss all of the items listed below.

a. CONTRACTOR's tentative schedules.

b. Transmittal, review, and distribution of CONTRACTOR's submittals.

c. Processing applications for payment.

d. Critical work sequencing.

e. Field decisions and Change Orders.

f. Use of Site, office and storage areas, security, housekeeping, and OWNER's needs.

g. Major equipment deliveries and priorities.

h. CONTRACTOR's assignments for safety and first aid.

i. Submittal Transmittal Form which the ENGINEER will furnish.

4. The ENGINEER will preside at the preconstruction conference and will arrange for keeping and distributing the minutes to all persons in attendance.

5. The CONTRACTOR and its subcontractors should plan on the conference taking no less than one (1) full working day. The meeting will cover the items listed in paragraphs 2 and 3, and reviewing the Drawings and Specifications, in extensive detail, with the ENGINEER and the OWNER.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

- END OF SECTION -

SECTION 01 42 10 - REFERENCE STANDARDS

PART 1 -- GENERAL

1.1 GENERAL

A. **Titles of Sections and Paragraphs:** Titles and subtitles accompanying specification sections and paragraphs are for convenience and reference only and do not form a part of the Specifications.

B. **Applicable Publications:** Whenever in these Specifications references are made to published specifications, codes, standards, or other requirements, it shall be understood that wherever no date is indicated, only the latest specifications, standards, or requirements of the respective issuing agencies which have been published as of the date that the Contract is advertised for Bids shall apply; except to the extent that said standards or requirements may be in conflict with applicable laws, ordinances, or governing codes. No requirements set forth in the Specifications or shown on the Drawings will be waived because of any provision of or omission from said standards or requirements.

C. **Specialists, Assignments:** In certain instances, specification text requires (or implies) that specific WORK is to be assigned to specialists or expert entities who must be engaged to perform that WORK. Such assignments shall be recognized as special requirements over which the CONTRACTOR has no choice or option. These requirements shall not be interpreted so as to conflict with the enforcement of building codes and similar regulations governing the WORK; also they are not intended to interfere with local union jurisdiction settlements and similar conventions. Such assignments are intended to establish which party or entity involved in a specific unit of WORK is recognized as "expert" for the indicated construction processes or operations. Nevertheless, the final responsibility for fulfillment of the entire set of Contract requirements remains with the CONTRACTOR.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. The CONTRACTOR shall construct the WORK in accordance with the Contract Documents and the referenced portions of those referenced codes, standards, and specifications.

B. In case of conflict between codes, reference standards, drawings, and the other Contract Documents, the most stringent requirements shall govern. All conflicts shall be brought to the attention of the ENGINEER for clarification and direction prior to ordering or providing any materials or furnishing labor. The CONTRACTOR shall bid for the most stringent requirements.

C. References to "OSHA Regulations for Construction" shall mean **Title 29, Part 1926, Construction Safety and Health Regulations,** Code of Federal Regulations (OSHA), including all changes and amendments thereto.

D. References to "OSHA Standards" shall mean **Title 29, Part 1910, Occupational Safety and Health Standards,** Code of Federal Regulations (OSHA), including all changes and amendments thereto.

E. **Applicable Safety Standards**: References to "Cal-OSHA" shall mean State of California, Department of Industrial Relations, Construction Safety Orders, as amended to date, and all changes and amendments thereto.

1.3 REGULATIONS RELATED TO HAZARDOUS MATERIALS

A. The CONTRACTOR shall be responsible that all WORK included in the Contract Documents, regardless if indicated or not, shall comply with all EPA, OSHA, RCRA, NFPA, and any other federal, state, and local regulations governing the storage and conveyance of hazardous materials, including petroleum products.

B. Where no specific regulations exist and the OWNER has not waived the requirement in writing, chemical, hazardous, and petroleum product piping and storage in underground locations shall be double containment piping and tanks or be installed in separate concrete trenches and vaults with an approved lining that cannot be penetrated by the chemicals.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

- END OF SECTION -

SECTION 01 74 30 - PRESSURE PIPE TESTING AND DISINFECTION

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall test and disinfect raw water pipelines and appurtenant piping, in accordance with the Contract Documents.

B. The CONTRACTOR shall be responsible for obtaining permits for discharging excess testing and disinfection water if required to satisfy permit limits.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with KRRP Project Submittals.

B. **Furnish:**

1. A testing plan and schedule, including method for water conveyance, and control, disposal shall be submitted in writing for approval.

PART 2 -- PRODUCTS

2.1 MATERIAL REQUIREMENTS

A. All test equipment, temporary valves, bulkheads, and other water control equipment shall be as determined by the CONTRACTOR. No materials shall be used which would be injurious to the WORK.

A. Chlorine for disinfection may be in the form of liquid chlorine, sodium hypochlorite solution, or calcium hypochlorite granules or tablets.

1. Liquid chlorine shall be in accordance with ANSI/AWWA B301 - Liquid Chlorine, and shall be used only when the following 3 conditions are met:
    a. With appropriate gas flow chlorinators and ejectors,
    b. Under the direct supervision of an experienced technician
    c. When appropriate safety practices are observed
2. Sodium and calcium hypochlorite shall be in accordance with ANSI/AWWA B300-Hypochlorites.

B. Dechlorination agents may be sodium bisulfate, sodium sulfite, or sodium thiosulfate.

PART 3 -- EXECUTION

3.1 GENERAL

A. Water for testing and disinfection of water pipelines will be furnished by the OWNER; however, the CONTRACTOR shall convey the water from the OWNER-designated source to the points of use.

B. All pressure pipelines shall be tested. All testing operations shall be performed in the presence of the ENGINEER.

C. Disinfection operations shall be scheduled as late as possible during the Contract Time to maximize the degree of sterility of the facilities at the time the WORK is accepted by the OWNER. Bacteriological testing shall be performed by a certified testing laboratory acceptable to the OWNER. Results of the bacteriological testing shall be satisfactory to the State Department of Health or other appropriate regulatory agency.

D. Disposal of flushing water and water containing chlorine shall be by methods acceptable to the ENGINEER.

A. Disinfection operations shall be scheduled as late as possible during the Contract Time to maximize the degree of sterility of the facilities at the time the WORK is accepted by the OWNER. Bacteriological testing shall be performed by a certified testing laboratory accepted by the OWNER. Results of the bacteriological testing shall be satisfactory with the State Department of Health or other appropriate regulatory agency.

3.2 PIGGING

A. The CONTRACTOR shall clean the system thoroughly by pigging to remove sand, grit, gravel, stones, fluids, construction waste, and all material which would not be found in a properly cleaned pipeline. Pigging shall obtain a smooth interior pipe surface free from any material or fluid not used in cleaning.

B. Pigging shall be defined as passage of a sufficient number of pigs through the pipeline to achieve the clean conditions required. Flushing will not be acceptable as a substitute for pigging.

C. Provision for pig access and egress points and disposal of water and materials shall be the CONTRACTOR's responsibility.

D. Pigs shall be individually marked and their location shall be controlled and monitored so that no pigs remain in the system after cleaning.

E. Pigging may be done in conjunction with initial filling for the hydrostatic test.

3.3 HYDROSTATIC TESTING OF PIPELINES

A. Prior to hydrostatic testing, pipelines shall be flushed or blown out as appropriate. The CONTRACTOR shall test pipelines in sections. Sections to be tested shall be defined by isolation valves in the pipeline. Where such valves are not present, the CONTRACTOR shall install temporary bulkheads or plugs for the purpose of testing.

Sections that do not have isolation valves shall be tested in approximate one-mile segments. Sections that have a zero leakage allowance may be tested as a unit. No section of the pipeline shall be tested until field-placed concrete or mortar has attained an age of 14 Days. The test shall be made by closing valves when available or by placing bulkheads and filling the line slowly with water. The CONTRACTOR shall be responsible for ascertaining that test bulkheads are suitably restrained to resist the thrust of the test pressure without damage to or movement of the adjacent pipe. Unharnessed sleeve-type couplings, expansion joints, or other sliding joints shall be restrained or suitably anchored prior to the test to avoid movement and damage to piping and equipment. Remove or protect any pipeline-mounted devices that may be damaged by the test pressure. The CONTRACTOR shall provide sufficient temporary tappings in the pipelines to allow for trapped air to exit. After completion of the tests, such taps shall be permanently plugged. Care shall be taken that air relief valves are open during filling.

B. The pipeline shall be filled at a rate which will not cause any surges or exceed the rate at which the air can be released through the release valves at a reasonable velocity. The air within the pipeline shall be allowed to escape completely. The differential pressure across the orifices in the air release valves shall not be allowed to exceed 5 psi at any time during filling. After the pipeline or section thereof has been filled, it shall be allowed to stand under a slight pressure for at least 24 hours to allow the concrete or mortar lining, as applicable, to absorb water and to allow the escape of air from air pockets. During this period, bulkheads, valves, and connections shall be examined for leaks. If leaks are found, corrective measures satisfactory to the ENGINEER shall be taken.

C. The hydrostatic test shall consist of holding the indicated test pressure on the pipeline segment for a period of 4 hours. The test pressure for yard piping shall be as indicated on the Piping Schedule measured at the lowest point of the pipeline section being tested. Visible leaks that appear during testing shall be repaired in a manner acceptable to the ENGINEER. Add water to restore the test pressure if the pressure decreases 5-psi below test pressure during the test period.

D. Pipe with welded joints shall have no leakage. Exposed piping shall show no visible leaks and no pressure loss during the test. In the case of pipelines that fail to pass the leakage test, the CONTRACTOR shall determine the cause of the leakage, shall take corrective measures necessary to repair the leaks, and shall again test the pipeline, repeating as necessary until the pipeline passes.

3.4 DISINFECTING PIPELINES

A. **General:** Potable water pipelines except those appurtenant to hydraulic structures shall be disinfected in accordance with the requirements of ANSI/AWWA C651 - Disinfecting Water Mains, using the Continuous-Feed Method as modified herein.

B. **Chlorination:** A chlorine-water mixture shall be uniformly introduced into the pipeline by means of a solution-feed chlorinating device. The chlorine solution shall be introduced at one end of the pipeline through a tap in such a manner that as the pipeline is filled with water, the dosage applied to the water entering the pipe shall be approximately 50 mg/l. Care shall be taken to prevent the strong chlorine solution in the line being disinfected from flowing back into the line supplying the water.

C. **Retention Period:** Chlorinated water shall be retained in the pipeline for at least 24 hours. After the chlorine-treated water has been retained for the required time, the free chlorine residual at the pipeline extremities and at other representative points shall be at least 25 mg/l. If testing does not demonstrate a residual of 25 mg/l or greater, the disinfection procedure above shall be repeated.

D. **Chlorinating Valves:** During the process of chlorinating the pipelines, valves and other appurtenances shall be operated from closed to full open to closed while the pipeline is filled with the heavily-chlorinated water.

E. **Sampling Ports:** The CONTRACTOR shall provide sampling ports along the pipeline as defined on AWWA C651. Taps may be made at manways and air valves to help facilitate the spacing requirement.

F. **Final Flushing:** After the applicable retention period, the heavily chlorinated water shall be flushed from the pipeline until chlorine measurements show that the concentration in the water leaving the pipeline is no higher than that generally prevailing in the system or is acceptable for domestic use. Any release of chlorinated water shall comply with federal, state, and local regulation and the permits for the project. Chlorine in excessive amounts shall be treated before discharge.

G. **Bacteriological Testing:** After final flushing and before the pipeline is placed in service, a sample, or samples shall be collected from the end of the line, and shall be tested for bacteriological quality in accordance with the requirements of the State Department of Health or other appropriate regulatory agency. For this purpose, the pipe shall be re-filled with fresh potable water and left for a period of 24 hours before any sample is collected. If testing does not demonstrate a free chlorine residual after the 24-hour period, the disinfection procedure above shall be repeated. If the initial disinfection treatment fails to produce satisfactory bacteriological test results, the disinfection procedure shall be repeated until acceptable results are obtained.

3.5 CONNECTIONS TO EXISTING SYSTEM

A. Where connections are to be made to an existing water system, the interior surfaces of all pipe and fittings used in making the connections shall be swabbed or sprayed with a one percent hypochlorite solution before installation. Thorough flushing shall be started as soon as the connection is completed and shall be continued until discolored water is eliminated.

- END OF SECTION -

SECTION 02 22 00 - SITE CONDITIONS ASSESSMENT

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall conduct thorough pre-construction and post-construction Site conditions surveys of the entire Project. Site conditions surveys shall consist of photographs, video recordings, and topographic mapping.

1.2 CONTRACTOR SUBMITTALS

A. Video surveys, photographs, and other data of the preconstruction conditions shall be submitted to the ENGINEER for record purposes prior to, but not more than three weeks before, commencement of any construction activities.

B. Except as otherwise indicated, post-construction topographic mapping shall be submitted to the ENGINEER within 60 days of completing WORK.

C. A complete set of all photographs and survey data of the post-construction conditions shall be completed and submitted prior to final inspection by the OWNER and ENGINEER.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.1 PHOTOGRAPHS AND VIDEO RECORDINGS

A. CONTRACTOR, as a minimum, shall document pre- and post-construction conditions by preparing video surveys of the following:

1. Roadways used to access the Site or haul materials and equipment to the Site.

2. Work areas, including actual work sites, materials processing and stockpiling areas, access corridors, disposal areas, and staging areas.

3. Any work completed by other contractors at the Site that will be connected to or otherwise affected by the WORK.

4. Driveways, sidewalks, and buildings which might be affected by the WORK.

B. Supplement video surveys with photographs and spot elevation surveys as required to thoroughly document the original condition and location of existing features and facilities.

3.2 TOPOGRAPHIC MAPPING

A. Topographic mapping shall be developed using the Project coordinates, shall be referenced to the Project base lines and bench marks, and shall be adequate to ascertain pre-construction and post-construction elevations of all public and private property within and adjacent to the construction limits

B. Topographic mapping shall be conducted to document the post-construction topography of the Site:

C. Spot elevation surveys used to document the elevation on abutting roadways, drives, and walks shall be taken at approximately 20-foot intervals and at the point of juncture with any structure to which they are attached or otherwise influenced by the WORK.

D. All pre- and post-construction topographic mapping and other data, including spot elevations, shall be prepared and sealed by a Professional Land Surveyor in the State of California.

E. All pre- and post-construction survey data shall be furnished as follows:

1. Site mapping shall be submitted as a separate electronic drawing in the latest version of AutoCAD.

2. Each AutoCAD site map shall also be submitted in PDF format.

3. ENGINEER will review PDF plots for accuracy relative to the indicated requirements.

4. CONTRACTOR shall amend mapping files as required, based on ENGINEER's comments.

5. The electronic mapping files shall be produced using field survey techniques with sufficient accuracy for reproduction and use as base maps at a scale of 1"=20' horizontal and 1-foot contour intervals as specified for National Map Accuracy Standards.

6. Electronic mapping files shall be three-dimensional.

7. Submit points lists for all topographic surveys in digital format.

- END OF SECTION -

SECTION 02 41 00 – DEMOLITION, SALVAGE, AND REHABILITATION

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall demolish and reconstruct existing civil and mechanical facilities as indicated, in accordance with the Contract Documents.

1.2 COORDINATION

A. The CONTRACTOR shall carefully coordinate the WORK in areas where existing facilities are interconnected with new facilities and where existing facilities remain operational. The WORK as indicated is not all inclusive, and the CONTRACTOR shall be responsible to perform the reconstruction indicated plus that which can be reasonably inferred from the Contract Documents as necessary to complete the Project. The Specifications and Drawings identify the major facilities that shall be demolished and reconstructed, but auxiliary utilities such as water, air, chemicals, drainage, lubrication, fluid power, electrical wiring, controls, and instrumentation are not necessarily shown. The CONTRACTOR shall comply with sequencing requirements in Section 01 11 00 – Summary of Work.

B. The CONTRACTOR shall note that the Drawings used to indicate demolition and reconstruction are based on record drawings of the existing facilities. These record drawings have been reproduced to show existing conditions and to clarify the scope of WORK. Prior to bidding, the CONTRACTOR shall conduct a comprehensive survey at the Site to verify the correctness and exactness of the Drawings, the scope of WORK, and the extent of auxiliary utilities. A complete set of record drawings is available for review at the Project site.

C. While demolition and reconstruction are being performed, the CONTRACTOR shall provide adequate access for the continued operation and maintenance of equipment. The CONTRACTOR shall erect and maintain fences, warning signs, barricades, and other devices around the reconstruction as required for the protection of the CONTRACTOR's employees and the OWNER's personnel. The CONTRACTOR shall remove such protection when reconstruction activities are complete, or as work progresses, or when directed by the ENGINEER.

1.3 CONTRACTOR SUBMITTALS

A. Demolition and reconstruction activities and procedures, including operational sequence, shall be submitted to the ENGINEER for approval in accordance with KRRP Project Submittals. The procedures shall provide for safe conduct of the WORK, careful removal and disposition of materials and equipment, protection of existing facilities which are to remain undisturbed, coordination with existing facilities to remain in service, and timely disconnection and reconnection of utility services. The procedures shall include a detailed description and time schedule of the methods and equipment to be used for each operation and the sequence of operation. A storage plan for salvaged items shall be included.

1.4 DEMOLITION

A. Existing pavement, structures, equipment, piping, valves, electrical gear, instrumentation, utilities, and related appurtenances such as anchors, supports, and hardware indicated or required to be demolished as part of the WORK shall be removed and disposed of unless otherwise indicated. Removal of buried structures, utilities, and appurtenances includes the related excavation and backfill as required. Removed items shall be disposed of offsite by the CONTRACTOR.

B. Items to be removed include:

Item	Description
Existing 24-inch diameter waterline from STA 1226+60+/- to STA 1228+78+/-	Steel pipe with cement mortar lining. Coal tarn enamel with additional 3-inch cement mortar coating. Pipe includes welded and gasketed joints, per Contract Drawings (D101).
Existing Underwater Riprap	¼ ton riprap cover over existing pipe

1.5 SALVAGE

A. Items of existing equipment, piping, valves, electrical gear, instrumentation, utilities, and appurtenances indicated to be salvaged shall be removed without any degradation in condition from that prior to removal. Salvaged items shall be stockpiled and protected on the Site at a location directed by the ENGINEER. The CONTRACTOR shall be responsible to properly safeguard the salvaged items against damage and loss during removal and handling.

B. No items have been identified to be salvaged.

1.6 RELOCATION

A. Items of existing equipment, piping, valves, electrical gear, instrumentation, utilities, and appurtenances required to be relocated shall be removed without any degradation in condition from that prior to removal. The CONTRACTOR shall be responsible to properly safeguard the relocated items against damage and loss during removal, handling, storage, and installation in the new location.

B. No items have been identified to be relocated.

1.7 ABANDONMENT

A. Items of existing equipment, piping, valves, electrical gear, instrumentation, utilities, and appurtenances required to be abandoned shall be prepared by the CONTRACTOR as indicated.

B. The existing 24” pipeline shall be capped and abandoned in place where indicated on the drawings.

1.8 REHABILITATION

A. Existing civil, pavement, landscaping, structural, mechanical, electrical, and instrumentation WORK disturbed or damaged by reconstruction activities shall be repaired and rehabilitated as indicated.

B. Damaged items shall be repaired or replaced with new items to restore items or surfaces to a condition equal to and matching that existing prior to damage.

1.9 DISPOSAL

A. The CONTRACTOR shall be responsible for the offsite disposal of debris resulting from reconstruction in compliance with local, state, and federal codes and requirements.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.1 GENERAL

A. The CONTRACTOR shall coordinate demolition and reconstruction WORK with the OWNER and ENGINEER. Unless otherwise indicated, the CONTRACTOR shall be responsible for the sequence of activities. WORK shall be performed in accordance with applicable safety rules and regulations.

B. The CONTRACTOR shall verify that any utilities connected to structures, equipment, and facilities to be removed, relocated, salvaged, replaced, or abandoned are rendered inoperable, replaced with new utilities, or adequately bypassed with temporary utilities before proceeding with demolition and reconstruction.

C. The CONTRACTOR shall take precautions to avoid damage to adjacent facilities and to limit the WORK activities to the extent indicated. If reconstruction beyond the scope indicated is required, the CONTRACTOR shall obtain approval from the ENGINEER prior to commencing.

3.2 PROTECTION OF EXISTING FACILITIES

A. Before beginning any reconstruction, the CONTRACTOR shall carefully survey the existing facilities and examine the Specifications and Drawings to determine the extent of reconstruction and coordination with the WORK. Existing facilities not subject to reconstruction shall be protected and maintained. Damaged existing facilities shall be repaired to the previous condition or replaced.

B. Persons shall be afforded safe passages around areas of demolition.

C. Structural elements shall not be overloaded. The CONTRACTOR shall be responsible for shoring, bracing, or adding new supports as may be required for adequate structural support as a result of WORK performed under this Section. The CONTRACTOR shall remove temporary protection when the WORK is complete or when so authorized by the ENGINEER.

D. The CONTRACTOR shall carefully consider bearing loads and capacities before placement of equipment and material on Site. In the event of any questions as to whether an area to be loaded has adequate bearing capacity, the CONTRACTOR shall consult with the ENGINEER prior to the placement of such equipment or material.

3.3 DEMOLITION, SALVAGE, AND RELOCATION

A. The Contract Documents indicate existing facilities to be demolished, salvaged, and/or relocated. Auxiliary utilities including such services as water, air, chemicals, drainage, lubrication, fluid power, electrical wiring, controls, and instrumentation are not necessarily indicated. The CONTRACTOR shall verify the scope of the WORK to remove the equipment indicated; coordinate its shutdown, removal, replacement, or relocation; and submit an outage plan in accordance with Section 01 11 00 – Summary of Work. The removal of existing facilities for demolition, salvage, and relocation shall include the following requirements:

1. The area shall be thoroughly cleaned such that little or no evidence of the previous equipment installation will remain.

2. Asphalt and concrete pavement, curbs, and gutters shall be removed as necessary to perform reconstruction. The limits of removal shall be sawcut. When the required improvements have been constructed, new asphalt and concrete pavement, curbs, and gutters shall be placed to match the original unless otherwise indicated.

3. Below-grade areas and voids resulting from demolition of structures shall be completely filled. Fill and compaction shall be in accordance with Section 31 00 00 - Earthwork. After fill and compaction, surfaces shall be graded to meet adjacent contours and to provide flow to surface drainage structures, or as indicated.

4. When existing pipe is removed, the CONTRACTOR shall plug the resulting open ends whether or not so indicated. Where removed piping is exposed, the remaining piping shall be blind-flanged or fitted with a removable cap or plug, as required, until the new pipe connection is made.

5. Electrical reconstruction shall be conducted by the CONTRACTOR in a safe and proper manner to avoid injury from electrical shock to the OWNER's and CONTRACTOR's personnel. Electrical equipment to be shut off for a period of time shall be tagged, locked out, and sealed with a crimped wire and lead seal and made inoperable. At no time shall electrical wiring or connections which are energized or could become energized be accessible to CONTRACTOR, OWNER, or other personnel without suitable protection or warning signs.

B. The CONTRACTOR shall perform a functional test of existing equipment that is relocated and reinstalled to ensure the equipment functions in the manner documented during the initial inspection. The CONTRACTOR shall inform the ENGINEER in writing a minimum of 5 Days prior to the functional testing in order for the OWNER and ENGINEER to witness the test. If, in the opinion of the ENGINEER, the relocated equipment does not function in a satisfactory manner, the CONTRACTOR shall make repairs and modifications necessary to restore the equipment to its original operating condition at no additional cost to the OWNER.

3.4 ABANDONMENT

A. Existing facilities to be abandoned shall be prepared as indicated. Where existing buried piping is to be abandoned, the CONTRACTOR shall remove the abandoned pipe for a distance of 5-feet from any connecting structures. Openings at the existing structures shall be repaired. The remaining pipe shall be capped at both ends prior to backfill.

3.5 REHABILITATION

A. Certain areas of existing structures, piping, conduits, and the like will be affected by WORK necessary to complete modifications under this Contract. The CONTRACTOR shall be responsible to rehabilitate those areas affected by its construction activities.

B. When new piping is to be connected to existing piping, the existing piping shall be cut square and ends properly prepared for the connection. Any damage to the lining and coating of the existing piping shall be repaired. Dielectric insulating joints shall be installed at interconnections between new and existing piping.

C. Where existing equipment, piping, and supports, electrical panels and devices, conduits, and associated appurtenances are removed, the CONTRACTOR shall rehabilitate the affected area such that little or no evidence of the previous installation remains. Abandoned connections to piping and conduits shall be terminated with blind flanges, caps, and plugs suited for the material, type, and service of the pipe or conduit.

D. Where reconstruction activities damage the painting and coating of adjacent or nearby facilities, the damaged areas shall be surface prepared and coated per the coating manufacturer’s recommendations to match the original painting and coating with a compatible system. Surfaces of equipment items that are to be relocated shall be prepared and be coated in accordance with the coating manufacturer's recommendations.

3.6 DISPOSAL

A. Demolition and removal of debris shall minimize interference with roads, streets, walks, and other adjacent occupied or used facilities which shall not be closed or obstructed without permission from the OWNER. Alternate routes shall be provided around closed or obstructed traffic ways.

B. Site debris, rubbish, and other materials resulting from reconstruction operations shall be legally removed and disposed of. Structures and equipment to be demolished shall be cleaned prior to demolition and the wash water properly disposed of. No trace of these structures shall remain prior to placing of backfill in the areas from which structures were removed.

C. Refuse, debris, and waste materials resulting from demolition and clearing operations shall not be burned.

3.7 OCCUPANCY AND POLLUTION CONTROL

A. Water sprinkling, temporary enclosures, chutes, and other suitable methods shall be used to limit dust and dirt rising and scattering in the area. The CONTRACTOR shall comply with government regulations pertaining to environmental protection.

B. Water shall not be used if it creates hazardous or objectionable conditions such as ice, flooding, or pollution.

3.8 CLEANING

A. During and upon completion of WORK, the CONTRACTOR shall promptly remove tools and equipment, surplus materials, rubbish, debris, and dust and shall leave areas affected by WORK in a clean, approved condition.

B. Adjacent structures shall be cleaned of dust, dirt, and debris caused by reconstruction, as directed by the ENGINEER or governing authorities, and adjacent areas shall be returned to condition existing prior to start of WORK.

C. The CONTRACTOR shall clean and sweep the street and road daily.

- END OF SECTION -

SECTION 31 00 00 - EARTHWORK

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall perform earthwork as indicated and required for construction of the WORK, complete and in place, in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. The CONTRACTOR shall submit samples of materials proposed for the WORK in conformance with the requirements of KRRP Project Submittals. Sample sizes shall be as determined by the testing laboratory

B. CONTRACTOR's Detailed Excavation Plan

1. The CONTRACTOR, prior to beginning any trench or structure excavation 5 feet deep or deeper, shall submit to the OWNER and shall be in receipt of the OWNER's written acceptance of the CONTRACTOR's detailed plan showing the design of shoring, bracing, sloping of the sides of excavation, or other provisions for worker protection against the hazard of caving ground during the excavation of such trenches or structure excavation.

2. The CONTRACTOR’s plan shall be prepared and signed and sealed by a Professional Engineer experienced in the field of geotechnical engineering and licensed in the State where the WORK is being performed.

3. The OWNER’s acceptance of said plan will be for verification of submittal of the plan with this requirement.

PART 2 -- PRODUCTS

2.1 FILL AND BACKFILL MATERIAL REQUIREMENTS

A. **General**

1. Fill, backfill, and embankment materials shall be selected or shall be processed and clean fine earth, rock, gravel, or sand, free from grass, roots, brush, other vegetation and organic matter.

2. Fill and backfill materials that are to be placed within 6 inches of any structure or pipe shall be free of rocks or unbroken masses of earth materials having a maximum dimension larger than 3 inches.

B. **Suitable Materials**

1. Materials not defined below as unsuitable will be considered as suitable materials and may be used in fills, backfilling, and embankment construction, subject to the indicated requirements.

2. If acceptable to the ENGINEER, some of the material listed as unsuitable may be used when thoroughly mixed with suitable material to form a stable composite.

3. Mixing or blending of materials to obtain a suitable composite is the CONTRACTOR's option but is subject to the approval of the ENGINEER.

4. The CONTRACTOR shall submit certification to the ENGINEER that the chloride concentration in imported materials within the pipe zone does not exceed 100 ppm, when tested in accordance with the requirements of AASHTO T291-94 – Standard Method of Test for determining Water-Soluble Chloride Ion Content in Soil.

5. Suitable materials may be obtained from on-Site excavations, may be processed on-Site materials, or may be imported.

6. If imported materials are required by this Section or are required in order to meet the quantity requirements of the WORK, the CONTRACTOR shall provide the imported materials as part of the WORK.

C. **Types of Suitable Materials**. The following types of suitable materials are defined:

Type AS (Aggregate Subbase): Crushed rock aggregate subbase material that can be compacted readily by watering and rolling to form a firm stable base. This material is often specified and required underneath the base course of asphaltic or concrete pavement. At the option of the CONTRACTOR, the grading for either the 3-inch maximum size or 2-inch maximum size gradation shall be used. The sand equivalent value shall be greater than 20. Crushed rock aggregate subbase material shall meet one of the following gradation requirements, as shown on the Drawings or approved by the OWNER:

Sieve Size	**Percentage Passing (3-inch Max)**	**Percentage Passing (2-inch Max)**
3-inch	100	100
2.0 inch	90 - 100	100
1.5 inch	-	95 - 100
No. 4	30 - 65	30 - 65
No. 16	15 - 40	15 - 40
No. 200	0 - 20	0 - 20

Type C (Civil Fill) (Not for use beneath concrete foundations): Civil Fill may consist of imported materials or natural on-site materials. Civil Fill may be a combination of Type AS material, Type GF, or Type SF material, or any mixture thereof, except as shown. Some mixing, removal of oversized particles (greater than 4-inch diameter) and/or removal of other unsuitable material may be required. On site sources of this material may consist of forest duff/topsoil 1 ft to 2 ft below ground surface (bgs), silty sand (Qal) between 2 ft to 10 ft bgs, poorly graded gravel with sand/silt (Qal) to 75 ft bgs (very dense, ~15-inch to 2-ft cobbles observed).

Type CLSM (Controlled Low Strength Material): Controlled low strength material (CLSM) shall be in accordance with Section 31 23 00 - Controlled Low Strength Material.

Type DRC (Drain-rock Coarse): Crushed rock or gravel meeting the following gradation requirements.

Sieve Size	Percentage Passing
2-inch	100
1.5-inch	90 - 100
1-inch	20 - 55
3/4-inch	1 - 15
No. 200	0 - 3

Type DRG (Drain-rock Graded): Drain-rock shall be crushed rock or gravel, durable and free from slaking or decomposition under the action of alternate wetting or drying. The drainrock shall have a sand equivalent value greater than 75. The finish graded surface of the drainrock immediately beneath hydraulic structures shall be stabilized to provide a firm, smooth surface upon which to construct reinforced concrete floor slabs. The material shall be uniformly graded and shall meet the following gradation requirements:

Sieve Size	Percentage Passing
1-inch	100
0.75-inch	90 – 100
0.375-inch	40 – 100
No. 4	25 – 40
No. 8	18 – 33
No. 30	5 – 15
No. 50	0 – 7
No. 200	0 – 3

The finish graded surface of the drain rock immediately beneath hydraulic structures shall be stabilized to provide a firm, smooth surface upon which to construct reinforced concrete floor slabs.

Type EF (Embankment Fills from on-site materials): Embankment Fill for the gravel lot portions of the project may be obtained from on-Site excavations, may be processed on-Site materials, or may be imported materials comprised of mixtures of Type AS, Type DRG, Type GF, or Type S material. If on-site material is used for embankments, it may require moisture conditioning to facilitate compaction. Drying of the embankment fill material may not be practical during cold or wet periods of the year. Acceptable embankment material shall meet or exceed the compaction density of 95 percent as determined by ASTM D-1557.

Type GF (Granular Fill 0.75-inch minus): Angular crushed rock, stone or gravel, and sand conforming to the requirements listed below. Do not use pea gravel as granular backfill: The material shall have a maximum liquid limit of 35 and a maximum plasticity index of 10. The material shall have a sand equivalent value greater than 75. (This material is also known as Class I crushed stone.)

Sieve Size	Percentage Passing
0.75-inch	100
No. 4	30 - 50
No. 200	0 - 6

Type PG (Pea Gravel fill): Crushed rock or gravel with 100 percent passing a 1/2-inch sieve and not more than 10 percent passing a Number 4 sieve.

Type SF (Structural Fill / Foundation Base): Crushed rock structural fill material of such nature that it can be compacted readily by watering and rolling to form a firm, stable base for fill material required beneath concrete foundations. This material is often specified and required directly underneath the finish course of asphaltic or concrete pavement. At the option of the CONTRACTOR, the grading for either the 1.5 inch maximum size or 0.75-inch maximum size gradation may be used material beneath concrete foundations. The sand equivalent value shall be greater than 22. The material shall meet the following gradation requirements:

	Percentage Passing	
Sieve Size	**1.5 inch Max Gradation**	**0.75-inch Max Gradation**
2-inch	100	-
1.5-inch	90 - 100	-
1-inch	-	100
0.75-inch	81 - 91	90 – 100
No. 4	43 - 53	55 – 67
No. 16	23 - 29	28 – 38
No. 200	4 - 10	4 – 10

Type SNF (Sand Fill): Sand material shall meet the following gradation requirements:

Sieve Size	Percentage Passing
0.375-inch	100
No. 4	90 - 100
No. 16	50 - 80
No. 50	5 - 25
No. 200	0 - 5

Type T (Topsoil): Stockpiled topsoil material which has been obtained at the Site by removing soil to a depth not exceeding 2 feet. Removal of the topsoil shall be done after the area has been stripped of vegetation and debris.

Type X-CTF (Cement-Treated fill): Material which consists of Type AS material, or any mixture of other approved materials which has been cement-treated so that the cement content of the material is not less than 5 percent by weight when tested in accordance with ASTM D 2901 - Standard Test Method for Cement Content of Freshly Mixed Soil Cement. The ultimate compressive strength at 28 days shall be not less than 400 psi when tested in accordance with ASTM D 1633 - Standard Test Method for Compressive Strength of Molded Soil - Cement Cylinders.

Schedule: Earth materials shall be as indicated in the Contract Drawings. Where clear definition in the drawings is not defined, the following schedule may be used to define acceptable fill materials.

Civil Work Area	Material Type
Embankment Fills – (Solids Settling Basins & other Embankments)	Type EF material, or Mixture of A thru H materials that meet Type EF gradation requirements.
Bedding for all pipes	SNF
Pipe Zone Fills (unless indicated as Trench Zone)	
Dielectrically / epoxy coated steel / cement mortar lined , polyethylene encased.	SF or CLSM
Pipes on grades >4% where backfills are graded with <10% passing No. 4 sieve	(CLSM) w/trench plugs of types J, L, or N at intervals of 200 feet or less.
Trench zone backfill except as identified below	X, C, EF or an approved mixture thereof.

Civil Work Area	Material Type
Final backfill for irrigated unpaved areas	T
Trench zone and final backfill under structures	Same as pipe zone except where concrete encasement is required
Replace pipeline trench over excavation	DRC with 6-inch top layer of PG, or non-woven filter fabric, or same as pipe zone backfill if trench is above water table.
Asphalt & Concrete Pavement Aggregate base & Gravel Road base materials	DRG, DRC
Asphalt & Concrete Pavement Aggregate subbase & Gravel Road subbase materials	AS
Backfill around structures (including berms)	C, EF, or an approved mixture
Under hydraulic or water retaining structures with underdrains	DRG
Under structures where ground water is removed to allow placement of concrete	DRC, underlain by non-woven filter fabric
All other structures	DRG,
Top 6-inches of embankment fills, or backfills around structures	T

D. **Unsuitable Materials.**

1. Soils which, when classified under ASTM D 2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System), fall in the classifications of PT, OH, CH, MH, or OL shall be classified as unsuitable materials.

2. In addition to the materials identified as unsuitable in the table above, a material shall be classified as unsuitable if one of the following conditions is present;

    a. Soils which cannot be compacted sufficiently to achieve the density specified for the intended use.

    b. Materials that contain hazardous or designated waste materials including petroleum hydrocarbons, pesticides, heavy metals, and any material which may be classified as hazardous or toxic according to applicable regulations.

2.2 MATERIALS TESTING

A. **Samples**

1. Soils testing of samples submitted by the CONTRACTOR will be performed by a testing laboratory of the OWNER's choice and at the CONTRACTOR’s expense.

2. The ENGINEER may direct the CONTRACTOR to supply samples for testing of any material used in the WORK.

B. **Particle Size Analysis**. Particle size analysis of soils and aggregates will be performed using ASTM D 422 - Standard Test Method for Particle-Size Analysis of Soils.

C. **Sand Equivalent Value**. Determination of sand equivalent value will be performed using ASTM D 2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.

D. **Unified Soil Classification System**

1. References in this Section to soil classification types and standards shall have the meanings and definitions indicated in ASTM D 2487.

2. The CONTRACTOR shall be bound by applicable provisions of ASTM D 2487 in the interpretation of soil classifications.

E. Testing for sulfate, resistivity, and pH shall be performed in accordance with AASHTO Test Methods T 288 and T 289.

F. Testing for chloride shall be performed in accordance with AASHTO T291-94 – Standard Method of Test for determining Water-Soluble Chloride Ion Content in Soil.

2.3 IDENTIFICATION TAPE

A. Unless otherwise indicated, identification tape shall be placed above buried pipelines that are not comprised of magnetic components at least in part.

B. Identification tape shall be as specified in Section 40 23 01 – Piping Identification.

PART 3 -- EXECUTION

3.1 EXCAVATION AND BACKFILLING - GENERAL

A. General

1. Except when specifically provided to the contrary, excavation shall include the removal of materials, including obstructions that would interfere with the proper execution and completion of the WORK.

2. The removal of such materials shall conform to the lines and grades indicated or ordered.

3. Unless otherwise indicated, the entire Site shall be stripped of vegetation and debris and shall be grubbed, and such material shall be removed from the Site prior to performing any excavation or placing any fill.

4. The CONTRACTOR shall furnish, place, and maintain supports and shoring that may be required for the sides of excavations.

5. Excavations shall be sloped or otherwise supported in a safe manner in accordance with applicable state safety requirements and the requirements of OSHA Safety and Health Standards for Construction (29CFR1926).

6. The CONTRACTOR shall provide quantity surveys where so required to verify quantities for Unit Price Contracts.

7. Surveys shall be performed prior to beginning WORK and upon completion by a surveyor licensed in the state where the Site is located.

B. Removal and Exclusion of Water

1. The CONTRACTOR shall remove and exclude water, including stormwater, groundwater, irrigation water, and wastewater, from excavations.

2. Dewatering wells, wellpoints, sump pumps, or other means shall be used to remove water and continuously maintain groundwater at a level at least 2 feet below the bottom of excavations before the excavation WORK begins at each location.

3. Water shall be removed and excluded until backfilling is complete and field soils testing has been completed.

3.2 OVER-EXCAVATION

A. **Indicated**

1. Where areas are indicated to be over-excavated, excavation shall be to the depth indicated, and backfill shall be installed to the grade indicated.

B. **Not Indicated**

1. When ordered to over-excavate areas deeper and/or wider than required by the Contract Documents, the CONTRACTOR shall over-excavate to the dimensions ordered and backfill to the indicated grade.

C. **Neither Indicated nor Ordered**

1. Any over-excavation carried below the grade that is neither ordered or nor indicated shall be backfilled and compacted to the required grade with the indicated material as part of the WORK

3.3 EXCAVATION IN LAWN AREAS

A. Where excavation occurs in lawn areas, the sod shall be carefully removed, dampened, and stockpiled in order to preserve it for replacement.

B. Excavated material may be placed on the lawn, provided that a drop cloth or other suitable method is employed to protect the lawn from damage, but the lawn shall not remain covered for more than 72 hours.

C. Immediately after completion of backfilling and testing of the pipeline, the sod shall be replaced and lightly rolled in a manner as to restore the lawn as near as possible to its original condition.

D. The CONTRACTOR shall provide new sod if the stockpiled sod has not been replaced within 72 hours.

3.4 EXCAVATION IN VICINITY OF TREES

A. Except where trees are indicated to be removed, trees shall be protected from injury during construction operations.

B. No tree roots larger than 2 inches in diameter shall be cut without the express permission of the ENGINEER.

C. Trees shall be supported during excavation by any means previously reviewed and accepted by the ENGINEER.

3.5 ROCK EXCAVATION

A. **Normal Excavation**. Nearly all excavation, except where indicated in the Contract Drawings shall be considered normal excavation, and may be accomplished using conventional equipment as follows:

1. For general excavation, a D-9N Caterpillar tractor with a single shank ripper, or equivalent equipment, is considered conventional equipment, if it can rip at a production rate of at least 300 bank cubic yards per hour.

2. For trench excavation, a 235C Caterpillar excavator with a medium stick and a rock ripping bucket, or equivalent equipment, is considered conventional equipment, if it can excavate at a production rate of at least 30 bank cubic yards per hour.

3. If material is encountered which the CONTRACTOR believes cannot be excavated by conventional equipment, the ENGINEER shall be notified immediately. The CONTRACTOR shall provide performance tests of the specified conventional or equivalent equipment. If the ENGINEER confirms in writing that the conventional equipment cannot perform at the production rates indicated, the excavation will be considered rock excavation.

B. **Rock Excavation**. Rock excavation shall include removal and disposal of the following items:

1. Boulders measuring 1/3 of a cubic yard or more in volume;

2. Rock material in ledges, bedding deposits, and un-stratified masses that cannot be removed using conventional equipment as defined herein and which require systematic drilling and blasting for removal;

3. Concrete or masonry structures that have been abandoned; and,

4. Conglomerate deposits that are so firmly cemented that they possess the characteristics of solid rock and cannot be removed using conventional equipment as herein defined and require systematic drilling and blasting for removal.

C. **Scope and Payment for Rock Excavation**

1. Rock excavation shall be performed by the CONTRACTOR, provided that if the quantity of rock excavation is affected by any change in the scope of the WORK an appropriate adjustment of the Contract Price will be made. Payment for rock excavation shall be as set forth in the Bid form as a unit price item. If a unit price item for rock excavation is not provided in the Bid form, the extra cost for excavation of rock will be treated as a change.

2. Otherwise, payment will be made in accordance with a negotiated price.

D. **Explosives and Blasting**. Blasting will not be permitted on the project site.

3.6 DISPOSAL OF EXCESS EXCAVATED MATERIAL

A. Unless otherwise indicated, excess excavated material shall be the property of the CONTRACTOR.

B. The CONTRACTOR shall be responsible for the removal and disposal of excess excavated material.

C. The CONTRACTOR shall remove and dispose of excess excavated material at a location selected by the CONTRACTOR and as approved by the ENGINEER or at an off-Site location selected and arranged for by the CONTRACTOR.

D. The CONTRACTOR shall obtain required permits and landowner and agency approvals for disposal of excess excavated material on-Site or off-Site and shall submit copies of related documents to the ENGINEER for information prior to disposal. CONTRACTOR shall pay costs associated with the removal and disposal

3.7 BACKFILL

A. **General**

1. Backfill shall not be dropped directly upon any structure or pipe.

2. Backfill shall not be placed around or upon any structure until the concrete has attained sufficient strength to withstand the loads imposed.

3. Backfill around water-retaining structures shall not be placed until the structures have been tested, and the structures shall be full of water while backfill is being placed.

B. **Pre-Placement Conditions**

1. Except for drainrock materials being placed in over-excavated areas or trenches, backfill shall not be placed until water is removed from the excavation and the trench sidewalls and bottom have been dried to a moisture content suitable for compaction

2. Immediately prior to placement of backfill materials, the bottoms and sidewalls of trenches and structure excavations shall have any loose, sloughing, or caving soil and rock materials removed.

3. Trench sidewalls shall consist of excavated surfaces that are in a relatively undisturbed condition before placement of backfill materials.

C. **Layering**

1. Backfill materials shall be placed and spread evenly in layers. During spreading, each layer shall be thoroughly mixed as necessary in order to promote uniformity of material in each layer.

2. When compaction is achieved using mechanical equipment, the layers shall be evenly spread such that when compacted each layer shall not exceed 6 inches in thickness.

D. **Moisture Content**

1. Where the backfill material moisture content is below the optimum moisture content, water shall be added before or during spreading until the proper moisture content is achieved.

2. Where the backfill material moisture content is too high to permit the indicated degree of compaction, the material shall be dried until the moisture content is satisfactory.

3.8 STRUCTURE, ROADWAY, AND EMBANKMENT EXCAVATION AND BACKFILL

A. **Excavation Beneath Structures and Embankments**

1. Except where indicated otherwise for a particular structure or where ordered by the ENGINEER, excavation shall be carried to an elevation 6 inches below the bottom of the footing or slab and brought back to grade with compacted materials acceptable for placement beneath structures.

2. The area where a fill or embankment is to be constructed shall be cleared of vegetation, roots, and foreign material.

3. Where indicated or ordered, areas beneath structures or fills shall be over-excavated.

4. The subgrade areas beneath embankments shall be excavated to remove not less than the top 6 inches of native material and where such subgrade is sloped, the native material shall be benched.

5. When such over-excavation is indicated, both the over-excavation and the subsequent backfill to the required grade shall be performed by the CONTRACTOR.

6. After the required excavation or over-excavation for fills and embankments has been completed, the exposed surface shall be scarified to a depth of 6 inches, brought to optimum moisture content, and rolled with heavy compaction equipment to obtain 95 percent of maximum density.

B. **Excavation Beneath Concrete Reservoirs**

1. Excavation under reservoirs shall extend to the bottom of the drainrock layer.

2. After such excavation has been completed, the exposed surface shall be rolled with heavy compaction equipment to 95 percent of maximum density and then graded to provide a reasonably smooth surface for placement of the drainrock.

3. Areas under the reservoir upon which fill, not drain rock, is to be placed, shall be scarified to a depth of 6 inches, brought to optimum moisture content, and compacted to obtain 95 percent of maximum density.

C. **Excavation Beneath Paved Areas**

1. Excavation under areas to be paved shall extend to the bottom of the aggregate base or subbase, if such base is called for; otherwise it shall extend to the paving thickness.

2. After the required excavation has been completed, the top 12 inches of exposed surface shall be scarified, brought to optimum moisture content, and rolled with heavy compaction equipment to obtain 95 percent of maximum density.

3. The finished subgrade shall be even, self-draining, and in conformance with the slope of the finished pavement.

4. Areas that could accumulate standing water shall be regraded to provide a self-draining subgrade.

D. **Notification of ENGINEER**

1. The CONTRACTOR shall notify the ENGINEER at least 3 Days in advance of completion of any structure or roadway excavation and shall allow the ENGINEER a review period of at least one day before the exposed foundation is scarified and compacted or is covered with backfill or with any construction materials.

E. **Compaction of Fill, Backfill, and Embankment Materials**

1. Each layer of backfill materials as defined herein, where the material is graded such that 10 percent or more passes a No. 4 sieve, shall be mechanically compacted to the indicated percentage of density.

2. Equipment that is consistently capable of achieving the required degree of compaction shall be used, and each layer shall be compacted over its entire area while the material is at the required moisture content.

3. Each layer of coarse granular backfill materials with less than 10 percent passing the No. 4 sieve shall be compacted by means of at least 2 passes from a vibratory compactor that is capable of obtaining the required density in 2 passes.

F. **Heavy Equipment**

1. Equipment weighing more than 10,000 pounds shall not be used closer to walls than a horizontal distance equal to the vertical depth of the fill above undisturbed soil at that time.

2. Hand-operated power compaction equipment shall be used where the use of heavier equipment is impractical or restricted due to weight limitations.

G. **Layering**

1. Embankment and fill material shall be placed and spread evenly in approximately horizontal layers.

2. Each layer shall be moistened and aerated as necessary.

3. Unless otherwise approved by the ENGINEER, no layer shall exceed 6 inches of compacted thickness.

4. The embankment and fill shall be compacted in conformance with Paragraph K, below.

H. **Embankments and Fills on Slopes**

1. When an embankment or fill is to be constructed and compacted against hillsides or fill slopes steeper than 4:1, the slopes of the hillsides or fills shall be horizontally benched in order to key the embankment or fill to the underlying ground.

2. A minimum of 12 inches perpendicular to the slope of the hillside or fill shall be removed and re-compacted as the embankment or fill is brought up in layers.

3. Material thus cut shall be re-compacted along with the new material.

4. Hillside or fill slopes 4:1 or flatter shall be prepared in accordance with Paragraph A, above.

I. **Compaction Requirements**

1. The following compaction requirements shall be in accordance with ASTM D 1557 - Test Method for Laboratory Compaction Characteristics of Soils Using Modified Effort (56,000 ft - lbf/ft^3) (2,700 $kN\text{-}m/m^3$) where the material is graded such that 10 percent or more passes a No. 4 sieve and in accordance with ASTM D 4253 - Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table, and D 4254 - Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density, where the material is coarse granular backfill materials with less than 10 percent passing the No. 4 sieve:

Location or Use of Fill or Backfill	**Percentage of Maximum Dry Density**	**Percentage of Relative Density**
Embankments and fills not	90	55

identified otherwise		
Embankments and fills beneath paved areas or structures	95	70
Backfill beneath structures and hydraulic structures	95	70
Topsoil	80	NA
Aggregate base or subbase	95	NA

3.9 PIPELINE AND UTILITY TRENCH EXCAVATION AND BACKFILL

A. **General**

1. Unless otherwise indicated or ordered, excavation for pipelines and utilities shall be open-cut trenches with minimum widths as indicated.

B. **Trench Bottom**

1. Except where pipe bedding is required, the bottom of the trench shall be excavated uniformly to the grade of the bottom of the pipe.

2. Excavations for pipe bells and welding shall be made as required.

3. Where pipe bedding is required, the bottom of the trench shall be excavated uniformly to the grade of the bottom of the pipe bedding.

C. **Open Trenches**

1. The maximum amount of open trench permitted in any one location shall be 500 feet or the length necessary to accommodate the amount of pipe installed in a single Day, whichever is greater.

2. Trenches shall be fully backfilled at the end of each Day or, in lieu thereof, shall be covered by heavy steel plates adequately braced and capable of supporting vehicular traffic in those locations where it is impractical to backfill at the end of each Day.

3. These requirements for backfilling or use of steel plate will be waived in cases where the trench is located further than 100 feet from any traveled roadway or occupied structure; in such cases, however, barricades and warning lights meeting appropriate safety requirements shall be provided and maintained.

D. **Embankments, Fills and Structural Backfills**

1. Where pipelines are to be installed in embankments, fills, or structure backfills, the fill shall be constructed to a level at least one foot above the top of the pipe before the trench is excavated.

2. Upon completion of the embankment or structural backfill, a trench conforming to the appropriate detail may be excavated and the pipe may be installed.

E. **Trench Shield**

1. If a moveable trench shield is used during excavation operations, the trench width shall be wider than the shield such that the shield is free to be lifted and then moved horizontally without binding against the trench sidewalls and causing sloughing or caving of the trench walls.

2. If the trench walls cave or slough, the trench shall be excavated as an open excavation with sloped sidewalls or with trench shoring, as indicated and as required by the pipe structural design.

3. If a moveable trench shield is used during excavation, pipe installation, and backfill operations, the shield shall be moved by lifting the shield free of the trench bottom or backfill and then moving the shield horizontally.

4. The CONTRACTOR shall not drag trench shields along the trench causing damage or displacement to the trench sidewalls, the pipe, or the bedding and backfill.

F. **Placing and Spreading of Backfill Materials**

1. Each layer of coarse granular backfill materials with less than 10 percent passing the No. 4 sieve shall be compacted by means of at least 2 passes from a vibratory compactor that is capable of achieving the required density in 2 passes and that is acceptable to the ENGINEER.

2. Where such materials are used for pipe zone backfill, vibratory compaction shall be used at vertical intervals of the lesser of one-half the diameter of the pipe; or 24 inches, measured in the uncompacted state.

3. In addition, these materials shall be subjected to vibratory compaction at the springline of the pipe and the top of the pipe zone backfill, regardless of whether that dimension is less than 24 inches or not.

4. Each layer of backfill material with greater than 10 percent passing the No. 4 sieve shall be compacted using mechanical compactors suitable for the WORK.

5. The material shall be placed and compacted under the haunch of the pipe and up each side evenly so as not to move the pipe during the placement of the backfill.

6. The material shall be placed in lifts that will not exceed 6 inches when compacted to the required density.

G. **Mechanical Compaction**

1. Backfill around and over pipelines that is mechanically compacted shall be compacted using light, hand-operated vibratory compactors and rollers that do not damage the pipe.

2. After completion of at least 2 feet of compacted backfill over the top of pipeline, compaction equipment weighing no more than 8,000 pounds may be used to complete the trench backfill.

H. **Pipe and Utility Trench Backfill**

1. Definitions

a. **Bedding**. The bedding is defined as that portion of pipe zone backfill material between the trench subgrade and the bottom of the pipe.

b. **Pipe Zone**. The pipe zone is defined as that portion of the vertical trench cross-section lying between a plane below the bottom surface of the pipe and a plane at a point above the top surface of the pipe as indicated.

c. **Trench Zone**. The trench zone (located above the pipe zone) is defined as that portion of the vertical trench cross-section lying as indicated between a plane above the top surface of the pipe and a plane at a point 18 inches below the finished surface grade, or if the trench is under pavement, 18 inches below the roadway subgrade.

d. **Final Backfill**. Final backfill is defined as backfill in the trench cross-sectional area within 6, 12, or 18 inches of finished grade, or if the trench is under pavement, backfill within 18 inches of the roadway subgrade.

2. Pipe Zone Backfill

a. Final Trim

1) After compacting the bedding, the CONTRACTOR shall perform a final trim using a stringline for establishing grade, such that each pipe section when first laid will be continually in contact with the bedding along the extreme bottom of the pipe.

2) Excavation for pipe bells and welding shall be made as required.

b. The pipe zone shall be backfilled with the indicated backfill material.

c. Pipe zone backfill materials shall be manually spread evenly around the pipe, maintaining the same height on both sides of the pipe such that when compacted the pipe zone backfill will provide uniform bearing and side support.

d. The CONTRACTOR shall exercise care in order to prevent damage to the pipeline coating, cathodic bonds, and the pipe itself during the installation and backfill operations.

3. Trench Zone Backfil

a. After the pipe zone backfill has been placed, backfilling of the trench zone may proceed.

I. **Identification Tape**

1. Install identification tape as indicated.

2. Terminate the tape in a precast concrete box either adjacent to or part of the valve box, manhole, vault, or other structure into which the non-metallic pipe enters or at the end of the non-metallic pipeline.

3. The termination box shall be covered with a cast iron lid.

4. The box shall be located at grade in paved areas or 6 inches above grade in unpaved areas.

J. **Trench Shield**

1. If a moveable trench shield is used during backfill operations, the shield shall be lifted to a location above each layer of backfill material prior to compaction of the layer.

2. The CONTRACTOR shall not displace the pipe or backfill while the shield is being moved.

K. **Compaction Requirements**

1. The following compaction test requirements shall be in accordance with ASTM D 1557 - Test Method for Laboratory Compaction Characteristics of Soils Using Modified Effort (56,000 ft - lbf/ft^3) (2,700 kN-m/m^3) where the material is graded such that 10 percent or more passes a No. 4 sieve, and in accordance with ASTM D 4253 - Standard Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table, and D 4254 - Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density where the material is coarse granular backfill materials with less than 10 percent passing the No. 4 sieve.

Location or Use of Fill or Backfill	Percentage of Maximum Dry Density
Pipe embedment backfill for flexible pipe.	> 95
Pipe bedding and over-excavated zones under bedding for flexible pipe, including trench plugs.	> 95
Pipe embedment backfill for steel yard piping	> 95
Pipe zone backfill portion above embedment for flexible pipe	> 95
Final backfill, beneath paved areas, gravel/dirt roads, or structures.	> 95
Final backfill, not beneath paved areas or structures.	> 90
Trench zone backfill, beneath paved areas, gravel/dirt roads, and structures, including trench plugs.	> 95
Trench zone backfill, not beneath paved areas, gravel/dirt roads, or	> 90

structures, including trench plugs.	

3.10 FIELD TESTING

A. **General**:

1. Field soils testing will be performed by a testing laboratory of the OWNER's choice at the CONTRACTOR's expense, except as indicated below.

B. **Density**

1. Where soil material is required to be compacted to a percentage of maximum density, the maximum density at optimum moisture content will be determined in accordance with Method C of ASTM D 1557.

2. Where cohesionless, free draining soil material is required to be compacted to a percentage of relative density, the calculation of relative density will be determined in accordance with ASTM D 4253 and D 4254.

3. Field density in-place tests will be performed in accordance with ASTM D 1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method, ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place By Nuclear Methods (Shallow Depth), or by such other means acceptable to the ENGINEER.

C. **Remediation**

1. In case the test of the fill or backfill shows non-compliance with the required density, the CONTRACTOR shall accomplish such remedy as may be required to ensure compliance.

2. Subsequent testing to show compliance shall be by a testing laboratory selected by the OWNER and paid by the CONTRACTOR.

D. **CONTRACTOR's Responsibilities**

1. The CONTRACTOR shall provide test trenches and excavations, including excavation, trench support and groundwater removal for the OWNER's field soils testing operations.

2. The trenches and excavations shall be provided at the locations and to the depths as required by the OWNER.

3. Lawn areas destroyed by test trenching and excavation shall be regraded and relandscaped with hydroseeding.

- END OF SECTION -

31 05 00 - MATERIALS FOR EARTHWORK

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31 05 00 - MATERIALS FOR EARTHWORK

REVISION INDEX

Revision No.	Signatures			Date (MMDDYY)	Pages Revised	Remarks
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B	Cyrus Niamir	Benoit Otis	Craig Nistor	020720	-	-
C	Cyrus Niamir	Benoit Otis	Craig Nistor	072920	-	-
D	Cyrus Niamir	Benoit Otis	Craig Nistor	080520	-	-
E	Cyrus Niamir	Benoit Otis	Craig Nistor	092520	-	-
F	Cyrus Niamir	Cory Vos	Craig Nistor	100720	-	-
G	Cyrus Niamir	Cory Vos	Craig Nistor	103020	-	-
H	Cyrus Niamir	Cory Vos	Craig Nistor	111320	-	-

Approval that this document adheres to the Knight Piésold Quality Syst CN

31 05 00 - MATERIALS FOR EARTHWORK

TABLE OF CONTENTS

PAGES

31 05 00 - MATERIALS FOR EARTHWORK

PART 1 - GENERAL

1.1 SUMMARY

A. This specification describes the aggregate material and geotextile requirements, including but not limited to:

1. E2 – Pipe Zone Material.
2. E3 – Structural Fill.
3. E4 – Select Fill.
4. E6/E8 – Bedding Material.
5. E7a/E7b/E7c – Erosion Protection.
6. E9/E9a/E9b – General Fill Material.
7. E10 – Random Fill.
8. E11 – Class II Aggregate Base.
9. CR1/CR2 – Concrete Rubble.

1.2 RELATED SECTIONS

A. Section 31 10 00 – Clearing, Grubbing and Stripping.

B. Section 31 23 00 – Excavation and Fill Placement.

C. Section 31 25 00 – Erosion and Sedimentation Controls.

D. Section 31 60 00 – Foundation Preparation.

E. Section 31 71 00 – Tunnel Construction.

F. Section 32 50 00 – Roads, Bridges and Culverts.

1.3 REFERENCE STANDARDS

A. Highway and Transportation Officials:

1. AASHTO M 43 - Standard Specification for Sizes of Aggregate for Road and Bridge Construction.
2. AASHTO M 147 - Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base, and Surface Courses.
3. AASHTO T 180 - Standard Method of Test for Moisture-Density Relations of Soils Using a 10-lb Rammer and an 18-in. Drop.

31 05 00 - MATERIALS FOR EARTHWORK

B. ASTM International:

1. ASTM C136/C136M - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
2. ASTM D123 - Standard Terminology Relating to Textiles.
3. ASTM D276 - Test Method Identification of Fibres in Textiles.
4. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort 56,000 ft-lbf/ft^3.
5. ASTM D2419 – Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
6. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
7. ASTM D3744 – Standard Test Method for Aggregate Durability Index.
8. ASTM D3776 - Standard Test Methods for Mass Per Unit Area (Weight) of Fabric.
9. ASTM D3786 - Standard Test Method for Bursting Strength of Textile Fabrics – Diaphragm Bursting Strength Tester Method.
10. ASTM D4253 - Standard test method for maximum index density and unit weight of soils using a vibratory table.
11. ASTM D4254 - Standard test method for minimum index density and unit weight of soils and calculation of relative density.
12. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
13. ASTM D4354 - Practice for Sampling of Geosynthetics for Testing.
14. ASTM D4355 - Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus).
15. ASTM D4439 - Terminology for Geotextiles.
16. ASTM D4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
17. ASTM D4533 - Standard Test Methods for Trapezoid Tearing Strength of Geotextiles.
18. ASTM D4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
19. ASTM D4751 - Standard Test Methods for Determining Apparent Opening Size of Geotextile.
20. ASTM D4759 - Practice for Determining the Specification Performance of Geosynthetics.
21. ASTM D4873 - Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples.
22. ASTM D6241 - Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe.
23. ASTM D6913 – Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis.
24. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

31 05 00 - MATERIALS FOR EARTHWORK

C. California State Parks Accessibility Guidelines, 2015 Edition.

D. California Department of Transportation (CalTrans) - Standard Specifications:

1. Section 96 – Geosynthetics.
2. Section 26 – Aggregate Bases.

E. Oregon Department of Transportation (ODOT) - Standard Specifications:

1. Section 02320 – Geosynthetics.

1.4 DEFINITIONS

A. **Bedding** – Material obtained from existing borrows or by blasting and/or crushing rock, cobbles, and boulders, to be used underneath erosion protection.

B. **D_{50}** – The diameter of the median rock size in the erosion protection gradation.

C. **Filter** – Natural or processed sand, gravel and cobbles, crushed rock, crushed gravel, or a mixture of these materials.

D. **Optimum Moisture Content** – The moisture content corresponding to the maximum dry density as determined by the standard Proctor compaction test using ASTM D1557.

E. **Erosion Protection** - Rock material with specified gradations used for the prevention of soil erosion caused by exposure to river flows.

F. **Riprap** – Previously installed rock material which may require sorting to meet Erosion Protection gradation specifications.

G. **Aggregate Base** – Road surface material (per Caltrans Standard Specifications, Section 26, 4-26) for all newly constructed non-asphalt surface roads.

1.5 SUBMITTALS

A. Items listed in this section are to be submitted to the Engineer for information prior to the start of any Works, unless noted otherwise.

B. Quality Control Plan.

C. Aggregate/Geosynthetic Supplier Accreditation.

31 05 00 - MATERIALS FOR EARTHWORK

D. Material Certificates: submit test results from manufacturers for review and approval by the engineer.

E. Quality Control Test Results: submit test results from QC control tests from materials sourced onsite for review and approval by the Engineer.

F. Material source plan: a detailed plan for each source of material including the proposed methods of exploitation and processing (if applicable).

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with relevant state standards (i.e. State of Oregon for JC Boyle and State of California Department of Transportation Standards for all other sites).

B. Work shall be in conformance with Drawings, submittals, and other project documents.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General.

1. Materials should be obtained as specified in Section 31 23 00 – Excavation and Fill Placement.
2. Materials shall be composed of durable particles free of organic matter, ice, snow, and other frozen materials. Organics are allowed in Type 10 random fill.
3. All materials shall be well-graded within their gradation limits.
4. Materials shall be in conformance with gradation bands shown on the Drawings.

B. Aggregate Materials Description and Requirements.

1. See Clause 2.1, C. for gradation plots.
2. Type E2 – Pipe Zone.
   a. Material description: Gravel and Sand.
   b. Placement and Compaction: Placed and spread evenly in maximum 6-inch lifts compacted to 95% maximum dry density as determined by ASTM D1557. If a well-defined density vs moisture curve cannot be determined from ASTM D1557, material shall be compacted to 75% relative density as per ASTM D4253 and ASTM D4254.
3. Type E3 – Structural Fill.

31 05 00 - MATERIALS FOR EARTHWORK

a. Material description: Gravel, and Sand.
b. Placement and Compaction: Placed and spread evenly in maximum 8-12 inch lifts compacted to 95% maximum dry density as determined by ASTM D698 (Section 5.3.1 - coarse granular fill), to be observed continuously (i.e. probe testing each lift, at 20 ft intervals pending results of test fill). Method specification for achieving required compaction shall be determined by the Engineer following test fill, per ASTM D698.
c. Plasticity: Plasticity Index < 12, Liquid Limit <35 as determined by ASTM D4318.

4. Type E4 – Select Fill.
   a. Material description: Cobbles, Gravel, and Sand.
   b. Placement and Compaction: Placed and spread evenly in maximum 18-inch lifts compacted to 95% maximum dry density as determined by ASTM D1557. If a well-defined density vs moisture curve cannot be determined from ASTM D1557, material shall be compacted to 75% relative density as per ASTM D4253 and ASTM D4254.
5. Type E5 – Road Embankment Fill.
   a. Material description: Cobbles, Gravel, Sand and Fines.
   b. Placement and Compaction: Placed and spread evenly in maximum 12-inch lifts compacted to 95% maximum dry density as determined by ASTM D1557.
   c. Plasticity: Plasticity Index < 12, Liquid Limit <35 as determined by ASTM D4318.
6. Type E6/E8: Bedding.
   a. Material description: Cobbles and Gravel.
   b. Placement and Compaction: Placed and spread E6/E8 evenly in maximum 12-inch lifts in a non-segregating manner. Provide nominal compaction using construction equipment (e.g. track walk, static rolling, bucket tamping, etc.).
7. Type E7 – Erosion Protection.
   a. Material description: Boulders and Cobbles.
   b. Erosion protection is categorized by type a/b/c as shown in the following table. All E7 erosion protection shall meet or exceed the gradations for each type as shown in Table 1.

31 05 00 - MATERIALS FOR EARTHWORK

Table 1 – Type E7 – Erosion Protection Details

E7 Type	Nominal Diameter (in)	D_{15} Min (in)	D_{50} Min (in)	D_{85} Min (in)
E7a	9	5.5	8.5	11.5
E7b	21	13.0	20.0	27.5
E7c	36	22.0	34.0	47.0

c. Placement: See Section 3.4. Thicknesses as shown on Drawings.

d. Erosion protection to be hard, durable, able to withstand long exposure to weathering, and have a minimum bulk saturated surface dry (SSD) specific gravity of 2.64 for the Oregon Site and 2.74 for the California Sites.

e. Erosion Protection should have a durability index of 40 or greater and a sand equivalent of 75 or greater.

f. Size to meet or exceed the size dimensions specified on the rock intermediate dimension (secondary axis).

g. Rock particles with a minimum dimension less than 1/3.5 the maximum dimension shall not be used.

8. Type E9 – General Fill.

a. Material description: Boulders, Cobbles, Gravel, Sand and Fines.

b. Placement and Compaction: Type E9 material placed and spread evenly in maximum 24-inch lifts. Provide nominal compaction using construction equipment (e.g. track walk, static rolling, bucket tamping, etc.).

9. Type E9a – General Fill.

a. Material description: Boulders, Cobbles, Gravel, Sand and Fines.

b. Placement and Compaction: Type E9a material is end dumped or placed with no compaction requirement.

10. Type E9b – General Fill for Final Stabilization.

a. Material description: Boulders, Cobbles, Gravel, and Sand.

b. Placement and Compaction: Type E9b material placed and spread evenly in maximum 24-inch lift. Provide nominal compaction using construction equipment (e.g. track walk, static rolling, bucket tamping, etc.).

11. Type E10 – Random Fill.

a. Material description: Overburden, rock, or organics.

b. No gradation requirements.

c. Placement: Material shall only be placed in designated disposal sites, as per the design drawings.

d. Compaction: Material shall be track walked to achieve nominal compaction.

31 05 00 - MATERIALS FOR EARTHWORK

12. Type E11 – Class II Aggregate Base.
    a. Material description: Gravel and Sand.
    b. Aggregate must be clean and consist of any combination of the following: Broken stone, Crushed gravel, Natural rough-surfaced gravel, Sand, Processed reclaimed asphalt concrete, PCC, LCB, or CTB. Use either 1-1/2-inch or 3/4-inch maximum aggregate gradation unless otherwise specified. Do not change selected aggregate gradation without authorization.
    c. Caltrans 26-1.02B Class 2 Aggregate Base Aggregate quality characteristics must comply with the requirements shown in Table 2.

Table 2 – Type E11 – Aggregate Quality Characteristics

Quality Characteristic	Requirement	
	Operating Range	Contract Compliance
Resistance (R-value, min)	--	78
Sand equivalent (min)	25	22
Durability index (min)	--	35

13. Type E12 – Engineered Streambed Material.
    a. Material description: Boulders, Cobbles, Gravel, Sand and Fines.
    b. Placement and Compaction: See Section 3.6. Thicknesses as shown on Drawings.
14. Type E13 – Drain Rock.
    a. Material description: Crushed, clean, angular gravel.
    b. Placement and Compaction: Placed and spread evenly in maximum 6-8 inch lifts, compacted using bucket tamping or hand tools.
    c. Drain Rock should have a durability index of 40 or greater and a sand equivalent of 75 or greater.
15. Type CR1/CR2 – Concrete Rubble.
    a. Material description: Broken Concrete/Reinforced Concrete, Boulders, Cobbles, Gravel, and Sand. Broken concrete destined for the disposal sites shall limit the protruding reinforcing bars to 9 inches in length. Where reinforcing bars are bent over the broken concrete pieces, the bent reinforcing bars shall be limited to 24 inches in length with a maximum of 4 inches from the surface of the broken concrete. Where reinforcing railroad rails are present in the concrete pieces, the protruding railroad rail shall not exceed 3 feet in length.

31 05 00 - MATERIALS FOR EARTHWORK

b. Placement and Compaction of Type CR1: End – Dumped Placement. Concrete rubble shall be end-dumped. During placement of concrete rubble, care shall be taken to fill voids with soil and rock materials. Concrete rubble shall not be used for final stabilization cover material of the disposal sites. Placement of concrete rubble in the scour hole at the J.C. Boyle facility differs from the specifications outlined in this section. See Technical Specification 31 23 00 Excavation and Fill Placement for the scour hole backfilling requirements.

c. Placement and Compaction of Type CR2: Placed and spread evenly in maximum 36-inch lift to provide a reasonably level surface for safe passage of equipment and then track walked. During placement of concrete rubble Type CR2, care shall be taken to fill voids with soil and rock materials as per Section 3.5.

C. Aggregate Material Gradation Limits.

1. Table 3 shows the gradation limits for the aggregate materials described in B excluding Types E7 – Erosion Protection (shown in B.) and E10 – Random Fill (no gradation requirements). The table below shall be used for plotting gradation minimum and maximum limits. Sieve sizes as required to test the materials shall be selected by the Contractor to provide the necessary information for acceptance of the material tested.

Table 3 – Aggregate Material Gradation limits

Material Type	Coarse Limit		Fine Limit	
	US Standard Sieve Sizes	Percent Passing by Weight (%)	US Standard Sieve Sizes	Percent Passing by Weight (%)
E2	1.5”	100	1/4”	100
	#16	5	#200	12
E3	3”	100	3/4”	100
	#4	60	#200	30
	#200	5		
E4	4”	100	3/8”	100
	#10	10	#16	60
			#200	10
E5	#4	100	3/8”	100
	#10	10	#16	60

31 05 00 - MATERIALS FOR EARTHWORK

Material Type	Coarse Limit		Fine Limit	
	US Standard Sieve Sizes	**Percent Passing by Weight (%)**	**US Standard Sieve Sizes**	**Percent Passing by Weight (%)**
			#200	30
E6	3”	100	1”	100
	1”	10	3/8”	10
E8	12”	100	3”	100
	3”	10	1”	10
E9	20”	100	3/8”	100
	3/4”	10	#16	60
			#200	30
E9a	20”	100	#16	100
	3/4”	10	#200	40
E9b	20”	100	3/8”	100
	3/4”	10	#16	60
			#200	10
E11	1”	100	¾”	100
	¾”	90	#4	60
	#4	35	#30	30
	#30	10	#200	9
	#200	2		
E12	60”	100	40”	100
	40”	85	20”	85
	12”	50	1”	50
	3/8”	0	#200	0
E13	4”	100	1.5”	100
	3”	30	1”	5
	2”	25		
	1”	5		

31 05 00 - MATERIALS FOR EARTHWORK

Material Type	Coarse Limit		Fine Limit	
	US Standard Sieve Sizes	Percent Passing by Weight (%)	US Standard Sieve Sizes	Percent Passing by Weight (%)
CR1	36”	100	3/8”	100
	12”	10	#16	60
			#200	30
CR2	24”	100	3/8”	100
	6”	10	#16	60
			#200	30

D. Geotextiles.

1. Geotextile installed for erosion and sediment control features shall provide bare soil retention, nurture vegetation, and provide high performance turf reinforcement. An acceptable product is Mirafi TM-Series or equivalent.
2. Geotextiles to be installed as per the Manufacturers recommendations and specifications and the following California and Oregon guidelines:
   a. California Stormwater BMP Handbook – Construction.
   b. Construction Stormwater Best Management Practiced Manual, 1200-C NPDES General Permit, State of Oregon, Department of Environmental Quality.
3. Geotextile installed for separation between subgrade and earthfill materials shall be a nonwoven, needle-punched fabric that meets the relevant state’s minimum physical property requirements, either Table 1 from Caltrans Section 96 “Geosynthetics” (shown in Table 4), or Table 2 from ODOT Section 02320 “Geosynthetics and Slope Protection” (shown in Table 5). All numeric values in Table 4 except AOS represent MARV in the weakest principal direction. Values for AOS represent maximum average roll values. Geotextile shall not be installed until conformance test results are reviewed and the geotextile is accepted by the Engineer.

31 05 00 - MATERIALS FOR EARTHWORK

Table 4 – Nonwoven Separation Geotextile Caltrans Requirements

Property	Value	Test Method
Grab Tensile Strength	250 lbs	ASTM D4632
Grab Tensile Elongation	< 50%	ASTM D4632
Tear Strength	90 lbs	ASTM D4533
CBR Puncture Strength	500 lbs	ASTM D6241
Permittivity	0.05 sec^{-1}	ASTM D4491
Apparent Opening Size (AOS)	0.012 in	ASTM D4751
UV Resistance (at 500 hours)	70% strength retained	ASTM D4355

Table 5 – Nonwoven Separation Geotextile ODOT Requirements

Property	Value	Test Method
Grab Tensile Strength	113 lbs	ASTM D4632
Grab Tensile Elongation	50%	ASTM D4632
Tear Strength	41 lbs	ASTM D4533
CBR Puncture Strength	223 lbs	ASTM D6241
Permittivity	0.05 sec^{-1}	ASTM D4491
Apparent Opening Size (AOS)	No. 30 US Sieve	ASTM D4751
UV Resistance (at 500 hours)	50% strength retained	ASTM D4355

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE AND HANDLING OF GEOSYNTHENTICS

A. Geosynthetic labeling, shipment, and storage shall follow ASTM D4873. Product labels shall clearly show the manufacturer or supplier name, style name, and roll number. During all periods of shipment and storage, the geotextile shall be protected from direct sunlight, ultraviolet rays, temperature greater than 140 degrees Fahrenheit, and mud, dirt, dust, and debris. At no time shall the geotextile be exposed to sunlight for a period exceeding 14 days.

B. Each geosynthetic roll shall be wrapped with a material that will protect the geosynthetic from damage due to shipment, water, sunlight, and contaminants.

31 05 00 - MATERIALS FOR EARTHWORK

C. During storage, geosynthetic rolls shall be elevated off the ground and adequately covered to protect them from the following: site construction damage, precipitation, extended ultraviolet radiation including sunlight, chemicals that are strong acids or strong bases, flames including welding sparks, excess temperatures, and any other environmental conditions that may damage the physical property values of the geosynthetic.

3.2 INSTALLATION OF GEOTEXTILES

A. The Contractor shall handle all geotextiles in such a manner as to ensure the geotextile is not damaged.

B. The surface on which the geotextile is to be placed shall be prepared to a smooth condition free of debris or obstructions which may damage the geotextile. The subgrade shall be approved by the Engineer prior to geotextile placement. Care shall be taken not to entrap stone, excessive dust, or moisture in the geotextile. The Contractor and Installer shall not operate equipment over the geotextile without meeting minimum cover requirements of capping operations. The Contractor shall follow the Manufacturer's recommendations and these Specifications during installation of the geotextile.

C. Geotextiles shall be deployed free of wrinkles and folds. On slopes, the geotextiles shall be anchored at the top and unrolled down the slope. In the presence of wind, all geotextiles shall be weighted with sandbags or other material which will not damage the geotextile.

D. Adjacent geotextile panels shall have minimum two-foot overlaps. All seams shall be oriented parallel to (in the direction of) the slope. Seams constructed perpendicular or transverse to the direction of the slope will not be accepted. The geotextile shall be examined over the entire surface after installation to ensure that no potentially harmful objects are present.

E. Damaged geotextiles and geotextiles contaminated with dirt shall be repaired immediately. Repairs shall be made with the same geotextile product style as the original material. All repairs shall meet the approval of the Engineer, prior to cover placement.

F. Geotextile panels which require repair to be replaced with new material. Replacement material shall have a minimum overlap of two feet at the entire perimeter. All seams shall be oriented parallel to (in the direction of) the slope. Seams constructed perpendicular or transverse to the slope will not be accepted.

G. Placement of cover on the geotextile shall be accomplished in a manner as to ensure that the geotextile is not damaged. Cover material shall be placed within 15 days of deployment.

31 05 00 - MATERIALS FOR EARTHWORK

H. Cover material shall be placed such that excess tensile stress is not mobilized in the geotextile. Cover placement operations shall comply with the requirements and limitations of the contract documents and project design documents.

3.3 INSTALLATION OF AGGREGATE MATERIALS

A. Excavation:

1. Excavate aggregate materials from Site locations as indicated in the Drawings and as specified in Section 31 23 00 – Excavation and Fill Placement.
2. Materials shall be obtained from approved locations or from on-site excavation borrow sites operated by the Contractor.
3. Contractor operated borrow sites shall be developed in accordance with all applicable State Acts.

B. Stockpiling:

1. Separate different aggregate materials with dividers or stockpile apart to prevent intermixing of aggregate types or contamination.
2. Direct surface water away from stockpile site to prevent erosion or deterioration of materials as per Section 31 25 00 – Erosion and Sedimentation Controls.
3. Stockpile hazardous materials on impervious material and cover to prevent erosion and leaching until they are disposed.

C. Placement: Place aggregate materials at Site locations as indicated on the Drawings and as specified in Section 31 23 00 – Excavation and Fill Placement.

D. Additional specific installation details for Type E7 – Erosion Protection included in section 3.4.

3.4 INSTALLATION OF EROSION PROTECTION - TYPE E7A/E7B/E7C

A. Erosion Protection – Type E7a/E7b/E7c shall be placed mechanically in a well interlocked fashion in locations shown in the Drawings to provide scour protection.

B. Erosion protection - Type E7a/E7b/E7c shall not be placed until foundation preparation is completed, geotextile installed (if applicable) and the subgrade surfaces have been observed by the Engineer.

C. The maximum drop high for Erosion protection - Type E7a/E7b/E7c placement is 2 feet.

D. Erosion protection - Type E7a/E7b/E7c shall be mechanically tamped after placement.

31 05 00 - MATERIALS FOR EARTHWORK

E. Erosion protection - Type E7a/E7b/E7c layer shall be constructed to the full course thickness in one operation and in such a manner as to avoid displacement of the underlying materials.

F. The rock shall be delivered and placed in a manner that results in a reasonably homogenous appearance, with the larger rocks uniformly distributed and firmly in contact with one another and with smaller rocks and spalls filling the voids between the larger rocks.

3.5 INSTALLATION OF CONCRETE RUBBLE

A. The installation of concrete rubble section does not apply to areas where Type E9 – General Fill is specified separately of concrete rubble. The Drawings denote separate concrete rubble placement from Type E9 – General Fill at locations such as the powerhouse backfill, and the installation of concrete rubble section only applies to the CR2 denoted locations.

B. Concrete rubble shall be covered by a minimum of 2 ft of cover material.

C. During the placement of Type CR2 - concrete rubble, care shall be taken by the contractor to infill voids between concrete pieces with soil and rock using the procedure below:

1. After a lift of concrete rubble has been placed, a layer of Type E9 general fill material shall be placed over the concrete rubble layer. The lift shall then be track walked to push the general fill into the voids and compact the concrete rubble.
2. If voids are still visible after the area has been track-walked another layer of E9 general fill shall be placed and the process repeated until the voids are no longer visible.
3. The thickness of the Type E9 fill that blankets the concrete rubble lift prior to nominal compaction will be dependant on the void ratio of the concrete and will be adjusted on an as-needed basis by the contractor. The Type E9 general fill layer shall be thin enough to avoid material bridging that would prevent the infilling of the voids.
4. The contractor shall avoid overfilling the concrete rubble and creating continuous layers of Type E9 material.

D. The placement of Type CR1 – concrete rubble shall remain end dumped and will not require the more stringent placement method outlined in Clause 3.5, C. Type CR1 is only specified on the drawings were slope stability is not a requirement, except for the scour hole which is governed by its own placement requirements as per Section 31 23 00 – Excavation and Fill Placement.

31 05 00 - MATERIALS FOR EARTHWORK

E. Where a capping layer is specified above segregated materials, or large particle material with cavities and/or voids, filter material may be specified by the Engineer.

3.6 INSTALLATION OF ENGINEERED STREAMBED MATERIAL

A. Contractor shall begin construction of the roughened channel from the downstream end, constructing downstream apron prior to constructing the roughened channel. Order of work will begin with downstream boulder buttress construction, engineered streambed material and roughness element construction, and upstream boulder buttress.

B. Boulder buttresses will be spaced as shown on the Drawings.

C. Intermediate roughness elements (i.e. random boulders and boulder clusters, 2 ft to 3.5 ft in size, located between buttresses) shall be placed to create a complex flow field. These roughness elements will require field fitting to create a network of bifurcating and confluencing low flow paths.

D. Engineered streambed material shall be placed and spread evenly in 1 ft lifts and compacted with vibratory roller.

E. Once firmly compacted, final surface shall undergo high pressure hose treatment to direct fines into the interstitial spaces to improve compaction.

F. Final channel grade will have an average longitudinal slope between boulder buttresses as shown on the Drawings. The roughened channel surface will have localized highs and lows. Roughness elements will not be included in calculation of roughened channel slope.

G. Final testing will require percolation test every 30 ft along roughened channel. Sandbags may be used to isolate a zone for testing (2 ft area min.). If percolation rate is exceeded greater than 120 min/in (4 hr minimum measurement period), further compaction and/or filling of interstitial spaces with high pressure fines/water is required.

H. The Engineer shall direct field survey and percolation and compaction testing for the roughened channel and provide final approval.

3.7 QUALITY

A. For materials procured off-site or from commercial suppliers, the Contractor shall provide quality control certificates in accordance with the testing frequencies detailed in Table 6.

31 05 00 - MATERIALS FOR EARTHWORK

B. The Contractor will be responsible for field quality testing (control tests) for all fill materials excavated from on-site borrow areas that are incorporated in the permanent work at the frequencies detailed in Table 66. Minimum testing requirements: frequency is “1 per” the number of cubic yards of material as required for the Work.

Table 6 – Control Testing Schedule

Material Type	Moisture Content (ASTM D2216)	Particle Size Distribution (ASTM D6913)	Laboratory Compaction (ASTM D1557 or D4523 & D4524 as applicable)	Specific Gravity and Absorption (ASTM D854 and ASTM D6473)	Atterberg Limits (ASTM D4318)	Durability Index (ASTM D3744)	Sand Equivalent (ASTM D2419)
	1 per	1 per	1 per	1 per	1 per	1 per	1 per
E2 – Pipe Zone	650	650	650	3,250	-	-	-
E3 – Structural Fill	650	650	650	3,250	3,250	-	-
E4 – Select Fill	1,300	1,300	1,300	3,250	-	-	-
E5 – Road Embankment Fill	1,300	1,300	1,300	3,250	-	-	-
E6 / E8 – Bedding	-	650	-	-	-	-	-
E7a/E7b/E7c – Erosion Protection	-	Visual	-	2000	-	2000	Source
E9/E9a/E9b – General Fill	-	20,000	-	-	-	-	-
E10 – Random Fill	-	-	-	-	-	-	-
E11 – Class II Aggregate Base	500	500	2,000	-	-	-	-
E12 – Engineered Streambed Material	-	Visual	-	2,000	-	2,000	-
E13 – Drain Rock	-	Source	-	Source	-	-	Source
CR1/CR2 – Concrete Rubble	-	Visual	-	-	-	-	-

NOTES:

1. CONTROL TESTING TO BE PERFORMED PRIOR TO USE OF MATERIALS IN THE WORKS TO CONFIRM MATERIAL COMPLIANCE. CONTROL TESTING MAY BE UNDERTAKEN ON STOCKPILED MATERIALS OR PRIOR TO DELIVERY OF COMMERCIAL PRODUCTS TO SITE. RECORD TESTING (SECTION 31 23 00 EXCAVATION AND FILL PLACEMENT) TO BE UNDERTAKEN ONCE MATERIALS ARE PLACED TO CONFIRM COMPLIANCE OF IN-SITU MATERIALS.
2. SOME E7A/E7B/E7C AND E13 CONTROL TESTS ARE USED TO CHARACTERIZE A SOURCE. ONE OF EACH TEST IS REQUIRED AT LOCATIONS OF PLANNED SOURCING, EITHER FROM A BORROW AREA OR MANUFACTURER.
3. IF TESTING VOLUME NOTED IN TABLE 6 EXCEEDS THE VOLUME OF PLACED FILL FOR A SPECIFIC AREA, THEN PERFORM A MINIMUM OF 1 TEST PER AREA.

31 05 00 - MATERIALS FOR EARTHWORK

C. If in the judgement of the Engineer, the volume of material represented by a failed control test is anticipated to result in work that deviates from design intent, remove, or dispose of the non-complying material. Rework shall be performed at the Contractor's expense.

D. Material quality, including such fill parameters as frozen/unfrozen state and inclusion of topsoil, shall verified by the Engineer prior to fill placement.

E. Aggregate Moisture Control:

1. Moisture Adjustment: Moisture content shall be adjusted as necessary to facilitate compaction. Moisture control shall be achieved by either windrowing, scarifying or adding water to achieve workable moisture content.
2. Water may be added to the material at the source or after the material has been brought into its final position, whichever is more practical. The Contractor shall obtain uniform moisture distribution in the lift by disking, blading, or other approved methods. The amount of water applied shall be controlled so that free water will not appear on the surface during or subsequent to compaction operations.
3. Material deposited on fill that is too wet shall be removed or spread and permitted to dry, assisted by disking or blading, if necessary, until the moisture content is reduced to the specified limits.
4. When the top surface of a layer becomes too dry or too smooth to permit suitable bonding with the subsequent layer, the Contractor shall loosen the material by scarifying or disking. The Contractor shall then moisten the loosened material to acceptable moisture content and re-compact the material to the specified density.

F. Any omissions or failure on the part of the Engineer to reject the work or materials shall not be construed as acceptance of unsuitable materials.

G. A testing laboratory will furnish test data on all materials manufactured for incorporation into permanent project structures. Certification shall meet the relevant state requirements.

END OF SECTION 31 05 00

SECTION 31 23 00 - CONTROLLED LOW STRENGTH MATERIAL

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall provide Controlled Low Strength Material (CLSM), complete and in place, in accordance with the Contract Documents.

B. CLSM shall be placed where indicated and may be used, if the ENGINEER approves, for the following purposes:

1. Normal CLSM with high slump, non-segregating consistency that readily flows and fills voids and difficult to reach places: pipe zone fill, trench zone fill, pipe abandonment, structure backfill, and structure cavity fill.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with KRRP Project Submittals.

B. Shop Drawings:

1. CLSM mix designs which show the proportions and gradations of materials proposed for each type of CLSM indicated. Each mix design shall be accompanied by independent laboratory test results of the indicated properties.

2. If the CONTRACTOR proposes to provide lower strength CLSM with aggregates that do not conform to ASTM C 33 - Concrete Aggregate, Shop Drawings shall include a testing program that will be used to control the variability of the aggregates. The testing program shall be acceptable to the Engineer.

1.3 QUALITY CONTROL

A. Testing will be performed by a testing laboratory selected by the OWNER at the OWNER's expense, except as otherwise indicated.

B. If tests of the CLSM show non-compliance with the specifications, the CONTRACTOR shall make changes as may be required to achieve compliance. Performing and paying for subsequent testing to show compliance shall be the CONTRACTOR's responsibility.

C. Correlation Tests

1. The CONTRACTOR shall perform a field correlation test for each mix of CLSM used in pipe zone, trench zone, or backfill used in amounts greater than 100-cubic yards or when CLSM is required to support traffic or other live loads on the fill less than 7 Days after placing CLSM.

2. Field correlation tests shall be performed in a test pit similar in cross section to the WORK and at least 10-feet long at a location near the WORK. The proposed location shall be acceptable to the ENGINEER.

3. Laboratory and field tests shall be performed on samples taken from the same CLSM batch mix. Tests shall be performed by a laboratory at the CONTRACTOR's expense.

4. Testing shall be performed once each 2 hours during the first 8 hours, once each 8 hours during the first week, and once each 24 hours until the CLSM mix reaches the maximum design strength.

    a. Compression testing shall be in accordance with ASTM D 4832 - Preparation and Testing of Soil-Cement Slurry Test Cylinders.

    b. Setting test shall be in accordance with ASTM C 403 - Time of Setting of Concrete Mixtures by Penetration Resistance

    c. Density tests shall be in accordance with ASTM C 138 - Unit Weight, Yield and Air Content (Gravimetric) of Concrete.

PART 2 -- PRODUCTS

2.1 CONTROLLED LOW STRENGTH MATERIAL

A. CLSM shall be a mixture of cement, pozzolan, coarse and fine aggregate, admixtures, and water, mixed in accordance with ASTM C 94 - Ready Mixed Concrete.

B. **Composition:** The following parameters shall be within the indicated limits and as necessary to produce the indicated compressive strengths.

1. Mix proportions as necessary

2. Entrained air content shall be between 20 percent minimum and 30 percent maximum.

3. Water reducing agent content as necessary

C. Properties

1. Density shall be between 120 PCF minimum and 145 PCF maximum

2. Slump shall be as required by the CONTRACTOR's methods, but shall not promote segregation nor shall slump exceed 9 inches.

3. Compressive strength at 28 Days:

    a. Normal CLSM: Between 400 psi minimum and 500 psi maximum. Unless specifically indicated otherwise, CLSM shall be Normal CLSM.

2.2 CEMENT

A. Cement shall be Type I or II in accordance with ASTM C 150 - Portland Cement.

2.3 POZZOLAN

A. Pozzolan shall be Type F or C in accordance with ASTM C 618 – Fly ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete. Pozzolan content, by weight, in Normal CLSM shall not be greater than cement content.

2.4 AGGREGATE

A. Aggregate shall consist of a well graded mixture of crushed rock, soil, or sand, with a nominal maximum size of 3/8-inch. One hundred percent shall pass the 1/2-inch sieve; no more than 30 percent shall be retained on the 3/8-inch sieve; and no more than 12 percent shall pass the number 200 sieve. If more than 5 percent of the aggregate passes the number 200 sieve, the material passing the number 200 sieve shall have a plasticity index of less than 0.73 (liquid limit-20), when tested in accordance with ASTM D 4318 - Liquid Limit, Plastic Limit, and Plasticity Index of Soils. Aggregate shall be free from organic matter and shall not contain more alkali, sulfates, or salts than the native materials at the Site.

2.5 ADMIXTURES

A. Air entraining admixtures shall be in accordance with ASTM C 260 - Air-Entraining Admixtures for Concrete.

B. Water reducing admixtures shall be in accordance with ASTM C 494 - Chemical Admixtures for Concrete.

2.6 WATER

A. Water shall be potable, clean, and free from objectionable quantities of silt, organic matter, alkali, salt, and other impurities.

PART 3 -- EXECUTION

3.1 PREPARATION

A. Subgrade and compacted fill to receive CLSM shall be prepared according to Section 31 00 00 - Earthwork.

3.2 BATCHING, MIXING AND DELIVERY

A. Batching, mixing, and delivery of CLSM shall conform to ASTM C 94. CLSM shall be mixed at a batch plant acceptable to the ENGINEER and shall be delivered in standard transit mix trucks.

3.3 PLACEMENT

A. CLSM shall be placed by tailgate discharge, conveyor belts, pumped, or other means. CLSM shall be directed in place by vibrator, shovel, or rod to fill crevices and pockets. Avoid over-consolidation which causes separation of aggregate sizes.

B. CLSM shall be continuously placed against fresh material unless otherwise approved by the ENGINEER. When new material is placed against existing CLSM, the placement area shall be free from loose and foreign material. The surface of the existing material shall be soaked a minimum of one hour before placement of fresh material but no standing water shall be allowed when placement begins.

C. Temperature of the CLSM shall be between 50 and 90 degrees F, when placed. CLSM shall not be placed when the air temperature is below 40 degrees F. No CLSM shall be placed against frozen subgrade or other materials having temperature less than 32 degrees F.

3.4 FINISHING

A. The finish surface shall be smooth and to the grade indicated or directed by the ENGINEER. Surfaces shall be free from fins, bulges, ridges, offsets, and honeycombing. Finishing by wood float, steel trowel, or similar methods is not required.

3.5 CURING

A. CLSM shall be kept damp for a minimum of 7 Days or until final backfill is placed.

3.6 PROTECTION

A. CLSM shall be protected from freezing for 72 hours after placement.

B. No fill or loading shall be placed on CLSM until probe penetration resistance, as measured in accordance with ASTM C 803 - Standard Test Method for Penetration Resistance of Hardened Concrete, exceeds 650 psi.

C. CLSM shall be protected from running water, rain, and other damage until the material has been accepted and final fill completed.

- END OF SECTION -

SECTION 31 23 19 – DEWATERING

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall dewater trench and structure excavations, in accordance with the Contract Documents. The CONTRACTOR shall secure all necessary permits to complete the requirements of this Section of the Specifications.

1.2 CONTRACTOR SUBMITTALS

A. Prior to commencement of excavation, the CONTRACTOR shall submit a detailed plan and operation schedule for dewatering of excavations. The CONTRACTOR may be required to demonstrate the system proposed and to verify that adequate equipment, personnel, and materials are provided to dewater the excavations at all locations and times. The CONTRACTOR's dewatering plan is subject to review by the ENGINEER.

1.3 QUALITY CONTROL

A. It shall be the sole responsibility of the CONTRACTOR to control the rate and effect of the dewatering in such a manner as to avoid all objectionable settlement and subsidence.

B. All dewatering operations shall be adequate to assure the integrity of the finished project and shall be the responsibility of the CONTRACTOR.

C. Where critical structures or facilities exist immediately adjacent to areas of proposed dewatering, reference points shall be established and observed at frequent intervals to detect any settlement which may develop. The responsibility for conducting the dewatering operation in a manner which will protect adjacent structures and facilities rests solely with the CONTRACTOR. The cost of repairing any damage to adjacent structures and restoration of facilities shall be the responsibility of the CONTRACTOR.

PART 2 -- PRODUCTS

2.1 EQUIPMENT

A. Dewatering, where required, may include the use of well points, sump pumps, temporary pipelines for water disposal, rock or gravel placement, and other means. Standby pumping equipment shall be maintained on the Site.

PART 3 -- EXECUTION

3.1 GENERAL REQUIREMENTS

A. The CONTRACTOR shall provide all equipment necessary for dewatering. It shall have on hand, at all times, sufficient pumping equipment and machinery in good working condition and shall have available, at all times, competent workmen for the operation of the pumping equipment. Adequate standby equipment shall be kept available at all times to insure efficient dewatering and maintenance of dewatering operation during power failure.

B. Dewatering for structures and pipelines shall commence when groundwater is first encountered, and shall be continuous until such times as water can be allowed to rise in accordance with the provisions of this Section or other requirements.

C. At all times, site grading shall promote drainage. Surface runoff shall be diverted from excavations. Water entering the excavation from surface runoff shall be collected in shallow ditches around the perimeter of the excavation, drained to sumps, and be pumped or drained by gravity from the excavation to maintain a bottom free from standing water.

D. Dewatering shall at all times be conducted in such a manner as to preserve the undisturbed bearing capacity of the subgrade soils at proposed bottom of excavation.

E. If foundation soils are disturbed or loosened by the upward seepage of water or an uncontrolled flow of water, the affected areas shall be excavated and replaced with drain rock.

F. The CONTRACTOR shall maintain the water level below the bottom of excavation in all work areas where groundwater occurs during excavation construction, backfilling, and up to acceptance.

G. Flotation shall be prevented by the CONTRACTOR by maintaining a positive and continuous removal of water. The CONTRACTOR shall be fully responsible and liable for all damages which may result from failure to adequately keep excavations dewatered.

H. If well points or wells are used, they shall be adequately spaced to provide the necessary dewatering and shall be sandpacked and/or other means used to prevent pumping of fine sands or silts from the subsurface. A continual check by the CONTRACTOR shall be maintained to ensure that the subsurface soil is not being removed by the dewatering operation.

I. The CONTRACTOR shall dispose of water from the WORK in a suitable manner without damage to adjacent property. CONTRACTOR shall be responsible for obtaining any permits that may be necessary to dispose of water. No water shall be drained into work built or under construction without prior consent of the ENGINEER. Water shall be filtered using an approved method to remove sand and fine-sized soil particles before disposal into any drainage system.

J. The release of groundwater to its static level shall be performed in such a manner as to maintain the undisturbed state of the natural foundation soils, prevent disturbance of compacted backfill and prevent flotation or movement of structures, pipelines, and sewers.

- END OF SECTION -

31 25 00 EROSION AND SEDIMENTATION CONTROLS

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31 25 00 EROSION AND SEDIMENTATION CONTROLS

REVISION INDEX

Revision No.	Signatures			Date (MMDDYY)	Pages Revised	Remarks
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Approval that this document adheres to the Knight Piésold Quality Syst CN

31 25 00 EROSION AND SEDIMENTATION CONTROLS

TABLE OF CONTENTS

PAGES

31 25 00 EROSION AND SEDIMENTATION CONTROLS

SECTION 31 25 00 EROSION AND SEDIMENTATION CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes temporary and permanent erosion and sediment controls including but not limited to the following:

1. Permanent erosion and sedimentation controls installed by the Contractor as specified in this Specification and as set out in the Drawings.
2. Temporary erosion and sediment controls installed by the Contractor where required.
3. The conversion of temporary measures to permanent measures.

1.2 RELATED SECTIONS

A. Section 02 41 00 – Demolition and Facility Removal.

B. Section 31 05 00 – Materials for Earthwork.

C. Section 31 10 00 – Clearing, Grubbing and Stripping.

D. Section 31 23 00 – Excavation and Fill Placement.

E. Section 31 60 00 – Foundation Preparation.

F. Section 31 80 00 – Care of Water.

1.3 REFERENCE STANDARDS

A. AASHTO

1. AASHTO M294: Standard Specification for Corrugated Polyethylene Drainage Pipe 12” - 60” (304.8mm – 1524.0mm).

B. ASTM or ASTM International (ASTM):

1. ASTM C602 - Standard Specification for Agricultural Liming Materials.
2. ASTM D3350: Standard Specification for Polyethylene Plastic Pipe and Fittings Materials.

31 25 00 EROSION AND SEDIMENTATION CONTROLS

3. ASTM F477: Standard Specification for Elastomeric Seals (Gaskets) for Joint Plastic Pipe.
4. ASTM F2306: Standard Specification for 12″ – 60″ (304.8mm – 1524.0mm) Annular Corrugated Profile-Wall Polyethylene Pipe and Fittings for Gravity-Flow Storm Sewer and Subsurface Drainage Applications.

C. State of California Water Resources Control Board:

1. California Stormwater Quality Association BMP Handbook – Construction.
2. Construction General Permit (CGP).

D. State of Oregon Department of Environmental Quality:

1. Construction Stormwater Best Management Practices Manual, 1200-C NPDES General Permit.
2. Section 8. Site Restoration, Erosion and Sediment Control, Clean Water Act Section 401 Certification.

E. State of California Department of Transportation (Caltrans) Standard Specifications, Section 21 – Erosion Control.

F. State of Oregon Department of Transportation (ODOT):

1. Oregon Department of Transportation (ODOT): Oregon Standard Specifications for Construction, 2018.

1.4 DEFINITIONS

A. **Permanent Erosion and Sediment Control** – measures required to address long term, post-deconstruction erosion and sedimentation control, that are related to stormwater pollution prevention.

B. **Temporary Erosion and Sediment Control** – measures installed by the Contractor to control the erosion and stormwater pollution during the mobilization and deconstruction Work.

C. **BMPs** – Best Management Practices, as specified in the referenced standards of the CASQA and Oregon DEQ. Non-stormwater management, material management including concrete, and dredging BMPs referenced in the standards are excluded from this specification and are addressed in the management plans.

D. **SWPPP** – Stormwater Pollution Prevention Plan, in California.

E. **QSP** – Qualified SWPPP Practitioner in California.

31 25 00 EROSION AND SEDIMENTATION CONTROLS

F. **QSD** –Qualified SWPPP Developer in California.

G. **CPESC** – Certified Professional in Erosion and Sediment Control in California and Oregon.

H. **Pre-Drawdown Year** – The calendar year when the Contractor mobilizes for the deconstruction and modifies, adjusts or adapts the existing dams and appurtenant structures to facilitate safe drawdown of the reservoirs, as shown on the Drawings.

I. **Drawdown Year** – The calendar year, following the pre-drawdown year, when the four reservoirs will be drawdown; the dams and associated facilities will be demolished, deconstructed, buried, and/or removed; and the fish volitional channels will be restored.

J. **Final Stabilization** – Surface treatment or cover to provide erosion control as a permanent measure. In general terms, the measure may be vegetative or non-vegetative or a combination thereof. The QSP/CPESC will provide for determination of the final stabilization, based on visual inspection.

K. **Non-vegetative Final Stabilization** – Placement of a final cover material, not suitable for vegetation, at final grade as shown on the Drawings. Fines are soil materials passing a US standard sieve #200 and are limited to 10% of the surface layer, by weight. Per the Drawings and Section 31 05 00 – Materials for Earthwork, acceptable materials are Select Fill (E4) and General Fill (E9b). The QSP/CPESC will provide for determination of the final stabilization, based on visual inspections or other means.

L. **Vegetative Final Stabilization** – Hydroseeding the final cover material, suitable for vegetation, at final grade as shown on the Drawings. Fines are soil materials passing a US standard sieve #200 and must be greater than 10% of the surface layer, by weight. Per the Drawings and Section 31 05 00 – Materials for Earthwork, acceptable surface materials for hydroseeding would General Fill (E9). The QSP/CPESC will provide for determination of the final stabilization, based on visual inspections or other means.

M. **Rain Event** – A 50% chance or greater forecasted or actual heavy rain event that occurs during the deconstruction activities and may require mobilization and implementation of additional temporary erosion and control measures.

N. **Rain Event Action Plan** – Pre-Rain Plan for addressing a rain event with a 50% chance or greater. The requirement for these, if any, will be specified in the CA SWPPPs or OR Erosion and Sediment Control Plan.

O. **Temporary construction roads** – Newly constructed roads used for the duration of construction.

P. **Rehabilitated construction roads** – Currently existing roads that need to be widened to accommodate wider trucks with heavier loads.

31 25 00 EROSION AND SEDIMENTATION CONTROLS

Q. **Permanent construction roads** – Newly constructed roads that will be fit for service by the public by the end of construction.

R. **Hold Point** – A period within the deconstruction activities where further progress awaits the approval or acceptance of the condition or work by the QSP, CPESC.

S. **Historic Construction** – Initial construction of the dams and appurtenant works.

T. **Historic Staging Areas** – Staging areas used in the initial construction. These are generally flat and may have some overgrowth.

U. **Historic Construction Roads** – Construction roads used in the initial construction. These areas have some overgrowth.

1.5 SUBMITTALS

A. Items listed in this section are to be submitted to the Engineer for information prior to the start of any Works, unless noted otherwise.

B. Erosion and Sediment Control Plan (ESCP) for Oregon and Stormwater Pollution Prevention Plan (SWPPP) for California including Best Management Practices (BMPs) indicating the specific erosion and sediment control measures, turbidity and silt control measures, air quality and dust control plans, QSP/CPESC hold points and plans for monitoring.

C. Seed Product Data: Data for seed mix, fertilizer, mulch, and other additives, including tackifiers (soil binder). Weed-free certifications and Phytophthora-free certifications, where available. Laboratory Test Results: indicating purity and germination rates for all seed species. It is recognized that members the Yurok Tribe have been collecting seed specimens for a number of years and that RES has recommended the Upland Diversity Mix (see Figure 1), which is subject to the CA SWPPPs and the OR Erosion and Sediment Control Plan.

31 25 00 EROSION AND SEDIMENTATION CONTROLS

Species	Common name	Lifeform	Seed Status
Amsinckia menziesii	Menzies' fiddleneck	Annual forb	To be collected
Acmispon americanus	Spanish lotus	Annual forb	Stored (PCS)
Angelica arguta	Lyall's angelica	Perennial forb	To be collected
Artemisia tridentata	big sagebrush	Shrub	Stored (PCS)
Danthonia californica	California oatgrass	Perennial grass	To be collected
Ericameria nauseosa	Rabbitbrush	Shrub	Stored (HRF, PCS)
Festuca microstachys	small fescue	Annual grass	To be collected
Grindelia nana	Idaho gumweed	Perennial forb	To be collected
Koeleria macrantha	June grass	Perennial grass	To be collected
Lomatium macrocarpum	bigseed biscuitroot	Perennial forb	To be collected
Lomatium nudicaule	barestem biscuitroot	Perennial forb	To be collected
Lomatium triternatum	nineleaf biscuitroot	Perennial forb	To be collected
Monardella odoratissima	mountain mondardella	Perennial forb	To be collected
Penstemon deustus	rock penstemon	Perennial forb	To be collected
Perideridia bolanderi	Bolander's yampah	Perennial forb	To be collected
Phacelia heterophylla var *virgata*	varied leaf phacelia	Perennial forb	To be collected
Poa secunda	Sandberg's bluegrass	Perennial grass	To be collected
Stipa lemmonii	Lemmon's needlegrass	Perennial grass	Stored (HRF)
Stipa occidentalis	western needlegrass	Perennial grass	To be collected

NOTES:

1. THE UPLAND DIVERSITY MIX WILL ALSO INCLUDE SPECIES FROM THE UPLAND PIONEER SEED MIX DEPENDING ON AVAILABILITY.
2. THE APPLICATION RATE AND SEED MIX COMPOSITION WILL BE DETERMINED FOLLOWING DRAWDOWN BASED ON RESERVOIR POST-DRAWDOWN CONDITIONS

Figure 1 – Upland Diversity Mix

D. Pre-deconstruction vegetative condition: to establish a baseline for closure of the construction permits, requiring restoration of 70% of the pre-deconstruction vegetative condition or evaluation and documentation of improved conditions using established analytical methods (e.g. RUSLE).

E. Rain Event Action Plan: Planning for rain events or justification for its exclusion in the CA SWPPPs or the OR Erosion and Sediment Control Plan.

F. Manufacturer's information on all fabricated materials to be used for the permanent and temporary erosion and sedimentation controls.

31 25 00 EROSION AND SEDIMENTATION CONTROLS

1.6 QUALITY ASSURANCE

A. Work shall be in conformance with the Drawings, submittals, and other project documents.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials will include fabricated products and natural materials.

B. To the extent possible, natural erosion control materials such as gravel and rock will originate from local excavations or onsite borrow areas as described in Section 31 05 00 - Materials for Earthwork.

C. Select materials, as shown on the Drawings, may also fulfill an erosion and sediment control function. All materials shall be implemented as detailed in the Erosion and Sediment Control Plan for Oregon, SWPPP for California, as shown on the Drawings, and as per manufacturer requirements.

D. Check dams shall generally be comprised of gravel bags that allow ready conformity to the local site topography. For gravel bags to be used for final stabilization, bag material will be made of a biodegradable material like burlap, or similar.

E. Pipes, and manholes and headwalls for managing storm water collection and conveyance to the outfalls will comply with the Drawings and manufacturer's instructions.

1. The pipe material is high density polyethylene (HDPE). Selected pipe is the Type S HDPE pipe with corrugated exterior and smooth interior. Joints will be gasketed bell and spigot. Nonrated and non-pressure tested watertight joints are suitable for gravity flow drainage applications. The pipe shall conform to the AASHTO and ASTM standards listed in the Reference Standards.
2. The pipe manufacturer shall provide material technical performance information and detailed instructions for installation. The installation instructions shall include minimum cover requirements corresponding to the expected traffic loadings of the Contractor's earthmoving equipment during the deconstruction period.

F. Grass Seed, Fertilizer and Mulch for Hydroseeding:

1. All seed for designated seeded areas will be genetically appropriate and sourced from the Upper Klamath and Lost River Watersheds as per the Contract Documents and the Restoration Specifications. See Figure 1.
2. The seed mix shall conform to the final seed mix selected in the Erosion and Sediment Control Plan in Oregon and the SWPPP in California.

31 25 00 EROSION AND SEDIMENTATION CONTROLS

3. Fertilizer may be added to the hydroseeding slurry to add the nutrients necessary to provide an acceptable soil for growth. Refer to the applicable guidelines provided in the ODOT Standard Specifications.
4. A straw or wood chip mulch may be added to the hydroseeding slurry to provide stability to the seed bed. Straw waddles/Fiber rolls, where necessary, to be installed in conjunction with hydroseeding to reduce sheet flow erosion and sediment transport so the seed can germinate and achieve revegetated stabilization. In some instances, erosion control mats may be necessary to foster vegetative growth.

G. Fiber Roll or Straw Wattles:

1. Straw wattles or fiber rolls shall consist of rolls or bales of tight fibrous material. The wrapping material shall also be primarily biodegradable.
2. See Table 1 for required fiber roll/straw waddle spacing criteria.

Table 1 – Fiber Roll/Straw Waddle Spacing Criteria

State	BMP Name	Slope	Spacing
California	Fiber Roll (SE-5)	< 4H:1V	20’
		4H:1V < Slope < 2H:1V	15’
		Slope > 2H:1V	10’
Oregon	Straw Waddle (2.16)	-	10’ to 25’

H. Tackifier or Soil Binder:

1. A tackifier or soil binder shall be used in locations where appreciable fines are high (>10%), as judged by the QSP/CPESC based on visual inspection.
2. A tackifier or soil binder shall be selected so as to minimize adverse impacts on native fisheries, if required.

I. Construction Entrances/Exits:

1. Construction entrances may comprise natural or man-made materials or a combination thereof.
2. Natural construction materials would include an aggregate-type material similar to E4 or E9b material described in Section 31 05 00 - Materials for Earthworks.
3. Fabricated material would include the many commercially available entrance/exit pads. Such pads are durable, U/V stable, and easily transferred to/from work fronts. Refer to FODS® LLC trackout control system, or similar.

31 25 00 EROSION AND SEDIMENTATION CONTROLS

PART 3 - EXECUTION

3.1 GENERAL

A. Historic staging areas and historic construction roads will be utilized to the extent practical.

B. Existing vegetation will be preserved to the extent practical.

C. For the staging areas, an initial setting out of the area will be undertaken prior to full mobilization of equipment, office trailers, and construction plant and services. The setting out will include site planning, establishment of limits, and staking the area. Drainage paths will be confirmed, stormwater diversion berms shall be constructed, and gravel bag check dams shall be established, as shown on the Drawings. The gravel bag check dams are intended to retain sediment upstream from the check dam. Prior to full mobilization, these perimeter BMPs shall be in place.

D. During deconstruction works, certain areas, such as powerhouse tailraces, will require dewatering by pumping. In accordance with the CA SWPPP and the OR Erosion and Sediment Control Plan, sediment controls will be used to extract excessive sediment from the pumping discharges.

E. Many project areas comprise steep, rocky terrain. Existing and cut stable rock slopes may not require any additional erosion and sediment control measures, as rock is an acceptable erosion and sediment control BMP.

F. After safe construction access is established to the disposal areas, the following BMPs will be established:

1. For disposal areas that border along the river valley wall, a buttress toe will be established at the base of the disposal area, above the 100-year flood level, as shown on the Drawings. The toe will be established with E4 or E9b material, which is available from: (a) a local quarry or (b) required excavation from deconstruction of the dams or road improvements.
2. Graded drainage paths along with gravel bag check dams, as shown on the Drawings.

G. Within the accelerated deconstruction period, the Contractor shall maintain placement of disposal material within the disposal site boundaries in order to maintain an active work site. Accelerated placement of disposal material will ultimately lead to faster final stabilization, subject to the review of a QSP/CPESC.

H. When any disposal area, or portion thereof, is deemed ready for final stabilization by the Contractor, a hold period will be scheduled to facilitate QSP/CSESC review and approval.

31 25 00 EROSION AND SEDIMENTATION CONTROLS

I. The Contractor shall verify that finished grades of each disposal site are in accordance with the Drawings, including final stabilization, which may include the application of hydroseeding or other measures.

J. Installation of erosion protection and bedding materials as engineered materials are described in Section 31 05 00 - Materials for Earthwork and Section 31 23 00 – Excavation and Fill Placement.

3.2 CONSRUCTION ROADS

A. Table 2 summarizes the various construction road types across the project areas.

Table 2 – List of KRRP Construction Roads

Project Site	Temporary Construction Road	Rehabilitated Construction Road	Permanent Construction Road
J.C. Boyle	Left Bank Access Road	Scour Hole Access Road (Optional)	Powerhouse Access Road Realignment
	Left Disposal Haul Road	Penstock Access Road (Optional)	-
	Right Disposal Haul Road	-	-
Copco No.1	Workpad Road (Stage 1)	Powerhouse Access Road Widening	Powerhouse Access Road Realignment
	Workpad Road (Stage 2)	-	-
Copco No.2	-	Diversion Dam Access Road	Spillway Apron Access Road
	-	Left Bank Access Road (Optional)	-
Iron Gate	Downstream Diversion Tunnel Access Road	-	-
	Powerhouse Haul Road	-	-
	Spillway Haul Road	-	-
	Disposal Site #1 and #2 Haul Roads	-	-

B. For all construction roads, measures shall be installed to reduce sediment laden runoff to surrounding construction areas and the Klamath River. Diversion berms or, in some cases safety berms, are to be constructed on the downstream side of road to trap sediment during rain events. All drainage paths, whether existing or constructed, shall be clear of debris throughout the deconstruction. Gravel bag check dams are to be installed along drainage paths near and downstream of borrow areas to trap sediment

31 25 00 EROSION AND SEDIMENTATION CONTROLS

during rainfall events. All culverts, existing or constructed, shall have their inlets protected by gravel bags or similar.

3.3 CONSTRUCTION SCHEDULING

A. Under the accelerated deconstruction schedule, it may be necessary to select final erosion control measures in the field, with oversight of the QSP/CPESC. The QSP/CPESC generally maintains a toolbox of possible solutions that may be implemented under special circumstances. Such toolbox is described in the reference standards.

B. Construction of erosion and sedimentation control measures are to be completed in accordance with the Erosion and Sediment Control Plan in Oregon, SWPPP in California, the Drawings, and these Specifications.

C. Accelerated Scheduling:

1. Scheduling of the construction of temporary and permanent erosion and sedimentation control measures is to be completed by the Contractor.
2. Required erosion and sediment control measures, where applicable, are to be constructed prior to clearing, construction and/or demolition activities.
3. Accelerated scheduling shall be addressed in the CA SWPPPs and the OR Erosion and Sediment Control Plan.

D. Rain Event Action Plan (REAP)

1. In general, deconstruction will be accelerated so that permanent stabilization occurs relatively quickly and during the dry summer months, such that some temporary BMP’s may be unnecessary. This is unique to the nature and mission of this project.
2. The requirement for REAP BMPs, if any, will be specified in the CA SWPPPs and OR Erosion and Sediment Control Plan.
3. If high fines materials are placed in a disposal area prior to a rain event (before permanent stabilization can be reached), they shall be stabilized with temporary BMPs including geotextile and mats or tackifier.

31 25 00 EROSION AND SEDIMENTATION CONTROLS

4. If permanent stabilization of the disposal areas can not be reached prior to a forecasted qualifying rain event, temporary BMP's will be deployed such that stormwater pollution will be prevented at a maximum extent practicable. Such temporary BMP's that will be considered include, but not limited to: Geotextile and mats and/or tackifier for slope protection, slope drains to divert concentrated flows, gravel bag check dams and other BMP's designated by the QSP or CPESC at the time the REAP inspection is conducted, if any.

3.4 CONVERSION OF TEMPORARY MEASURES TO PERMANENT MEASURES

A. Temporary measures may be converted to permanent measures, where accepted by the QSP/CPESC. As and where practical, temporary diversion berms, drainage paths/ditches, biodegradable gravel bag check dams, and sediment traps shall be converted to permanent measures, and will form part of the documentation for closure of the construction permits. Such conversion shall require the following:

1. Inspection by the Engineer and QSP/CPESC.
2. Removal and replacement of damaged measures.
3. Cleaning of sediment traps where the accumulated sediment is more than one-third the depth up to the overflow elevation. Sediment collected will be disposed of in designated areas.
4. Other measures in accordance with specific field conditions.

3.5 TEMPORARY MEASURES

A. Maintain all temporary erosion and sediment control structures during the Work or until the permanent erosion and sediment control structures are installed.

B. Temporary measures are to remain in place until completion of construction activities and appropriate permanent measures are in place. The Contractor is responsible for the removal of all temporary measures, unless converted to permanent measures as outlined above.

C. Construction access roads, where practical, will utilize the remnants of construction roads that were developed during the original construction.

3.6 PERMANENT MEASURES

A. Fill locations must be stabilized by either of two methods: vegetative or non-vegetative as described in the California Stormwater BMP Handbook and the Oregon Construction Stormwater Best Management Practices Manual.

31 25 00 EROSION AND SEDIMENTATION CONTROLS

1. Vegetative grade stabilization involves hydroseeding, as shown on the Drawings. Seeding of designated areas shall be carried out upon completion of construction or disposal work and after any required reclamation work has been completed.
2. Non-vegetative stabilization involves providing rock slope protection or a gravel mulch protection, as shown on the Drawings.

3.7 SITE DEWATERING AND WATER CONTROL

A. Refer to Section 31 23 00 – Excavation and Fill Placement.

B. The Contractor shall be responsible for dewatering excavations and the Worksite by the control of groundwater and/or river or stream diversion where required to complete the Work.

C. Where possible install collection swales downstream of the Worksite to collect sediment laden runoff.

D. Where possible install diversion swales upstream of the Worksite to divert runoff before contact.

E. Where appropriate, control the discharge of collected/diverted water and provide energy dissipation.

F. Care of water must meet permit requirements, Section 31 80 00 – Care of Water requirements and comply with the Contract Documents.

3.8 INSPECTION AND MAINTENANCE

A. The Contractor shall regularly inspect and maintain the construction site for the control measures identified in the Erosion and Sediment Control Plan for Oregon or the SWPPP for California. As a minimum, the Contractor shall inspect temporary infrastructure on a daily basis during periods of prolonged rainfall. The Contractor shall identify corrective actions and time frames to address any damaged measures or reinitiate any measures that have been discontinued. The CA SWPPPs and OR Erosion and Sediment Control Plan is to provide further details on BMP inspection requirements.

B. If the Engineer or QSP/CPESC identifies a deficiency in the deployment or functioning of an identified control measure, the deficiency shall be corrected in a timely manner. If the permitting agency identifies a deficiency in the deployment or functioning of an identified control measure, the Contractor will be notified, and the deficiencies shall be corrected by the Contractor in a timely manner.

END OF SECTION 31 25 00

SECTION 32 11 13 - A.C. PAVEMENT AND BASE

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall provide A.C. pavement and base, complete and in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

AASHTO M 82	Cut-Back Asphalt (Medium Curing Type)
AASHTO M 140	Emulsified Asphalt
AASHTO M 208	Cationic Emulsified Asphalt
AASHTO M 320	Standard Specification for Performance-Graded Asphalt Binder
ASTM D 242	Mineral Filler for Bituminous Paving Mixtures
ASTM D 692	Coarse Aggregate for Bituminous Paving Mixtures
ASTM D 977	Emulsified Asphalt
ASTM D 1073	Fine Aggregate for Bituminous Paving Mixtures
ASTM D 1188	Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
ASTM D 1557	Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf per cu ft)
ASTM D 2027	Cutback Asphalt (Medium Curing Type)
ASTM D 2397	Cationic Emulsified Asphalt
ASTM D 2726	Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures.
ASTM D 3515	Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.
ASTM D 6373-16	Standard Specification for Performance Graded Asphalt Binder
AI MS-2	Asphalt Mix Design Methods, 7th Edition (*Asphalt Institute)*

B. State Standards

State of California Department of Transportation (CalTrans). *Standard Specifications 2018*.

1.3 CONTRACTOR SUBMITTALS

A. Submittals shall be in accordance with KRRP Project Submittals. Include job-mix formulas and other pertinent information satisfactory to the ENGINEER.

B. **Suitability Tests of Proposed Materials:** Tests for conformance with the Specifications shall be performed prior to start of the WORK. The samples shall be identified to show the name of the material, aggregate source, name of the supplier, contract number, and the segment of the WORK where the material represented by the sample is to be used. Results of all tests shall be submitted to the ENGINEER for approval. Materials to be tested shall include aggregate base, coarse and fine aggregate for paving mixtures, mineral filler, and asphalt cement.

PART 2 -- PRODUCTS

2.1 AGGREGATE BASE

A. Materials for aggregate base shall be Type GF material in accordance with Section 31 00 00 - Earthwork.

2.2 PRIME COAT

A. Prime coat shall be Type RS-2 liquid asphalt complying with the requirements of AASHTO M 82 (ASTM D 2027) and Caltrans Standard Specifications, Section 94, Asphaltic Emulsions.

2.3 TACK COAT

A. Tack coat shall be emulsified asphalt Grade SS-1 or SS-1h, CSS-1 or CSS-1h diluted with one part water to one part emulsified asphalt, undiluted asphalt Grade RS-1 or CRS-1, or paving asphalt grade 64-22. Emulsified asphalt shall comply with the requirements of AASHTO M 140 (ASTM D 977) or M 208 (ASTM D 2397); paving asphalt shall comply with the requirements of AASHTO M 226 (ASTM D 3381).

2.4 ASPHALT CEMENT

A. Asphalt Cement shall be Performance Grade 64-22 complying with the requirements of AASHTO M320 (ASTM D 6373-16).

2.5 MINERAL AGGREGATE

A. Mineral aggregate shall be crushed stone, crushed slag, crushed gravel, stone or slag screening, sand, mineral filler, or a combination of two or more of these materials. Coarse and fine aggregates shall comply with all the quality requirements, except soundness, of ASTM D 692 and D 1073, respectively. Coarse aggregate failing to comply with abrasion requirements may be used if experience has demonstrated it to be satisfactory.

B. Mineral filler shall comply with ASTM D 242.

C. Combinations of aggregates having a history of polishing shall not be used in surface courses.

2.6 ASPHALT-AGGREGATE MIXTURE

A. Asphalt-aggregate mix shall be Performance Grade 64-22, 1/2” maximum aggregate size Type A HMA per CalTrans specifications 39-2.02B(4)(b) and shall comply with Superpave HMA mix design, material specifications, and testing as described in MS-2 Asphalt Mix Design Methods by the *Asphalt Institute*.

2.7 PAVEMENT MARKING PAINT

A. Pavement marking paint shall be a product specifically formulated for use on asphalt concrete pavement and shall have a proven record of performance and durability.

PART 3 -- EXECUTION

3.1 SUBGRADE PREPARATION

A. The subgrade shall be prepared in accordance with Section 31 00 00 - Earthwork as applicable to roadways and embankments. The surface of the subgrade after compaction shall be hard, uniform, smooth and true to grade and cross-section. Subgrade for pavement shall not vary more than 0.02-foot from the indicated grade and cross section. Subgrade for base material shall not vary more than 0.04-foot from the indicated grade and cross section.

3.2 AGGREGATE BASE

A. Aggregate base shall be provided where indicated to the thickness indicated. Imported aggregate bases shall be delivered to the Site as uniform mixtures and each layer shall be spread in one operation. Segregation shall be avoided and the base shall be free of pockets of coarse or fine material. Where the required thickness is 6-inches or less, the base materials may be spread and compacted in one layer. Where the required thickness is more than 6-inches; the base material shall be spread and compacted in two or more layers of approximately equal thickness, and the maximum compacted thickness of any one layer shall not exceed 6-inches. The relative compaction of each layer of aggregate base shall be not less than 95 percent of maximum density when measured in accordance with ASTM D 1557. The compacted surface of the finished aggregate shall be hard, uniform, smooth and at any point shall not vary more than 0.02 foot from the indicated grade or cross-section.

3.3 PRIME COAT

A. Prior to placing of pavement a prime coat of cutback asphalt shall be applied to the compacted base or subgrade at a rate between 0.10 and 0.25 gal/sq yd.

3.4 TACK COAT

A. A tack coat shall be applied to existing paved surfaces where new asphalt concrete is to be placed on existing pavement. It shall also be applied to the contact surfaces of all cold pavement joints, curbs, gutters, manholes and the like immediately before the adjoining asphalt pavement is placed. Care shall be taken to prevent the application of tack coat material to surfaces that will not be in contact with the new asphalt concrete pavement. Diluted emulsified asphalt shall be applied at the rate of 0.05 to 0.15 gal/sq yd. Undiluted emulsified asphalt shall be applied at the rate of 0.025 to 0.075 gal/sq yd. Paving asphalt shall be applied at the rate of approximately 0.05 gal/sq yd.

3.5 ASPHALT CONCRETE

A. At the time of delivery to the Site, the temperature of mixture shall not be lower than 260 degrees F or higher than 320 degrees F, the lower limit to be approached in warm weather and the higher in cold weather.

B. Asphalt concrete shall not be placed when the atmospheric temperature is below 40 degrees F or during unsuitable weather.

C. The asphalt concrete shall be evenly spread upon the subgrade or base to such a depth that, after rolling, it will be of the required cross section and grade of the course being constructed.

D. The depositing, distributing, and spreading of the asphalt concrete shall be accomplished in a single, continuous operation by means of a self-propelled mechanical spreading and finishing machine designed specially for that purpose. The machine shall be equipped with a screed or strike-off assembly capable of being accurately regulated and adjusted to distribute a layer of the material to a definite pre-determined thickness. When paving is of a size or in a location that use of a self-propelled machine is impractical, the ENGINEER may waive the self-propelled requirement.

E. Spreading, once commenced, shall be continued without interruption.

F. The mix shall be compacted immediately after placing. Initial rolling with a steel-wheeled tandem roller, steel three-wheeled roller, vibratory roller, or a pneumatic-tired roller shall follow the paver as closely as possible. If needed, intermediate rolling with a pneumatic-tired roller shall be done immediately behind the initial rolling. Final rolling shall eliminate marks from previous rolling. In areas too small for the roller, a vibrating plate compactor or a hand tamper shall be used to achieve thorough compaction.

G. Upon completion the pavement shall be true to grade and cross-section. When a 10-ft straightedge is laid on the finished surface parallel to the center of the roadway, the surface shall not vary from the edge of the straightedge more than 1/8-in except at intersections or changes of grade. In the transverse direction, the surface shall not vary from the edge of the straightedge more than 1/4-in.

H. The relative density after compaction shall be 95 percent of the density obtained by using ASTM D 1188 or D 2726. A properly calibrated nuclear asphalt testing device shall be used for determining the field density of compacted asphalt concrete, or slabs or cores may be laboratory tested in accordance with ASTM D 1188.

3.6 PAVEMENT MARKING

A. Pavement marking paint shall be applied where indicated only when the pavement surface is dry and clean, and when the air temperature is above 40 degrees F. All equipment used in the application of pavement marking shall produce stripes and markings of uniform quality with clean and well-defined edges that conform to the details and dimensions indicated. Drips, overspray, improper markings, and paint material tracked by traffic shall be immediately removed from the pavement surface by methods previously reviewed by the ENGINEER.

- END OF SECTION -

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SECTION 33 05 00 - PRECAST CONCRETE MANHOLES AND VAULTS

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall provide precast concrete manholes and vaults, complete and in place, in accordance with the Contract Documents.

1.2 SPECIFICATIONS, CODES AND STANDARDS

A. Commercial Standards

ASTM A 48	Gray Iron Castings
ASTM C 150	Portland Cement
ASTM C 443	Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
ASTM C 478	Precast Reinforced Concrete Manhole Sections
ASTM C 890	Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures
ASTM C 913	Standard Specification for Precast Concrete Water and Wastewater Structures
ASTM C 923	Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals

1.3 CONTRACTOR SUBMITTALS

A. **General:** Furnish submittals in accordance with KRRP Project Submittals.

B. **Shop Drawings**

1. Show dimensions, locations, lifting inserts, reinforcement, and joints.

2. Structural design calculations for vaults, signed by a registered engineer.

A. Manufacturer's Certification for Vaults: Written certification that the vault complies with the requirements of this Section.

1.4 QUALITY CONTROL

A. **Inspection:** After installation, the CONTRACTOR shall demonstrate that manholes and vaults have been properly installed, level, with tight joints, at the correct elevations and orientations, and that the backfilling has been carried out in accordance with the Contract Documents.

PART 2-- PRODUCTS

2.1 MANHOLES

A. The CONTRACTOR shall provide precast manhole sections and conical sections conforming to ASTM C 478 and the requirements of this Section. Adjusting rings shall be standard items from the manufacturer of the manhole sections. Minimum wall thickness of rings shall be 4-inches if steel reinforced and 6-inches if not reinforced.

B. Axial length of sections shall be selected to provide the correct total height with the fewest joints.

C. Conical sections shall be designed to support cast iron frames and covers under an H-20 loading, unless indicated otherwise.

D. Where the manhole barrel diameter is greater than 48-inches, a flat slab-transition, either concentric or eccentric, shall be used to transition to 48-inch diameter riser sections. Underside of the transition shall be at least 7-feet above the top of the bench.

B. **Design Criteria:** Manhole walls, transitions, conical sections, and base shall be designed per ASTM C 478 for the depths indicated and the following:

1. AASHTO H-20 loading applied to the cover.

2. Unit weight of soil of 120 pcf located above all portions of the manhole.

3. Lateral soil pressure based on saturated soil producing 100 pcf acting on an empty manhole.

4. Internal fluid pressure based on unit weight of 63 pcf with manhole filled from invert to cover with no balancing external soil pressure.

5. Dead load of manhole sections fully supported by the base and transition.

6. Additional reinforcing steel in walls to transfer stresses at openings.

7. The minimum clear distance between the edges of any 2 wall penetrations shall be 12-inches or one-half of the diameter of the smaller penetration, whichever is greater.

F. Joints shall be sealed with O-ring gaskets conforming to ASTM C 443.

G. Concrete for base and channel formation shall be 4,000 psi concrete at 28 days.

H. Barrel section to sewer pipe connections shall be sealed with resilient connectors complying with ASTM C 923. Mechanical devices shall be stainless steel.

I. Manhole and Vault Manufacturers, or Equal

1. **Jensen Precast, Fontana, CA**
2. **Oldcastle Infrastructure, Santa Rosa, CA**
3. **Hanson Concrete Products, Inc., Milpitas, CA**
4. **Teichert Precast, Sacramento, CA**

2.2 FRAMES AND COVERS

A. **Castings:** Castings for manhole frames and covers shall be non-rocking and shall conform to the requirements of ASTM A 48, Class 30. Unless otherwise indicated, cast iron covers and frames shall be heavy traffic type, 30 inches in diameter, with embossed lettering saying to meet the requirements of the City or the local utility company. Frame and cover shall be designed for H-20 traffic loading.

B. Castings Manufacturers, or Equal

1. **Alhambra Foundry Co., Ltd.**
2. **Neenah Foundry Co.**
3. **Vulcan Foundry, Inc**

2.3 VAULTS

A. The CONTRACTOR shall provide precast vaults designed for the indicated applications and of the sizes indicated.

B. The minimum structural member thickness for vaults shall be 5-inches. Cement shall be Type V Portland cement as specified in ASTM C 150. The minimum 28-day concrete compressive strength shall be 4,000 psi. All reinforcing steel shall be embedded in the concrete with a minimum clear cover as recommended by ACI 318.

C. Design Loading: Vaults in areas subject to vehicular traffic shall be designed for H-20 traffic loading. Vaults in other areas shall be designed for a vertical live load of 300 psf. Lateral loads on vaults in all areas shall be calculated from:

	L	=	90 h, plus surcharge of 240 psf in areas of vehicular traffic
Where	L	=	loading in psf
	h	=	depth of fill in feet

D. Where joints are designed in pre-cast concrete vaults, such joints shall be interlocking to secure proper alignment between members and prevent migration of soil through the joint. Structural sections at joints shall be sized sufficiently to reinforce the section against localized distress during transportation and handling and against excess contact bearing pressures through the joint.

E. Where openings for access to the vault are required, the full clear space opening indicated shall be provided, without obstructions from brackets or supports. For large openings where brackets or supports are designed to protrude into the opening for support of required covers, such brackets or supports shall be designed to be easily removed and replaced with a minimum of effort and without cutting or welding.

F. Covers for access openings shall be provided. Frames for covers shall be fabricated from steel, galvanized after fabrication, or aluminum and shall be integrally cast into the vault concrete sections. All covers shall be tight fitting to prevent the entrance of dirt and debris. Where edge seams are permitted, no gaps greater than 1/16-inch between edges will be accepted. All covers, except round, heavy-weight, cast iron manhole covers, shall have securing mechanisms to hold the covers firmly in place against the effects of repetitious live loads such as pedestrian or vehicle traffic.

G. Where hatch frames are shown with drainage couplings, the vault shall be furnished for drainage conduit extending through the vault as shown on the drawings.

H. Where penetration of the pre-cast concrete vault are required for piping, conduit, or ducts, such penetrations shall be accommodated through pre-cast openings or thin-wall knock-out sections. All openings for penetrations shall be smooth and free of surface irregularities and without exposed steel reinforcing. Vaults need not be designed to resist thrust from piping passing through the vault.

PART -- EXECUTION

3.1 GENERAL

A. Pre-cast concrete sections shall be transported and handled with care in accordance with the manufacturer’s written recommendations. Where lifting devices are provided in pre-cast sections, such lifting devices shall be used as intended. Where no lifting devices are provided, the CONTRACTOR shall follow the manufacturer’s recommendations for lifting procedures to provide proper support during lifting.

B. Buried pre-cast concrete vaults shall be assembled and placed in excavations on properly compacted soil foundations as indicated. Pre-cast concrete vaults shall be set to grade and oriented to provide the required dimensions and clearances from pipes and other structures.

C. Prior to backfilling, all cracks and voids in pre-cast concrete vaults shall be filled with non-shrink grout or polyurethane sealant, or both. Around pipe and conduit penetrations, openings shall be sealed with polyurethane sealant. With the authorization of the ENGINEER, grout or a closed-cell flexible insulation may be used as filler material prior to placing a final bed of polyurethane sealant.

- END OF SECTION -

SECTION 33 11 11 - STEEL PIPE, SPECIALS, AND FITTINGS (AWWA C200, MODIFIED)

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall provide steel pipe, specials, and fittings, complete and in place, in accordance with the Contract Documents.

B. A single pipe manufacturer shall be made responsible for furnishing steel pipe, specials, fittings, and appurtenances such as bolts and gaskets for the WORK.

C. **Pipe Material Group No. 8**. The piping system defined in this section is referred to in the Pipe Schedule on Contract Sheet G007 as Piping Material Group No. 8. **(Note that steel Pipe of 14-inch diameter and larger, as called out on the Contract Drawings, shall be based upon outside diameter of steel shell dimensions, per Part 2.1.A of this Section.)**

D. **Pipeline Options A & B**. The CONTRACTOR is alerted that two different steel pipe fabrication and installation options are provided for different sections of the new pipeline alignment, in accordance with the ***Pipeline Options Summary Table*** on Sheet G008. This specification section applies primarily to Option B which is the furnishing of spiral welded steel pipe, specials and fittings in accordance with AWWA C200, as modified in this section herein. This section also applies to the joint-end requirements, welding requirements, and installation requirements for Pipeline Option A. The pipe material and fabrication requirements for Pipeline Option A are covered in Section 40 23 15 – Steel Pipe (ASTM A53).

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with KRRP Project Submittals.

B. Furnish the following information with Shop Drawings:

1. Certified dimensional drawings of fittings and appurtenances

2. Joint and pipe/fitting wall construction details which indicate the type and thickness of cylinder; the position, type, size, and area of reinforcement; coating and lining holdbacks, manufacturing tolerances, and other pertinent information required for the manufacture of the product

3. Joint details where deep bell or butt strap joints are required for control of temperature stresses

4. Details for elbows, wyes, tees, outlets, connections, test bulkheads, and nozzles or other specials that indicate amount and position of reinforcement

5. Fittings and specials, showing proper reinforcement to withstand the internal pressure, both circumferential and longitudinal, and the external loading conditions as indicated

6. Material lists and steel reinforcement schedules that describe materials to be utilized, including metallurgical, chemical, and physical test reports from each heat of steel to verify the steel conforms to the indicated requirements

7. Line layout and marking diagrams which indicate the specific number of each pipe and fitting, the location of each pipe, the direction of each fitting in the completed line, and the following:

    a. the pipe station and invert elevation at every change in grade or horizontal alignment

    b. the station and invert elevation to which the pipe will be laid

    c. elements of curves and bends, both in horizontal and vertical alignment

    d. the limits within each reach of restrained and/or welded joints or of concrete encasement

    e. location and dimensional allocations for each indicated valve, fitting, and appurtenance

8. Welds

    a. Submit full and complete information regarding location, type, size, and extent of welds.

    b. The Shop Drawings shall distinguish between shop and field welds.

    c. Shop Drawings for field welds shall indicate by welding symbols or sketches the details of the welded joints and the preparation of parent metal required to make them. Submittal shall include a complete Welding Procedure Specification (WPS) guide sheet for each category of weld (fillet weld, single-bevel butt weld, double-bevel butt weld, etc.) that defines all specific details for the supplied weld including:

        1) Welding Procedure Specification (WPS) which identifies characteristics including joint and backing ring (if applicable) geometry, base metal and filler metal characteristics, pre-heating and post-heating requirements, electrical characteristics, welding technique, and a welding parameter sheet.

        2) Propose Welding Procedure Qualification (WPQ) process,

        3) Proposed inspection and non-destructive examination (NDE) requirements to meet the requirements of this Section.

    d. Joints or groups of joints in which welding sequence or technique are especially important shall be carefully controlled to minimize shrinkage stresses and distortion.

9. Drawings showing the location, design, and details of bulkheads for hydrostatic testing of the pipeline, and details for removal of test bulkheads and repair of the lining

10. Details and locations of closures for length adjustment and for construction convenience

11. Detail drawings indicating the type, number, and other pertinent details of the slings, strutting, and other methods proposed for pipe handling during manufacturing, transport, and installation

12. Manufacturer's Written Quality Assurance/Control Program

C. Certifications

1. The CONTRACTOR shall furnish a certified affidavit of compliance for pipe and other products or materials that such are in accordance with appropriate specifications (AWWA C200 - Steel Water Pipe 6 in and Larger, AWWA C205 - Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 in and Larger-Shop Applied, AWWA C206 – Field Welding of Steel Pipe, AWWA C207 - Steel Pipe Flanges for Waterworks Service - Sizes 4 In Through 144 In, AWWA C208 - Dimensions for Fabricated Steel Water Pipe Fittings, AWWA C210 - Liquid–Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines, AWWA C213 - Fusion-Bonded Epoxy Coatings for the Interior and Exterior of Steel Water Pipelines, AWWA C218 - Coating the Exterior of Aboveground Steel Water Pipelines and Fittings, and AWWA C219 - Bolted, Sleeve-Type Couplings for Plain-End Pipe AWWA C221 - Fabricated Steel Mechanical Slip-Type Expansion Joints), , and the following supplemental requirements:

   a. physical and chemical properties of steel

   b. hydrostatic test reports

   c. results of production weld tests

   d. sand, cement, and mortar tests

   e. coating adhesion tests

   f. records of coating application, including steel surface preparation procedures

2. Performance and payment for sampling and testing necessary for certification are the CONTRACTOR's responsibility as part of the WORK.

D. Manufacturer’s Qualifications

1. Furnish a copy of manufacturer’s certification to ISO 9000, Steel Plate Fabricator’s Association (SPFA), or Lloyd’s Register Quality Assurance (LRQA), and documentation of manufacturer’s experience in fabricating AWWA C200 pipe.

E. Design Calculations of Fittings and Specials

1. Furnish a copy of the design calculations for fittings and specials including miters, welds, and reinforcement, prior to manufacture of the pipe, fittings, and specials.

1.3 QUALITY CONTROL

A. Pipe Manufacturer Qualifications

1. The pipe manufacturer shall be certified to ISO 9000, the Steel Plate Fabricator's Association (SPFA), or Lloyd's Register Quality Assurance (LRQA), and shall be experienced in fabrication of AWWA C200 pipe of similar diameters, lengths, and wall thickness to this WORK.

2. Experience shall be in the production facilities and personnel, not the name of the company that owns the production facility or employs the personnel.

B. Inspection

1. Pipe shall be subject to inspection at the place of manufacture in accordance with the provisions of AWWA C200, C205, C207, C208 and all other AWWA specifications as supplemented by the indicated requirements.

2. Pipe joints shall include a video camera inspection to validate the field lining has been adequately repaired and applied at field welded joints. Video footage shall be submitted to ENGINEER for review and approval.

3. The CONTRACTOR shall notify the ENGINEER in writing of the manufacturing start date not less than 14 Days prior to the start of any phase of the pipe manufacture.

C. Tests

1. Except as indicated otherwise, materials used in the manufacture of the pipe shall be tested in accordance with the requirements of AWWA C200, C205, C207 and C208 as follows and as applicable:

    a. Shop Tests

        1) After the joint configuration is completed and prior to lining with cement mortar, each length of pipe of each diameter and pressure class shall be shop- hydro tested and certified to a pressure of at least 70 percent of the yield strength of the steel.

        2) The test pressure shall be held for a minimum of 2 minutes and the pipe visually inspected to confirm that welds are sound and leak-free.

    b. In addition to the tests required in AWWA C200, weld tests shall be conducted on each 3,000-feet of production welds and at any other times there is a change in the grade of steel, welding procedure, or welding equipment.

    c. Fittings fabricated from straight pipe previously passing a hydrostatic test need not have an additional hydrostatic test, provided that the welds are tested by nondestructive means and are demonstrated to be sound.

D. Shop Testing of Steel Plate Specials

1. If any special has been fabricated from straight pipe not previously tested and is of the type listed herein (bends, wyes, crosses, tees with side outlet diameter greater than 30 percent of the main pipe diameter, and manifolds), the special shall be hydrostatically tested with a pressure equal to 1.5 times the design working pressure.

2. Specials not required to be hydrostatically tested shall be tested by liquid dye penetrant inspection method in accordance with ASTM E 165 - Standard Test Methods for Liquid Penetrant Examination, Method A, or the magnetic particle method in ASME Section VIII, Division 1, Appendix VI.

3. Reinforcing plates shall be tested by the solution method using approximately 40 psig air pressure introduced between the plates through a threaded test hole; the test hole shall be properly plugged following successful testing.

4. Weld Imperfections

   a. Weld defects, cracks, leaks, distortion, or signs of distress during testing shall require corrective measures.

   b. Weld defects shall be gouged out and re-welded.

   c. After corrections, the special shall be retested.

5. Test Heads

   a. Where welded test heads or bulkheads are used, extra length shall be provided to each opening of the special.

   b. After the removal of each test head, the special shall be trimmed back to the design points with finished plate edges ground smooth, straight, and prepared for the field joint.

6. Testing shall be performed before joints have been coated or lined.

7. Ultrasonic examination shall be performed in accordance with the following:

   a. Steel plate that will be in welded joints or welded stiffener elements shall be examined ultrasonically for laminar discontinuities where both of the following conditions exist:

      1) any plate in the welded joint has a thickness exceeding 0.50 inches.

      2) any plate in the welded joint is subject to transverse tensile stress through its thickness during the welding or service

   b. Ultrasonic examination may be waived where joints are designated to minimize potential laminar tearing.

c. The ultrasonic examination shall be in accordance with ASTM A 578 - Straight Beam Ultrasonic Examination of Plain and Clad Steel Plates for Special Applications, with a Level I acceptance standard.

8. Plates that are not in conformance with the acceptance criteria in ASTM A 578 may be used in the WORK if the areas that contain the discontinuities are a distance at least 4 times the greatest dimension of the discontinuity away from the weld joint.

E. The CONTRACTOR shall be responsible for performing and paying for the indicated material tests.

F. The ENGINEER has the right to witness testing conducted by the CONTRACTOR provided that the CONTRACTOR's schedule is not delayed for the convenience of the ENGINEER.

G. Additional Testing

1. In addition to those tests specifically required, the ENGINEER may request additional samples of any material including mortar lining and coating for testing by the OWNER.

2. The additional samples shall be furnished as part of the WORK.

H. Field Testing

1. Field testing shall be in accordance with the requirements of Section 01 74 30 Pressure Pipeline Testing.

I. Welding Requirements

1. Welding procedures used to fabricate and install pipe shall be prequalified under the provisions of ANSI/AWS D1.1 - Structural Welding Code-Steel, and the ASME Boiler and Pressure Vessel Code, Section IX.

2. Welding procedures shall be required for longitudinal and girth or spiral welds for pipe cylinders, spigot and bell ring attachments, reinforcing plates and ring flange welds, and plates for lug connections.

J. Welder Qualifications

1. Welding shall be performed by skilled welders, welding operators, and tackers who have had adequate experience in the methods and materials to be used.

2. Welders shall be qualified under the provisions of ANSI/AWS D1.1 or the ASME Boiler and Pressure Vessel Code, Section IX by an independent local, approved testing agency not more than 6 months prior to commencing WORK on the pipeline.

3. Machines and electrodes similar to those used in the WORK shall be used in qualification tests.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Lined and coated steel pipe and specials shall conform to AWWA C200, C205, C207, C208, C210, and C213, subject to the following supplemental requirements:

1. The pipe, specials, and fittings shall be of the diameter and class indicated and shall be provided complete with rubber gaskets or welded joints as indicated.

2. For pipe, specials, and fittings of 14-inch diameter and larger, the pipe diameter as indicated on the Contract Drawings are the required minimum <u>outside</u> diameter of the steel pipe shell.

3. When indicated as a minimum, wall thickness tolerance shall be as allowed by AWWA C200 or the ASTM nominal sheet or plate tolerance, whichever is less.

B. Markings

1. The manufacturer shall legibly mark pipe, specials, and fittings in accordance with the laying schedule and marking diagram.

2. Each pipe, special, and fitting shall be numbered in sequence and said number shall appear on the laying schedule and marking diagram in its proper location for installation.

3. Each pipe, fitting, and special shall be marked at each end with top field centerline.

C. Handling and Storage

1. The pipe, specials, and fittings shall be handled by use of wide slings, padded cradles, or other devices designed and constructed to prevent damage to the pipe coating and exterior.

2. The use of chains, hooks, or other equipment that might injure the pipe coating or exterior will not be permitted.

3. Stockpiled pipe, specials, and fittings shall be supported on padded skids, sand or earth berms free of rock exceeding 3 inches in diameter, sandbags, or suitable means so that the pipe including coating and lining coating will not be damaged.

4. Pipe, specials, and fittings shall not be rolled and shall be secured to prevent accidental rolling.

D. The CONTRACTOR shall replace or repair damaged pipe, specials, and fittings.

E. Strutting

1. Adequate strutting shall be provided on specials, fittings, and straight pipe in order to avoid damage to the pipe, specials, and fittings during handling, storage, hauling, and installation.

2. For mortar-lined steel pipe, specials, or fittings the following requirements shall apply:

   a. The strutting shall be placed as soon as practicable after the mortar lining has been applied and shall remain in place while the pipe, special, or fitting is loaded, transported, unloaded, installed, and backfilled at the Site.

   b. The strutting materials, size, and spacing shall be adequate to support the earth backfill plus any greater loads that may be imposed by the backfilling and compaction equipment.

   c. Any pipe, special, or fitting damaged during handling, hauling, storage, or installation due to improper strutting shall be repaired or replaced.

F. Laying Length

1. The minimum pipe laying lengths for straight lengths of each pipeline segment shall be as indicated on Contract Drawing G008. Shorter lengths may be provided where required for elbow, bends and other pipe specials.

G. Lining

1. The pipe, specials, and fittings shall have smooth, dense interior surfaces and shall be free from fractures, excessive interior surface crazing, and roughness.

2. Cement mortar lining shall be held back at butterfly valves where required to allow for the butterfly disc to pass through the pipe unobstructed. Epoxy lining shall be applied to the hold backs per this specification.

H. Closures and Correction Pieces

1. Closures and correction pieces shall be provided as required such that closures may be made due to different headings in the pipe laying operation and such that corrections may be made to adjust the pipe laying to conform to the indicated pipe stationing.

2.2 MATERIALS

A. Mortar

1. Materials for mortar shall conform to the requirements of AWWA C205; provided that cement for mortar coating shall be Type V, and mortar lining shall be Type II or Type V.

2. Cement in mortar lining and coating shall not originate from kilns that burn metal-rich hazardous waste fuel, nor shall a fly ash or pozzolan be used as a cement replacement.

3. Admixtures shall contain no calcium chloride.

B. Steel for Cylinder and Fittings

1. Pipe, specials, and fittings manufactured under AWWA C200 shall satisfy the following requirements:

    a. minimum yield strength of steel: 42,000 psi.

    b. manufactured by a continuous casting process

    c. fully kilned

    d. fine grain practice

    e. maximum carbon content: 0.25 percent

    f. maximum sulfur content: 0.015 percent

    g. minimum elongation: 22 percent in a 2-inch gauge length

    h. in accordance with one of the following Standards:

        1) ASTM A1011 - Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability

        2) ASTM A572 - High Strength Low-Alloy Columbium-Vanadium Structural Steel

        3) ASTM A1018 - Steel, Sheet and Strip, Heavy Thickness Coils, Hot-Rolled Carbon, Structural, High-Strength Low-Alloy Columbium or Vanadium, and High-Strength Low-Alloy with Improved Formability

2. Testing

    a. Steel equal to or greater than 0.5 inch thick used in fabricating pipe shall be tested for notch toughness using the Charpy V-Notch test in accordance with ASTM A 370 - Test Methods and Definitions for Mechanical Testing of Steel Products.

    b. The frequency of testing shall be one impact test (set of 3 specimens - transverse, not longitudinal) for each coil used in manufacturing the pipe.

    c. The testing frequency for sheets and plates shall be one impact test (set of 3 specimens) for each 50 tons of product.

    d. The steel shall withstand a minimum impact of 25 ft-lb at a temperature of 30 degrees F.

C. Epoxy Coating

1. Where indicated, the interior and exterior surfaces of pipe, fittings, and specials shall be coated with epoxy in accordance with AWWA C210 and the following:

    a. Surface Preparation: grit blast to near white metal condition, SSPC SP 10

b. Application: total primer and epoxy coating thickness shall be minimum 16 mils DFT

c. No single coat thickness shall exceed the manufacturer's recommendations.

d. Manufacturer: **Tnemec Series 139 Pota-Pox II**, **Devoe 233H**, Sherwin Williams Dura-Plate UHS Epoxy, or equal.

2.3 DESIGN OF PIPE

A. General

1. The pipe shall be suitable to transmit raw water under the indicated conditions, including chlorination as practiced by the Owner.

2. The steel pipe shall have field-welded butt joints as indicated on the Contract Drawings.

3. See **Contract Sheet G008** for pipe coatings and linings.

B. The pipe shall be designed, manufactured, tested, inspected, and marked according to applicable requirements as indicated and, except as indicated, shall conform to AWWA C200.

C. Pipe Dimensions

1. The pipe shall be of the outside shell diameter and minimum wall thickness as indicated in the **Contract Drawing G008**.

D. Fitting Dimensions

1. Fittings including elbows over 40-degrees, tees, and other specials shall be of the outside diameter as indicated, and shall be of a minimum wall thickness of 0.375-inches (3/8”) unless otherwise specified herein.

E. Joint Design

1. Butt-strap joints shall be used only where required for closures or where indicated.

2. Unless indicated otherwise, the standard joint design for all steel straight pipe and fittings shall be field, single bevel, complete penetration butt welds and factory butt welds, designed for welding from the outside of the pipe. The final bevel geometry and weld design shall be as required by applicable standards and as provided by the Contractor’s certified welders or their qualified welding subcontractor.

3. ANSI B16.5 Class 300 hub-type steel flanges shall be used on the bridge crossing and for connection to valves, and other specials as shown on the Contract drawings.

F. Shop-applied interior linings and exterior coatings shall be held back from the ends of the pipe on all field butt welds and field butt-strap welds as indicated or as otherwise acceptable to the ENGINEER.

1. Cement mortar lining shall be held back at butterfly valves where required to allow for the butterfly disc to pass through the pipe unobstructed. Epoxy lining shall be applied to the hold backs per this specification.

G. Restrained Joints

1. All joints shall be restrained joints unless otherwise indicated

2. Restrained joints shall include all field-welded joints, flanged joints, and butt-strap welded joints as indicated.

3. Designs shall include stresses created by the greater of:

   a. a temperature differential of 40 degrees F plus Poisson's effect in combination with hoop stress, or;

   b. thrust due to bulkheads, bends, reducers, and line valves resulting from working pressure in combination with hoop stress.

4. For field-welded joints, design stresses shall not exceed 50 percent of the specified minimum yield strength of the grade of steel utilized, or 21,000 psi, whichever is less, for the part being examined when longitudinal thrust is assumed to be uniformly distributed around the circumference of the joint

2.4 SPECIALS AND FITTINGS

A. **Design**

1. Except as otherwise indicated, materials, fabrication and shop testing of specials and fittings shall conform to the requirements stated above for pipe and shall conform to the dimensions of AWWA C208.

2. The minimum thickness of plate for pipe from which specials are to be fabricated shall be a minimum as shown on the Contract drawings and the greatest of those determined by the following 3 criteria:

   a. Working and Transient Pressure Design

$$T = \frac{P_w D/2}{Y/S_w} \qquad T = \frac{P_t D/2}{Y/S_t}$$

Where:

T	=	Steel cylinder thickness in inches
D	=	Outside diameter of steel cylinder in inches
P_w	=	Design working pressure in psi
P_t	=	Design transient pressure in psi
Y	=	Specified minimum yield point of steel in psi
S_w	=	Safety factor of 2.5 at design working pressure
S_t	=	Safety factor at design transient pressure; for elbows 1.875 and 2.0 for other specials

b. Mainline Pipe Thickness: Plate thickness for specials shall be not less than the adjacent mainline pipe.

c. Thickness Based on Pipe Diameter

Outside Pipe Diameter, inches	Pipe Manifolds Piping Above Ground and buried piping
25 and under	5/16 (0.3125) inch

B. **Specials**

1. Specials installed on saddle supports shall be designed to limit the longitudinal bending stress to a maximum of 10,000 psi.

2. Design shall be in accordance with the provisions of Chapter 7 of AWWA Manual M11.

C. **Deflections and Angles**

1. Moderate deflections and long radius curves may be constructed by means of beveled joint rings, by pulling standard joints, by using short lengths or pipe, or a combination of these methods provided that pulled joints shall not be used in combination with bevels.

2. The maximum total allowable angle for beveled joints shall be 5 degrees per pipe joint.

3. Bevels shall be provided on the bell ends.

4. Mitering of the spigot ends will not be accepted.

5. The maximum allowable angle for pulled joints shall be in accordance with the manufacturer's recommendations, or the angle which results from a 3/4-inch pull-out from normal joint closure, whichever is less.

6. Horizontal deflections or fabricated angles shall fall on the alignment.

7. Vertical Deflections

   a. Vertical deflections shall fall on the alignment and shall be at locations adjacent to underground obstructions, points of minimum earth cover, and pipeline outlets and structures.

   b. The pipe angle points shall match the indicated angle points.

D. **Outlets, Tees, Wyes, Crosses, and Nozzles**

1. Outlets 12 inches and smaller may be fabricated from Schedule 40 or heavier steel pipe in the standard outside diameters, that is, 12-3/4-inch, 10-3/4-inch, 8-5/8-inch, 6-5/8-inch, and 4-1/2-inch.

2. The minimum plate thickness for reinforcements shall be 0.25-inch.

3. The outlet reinforcement design shall be in accordance with the procedures given in Chapter 13 of AWWA Manual M11, and the design pressures and factors of safety indicated above.

4. In lieu of saddle or wrapper reinforcement as provided by the design procedure in Manual M11, pipe or specials with outlets may be fabricated entirely of steel plate having a thickness equal to the sum of the pipe wall plus the required reinforcement.

5. Where Manual M11 requires the design procedure for crotch plate reinforcement, such reinforcement shall be provided.

6. Reinforcing Plates

   a. Outlets shall be fabricated such that there is always at least a 12-inch distance between the outer edge of the reinforcing plate and any field-welded joints.

   b. For outlets without reinforcing plates, outlets shall penetrate the steel cylinders so that there is at least a 12-inch clearance between the outlet and any field-welded joints.

7. Tees, wyes, crosses, elbows, and manifolds shall be fabricated such that the outlet clearances and reinforcing plates from any weld joints are a minimum of 5 times cylinder thickness or 2 inches, whichever is greater.

8. Longitudinal weld joints in adjacent cylinder sections shall be oriented such that there is a minimum offset of 5 times cylinder thickness or 2 inches, whichever is greater.

9. Reinforcement

   a. Reinforcement for wyes, tees, outlets, and nozzles shall be designed in accordance with AWWA Manual M11.

   b. Reinforcement shall be designed for the design pressure indicated and shall be as indicated.

10. Specials and fittings shall be equal in pressure design strength and shall have the same lining and coating as the adjoining pipe.

11. Unless otherwise indicated, the minimum radius of elbows shall be 2.5 times the pipe diameter and the maximum miter angle on each section of the elbow shall not exceed 11-1/4 degrees.

E. **Welded Fittings**. Steel welding fittings shall conform to ASTM A 234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.

F. **Ends for Mechanical-Type Couplings**

1. Except as otherwise indicated, where mechanical-type couplings are indicated the ends of pipe shall be flanged per the requirements of Section 2.3.E of this section.

2.5 PIPE INTERIOR LINING

A. The lining system required for each portion of the pipeline shall be as indicated on the **Pipe Schedule** given on Contract Drawing G008.

A. **Liquid Epoxy Lining for Shop Application**

1. Unless indicated otherwise, interior surfaces of pipe, specials, and fittings shall be cleaned and centrifugally lined in the shop with an approved liquid applied epoxy system in conformity with AWWA C210, be NSF 61 certified and meet the following requirements:

    a. Steel surface preparation shall be in accordance with SSPC SP-10.

    b. Apply 2 or more coats of either Devoe Bar Rust 233H, Tnemec Epoxoline 80, Carboline 140HS, Sherwin Williams Dura-Plate, or Amerlock 400 for a minimum total dry film thickness (DFT) of 20 mils.

    c. Inspection and testing of the lining shall be per AWWA C210 and the product Manufacturer's recommendations.

2. During the lining operation and thereafter, the pipe, specials, and fittings shall be maintained in a round condition by suitable bracing or strutting.

3. The lining machines shall be of a type that has been used successfully for similar WORK.

4. Every precaution shall be taken to prevent damage to the lining.

5. If the lining is damaged or found defective at the Site, the damaged or unsatisfactory portions shall be replaced with lining conforming to the indicated requirements.

B. **Cement-Mortar Lining for Shop Application**

1. Unless indicated otherwise, interior surfaces of pipe, specials, and fittings shall be cleaned and lined in the shop with cement mortar lining applied centrifugally in conformity with AWWA C205.

2. During the lining operation and thereafter, the pipe, specials, and fittings shall be maintained in a round condition by suitable bracing or strutting.

3. The lining machines shall be of a type that has been used successfully for similar WORK.

4. Every precaution shall be taken to prevent damage to the lining.

5. If the lining is damaged or found defective at the Site, the damaged or unsatisfactory portions shall be replaced with lining conforming to the indicated requirements.

C. The progress of the application of mortar lining shall be regulated in order that handwork, including the repair of defective areas, is cured in accordance with the provisions of AWWA C205.

D. Cement mortar for patching shall be the same materials as the mortar for machine lining, except that a finer grading of sand and mortar richer in cement shall be used when field inspection indicates that such mix will improve the finished lining of the pipe.

E. Cement-Mortar Lining for Field Application

1. Unless otherwise indicated, steel pipe shall be mortar-lined.

2. The materials and design of in-place cement mortar lining shall be in accordance with AWWA C602 and the following supplementary requirements:

   a. Pozzolanic material shall not be used in the mortar mix.

   b. Admixtures shall contain no calcium chloride.

   c. The minimum lining thickness shall be as indicated for shop-applied cement mortar lining, and finished inside diameter after lining shall be a minimum of thickness in accordance with AWWA C205.

   d. Temperature and shrinkage cracks in the mortar less than 1/16 inch wide need not be repaired, whereas pipe, specials, or fittings with mortar cracks wider than 1/16 inch shall be rejected.

F. The minimum lining thickness and tolerance shall be in accordance with AWWA C205.

G. **Field Joints**

1. The pipe shall be left bare as indicated where field welding joints occur, with lining holdbacks as indicated either in AWWA C205, AWWA C210 or as shown on the drawing details.

2. Ends of the linings shall be left square and uniform.

3. Feathered or uneven edges will not be accepted.

4. Liquid epoxy for field patching shall be the same materials as the epoxy used during shop-applied lining process.

H. **Defective Linings**

1. Defective linings, as determined by the ENGINEER, shall be removed from the pipe wall and shall be replaced to the full thickness required.

2. Defective linings shall be cut back to a square shoulder in order to avoid feather-edged joints.

I. **Hand-Applied Linings**

1. Specials and fittings that cannot be mechanically lined and coated shall be lined and coated by hand-application using the same materials as used for the pipe and in accordance with the applicable AWWA or ASTM standards and as indicated. The CONTRACTOR has the option to provide handholes at each joint to repair the lining or may swab the interior cement mortar lining per AWWA C205.

2. Coating and lining applied in this manner shall provide protection equal to that for the pipe.

3. Fittings may be fabricated from pipe that has been mechanically lined and/or coated.

4. Areas of lining and coating that have been damaged by such fabrication shall be repaired by hand-application.

J. **Protection of Pipe Lining/Interior**

1. For pipe, specials, and fittings with plant-applied cement-mortar linings, the CONTRACTOR shall provide a suitable bulkhead cap or plug on the ends of the pipe and on each opening to prevent the lining from drying out.

2. Bulkheads shall be substantial enough to remain intact during shipping and storage until the pipe is installed.

2.6 PIPE EXTERIOR COATING

A. **Exterior Coating of Exposed Piping**

1. The exterior surfaces of pipe, specials, and fittings that will be exposed to the atmosphere inside tunnels, structures (excluding air-release valve vaults) or above ground at bridge crossing shall be thoroughly cleaned and then given a shop coat of primer compatible with the finish coating required. The final exterior liquid applied coating shall be per the requirements of AWWA C210 and shall be field-applied under atmospheric / environmental conditions as required by the coating manufacturer.

B. **Shop Applied Prime Coating for Concrete Encased Pipe**

1. For the concrete encased portions of the pipeline (Drawing GC004), the exterior surfaces of pipe, fittings, and specials shall be given a shop coat of primer. The final applied primer coating shall be per the requirements of AWWA C210 and as specified in this Section, and shall be shop-applied under atmospheric / environmental conditions as required by the prime coat manufacturer. Prime coat shall meet the following:

   a. Surface Preparation: grit blast to near white metal condition, SSPC SP 10

   b. Application: two or more coats of the two-part, chemically cured epoxy primer.

   c. Inspection and testing of the lining shall be per AWWA C210 and the product Manufacturer's recommendations.

d. During the coating operation and thereafter, the pipe, specials, and fittings shall be maintained in a round condition by suitable bracing or strutting.

e. The coating machines shall be of a type that has been used successfully for similar Work.

f. No holdback of primers shall be allowed on the exterior of any pipe.

C. **Exterior Coating of Buried Piping**

1. Pipe for buried service that will not be encased in concrete, including bumped heads, shall be coated with a minimum one-inch thickness of reinforced cement-mortar coating.

2. Unless otherwise indicated, exterior surfaces of pipe or fittings passing through structure walls shall be cement-mortar coated from the center of the wall or from the wall flange to the end of the underground portion of pipe or fitting.

3. The coating shall be reinforced with a spiral wire reinforcement or welded wire fabric in accordance with AWWA C205.

4. The welded wire fabric shall be securely fastened to the pipe with welded clips or strips of steel.

5. The wire shall be spaced a maximum 2 inches on centers and shall extend circumferentially around the pipe.

6. The ends of reinforcement strips shall be lapped 4 inches, and the free ends shall be tied or looped to assure continuity of the reinforcement.

2.7 PIPE APPURTENANCES

A. Pipe appurtenances shall be in accordance with the requirements of Division 33.

B. Access manways shall be as indicated on the Contract Drawings. Precast concrete access manholes and vaults with covers shall be as indicated in the Contract Drawings.

C. Threaded outlets shall be forged steel suitable for 3,000-psi service, and shall be as manufactured by **Vogt**, or equal.

PART 3 -- EXECUTION

3.1 INSTALLATION OF PIPE

A. **Handling and Storage**

1. Pipe, specials, and fittings shall be carefully handled and protected against damage to lining and coating/interior and exterior surfaces, and impact shocks and free fall.

2. Pipe, specials, and fittings shall not be placed directly on rough ground but shall be supported in a manner that will protect the pipe against injury whenever stored at the Site or elsewhere.

3. Pipe, specials, and fittings shall be handled and stored at the Site in accordance with the requirements indicated in Part 2, above.

4. No pipe shall be installed when the lining or coating, or interior or exterior surfaces show cracks that may be harmful as determined by the ENGINEER.

5. Such damaged lining and coating, and interior and exterior surfaces shall be repaired or a new undamaged pipe, special, or fitting shall be provided.

B. Pipe damaged prior to Substantial Completion shall be repaired or replaced.

C. The CONTRACTOR shall inspect each pipe, special, and fitting for damage.

D. The CONTRACTOR shall remove or smooth out any burrs, gouges, weld splatter, or other small defects prior to laying the pipe, special, or fitting.

E. **Cleaning**

1. Before the placement of pipe, specials, or fittings in the trench, each shall be thoroughly cleaned of any foreign substance that may have collected thereon and shall be kept clean thereafter.

2. For this purpose, the openings of pipes, specials, and fittings in the trench shall be closed during any interruption to the WORK.

F. **Placement**

1. CONTRACTOR shall avoid all laying procedures which create concentrated loads on the steel pipe. Pipe, specials, and fittings shall be laid directly:

   a. On the imported and properly compacted bedding material, or

   b. If CLSM is being utilized in the pipe zone and pipe bedding area, on soil pads or other approved compressible material such as extruded polystyrene foam insulation. Soil pads shall maintain horizontal and vertical alignment during backfilling operation, and shall have a lower compressible strength than the surrounding CLSM material

2. Only compressible blocking as specified will be permitted, and the bedding shall be such that it forms a continuous, solid bearing for the full length of the pipe, special, or fitting.

3. Excavations shall be made as needed to facilitate removal of handling devices after the item has been laid.

4. Bell holes shall be formed at the ends of the pipe to prevent point loading at the bells or couplings.

5. Excavation outside the normal trench section shall be made at field joints as needed to permit adequate access to the joints for field connection operations and for application of coating on field joints.

6. Except for short runs that may be permitted by the ENGINEER, pipes shall be laid uphill if on grades exceeding 10 percent.

7. Pipe that is laid on a downhill grade shall be blocked and held in place until sufficient support is furnished by the following pipe to prevent movement.

8. Bends shall be installed as indicated.

G. **Installation Tolerances**

1. Each section of pipe, special, or fitting shall be laid in the order and position on the laying diagram and in accordance with the following:

    a. Each section of pipe, special, or fitting having a nominal diameter less than 48 inches shall be laid to line and grade, within plus or minus 2-inches horizontal deviation and plus or minus .

    b. In addition to the horizontal and vertical tolerances above, the pipe shall be laid so that no high or low points other than those on the laying diagram are introduced.

    c. After installation, the pipe, specials, and fittings shall not show deflection greater than:

        1) flexible-lined and mortar-coated (rock-shielded) pipe, specials, and fittings: 2.25 percent

        2) mortar-lined and mortar-coated pipe, specials, and fittings: 1.5 percent

    d. The allowable deflection shall be based on the design inside diameter.

H. **Test Section**

1. At the beginning of pipe laying operations, the CONTRACTOR shall perform a test section to demonstrate that the methods and materials to be used will satisfy the pipe zone backfill compaction and pipe deflection criteria.

2. The maximum length of the test section shall be 500 feet.

3. The CONTRACTOR shall not proceed with production pipe laying beyond the test section without the ENGINEER's approval.

4. The entire test section length that does not comply with the Contract Documents shall be reworked as necessary to comply.

5. The ENGINEER will observe construction of the test section.

6. The OWNER will take measurements and keep records for quality assurance purposes.

7. Any change in means, methods, and trench conditions, including excavation, bedding, and pipe zone materials, in situ soils, water conditions, and backfill and compaction methods shall require another successful test section before additional production pipe installation.

I. **Changes in Alignment and/or Grade**

1. Where necessary to raise or lower the pipe, specials, or fittings due to unforeseen obstructions or other causes, the ENGINEER may change the alignment and/or the grade.

2. Such change shall be made by the deflection of joints, by the use of bevel adapters, or by the use of additional fittings, although in no case shall the deflection in a joint exceed 75 percent of the maximum deflection recommended by the pipe manufacturer.

3. No joint shall be misfit any amount that will be detrimental to the strength and water tightness of the finished joint.

4. In each case the joint opening, before finishing with the protective mortar inside the pipe, or prior to applying in-place mortar lining, shall be the controlling factor.

J. **Struts**

1. Struts in pipe 42-inch diameter and larger shall be left in place until backfilling operations have been completed.

2. Struts in pipe smaller than 42-inch may be removed immediately after laying.

3. A laboratory selected and paid by the OWNER may monitor pipe deflection by measuring pipe inside diameter before struts are removed and 24 hours after struts are removed.

4. Pipe deflection shall not exceed 1.5 percent 24 hours after the struts have been removed.

5. After the backfill has been placed, the struts shall be removed and shall remain the property of the CONTRACTOR.

K. **Cold Weather Protection**

1. No pipe, special, or fitting shall be installed upon a foundation into which frost has penetrated or at any time that there is a danger of the formation of ice or penetration of frost at the bottom of the excavation.

2. No pipe, special, or fitting shall be laid unless it can be established that the trench will be backfilled before the formation of ice and frost occurs.

L. **Pipe, Specials, and Fitting Protection**

1. The openings of pipe, specials, and fittings with shop-applied mortar lining shall be protected with suitable bulkheads to maintain a moist atmosphere and to prevent unauthorized access by persons, animals, water, or any undesirable substance.

2. The bulkheads shall be designed to prevent the drying out of the interior of the pipe, specials, and fittings.

3. The CONTRACTOR shall introduce water into the pipe to keep the mortar moist if moisture has been lost due to damaged bulkheads.

4. Means shall be provided to prevent the pipe from floating due to water in the trench from any source.

5. Pipe that has floated shall be repaired, including restoration to original condition and profile.

M. **Pipe Cleanup**

1. As pipe laying progresses, the CONTRACTOR shall keep the pipe interior free of debris.

2. The CONTRACTOR shall completely clean the interior of the pipe of sand, dirt, mortar splatter, and any other debris following completion of pipe laying, pointing of joints, and any necessary interior repairs prior to testing and disinfecting of the completed pipeline.

3.2 WELDED JOINTS

A. **General**

1. CONTRACTOR shall submit a Welding Procedure Specification (WPS) in accordance with ASME Section IX to define the parameters of the weld and welding procedure for each major type of weld provided for the project.

2. Prior to beginning the welding procedure, any tack welds used to position the pipe during laying shall be removed.

3. Where more than one pass is required, each pass except the first and final ones shall be peened to relieve shrinkage stresses, and dirt, slag, and flux shall be removed before the succeeding bead is applied.

4. Prior to butt welding, the pipe and joint shall be properly positioned in the trench using line up clamps so that, in the finished joint, the abutting pipe sections shall not be misaligned more than 1/16 inch on the outside diameter of the shell.

5. Field welded joints shall be in accordance with AWWA C206 - Field Welding of Steel Water Pipe.

6. Where exterior welds are performed, adequate space shall be provided for welding and inspection of the joints.

7. Butt straps shall be as indicated.

8. A heat resistant shield shall be draped over at least 24-inches of coating beyond the holdback on both sides of the weld during welding to avoid damage to the coating by hot weld splatter.

9. Welding grounds shall not be attached to the coated part of the pipe.

10. Back-gouging of complete penetration welds is not required for pipe applications. Interior of all V-groove butt-welds shall be ground smooth thru the furnished hand-holes or other means, to allow for proper field application of liner over the joint, and to prevent hydraulic vortices from forming when water passes over the weld zone.

11. Following hydraulic tests of the welded joint, the exterior joint spaces shall be field coated as indicated.

B. **Butt Weld Joints for Beveled-end Pipe (Single V-Groove Bevel)**

1. Single V-groove bevels may be used on steel pipe with wall thicknesses up to 0.625 inches. V-groove shall be developed for either interior or exterior joint welding, as required by the Contract Documents.

2. Single V-groove bevel end joints shall be such as to provide a complete joint penetration (CJP) weld. CONTRACTOR may utilize *Prequalified* welded joints for CJPs as defined in Part 8 of the AISC Steel Construction Manual or in the appropriate Section of the ASME Boiler & Pressure Vessel Code.

3. Bevel angles shall be between 30 and 35 degrees maximum. Total included angle shall be between 60 and 70 degrees.

4. Geometry of the root (face height and width opening) shall be determined by the CONTRACTOR, but shall be no less than 1/16-inch each dimension.

5. Use of backing rings for these joints is at the option of the CONTRACTOR. If no backing rings are utilized, CONTRACTOR shall provide certifications showing that Welders have the required experience in welding the “open-style” bevel joints without backing rings.

C. **Trench Backfilling after Joint Welding**

1. After the pipe and joint are properly positioned in the trench, the length of pipe between joints shall be backfilled to at least one foot above the top of the pipe.

2. Care shall be exercised during the initial backfilling to prevent movement of the pipe and to prevent any backfill material from being deposited on the joint.

D. **Temperature Stresses**

1. To control temperature stresses, the unbackfilled joint areas of the pipe shall be shaded from the direct rays of the sun by the use of properly supported awnings, umbrellas, tarpaulins, or other suitable materials for a minimum period of 2 hours prior to the beginning of the welding operation and until the weld has been completed.

2. Shading materials at the joint area shall not rest directly on the pipe but shall be supported to allow air circulation around the pipe.

3. Shading of the pipe joints need not be performed when the ambient air temperature is below 45 degrees F.

E. **Shrinkage Control Joints**

1. The welding of each such shrinkage control joint shall be performed at intervals not exceeding 250-ft and shall be performed when the temperature is approximately the lowest during the 24 hour day, after at least 250 feet of pipe have been laid and the joints have been welded ahead of and in back of the shrinkage control joint, and after backfill has been completed to at least one foot above the top of the pipe ahead of and in back of the shrinkage control joint.

2. Where shrinkage control joints occur in a traveled roadway or other inconvenient location, the location of the shrinkage control joint may be adjusted, as acceptable to the ENGINEER.

F. **Inspection of Field-Welded Joints**

1. An independent testing laboratory acceptable to the ENGINEER but paid by the CONTRACTOR shall inspect the joints.

2. Inspection shall be as soon as practicable after the welds are completed.

3. Fillet welds shall be tested by the Magnetic Particle Inspection Method in accordance with ASME Section VIII, Division 1, Appendix VI.

4. Butt weld joints shall be inspected by Non-destructive Examination (NDE) processes utilizing either radiographic methods in accordance with API Standard 1104, or approved ultrasonic testing methods.

G. **Repair of Welds**

1. Defective welds shall be repaired by the CONTRACTOR to meet the indicated requirements.

2. Defects in welds or defective welds shall be removed, and that section of the joint shall then be re-welded.

3. Only sufficient removal of defective material that is necessary to correct the defect shall be required.

4. After the repair is made, the joint shall be checked by repeating the original test procedure.

5. Welds deficient in size shall be repaired by adding weld metal.

3.3 PREPARATION FOR FIELD COATING

A. **General:** Surfaces to receive protective coatings shall be prepared as indicated prior to application of coatings. The CONTRACTOR shall examine surfaces to be coated and shall correct surface defects before application of any coating material. Marred or abraded spots on shop-primed and on factory-finished surfaces shall receive touch-up restoration prior to any field coating application. Surfaces to be coated shall be dry and free of visible dust.

B. Care shall be exercised not to damage adjacent Work during blasting operations. Spraying shall be conducted under carefully controlled conditions. The CONTRACTOR shall be fully responsible for and shall promptly repair any and all damage to adjacent Work or adjoining property occurring from blasting or coating operations.

C. **Protection of Painted Surfaces:** Cleaning and coating shall be coordinated so that dust and other contaminants from the preparation process will not fall on wet, newly-coated surfaces, or likewise harm existing surfaces.

3.4 SURFACE PREPARATION STANDARDS

A. **Steel Structures Painting Council (SSPC) Standards.** The following referenced standards for surface preparation according to specifications of the Steel Structures Painting Council (SSPC) shall form a part of this specification:

1. **SSPC SP1 - Solvent Cleaning**: Removal of oil, grease, soil, salts, and other soluble contaminants by cleaning with solvent, vapor, alkali, emulsion, or steam.

2. **SSPC SP2 - Hand Tool Cleaning:** Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by hand chipping, scraping, sanding, and wire brushing.

3. **SSPC SP3 - Power Tool Cleaning**: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by power tool chipping, descaling, sanding, wire brushing, and grinding.

4. **SSPC SP5 - White Metal Blast Cleaning**: Removal of all visible rust, oil, grease, soil, dust, mill scale, paint, oxides, corrosion products and foreign matter by blast cleaning.

5. **SSPC SP6 - Commercial Blast Cleaning**: Removal of all visible oil, grease, soil, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except that staining shall be limited to no more than 33 percent of each square inch of surface area.

6. **SSPC SP7 Brush-Off Blast Cleaning**: Removal of all visible oil, grease, soil, dust, loose mill scale, loose rust, and loose paint.

7. **SSPC SP10 Near-White Blast Cleaning** : Removal of all visible oil, grease, soil, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except that staining shall be limited to no more than 5 percent of each square inch of surface area.

8. **SSPC-SP13 Surface Preparation of Concrete**: Removal of protrusions, laitance and efflorescence, existing coatings, form-release agents, and surface contamination by detergent or steam cleaning, abrasive blasting, water jetting, or impact or power tool methods as appropriate for the condition of the surface and the requirements of the coating system.

3.5 JOINT COATING AND LINING

A. **General**

1. The interior and exterior joint recesses shall be thoroughly wiped clean.

2. Remove water, loose scale, dirt, and other foreign material from the inside surface of the pipe.

B. **Testing**

1. The CONTRACTOR will test each joint with an electrical detector, furnished by the CONTRACTOR and capable of at least a 12,000 volt output.

2. The tests will be performed using 6,000 to 7,000 volts.

3. The CONTRACTOR shall repair any holidays.

4. Re-Testing

   a. When a visual inspection indicates that a portion of the coating system has sustained physical damage, the CONTRACTOR shall perform an electrical holiday test of 6,000 to 7,000 volts.

   b. When the test indicates no holiday, a notation shall be applied to the area indicating the test is satisfactory.

C. **Coating Repair**

1. Epoxy and Prime Coated Pipe: Perform coating repairs on prime coated pipe in accordance with the Manufacturer's recommendations and the requirements of AWWA C210, satisfying both requirements at a minimum.

2. Rock Shield / Mortar-Coated Pipe: Perform coating repairs on mortar-coated pipe in accordance with the requirements of AWWA C205.

D. **Coating of Fittings and Specials**: Fittings and specials shall be coated in accordance with AWWA C205 or AWWA C210 and the requirements specified herein.

E. **Joint Lining**

1. The CONTRACTOR has an option to provide handholes at each joint to repair the lining at each joint, or to swab the joint to repair the lining.

2. Materials of construction for mortar shall be in accordance with the requirements of AWWA C602.

3. The mortar shall be tightly packed into the joint recess and troweled flush with the interior surface, and excess shall be removed.

4. At no point shall there be an indentation or projection of the mortar exceeding 1/16 inch.

5. The joint shall be completed and excess mortar on the inside of the joint shall be swabbed out. Visual inspection shall occur and the CONTRACTOR shall remove any loose scale, dirt, and other foreign material from the inside surface of the pipe.

6. If swabbing to repair the joint, the lap weld should be tack welded immediately after assembly to minimize movement of the joint. The CONTRACTOR shall allow the cement mortar patch to cure for a minimum of 8 hours prior to completing the required weld.

7. If handholes are used, the lid of the hand hole plug shall be tack welded in place and the CONTRACTOR shall allow for the cement mortar patch to cure for a minimum of 8 hours prior to completing the final seal weld of the plug.

3.6 INSTALLATION OF PIPE APPURTENANCES

A. **Installation of Valves**

1. Valves shall be handled in a manner to prevent any injury or damage to the valve or any part of it.

2. Joints shall be thoroughly cleaned and prepared prior to installation.

3. The CONTRACTOR shall adjust stem packing and operate each valve prior to installation to verify proper operation.

4. Valves shall be installed so that the valve stems are plumb and in the location indicated.

5. Buried valves and flanges shall be coated and protected.

B. **Installation of Flanged Joints**

1. Before the joint is assembled, the flange faces shall be thoroughly cleaned of foreign material with a power wire brush.

2. The gasket shall be centered and the connecting flanges drawn up watertight without unnecessarily stressing the flanges.

3. Bolts shall be tightened in a progressive diametrically opposite sequence and torqued with a suitable and calibrated torque wrench.

4. Clamping torque shall be applied to the nuts only.

5. Full-face reinforced rubber gaskets shall be applied to the inside face of blind flanges with adhesive.

C. **Insulated Joints**

1. Insulated joints and appurtenant features shall be provided as indicated.

2. The CONTRACTOR shall exercise special care when installing these joints in order to prevent electrical conductivity across the joint.

3. After the insulated joint is completed, an electrical resistance test shall be performed by the CONTRACTOR.

4. If the resistance test indicates a short circuit, the CONTRACTOR shall remove the insulating units to inspect for damage, replace all damaged portions, and reassemble the insulating joint.

5. The insulated joint shall then be retested to assure proper insulation.

D. **Flexible Coupled Joints**

1. When installing flexible couplings, care shall be taken that the connecting pipe ends, couplings, and gaskets are clean and free of dirt and foreign matter, with special attention given to the contact surfaces of the pipe, gaskets, and couplings.

2. The couplings shall be assembled and installed in conformance with the recommendations and instructions of the coupling manufacturer.

E. **Bolting**

1. Wrenches used in bolting couplings shall be of a type and size recommended by the coupling manufacturer.

2. Coupling bolts shall be tightened in such a manner as to secure a uniform annular space between the follower rings and the body of the pipe.

3. Bolts shall be tightened approximately the same amount.

4. Diametrically opposite bolts shall be tightened progressively and evenly.

5. Final tightening shall be performed with a suitable and calibrated torque wrench set for the torque recommended by the coupling manufacturer.

6. Clamping torque shall be applied to the nut only.

3.7 CORROSION CONTROL

A. **Joint Bonding/Electrolysis Test Stations**

1. Except where otherwise indicated, joints shall be bonded for any pipe joints that are non-welded joints.

2. The pipe shall be cleaned to bare bright metal at the point where the bond is to be installed.

3. Electrolysis test stations shall be installed where indicated on Drawings.

B. Cathodic Protection: Corrosion mitigation and testing materials, such as an impressed current cathodic protection system, magnesium anodes, reference electrodes, and test lead wires shall be provided where indicated.

- END OF SECTION -

SECTION 40 23 00 - PIPING, GENERAL

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall provide the piping systems indicated, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to all piping sections in Divisions 33 and 40.

C. **Pipe Fabrication Drawings**. The Contract Drawings define the general layout, configuration, routing, method of support, pipe size, and pipe type. The contract drawings are **not** pipe construction or fabrication drawings. The CONTRACTOR shall provide detailed pipe fabrication and pipe laying submittals in accordance with the requirements of the individual pipe material specification sections.

D. **Pipe Supports and Spacing**. Where pipe supports and spacing are indicated on the Drawings and are referenced to a standard detail, the CONTRACTOR shall use that detail. Where pipe supports are not indicated on the Drawings, it is the CONTRACTOR'S responsibility to develop the details necessary to design and construct piping systems to accommodate the specific equipment provided, and to provide spacers, adapters, and connectors for a complete and functional system.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with KRRP Project Submittals.

B. **Shop Drawings:** Shop Drawings shall contain information as required in the individual pipe material specification section as well as the following information:

1. Layout and Fabrication Drawings: Layout drawings including necessary details, dimensions, and material lists for pipe joints, fittings, specials, bolts and nuts, gaskets, valves, appurtenances, anchors, and guides. Fabrication drawings shall indicate spacers, pipe adapters and couplings, connectors, fittings, and location of pipe supports to accommodate the equipment and valves in a complete and functional system.

2. Modular Seals for Pipe Penetrations: Manufacturer's information sheets showing materials and installation procedures.

3. Where applicable, all pipe coupling systems, including standard sleeve couplings, flange coupling adaptors, welded-ring restrained couplings, and /or grooved joint products shall be shown on shop drawings and product submittals and shall be specifically identified with the applicable Manufacturer’s style or series number.

C. **Samples:** The CONTRACTOR shall provide and pay for any pipe material sampling and product testing as necessary and as required in the individual pipe material specifications.

D. **Certifications**

1. Necessary certificates, test reports, and affidavits of compliance shall be obtained by the CONTRACTOR.

2. A certification from the pipe fabricator that each pipe length will be manufactured subject to the fabricator’s or a recognized Quality Control Program. An outline of the Quality Control Program shall be submitted to the ENGINEER for review prior to the manufacture of any pipe.

PART 2 -- PRODUCTS

2.1 GENERAL

A. **Extent of Work:** Pipes, fittings, and appurtenances shall be provided in accordance with the requirements of the applicable Sections of Divisions 33 and 40 and as indicated.

B. **Pipe Supports:** Pipes shall be adequately supported, restrained, and anchored in accordance with the Daggett Bridge Design Package, and as indicated on the Daggett Bridge Contract Drawings.

C. **Interior Linings:** Application, thickness, and curing of pipe interior linings shall be in accordance with the applicable Sections of Division 33, unless otherwise indicated.

D. **Exterior Coatings:** Application, thickness, and curing of exterior coatings on buried pipe shall be in accordance with the applicable Sections of Division 33, unless otherwise indicated. For pipes above ground or in structures, exterior coatings of such pipe shall be in accordance with the applicable Sections of Division 33.

E. **Pressure Rating:** Piping systems shall be designed for the maximum expected pressure as defined in Section 01 74 30 - Pressure Pipe Testing and Disinfection, or as indicated on the Contract Drawing, Piping Schedule, whichever is greater.

F. **Inspection:** Pipe shall be subject to inspection at the place of manufacture. During the manufacture, the OWNER and ENGINEER shall be given access to areas where manufacturing is in progress and shall be permitted to make inspections necessary to confirm compliance with requirements.

G. **Tests:** Except where otherwise indicated, materials used in the manufacture of the pipe shall be tested in accordance with the applicable specifications and standards. Welds shall be tested as indicated. The CONTRACTOR shall be responsible for performing material tests.

H. **Welding Requirements:** Qualification of welding procedures used to fabricate pipe shall be in accordance with the provisions of AWS D1.1 - Structural Welding Code. Welding procedures shall be submitted for the ENGINEER's review.

I. **Welder Qualifications:** Welding shall be done by skilled welders and welding operators who have adequate experience in the methods and materials to be used. Welders shall be qualified under the provisions of AWS D1.1 or the ASME Boiler and Pressure Vessel Code, Section 9, by an independent local, approved testing agency not more than 6 months prior to commencing WORK on the piping. Machines and electrodes similar to those used in the WORK shall be used in qualification tests. Qualification testing of welders and materials used during testing is part of the WORK.

2.2 PIPE FLANGES

A. **General:** Flanges shall have flat faces and shall be attached with bolt holes straddling the vertical axis of the pipe unless otherwise indicated. Attachment of the flanges to the pipe shall conform to the applicable requirements of AWWA C207. Flange faces shall be perpendicular to the axis of the adjoining pipe. Flanges for miscellaneous small diameter pipes shall be in accordance with the standards indicated for these pipes.

B. **Pressure Ratings**

1. Flanges shall conform to ASME B16.5, 300 lb class.

2. Selection based on test pressure: AWWA flanges shall not be exposed to test pressures greater than 125 percent of rated capacity. For higher test pressures, the next higher rated AWWA flange or an ANSI-rated flange shall be selected.

C. **Blind Flanges:** Blind flanges shall be in accordance with AWWA C207, or as indicated for miscellaneous small pipes. Blind flanges for pipe sizes 10-inches and greater shall be provided with lifting eyes in the form of welded or screwed eye bolts.

D. **Flange Coating:** Machined faces of metal blind flanges and pipe flanges shall be coated with a temporary rust-inhibitive coating to protect the metal until the installation is completed.

E. **Flange Bolts:** Bolts and nuts shall conform the following, unless noted otherwise on the Contract Drawings. All-thread studs may be used on valve flange connections where space restrictions preclude the use of regular bolts.

1. Corrosive Service

a. Bolts, nuts, and washers in the locations listed below shall be fabricated from ASME SAE Grade 5 steel with a fluoropolymer based heat fusion-bonded coating system; Tripac 2000 Blue or equal, or as indicated otherwise on the Contract Drawings.

1) Buried locations

2) Submerged locations

3) Locations subject to seasonal or occasional flooding

4) Inside hydraulic structures below the top of the structure

5) Inside buried vaults, manholes, and structures that do not drain through a gravity sewer or to a sump with a pump

6) Inside trenches, containment walls, and curbed areas

7) Locations indicated or designated by the ENGINEER to be provided with corrosion resistant steel bolts

2. **Medium Pressure Buried Pipe Flange Hardware**. Buried pipe flange bolts and nuts on pipe of Class 275 and greater shall be in accordance with ASTM A193/A194, Grade B7.

3. Anti-seize Lubricant Coating

   a. Threads on stainless steel bolts shall be protected with an antiseize lubricant suitable for submerged stainless steel bolts, meeting government specification MIL-A-907E.

   b. Buried bolts in poorly drained soil shall be coated the same as the buried pipe.

   c. Antiseize lubricant shall be classified as acceptable for potable water use by the NSF.

   d. Antiseize lubricant shall be "PURE WHITE" by **Anti-Seize Technology,** Franklin Park, IL, 60131, or equal.

4. Bolt Requirements

   a. The bolt and nut material shall be free-cutting steel.

   b. The nuts shall be capable of developing the full strength of the bolts.

   c. Threads shall be Coarse Thread Series conforming to the requirements of the American Standard for Screw Threads.

   d. Bolts and cap screws shall have hexagon heads and nuts shall be Heavy Hexagon Series.

   e. Bolts and nuts shall be installed with washers fabricated from material matching the base material of bolts, except that hardened washers for high-strength bolts shall conform to the requirements of the AISC Specification.

   f. Lock washers fabricated from material matching the bolts shall be installed where indicated.

   g. The length of each bolt shall be such that the bolt extends at least 1/8-inch beyond the outside face of the nut before tightening, except for anchor bolts which shall be flush with the face of the nut before tightening.

F. **Insulating Flange Sets:** Insulating flange sets shall be provided where indicated. Each insulating flange set shall consist of an insulating gasket, insulating sleeves and washers, and a steel washer. Insulating sleeves and washers shall be one piece when flange bolt diameter is 1.5 inch or smaller and shall be made of acetal resin. For bolt diameters larger than 1.5 inches, insulating sleeves and washers shall be 2 piece and shall be made of polyethylene or phenolic material.

1. Steel washers shall be in accordance with ASTM A 325 - Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.

2. Insulating gaskets shall be full-face.

3. Insulated flanges shall have bolt holes 1/4-inch diameter greater than the bolt diameter.

4. Insulating flange sets shall be as manufactured by **JM Red Devil, Type E**, **Maloney Pipeline Products Co**, **PSI Products, Inc.,** or equal

G. **Flange Gaskets**

1. Gaskets for flanged joints used in general water and wastewater service shall be full-faced type, with material and thickness in accordance with AWWA C207, suitable for temperatures to 700 deg F, a pH of one to 11, and pressures to 1,000 psig. Blind flanges shall have gaskets covering the entire inside face of the blind flange and shall be cemented to the blind flange. Ring gaskets shall not be permitted unless otherwise indicated. Flange gaskets shall be as manufactured by **John Crane, Style 2160, Garlock, Style 3000,** or equal**.**

2. Gaskets for flanged joints used in chemicals, air, solvents, hydrocarbons, steam, chlorine and other fluids shall be made of materials compatible with the service, pressure, and temperature.

3. Gaskets for flanged joints used in water with chloramines shall be **Gylon, Style 3500** as manufactured by **Garlock,** by **Crane**, or equal.

2.3 MECHANICAL-TYPE COUPLINGS (GROOVED OR BANDED PIPE)

A. **General:** Cast mechanical-type couplings shall be provided where indicated. The couplings shall conform to the requirements of AWWA C606 - Grooved and Shouldered Joints. Gaskets for mechanical-type couplings shall be compatible with the piping service and fluid utilized, in accordance with the coupling manufacturer's recommendations. The wall thickness of grooved piping shall conform to the coupling manufacturer's recommendations to suit the highest expected pressure. To avoid excessive load on equipment caused by pipe movement due to steady state or transient pressure conditions, equipment connections with mechanical-type couplings shall have rigid grooved couplings or flexible type coupling with harness in sizes where rigid type couplings are not available, unless thrust restraint is provided by other means. Mechanical type couplings shall be bonded. The CONTRACTOR shall have the coupling manufacturer's service representative verify the correct choice and application of couplings and gaskets, and the workmanship, to assure a correct installation. To assure uniform and compatible piping components, grooved fittings, couplings, and valves shall be furnished by the same manufacturer as the coupling. Grooving tools shall be from the same manufacturer as the grooved components.

2.4 SLEEVE-TYPE COUPLINGS

A. **General:** Sleeve-type couplings shall be provided where indicated. The CONTRACTOR will not be allowed to substitute a sleeve-split coupling, or any other type in lieu of sleeve coupling unless approved by the ENGINEER.

B. **Construction:** Sleeve couplings shall be in accordance with AWWA C219 - Standard for Bolted Sleeve-Type Couplings for Plain-End Pipe. Couplings shall be steel with steel bolts, without pipe stop. Couplings shall be of sizes to fit the pipe and fittings indicated. The middle ring shall be not less than 1/4-inch thick or at least the same wall thickness as the pipe to which the coupling is connected. If the strength of the middle ring material is less than the strength of the pipe material, the thickness of the middle ring shall be increased to have the same strength as the pipe. The coupling shall be either 5- or 7-inches long for sizes up to and including 30-inches and 10-inches long for sizes greater than 30-inches, for standard steel couplings, and 16-inches long for long-sleeve couplings. The followers shall be single-piece contoured mill sections welded and cold-expanded as required for the middle rings, and of sufficient strength to accommodate the number of bolts necessary to obtain adequate gasket pressures without excessive rolling. The shape of the follower shall be of such design as to provide positive confinement of the gasket. Bolts and nuts shall conform to the requirements of Section 05500. Buried sleeve-type couplings shall be epoxy-coated at the factory as indicated.

C. **Pipe Preparation:** Where indicated, the ends of the pipe shall be prepared for flexible steel couplings. Plain ends for use with couplings shall be smooth and round for a distance of 12-inches from the ends of the pipe, with outside diameter not more than 1/64-inch smaller than the nominal outside diameter of the pipe. The middle ring shall be tested by cold-expanding a minimum of one percent beyond the yield point, to proof-test the weld to the strength of the parent metal. The weld of the middle ring shall be subjected to air test for porosity.

D. **Gaskets**

1. Gaskets for sleeve-type couplings shall be rubber-compound material that will not deteriorate from age or exposure to air under normal storage or use conditions. Gaskets for wastewater and sewerage applications shall be Buna "N," Grade 60, or equivalent suitable elastomer. The rubber in the gasket shall meet the following specifications:

    a. Color: Black

    b. Surface: Non-blooming

    c. Durometer Hardness: 75 ± 5

    d. Tensile Strength: 1,000 psi minimum

    e. Elongation: 175 percent minimum

2. The gaskets shall be immune to attack by impurities normally found in water or wastewater. Gaskets shall meet the requirements of ASTM D 2000 - Classification System for Rubber Products in Automotive Applications, AA709Z, meeting Suffix

B13 Grade 3, except as noted above. Where sleeve couplings are used in water containing chloramine or other fluids which attack rubber materials, gasket material shall be compatible with the piping service and fluid utilized.

3. Gasket materials used in water with chloramines shall be **Gylon Style 3500** by **Garlock** or by **Crane,** or equal.

E. **Piping Connection to Equipment:** Where piping connects to mechanical equipment such as pumps, compressors, and blowers, the piping shall be brought to the equipment connection aligned and perpendicular to the axis of the flange or fitting for which the piping is to be connected. The piping shall not impose excessive stress to the equipment connection to cause misalignment of the equipment. The CONTRACTOR shall assign the responsibility to the equipment manufacturer to review the piping connection to the equipment and submit any modifications to the ENGINEER for review.

F. **Insulating Sleeve Couplings:** Where insulating couplings are required, both ends of the coupling shall have a wedge-shaped gasket which assembles over a sleeve of an insulating compound material compatible with the fluid service in order to obtain insulation of coupling metal parts from the pipe.

G. **Restrained Joints:** Sleeve-type couplings on pressure lines shall be harnessed unless thrust restraint is provided by other means. Harnesses shall be designed by the pipe manufacturer in accordance with AWWA Manual M11, or as indicated. Harness sets shall be designed for the maximum test pressure of the pipe in which they are installed. Where harness sets are installed near the suction and discharge of the pump, harness bolts shall have zero elongation to prevent misalignment of the pump imparted by the thrust within the piping system.

H. **Manufacturers,** or equal

1. Dresser, Style 38

2. Ford Meter Box Co., Inc., Style FC1 or FC3

3. Smith-Blair, Style 411

2.5 FLANGE COUPLING ADAPTERS

A. Flange coupling adapters shall be provided where indicated. The CONTRACTOR will not be allowed to substitute any other type in lieu of flange coupling adapter unless approved by the ENGINEER. The coupling shall be rated as indicated.

B. **Construction**: Flange coupling adapter body shall be fabricated from steel ASTM A 512 - Cold-Drawn Buttweld Carbon Steel Mechanical Tubing or A 513 - Electric-Resistance Welded Carbon and Alloy Steel Mechanical Tubing with steel bolts, without pipe stop. Flange shall be in accordance with AWWA C207. Couplings shall be of sizes to fit the pipe and fittings indicated. The body shall be not less than 1/4-inch thick or at least the same wall thickness as the pipe to which the coupling is connected. If the strength of the body material is less than the strength of the pipe material, the thickness of the middle ring shall be increased to have the same strength as the pipe. The follower flange shall be fabricated from steel, ASTM A 576 - Steel Bars, Carbon, Hot Wrought, Special Quality or AISI C1012. The shape of the follower shall be of such design as to provide positive confinement of the gasket. Flange coupling adapters installed in piping system rated for positive pressure, the coupling shall be restrained with harness bolts or tie rods. Other means of restraining the coupling such as set screws will not be acceptable. All couplings shall be epoxy lined and coated at the factory as indicated.

C. **Gaskets**: Gaskets for flange coupling adapters shall be rubber-compound material that will not deteriorate from age or exposure to air under normal storage or use conditions. Gaskets for wastewater and sewerage applications shall be Buna "N," Grade 60 NSF approved, or equivalent suitable elastomer.

1. The rubber in the gasket shall meet the following specifications:

    a. Color - Jet Black

    b. Surface - Non-blooming

    c. Durometer Hardness - 74 ± 5

    d. Tensile Strength - 1,000 psi Minimum

    e. Elongation - 175 percent Minimum

2. The gaskets shall be immune to attack by impurities normally found in water or wastewater. Gaskets shall meet the requirements of ASTM D 2000 - Classification System for Rubber Products in Automotive Applications, AA709Z, meeting Suffix B13 Grade 3, except as noted above. Where flange coupling adapters are used in water containing chloramine or other fluids which attack rubber materials, gasket material shall be compatible with the piping service and fluid utilized.

3. Gasket materials used in water with chloramines shall be **Gylon Style 3500** by **Garlock** or by **Crane,** or equal.

D. **Piping Connection to Equipment:** Where piping connects to mechanical equipment such as pumps, compressors, and blowers, the piping shall be brought to the equipment connection aligned and perpendicular to the axis of the flange or fitting for which the piping is to be connected. The piping shall not impose excessive stress to the equipment connection to cause misalignment of the equipment. The CONTRACTOR shall assign the responsibility to the equipment manufacturer to review the piping connection to the equipment and submit any modifications to the ENGINEER for review.

E. **Restrained Joints:** Flange coupling adapters on pressure lines shall be harnessed unless thrust restraint is provided by other means. Harnesses shall be designed by the pipe manufacturer in accordance with AWWA Manual M11, or as indicated. Harness sets shall be designed for the maximum test pressure of the pipe in which they are installed. Where harness sets are installed near the suction and discharge of the pump, harness bolts shall have zero elongation to prevent misalignment of the pump imparted by the thrust within the piping system.

F. **Manufacturers,** or equal

1. Romac Industries DJ400

2. Smith-Blair, Model 975

3. JCM, Model 309

2.6 EXPANSION JOINTS

A. Piping subject to expansion and contraction shall be provided with sufficient means to compensate for such movement without exertion of undue forces to equipment or structures. This may be accomplished with expansion loops, bellow-type expansion joints, or sliding-type expansion joints. Expansion joints shall be flanged end, stainless steel, Monel, rubber, or other materials best suited for each individual service. The CONTRACTOR shall submit detailed calculations and manufacturer's Shop Drawings of proposed expansion joints, piping layouts, and anchors and guides, including information on materials, temperature, and pressure ratings.

2.7 MODULAR MECHANICAL SEALS FOR PIPING PENETRATIONS

A. Where indicated and where required to prevent flow of water or air, the passages of piping through wall sleeves and cored openings shall be sealed with modular interlocking link mechanical closures. Individual links shall be constructed of EPDM rubber, be suitable for temperatures between minus 40 and plus 250 deg F, and be shaped to fill the annular space between the outside of the pipe and the inside of the wall sleeve or cored opening.

   1. Links shall be assembled with type 316 stainless steel bolts and nuts to form a continuous rubber belt around the pipe.

   2. Pressure plates under each bolt and nut shall be fabricated of a corrosion-resistant composite material.

   3. Sizing and installation of sleeves and assemblies shall be in accordance with the manufacturer's recommendations.

   4. Modular mechanical seals for pipe penetrations shall be **Link Seal** by **Thunderline Corporation,** or equal

PART 3 -- EXECUTION

3.1 MATERIAL DELIVERY, STORAGE, AND PROTECTION

A. Piping materials, fittings, valves, and accessories shall be delivered in a clean and undamaged condition and stored off the ground for protection against oxidation caused by ground contact. Defective or damaged materials shall be replaced with new materials.

3.2 GENERAL

A. Piping, fittings, and appurtenances shall be installed in accordance with the requirements of applicable Sections of Division 33 and Division 40. Proprietary manufactured couplings shall be installed in accordance with the coupling manufacturer's recommendation.

B. Care shall be taken to insure that piping flanges, mechanical-type couplings, sleeve-type couplings, flexible connectors, and expansion joints are properly installed as follows:

1. Gasket surfaces shall be carefully cleaned and inspected prior to making up the connection. Each gasket shall be centered properly on the contact surfaces.

2. Connections shall be installed to prevent inducing stress to the piping system or the equipment to which the piping is connected. Contact surfaces for flanges, couplings, and piping ends shall be aligned parallel, concentric, and square to each axis at the piping connections.

3. Bolts shall be initially hand-tightened with the piping connections properly aligned. Bolts shall be tightened with a torque wrench in a staggered sequence to the AISC recommended torque for the bolt material.

4. After installation, joints shall meet the indicated leakage rate. Flanges shall not be deformed nor cracked.

C. **Lined Piping Systems:** The lining manufacturer shall take full responsibility for the complete, final product and its application. Pipe ends and joints of lined pipes at screwed flanges shall be epoxy-coated to assure continuous protection.

D. **Protective Coatings for Buried Couplings (rigid and flexible).** Where pipe couplings are buried, all such couplings shall be given a liquid epoxy coating in the factory (unless otherwise specified) and shall be protected in the ground with a field applied use of a cross-linked polyolefin backed, heat-shrinked protective wrapping (*Canusa Aqua-Shield* or equal).

E. **Core Drilling:** Where core drilling is required for pipes passing through existing concrete, core drilling locations shall be determined by radiograph of concrete construction to avoid damage to embedded raceways and reinforcing bars.

F. **Cleanup:** After completion of the WORK, cuttings, joining and wrapping materials, and other scattered debris shall be removed from the Site. The entire piping system shall be handed over in a clean and functional condition.

- END OF SECTION -

SECTION 40 23 01 - PIPING IDENTIFICATION

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall provide identification for exposed piping and valves, complete and in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

ANSI A13.1	Scheme for the Identification of Piping Systems

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with KRRP Project Submittals.

B. **Shop Drawings**: A list of suggested wording for each valve tag, prior to fabrication.

C. Samples

1. One sample of each type of identification device.

2. Sample of each proposed color required by the pipe color schedule.

PART 2 -- PRODUCTS

2.1 IDENTIFICATION OF PIPING

A. Except as indicated below for very short pipe lengths, identify exposed piping larger than 2-inches nominal size for the pipe contents and direction of flow.

1. Marker Type

   a. Adhesive: Vinyl or polyester sheet with UV- resistant ink, shaped similar to pipe curvature and coated with pressure sensitive adhesive.

2. Marker Area: Sized per pipe size according to ANSI A13.1; color from the table below.

3. Lettering: Sized per pipe size according to ANSI A13.1; color from the table below.

4. Arrows: at least 2 arrows at each marker area, showing direction of flow.

B. Pipe identification shall be as manufactured by **Brady, Seton,** or equal.

2.2 EXISTING IDENTIFICATION SYSTEMS

A. In installations where existing piping identification systems have been established, the CONTRACTOR shall follow the existing system. Where existing identification systems are incomplete, utilize the existing system as far as practical and supplement with the indicated system.

2.3 IDENTIFICATION OF VALVES AND SHORT PIPE LENGTHS

A. Identifying devices for valves and the sections of pipe that are too short to be identified with markers and arrows shall be identified with metal or plastic tags.

B. Metal tags shall be stainless steel with embossed lettering. Plastic tags shall be solid black plastic laminate with white embossed letters. Tags shall be designed to be firmly attached to the valves or short pipes or to the structure immediately adjacent to such valves or short pipes.

C. Wording on the valve tags shall describe the exact function of each valve.

PART 3 -- EXECUTION

3.1 GENERAL

A. Markers and identification tags shall be installed in accordance with the manufacturer's printed instructions, and shall be neat and uniform in appearance. Tags and markers shall be readily visible from all normal working locations.

3.2 VALVE TAGS

A. Valve tags shall be permanently attached to the valve or structure by means of 2 stainless steel bolts or screws.

3.3 MARKER LOCATIONS

A. Each pipe shall be marked at:

1. Intervals of 20-feet in straight runs.

2. Within 2-feet of turns, elbows, and valves.

3. On the upstream side of tees, branches, and other distribution points.

3.4 IDENTIFICATION COLORS

A. Conform to the following color codes.

Color Schedule

Pipe Contents		Pipe Color	Marker Color	Letter Color
Abbreviation	**Identification**			
RW	Raw water		green	white

- END OF SECTION -

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SECTION 40 23 15 - STEEL PIPE (ASTM A53 / A106, MODIFIED)

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall provide A53 steel pipe and appurtenances for the raw water pipeline, complete and in place, in accordance with the Contract Documents.

B. The requirements of Section 40 23 00 - Piping, General apply to the WORK of this Section.

C. **Pipe Material Group No. 6**. The piping system defined in this section is referred to in the Pipe Schedule on Contract Sheet G007 as Piping Material Group No. 6.

D. **Pipeline Options A & B**. The CONTRACTOR is alerted that two different steel pipe fabrication and installation options are provided for different sections of the new pipeline alignment, in accordance with the ***Pipeline Options Summary Table*** on Sheet G008. This specification section applies primarily to Option A which is the furnishing of longitudinal welded steel pipe, specials and fittings in accordance with ASTM A53 steel pipe, as modified in this section herein. This section also applies to the joint-end requirements, welding requirements, and installation requirements for Pipeline Option A. The pipe material and fabrication requirements for Pipeline Option B are covered in Section 33 11 11 – Steel Pipe, Specials, and Fittings (AWWA C200, modified).

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with KRRP Project Submittals.

B. Furnish the information with Shop Drawings as Specified in Section 33 11 11:

C. Design Calculations of Fittings and Specials

1. Furnish a copy of the design calculations for fittings and specials including miters, welds, and reinforcement, prior to manufacture of the pipe, fittings, and specials.

1.3 QUALITY CONTROL

A. Pipe Manufacturer Qualifications shall meet or exceed the qualifications outlined in Section 33 11 11.

B. Inspection requirements shall meet or exceed the qualifications outlined in Section 33 11 11.

C. Pipe joints shall include a video camera inspection to validate the field lining has been adequately repaired and applied at field welded joints. Video footage shall be submitted to ENGINEER for review and approval

D. Field Testing

1. Field testing shall be in accordance with the requirements of Section 01 74 30 Pressure Pipeline Testing and Disinfection.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Lined and coated steel pipe and specials shall conform to ASTM A53, subject to the following supplemental requirements:

1. The pipe, specials, and fittings shall be of the diameter and class indicated and shall be provided complete with welded joints as indicated.

2.2 PIPE MATERIAL

A. **Raw Water Service:** Unless otherwise indicated, black steel pipe shall conform to ASTM A 53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless or ASTM A 106 - Seamless Carbon Steel Pipe for High Temperature Service, Grade B, and shall be wall thickness as indicated in the Piping Schedule.

B. Pipe Dimensions

1. The pipe shall be of the outside shell diameter and minimum wall thickness as indicated in the ***Pipe Options Summary Table*** located on Contract Drawing G008.

2.3 PIPE JOINTS

A. Black steel pipe for general service shall have welded joints, or flanged joints. Where indicated, black steel pipe shall have grooved ends for shouldered couplings or plain ends for sleeve-type couplings.

1. Butt-strap joints shall be used only where required for closures or where indicated.

2. Unless indicated otherwise, the standard joint design for all steel straight pipe and fittings shall be field, single bevel, complete penetration butt welds and factory butt welds, designed for welding from the outside of the pipe. The final bevel geometry and weld design shall be as required by applicable standards and as provided by the Contractor’s certified welders or their qualified welding subcontractor.

3. ANSI 16.5 Class 300 hub-type steel flanges shall be used on the bridge crossing and for connection to valves, flow meters, and other specials as shown on the Contract drawings.

2.4 SPECIALS AND FITTINGS

A. Specials and fittings shall meet or exceed the qualifications outlined in Section 33 11 11.

B. **Common Use:** The following fittings shall be provided for galvanized or black steel pipe, as indicated in the Piping Schedule:

1. Butt welding fittings conforming to ASME B 16.9 - Factory-Made Wrought Steel Butt Welding Fittings, Schedule as indicated.

2. Flanged cast iron fittings conforming to ASME B 16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800.

3. Flanged steel fittings conforming to ASME B 16.5 - Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys.

C. Special Applications

1. High tensile alloy steel corrosion-resistant bolts and nuts shall be used with each set of flanged unions. Unions shall be rated for 600 lb. CWP service pressure, reducing-type, straight-type or blind-type, as required for the installation. Blind unions shall be provided as cleanouts where indicated, and straight unions shall be provided adjacent to each threaded valve or piece of equipment. Unions shall be as manufactured by **Henry Valve Company, Vogt Valve Co.,** or equal.

2.5 PIPE INTERIOR LINING

A. The lining system required for each portion of the pipeline shall be as indicated on the **Pipe Schedule** given on Contract Drawing G008.

B. **Liquid Epoxy (for pipe Option A per the table on Sheet G008). See Specification Section 33 11 11.**

2.6 PIPE EXTERIOR COATING

A. **Exterior Coating of Exposed Piping, see Specification Section 33 11 11.**

B. **Shop Applied Prime Coating for Concrete Encased Pipe. See Section 33 11 11.**

C. **Exterior Coating of Buried Piping when using Fusion Bonded Epoxy**

1. All pipe shall be coated on the exterior only with fusion bonded epoxy per AWWA C213.

2. **Fusion Bond Epoxy** (for Manufacturer's shop application only)

a. Material

Type	100 percent solids fusion bond epoxy
Demonstrated suitable for	Fluidized bed or electrostatic spray application, recommended for, fittings, and pipe appurtenances.

b. Application in accordance with NACE SP0394-2013 and the following Dry Film Thickness (DFT):

Surface Preparation	**Product**	**Surface and DFT**
Steel Structures Painting Council (SSPC) Standard SP10 Near-White Blast Cleaning	*3M Scotchkote 134 or 206N, or Approved Equal*	Buried Coating: minimum DFT of 14-mils and as recommended by coating manufacturer.

c. Do not apply coating until shop tests have been completed.

3. Liquid Applied Epoxy for Field Application on Girth Welded Joints

a. Material

Type	100 percent solids, novolatile two component epoxy coating system that can be spray applied or brush applied to intended substrate.
Demonstrated suitable for	Protection of field joint girth welds, valves and fittings, as a holiday repair material on FPE coated pipe.

Surface Preparation	**Product**	**Surface and DFT**
Per Coating manufacturer's recommendations.	*CANUSA-CPS HBE-95*, or equal	minimum DFT of 20-mils and as recommended by coating manufacturer

b. At the ends of each pipe segment, FBE coating shall be held back at least 6-inches for field welding. Hold backs shall be covered with factory applied primer to temporarily protect the pipe from corrosion during transport and storage.

c. Where coating was held back, bare metal shall be coated with liquid applied epoxy.in the field, after weld inspections have been completed and approved.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. **General:** Pipes shall be installed in a neat and workmanlike manner, properly aligned, and cut from measurements taken at the Site to avoid interferences with structural members, architectural features, openings, and equipment. Exposed pipes shall afford maximum headroom and access to equipment, and where necessary, piping shall be installed with sufficient slopes for venting or drainage of liquids and condensate to low points. Installation shall be free from defects.

B. **Supports and Anchors:** Piping shall be firmly supported with fabricated or commercial hangers or supports. Where necessary to avoid stress on equipment or structural members, the pipes shall be anchored or harnessed. Expansion joints and guides shall compensate for pipe expansion due to temperature differences.

C. **Valves and Unions:** Water piping to fixtures, groups of fixtures, and equipment shall be provided with a shutoff valve and union, unless the valve has flanged ends. Low points in water systems shall have drainage valves. Unions shall be provided at threaded valves, equipment, and other devices requiring occasional removal or disconnection.

D. **Handling and Storage**

1. Pipe, specials, and fittings shall be carefully handled and protected against damage to lining and coating/interior and exterior surfaces, and impact shocks and free fall.

2. Pipe, specials, and fittings shall not be placed directly on rough ground but shall be supported in a manner that will protect the pipe against injury whenever stored at the Site or elsewhere.

3. Pipe, specials, and fittings shall be handled and stored at the Site in accordance with the requirements indicated in Part 2, above.

4. No pipe shall be installed when the lining or coating, or interior or exterior surfaces show cracks that may be harmful as determined by the ENGINEER.

5. Such damaged lining and coating, and interior and exterior surfaces shall be repaired or a new undamaged pipe, special, or fitting shall be provided.

E. Pipe damaged prior to Substantial Completion shall be repaired or replaced.

F. The CONTRACTOR shall inspect each pipe, special, and fitting for damage.

G. The CONTRACTOR shall remove or smooth out any burrs, gouges, weld splatter, or other small defects prior to laying the pipe, special, or fitting.

H. **Cleaning**

1. Before the placement of pipe, specials, or fittings in the trench, each shall be thoroughly cleaned of any foreign substance that may have collected thereon and shall be kept clean thereafter.

2. For this purpose, the openings of pipes, specials, and fittings in the trench shall be closed during any interruption to the WORK.

I. **Placement**

1. CONTRACTOR shall avoid all laying procedures which create concentrated loads on the steel pipe. Pipe, specials, and fittings shall be laid directly:

   a. On the imported and properly compacted bedding material, or

   b. If CLSM is being utilized in the pipe zone and pipe bedding area, on soil pads or other approved compressible material such as extruded polystyrene foam insulation. Soil pads shall maintain horizontal and vertical alignment during backfilling operation, and shall have a lower compressible strength than the surrounding CLSM material

2. Only compressible blocking as specified will be permitted, and the bedding shall be such that it forms a continuous, solid bearing for the full length of the pipe, special, or fitting.

3. Excavations shall be made as needed to facilitate removal of handling devices after the item has been laid.

4. Bell holes shall be formed at the ends of the pipe to prevent point loading at the bells or couplings.

5. Excavation outside the normal trench section shall be made at field joints as needed to permit adequate access to the joints for field connection operations and for application of coating on field joints.

6. Except for short runs that may be permitted by the ENGINEER, pipes shall be laid uphill if on grades exceeding 10 percent.

7. Pipe that is laid on a downhill grade shall be blocked and held in place until sufficient support is furnished by the following pipe to prevent movement.

8. Bends shall be installed as indicated.

J. **Installation Tolerances**

1. Each section of pipe, special, or fitting shall be laid in the order and position on the laying diagram and in accordance with the following:

a. Each section of pipe, special, or fitting having a nominal diameter less than 48 inches shall be laid to line and grade, within plus or minus 2-inches horizontal deviation and plus or minus .

b. In addition to the horizontal and vertical tolerances above, the pipe shall be laid so that no high or low points other than those on the laying diagram are introduced.

c. After installation, the pipe, specials, and fittings shall not show deflection greater than:

1) flexible-lined and mortar-coated (rock-shielded) pipe, specials, and fittings: 2.25 percent

2) mortar-lined and mortar-coated pipe, specials, and fittings: 1.5 percent

d. The allowable deflection shall be based on the design inside diameter.

K. **Test Section**

1. At the beginning of pipe laying operations, the CONTRACTOR shall perform a test section to demonstrate that the methods and materials to be used will satisfy the pipe zone backfill compaction and pipe deflection criteria.

2. The maximum length of the test section shall be 500 feet.

3. The CONTRACTOR shall not proceed with production pipe laying beyond the test section without the ENGINEER's approval.

4. The entire test section length that does not comply with the Contract Documents shall be reworked as necessary to comply.

5. The ENGINEER will observe construction of the test section.

6. The OWNER will take measurements and keep records for quality assurance purposes.

7. Any change in means, methods, and trench conditions, including excavation, bedding, and pipe zone materials, in situ soils, water conditions, and backfill and compaction methods shall require another successful test section before additional production pipe installation.

L. **Changes in Alignment and/or Grade**

1. Where necessary to raise or lower the pipe, specials, or fittings due to unforeseen obstructions or other causes, the ENGINEER may change the alignment and/or the grade.

2. Such change shall be made by the deflection of joints, by the use of bevel adapters, or by the use of additional fittings, although in no case shall the

deflection in a joint exceed 75 percent of the maximum deflection recommended by the pipe manufacturer.

3. No joint shall be misfit any amount that will be detrimental to the strength and water tightness of the finished joint.

M. **Struts**

1. Struts in pipe 42-inch diameter and larger shall be left in place until backfilling operations have been completed.

2. Struts in pipe smaller than 42-inch may be removed immediately after laying.

3. A laboratory selected and paid by the OWNER may monitor pipe deflection by measuring pipe inside diameter before struts are removed and 24 hours after struts are removed.

4. Pipe deflection shall not exceed 1.5 percent 24 hours after the struts have been removed.

5. After the backfill has been placed, the struts shall be removed and shall remain the property of the CONTRACTOR.

N. **Cold Weather Protection**

1. No pipe, special, or fitting shall be installed upon a foundation into which frost has penetrated or at any time that there is a danger of the formation of ice or penetration of frost at the bottom of the excavation.

2. No pipe, special, or fitting shall be laid unless it can be established that the trench will be backfilled before the formation of ice and frost occurs.

O. **Pipe, Specials, and Fitting Protection**.

1. Means shall be provided to prevent the pipe from floating due to water in the trench from any source.

2. Pipe that has floated shall be repaired, including restoration to original condition and profile.

P. **Pipe Cleanup**

1. As pipe laying progresses, the CONTRACTOR shall keep the pipe interior free of debris.

2. The CONTRACTOR shall completely clean the interior of the pipe of sand, dirt, mortar splatter, and any other debris following completion of pipe laying, pointing of joints, and any necessary interior repairs prior to testing and disinfecting of the completed pipeline.

3.2 PIPE PREPARATION

A. Prior to installation, each pipe length shall be carefully inspected, be flushed clean of any debris or dust, and be straightened if not true. Fittings shall be equally cleaned before assemblage.

3.3 PIPE JOINTS

A. **Welded Joints:** Welded joints shall conform to the specifications and recommendations of ASME B 31.1 - Power Piping. Welding shall be done by skilled and qualified welders per Section 40 23 00 - Piping, General.

B. Welded Joints shall also meet or exceed all of the requirements in **Section 33 11 11 part 3.2 Welded Joints.**

3.4 PREPARATION FOR FIELD COATING

A. **General:** Surfaces to receive protective coatings shall be prepared as indicated prior to application of coatings. The CONTRACTOR shall examine surfaces to be coated and shall correct surface defects before application of any coating material. Marred or abraded spots on shop-primed and on factory-finished surfaces shall receive touch-up restoration prior to any field coating application. Surfaces to be coated shall be dry and free of visible dust.

B. Care shall be exercised not to damage adjacent Work during blasting operations. Spraying shall be conducted under carefully controlled conditions. The CONTRACTOR shall be fully responsible for and shall promptly repair any and all damage to adjacent Work or adjoining property occurring from blasting or coating operations.

C. **Protection of Painted Surfaces:** Cleaning and coating shall be coordinated so that dust and other contaminants from the preparation process will not fall on wet, newly-coated surfaces, or likewise harm existing surfaces.

3.5 SURFACE PREPARATION STANDARDS

A. **Steel Structures Painting Council (SSPC) Standards.** The following referenced standards for surface preparation according to specifications of the Steel Structures Painting Council (SSPC) shall form a part of this specification:

1. **SSPC SP1 - Solvent Cleaning**: Removal of oil, grease, soil, salts, and other soluble contaminants by cleaning with solvent, vapor, alkali, emulsion, or steam.

2. **SSPC SP2 - Hand Tool Cleaning:** Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by hand chipping, scraping, sanding, and wire brushing.

3. **SSPC SP3 - Power Tool Cleaning**: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by power tool chipping, descaling, sanding, wire brushing, and grinding.

4. **SSPC SP5 - White Metal Blast Cleaning**: Removal of all visible rust, oil, grease, soil, dust, mill scale, paint, oxides, corrosion products and foreign matter by blast cleaning.

5. **SSPC SP6 - Commercial Blast Cleaning**: Removal of all visible oil, grease, soil, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except that staining shall be limited to no more than 33 percent of each square inch of surface area.

6. **SSPC SP7 Brush-Off Blast Cleaning**: Removal of all visible oil, grease, soil, dust, loose mill scale, loose rust, and loose paint.

7. **SSPC SP10 Near-White Blast Cleaning** : Removal of all visible oil, grease, soil, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except that staining shall be limited to no more than 5 percent of each square inch of surface area.

8. **SSPC-SP13 Surface Preparation of Concrete**: Removal of protrusions, laitance and efflorescence, existing coatings, form-release agents, and surface contamination by detergent or steam cleaning, abrasive blasting, water jetting, or impact or power tool methods as appropriate for the condition of the surface and the requirements of the coating system.

3.6 JOINT COATING AND LINING

A. **General**

1. The interior and exterior joint recesses shall be thoroughly wiped clean.

2. Remove water, loose scale, dirt, and other foreign material from the inside surface of the pipe.

B. **Testing**

1. The CONTRACTOR will test each joint with an electrical detector, furnished by the CONTRACTOR and capable of at least a 12,000 volt output.

2. The tests will be performed using 6,000 to 7,000 volts.

3. The CONTRACTOR shall repair any holidays.

4. Re-Testing

   a. When a visual inspection indicates that a portion of the coating system has sustained physical damage, the CONTRACTOR shall perform an electrical holiday test of 6,000 to 7,000 volts.

   b. When the test indicates no holiday, a notation shall be applied to the area indicating the test is satisfactory.

C. **Coating Repair**

1. Perform coating repairs on coated pipe in accordance with the Manufacturer's recommendations and the requirements of AWWA C213, satisfying both requirements at a minimum.

2. Rock Shield / Mortar-Coated Pipe: Perform coating repairs on mortar-coated pipe in accordance with the requirements of AWWA C205.

D. **Coating of Fittings and Specials**: Fittings and specials shall be coated in accordance with AWWA C205 or AWWA C210 and the requirements specified herein.

3.7 INSTALLATION OF PIPE APPURTENANCES

Installation of pipe and appurtenances shall meet or exceed Section 33 11 11 part 3.6 Installation of Pipe and Appurtenances

3.8 INSPECTION AND FIELD TESTING

A. **Inspection:** Finished installations shall be carefully inspected for proper supports, anchoring, interferences, and damage to pipe, fittings, and coating. Any damage shall be repaired.

B. **Field Testing:** Prior to enclosure or burying, piping systems shall be pressure tested as required in the Piping Schedule for a period of not less than one hour without exceeding the tolerances listed in the Piping Schedule. Where no pressures are indicated, the pipes shall be subject to 1-1/2 times the maximum working pressure. The CONTRACTOR shall furnish test equipment, labor, materials, and devices as part of the WORK. For additional testing requirements, refer to Section 01 74 30 - Pressure Pipe Testing and Disinfection.

1. Leakage may be determined by loss of pressure, soap solution, chemical indicator, or other positive and accurate method. Fixtures, devices, or other accessories which are to be connected to the lines and which would be damaged if subjected to the test pressure shall be disconnected and ends of the branch lines plugged or capped as required during the testing procedures.

2. Leaks shall be repaired, and the system shall be re-tested until no leaks are found.

3.9 CORROSION CONTROL

A. **Joint Bonding/Electrolysis Test Stations**

1. Except where otherwise indicated, joints shall be bonded for any pipe joints that are non-welded joints.

2. The pipe shall be cleaned to bare bright metal at the point where the bond is to be installed.

3. Electrolysis test stations shall be installed where indicated on Drawings.

B. Cathodic Protection: Corrosion mitigation and testing materials, such as an impressed current cathodic protection system, magnesium anodes, reference electrodes, and test lead wires shall be provided where indicated.

- END OF SECTION -

SECTION 43 25 00 - VALVES, GENERAL

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall provide valves, actuators, and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to valves and valve actuators except where otherwise indicated. Valves and actuators in particular locations may require a combination of units, sensors, limit switches, and controls indicated in other Sections of the Specifications.

C. Where a valve is to be supported by means other than the piping to which it is attached, the CONTRACTOR shall obtain from the valve manufacturer a design for support and foundation. The design, including drawings and calculations sealed by an engineer, shall be submitted with the Shop Drawings. When the design is approved, the support shall be provided.

D. **Unit Responsibility:** A single manufacturer shall be made responsible for coordination of design, assembly, testing, and furnishing each valve; however, the CONTRACTOR shall be responsible to the OWNER for compliance with the requirements of each valve section. Unless indicated otherwise, the responsible manufacturer shall be the manufacturer of the valve.

E. **Single Manufacturer:** Where 2 or more valves of the same type and size are required, the valves shall be furnished by the same manufacturer.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with KRRP Project Submittals.

B. **Shop Drawings:** Shop Drawings shall contain the following information:

1. Valve name, size, Cv factor, pressure rating, identification number (if any), and specification section number.

2. Complete information on valve actuator, including size, manufacturer, model number, limit switches, and mounting.

3. Cavitation limits for control valves.

4. Assembly drawings showing part nomenclature, materials, dimensions, weights, and relationships of valve handles, handwheels, position indicators, limit switches, integral control systems, needle valves, and control systems.

5. Valve Labeling: A schedule of valves to be provided with stainless steel tags, indicating in each case the valve location and the proposed wording for the tag.

C. **Technical Manual:** The Technical Manual shall contain the required information for each valve.

D. **Spare Parts List:** A Spare Parts List shall contain the required information for each valve assembly, where indicated.

E. **Factory Test Data:** Where indicated, signed, dated, and certified factory test data for each valve requiring certification shall be submitted before shipment of the valve. The data shall also include certification of quality and test results for factory-applied coatings.

PART 2 -- PRODUCTS

2.1 PRODUCTS

A. **General:** Valves and gates shall be new and of current manufacture. Shut-off valves 6-inches and larger shall have actuators with position indicators. Gate valves 18-inches and larger or where chain wheel is required, shall be furnished with spur gear and hand wheel. Buried valves shall be provided with valve boxes and covers containing position indicators and valve extensions. Manual shut-off valves mounted higher than 7-feet above working level shall be provided with chain actuators.

B. **Protective Coating:** The exterior surfaces of valves and the wet interior surfaces of ferrous valves of sizes 4-inches and larger shall be coated with Fusion Bonded Epoxy (FBE). The valve manufacturer shall certify in writing that the required coating has been applied and tested in the manufacturing plant prior to shipment, in accordance with these Specifications. Flange faces of valves shall not be epoxy coated.

C. **Valve Labeling:** Except when such requirement is waived by the ENGINEER in writing, a label shall be provided on shut-off valves and control valves except for hose bibbs and chlorine cylinder valves. The label shall be of 1/16-inch plastic or stainless steel, minimum 2-inches by 4-inches in size, as indicated in Section 40 23 01 - Piping Identification, and shall be permanently attached to the valve or on the wall adjacent to the valve as directed by the ENGINEER.

D. **Valve Testing:** As a minimum, unless otherwise indicated or recommended by the reference standards, valves 3-inches in diameter and smaller shall be tested in accordance with manufacturer's standard and 4-inches in diameter and larger shall be factory tested as follows:

1. **Hydrostatic Testing:** Valve bodies shall be subjected to internal hydrostatic pressure equivalent to twice the water rated pressure of the valve. Metallic valve rating pressures shall be at 100 degrees F and plastic valves shall be 73 degrees, or at higher temperature according to type of material. During the hydrostatic test, there shall be no leakage through the valve body, end joints, or shaft seals, nor shall any part of the valve be permanently deformed. The duration shall be sufficient time to allow visual examination for leakage. Test duration shall be at least 10 minutes.

2. **Seat Testing:** Valves shall be tested for leaks in the closed position with the pressure differential across the seat equal to the water rated pressure of the valve. The duration of test shall be sufficient time to allow visual examination for leakage. Test duration shall be at least 10 minutes. Leakage past the closed valve shall not

exceed 1 fluid ounce per hour per inch diameter for metal seated valves. Resilient-seated valves shall be drop-tight.

3. **Performance Testing:** Valves shall be shop-operated from fully closed to fully open position and reverse under no-flow conditions in order to demonstrate the valve assembly operates properly.

E. **Certification:** Prior to shipment, the CONTRACTOR shall submit for valves over 12-inches in size, certified, notarized copies of the hydrostatic factory tests, showing compliance with the applicable standards of AWWA, ANSI, or ASTM.

F. **Valve Marking:** Valve bodies shall be permanently marked in accordance with MSS SP25 - Standard Marking Systems for Valves, Fittings, Flanges, and Unions.

2.2 MATERIALS

A. **General:** Materials shall be suitable for the intended application. Materials in contact with potable water shall be listed as compliant with NSF Standard 61. Materials not indicated shall be high-grade standard commercial quality, free from defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended. Unless otherwise indicated, valve and actuator bodies shall conform to the following requirements:

1. **Cast Iron:** Close-grained gray cast iron, conforming to ASTM A 48 - Gray Iron Castings, Class 30, or to ASTM A 126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

2. **Ductile Iron:** ASTM A 536 - Ductile Iron Castings, or to ASTM A 395 - Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.

3. **Steel:** ASTM A 216 - Steel Castings, Carbon Suitable for Fusion Welding for High-Temperature Service, or to ASTM A 515 - Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service.

4. **Bronze:** ASTM B 62 - Composition Bronze or Ounce Metal Castings, and valve stems not subject to dezincification shall conform to ASTM B 584 - Copper Alloy Sand Castings for General Applications.

5. **Stainless Steel:** Stainless steel valve and operator bodies and trim shall conform to ASTM A 351 - Steel Castings, Austenitic, for High-Temperature Service, Grade CF8M, or shall be Type 316 stainless steel.

6. **PVC:** Poly vinyl chloride materials for valve body, flanges, and cover shall conform to Cell Classification 12454.

7. **CPVC:** Chlorinated poly vinyl chloride materials for valve body, flanges, and cover shall conform to Cell Classification 23447.

8. **NSF Standard 14:** Materials shall be listed for use in contact with potable water.

2.3 VALVE CONSTRUCTION

A. **Bodies:** Valve bodies shall be cast, molded (in the case of plastic valves), forged, or welded of the materials indicated, with smooth interior passages. Wall thicknesses shall be uniform in agreement with the applicable standards for each type of valve, without casting defects, pinholes, or other defects that could weaken the body. Welds on welded bodies shall be done by certified welders and shall be ground smooth. Valve ends shall be as indicated, and be rated for the maximum temperature and pressure to which the valve will be subjected.

B. **Valve End Connections:** Unless otherwise indicated, valves 2-1/2 inches diameter and smaller may be provided with threaded end connections. Valves 3-inches and larger shall have flanged end connections.

C. **Bonnets:** Valve bonnets shall be clamped, screwed, or flanged to the body and shall be of the same material, temperature, and pressure rating as the body. The bonnets shall have provision for the stem seal with the necessary glands, packing nuts, or yokes.

D. **Stems:** Valve stems shall be of the materials indicated, or, if not indicated, of the best commercial material for the specific service, with adjustable stem packing, O-rings, Chevron V-type packing, or other suitable seal. Where subject to dezincification, bronze valve stems shall conform to ASTM B 62, containing not more than 5 percent of zinc or more than 2 percent of aluminum, with a minimum tensile strength of 30,000 psi, a minimum yield strength of 14,000 psi, and an elongation of at least 10 percent in 2 inches. Where dezincification is not a problem, bronze conforming to ASTM B 584 may be used, except that zinc content shall not exceed 16 percent.

E. **Stem Guides:** Stem guides shall be provided, spaced 10-feet on centers unless the manufacturer can demonstrate by calculation that a different spacing is acceptable. Submerged stem guides shall be 304 stainless steel.

F. **Internal Parts:** Internal parts and valve trim shall be as indicated for each individual valve. Where not indicated, valve trim shall be of Type 316 stainless steel or other best suited material.

G. **Nuts and Bolts:** Nuts and bolts on valve flanges and supports shall be in accordance with Section 05 50 00 - Miscellaneous Metalwork.

2.4 VALVE ACCESSORIES

A. Valves shall be furnished complete with the accessories required to provide a functional system.

2.5 SPARE PARTS

A. The CONTRACTOR shall furnish the required spare parts suitably packaged and labeled with the valve name, location, and identification number. The CONTRACTOR shall also furnish the name, address, and telephone number of the nearest distributor for the spare parts of each valve. Spare parts are intended for use by the OWNER, after expiration of the correction of defects period.

2.6 MANUFACTURERS

A. **Manufacturer's Qualifications:** Valve manufacturers shall have a successful record of not less than 5 years in the manufacture of the valves indicated.

PART 3 -- EXECUTION

3.1 VALVE INSTALLATION

A. **General:** Valves, actuating units, stem extensions, valve boxes, and accessories shall be installed in accordance with the manufacturer's written instructions and as indicated. Gates shall be adequately braced to prevent warpage and bending under the intended use. Valves shall be firmly supported to avoid undue stresses on the pipe.

B. **Access:** Valves shall be installed with easy access for actuation, removal, and maintenance and to avoid interference between valve actuators and structural members, handrails, or other equipment.

C. **Valve Accessories:** Where combinations of valves, sensors, switches, and controls are indicated, the CONTRACTOR shall properly assemble and install such items so that systems are compatible and operating properly. The relationship between interrelated items shall be clearly noted on Shop Drawing submittals.

- END OF SECTION -

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SECTION 43 25 02 - BUTTERFLY VALVES, DOUBLE OFFSET,

(AWWA C519 MODIFIED)

PART 1 -- GENERAL

1.1 SUMMARY

A. The Valve Supplier shall provide butterfly valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 43 25 00 - Valves, General apply to this Section.

C. Valves shall conform to the lay length standard dimensions set forth in AWWA C519 Flanged Valves and shall be supplied with integral flanges as specified.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with KRRP Project Submittals.

B. Shop Drawings

1. Complete Shop Drawings of butterfly valves and actuators.

2. Drawings showing valve port diameter complete with dimensions, part numbers, and materials of construction.

3. Dynamic seating and unseating torque requirements.

4. Certified statement of proof-of-design tests from the valve manufacturer. Valve manufacturer shall state that the valves proposed for this project will be manufactured with identical basic type of seat design and materials of construction to the prototype evaluated under the proof of design testing.

5. Manufacturer's certification that the valve complies with applicable provisions of AWWA C519-18 – High Performance Waterworks Butterfly Valves.

1.3 QUALITY ASSURANCE

A. Valves shall be subjected to performance, leakage, and hydrostatic tests in accordance with procedures and acceptance criteria established by AWWA C519, as a minimum.

B. Manufacturer and Valve Supplier shall acknowledge that valve shall be designed for cold working pressure of 310 psig and transient pressure of 360 psig. Use of Class 250 flanged valves per AWWA C504 shall not be considered suitable or acceptable valves for this application. .

C. Manufacture shall be ISO 9001:2008, accredited and certified. Manufacture must have minimum 5-years' experience in the production of double eccentric Butterfly Valves.

PART 2 -- PRODUCTS

2.1 DOUBLE ECCENTRIC BUTTERFLY VALVES, 360 PSI SERVICE (AWWA C519-18)

A. **General:** Butterfly valves for steady-state water working pressures and steady-state differential pressure up to 360 psig for brief periods of operation. Valves shall be rated as Class 500 per AWWA C519 with a velocity designation of B (up to 16 ft/sec.). Valve shall be designed for raw (unfiltered) fresh water service having a pH range from 6 to 10 and temperature range from 35 to 75 degrees F shall meet and exceed all requirements of AWWA C519-18 - High Performance Waterworks Butterfly Valves, according to the specification requirements as identified below.

   1. Position-seated and interference fit seating designs shall not be acceptable. Valves shall be designed so that the disc can never be rotated through the seat.

   2. Butterfly valves shall be rated for working pressures of no less than 360 PSI and shall provide zero leakage at full rated pressure.

B. **Design and Construction:** The butterfly valve shall be of a double offset design whereby the centerline of the disc is horizontally and vertically offset from the body seat and where the elastomeric seat releases compression only after a few degrees of the opening. Unless otherwise indicated, all components of the valve, disc and shaft construction including all associated bearings, retainer rings and other components shall meet at a minimum the requirements of AWWA C519-18. Materials of construction shall be in accordance with the requirements below, and suitable for the service and design pressures as indicated herein

   1. Valves shall be of the body type, pressure class, end joint, and actuator indicated on the Valve Schedule (Contract Drawing G007).

   2. Valve Body and Disc: Carbon Steel (FBE Coated and Lined), ASTM 2205 Duplex stainless steel or equal, or Ductile iron, ASTM A536 65-45-12 (FBE Coated and Lined).

      a. Valve discs shall be secured to the valve shaft using mechanically retained stainless steel shaft locking bolts or tangential pins.

   3. Valve Flanged Ends: Ends shall be flanged and compatible with ASME / ANSI B16.5 Class 300 flanges and meet or exceed the minimum pressure requirement. Flanges shall be per Table 1-F of AWWA C519 for the required pressure rating.

   4. The valve size, pressure rating, year of manufacture, and manufacturer’s name and model shall be cast onto the valve body or be on a permanently attached nameplate.

   5. Lifting lugs: Predrilled lifting hole lugs shall be provided on each flange to assist in installation and removal of valve into piping works.

   6. Valve Disc Seats: Disc elastomeric seats shall be EPDM mounted on the valve disc with a AISI 316 stainless steel seat retainer. The seat retainer shall be counter bored and drilled. S eat retaining fasteners shall be AISI 316 Stainless Steel and shall not extrude above the seat retaining ring. Seat shall be field replaceable and

adjustable with common tools.

7. Valve Body Metallic Seats: The metallic body seat shall be 316L NiCr Stainless Steel or weld nickel weld body seat and applied to the valve body by means of a machined weld overlay process eliminating the possibility of leakage through the body/seat joint.

8. Valve Shafts: Both shafts shall be made of high strength ASTM 2205 Duplex grade or 17-4 Stainless Steel.

    a. Valve shaft shall be one-piece or two-piece construction with long length stainless steel bearings.

    b. Shaft shall conform to API 609 anti-blowout protection and according to Part 4.2.3.2 of AWWA C519. Allowable stresses shall be limited to 33 percent of ultimate tensile strength and 67 percent of yield strength in accordance with ASME, Sec. III, Case N62.6.

9. Shaft Bearings: Valve shaft bearings shall be corrosion resistant, self-lubricating sleeve type and made of bronze or self-lubricated teflon lined fiberglass backed bearings. Top and bottom bearing flush taps shall be provided to prevent ingress of particulates or contaminants to the bearing area.

10. Shaft Seals: Shaft Seals or Self Adjusting V-type packing with mechanically retained packing gland.

11. All bolts and retaining rings shall be 304 or 316 stainless steel unless otherwise specified.

12. Coatings: If carbon steel or ductile iron bodies are used for the body or disc, such surfaces shall be coated with a minimum of 12 mil DFT of fusion bonded epoxy (FBE). FBE coatings are not required on valves with stainless steel bodies and discs.

C. **Seal Rings.** Seal rings if used, shall have a field-replaceable laminated or elastomeric seal ring retained in the body or on the disc. The seal ring shall be constructed of laminates of stainless steel and graphite, or may be elastomeric material when specified. Seal ring design shall also include the following parameters:

    1. The seal ring shall be accessible (replaceable) by positioning the disc in a proper orientation and removing an adjacent pipe spool piece without removing or disassembling the valve.

    2. The seal ring shall be machined in an inclined conical shape to match the companion surface in the body or on the disc, as appropriate. The overall geometry of the seal ring shall be formed into an elliptical shape to provide resilient seating.

    3. Each seal ring shall be identical and interchangeable for valves of the same size.

    4. The seal ring shall be held securely in place by a retaining ring bolted in place. Seal ring and bolt material shall be stainless steel.

5. A spiral wound gasket shall be provided to prevent leakage around the seal ring. Flat static gaskets shall not be acceptable.

6. The seal ring shall be indexed and keyed to assure exact and proper installation or reinstallation without shims.

7. No special tools shall be required to install the seal ring.

D. **Lay Lengths and Flanges:** Valve shall conform to lay length standard dimensions set forth in AWWA C519-18, Table 1-C. Valve flanges shall be suitable for mating to steel pipe with ASME B16.5 Class 300 flanges.

E. **Factory Inspection and Testing**

1. Each valve shall be supplied with a factory inspection certificate outlining body pressure test, leakage test, valve size, valve serial number, pressure rating, body heat no., disc heat no., stem heat no. seat material, and seat heat no.

2. One prototype for each size of valve to be provided shall be subjected to proof-of-design tests in accordance with, at a minimum, procedures established by AWWA C519.

3. Results of proof-of-design tests and certification by a company officer shall be submitted to the ENGINEER with the Shop Drawings.

F. **Manual Actuators (for 24-inch isolation valves):** Unless otherwise indicated, manually-actuated butterfly valves shall conform to ANSI/AWWA C540, subject to the following requirements.

1. All actuators shall be self-locking worm gear type and shall hold the valve disc in the closed, open, and any intermediate position without creeping or fluttering and be supplied from known and reputable gear manufacturer.

2. Manual actuators shall be of handwheel design and include a position indicator. Screw-type (traveling nut) actuators will not be permitted.

3. Handwheel orientation shall match the layout depicted on the construction drawings.

4. Rim pull shall not exceed 80 ft-lbs at the maximum pressure requirement.

G. **Worm Gear Actuators (for 4-inch drain valves)**: Buried valves, shall be equipped with worm-gear actuators, lubricated and sealed to prevent entry of dirt or water into the housing. Buried actuators shall be epoxy coated as indicated on the Valve Schedule (Contract Drawing G007). Buried actuators shall be from supplied from known and reputable gear manufacturer. Rim pull shall not exceed 150 ft-lbs at the maximum pressure requirement.

H. **Manufacturers, or Equal**

1. AV-Tek, *AWWA DEX* Butterfly Valve

2. Valmatic Double Offset High Performance Butterfly Valve

3. Dezurik

4. Vanessa

5. Emerson

6. Keystone

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Exposed butterfly valves shall be installed with a means of removing the complete valve assembly without dismantling the valve or operator. Installation shall be in accordance with Section 43 25 00 – Valves, General.

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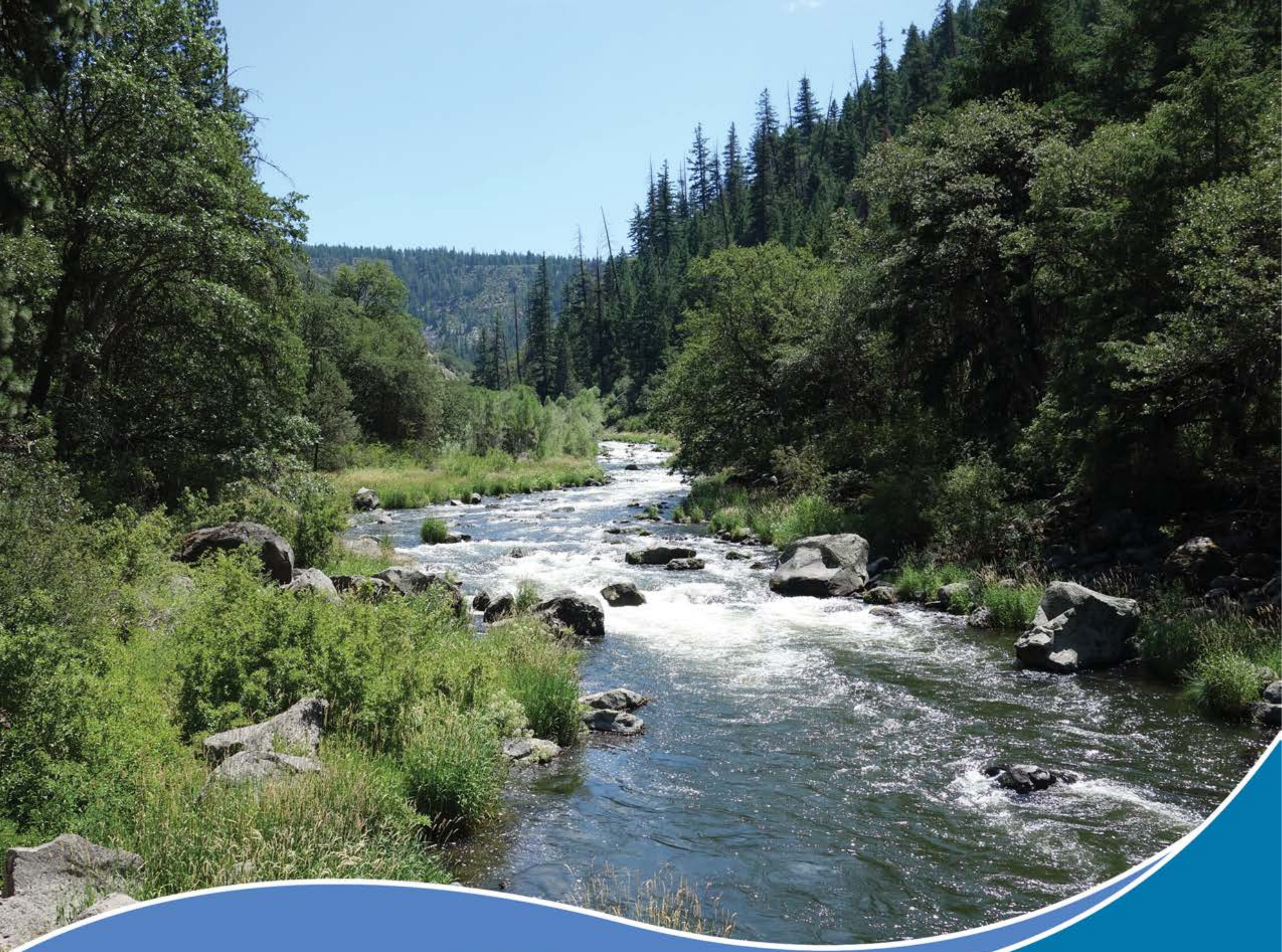
Attachment A
Klamath River Renewal Project – Geotechnical Data Report

SUPPLEMENTAL INFORMATION ONLY



Klamath River Renewal Project

Geotechnical Data Report

KLAMATH RIVER RENEWAL CORPORATION

June 2019

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Table of Contents

List of Tables

List of Figures

Appendices

Acronyms and Abbreviations

GDR	Geotechnical Data Report
psi	pound(s) per square inch
SPT	Standard Penetration Test
bgs	below ground surface
KRRP	Klamath River Renewal Project
ModCal	Modified California
HDD	horizontal directional drilling

Chapter 1: Introduction

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1. INTRODUCTION

1.1 Purpose and Scope

This Geotechnical Data Report (GDR) includes the results of the field investigation conducted from February 2018 through January 2019, and associated laboratory and geophysical testing.

1.2 Report Organization

After this introductory section, the GDR is organized as follows:

- Section 2: Describes the investigations at Copco and Iron Gate Reservoirs, at Jenny Creek, Camp Creek, Lakeview, Dry Creek, Fall Creek, and Scotch Creek Bridges, and along the proposed City of Yreka replacement water line. The investigations included soil and rock borings, piezometer construction, downhole geophysical testing, and field hydraulic conductivity testing.
- Section 3: Describes the laboratory testing.
- Section 4: Discusses the limitations of the work.

The data collected during the investigations is presented in Appendices A through E.

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Chapter 2: Field Investigations

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2. FIELD INVESTIGATIONS

2.1 Subsurface Investigations

AECOM performed geotechnical investigations for the Klamath River Renewal Project between February 2018 and January 2019. The geotechnical investigations are described below. The field investigations were conducted in general conformance with the following ASTM standards:

1. Rock core drilling, ASTM D2113
2. Soil logging, ASTM D2488
3. Standard penetration test (SPT) sampling, ASTM D1586
4. Thin-walled (Shelby) tube sampling, ASTM D1587
5. Preserving and transporting of soil samples, ASTM D4220

2.1.1 Soil and Rock Borings

Forty-eight soil and/or rock core borings were drilled between February 1, 2018 and January 23, 2019. Boring locations are shown on Figure 1 Sheets 1 through 8 and summarized in Table 1 – Borings Summary Table.

The borings were drilled by Taber Drilling of West Sacramento, California, Gregg Drilling of Martinez, California, and/or Pitcher Drilling of East Palo Alto, CA. The locations of the borings were surveyed with a hand-held GPS unit with an approximate accuracy of ±15 feet. The coordinate locations for the borings are shown on the boring logs in State Plane Zone 1 coordinates.

Drilling footage totaled 2163.4 linear feet at the Copco Reservoir, Iron Gate Reservoir, City of Yreka Water line, and bridge abutment borings. The borings ranged in depth from 10.5 to 120 feet below ground surface (bgs). All but two borings were drilled vertically; two borings (B-202 and B-206) were drilled at an angle of 60° below horizontal.

The 2.5-inch HQ-3 core, 1.375-inch I.D. Standard Penetration Test (SPT), 2.5-inch I.D. Modified California (ModCal), and 2.0-inch I.D. California drive samples were photographed, labeled, bagged, or boxed (for rock cores), and stored onsite prior to transport of the samples to Tonon USA in Austin, TX, Cooper Testing Laboratory in Palo Alto, CA, or Inspection Services Inc. of Berkeley, CA. Pitcher barrel, Osterberg, and Shelby Tube samples were sealed with paraffin and carefully transported to the laboratory for testing.

City of Yreka Water Line Borings

Nine borings (B-201 to B-203, B-205 through B-208, BI-02 and BI-03) totaling 696.2 linear feet were drilled along a proposed tunnel alignment to determine subsurface geologic conditions for the replacement of the existing City of Yreka waterline by Horizontal Directional Drilling (HDD) or micro tunnel drilling. These boring locations are shown on Figure 1, Sheet 4, and the boring logs are presented in Appendix A.

The borings were drilled from February 21st to 23rd, August 14th to September 21st, 2018, and January 8th to January 11th, 2019. The boring logs and core box photographs are presented in Appendix A and Appendix E, respectively. Borings were advanced using hollow stem auger, rotary wash, and/or rock core drilling methods, and sampling methods included HQ-3 core, SPT, and a ModCal drive sampler. Blows per each 6-inches of driven sample were recorded.

Three of the borings (B-201, B-202, and B-206) were drilled by Pitcher Drilling Company of East Palo Alto, CA with a track-mounted Fraste XL drill rig. Three additional borings (B-205, B-207, and B-208) were drilled by Gregg Drilling of Martinez, CA with a truck-mounted B-53 drill rig. Three borings (BI-02, BI-03, and B-203) were drilled by Taber Drilling of West Sacramento, CA with BI-02 being drilled using a truck-mounted CME-55 and BI-03 and B-203 being drilled using a barge-mounted CME-45 drill rig.

Copco No. 1 Rim Stability

A subsurface investigation with laboratory testing was performed at Copco No. 1 reservoir to characterize and analyze the stability of the fluvio-lacustrine terrace deposits (diatomite) present around the reservoir rim and within the reservoir bed. Twenty-one hollow stem auger and rotary wash borings, described below, were completed as part of the rim stability investigation. The boring locations are shown on Figure 1, Sheets 6 through 8, and boring logs are presented in Appendix A.

Eleven rotary wash borings, BC-01 through BC-10 and BC-8a, were performed by Taber Drilling using a barge-mounted CME 45 between February 1st and 14th, 2018. The boring depths ranged from 11.5 to 96.5 feet below ground surface.

On land, along the Copco Reservoir Rim, five borings (BC-11 through BC-15) were drilled by Gregg Drilling, between October 2nd and 18th, 2018,using a truck-mounted Mobile B-53 (BC-13 through BC-15) and a track-mounted Geoprobe (BC-11 and BC-12). The borings were advanced to bedrock (10.5 to 42 feet bgs). BC-15 encountered bedrock within 1 foot of the surface; where the boring was terminated, and no boring log or laboratory test data is included as part of this GDR.

Soil samples were obtained in BC-01 to BC-15 using SPT, ModCal, and 3-inch diameter thin-walled Shelby tubes. The tubes were advanced by direct push or with a hydraulically activated piston sampler (Osterberg). Blows per each 6-inches of driven sample and hydraulic gage down pressure for undisturbed samples were recorded.

Five additional over-water borings (BC-16 through BC-20) were completed between January 13th and 14th, 2019. BC-16 through BC-20 were drilled without sampling to bedrock, with the goal of identifying the top of bedrock. Bedrock was inferred when the driller noted significantly harder drilling conditions. Bedrock was sampled with an SPT sampler at the bottom of each exploration to confirm that bedrock was encountered.

Iron Gate Rim Stability

One boring, BI-01 shown on Figure 1, Sheet 3, was completed to characterize landslide history of a feature identified in aerial photograph at Iron Gate reservoir. Two other borings, BI-02 and BI-03 shown on Figure 1, Sheet 4, provided data for the rim stability analysis of Iron Gate, and are described in the City of Yreka Water Line section above.

The one rotary wash boring was drilled on February 20th, 2018 to 22.2 feet below ground surface with a barge-mounted CME-45 by Taber Drilling. The material was sampled with a ModCal or SPT; blows per 6-inches were recorded.

Bridge Abutment Borings

Seventeen borings were planned at the abutments of bridges requiring replacement or improvement during the Klamath River Renewal Project:

- Camp Creek Bridge (four borings, BC-01, BC-02, BC-03, and BC-20), See Figure 1, Sheet 2
- Jenny Creek Bridge (four borings, BC-04, BC-05, BC-06, and BC-07), See Figure 1, Sheet 3
- Lakeview Bridge (two borings, B-08 and B-10), See Figure 1, Sheet 1
- Fall Creek Bridge (two borings, B-13 and B-14), See Figure 1, Sheet 5
- Daggett Bridge (three borings, B-15, B-16, and B-17), See Figure 1, Sheet 4
- Scotch Creek Bridge (two borings, B-18 and B-19), See Figure 1, Sheet 2

The boring locations are shown on Figure 1, Sheets 1 through 5, and boring logs are presented in Appendix A.

Fourteen of the borings were drilled by Gregg Drilling between September 25 and October 18, 2018 with a truck-mounted Mobile B-53 drill rig to depths between 21.2 and 56.9 feet below ground surface. The borings were advanced with hollow stem auger, rotary wash, and/or HQ-3 rock coring. Soil was sampled with a ModCal or SPT; blows per 6 inches of driven sample were recorded.

Three additional borings, B-15 through B-17, were drilled by Taber Drilling with a barge-mounted CME-45 drill rig and a truck-mounted CME-75 between January 12th and 23rd, 2019. The depths of these borings ranged from 24.5 to 51.5 feet below grade. The borings were advanced using solid stem auger, rotary wash, and HQ-3 rock coring. Soil was sampled with a ModCal or SPT; blows per six inches of driven sample were recorded.

2.1.2 Piezometers

Two vibrating wire piezometers (VWP) were installed in each of the inclined borings B-202 and B-206, as shown in Table 1. In B-202, the VWPs were installed at 24.2 feet and at 62.4 bgs (28 and 72 lineal feet on boring trajectory). The VWPs were installed at 21.7 feet and another at 79.7 feet (at 25 and 92 lineal feet on boring trajectory) in B-206. All four VWPs were installed with recording dataloggers. Groundwater level data from the VWPs will be reported as an addendum to this report.

Borings were tremie-backfilled with neat cement grout to the ground surface without installation of a screen or sand sock.

2.1.3 Field Hydraulic Conductivity (Packer) Testing

Nine hydraulic conductivity (packer) tests were performed as part of the geotechnical investigation: seven by Taber Drilling with one in each of borings BI-02 and BI-03, and five in boring B-203 and two by Pitcher Drilling in boring B-206.The tests were performed to characterize hydraulic conductivities of the rock along the new HDD or micro-tunnel alignment for the City of Yreka water line. Results of the packer tests are presented in Appendix B.

Single Pneumatic Packer Tests

For borings BI-02, BI-03, and B-203, testing with a single pneumatic packer was used in a down-stage method, meaning that each successive packer test was performed as the hole was drilled deeper. An In-situ Level Troll 300 water pressure data logger installed in the packer assembly with a surface readout was used to monitor water pressures within the test intervals of the boreholes. Test interval lengths were 20.0 feet.

Prior to conducting the hydraulic conductivity testing, each borehole was conditioned by circulating clear water to remove cuttings and traces of polymer-based drilling fluid. Drill rods were then lifted off the bottom of the hole approximately 20 feet to expose the test section of the borehole.

For each interval a maximum test pressure (P_{max}) of 1 psi/foot of depth to the center of the test section was used to reduce the potential for hydrofracturing of the formation. When the packer assembly was in place and inflated, the testing commenced. Testing generally consisted of a five-step test at varying pressures approximately equal to ½ P_{max}, ¾ P_{max}, P_{max}, ¾ P_{max}, and ½ P_{max}. At each step, the pressure was held constant until a steady rate of flow could be maintained, which was then monitored for approximately five minutes. At the completion of the fifth step, the packer was deflated, removed from the borehole and drilling resumed.

Double Pneumatic Packer Tests

For boring B-206, an upstage technique was used after completion of drilling, with two pneumatic packers sealing off 10-foot intervals of the borehole for testing. A vibrating wire pressure transducer installed in the packer assembly with a surface readout was used to monitor water pressure during the test. Clean water was circulated in the boring after drilling to remove cuttings and traces of drilling fluid.

As for the single pneumatic packer tests discussed above, the maximum test pressure (P_{max}) of 1 psi/foot of depth to the center of the test section was used to prevent hydrofracturing of the formation. Due to poor performance of the flow metering equipment and hydraulic response of the formation at the test intervals, testing consisted of a one-step test at P_{max}. The pressure was held constant until a steady rate of flow could be maintained, which was then monitored for approximately five minutes. After the two consecutive tests (85 to 95 feet, and then 75 to 85 feet), the packer was deflated and removed from the borehole. Additional tests were not performed in this borehole due to failure of the pressure monitoring equipment. The boring was subsequently backfilled by tremie-grouting.

2.1.4 Borehole Geophyiscal Surveys

Televiewer Logging

To identify the orientation and width of planar geologic structural features encountered by the borings, borehole acoustic televiewer logging was performed in two borings drilled along the proposed water tunnel alignment (B-202 and B-206). Televiewer logging was performed by NORCAL Geophysical Consultants, Inc. and the results of which are presented in Appendix C.

Chapter 3: Laboratory Testing

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3. LABORATORY TESTING

Representative soil samples obtained from the exploratory borings were tested by Cooper Testing Labs in Palo Alto, California and Inspection Services Inc. in Berkeley, California. Representative rock samples were also obtained from the borings and tested by Tonon Laboratory in Austin, Texas and Cooper Testing Labs in Palo Alto, California. Laboratory test reports are presented in Appendix D.

The following geotechnical tests were performed on soils samples from borings:

1. Moisture Content, ASTM D2216
2. Atterberg Limits, ASTM D4318
3. Consolidated Undrained triaxial Compression Strength Tests, ASTM D4767
4. Unconsolidated Undrained triaxial Compression Strength Tests, ASTM D2850
5. Consolidation, ASTM D2435
6. Grain-Size Distribution Analysis, ASTM D422
7. Percent Passing No. 200, ASTM D1140
8. Moisture-Density tests, ASTM D7263b
9. X-rays of Samples
10. Corrosion Testing (pH and Minimum Resistivity (CT 643), Sulfate (CT 147), and Chloride (CT 422))

The following geotechnical tests were performed on rock core samples from borings:

1. Brazilian Tensile Strength Test, ASTM D3967
2. Moisture Content, ASTM D2216
3. Cerchar Abrasiveness tests, ASTM D7625
4. Point Load tests, ASTM D5731
5. Mohs Hardness
6. Unconfined Compressive Strength tests, ASTM D7012

7. Punch Penetration testing, Colorado Schools of Mines – 13
8. Bulk Density tests, ISRM 1977
9. Petrographic Analyses

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Chapter 4: Limitations

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4. LIMITATIONS

This GDR references geotechnical data obtained from various phases of geotechnical investigation programs and serves as a source of geotechnical information for the Klamath River Renewal Project.

Groundwater levels presented reflect conditions observed at the time of measurement and are expected to vary over time. The conditions indicated in boring logs and geophysical surveys represent only the subsurface conditions at the locations of the borings. The actual subsurface conditions are expected to vary between those locations.

This report does not interpret the available data. It is the Contractor's responsibility to become familiar with the data in this GDR. The Contractor shall make its own interpretation of this data and shall assume full responsibility for its interpretation.

AECOM represents that the work described in this GDR were conducted in a manner consistent with the standard of care ordinarily applied as the state of practice in the profession within the limits prescribed by our client. No other warranties, either expressed or implied, are included or intended in this GDR.

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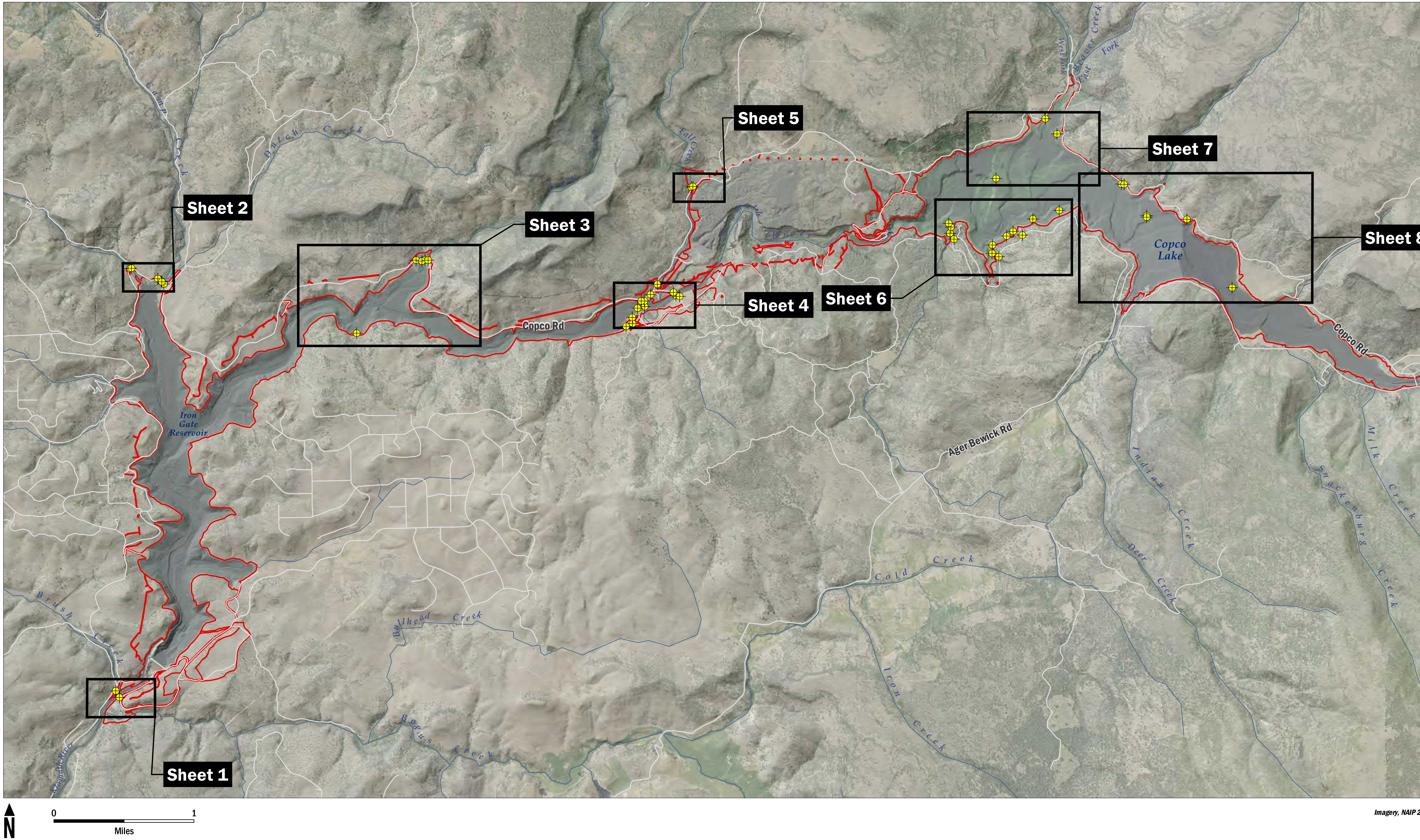
TABLE 1

BORING NUMBER	LOCATION	BORING TYPE	DEPTH (feet)	BEARING/ PLUNGE	PIEZO INSTALLED	IN-SITU TESTING	GOAL
B-01	Camp Creek	soil/core	25.5	Vertical	NA	NA	Bridge Foundation
B-02	Camp Creek	soil	31.4	Vertical	NA	NA	Bridge Foundation
B-03	Camp Creek	soil/core	27.3	Vertical	NA	NA	Bridge Foundation
B-04	Jenny Creek	soil/core	31.5	Vertical	NA	NA	Bridge Foundation
B-05	Jenny Creek	soil/core	50.0	Vertical	NA	NA	Bridge Foundation
B-06	Jenny Creek	soil/core	56.9	Vertical	NA	NA	Bridge Foundation
B-07	Jenny Creek	soil/core	31.8	Vertical	NA	NA	Bridge Foundation
B-08	Lakeview Bridge	soil/core	52.8	Vertical	NA	NA	Bridge Foundation
B-10	Lakeview Bridge	soil/core	52.2	Vertical	NA	NA	Bridge Foundation
B-13	Fall Creek	core	21.1	Vertical	NA	NA	Bridge Foundation
B-14	Fall Creek	core	28.6	Vertical	NA	NA	Bridge Foundation
B-15	Daggett Bridge	soil/core	51.5	Vertical	NA	NA	Bridge Foundation
B-16	Daggett Bridge Over Water	soil/core	24.5	Vertical	NA	NA	Bridge Foundation
B-17	Daggett Bridge	soil/core	41.5	Vertical	NA	NA	Bridge Foundation
B-18	Scotch Creek	soil	28.3	Vertical	NA	NA	Bridge Foundation
B-19	Scotch Creek	soil/core	37.5	Vertical	NA	NA	Bridge Foundation
B-20	Camp Creek	soil/core	47.0	Vertical	NA	NA	Bridge Foundation
B-201	Upper Irongate	soil/core	50.5	Vertical	NA	NA	Water Line
B-202	Upper Irongate	soil/core	100.5	30/205	VWP	T	Water Line
B-203	Upper Irongate	soil/core	120.0	Vertical	NA	HC	Water Line
B-205	Upper Irongate - Copco Road	soil/core	62.0	Vertical	NA	NA	Water Line
B-206	Upper Irongate - Copco Road	soil/core	100.0	30/295	VWP	T, HC	Water Line
B-207	Upper Irongate - Copco Road	soil/core	81.1	Vertical	NA	NA	Water Line
B-208	Upper Irongate	soil/core	80.0	Vertical	NA	NA	Water Line
BC-01	Copco - Over Water	soil	30.4	Vertical	NA	NA	Rim Stability
BC-02	Copco - Over Water	soil	64.6	Vertical	NA	NA	Rim Stability
BC-03	Copco - Over Water	soil	96.5	Vertical	NA	NA	Rim Stability
BC-04	Copco - Over Water	soil	73.5	Vertical	NA	NA	Rim Stability
BC-05	Copco - Over Water	soil	20.5	Vertical	NA	NA	Rim Stability
BC-06	Copco - Over Water	soil	15.4	Vertical	NA	NA	Rim Stability
BC-07	Copco - Over Water	soil	15.9	Vertical	NA	NA	Rim Stability
BC-08	Copco - Over Water	soil	11.5	Vertical	NA	NA	Rim Stability
BC-08a	Copco - Over Water	soil	85.2	Vertical	NA	NA	Rim Stability
BC-09	Copco - Over Water	soil	70.5	Vertical	NA	NA	Rim Stability
BC-10	Copco - Over Water	soil	43.0	Vertical	NA	NA	Rim Stability
BC-11	Copco Road	soil	10.5	Vertical	NA	NA	Rim Stability
BC-12	Copco Road	soil	16.5	Vertical	NA	NA	Rim Stability
BC-13	Copco Road	soil	42.0	Vertical	NA	NA	Rim Stability
BC-14	Copco Road	soil	15.4	Vertical	NA	NA	Rim Stability
BC-15	Copco Road	soil	1.0	Vertical	NA	NA	Rim Stability
BC-16	Copco Rim	soil	64.8	Vertical	NA	NA	Rim Stability
BC-17	Copco Rim	soil	37.4	Vertical	NA	NA	Rim Stability
BC-18	Copco Rim	soil	34.5	Vertical	NA	NA	Rim Stability
BC-19	Copco Rim	soil	37.5	Vertical	NA	NA	Rim Stability
BC-20	Copco Rim	soil	19.0	Vertical	NA	NA	Rim Stability
BI-01	Irongate Rim - Over Water	soil	22.2	Vertical	NA	NA	Rim Stability
BI-02	Irongate - Fall Creek	soil/core	67.0	Vertical	NA	HC	Water Line
BI-03	Irongate - Over Water	soil/core	35.1	Vertical	NA	HC	Water Line
NOTES:	1) HC = hydraulic conductivity, T = televiewer, VWP = vibrating wire piezometer, NA = not applicable						



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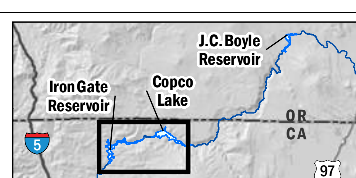
Klamath River Renewal Project

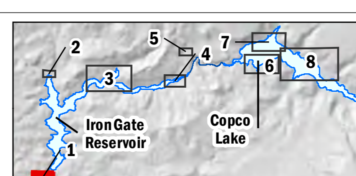


As-Drilled Boring
Road
Detail Sheet Extent
Limits of Work

FIGURE 1

Planned and Completed Geotechnical Borings Overview

AECOM
Klamath River Renewal Corporation
Klamath River Renewal Project



As-Drilled Boring
Project Boundary

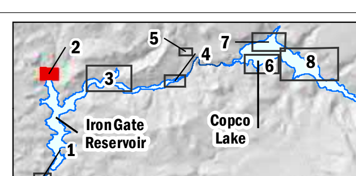
FIGURE 1

Planned and Completed Geotechnical Borings

Sheet 1 of 8

Imagery, NAIP 2014

AECOM
Klamath River Renewal Corporation
Klamath River Renewal Project



As-Drilled Boring

Project Boundary

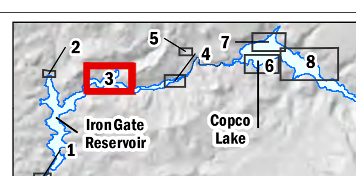
FIGURE 1

Planned and Completed Geotechnical Borings

Sheet 2 of 8

AECOM Oakland CA 6/18/2019 USER alexander.remar PATH \\Oakland\Oakland\Projects\Secure\Water\Klamath Dam\400-Technical\440 GIS\02_Maps\02_Map_Production_and_Reports\Geotechnical_WorkPlan\Figure 1 Planned and Completed Geotechnical Borings Mapbook.mxd

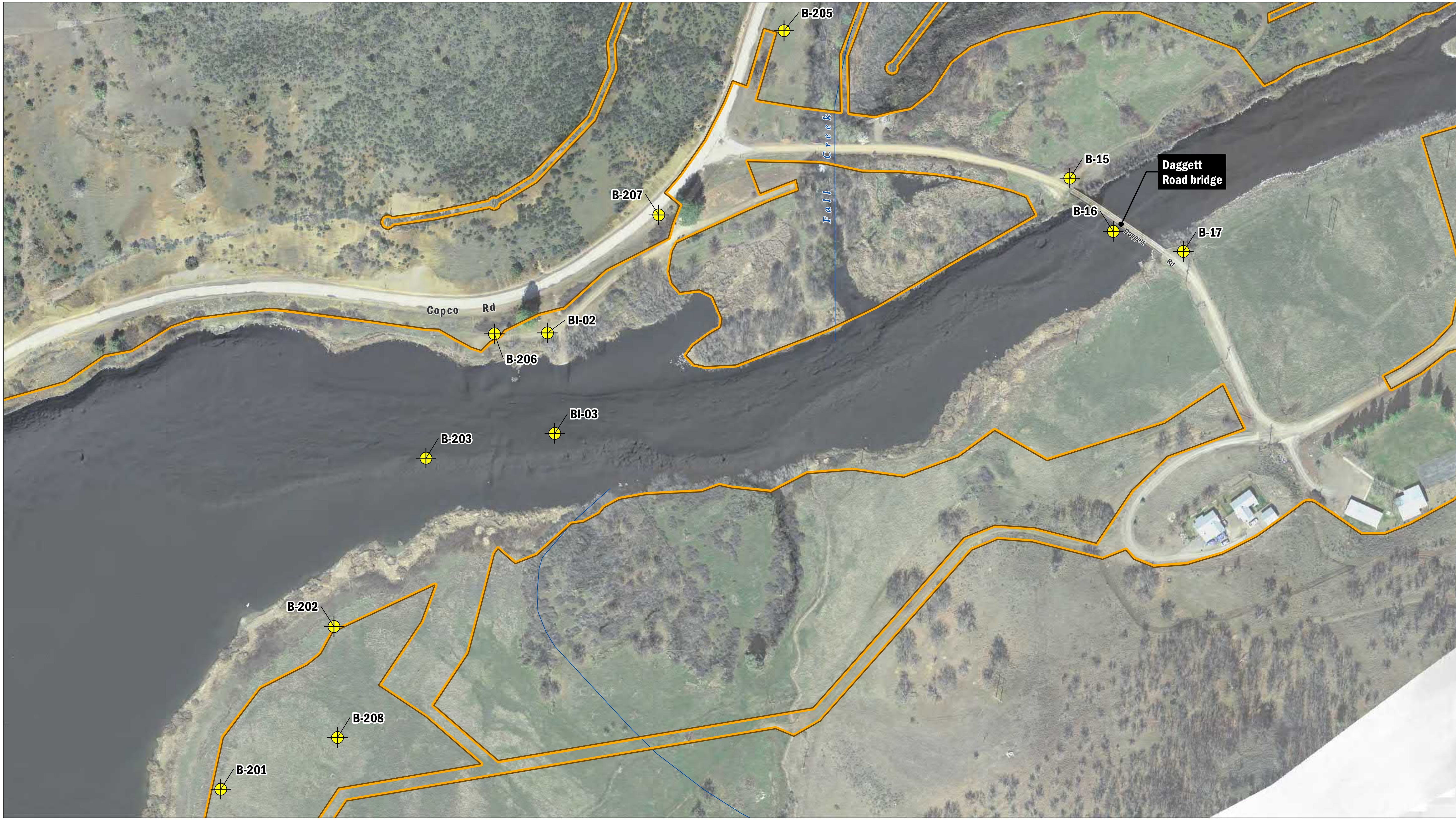
AECOM
Klamath River Renewal Corporation
Klamath River Renewal Project



As-Drilled Boring
Project Boundary

FIGURE 1
Planned and Completed Geotechnical Borings
Sheet 3 of 8

AECOM Oakland CA 6/18/2019 USER alexander.remar PATH \\Oakland\Oakland\Projects\Secure\Water\Klamath Dam\400-Technical\440 GIS\02_Maps\02_Map_Production_and_Reports\Geotechnical_WorkPlan\Figure 1 Planned and Completed Geotechnical Borings Mapbook.mxd

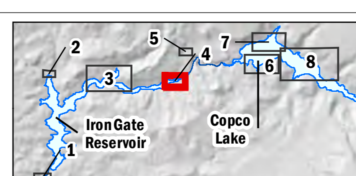


N

0 500
Feet

Imagery, NAIP 2014

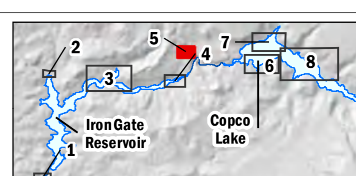
AECOM
Klamath River Renewal Corporation
Klamath River Renewal Project



As-Drilled Boring
Project Boundary

FIGURE 1
Planned and Completed Geotechnical Borings
Sheet 4 of 8

AECOM
Klamath River Renewal Corporation
Klamath River Renewal Project

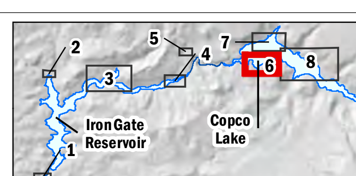


As-Drilled Boring
Project Boundary

FIGURE 1

Planned and Completed Geotechnical Borings
Sheet 5 of 8

AECOM
Klamath River Renewal Corporation
Klamath River Renewal Project



As-Drilled Boring
Project Boundary

FIGURE 1

Planned and Completed Geotechnical Borings

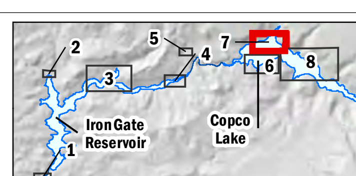
Sheet 6 of 8

N

0 500
Feet

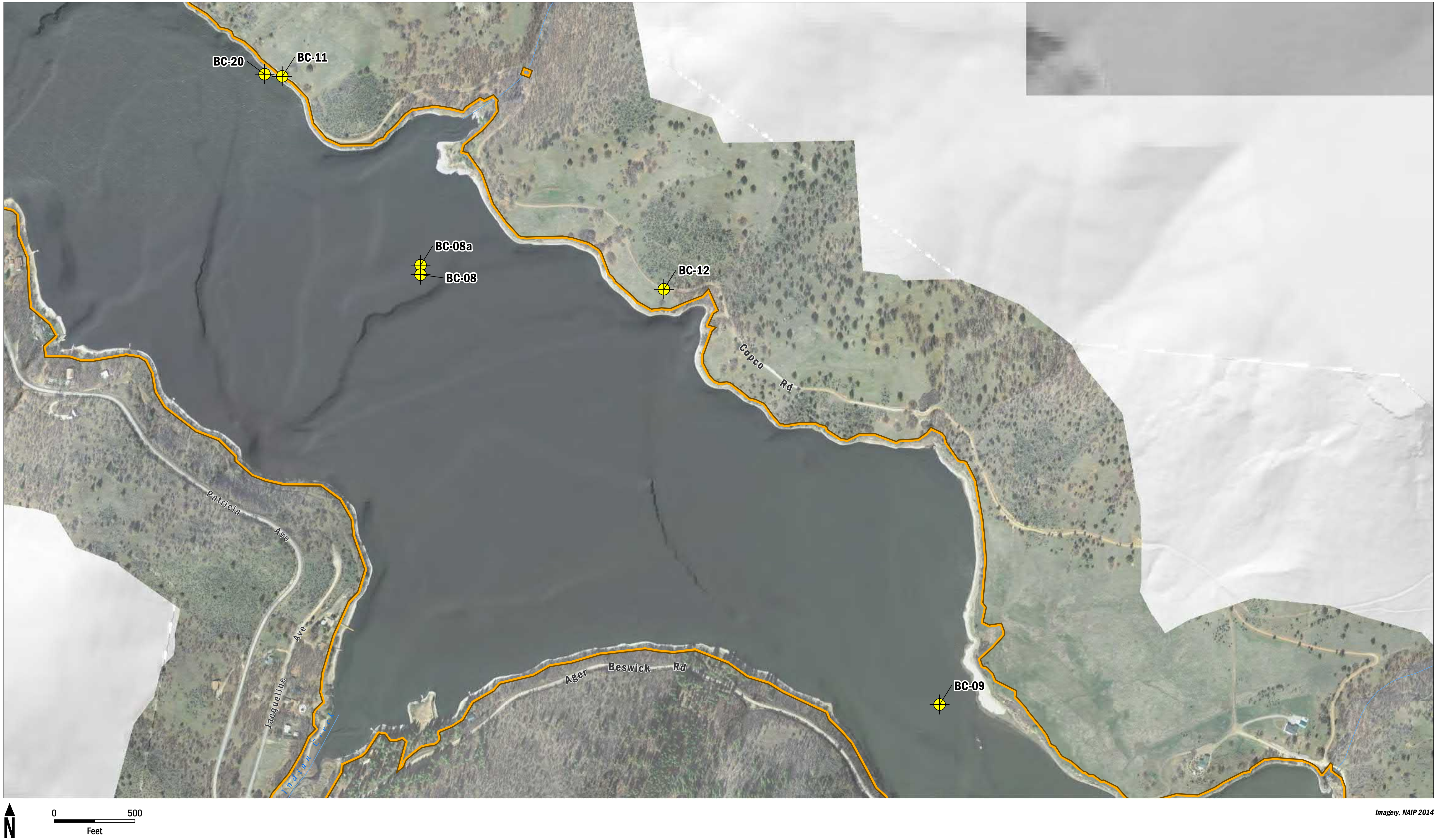
Imagery, NAIP 2014

AECOM
Klamath River Renewal Corporation
Klamath River Renewal Project



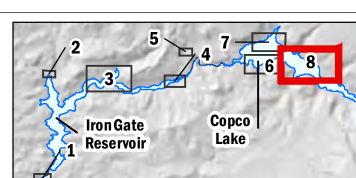
As-Drilled Boring
Project Boundary

FIGURE 1
Planned and Completed Geotechnical Borings
Sheet 7 of 8



Imagery, NAIP 2014

AECOM
Klamath River Renewal Corporation
Klamath River Renewal Project



As-Drilled Boring

Project Boundary

FIGURE 1

Planned and Completed Geotechnical Borings

Sheet 8 of 8

APPENDIX A BORING LOGS

Project: Klamath River Dam Removal Project Project Location: Klamath River Project Number: 60537920	Key to Log of Soil Boring Sheet 1 of 4

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

FAT CLAY (CH)

FAT CLAY with SAND (CH)

SANDY FAT CLAY with GRAVEL (CH)

SANDY FAT CLAY (CH)

LEAN CLAY WITH ORGANICS (CL)

SANDY LEAN CLAY (CL)

LEAN CLAY with GRAVEL and SAND (CL)

GRAVELLY LEAN CLAY (CL)

LEAN CLAY with SAND (CL)

SANDY LEAN CLAY with GRAVEL (CL)

CLAYEY GRAVEL (GC)

CLAYEY GRAVEL with SAND (GC)

POORLY GRADED GRAVEL (GP)

POORLY GRADED GRAVEL with SAND (GP)

POORLY GRADED GRAVEL with CLAY (GP-GC)

WELL GRADED GRAVEL WITH SAND (GW)

TYPICAL SAMPLER GRAPHIC SYMBOLS

2.5-inch I.D. Modified California

Standard Penetration Test

Shelby Tube

2.0-inch I.D. California

GENERAL NOTES

-**Check By:** Soil and core samples reviewed in-person by Project Geologist.

-**Reviewed By:** Soil and core samples reviewed via run photos or core box photos in office by Project Engineer.

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

Key to Log of Soil and Core Boring

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
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

COLUMN DESCRIPTIONS

1. **Elevation:** Elevation (in feet) referenced to North American Vertical Datum of 1988 (NAVD88).
2. **Depth:** Distance (in feet) below the collar of the borehole.
3. **Run No.:** Number of the individual coring interval.
4. **Box No.:** Number of the core box which contains core from the corresponding runs.
5. **Recovery:** Amount in percent of core recovered from coring interval; calculated as length of core recovered divided by length of run.
6. **Fractures per Foot:** (Fracture Frequency) The number of naturally occurring fractures in each foot of core; does not include mechanical breaks (induced by drilling) or healed fractures. "NA" indicates not applicable due to lack of core recovery or soil-like nature of rock.
7. **R Q D:** (Rock Quality Designation) Amount (in percent) of intact core (pieces of sound core greater than 4 inches in length) in each coring interval; calculated as the sum of lengths of intact core divided by length of core run.
8. **Fracture Drawing:** Sketch of the naturally occurring fractures and mechanical breaks, showing the angle of the fractures relative to the cross-sectional axis of the core. "NR" indicates no recovery.
9. **Fracture Number:** Location of each naturally occurring fracture (numbered) and mechanical break (labeled "M"). Naturally occurring fractures are described in Column 11 (keyed by number) using descriptive terms defined on Sheet 2 (Items a through g).
10. **Lithology:** Graphic depiction of subsurface material encountered, typical symbols are explained below
11. **Description:** Lithologic description in this order: rock type, color, grain size, texture, weathering, strength, and other features; descriptive terms are defined on Sheet 2. Also, abbreviated description of fractures numbered in Column 9 using terms defined on Sheet 2.
12. **Sample Type:** Type of soil sample collected at depth interval shown; sampler symbols are explained below.
13. **Sample Number:** Sample identification number.
14. **Blows / 6 in.:** Number of blows to advance driven sampler each 6-inch drive interval, or distance noted, using a 140-lb hammer with a 30-inch drop (unless otherwise noted).
15. **Recovery:** Actual soil recovery in driven sampler as a percentage of the sampler penetration.
16. **Drill Time [Rate]:** Time (in 24-hour clock) marking start and finish of each run; drill rate (in feet per hour) is reported in brackets.
17. **Field Notes and Tests Results:** Comments and observations regarding drilling or sampling made by driller or field personnel.

OTHER GRAPHIC SYMBOLS

TYPICAL MATERIAL GRAPHIC SYMBOLS

SILT with SAND and GRAVEL (ML)

SANDY SILT (ML)

ORGANIC SILT WITH SAND (OL)

GRAVELLY FAT CLAY with SAND (CH)

CLAYEY SAND to SANDY LEAN CLAY (SC-CL)

CLAYEY SAND with GRAVEL (SC)

SILTY SAND (SM)

SILTY to CLAYEY SAND with GRAVEL (SM-SC)

SILTY SAND with GRAVEL (SM)

POORLY GRADED SAND (SP)

POORLY GRADED SAND with GRAVEL (SP)

POORLY GRADED SAND with SILT (SP-SM)

WELL GRADED SAND with GRAVEL (SW)

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

Key to Log of Core Boring

Elevation, feet	Depth, feet	ROCK CORE: Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing	Number	Lithology	MATERIAL DESCRIPTION	Drill Time, 24-hr [Drill Rate, ft/hr]	FIELD NOTES AND OTHER TESTS
1	2	3	4	5	6	7	8	9	10	11	13	14

COLUMN DESCRIPTIONS

1 **Elevation:** Elevation (in feet) referenced to mean sea level (MSL).

2 **Depth:** Distance (in feet) below the collar of the borehole.

3 **Run No.:** Number of the individual coring interval.

4 **Box No.:** Number of the core box which contains core from the corresponding run.

5 **Recovery:** Amount (in percent) of core recovered from the coring interval; calculated as length of core recovered divided by run length.

6 **Fractures per Foot:** (Fracture Frequency) The number of naturally occurring fractures in each foot of core; does not include mechanical breaks (induced by drilling) or healed fractures. "NA" indicates not applicable due to lack of core recovery.

7 **R Q D:** (Rock Quality Designation) Amount (in percent) of intact core (pieces of sound core greater than 4 inches in length) in the coring interval; calculated as the sum of lengths of intact core divided by the run length. RQD value with "*" indicates moderately weathered / altered rock that does not meet soundness requirements, but provides an indication of rock quality with respect to degree of fracturing.

8 **Fracture Drawing:** Sketch of the naturally occurring fractures and mechanical breaks, showing the angle of the fractures relative to the cross-sectional axis of the core. "NR" indicates no recovery.

9 **Fracture Number:** Location of each naturally occurring fracture (numbered) and mechanical break (labeled "M"). Naturally occurring fractures are described in Column 11 (keyed by number) using descriptive terms defined on Sheet 2 (Items a through g).

10 **Lithology:** A graphic log of material encountered using symbols to represent differing soil and rock types; symbols are explained below.

11 **Description:** Lithologic description in this order: rock type, color, texture, grain size, weathering, strength, and other features; descriptive terms are defined on Sheet 2. A detailed description of overburden material is not necessarily provided. Also, abbreviated description of fractures numbered in Column 9 using terms defined on Sheet 2.

12 **Drill Time [Rate]:** Time (in 24-hour clock) marking start and finish of each run; drill rate (in feet per hour) is reported in brackets.

13 **Field Notes and Other Tests:** Comments regarding drilling and sampling made by driller or field personnel. Tested rock specimen intervals and a record of tests performed using the abbreviations listed below.

TYPICAL MATERIAL GRAPHIC SYMBOLS

ASPHALT | ANDESITE | BASALT | BOULDERS and COBBLES

BOULDER | DIATOMITE | DIATOMITE WITH ELASTIC SILT | VOLCANIC BRECCIA

VOLCANIC CINDER | VOLCANIC CLAYSTONE | VOLCANIC CONGLOMERATE | VOLCANIC MUDSTONE

VOLCANIC SANDSTONE | VOLCANIC SILTSTONE/CLAYSTONE | VOLCANIC SILTSTONE | VOLCANIC SILTY SANDSTONE

OTHER GRAPHIC SYMBOLS

- Static Water Level
- First water encountered at time of drilling
- Inferred or transitional contact
- Change in material properties within a stratum

LABORATORY TEST ABBREVIATIONS

PL: Point Load Index Test (psi)
UC: Unconfined Compressive Strength test (psi)

Material descriptions and stratum lines are interpretive; field descriptions may have been modified to reflect lab test results. Descriptions on these logs apply only at the specific boring locations and at the time the borings were advanced, and are not warranted to be representative of subsurface conditions at other locations or times.

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

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

Log of Soil and Core Boring B-01

Date(s) Drilled	**9/27/2018**	Logged By	**S. Janowski**	Reviewed By	**B. Aldridge**
Drilling Method	**Hollow Stem Auger, HQ-3 Rock Core**	Drill Bit Size/Type	**6-inch flight auger, HQ-3 wireline diamond bit**	Total Depth of Borehole	**25.5 feet**
Drill Rig Type	**Truck Mounted Mobile B-53**	Drilling Contractor	**Gregg Drilling**	NAVD 88 Ground Surface Elevation	**2346 feet**
Groundwater Level	**Not encountered before rotary wash drilling**	Sampling Methods	**2.5-inch ID ModCal; SPT; HQ Core Barrel**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Cement grout to ground surface**	Borehole Location	**Camp Creek Bridge**	Coordinate Location	**N 2602866 E 6443027**

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
	0								2-inches GRAVEL roadway						Start 9:00 9/27/2018; hang auger 0.0-5.0ft.
									CLAYEY GRAVEL (GC); very stiff; yellowish brown (10YR 5/6); 60% subangular GRAVEL to 1-inch; 30% low plasticity FINES; 10% fine grained SAND; moist --ROAD FILL--						
	1														
2344	2														
	3														
2342	4														pp = 2.75 tsf
	5								LEAN CLAY with GRAVEL and SAND (CL); very stiff; dark yellowish brown (10YR 4/4); 80% medium plasticity FINES; 10% fine grained SAND; 10% subangular GRAVEL to 1/2-inch; moist --ALLUVIUM--		S-01	6, 7, 8	0		Hollow stem auger 5.0ft. to 9.0ft. pp = 2.25 tsf
2340	6														
	7										S-02	6, 7, 8	0		
2338	8														
									GRAVEL and COBBLES in a SANDY LEAN CLAY matrix; GRAVEL and COBBLES are subrounded Basalt						
	9	1	1	80	NA, NA	NA					S-03	19, 17, 10	11	1014 [13] 1021	Auger refusal at 9.0ft.; advance 4.5-inch casing to 9.0ft. and switch to rotary wash drilling with 3 7/8-inch tricone bit.
2336	10														
	11	2		100	NA, NA	NA	m							1037 [9] 1044	
2334	12	3		60	NA, NA	NA	NR							1056 [25]	75% fluid circulation
	13														

Report: GEO_CORE+SOIL_NO PACK_WITH LITH; File: KLAMATH_MASTER.GPJ; 6/20/2019 B-01

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

Log of Soil and Core Boring B-01

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
	13		1		NA				GRAVEL and COBBLES in a SANDY LEAN CLAY matrix; GRAVEL and COBBLES are subrounded Basalt --ALLUVIUM--*(continued)*						75% fluid circulation
2332	14	4		80	NA	NA								1102 / 1112 [9] 1119	
	15	5		87	NA / NA	NA			VOLCANIC BRECCIA; dark reddish brown (10R 3/4); highly weathered; very weak; highly fractured; friable --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--					1124 [23] 1128	
2330	16						m		Becomes yellowish grey (5Y 7/2), moderately weathered						
	16.5	6		94	NA	88*								1136	
	17				0										
2328	18				>6		m m		Becomes greyish brown (5YR 3/2); Intensely fractured						
	19				0		1							[16]	*Rock does not meet soundness criteria for RQD calculation
2326	20				1		2		1: 15, V, T-VN, H+Uk, Fi, Pl, ? 2: 60, J, N-W, Sd, Fi, Wa, ?						
	21				NA		m m							1155	
2324	21.5	7		70	NA / NA	0	m m							1244 [15] 1248	
	22.5	8		0	NA	0								1254 [12] 1259	
2322	23.5	9		50	NA / NA / >6	0								1304 [12] 1314	
2320	25.5								**TOTAL DEPTH = 25.5 FEET**						
	26														
	27														
2318	28														
	29														

Project: Klamath River Renewal Project Project Location: Copco and Iron Gate Reservoirs Project Number: 60537920	**Log of Soil Boring B-02** Sheet 1 of 2

Date(s) Drilled	**10/12/2018**	Logged By	**P. Respess**	Reviewed By	**B. Aldridge**
Drilling Method	**Hollow Stem Auger**	Drill Bit Size/Type	**6-inch flight auger**	Total Depth of Borehole	**31.4 feet**
Drill Rig Type	**Truck Mounted Mobile B-53**	Drilling Contractor	**Gregg Drilling**	NAVD 88 Ground Surface Elevation	**2340 feet**
Groundwater Level(s)	**13.5 feet below ground surface 10/12/2018**	Sampling Method(s)	**SPT**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Cement grout to ground surface**	Borehole Location	**Camp Creek Bridge**	Coordinate Location	**N 2602747 E 6443180**

Elevation feet	Depth, feet	SAMPLES Type	SAMPLES Number	SAMPLES Sampling Resistance	SAMPLES Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
2340	0						2-inches GRAVEL roadway POORLY GRADED GRAVEL (GP); dense; fine to coarse GRAVEL and COBBLES; fine to corase grained SAND; little no plasticity FINES; moist --FILL--				Start 9:00 9/27/2018; hollow stem auger 0-31ft.
							LEAN CLAY (CL); medium stiff; brown; medium plasticity FINES; trace fine grained SAND; occasional GRAVEL and COBBLE				
2335	5										Logged from auger cuttings and rig chatter
2330	10										
							∇				
2325	15										
2320	20						POORLY GRADED GRAVEL with SAND (GP); medium dense to dense; fine to coarse GRAVEL to BOULDERS; fine to coarse grained SAND; some no plasticity FINES --ALLUVIUM-- BOULDER, basalt				Rig chatter indicated rocky layer
2315	25						BOULDER, basalt				
			S-01	14 14 44	100		SILTY SAND with GRAVEL (SM); very dense; GRAVEL up to 1-inch; fine to coarse grained SAND; no plasticity FINES --ALLUVIUM--	14		15	SA: G=32%; S=53%; F=15%
	30										

Report: GEO_10B1_OAK; File: KLAMATH_MASTER.GPJ; 6/20/2019 B-02

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

Log of Soil Boring B-02

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
2310	30		S-02	50/0	0		[As Above] --ALLUVIUM--*(continued)*				S-02 attempted at 31.4; logged from flake in shoe
							BASALT; dark grey; slightly weathered to fresh; moderately strong --TERTIARY to QUATERNARY INTRUSIVE BASALT--				
							TOTAL DEPTH = 31.4 FEET				
2305	35										
2300	40										
2295	45										
2290	50										
2285	55										
2280	60										
	65										

Project: Klamath River Renewal Project **Project Location: Copco and Iron Gate Reservoirs** **Project Number: 60537920**	**Log of Soil and Core Boring B-03** Sheet 1 of 2

Date(s) Drilled	**10/12/2018-10/16/2018**	Logged By	**P. Respess**	Reviewed By	**B. Aldridge**
Drilling Method	**Hollow Stem Auger, Rotary Wash, HQ-3 Rock Core**	Drill Bit Size/Type	**6-inch flight auger, 3 7/8-inch tricone, 3 7/8-inch diamond core bit**	Total Depth of Borehole	**27.3 feet**
Drill Rig Type	**Truck Mounted Mobile B-53**	Drilling Contractor	**Gregg Drilling**	NAVD 88 Ground Surface Elevation	**2341 feet**
Groundwater Level	**Not encountered before rotary wash drilling**	Sampling Methods	**2.5-inch ID ModCal, HQ Core Barrel**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Cement grout to ground surface**	Borehole Location	**Camp Creek**	Coordinate Location	**N 2602664 E 6443265**

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								POORLY GRADED GRAVEL with SAND (GP); medium dense to dense; fine to coarse GRAVEL to BOULDERS; fine to corase grained SAND; some no plasticity FINES; dry to moist --FILL--						Start 12:00 10/12/2018; hang auger 0.0-5.0ft.
2340	1														
	2														
2338	3								BOULDER and COBBLES; 3.0-4.8ft.: BOULDER --ALLUVIUM--						
	4														End of day 10/12/2018 Begin day 10/15/2018
2336	5								BOULDER						Switch to rotary wash drilling with 3 7/8-inch tricone bit
	6														
2334	7								BOULDERS and COBBLES						Advance 4.5-inch casing to 5ft.
	8														
2332	9														
	10								BOULDERS and COBBLES						
2330	11														
	12														
2328	13														

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
	13							BOULDER and COBBLES --ALLUVIUM--*(continued)*						Reddish clay cuttings
2326	14							VOLCANIC SILTSTONE; reddish brown to olive grey; moderately to highly weathered; very weak to weak; very thinnly laminated; locally clayey --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--						
	15–16.5									S-01	14, 19, 23			S-01 One liner retained (16-16.5ft.)
2324	17													
2322	18–19													
2320	20–21.5									S-02	27, 31, 46			Rig chatter at 20ft. indicates rocky layer; S-02 One liner retained (21-21.5ft.)
2318	22–23	1	1	82	NA	78*	m, m	becomes moderately weathered; weak					0810	End of day 10/15/2018 Begin day 10/16/2018
	23–24				1		m, 1							Advance 4.5-inch casing to 22ft. Switch to HQ-3 rock coring at 22.3ft.
2316	24–25				1		m, m, m, m, 2	1: J, 30, N, Cl, Fi, Pl, S-SR (dissolution voids along joint) 2: J, 10-15, VN, Cl, Fi, Pl-Wa, S-SR					[7]	
	25–26				0		NR, m							
2314	26–27				0									26.3-27.3ft. driller reports harder drilling condition
	27–27.3				NA		NR, m, m						0852	
	27.3							**TOTAL DEPTH = 27.3 FEET**						
2312	28–29													

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

Log of Soil and Core Boring B-04

Date(s) Drilled	**9/25/2018**	Logged By	**S. Janowski**	Reviewed By	**B. Aldridge**
Drilling Method	**Hollow Stem Auger, HQ-3 Rock Core**	Drill Bit Size/Type	**6-inch flight auger, HQ-3 wireline diamond bit**	Total Depth of Borehole	**31.5 feet**
Drill Rig Type	**Truck Mounted Mobile B-53**	Drilling Contractor	**Gregg Drilling**	NAVD 88 Ground Surface Elevation	**2343 feet**
Groundwater Level	**Not encountered before rotary wash drilling**	Sampling Methods	**2.5-inch ID Mod Cal, HQ Core Barrel**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Cement grout to ground surface**	Borehole Location	**Jenny Creek Bridge**	Coordinate Location	**N 2603560 E 6452773**

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
	0									2-inches ASPHALT roadway						Start 9:30 9/25/2018 Hand Auger 0-5ft.
2342										POORLY GRADED SAND with GRAVEL (SP); greenish grey (10G 5/1); 40% subangular GRAVEL up to 1-inch; 60% medium grained SAND; moist --ROAD BASE--						
	1									SANDY LEAN CLAY with GRAVEL (CL); very stiff to hard; brown (10YR 4/3); 60% low plasticity FINES; 20% subangular gravel up to 2-inches; 20% fine grained SAND; moist --ROAD FILL--						pp = 3.25 tsf
	2															
2340	3															
	4															pp = 4.25 tsf
2338	5									Becomes brown (10YR 5/3 with subangular to subrounded GRAVEL up to 1 1/2-inches, effervescent, with rootlets			15			Hollow Stem Auger 5-9.5 ft.
	6											S-01	13	67		pp = >4.5 tsf
2336													11			
	7															
	8									CLAYEY GRAVEL with SAND (GC); very stiff; brown (10YR 4/3); 60% subrounded COBBLES and GRAVELS; 30% low plasticity FINES; 10% medium grained SAND --ALLUVIUM--						
2334	9									Becomes basalt COBBLES up to 5 inches in a clayey matrix			21			Auger refusal at 9.5ft.; advance 4.5-inch casing to 9.5ft.
	10											S-02	13	89		pp = 3.0 tsf
2332													50			
	11	1	1	100	NA	NA		m							1147	Switch to HQ coring at 11ft. with wireline diamond bit; advance 4.5-inch casing to 9.0ft.
	12	2		64	NA	NA	NR									
2330	13															

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
	13		1		NA		NR		CLAYEY GRAVEL with SAND (GC); very stiff; brown (10YR 4/3); 60% subrounded COBBLES and GRAVELS; 30% low plasticity FINES; 10% medium grained SAND --ALLUVIUM--*(continued)*						Driller indicated good fluid return while pump running but rapid fluid level drop between runs
	14	2		64	NA	NA								[30]	
2328	15				NA				Becomes greyish red (5YR 4/2) to brownish black (5YR 2/1), basalt BOULDERS with minor matrix and subrounded GRAVELS infilling void spaces with some vesicles up to 3/4-inches.						
2326	16				NA									1157 / 1206	
	17				NA		NR								
	18				NA										
2324	19	3		72	NA	NA								[21]	
	20				NA										
2322	21				NA									1220 / 1232	
	22				NA										
2320	22.5				NA				BASALT; olive grey (5Y 3/2); completely weathered; very weakly decomposed and easily friable by hand --TERTIARY to QUATERNARY INTRUSIVE BASALT--						
	23	4		40	NA	0								[13]	
2318	24				NA		NR								
	25				NA				Becomes dusky yellow green (5Y 5/2) and pale reddish brown (10Y 5/4), highly to completely weathered, highly to intensely fractured					1250 / 1257	Bit blocked off during run
	26	5		70	NA	0	NR							[10]	
2316	26.5				NA									1303 / 1310	
	27	6		0	NA	0	NR							[7]	
	27.5				NA									1319 / 1431	Bit blocked off during run
2314	28	7		30	NA	0	NR								
	29														

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

Log of Soil and Core Boring B-04

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	7	1	30	NA	0	NR			BASALT; dusky yellow green (5Y 5/2) and pale reddish brown (10Y 5/4); highly to completely weathered; highly to intensely fractured; very weak; No Recovery likely in completely weathered zones --TERTIARY to QUATERNARY INTRUSIVE BASALT--*(continued)*					[13]	
	30				NA										1445	
2312	31	8		0	NA	0	NR								1455 [7] 1504	Bit blocked off during run
										TOTAL DEPTH = 31.5 FEET						
2310	32, 33															
2308	34, 35															
2306	36, 37															
2304	38, 39															
2302	40, 41															
2300	42, 43															
2298	44, 45															

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

Log of Soil and Core Boring B-05

Date(s) Drilled	9/26/2018	Logged By	S. Janowski	Reviewed By	B. Aldridge
Drilling Method	Hollow Stem Auger, HQ-3 Rock Core	Drill Bit Size/Type	6-inch flight auger, HQ-3 wireline diamond bit	Total Depth of Borehole	50.0 feet
Drill Rig Type	Truck Mounted Mobile B-53	Drilling Contractor	Gregg Drilling	NAVD 88 Ground Surface Elevation	2342 feet
Groundwater Level	Not encountered before rotary wash drilling	Sampling Methods	2.5-inch ID ModCal; SPT; HQ Core Barrel	Hammer Data	Automatic hammer; 140 lbs, 30-inch drop
Borehole Backfill	Cement grout to ground surface	Borehole Location	Jenny Creek Bridge	Coordinate Location	N 2603527 E 6452997

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
	0								2-inches ASPHALT roadway						Start 8:30 9/26/2018 hand auger 0-5ft.
2342									POORLY GRADED SAND with GRAVEL (SP); greenish grey (10G 5/1); 60% medium grained SAND; 40% subangular GRAVEL up to 1-inch; moist --ROAD BASE--						
	1								SANDY LEAN CLAY (CL); very stiff; brown (10YR 1/3); low plasticity FINES; fine to medium grained SAND; subangular GRAVEL up to 2-inches; moist --ROAD FILL--						
2340	2														Pocket Pen = 3.5 tsf
	3														
2338	4														
	5								Becomes dark yellowish brown (10YR 4/4); dry to moist			5			Hollow stem auger 5-7.5 ft. SA: G=7%; S=25%; F=68% pp = 1.5 tsf
2336	6								LEAN CLAY with GRAVEL (CL); stiff; brown (10YR 4/3); 75% medium plasticity FINES; 15% subangular to subrounded GRAVEL up to 3/4-inch; 10% fine grained SAND; moist; with rootlets --ALLUVIUM--		S-01	4 / 9	72		
	7		1		NA									1019	
2334	8				NA		NR		With pulverized GRAVEL (from drive sampler); increased GRAVEL to 25% up to 1-inch		S-02	32 / 12 / 7	72		Auger refusal at 7.5ft. pp = 2.75 tsf
	9	1		15	NA	NA			With greyish black (N2), aphanitic basalt COBBLES and GRAVELS in a washed-out CLAY matrix					[48]	Advance 4.5-inch casing to 7.5 ft.; switch to HQ coring at 7.5ft. with wireline diamond bit
2332	10				NA		NR								
	11				NA									1024 / 1104	pp = 1.5 tsf
2330	12	2		20	NA	NA	NR				S-03	4 / 8 / 4	39		
	13				NA										

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
	13	2	1	20	NA	NA				COBBLES and GRAVELS in a washed-out CLAY matrix; brown (10YR 4/3) --ALLUVIUM--*(continued)*					[38]	50-75% drill fluid return
2328	14				NA		NR									
	15				NA										1112	
2326	16	3		40	NA	NA	NR								1115 [24]	
	17				NA										1120	Bit blocked off during run
2324	18	4		50	NA	NA	NR								1126	
	19				NA										[60]	
	19.5									Basalt BOULDER; greyish red (5RP 4/2); slightly weathered; strong						UCS = 14975 psi
2322	20				NA										1129	
	21	5		80	NA	NA	NR			COBBLES and GRAVELS in a washed-out CLAY matrix; very dark grey (10YR 3/1)					1134 [17]	
2320	22				NA										1141	
	23	6		73	NA	NA				Basalt COBBLES and BOULDERS are non vesiculated to vesiculated with vesicles up to 1/2-inch					1156	
2318	24				NA										[30]	
	25				NA		NR								1202	
2316	26	7		43	NA	NA	NR								1236 [20]	
	27				NA										1242	
2314	28	8		43	NA	NA									1331	
	29															

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing	Lithology	MATERIAL DESCRIPTION	Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	29	8	1	43	NA	NA	NR		COBBLES and GRAVELS in a washed-out CLAY matrix; brown (10YR 4/3) --ALLUVIUM--*(continued)*					[30]	0% Fluid return
2312	30				NA									1337	
	31	9		20	NA	NA	NR							1344	
2310	32				NA									[19]	
	33				NA									1352	
2308	34	10		20	NA	NA	NR							1401	
	35				NA									[21]	
					NA									1408	
2306	36	11		85	NA	NA	NR				S-04	12	0	1439	
	37				NA							11		[20]	
			2		NA							11		1445	
2304	38	12		43	NA	NA	NR							1528	
	39				NA									[36]	
2302	40				NA									1533	
	41	13		45	NA	NA	NR							1600	
2300	42				NA									[20]	
	43				NA									1606	
	43	14		57	NA	NA	NR							1611	
2298	44				NA									[20]	
	45														

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

Log of Soil and Core Boring B-05

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
	45	14	2	57	NA	NA			COBBLES and GRAVELS in a washed-out CLAY matrix; brown (10YR 4/3) --ALLUVIUM--*(continued)*					1620	0% Fluid return
2296	46	15		65	NA NA	NA	NR							1626 [15] 1634	Bit blocked off during run
2294	48	16		0	NA NA	NA	NR							1711 [20] 1717	
2292	50								**TOTAL DEPTH = 50.0 FEET**						
	51														
2290	52														
	53														
2288	54														
	55														
2286	56														
	57														
2284	58														
	59														
2282	60														
	61														

Project: Klamath River Renewal Project Project Location: Copco and Iron Gate Reservoirs Project Number: 60537920	Log of Soil and Core Boring B-06 Sheet 1 of 4

Date(s) Drilled	10/8/2018-10/9/2018	Logged By	P. Respess	Reviewed By	B. Aldridge
Drilling Method	Hollow Stem Auger, Rotary Wash, HQ-3 Rock Core	Drill Bit Size/Type	3 7/8-inch tricone; 3 7/8-inch diamond core bit	Total Depth of Borehole	56.9 feet
Drill Rig Type	Truck Mounted Mobile B-53	Drilling Contractor	Gregg Drilling	NAVD 88 Ground Surface Elevation	2339 feet
Groundwater Level	13.7 feet below ground surface 10/8/2018	Sampling Methods	2.5-inch ID ModCal, HQ Core Barrel	Hammer Data	Automatic hammer; 140 lbs, 30-inch drop
Borehole Backfill	Cement grout to ground surface	Borehole Location	Jenny Creek	Coordinate Location	N 2603580 E 6453115

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								SANDY LEAN CLAY (CL); stiff; yellowish brown; >50% medium plasticity FINES; fine to coarse grained SAND; GRAVEL up to 2-inches; dry to moist --FILL--						Start 9:10 10/8/2018; hollow stem auger 0-16.5ft.
2338	1														
2336	2, 3														
2334	4, 5										S-01	3 6 4			S-01 One liner retained (5-5.5ft.)
2332	6, 7														
2330	8, 9								SILTY SAND (SM); loose; brownish grey; fine to medium grained SAND; little coarse grained SAND and wood fragments; wet --ALLUVIUM--						Smoother drilling at 9.0ft.
2328	10, 11										S-02	2 1 3			S-02 One liner retained (10.5-11ft.) SA: S=75%; F=25%
2326	12, 13														

Report: GEO_CORE+SOIL_NO PACK_WITH LITH; File: KLAMATH_MASTER.GPJ; 6/20/2019 B-06

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

Log of Soil and Core Boring B-06

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
	13								SILTY SAND (SM); loose; brownish grey; fine to medium grained SAND; little coarse grained SAND and wood fragments; wet --ALLUVIUM--*(continued)*						
	14														
2324															
	15										S-03	19			S-03 One liner retained (16-16.5ft.)
									POORLY GRADED GRAVEL (GP); medium dense; brownish grey; rounded GRAVEL, COBBLES, and BOULDERS; SAND and CLAY infilling; wet			29			
	16											18			
2322															Switch to rotary wash drilling with 3 7/8-inch tricone bit; advance 4.5-inch casing to 19ft.
	17														
	18								BOULDER						
2320															
	19														
	20														
2318									CLAY, yellowish brown						
	21														Logged from cuttings
	22								CLAY, yellowish brown						
2316															
	23														30-60% Fluid return (higher in boulders)
	24														
2314															
	25								BOULDER						
	26														
2312															
	27								CLAY, reddish brown						
	28														
2310															
	29														

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
	29								CLAYEY GRAVEL with SAND (GC); medium dense; brownish grey; rounded GRAVEL, COBBLES, and BOULDERS; SAND and CLAY infilling; wet --ALLUVIUM--						
	30											22			S-04 One liner retained (31-31.5ft.) SA: G=53%; S=22%; F=25%
2308											S-04	16			
	31											14			Advance 4.5-inch casing to 30ft.
	32														
2306	33														
	34														
2304	35								BOULDER, basalt						On boulder; no drive sample attempted
	36														
2302	37								BOULDER, basalt						
	38														
2300	39														
	40											13			S-05 One liner retained (41-41.4ft.)
2298											S-05	27			
	41											50/5			Advance 4.5-inch casing to 40ft.
	42								BOULDER, basalt						
2296	43														
	44														Total fluid loss at 44ft. (0% fluid return)
2294	45														

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Lithology	MATERIAL DESCRIPTION	Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	45							POORLY GRADED GRAVEL (GP); medium dense; brownish grey; rounded GRAVEL, COBBLES, and BOULDERS; SAND and CLAY infilling; wet --ALLUVIUM--		S-06	7, 10, 36			S-06 One liner retained (46-46.5ft.) SA: G=93%; S=7%
2292	46–47													Advance 4.5-inch casing to 45ft.
2290	48–49							VOLCANIC SILTSTONE/CLAYSTONE; olive grey; moderately to highly weathered; weak; thinnly laminated --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--						Hole caving; End of day 10/8/2018 Begin day 10/9/2018
2288	50–51									S-07	31, 40, 36			S-07 Two liner retained (50.5-51.0 51.0-51.5ft.) Advance 4.5-inch casing to 50ft.; driller reports consistent olive grey clayey cuttings at 47.5ft.; switch to HQ-3 rock core at 52ft.
	51.3							VOLCANIC SILTY SANDSTONE; light yellowish brown; highly to moderately weathered; weak to moderately strong; fine to medium grained; becomes bluish grey at 51.8ft.						
2286	52	1	1	75	>6, >6, NA	0		VOLCANIC SILTSTONE/CLAYSTONE; reddish brown; moderately weathered; very weak to weak; thinnly laminated					1204 [13] 1217	
2284	55	2		40		0							1230 [6] 1235	Formation pressurized; fluid continued to flow from hole after pump stopped; advanced 4.5-inch casing to 55ft; reddish brown clayey cuttings 55.4-56.6 ft.
	55.3	3		0	NA	0							1253 [7] 1304	
2282	56.5	4		100	NA	0		BASALT; slightly weathered; moderately strong --TERTIARY to QUATERNARY INTRUSIVE BASALT--					1309 [8] 1316	
	57							**TOTAL DEPTH = 56.9 FEET**						
2280	58–59													
2278	60–61													

Fracture Drawing: NR (55–56 ft)

Project: Klamath River Renewal Project	Log of Soil and Core Boring B-07
Project Location: Copco and Iron Gate Reservoirs	Sheet 1 of 3
Project Number: 60537920	

Date(s) Drilled	10/4/2018-10/5/2018	Logged By	B. Kozlowicz	Reviewed By	B. Aldridge
Drilling Method	Hollow Stem Auger, HQ-3 Rock Core	Drill Bit Size/Type	6-inch flight auger, 3 7/8-inch diamond core bit	Total Depth of Borehole	31.8 feet
Drill Rig Type	Truck Mounted Mobile B-53	Drilling Contractor	Gregg Drilling	NAVD 88 Ground Surface Elevation	2338 feet
Groundwater Level	Not encountered before rotary wash drilling	Sampling Methods	2.5-inch ID ModCal, HQ Core Barrel	Hammer Data	Automatic hammer; 140 lbs, 30-inch drop
Borehole Backfill	Cement grout to ground surface	Borehole Location	Jenny Creek	Coordinate Location	N 2603568 E 6453234

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
		ROCK CORE								SOIL SAMPLES					
	0								POORLY GRADED SAND with GRAVEL (SP); loose to medium dense; light olive brown (2.5Y 5/3); 60% fine to medium grained SAND; 35% angular GRAVEL up to 2-inches; 5% no plasticity FINES; dry --FILL--						Start 15:00 10/4/2018 hand auger 0-4.5ft.
	1														
2336	2														
	3														
2334	4														
	4.5								VOLCANIC SANDSTONE; grey; fine grained; moderately weathered --ROCKY FILL?--			28			
	5										S-01	27	20		Hollow stem auger 5-7ft.
2332	6											20			
	7								CLAYEY GRAVEL with SAND (GC); dark yellowish to olive brown; subangular to subrounded GRAVEL up to 1.5-inches --ROCKY FILL/ALLUIVUM?--						Hard rocky drilling 6-7ft; auger refusal at 7ft.
	7.5				NA									0818	Advance 4.5-inch casing to 6.8ft. Switch to HQ coring at 7ft. with wireline diamond bit; runs 1 and 2 not retained
2330	8				NA		NR								
	9								VOLCANIC SANDSTONE BOULDER; dark grey; slightly weathered; very strong; fine to medium grained						
	9.5	1		25	NA	NA								[30]	
2328	10														End of day 10/4/2018 Begin day 10/5/2018
	10.5				NA		NR								
	11.5				NA									0826 0833	Advance 4.5-inch casing to 9ft.
2326	12														
	12.5				NA										0% Fluid Return
	13														

Report: GEO_CORE+SOIL_NO PACK_WITH LITH; File: KLAMATH_MASTER.GPJ; 6/20/2019 B-07

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

Log of Soil and Core Boring B-07

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
	13				NA				CLAYEY GRAVEL with SAND (GC); dark yellowish to olive brown; subangular to subrounded GRAVEL up to 1.5-inches --ROCKY FILL/ALLUIVUM?--						Continuted 0% Fluid Return
2324	14	2		0	NA	NA	NR							[75]	
	15				NA										
2322	16				NA				SILTY SAND (SM); medium dense; very dark grey (10YR 3/1); 80% fine grained SAND; 20% no to low plasticity FINES --ALLUVIUM--			9		0837	SA: G=4%; S=55%; F=41%
	17				NA				VOLCANIC CLAYSTONE; dusky red (10R 3/3); highly weathered; very weak --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--		S-02	37	100		
2320	18	3		0	NA	NA	NR					50/5		0859 [20] 0902	
	19		1		NA				Broken, likely NR zone					0910	
2318	20	4		82	2	36			Becomes slightly to moderately weathered, highly fractured, with occasional small, angular GRAVEL					[12]	
	21				3									0924	
2316	22				5				Becomes mostly moderately weathered, with various amounts of fine to coarse grained SANDSTONE and trace small, subangular GRAVEL, with weak, subhorizontal bedding					1048	
	23				3										
2314	24	5		100	4	10			All Fractures: ?, J, N-VN, No, No, Pl, SR					[17]	
	25				5										
2312	26				6									1106	
	27				4				VOLCANIC SANDSTONE; dark reddish brown (2.5YR 3/4) to dark red (2.5YR 3/6), grades to fine to medium grained					1119	*Rock does not meet soundness criteria for RQD calculation
2310	28				3										
	29														

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

Log of Soil and Core Boring B-07

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
	29	6	1	100	3	16*				VOLCANIC SANDSTONE; dark reddish brown (2.5YR 3/4) to dark red (2.5YR 3/6), grades to fine to medium grained --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--*(continued)*					[16]	
2308	30				4											
	31				NA					Shoe disturbed					1138	
2306	32									**TOTAL DEPTH = 31.8 FEET**						
	33															
2304	34															
	35															
2302	36															
	37															
2300	38															
	39															
2298	40															
	41															
2296	42															
	43															
2294	44															
	45															

Project: Klamath River Renewal Project **Project Location:** Copco and Iron Gate Reservoirs **Project Number:** 60537920	**Log of Soil and Core Boring B-08** Sheet 1 of 4

Date(s) Drilled	**10/16/2018**	Logged By	**P. Respess**	Reviewed By	**B. Aldridge**
Drilling Method	**Hollow Stem Auger, Rotary Wash, HQ-3 Rock Core**	Drill Bit Size/Type	**3 7/8-inch tricone; 3 7/8-inch diamond HQ bit**	Total Depth of Borehole	**52.8 feet**
Drill Rig Type	**Truck Mounted Mobile B-53**	Drilling Contractor	**Gregg Drilling**	NAVD 88 Ground Surface Elevation	**2194 feet**
Groundwater Level	**Not encountered before rotary wash drilling**	Sampling Methods	**2.0-inch ID California Sampler, SPT, HQ Core Barrel**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Cement grout to ground surface**	Borehole Location	**Lakeview Bridge**	Coordinate Location	**N 2587323 E 6441439**

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
2194	0								POORLY GRADED GRAVEL with SAND (GP); medium dense to dense; greyish brown; fine to coarse grained SAND; fine to coarse, angular to rounded GRAVEL with COBBLES and BOULDERS; dry --FILL--						Start 11:30 10/16/2018; hollow stem auger 0-3ft.
	1														
2192	2														
	3														Switch to rotary wash drilling at 3ft.
2190	4														
	5														
2188	6														
	7														
2186	8														
	9														
2184	10														Advance 4.5-inch casing to 10ft.
	11														
2182	12														
	13														

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
2180	13–16								GRAVELLY FAT CLAY with SAND (CH); very stiff; olive brown; medium to high plasticity FINES; trace fine grained SAND; occasional fine to coarse GRAVEL; wet --FILL--*(continued)*		S01	4 7 13			LL= 69; PL=22
	15								Rocky layer Becomes greyish green						Rig chatter with grayish green cuttings
2178, 2176	16–20								SILT with SAND (ML); very soft; olive brown; low plasticity FINES; trace fine to coarse grained SAND; occasional fine GRAVEL; wet --FILL--		S02	0 0 0			S-02 advanced with weight of hammer to 8-inches then pushed to 18-inches with 100 psi without liners SA: G=8%; S=12%; F=80%
2174	20–21.5										S03	7 3 3			Advance 4.5-inch casing to 20ft; bluish grey cuttings; S-03 driven without liners
2172	21.5–22								Rocky layer						
	23–23.5								Rocky layer						
2170	23.5–27								POORLY GRADED GRAVEL with SAND (GP) to POORLY GRADED SAND with GRAVEL (SP); dense; brown; fine to medium, locally coarse grained SAND; fine to coarse GRAVEL; wet --ALLUVIUM--						Driller notes smooth drilling below 23.5ft.
2168	25										S04	50/5			Advance 4.5-inch casing to 25ft.
2166	27–29								VOLCANIC CONGLOMERATE; medium grey; slightly weathered to fresh; moderately strong to strong; highly fractured; fine grained with rounded clasts up to 2 1/2-inches; well cemented with mechanical breaks along fractures --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--						Basalt chip in cuttings; steady drilling

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

Log of Soil and Core Boring B-08

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Number	MATERIAL DESCRIPTION	Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	29							VOLCANIC CONGLOMERATE; medium grey; slightly weathered to fresh; moderately strong to strong; highly fractured; fine grained with rounded clasts up to 2 1/2-inches; well cemented with mechanical breaks along fractures --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--*(continued)*						
2164	30													
	31													
2162	32													
	33													
2160	34													
	35		1		0		m, m, m, m						1512	Switch to HQ-3 rock coring at 35ft.
2158	36	1		100	0	89	m, m,m, m, m, m, m						[15]	
	37				NA		1	1: 70, J, VN, Ch?, Pa, Pl-Wa, SR					1523	
2156	38				1		m, m						1532	
	39				1		1, 1, m, m	VOLCANIC SANDSTONE; light to medium grey; slightly weathered to fresh; moderately strong; highly fractured; fine grained with angular, white clasts up to 5 mm						
2154	40	2		100	1	95	m,m, m, 2, m, 2						[16]	
	41				1			1: 40, J, VN-N, No, No, Wa, SR 2: 20, J, N, Cl, Pa, Wa, SR 3: 80, J, N-MW, Ca, Fi, Wa, SR						
2152	42				1		m, 3						1551	
	43				1		m, m, 1, m,m, m	1: 80-90, J, N-MW, Ca, Fi, Wa, SR					1600	
2150	44				0		m							
	45													

Report: GEO_CORE+SOIL_NO PACK_WITH LITH; File: KLAMATH_MASTER.GPJ; 6/20/2019 B-08

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

Log of Soil and Core Boring B-08

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	MATERIAL DESCRIPTION	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	45	3	1	100	1	70	2	VOLCANIC SANDSTONE; light to medium grey; slightly weathered to fresh; moderately strong; highly fractured; fine grained with angular, white clasts up to 5 mm --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--*(continued)*	[21]	
2148	46				0		m	2: 60, J, Vn, Ch/Cl, Fi, Pl, SR		UCS = 15268 psi
	47				0		m, m		1614	
2146	48	4	2	100	2	42	1, 2	VOLCANIC CONGLOMERATE 1: 5-15, J, VN-N, Cl, Pa, Wa, SR 2: 40, J, VN, Fe, Su, Pl, S 3: 50-60, J, Vn, Qz, Su, Pl, S	1622	
	49				3		1, 3, 4	VOLCANIC CONGLOMERATE		
2144	50				3		4, 5,6, 6	VOLCANIC CONGLOMERATE 4: 30, J, VN, Qz, Pa/Su, Pl-Wa, S-SR 5: 40, J, VN, Qz, Su/Pa, Pl-Wa, S-SR 6: 40, J, VN, Qz, Su/Pa, Pl-Wa, S-SR 7: 10, J, T, H+Uk, Uk, Wa, SR 8: 60, J, VN, Qz, Su, Pa, Pl, S	[17]	
	51				3		7, 1,6	VOLCANIC CONGLOMERATE; medium grey; slightly weathered to fresh; moderately strong to strong; highly fractured; fine grained with rounded clasts up to 2 1/2-inches; well cemented with mechanical breaks along fractures		
2142	52				NA		8, 4		1640	
	53							**TOTAL DEPTH = 52.8 FEET**		
2140	54									
	55									
2138	56									
	57									
2136	58									
	59									
2134	60									
	61									

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

Log of Soil and Core Boring B-10

Date(s) Drilled	**10/17/2018-10/18/2018**	Logged By	**P. Respess**	Reviewed By	**B. Aldridge**
Drilling Method	**Rotary Wash, HQ-3 Rock Core**	Drill Bit Size/Type	**3 7/8-inch tricone; 3 7/8-inch diamond HQ bit**	Total Depth of Borehole	**52.2 feet**
Drill Rig Type	**Truck Mounted Mobile B-53**	Drilling Contractor	**Gregg Drilling**	NAVD 88 Ground Surface Elevation	**2194 feet**
Groundwater Level	**Not encountered before rotary wash drilling**	Sampling Methods	**SPT, HQ Core Barrel**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Cement grout to ground surface**	Borehole Location	**Lakeview Bridge**	Coordinate Location	**N 2587076 E 6441583**

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								POORLY GRADED GRAVEL with SAND (GP); medium dense to dense; greyish brown; fine to coarse grained SAND; fine to coarse, angular to rounded GRAVEL with COBBLES and BOULDERS; dry --FILL--						Start 10:10 10/17/2018; rotary wash drilling 0-29.5
	1														
2192	2														
	3														
2190	4								CLAYEY SAND (SC); medium dense; reddish brown; fine to coarse grained SAND; medium to high plasticity FINES; trace to some GRAVEL; moist		S01	10 6 4	0		
	5														
2188	6								POORLY GRADED GRAVEL with SAND (GP); medium dense to dense; greyish brown; fine to coarse grained SAND; fine to coarse, angular to rounded GRAVEL with COBBLES and BOULDERS; dry						
	7														
2186	8														
	9														
2184	10														Too cobbley for drive sample at 10ft.
	11														
2182	12														
	13														

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
	13								POORLY GRADED GRAVEL with SAND (GP); medium dense to dense; greyish brown; fine to coarse grained SAND; fine to coarse, angular to rounded GRAVEL with COBBLES and BOULDERS; dry --FILL--*(continued)*						
2180	14														
	15														
2178	16														
	17														
2176	18														
	19														
2174	20														
	21														
2172	22														
	23														
2170	24														Advance 4.5-inch casing to 23.5ft.
	25														
2168	26										S02	12, 20, 26			S-02 bagged
	27														
2166	28								VOLCANIC CONGLOMERATE; medium grey; slightly weathered to fresh; moderately strong to strong; rounded clasts up to 2 1/2-inches in a fine grained matrix; moderately fractured with mechanical breaks around clasts; well cemented --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--						
	29														

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
2164	29–32	1	1	100	NA, 1, 0	72	1, 2, m, m, 3, m, m, m, m, m, m		VOLCANIC CONGLOMERATE; medium grey; slightly weathered to fresh; moderately strong to strong; rounded clasts up to 2 1/2-inches in a fine grained matrix; moderately fractured with mechanical breaks around clasts; well cemented --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--*(continued)* 1: 60, J, VN, No, No, Pl, S 2: 10, J, VN, Qz, Sp, Pl, S 3: 40, J, VN, Fe, St, Pl, S					1305 [15] 1315	Switch to HQ-3 rock coring at 29.5ft.
2162	32–33.4	2		100	1	86	1, 2		1: 35, J, VN, No, No, Pl-Wa, SR 2: 45, J, VN, Fe, St, Wa, S-SR VOLCANIC SANDSTONE; light to medium grey; slightly weathered; strong; fine grained with white clasts up to 6 mm					1335 [14] 1341	
2160, 2158	33.4–37	3		94	NA, 3, 0, 1	78	m, m, 1, 2, 3, m, m, m, m, m, m, 4		VOLCANIC SANDSTONE; light to medium grey; slightly weathered; strong; fine grained with white clasts up to 6 mm 1: 20, J, VN, No, No, Pl-Wa, SR 2: 40, J, VN, No, No, Pl-Wa, SR 3: 60, J, VN, No, No, Wa, SR 4: 20, J, VN, Qz, Sp, Pl-Wa, SR					1355 [6] 1430	Driller reports hard drilling at 33.4ft.
2156	37–38.6	4		100	0, NA	100	m, m, m, m							1442 [4] 1505	
2154, 2152	38.6–42	5		91	1, 0, 1	71	1, 2, m, 3, m, m, 4, m, m		VOLCANIC SANDSTONE; light to medium grey; slightly weathered; strong; fine grained with white clasts up to 6 mm 1: 30, J, VN, No, No, Pl-Wa, SR 2: 20, J, VN-N, Fe, St, Pl, SR 3: 60, J, MW, Qz, Pa-Sp, Wa, SR-R 4. 30, J, N-MW, Qz, Sp, Wa-Pl, SR VOLCANIC SANDSTONE; light to medium grey; slightly weathered; strong; fine grained with white clasts up to 6 mm					1525 [8] 1550	
2150	42–45	6	2	100	2, 2, 1	69	1, 2, 1, 3, m		1: 10-15, J, N, Fe, St, Pl-Wa, SR 2: 30, J, T-VN, Fe, St, Pl, S 3: 55, J, N-MW, Fe, St, Wa-Pl, S-SR					0755 [9]	End of day 10/17/2018 Begin day 10/18/2018

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
	45		2		1		4 m m		VOLCANIC CONGLOMERATE; medium grey; slightly weathered to fresh; moderately strong to strong; rounded clasts up to 2 1/2-inches in a fine grained matrix; moderately fractured with mechanical breaks around clasts; well cemented --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--*(continued)*						
2148	46				1		m 5		4: 20, J, T, No, No, Pl, S 5: 60, J, N, Fe, St, Wa-St, SR-R						
	47				NA		1 2 3							0830 0847	
2146	48				2		5 m 4		1: 85-90, J, T, H+Uk, Pl-Wa, SR 2: 50, J, N, Fe, St, Wa, SR 3: 60, J, N-MW, Fe, St, Pl-Wa, SR 4: 60, J, VN, Fe, St, Pl-Wa, SR 5: 50, J, VN, Fe, St, Wa, SR 6: 10, J, VN-N, Fe, St, Pl, SR						
2144	49	7		82	2	71	3 6 6							[9]	
	50				3		4 4		VOLCANIC SANDSTONE; light to medium grey; slightly weathered; strong; fine grained with white clasts up to 6 mm						
2142	51				NA		m m								
	52						NK							0920	
									TOTAL DEPTH = 52.2 FEET						

Elevation, feet: 2140, 2138, 2136, 2134
Depth, feet: 53, 54, 55, 56, 57, 58, 59, 60, 61

Project: Klamath River Renewal Project **Project Location:** Copco and Iron Gate Reservoirs **Project Number:** 60537920	**Log of Core Boring B-13** Sheet 1 of 2

Date(s) Drilled	**10/3/2018**	Logged By	**B. Kozlowicz**	Reviewed By	**B. Aldridge**
Drilling Method	**HQ-3 Rock Core**	Drill Bit Size/Type	**3 3/4-inch diamond core bit**	Total Depth of Borehole	**21.1 feet**
Drill Rig Type	**Truck Mounted Mobile B-53**	Drilling Contractor	**Gregg Drilling**	NAVD 88 Ground Surface Elevation	**2494 feet**
Groundwater Level	**Not encountered before HQ rock coring**	Sampling Methods	**HQ Core Barrel**	Inclination from Horizontal/True North Bearing	**Vertical**
Borehole Completion	**Bentonite cement grout to ground surface**	Location	**Fall Creek**	Coordinate Location	**N 2606346 E 6463221**

Elevation, feet	Depth, feet	ROCK CORE: Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing	Number	Lithology	MATERIAL DESCRIPTION	Packer Test Intervals	Drill Time, 24-hr [Drill Rate, ft/hr]	FIELD NOTES AND OTHER TESTS
2494	0									1-inch ASPHALT WELL GRADED SAND with GRAVEL (SW); medium dense to dense; dark yellowish brown (10YR 4/4); fine to coarse grained SAND; angular to rounded GRAVEL up to 2-inches --ROAD BASE--			Start 12:00 10/3/2018 hand auger 0-3.5ft.
2492	2	1	1	60	NA >6	0	NR			BASALT; very dark grey to black; slightly to moderately weathered; strong; highly fractured with iron staining along fracture surfaces; porphyritic; vesicular; with plagioclase phenocrysts up to 1/4-inch and irregular vesicles up to 1/2-inch --TERTIARY to QUATERNARY INTRUSIVE BASALT--		1252 [23] 1256	
2490	3.5	2		28	NA NA	0	NR			Becomes dark yellowish brown, locally highly weathered with CLAYEY SAND, with rootlets		1324 [29] 1330	Auger refusal at 3.5ft.; switch to HQ rock coring with 3 3/4-inch diamond bit 0% fluid return
2488	6.4	3		66	NA >6 >6 NA NA NA	0	NR			Becomes highly to locally completely weathered to a CLAYEY SAND/SANDY CLAY with trace small gravel and strong, slightly weathered corestones of BASALT CLAYEY SAND/SANDY CLAY		1338 [20] 1353	
2482	11.4	4		68	>6	19				highly fractured with SANDY CLAY infilling		1405	

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing	Number	Lithology	MATERIAL DESCRIPTION	Packer Test Intervals	Drill Time, 24-hr [Drill Rate, ft/hr]	FIELD NOTES AND OTHER TESTS
	13	4	1	68	5	19				BASALT; very dark grey to black; slightly to locally completely weathered; strong; highly to intensely fractured; porphyritic; vesicular; with plagioclase phenocrysts up to 2/5-inches and irregular vesicles up to 1/2-inch; fractures are wide and infilled with CLAYEY SAND/SANDY CLAY and small GRAVEL --TERTIARY to QUATERNARY INTRUSIVE BASALT--*(continued)*		[28]	Continued 0% fluid return
2480	14				NA								
	15				NA		NR					1415	
2478	16	5		70	>6	18						1424	Bit blocked off during run
	17				4								UCS = 6528 psi
2476	18				3					CLAYEY SAND and GRAVEL with roots		[30]	
	19				NA								
2474	20				NA		NR					1434	
	21									**TOTAL DEPTH = 21.1 FEET**			
2472	22												
	23												
2470	24												
	25												
2468	26												
	27												
2466	28												
	29												

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

Log of Soil and Core Boring B-14

Date(s) Drilled	**10/4/2018**	Logged By	**B. Kozlowicz**	Reviewed By	**B. Aldridge**
Drilling Method	**HQ-3 Rock Core**	Drill Bit Size/Type	**6-inch flight auger, 3 3/4-inch diamond coring bit**	Total Depth of Borehole	**28.6 feet**
Drill Rig Type	**Truck Mounted Mobile B-53**	Drilling Contractor	**Gregg Drilling**	NAVD 88 Ground Surface Elevation	**2494 feet**
Groundwater Level	**Not encountered before HQ rock coring**	Sampling Methods	**2.5-inch ID ModCal, HQ Core Barrel**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Bentonite cement grout to ground surface**	Borehole Location	**Fall Creek**	Coordinate Location	**N 2606321 E 6463161**

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	MATERIAL DESCRIPTION	Soil Samples: Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
2494	0							WELL GRADED GRAVEL with SAND (GW); loose to medium dense; dark yellowish brown (10YR 4/4); angular to subangular GRAVEL up to 3-inches; fine to coarse grained SAND; trace no plasticity FINES --ROAD FILL--						Start 9:00 10/4/2018 hand auger 0-2ft.
	1													
2492	2							SANDY LEAN CLAY (CL); stiff; very dark brown (7.5YR 2.5/3); 60% low plasticity FINES; 40% fine to medium grained SAND; trace angular, coarse grained SAND; trace fine GRAVEL --ALLUVIUM/COLLUVIUM?--						
		1	1	12	NA	0	NR	At 2.3ft.: Cored 4-inch cobble of dark grey, VOLCANIC SANDSTONE, fine to medium grained, with dark yellowish brown SANDY CLAY and 1-inch root					0920 [27] 0929	Auger refusal at 2.3ft.; switch to HQ rock coring with 3 3/4-inch diamond bit
	3				NA									
2490	4				NA									Run 1 bagged
	5				NA									
2488	6				NA			FAT CLAY with SAND (CH); very stiff; dark brown (7.5YR 3/3); medium plasticity FINES; fine to medium SAND; rare angular GRAVEL		S-01	8 / 17 / 17	60		SA: G=1%; S=29%; F=70% LL=62; PL=22
	7				NA									Two liners retained
2486	8	2		40	NA	0	NR	COBBLES and BOUDLERS with CLAYEY SAND and GRAVEL; dark greenish grey and olive to reddish brown; slightly weathered, moderately strong volcanic sandstone COBBLES --CHANNEL ALLUVIUM--					1026 [18] 1031	
	9				NA			Becomes grey, volcanic sandstone COBBLE with rounded upper terminus						
								COBBLES and BOUDLERS become dusky red, fine grained, slightly weathered, very strong intrusive volcanic					1040	80-100% fluid return
2484	10	3		60	NA	25	NR						[13] 1049	
	11				NA									
2482	12	4		7	NA	0							1058 [18] 1103	Coarse grained SAND in cuttings
	13													

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
	13	5	1	100	1	0				PORPHYRITIC ANDESITE; very dark greyish brown (10YR 3/2); highly weathered; very weak; locally friable; with steeply dipping vein infilled with very pale yellow, fine grained SAND --TERTIARY VOLCANICS, undifferentiated--					1103 [6] 1109 1124	100% fluid return
2480	14				0					Becomes dark reddish brown and very pale yellow, weak to extremely weak, highly to completely altered; with irregular chlorite alteration and vitreous quartz crystals up to 1/4-inch						
	15				0											
2478	16	6		70	0	0									[18]	
	17				NA		NR									
2476	18				NA										1141 1149	Fast drilling 18.6 to 20.5ft likely no recovery zone
	19				NA		NR									
2474	20				NA											
	21	7		62	0	0									[19]	
2472	22				0											
	23				0										1205 1215	
2470	24	8		80	NA	0	NR								[12] 1220 1228	
	25				4					Becomes moderately to locally highly weathered, moderately strong, highly fractured						
2468	26	9		63	3	0									[17]	
	27				NA		NR			Becomes highly to completely weathered, extremely weak, friable						
2466	28				NA										1242	
	29									TOTAL DEPTH = 28.6 FEET						

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

Log of Soil and Core Boring B-15

Date(s) Drilled	1/22/2019-1/23/209	Logged By	S. Janowski	Checked By	P. Respess
Drilling Method	Solid Stem Auger, HQ-3 Rock Core	Drill Bit Size/Type	4-inch solid stem auger, 4-inch diamond coring bit	Total Depth of Borehole	51.5 feet
Drill Rig Type	Truck Mounted CME 75	Drilling Contractor	Taber Drilling	NAVD 88 Ground Surface Elevation	2344 feet
Groundwater Level	11.7' 1/23/2019	Sampling Methods	2.5-inch ID ModCal, SPT, HQ Core Barrel	Hammer Data	Automatic hammer; 140 lbs, 30-inch drop
Borehole Backfill	Cement grout to ground surface	Borehole Location	North end of Daggett Road Bridge	Coordinate Location	N 2602349 E 6462482

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
2344	0								SANDY LEAN CLAY with GRAVEL (CL); very stiff; moist; dark brown (10yr3/3); 20% subrounded to rounded GRAVEL to 3/4"; 20% fine- to medium-grained SAND; 60% medium plasticity FINES --FILL--						
	1														
2342	2														
	3														
2340	4														
	5										1-1 1-2	6 6 8	78		pp=3.0 tsf
2338	6														
	7														
2336	8								CLAYEY GRAVEL with SAND (SC); very dense; moist; yellowish brown to dark brown; interbedded layers of gravel with clay and sand --ALLUVIUM--						Fill estimate based on height of slope embankment
	9														
2334	10										2	100/1"	100		
	11														
2332	12														
	13														

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
	13								CLAYEY GRAVEL with SAND (SC); very dense; moist; yellowish brown to dark brown; interbedded layers of gravel with clay and sand --ALLUVIUM-- *(continued)*						
2330	14														
	15											16			SA: G=42%; S=27%; F=31%
											3	20	78		
2328	16											34			
	17								BASALT BOULDERS and COBBLES in SAND & GRAVEL matrix; medium dark gray (N4) to dark gray (N3), strong, some boulders are scoriaceous, matrix washed out --ALLUVIUM--						Rig chatter
2326	18														
	19														
2324	20											17			
											4	50	61		
	21	1	1	100	NA	0						50		0921 [6] 0926	End of day 1/22/2019
														0933	Begin day 1/23/2019; AM water level=11.7' bgs Switch to HQ rock core
2322	22				NA										
	23				NA		NR								
2320	24	2		2	NA	0								[100]	
	25				NA										
2318	26													0936	
					NA						5	65	100		
	27													0956	
					NA										
2316	28	3		71		27*	NR								*Rock does not meet soundness criteria for RQD calculation
					NA				VOLCANICLASTIC BRECCIA --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--						
	29														

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

Log of Soil and Core Boring B-15

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
	29	3	1	71	5	27*	1,1; 1; 1	VOLCANICLASTIC BRECCIA; light olive gray (5Y5/2); moderately weathered; weak; highly to intensely fractured; angular clasts to 1/2" --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--					[68]	
2314	30				6		1; 1	1: 20°, J, MW, Sd, Sp, Wa, R Becomes grayish blue-green (5BG5/2); slightly weathered; moderately strong						*Rock does not meet soundness criteria for RQD calculation
	31				0		M						1000 1008	
2312	32				3		1; 1; M; 1; M	1: 30°, J, MW, Sd+Fe, Sp+Su, Wa, R						
	33				1		M; 1							
2310	34	4		100	0	82		Becomes slightly fractured					[60]	
	35				0									
2308	36				0		M						1013 1017	
	37				0		M; M							
2306	38				0		M; M	Becomes light olive gray (5Y5/2); moderately weathered; weak; highly fractured						
	39	5		100	1	96*	1	1: 15°, J, MW, Fe, Su, Wa, VR					[75]	*Rock does not meet soundness criteria for RQD calculation
2304	40		2		1		M; M; 2							
	41				2		1	2: 60°, J/Sh, MW, Fe+Mn+Sd, Su+Sp, Wa, R Becomes grayish blue-green (5BG5/2); slightly weathered 1: 20°, J, MW, No, No, Wa-St, VR					1021 1024	
2302	42				1		1; M	Becomes moderately fractured						
	43				0		M							
2300	44	6		100	0	72	M	Becomes weak to very weak					[43]	
	45													

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
	45	6	2	100	4	72	1, 1		VOLCANICLASTIC BRECCIA; grayish blue-green (5BG5/2); slightly weathered; weak to very weak; highly fractured; angular clasts to mostly to 1/2", occasionally to 1.5" --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)-- *(continued)*						
2298	46				0		M, M, M							1031 / 1035	UCS = 1546 psi
	47				0		M								
2296	48				1		1		1: 20°, J, MW, No, No, Wa, R 2: 15°, J, N-VN, Sd+Si, So-Pa, Pl, R-SR						
	49	7		100	2	94	2,2							[43]	
2294	50				2		2, 2								
	51				0		M							1042	
2292	52								**TOTAL DEPTH = 51.5 FEET** **Grout mix: 30 gallons of water, six 47# bags of cement, no bentonite**						
	53														
2290	54														
	55														
2288	56														
	57														
2286	58														
	59														
2284	60														
	61														

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

Log of Soil and Core Boring B-16

Date(s) Drilled	**1/12/2019**	Logged By	**P. Respess**	Checked By	**S. Janowski**
Drilling Method	**Rotary Wash, HQ-3 Rock Core**	Drill Bit Size/Type	**3-7/8-inch tricone, 3 3/4-inch diamond coring bit**	Total Depth of Borehole	**24.5 feet**
Drill Rig Type	**Barge Mounted CME-45**	Drilling Contractor	**Taber Drilling**	NAVD 88 Ground Surface Elevation	**2319 feet**
Groundwater Level	**12 feet above ground surface**	Sampling Methods	**SPT, HQ Core Barrel**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Bentonite cement grout to ground surface**	Borehole Location	**12' downstream of Daggett Road bridge**	Coordinate Location	**N 2602237 E 6462573**

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	MATERIAL DESCRIPTION	Soil Samples Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	0							VOLCANICLASTIC BRECCIA; gray-green; completely weathered; extremely weak; fine-grained matrix; dark gray-black angular clasts up to 1/4"-1/2"; slightly fractured with widely-spaced natural fractures; numerous mechanical breaks --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--			3			12' of water in river at time of drilling
										1	5			
2318	1										15			5" HWT casing driven to 14' (refusal) Tricone to 15' and continue with HQ core High Water Circulation Return (WCR)
	2													
2316	3	1	1	100	0	100	M, M, M	Becomes moderately to slightly weathered; moderately strong; slightly fractured; multi-colored clasts up to 2"					1024 [90]	
								Broken mechanical						
	4				0		M, M, M						1025 / 1029	
2314	5				0									
	6				0		M							
2312	7	2		100	1	100	1, M	1: 20°, J, N, No, No, Wa, SR					[150]	
	8				0									
2310	9				0		M						1031 / 1034	
	10				0		M							
2308	11				0									
	12	3		100	0	100	M, M						[100]	
	13													

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

Log of Soil and Core Boring B-16

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
2306	13	3	1	100	0	100	M	VOLCANICLASTIC BRECCIA; gray-green; moderately to slightly weathered; moderately strong; slightly fractured; multi-colored clasts up to 2"; numerous mechanical breaks. Becomes clasts up to 3-4" at 13.8' --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)-- *(continued)*						High WCR
	14				0		M						1037 / 1040	
2304	15	4	2	100	0	100	M, M							
	16				1		1	1: 30°, J, N, No, No, Pl-Wa, SR						
2302	17				0		M						[150]	
	18				0		M, M							
2300	19				0		M, M						1042 / 1045	
	20	5		96	0	96								
2298	21				0		M							
	22				0		M, M						[75]	
2296	23				0									
	24				NA		1, NR						1049	
	24.5							**TOTAL DEPTH = 24.5 FEET** **15 gallons of grout: 6 sack mix with 5% bentonite**						
2294	25													
	26													
2292	27													
	28													
	29													

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

Log of Soil and Core Boring B-17

Date(s) Drilled	**1/22/2019**	Logged By	**S. Janowski**	Checked By	**P. Respess**
Drilling Method	**Solid Stem Auger, HQ-3 Rock Core**	Drill Bit Size/Type	**4-inch solid stem auger, 4-inch diamond coring bit**	Total Depth of Borehole	**41.5 feet**
Drill Rig Type	**Truck Mounted CME 75**	Drilling Contractor	**Taber Drilling**	NAVD 88 Ground Surface Elevation	**2341 feet**
Groundwater Level	**Not encountered before HQ rock coring**	Sampling Methods	**2.5-inch ID ModCal, SPT, HQ Core Barrel**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Cement grout to ground surface**	Borehole Location	**South end of Daggett Road Bridge**	Coordinate Location	**N 2602195 E 6462721**

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
	0								GRAVELLY CLAY with SAND (CL); stiff; moist; dark brown (7.5YR3/3); subangular to subrounded GRAVEL to 1/2"; medium-grained SAND; medium plasticity FINES --FILL--						
2340	1														
	2														
2338	3														
	4														
2336	5										1-1 1-2	5 50/5"	100		pp=1.0 tsf Driller adds water to facilitate advancement
	6														
2334	7														
	8														
2332	9								SANDY GRAVEL (GP); very dense; moist; brown; subangular to subrounded GRAVEL to 2.25"; medium- to coarse-grained SAND --ALLUVIUM--						
	10										2-1 2-2	42 50/4"	100		
2330	11														
	12														
2328	13								VOLCANICLASTIC BRECCIA --TERTIARY VOLCANICS--						Driller felt change during advancement

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	MATERIAL DESCRIPTION	Soil Samples Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	13							VOLCANICLASTIC BRECCIA; greenish-gray (5G6/1); slightly weathered; moderately strong; slightly fractured; angular clasts to 1/2" in fine matrix --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)-- *(continued)*						
	14													
2326														
	15		1		0		M			3	50/4"	100	1110	Switch to HQ core
	16	1		100		100							[45]	
2324					0		M						1112 / 1147	
	17				0									
	18													UCS = 2130 psi
2322					0		M							
	19	2		100		100	M, M, M						[75]	
					0									
	20				0									
2320														
	21				0								1151 / 1216	
	22				0									
2318														
	23				1		1	Very weak 1: 20°, J, VN, Cl+Sd, Sp, Pl, S-SR						
	24	3		100		84	1, 1	Weak					[100]	
2316					2									
	25				0		M							
	26						M, M							
2314					0								1219 / 1223	
	27				0									
	28	4		100		100	M						[75]	
2312					0									
	29													

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

Log of Soil and Core Boring B-17

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Number	MATERIAL DESCRIPTION	Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	29		2		0			VOLCANICLASTIC BRECCIA; greenish-gray (5G6/1); slightly weathered; moderately strong; slightly fractured; angular clasts to 1/2" in fine matrix --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)-- *(continued)*						
	30	4		100	0	100							[75]	
2310	31				0		M						1227 / 1231	
	32				0			Coarser clasts to 2"						
2308	33				0									
	34	5		100	1	86							[100]	
2306	35				3		1	Light brownish gray (5YR6/1); moderately weathered; weak; highly fractured 1: 60°, J/Sh, W, Ca+Mn+Fe, Pa+Su IR, VR-Slk (rough grooves) Abundant mechanical fractures						
	36				0		M						1234 / 1239	
2304	37				0		M, M							
	38				0		M							
2302	39	6		100	0	100							[75]	
	40				0		M	1.5" Clast						UCS = 2985 psi
2300	41				0								1243	

TOTAL DEPTH = 41.5 FEET
Grout mix: 20 gallons of water, five 47# bags of cement, no bentonite

Depth scale continues: 42, 43, 44, 45; Elevation 2298, 2296.

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

Log of Soil Boring B-18

Date(s) Drilled	**10/11/2018**	Logged By	**P. Respess**	Reviewed By	**B. Aldridge**
Drilling Method	**Hollow Stem Auger**	Drill Bit Size/Type	**6-inch flight auger**	Total Depth of Borehole	**28.3 feet**
Drill Rig Type	**Truck Mounted Mobile B-53**	Drilling Contractor	**Gregg Drilling**	NAVD 88 Ground Surface Elevation	**2347 feet**
Groundwater Level(s)	**15.0 feet below ground surface (10/11/2018)**	Sampling Method(s)	**2.5-inch ID ModCal, SPT**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Cement grout to ground surface**	Borehole Location	**Scotch Creek**	Coordinate Location	**N 2603250 E 6441988**

Elevation feet	Depth, feet	SAMPLES: Type	SAMPLES: Number	SAMPLES: Sampling Resistance	SAMPLES: Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	0						2.5-inches ASPHALT roadway				Start 10/11/2018; hollow stem auger 0-28ft.
							GRAVEL				
2345							SANDY LEAN CLAY (CL); medium stiff to stiff; reddish brown; 80-90% medium plasticity FINES; 10-20% fine to coarse grained SAND; occasional GRAVEL and COBBLE --FILL--				Smooth drilling
	5						GRAVEL				Rig chatter
2340											Return to smooth drilling to 13ft.
	10										
2335											
							POORLY GRADED GRAVEL with SAND (GP); medium dense; varied dark grey with purple, red, and yellowish brown; fine to coarse angular GRAVEL, COBBLES, and BOUDLERS; fine to coarse grained SAND --FILL--*(continued)*				Rig chatter
	15						▽				
2330											
							BOUDLER				Driller indicates hard rock at 18ft.
	20										
2325							ALLUVIUM				Driller indicates smooth, consistent drilling 22-25ft.
	25		S-01	50/3	0						
			S-02	100/4			BOUDLER, basalt				
2320											
			S-03	100/4			VOLCANIC SILTSTONE; reddish purple; slightly weathered to fresh; weak to moderately strong; very thinly laminated --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS)?--				
	30						**TOTAL DEPTH = 28.3 FEET**				

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

Log of Soil and Core Boring B-19

Date(s) Drilled	**10/11/2018**	Logged By	**P. Respess**	Reviewed By	**B. Aldridge**
Drilling Method	**Hollow Stem Auger, Rotary Wash, HQ-3 Rock Core**	Drill Bit Size/Type	**3 7/8-inch tricone; 3 7/8-inch #6 HQ bit**	Total Depth of Borehole	**37.5 feet**
Drill Rig Type	**Truck Mounted Mobile B-53**	Drilling Contractor	**Gregg Drilling**	NAVD 88 Ground Surface Elevation	**2346 feet**
Groundwater Level	**15.0 feet below ground surface (10/11/2018)**	Sampling Methods	**2.5-inch ID ModCal, SPT, HQ Core Barrel**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Cement grout to ground surface**	Borehole Location	**Scotch Creek**	Coordinate Location	**N 2603261 E 6442042**

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
2346	0								2.5-inches ASPHALT roadway						Start 10/11/2018; hollow stem auger 0-23ft.
									GRAVEL --ROAD BASE--						
	1								SANDY LEAN CLAY (CL); medium stiff to stiff; reddish brown; 80-90% medium plasticity FINES; 10-20% fine to coarse grained SAND; occasional GRAVEL and COBBLE --FILL--						
2344	2														
	3														
2342	4														
	5								SANDY SILT (ML); stiff; light reddish brown; non to medium plasticity FINES; fine to medium grained SAND --FILL--		S01	9, 8, 10			S-01 One liner retained (6-6.5ft.) SA: S=30%; F=70%
2340	6														
	7														
2338	8														
	9														
2336	10								FAT CLAY with SAND (CH); medium stiff; light reddish brown; high plasticity FINES; fine to medium grained SAND --FILL--		S02	9, 7, 7			S-02 One liner retained (11-11.5ft.) LL=54; PL=22
	11														
2334	12														
	13														

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

Log of Soil and Core Boring B-19

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							POORLY GRADED GRAVEL with SAND (GP); medium dense; dark grey with some yellow brown; fine to coarse angular GRAVEL, COBBLES, and BOUDLERS; fine to coarse grained SAND; trace to little low plasticity FINES; moist to wet --FILL--*(continued)*						Rig chatter
	14													
2332														
	15							▽		S03	6, 4, 4			S-03 One liner retained (16-16.5ft.) SA: G=6%; S=42%; F=52%
	16													
2330								SANDY SILT (ML); soft to medium stiff; dark grey; fine grained SAND; low plasticity FINES; trace GRAVEL; wet						
	17							CLAYEY GRAVEL with SAND (GC); medium dense; dark grey with some yellow brown; fine to coarse angular GRAVEL, COBBLES, and BOUDLERS; fine to coarse grained SAND; low plasticity FINES; moist to wet						Continued rig chatter
	18													
2328														
	19													
	20									S04	12, 21, 12			S-04 One liner retained (21-21.5ft.) SA: G=40%; S=34%; F=26%
2326														
	21													
	22							ALLUVIUM						
2324														
	23							BOUDLER, basalt						
	24													
2322														Switch to rotary wash drilling with 3 7/8-inch tricone bit; yellowish brown clayey cuttings with rounded gravel 24.5-28ft.
	25													
	26													
2320														
	27													
	28							VOLCANIC SILTY CLAYSTONE/SILTSTONE; reddish purple; slightly weathered; weak; very thinly laminated --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--						Reddish purple clayey and rock cuttings
2318														
	29													

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								VOLCANIC SILTY CLAYSTONE/SILTSTONE; reddish purple; slightly weathered; weak; very thinly laminated --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--*(continued)*						
	30								Becomes weak to moderately strong		S05	50/3		1150	Switch to HQ rock coring with 3 7/8-inch diamond bit; all breaks mechanical
2316			1		0		m								
	31						m m								
		1		100	0	100	m m							[8]	
	32														
2314					0		m m m m							1208 1215	
	33				0		m m m								
	34														
2312					0										
	35	2		86		86	m							[13]	
					0										
	36														
2310					0		m								0.7 ft. of core slipped out of core barrel; left in hole prior to grouting
	37				NA		NR							1238	
									TOTAL DEPTH = 37.5 FEET						
	38														
2308															
	39														
	40														
2306															
	41														
	42														
2304															
	43														
	44														
2302															
	45														

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

Log of Soil and Core Boring B-20

Date(s) Drilled	**10/10/2018**	Logged By	**P. Respess**	Reviewed By	**B. Aldridge**
Drilling Method	**Hollow Stem Auger, Rotary Wash, HQ-3 Rock Core**	Drill Bit Size/Type	**3 7/8-inch tricone; 3 7/8-inch #6 HQ bit**	Total Depth of Borehole	**47.0 feet**
Drill Rig Type	**Truck Mounted Mobile B-53**	Drilling Contractor	**Gregg Drilling**	NAVD 88 Ground Surface Elevation	**2340 feet**
Groundwater Level	**14.5 feet below ground surface 10/10/2018**	Sampling Methods	**2.5-inch ID ModCal, SPT, HQ Core Barrel**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Cement grout to ground surface**	Borehole Location	**Camp Creek**	Coordinate Location	**N 2602768 E 6443160**

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								2.5-inches Aggregate base						Start 9:00 10/10/2018; hollow stem auger 0-28ft.
2340									POORLY GRADED GRAVEL (GP); dense; fine to coarse GRAVEL and COBBLES, little no plasticity FINES; moist --FILL--						
	1														
	2														
2338															
	3								FAT CLAY (CH); medium stiff; brown; medium plasticity FINES; trace fine grained SAND; occasional GRAVEL and COBBLES; moist						
	4														
2336															
	5										S01	3			S-01 One liner retained (5.5-6ft.) LL=87; PL=24
	6											5			
2334												6			
	7														
	8														
2332															
	9														
	10								SANDY LEAN CLAY (CL); medium stiff; brown; medium plasticity FINES; fine to coarse grained SAND; rare GRAVEL; moist		S02	4			S-02 One liner retained (10.5-11ft.) SA: G=3%; S=33%; F=64%
2330												4			
	11											6			
	12														
2328															
	13														

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
	13								SANDY LEAN CLAY (CL); medium stiff; brown; medium plasticity FINES; fine to coarse grained SAND; rare GRAVEL; moist --FILL--*(continued)*						
2326	14								SANDY CLAY to CLAYEY SAND (CL-SC); medium stiff; olive brown; ~ 50% medium plasticity FINES; ~50% fine to coarse grained SAND and fine GRAVEL ▽						
2324	15–16										S03	7, 8, 7			S-03 One liner retained (16-16.5ft.)
2322	17–19								POORLY GRADED GRAVEL with SAND (GP); medium dense to dense; fine to coarse grained SAND; fine to coarse GRAVEL with COBBLES and BOULDERS, wet --ALLUVIUM--						
2320	20–21								CLAYEY SAND (SC); medium dense; fine to coarse grained SAND; fine GRAVEL with COBBLES and BOULDERS, wet --ALLUVIUM--		S04	4, 5, 6			S-04 One liner retained (21-21.5ft.) SA: G=14%; S=42%; F=44%
2318, 2316	22–24														
2314	25–27										S05	22, 24, 18			S-05 One liner retained (26-26.5ft.)
2312	28–29								BOULDER: 28-29.5 ft.						Switch to rotary wash drilling with 3 7/8-inch tricone bit at 28ft.

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

Log of Soil and Core Boring B-20

Columns: 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

Elevation marks: 2310, 2308, 2306, 2304, 2302, 2300, 2298, 2296
Depth marks: 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45

29–29.5 ft: BOULDER: 28-29.5 ft.
--ALLUVIUM--*(continued)*

29.5–31 ft: POORLY GRADED GRAVEL with SAND (GP); medium dense to dense; fine to coarse grained SAND; fine to coarse GRAVEL with COBBLES and BOULDERS

Field notes (~30 ft): Skip sample; rig behavior indicates gravel and cobbles

31–45 ft: BASALT; dark grey; slightly weathered; moderately strong; with Fe staining around joints; chlorite and quartz infilling; numerous healed fractures
--TERTIARY to QUATERNARY INTRUSIVE BASALT--

Field notes (~35 ft): Skip sample; rig behavior indicates gravel and cobbles

Soil sample at 40 ft: Number S06; Blows 50/1.5

Rock core:

Run No.	Box No.	Depth (ft)	Recovery, %	Fractures per Foot	R Q D, %	Drill Time [Rate, ft/hr]
1	1	40–42.7	100	3, 2, 2	30	1305 / [7] / 1328
2		42.7–45	100	0, 1	79	1338 / [12]

Field notes (40 ft): Switch to HQ rock coring with 3 7/8-inch diamond bit
UCS = 343 psi

Run 1 fractures (Numbers 1, 2, 3, m, 4, 5, 1, 6):
1: 60, J, N, Fe+Ch, Pa, Wa-Pl, SR
2: 70-90, J, VN, Fe, Pa, Wa, SR
3: 70, J/V, Vn, Qz, Pa, Wa, SR
4: 60, V, VN, Qz, Pa-Sp, Wa-Pl, SR
5: 40, J/V, N, Qz+Ch, Fi, Wa, ?
6: 40, J, VN, Ch, Pa-Su, Pl-Wa, SR

Run 2 fractures (Number 1):
1: 40, J, VN, Ch, Fi, Pl, ?

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
	45		1		1			2		BASALT; dark grey; slightly weathered; moderately strong; with Fe staining around joints; chlorite and quartz infilling; numerous healed fractures --TERTIARY to QUATERNARY INTRUSIVE BASALT--*(continued)*						UCS = 7517 psi
	46							3		2: 60, J/V, W (20mm), Ch, Fi, Wa, ?						
2294					2					3: 60, J, N, Ch, Sp, SR, ?						
								4		4: 70, J, VN, Ch, Sp, SR						
	47									**TOTAL DEPTH = 47.0 FEET**					1400	
	48															
2292																
	49															
	50															
2290																
	51															
	52															
2288																
	53															
	54															
2286																
	55															
	56															
2284																
	57															
	58															
2282																
	59															
	60															
2280																
	61															

Log of Soil and Core Boring B-201

Date(s) Drilled	8/23/2018 - 8/24/2018	Logged By	T. Vande Voorde	Checked By	B. Kozlowicz/K. Zeiger
Drilling Method	Rotary Wash; HQ-3 Rock Core	Drill Bit Size/Type	5-inch tricone; 5-inch rock bit; 4-inch #2 diamond coring bit	Total Depth of Borehole	50.5 feet
Drill Rig Type	Track Mounted Fraste XL	Drilling Contractor	Pitcher Drilling Company	NAVD 88 Ground Surface Elevation	2334 feet
Groundwater Level	Not encountered before rotary wash drilling	Sampling Methods	2.5-inch ID ModCal; SPT; HQ Core Barrel	Hammer Data	Automatic hammer; 140 lbs, 30-inch drop
Borehole Backfill	Cement grout to ground surface	Borehole Location	Iron Gate Reservoir; S of Klamath River	Coordinate Location	N 2601064 E 6460697

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								SANDY FAT CLAY (CH); very stiff; very dark greyish brown (10YR 3/4) with mottled yellow; 52% high plasticity FINES; 42% medium to coarse grained SAND; 6% angular GRAVEL up to 1 1/4-inch; trace organics (roots); dry --ALLUVIUM--						Start 10:00 8/23/2018 Trash barrel drilling to 3.5ft.
2332	1–2														Trash barrel sample at 1.5ft bagged.
	3								Becomes brown (10YR 4/3); GRAVEL is volcanic tuff and basalt						Trash barrel sample at 3-3.5ft bagged.
2330	4														Begin rotary wash drilling at 3.5ft with 5-inch tricone bit
	5								With streaks of very pale brown (10YR 8/4); GRAVEL up to 1/2-inch		S01	7 13 17	50		Switch to 5-inch rock bit at 5ft.
2328	6														2 liners retained LL=52; PL=23 SA: G=6.1% S=42.4%; F=51.5%
2326	7														
	8								FAT CLAY (CH); medium stiff; brown (10YR 4/3); 85% high plasticity FINES; 15% fine grained SAND; trace angular GRAVEL up to 1/4-inch; moist; cohesive						Rig chatter
2324	9														
	10										S02	2 3 4	33		
2322	11–13														

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

Log of Soil and Core Boring B-201

Elevation, feet	Depth, feet
	13
2320	
	14
	15
2318	
	16
	17
2316	
	18
	19
2314	
	20
	21
2312	
	22
	23
2310	
	24
	25
2308	
	26
	27
2306	
	28
	29

MATERIAL DESCRIPTION

Depth, feet	Material Description
13–19	FAT CLAY (CH); medium stiff; brown (10YR 4/3); 85% high plasticity FINES; 15% fine grained SAND; trace angular GRAVEL up to 1/4-inch; moist; cohesive --ALLUVIUM-- *(continued)*
15	Becomes 100% high plasticity FINES; with trace organic material (rodent bone) and black laminations
19–22	CLAYEY GRAVEL with SAND (GC); medium dense; brown (10YR 4/3); 55% angular basaltic GRAVEL up to 1 1/4-inch; 30% angular coarse grained SAND; 15% low plasticity FINES; wet
22–28.5	BOULDERS and COBBLES; dark bluish grey with white filled vesicles; round to angular COBBLES; some fine to coarse grained SAND; trace FINES; GRAVEL is slightly weathered, strong to very strong basalt --RIVER ALLUVIUM--
26	Round to angular basaltic GRAVEL and COBBLES up to 5-inches; occasional brecciated tuff
28.5	BASALT (see next page) 1: 25, J, VN, Fe, Su, Pl, SR 2: 25, J, W, Fe+Sd, Fi, Pl, R

SOIL SAMPLES

Depth, feet	Number	Blows / 6 in.	Recovery, %	Field Notes and Test Results
15–16.5	S03	3, 7, 5	89	3 liners retained LL=64; PL=26 SA: S=14%; SILT=36.6% CLAY=43.4%
20–21.5	S04	7, 10, 16	33	Possible slough
23–23.5	S05	50	50	

ROCK CORE

Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing	Number	Drill Time [Rate, ft/hr]
23.5–24.5	1	1	70	NA	NA	NR		1231 [4] 1248
24.5–25.5	2		90	NA	NA	NR		1258 [4] 1314
25.5–27.5	3		85	NA	NA	NR		1323 [7] 1341
27.5–28.5	4		100	NA	NA			1349 [5] 1402
28.5–29	5		100	1	80		m, 1	1422 [4]

FIELD NOTES AND TEST RESULTS

Depth, feet	Field Notes
22	Rig chatter
22–23	Some water loss Basalt fragments in cuttings 22-23ft.
23	Advance 5-inch casing to 23ft.
23.5	Switch to HQ coring with 4-inch #2 diamond bit at 23.5ft.
25.5–29.5	High water take 25.5ft to 29.5 ft.

ROCK CORE

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Number	Drill Time [Rate, ft/hr]
	29	5	1	100	1	80	2, 3, 4	[4] 1436 / 1459
2304	30	6		100	5	40*	1, 2, 3, 1, 4	[5]
2302	31–32				4		m, 1	1521 / 0830
	32–33	7		60	>6	0	2, 2, 3, 4, 5	[2] 0940 / 0958
2300	33–34				NA		m, m, m, m	
	34–35	8		57	0	0	m, 1	[4]
2298	35–36				NA			
	36–37				NA		m, 1, 1	1045 / 1055
2296	37–38		2		4		1, 1, 1, 1, 1	
	38–39	9		100	3	25*	2, 2, 2, 3	[4]
2294	39–40				5		2, 2	
	40–41				4		4, m, 1, 2	1154 / 1206
2292	41–42	10		100	4	20*	2, 3, 4, m, 4	[4]
	42–43				5		5, 1, 4	1234 / 1246
2290	43–44	11		100	5	60*	2, 2, 3	
	44–45				0			[8]

MATERIAL DESCRIPTION

BASALT; moderate bluish grey; slightly weathered; moderately strong to very strong; highly fractured; fine grained; with CaCO3 filled vesicles and occasional green phenocrysts
--TERTIARY to QUATERNARY INTRUSIVE BASALT--

1: 20, J, VN, Fe, Su, Pl, R
2: 80-90, J, VN, Fe, Su, Wa, SR
3: 50, J, N-MW, Fe+Cl, Su+Fi, Pl, SR
4: 60, J, N, Fe, Su, Pl. SR

Becomes slightly to moderately weathered with brown staining along joints; intensely fractured

Becomes light bluish grey; moderately to highly weathered/altered; moderately strong; with 1/2-inch wide Calcite vein
1: 30, J, ?, Fe+Sd, Su+Pa, Pl, R
2: 65, J, VN, Fe+Sd+Ca, Fi, Pl
3: 80, J, VN, H+Fe, Su, Pl, ?
4: 15, J, MW, Fe+Ca, Pa, Ir, VR
5: 70, J, VN, H+Fe+Sd, Fi, Pl

Becomes highly to completely weathered, highly oxidized, yellowish brown

Brown, moderately weathered, moderately strong

Becomes dark yellowish brown to pale tan, completely weathered, very weak, highly fractured, granular, partially decomposed to clay
1: 50, J, ?, No, No, Pl, R (possibly mechanical)

Becomes moderately to highly weathered, moderately strong to strong, fine grained matrix

1: 10-20, J, VN-N, Fe + some are H, Fi-Pa, Pl
2: 20-30, J, N, H+Fe, Fi, Pl
3: 5, J, MW, Fe+Cl, Su+Pa, Ir, R
4: 50, J, N, Fe+Sd, Su+Sp, Pl, R

Intensely fractured/broken, abundant oxidation

Becomes light bluish grey, slightly to locally moderately weathered, strong to very strong, irregular calcite filled vesicles
1: 20, J, N, Fe, Su, Pl, R
2: 15, J, N-VN, H+Fe, Pl, ?
3: 30, J, VN, No, No, Pl, ? (possibly mechanical)
4: 15, J, N, Fe, Su, Pl, R

Becomes moderately strong
5: 20, J, ?, Fe, Su, Pl, R
Intensely fractured

1: 30, J, VN, H+Fe, Fi, Pl
2: 10, J, N-VN, H+Fe, Pl
3: 60, J, VN, H+Fe, Su, Pl, SR
4: 60, J, VN, H+Fe, Fi, Pl

Becomes bluish grey with brownish orange staining along fractures, strong, fine grained, with irregular Calcite filled vesicles and veins

SOIL SAMPLES: Type | Number | Blows / 6 in. | Recovery, %

FIELD NOTES AND TEST RESULTS

Less but continued water take

Caving borehole at 26 ft.

End of day 8/23/2018
Begin day 8/24/2018

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

Log of Soil and Core Boring B-201

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
2288	45	11	2	100	4, 4, 3	60*	5, 6, 6, 6, 7, 8, 9, 10, m		BASALT; bluish grey; slightly to locally moderately weathered; strong; highly fractured; fine grained with calcite filled vesicles; brownish orange oxidation along fractures --TERTIARY to QUATERNARY INTRUSIVE BASALT-- *(continued)* 5: 10-15, J, N, Fe, Su, Pl 6: 10, J, N-W, Fe, Su, Ir, VR 7: 80, J, N-MW, Fe+Ca, Su+Pa, Pl, SR 8: 55, J, N, Fe, Su, Pl, SR with 1-inch weathered rind 9: 20, V, N, Ca, Fi, Pl 10: 40, J, ?, Fe, Su, Pl-Ir, VR					[8] 1323	
2286	47.5	12		100	1, 1, NA	100	1, 2, m, 3		Becomes dark bluish grey, slightly weathered, very strong, with white, round to angular infilling, possible flow direction of ~60° 1: 40, J, MW, Ca+Fe, Fi+Su, Pl, SR 2: 80-90, J, VN, Fe+Ca, Su+Pa, Pl-Ir, R 3: 60, J, N-MW, Fe+Ca, Su+Fi, Pl, R					1332 [11] 1349	
	50.5								**TOTAL DEPTH = 50.5 FEET**						

Elevation scale: 2288, 2286, 2284, 2282, 2280, 2278, 2276, 2274
Depth scale: 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61

Project: Klamath River Renewal Project Project Location: Copco and Iron Gate Reservoirs Project Number: 60537920	**Log of Core Boring B-202** Sheet 1 of 7

Date(s) Drilled	8/18/2018 - 8/22/2018	Logged By	T. Vande Voorde	Checked By	B. Kozlowicz/K. Zeiger
Drilling Method	Rotary Wash, HQ-3 Rock Core	Drill Bit Size/Type	3 7/8-inch tricone; 4-inch #6 diamond coring bit; 4-inch carbonado coring bit	Total Depth of Borehole	100.5 feet
Drill Rig Type	Track Mounted Fraste XL	Drilling Contractor	Pitcher Drilling Company	NAVD 88 Ground Surface Elevation	2332 feet
Groundwater Level	4.8 feet bgs 8/23/2018	Sampling Methods	HQ Core Barrel	Inclination from Horizontal/True North Bearing	60°/205°
Borehole Completion	Two VWPs with neat cement grout to ground surface	Location	Iron Gate Reservoir; S/SE of Daggett Rd	Coordinate Location	N 2601406 E 6460935

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	Packer Test Intervals	Drill Time, 24-hr [Drill Rate, ft/hr]	FIELD NOTES AND OTHER TESTS
	0								SANDY FAT CLAY with GRAVEL (CH); stiff; dark brown (10YR 3/3) to very dark greyish brown (10YR 3/2); 70% high plasticity FINES; 15% angular GRAVEL up to 1/4-inch; 15% coarse grained SAND; dry; GRAVEL is volcanic tuff; some organics (grass and roots) --ALLUVIUM--			6-inch trash barrel to 8.5ft.
2332												
	1											
	2											
2330	3											
	4											
2328	5								With increasing SAND; becomes brown (10YR 4/3); dry to moist			
	6											
	7											
2326												
	8											Advance 4-inch casing to 9ft. Switch to rotary wash drilling with 3 7/8-inch tricone bit.
	9											
2324	10											
	11											
2322	12											
	13											

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

Log of Core Boring B-202

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing / Number	MATERIAL DESCRIPTION	Packer Test Intervals	Drill Time, 24-hr [Drill Rate, ft/hr]	FIELD NOTES AND OTHER TESTS
	13–14							With increasing GRAVEL and decreasing SAND; abundant grey to black basaltic COBBLES fragments			Rig chatter; possible boulder at 13-14ft.
2320	14–15.5	1	1	53	NA; NA	NA	NR	BOULDERS and COBBLES; bluish grey; 60% angular GRAVEL up to 2-inches; 30% medium to coarse grained SAND; 10% medium plasticity FINES; BOUDLERS (fragments) and COBBLES are fresh to slightly weathered, rounded, very strong porphyritic BASALT up to 10-inches; MATRIX is fine grained with quartz and trace pyrite phenocrysts weathered to a POORLY GRADED SAND with GRAVEL and CLAY; --RIVER ALLUVIUM--		1301 [8] 1312	Switch to HQ coring at 14ft with 4-inch #6 diamond coring bit
2318, 2316	15.5–19	2		66	NA; NA; NA; NA	NA	NR			1324 [6] 1357	Coarse material from Run 1 - 14 retained in core box
	19–20.5	3		100	NA; NA	NA		With basaltic BOULDERS (fragments) up to 1-foot; rounded to angular GRAVEL, coarse grained SAND, and medium plasticity FINES		1413 [6] 1429	
2314	20.5–23	4		56	NA; NA; NA	NA	NR			1438 [14] 1449	Driller notes softer material at 21.5ft. Minor fluid loss.
2312	23–24.5	5		87	NA; NA	NA	NR			1457 [7] 1510	Driller notes material is alternating soft and hard.
	24.5–25.5	6		100	NA	NA				1521 [10] 1527	
2310	25.5–28	7		100	NA; NA; NA	NA				1535 [11] 1549	Minor fluid loss.
2308	28–29	8		68	NA	NA		with basaltic BOULDERS (fragments) and COBBLES up to 5-inches; abundant rounded GRAVEL		0750 [6]	End of day 8/18/2018 Begin day 8/19/2018

ROCK CORE

Depth, feet	Elevation, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing	Drill Time, 24-hr [Drill Rate, ft/hr]
29–30.5		8	1	68	NA / NA	NA	NR	[6] 0814
30.5–32.5	2306	9		100	NA / NA	NA		1102 [8] 1117
32.5–34.5	2304	10		100	NA / NA	NA		0934 [7] 0951
34.5–36.5	2302	11		85	NA / NA	NA	NR	1002 [4] 1031
36.5–39	2300	12		12	NA / NA / NA	NA	NR	1046 [7] 1108
39–40.5	2298	13		0	NA / NA	NA	NR	1126 [6] 1142
40.5–45	2296, 2294	14		8	NA / NA / NA / NA / NA	NA	NR	1216 [13]

MATERIAL DESCRIPTION

29 ft: BOULDERS and COBBLES; bluish grey; 60% angular GRAVEL up to 2-inches; 30% medium to coarse grained SAND; 10% medium plasticity FINES; BOULDERS (fragments) and COBBLES are fresh to slightly weathered, rounded, very strong BASALT up to 10-inches; MATRIX is fine grained with quartz and trace pyrite phenocrysts weathered to a POORLY GRADED SAND with GRAVEL and CLAY; with boulders and cobbles up to 8-inches at 28.2'
--RIVER ALLUVIUM--*(continued)*

32.7 ft: Becomes round to angular COBBLES up to 4-inches, abundant fine GRAVEL, coarse grained SAND, with some brown, no plasticity FINES

40.7 ft: With basalt and very strong brecciated tuff COBBLES

FIELD NOTES AND OTHER TESTS

- 29 ft: Increasing fluid loss.
- 30.1 ft: Advance 4-inch casing to 29.5ft.
- 32.1 ft: Swivel breaks at 32.5ft; End of day 8/19/2018 Begin day 8/20/2018
- 35.1 ft: Drill fluid becomes brownish grey.
- 36.3 ft: Some fluid loss.
- 40.1 ft: Switch to 4" carbonado bit at 40.5ft; pale brown, tuff-like material in bit
- 43.1 ft: Drill fluid becomes light grey

Packer Test Intervals: (none)

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

Log of Core Boring B-202

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Number	MATERIAL DESCRIPTION	Packer Test Intervals	Drill Time, 24-hr [Drill Rate, ft/hr]	FIELD NOTES AND OTHER TESTS
	45	14		8	NA	NA	NR	VOLCANIC BRECCIA; light grey; highly to completely weathered; very weak with strong clasts; slightly fractured; locally friable; fine grained matrix with angular to subrounded strong, black clasts up to 3/4-inch and extremely weak, green clasts up to 1 1/4-inch --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--		1240 / 1252	
	46		2				m				
2292		15		65	NA	0	NR			[8]	
	47				NA		m			1307 / 1321	
	48				0		1, m	1: 15, J, N, No, No, Pl, R-VR (likely mechanical)			
								Becomes pale greenish grey, weak to locally extremely weak, highly weathered, increased percentage of clasts in a fine grained matrix			Minor fluid loss.
2290	49	16		100	0	0	m			[7]	
	50				0		m, 1			1347 / 1403	
2288	51				0		2	1: 10, J, N-VN, Ch?, Pa, Pl, R (mechanical) 2: 0, J, N-MW, No, No, Ir, VR (mechanical) 3: 15, J, VN-N, No, No, Pl, R (mechanical)			
	52				0		3				
	53	17		100	0	0				[10]	
2286	54				0			With green, clayey clasts elongated vertically			
	55				1		1, m			1434 / 1303	End of day 8/20/2018 Begin day 8/21/2018
2284	56				0			Light bluish grey, completely weathered, extremely weak, with coarse grained SAND and fine GRAVEL			
	57				NA		1, m	Increasingly cohesive, extremely weak, highly to completely weathered, with smaller clasts			
2282	58	18		44	NA	0	NR	1: 55, J, VN-N, No, No, Pl		[14]	
	59				NA						
2280	60				1		m, m, 1	60.5-61.4ft: completely weathered to a residual soil, extremely weak, friable, with soil-like texture, clasts up to 1/2-inch		1325 / 1340	
	61										

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	Packer Test Intervals	Drill Time, 24-hr [Drill Rate, ft/hr]	FIELD NOTES AND OTHER TESTS
	61		3		0		m		VOLCANIC BRECCIA; light bluish grey; completely weathered; extremely weak with strong clasts; slightly fractured; locally friable; fine grained matrix with angular to subrounded strong, black clasts up to 3/4-inch and extremely weak, green clasts up to 1 1/4-inch --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--*(continued)*			
2278	62–63	19		80	0	0			Highly weathered, with strong, black clasts up to 3/4-inch and very soft, green clasts up to 1 1/4-inch, extremely weak/friable 63.6-64.2'		[15]	
	63–64				0		1, m, m, m					
	64–65				NA		NR		1: 0, J, MW, No, No, Pl/Ir, R (mechanical)			
2276	65				NA		NR, m, m		Weaker zone		1400	
	65.5–68	20		100	0, 0	0			Becomes highly to completely weathered; increased clast size and percentage, larger subrounded basaltic clasts		1412 [9]	
2274	67–68				0		m				1429	
	68–70.5	21		100	0, 0	0			With subangular clasts; 1 to 2-inch thick, planar green clast		1442 [7]	
2272	70–70.5				0		m				1505	0.1' of Run 20 recovered with Run 21
	70.5–75.5	22	4	100	0, 0, 0, 0, 0	0	1, 2, m, m, m		Becomes very light bluish grey, with basaltic clasts up to 1.5-inch and filled vesicles; Planar green clast; 1: 50-60, J, VN, No, No, Pl, SR (mechanical); 2: 5, J, VN, No, No, Pl, SR (mechanical); Planar green clast		1517 [7]	
2270 / 2268	72–75										1600	
2266	75.5–77	23		100	0, 0	0			Becomes light greenish grey; decreasing percentage of clasts		0722 [8]	End of day 8/21/2018 Begin day 8/22/2018 0.2' of Run 20 recovered with Run 21

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	Packer Test Intervals	Drill Time, 24-hr [Drill Rate, ft/hr]	FIELD NOTES AND OTHER TESTS
	77		4		0				VOLCANIC BRECCIA; light greenish grey; highly to completely weathered; extremely weak with strong clasts; slightly fractured; locally friable; fine grained matrix with angular to subrounded strong, black clasts and extremely weak, green clasts up --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated) --*(continued)*			
	78	23		100	0	0	m				[8]	
2264	79				0		1		With increased clast size and percentage; matrix is extremely weak matrix with strong basaltic clasts and decomposed green clasts 1: 0-5, J, N, No, No, Pl, SR (mechanical)			
	80				0		m, m, m				0802 / 0817	
2262	81				0		m					UCS 82.0-82.8 = 614 psi
	82				0		m		With stronger matrix			Top of Run 24 mechanically broke when transferring to core box
2260	83	24		100	0	0					[10]	
	84		5		0		m					
	85				0		m				0847 / 0900	
2258	86				0				With weaker matrix			
	87				1		1		1: 30, J/V, N-MW, Ca, Fi, Pl, SR-R (vuggy with Calcite crystals)			
2256	88	25		100	0	6	m				[30]	
	89				0							
2254	90				1		2, 3, m		2: 10-40, Contact, rough 3: 55, J, N?, Ca?, Pa, Pl, SR-S VOLCANIC MUDSTONE; dusky to very dusky red (2.5 YR 3/2 TO 2.5/2); slightly weathered; weak to very weak; slightly fractured; fine grained with occasional gravel up to 1/2-inch		0910 / 0923	
	91				0		m		Becomes dark reddish brown			
2252	92	26		86	0	86	m				[19]	
	93											

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	Packer Test Intervals	Drill Time, 24-hr [Drill Rate, ft/hr]	FIELD NOTES AND OTHER TESTS
	93		5		2		1		VOLCANIC MUDSTONE; dusky to very dusky red (2.5 YR 3/2 TO 2.5/2); slightly weathered; weak to very weak; slightly fractured; fine grained with occasional gravel up to 1/2-inch --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated) --*(continued)*			
	94	26		86	NA	86	2, 2, m		With trace gravel		[19]	
2250	95				NA		m		1: 40, J, N, Cl, Fi, Pl, ? 2: 20-30, J, N-W, Cl + Gravel, Pa-No, Ir-Pl, R		0939	
	96	27	6	100	0	100	1, m, 2, m, 1		Without gravel; increasing strength 1: 10, J/V, N-MW, H+Cl, Fi, Pl, ? 2: 70, J, ?, No, No, Pl. ? (mechanical) 1: 40, J, W, Cl+Sd, Pa, Pl, R		0955 [8] 1003 1017	
2248	97				0							
	98	28		93	0	86					[13]	
2246	99				NA							
	100				NA						1035	

TOTAL DEPTH = 100.5 FEET
Televiewer and caliper survey by NorCal Geophysics 8/22/2018.
Install two VWPs at 28ft and 72ft with neat cement grout to ground surface with 3ft above-ground monument.

Depth scale continues: 101, 102 (2244), 103, 104 (2242), 105, 106 (2240), 107, 108, 109

Project: Klamath River Renewal Project Project Location: Copco and Iron Gate Reservoirs Project Number: 60537920	**Log of Soil and Core Boring B-203** Sheet 1 of 8

Date(s) Drilled	**1/8/2019-1/11/2019**	Logged By	**P. Respess**	Checked By	**S. Janowski**
Drilling Method	**Rotary Wash, HQ-3 Rock Core**	Drill Bit Size/Type	**3-7/8-inch tricone, 3 3/4-inch diamond coring bit #10**	Total Depth of Borehole	**120.0 feet**
Drill Rig Type	**Barge Mounted CME-45**	Drilling Contractor	**Taber Drilling**	NAVD 88 Ground Surface Elevation	**2305 feet**
Groundwater Level	**25 feet above ground surface**	Sampling Methods	**SPT, HQ Core Barrel**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Completion	**Bentonite cement grout to ground surface**	Location		Coordinate Location	**N 2601762 E 6461124**

Elevation, feet	Depth, feet	ROCK CORE: Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	MATERIAL DESCRIPTION	Packer Test Intervals	SOIL SAMPLES: Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	0							SILTY SAND with GRAVEL and COBBLES (SM); various lithologies; shell fragments; rounded clasts --ALLUVIUM (Qal)--			1	20, 54			Mudline is 24' below reservoir level
2304	1														End of day 1/8/2019
	2	1	1	16	NA, NA, NA	NA	NR							0906, [15]	Begin day 1/9/2019 Mudline is 25' below reservoir level Tricone to 2' switch to HQ-3
2302	3							BASALT COBBLE							
	4				NA		NR	VOLCANICLASTIC BRECCIA; yellow-brown; highly weathered; very weak; angular clasts up to 1/4"-1" --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--						0916	Yello-brown cuttings
2300	5	2		0	NA, NA	0	NR							0923	0% Water Circulation Return (WCR)
2298	6.5				NA, NA						2	18, 38, 50/5"	71	0923	
	8	3		0	NA, NA	0	NR							1239, [10]	Advance 5" HWT casing to 8'; good WCR
2296	9							Becomes grayish blue-green (5BG5/2)							Blue-gray cuttings
2294	10				NA, NA, NA									1252	0% WCR to 13' Change HQ drill bit; no advancement; change to tricone advancement
2292	13														

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

Log of Soil and Core Boring B-203

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing	Number	MATERIAL DESCRIPTION	Packer Test Intervals	Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	13		1		NA				VOLCANICLASTIC BRECCIA; grayish blue-green (5BG5/2); highly weathered; very weak; angular clasts up to 1/4"-1" --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)-- *(continued)*						1410	Good WCR; blue-green clayey cuttings
	14				NA											
2290	15	4		0	NA	0	NR								[16]	
	16				NA			M							1423 / 1443	Change HQ drill bit to increase recovery
2288	17				NA											
	18				NA											Blue-green clayey cuttings
2286	19	5		20	NA	0	NR								[75]	
	20				NA			M, M								
2284	21				NA			M, M	Broken; Becomes slightly weathered; moderately strong; slightly fractured						1447 / 1455	
	22				0											
2282	23	6		100	0	0		M, M							[30]	
	24				0			M							1500 / 1503	
2280	25	7		100	0	0				PT#1 26.5'-46.5'					[38]	
	26				0			M, M							1507 / 1510	
2278	27							M,M	Moderately weathered; weak							
	28	8		100	0	0									[38]	
2276	29				0			M								

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	MATERIAL DESCRIPTION	Packer Test Intervals	Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	29		1		0			VOLCANICLASTIC BRECCIA; grayish blue-green (5BG5/2); slightly weathered; moderately strong; angular clasts up to 1/4"-1"; slightly fractured --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)-- *(continued)*							Good WCR
	30	8		100	0	0	M							[38]	
2274	31				0		M	Becomes moderately weathered; weak to very weak						1518 1526	
	32		2		0		M, M, M	Broken							
2272	33				0										
	34	9		100	0	0		Becomes very to extremely weak						[38]	
2270	35				1		M,1	1: 50°, J, N, Ca, Pa, Ir-Wa, SR							
	36				NA		NR	Broken						1534 1539	
2268	37				0		M, M,M	Becomes weak to very weak							
	38				0		M								
2266	39	10		92	0	0	M							[43]	
	40				1		M, M, 1	1: 40°, J, N, Ca, Pa, Ir-Wa, SR							
2264	41				NA		M, M, NR							1546 1550	
	42				0		M, M								
2262	43				0										
	44	11		92	0	0	M, M	BASALT; grayish red purple (5RP4/2); highly weathered; very to extremely weak						[38]	Red-brown cuttings
2260	45														

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Number	MATERIAL DESCRIPTION	Packer Test Intervals	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	45		2		NA		M	BASALT; grayish red purple (5RP4/2); highly weathered; very to extremely weak; slightly fractured; mechanically broken to 47.8' --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)-- *(continued)*	[illegible]-65.5'						
		11		92		0									
	46				NA		M							1558 / 1020	End of day 1/9/2019 Begin day 1/10/2019
2258	47		3												
					NA		M								
	48							VOLCANICLASTIC BRECCIA; dark greenish gray to greenish gray (5G4/1-6/1); slightly weathered; weak; slightly fractured; angular clasts up to 1/4"-1"; abundant calcite inclusions and veinlets							
		12		100	0	73	M							[40]	
2256	49						M								
					1		1	Becomes moderately fractured 1: 30°, J/V, VN-N, Ca, Pa, Ir-Wa, SR							
	50							Mechanically broken							50% WCR
					NA		M	BASALT; medium bluish gray (5B5/1) to dark gray (N3); slightly weathered; moderately strong; abundant calcite inclusions						1026 / 1033	
2254	51				0		M								
	52				0										
2252	53	13		96		96								[33]	
					1		1	1: 70°, J, N, Cl, Fi, Pl-Wa							
							M								
	54				0		M								
2250	55				NA		1	Becomes dark gray (N3); highly to moderately fractured 1: 70°, J, VN, No, No, Pl-Wa, SR 2: 35°, J, VN, No, No, Pl-Wa, SR 3: 60°, J, N, Ca, Pa, Pl-Wa, SR 4: 50°, J, VN, No, No, Pl-Wa, SR 5: 20°, J, VN, No, No, Pl-Wa, SR						1042 / 1051	
	56						2, 3								
					2		4								
2248	57				1		5								
	58	14		100		86								[43]	0% WCR
					0										
2246	59				1										
	60						6, M, M	6: 30°, J, VN-N, Ca (Ch?), Pa, Pl-Wa, SR							
					NA		M,M, M	Overdrilled						1058 / 1108	
2244	61	15	4	100		100	M,M								

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	MATERIAL DESCRIPTION	Packer Test Intervals	Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	61	15	4	100	1	100	1	VOLCANICLASTIC BRECCIA; dark greenish gray to greenish gray (5G4/1-6/1); slightly weathered; moderately strong, angular clasts up to 1/4"-2"; hihgly to moderately fractured; abundant calcite inclusions and veinlets --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)-- *(continued)*						[25]	Continued 0% WCR
	62				0		M	1: 40°, J, N, Ca, Pa, Ir-St, SR-R							
2242	63	16		80	1	80	M, 1							1114 / 1120	
	64				1		1	1: 35°, J, VN-N, No, No, Pl-Wa, SR	PT#3 65.5'-85.5'					[38]	
2240	65				NA		M, NR							1124 / 1306	
	66	17		100	0	100	M, 1,M	1: 60°, J, VN-N, No, No, Wa, SR							
2238	67				1			BASALT; dark gray (N3); slightly weathered; moderately strong; highly to locally intensely fractured; abundant calcite inclusions							
	68				1		2, 3	2: 60°, J, VN, No, No, Wa, SR 3: 70°, J, N-MW, Ca, Pa, Wa, SR						[38]	
2236	69				1		M								
	70				NA		4, M	4: 70°, J/Sh, VN, Ca, Pa, Pl-Wa, S-Slk Mechanically broken						1314 / 1321	
2234	71	18		100	1	92	1,2, M, 3	1: 80°, J, VN-N, Ca+Ch?, Pa, Pl-Wa, S-SR 2: 60°, J, VN-N, Ca+Ch?, Pa, Wa, SR 3: 50°, J, VN, No, No, Pl-Wa, SR-S 4: 50°, J, VN-N, Ca, Pa, Wa, SR 5: 60°, J, VN, Ca, Pa, Pl, S							
	72				2		M, 4, 4								
2232	73				0		M							[50]	
	74				1		5	Becomes medium dark gray (N4)							
2230	75				2		M, M, 5, M	Becomes dark gray (N3)						1327 / 1332	
	76	19	5	100	NA	76	1, 2, M	1: 80°, J, N, Ca, Sp, Pl-Wa, S-SR 2: 50°, J, VN, Ca, Sp, Pl-Wa, S-SR Weak; mechanically broken							
2228	77														

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

Log of Soil and Core Boring B-203

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	MATERIAL DESCRIPTION	Packer Test Intervals	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	77		5		6		M, 3, 4	BASALT; dark gray (N3); slightly weathered; moderately strong; highly to locally intensely fractured; abundant calcite inclusions; with numerous healed fractures (not logged) --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)-- *(continued)*			Continued 0% WCR
	78	19		100	3	76	5, M, 6	3: 55°, J, VN, Ca, Sp, Wa, S-SR 4: 60°, J, VN-N, Ca, Sp, Wa, S-SR 5: 40°, J, VN, Ca, Sp, Pl-Wa, SR 6: 30°, J, VN, Ca, Sp, Pl-Wa, SR 7: 40°, J, VN-N, Ca, Sp, Pl-Wa, SR 8: 40°, J, VN-N, Ca, Sp, Pl-Wa, SR 9: 50°, J, VN-N, Ca, Sp, Pl-Wa, SR 10: 75°, J, VN-N, Ca, Sp, Pl-Wa, SR		[60]	
2226	79				3		7, 8, M				
	80				5		9, 10, M	Weak; mechanically broken		1337 / 1342	
2224	81				3		1, 2, M, 3	1: 30°, J, VN, Ca, Sp, Pl-Wa, SR 2: 50°, J, N, Ca, Sp, Pl-Wa, SR 3: 30°, J, N, Ca, Sp, Pl-Wa, SR			
	82				0						
2222	83	20		100	3	90	3, 4, 3	4: 25°, J, N, Ca, Sp, Pl-Wa, SR		[60]	
	84				2		M		PT#4 85.5'-105.5'		
2220	85				NA		M	Mechanically broken		1347 / 1454	
	86				NA			Weak; intensely fractured with slickensides (shear zone)			
2218	87				3		1				
	88	21		100	7	50	2, M, 3, 4, 3	1: 60°, J, N, Ca, Sp, Pl-Wa, SR 2: 75°, J, N, Ca, Sp, Pl, S 3: 20°, J, VN-N, Ca, Sp, Wa, SR 4: 50°, J, VN, Ca, Sp, Pl-Wa, SR 5: 40°, J, N, Ca, Sp, Wa, SR		[30]	
2216	89				6		5, 2, 3				
	90				2		M, 1			1504 / 1510	
2214	91		6		5		2, 2, 2, 2, 2	1: 60°, J, N, Ca, Sp, Pl-Wa, S-SR 2: 35°-45°, J, VN-N, Ca, Sp, Pl-Wa, S-SR			
	92	22		100	1	86	2			[38]	
2212	93										

SOIL SAMPLES: Type | Number | Blows / 6 in. | Recovery, %

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

Log of Soil and Core Boring B-203

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	MATERIAL DESCRIPTION	Packer Test Intervals	Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	93		6		2		M,2 M	VOLCANICLASTIC BRECCIA; grayish blue-green (5BG5/2); slightly weathered; moderately strong; highly to moderately fractured; abundant calcite inclusions and veinlets; with numerous healed fractures (not logged) --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)-- *(continued)*							Continued 0% WCR
	94	22		100	2	86	3,M	3: 70°, J, VN-N No, No, Wa-Ir, SR						[38]	
2210	95				0		M							1518 / 1524	
	96				2		1 1	1: 40°, J, VN-N, No, No, Pl-Wa, S-SR; Becomes mottled very dusky purple (5RP2/2) and grayish blue green (5BG5/2)							
2208	97				1		M M 1	Mechanically broken							
	98	23		100	1	94	1 M M							[33]	
2206	99				1		M M 2 M	2: 50°, J, N, No, No, Wa, SR							
	100				1		M 1	Mechanically broken						1533 / 1539	
2204	101				2		M,2 3 M	1: 30°, J, N, No, No, Pl-Wa, SR; 2: 40°, J, VN-N, No, No, Pl-Wa, SR; 3: 50°, J, N, No, No, Pl-Wa, SR; Mechanically broken							
2202	102–103	24		62	NA / NA	28	NR							[33]	
	104				4		M 4,4 5 4,4	4: 70°, J, VN-N, Ca, Sp/Pa, Pl, S-SR; 5: 70°, V, N, Ca, Fi, Pl, S?; 6: 90°, J, N, No, No, Pl-Wa, S-SR	PT#5 105'-120'						
2200	105		7		2		6 M	PORPHORYTIC BASALT; dark gray to grayish black (N3-N2); slightly weathered to fresh; moderately strong to strong; abundant white phenocrysts (feldspar?) and healed calcite fractures and veins; highly fractured --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)-- *(continued)*						1548 / 1011	End of day 1/10/2019; Begin day 1/11/2019
2198	106–107				2		1 2	1: 30°, J, VN-N, No, No, Wa, S-SR; 2: 20°, J, VN-N, Ca?+Ch?, Sp, Pl-Wa, SR; 3: 80°, J/V, N, Ca?+Ch?, Fi, Pl, S-SR							
	108	25		78	1	71	3	Becomes slightly fractured						[25]	
2196	109				0		M								

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

Log of Soil and Core Boring B-203

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	MATERIAL DESCRIPTION	Packer Test Intervals	Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	109	25	7	78	NA	71	NR	PORPHORYTIC BASALT; dark gray to grayish black (N3-N2); slightly weathered to fresh; moderately strong to strong; abundant white phenocrysts (feldspar?) and healed calcite fractures and veins; slightly fractured --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)-- *(continued)*							Faster drilling 109'-110' Continued 0% WCR
	110				0		M							1022 / 1029	
2194	111				0		M								
	112	26		80	0	100	M							[30]	
2192							M, M	Becomes very dark red (5R2/6)							
	113				NA			Highly weathered; very to extremely weak; crushed							Faster drilling 113'-117'
	114				NA		NR	VOLCANICLASTIC BRECCIA; very dusky purple (5RP2/2) to grayish blue-green (5BG5/2); highly weathered; weak to very weak; moderately fractured; angular to subangular medium- to coarse-grained sand-sized clasts with occasional to 1/2"; with numerous mechanical fractures --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)-- *(continued)*							
2190	115				NA		NR, M, M							1039 / 1047	
	116				0		M, M,M, M	Becomes moderately strong							
2188	117	27		92	1	76	M,M, M	Becomes very dusky purple (5RP2/2)						[14]	Slower drilling to TD
	118				0		M,M, 1,M	1: 25°, J?, VN, No, No, Pl, S							
2186	119				0		M,M, M, M, M,M, M,M, M							1109	
	120							**TOTAL DEPTH = 120.0 FEET**							
2184	121														
	122														
2182	123														
	124														
2180	125														

Project: Klamath River Renewal Project Project Location: Copco and Iron Gate Reservoirs Project Number: 60537920	Log of Soil and Core Boring B-205 Sheet 1 of 5

Date(s) Drilled	9/12/2018	Logged By	K. Zeiger	Checked By	P. Respess
Drilling Method	Rotary Wash, HQ-3 Rock Core	Drill Bit Size/Type	3 7/8-inch PDC drag bit, 3 3/4-inch carbide tooth bit	Total Depth of Borehole	62.0 feet
Drill Rig Type	Truck Mounted Mobile B-53	Drilling Contractor	Gregg Drilling	NAVD 88 Ground Surface Elevation	2359 feet
Groundwater Level	21.7 feet bgs 9/13/2018	Sampling Methods	2.5-inch ID ModCal; HQ Core Barrel	Hammer Data	Automatic hammer; 140 lbs, 30-inch drop
Borehole Backfill	Cement grout to ground surface	Borehole Location	Iron Gate Reservoir along Copco Road	Coordinate Location	N 2602659 E 6461881

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								CLAYEY GRAVEL (GC); dense; dark brown (10YR 3/2); 70% angular GRAVEL up to 1-inch; 25% low plasticity FINES; 5% organics; dry; GRAVEL is volcanic --COLLUVIUM--						Hollow stem auger to 0 to 19ft.
2358	1														
									Boulder (fragments)						
	2								Boulder (fragments)						
2356	3														
	4														
2354	5											9			One liner retained (5.8-6.3ft.)
	6										S01	22	87		
												29			
2352	7														
	8								CLAYEY GRAVEL with SAND (GC); medium dense; dark brown (7.5YR 3/2); 35% high plasticity FINES; 40% subangular GRAVEL up to 1-inch; 25% fine grained SAND; dry; cohesive; gravel is chert and rhyolite --COLLUVIUM/RESIDUAL SOIL--						Lithology transition logged from cuttings
2350	9								At 9ft.: becomes moist						
	10								With gravel up to 2.5-inches			19			One liner retained (11-11.5ft.) LL=61; PL=22 SA: G=38.4% S=25.7%; F=34.9%
2348	11										S02	14	100		
									GRAVELLY FAT CLAY (CH); hard; dark brown (7.5 YR 3/2); 65% high plasticity FINES; 35% subangular GRAVEL to 1-inch; moist; cohesive			21			
	12														
2346	13														

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
2346	13								GRAVELLY FAT CLAY (CH); hard; dark brown (7.5 YR 3/2); 65% high plasticity FINES; 35% subangular GRAVEL to 1-inch; moist; cohesive --COLLUVIUM/RESIDUAL SOIL--*(continued)*						
	14														
2344	15								POORLY GRADED GRAVEL with CLAY and SAND (GP-GC); very dense; light olive grey (5Y 5/2); 60% rounded GRAVEL up to 1 1/2-inches; 30% low plasticity FINES; 10% medium grained SAND; dry; cohesive; gravel is weathered in place --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--		S03	23 50/2"	100		Driller reports hard consistent drilling 15.5-19.0ft. Cuttings are dry gravelly
	16														
2342	17														
	18														
2340	19				NA						S04	92/6"	50		Advance 4-inch casing to 19.5ft. Switch to HQ-3 rock coring.
			1				m		VOLCANIC CONGLOMERATE; light olive grey (5Y 5/2); highly weathered; very weak; fine grained with rounded to angular clasts up to 1/2-inch					1406	
	20				NA		m, m								
2338	21	1		52		NA	NR							[17]	
					NA				▼						
	22													1415 / 1438	
					0										
2336	23								Becomes medium bluish grey (5B 5/1); moderately weathered; weak to very weak; massive						
					0										
	24	2		100	0	34*	m		Becomes highly weathered; very weak					[75]	*Rock does not meet soundness criteria for RQD calculation
2334	25				0										
	26								Light olive grey (5Y 5/2)						
					0		m								
2332	27													1442 / 1452	
					0										
	28	3		100		0									
					0										
2330	29														

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	MATERIAL DESCRIPTION	Soil Samples Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
2330	29	3	1	100	0	0		VOLCANIC CONGLOMERATE; medium bluish grey (5B 5/1); highly weathered; very weak; massive; fine grained with rounded to angular clasts up to 1/2-inch; chlorite rich matrix (?) --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--*(continued)*					[100]	
	30		2		0									
2328	31				0									
	32	4			0								1455 / 1505	
2326	33				4		1, 1, 2, 3	1: 5, J, MW, No, No, Wa, SR (likely mechanical) 2: 35, J, MW, No, No, Wa, SR (likely mechanical) 3: 20, J, MW, No, No, Wa, SR (likely mechanical)						Run 4 broken during removal from core barrel (all fractures mechanical?)
	34	4		100	2	0	1, 2, 1						[75]	
2324	35				2		1							
	36				4		1, 2, 1, 1							
2322	37	5			0								1509 / 1518	
	38				0		m							
2320	39	5	3	100	0	0	m, m	Broken while placing in box					[75]	
	40				0									
2318	41				0									
	42	6			0			With clasts up to 3/4-inch					1522 / 1528	
2316	43				0									
	44	6		100	0	0	m	Completely weathered to clay; extremely weak					[60]	
2314	45													

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

Log of Soil and Core Boring B-205

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Number	MATERIAL DESCRIPTION	Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
2314	45	6	3	100	0	0	m	VOLCANIC CONGLOMERATE; medium bluish grey (5B 5/1); highly weathered; very weak; massive; fine grained with rounded to angular clasts up to 3/4-inch --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--*(continued)*						
	46				0									
2312	47				0								1533 / 1540	47-49.5ft. wrapped for review
	48				5		1, 2, 3	Fractured zone with iron and manganese staining						
2310	49	7	4	100	3	0		1: 85, J, T, Fe+Mn, Su, Wa, SR 2: 10, J, N, No, No, Wa-Ir, R 3: 25, J, MW, Fe+Mn, Su, Wa, SR					[50]	
	50				0									
2308	51				0									
	52				0								1546 / 1555	
2306	53	8		86	1	0	m, 1	1: 10, J, T, No, No, Wa, SR (contact between weathering zones) Becomes completely weathered; extremely weak; clayey					[42]	
	54				NA		1	Becomes highly weathered; very weak					1559 / 1626	Soft zone plugged bit during Run 8
2304	55				0		m							
	56	9		100	0	0		1: 35, J, N, No, No, Pl, S					[12]	
2302	57				NA		m, 1, 2, 1	Becomes moderately weathered; weak; intenselt fractured with calcite precipitation					1637 / 1650	
	58				3		3, 4	VOLCANIC BRECCIA; dusky brown (5YR 2/2); highly weathered; weak; highly fractured; with angular clasts up to 1-inch; 58.4-58.7' crushed						
2300	59	10	5	96	5	20*	5, 5, 6	1: 85, J, N, No, No, Wa, SR 2: 70, J, N, Ca, Pa, Pl, Sr 3: 35, J, N, No, No, Pl, S 4: ~10, J, T, No, No, Wa-Ir, SR-R 5: 10-15, J, N, No, No, Wa-Pl, SR 6: 25, J/Bedding, N-T, No, No, Wa, SR					[33]	
	60				2		5, 5							
2298	61													

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
2298	61	10	5	96	1	20*	7		VOLCANIC BRECCIA; dusky brown (5YR 2/2); highly weathered; weak; highly fractured; with angular clasts up to 1-inch --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--*(continued)*					1659	
	62								7: 45, J, N, Ca, Sp, Pl, SR						
									TOTAL DEPTH = 62.0 FEET						
2296	63														
	64														
2294	65														
	66														
2292	67														
	68														
2290	69														
	70														
2288	71														
	72														
2286	73														
	74														
2284	75														
	76														
2282	77														

Project: Klamath River Renewal Project	Log of Core Boring B-206
Project Location: Copco and Iron Gate Reservoirs	Sheet 1 of 7
Project Number: 60537920	

Date(s) Drilled	8/14/2018 - 8/16/2018	Logged By	T. Vande Voorde	Checked By	B. Kozlowicz/K. Zeiger
Drilling Method	Rotary Wash, HQ-3 Rock Core	Drill Bit Size/Type	3 7/8-inch tricone; 4-inch #13 diamond coring bit; 4-inch carbonado coring bit	Total Depth of Borehole	100.0 feet
Drill Rig Type	Track Mounted Fraste XL	Drilling Contractor	Pitcher Drilling Company	NAVD 88 Ground Surface Elevation	2337 feet
Groundwater Level	7.4 feet bgs 8/17/2018	Sampling Methods	HQ Core Barrel	Inclination from Horizontal/True North Bearing	60°/295°
Borehole Completion	Two VWPs with neat cement grout to ground surface	Location	Iron Gate Reservoir; W of Fall Creek boat ramp	Coordinate Location	N 2602022 E 6461272

Elevation, feet	Depth, feet	ROCK CORE: Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing	Number	Lithology	MATERIAL DESCRIPTION	Packer Test Intervals	Drill Time, 24-hr [Drill Rate, ft/hr]	FIELD NOTES AND OTHER TESTS
	0									SANDY FAT CLAY with GRAVEL (CH); dry; dark brown (10YR 3/3) with trace mottled yellow (10YR 7/6); 75% high plasticity FINES; 15% subangular to rounded GRAVEL up to 1 1/4-inch; 10% fine to coarse grained SAND; little organic material (roots) --ALLUVIUM--			Trash barrel to 10ft.
2336	1												
	2												
2334	3												
	4												
2332	5									With angular basaltic and some volcanic tuff GRAVEL up to 1 1/2-inch			
	6												
	7												
2330	8												
	9												
2328	10												Begin rotary wash drilling at 10 ft. with 3 7/8-inch tricone bit; Drill fluid is light grey Rig chatter.
	11												
2326	12												
	13												

Project: Klamath River Renewal Project Project Location: Copco and Iron Gate Reservoirs Project Number: 60537920	**Log of Core Boring B-206** Sheet 2 of 7

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Number	MATERIAL DESCRIPTION	Packer Test Intervals	Drill Time, 24-hr [Drill Rate, ft/hr]	FIELD NOTES AND OTHER TESTS
	13							SANDY FAT CLAY with GRAVEL (CH); dry; dark brown (10YR 3/3) with trace mottled yellow (10YR 7/6); 75% high plasticity FINES; 15% subangular to rounded GRAVEL up to 1 1/2-inch; 10% fine to coarse grained SAND; trace organic material (roots) --ALLUVIUM-- *(continued)*			
	14										
2324											
	15							←Weathered light yellow and greenish brown tuff fragments in cuttings			
	16										
2322	17										
	18										
2320	19										
	20		1		NA			←Basalt and volcanic tuff fragments in cuttings		1222	Begin HQ rock core at 20ft. with 4-inch carbonado bit.
2318	21	1		40	NA	NA		BOULDER; 2-foot rounded basalt boulder; possible rounded basaltic COBBLES near bottom of run		[4]	Run 1 not retained.
	22				NA			BASALT; grey to bluish grey (5B 6/1); slightly to moderately weathered; strong; highly fractured; abundant healed joints with calcite infilling; aphanitic matrix with feldspar phenocrysts up to 1/4-inch; with 1/2 to 1-inch weathering rind on joints --TERTIARY to QUATERNARY INTRUSIVE BASALT--			
	23				NA					1305 1340	Switch to 4-inch #13 diamond coring bit at 23 ft.
2316	24	2		70	5	0	1 2 3 4 5 6 7	1: 70, J, N, Ca, Fi, Pl, SR 2: 30, J, VN, Fe, Pa+Su, Pl, SR 3: 30, J, VN, H+Fe, Fi, Pl, ? 4: 70, J, VN, Ca+Fe, Pa, Pl, SR 5: 25, J, VN, Fe, Su, Pl, SR 6: 50, J, VN, Fe, Su, Pl, ? 7: 40, J, N, Fe+Ca, Sp, Pl, SR		[3]	
	25				3		1,2 3,4 5 3	↓Without weathering rings		1416 1442	Reviewer note: All healed veins and fractures were mechanically broken by core handling.
2314	26				3		7 3 3	1: 50, J, ?, Fe, Sp, Pl. ? 2: 40, J, ?, Fe, Sp, Pl, ? 3: 60, J, VN, H+Ca, Fi, Pl, SR 4: 50, J, VN, H+Ca, Fi, Pl, SR 5: 35, J, VN, H+Fe+Ca, Pa, Pl, SR 6: 80-90, J, VN, H+Ca, Fi, Pl, SR 7: 30, J, VN, H+Ca, Fi, Pl, SR 8: 75, J, VN, Ca, Pa, Pl, SR 9: 75, J, VN-T, Ca, Sp, Pl, SR 10: 50, J, VN, Ca, Sp, Pl, SR			
	27	3		100	4	100	6 4 m			[4]	
2312	28				5		7 8 9 10				
	29									1541	

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	Packer Test Intervals	Drill Time, 24-hr [Drill Rate, ft/hr]	FIELD NOTES AND OTHER TESTS
	29		1		3		1, 2, 3, 4		BASALT; grey to bluish grey (5B 6/1); slightly weathered; strong; highly fractured; abundant healed joints with calcite infilling; aphanitic matrix with feldspar phenocrysts up to 1/4-inch --TERTIARY to QUATERNARY INTRUSIVE BASALT--*(continued)*--		1600	
2310	30				2		4, 4, 4		1: 40, J, VN, Ca, Sp, Pl, SR 2: 60, J, VN, Ca, Fi, Pl, SR 3: 85, J, VN, H+Ca, Sp, ?, ? (possible mechanical) 4: 40-50, J, VN-T, Ca+Mn, Sp, Pl, SR			
	31	4		96	5	90	4, 5, 4, 6				[11]	
	32				1		4		5: 65, J, VN, H+No, No, Ir, ? 6: 60, J, N, Uk, Pa, Pl, SR 7: 30, J, VN, Fe, Su, Pl, SR			
2308	33				4		4, 4					
	34				5		7, 1, 2, 3, 2		1: 50, J, N, Ca, Sp, Pl, SR 2: 45-50, J, VN-MW, Ca+Mn, Fi, Pl, S + with 90° slk 3: 15, J, N, Ca+Mn, Pa, Ir, ?		1627 0750	End of day 8/14/2018 Begin day 8/15/2018
2306	35				4		2, 4, 5		4: 55, J, VN, Ca, Sp, Pl, SR (with MN staining) 5: 60, J, N, H+Ca, Fi, Pl, SR (with MN staining) 6: 40, J, VN, Ca, Fi+Sp, Pl, SR (with MN staining)			Drill fluid becomes light grey greenish grey at 35ft.
	36	5	2	100	3	80	6, 6, 2				[8]	
2304	37				3		2, 7		With wider fractures with more infilling 7: 70, J, VN-MW, H+Ca, Fi, Pl, ? 8: 5, J, N, Ca, Fi, Pl, ? 9: 80, J, ?, Ca+Mn, Sp, Pl, ?			
	38				5		2,8, 2, 9					
	39				>6		m, 1, 2		1: 25, J, N, Ca, Pa, Pl, SR 2: 70-80, J, Mn, Sp, St/Ir, R		0829 0853	
2302	40	6		83	4	52	m, 3		Crushed; likely mechanical		[6]	
	41				3		3, 4, NR		3: 40, J, T-VN, Ca?, Sp, Pl, SR 4: 60, J, No, No, Pl, S-SR 5: 60, J/Sh, MW, CR+Sd+Ca, Fi, Pl, SR			
2300	42	7		100	>6	0	m, 1, 2, m		Becomes intensely fractured 1: 50, J, Ca?, Sp, Ir, R 2: 80, J, VN, H+Uk, Fi, Wa, ?		0925 0932 [1]	Lost all circulation at 42.5 ft.
	43				>6		m, 1, 4,2, 2		1: 45, J, Mn?, Su, Pl, R 2: 50-60, J, VN-MW, H+Ca, Fi, Pl, SR 3: 55, J, Ca, Fi-Pa, Pl, SR 4: 60, V, ?, Ca?, Fi, Pl, ? 5: 70, J, ?, Ca, Pa, Pl, SR		1015 1029	
2298	44	8		100	>6	40	3, 2, 2, 3, 2, 2				[5]	
	45										1053	

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

Log of Core Boring B-206

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Drill Time, 24-hr [Drill Rate, ft/hr]
	45	9	2	100	>6	50	2 5 1 1 2	1107
	46				>6		3 3 3 1 4	
2296	47		3		6		5 5 1 6	[7]
	48				1		7	
2294	49				1		7	1148
	50	10		100	1	100	m 1	1159
2292	51				1		2 2	
	52				0			[12]
	53				1		3	
2290	54				1		4 m m m	1224
	55	11		83	1	50	m 1	1239
2288	56				3		2 3 3	[10]
	57				4		4 5 m	1254
	57.5	12		100		100	1 5 m	1306
2286	58				2			[14]
	59				2		2 3 m	1317
2284	60	13	4	98	0	90		1332 [11]
	61							

MATERIAL DESCRIPTION

BASALT; grey to bluish grey (5B 6/1); slightly weathered; strong; intensely fractured; abundant healed joints with calcite infilling; aphanitic matrix with feldspar phenocrysts up to 1/4-inch
--TERTIARY to QUATERNARY INTRUSIVE BASALT--*(continued)*--

1: 45, J, VN, Ca, Fi, Pl, S-SR
2: 60-90, J, VN, H+Uk, Fi, Pl, ?
3: 30-40, J, VN, H+Ca, Fi, Pl, ?
4: 30, J, VN, H+Fe?, Fi, Ir, ?
5: 80, J, VN-N, Ca+Fe, Fi, Pl, ?

Becomes moderately fractured; with healed fractures

6: 60, J, N, Fe+Ca, Pa, Pl, ?
7: 40, J, N, H+Uk, Fi, Pl, ?

1: 40, J, N, H+Ca+Mn+Fe, Fi+Su, Pl, SR
2: 75; J, N, Fe+Mn+Ca, Su+Pa, Pl, SR
3: 50, J, T, H+No, No, Pl
4: 85, J, VN-N, Ca+Fe, Fi-Pa, Pl-Wa, SR

1: 90, J, T, H+Fe?, Fi, Wa, ?
2: 35, J, VN, Ca?, Pa-Sp, Pl, SR
3: 70, J, VN-N, Ca+Fe, Fi, Pl, ?

Becomes highly fractured

4: 20, J, VN, Ca?, Pa, Pl, SR
5: 85, J, VN, Ca/Ch?, Pa, Pl, SR

1: 80, J, N, Ca?, Pl, Pa, SR
2: 75, J, N, H+Ca+Mn, Fi+Sp, Pl, SR
3: 65, J, VN, Ca?, Sp, Pl, SR

FIELD NOTES AND OTHER TESTS

47.4-48.7ft.: Mohs Hardness = 3-4; UCS = 20,886 psi

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Number	Lithology	MATERIAL DESCRIPTION	Packer Test Intervals	Drill Time, 24-hr [Drill Rate, ft/hr]	FIELD NOTES AND OTHER TESTS
	61–65	13	4	98	1, 2, 2, 2	100	1, 2, 3, 4, 5, 6, 7, m	Basalt	BASALT; grey to bluish black (5B 2.5/1); slightly weathered; strong; moderate to highly fractured; abundant healed joints with calcite infilling; aphanitic matrix with feldspar phenocrysts up to 1/4-inch --TERTIARY to QUATERNARY INTRUSIVE BASALT--*(continued)*-- 1: 70, J, VN, H+Ca?, Fi, Pl, ? 2: 55, J, N, Ca, Fi, Pl, ? 3: 80, J, T-N, H+Ca?, Fi, Pl, ? 4: 60, J, N, Ca+Fe; Fi+Sp, Pl, SR 5: 50, J, VN, H+No, No, Pl, ? 6: 80, J, VN, H+Ca, Fi, Pl, ? 7: 85, J, VN, Ca, Pa, Pl, ?		[11] 1359	
2282 (63)												
	65–67.5	14		100	2, 1, 4	100	1, m, 2, 3, m	Basalt	1: 55, J, N, Ca?, Su, Ir, ? 2: 45, J, VN, Ca, Sp, Pl, SR 3: 45, J, VN, Ca, Pa, Pl, SR (67) With small, calcite infilled vesicles oriented at 30 degrees		1411 [7] 1434	65.2-66.5: Mohs Hardness = 3-4; UCS = 15,739 psi
2280 (65.4)												
2278 (67.7)												
	67.5–70	15		100	2, 1	100	1, 2, 2, 3	Basalt	(68) 1-inch diameter calcite nodule 1: 90, J, VN-T, H+Ca, Fi, Pl, ? 2: 75, J, T, H+Ca?, Fi, Pl. ? 3: 65, J, VN, Fe, Su, Pl, SR (69) Becomes slightly fractured		1454 [9] 1510	
2276 (70)												
	70–75	16	5 (from 73.6)	96	0, 0, 1, 4, 0	96	m, 1, 2, 2, 3, 4, 5, 6, 6, 7, m	Basalt / Volcanic Breccia	1: 70, J, T, H+Ca?, Fi, Pl, ? 2: 35, V, T, Ca?, Fi, Pl, ? 3: 40, V, N, Ca/Qz?, Fi, Pl, ? 4: 60, J, T, H+Ca?, Fi, Pl, ? 5: 60, J, VN-N, Ca?, Sp, Pl, ? (possibly mechanical) 6: 70, J, N, H+Ca, Fi, Pl, SR (Contact between Basalt and Tuff Breccia) 7: 30, J, N, Ca?, Sp, Pl, ? (possibly mechanical) (73.9) VOLCANIC BRECCIA; greenish grey with grey and black clasts; moderately weathered; moderately strong to strong; slightly to highly fractured; medium grained matrix with angular clasts up to 1-inch; some calcite veins --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--		1524 [9] 1556	
2274 (72.3)												
2272 (74.6)												
	75–77	17		100	3, 4	100*	m, m, 1, 1, 1, 2, 2, 3, 2	Volcanic Breccia	1: 20-30, J, VN, H+Uk, Fi-Sp, Ir, SR 2: 85, J, MW, Ca, Fi, Pl, SR 3: 75, V, N-MW, Ca, Fi, Pl-Wa, ?		0727 [7]	End of day 8/15/2018 Begin day 8/16/2018 *Rock does not meet soundness criteria for RQD calculation
2270 (76.9)	77											

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

Log of Core Boring B-206

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Number	Lithology	Packer Test Intervals	Drill Time, 24-hr [Drill Rate, ft/hr]	FIELD NOTES AND OTHER TESTS
	77–78	17	5	100	3	100*	m, 4, 4	△ △		[7]	
	78–79				3		5, 6	△ △			
2268	79–80				2		m, m, m, m	△ △		0810	
	80–81	18			4		m, 1, 1	△ △		0825	Packer test #2 from 75.0 to 85.0
2266	81–82				NA		NR	△ △			
	82–83			46	NA	16		△ △		[9]	
2264	83–84				2		2, m	△ △			
	84–85				NA		NR	△ △		0858	
	85–86	19			0		m, 1	△ △		0923	
2262	86–87			92	3	91*	2, m, 2	△ △		[5]	
	87–88	20			1		m, 1	△ △		0951 / 1050	Switch to 4-inch carbonado bit
2260	88–89		6	88	3	75*	1, 1, 2	△ △		[8]	
	89–90				NA		NR, m	△ △		1110	
2258	90–91	21			0		m, m	△ △		1123	Packer test #1 from 85.0 to 95.0
	91–92				2		1, 1, 1, 1	△ △			
	92–93			100	2	75*	1, 2, 1, 1, 3	△ △		[7]	

MATERIAL DESCRIPTION

VOLCANIC BRECCIA; greenish grey with grey and black clasts; moderately weathered; moderately strong to strong; highly fractured; medium grained matrix with angular clasts up to 1-inch; some calcite veins

--TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)-- *(continued)*

- 4: 50-60, J, VN-T, Ca?, Fi, Pl, ?
- 5: 70, V, MW, Uk, Fi, Pl, ?
- With planar, 70° fabric
- 6: 70, J, VN, Ca, Pa, Pl, SR
- Becomes highly weathered/altered; weak to very weak; locally crushed
- 1: 30, J, VN, No, No, Pl, ? (possibly mechanical)
- Becomes slightly weathered; moderately strong to strong; with light bluish grey and dark grey clasts 1/8-inch to 1-inch
- 2: 60, J, N, No, No, Pl, R
- Weak rock in shoe
- Becomes moderately weathered; moderately strong; medium to coarse grained matrix with strong black and grey clasts and soft clayey green clasts
- 1: 40, J, VN-T, No, No, Ir, ?
- 2: 60, J, N-VN, H+Ca, Fi-Pa, Pl, SR
- 1: 30-40, J, VN-N, Ca, Pa, Pl, SR
- 2: 10, J, ?, No, No, Pl, R
- With more abundant soft, green clasts
- With decreasing clast size
- Becomes locally moderately strong to strong; moderately to locally highly weathered/altered; intensely fractured
- With fewer breccia clasts
- 1: 0-10, J, VN, No, No, Pl-Ir, ? (possibly mechanical)
- 2: 25, J, Vn, Mn?, Fi, Pl, ? (surface staining around joint)
- 3: 0, J, VN, Mn?, Su, St-Pl, ? (surface staining around joint)

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

Log of Core Boring B-206

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Number	MATERIAL DESCRIPTION	Packer Test Intervals	Drill Time, 24-hr [Drill Rate, ft/hr]	FIELD NOTES AND OTHER TESTS
2256	93	21	6	100	1	75*	3	VOLCANIC BRECCIA; greenish grey with grey and black clasts; moderately to highly weathered; moderately strong; moderately fractured; medium to coarse grained matrix with angular clasts up to 1/2-inch --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--*(continued)*		[7]	
	94				0		m, m, m	At 94.3ft.: becomes browish grey; weak to moderately strong		1208	
	95							With 45° fabric		1215	
2254		22		100	1	100*	1				
	96				3		1, 1	Becomes slightly weathered; strong to moderately strong; with enlongated inclusions along fabric 1: 0, J, VN-MW, Ca?, Sp, Pl, SR 2: 0, J, MW, Cl+Sd, Fi, Pl, ? 3: 50, J, MW, H+Uk, Fi, Pl, ?			
2252	97				0		m			[7]	
	98				2		2, 1	Becomes very light bluish grey; moderately strong; matrix supported			
	99				3		1, m, m, 3	Becomes brownish grey; fewer clasts		1300	
2250	100							**TOTAL DEPTH = 100.0 FEET** **Televiewer and caliper survey by NorCal Geophysics 8/16/2018.** **Install two VWPs at 25ft and 92ft with neat cement grout to ground surface with 12" flush mount monument.**			

Elevation scale: 2256, 2254, 2252, 2250, 2248, 2246, 2244
Depth scale: 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109

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

Log of Soil and Core Boring B-207

Date(s) Drilled	**9/13/2018-9/18/2018**	Logged By	**K. Zeiger/B. Kozlowicz**	Checked By	**P. Respess**
Drilling Method	**Rotary Wash, HQ-3 Rock Core**	Drill Bit Size/Type	**2 7/8-inch ID HQ Bit**	Total Depth of Borehole	**81.1 feet**
Drill Rig Type	**Truck Mounted Mobile B-53**	Drilling Contractor	**Gregg Drilling**	NAVD 88 Ground Surface Elevation	**2359 feet**
Groundwater Level	**23.1 feet bgs 9/14/2018**	Sampling Methods	**2.5-inch ID ModCal, HQ Core Barrel**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Cement grout to ground surface**	Borehole Location	**Iron Gate Reservoir along Copco Road**	Coordinate Location	**N 2602272 E 6461618**

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								CLAYEY GRAVEL (GC); loose; brown (7.5YR 4/3); 70% angular to rounded GRAVEL up to 2 inches; 30% low plasticity FINES; dry; gravel is chert, rhyolite, and other volcanics; abundant roots --ROAD FILL--						Start 12:00 9/13/2018 with Hollow Stem Auger to 15.2ft.; K. Zeiger logging
2358	1														
	2														
2356	3														
	4														
2354	5								GRAVELLY LEAN CLAY (CL); medium stiff; brown (10YR 4/3); 60% low plasticity FINES; 40% angular GRAVEL up to 1 inch; dry; with roots and rootlets --COLLUVIUM/RESIDUAL SOIL--			9			
	6										S-01	7	100		
												2			
2352	7														
	8														
2350	9														
	10								SANDY LEAN CLAY with GRAVEL (CL); stiff; brown (10YR 4/3); 55% low plasticity FINES; 25% angular GRAVEL; 25% fine grained SAND; dry; gravel is highly weathered; with rootlets --COMPLETELY WEATHERED VOLCANIC BRECCIA--			8			One liner retained (11.0-11.5ft.)
2348	11										S-02	10	100		
												8			
	12														
2346	13														

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

Log of Soil and Core Boring B-207

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Number	MATERIAL DESCRIPTION	Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	13							VOLCANIC BRECCIA; grey (7.5YR 5/1); slightly weathered; strong; cemented fine grained matrix with angular volcanic clasts up 4 inches; highly fractured --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--						
	14													
2344	15		1		NA		1 2	1: 10, J, N, No, No, Wa, SR 2: 50, J, N, Fe, Sp, Wa, R 3: 20, J, N?, Ca, Sp, Wa, SR (run break)		S-03	50/3.5"	100	1400	Switch to HQ coring with 2 7/8 inch HQ bit at 15.2ft.
	16	1		94	2	61							[20]	
2342	17				1		3						1405 1411	
	18				>6		1 2 3 3	Becomes light yellowish brown (10YR 6/4), highly waethered, weak, locally crushed						
2340	19	2		100	>6	26	3	1: 60, J, N, No, No, Pl, SR 2: 60, J, MW, rootlet, Sp, Pl, S-SR 3: 20-40, J, N, Fe, Su+Sp, Wa, SR 4: 80, J, MW, Fe, Su, Wa, SR-R					[25]	
	20				4		4 3	With clasts weathering out of matrix						
2338	21				2		3						1423	0.3ft. of Run 2 recovered with Run 3; HQ inner barrel stuck in rods after Run 2 pull rods to retrieve.
	22				0		m	1: 20, J, T, No, No, Wa, SR 2: 45, J, N, Ca?, Pa, Pl, S+Slk 3: 10, J, N, No, No, Wa, SR 4: 35, J, N, No, No, Pl, S					1518	
2336	23				2		1							
	24	3		96	4	0	2	With fracturing along clast boundaries					[20]	
2334	25				>6		2 3							
	26				NA		3 3 4 3	Completely weathered, extremely weak					1533	
2332	27				0			Becomes moderately weathered, moderately strong					1541	
	28	4		100	>6	46*	1 2 3	1: 50, J, N, No, No, Wa, SR 2: 60, J, MW, Fe+Mn, Su, Wa-St, SR-R 3: 10, J, T, Fe, Sp, Wa-Pl, SR						
2330	29													

Project: Klamath River Renewal Project Project Location: Copco and Iron Gate Reservoirs Project Number: 60537920	Log of Soil and Core Boring B-207 Sheet 3 of 6

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Number	Lithology	MATERIAL DESCRIPTION	Soil Samples: Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	29	4	1	100	>6	46*	3, 4, 3, 5	△ △	VOLCANIC BRECCIA; light yellowish brown (10YR 6/4); moderately weathered; moderately strong; locally crushed; highly fractured --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)-- *(continued)*					[18]	
	30				0			△ △							
2328	31		2		2		6, 6	△ △	4: 55, J, N, No, No, Pl, S (clast boundary) 5: 80, J, MW, Fe+Mn, Su, Wa-Ir, SR_R 6: 20, J, N, No, No, Wa, SR						
	32	5		100	>6	0	1, 2, 1	△ △	Becomes highly weathered, weak, intensely fractured					1558 1605	
2326	33				>6		3, 4, 3	△ △	1: 85, JN, No, No, Wa, SR 2: 20, J, T, Fe+Mn, Su, Wa, SR 3: 30, J, N, No, No, Wa, SR 4: 40, J, N, Fe+Mn, Su, Pl, SR 5: 65, J, N, Fe+Mn, Su, Pl, SR 6: 35, J, N, Fe+Mn, Su, Wa, SR						
	34				>6		3	△ △						[16]	
2324	35				>6		5, 5, 6	△ △	Highly to completely weathered						Lost all circulation at 35.0ft.
	36	6		67	NA	0		△ △						1622 1637 [5] 1644	
2322	37	7		56	>6	10	1, 2, 3	△ △	Highly to completely weathered, crushed Becomes moderately weathered, moderately strong					0859	End of day 9/13/2018 Begin day 9/14/2018
	38				2		1	△ △							Driller noted 'harder' drilling conditions
2320	39				NA		3, 3, 4	△ △	Becomes completely weathered to a CLAYEY SAND, extremely weak					[23]	
	40				NA			△ △							
2318	41				NA			△ △							
	42	8		40	NA	0		△ △						0912 1203	1500 gallons of water used in Run 7
2316	43				NA			△ △							Advance 4-inch casing to 29ft.
	44				NA			△ △						[19]	
2314	45														

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

Log of Soil and Core Boring B-207

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Number	MATERIAL DESCRIPTION	Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	45	8	2	40	>6	0		VOLCANIC BRECCIA; light yellowish brown (10YR 6/4); completely weathered to a CLAYEY SAND; extremely weak; locally crushed --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)-- *(continued)*						
	46				>6		1, 2	At 46ft.: becomes very dark greenish grey (5BG 3/1) and greenish grey (5G 6/1); moderately weathered; moderately strong; intensely fractured 1: 20, J, N, Sa, Pa, Pl, S 2: 50, J, T, No, No, Pl, S						
2312	47				3		1, 1, m, 1, 2	At 47ft.: becomes very dark greenish grey (5BG 3/1), highly weathered, very weak, with angular clasts weathering out of soft matrix					1219 1241	
	48				1		m, m							
2310	49	9	3	100	2	18	3, 4	Slightly weathered, strong clast					[17]	
	50				2		4, 5	1: 10, J, N, No, No, Wa, SR 2: 45, J, N, No, No, Wa, SR 3: 55, J, T, No, No, Wa, SR 4: 30, J, N?, No, No, Pl, S (clast boundary) 5: 20, J, T, No, No, Wa, SR						
2308	51				0									
	52				>6			Crushed					1259 1309	
2306	53				3		1, 1	With calcite veins						
	54	10		66	2	0	2, 3	1: 65, J, N, No, No, Wa, SR 2: 30, J, N, No, No, Wa-St, SR 3: 10, J, T, No, No, Wa-Pl, SR					[13]	
2304	55				NA									
	56				NA									
2302	57				>6		1, 2, 3, 4, 5	Becomes slightly to moderately weathered, moderately strong Crushed Becomes slightly fractured					1333 1341	
	58				2									
2300	59	11		100	0	90	m	Clast weathering out of matrix					[15]	
	60				0			1: 85, J, MW, No, No, Wa-St, R 2: 10, J, MN, No, No, Wa-St, R 3: 15, J, N, No, No, Wa, SR 4: 50, V, N, H+Ca, Fi, Ir, ? 5: 30, V, MW, H+Ca, Fi, Wa, ?						
2298	61													

Fracture Drawing:

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Number	MATERIAL DESCRIPTION	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	61	11	3	100	0	90		VOLCANIC BRECCIA; very dark greenish grey (5BG 3/1) and greenish grey (5G 6/1); slightly to locally moderately weathered; moderately strong; slightly fractured; fine grained matrix with angular to subangular clasts of porphyritic basalt up to 1.5 inches		
	62	12	4	82	1	52	1	--TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)-- *(continued)*	1401 / 0840	End of day 9/14/2018 Begin day 9/18/2018 B. Kozlowicz logging Water level at 28.8 ft. 9/18/2018
2296	63				0		m	1: 30-40, J, N, No, No, Ir, R 2: 30, J/Sh, MW, Ca, Sp, Pl, SR 3: 90, J/Sh, MW, Ca, Sp, Pl, SR		
	64				0				[10]	50% fluid circulation
2294	65				4		2, 2, 3	Becomes moderately weathered, weak to very weak along fracture zones with irregular, subvertical anastomosing calcite veins and small, angular clasts		
	66				NA			Extremely weak, completely weathered/altered to a CLAYEY SAND		
2292	67	13		94	2	47	1, 1	Becomes highly fractured with clasts up to 2.5 inches	0909 / 0919	
	68				NA		1, 2	1: 30, J, VN, No, No, Pl, R 2: 80-90, J, N, No, No, Pl, SR with very weak, friable zone along fracture	[9]	
2290	69	14		100	2	74	1	Becomes slightly fractured, strong	0932 / 0955	
	70				0			1: 80-90, J, N, No, No, Pl, SR-R	[10]	
2288	71				0					
	72	15		100	2	88	1	Very strong, dark gray basalt with calcite	1013 / 1032	
2286	73				2		1, 2	Very strong, dark gray porphyritic basalt		
	74				0		m		[9]	
2284	75				0		m	1: 45, J, VN, No, No, Pl, R (possibly mechanical) 2: 10, J, VN, No, No, Ir, SR-R		
	76				0		m			
2282	77								1107	

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
	77		5		0				VOLCANIC BRECCIA; very dark greenish grey (5BG 3/1) to greenish grey (5G 6/1) and dark grey; slightly weathered; strong; slightly fractured; fine grained matrix with angular to subangular clasts of porphyritic basalt up to 1 inch --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)-- *(continued)*					1128	
	78				0		1, m		1: 75-90. V, MW, H+Ca, Fi, Ir-St, ? 2: 40, J, VN, No, No, Pl, SR-R (possibly mechanical)						
2280	79	16		100	2	85	2		Very strong, dark grey porphyritic basalt					[14]	
	80				0		2								
2278	81													1146	
									TOTAL DEPTH = 81.1 FEET						
	82														
2276	83														
	84														
2274	85														
	86														
2272	87														
	88														
2270	89														
	90														
2268	91														
	92														
2266	93														

Project: Klamath River Renewal Project **Project Location: Copco and Iron Gate Reservoirs** **Project Number: 60537920**	**Log of Soil and Core Boring B-208**

Date(s) Drilled	**9/18/2018-9/21/2018**	Logged By	**B. Kozlowicz/T. Vande Voorde**	Checked By	**B. Kozlowicz**
Drilling Method	**Hollow Stem Auger, HQ-3 Rock Core**	Drill Bit Size/Type	**6-inch flight auger, 4-inch diamond core bit, 4-inch drag bit**	Total Depth of Borehole	**80.0 feet**
Drill Rig Type	**Truck Mounted Mobile B-53**	Drilling Contractor	**Gregg Drilling**	NAVD 88 Ground Surface Elevation	**2338 feet**
Groundwater Level	**14.1 feet bgs 9/19/2018**	Sampling Methods	**2.5-inch ID ModCal, HQ Core Barrel**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Cement grout to ground surface**	Borehole Location	**Iron Gate Reservoir; Dagget Road**	Coordinate Location	**N 2601173 E 6460942**

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
2338	0								CLAYEY SAND with GRAVEL (SC); loose to medium dense; dark brown (10YR 3/3); 40% low plasticity FINES; 40% fine to coarse grained SAND; 20% angular to subrounded GRAVEL and COBBLES up to 3 inches; dry --ALLUVIUM--						Start 15:50 9/18/2018 with Hollow Stem Auger; B. Kozlowicz logging
	1														
2336	2														
	3														
2334	4														
	5														
2332	6														
	7								SANDY LEAN CLAY (CL); very stiff; 70% medium plasticity FINES; 30% fine to medium grained SAND; trace small GRAVEL; moist --ALLUVIUM--						
2330	8														
	9														
2328	10										S-01	16 11 16	20		
	11														
2326	12								∇						
	13														

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

Log of Soil and Core Boring B-208

ROCK CORE

Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number
20–21	1	1	100	NA	NA	NR
21–26	2		32	NA; NA; NA; NA; NA	NA	NR
26–27.7	3		100	NA; NA	NA	
27.7–29	4		15	NA	NA	NR

MATERIAL DESCRIPTION

Depth, feet	Elevation, feet	Material Description
13–16		SANDY LEAN CLAY (CL); very stiff; 70% medium plasticity FINES; 30% fine to medium grained SAND; trace small GRAVEL; moist --ALLUVIUM--*(continued)*
14	2324	▼ (water level)
16	2322	SANDY LEAN CLAY with GRAVEL (CL); medium still; with rounded to subangular GRAVEL; wet
17.5		GRAVEL and COBBLES with SANDY LEAN CLAY/CLAYEY SAND; washed, rounded COBBLES and BOULDERS (fragments) up to 6 inches --RIVER ALLUVIUM--
24.5		With washed, subrounded to rounded GRAVEL; some angular to coarse grained SAND; COBBLES are vesicular up to 6-inches

Elevations marked: 2324 (14 ft), 2322 (16 ft), 2320 (18 ft), 2318 (20 ft), 2316 (22 ft), 2314 (24 ft), 2312 (26 ft), 2310 (28 ft).

SOIL SAMPLES

Depth, feet	Number	Blows / 6 in.	Recovery, %
15–16.5	S-02	6, 6, 8	33
20	S-03	50/5"	71

DRILL TIME [Rate, ft/hr]

Depth, feet	Drill Time
21	1143
23.5	[18]
26	1200 / 1302
27	[26]
27.7	1306 / 1311

FIELD NOTES AND TEST RESULTS

Depth, feet	Field Notes
17	Rig chatter
20	Switch to HQ coring with 4-inch #2 diamond bit at 2.0ft. Advance 4.5-inch casing to 19.0ft; End of Day 9/18/2018
22	Begin Day 9/19/2018; T. VandeVoorde logging; 0% fluid return
24	Advance 4.5-inch casing to 24ft.

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	MATERIAL DESCRIPTION	Soil Samples: Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	29	4	1	15	NA	NA	NR	GRAVEL and COBBLES with SANDY LEAN CLAY/CLAYEY SAND; washed, rounded vesicular COBBLES and BOULDERS (fragments) up to 6 inches; washed, subrounded to rounded GRAVEL; some angular to coarse grained SAND --RIVER ALLUVIUM--*(continued)*					[66]	Advance 4.5-inch casing to 29ft.
2308	30				NA			At 30ft: With vesicular, basaltic GRAVEL and COBBLES up to 3 inches						Angular coarse grained SAND recovered from cutting possibly from no recovery zones
	31	5		14	NA	NA	NR						1314 / 1316	Cuttings bagged for review
2306	32				NA									Driller notes sandy loose drilling conditions
	33				NA								[100]	
2304	34				NA			COBBLES become angular to rounded						Initially no recovery for Run 5; run recored and bagged for review
	35				NA									
2302	36	6		0	NA	NA	NR	Coarse black and light brown SAND in cuttings					1319 / 1535	
	37				NA									
2300	38				NA								[33]	Cuttings bagged for review
	39				NA									Driller notes change in cuttings with increased brown fine grained SAND or FINES; change in color of drilling fluid from grey to brown
2298	40				NA									
	41	7		34	NA	NA	NR						1544 / 1615	
2296	42				NA									
	43				NA								[27]	
2294	44				NA			With rounded, basaltic COBBLES; angular, vesicular basaltic GRAVEL; some medium to coarse grained SAND						
	45													

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	MATERIAL DESCRIPTION	Soil Samples Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	45	7	1	34	NA	NA		GRAVEL and COBBLES with SAND; rounded, basaltic COBBLES; angular, vesicular basaltic GRAVEL; some medium to coarse grained SAND; 45-46 ft. fine-grained, basaltic BOUDLER with 1-2 mm feldspar phenocrysts --RIVER ALLUVIUM--*(continued)*					1626	Continued 20-30% fluid return
2292	46	8		56	NA	NA							1704	
	47				NA		NR							
2290	48				NA			With more rounded COBBLES and BOULDERS; variable volcanic lithologies of basaltic, andesite, and tuff					[13]	
	49				NA									Drilling fluid becomes dark brown
2288	50				NA								1727	
	51	9		0	NA	NA	NR						1737 [6] 1744	
2286	52				NA		NR						1748	
	53	10		84	NA	0	m m m m	VOLCANIC BRECCIA; dark, dusky purple and bluish grey; moderately weathered; extremely weak; fine grained matrix with strong clasts --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--					[12]	
2284	54				NA								1803	Advance 4.5-inch casing to 54ft.
	55	11		17	NA	0	NR	Strong, volcanic breccia clast in shoe					0931 [7] 0941	End of day 9/19/2018 Begin day 9/20/2018
2282	56		2		NA								0949	
	57	12		0	NA	0	NR						[7] 1006	
2280	58	13		50	NA	0	NR	Becomes very dusky red (2.5YR 2.5/2) to dark reddish brown (2.5YR 2.5/4); moderately to highly weathered, very weak breccia clasts in a friable, completely weathered, extremely weak matrix; locally recovered as CLAYEY SAND with GRAVEL					1008 [3] 1021	
	59				NA					S-04	31 50/3"	44		Switch to new #2 diamond bit at 59ft.
										S-05	70/2"	100	1128	
2278	60	14		73	NA	0	NR m m m						[7]	
	61												1141	

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

Log of Soil and Core Boring B-208

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Number	MATERIAL DESCRIPTION	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	61–65	15	2	100	0, 0, 0, 0	0	m, m, m, m, m	VOLCANIC BRECCIA; dark brown to dusky purple; moderately to highly weathered; extremely weak; fine grained, sandy matrix with basaltic breccia clasts --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--*(continued)*	1152 [15] 1208	Continued 20-30% fluid return; hard drilling (1500psi down pressure)
2276	62									
2274	64									
	65–66	16		100	0	0	m, m, m, m, m	With breccia clasts up to 1/2 inch; locally very weak	1236 [20] 1239	Switch to 4-inch drag bit at 65ft.
2272	66–71	17		90	0, 0, 1, 0, 0	0	NR, 1, 2, m, m?, 3, 2	Becomes moderately weathered; moderately strong; locally extremely weak; moderately fractured	1225 [8] 1302	
2270	68							Medium to coarse grained VOLCANIC SANDSTONE; brownish purple to greenish grey (10GY 5/1)		Drilling fluid becomes light grey
	69							1: 60, J, W, Sd, Sp, Pl, SR 2: 80-90, V, N-MW, H+Ca, Fi, Pl 3: 30, V, N, H+Ca, Fi, Pl		Drilling fluid becomes brown/purple
2268	70							Greenish grey to dark greenish grey		
	71–76	18	3 (from 72.4)	100	0, 0, 2, 0, 0	0	1, 2, 3, m, 3, 4, 5, 5, 6, m, m	1: 65-90, V, MW-W, Ca, Fi, Pl, S-SR 2: 0, V, MW, Ca, Fi, Pl, SR 3: 70, V, N, Ca, Fi, Pl, ? 4: 80-90, V, N, Ca, Fi, Wa, ? 5: 50, J, VN, H+Ca, Fi, Pl 6: 60-65, V, VN, Ca, Fi, Pl	1311 [38] 1319	
2266	72									
2264	74							With increasing number of breccia clasts		
	75							Greenish grey		
2262	76–77	19		86	>6	20	m, m, 1,1, 1,1, 2	Becomes highly to intensely fractured; matrix becomes clayey 1: 0-20, J, VN-W, No, No, Pl-Ir, SR 2: 60, V, VN, Ca, Fi, Pl, ?	1325	

Lithology: △ △ (volcanic breccia symbol) throughout.

SOIL SAMPLES: Type | Number | Blows / 6 in. | Recovery, % — no entries.

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
	77	19	3	86	3	20		1, 3, 4, 4, m		VOLCANIC BRECCIA; dark reddish grey (10YR 3/1); moderately weathered; extremely weak; highly fractured --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--*(continued)*					[29]	
2260	78				0		NR			3: 65, J, VN, No, No, SR, Pl 4: 10, J, W, No, No, Ir, SR					1331	
	79	20		38	NA	0	NR			Becomes <10% clasts; 90% clayey matrix					1420 [22] 1423	
2258	80									**TOTAL DEPTH = 80.0 FEET**						
	81															
2256	82															
	83															
2254	84															
	85															
2252	86															
	87															
2250	88															
	89															
2248	90															
	91															
2246	92															
	93															

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

Log of Soil Boring BC-01

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**	NAVD 88 Ground Surface Elevation	**2597 feet**
Groundwater Level(s)	**12.3 feet above ground surface (2/5 at 15:15)**	Sampling Method(s)	**2.5-inch ID ModCal, SPT**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Bentonite cement grout to 10 feet bgs**	Borehole Location	**Copco Reservoir**	Coordinate Location	**N 2608898 E 6476516**

Elevation feet	Depth, feet	SAMPLES Type	SAMPLES Number	SAMPLES Sampling Resistance	SAMPLES Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	0		S01	1 1 0	100		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 consist 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										
2590			S02	4 3 4	100		Becomes soft; dark olive brown (2.5Y 3/3) to very dark grayish brown (2.5Y 3/2) with trace gravel	43	8		Advance 6-inch casing to 8 feet with hammer LL=33; PL=25
	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	80			99			
											End of day 16:45,Begin day 08:30 Advance 6-inch casing to 11 feet with hammer
	15										
2580											
	20										
2575			S04	3 2 5	93		Becomes soft with iron staining on irregular subvertical fractures	93	34	99	LL=85; PL=51 SA: G=0%; S=1%; F=99%
	25										
2570											
							BASALT; black (10Y 2.5/1); highly to completely weathered; friable --TERTIARY to QUATERNARY INTRUSIVE BASALT--				Cuttings become dark greenish gray sandy clay; slower drilling
			S05	31 50/6"	60						
	30										

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	30		S06	50/5"	100						
							TOTAL DEPTH = 30.4 FEET				
2565											
	35										
2560											
	40										
2555											
	45										
2550											
	50										
2545											
	55										
2540											
	60										
2535											
	65										

Log of Soil Boring BC-02

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	NAVD 88 Ground Surface Elevation	2600 feet
Groundwater Level(s)	9.4 feet above ground surface (2/5 at 9:00)	Sampling Method(s)	2.5-inch ID ModCal, SPT, 3-inch Shelby Tube	Hammer Data	Automatic hammer; 140 lbs, 30-inch drop
Borehole Backfill	Bentonite cement grout to 10 feet bgs	Borehole Location	Copco Reservoir	Coordinate Location	N 2608331 E 6476958

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	0		S01	2 10 12	85		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--			28	Drove sampler for extra 6 inches (last three blowcounts reported) SA: G=52%; S=20%; F=28%
							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 --LACUSTRINE DIATOMACEOUS TERRACE (Ql)--				Advance 6-inch casing to 3.8 feet with hammer
2595	5		S02	5 5 10	13		Black angular basalt cobble				
			S03	18 10 10	60		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) Advance 6-inch casing to 8.8 feet with hammer
2590	10		S04	11 9 9	53						
							Becomes light yellowish brown (2.5Y 6/4); extremely weak/clayey; moderately fractured				
2585	15		S05	4 4 6	80			84	46	99	LL=105; PL=59 SA: S=1%; F=99%
							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	100			148			TX-ICU About 50% WCR
2575	25		S07	3 2 3	93						S-07: Two liners retained (25-25.5ft., 25.5-26ft)
											About 25% to 50% WCR
2570	30										

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	30						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)--*(continued)*				
2565	35		S08	200 to 500 psi	84			149			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	100			178	102	100	LL=187; PL=85 SA: S=1%; F=99% S-09: Two liners retained (45-45.5ft., 45.5-46ft)
2550	50										
2545	55		S10	2 3 5	100			171			S-10: Two liners retained (55-55.5ft., 55.-56 ft.)
2540	60										
							BASALT; black (10Y 2.5/1); slightly weathered; strong; recovered as angular gravel up to 1-inch in diameter --TERTIARY to QUATERNARY INTRUSIVE BASALT--				Harder drilling, small black basalt chips in cuttings
			S11	50/3"	100						
2535	65										

TOTAL DEPTH = 64.6 FEET

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

Log of Soil 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	NAVD 88 Ground Surface Elevation	2584 feet
Groundwater Level(s)	24.3 feet above ground surface (2/6 at 12:00)	Sampling Method(s)	2.5-inch ID ModCal, SPT, 3-inch Shelby Tube, HQ Core Barrel	Hammer Data	Automatic hammer; 140 lbs, 30-inch drop
Borehole Backfill	Bentonite cement grout to 10 feet bgs	Borehole Location	Copco Reservoir	Coordinate Location	N 2606643 E 6474657

Elevation feet	Depth, feet	SAMPLES Type	SAMPLES Number	SAMPLES Sampling Resistance	SAMPLES Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	0						ORGANIC SILT WITH SAND (OL); very soft; very dark grayish brown (2.5Y 3/2) --RECENT LAKE SEDIMENT--				
			S01	1 2 3	2		SANDY LEAN CLAY (CL); soft; black (5Y 2.5/2); fine grained sand; trace rounded gravel; small angular rock fragments; and fine rootlets --COLLUVIUM/RESIDUAL SOIL--	35	NP	67	Sampler settled to 1-foot; drove sampler for extra 6 inches (last three blowcounts reported) LL=48; PL=25 SA: G=3%; S=30%; F=67% Advanced 6-inch casing to 4 feet (stiff from 3 feet)
2580	5		S02	4 3 2	0.6		Without gravel	25			
			R1				POORLY GRADED GRAVEL with CLAY (GP-GC); subrounded gravel up to 2.5-inch in diameter of varied volcanic lithology and clayey infill --LACUSTRINE DIATOMACEOUS TERRACE (Ql)--				Hard chattering drilling Switch to rock core bit with SPT sampler
2575	10										
			S03	6 3 2	0.1		DIATOMITE; light olive brown (2.5Y 5/3); very soft; locally clayey with vessicular basalt GRAVEL; bedding/fractures not present --LACUSTRINE DIATOMACEOUS TERRACE (Ql)--				Faster drilling from 10.5 to 11.5 feet
2570	15		R2								Return fluid becomes olive Advanced 6-inch casing to 14 feet with hammer
			S04	6 4 5	1.0		Becomes olive brown to dark greyish brown (2.5Y 4/3 to 4/2), extremely weak, massive				Switch back to tricone bit
2565	20										
2560							DIATOMITE with ELASTIC SILT; dark grayish brown (2.5Y 4/2); massive/soft to very soft --LACUSTRINE DIATOMACEOUS TERRACE (Ql)--				
	25		S05	3 3 4	1.3			80	NP	100	LL=69; PL=59 SA: F=100%
2555	30										

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

Log of Soil Boring BC-03

Elevation feet	Depth, feet	SAMPLES Type	SAMPLES Number	SAMPLES Sampling Resistance	SAMPLES Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	30						DIATOMITE with ELASTIC SILT; dark grayish brown (2.5Y 4/2); massive/soft to very soft --LACUSTRINE DIATOMACEOUS TERRACE (Ql)--*(continued)*				
2550	35										
2545	40		S06	200 to 400 psi	2.5			85 90			TX-ICU TX-ICU
2540	45										Cutting very dark greenish gray
2535	50										
2530	55										
2525	60										
2520	65										

Log of Soil Boring BC-03

Elevation feet	Depth, feet	Samples: Type	Samples: Number	Samples: Sampling Resistance	Samples: Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	65		S07	5 5 7	1.5		DIATOMITE with ELASTIC SILT; dark greenish gray (10Y 4/1); massive/soft to very soft; 1 to 2-inch beds/lenses of very dark gray to black clay --LACUSTRINE DIATOMACEOUS TERRACE (Ql)--*(continued)*				End of day 2/6/2018 Begin day 2/7/2018 Cuttings greenish black
2515	70										
2510	75										
2505	80		S08	100 psi	0						
2500	85		S09		0.25		With trace rounded GRAVEL (possibly slough)				
2495	90		S10		1.0			120			TX-ICU
2490	95		S11	4 5 5	0.2						Driller out of rods
							TOTAL DEPTH = 96.5 FEET				
2485	100										

Project: Klamath River Renewal Project Project Location: Copco and Iron Gate Reservoirs Project Number: 60537920	Log of Soil Boring BC-04 Sheet 1 of 3

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	NAVD 88 Ground Surface Elevation	2597 feet
Groundwater Level(s)	11.8 feet above ground surface (2/1)	Sampling Method(s)	2.5-inch ID ModCal, SPT, 3-inch Shelby Tube	Hammer Data	Automatic hammer; 140 lbs, 30-inch drop
Borehole Backfill	Bentonite cement grout to 10 feet bgs	Borehole Location	Copco Reservoir	Coordinate Location	N 2604812 E 6472949

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	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
2595										44	SA: G=5%; S=51%; F=44%
			S01	1 0 1	57		Becomes organic rich and softer/looser with increased nonplastic fines				Sampler advanced 1 foot on first blow and 2.5 feet on second blow
	5										Advance 6-inch casing to 5.5 feet with hammer
2590							CLAYEY SAND (SC); very loose; very dark brown (10YR 2/2); trace fine GRAVEL and coarse organics --RECENT LAKE SEDIMENT--			58	SA: G=3%; S=39%; F=58%
			S02	2 3 3	100						Drove sampler for extra 6 inches (last three blowcounts reported)
	10										Advance 6-inch casing to 11 feet (resistance at 11 feet)
2585			S03	4 11 18	87		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	Advance 6-inch casing to 12.5 feet with hammer SA: G=9%; S=50%; F=41%
			S04	400 psi	100			61 54			TX-ICU TX-ICU
	15										
2580											100 percent WCR
			S05	400 psi	100			105			TX-ICU
	20										
2575							DIATOMITE with ELASTIC SILT; soft to completely weathered; light greenish gray (5GY 7/1) --LACUSTRINE DIATOMACEOUS TERRACE (Ql)--				
			S06	200 to 400 psi	100			155			TX-ICU
	25										Lost circulation to 27.5 feet
2570											
			S07	2 3 5	90		Becomes mottled with very pale brown (10YR 8/3) and light greenish gray (5GY 7/1) with 10 degree bedding				Drove sampler for extra 6 inches (last three blowcounts reported) About 50% WCR
	30										

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	30						DIATOMITE with ELASTIC SILT; soft to completely weathered; light greenish grey (10YR 8/3) mottled with very pale brown (10YR 8/3) and light greenish gray (5GY 7/1) with 10 degree bedding --LACUSTRINE DIATOMACEOUS TERRACE (Ql)--*(continued)*				
2565											
			S08	200 to 500 psi	60			117	35	99	LL=120; PL=85 SA: S=1%; F=99% Consol TX-ICU
	35										LL = 60 PL = 24 PI = 36
2560											1% Sand 99% Fines About 75% WCR
							Becomes completely weathered to a FAT CLAY; with 0.25-inch very dark gray (5Y 3/1) 10-degree beds (varves?)				
	40										
2555											About 50% to 75% WCR
			S09	1 1 1	100		With vertical dark grey stained (Mn?) fractures				
	45										
2550											
	50										
2545								154			TX-UU
			S10	200 to 400 psi	100						TX-ICU
	55										
2540											
	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 crystals along very dark gray (5Y 3/1) sub-vertical fractures --LACUSTRINE DIATOMACEOUS TERRACE (Ql)--				
2535											
			S11	2 2 2							Final hammer blow advanced sampler 2-inches
	65										

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
2530	65						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 crystals along very dark gray (5Y 3/1) sub-vertical fractures --LACUSTRINE DIATOMACEOUS TERRACE (Ql)--*(continued)*				
2525	70						ANDESITE(?); dark grey and reddish brown; moderately to highly weathered; medium strong; fine to medium grained --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--				Hard drilling, very dark gray to black volcanic fragments in cuttings
			S12	30 50/5"							
							TOTAL DEPTH = 73.5 FEET				
2520	75										
2515	80										
2510	85										
2505	90										
2500	95										
	100										

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

Log of Soil Boring BC-05

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**	NAVD 88 Ground Surface Elevation	**2601 feet**
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 ModCal, SPT, 3-inch Shelby Tube**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Bentonite cement grout to 10 feet bgs**	Borehole Location	**Copco Reservoir**	Coordinate Location	**N 2604139 E 6474515**

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	0		S01	0 0 0	35		SILTY SAND with GRAVEL (SM); very loose; very dark grayish brown (2.5Y 3/2); greenish gray clayey diatomite GRAVEL up to 1-inch in diameter; nonplastic FINES --RECENT LAKE SEDIMENT--				Sampler advanced 2 feet under hammer weight
2600											Advance 6-inch casing to 5 feet with hammer
	5										
2595											
			S02	4 10 20			Clayey gravel made up of mostly DIATOMITE clasts up to 0.75 inches in diameter				Drove sampler for extra 6 inches (last three blowcounts reported)
							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 GRAVEL of diatomite and organics --FLUVIO-LACUSTRINE TERRACE DEPOSIT WITH GRAVEL (Qtg)--				Advance 6-inch casing to 8.5 feet (refusal) End of day 2/2/18 at 9.0 ft. Begin day 2/8/18
2590	10		S03	2 1 1	100		DIATOMITE with ELASTIC SILT; extremely weak/very soft; greenish gray (5GY 6/1); 20-degree bedding and 90-degree fractures; with fine roots at 11ft. --LACUSTRINE DIATOMACEOUS TERRACE (Ql)--				
2585	15		S04	200 to 400 psi	100		Becomes medium stiff to stiff with olive yellow (2.5Y 6/6) with angular clasts; friable	135 30			TX-ICU TX-ICU
							VOLCANIC SANDSTONE; yellowish brown(10YR 5/6); highly to completely weathered; very weak; locally clayey --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--				Harder drilling with yellowish to reddish brown rock chips in cuttings
	20		S05	32 50/5"							
2580							**TOTAL DEPTH = 20.5 FEET**				
2575	25										
	30										

Project: Klamath River Renewal Project Project Location: Copco and Iron Gate Reservoirs Project Number: 60537920	Log of Soil 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	NAVD 88 Ground Surface Elevation	2578 feet
Groundwater Level(s)	29.2 feet above ground surface (2/2 at 13:00)	Sampling Method(s)	2.5-inch ID ModCal, SPT	Hammer Data	Automatic hammer; 140 lbs, 30-inch drop
Borehole Backfill	Bentonite cement grout to 10 feet bgs	Borehole Location	Copco Reservoir	Coordinate Location	N 2605112 E 6476050

Elevation feet	Depth, feet	SAMPLES Type	SAMPLES Number	SAMPLES Sampling Resistance	SAMPLES Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	0						--RECENT LAKE SEDIMENT--				Advance 6-inch casing to 5ft. with hammer from 2 to 5ft.
2575							LEAN CLAY with SAND (CL); stiff; olive gray to dark olive gray (5Y 4/2 to 5Y 3/2); 20% fine grained SAND; 80% low to medium plasticity FINES; trace fine angular volcanic GRAVEL and wood debris/roots up to 1-inch --COLLUVIUM--				
	5		S01	5 9 14	100						
2570							VOLCANIC SANDSTONE; dark greenish gray to black (5GY 4/1 to GLEY1 2.5/N); moderately to slightly weathered --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--				Harder drilling with gravelly cuttings
	10		S02	50/4"	100						Hard, slow drilling at 15ft.
2565											
	15		S03	50/4"							
							TOTAL DEPTH = 15.4 FEET				
2560											
	20										
2555											
	25										
2550											
	30										

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

Log of Soil 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**	NAVD 88 Ground Surface Elevation	**2581 feet**
Groundwater Level(s)	**26.2 feet above ground surface (2/2 at 15:30)**	Sampling Method(s)	**2.5-inch ID ModCal**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Bentonite cement grout to 10 feet bgs**	Borehole Location	**Copco Reservoir**	Coordinate Location	**N 2605439 E 6477039**

Elevation feet	Depth, feet	SAMPLES Type	SAMPLES Number	SAMPLES Sampling Resistance	SAMPLES Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	0						--RECENT LAKE SEDIMENTS--				
2580			S01	0 0 0	100		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 2ft. with weight of hammer Advance 6-inch casing to 2 ft.
			S02	5 7 8	67		Wood/roots up to 1-inch in size	34	NP	65	LL=60; PL=24 SA: G=15%; S=20%; F=65% End of day 2/2/2018 Begin day 2/3/2018 Advance 6-inch casing to 5 ft. with hammer
2575	5										
			S03	2 5 4	40		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 ft. Advance 6-inch casing to 10 ft. with hammer
2570	10										
			S04	9 9 7	100		POORLY GRADED SAND with SILT and GRAVEL (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--			8	SA: G=27%; S=65%; F=8%
	15		S05	20 50/4"			With shell hash				Hole caving; advanced 6-inch casing to 14ft. 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 --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--				
							TOTAL DEPTH = 15.9 FEET				
2560	20										
2555	25										
	30										

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

Log of Soil Boring BC-08

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, 2 7/8-inch drag bit**	Total Depth of Borehole	**11.5 feet**
Drill Rig Type	**Barge Mounted CME-45**	Drilling Contractor	**Taber Drilling**	NAVD 88 Ground Surface Elevation	**2586 feet**
Groundwater Level(s)	**22.2 feet above ground surface (2/3 at 14:00)**	Sampling Method(s)	**2.5-inch ID ModCal, SPT**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Bentonite cement grout to 10 feet bgs**	Borehole Location	**Copco Reservoir**	Coordinate Location	**N 2605190 E 6480346**

Elevation feet	Depth, feet	SAMPLES Type	SAMPLES Number	SAMPLES Sampling Resistance	SAMPLES Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
2585	0						ORGANIC SILT to ORGANIC CLAY (OL/OH); very soft; dark olive gray (5Y 3/2) with coarse organic debris				Advance 6-inch casing to 3 feet with hammer
							FAT CLAY with SAND (CH); 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	87			31	NP		LL=56; PL=24
2580	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
			S02	22 29 37	47						
2575	10										
							TOTAL DEPTH = 11.5 FEET				
2570	15										
2565	20										
2560	25										
	30										

Project: Klamath River Renewal Project	Log of Soil Boring BC-08a
Project Location: Copco and Iron Gate Reservoirs	Sheet 1 of 3
Project Number: 60537920	

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	NAVD 88 Ground Surface Elevation	2583 feet
Groundwater Level(s)	25.3 feet above ground surface (2/14 at 10:00)	Sampling Method(s)	2.5-inch ID ModCal, SPT	Hammer Data	Automatic hammer; 140 lbs, 30-inch drop
Borehole Backfill	Bentonite cement grout to 10 feet bgs	Borehole Location	Copco Reservoir	Coordinate Location	N 2605249 E 6480346

Elevation feet	Depth, feet	SAMPLES Type	SAMPLES Number	SAMPLES Sampling Resistance	SAMPLES Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	0						ORGANIC SILT (OL); very soft; very dark brown (10YR 2/2) --RECENT LAKE SEDIMENT--				
2580											
	5		S01	9 20 50/4"	67		CLAYEY SAND to SANDY LEAN CLAY (SC-CL); loose/medium dense; black (10YR 2/1); fine to medium grained SAND; medium plasticity FINES; trace fine rounded GRAVEL --COLLUVIUM/RESIDUAL SOIL--				Sampler sank to 4ft.; drove sampler for extra 18 inches (last three blowcounts reported, previous blows were 2-2-7)
2575			S02	50/8"	80		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 11ft. Advance 6-inch casing to 8ft. with hammer
	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										Advance 6-inch casing to 14ft. with hammer
2565											
			S03	3 4 5	80						
	20										
2560											
	25										
2555											
	30										

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

Log of Soil Boring BC-08a

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	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											
	35		S04	2 4 4	0						
2545											
	40										
2540											
	45										
2535											Cuttings become olive gray and greenish gray
	50										
2530											
	55		S05	2 2 3	100			179	112	99	LL=200; PL=88 SA: S=1%; F=99%
2525											
	60										
2520											
	65										

Elevation feet	Depth, feet	Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	65						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)--*(continued)*				
2515											
	70										
2510							With 0.1-0.2-inch irregular subhorizontal bedding With 0.5-inch dark reddish brown (5YR 2.5/2) CLAY bed at 20°				
	75		S06	1 2 4							
2505											
	80										
2500											Harder drilling
	85		S07	50/3"	50		BASALT; black (10Y 2.5/1); slightly weathered; strong; recovered as angular gravel up to 1-inch in diameter --TERTIARY to QUATERNARY INTRUSIVE BASALT--				Tricone refusal
							TOTAL DEPTH = 85.2 FEET				
2495											
	90										
2490											
	95										
2485											
	100										

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

Log of Soil Boring BC-09

Date(s) Drilled	2/13/2018	Logged By	B. Kozlowicz	Checked By	D. Simpson
Drilling Method	Rotary Wash, HQ-3 Rock Core	Drill Bit Size/Type	4-inch Tricone, 4-inch diamond #2 bit	Total Depth of Borehole	70.5 feet
Drill Rig Type	Barge Mounted CME-45	Drilling Contractor	Taber Drilling	NAVD 88 Ground Surface Elevation	2602 feet
Groundwater Level(s)	5.8 feet above ground surface (2/13 at 9:00)	Sampling Method(s)	2.5-inch ID ModCal, SPT, 3-inch Shelby Tube, HQ Core Barrel	Hammer Data	Automatic hammer; 140 lbs, 30-inch drop
Borehole Backfill	Bentonite cement grout to 10 feet bgs	Borehole Location	Copco Reservoir	Coordinate Location	N 2602526 E 6483561

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	0						--RECENT LAKE SEDIMENT--				
			S01	0 0 0	50		FAT CLAY with SAND (CH); medium stiff; brown (10YR 4/3) --ALLUVIUM/RESIDUAL SOIL--				Sampler advanced 2 feet under weight of hammer
2600			R01		70		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	67		DIATOMITE with ELASTIC SILT; medium stiff/weak; dark yellowish brown (10YR 4/4); trace fine grained SAND --LACUSTRINE DIATOMACEOUS DEPOSIT (Ql)--				
2595											Advance 6-inch casing to 4.5 feet
			S03	9 9 7	67						
	10										
2590							Becomes greenish gray (10Y 5/1); extremely weak/soft				
			S04	3 3 4	80						
	15										
2585											
	20										
2580											
			S05	200 psi	74			80	21	100	TX-UU LL=74; PL=53 SA: F=100% TX-ICU
	25										
2575											
	30										

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	30						DIATOMITE with ELASTIC SILT; extremely weak/soft; greenish gray (10Y 5/1); trace fine grained SAND --LACUSTRINE DIATOMACEOUS DEPOSIT (Ql)--*(continued)*				
2570											
			S06	3 3 4	0						
	35										
2565											
			S07	3 3 5	90						Sampler advanced an additional 6 inches by pushing
	40										
2560											
	45										
2555											
	50										
2550											
			S08	200 psi	0						
	55										
2545											
	60										
2540											
	65										

Project: Klamath River Renewal Project Project Location: Copco and Iron Gate Reservoirs Project Number: 60537920	**Log of Soil Boring BC-09**

Elevation feet	Depth, feet	Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	65						DIATOMITE with ELASTIC SILT; extremely weak/soft; greenish gray (10Y 5/1); trace fine grained SAND --LACUSTRINE DIATOMACEOUS DEPOSIT (Ql)--*(continued)*				
2535											
			S09	200 to 400 psi	100			92 96			Consol TX-ICU TX-ICU
	70										
							TOTAL DEPTH = 70.5 FEET				
2530											
	75										
2525											
	80										
2520											
	85										
2515											
	90										
2510											
	95										
2505											
	100										

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

Log of Soil Boring BC-10

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**	NAVD 88 Ground Surface Elevation	**2579 feet**
Groundwater Level(s)	**29.3 feet above ground surface (2/7 at 14:40)**	Sampling Method(s)	**2.5-inch ID ModCal, SPT, 3-inch Shelby Tube**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Bentonite cement grout to 10 feet bgs**	Borehole Location	**Copco Reservoir**	Coordinate Location	**N 2604959 E 6472871**

Elevation feet	Depth, feet	SAMPLES Type	SAMPLES Number	SAMPLES Sampling Resistance	SAMPLES Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	0						--RECENT LAKE SEDIMENT--				Set 6-inch casing to 4 feet (very soft to 2.5 feet)
2575							--COLLUVIUM/RESIDUAL SOIL/SLOPE WASH--				
	5										
							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)--				Hard, chattering drilling
2570											
	10		S01	25 26 19	100					1	SA: G=85%; S=15%; F=<1% Advance 6-inch casing to 9 feet with hammer Tricone bit refusal; rock core barrel used to advance
2565							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 Advance 6-inch casing to 14 feet with hammer
	15		S02	10 5 5	27						
2560											
	20										
2555							Becomes light olive brown (2.5Y 5/4) and olive brown (5Y 5/3) with 0.1 to 0.5 inch 10-degree bedding and some oxidation stains				
	25		S03	5 4 6	80						
2550											
	30										

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	30						DIATOMITE with ELASTIC SILT; medium stiff/extremely weak; light olive brown (2.5Y 5/4) and olive brown (5Y 5/3); with 0.1 to 0.5 inch 10-degree bedding and some oxidation stains --LACUSTRINE DIATOMACEOUS TERRACE (Ql)--*(continued)*				
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 --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--				Harder drilling
	40		S05	200 to 400 psi	75						
			S04	6 20 37	60		ANDESITE; reddish brown (5YR 5/3); strong brown (7.5YR 5/6); and dusky purple; highly to completely weathered; very weak; coarse grained --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--				
2535							**TOTAL DEPTH = 43.0 FEET**				
	45										
2530	50										
2525	55										
2520	60										
2515	65										

Project: Klamath River Renewal Project **Project Location: Copco and Iron Gate Reservoirs** **Project Number: 60537920**	**Log of Soil Boring BC-11** Sheet 1 of 1

Date(s) Drilled	**10/18/2018**	Logged By	**B. Kozlowicz**	Checked By	**B. Aldridge**
Drilling Method	**Hollow Stem Auger/Direct Push**	Drill Bit Size/Type	**6-inch flight auger**	Total Depth of Borehole	**10.5 feet**
Drill Rig Type	**Truck Mounted Marl M2.5 DP**	Drilling Contractor	**Gregg Drilling**	NAVD 88 Ground Surface Elevation	**2617 feet**
Groundwater Level(s)	**Not encountered**	Sampling Method(s)	**2.5-inch ID ModCal, SPT**	Hammer Data	**Geoprobe Hydraulic Hammer**
Borehole Backfill	**Cement grout to ground surface**	Borehole Location	**Copco Road/Reservoir Rim**	Coordinate Location	**N 2606419 E 6479490**

Elevation feet	Depth, feet	SAMPLES Type	SAMPLES Number	SAMPLES Sampling Resistance	SAMPLES Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (% <#200 Sieve)	REMARKS AND OTHER TESTS
	0						ROAD BASE				Start 10/18/2018 with hollow stem auger
							DIATOMITE; pale yellow (2.5Y 7/3); moderately weathered; with occasional subvertical fractures and trace small rootlets --QUATERNARY DIATOMITE (Qd)--				
2615							POORLY GRADED GRAVEL? (GP); very dark grey; with slightly weathered basalt fragments --RESIDUAL SOIL/COLLUVIUM--				Rig chatter at2ft.
			S01		57						Auger refusal at 3.5ft; move 30ft. west of initial boring location and redrill
	5		S02		100		VOLCANIC BEDROCK?; olive grey and reddish to yellowish brown; completely weathered; extremely weak; friable --COMPLETELY WEATHERED VOLCANIC BEDROCK--				
2610											
	10		S03				Becomes yellowish red				
							TOTAL DEPTH = 10.5 FEET				
2605											
	15										
2600											
	20										
2595											
	25										
2590											
	30										

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

Log of Soil Boring BC-12

Date(s) Drilled	**10/17/2018**	Logged By	**B. Kozlowicz**	Checked By	**B. Aldridge**
Drilling Method	**Hollow Stem Auger/Direct Push**	Drill Bit Size/Type	**6-inch flight auger**	Total Depth of Borehole	**16.5 feet**
Drill Rig Type	**Truck Mounted Marl M2.5 DP**	Drilling Contractor	**Gregg Drilling**	NAVD 88 Ground Surface Elevation	**2642 feet**
Groundwater Level(s)	**Not encountered**	Sampling Method(s)	**2.5-inch ID ModCal, SPT**	Hammer Data	**Geoprobe Hydraulic Hammer**
Borehole Backfill	**Bentonite cement grout to ground surface**	Borehole Location	**Copco Road/Reservoir Rim**	Coordinate Location	**N 2605101 E 6481855**

Elevation feet	Depth, feet	SAMPLES Type	SAMPLES Number	SAMPLES Sampling Resistance	SAMPLES Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
2640	0						SILTY to CLAYEY SAND with GRAVEL (SM-SC); medium dense; brown (10YR 5/5); with angular GRAVEL up to 3-inches --ROAD BASE--				Start 14:00 10/18/2018 with hollow stem auger
							SILTY SAND (SM); loose to medium dense; dark brown (10YR 3/3); with occasional small GRAVEL; dry --COLLUVIUM--				
2635	5		S-01				CLAYEY SAND to SANDY LEAN CLAY (SC-CL); loose to medium dense; dark brown (10YR 3/3); with angular GRAVEL up to 2-cines; low plasticity FINES; moist				S-01 bagged Smooth drilling 0-4.7ft. Rig chatter 4.7-5.5ft. Smooth drilling 5.5-9ft.
2630	10		S-02		100		POORLY GRADED SAND (SP); loose to medium dense; yellowish brown (10YR 5/4); with small, subangular diatomite GRAVEL; fine to medium grained SAND; dry --Fluvio-Lacustrine Terrace Deposit (Qt)--				S-03 Three liners retained (8.5-9, 9-9.5, 9.5-10ft.)
2625	15		S-03		100		VOLCANIC BEDROCK; very dense; greyish brown (10YR 5/2) to olive brown (2.5Y 4/4); highly to completely weathered; very weak; friable; medium to coarse grained; possibly PORPHYRITIC ANDESITE --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--				
							TOTAL DEPTH = 16.5 FEET				
2620	20										
2615	25										
	30										

Project: Klamath River Renewal Project Project Location: Copco and Iron Gate Reservoirs Project Number: 60537920	Log of Soil Boring BC-13 Sheet 1 of 2

Date(s) Drilled	10/2/2018	Logged By	B. Kozlowicz	Checked By	B. Aldridge
Drilling Method	Hollow Stem Auger	Drill Bit Size/Type	6-inch flight auger	Total Depth of Borehole	42.0 feet
Drill Rig Type	Truck Mounted Mobile B-53	Drilling Contractor	Gregg Drilling	NAVD 88 Ground Surface Elevation	2673 feet
Groundwater Level(s)	Not encountered	Sampling Method(s)	3.0-inch Shelby Tube, SPT	Hammer Data	Automatic hammer; 140 lbs, 30-inch drop
Borehole Backfill	Bentonite cement grout to ground surface	Borehole Location	Copco Road/Reservoir Rim	Coordinate Location	N 2604508 E 6475654

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	0						2-inches ASPHALT				Start 13:50 10/2/2018 with hand auger
							POORLY GRADED GRAVEL with SAND (GP); dense; brown (10YR 4/4); angular GRAVEL up to 3-inches; dry --ROAD BASE--				
							LEAN CLAY with SAND (CL); stiff; dark brown (10YR 3/3); low to medium plasticity FINES; fine to coarse grained SAND; trace small GRAVEL; with rootlets --RESIDUAL SOIL/ALLUVIUM--				
2670											
	5						DIATOMACEOUS SAND (SP); loose to medium dense; yellowish brown (10YR 5/4); fine grained --QUATERNARY DIATOMITE--				Hollow stem auger 5 to 42ft.
			S-01	1600 psi	100		Becomes medium dense to dense with some small, angular gravel				TX-UU
2665											
	10						DIATOMITE; pale yellow (2.5Y 7/3); moderately weathered; with occasional subvertical fractures and trace small rootlets				
			S-02	1560 psi	95			23			TX-ICU
2660											
	15						Becomes pale yellow (2.5Y 7/3), slightly weathered, extremely weak, without fractures or roots				
			S-03	1500 psi	90			30			
2655											
	20										
			S-04	1400 psi	100		With Fe + Mn stained vertical fracture surfaces	59			TX-UU
2650											
	25										
2645											Cuttings become moist
	30										

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	30		S-05	500 to 1100	100		DIATOMITE; pale yellow (2.5Y 7/3); dry; slightly weathered; extremely weak; massive; with trace orange mottling --QUATERNARY DIATOMITE--*(continued)*	72			TX-UU
2640											
	35						LEAN CLAY with SAND (CL); stiff; dark yellowish brown (10YR 3/4); with trace rootlets --COLLUVIUM/RESIDUAL SOIL--				Logged from cuttings
2635											
	40		S-06	500 to 1600	67			21			
			S-07	50/6"	100		CLAYEY SAND (SC); very dense/extremely weak; olive and dark yellowish brown to reddish brown; with weakly expressed 20°foliation/bedding --COMPLETELY WEATHERED VOLCANICLASTIC BEDROCK--				
2630							**TOTAL DEPTH = 42.0 FEET**				
	45										
2625											
	50										
2620											
	55										
2615											
	60										
2610											
	65										

Project: Klamath River Renewal Project	Log of Soil Boring BC-14
Project Location: Copco and Iron Gate Reservoirs	
Project Number: 60537920	Sheet 1 of 1

Date(s) Drilled	**10/2/2018**	Logged By	**B. Kozlowicz**	Checked By	**B. Aldridge**
Drilling Method	**Hollow Stem Auger**	Drill Bit Size/Type	**6-inch flight auger**	Total Depth of Borehole	**15.4 feet**
Drill Rig Type	**Truck Mounted Mobile B-53**	Drilling Contractor	**Gregg Drilling**	NAVD 88 Ground Surface Elevation	**2663 feet**
Groundwater Level(s)	**Not encountered**	Sampling Method(s)	**3.0-inch Shelby Tube, SPT**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Bentonite cement grout to ground surface**	Borehole Location	**Copco Road/Reservoir Rim**	Coordinate Location	**N 2603695 E 6474756**

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	0						3-inches ASPHALT				Start 10:00 10/2/2018 with hand auger 0-5ft.
							POORLY GRADED GRAVEL with SAND (GP); medium dense; dark yellowish brown; with angular GRAVEL up to 3-inches; dry --ROAD BASE--				
							DIATOMITE; very pale brown (10YR 7/4); moderately weathered; medium stiff/dense/very weak; dry; with irregular subvertival, Fe stained fractures --QUATERNARY DIATOMITE--				
2660											
	5		S-01	1200 psi	80			23			Hollow stem auger 5 to 15.4ft. TX-ICU
			S-02	1500 psi	100						TX-UU
2655											
	10		S-03	1600 psi	100			45			TX-UU
			S-04		100			24			TX-ICU
2650											
	15		S-05	50/5	100		VOLCANIC BEDROCK; yellowish to reddish brown; highly to completely weathered; very dense/very weak --BEDROCK--				Drilling becomes hard
							TOTAL DEPTH = 15.4 FEET				
2645											
	20										
2640											
	25										
2635											
	30										

Project: Klamath River Renewal Project Project Location: Copco and Iron Gate Reservoirs Project Number: 60537920	**Log of Soil Boring BC-16** Sheet 1 of 2

Date(s) Drilled	**1/14/2019**	Logged By	**P. Respess**	Checked By	**S. Janowski**
Drilling Method	**Rotary Wash**	Drill Bit Size/Type	**4-inch Tricone**	Total Depth of Borehole	**64.8 feet**
Drill Rig Type	**Barge Mounted CME-45**	Drilling Contractor	**Taber Drilling**	NAVD 88 Ground Surface Elevation	**2592 feet**
Groundwater Level(s)	**14 feet above ground surface (1/14/2019)**	Sampling Method(s)	**2.5-inch ID ModCal**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Bentonite cement grout to ground surface**	Borehole Location	**Copco Lake**	Coordinate Location	**N 2604576 E 6472913**

Elevation feet	Depth, feet	SAMPLES Type	SAMPLES Number	SAMPLES Sampling Resistance	SAMPLES Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	0						SILTY CLAY (CL-ML); soft; wet; grayish brown; apparent mix of diatomite and topsoil/colluvium --SLUMPED BANK MATERIAL--				Boring logged from cuttings
2590											
	5										
							DIATOMITE; greenish gray; soft				
2585											
	10										
2580											
	15										
2575											
	20										
2570											
	25										
2565											
	30										

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	30						DIATOMITE; greenish gray; soft *--continued--*				
2560											
	35										
2555											
	40										
2550											
	45										
2545											
	50										
2540											
	55										
2535											
	60										
2530											
							VOLCANICLASTIC SANDSTONE; medium gray; completely to highly weathered; weak; angular to subangular, fine- to medium-grained clasts				Harder drilling Rig repair 1315-1335
	65		1	50/3"	100						Bottom liner retained

TOTAL DEPTH = 64.8 FEET

Project: Klamath River Renewal Project Project Location: Copco and Iron Gate Reservoirs Project Number: 60537920	Log of Soil Boring BC-17 Sheet 1 of 2

Date(s) Drilled	1/14/2019	Logged By	P. Respess	Checked By	S. Janowski
Drilling Method	Rotary Wash	Drill Bit Size/Type	4-inch Tricone	Total Depth of Borehole	37.4 feet
Drill Rig Type	Barge Mounted CME-45	Drilling Contractor	Taber Drilling	NAVD 88 Ground Surface Elevation	2593 feet
Groundwater Level(s)	12.5 feet above ground surface (1/14/2019)	Sampling Method(s)	2.5-inch ID ModCal	Hammer Data	Automatic hammer; 140 lbs, 30-inch drop
Borehole Backfill	Bentonite cement grout to ground surface	Borehole Location	Copco Lake	Coordinate Location	N 2603825 E 6474508

Elevation feet	Depth, feet	SAMPLES Type	SAMPLES Number	SAMPLES Sampling Resistance	SAMPLES Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	0						SILTY CLAY (CL-ML); soft; wet; brown to grayish brown; apparent mix of diatomite and topsoil/colluvium --SLUMPED BANK MATERIAL--				Boring logged from cuttings
2590											
	5						DIATOMITE; greenish gray; soft				
2585											
	10										
2580											
	15										
2575											
	20										
2570											
	25										
2565											
	30										

Project: Klamath River Renewal Project Project Location: Copco and Iron Gate Reservoirs Project Number: 60537920	Log of Soil Boring BC-17 Sheet 2 of 2

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	30						DIATOMITE; greenish gray; soft *--continued--*				
2560							VOLCANICLASTIC SANDSTONE; grayish brown; completely to highly weathered; weak; angular to subangular, fine- to medium-grained clasts				
	35		1	23 27 50/5"							Bottom liner retained
2555							**TOTAL DEPTH = 37.4 FEET**				
	40										
2550											
	45										
2545											
	50										
2540											
	55										
2535											
	60										
2530											
	65										

Project: Klamath River Renewal Project Project Location: Copco and Iron Gate Reservoirs Project Number: 60537920	**Log of Soil Boring BC-18** Sheet 1 of 2

Date(s) Drilled	1/14/2019	Logged By	P. Respess	Checked By	S. Janowski
Drilling Method	Rotary Wash	Drill Bit Size/Type	4-inch Tricone	Total Depth of Borehole	34.5 feet
Drill Rig Type	Barge Mounted CME-45	Drilling Contractor	Taber Drilling	NAVD 88 Ground Surface Elevation	2598 feet
Groundwater Level(s)	8 feet above ground surface (1/14/2019)	Sampling Method(s)	2.5-inch ID ModCal	Hammer Data	Automatic hammer; 140 lbs, 30-inch drop
Borehole Backfill	Bentonite cement grout to ground surface	Borehole Location	Copco Lake	Coordinate Location	N 2604477 E 6475056

Elevation feet	Depth, feet	SAMPLES: Type	SAMPLES: Number	SAMPLES: Sampling Resistance	SAMPLES: Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	0						SILTY CLAY (CL-ML); soft; wet; brown to grayish brown; apparent mix of diatomite and topsoil/colluvium; tree root fragments --SLUMPED BANK MATERIAL--				Boring logged from cuttings
2595											
							DIATOMITE; greenish gray to yellowish brown; soft				
	5										
2590											
	10										
2585											
	15										
2580											
	20										
2575											
	25										
2570											
	30										

Project: Klamath River Renewal Project Project Location: Copco and Iron Gate Reservoirs Project Number: 60537920	**Log of Soil Boring BC-18** Sheet 2 of 2

Elevation feet	Depth, feet	SAMPLES Type	SAMPLES Number	SAMPLES Sampling Resistance	SAMPLES Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	30						DIATOMITE; greenish gray to yellowish brown; soft *--continued--*				
2565			1	27 23 24			VOLCANICLASTIC SANDSTONE; grayish brown; completely to highly weathered; weak; angular to subangular, fine- to medium-grained clasts				Bottom liner retained
	35						**TOTAL DEPTH = 34.5 FEET**				
2560											
	40										
2555											
	45										
2550											
	50										
2545											
	55										
2540											
	60										
2535											
	65										

Project: Klamath River Renewal Project Project Location: Copco and Iron Gate Reservoirs Project Number: 60537920	Log of Soil Boring BC-19 Sheet 1 of 2

Date(s) Drilled	1/13/2019	Logged By	P. Respess	Checked By	S. Janowski
Drilling Method	Rotary Wash	Drill Bit Size/Type	4-inch Tricone	Total Depth of Borehole	37.5 feet
Drill Rig Type	Barge Mounted CME-45	Drilling Contractor	Taber Drilling	NAVD 88 Ground Surface Elevation	2599 feet
Groundwater Level(s)	7 feet above ground surface (1/13/2019)	Sampling Method(s)	2.5-inch ID ModCal	Hammer Data	Automatic hammer; 140 lbs, 30-inch drop
Borehole Backfill	Bentonite cement grout to ground surface	Borehole Location	Copco Lake	Coordinate Location	N 2604654 E 6475303

Elevation feet	Depth, feet	SAMPLES Type	SAMPLES Number	SAMPLES Sampling Resistance	SAMPLES Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	0						SILTY CLAY (CL-ML); soft; wet; brown to grayish brown; apparent mix of diatomite and topsoil/colluvium --SLUMPED BANK MATERIAL--				Boring logged from cuttings
2595	5										
2590	10						DIATOMITE; light gray; soft; occasional fine- to coarse-grained SAND				
2585	15										
2580	20										
2575	25										
2570	30										

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	30						DIATOMITE; light gray; soft; occasional fine- to coarse-grained SAND *--continued--*				
2565	35										
			1	12 24 29			VOLCANICLASTIC SANDSTONE; light to medium gray; completely to highly weathered; weak; angular to subangular, fine- to medium-grained clasts				Two bottom liners retained
							TOTAL DEPTH = 37.5 FEET				
2560	40										
2555	45										
2550	50										
2545	55										
2540	60										
2535	65										

Project: Klamath River Renewal Project Project Location: Copco and Iron Gate Reservoirs Project Number: 60537920	**Log of Soil Boring BC-20** Sheet 1 of 1

Date(s) Drilled	1/14/2019	Logged By	P. Respess	Checked By	S. Janowski
Drilling Method	Rotary Wash	Drill Bit Size/Type	4-inch Tricone	Total Depth of Borehole	19.0 feet
Drill Rig Type	Barge Mounted CME-45	Drilling Contractor	Taber Drilling	NAVD 88 Ground Surface Elevation	2597 feet
Groundwater Level(s)	9 feet above ground surface (1/14/2019)	Sampling Method(s)	2.5-inch ID ModCal	Hammer Data	Automatic hammer; 140 lbs, 30-inch drop
Borehole Backfill	Bentonite cement grout to ground surface	Borehole Location	Copco Lake	Coordinate Location	N 2606433 E 6479381

Elevation feet	Depth, feet	SAMPLES Type	SAMPLES Number	SAMPLES Sampling Resistance	SAMPLES Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	0						DIATOMITE; greenish gray to light yellowish brown; soft				Boring logged from cuttings
2595											
	5										
2590											
	10										
2585											
	15										
2580											
			1	50/0.5"	100		BASALT?; dark gray to black; hard; aphanitic				Hard drilling
							TOTAL DEPTH = 19.0 FEET				
	20										
2575											
	25										
2570											
	30										

Report: GEO_10B1_OAK; File: KLAMATH_MASTER.GPJ; 6/20/2019 BC-20

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

Log of Soil Boring BI-01

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	NAVD 88 Ground Surface Elevation	2318 feet
Groundwater Level(s)	11.8 feet above ground surface (2/20/2018)	Sampling Method(s)	2.5-inch ID ModCal, SPT	Hammer Data	Automatic hammer; 140 lbs, 30-inch drop
Borehole Backfill	Cement grout to ground surface	Borehole Location	Iron Gate Reservoir	Coordinate Location	N 2600814 E 6450535

Elevation feet	Depth, feet	SAMPLES Type	SAMPLES Number	SAMPLES Sampling Resistance	SAMPLES Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	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--				
2315			S-1	0 0 0	40		LEAN CLAY (CL); stiff; dry; dark red brown (5YR 3/4); trace rootlets; CaCO3 ribbons; developed soil texture --COLLUVIUM/RESIDUAL SOIL--				S-1 Sampler sank under weight of rods 12.5-14.5ft. and pushed 14.-17.5ft.
	5										
2310			S-2	4 7 8	100						Advance 5-inch casing 7.5ft.
	10		S-3	6 8 13	67						Begin rotary wash drilling
			S-4	50/4"	100		BASALT; dark red brown (5YR 2.5/2); fresh; strong --TERTIARY to QUATERNARY INTRUSIVE BASALT--				Driller notes change at 11.5ft., Volcanics in cuttings Driller notes bedrock drilling conditions from 12ft.-17ft.
2305											
	15										
			S-5	50/3"	50		VOLCANIC BRECCIA; mottled dark gray (2.5Y 4/1) and light yellow brown (2.5Y 6/4); slightly weathered; moderately strong; coarse grained with quartz phenocrysts --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--				
2300											
	20										
			S-6	50/3"	100		**TOTAL DEPTH = 22.2 FEET**				
2295											
	25										
2290											
	30										

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

Log of Soil and Core Boring BI-02

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**	NAVD 88 Ground Surface Elevation	**2334 feet**
Groundwater Level	**4.8 feet below ground surface (2/22/2018)**	Sampling Methods	**2.5-inch ID ModCal, HQ Core Barrel**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Cement grout to ground surface**	Borehole Location	**Iron Gate Reservoir; near Fall Creek Boat Ramp**	Coordinate Location	**N 2602024 E 6461383**

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
2334	0								SANDY FAT CLAY (CH); stiff; very dark brown (7.5YR 2.5/3); moist; high plasticity fines; 10 percent rounded gravel up to 1-inch in diameter --OLD ALLUVIUM- FLOOD PLAIN DEPOSIT--						4-inch solid stem auger
	1														
2332	2														
	3														
2330	4								▼						
	5										S-1	6 8 13	87	14:30	LL=78; PL=28 SA: G=11%; S=21%; F=68%
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); high 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	100	14:40	LL=58; PL=28 SA: G=5%; S=33%; F=62%
	11														
2322	12														
	13														

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

Log of Soil and Core Boring BI-02

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	MATERIAL DESCRIPTION	Soil Samples Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
2320	13–15							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-- *(continued)*						First water at 14.0 feet; after 20 minutes at 4.8 feet
2318	15–17.5		1					SANDY FAT CLAY (CH); medium stiff to stiff; brown (7.5YR 5/4); fine grain sand; high plasticity fines; trace rounded gravel up to 1-inch --OLDER ALLUVIUM/RESIDUAL SOIL--		S-3	6, 6, 7	100	15:00	LL=51; PL=27 SA: G=8%; S=40%; F=52% Advance 4-inch casing to 14 feet. Switch to rotary wash
2316, 2314	17.5–21.6	1		17	NA, NA, NA, NA, NA	0	1, 2; NR	VOLCANIC 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 --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)-- 1: 60, J, N, No, No, Pl, SR 2: 10, J, MW, No, No, Wa, SR					1549 [21] 1601	Refusal with tricone bit; switch to HQ rock core. Clayey volcanics cuttings. 100% fluid return
2312, 2310	21.6–24.5	2		100	2, 3, 1	48*	1, 2, 3, 3, 1, 4, m	Becomes moderately to slightly weathered; weak to 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 4: 20, J, N, No, No, Wa, SR Run break					1610 [22] 1618	*Rock does not meet soundness criteria for RQD calculation
2308	24.5–27	3		100	2, 1	100	1, 2, 1, 1, m	1: 30. J, N, No, No, Wa, SR 2: 5, J, T, H+Uk, Pa, Wa, ? Run break					1622 [21] 1629	
2306	27–29	4		100	1, 0	100	1, m	1: 5, J, N, No, No, Wa, SR					1634 [30]	27.0-27.9ft.: Mohs Hardness = 3 UCS = 841 psi Bulk Density= 141.42pcf

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
	29	4	1	100	1	100	2	VOLCANIC BRECCIA; green gray (10Y 6/1); moderately to slightly weathered; weak to moderately strong; moderately fractured with angular breccia clasts up to 1-inch; medium grained matrix --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--*(continued)*					[30]	Mechanically broken from placement in box
2304	30				1		2	2: 10-15, J, N, No, No, Wa-St, R						100% fluid return
	31				0									
2302	32	5		100	1	96	m, 1						1644 / 1647	
	33				2		1							
2300	34		2		1		2, 3	1: 10, J, N, No, No, Wa,SR 2: 40, J, N, No, No, St, SR 3: 30, J, T, H+Uk, No, No, Wa, ? 4: 10, J, N, No, No, Wa-St, SR					[31]	
	35				1		4							
2298	36				0									
	37	6		100	1	100	1						1657 / 1701	
2296	38				1		1							
	39				1		2	1: 10, J, N, No, No, Wa-St, R 2: 15, J, T, No, No, Wa, SR 3: 30, J, N, No, No, Wa-Pl, SR					[26]	
2294	40				1		3							
	41				0									
2292	42	7		100	1	96	1						1712 / 1206	End of day 2/22/2018 Begin day 2/23/2018
	43				4		2	1: 10, J, N, No, No, Wa, SR 2: 10-30, J, T, No, No, Wa, SR						
2290	44				1		1						[43]	
	45													

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
	45				1		3	△ △	VOLCANIC BRECCIA; green gray (10Y 6/1); moderately to slightly weathered; weak to moderately strong; moderately fractured; angular breccia clasts up to 1-inch; fine to medium grained matrix --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)-- *(continued)*						100% fluid return
2288	46		3		1		4	△ △	3: 10-30, J, MW, No, No, Wa-Ir, SR-R 4: 30, J, N, No, No, Wa-Pl, SR						
	47				0			△ △	Becomes strong; slightly fractured					1213 1216	Brazilian Tensile Strength Test
2286	48				0		1 2	△ △	1: 20, J, MW, H+Ca, Fi, Wa, ? 2: 15, J, N, No, No, Wa-St, R						
	49	8		100	1	100		△ △						[25]	48.9-50.3ft.: Mohs Hardness = 3 UCS = 1 736 psi Bulk Density=149.67pcf
2284	50				0			△ △							Punch Penetration Index Test
	51				1		2	△ △							Cerchar Abrasiveness Test
2282	52				0			△ △						1228 1232	Brazilian Tensile Strength Test
	53				0			△ △							
2280	54	9		100	1	98	1	△ △	1: 30, J, N, No, No, St, R 2: 20, J, N, No, No, Wa-St, SR					[23]	Mechanically broken from placement in box
	55				0		m	△ △							55.4-56.3ft.: Mohs Hardness = 3 UCS = 2 288 psi Bulk Density=148.46pcf
2278	56				1		m 2	△ △							
	57				1		1	△ △						1245 1250	Packer test #1 from 47.0 to 67.0
2276	58				0			△ △							
	59	10		100	1	96	2	△ △	1: 20, J, N, No, No, Wa, SR 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 Drawing Number	MATERIAL DESCRIPTION	Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	61		4		1		m, m, 3	VOLCANIC BRECCIA; green gray (10Y 6/1); moderately to slightly weathered; weak to strong; slightly fractured; angular breccia clasts up to 1-inch; fine to medium grained matrix --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--*(continued)*					1305	
2272	62				0			3: 5, J, N, No, No, Wa, SR					1311	Mechanically broken from placement in box
	63				1		1, 2							
2270	64	11		100	0	72		1: 30, V, N-T, H+Ca, Fi, Wa, ? 2: 10, J, N, No, No, Wa-St, SR-R 3: 60, J/V, MW, Ca, Pa, Wa-Pl, SR 4: 60-70, J/V, N, H+Ca, Fi, Wa, ?					[19]	
	65				1		3							
2268	66				3		4, 4, m						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 Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core 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	NAVD 88 Ground Surface Elevation	2306 feet
Groundwater Level	25.3 feet above ground surface (2/21)	Sampling Methods	2.5-inch ID ModCal, HQ Core Barrel	Hammer Data	Automatic hammer; 140 lbs, 30-inch drop
Borehole Backfill	Cement grout 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 Samples Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	0							POORLY GRADED GRAVEL with SILT and SAND (GP-GM); dark green gray (N 4/1); wet; loose; subangular to subrounded gravel up to 0.25-inch --RIVER ALLUVIUM--						Advance 5-inch casing to 3ft.
2304	1–2													
2302	3–4							VOLCANIC 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 --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--		S-1	12 50/2.5"	47	10:10	LL=41; PL=26 SA: G=61%; S=30%; F=9% Advance 5-inch casing to 4ft.
2300	5–6		1		>6		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 rock core
	6–7				>6		3 4 2 5							
2298	7–8	1		89	>6	0	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 6: 40, J, N, No, No, Wa, SR 7: 70, J, T, No, No, Wa, SR,					[13]	
	8–9				>6		6 4 7							
2296	9–10				NA		5						1120	
	10–11				NA		1						1143	LL=58; PL=28 SA: G=5%; S=33%; F=62%
2294	11–12				4		2 3 3	1: ~10, J, N, No, No, Wa, SR 2: 30, J, N-T, No, No, Wa-St, SR 3: 40-50, J, N, No, No, Wa-St, SR-R 4: 20, J, MW, No, Wa, St, SR-R						
	12–13	2		100	5	14*	4 3 4 2						[19]	*Rock 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	MATERIAL DESCRIPTION	Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
2292	13–14	2	1	100	5	14*	5, 2, 2	VOLCANIC 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 --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--(continued) 5: 30, J, N, No, No, Wa-Pl, SR						
	14–15				5		1, 2, 2							
2290	15–16	3		100	3	100*	1	Becomes slightly fractured; moderately strong					1159 / 1215	LL=51; PL=27 SA: G=8%; S=40%; F=52% Packer test #1 from 15.1 to 35.1ft.
	16–17				0									
2288	17–18				1		2	1: 35, J, N, No, No, St, R 2: 30, J, N, No, No, Wa, SR 3: 20, J, T, No, No, Wa, SR					[23]	17.4-18.4ft.: UCS = 221 psi *Rock does not meet soundness criteria for RQD calculation 17.4-18.4ft.: Mohs Hardness = 3 UCS = 221 psi Bulk Density=138.44pcf Brazilian Tensile Strength Test
	18–19				1		3							
2286	19–20				0									
	20–21	4	2	100	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	
2284	21–22				2		3, 2	Becomes moderately fractured						21.5-22.9ft.: Mohs Hardness = 3 UCS = 352 psi Bulk Density=134.96pcf
	22–23				1		3						[18]	Brazilian Tensile Strength Test
2282	23–24				0									
	24–25				1		3							Punch Penetration Index Test
2280	25–26	5		100	0	48*							1256 / 1301	Cerchar Abrasiveness Test
	26–27				5		1, 2, 3, 3	Moderately to highly weathered; weak to very weak; fractures 1; 2; 3 are likely mechanical						Clayey coating 26.5-27.2ft. is from when return hose got disconnected during run
2278	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]	
	28–29				>6		6	Crushed zone 6: 65, J, MW, Sd, Pa, Wa, SR						

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

Log of Soil and Core Boring BI-03

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
2276	29–30	5	2	100	0	48*		△ △	VOLCANIC BRECCIA; green gray (5G 6/1); moderately to highly weathered; weak to moderately strong; moderately fractured; fine to medium grained matrix with angular to subrounded clasts up to 0.75-inches --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--*(continued)*					1321	
	30–31	6		100	2	54*	1, 1	△ △	At 30.1ft: Becomes intensely fractured, weak to moderately strong, locally very weak to weak					1327	
2274	31–32				4		2, 2, 3, 1	△ △	1: 5, J, N, No, No, Pl-Wa, SR 2: 20, J, N-MW, No, No, Wa, SR 3: 35, J, N, Ca+Sd, Pa, Pl, S 4: 30, J, N, No, No, Pl, SR						
	32–33				0			△ △						[15]	
2272	33–34				3		4, 3	△ △							*Rock does not meet soundness criteria for RQD calculation
	34–35				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-Pl, SR					1347	

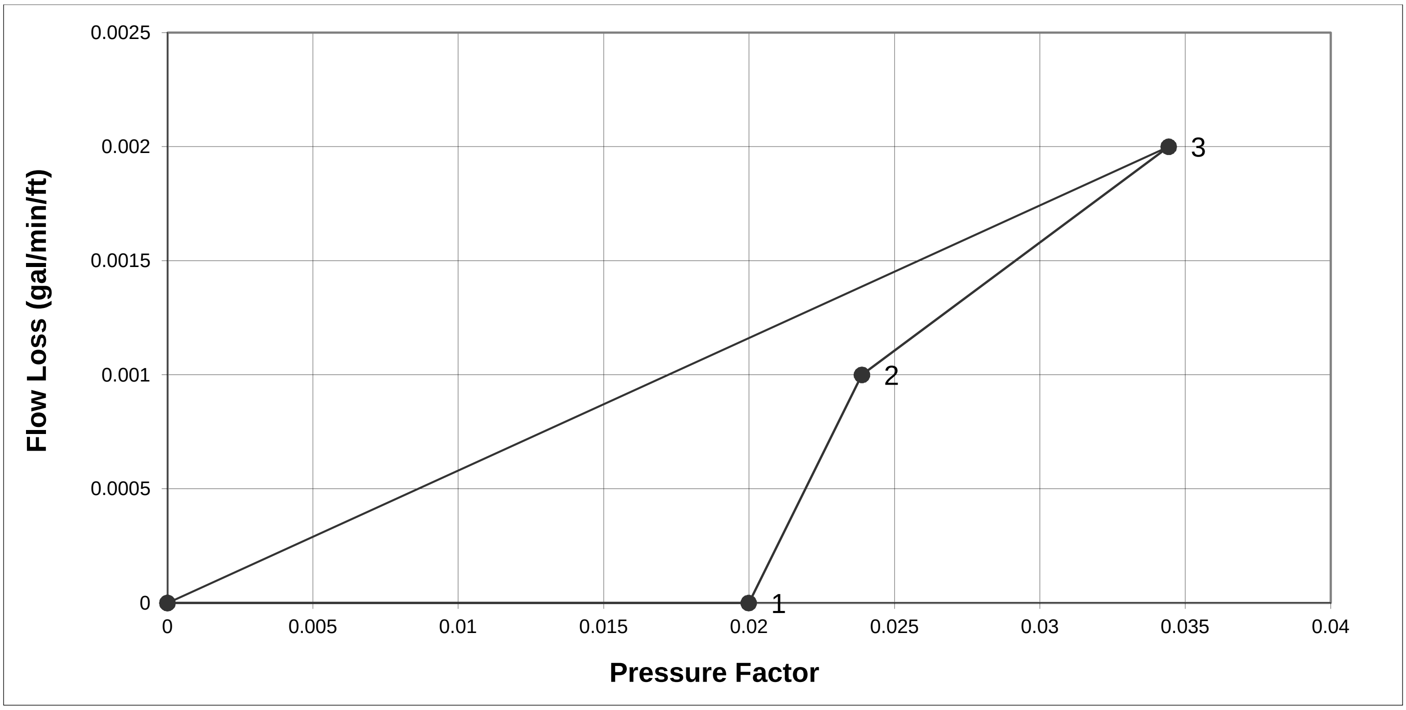
TOTAL DEPTH = 35.1 FEET

Elevation scale: 2270, 2268, 2266, 2264, 2262; Depth scale: 36, 37, 38, 39, 40, 41, 42, 43, 44, 45

APPENDIX B PACKER TEST DATA

Boring	B-203		Top of Test Elevation (ft)	2278.5
Surface El. (ft)	2305		Bottom of Test Elevation (ft)	2258.5
Groundwater El. (ft)	2330		Top of Test Depth (ft)	26.5
Test No.	1		Bottom of Test Depth (ft)	46.5
Test Interval Center Elevation (ft)	2268.5		Angle from Vertical (deg)	0
Test Interval Length, L (ft)	20.0			
Max. Measured Pressure, P_{MAX} (psi)	62.0			
Reference Pressure, P_0 (psi)	145			
Representative Lugeon Value	0			

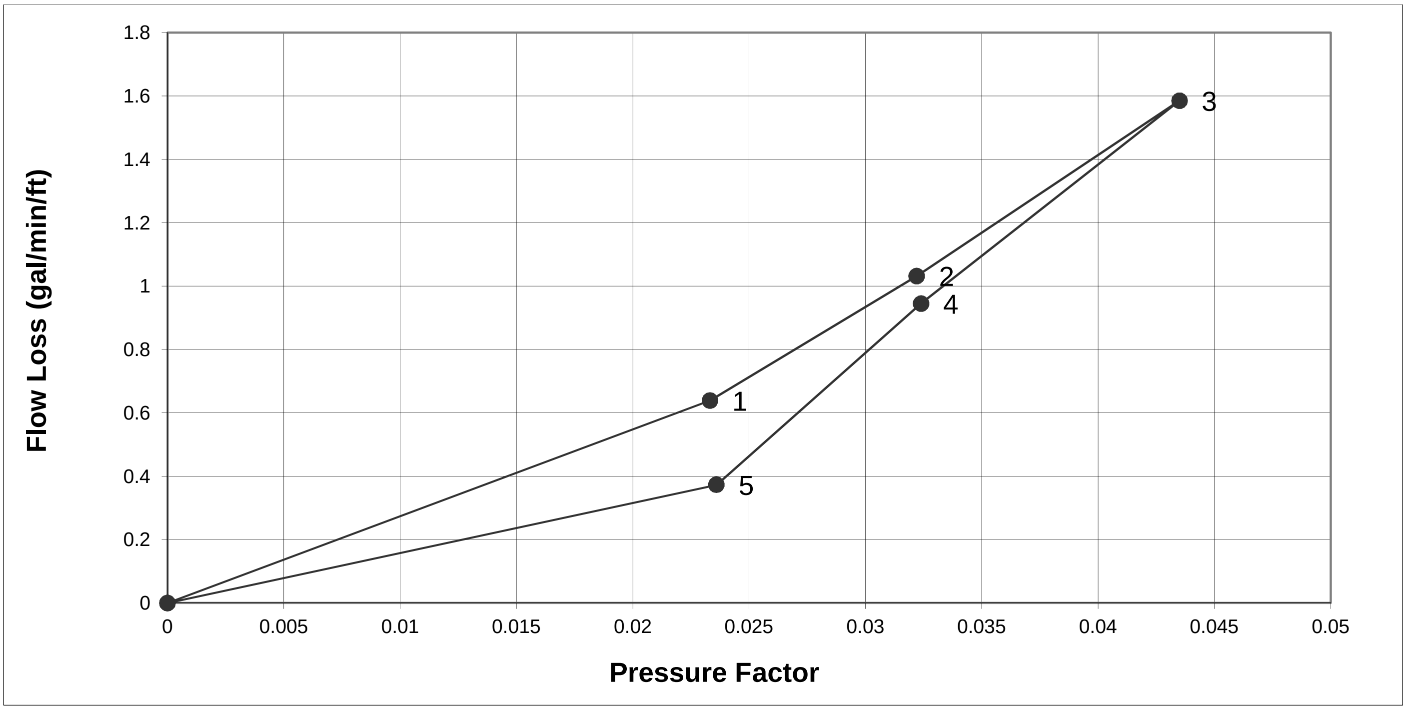
Step No.	%P_{MAX}	Measured Pressure (psi)	Pressure Factor, ψ	Flow, q (gal/min)	Flow loss (gal/min/ft)	Lugeon
0	0		0	0	0	-
1	50%	36.00	0.019990005	0.00	0.0000	0
2	75%	43.00	0.02387695	0.02	0.0010	0
3	100%	62.00	0.034427231	0.04	0.0020	0
4	75%		#N/A			
5	50%		#N/A			
0	0		0	0	0	



Boring	B-203
Surface El. (ft)	2305
Groundwater El. (ft)	2330
Test No.	2
Test Interval Center Elevation (ft)	2249.5
Test Interval Length, L (ft)	20.0
Max. Measured Pressure, P_{MAX} (psi)	78.3
Reference Pressure, P_0 (psi)	145
Representative Lugeon Value	36

Top of Test Elevation (ft)	2259.5
Bottom of Test Elevation (ft)	2239.5
Top of Test Depth (ft)	45.5
Bottom of Test Depth (ft)	65.5
Angle from Vertical (deg)	0

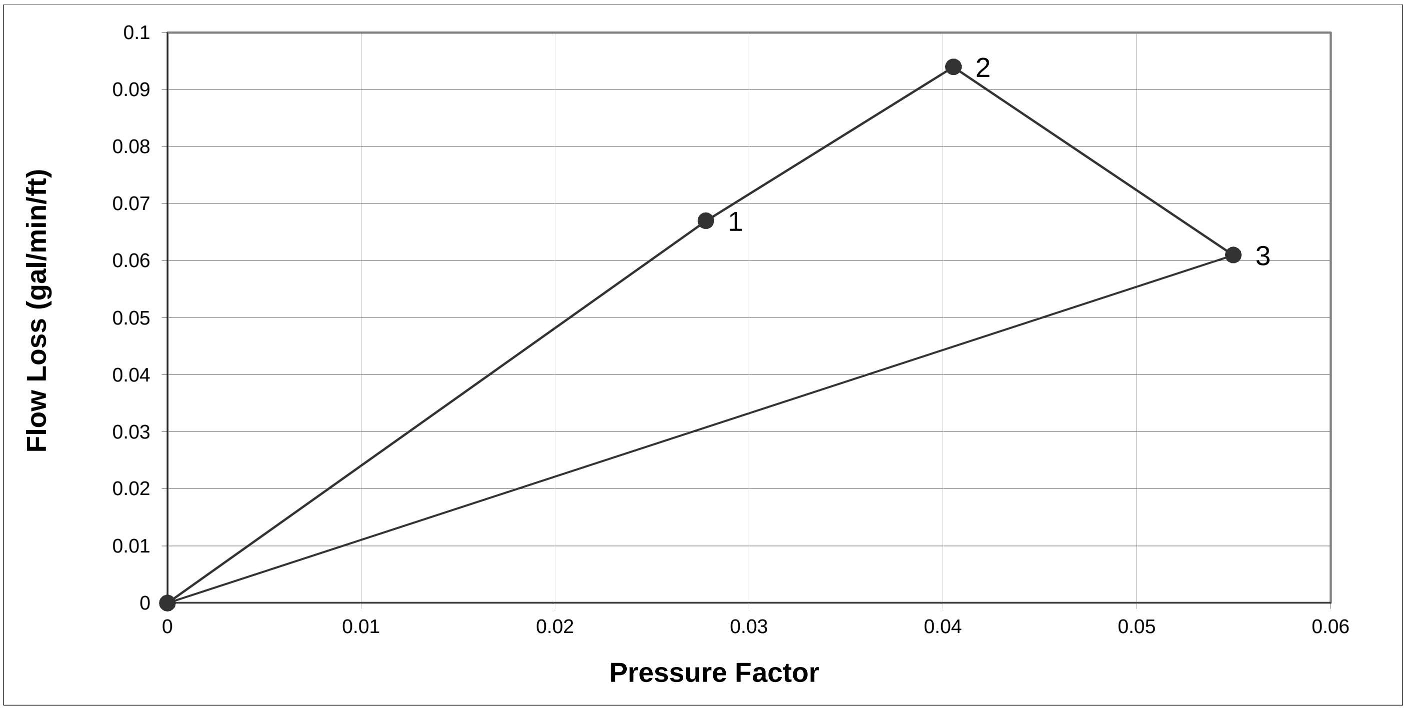
Step No.	$\%P_{MAX}$	Measured Pressure (psi)	Pressure Factor, ψ	Flow, q (gal/min)	Flow loss (gal/min/ft)	Lugeon
0	0		0	0	0	-
1	50%	42.00	0.023321672	12.78	0.6390	27
2	75%	58.00	0.032206119	20.64	1.0320	32
3	100%	78.33	0.04349677	31.70	1.5850	36
4	75%	58.33	0.032391212	18.90	0.9450	29
5	50%	42.50	0.023599311	7.46	0.3730	16
0	0		0	0	0	



Boring	B-203
Surface El. (ft)	2305
Groundwater El. (ft)	2330
Test No.	3
Test Interval Center Elevation (ft)	2229.5
Test Interval Length, L (ft)	20.0
Max. Measured Pressure, P_{MAX} (psi)	99.0
Reference Pressure, P_0 (psi)	145
Representative Lugeon Value	1

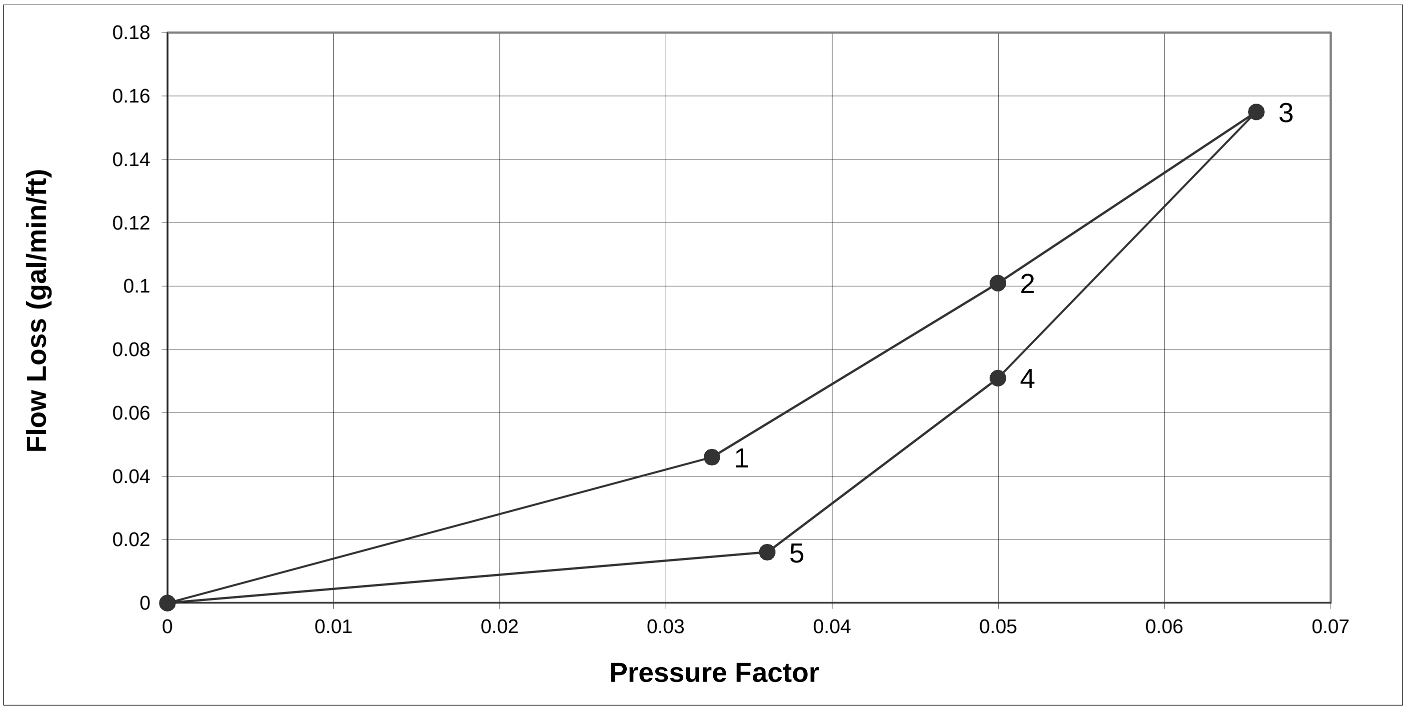
Top of Test Elevation (ft)	2239.5
Bottom of Test Elevation (ft)	2219.5
Top of Test Depth (ft)	65.5
Bottom of Test Depth (ft)	85.5
Angle from Vertical (deg)	0

Step No.	$\%P_{MAX}$	Measured Pressure (psi)	Pressure Factor, ψ	Flow, q (gal/min)	Flow loss (gal/min/ft)	Lugeon
0	0		0	0	0	-
1	50%	50.00	0.027763896	1.34	0.0670	2
2	75%	73.00	0.040535288	1.88	0.0940	2
3	100%	99.00	0.054972514	1.22	0.0610	1
4	75%		#N/A			
5	50%		#N/A			
0	0		0	0	0	



Boring	B-203		Top of Test Elevation (ft)	2219.5
Surface El. (ft)	2305		Bottom of Test Elevation (ft)	2199.5
Groundwater El. (ft)	2330		Top of Test Depth (ft)	85.5
Test No.	4		Bottom of Test Depth (ft)	105.5
Test Interval Center Elevation (ft)	2209.5		Angle from Vertical (deg)	0
Test Interval Length, L (ft)	20.0			
Max. Measured Pressure, P_{MAX} (psi)	118.0			
Reference Pressure, P_0 (psi)	145			
Representative Lugeon Value	2			

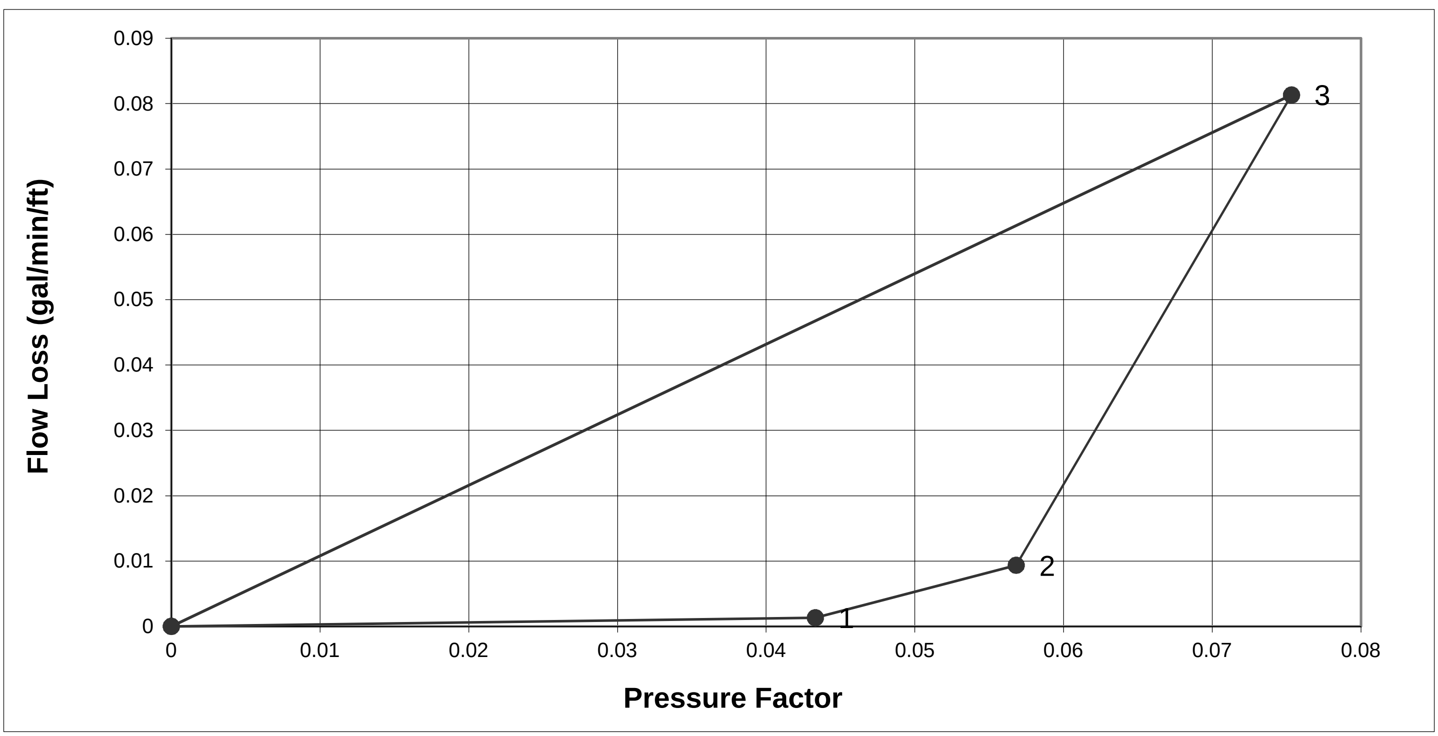
Step No.	$\%P_{MAX}$	Measured Pressure (psi)	Pressure Factor, ψ	Flow, q (gal/min)	Flow loss (gal/min/ft)	Lugeon
0	0		0	0	0	-
1	50%	59.00	0.032761397	0.92	0.0460	1
2	75%	90.00	0.049975012	2.02	0.1010	2
3	100%	118.00	0.065522794	3.10	0.1550	2
4	75%	90.00	0.049975012	1.42	0.0710	1
5	50%	65.00	0.036093065	0.32	0.0160	0
0	0		0	0	0	



Boring	B-203
Surface El. (ft)	2305
Groundwater El. (ft)	2330
Test No.	5
Test Interval Center Elevation (ft)	2192.5
Test Interval Length, L (ft)	15.0
Max. Measured Pressure, P_{MAX} (psi)	135.7
Reference Pressure, P_0 (psi)	145
Representative Lugeon Value	1

Top of Test Elevation (ft)	2200.0
Bottom of Test Elevation (ft)	2185.0
Top of Test Depth (ft)	105
Bottom of Test Depth (ft)	120
Angle from Vertical (deg)	0

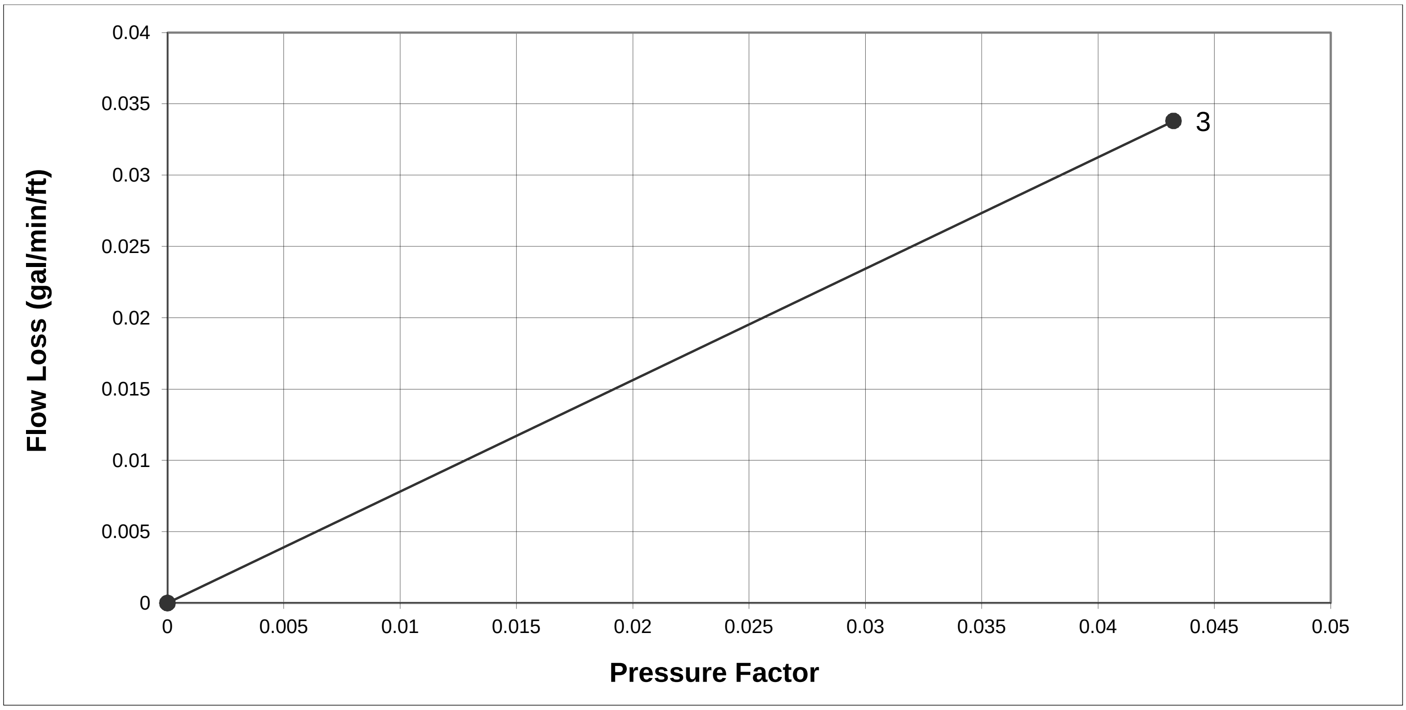
Step No.	$\%P_{MAX}$	Measured Pressure (psi)	Pressure Factor, ψ	Flow, q (gal/min)	Flow loss (gal/min/ft)	Lugeon
0	0		0	0	0	-
1	50%	78.00	0.043311677	0.02	0.0013	0
2	75%	102.33	0.05682344	0.14	0.0093	0
3	100%	135.67	0.075332704	1.22	0.0813	1
4	75%		#N/A			
5	50%		#N/A			
0	0		0	0	0	



Boring	B-206
Surface El. (ft)	2336.62231
Groundwater El. (ft)	2328.02231
Test No.	1
Test Interval Center Elevation (ft)	2258.7
Test Interval Length, L (ft)	10.0
Max. Measured Pressure, P_{MAX} (psi)	77.9
Reference Pressure, P_0 (psi)	145
Representative Lugeon Value	1

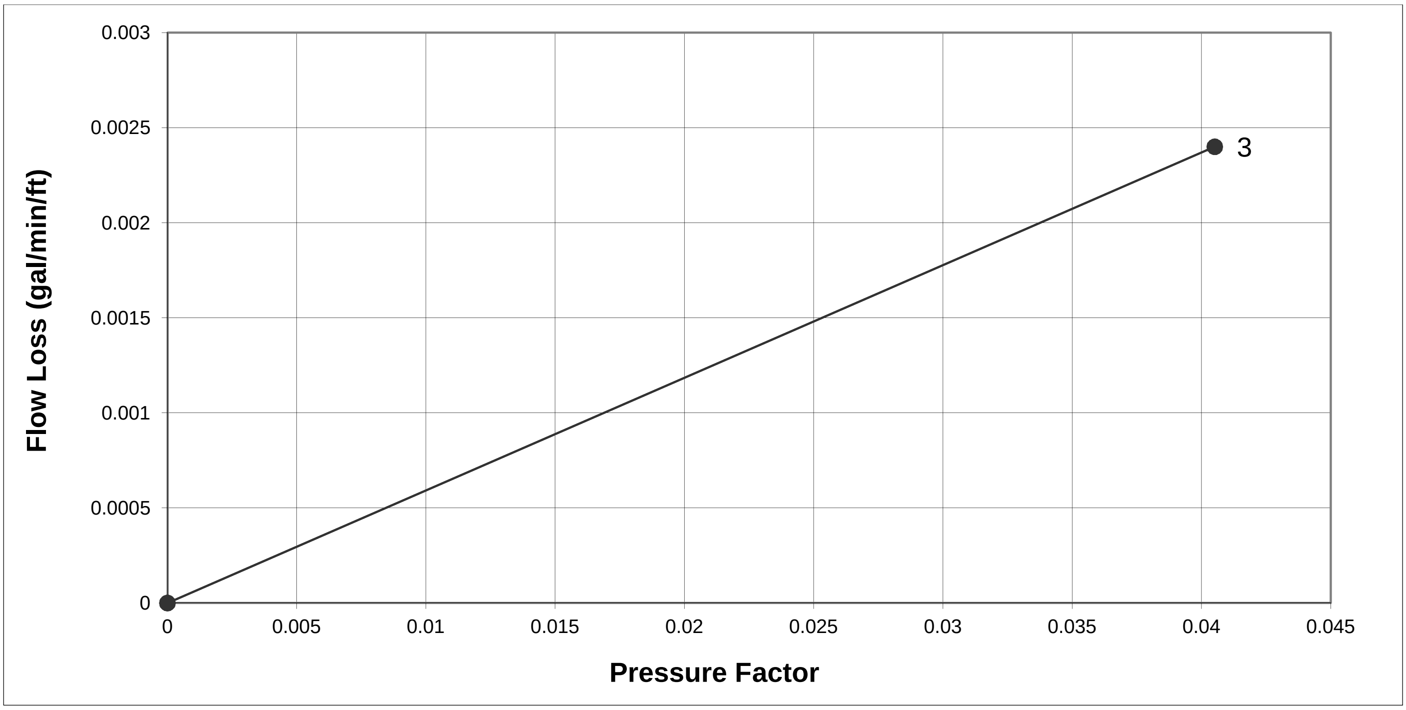
Top of Test Elevation (ft)	2263.0
Bottom of Test Elevation (ft)	2254.3
Top of Test Depth (ft)	85
Bottom of Test Depth (ft)	95
Angle from Vertical (deg)	30

Step No.	%P_{MAX}	Measured Pressure (psi)	Pressure Factor, ψ	Flow, q (gal/min)	Flow loss (gal/min/ft)	Lugeon
0	0		0	0	0	-
1	50%		#N/A			
2	75%		#N/A			
3	100%	77.88	0.043245044	0.34	0.0338	1
4	75%		#N/A			
5	50%		#N/A			
0	0		0	0	0	



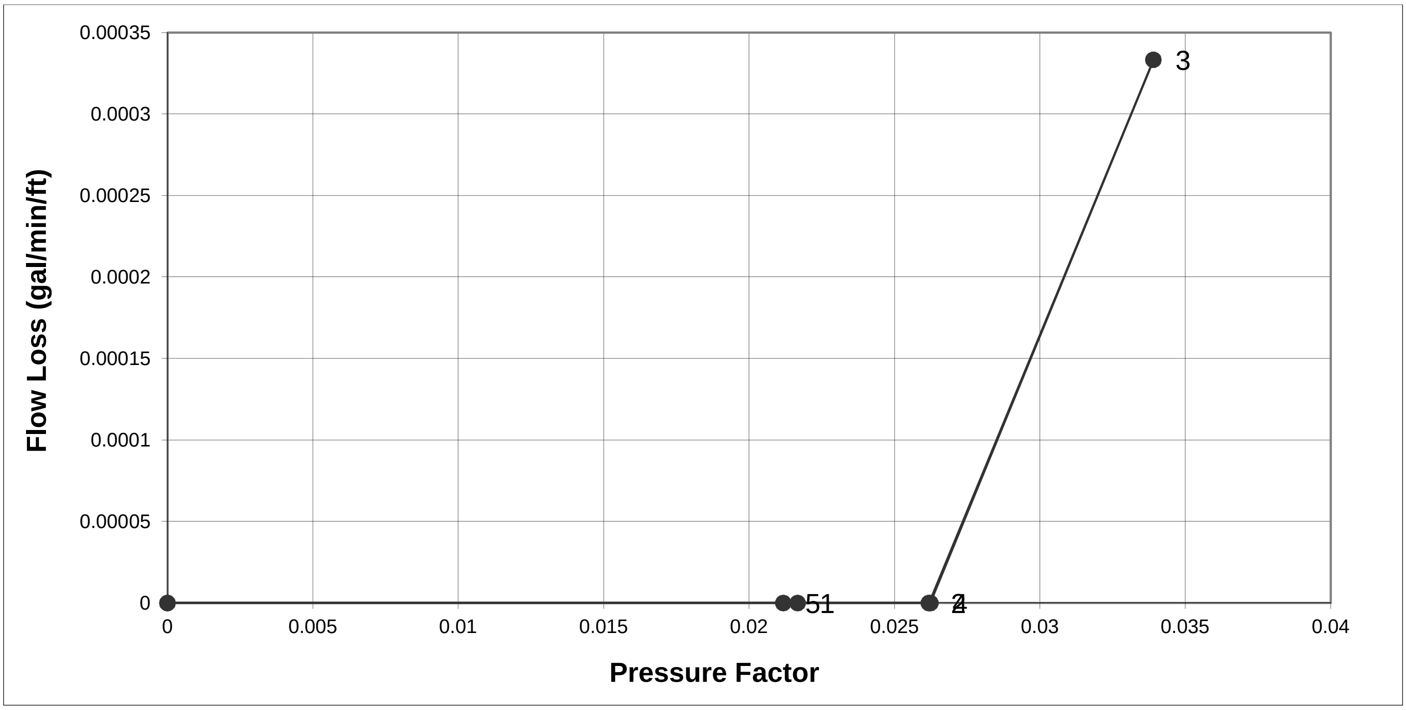
Boring	B-206		Top of Test Elevation (ft)	2271.7
Surface El. (ft)	2336.62231		Bottom of Test Elevation (ft)	2263.0
Groundwater El. (ft)	2328.02231		Top of Test Depth (ft)	75
Test No.	2		Bottom of Test Depth (ft)	85
Test Interval Center Elevation (ft)	2267.3		Angle from Vertical (deg)	30
Test Interval Length, L (ft)	10.0			
Max. Measured Pressure, P_{MAX} (psi)	73.0			
Reference Pressure, P_0 (psi)	145			
Representative Lugeon Value	0			

Step No.	$\%P_{MAX}$	Measured Pressure (psi)	Pressure Factor, ψ	Flow, q (gal/min)	Flow loss (gal/min/ft)	Lugeon
0	0		0	0	0	-
1	50%		#N/A			
2	75%		#N/A			
3	100%	72.96	0.040513077	0.02	0.0024	0
4	75%		#N/A			
5	50%		#N/A			
0	0		0	0	0	



Boring	BI-02		Top of Test Elevation (ft)	2287.3
Surface El. (ft)	2334.3		Bottom of Test Elevation (ft)	2267.3
Groundwater El. (ft)	2329.5		Top of Test Depth (ft)	47
Test No.	1		Bottom of Test Depth (ft)	67
Test Interval Center Elevation (ft)	2277.3		Angle from Vertical (deg)	0
Test Interval Length, L (ft)	20.0			
Max. Measured Pressure, P_{MAX} (psi)	61.1			
Reference Pressure, P_0 (psi)	145			
Representative Lugeon Value	0			

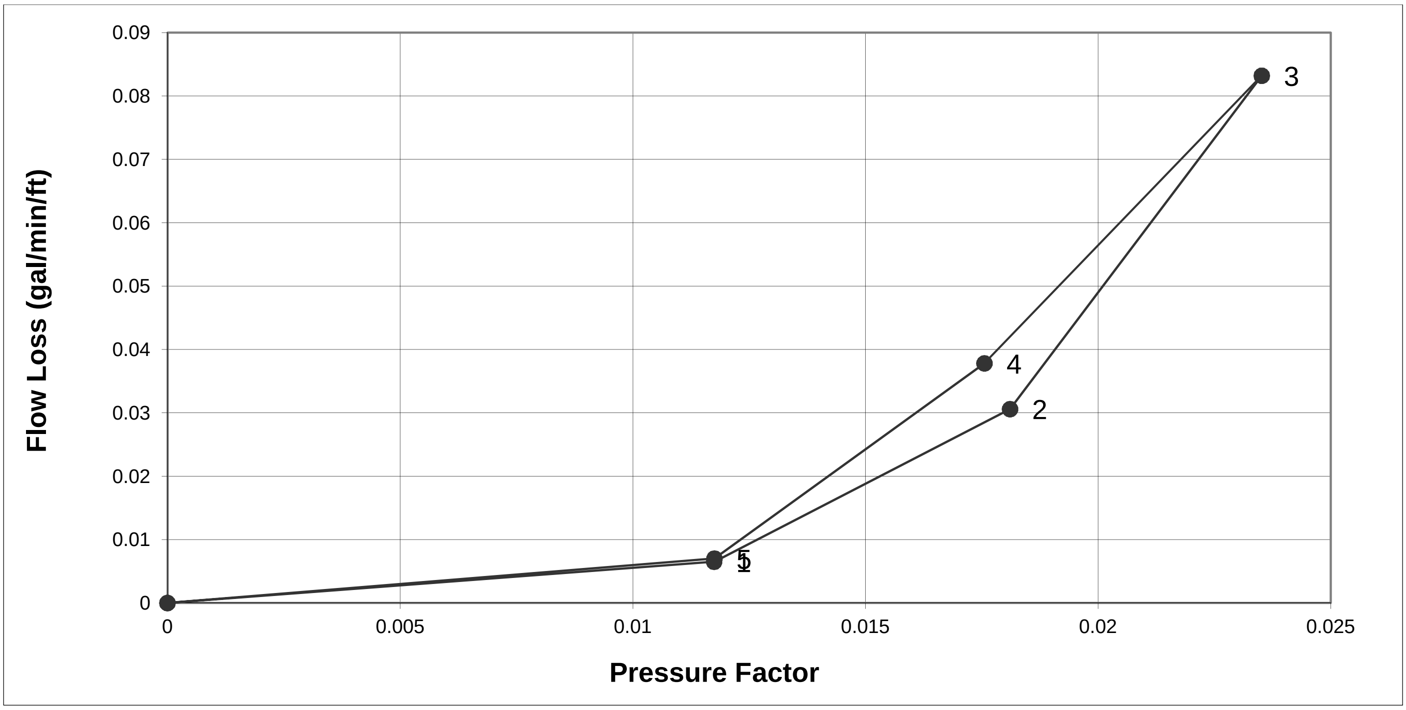
Step No.	$\%P_{MAX}$	Measured Pressure (psi)	Pressure Factor, ψ	Flow, q (gal/min)	Flow loss (gal/min/ft)	Lugeon
0	0		0	0	0	-
1	50%	39.02	0.021669027	0.00	0.0000	0
2	75%	47.15	0.026180984	0.00	0.0000	0
3	100%	61.06	0.033903789	0.01	0.0003	0
4	75%	47.24	0.026232069	0.00	0.0000	0
5	50%	38.13	0.021173117	0.00	0.0000	0
0	0		0	0	0	



Boring	BI-03
Surface El. (ft)	2302.2
Groundwater El. (ft)	2327.5
Test No.	1
Test Interval Center Elevation (ft)	2277.1
Test Interval Length, L (ft)	20.0
Max. Measured Pressure, P_{MAX} (psi)	42.4
Reference Pressure, P_0 (psi)	145
Representative Lugeon Value	4

Top of Test Elevation (ft)	2287.1
Bottom of Test Elevation (ft)	2267.1
Top of Test Depth (ft)	15.1
Bottom of Test Depth (ft)	35.1
Angle from Vertical (deg)	0

Step No.	$\%P_{MAX}$	Measured Pressure (psi)	Pressure Factor, ψ	Flow, q (gal/min)	Flow loss (gal/min/ft)	Lugeon
0	0		0	0	0	-
1	50%	21.16	0.011748459	0.13	0.0065	1
2	75%	32.61	0.018106835	0.61	0.0306	2
3	100%	42.36	0.023519129	1.66	0.0832	4
4	75%	31.62	0.017556	0.76	0.0378	2
5	50%	21.16	0.01175168	0.14	0.0070	1
0	0		0	0	0	



APPENDIX C TELEVIEWER DATA

NORCAL
GEOPHYSICAL CONSULTANTS INC.
A Terracon COMPANY

October 11, 2018

AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612, USA

Subject: Borehole Televiewer Logging Survey
Klamath River Project
Iron Gate Reservoir
Siskiyou County, California

NORCAL Job No: NS185074

Attention: Ben Kozlowicz

This report presents the findings of a borehole geophysical investigation performed by NORCAL Geophysical Consultants, Inc. at the Klamath River Project at the northeast end of Iron Gate Reservoir. This investigation was part of a geotechnical study to assess subsurface conditions along a propose water tunnel alignment. The survey was performed on two separate mobilizations during the period of August 16 through 23, 2018 by NORCAL Professional Geophysicist William J. Henrich PGp 893. Logistical support and safety information were provided onsite by Mr. Tim VandeVoorde, Engineering Geologist of AECOM.

1.0 SITE DESCRIPTION

Our work concerned 2 boreholes situated near the north and south shore at the very northeastern end of Iron Gate Reservoir (see Plate 1, Borehole Location Map). The purpose of this investigation was to help determine rock mass characteristics that included orientations and depth distribution of bedrock discontinuities. The site was underlain by unconsolidated river deposits, basalt flows and tuff breccia.

2.0 SCOPE

Geophysical borehole logging was conducted in two drilled boreholes labeled as B-202 and B-206. The geophysical logging methods consisted of acoustic televiewer and caliper. The scope of work included a report detailing analysis, methods, and presentation of results.

3.0 BOREHOLE CONDITIONS

Both boreholes were inclined 60 degrees from horizontal. They contained shallow Hwt. 4.5- inch diameter steel conductor casings from depths of 9 to 29.5-ft bgs. The casing was installed to prevent caving from unconsolidated river deposits. Below the conductor casing the boreholes were advanced with a HQ- diamond coring method. The HQ open bore diameter was approximately 3.82-inches. The principle rock types consisted of relatively hard, well consolidated basalt and highly weathered, weak tuff breccia. The latter geologic unit tended to cave and create washouts of the borehole wall. This impeded the advancement of the acoustic televiewer in Borehole B-202.

4.0 GEOPHYSICAL LOGGING EQUIPMENT AND METHODOLOGY

NORCAL conducted geophysical borehole logging using a digital ***MICROLOGGER2*** System manufactured by **Robertson Geologging, Ltd.** This system consisted of the following components:

- control console,
- computer,
- motorized cable winch,
- Televiewer (acoustic)
- caliper

4.1 TELEVIEWER

Complete descriptions of the methodology, data acquisition and data analysis procedures are presented in Appendix A.

4.2 CALIPER

Caliper logs are a measure of the borehole diameter versus depth. The tool was used both as a survey technique to assess the relative consolidation of bedrock and provide parameter input to a computer program that calculates discontinuity dip. The caliper tool consists of three interconnected mechanical arms that are spring loaded against the borehole wall. The horizontal deflections of the arms gauge the borehole diameter in units of inches with depth. The logging measurement was made in the up hole direction at a speed of approximately 12-ft per minute. The data sampling rate for this instrumentation was every 0.2-ft.

5.0 RESULTS AND INTERPRETATION

Caliper and televiewer field logs are presented in Appendix B. Specific interpreted log plots (Televiewer Analysis of Dips) from the televiewer logging are presented in Appendix C. Supporting numerical tables (Discontinuity Tables) that tabulated depth, dip angles, dip azimuths, aperture thickness where applicable and fracture classification are presented in Appendix D.

Over 95 percent of all discontinuities subjected to orientation analysis were classified as fractures. The remaining percentage were attributed to lithologic contacts between basalt and tuff breccia. Fracture classifications are discussed in Appendix A. The discontinuities classified as fractures were present only in the basalt unit in Borehole B-206. No discontinuities in the tuff breccia in the lower portion of this borehole and the entire logged open borehole section of B-202 were observed. This is because this unit, based on very low BHTV amplitude returns and variable borehole diameters (washouts), is highly weathered and poorly consolidated. As a result, this geologic unit was not capable of supporting brittle fractures. Note that not all visible fractures-joints on the televiewer images were chosen for orientation analysis. This was because these non-selected features were either too fragmented or feint to be considered representative. We did subdivide or classify the fractures-joints based on the appearance of the televiewer image and related caliper responses.

6.0 STANDARD OF CARE

The scope of NORCAL's services for this project consisted of using geophysical methods to characterize the subsurface. The accuracy of our findings is subject to specific site conditions and limitations inherent to the techniques used. We performed our services in a manner consistent with the standard of care ordinarily exercised by members of the profession currently employing similar methods. No warranty, with respect to the performance of services or products delivered under this agreement, expressed or implied, is made by NORCAL.

Thank you for the opportunity to participate on this project.

Sincerely,

NORCAL Geophysical Consultants, Inc.

William J. Henrich
Professional Geophysicist PGp 893

REGISTERED GEOPHYSICIST
WILLIAM J. HENRICH
10/11/2018
No. 893
STATE OF CALIFORNIA

Donald J. Kirker

Donald J. Kirker
Professional Geophysicist PGp 997

PROFESSIONAL GEOPHYSICIST
DONALD KIRKER
No. 997
10-11-18
STATE OF CALIFORNIA

WJH/DJK/tlt
Enclosures:

Appendix A: Borehole Imaging Televiewer Surveying and Data Processing
Appendix B: Field Logs Televiewer and Caliper Survey, Boreholes B-202 and B-206
Appendix C: Interpreted Televiewer Plot, Borehole B-206
Appendix D: Discontinuity Table Borehole B-206

NORCAL GEOPHYSICAL CONSULTANTS INC.
A Terracon COMPANY

Appendix A:

Televiewer Analysis Boreholes B-202 and B-206

APPENDIX A

BOREHOLE TELEVIEWER SURVEY

1.0 METHODOLOGY

Televiewers are downhole tools that are used to produce radial images of the interior of a borehole. The images are composited sequentially using computer software to produce continuous color images. These images are like unfolded, or unwrapped, cylinders displayed on a two-dimensional surface. The "unwrapped" radial images are referenced to magnetic north by an on-board magnetic compass. In addition, an on-board three-axis magnetic inclinometer determines the inclination and azimuth of the borehole.

Televiewer images can be used to detect bedrock discontinuities (joints, fractures, bedding planes, geologic contacts, etc.) in boreholes and determine their frequency, depths and orientations. Interpretable discontinuities appear as thin sinusoidal forms that stretch across the image. Interactively fitting lines to these sinusoids provides data that computer software uses to determine the orientation and dip of the discontinuities. The midpoint or half amplitude of the sinusoid is taken as the depth of the discontinuity.

There are two types of televiewers; optical and acoustic. Optical televiewers (OPTV) use a digital optical sensor to produce radial images to a vertical resolution as fine as 0.004 feet and a radial resolution to 720 pixels. However, they can only be used in dry holes or in water filled holes with sufficient clarity to create an interpretable high resolution image. Acoustic televiewers (BHTV) require a water column to act as a medium for the transmission and reception of acoustic signals. The water does not have to be optically clear. In operation the BHTV transmits an ultrasonic signal into the borehole fluid and detects ultrasonic energy that is reflected from the borehole wall. Sidewall borehole images are created by measuring variations in the two-way travel time of the ultrasonic pulses as well as variations in the amplitude of the reflected signals.

2.0 DATA ACQUISITION

Prior to Televiewer logging we checked the correct operation of the onboard tool compass of bearing direction against the readings provided by a Brunton Compass. This procedure involves setting the probe vertically in a jig with a bar situated in the south (magnetic) direction and recording a time-drive record so that the bar forms a straight line down the center of the waterfall image. Alternately, we incline the probe (greater than 45 degrees from vertical) in an arbitrary direction and compare the bearing displayed in test mode to the bearing indicated on the Brunton compass face. Variations of 1 to 2 degrees in azimuth between the tool display and Brunton Compass bearing confirms the tools compass is operating satisfactory.

Given that all boreholes maintained a shallow fluid level, image logging was accomplished with the acoustic method. We acquired acoustic BHTV data at a rate of approximately 1000 two-way pulses times per second. The tool was raised/lowered at a rate of 4.5-ft per minute. This resulted in a BHTV depth sample interval of 0.006 ft. Two logs were acquired in each borehole; one in the up direction and one in the down direction. This allowed us to demonstrate the tools compass stability by comparing the orientations of common features between the two logs.

3.0 DATA ANALYSIS

We used the computer program ***WELLCAD*** (Version 5.1, ALT, and Luxemburg) to display BHTV images and to calculate the orientations of interpreted discontinuities (e.g. fractures, joints, bedding).

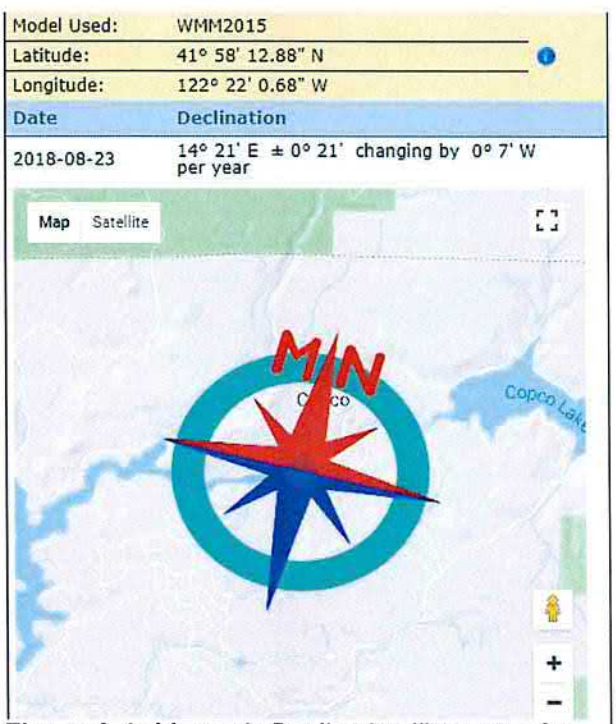


Figure A-1: *Magnetic Declination Illustration for Eastern Iron Gate Reservoir.*

Corrections for the magnetic declination in the survey area required adding 14.3 degrees to the magnetic compass bearings in order to orient the borehole images to true north (see Figure A-1 below). Since borehole diameter is a major reduction parameter in determining dip magnitude, we input caliper log measurements. In each borehole, discontinuity analyses were performed interactively on sections of the unwrapped optical or acoustic amplitude images as viewed on a computer monitor. An interpretable discontinuity on a two-dimensional unwrapped borehole televiewer log appears as a recognizable sinusoidal trace that usually extends across the full width of the borehole image. The sinusoidal shape is a manifestation of planar discontinuities intercepting a three-dimensional cylindrical borehole. Planar discontinuities can be geologic features that include discrete fractures or joints, bedding planes and planar intrusions such as veins and geologic contacts. The traces of discontinuities identified on the image logs were fitted with a bendable sinusoid overlying the trace, as shown in Figure A-2. This provided data that were used by ***WELLCAD*** to calculate a plane representing the orientation of the discontinuity in terms of dip direction and dip magnitude. This process was repeated for every significant discontinuity until the entire borehole was interpreted. At this stage, the apparent dip direction and dip magnitude of the identified discontinuities were converted to true geographic dip azimuth and dip magnitude by factoring the borehole tilt (inclination) and azimuth at the depth of the discontinuity.

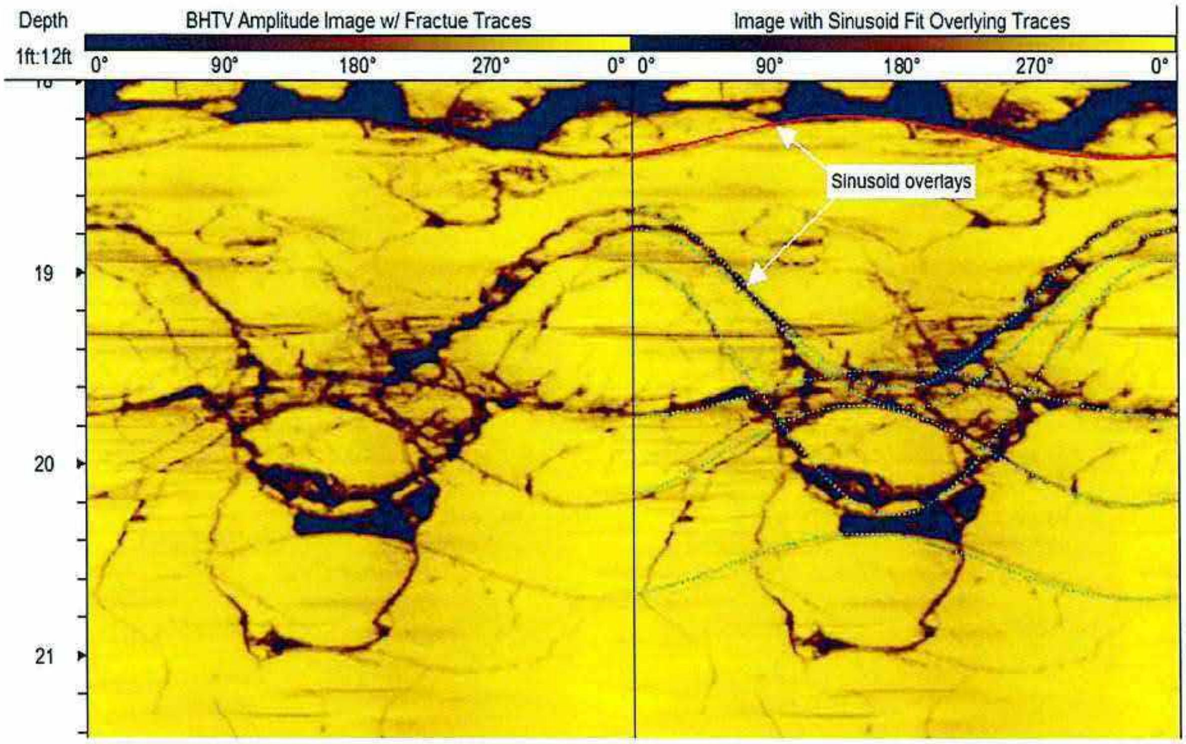


Figure A-2: *A sample BHTV section showing observable discontinuity traces (left) versus the same image (right) with the addition of interpreted sinusoidal overlays (solid red and green colored traces).*

Based on observations of the core and discussions with the on-site geologist, as well as our own experience identifying planar features in acoustic televiewer images, we classified discontinuity features into three fracture/joints categories as follows:

1) "Open continuous fractures". These have characteristics that are relatively wide (measureable >> 1mm) apparent apertures, continuous sinusoidal traces across the circumference of the borehole wall and show relief/breakage along the borehole wall. This relief is usually shown as diameter enlargements on the caliper log.

2) "Thin partial to continuous fracture". These features are "thin" (indicative of very small apertures 1 mm or less) partial or discontinuous across the full 360 degrees span of the image to continuous. Feature traces can be irregular (non-sinusoidal) especially if the dip angles are greater than 60 degrees.

3) "Lithologic Contacts". Boundaries between basalt and tuff breccia.

We did not tabulate (interpret) cemented or highly discontinuous or fragmented fractures.

4.0 PRESENTATIONS

Field Logs showing the two completed BHTV logging runs referenced to magnetic North are presented in Appendix B. Two televiewer images are presented to show the stability of the compass orientation of common fracture features between separate logging runs. The Televiewer Analysis for B-206 referenced to true geographic North, is presented in Appendix C. This plot is several pages long, with header information presented at the top of the first page only. The plot contains several columns of information described, from left to right, as follows:

COLUMN 1 – DEPTH AXIS

The depth axis indicates the relative vertical distance below the ground surface. Ground surface was set equal to zero feet. Depth values are positive and increase in the downward direction.

COLUMN 2 - TELEVIEWER IMAGE

This is an unwrapped false color (BHTV) image representing the interior of the borehole wall. On the BHTV images the relationship between color and signal amplitude is indicated by the color bar at the top of the header. Dark shades (blue) indicate relatively low amplitude and the brighter shades (yellow) indicate relatively high amplitudes. BHTV images are oriented relative to true North as indicated by the azimuth information presented in the header where North, East, South and West correspond to 0°, 90°, 180° and 270°, respectively. The diameter of the borehole is indicated by the white dashed line superimposed on the image. Solid and dashed color lines superimposed on sinusoidal fracture/joint traces depict interpreted discontinuities. The colors of the lines relate to the fracture/joint classification as follows, red = open continuous fractures, teal = "thin", partial to complete fractures and blue = lithologic contacts. Note, that due to the wide apparent thickness of some fractures, we expanded the line trace into a broader hachured sinusoidal section.

COLUMN 3 - DIPS PLOT

The Dips Plot indicates the dip of discontinuities and their direction of maximum dip. These parameters are indicated by small symbols called "tadpoles" which consist of colored circles or squares with a straight line (tail) extending from them. The position of the tadpole indicates the degree of dip, from 0° on the left to 90° on the right, according to the scale shown at the top of the column. The direction that the tail is pointing indicates the direction of dip where straight up is true north and 90° to the right indicates due east. The tadpole symbol colors relate to the three classifications of fractures and joints. A Discontinuity Legend in the sub-header related the colors to the classification. The numerical values of dip azimuth and dip angle are also presented in discontinuity tables presented at the end of this appendix.

COLUMN 4 - CORE PLOT

This plot is a graphic rendering of the BHTV image into a 3-D core based on amplitude variations. This is basically what the image shown in Column 2 would look like if it was re-wrapped to form a cylinder where the vertical center line of the cylinder represents true north (0°), the right edge represents west (270°) and the left edge represents east (90°). South (180°) is out of view behind the core. Although the color spectrum of the core is the same as that used for the BHTV image, the core reconstruction tends to compress the amplitude spectrum into a darker range. This has the effect of making the core appear to be reddish rather than yellow. Planes drawn through the interpreted discontinuities illustrate the relative dip and dip direction of the discontinuities.

COLUMN 5 - BOREHOLE DEVIATION

This plot indicates the azimuth and tilt of the borehole. The solid blue line represents the dip direction, from 0° to 360°, according to the header scale labeled "Azimuth". The dotted green line represents the angle of the borehole from true vertical according to the header scale labeled "Tilt". This scale ranges from 0° to 4°.

5.0 DISCONTINUITY TABLES

The dip azimuth and dip angle of all interpreted discontinuities from the televiewer analysis plot are tabulated Appendix D. The tables present 5 column headers listed left to right as follows: Depth, Dip Azimuth, Dip Angle, Corrected Aperture and Discontinuity Classification. A brief description of the meaning of these terms is presented below.

Depth – relates to the center of discontinuity's sinusoid in feet below ground surface.

Dip Azimuth – dip direction of the discontinuity in degrees from true North.

Dip Angle – inclination of the plane of the discontinuity in degrees from horizontal.

Corrected Aperture – true thickness of fracture/joint corrected for dip measured in tenths of inches. In this survey, we used this processing facility to indicate the true thickness of weathered/altered fractures.

Discontinuity Classification – number designating classification type of fracture/joint (see Legend for explanation).

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GEOPHYSICAL CONSULTANTS INC.
A Terracon COMPANY

Appendix B:

Field Logs Televiewer and Caliper Survey
Boreholes B-202 and B-206

ACOUSTIC TELEVIEWER, CALIPER LOGS

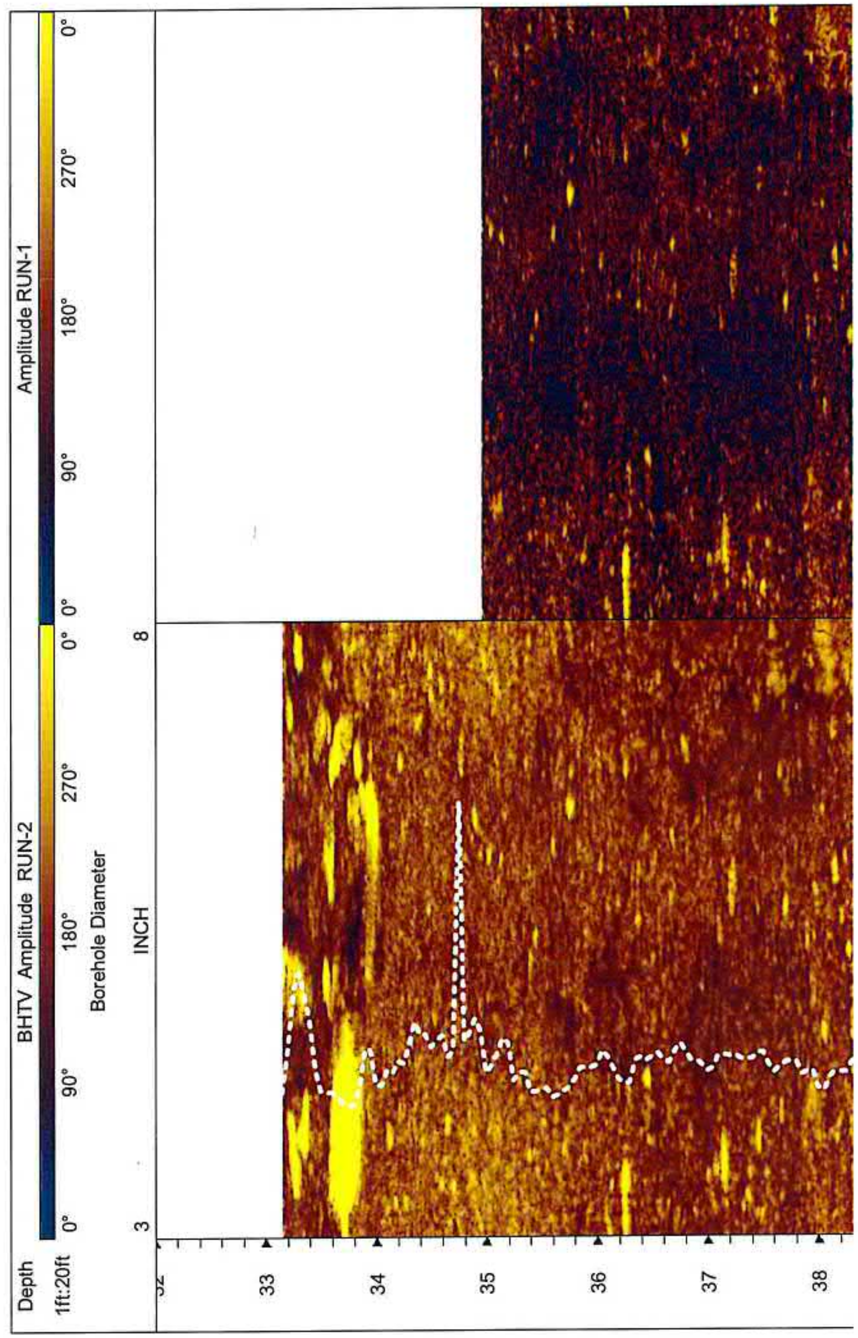
NORCAL GEOPHYSICAL CONSULTANTS, INC.

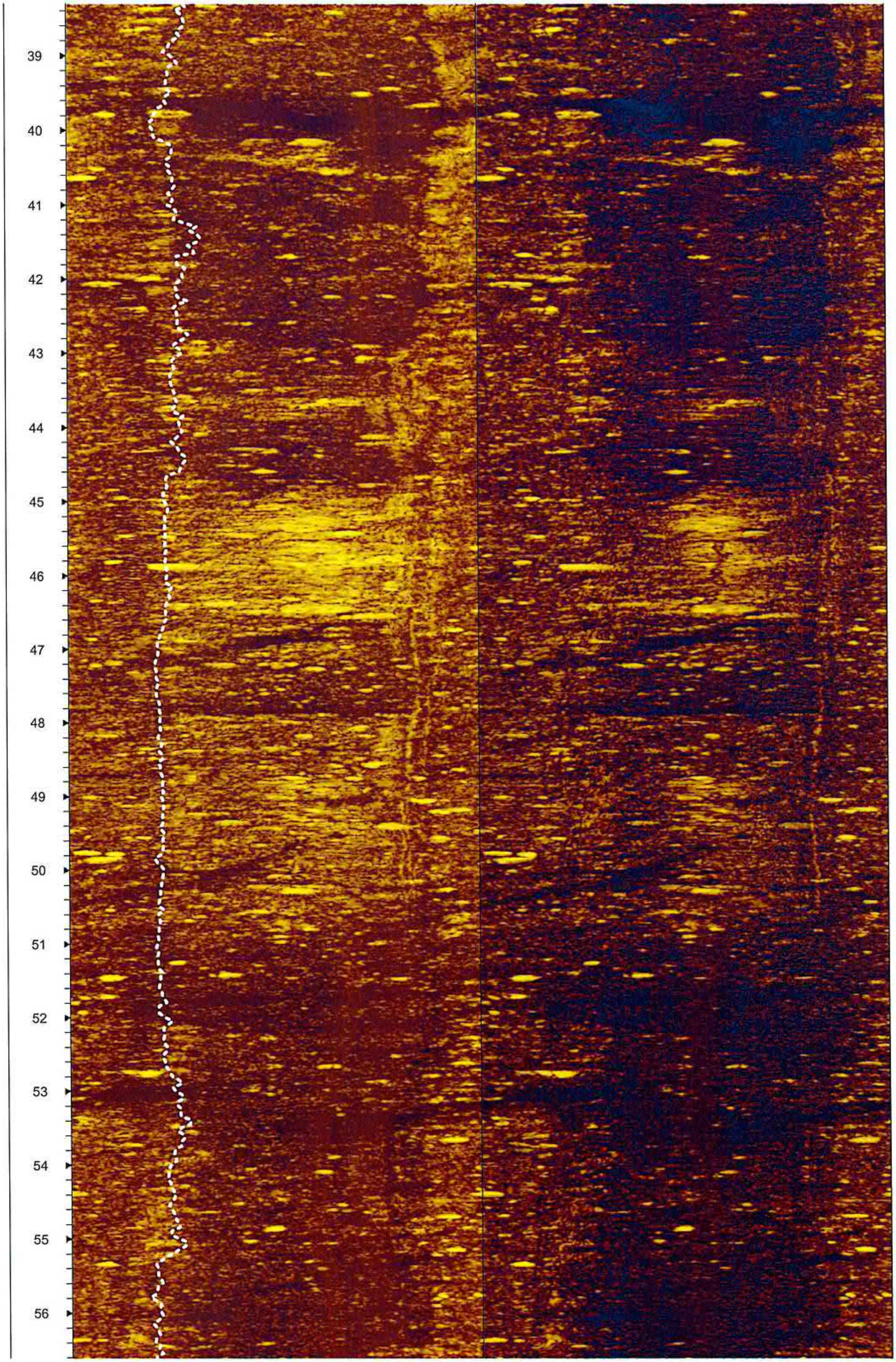
CO AECOM
WELL B-202
FLD IRON GATE RESERVOIR
CTY SISKIYOU CO.
STE CA
FILING No NS185074

COMPANY	AECOM				
WELL ID	B-202				
FIELD	IRON GATE RESERVOIR				
COUNTRY	USA		STATE	CA	
LOCATION LAT 41.97048 LONG -122.37038 SEC	TWP	RGE		OTHER SERVICES	
PERMANENT DATUM	GROUND SURFACE	ELEVATION	~2300' msl	K.B.	
LOG MEAS. FROM	GROUND SURFACE	ABOVE PERM. DATUM		D.F.	
DRILLING MEAS. FROM	GROUND SURFACE			G.L.	

DATE	AUGUST 23, 2018	TYPE FLUID IN HOLE	water w/ polymer
RUN No	RUNS 1 through 3	SALINITY	na
TYPE LOG	CALIPER AND BHTV (3)	DENSITY	
DEPTH-DRILLER	100	LEVEL	11
DEPTH-LOGGER	97.8' bgs	MAX. REC. TEMP.	na
BTM LOGGED INTERVAL	BHTV 82' BGS		
TOP LOGGED INTERVAL	BHTV 18.06' BGS		
OPERATING RIG TIME	3		
RECORDED BY	W HENRICH		
WITNESSED BY	Tim VerdeVoorde		

RUN	BOREHOLE RECORD			CASING RECORD			
NO.	BIT	FROM	TO	SIZE	WGT.	FROM	TO
1	4.25"	0	29.5 ft	4.25"	Hwt	0	29.5
2	HQ 3.825"	29.5	100 ft				

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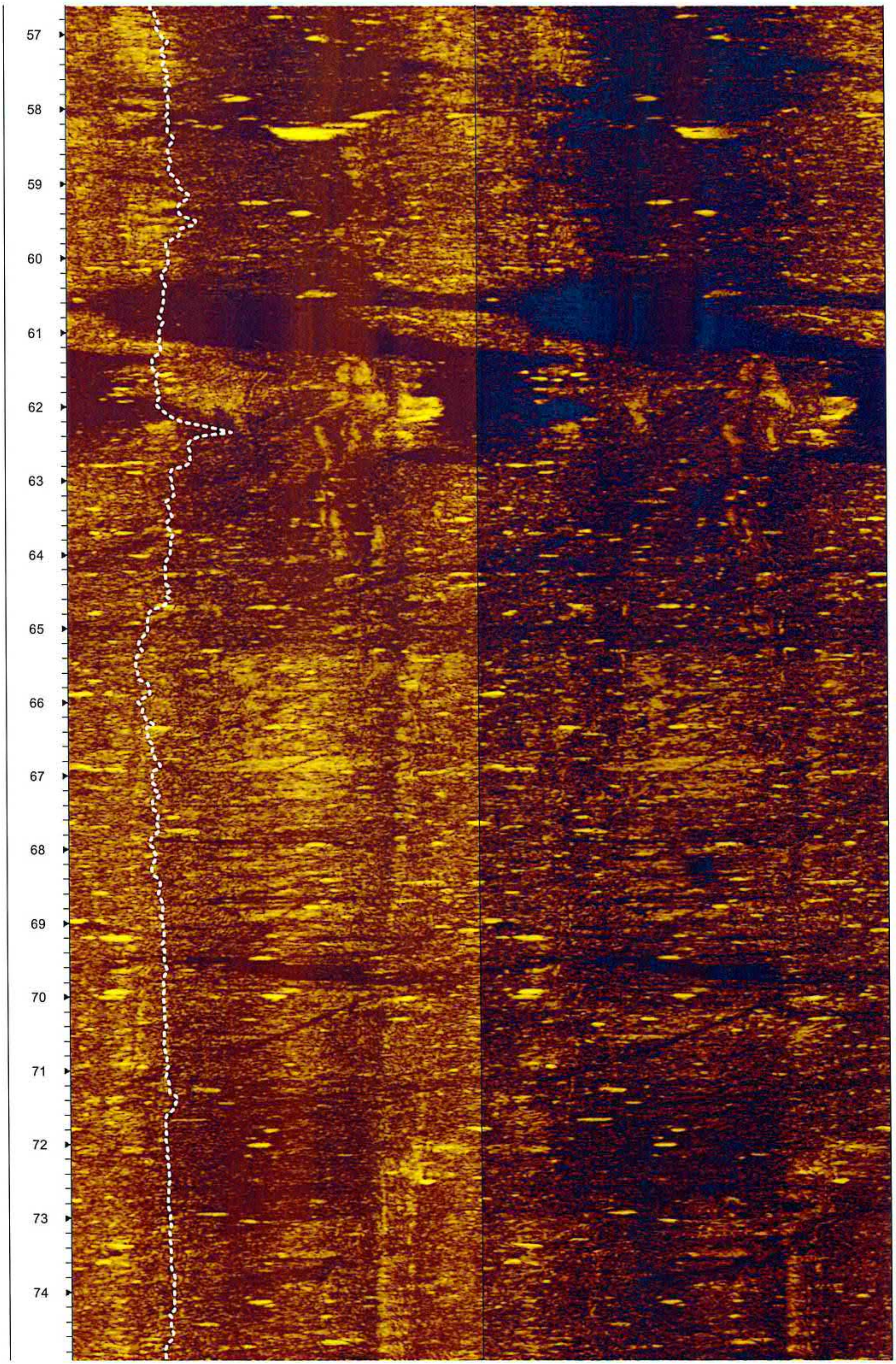
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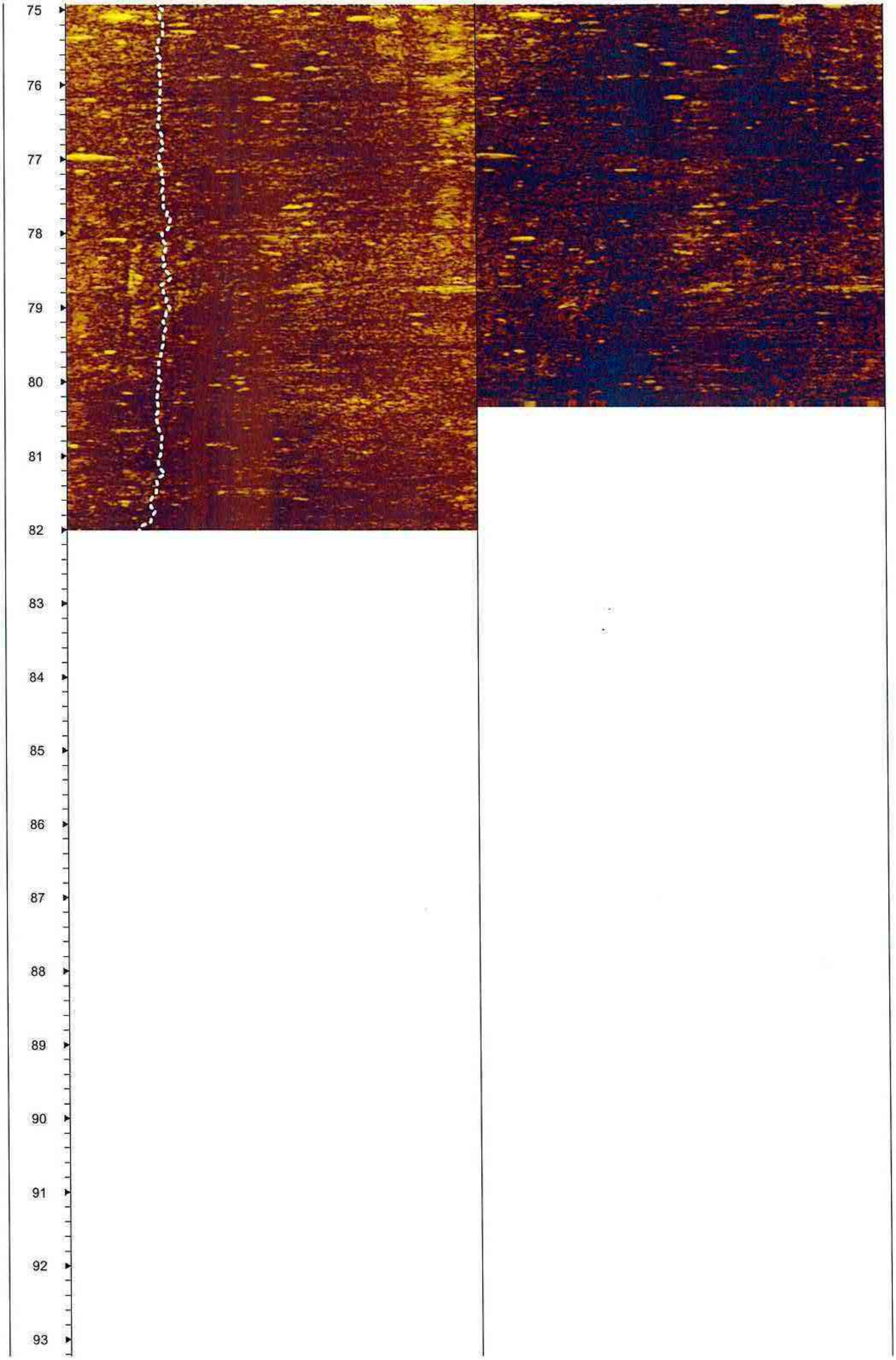
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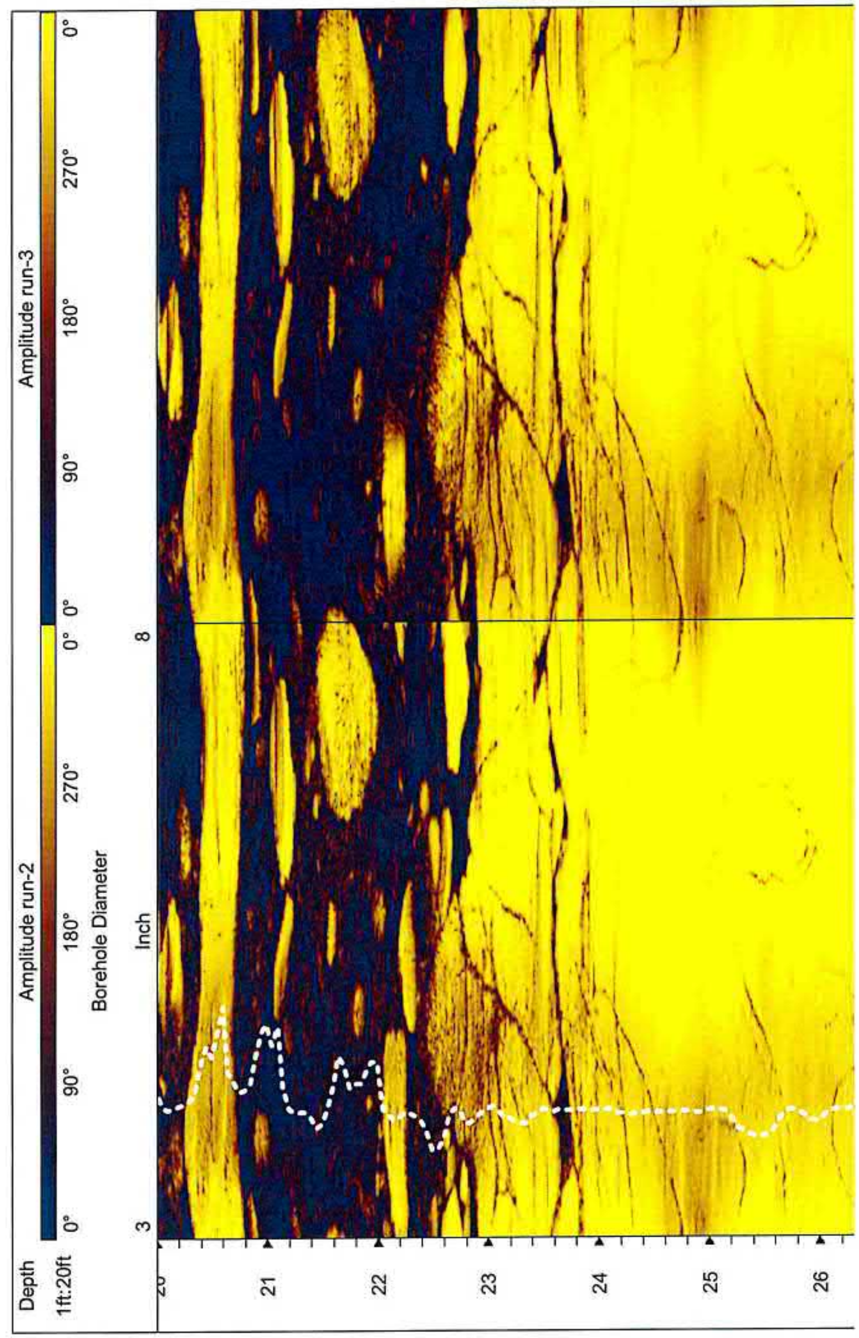
NORCAL GEOPHYSICAL CONSULTANTS, INC.

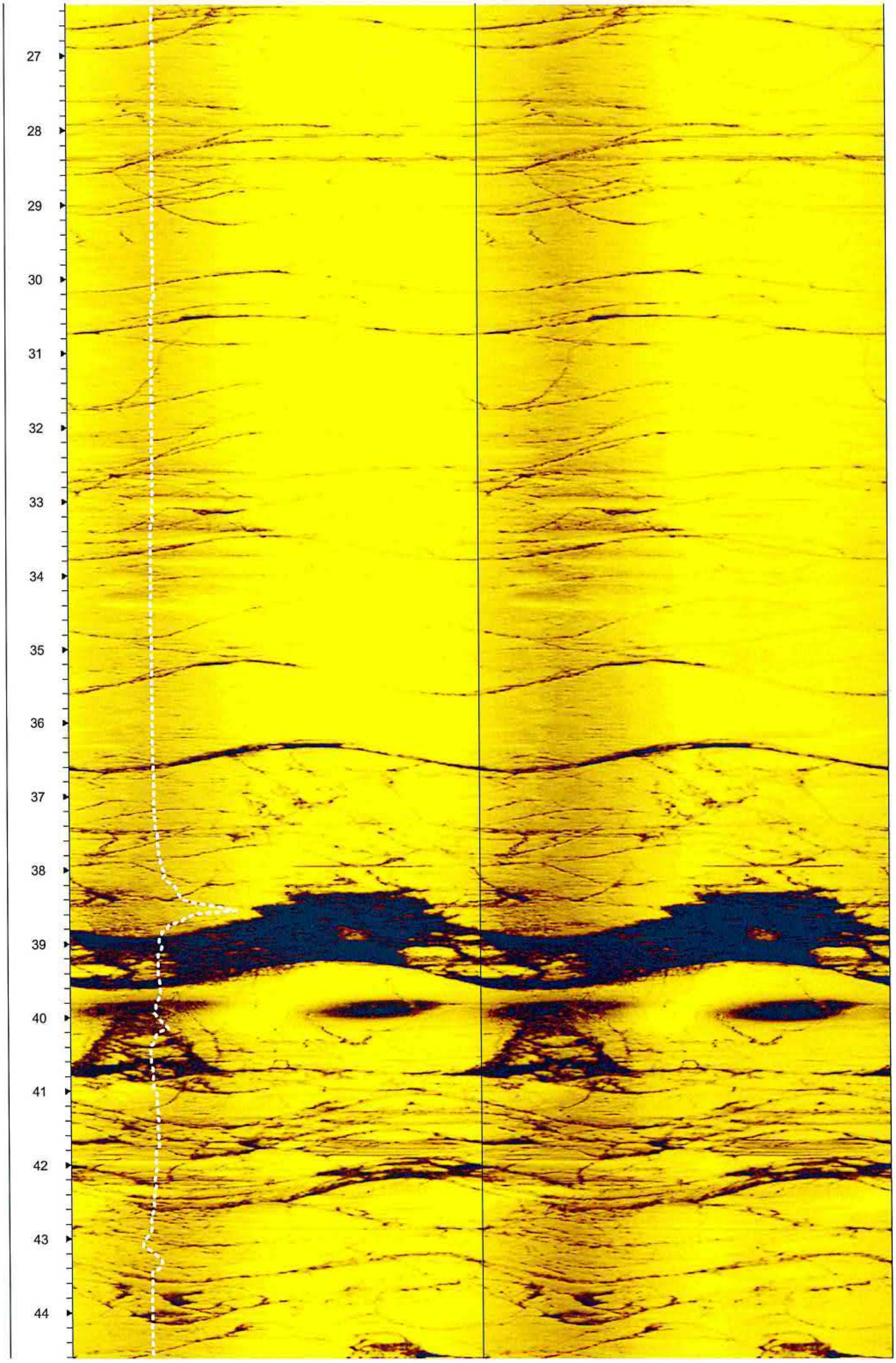
ACOUSTIC TELEVIEWER, CALIPER LOGS

CO AECOM WELL B-206 FLD IRON GATE RESERVOIR CTY SISKIYOU CO. STE CA FILING No NS185074	COMPANY AECOM WELL ID B-206 FIELD IRON GATE RESERVOIR COUNTRY USA		STATE CA	
	LOCATION LAT 41.972184 LONG -122.36915 SEC TWP RGE		OTHER SERVICES	
PERMANENT DATUM	GROUND SURFACE	ELEVATION	~2300' msl	K.B.
LOG MEAS. FROM	GROUND SURFACE	ABOVE PERM. DATUM		D.F.
DRILLING MEAS. FROM	GROUND SURFACE			G.L.

DATE	AUGUST 18, 2018	TYPE FLUID IN HOLE	
RUN No	RUNS 1 through 4	SALINITY	na
TYPE LOG	CALIPER AND BHTV (3)	DENSITY	
DEPTH-DRILLER	100	LEVEL	10
DEPTH-LOGGER	98.45	MAX. REC. TEMP.	na
BTM LOGGED INTERVAL	98.5		
TOP LOGGED INTERVAL	BHTV 18.06' BGS		
OPERATING RIG TIME	3		
RECORDED BY	W HENRICH		
WITNESSED BY	Tim VerdeVoorde		

RUN	BOREHOLE RECORD			CASING RECORD			
NO.	BIT	FROM	TO	SIZE	WGT.	FROM	TO
1	4.25"	0	9 ft	4.25	Hwt	0	9
2	HQ 3.825"	9	100 ft				

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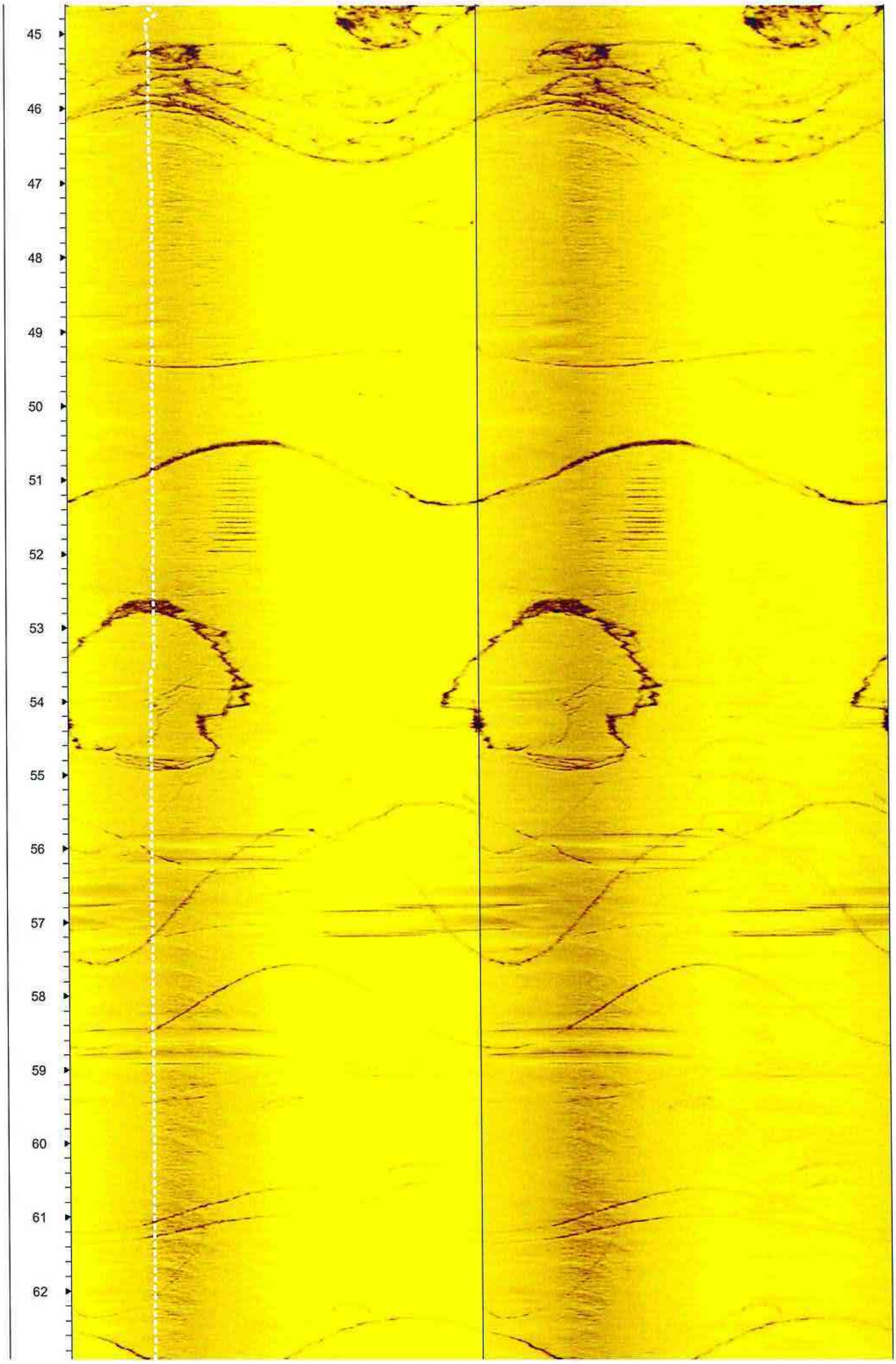
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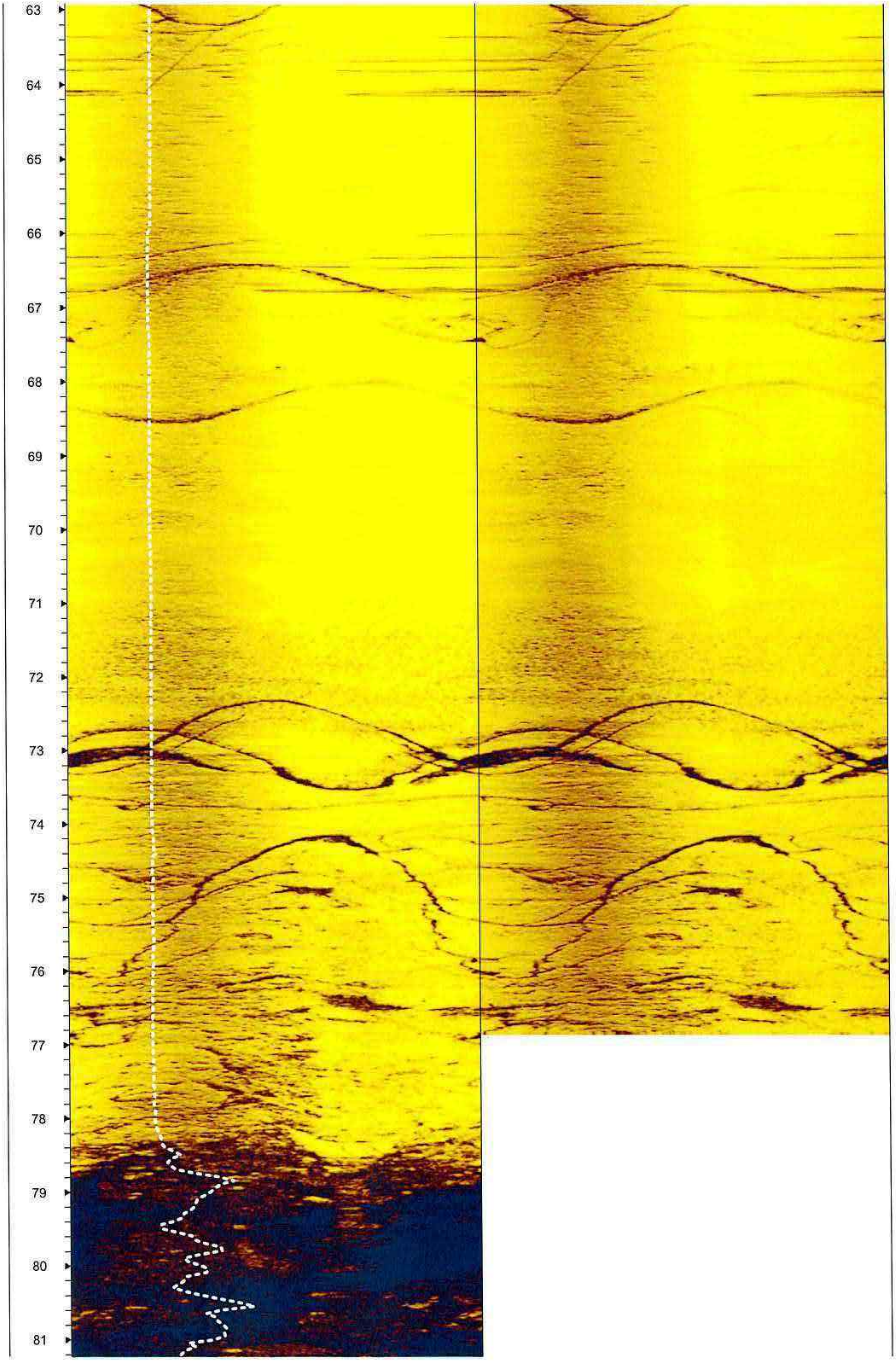
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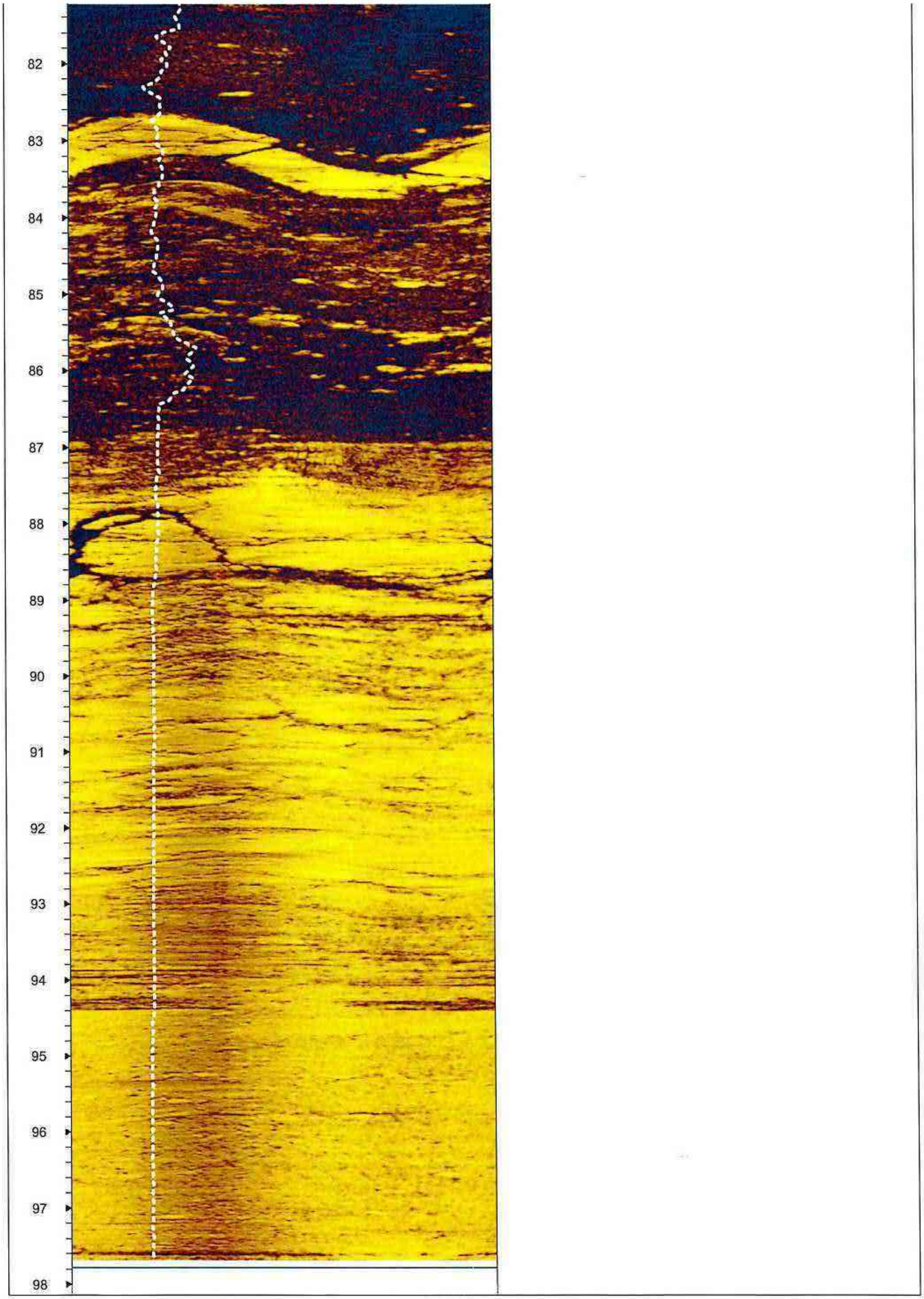
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GEOPHYSICAL CONSULTANTS INC.
A Terracon COMPANY

Appendix C:

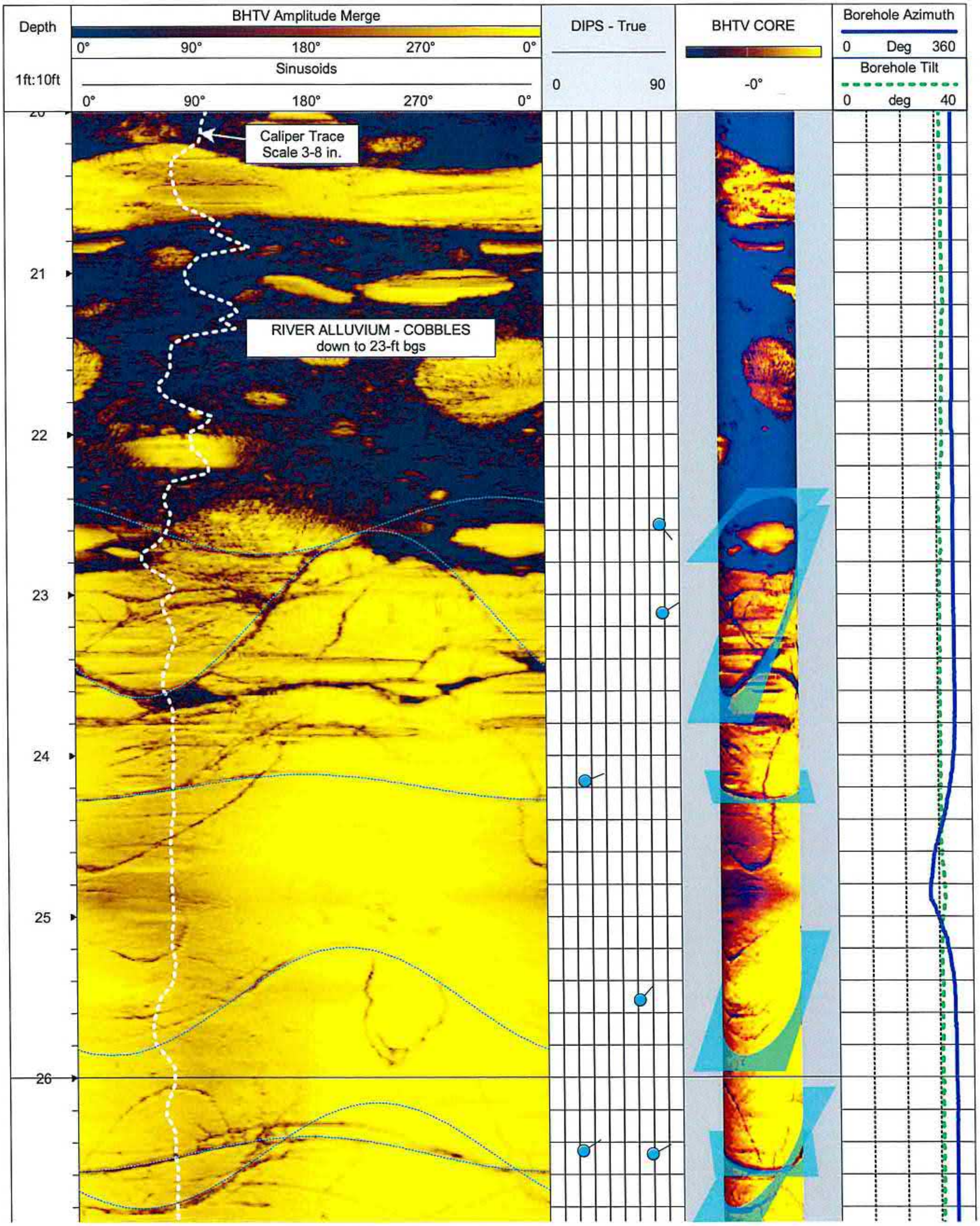
Televiewer Analysis Plot
Borehole B-206

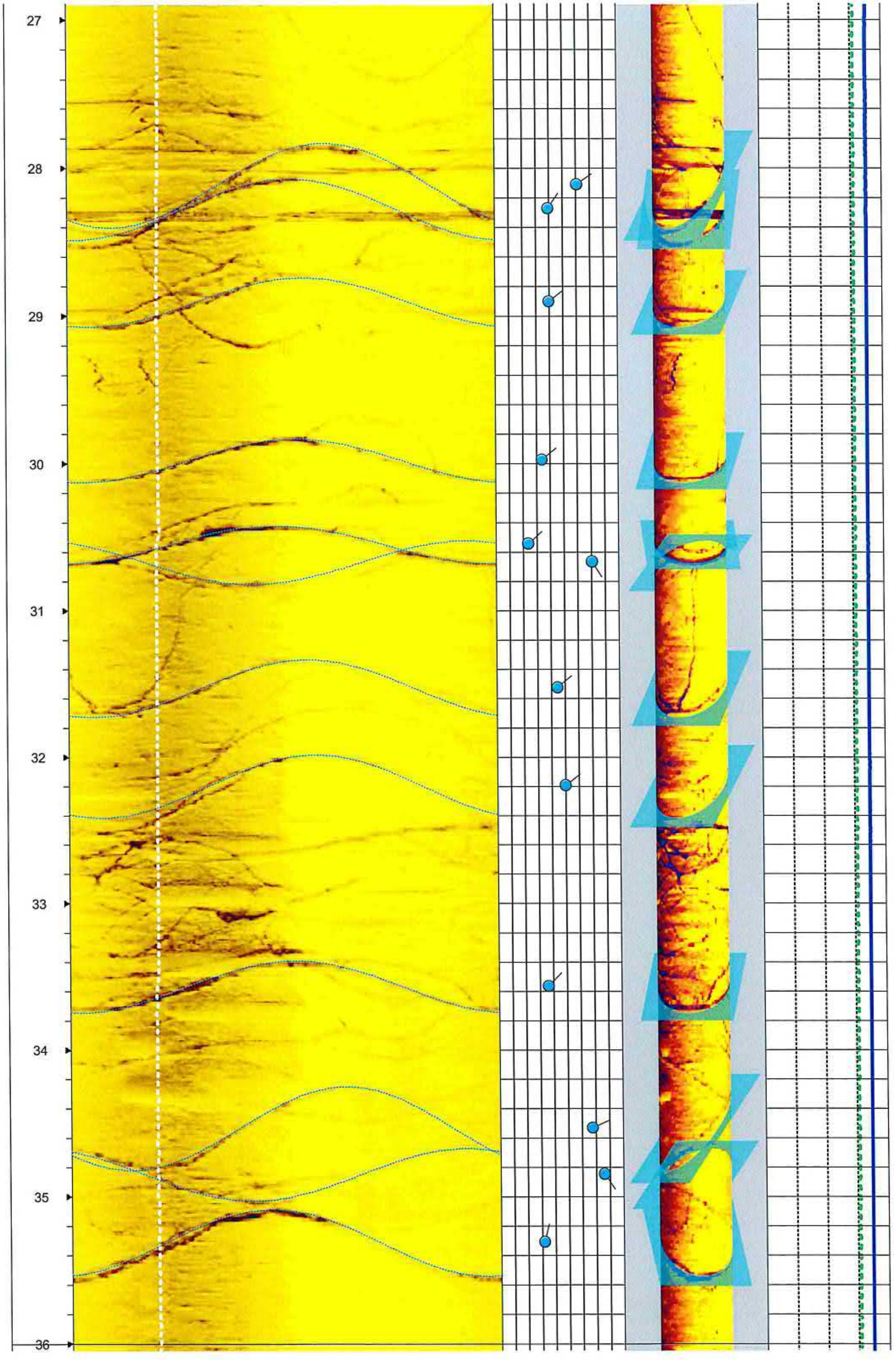
NORCAL GEOPHYSICAL CONSULTANTS INC. A Terracon COMPANY	**TELEVIEWER ANALYSIS**	COMPANY: AECOM WELL ID: B-206 FIELD: Iron Gate Reservoir COUNTY: Siskiyou	DATE: 8-16-2018 CASING: Steel to 9 ft-bgs JOB NO. NS185074 STATE: CA

NOTES:

DISCONTINUITY LEGEND

Code	Tadpole	Sine Wave	Name
1			Open, continuous fracture
2			Thin, partial to continuous fracture
3			Lithologic contact

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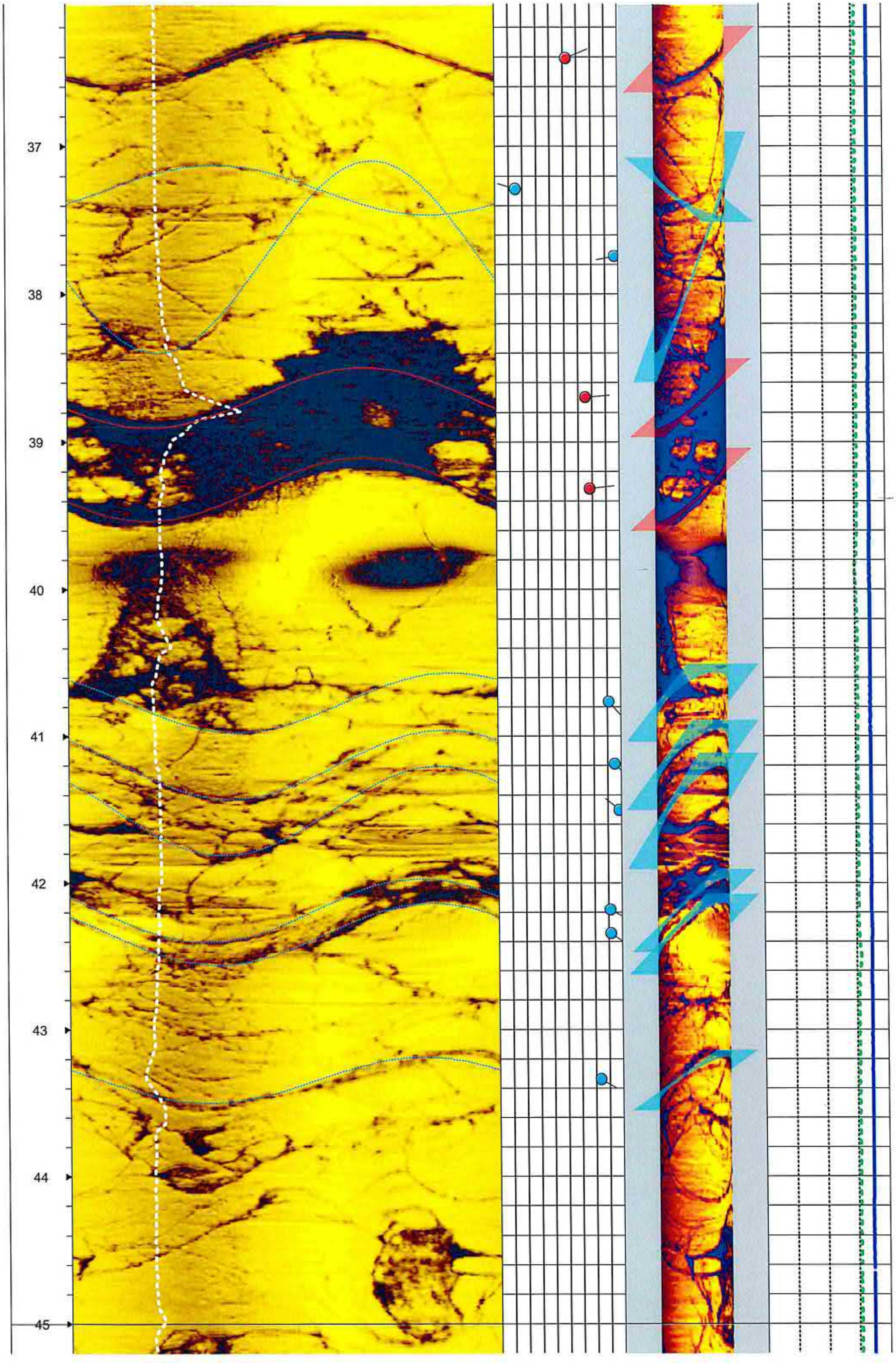

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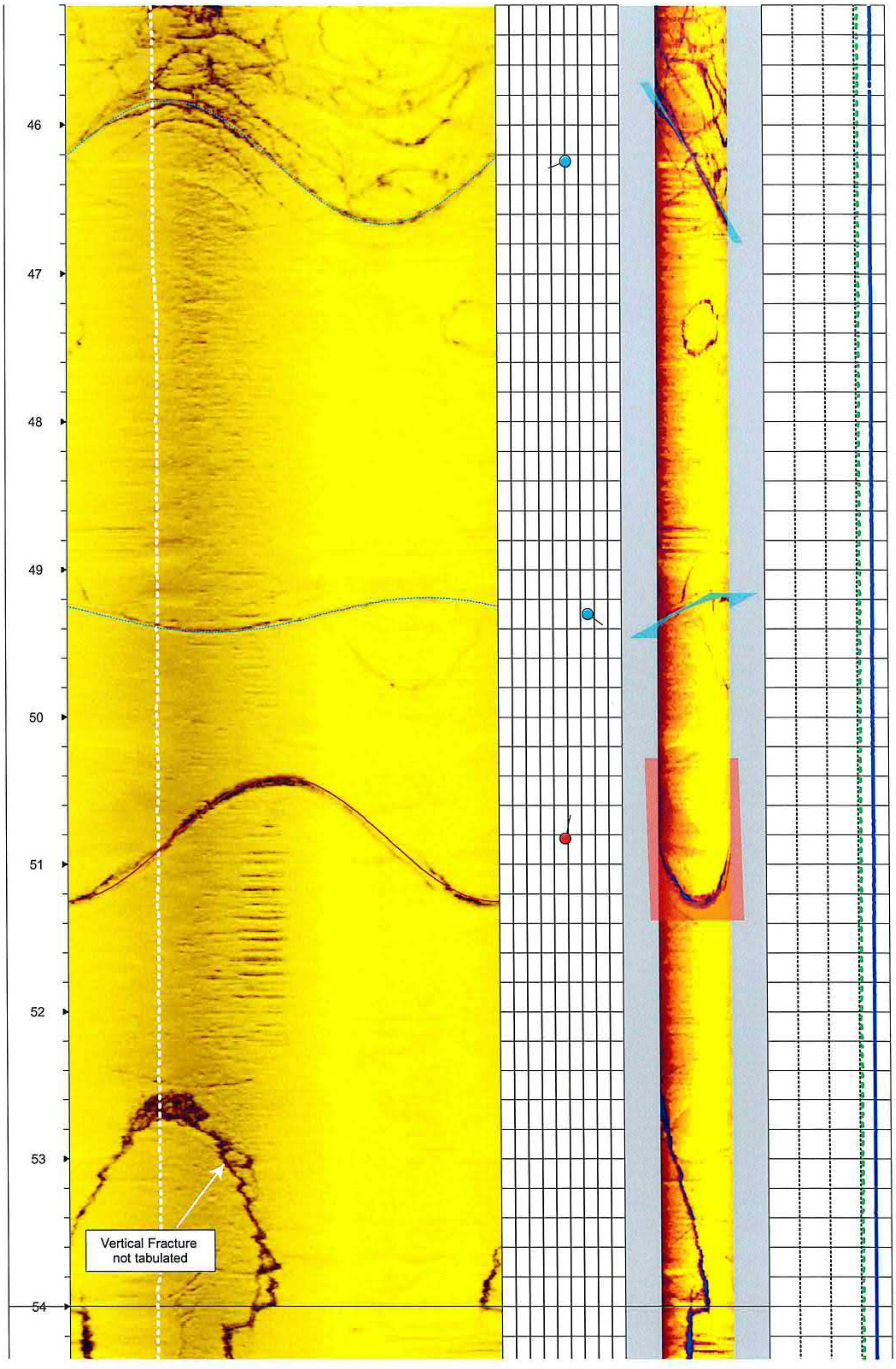
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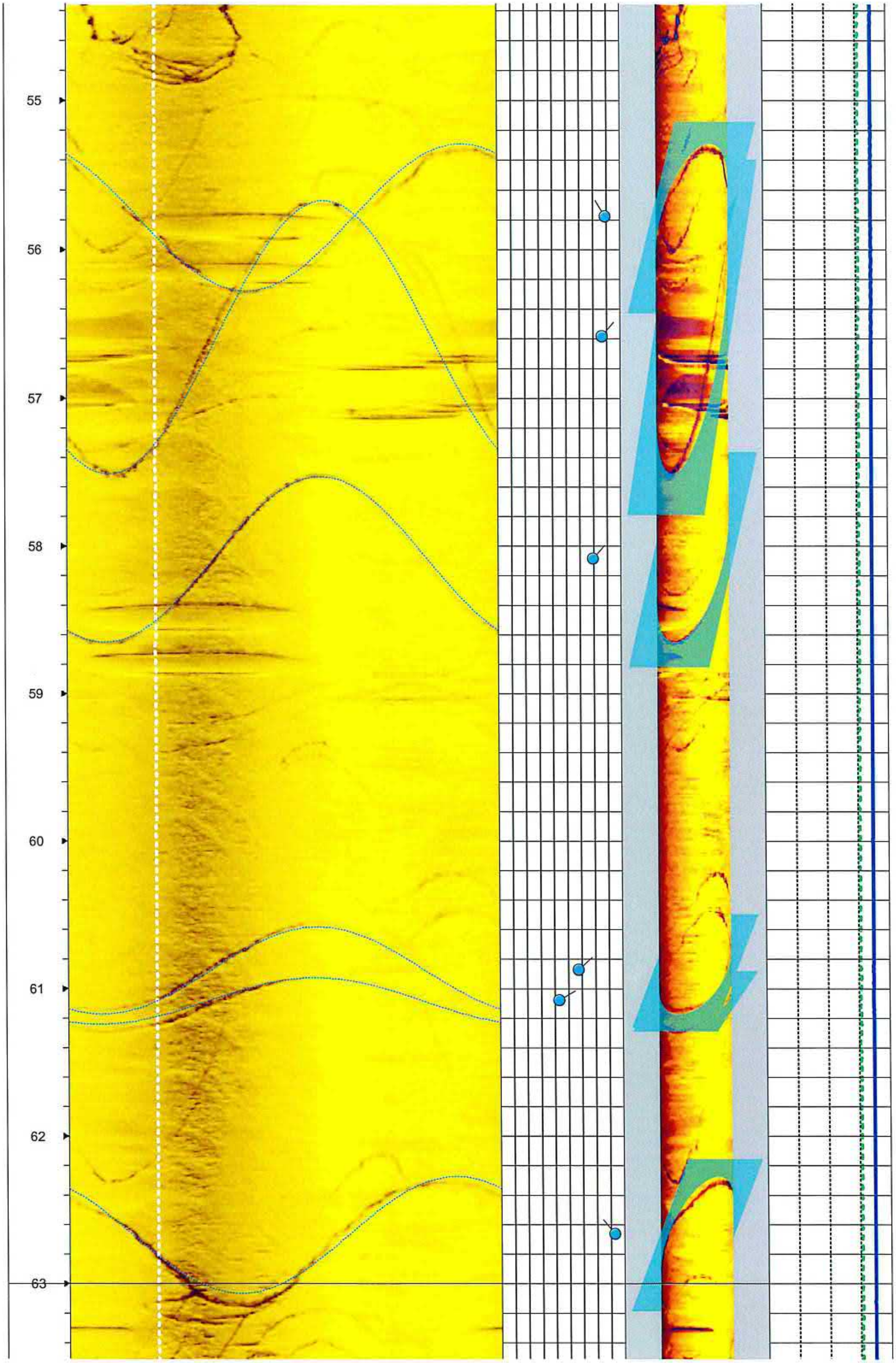
Vertical Fracture not tabulated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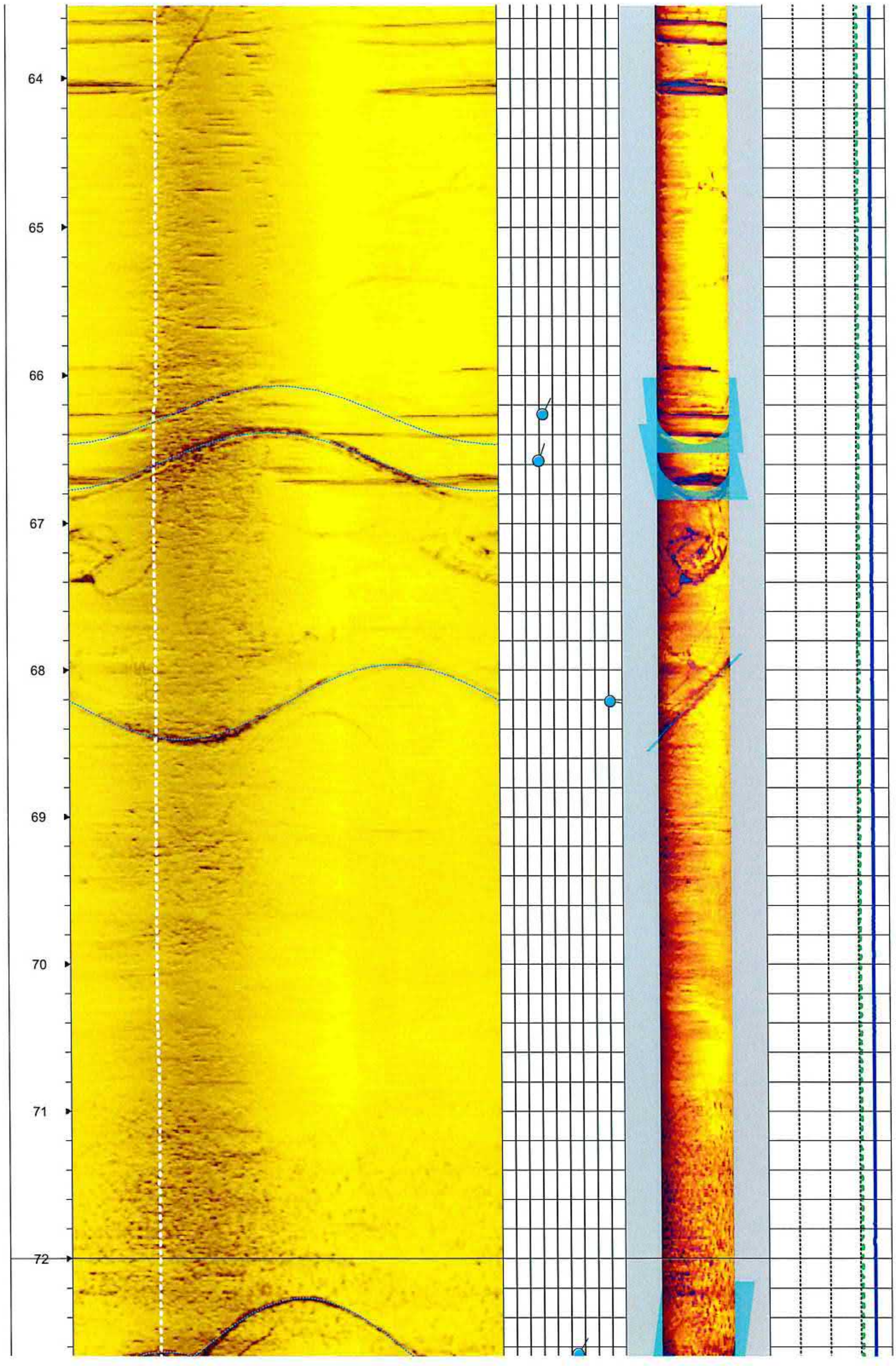

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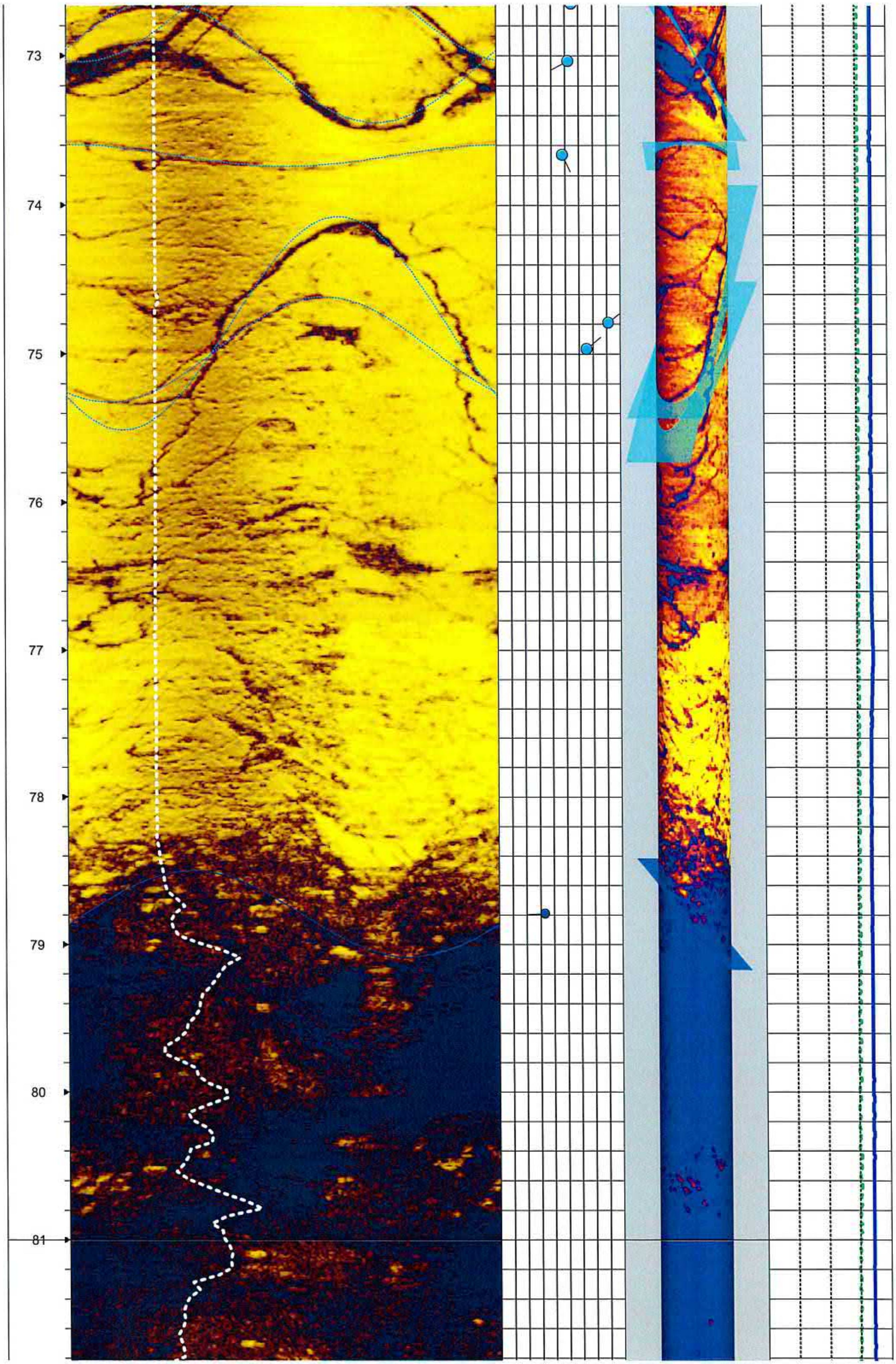
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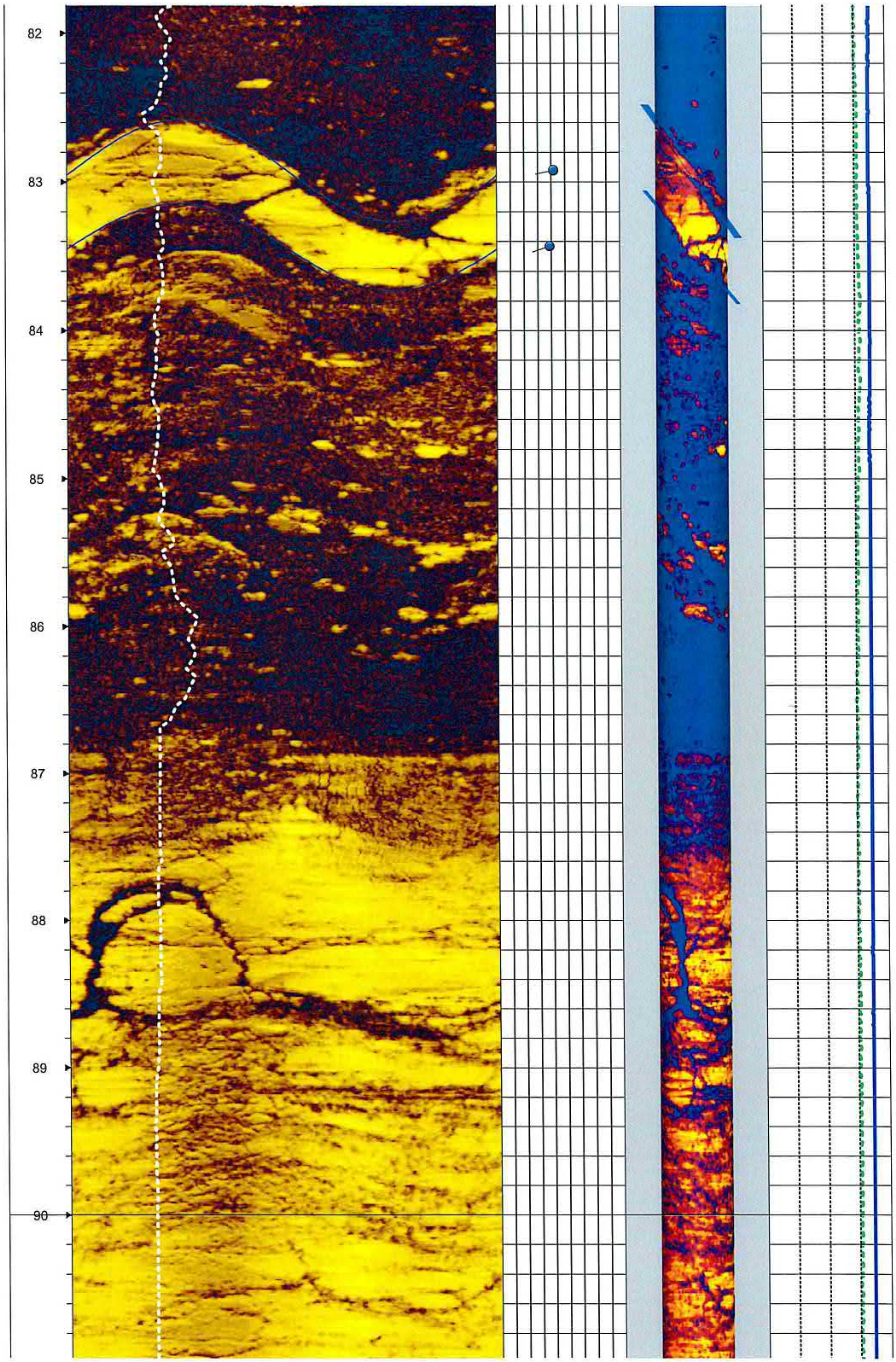

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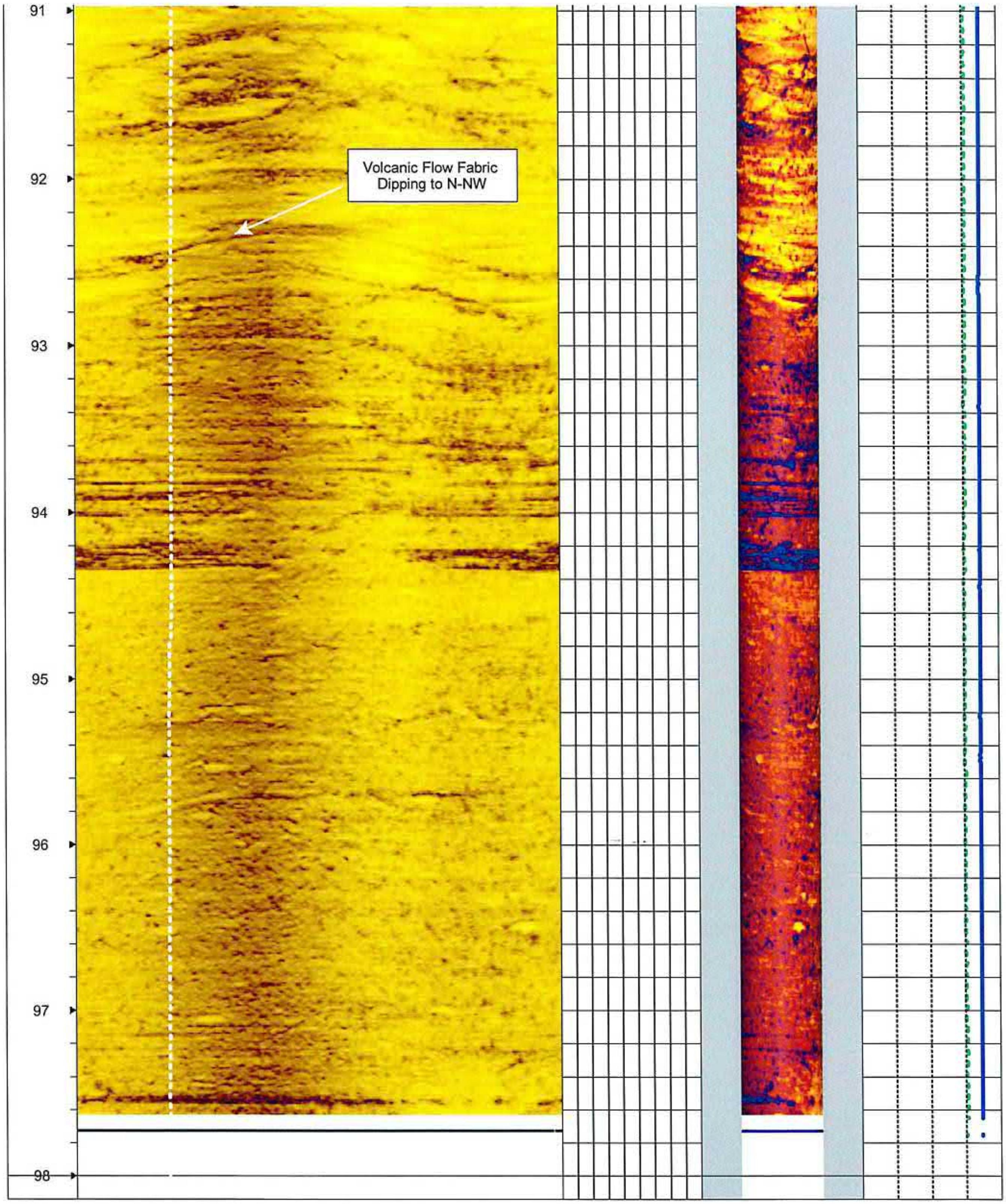
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Volcanic Flow Fabric
Dipping to N-NW

NORCAL GEOPHYSICAL CONSULTANTS INC.
A Terracon COMPANY

Appendix D:

Discontinuity Table
Boreholes B-206

Borehole-B-206 Borehole Discontinuity Orientations from Televiewer Analysis
Klamath River Project, Siskiyou Co., CA
NORCAL JOB NO. NS185074

DISCONTINUITY LEGEND

Code	Tadpole	Sine Wave	Name
1			Open, continuous fracture
2			Thin, partial to continuous fracture
3			Lithologic contact

Field work conducted in July, 2018				
Depth	Dip Azimuth	Dip Angle	Vein Thickness	Discontinuity Classification
ft	deg	deg	1/10 inches	(see Explanation)
22.57	140.32	76.75	na	2
23.12	58.29	78.68	na	2
24.16	67.97	25.98	na	2
25.52	42.73	61.45	na	2
26.46	57.25	22.54	na	2
26.48	62.09	69.06	na	2
28.11	53.72	60.46	na	2
28.27	35.86	39.18	na	2
28.9	52	39.62	na	2
29.97	51.76	33.87	na	2
30.54	46.92	23.86	na	2
30.67	148.32	70.68	na	2
31.53	49.6	44.6	na	2
32.19	52.06	49.96	na	2
33.56	43.07	36.46	na	2
34.53	65.47	67.69	na	2
34.85	146.65	76.34	na	2
35.31	13.66	32.06	na	2
36.41	68.13	52.28	na	1
37.29	286.06	15.36	na	2
37.74	258.54	87.17	na	2
38.7	85.98	65.14	0.47	1
39.32	82.73	68.45	0.34	1
40.77	138.04	81.09	na	2
41.19	134.45	85.46	na	2
41.51	309.75	88.64	na	2
42.19	118.19	81.57	na	2
42.35	126.15	81.88	na	2
43.34	120.37	73.78	na	2
46.25	249.1	50.56	na	2
49.3	124.62	65.04	na	2
50.83	11.82	48.04	na	1
55.78	328.96	79.19	na	2
56.58	41.25	76.59	na	2
58.08	41.73	69.34	na	2

60.87	46.4	57.42	na	2
61.08	59.22	43.18	na	2
62.66	321.44	82.92	na	2
66.26	26.68	32.79	na	2
66.58	18.98	29.74	na	2
68.21	99.31	81.31	na	2
72.65	29.26	54.98	na	2
73.03	242.35	52.54	na	2
73.66	155.6	48.28	na	2
74.79	53.08	81.3	na	2
74.97	50.2	65.09	na	2
78.79	266.85	33.13	na	3
82.92	257.8	41.65	na	3
83.43	251.52	38.95	na	3

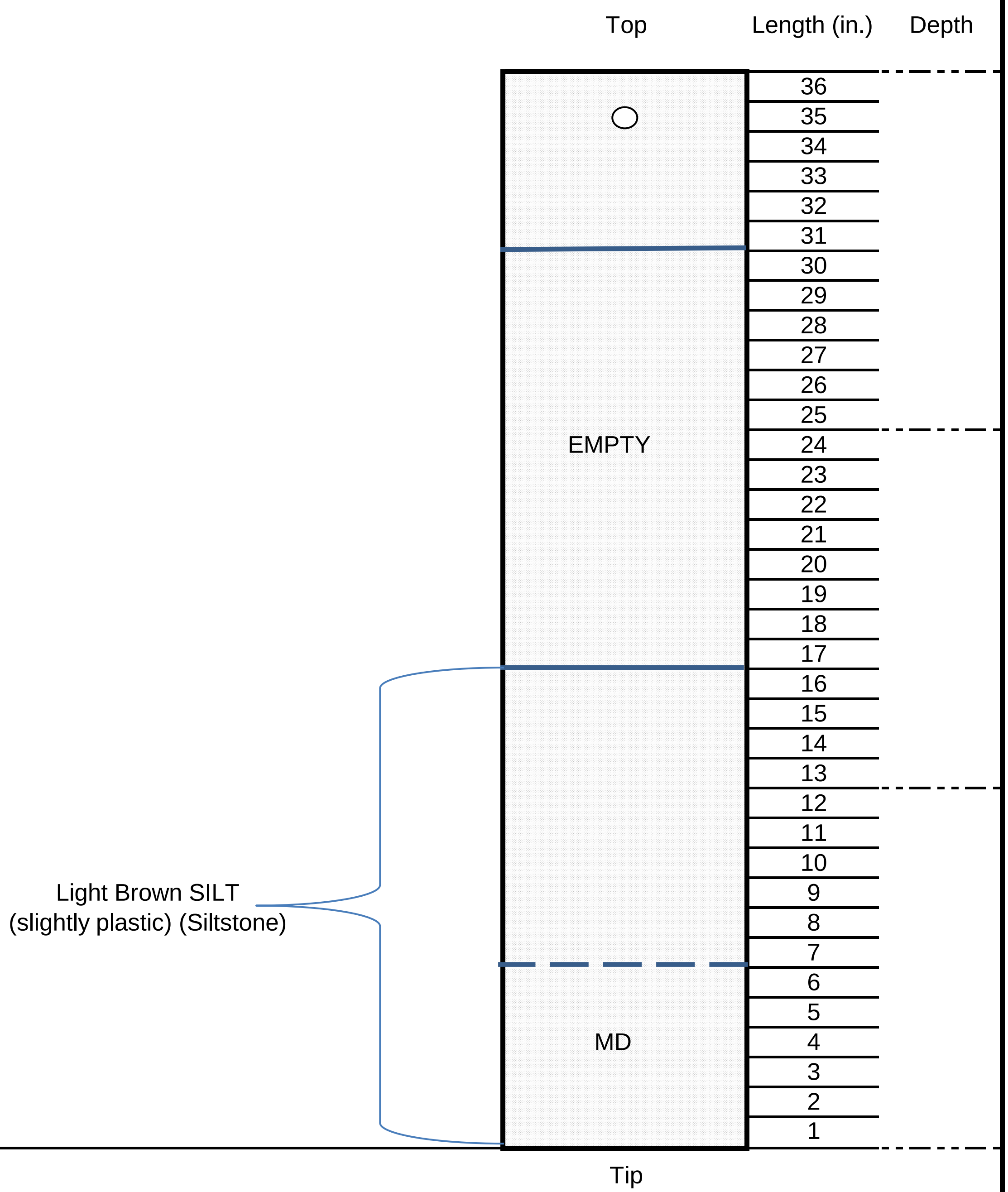
Note: "na" = true thickness of discontinuty aperture not determined

APPENDIX D LABORATORY TEST DATA

Log of Shelby Tube

CTL No.:	020-272	Date:	1/15/2019
Company Name:	AECOM	Run By:	MD
Project Name:	Klamath River Dam	Reduced By:	RU
Project No.:	60537920		

Boring: **BC-13** Sample: **S03** Depth (ft.): **17'**

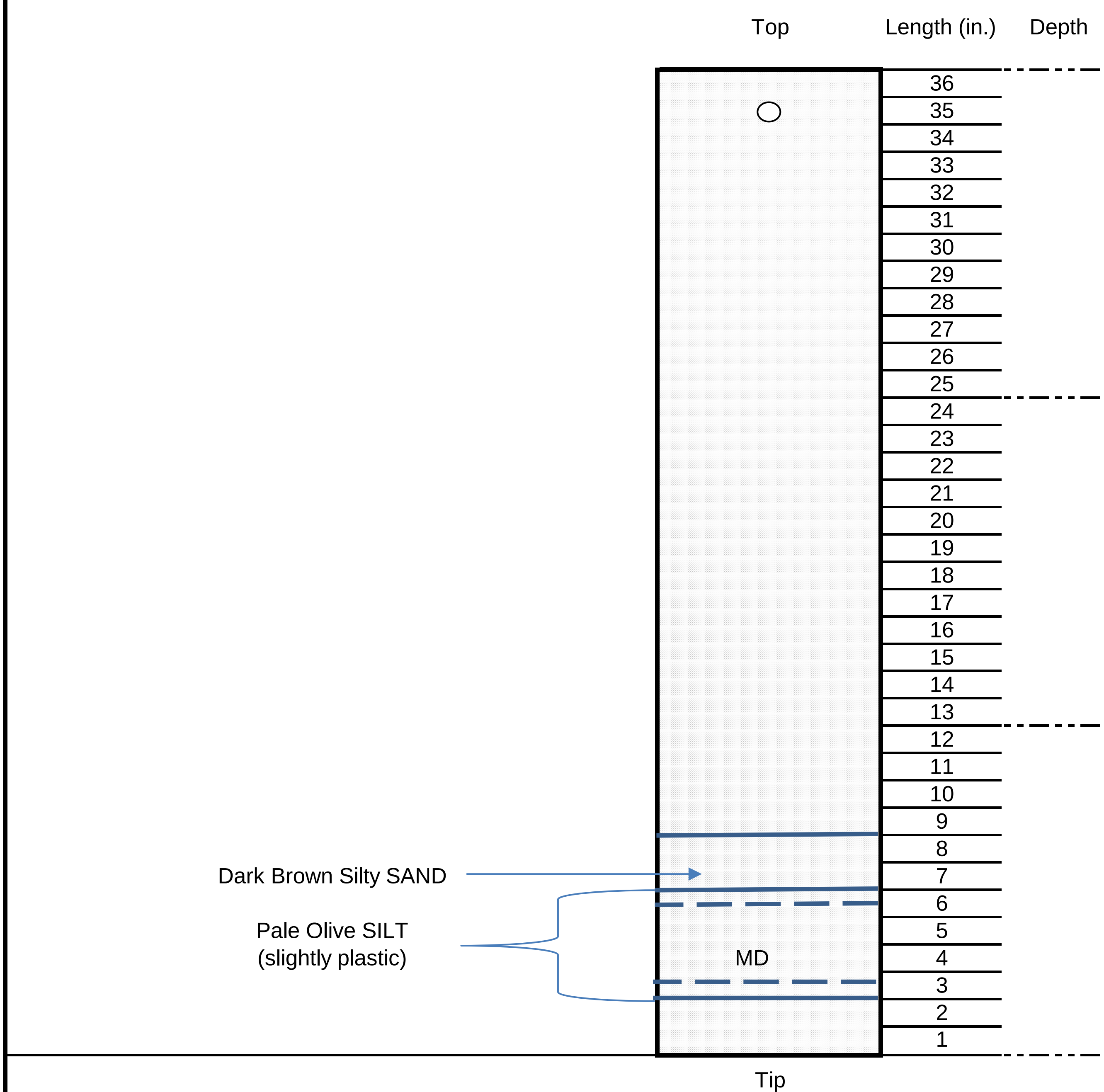


NOTE: All descriptions are visual descriptions unless classification tests were performed on that portion of the tube. Dashed lines indicate zones where listed tests were performed.

Log of Shelby Tube

COOPER TESTING LABORATORY

CTL No.: 020-272
Date: 1/15/2019
Company Name: AECOM
Run By: MD
Project Name: Klamath River Dam
Reduced By: RU
Project No.: 60537920
Boring: **BC-13**
Sample: **S04**
Depth (ft.): **22'**

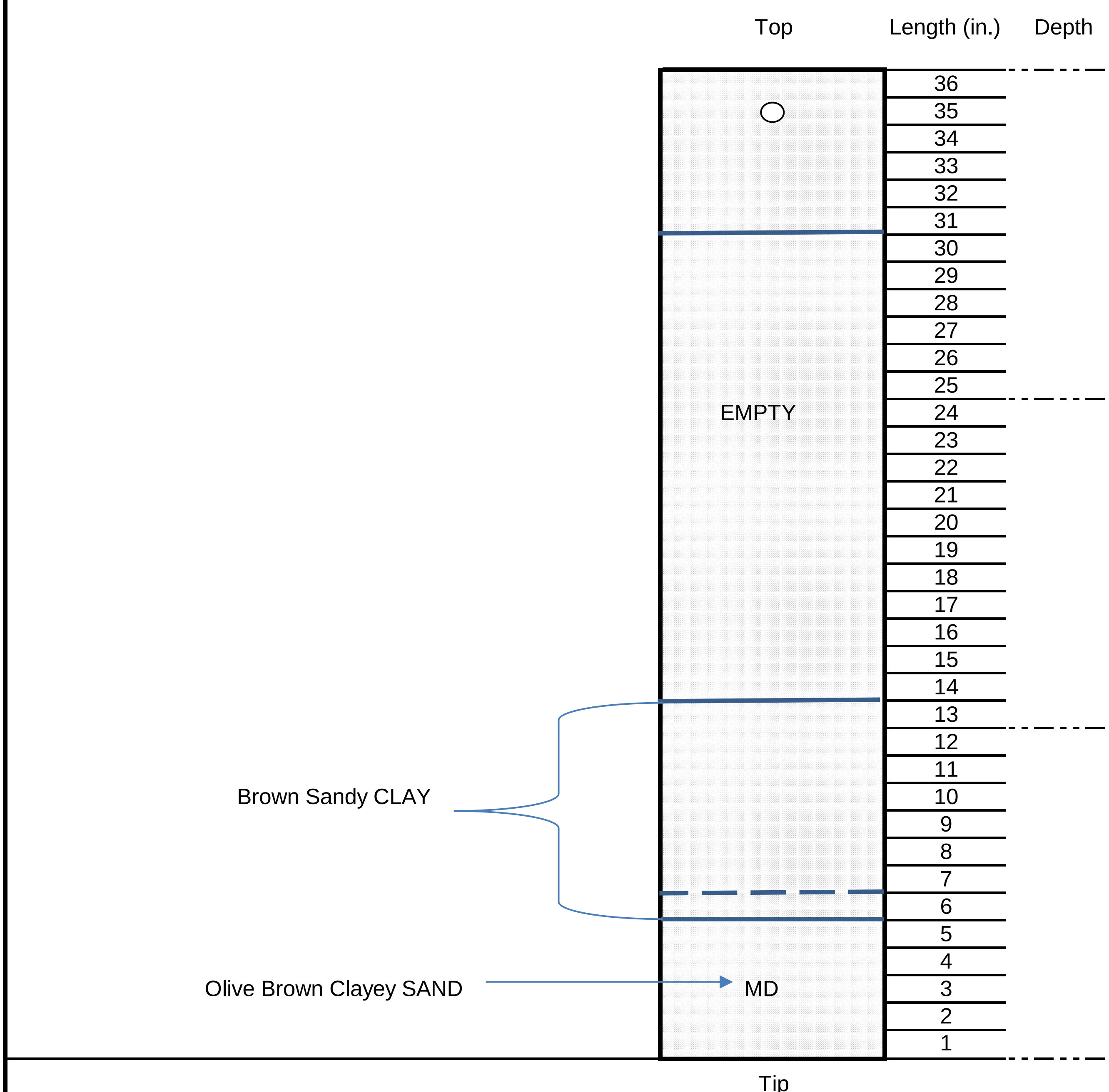


NOTE: All descriptions are visual descriptions unless classification tests were performed on that portion of the tube. Dashed lines indicate zones where listed tests were performed.

COOPER TESTING LABORATORY

Log of Shelby Tube

CTL No.:	020-272		Date:	1/15/2019	
Company Name:	AECOM		Run By:	MD	
Project Name:	Klamath River Dam		Reduced By:	RU	
Project No.:	60537920				
Boring:	**BC-13**	Sample:	**S06**	Depth (ft.):	**40'**



NOTE: All descriptions are visual descriptions unless classification tests were performed on that portion of the tube. Dashed lines indicate zones where listed tests were performed.

California State Certified Laboratory No. 2153

CERCO analytical
1100 Willow Pass Court, Suite A
Concord, CA 94520-1006
925 462 2771 Fax. 925 462 2775
www.cercoanalytical.com

22 February, 2019

Job No. 1902023
Cust. No. 12259

Mr. John Hunt
Inspection Services Inc.
1798 University Avenue
Berkeley, CA 94703-1514

Subject: Project No.: 60537920
Project Name: Klamath River Dam Removal Project
Corrosivity Analysis – CalTrans Test Methods

Dear Mr. Hunt:

Pursuant to your request, CERCO Analytical has analyzed the soil samples submitted on February 05, 2019. Based on the analytical results, this brief corrosivity evaluation is enclosed for your consideration.

Based upon the resistivity measurements, Sample No.003 is classified as "severely corrosive" and the remaining samples are classified as "corrosive". All buried iron, steel, cast iron, ductile iron, galvanized steel and dielectric coated steel or iron should be properly protected against corrosion depending upon the critical nature of the structure. All buried metallic pressure piping such as ductile iron firewater pipelines should be protected against corrosion.

The chloride ion concentrations reflect none detected with a reporting limit of 15 mg/kg.

The sulfate ion concentrations reflect none detected & 26 mg/kg and are determined to be insufficient to damage reinforced concrete structures and cement mortar-coated steel at these locations.

The pH of the soils ranged from 7.84 to 8.97, which does not present corrosion problems for buried iron, steel, mortar-coated steel and reinforced concrete structures.

This corrosivity evaluation is based on general corrosion engineering standards and is non-specific in nature. For specific long-term corrosion control design recommendations or consultation, please call *JDH Corrosion Consultants, Inc. at (925) 927-6630.*

We appreciate the opportunity of working with you on this project. If you have any questions, or if you require further information, please do not hesitate to contact us.

Very truly yours,
CERCO ANALYTICAL, INC.

Cheryl McMillen for

J. Darby Howard, Jr., P.E.
President

JDH/jdl
Enclosure

California State Certified Laboratory No. 2153

CERCO analytical
1100 Willow Pass Court, Suite A
Concord, CA 94520-1006
925 462 2771 Fax. 925 462 2775
www.cercoanalytical.com

Client:	Inspection Services, Inc.
Client's Project No.:	60537920
Client's Project Name:	Klamath River Dam Removal Project
Date Sampled:	1-Feb-19
Date Received:	5-Feb-19
Matrix:	Soil
Authorization:	Signed Chain of Custody

Date of Report: 22-Feb-2019

Job/Sample No.	Sample I.D.	Moisture (%)	pH	Min.Resistivity (ohms-cm)**	Sulfide (mg/kg)*	Chloride (mg/kg)*	Sulfate (mg/kg)*
1902023-001	B-6, S-01 @ 5-6.5'	-	8.97	840	-	N.D.	N.D.
1902023-002	B-19, S-01 & S-02 @ 5-11.5'	-	7.97	980	-	N.D.	26
1902023-003	B-20, S-01 & S-02 @ 5-11.5'	-	7.84	470	-	N.D.	N.D.
Method:		CT 226 (a)	CT 643 (b)	CT 643 (b)	-	CT 422 (c)	CT 417 (c)
Reporting Limit:		-	-	-	50	15	15
Date Analyzed:		-	8-Feb-2019	14-Feb-2019 & 19-Feb-2019	-	8-Feb-2019	8-Feb-2019

* Results Reported on an "As Received" Basis

N.D. - None Detected

(a) Rev. July 2010 (b) Rev. June 2007 (c) Rev. November 2006

Cheryl McMillen
Laboratory Director

Quality Control Summary - All laboratory quality control parameters were found to be within established limits

Chain of Custody

1100 Willow Pass Court
Concord, CA 94520-1006
925 462 2771
Fax: 925 462 2775
CERCO analytica

Page of

Job No.	CU#	Client Project I.D.
1902093	17589	60537920

Schedule
Analyte
CalTrans w/Brief Evalation

Date Sampled | Date Due

ANALYSIS

Full Name: John Hunt
Fax
Phone
Company: IST Berkeley
Cell 510-809-5130 ☒
Sample Source: Klamath River Dam Removal Project

Lab No.	Sample I.D.	Date	Time	Matrix	Contain.	Size	Preserv.	Qty.	pH	Sulfate	Chloride	Resistivity-Minimum	Brief Evaluation
001	B-6 S-01 5-6.5'	2-1				Baggie			x	x	x	x	X
002	B-19 S-01 5-11.5' S-02	2-1				baggie			X	X	X	X	X
003	B-20 S-01 5-11.5' S-02	2-1				Baggie			X	X	X	X	X

MATRIX: DW - Drinking Water; GW - Ground Water; SW - Surface Water; WW - Waste Water; Water; SL - Sludge; S - Soil; Product

ABBREVIATIONS: HB - Hosebib; PV - Petcock Valve; PT - Pressure Tank; PH - Pump House; RR - Restroom; GL - Glass; PL - Plastic; ST - Sterile

SAMPLE RECEIPT: Total No. of Containers; Rec'd Good Cond/Cold; Conforms to Record; Temp. a t Lab -°C; Sampler

		Date	Time
Relinquished By:	[signature]	2/5/19	1213
Received By:	[signature]	2/5/19	1213
Relinquished By:		Date	Time
Received By:		Date	Time
Relinquished By:		Date	Time
Received By:		Date	Time

Comments:
THERE IS AN ADDITIONAL CHARGE FOR METAL/POLY TUBES

jhunt@inspectionservices.net

8/6/2009

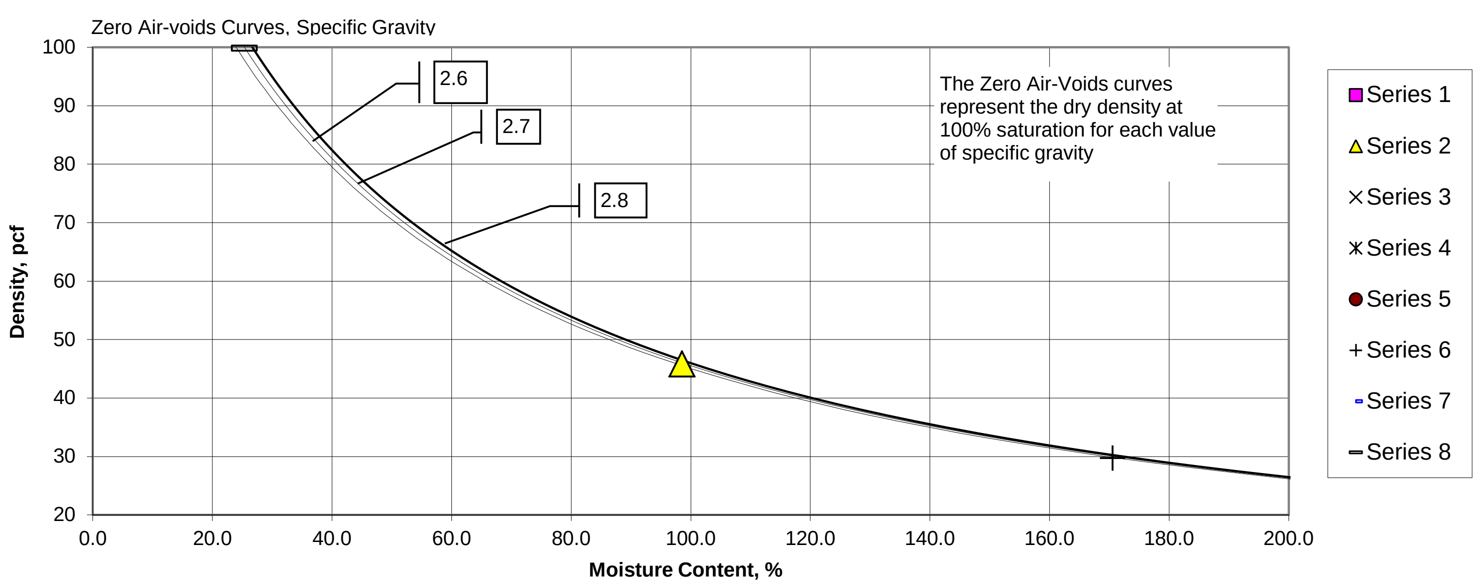
Moisture-Density-Porosity Report
Cooper Testing Labs, Inc. (ASTM D7263b)

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



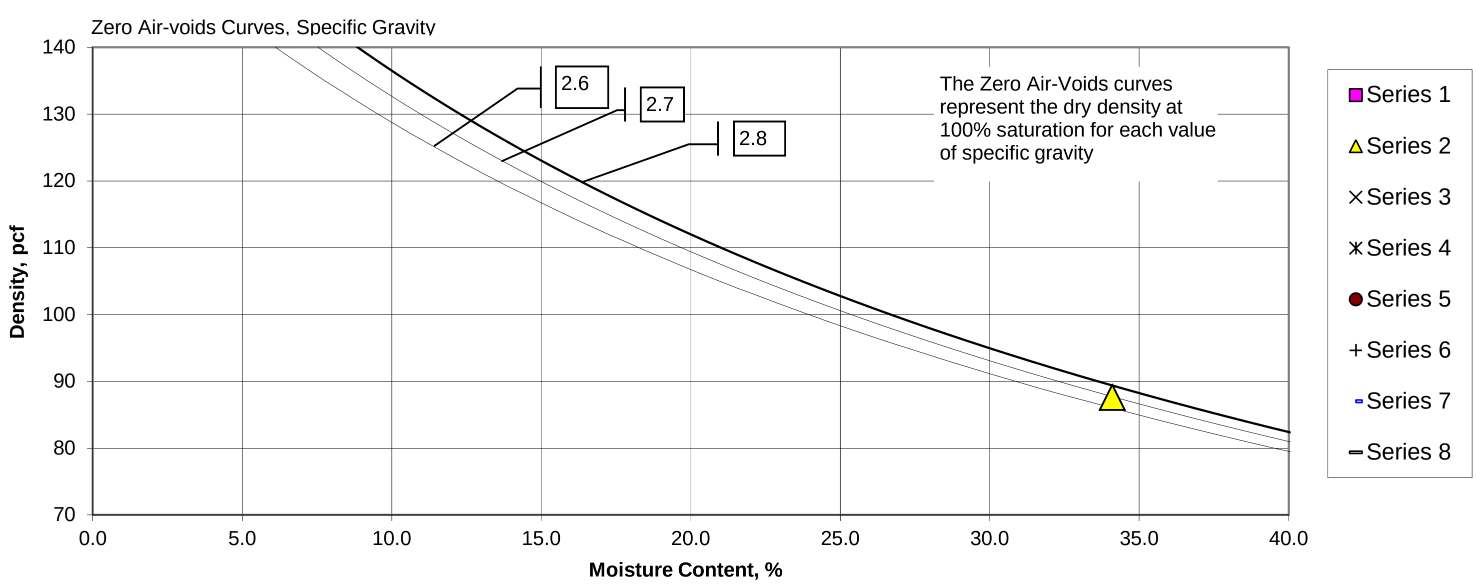
Moisture-Density-Porosity Report
Cooper Testing Labs, Inc. (ASTM D7263b)

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,Ѳw,%		47.8						
Volumetric Air Cont., Ѳa,%		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

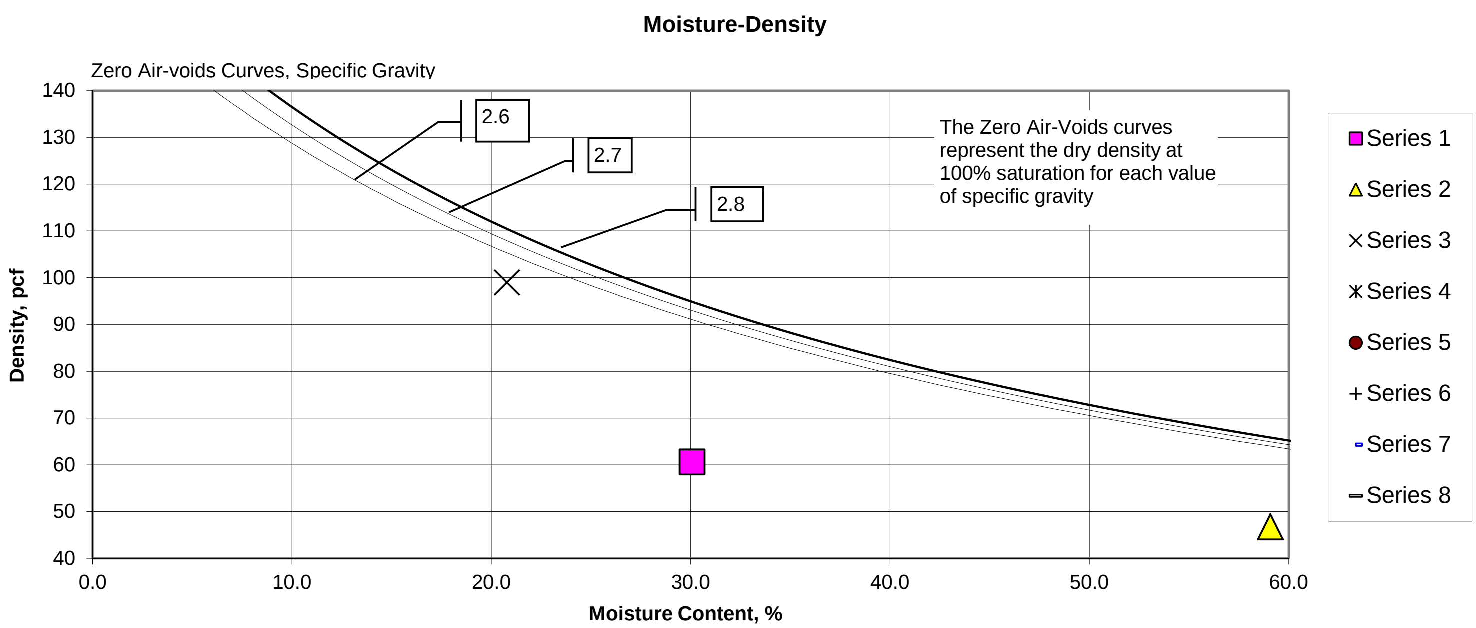


Moisture-Density-Porosity Report
Cooper Testing Labs, Inc. (ASTM D7263b)

CTL Job No: 020-272 **Project No.** 60537920 **By:** RU
Client: AECOM **Date:** 01/18/19
Project Name: Klamath **Remarks:**

Boring:	BC-13	BC-13	BC-13					
Sample:	S03	S04	S06					
Depth, ft:	17	22	40					
Visual Description:	Light Brown SILT (Siltstone) (slightly plastic)	Pale Olive SILT (slightly plastic)	Olive Brown Clayey SAND					
Actual G_s								
Assumed G_s	2.70	2.70	2.70					
Moisture, %	30.1	59.1	20.8					
Wet Unit wt, pcf	78.8	74.4	119.6					
Dry Unit wt, pcf	60.6	46.8	99.0					
Dry Bulk Dens.pb, (g/cc)	0.97	0.75	1.59					
Saturation, %	45.5	61.2	79.7					
Total Porosity, %	64.1	72.3	41.3					
Volumetric Water Cont,Θw,%	29.2	44.2	32.9					
Volumetric Air Cont., Θa,%	34.9	28.0	8.4					
Void Ratio	1.79	2.61	0.70					
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.

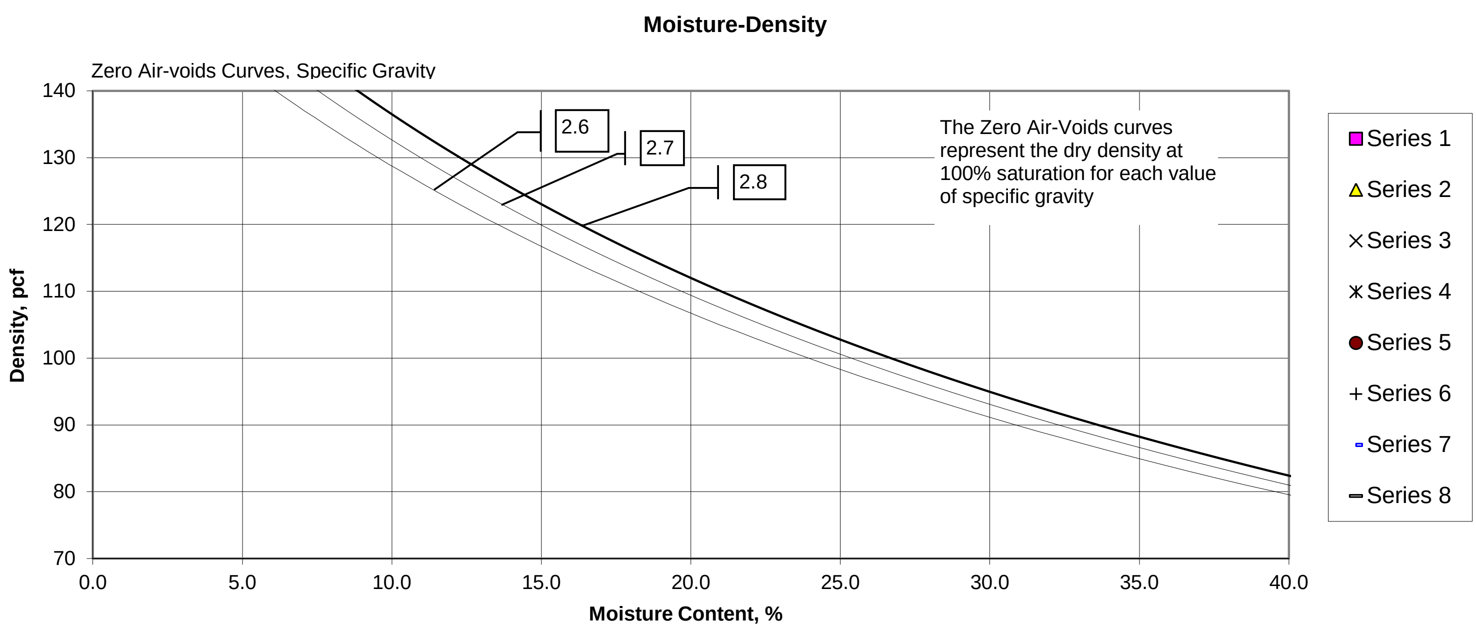


Moisture-Density-Porosity Report
Cooper Testing Labs, Inc. (ASTM D7263b)

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:					BI-02	BI-02	BI-02	BI-03
Sample:					S1	S2	S3	S-1
Depth, ft:					5	10	15	3.5
Visual Description:					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								
Moisture, %					27.8	28.7	38.4	12.0
Wet Unit wt, pcf								
Dry Unit wt, pcf								
Dry Bulk Dens.pb, (g/cc)								
Saturation, %								
Total Porosity, %								
Volumetric Water Cont,Θw,%								
Volumetric Air Cont., Θa,%								
Void Ratio								
Series					1	2	3	4

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 TEST

Client : AECOM

Project : Klamath River Dam Removal Project

ISI Lab No.: G-63174
Job no : 60537920

	Boring #	B-2	B-4	B-5	B-6	B-6	B-6	B-6	B-6
	Sample #	S-01	S-01	S-02	S-02	S-03	S-04	S-05	S-06
	Depth (ft.)	27-27.5	5-6.5	7.5-9	10-11.5	15-16.5	30-31.5	40-41.5	45-46.5
	Soil type: (visual)	Gray silty sand with gravel	Grayish brown sandy clay with gravel	Grayish brown clayey gravel with sand	Grayish brown silty sand with organics	Dark gray clayey sand	Reddish brown clayey gravel with sand	Grayish brown gravel with sand	Gray gravel
1.	Date tested:	01/23/19	01/26/19	01/26/19	01/23/19	01/26/19	01/26/19	01/26/19	01/26/19
2.	Tested by:	JH	JH	JH	JH	JH	JH	JH	JH
3.	Specimen height (in.)		5.17		5.37		5.98		
4.	Wt. of specimen + tare (gm)		805.91		824.75		1173.34		
5.	Tare wt. (gm)		0.00		206.10		203.70		
6.	Diameter (in.)		2.42		2.42		2.42		
7.	Wet wt. of soil + dish wt. (gm)	1157.51	1002.84	453.90	446.32	384.60	1323.52	974.35	825.39
8.	Dry wt. of soil + dish wt. (gm)	1032.81	912.52	437.81	359.22	317.89	1209.09	945.10	788.49
9.	Wt. of dish (gm)	166.03	200.96	83.11	187.89	84.88	361.35	187.94	188.28
10.	Dish ID								

Wet Density (pcf)		129.0		95.3		134.2		
Dry Density (pcf)		114.5		63.2		118.2		
Moisture Content (%)	14.4	12.7	4.5	50.8	28.6	13.5	3.9	6.1

Gs (Assumed)	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70
Void Ratio		0.472		1.666		0.425		
Saturation (%)		72.6		82.4		85.7		

Additional data:

Wt. of dry soil + dish before washing (gm)								
Wt. of dry soil + dish after washing (gm)								
% Passing # 200 sieve								
USCS symbol								

MOISTURE & DENSITY TEST

Client : AECOM Project : Klamath River Dam Removal Project ISI Lab No.: G-63174 Job no : 60537920

	Boring #	B-7	B-8	B-8	B-8	B-8	B-10	B-19	B-19
	Sample #	S-02	S-01	S-02	S-03	S-04	S-02	S-01	S-03
	Depth (ft.)	16.5-18	13-14.5	16-17.5	20-21.5	25-25.5	25.5-27	5-6.5	15-16.5
	Soil type: (visual)	Gray clayey sand with organics			Grayish brown clay with sand	Dark grayish brown clayey sand	Grayish brown clayey sand		Mottled grayish brown sandy clay
1.	Date tested:	01/26/19	01/26/19	01/26/19	01/26/19	01/26/19	01/26/19	01/26/19	01/26/19
2.	Tested by:	JH	JH	JH	JH	JH	JH	JH	JH
3.	Specimen height (in.)							5.67	
4.	Wt. of specimen + tare (gm)							788.65	
5.	Tare wt. (gm)							0.00	
6.	Diameter (in.)							2.42	
7.	Wet wt. of soil + dish wt. (gm)	359.80	113.16	124.99	133.28	499.55	457.34	237.77	1074.57
8.	Dry wt. of soil + dish wt. (gm)	269.65	100.69	95.27	113.85	469.95	428.90	204.03	939.01
9.	Wt. of dish (gm)	85.87	50.55	50.56	51.16	188.28	85.30	50.63	356.12
10.	Dish ID								

Wet Density (pcf)							115.1	
Dry Density (pcf)							94.4	
Moisture Content (%)	49.1	24.9	66.5	31.0	10.5	8.3	22.0	23.3

Gs (Assumed)	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70
Void Ratio							0.786	
Saturation (%)							75.6	

Additional data:

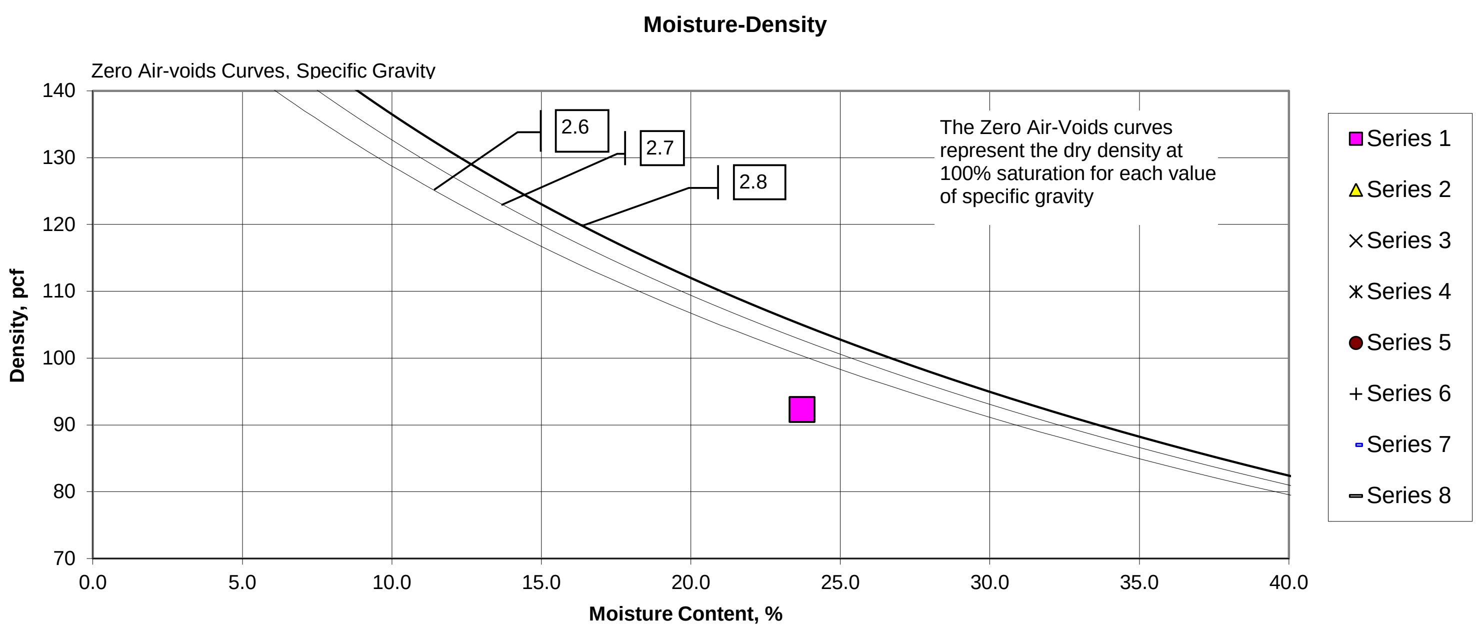
Wt. of dry soil + dish before washing (gm)								
Wt. of dry soil + dish after washing (gm)								
% Passing # 200 sieve								
USCS symbol								

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

CTL Job No:	020-277	**Project No.**	60537920	**By:**	RU
Client:	AECOM	**Date:**	03/21/19		
Project Name:	Klamath River Renewal Project	**Remarks:**			

Boring:	B-15							
Sample:	S1							
Depth, ft:	5-5.5							
Visual Description:	Brown Sandy Fat CLAY							
Actual G_s								
Assumed G_s	2.70							
Moisture, %	23.7							
Wet Unit wt, pcf	114.1							
Dry Unit wt, pcf	92.3							
Dry Bulk Dens.ρb, (g/cc)	1.48							
Saturation, %	77.3							
Total Porosity, %	45.3							
Volumetric Water Cont,Θw,%	35.0							
Volumetric Air Cont., Θa,%	10.3							
Void Ratio	0.83							
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 TEST

Client : AECOM

Project : Klamath River Dam Removal Project

ISI Lab No.: G-63174

Job no : 60537920

	Boring #	B-19	B-20	B-20	B-20				
	Sample #	S-04	S-03	S-04	S-05				
	Depth (ft.)	20-21.5	15-16.5	20-21.5	25-26.5				
	Soil type: (visual)	Grayish brown clayey gravel with sand	Grayish brown sandy clay	Grayish brown clayey sand	Grayish brown clayey sand with gravel				
1.	Date tested:	01/26/19	01/26/19	01/26/19	01/26/19				
2.	Tested by:	JH	JH	JH	JH				
3.	Specimen height (in.)								
4.	Wt. of specimen + tare (gm)								
5.	Tare wt. (gm)								
6.	Diameter (in.)								
7.	Wet wt. of soil + dish wt. (gm)	1187.41	680.92	765.13	630.86				
8.	Dry wt. of soil + dish wt. (gm)	1024.76	550.85	657.31	563.27				
9.	Wt. of dish (gm)	311.57	186.22	188.13	187.57				
10.	Dish ID								

Wet Density (pcf)								
Dry Density (pcf)								
Moisture Content (%)	22.8	35.7	23.0	18.0				

Gs (Assumed)	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70
Void Ratio								
Saturation (%)								

Additional data:

Wt. of dry soil + dish before washing (gm)								
Wt. of dry soil + dish after washing (gm)								
% Passing # 200 sieve								
USCS symbol								

COOPER TESTING LABORATORY

#200 Sieve Wash Analysis
ASTM D 1140

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).

#200 Bulk Sieve Wash Analysis
ASTM D 1140m

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-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).

ASTM D-1140
PERCENT PASSING NO. 200 SIEVE REPORT
Method A
Specimens Soaked Overnight without Deflocculating Agent
Dry Mass Determined Directly

Client Name AECOM
Project Name Klamath River Dam Removal Project
Project Number 60537920

Boring Number	B-6	B-6	B-8	B-10	B-20
Sample Number	S-03	S-05	S-04	S-02	S-03
Depth (ft)	15-16.5	40-41.5	25-25.5	25.5-27	15-16.5
Percent of Soil Finer than No. 200 Sieve	36.2	2.4	27.6	15.7	67.8
Visual Classification	Dark gray clayey sand	Grayish brown gravel with sand	Dark grayish brown clayey sand	Grayish brown clayey sand	Grayish brown sandy clay
Date	01/26/19	01/26/19	01/26/19	01/26/19	01/26/19
Weight of Dry Soil + Pan (before wash)	317.9	945.1	470.0	428.9	550.9
Weight of Dry Soil + Pan (after wash)	233.5	927.2	392.2	375.1	303.7
Weight of Pan	84.9	187.9	188.3	85.3	186.2

COOPER TESTING LABORATORY

#200 Sieve Wash Analysis
ASTM D 1140

Job No.:	020-277	**Project No.:**	60537920	**Run By:**	MD
Client:	AECOM	**Date:**	3/26/2019	**Checked By:**	DC
Project:	Klamath River Renewal Project				

Boring:	B-15							
Sample:	S3							
Depth, ft.:	15-16.5							
Soil Type:	Brown Clayey GRAVEL w/ Sand							
Wt of Dish & Dry Soil, gm	687.3							
Weight of Dish, gm	172.2							
Weight of Dry Soil, gm	515.1							
Wt. Ret. on #4 Sieve, gm	218.3							
Wt. Ret. on #200 Sieve, gm	357.6							
% Gravel	**42.4**							
% Sand	**27.0**							
% Silt & Clay	**30.6**							

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).

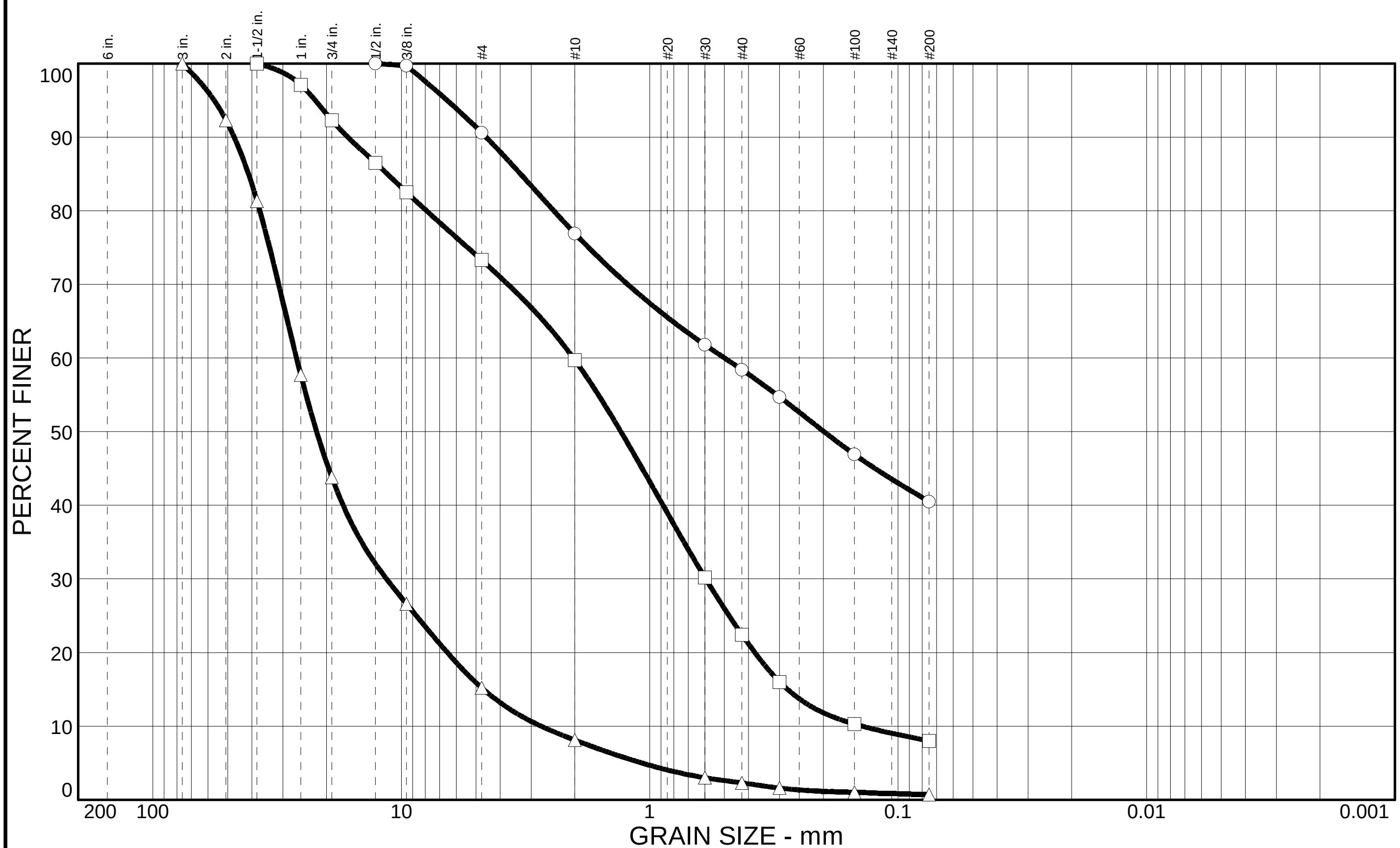
ASTM D-1140
PERCENT PASSING NO. 200 SIEVE REPORT

Method A
Specimens Soaked Overnight without Deflocculating Agent
Dry Mass Determined Directly

Client Name AECOM
Project Name Klamath River Dam Removal Project
Project Number 60537920

Boring Number	B-20				
Sample Number	S-05				
Depth (ft)	25-26.5				
Percent of Soil Finer than No. 200 Sieve	23.1				
Visual Classification	Grayish brown clayey sand with gravel				
Date	01/26/19				
Weight of Dry Soil + Pan (before wash)	563.3				
Weight of Dry Soil + Pan (after wash)	476.3				
Weight of Pan	187.6				

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'

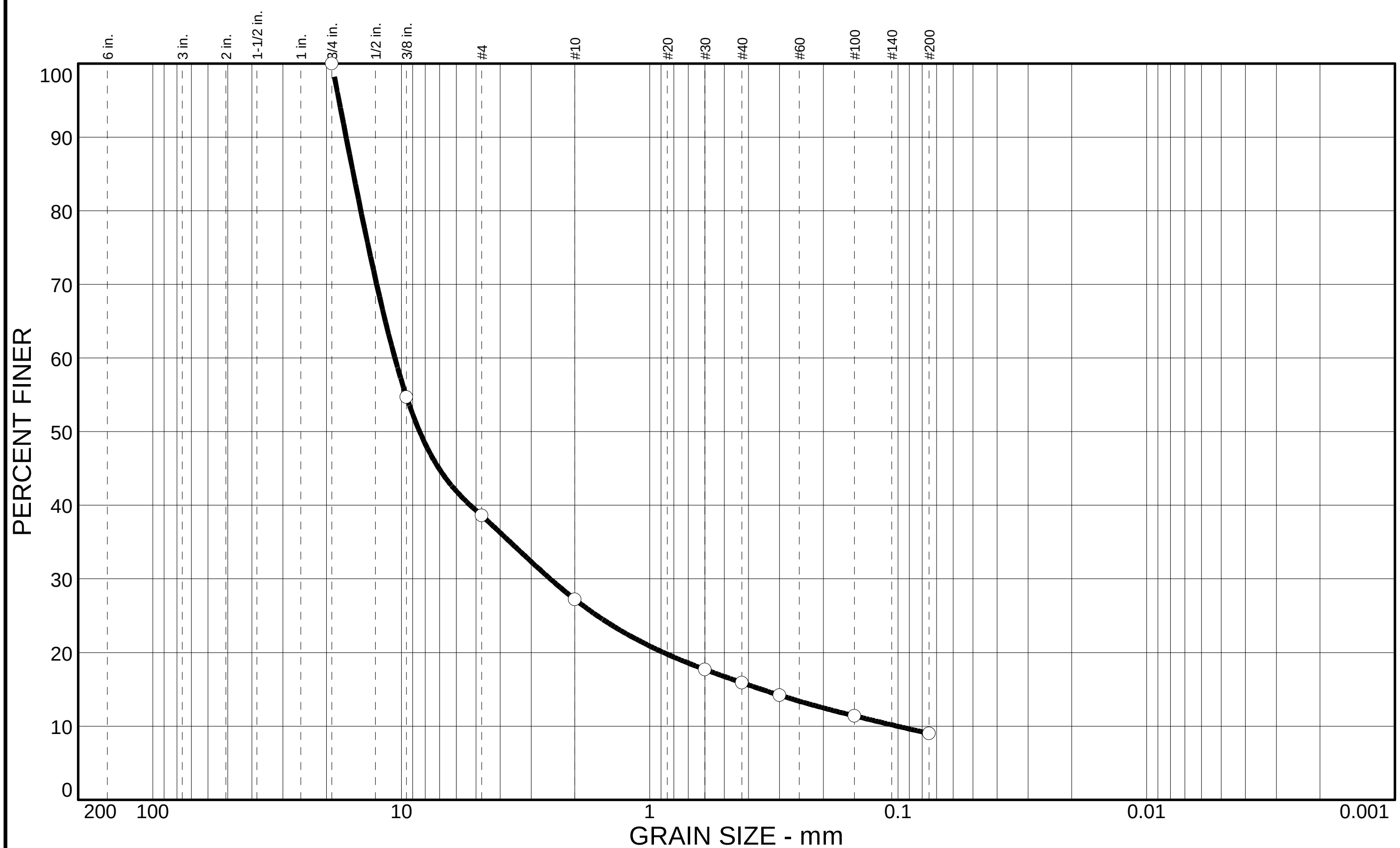
COOPER TESTING LABORATORY

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'

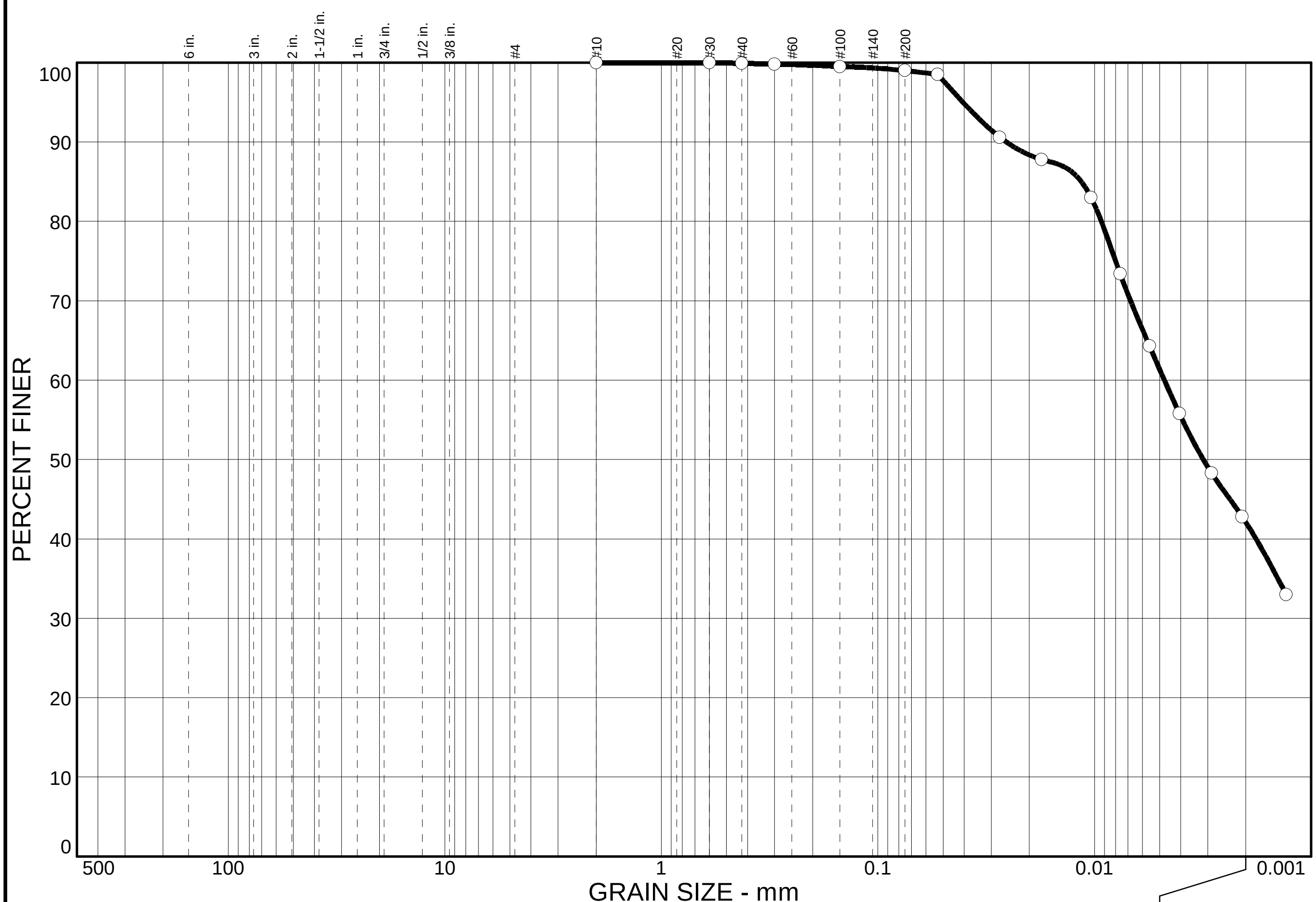
COOPER TESTING LABORATORY

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

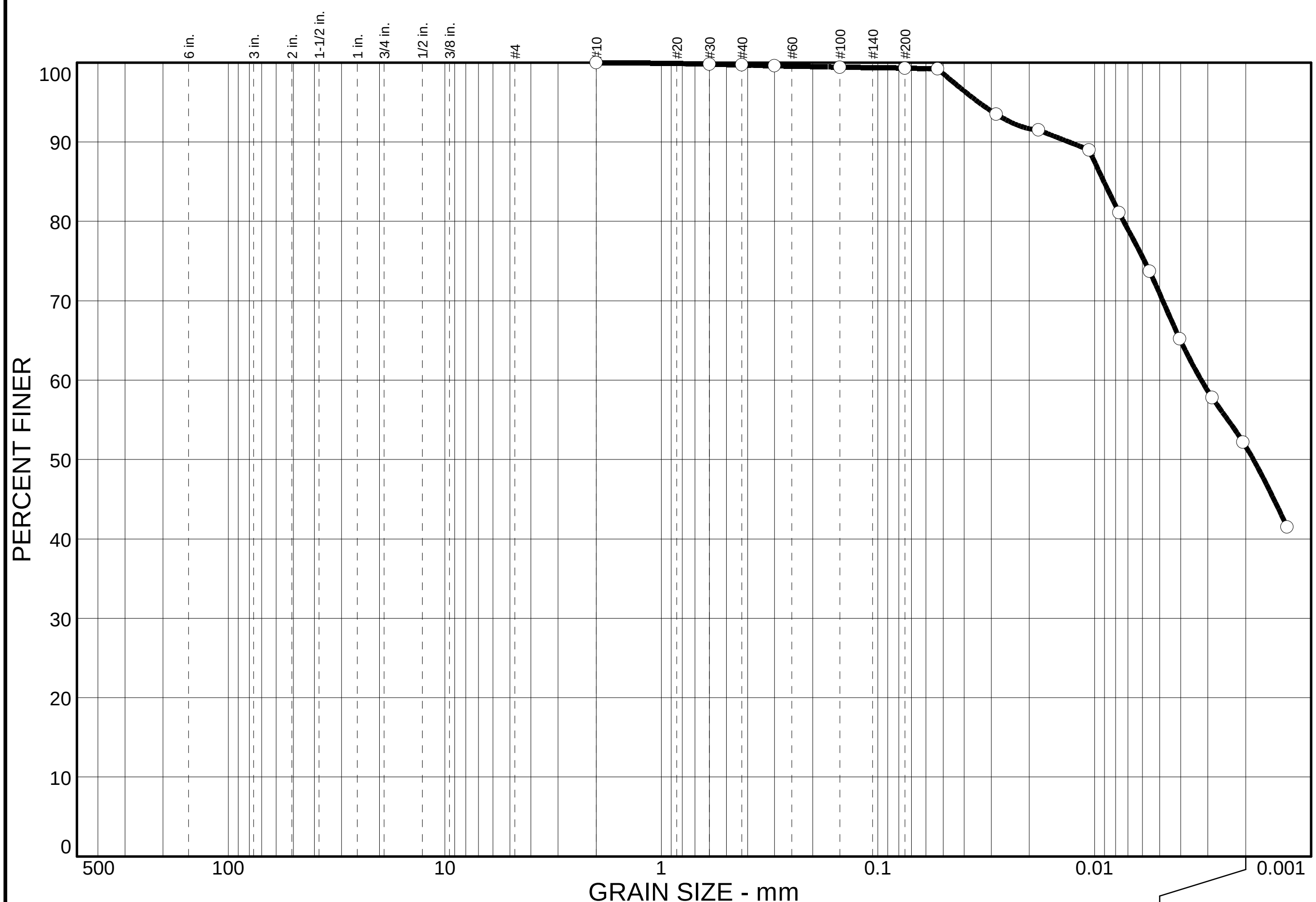
Sample No.: S-04 **Source of Sample:** BC-01 **Date:** 6/5/18
Location: **Elev./Depth:** 21.5'

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

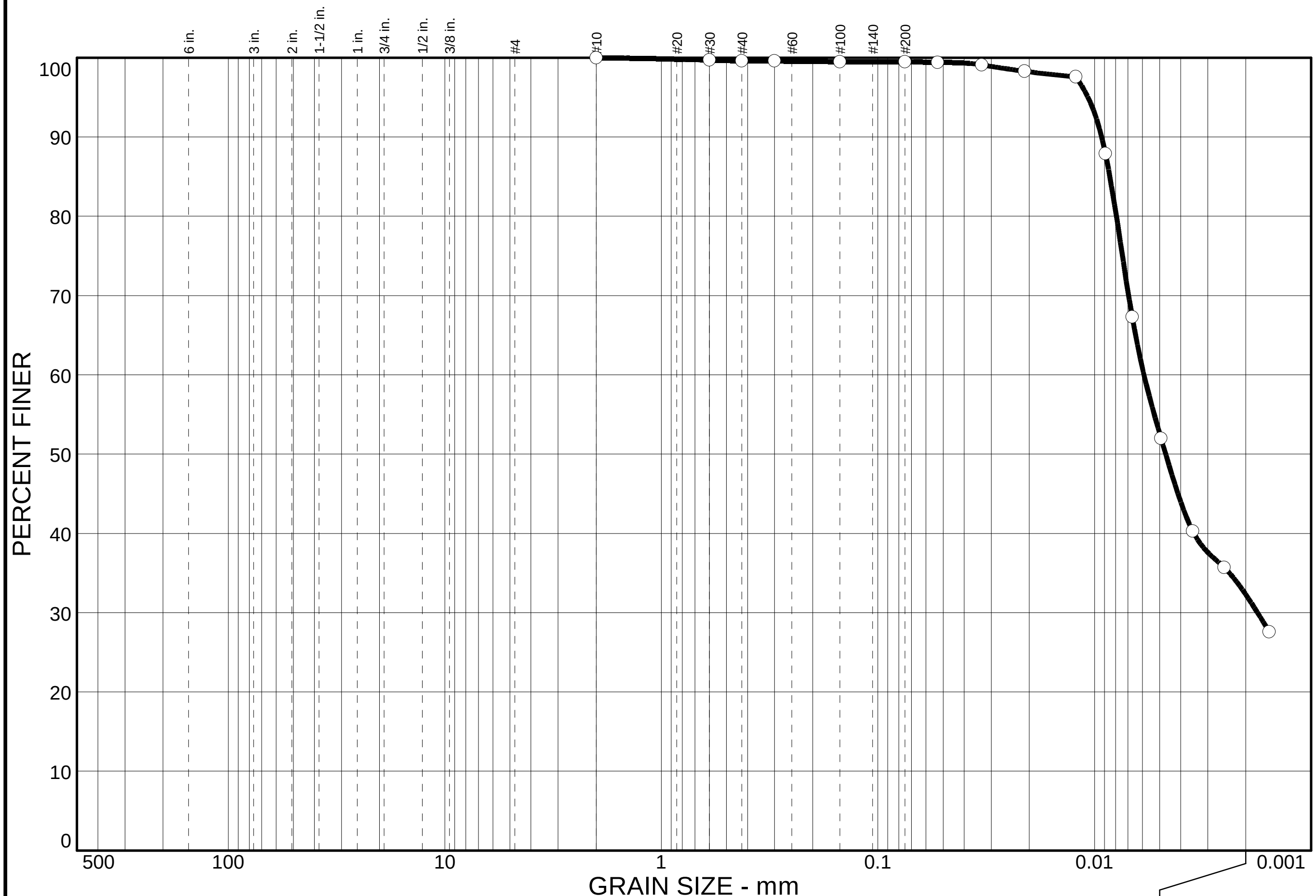
Sample No.: S-05 **Source of Sample:** BC-02 **Date:** 6/5/18
Location: **Elev./Depth:** 14.5'

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

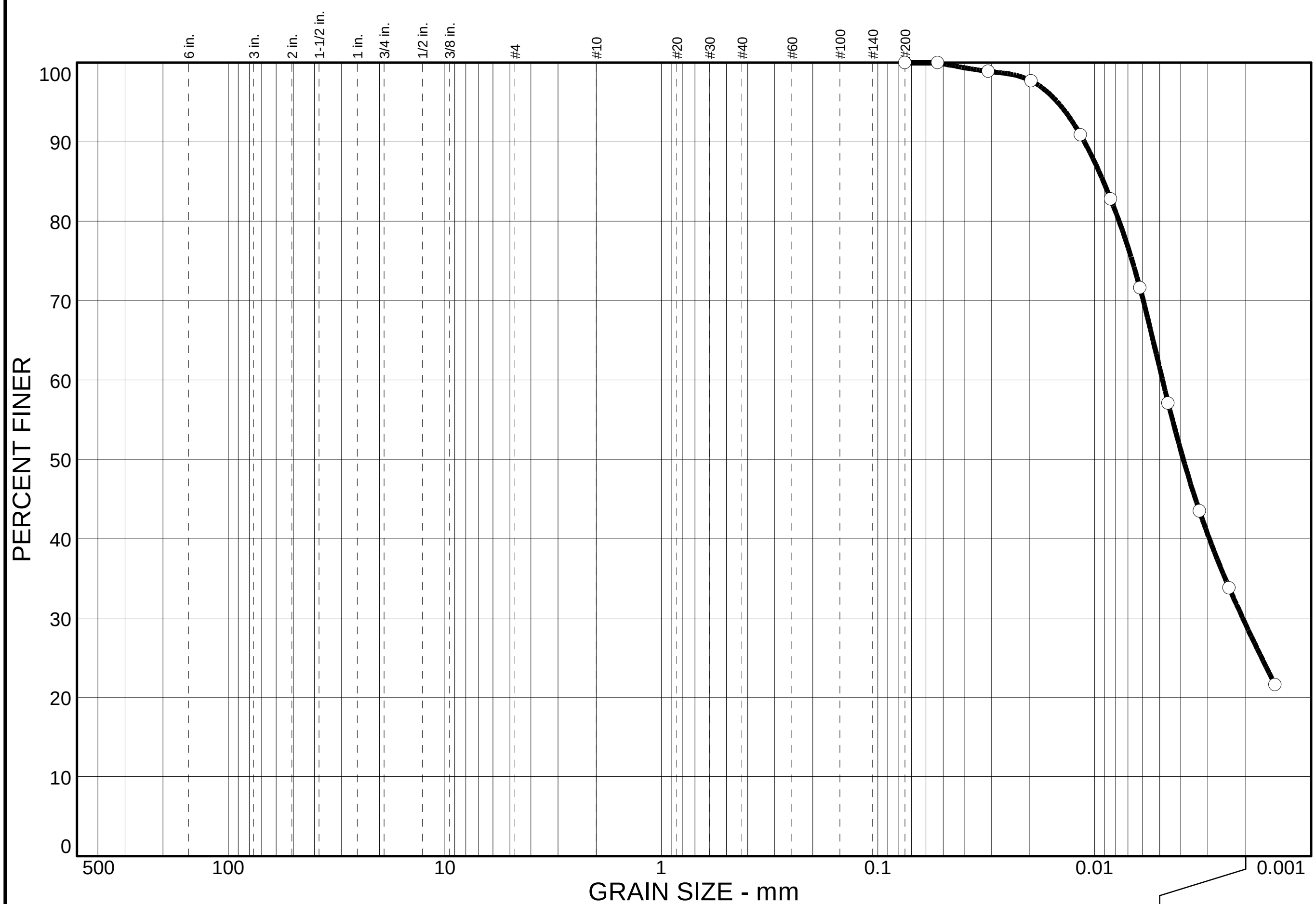
Sample No.: S-09 **Source of Sample:** BC-02 **Date:** 6/5/18
Location: **Elev./Depth:** 44.5'

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

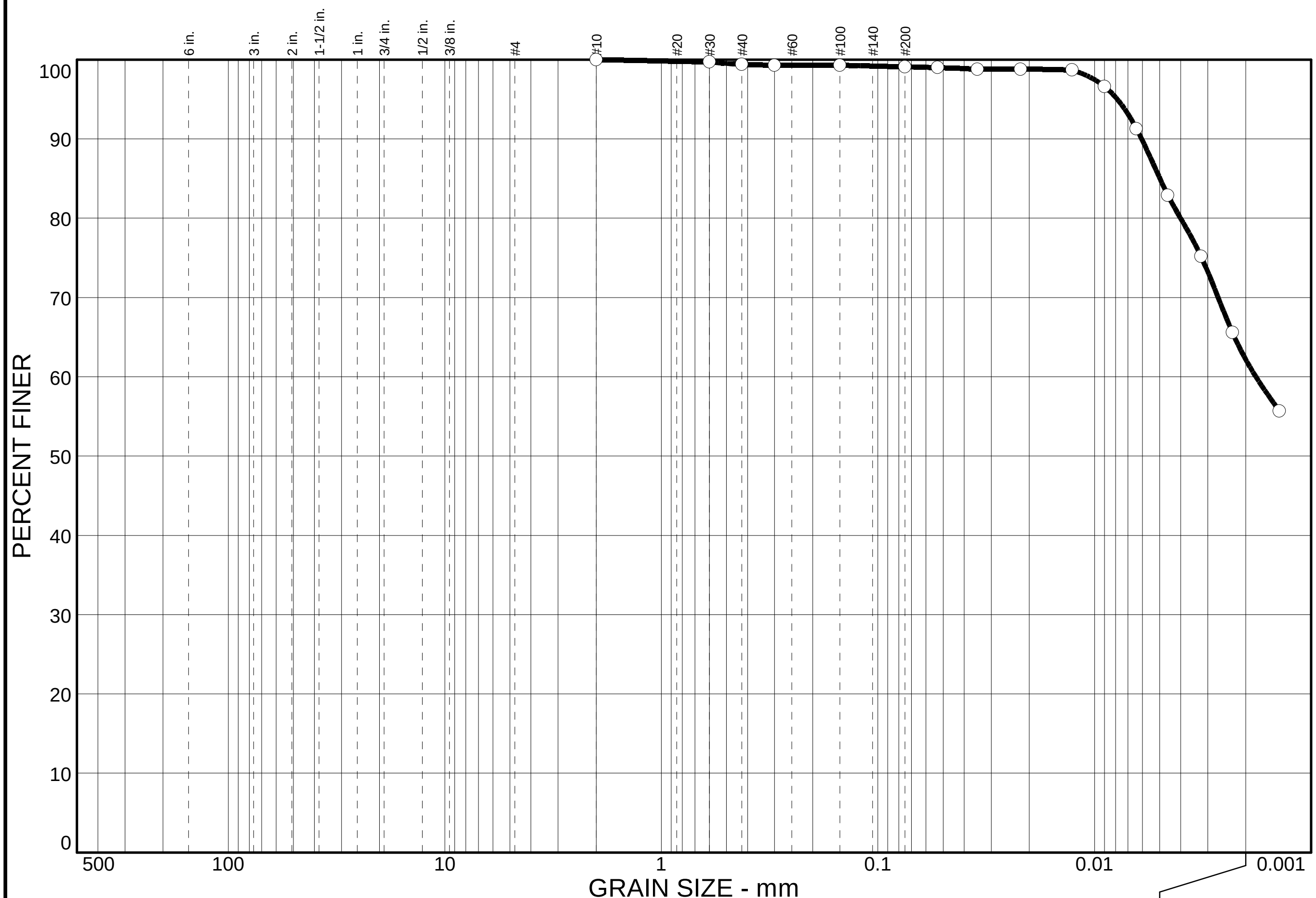
Sample No.: S-05 **Source of Sample:** BC-03 **Date:** 6/5/18
Location: **Elev./Depth:** 24.5'

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

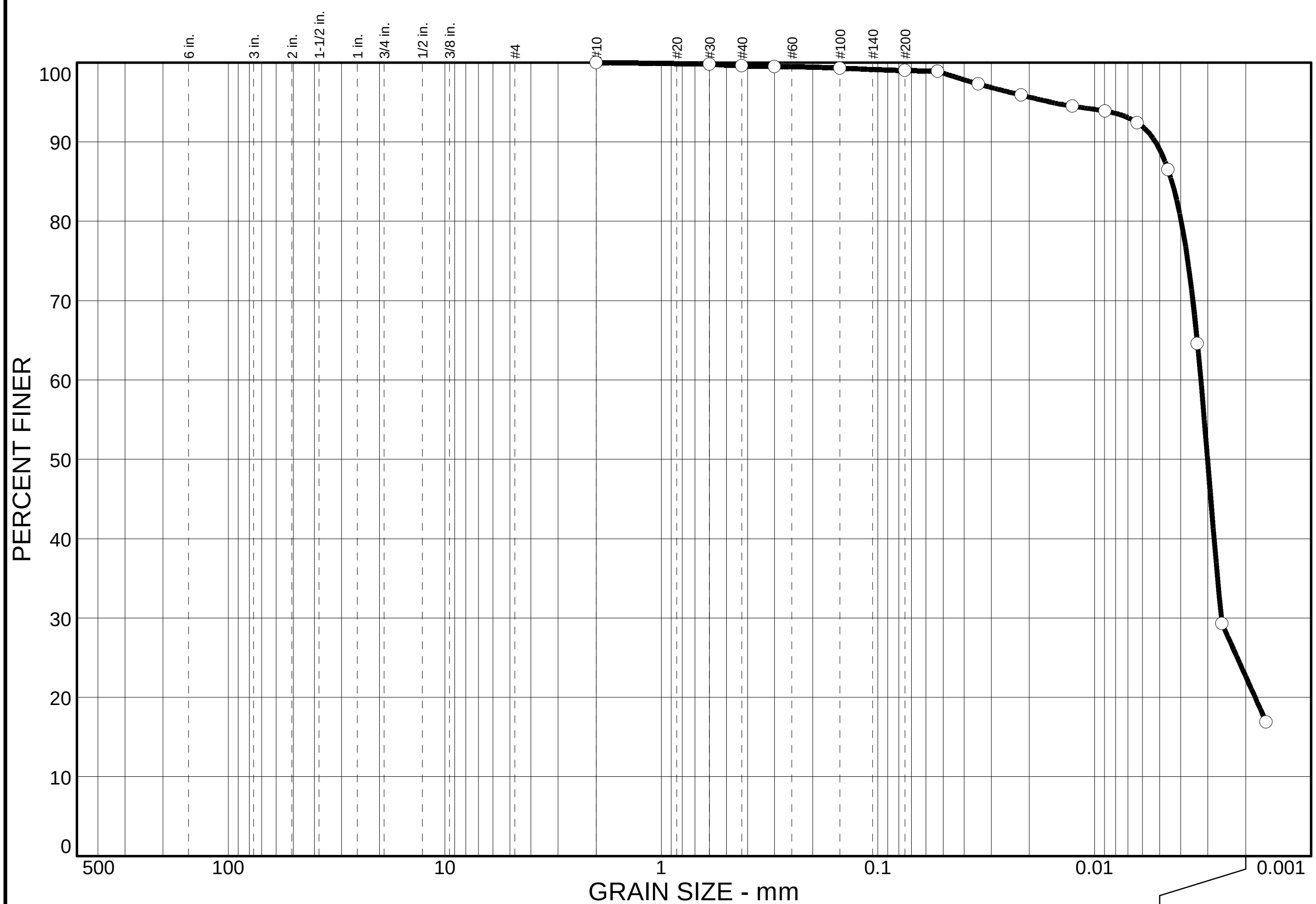
Sample No.: S-08 **Source of Sample:** BC-04 **Date:** 5/16/18
Location: **Elev./Depth:** 32.5(Tip-16")

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

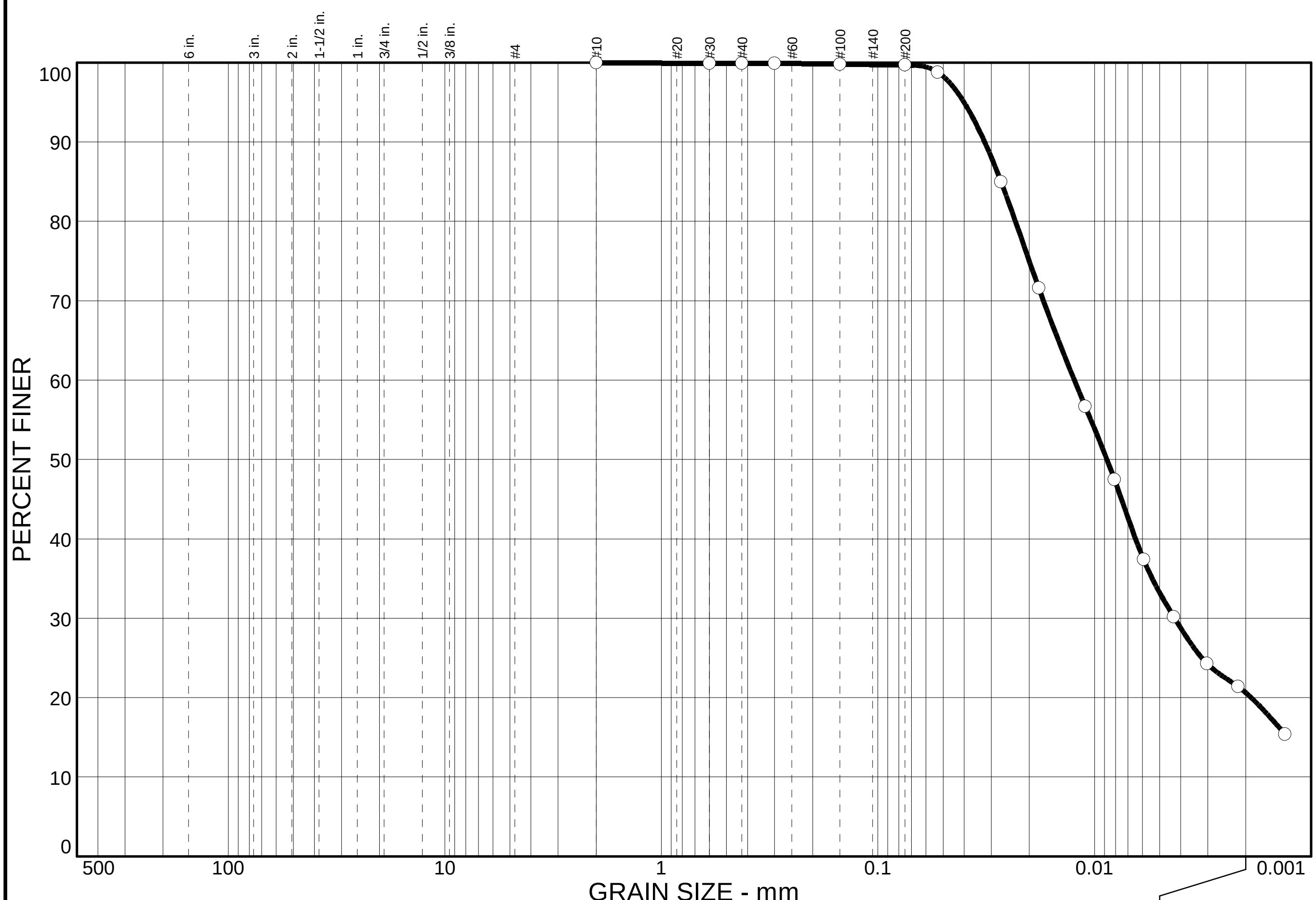
Sample No.: S-05 **Source of Sample:** BC-08A **Date:** 6/5/18
Location: **Elev./Depth:** 54'

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

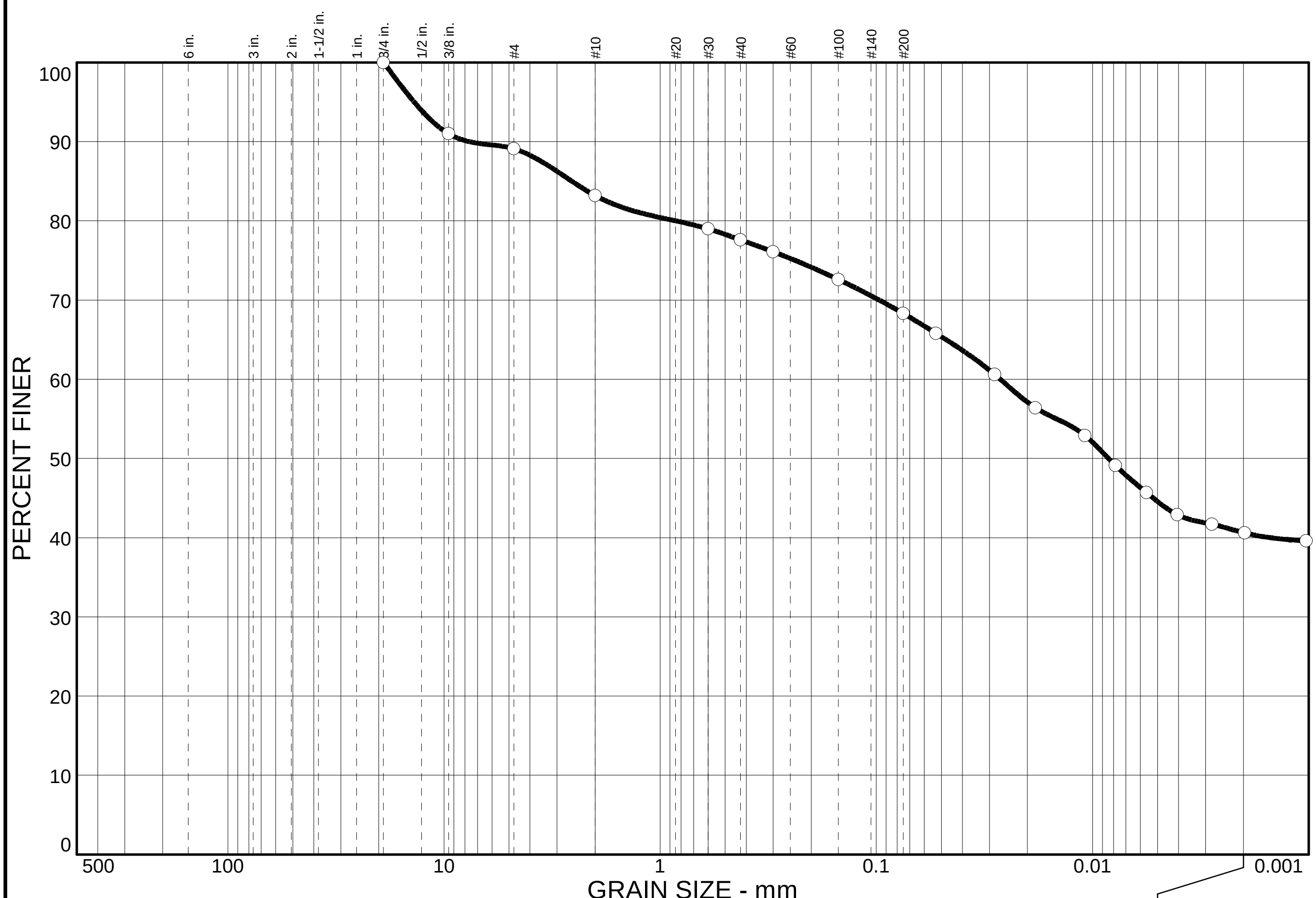
Sample No.: S-05 **Source of Sample:** BC-09 **Date:** 6/5/18
Location: **Elev./Depth:** 23(Tip-5")

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

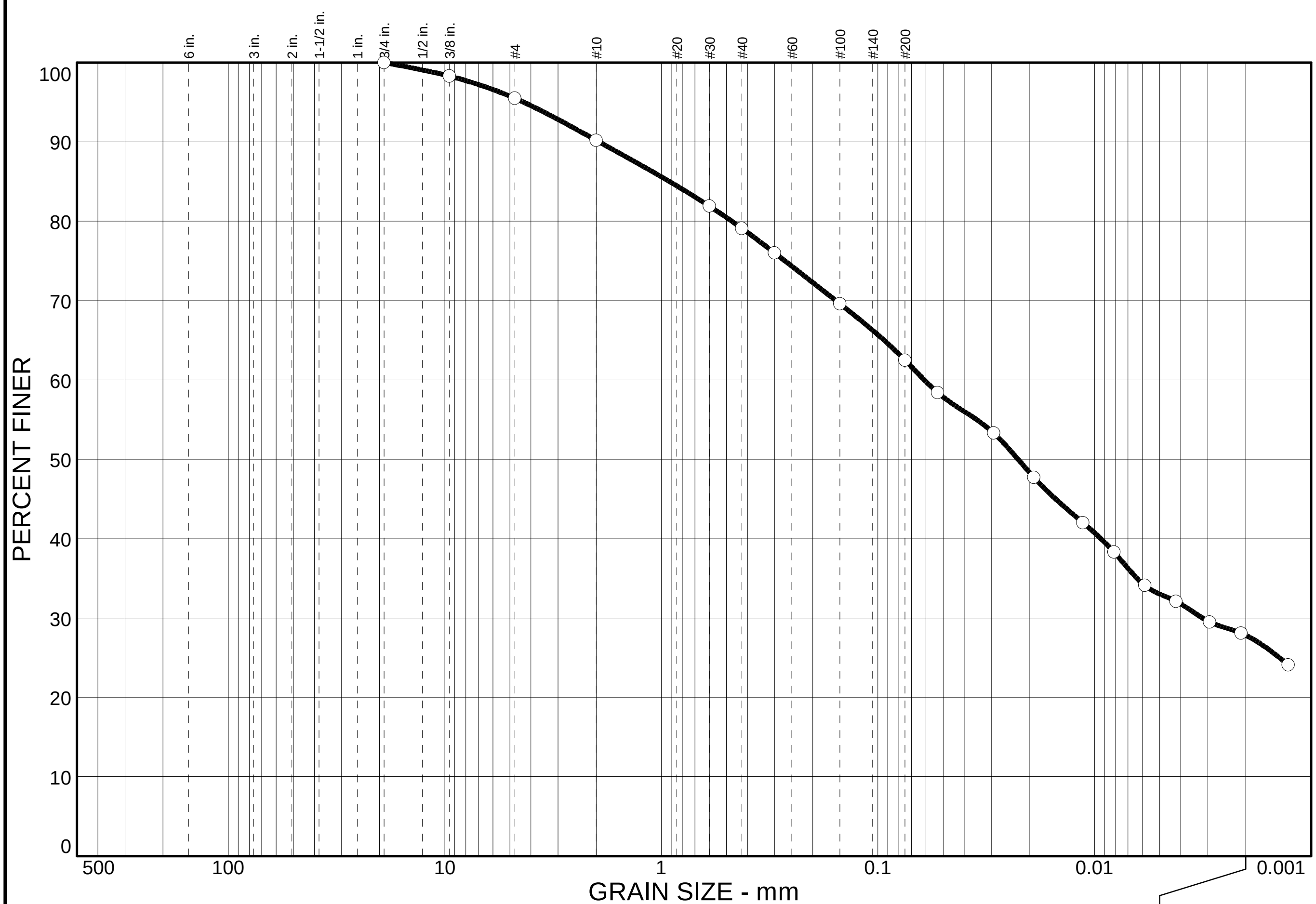
Sample No.: S-01 **Source of Sample:** BI-02 **Date:** 6/6/18
Location: **Elev./Depth:** 5'

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

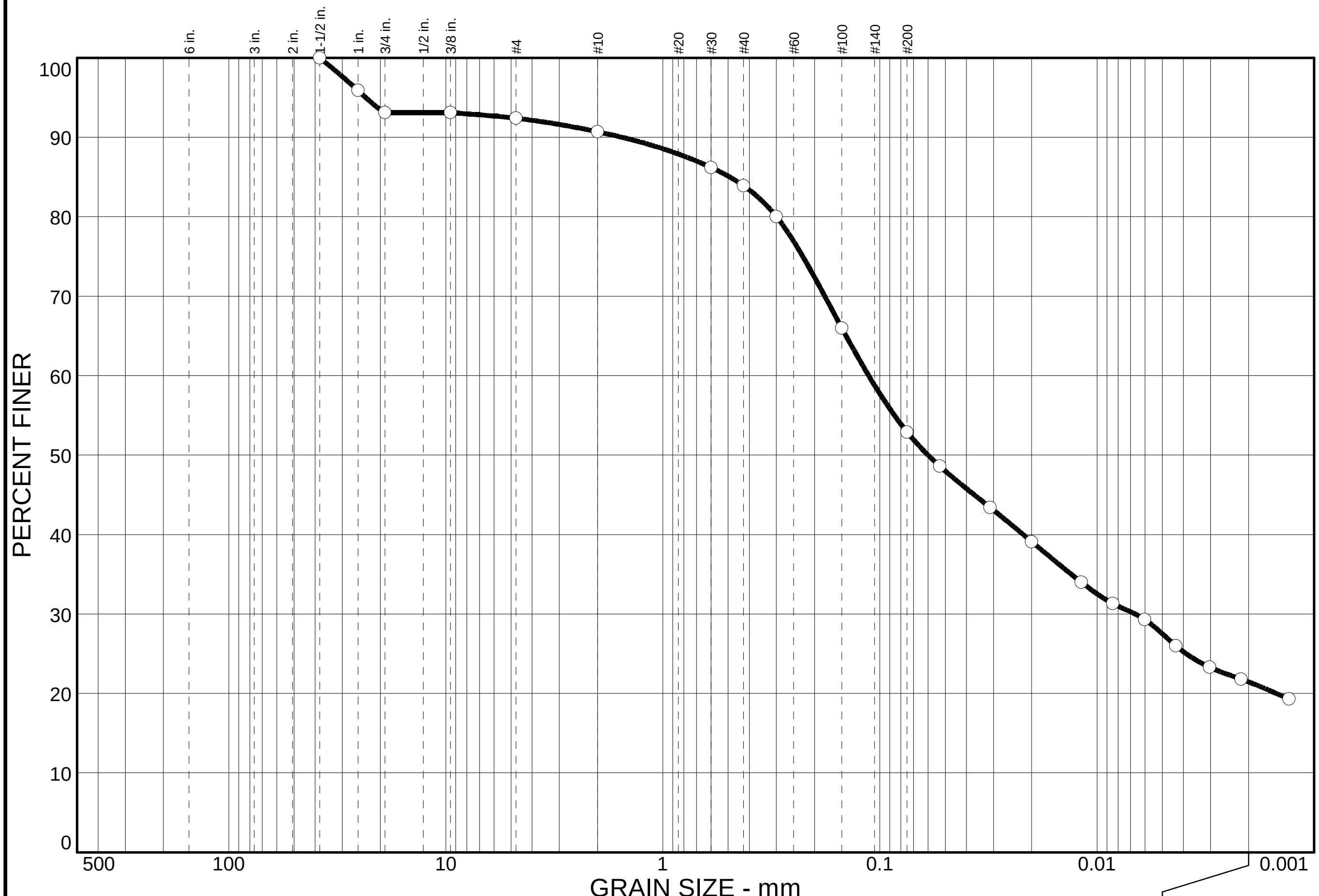
Sample No.: S-02 **Source of Sample:** BI-02 **Date:** 6/6/18
Location: **Elev./Depth:** 10'

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.

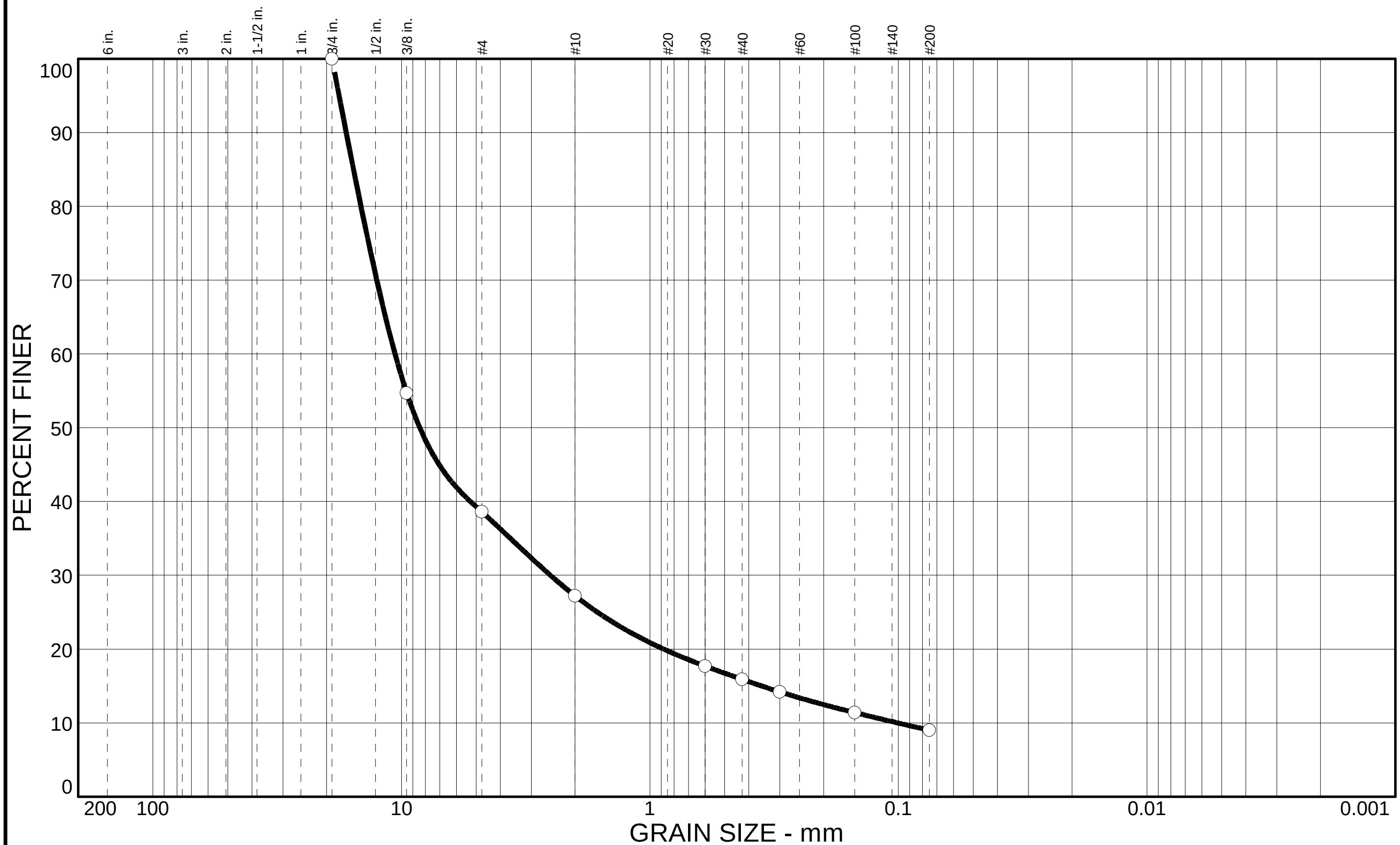
Sample No.: S-03 **Source of Sample:** BI-02 **Date:** 6/6/18
Location: **Elev./Depth:** 15'

COOPER TESTING LABORATORY

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

Project No: 020-251 **Figure**

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'

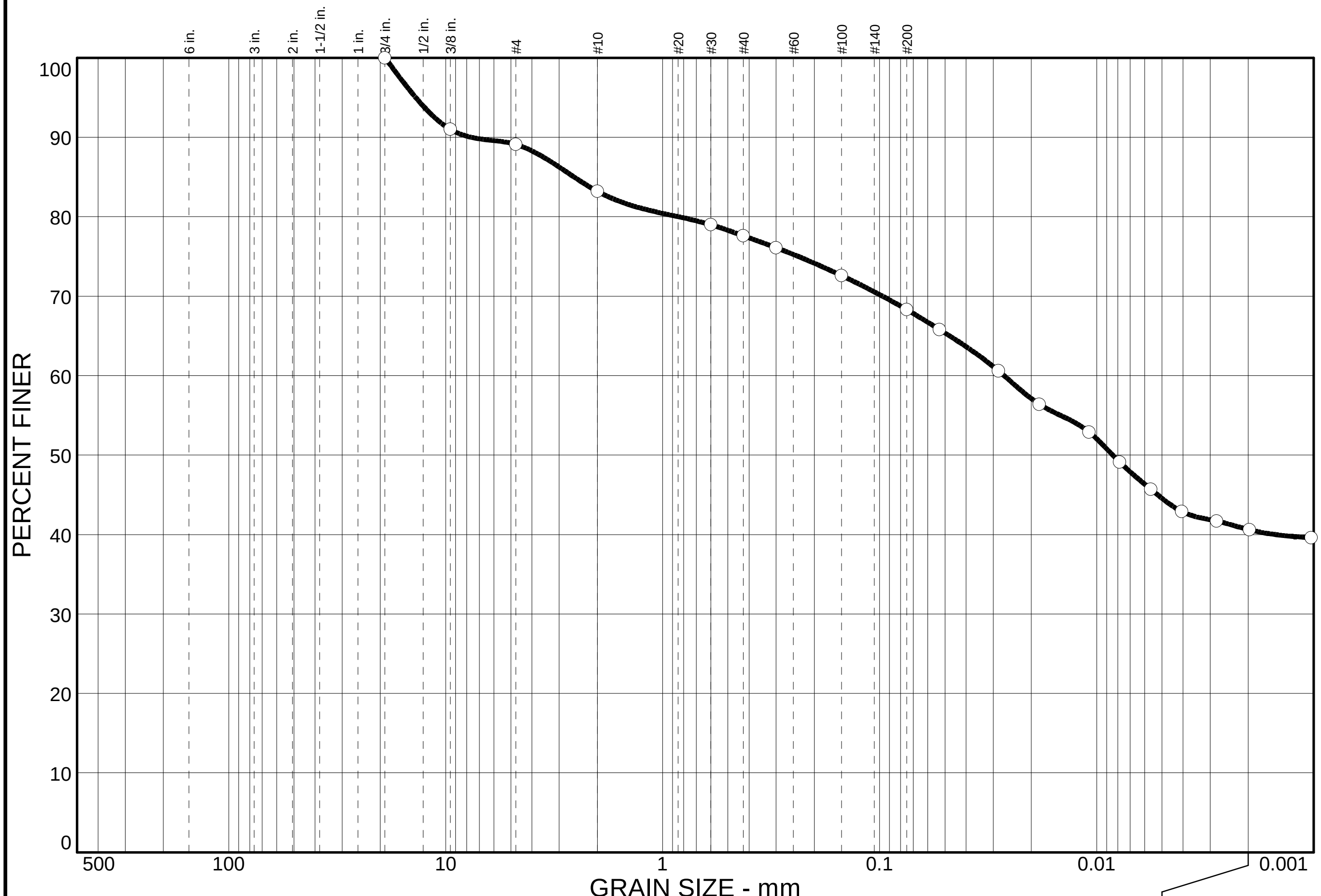
COOPER TESTING LABORATORY

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	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

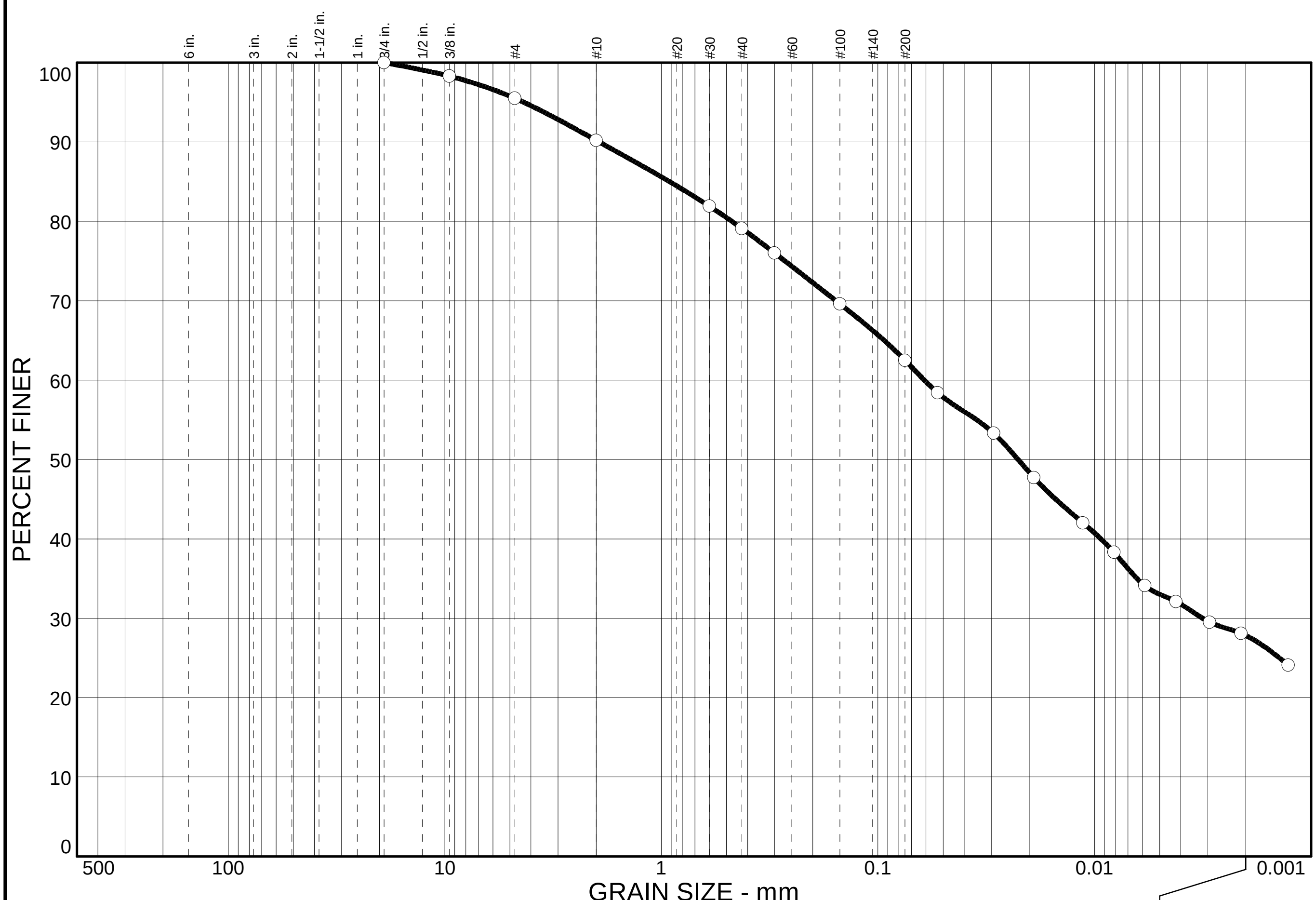
Sample No.: S-01 **Source of Sample:** BI-02 **Date:** 6/6/18
Location: **Elev./Depth:** 5'

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

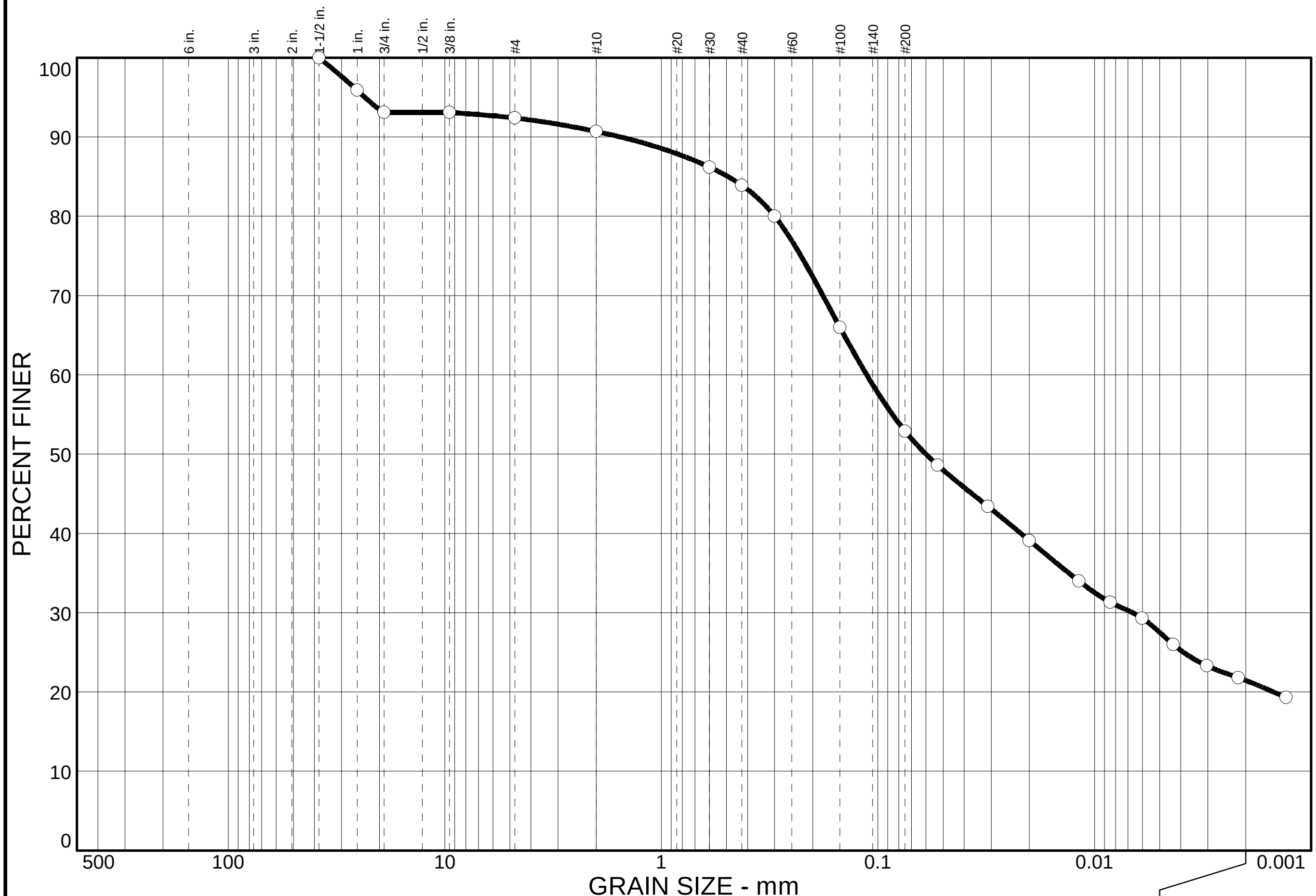
Sample No.: S-02 **Source of Sample:** BI-02 **Date:** 6/6/18
Location: **Elev./Depth:** 10'

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.

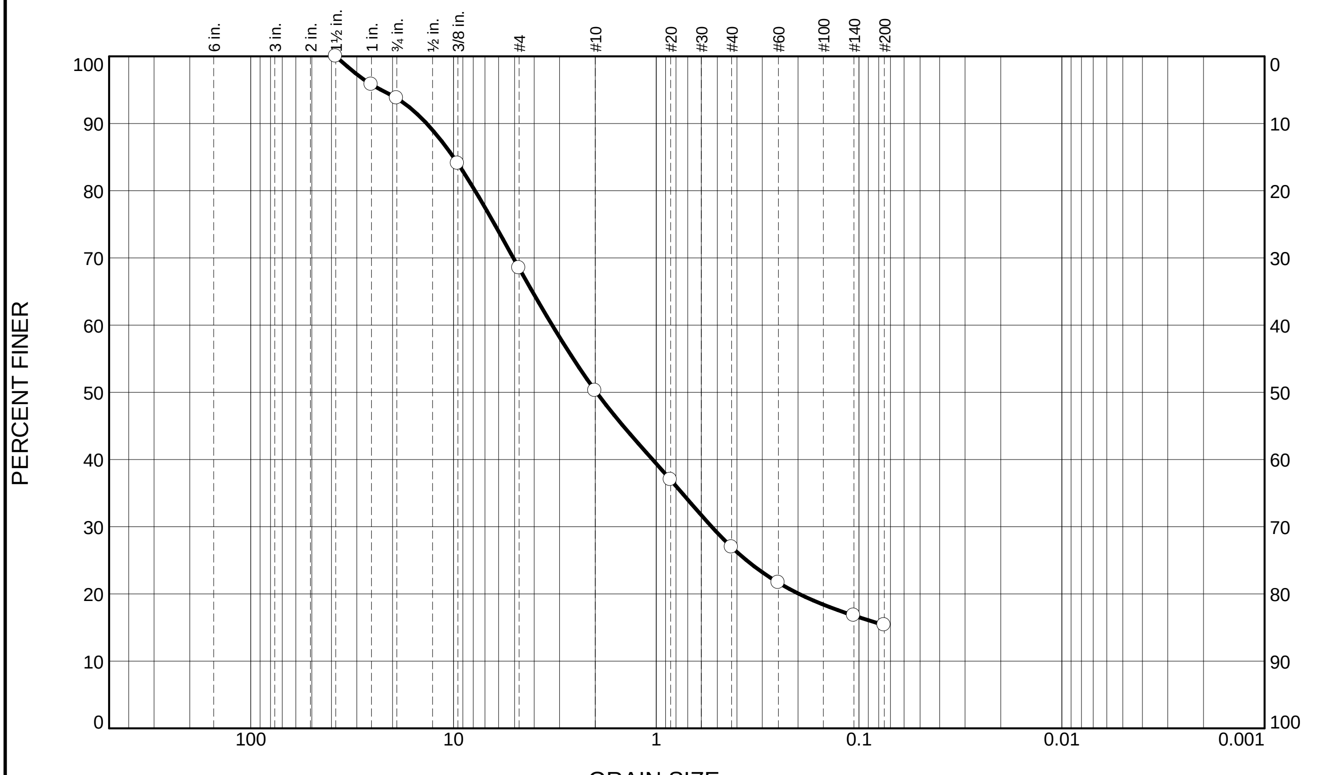
Sample No.: S-03 **Source of Sample:** BI-02 **Date:** 6/6/18
Location: **Elev./Depth:** 15'

COOPER TESTING LABORATORY

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

Project No: 020-251 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	6	26	18	23	12	15	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5	100		
1	96		
3/4	94		
3/8	84		
#4	68		
#10	50		
#20	37		
#40	27		
#60	22		
#140	17		
#200	15		

* (no specification provided)

Soil Description

Gray silty sand with gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 13.5779 D_{85}= 10.0161 D_{60}= 3.2642

D_{50}= 1.9723 D_{30}= 0.5334 D_{15}=

D_{10}= C_u= C_c=

Classification

USCS= SM AASHTO=

Remarks

Source of Sample: B-2 **Depth:** 27-27.5

Sample Number: S-01

Date: 2-1-19

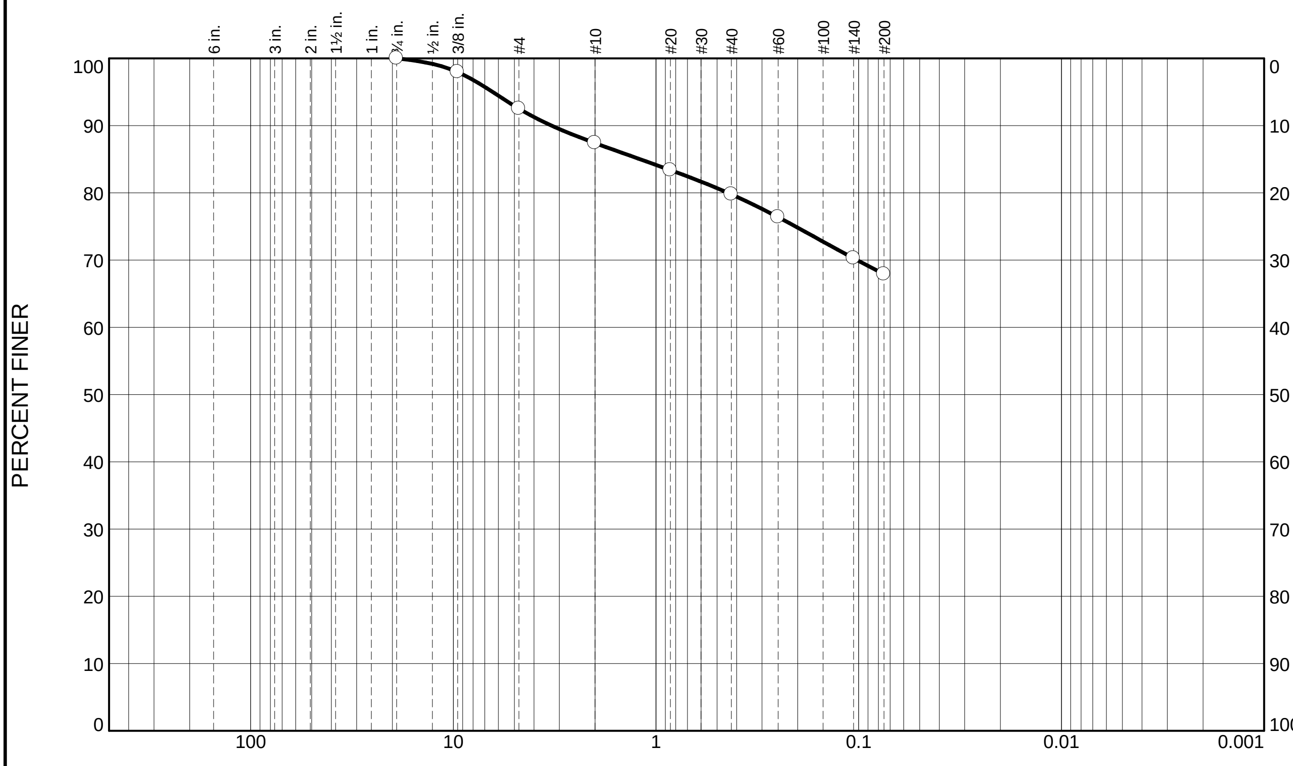
Client: AECOM

Project: Klamath River Dam Removal Project 60537920

Project No: 2301-069.0 **Figure**

Tested By: JH **Checked By:** JH

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	7	6	7	12	68	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100		
3/8	98		
#4	93		
#10	87		
#20	83		
#40	80		
#60	76		
#140	70		
#200	68		

* (no specification provided)

Soil Description

Brown clay with sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 3.2821 D_{85}= 1.2011 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO=

Remarks

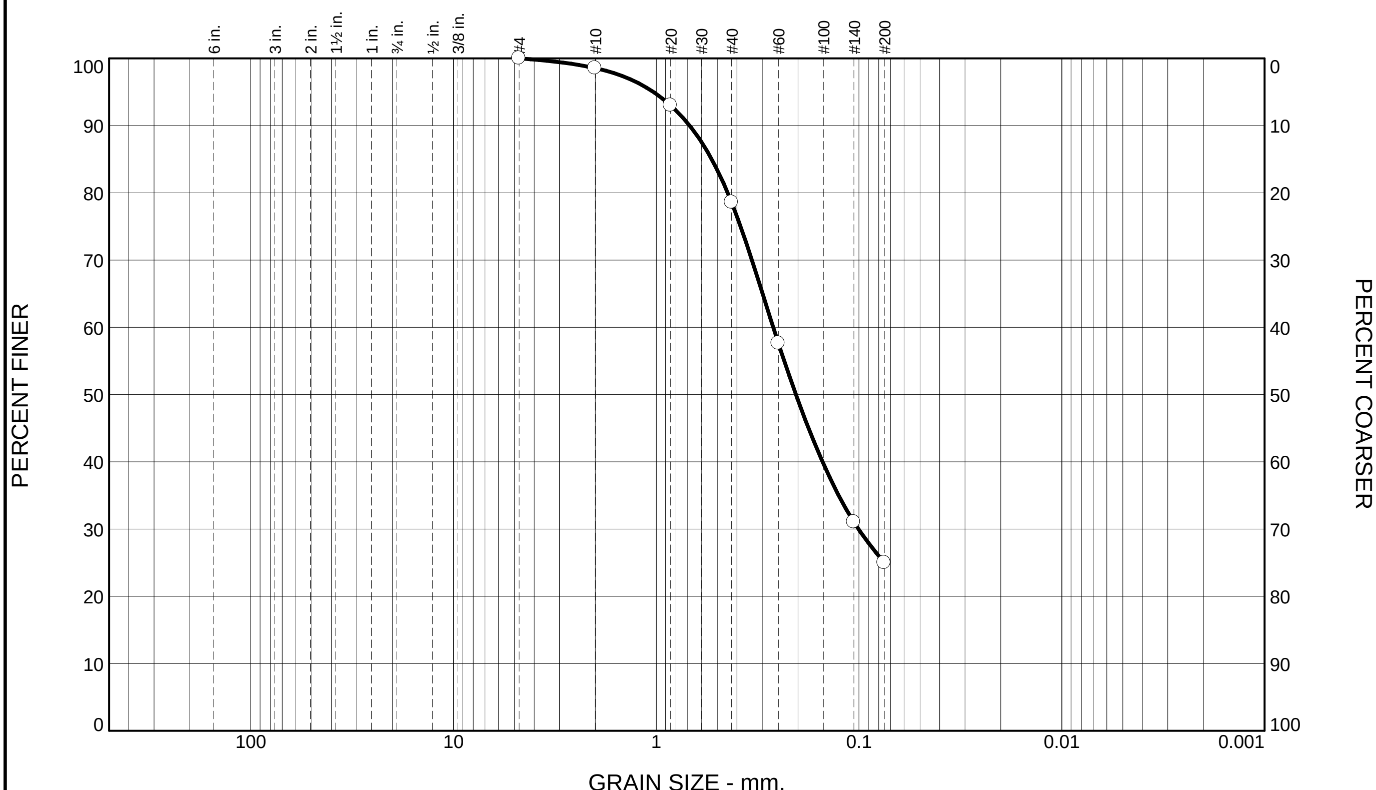
Source of Sample: B-5 **Depth:** 5-6.5
Sample Number: S-01

Date: 2-1-19

Client: AECOM
Project: Klamath River Dam Removal Project
60537920
Project No: 2301-069.0 **Figure**

Tested By: JH **Checked By:** JH

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	1	20	54	25	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100		
#10	99		
#20	93		
#40	79		
#60	58		
#140	31		
#200	25		

* (no specification provided)

Soil Description

Grayish brown silty sand with organics

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.6851 D_{85}= 0.5329 D_{60}= 0.2650
D_{50}= 0.2048 D_{30}= 0.1007 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SM AASHTO=

Remarks

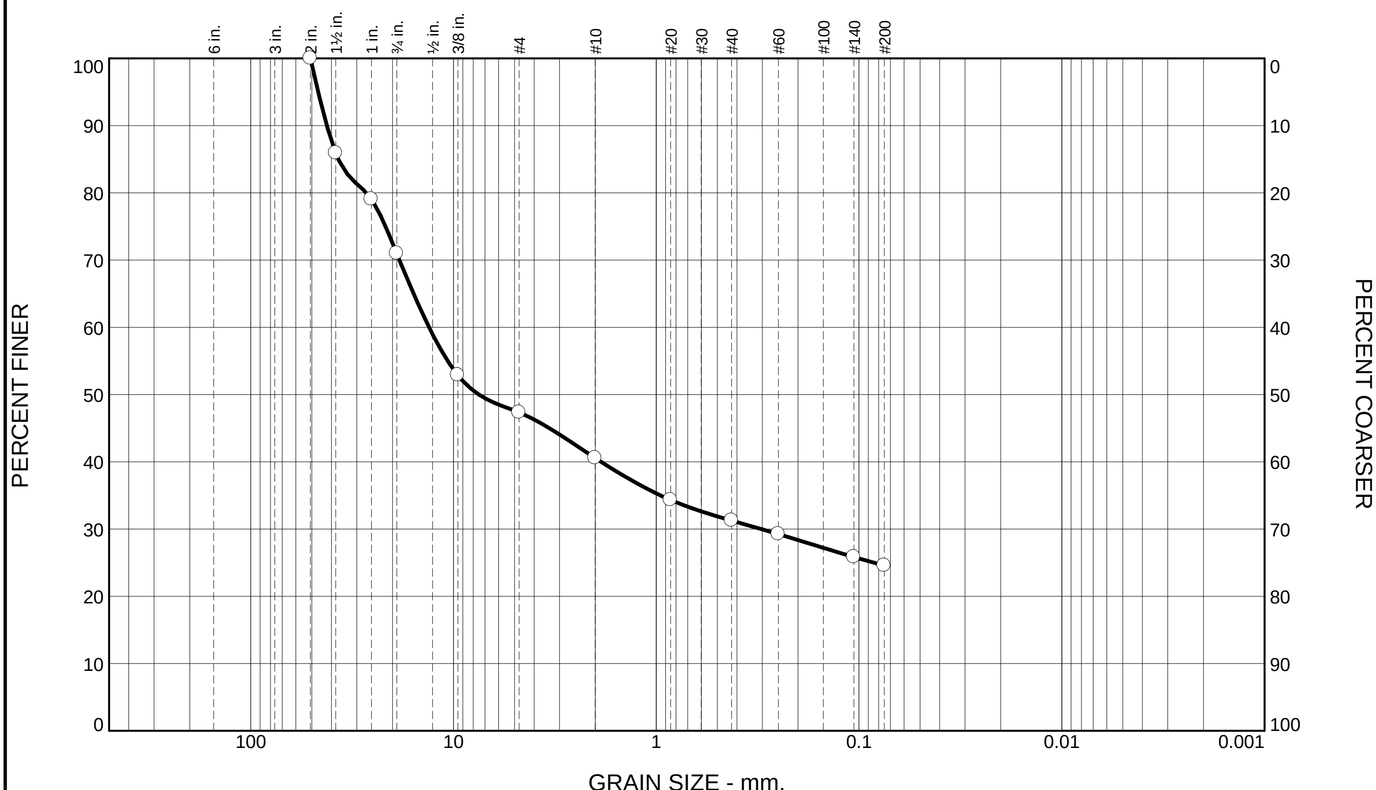
Source of Sample: B-6 **Depth:** 10-11.5
Sample Number: S-02

Date: 2-1-19

Client: AECOM
Project: Klamath River Dam Removal Project
60537920
Project No: 2301-069.0 **Figure**

Tested By: JH **Checked By:** JH

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	29	24	6	10	6	25	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2	100		
1.5	86		
1	79		
3/4	71		
3/8	53		
#4	47		
#10	41		
#20	34		
#40	31		
#60	29		
#140	26		
#200	25		

* (no specification provided)

Soil Description

Reddish brown clayey gravel with sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 42.1617 D_{85}= 36.9884 D_{60}= 13.2018
D_{50}= 7.5052 D_{30}= 0.3044 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= GC AASHTO=

Remarks

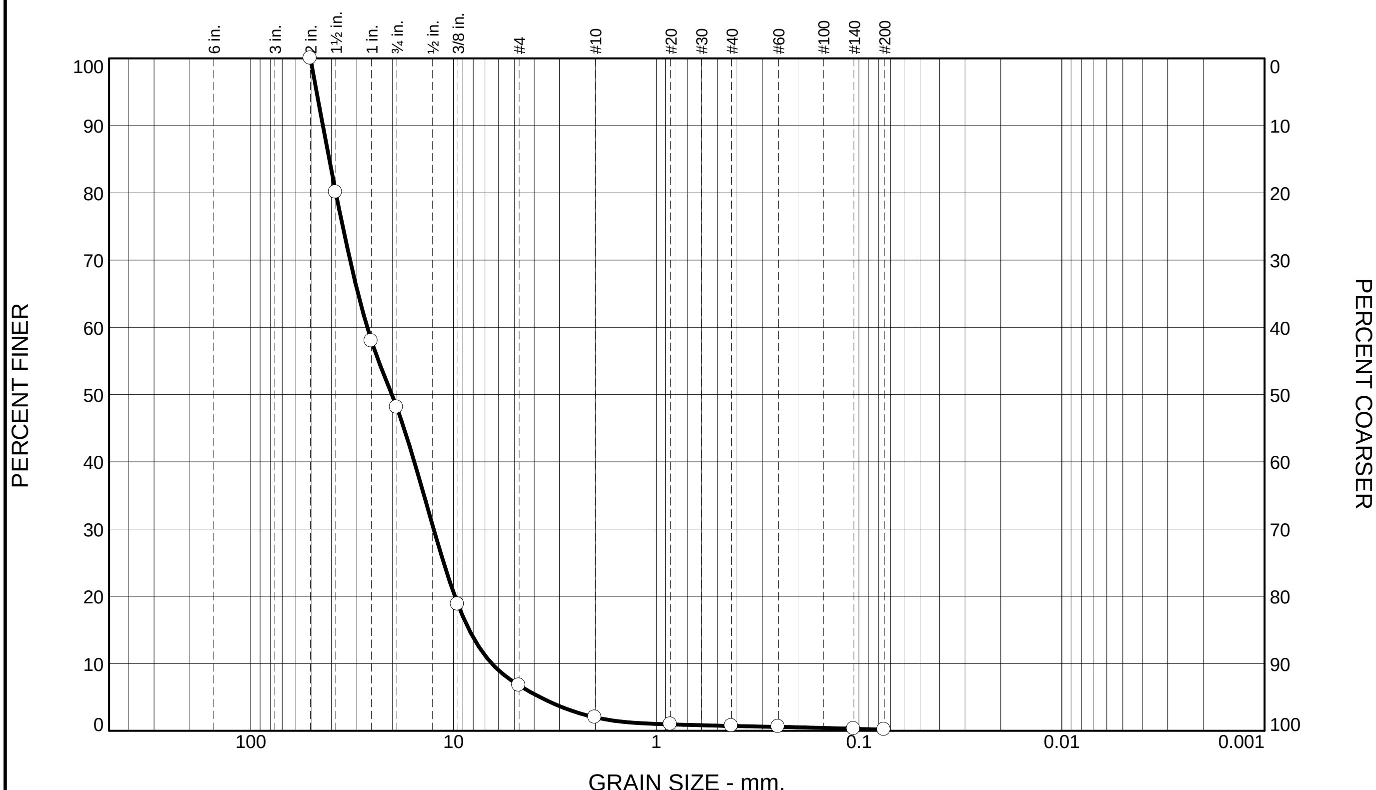
Source of Sample: B-6 **Depth:** 30-31.5
Sample Number: S-04

Date: 2-1-19

Client: AECOM
Project: Klamath River Dam Removal Project
60537920
Project No: 2301-069.0 **Figure**

Tested By: JH **Checked By:** JH

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	52	41	5	1	1	0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2	100		
1.5	80		
1	58		
3/4	48		
3/8	19		
#4	7		
#10	2		
#20	1		
#40	1		
#60	1		
#140	0		
#200	0.2		

* (no specification provided)

Soil Description

Gray gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 44.0963 D_{85}= 41.0141 D_{60}= 26.6693
D_{50}= 20.1288 D_{30}= 12.5388 D_{15}= 8.3745
D_{10}= 6.4815 C_u= 4.11 C_c= 0.91

Classification

USCS= GP AASHTO=

Remarks

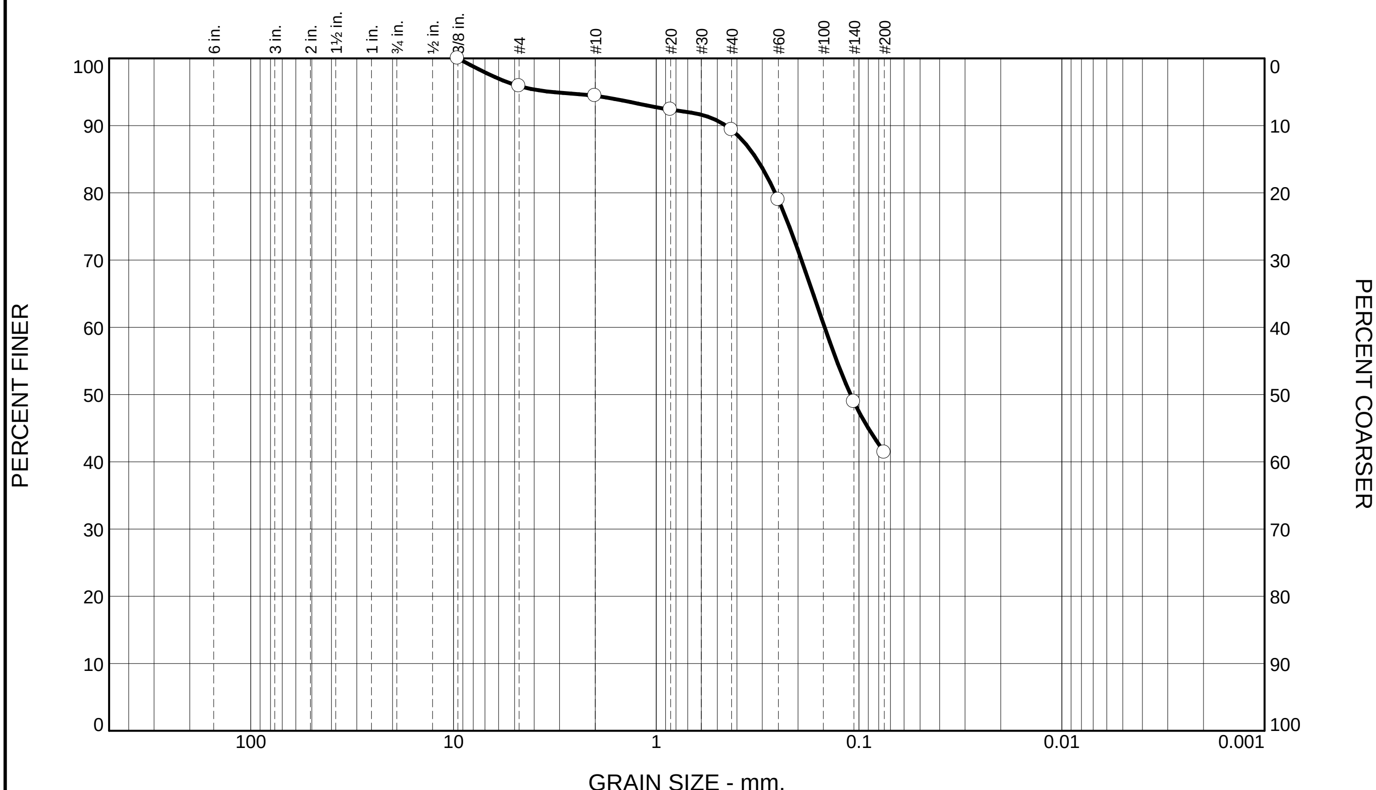
Source of Sample: B-6 **Depth:** 45-46.5
Sample Number: S-06

Date: 2-1-19

Client: AECOM
Project: Klamath River Dam Removal Project 60537920
Project No: 2301-069.0 **Figure**

Tested By: JH **Checked By:** JH

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	4	2	5	48	41	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8	100		
#4	96		
#10	94		
#20	92		
#40	89		
#60	79		
#140	49		
#200	41		

* (no specification provided)

Soil Description

Gray clayey sand with organics

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.4544 D_{85}= 0.3191 D_{60}= 0.1478
D_{50}= 0.1102 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO=

Remarks

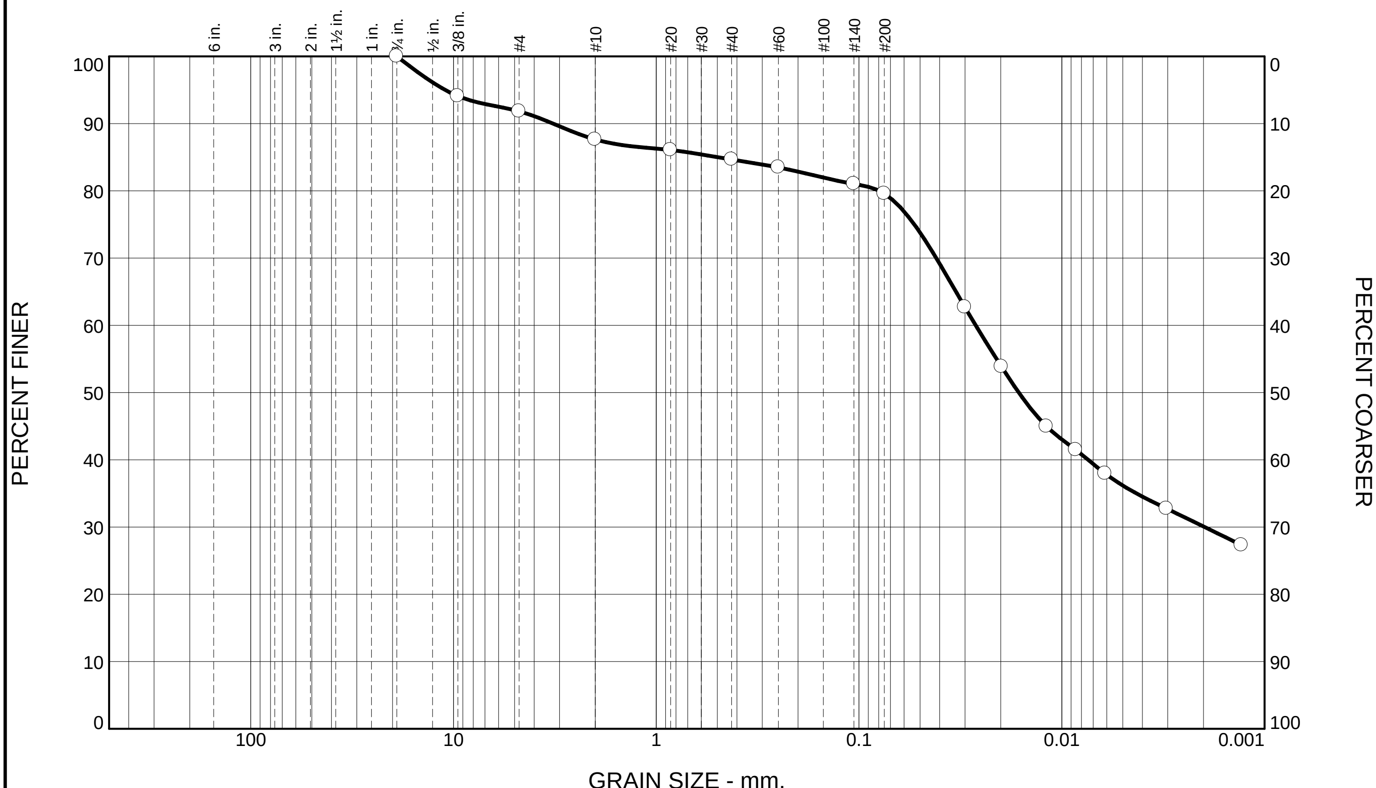
Source of Sample: B-7 **Depth:** 16.5-18
Sample Number: S-02

Date: 2-1-19

Client: AECOM
Project: Klamath River Dam Removal Project
60537920
Project No: 2301-069.0 **Figure**

Tested By: JH **Checked By:** JH

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	8	4	3	5	44	36

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100		
3/8	94		
#4	92		
#10	88		
#20	86		
#40	85		
#60	83		
#140	81		
#200	80		
0.0301 mm.	63		
0.0198 mm.	54		
0.0119 mm.	45		
0.0085 mm.	41		
0.0061 mm.	38		
0.0030 mm.	33		
0.0013 mm.	27		

* (no specification provided)

Soil Description

Black silt with sand and organics

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 3.2357 D_{85}= 0.4971 D_{60}= 0.0266
D_{50}= 0.0163 D_{30}= 0.0020 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO=

Remarks

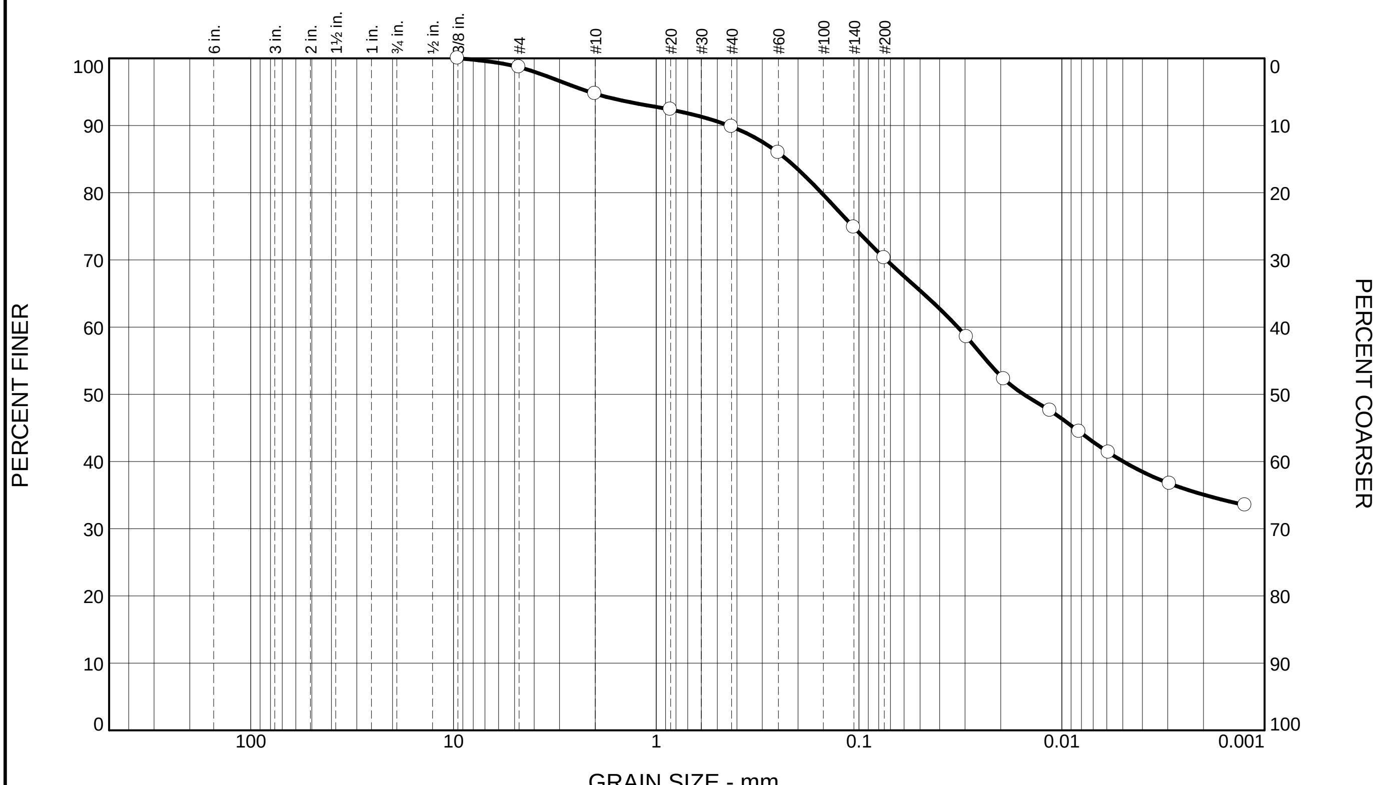
Source of Sample: B-8 **Depth:** 16-17.5
Sample Number: S-02

Date: 2-11-19

Client: AECOM
Project: Klamath River Dam Removal Project
60537920
Project No: 2301-069.0 **Figure**

Tested By: JH **Checked By:** JH

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	1	4	5	20	30	40

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8	100		
#4	99		
#10	95		
#20	92		
#40	90		
#60	86		
#140	75		
#200	70		
0.0294 mm.	59		
0.0193 mm.	52		
0.0114 mm.	48		
0.0082 mm.	44		
0.0059 mm.	41		
0.0029 mm.	37		
0.0012 mm.	33		

* (no specification provided)

Soil Description

Brown sandy clay

Atterberg Limits

PL= 22 LL= 62 PI= 40

Coefficients

D_{90}= 0.4406 D_{85}= 0.2283 D_{60}= 0.0326
D_{50}= 0.0154 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CH AASHTO= A-7-6(27)

Remarks

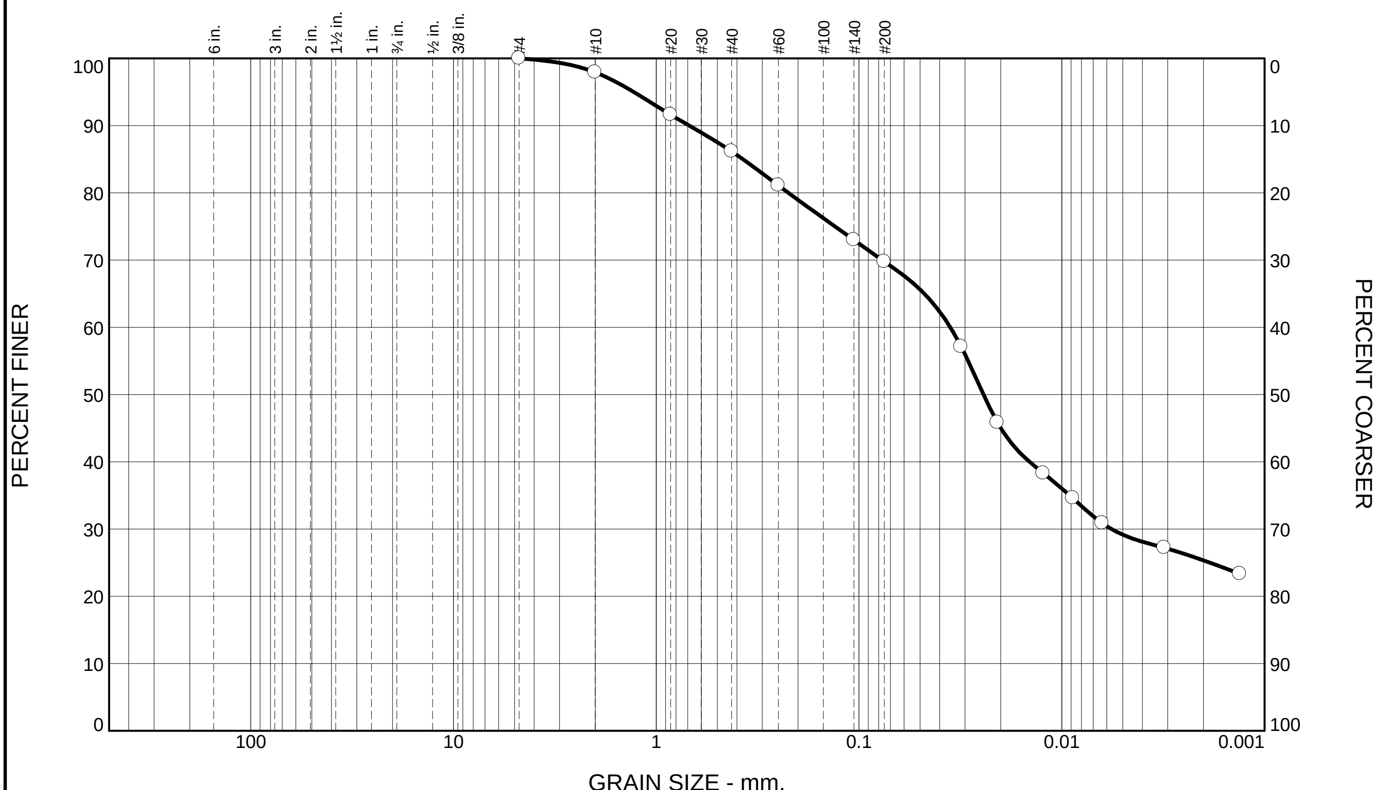
Source of Sample: B-14 **Depth:** 6.4-7.9
Sample Number: S-01 **Date:** 2-11-19

isi

Client: AECOM
Project: Klamath River Dam Removal Project
60537920
Project No: 2301-069.0 **Figure**

Tested By: JH **Checked By:** JH

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	2	12	16	41	29

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100		
#10	98		
#20	92		
#40	86		
#60	81		
#140	73		
#200	70		
0.0313 mm.	57		
0.0207 mm.	46		
0.0123 mm.	38		
0.0088 mm.	35		
0.0063 mm.	31		
0.0031 mm.	27		
0.0013 mm.	23		

* (no specification provided)

Soil Description

Brown sandy silt

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.6889 D_{85}= 0.3736 D_{60}= 0.0355
D_{50}= 0.0243 D_{30}= 0.0057 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO=

Remarks

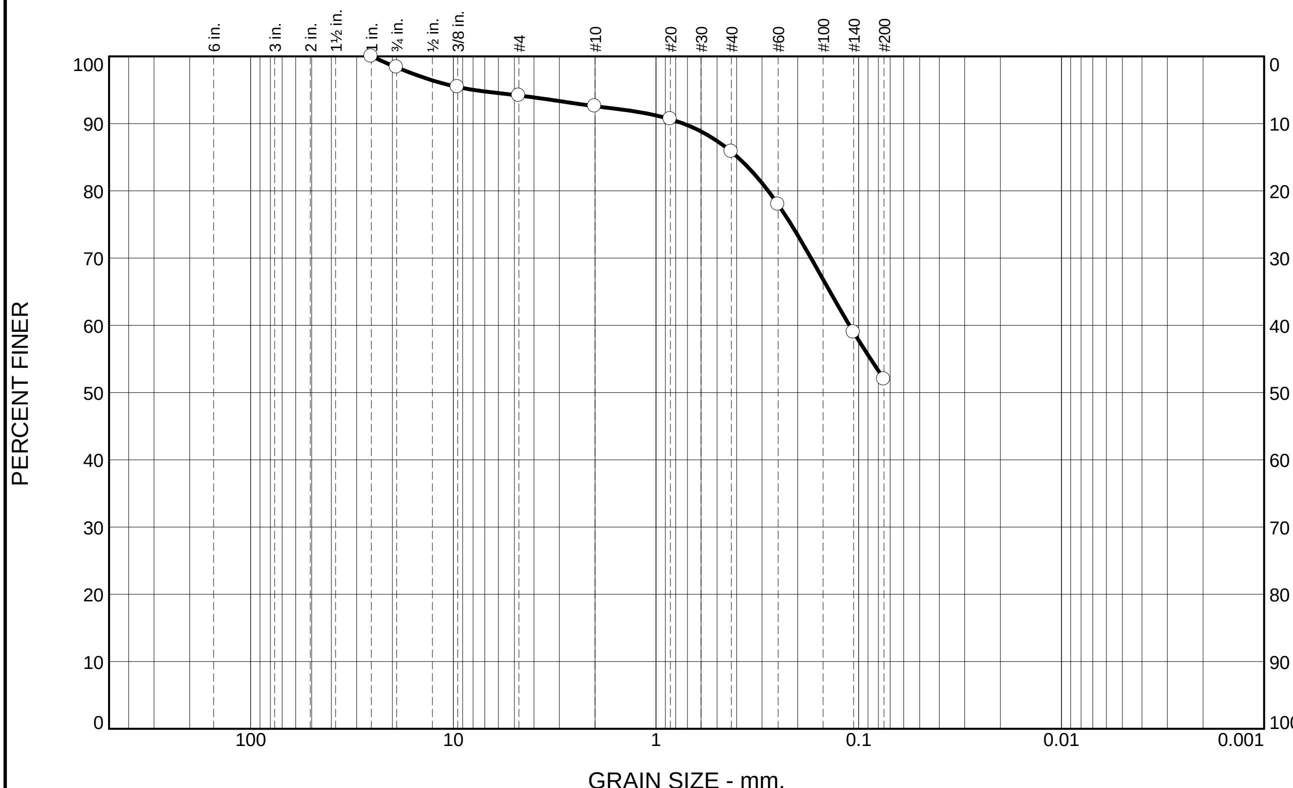
Source of Sample: B-19 **Depth:** 5-6.5
Sample Number: S-01

Date: 2-11-19

Client: AECOM
Project: Klamath River Dam Removal Project
60537920
Project No: 2301-069.0 **Figure**

Tested By: JH **Checked By:** JH

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	2	4	1	7	34	52	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1	100		
3/4	98		
3/8	95		
#4	94		
#10	93		
#20	91		
#40	86		
#60	78		
#140	59		
#200	52		

* (no specification provided)

Soil Description

Mottled grayish brown sandy clay

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.7332 D_{85}= 0.3954 D_{60}= 0.1112
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO=

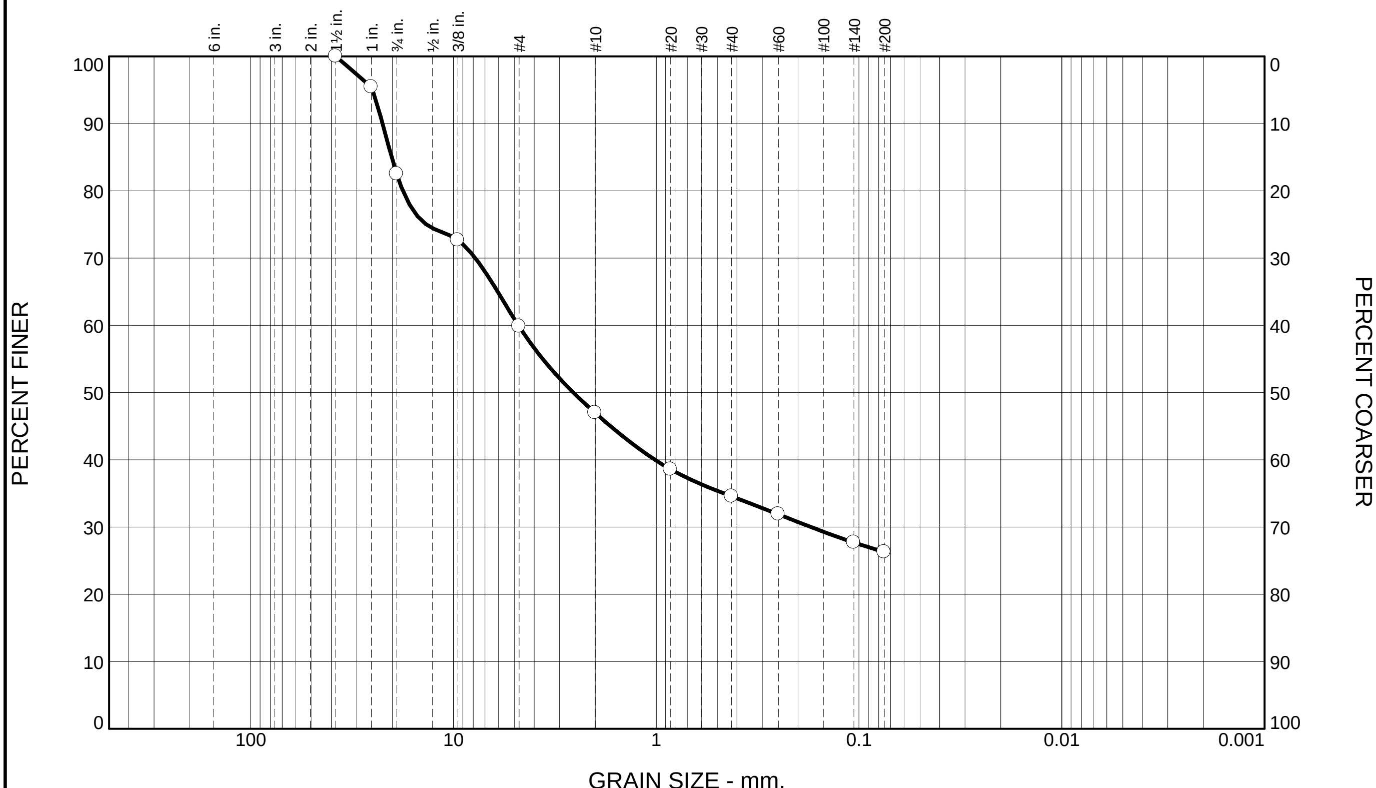
Remarks

Source of Sample: B-19 **Depth:** 15-16.5
Sample Number: S-03 **Date:** 2-1-19

Client: AECOM
Project: Klamath River Dam Removal Project
60537920
Project No: 2301-069.0 **Figure**

Tested By: JH **Checked By:** JH

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	18	22	13	12	9	26	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5	100		
1	95		
3/4	82		
3/8	73		
#4	60		
#10	47		
#20	39		
#40	35		
#60	32		
#140	28		
#200	26		

* (no specification provided)

Soil Description

Grayish brown clayey gravel with sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 22.3903 D_{85}= 20.1845 D_{60}= 4.7896
D_{50}= 2.5659 D_{30}= 0.1726 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= GC AASHTO=

Remarks

Source of Sample: B-19 **Depth:** 20-21.5
Sample Number: S-04

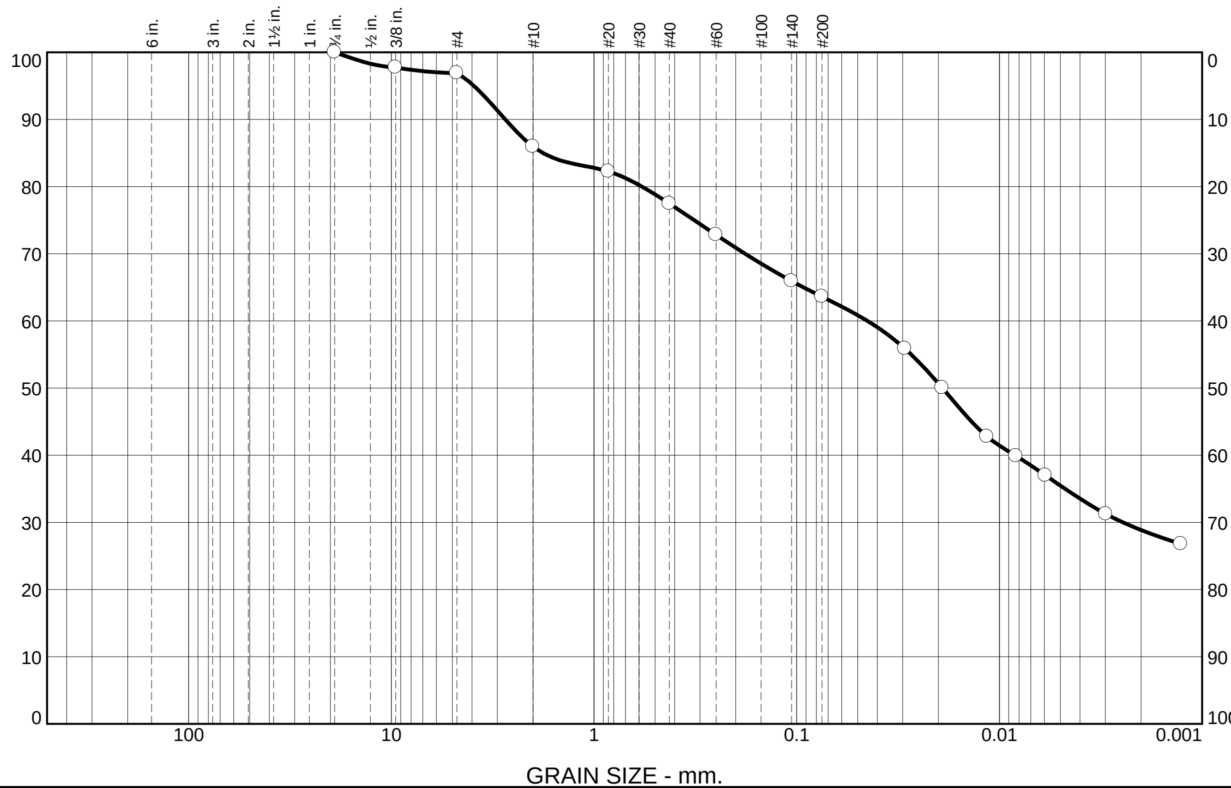
Date: 2-1-19

isi

Client: AECOM
Project: Klamath River Dam Removal Project 60537920
Project No: 2301-069.0 **Figure**

Tested By: JH **Checked By:** JH

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	3	11	9	13	29	35

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100		
3/8	98		
#4	97		
#10	86		
#20	82		
#40	77		
#60	73		
#140	66		
#200	64		
0.0292 mm.	56		
0.0191 mm.	50		
0.0115 mm.	43		
0.0083 mm.	40		
0.0059 mm.	37		
0.0030 mm.	31		
0.0013 mm.	27		

* (no specification provided)

Soil Description

Brown sandy clay

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 2.7420 D_{85}= 1.7874 D_{60}= 0.0448
D_{50}= 0.0191 D_{30}= 0.0025 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO=

Remarks

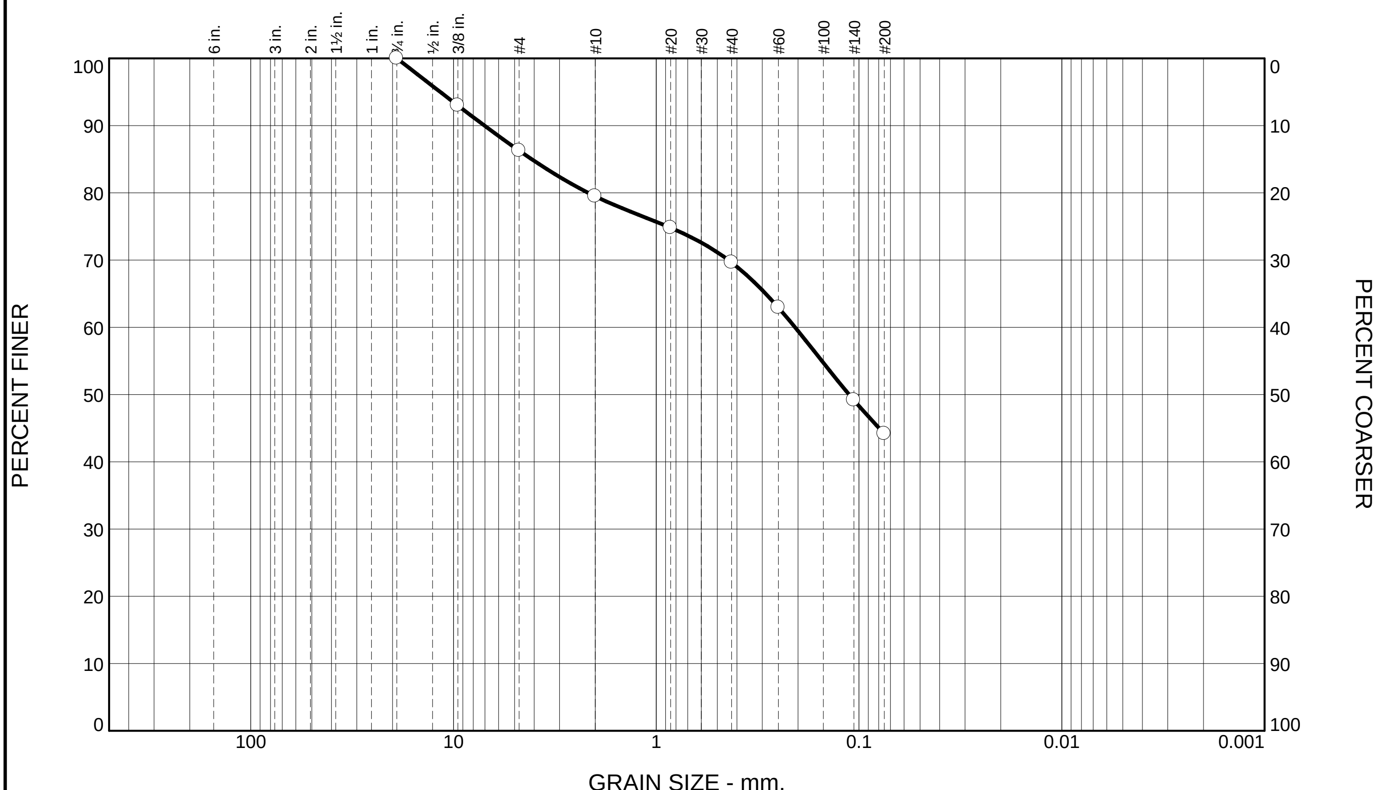
Source of Sample: B-20 **Depth:** 10-11.5
Sample Number: S-02

Date: 2-11-19

Client: AECOM
Project: Klamath River Dam Removal Project
60537920
Project No: 2301-069.0 **Figure**

Tested By: JH **Checked By:** JH

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	14	7	9	26	44	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100		
3/8	93		
#4	86		
#10	79		
#20	75		
#40	70		
#60	63		
#140	49		
#200	44		

* (no specification provided)

Soil Description

Grayish brown clayey sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 7.0418 D_{85}= 4.1173 D_{60}= 0.2068
D_{50}= 0.1119 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO=

Remarks

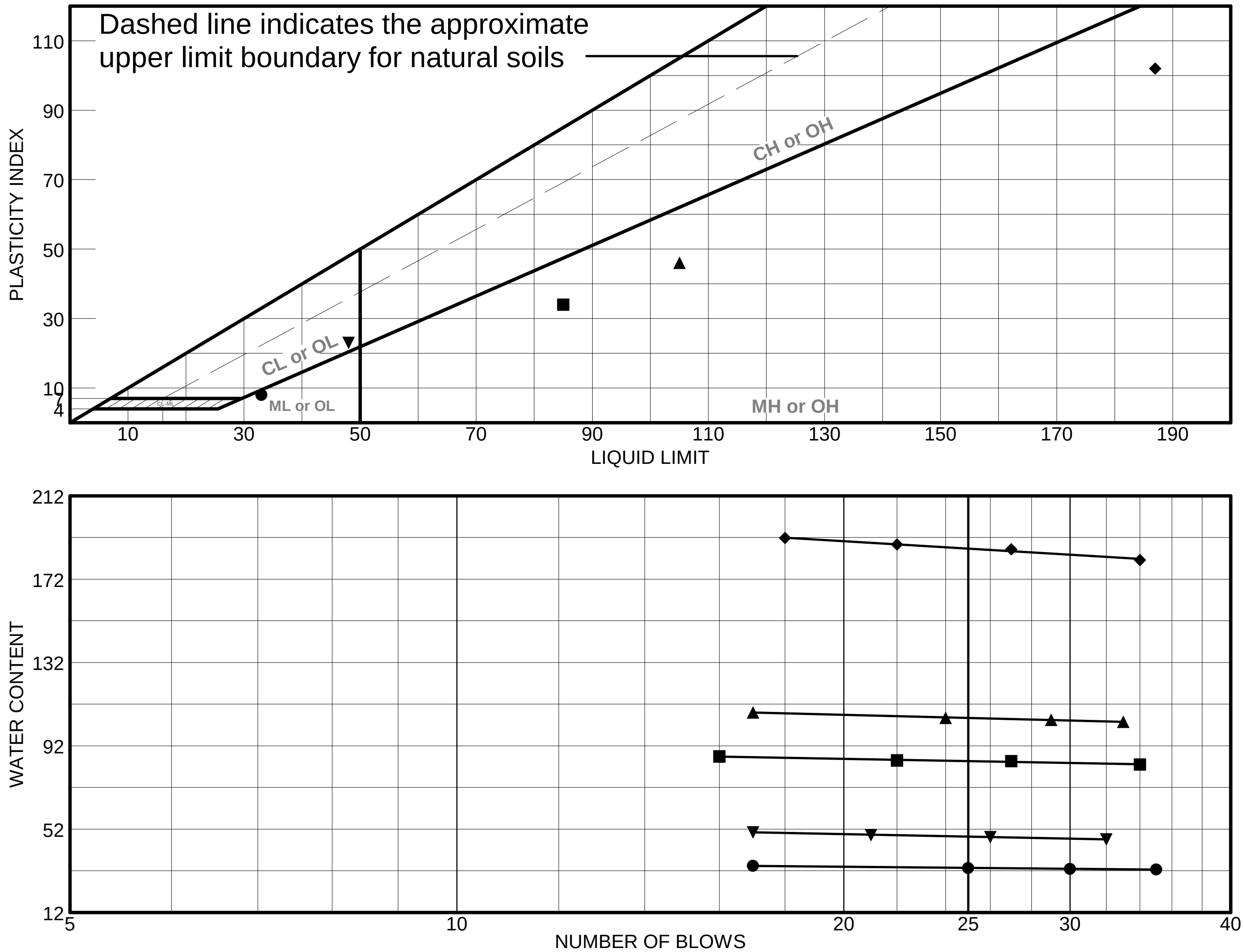
Source of Sample: B-20 **Depth:** 20-21.5
Sample Number: S-04 **Date:** 2-1-19

isi

Client: AECOM
Project: Klamath River Dam Removal Project
60537920
Project No: 2301-069.0 **Figure**

Tested By: JH **Checked By:** JH

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'

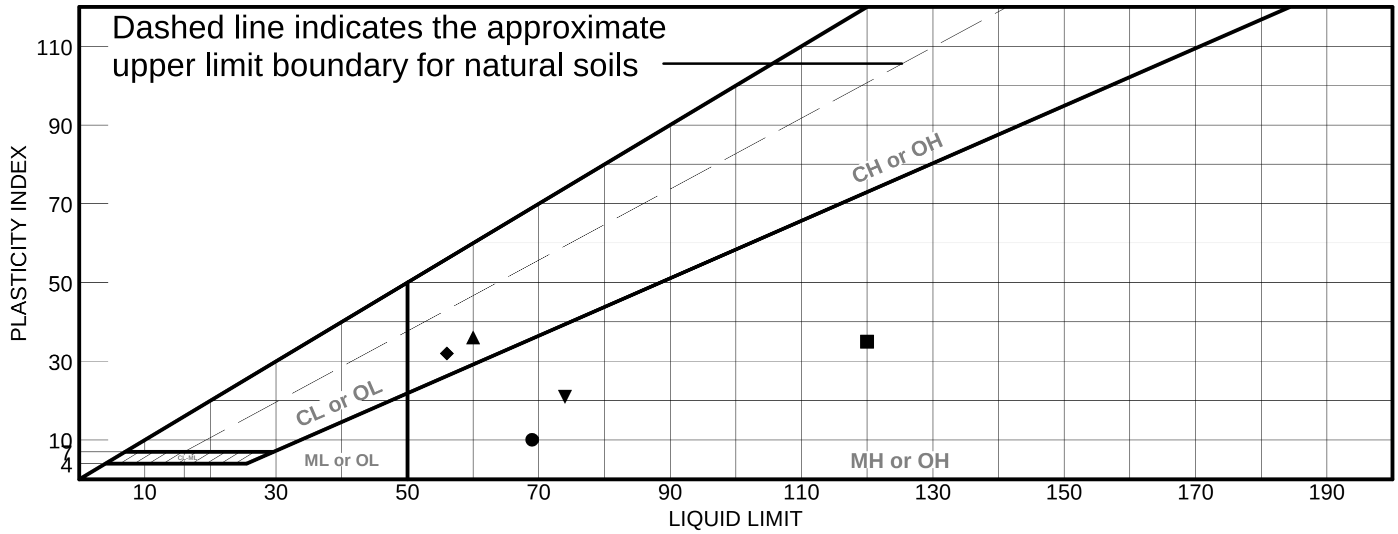
Remarks:
●
■
▲
◆
▼

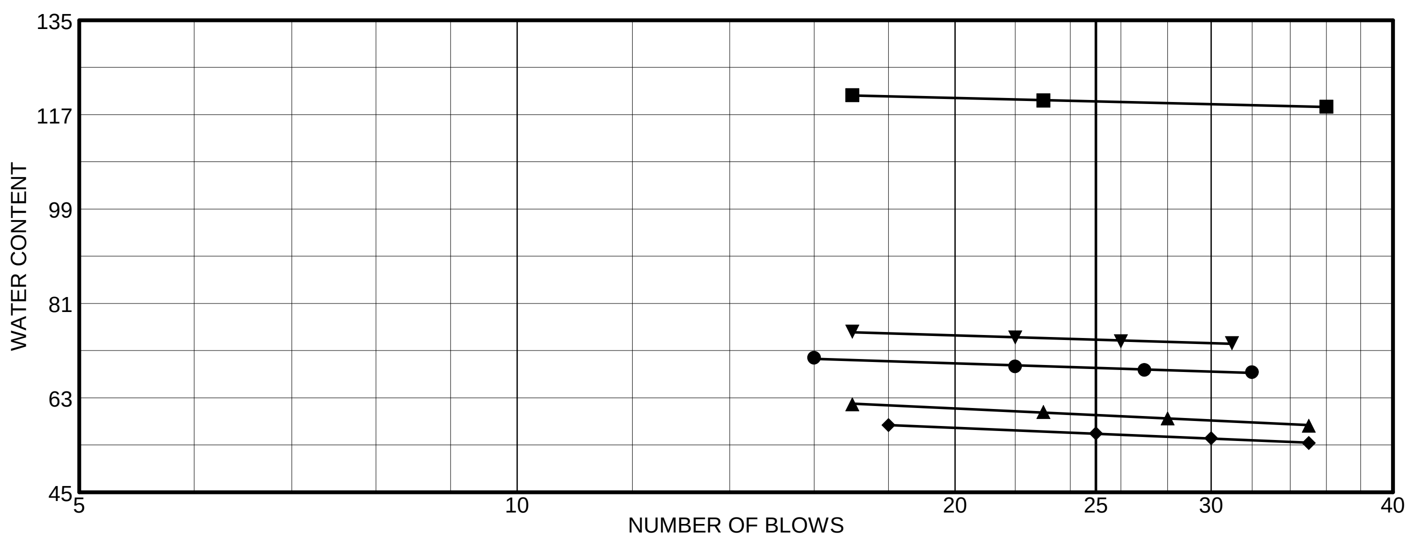
LIQUID AND PLASTIC LIMITS TEST REPORT

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")

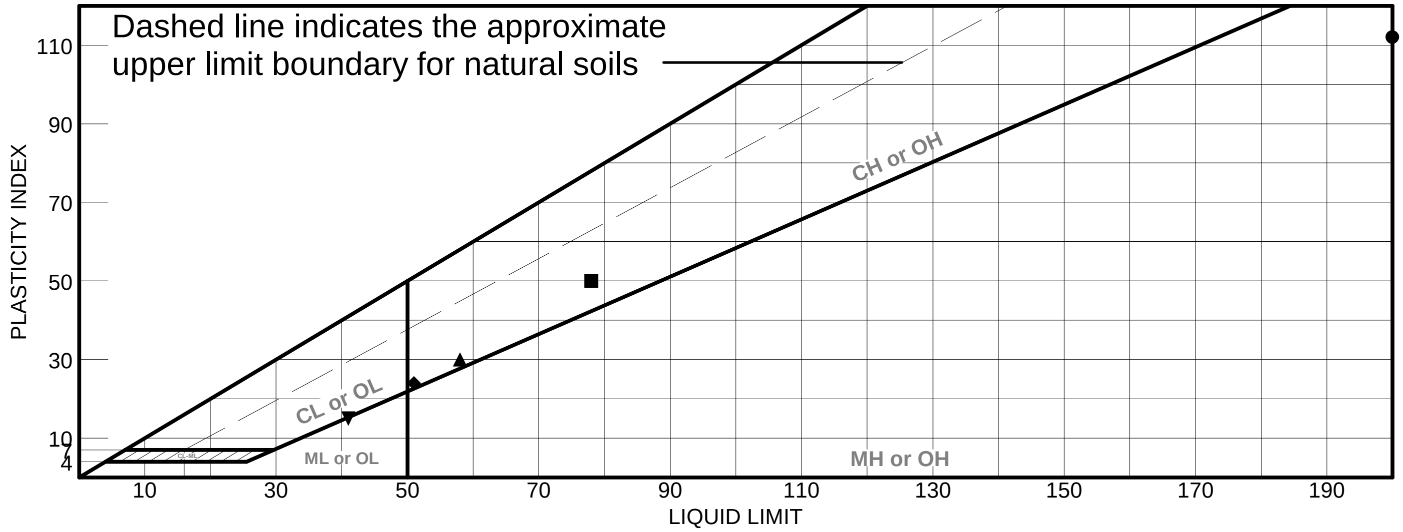
Remarks:
●
■
▲
◆
▼

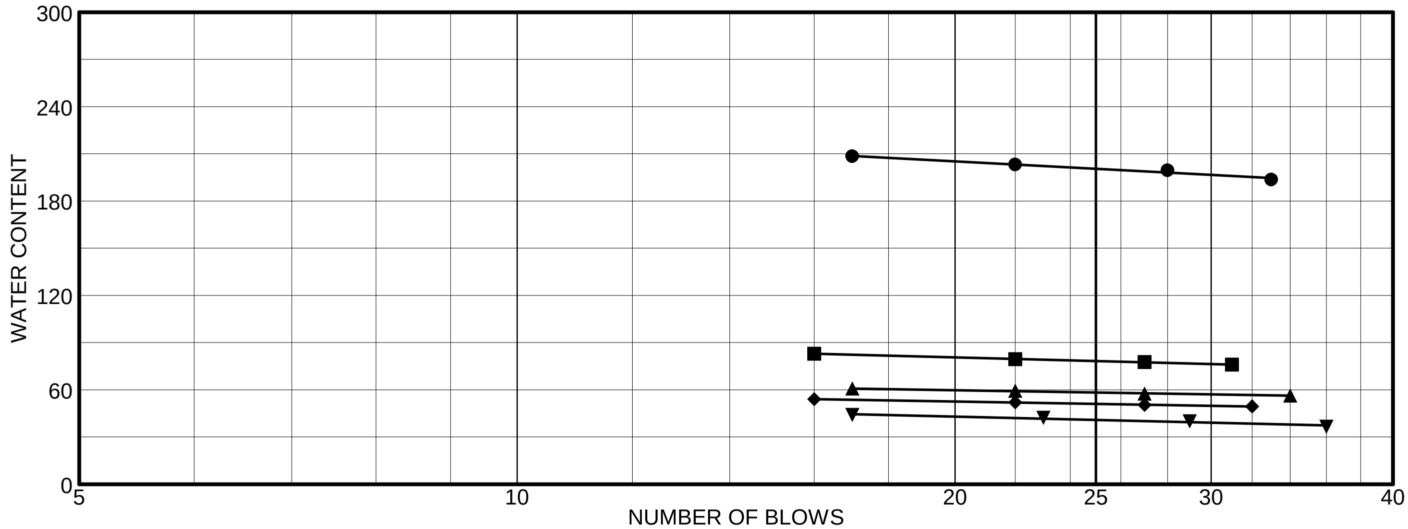
LIQUID AND PLASTIC LIMITS TEST REPORT

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'

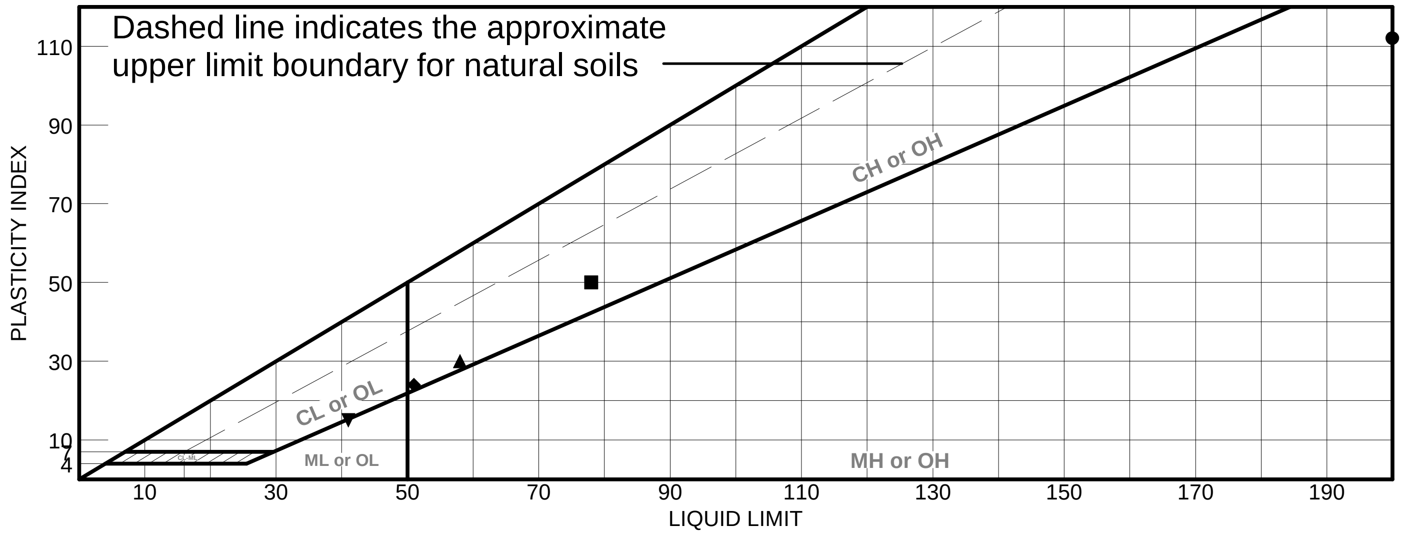
Remarks:
●
■
▲
◆
▼

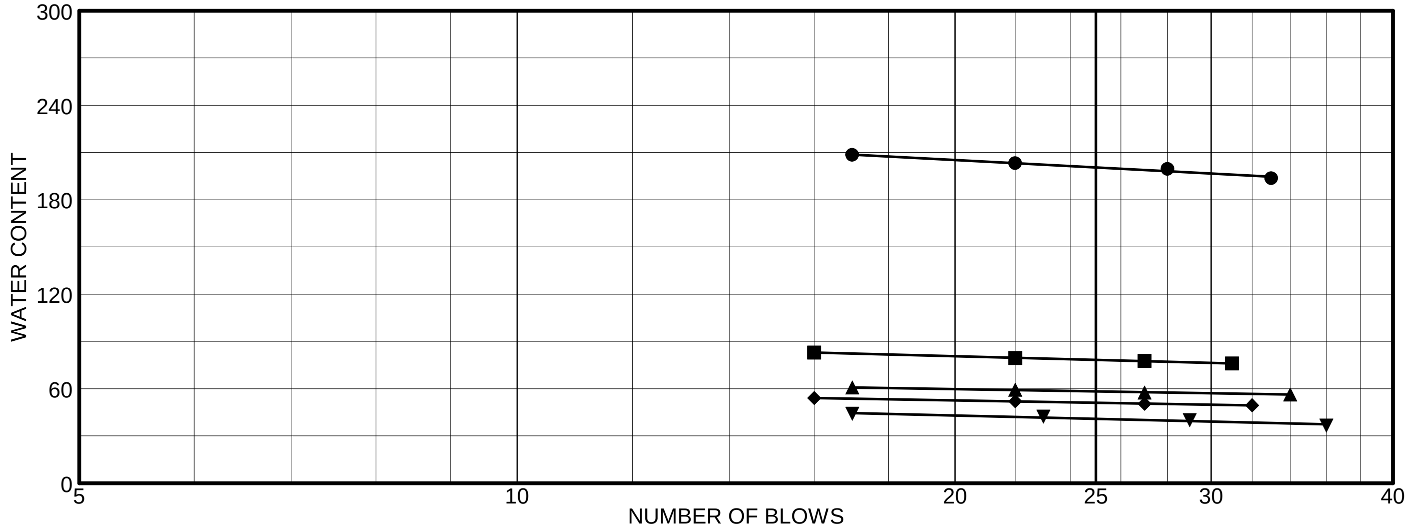
LIQUID AND PLASTIC LIMITS TEST REPORT

COOPER TESTING LABORATORY

Figure

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'

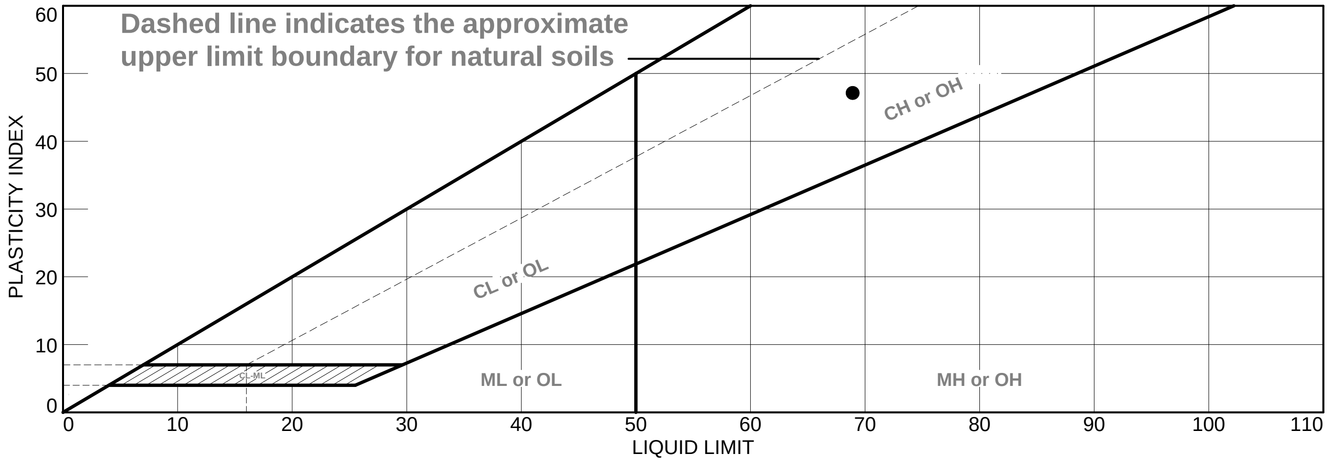
Remarks:
●
■
▲
◆
▼

LIQUID AND PLASTIC LIMITS TEST REPORT

COOPER TESTING LABORATORY

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Dark brown clay with sand	69	22	47			CH

Project No. 2301-069.0 **Client:** AECOM

Project: Klamath River Dam Removal Project 60537920

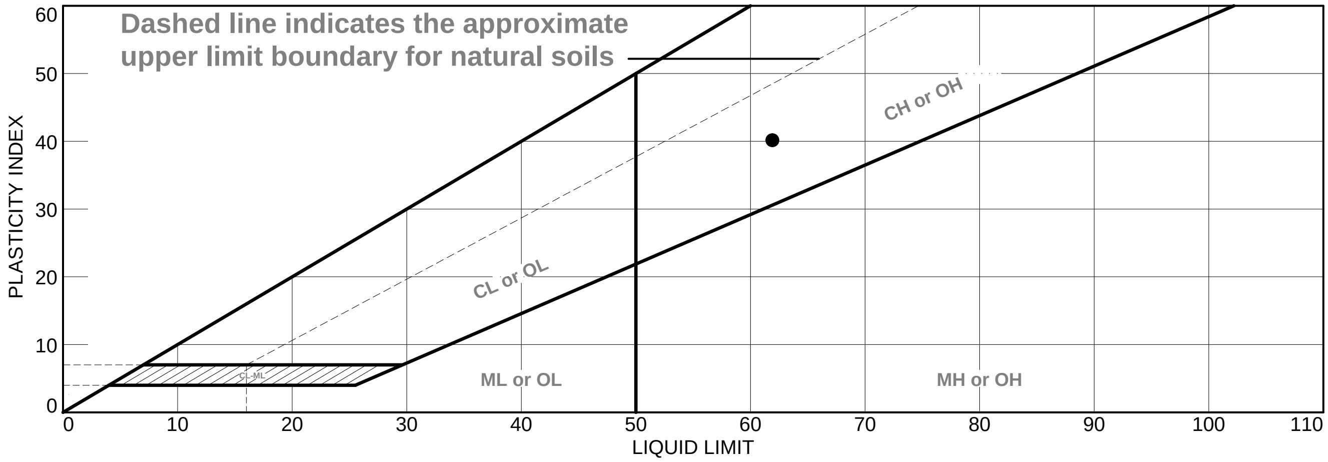
● **Source of Sample:** B-8 **Depth:** 13-14.5 **Sample Number:** S-01

Remarks:

Figure

Tested By: JH **Checked By:** JH

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Brown sandy clay	62	22	40	90	70	CH

Project No. 2301-069.0 **Client:** AECOM

Project: Klamath River Dam Removal Project
60537920

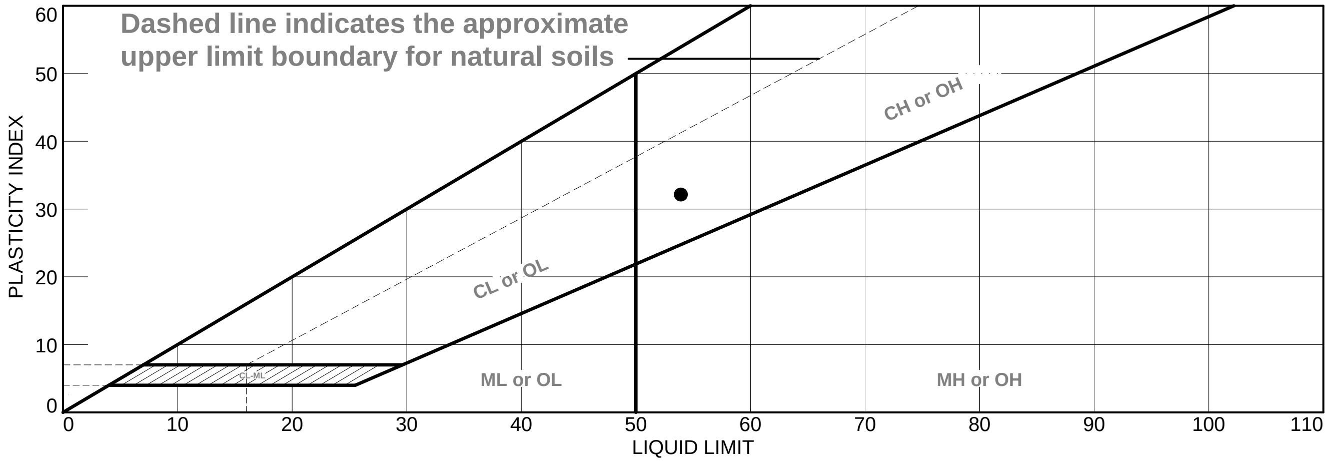
● **Source of Sample:** B-14 **Depth:** 6.4-7.9 **Sample Number:** S-01

Remarks:

Figure

Tested By: JH **Checked By:** JH

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Brown clay	54	22	32			CH

Project No. 2301-069.0 **Client:** AECOM

Project: Klamath River Dam Removal Project
60537920

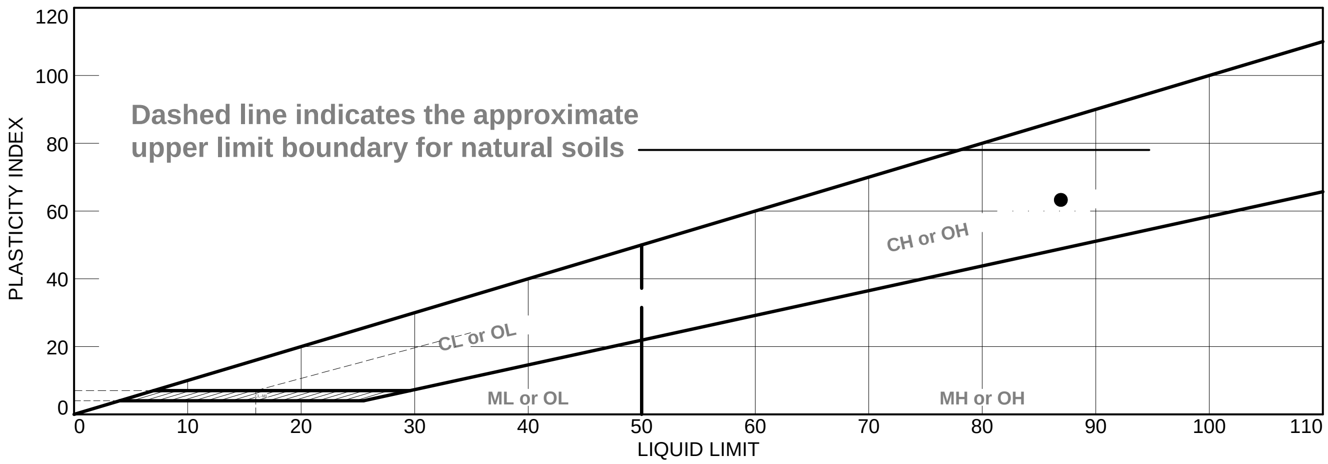
● **Source of Sample:** B-19 **Depth:** 10-11.5 **Sample Number:** S-02

Remarks:

Figure

Tested By: JH **Checked By:** JH

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Brown clay	87	24	63			CH

Project No. 2301-069.0 **Client:** AECOM

Project: Klamath River Dam Removal Project
60537920

● **Source of Sample:** B-20 **Depth:** 5-6.5 **Sample Number:** S-01

Remarks:

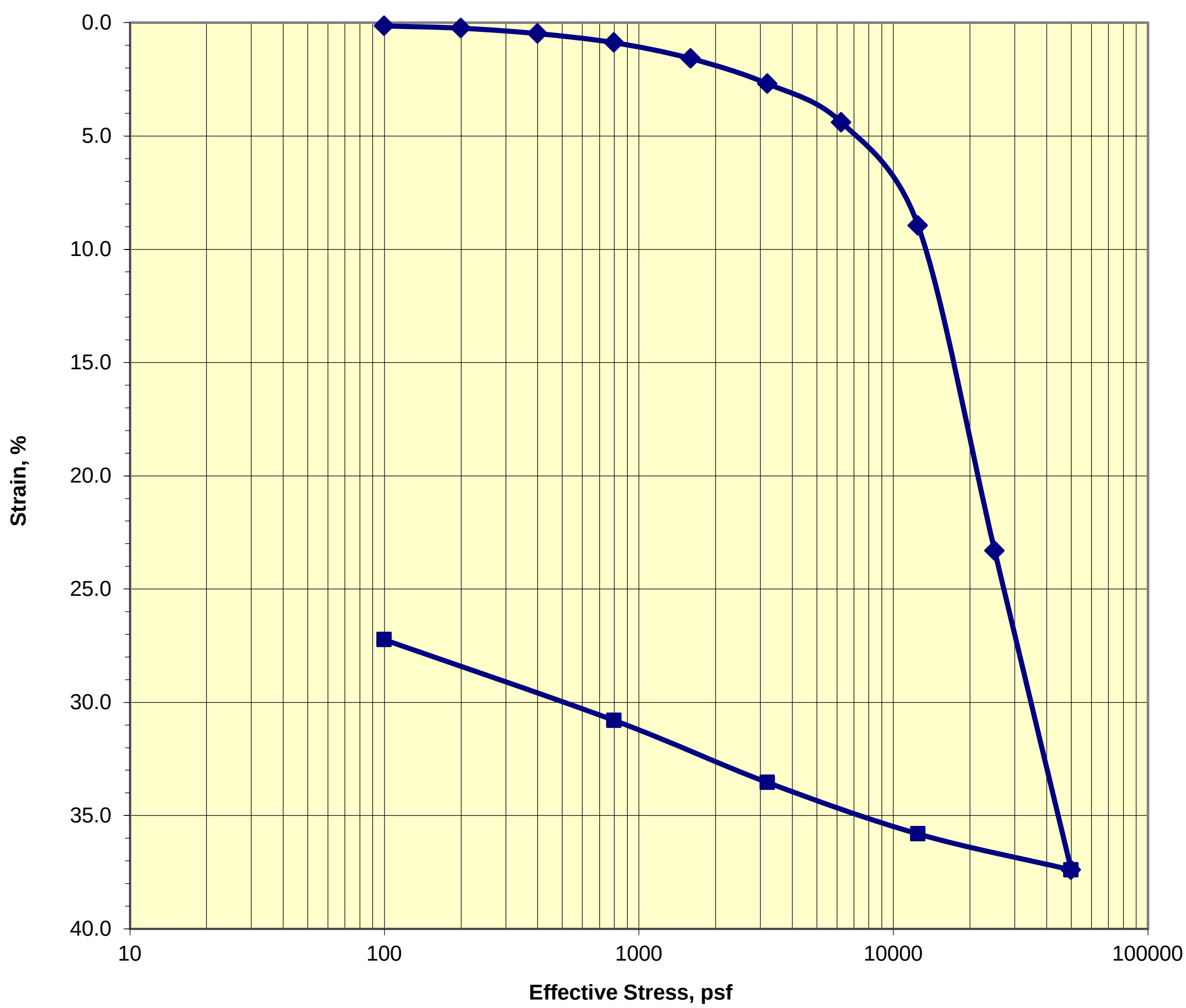
Figure

Tested By: JH **Checked By:** JH

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

Strain-Log-P Curve



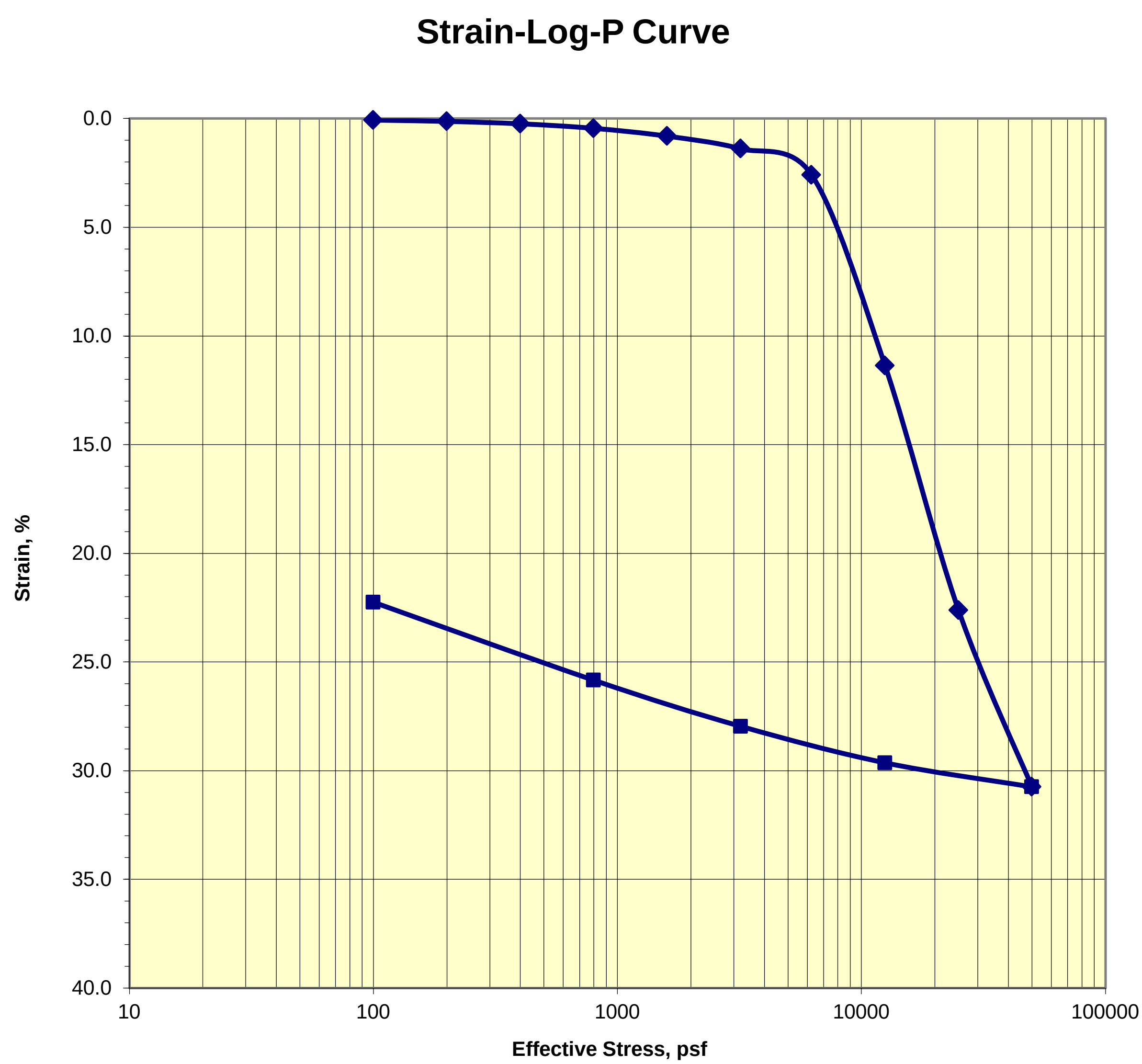
Assumed Gs 2.6	**Initial**	**Final**
Moisture %:	149.5	104.4
Dry Density, pcf:	32.1	43.7
Void Ratio:	4.058	2.715
% Saturation:	95.8	100.0

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

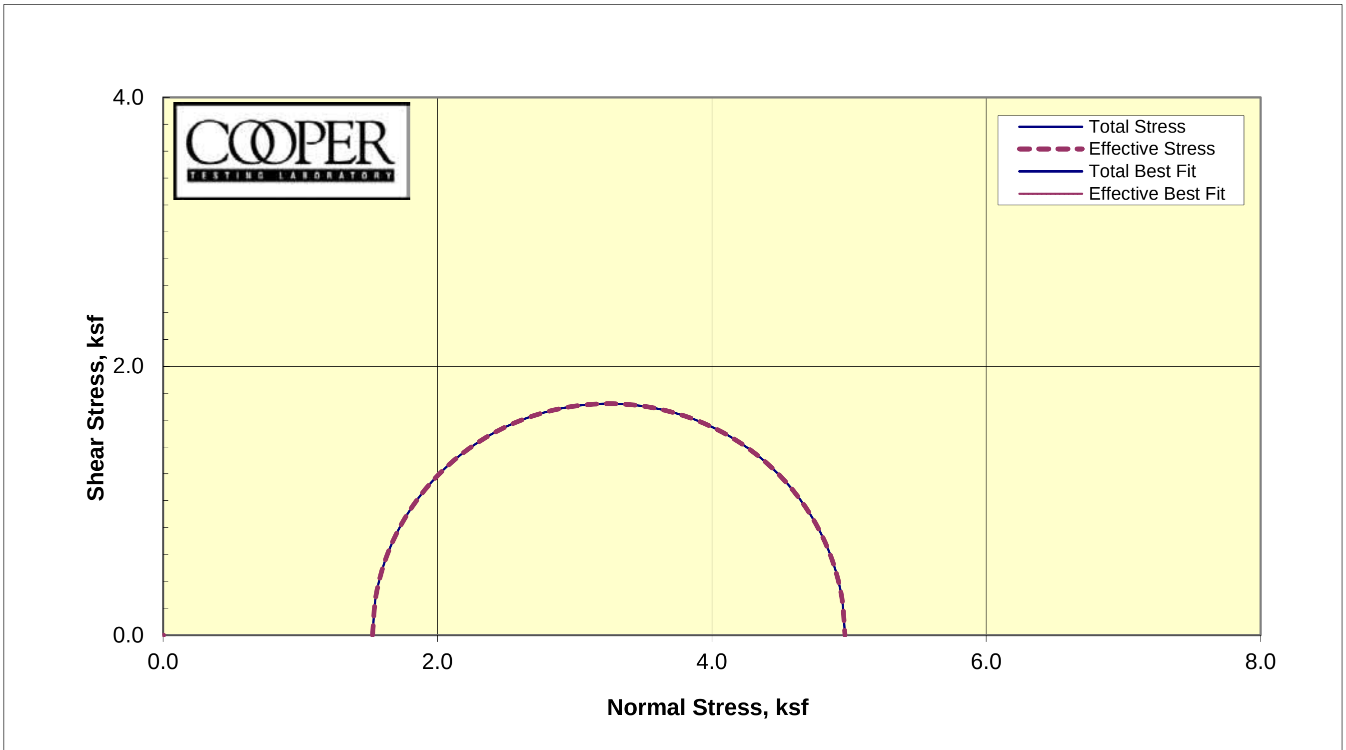


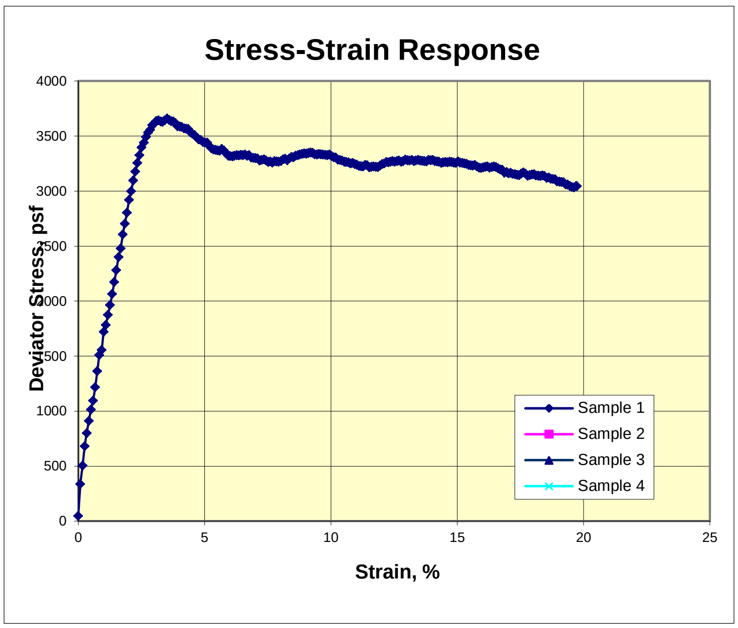
Assumed Gs 2.6	Initial	Final
Moisture %:	88.4	60.3
Dry Density, pcf:	48.6	63.2
Void Ratio:	2.340	1.568
% Saturation:	98.2	100.0

Remarks:

Triaxial Unconsolidated-Undrained

(ASTM D2850m)





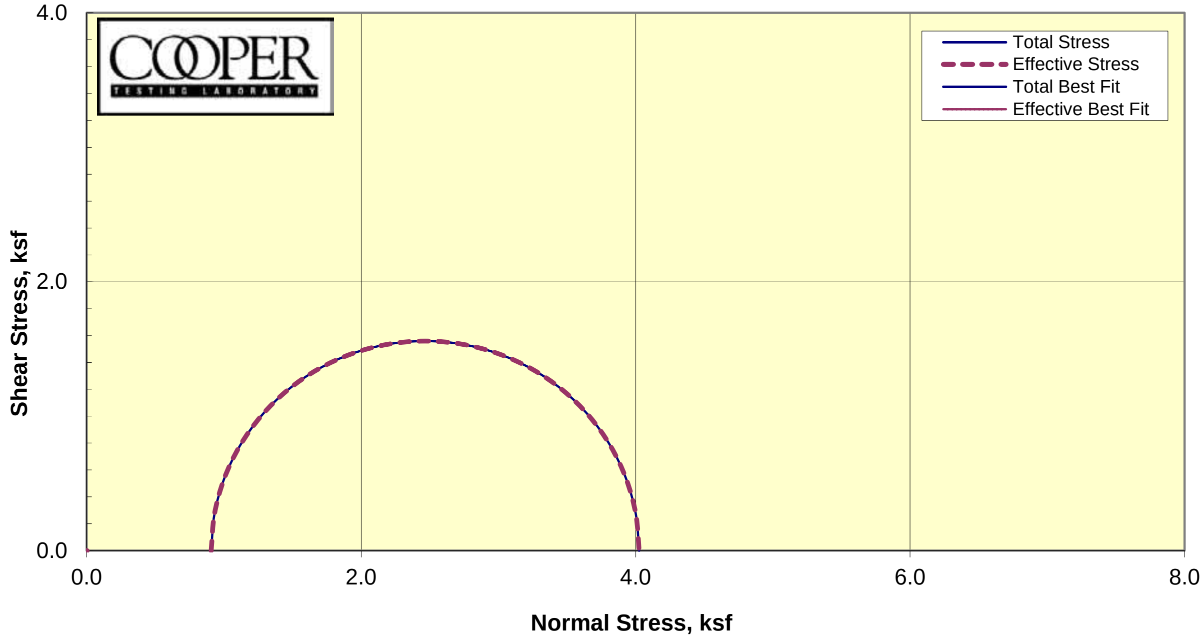
Sample:	1	2	3	4
MC, %	160.5			
Dry Dens, pcf	30.5			
Sat. %	95.9			
Void Ratio	4.519			
Diameter in	2.87			
Height, in	6.08			
	Final			
MC, %	163.5			
Dry Dens, pcf	31.1			
Sat. %	100.0			
Void Ratio	4.414			
Diameter, in	2.84			
Height, in	6.08			
Cell, psi	49.1			
BP, psi	38.5			
	Effective Stresses 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		

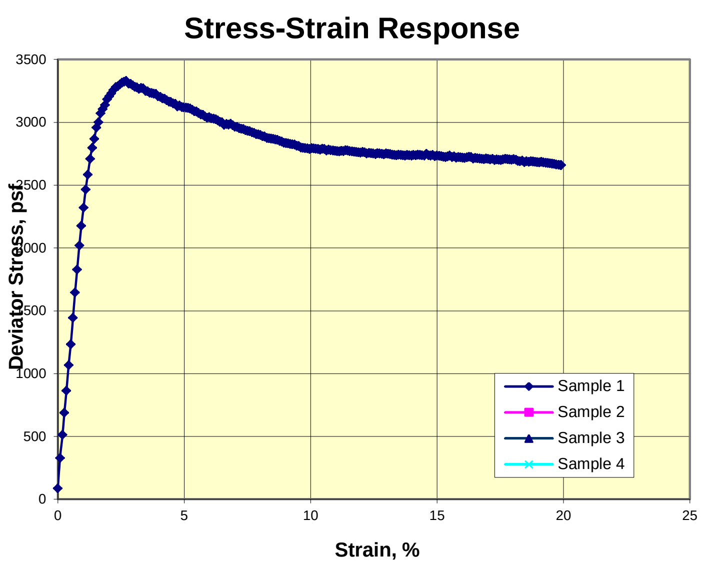
Job No.:	020-251	**Date:**	5/24/2018
Client:	AECOM		BY:MD/DC
Project:	60537920		
Sample 1)	BC-04_S-10 @ 52.5(Tip-18") Bluish Gray CLAY (Silty)		
Sample 2)			
Sample 3)			
Sample 4)			

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)

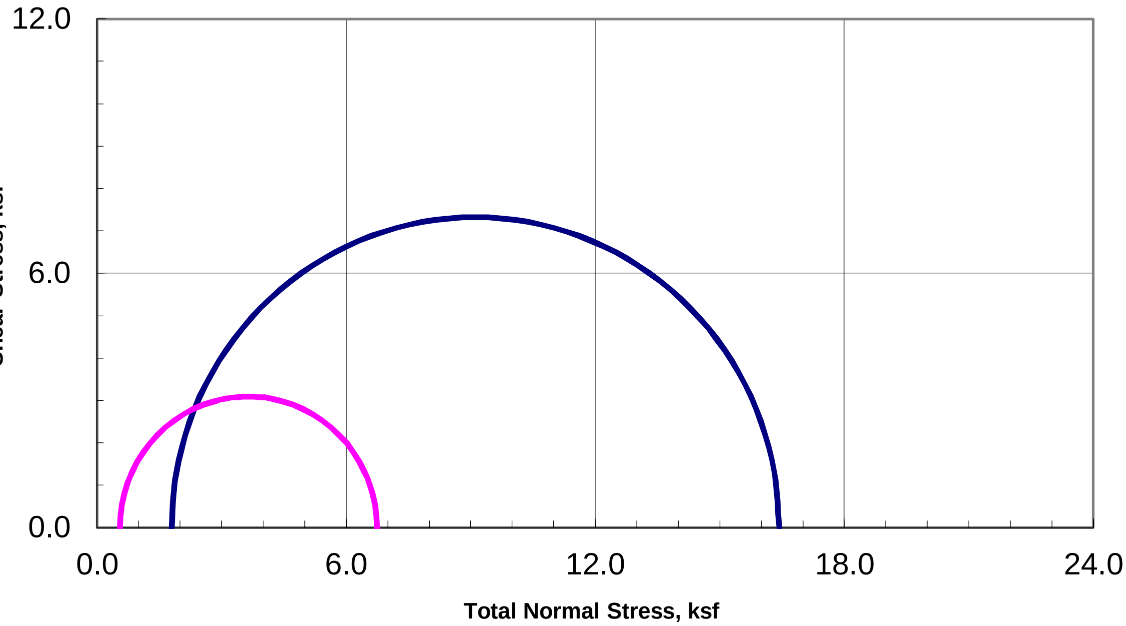
Sample 4)

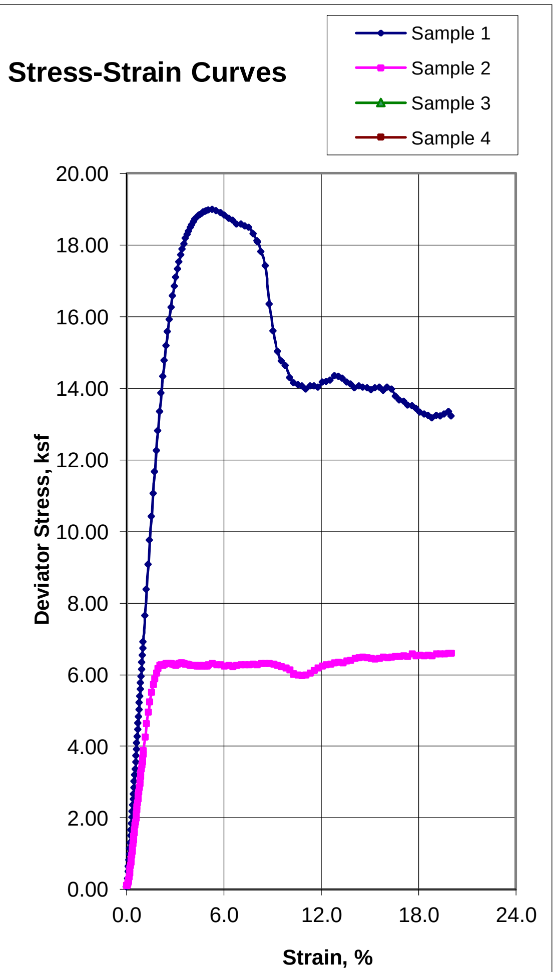
REMARKS: Strengths picked at 5% strain.

*Sample was back-pressure saturated prior to shear.

Cooper Testing Labs, Inc.
937 Commercial Street
Palo Alto, CA 94303

Unconsolidated-Undrained Triaxial Test
ASTM D2850





Sample Data				
	1	2	3	4
Moisture %	76.6	34.4		
Dry Den,pcf	48.3	70.8		
Void Ratio	2.363	1.293		
Saturation %	84.3	69.3		
Height in	6.06	6.04		
Diameter in	2.86	2.85		
Cell psi	12.4	3.8		
Strain %	10.00	10.00	10.00	10.00
Deviator, ksf	14.642	6.188		
Rate %/min	1.00	1.00		
in/min	0.061	0.060		
Job No.:	**020-272**			
Client:	**AECOM**			
Project:	**60537920**			
Boring:	BC-13	BC-14		
Sample:	S04	S02		
Depth ft:	22(Tip-12')	7(Tip-1")		

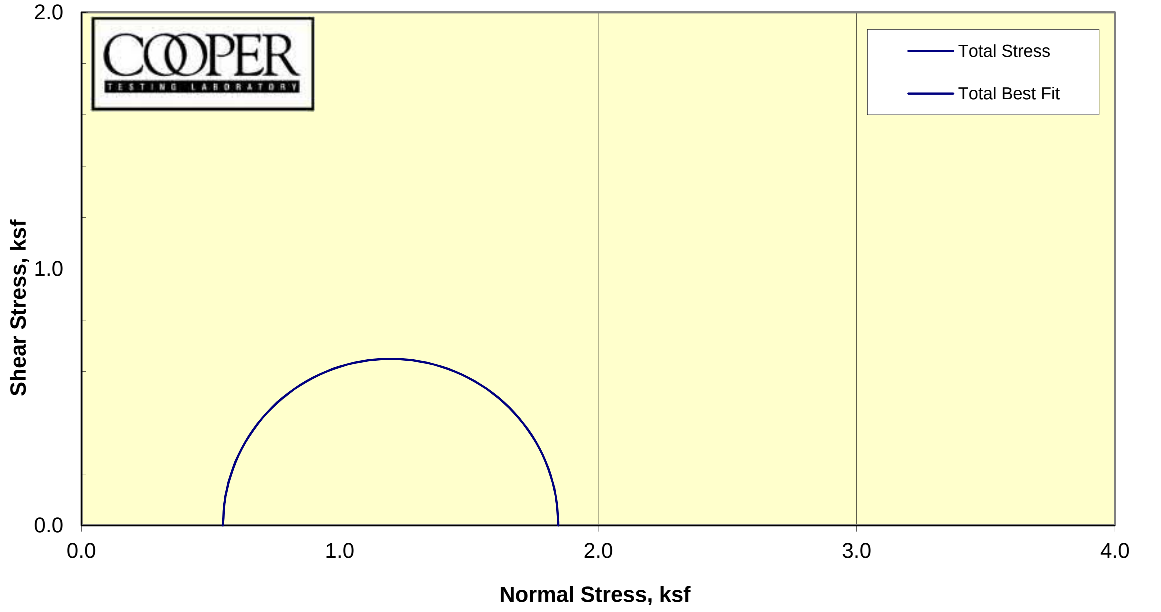
Visual Soil Description

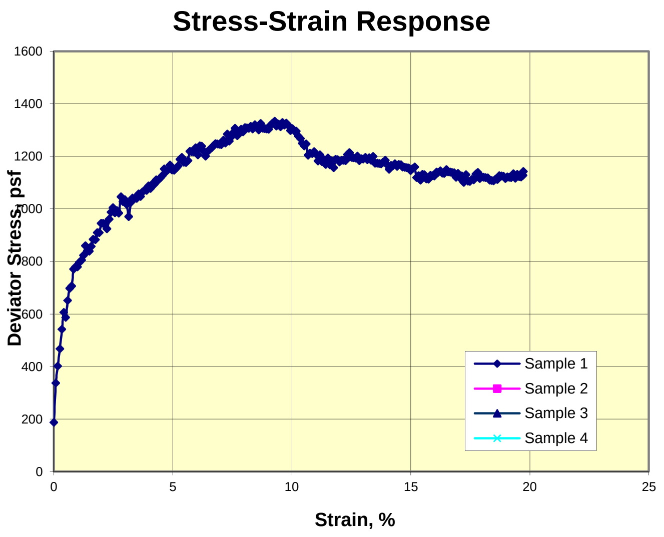
Sample #	
1	Olive Brown CLAY w/ Sand
2	Light Yellowish Brown Sandy CLAY w/ Claystone
3	
4	

Remarks:

Note: Strengths are picked at the peak deviator stress or 15% strain which ever occurs first per ASTM D2850.

Triaxial Unconsolidated-Undrained
(ASTM D2850m)





Sample:	1	2	3	4
MC, %	21.9			
Dry Dens, pcf	77.6			
Sat. %	52.3			
Void Ratio	1.090			
Diameter in	2.87			
Height, in	6.09			
	Final			
MC, %	39.9			
Dry Dens, pcf	79.6			
Sat. %	100.0			
Void Ratio	1.038			
Diameter, in	2.84			
Height, in	6.09			
Cell, psi	92.8			
BP, psi	89.0			
	Effective Stresses At:			
Strain, %	10.0			
Deviator ksf	1.299			
Excess PP	0.000			
Sigma 1	1.846			
Sigma 3	0.547			
P, ksf	1.196			
Q, ksf	0.649			
Stress Ratio	3.373			
Rate in/min	0.0600			
Total C	N/A	ksf		
Total Phi	N/A	Degrees		
Eff. C	N/A	ksf		
Eff. Phi	N/A	Degrees		

Job No.: 020-272 **Date:** 12/19/2018

Client: AECOM BY:MD/DC

Project: 60537950

Sample 1) BC-13_S01 @ 7(Tip-4") Olive Brown Silty SAND (Weathered Rock)

Sample 2)

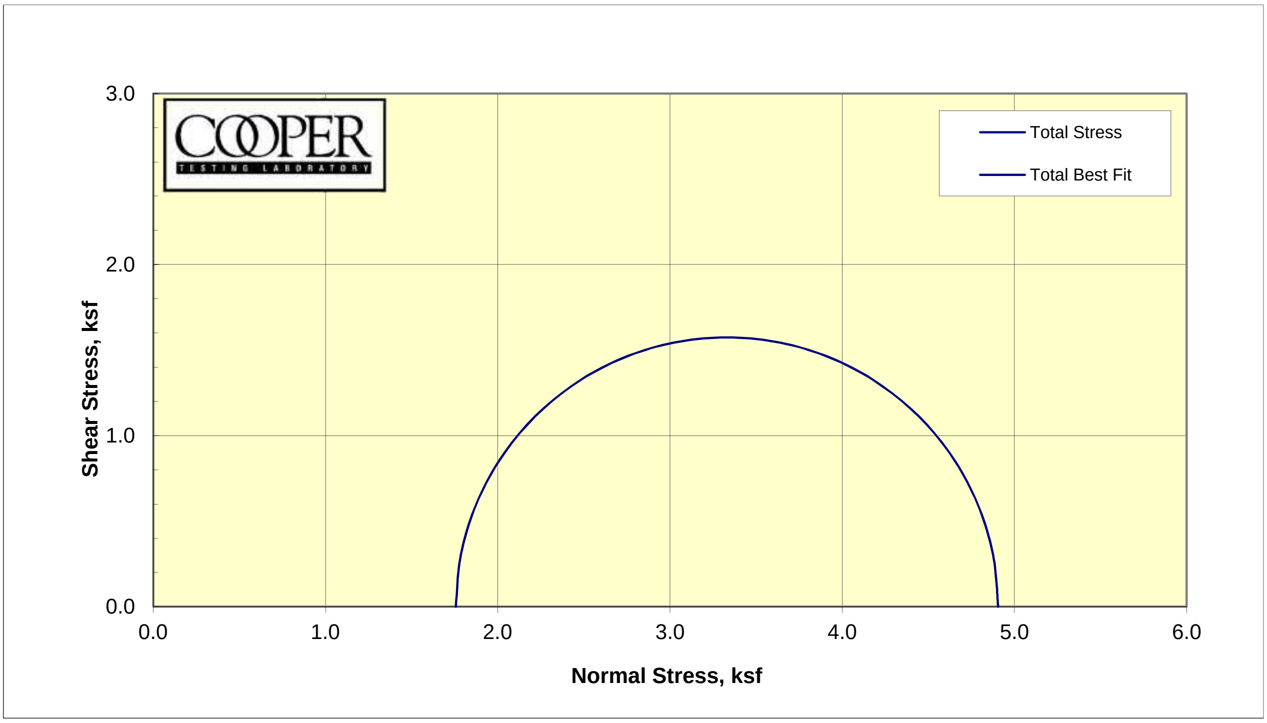
Sample 3)

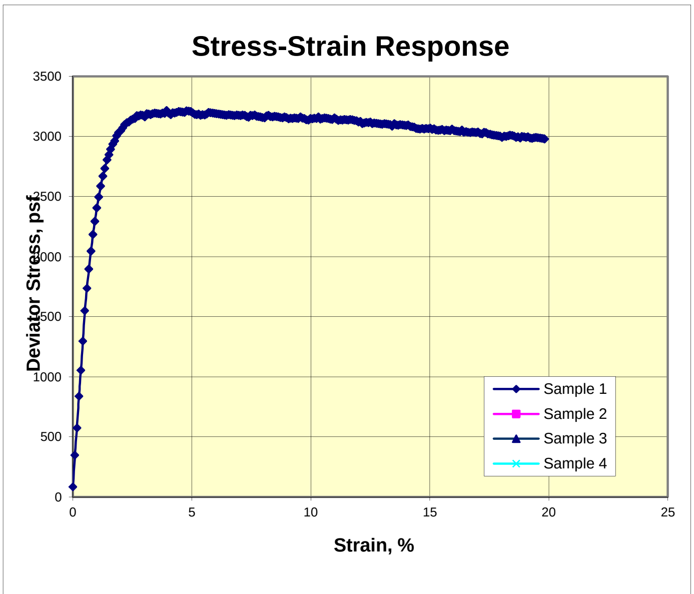
Sample 4)

REMARKS: Strengths picked at 10% strain.

*Sample was back-pressure saturated prior to shear.

Triaxial Unconsolidated-Undrained
(ASTM D2850m)





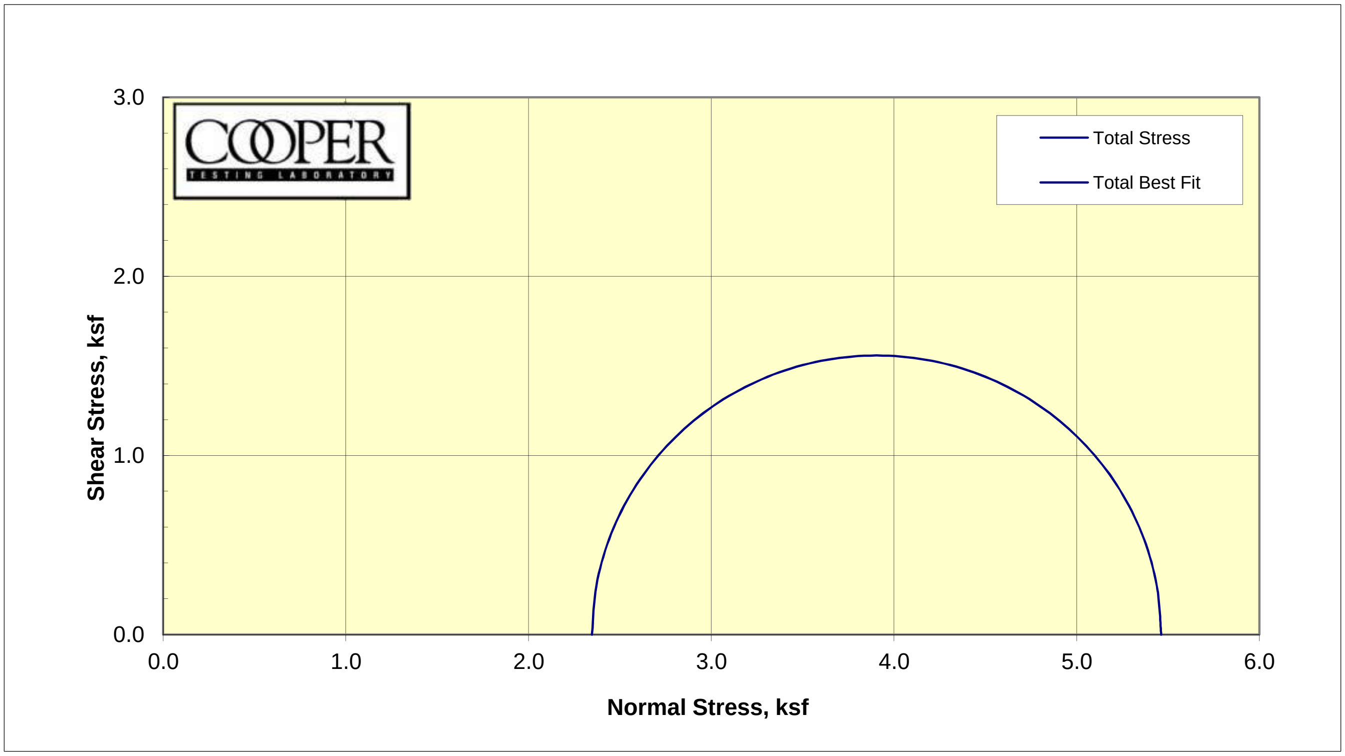
Sample:	1	2	3	4
MC, %	28.4			
Dry Dens, pcf	74.3			
Sat. %	62.4			
Void Ratio	1.184			
Diameter in	2.87			
Height, in	6.08			
	Final			
MC, %	42.6			
Dry Dens, pcf	77.0			
Sat. %	100.0			
Void Ratio	1.108			
Diameter, in	2.83			
Height, in	6.06			
Cell, psi	91.2			
BP, psi	79.0			
	Effective Stresses At:			
Strain, %	10.0			
Deviator ksf	3.148			
Excess PP	0.000			
Sigma 1	4.905			
Sigma 3	1.757			
P, ksf	3.331			
Q, ksf	1.574			
Stress Ratio	2.792			
Rate in/min	0.0592			
Total C	N/A	ksf		
Total Phi	N/A	Degrees		
Eff. C	N/A	ksf		
Eff. Phi	N/A	Degrees		

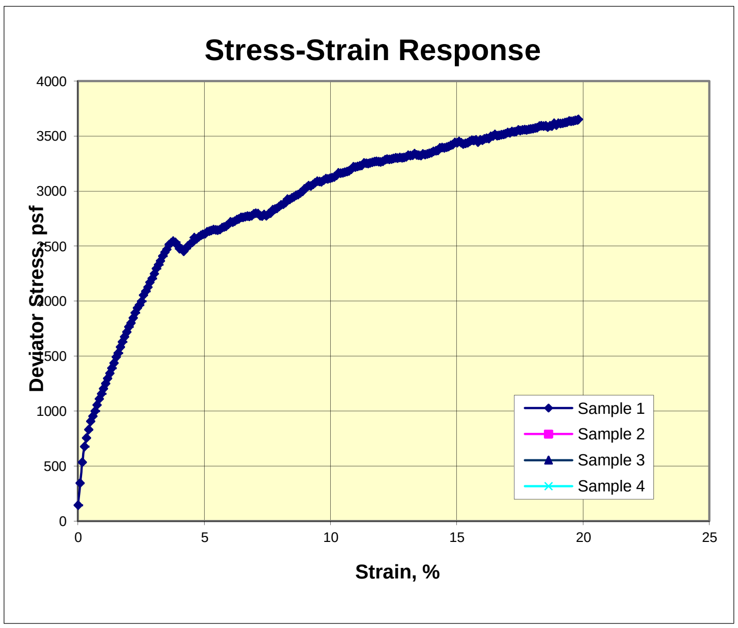
Job No.: 020-272 **Date:** 12/19/2018
Client: AECOM BY:MD/DC
Project: 60537920
Sample 1) BC-13_S04 @ 22(Tip-18.5") Olive Brown Silty SAND/ Clayey SAND (Weathered Rock)
Sample 2)
Sample 3)
Sample 4)

REMARKS: Strengths picked at 10% strain.
*Sample was back-pressure saturated prior to shear.

Triaxial Unconsolidated-Undrained

(ASTM D2850m)





Sample:	1	2	3	4
MC, %	72.2			
Dry Dens, pcf	39.4			
Sat. %	60.3			
Void Ratio	3.116			
Diameter in	2.87			
Height, in	6.08			
	Final			
MC, %	112.3			
Dry Dens, pcf	41.4			
Sat. %	100.0			
Void Ratio	2.919			
Diameter, in	2.81			
Height, in	6.06			
Cell, psi	95.3			
BP, psi	79.0			
	Effective Stresses At:			
Strain, %	10.0			
Deviator ksf	3.116			
Excess PP	0.000			
Sigma 1	5.463			
Sigma 3	2.347			
P, ksf	3.905			
Q, ksf	1.558			
Stress Ratio	2.327			
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.: 020-272 **Date:** 12/19/2018

Client: AECOM BY:MD/DC

Project: 60537920

Sample 1) BC-13_S05 @ 30.5(Tip-11") Pale Brown SILT (slightly plastic) w/ CaCO3 deposits (Weathered Rock)

Sample 2)

Sample 3)

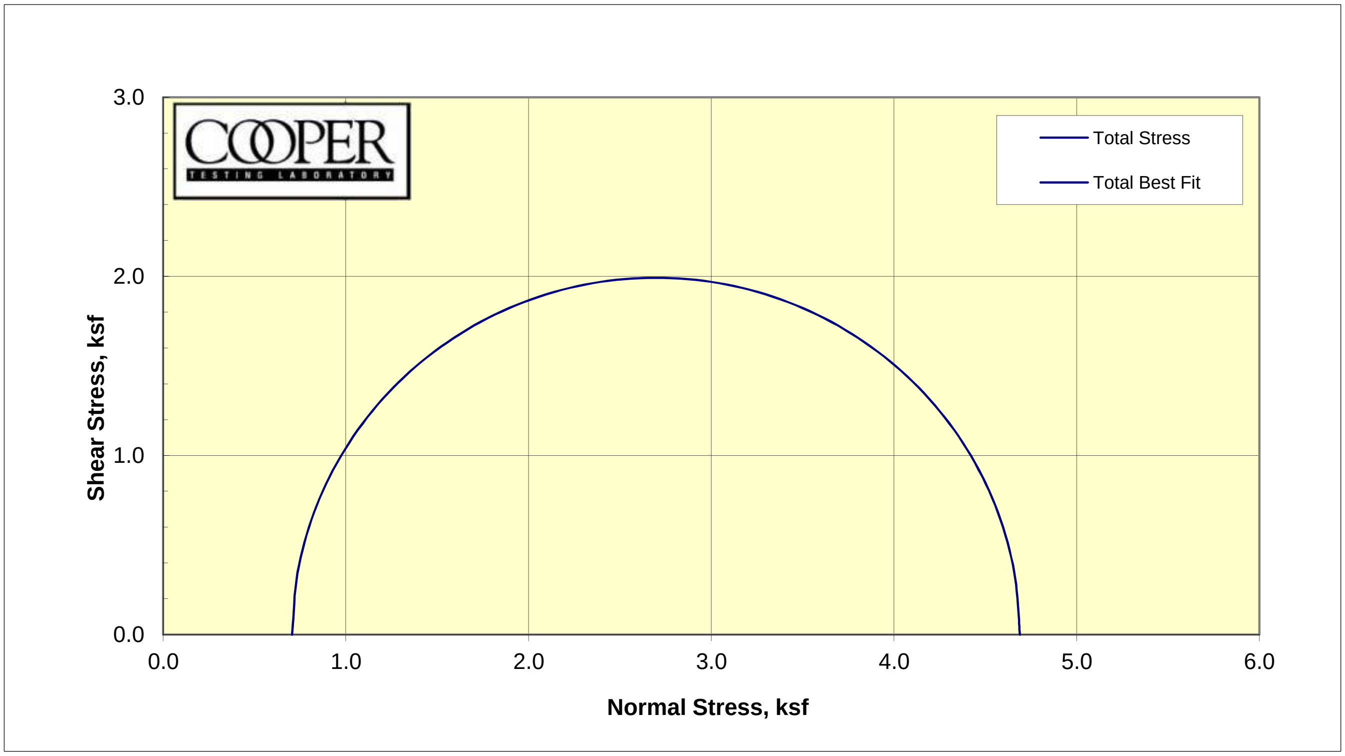
Sample 4)

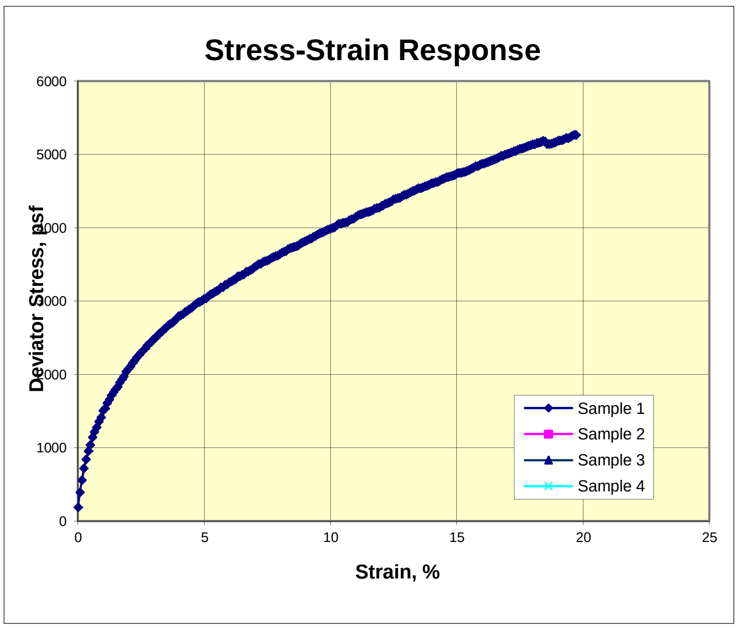
REMARKS: Strengths picked at 5% strain.

*Sample was back-pressure saturated prior to shear.

Triaxial Unconsolidated-Undrained

(ASTM D2850m)





Sample:	1	2	3	4
MC, %	45.1			
Dry Dens, pcf	54.7			
Sat. %	59.6			
Void Ratio	1.968			
Diameter in	2.87			
Height, in	6.09			
	Final			
MC, %	72.9			
Dry Dens, pcf	56.0			
Sat. %	100.0			
Void Ratio	1.895			
Diameter, in	2.84			
Height, in	6.09			
Cell, psi	73.9			
BP, psi	69.0			
	Effective Stresses At:			
Strain, %	10.0			
Deviator ksf	3.984			
Excess PP	0.000			
Sigma 1	4.690			
Sigma 3	0.706			
P, ksf	2.698			
Q, ksf	1.992			
Stress Ratio	6.646			
Rate in/min	0.0587			
Total C	N/A	ksf		
Total Phi	N/A	Degrees		
Eff. C	N/A	ksf		
Eff. Phi	N/A	Degrees		

Job No.: 020-272 **Date:** 12/19/2018

Client: AECOM BY:MD/DC

Project: 60537920

Sample 1) BC-14_S03 @ 9(Tip-1") Olive Brown Clayey GRAVEL w/ Sand (Weathered Rock)

Sample 2)

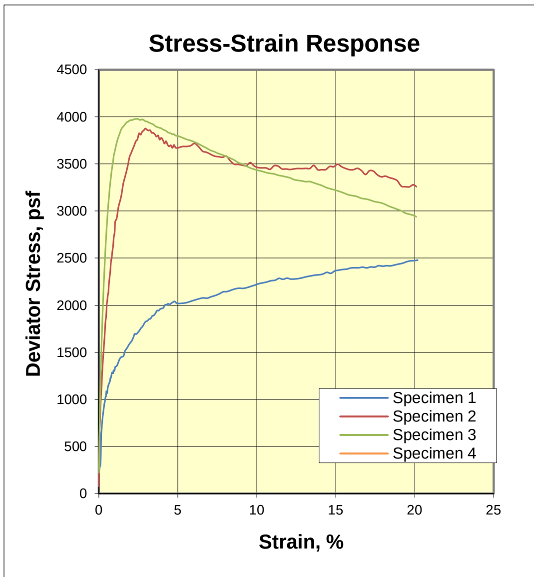
Sample 3)

Sample 4)

REMARKS: Strengths picked at 10% strain.

*Sample was back-pressure saturated prior to shear.

Consolidated Undrained Triaxial Compression with Pore Pressure
ASTM D4767

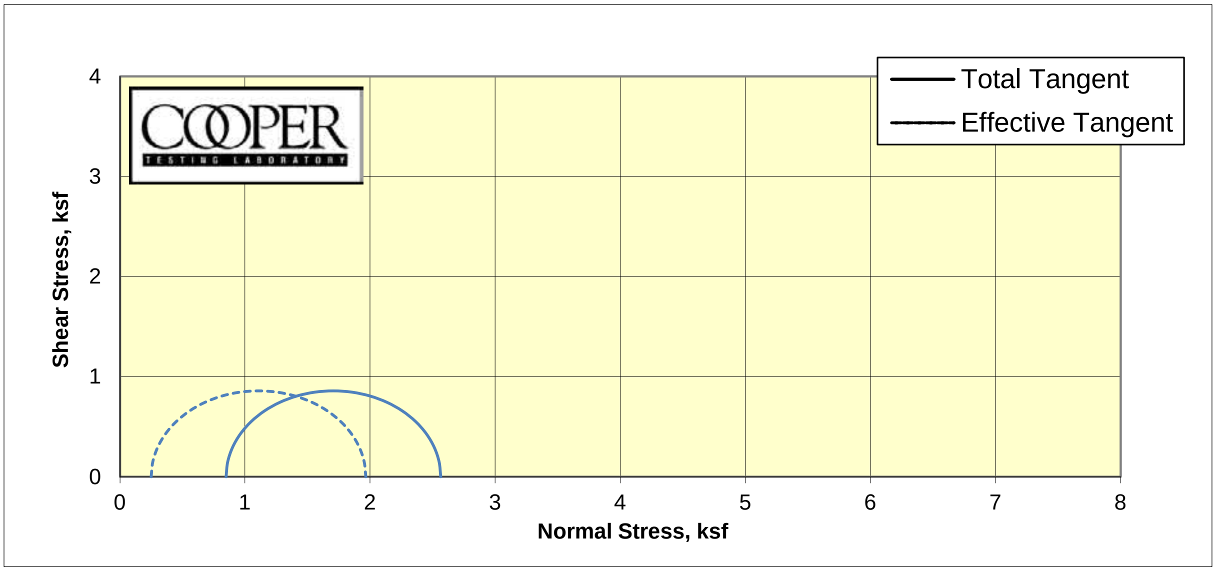


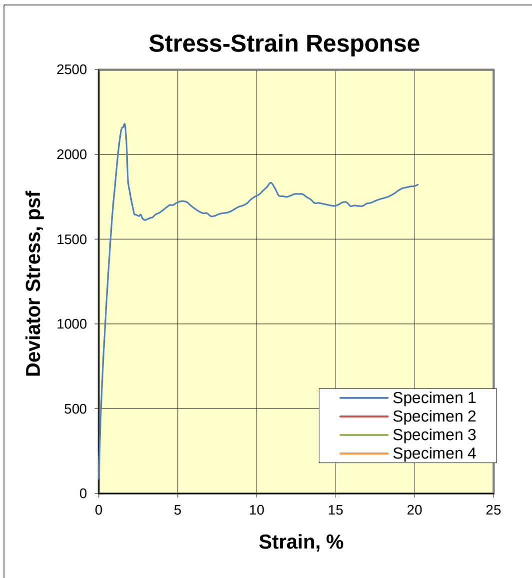
Specimen	1	2	3	4
Boring	Outcrop #1	Outcrop #1	Outcrop #1	
Sample				
Depth				
Visual Description	Pale Brown Siltstone (Diatomite)	Pale Brown Siltstone (Diatomite)	Pale Brown Siltstone (Diatomite)	
MC (%)	8.2	7.1	5.9	
Dry Density (pcf)	53.1	56.9	58.0	
Saturation (%)	10.2	9.7	8.4	
Void Ratio	2.176	1.961	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	

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.

Consolidated Undrained Triaxial Compression with Pore Pressure
ASTM D4767





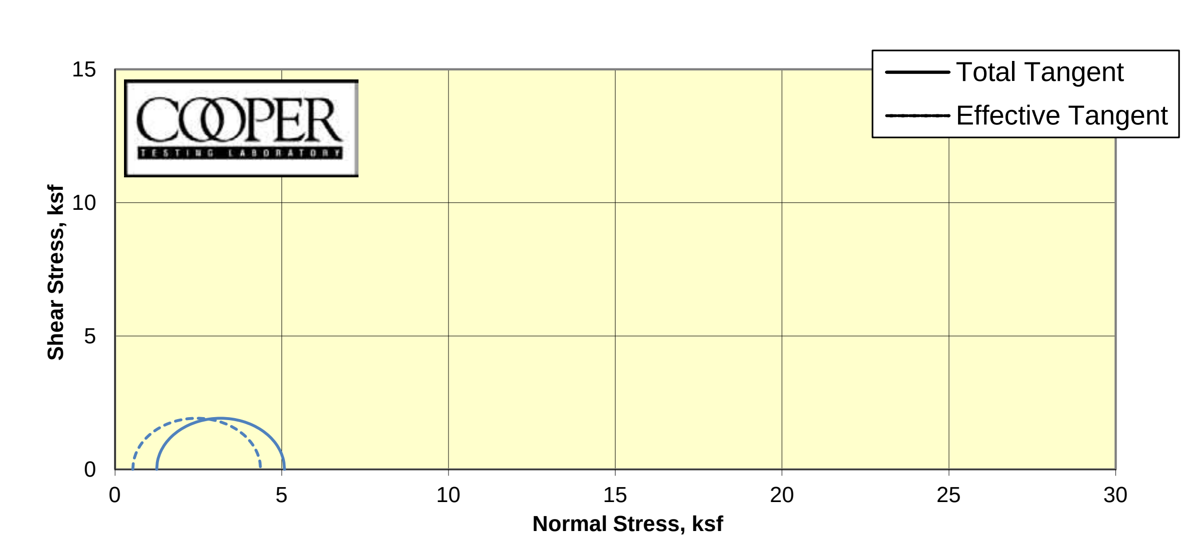
CTL Number:	020-251
Client Name:	AECOM
Project Name:	Klamath River Dam Removal Project
Project Number:	60537920
Date: 5/30/2018	**By:** MD/DC

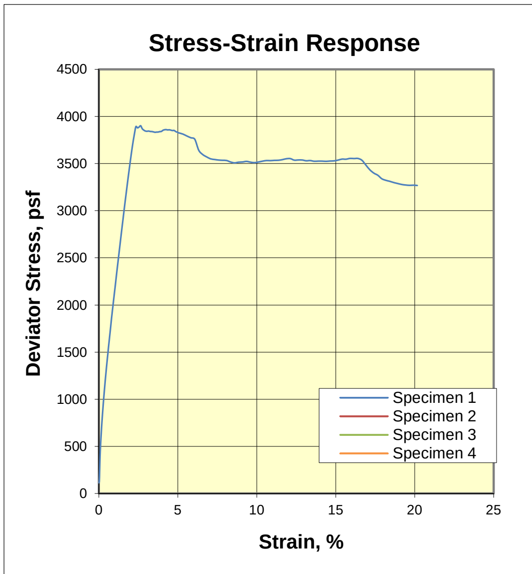
Total C	#DIV/0!	ksf
Total phi	#DIV/0!	degrees
Eff. C	#DIV/0!	ksf
Eff. Phi	#DIV/0!	degrees

©

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

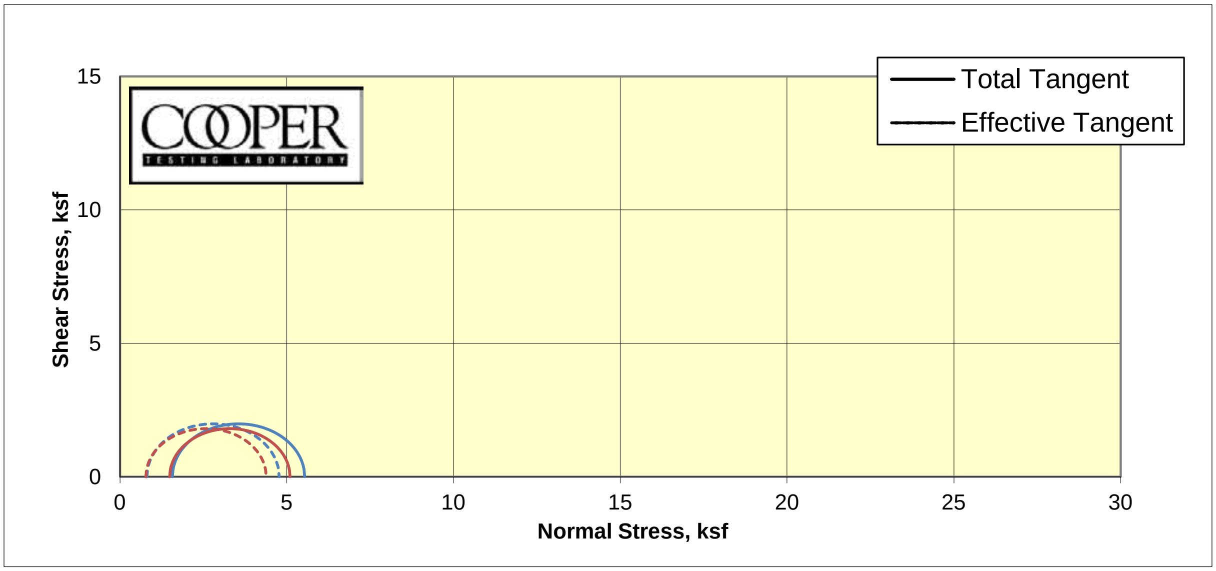


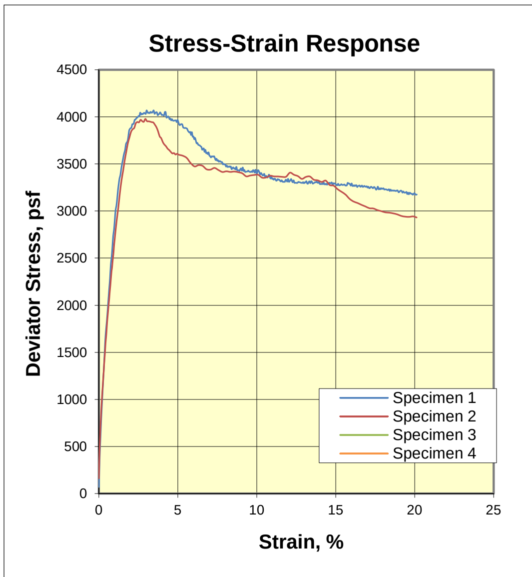


Specimen	1	2	3	4
Boring	BC-02			
Sample	S-08			
Depth	34.5(Tip-6")			
Visual Description	Pale Brown CLAY (Silty)			
MC (%)	148.8			
Dry Density (pcf)	32.7			
Saturation (%)	96.6			
Void Ratio	4.158			
Diameter (in)	2.87			
Height (in)	6.07			
	Final			
MC (%)	148.5			
Dry Density (pcf)	33.6			
Saturation (%)	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





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		

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	
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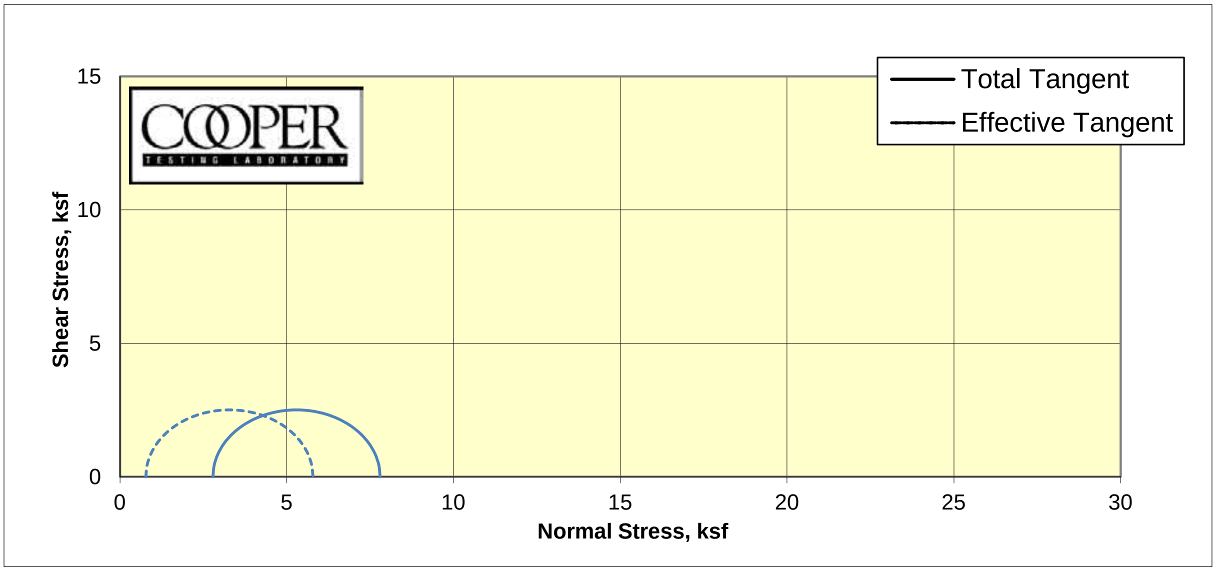
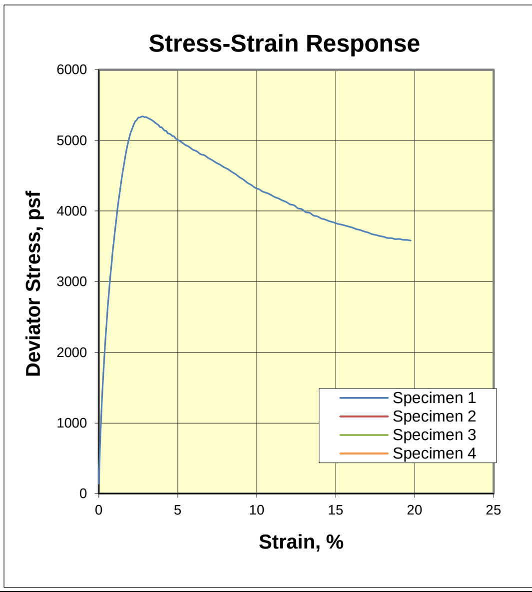
Eff. Phi	#DIV/0!	degrees	©

Consolidated Undrained Triaxial Compression with Pore Pressure
ASTM D4767

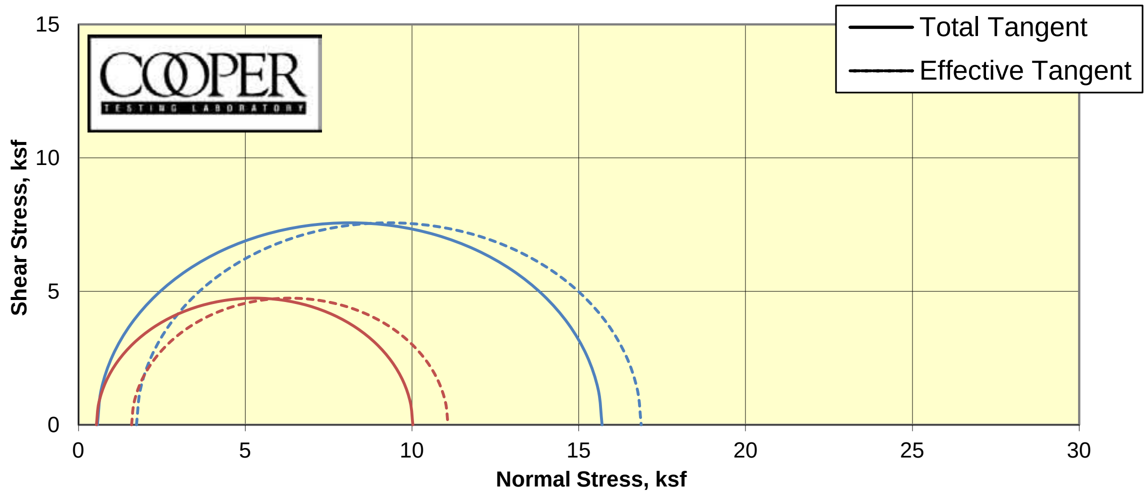


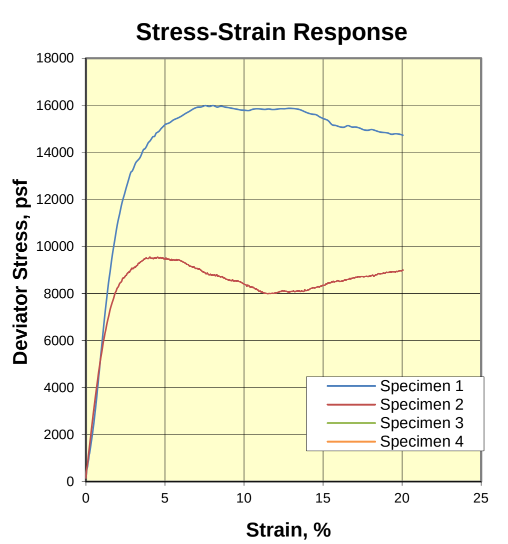


CTL Number:	020-251			
Client Name:	AECOM			
Project Name:	Klamath River Dam Removal Project			
Project Number:	60537920			
Date:	5/21/2018	By:	MD/DC	
Total C	#DIV/0!	ksf		
Total phi	#DIV/0!	degrees		
Eff. C	#DIV/0!	ksf		
Eff. Phi	#DIV/0!	degrees		©

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

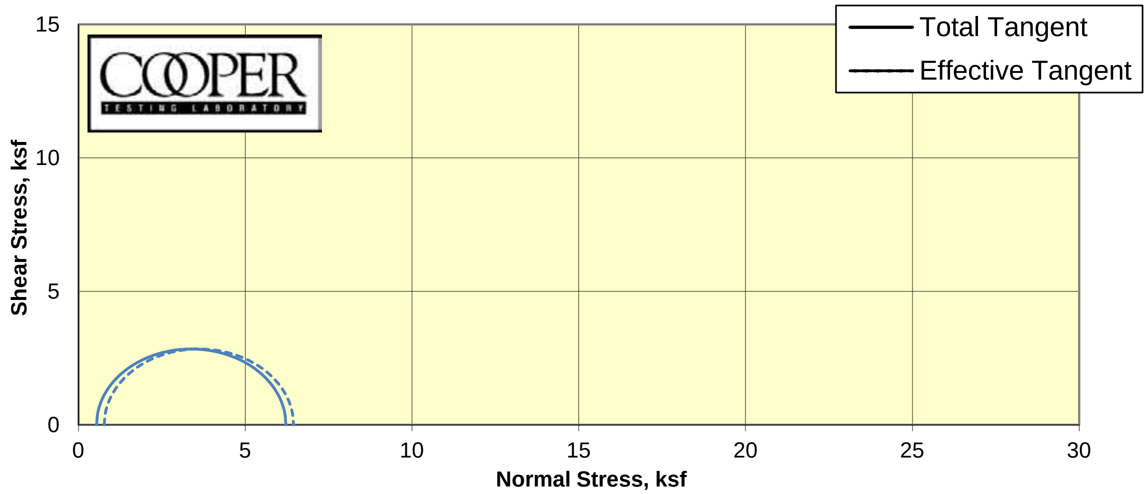


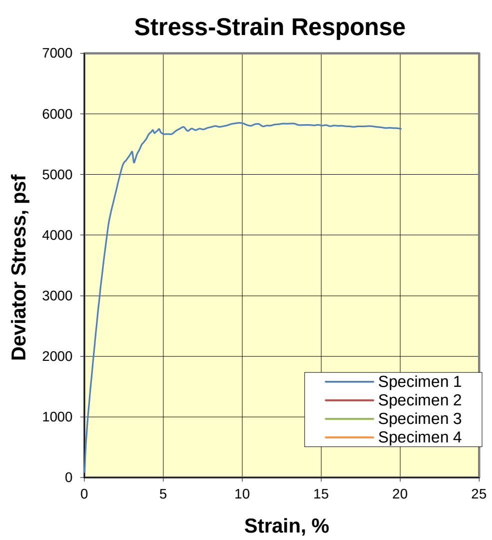


CTL Number:	020-251		
Client Name:	AECOM		
Project Name:	Klamath River Dam Removal Project		
Project Number:	60537920		
Date:	6/6/2018	By:	MD/DC
Total C	#DIV/0!	ksf	
Total phi	#DIV/0!	degrees	
Eff. C	#DIV/0!	ksf	
Eff. Phi	#DIV/0!	degrees	©

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

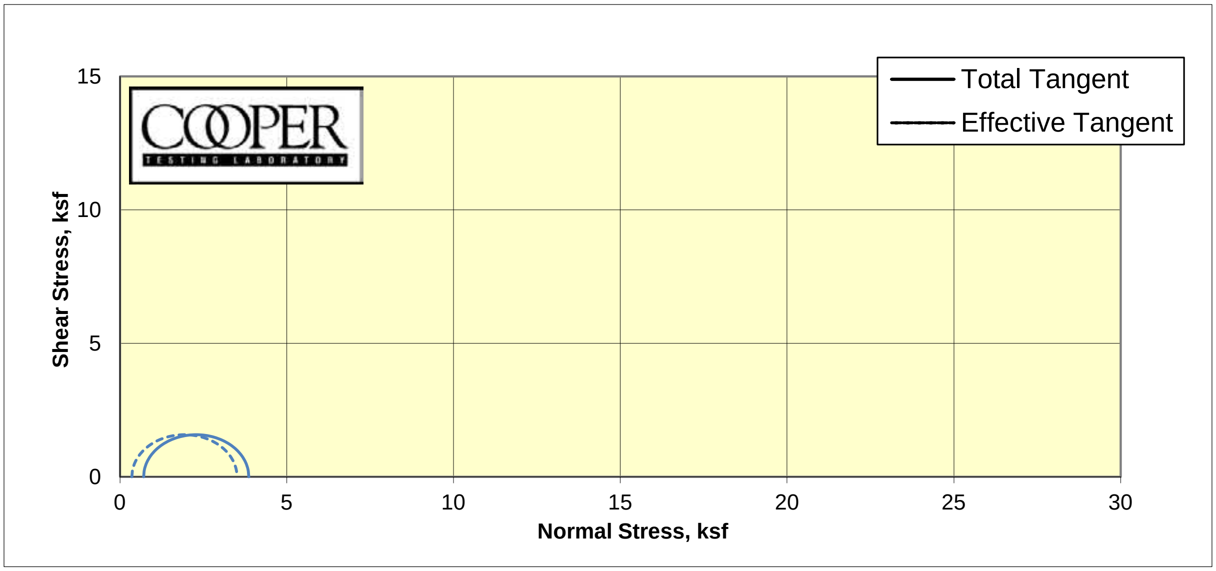


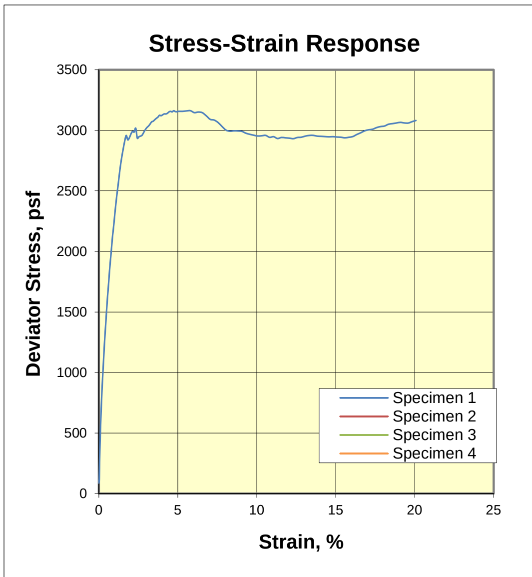


Specimen	1	2	3	4
Boring	BC-04			
Sample	S-5			
Depth	17.5(Tip-6")			
Visual Description	Light Gray CLAY			
MC (%)	104.7			
Dry Density (pcf)	42.1			
Saturation (%)	94.2			
Void Ratio	3.000			
Diameter (in)	2.87			
Height (in)	6.08			
	Final			
MC (%)	105.4			
Dry Density (pcf)	43.8			
Saturation (%)	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			

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



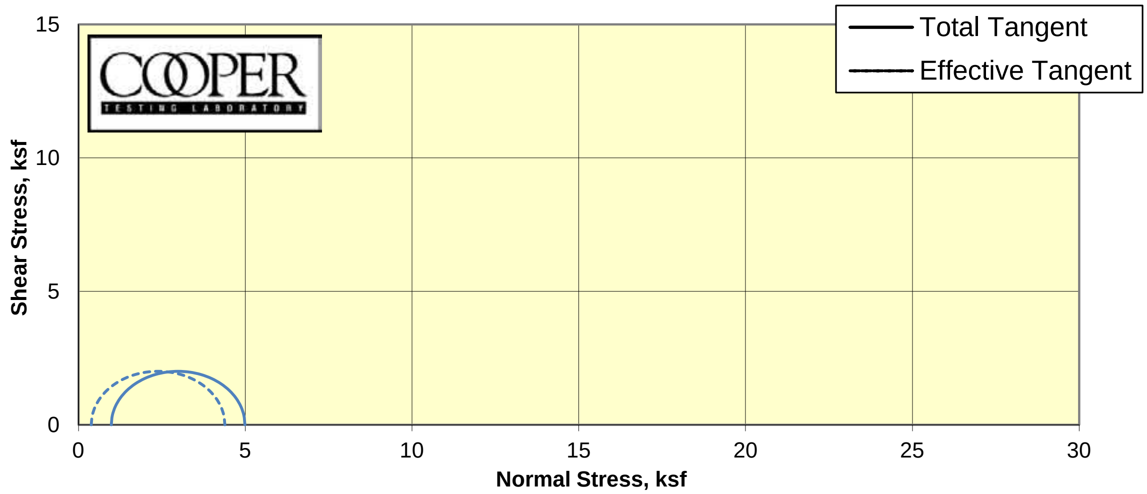


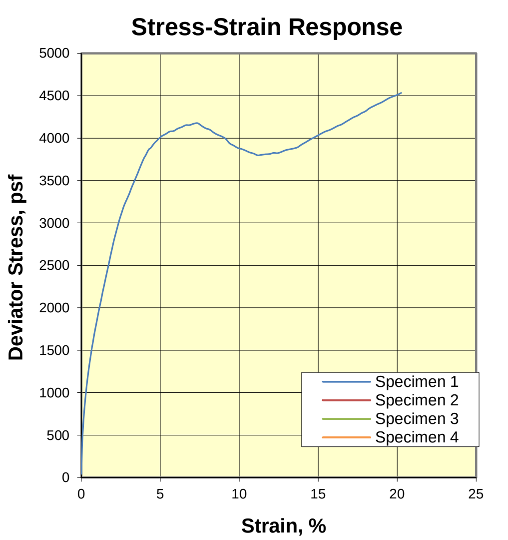
CTL Number:	020-251
Client Name:	AECOM
Project Name:	Klamath River Dam Removal Project
Project Number:	60537920
Date:	5/30/2018 By: MD/DC

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-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			

Consolidated Undrained Triaxial Compression with Pore Pressure
ASTM D4767

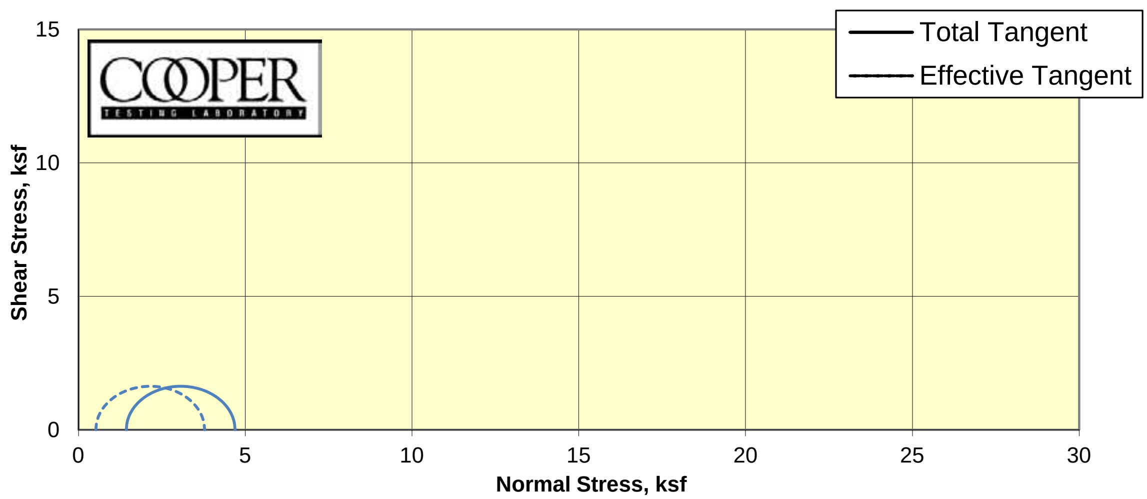


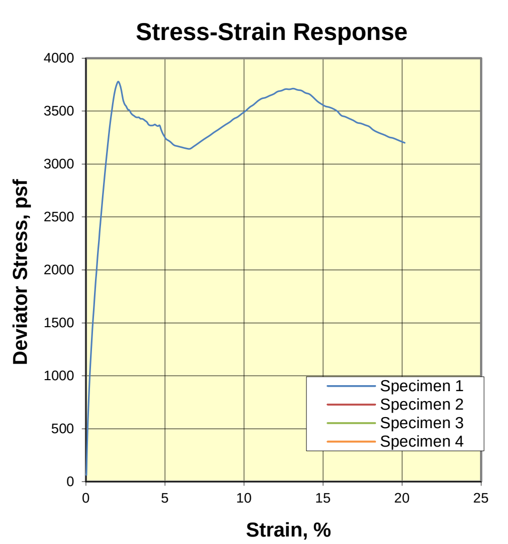


Specimen	1	2	3	4
Boring	BC-04			
Sample	S-08			
Depth	32.5(Tip-10")			
Visual Description	Pale Brown Mottled Gray Elastic SILT			
MC (%)	117.2			
Dry Density (pcf)	36.9			
Saturation (%)	89.7			
Void Ratio	3.397			
Diameter (in)	2.87			
Height (in)	6.08			
	Final			
MC (%)	115.5			
Dry Density (pcf)	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			

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	©

Consolidated Undrained Triaxial Compression with Pore Pressure
ASTM D4767





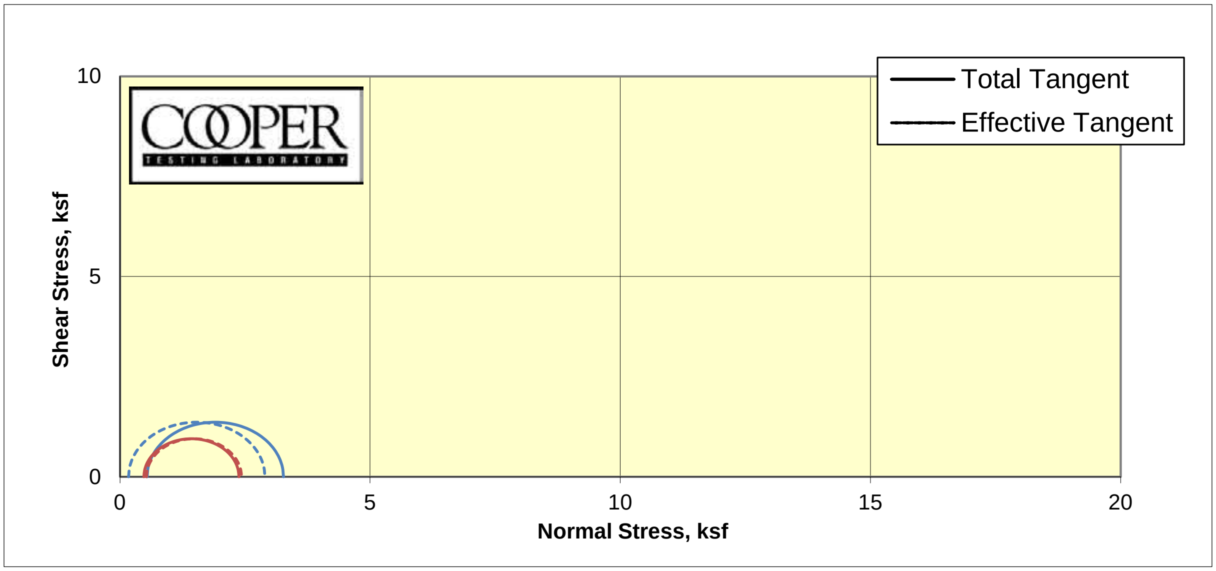
CTL Number:	020-251
Client Name:	AECOM
Project Name:	Klamath River Dam Removal Project
Project Number:	60537920
Date:	5/25/2018 By: MD/DC

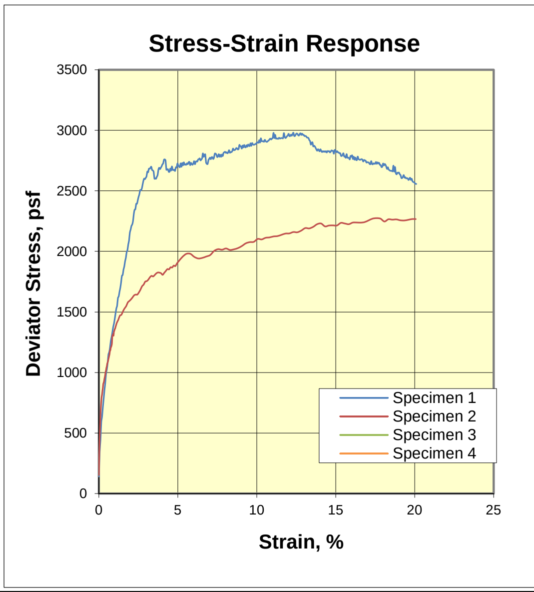
Total C	#DIV/0!	ksf
Total phi	#DIV/0!	degrees
Eff. C	#DIV/0!	ksf
Eff. Phi	#DIV/0!	degrees

©

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

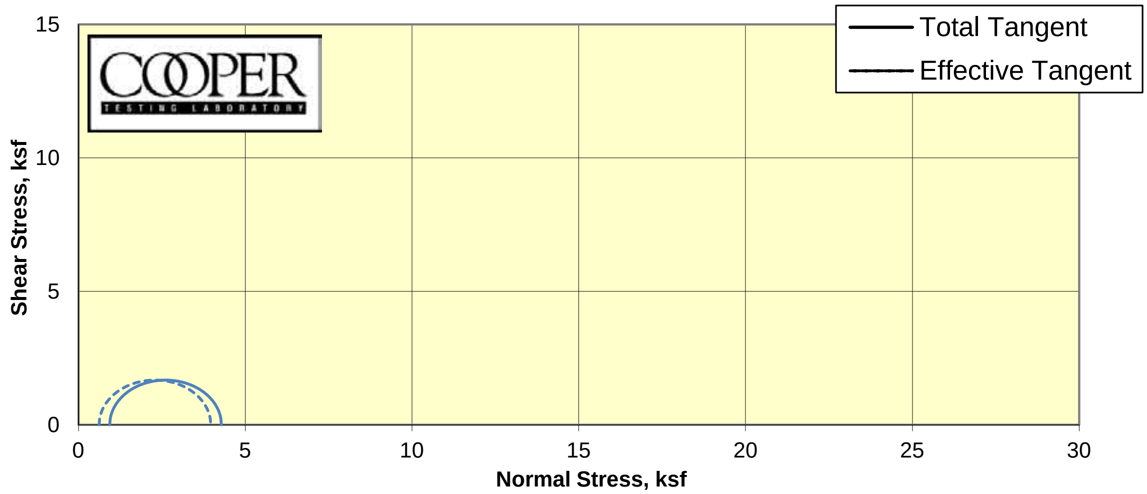


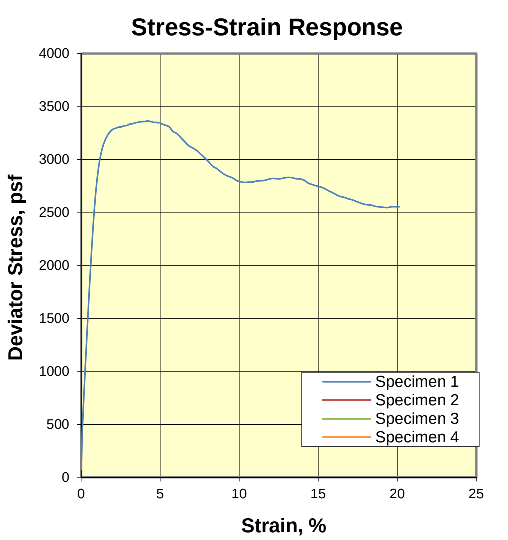


CTL Number:	020-251		
Client Name:	AECOM		
Project Name:	Klamath River Dam Removal Project		
Project Number:	60537920		
Date:	5/24/2018	By:	MD/DC
Total C	#DIV/0!	ksf	
Total phi	#DIV/0!	degrees	
Eff. C	#DIV/0!	ksf	
Eff. Phi	#DIV/0!	degrees	©

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

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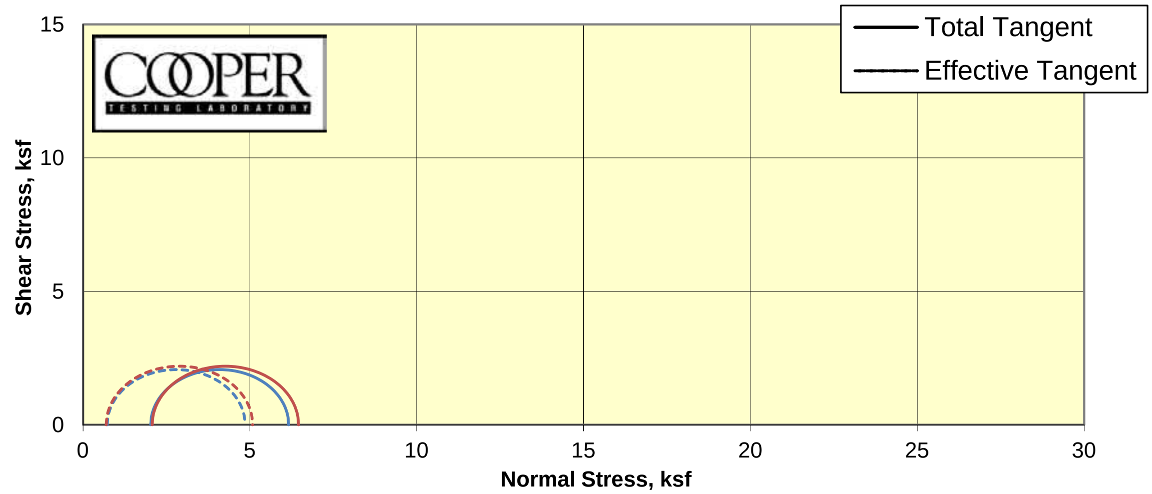
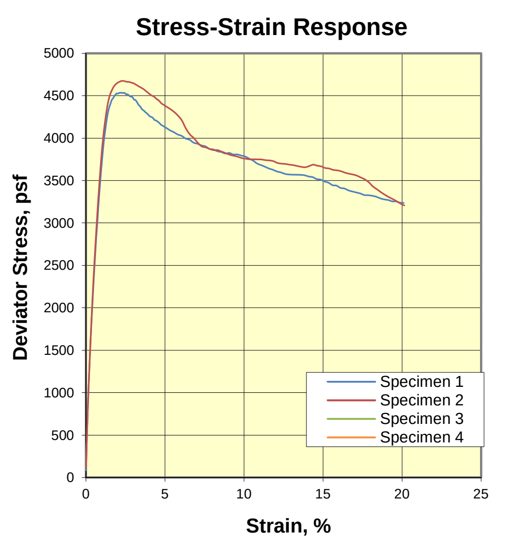
Specimen	1	2	3	4
Boring	BC-09			
Sample	S-05			
Depth	23(Tip-5")			
Visual Description	Dark Gray Elastic SILT			
MC (%)	79.5			
Dry Density (pcf)	51.9			
Saturation (%)	97.1			
Void Ratio	2.130			
Diameter (in)	2.87			
Height (in)	6.07			
	Final			
MC (%)	79.4			
Dry Density (pcf)	53.0			
Saturation (%)	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

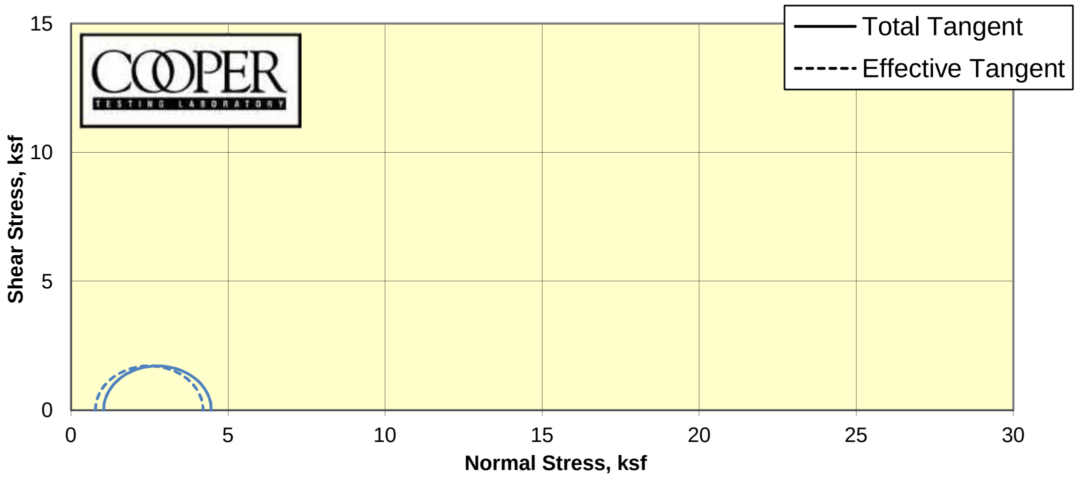


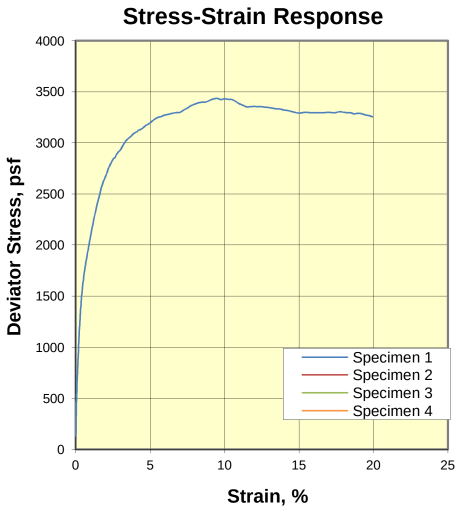


CTL Number:	020-251
Client Name:	AECOM
Project Name:	Klamath River Dam Removal Project
Project Number:	60537920
Date:	6/6/2018 By: MD/DC
Total C	#DIV/0! ksf
Total phi	#DIV/0! degrees
Eff. C	#DIV/0! ksf
Eff. Phi	#DIV/0! degrees ©

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		

Consolidated Undrained Triaxial Compression with Pore Pressure
ASTM D4767

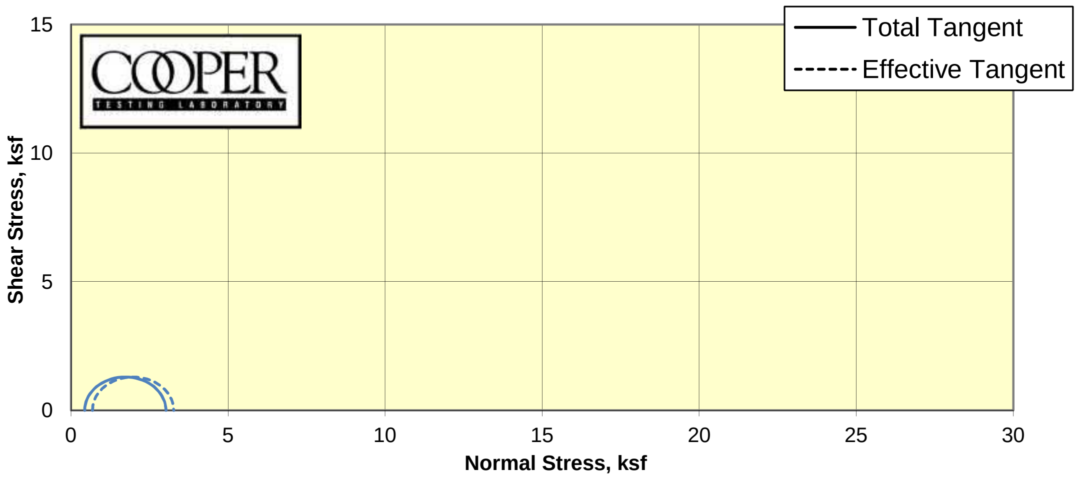


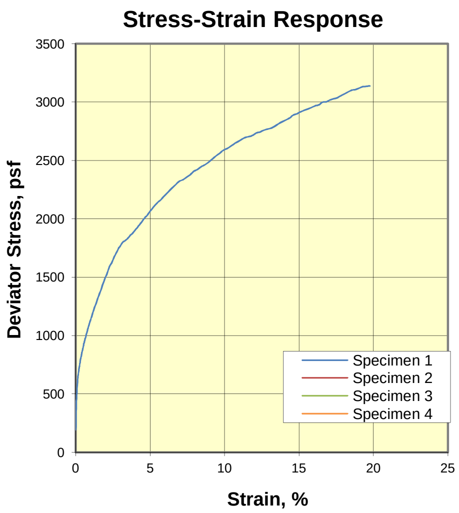


CTL Number:	020-272		
Client Name:	AECOM		
Project Name:	Klamath River Dam Removal Project		
Project Number:	60537920		
Date:	1/2/2019	By:	MD/DC
Total C	#DIV/0!	ksf	
Total phi	#DIV/0!	degrees	
Eff. C	#DIV/0!	ksf	
Eff. Phi	#DIV/0!	degrees	©

Specimen	1	2	3	4
Boring	BC-13			
Sample	S02			
Depth	12(Tip-0.5')			
Visual Description	Pale Brown SILT (slightly plastic) (Weathered Rock)			
MC (%)	23.3			
Dry Density (pcf)	59.6			
Saturation (%)	35.1			
Void Ratio	1.725			
Diameter (in)	2.87			
Height (in)	6.09			
	Final			
MC (%)	63.5			
Dry Density (pcf)	61.2			
Saturation (%)	100.0			
Void Ratio	1.651			
Diameter (in)	2.83			
Height (in)	6.11			
Cell Pressure (psi)	136.9			
Back Pressure (psi)	129.7			
	Effective Stresses At:			
Strain (%)	10.0			
Deviator (ksf)	3.431			
Excess PP (psi)	1.8			
Sigma 1 (ksf)	4.206			
Sigma 3 (ksf)	0.775			
P (ksf)	2.491			
Q (ksf)	1.716			
Stress Ratio	5.425			
Rate (in/min)	0.0005			

Consolidated Undrained Triaxial Compression with Pore Pressure
ASTM D4767

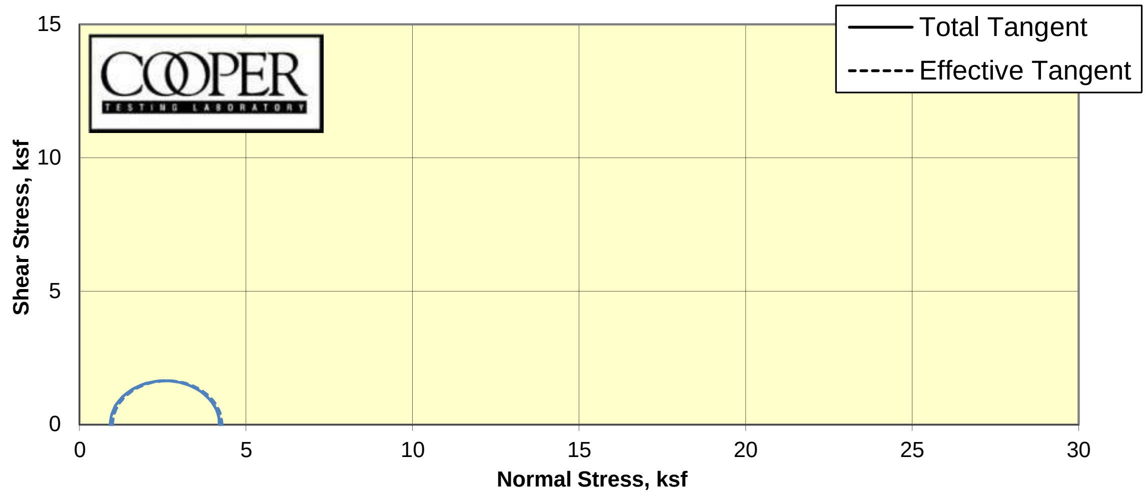


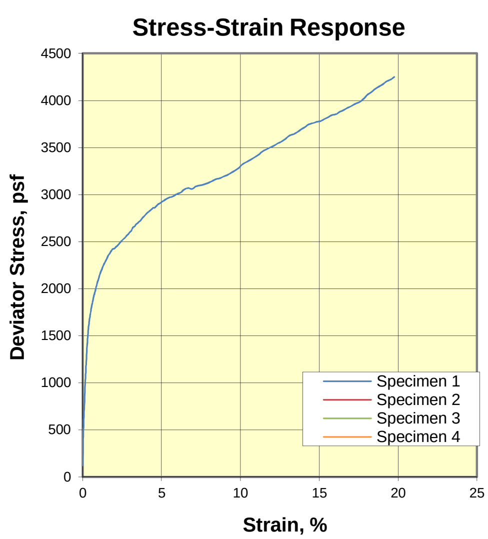


CTL Number:	020-272		
Client Name:	AECOM		
Project Name:	Klamath River Dam Removal Project		
Project Number:	60537920		
Date:	1/3/2019	By:	MD/DC
Total C	#DIV/0!	ksf	
Total phi	#DIV/0!	degrees	
Eff. C	#DIV/0!	ksf	
Eff. Phi	#DIV/0!	degrees	©

Specimen	1	2	3	4
Boring	BC-14			
Sample	S01			
Depth	5(Tip-1")			
Visual Description	Pale Brown SILT w/ Gravel (Weathered Rock)			
MC (%)	23.3			
Dry Density (pcf)	59.7			
Saturation (%)	34.5			
Void Ratio	1.823			
Diameter (in)	2.87			
Height (in)	6.09			
	Final			
MC (%)	66.8			
Dry Density (pcf)	60.1			
Saturation (%)	100.0			
Void Ratio	1.804			
Diameter (in)	2.84			
Height (in)	6.16			
Cell Pressure (psi)	132.4			
Back Pressure (psi)	129.4			
	Effective Stresses At:			
Strain (%)	10.0			
Deviator (ksf)	2.587			
Excess PP (psi)	-1.7			
Sigma 1 (ksf)	3.269			
Sigma 3 (ksf)	0.682			
P (ksf)	1.976			
Q (ksf)	1.293			
Stress Ratio	4.791			
Rate (in/min)	0.0005			

Consolidated Undrained Triaxial Compression with Pore Pressure
ASTM D4767





Specimen	1	2	3	4
Boring	BC-14			
Sample	S04			
Depth	12(Tip-1")			
Visual Description	Olive Brown Sandy SILT w/ Gravel (Weathered Rock)			
MC (%)	24.2			
Dry Density (pcf)	63.5			
Saturation (%)	39.5			
Void Ratio	1.653			
Diameter (in)	2.86			
Height (in)	6.09			
	Final			
MC (%)	61.1			
Dry Density (pcf)	63.6			
Saturation (%)	100.0			
Void Ratio	1.649			
Diameter (in)	2.84			
Height (in)	6.17			
Cell Pressure (psi)	136.6			
Back Pressure (psi)	130.2			
	Effective Stresses At:			
Strain (%)	10.0			
Deviator (ksf)	3.284			
Excess PP (psi)	-0.5			
Sigma 1 (ksf)	4.272			
Sigma 3 (ksf)	0.989			
P (ksf)	2.630			
Q (ksf)	1.642			
Stress Ratio	4.322			
Rate (in/min)	0.0005			

CTL Number:	020-272		
Client Name:	AECOM		
Project Name:	Klamath River Dam Removal Project		
Project Number:	60537920		
Date:	1/3/2019	By:	MD/DC
Total C	#DIV/0!	ksf	
Total phi	#DIV/0!	degrees	
Eff. C	#DIV/0!	ksf	
Eff. Phi	#DIV/0!	degrees	©

List of Photos

Photo 1: 020-272 BC-13 S01 @ 7' (Tip-4'') After TXUU.JPG
Photo 2: 020-272 BC-13 S01 @ 7' (Tip-4'') Before TXUU.JPG
Photo 3: 020-272 BC-13 S02 @ 12' (Tip-0.5'') After TXCUPP #1.JPG
Photo 4: 020-272 BC-13 S02 @ 12' (Tip-0.5'') After TXCUPP #2.JPG
Photo 5: 020-272 BC-13 S02 @ 12' (Tip-0.5'') Before TXCUPP.JPG
Photo 6: 020-272 BC-13 S04 @ 22' (Tip-12'') After TXUU.JPG
Photo 7: 020-272 BC-13 S04 @ 22' (Tip-12'') Before TXUU.JPG
Photo 8: 020-272 BC-13 S04 @ 22' (Tip-18.5'') After TXUU.JPG
Photo 9: 020-272 BC-13 S04 @ 22' (Tip-18.5'') Before TXUU.JPG
Photo 10: 020-272 BC-13 S05 @ 30.5' (Tip-0.5'') Before TXCUPP.JPG
Photo 11: 020-272 BC-13 S05 @ 30.5' (Tip-11'') After TXUU #1.JPG
Photo 12: 020-272 BC-13 S05 @ 30.5' (Tip-11'') After TXUU #2.JPG
Photo 13: 020-272 BC-13 S05 @ 30.5' (Tip-11'') Before TXUU.JPG
Photo 14: 020-272 BC-14 S01 @ 5' (Tip-1'') After TXCUPP #1.JPG
Photo 15: 020-272 BC-14 S01 @ 5' (Tip-1'') After TXCUPP #2.JPG
Photo 16: 020-272 BC-14 S01 @ 5' (Tip-1'') Before TXCUPP.JPG
Photo 17: 020-272 BC-14 S02 @ 7' (Tip-1'') After TXUU #1.JPG
Photo 18: 020-272 BC-14 S02 @ 7' (Tip-1'') After TXUU #2.JPG
Photo 19: 020-272 BC-14 S02 @ 7' (Tip-1'') Before TXUU.JPG
Photo 20: 020-272 BC-14 S03 @ 9' (Tip-1'') After TXUU #1.JPG
Photo 21: 020-272 BC-14 S03 @ 9' (Tip-1'') After TXUU #2.JPG
Photo 22: 020-272 BC-14 S03 @ 9' (Tip-1'') After TXUU #3.JPG
Photo 23: 020-272 BC-14 S03 @ 9' (Tip-1'') Before TXCUPP.JPG
Photo 24: 020-272 BC-14 S04 @ 12' (Tip-1'') After TXCUPP #1.JPG
Photo 25: 020-272 BC-14 S04 @ 12' (Tip-1'') After TXCUPP #2.JPG
Photo 26: 020-272 BC-14 S04 @ 12' (Tip-1'') Before TXCUPP.JPG
Photo 27: 202-251 BC-02 S06 @ 19.5' (tip-2'') After TXCUPP #1.JPG
Photo 28: 202-251 BC-02 S06 @ 19.5' (tip-2'') After TXCUPP #2.JPG
Photo 29: 202-251 BC-02 S06 @ 19.5' (tip-2'') Before TXCUPP.JPG
Photo 30: 202-251 BC-02 S08 @ 34.5' (tip-6'') After TXCUPP #1.JPG
Photo 31: 202-251 BC-02 S08 @ 34.5' (tip-6'') After TXCUPP #2.JPG
Photo 32: 202-251 BC-03 S06 @ 39.5' (tip-4'') After TXCUPP #1.JPG
Photo 33: 202-251 BC-03 S06 @ 39.5' (tip-4'') After TXCUPP #2.JPG
Photo 34: 202-251 BC-03 S06 @ 39.5' (tip-4'') Before TXCUPP.JPG
Photo 35: 202-251 BC-03 S06 @ 39.5' (tip-11'') After TXCUPP #1.JPG
Photo 36: 202-251 BC-03 S06 @ 39.5' (tip-11'') After TXCUPP #2.JPG
Photo 37: 202-251 BC-03 S06 @ 39.5' (tip-11'') Before TXCUPP.JPG
Photo 38: 202-251 BC-03 S10 @ 90' (tip-13'') After TXCUPP #1.JPG
Photo 39: 202-251 BC-03 S10 @ 90' (tip-13'') After TXCUPP #2.JPG
Photo 40: 202-251 BC-03 S10 @ 90' (tip-13'') Before TXCUPP.JPG
Photo 41: 202-251 BC-04 S04 @ 12.5' (tip-4'') After TXCUPP #1.JPG
Photo 42: 202-251 BC-04 S04 @ 12.5' (tip-4'') After TXCUPP #2.JPG
Photo 43: 202-251 BC-04 S04 @ 12.5' (tip-4'') Before TXCUPP.JPG

Photo 44: 202-251 BC-04 S04 @ 12.5' (tip-15'') After TXCUPP #1.JPG
Photo 45: 202-251 BC-04 S04 @ 12.5' (tip-15'') After TXCUPP #2.JPG
Photo 46: 202-251 BC-04 S04 @ 12.5' (tip-15'') Before TXCUPP.JPG
Photo 47: 202-251 BC-04 S05 @ 17.6' (tip-6'') After TXCUPP #1.JPG
Photo 48: 202-251 BC-04 S05 @ 17.6' (tip-6'') After TXCUPP #2.JPG
Photo 49: 202-251 BC-04 S05 @ 17.6' (tip-6'') Before TXCUPP.JPG
Photo 50: 202-251 BC-04 S06 @ 22.5' (tip-2'') After TXCUPP #1.JPG
Photo 51: 202-251 BC-04 S06 @ 22.5' (tip-2'') After TXCUPP #2.JPG
Photo 52: 202-251 BC-04 S06 @ 22.5' (tip-2'') Before TXCUPP.JPG
Photo 53: 202-251 BC-04 S08 @ 32.5' (tip-10'') After TXCUPP #1.JPG
Photo 54: 202-251 BC-04 S08 @ 32.5' (tip-10'') After TXCUPP #2.JPG
Photo 55: 202-251 BC-04 S08 @ 32.5' (tip-10'') Before TXCUPP.JPG
Photo 56: 202-251 BC-04 S10 @ 52.5' (tip-4'') After TXCUPP #1.JPG
Photo 57: 202-251 BC-04 S10 @ 52.5' (tip-4'') After TXCUPP #2.JPG
Photo 58: 202-251 BC-04 S10 @ 52.5' (tip-4'') Before TXCUPP.JPG
Photo 59: 202-251 BC-04 S10 @ 52.5' (tip-18'') After TXCUPP #1.JPG
Photo 60: 202-251 BC-04 S10 @ 52.5' (tip-18'') After TXCUPP #2.JPG
Photo 61: 202-251 BC-04 S10 @ 52.5' (tip-18'') Before TXCUPP.JPG
Photo 62: 202-251 BC-05 S04 @ 14.5' (tip-1'') After TXCUPP #1.JPG
Photo 63: 202-251 BC-05 S04 @ 14.5' (tip-1'') After TXCUPP #2.JPG
Photo 64: 202-251 BC-05 S04 @ 14.5' (tip-1'') Before TXCUPP.JPG
Photo 65: 202-251 BC-05 S04 @ 14.5' (tip-16'') After TXCUPP #1.JPG
Photo 66: 202-251 BC-05 S04 @ 14.5' (tip-16'') After TXCUPP #2.JPG
Photo 67: 202-251 BC-05 S04 @ 14.5' (tip-16'') Before TXCUPP.JPG
Photo 68: 202-251 BC-09 S05 @ 23' (tip-5'') After TXCUPP #1.JPG
Photo 69: 202-251 BC-09 S05 @ 23' (tip-5'') After TXCUPP #2.JPG
Photo 70: 202-251 BC-09 S05 @ 23' (tip-5'') Before TXCUPP.JPG
Photo 71: 202-251 BC-09 S05 @ 23' (tip-13'') After TXCUPP #1.JPG
Photo 72: 202-251 BC-09 S05 @ 23' (tip-13'') After TXCUPP #2.JPG
Photo 73: 202-251 BC-09 S05 @ 23' (tip-13'') Before TXCUPP.JPG
Photo 74: 202-251 BC-09 S09 @ 68' (tip-4'') After TXCUPP #1.JPG
Photo 75: 202-251 BC-09 S09 @ 68' (tip-4'') After TXCUPP #2.JPG
Photo 76: 202-251 BC-09 S09 @ 68' (tip-4'') Before TXCUPP.JPG
Photo 77: 202-251 BC-09 S09 @ 68' (tip-10'') After TXCUPP #1.JPG
Photo 78: 202-251 BC-09 S09 @ 68' (tip-10'') After TXCUPP #2.JPG
Photo 79: 202-251 BC-09 S09 @ 68' (tip-10'') Before TXCUPP.JPG

Photo 1: 020-272 BC-13 S01 @ 7' (Tip-4'') After TXUU.JPG

Photo 2: 020-272 BC-13 S01 @ 7' (Tip-4'') Before TXUU.JPG

Photo 3: 020-272 BC-13 S02 @ 12' (Tip-0.5'') After TXCUPP #1.JPG

Photo 4: 020-272 BC-13 S02 @ 12' (Tip-0.5'') After TXCUPP #2.JPG

Photo 5: 020-272 BC-13 S02 @ 12' (Tip-0.5'') Before TXCUPP.JPG

Photo 6: 020-272 BC-13 S04 @ 22' (Tip-12'') After TXUU.JPG

Photo 7: 020-272 BC-13 S04 @ 22' (Tip-12'') Before TXUU.JPG

Photo 8: 020-272 BC-13 S04 @ 22' (Tip-18.5'') After TXUU.JPG

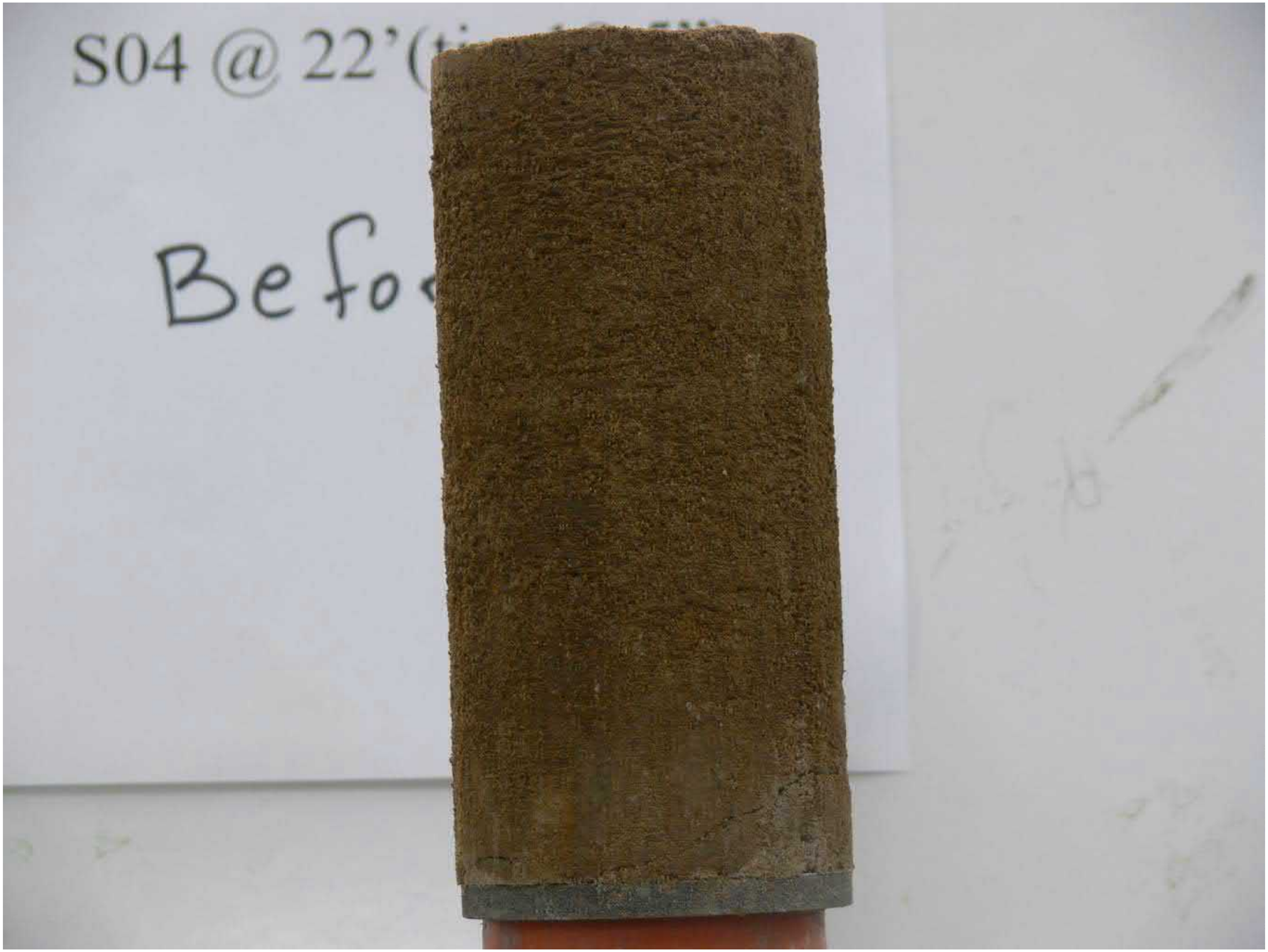


Photo 9: 020-272 BC-13 S04 @ 22' (Tip-18.5'') Before TXUU.JPG

Photo 10: 020-272 BC-13 S05 @ 30.5' (Tip-0.5'') Before TXCUPP.JPG

Photo 11: 020-272 BC-13 S05 @ 30.5' (Tip-11'') After TXUU #1.JPG

Photo 12: 020-272 BC-13 S05 @ 30.5' (Tip-11'') After TXUU #2.JPG

Photo 13: 020-272 BC-13 S05 @ 30.5' (Tip-11'') Before TXUU.JPG

Photo 14: 020-272 BC-14 S01 @ 5' (Tip-1'') After TXCUPP #1.JPG

Photo 15: 020-272 BC-14 S01 @ 5' (Tip-1'') After TXCUPP #2.JPG

Photo 16: 020-272 BC-14 S01 @ 5' (Tip-1'') Before TXCUPP.JPG

Photo 17: 020-272 BC-14 S02 @ 7' (Tip-1'') After TXUU #1.JPG

Photo 18: 020-272 BC-14 S02 @ 7' (Tip-1'') After TXUU #2.JPG

Photo 19: 020-272 BC-14 S02 @ 7' (Tip-1'') Before TXUU.JPG

Photo 20: 020-272 BC-14 S03 @ 9' (Tip-1'') After TXUU #1.JPG

Photo 21: 020-272 BC-14 S03 @ 9' (Tip-1'') After TXUU #2.JPG

Photo 22: 020-272 BC-14 S03 @ 9' (Tip-1'') After TXUU #3.JPG

Photo 23: 020-272 BC-14 S03 @ 9' (Tip-1'') Before TXCUPP.JPG

Photo 24: 020-272 BC-14 S04 @ 12' (Tip-1'') After TXCUPP #1.JPG

Photo 25: 020-272 BC-14 S04 @ 12' (Tip-1'') After TXCUPP #2.JPG

Photo 26: 020-272 BC-14 S04 @ 12' (Tip-1'') Before TXCUPP.JPG

Photo 27: 202-251 BC-02 S06 @ 19.5' (tip-2'') After TXCUPP #1.JPG

Photo 28: 202-251 BC-02 S06 @ 19.5' (tip-2'') After TXCUPP #2.JPG

Photo 29: 202-251 BC-02 S06 @ 19.5' (tip-2'') Before TXCUPP.JPG

Photo 30: 202-251 BC-02 S08 @ 34.5' (tip-6'') After TXCUPP #1.JPG

Photo 31: 202-251 BC-02 S08 @ 34.5' (tip-6'') After TXCUPP #2.JPG

Photo 32: 202-251 BC-03 S06 @ 39.5' (tip-4'') After TXCUPP #1.JPG

Photo 33: 202-251 BC-03 S06 @ 39.5' (tip-4'') After TXCUPP #2.JPG

Photo 34: 202-251 BC-03 S06 @ 39.5' (tip-4'') Before TXCUPP.JPG

Photo 35: 202-251 BC-03 S06 @ 39.5' (tip-11'') After TXCUPP #1.JPG

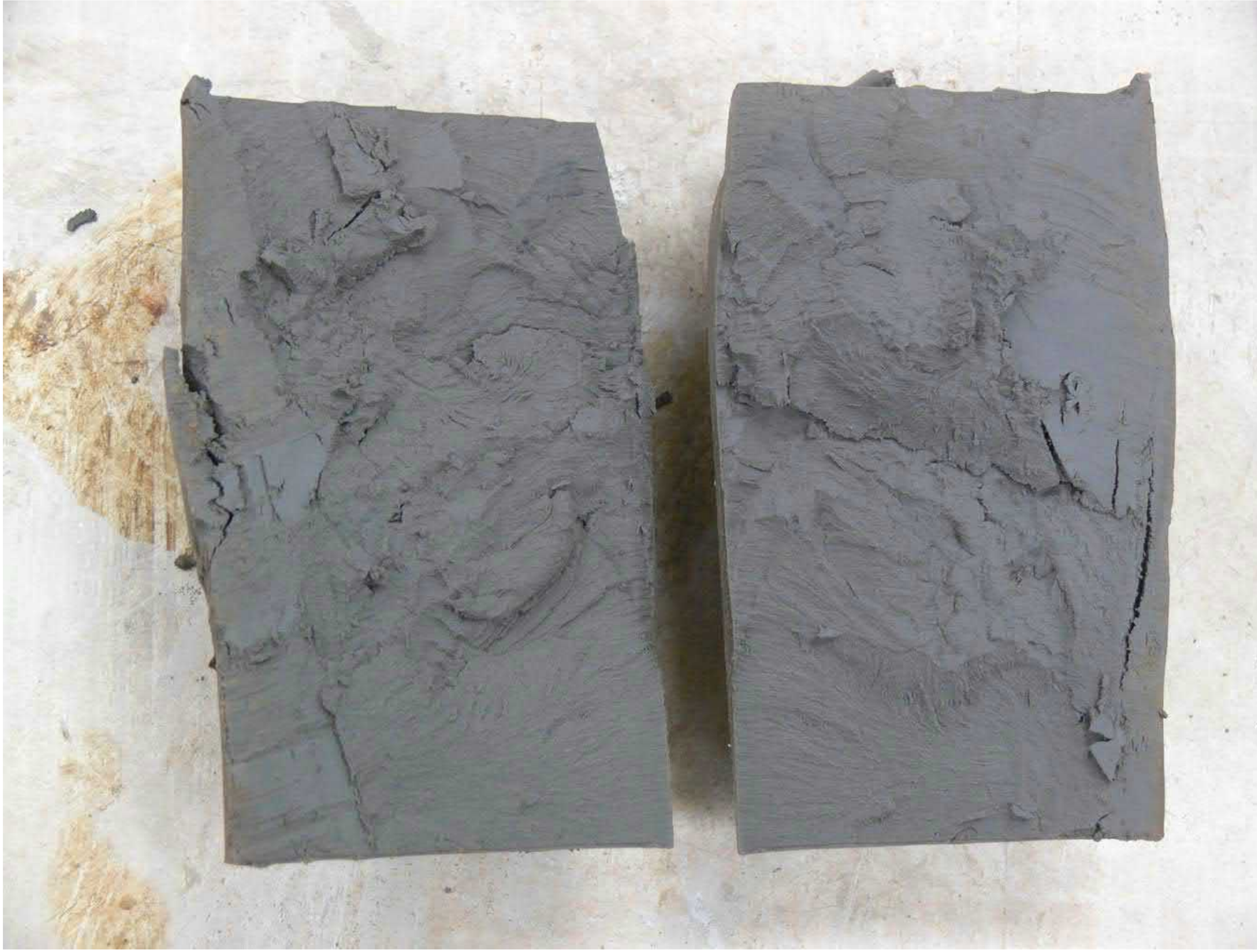


Photo 36: 202-251 BC-03 S06 @ 39.5' (tip-11'') After TXCUPP #2.JPG

Photo 37: 202-251 BC-03 S06 @ 39.5' (tip-11'') Before TXCUPP.JPG

Photo 38: 202-251 BC-03 S10 @ 90' (tip-13'') After TXCUPP #1.JPG

Photo 39: 202-251 BC-03 S10 @ 90' (tip-13'') After TXCUPP #2.JPG

Photo 40: 202-251 BC-03 S10 @ 90' (tip-13'') Before TXCUPP.JPG

Photo 41: 202-251 BC-04 S04 @ 12.5' (tip-4'') After TXCUPP #1.JPG

Photo 42: 202-251 BC-04 S04 @ 12.5' (tip-4'') After TXCUPP #2.JPG

Photo 43: 202-251 BC-04 S04 @ 12.5' (tip-4'') Before TXCUPP.JPG

Photo 44: 202-251 BC-04 S04 @ 12.5' (tip-15'') After TXCUPP #1.JPG

Photo 45: 202-251 BC-04 S04 @ 12.5' (tip-15'') After TXCUPP #2.JPG

Photo 46: 202-251 BC-04 S04 @ 12.5' (tip-15'') Before TXCUPP.JPG

Photo 47: 202-251 BC-04 S05 @ 17.6' (tip-6'') After TXCUPP #1.JPG

Photo 48: 202-251 BC-04 S05 @ 17.6' (tip-6'') After TXCUPP #2.JPG

Photo 49: 202-251 BC-04 S05 @ 17.6' (tip-6'') Before TXCUPP.JPG

Photo 50: 202-251 BC-04 S06 @ 22.5' (tip-2'') After TXCUPP #1.JPG

Photo 51: 202-251 BC-04 S06 @ 22.5' (tip-2'') After TXCUPP #2.JPG

Photo 52: 202-251 BC-04 S06 @ 22.5' (tip-2'') Before TXCUPP.JPG

Photo 53: 202-251 BC-04 S08 @ 32.5' (tip-10'') After TXCUPP #1.JPG

Photo 54: 202-251 BC-04 S08 @ 32.5' (tip-10'') After TXCUPP #2.JPG

Photo 55: 202-251 BC-04 S08 @ 32.5' (tip-10'') Before TXCUPP.JPG

Photo 56: 202-251 BC-04 S10 @ 52.5' (tip-4'') After TXCUPP #1.JPG

Photo 57: 202-251 BC-04 S10 @ 52.5' (tip-4'') After TXCUPP #2.JPG

Photo 58: 202-251 BC-04 S10 @ 52.5' (tip-4'') Before TXCUPP.JPG

Photo 59: 202-251 BC-04 S10 @ 52.5' (tip-18'') After TXCUPP #1.JPG

Photo 60: 202-251 BC-04 S10 @ 52.5' (tip-18'') After TXCUPP #2.JPG

Photo 61: 202-251 BC-04 S10 @ 52.5' (tip-18'') Before TXCUPP.JPG

Photo 62: 202-251 BC-05 S04 @ 14.5' (tip-1'') After TXCUPP #1.JPG

Photo 63: 202-251 BC-05 S04 @ 14.5' (tip-1'') After TXCUPP #2.JPG

Photo 64: 202-251 BC-05 S04 @ 14.5' (tip-1'') Before TXCUPP.JPG

Photo 65: 202-251 BC-05 S04 @ 14.5' (tip-16'') After TXCUPP #1.JPG

Photo 66: 202-251 BC-05 S04 @ 14.5' (tip-16'') After TXCUPP #2.JPG

Photo 67: 202-251 BC-05 S04 @ 14.5' (tip-16'') Before TXCUPP.JPG

Photo 68: 202-251 BC-09 S05 @ 23' (tip-5'') After TXCUPP #1.JPG

Photo 69: 202-251 BC-09 S05 @ 23' (tip-5'') After TXCUPP #2.JPG

Photo 70: 202-251 BC-09 S05 @ 23' (tip-5'') Before TXCUPP.JPG

Photo 71: 202-251 BC-09 S05 @ 23' (tip-13'') After TXCUPP #1.JPG

Photo 72: 202-251 BC-09 S05 @ 23' (tip-13'') After TXCUPP #2.JPG

Photo 73: 202-251 BC-09 S05 @ 23' (tip-13'') Before TXCUPP.JPG

Photo 74: 202-251 BC-09 S09 @ 68' (tip-4'') After TXCUPP #1.JPG

Photo 75: 202-251 BC-09 S09 @ 68' (tip-4'') After TXCUPP #2.JPG

Photo 76: 202-251 BC-09 S09 @ 68' (tip-4'') Before TXCUPP.JPG

Photo 77: 202-251 BC-09 S09 @ 68' (tip-10'') After TXCUPP #1.JPG

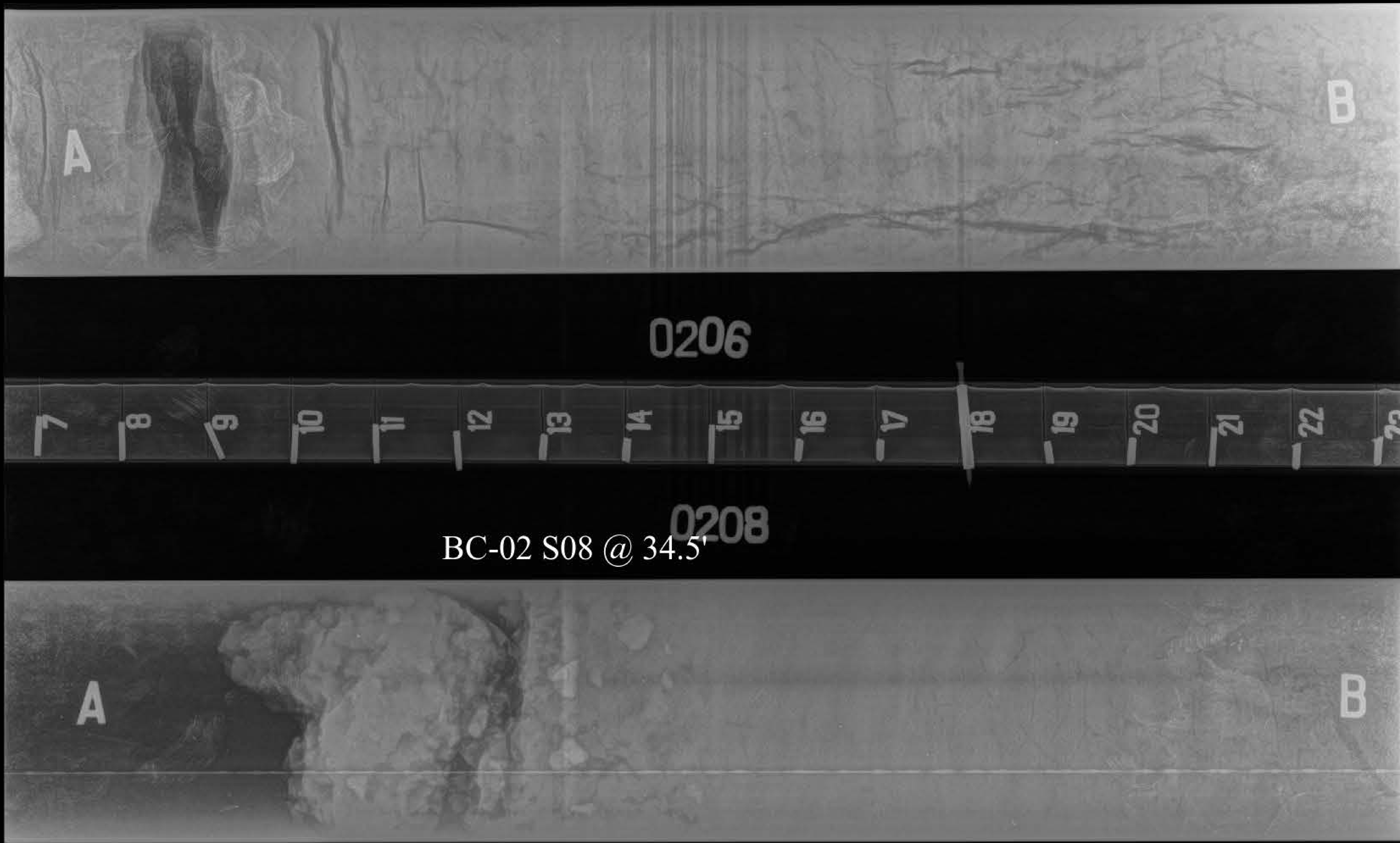
Photo 78: 202-251 BC-09 S09 @ 68' (tip-10'') After TXCUPP #2.JPG

Photo 79: 202-251 BC-09 S09 @ 68' (tip-10'') Before TXCUPP.JPG

CTL# 020-251
AECOM
Klamath River Dam Removal
60537920

Scale in inches
0 = Top of Tube

BC-02 S06 @ 19.5'



BC-02 S08 @ 34.5'

CTL# 020-251
AECOM
Klamath River Dam Removal
60537920

Scale in inches
0 = Top of Tube

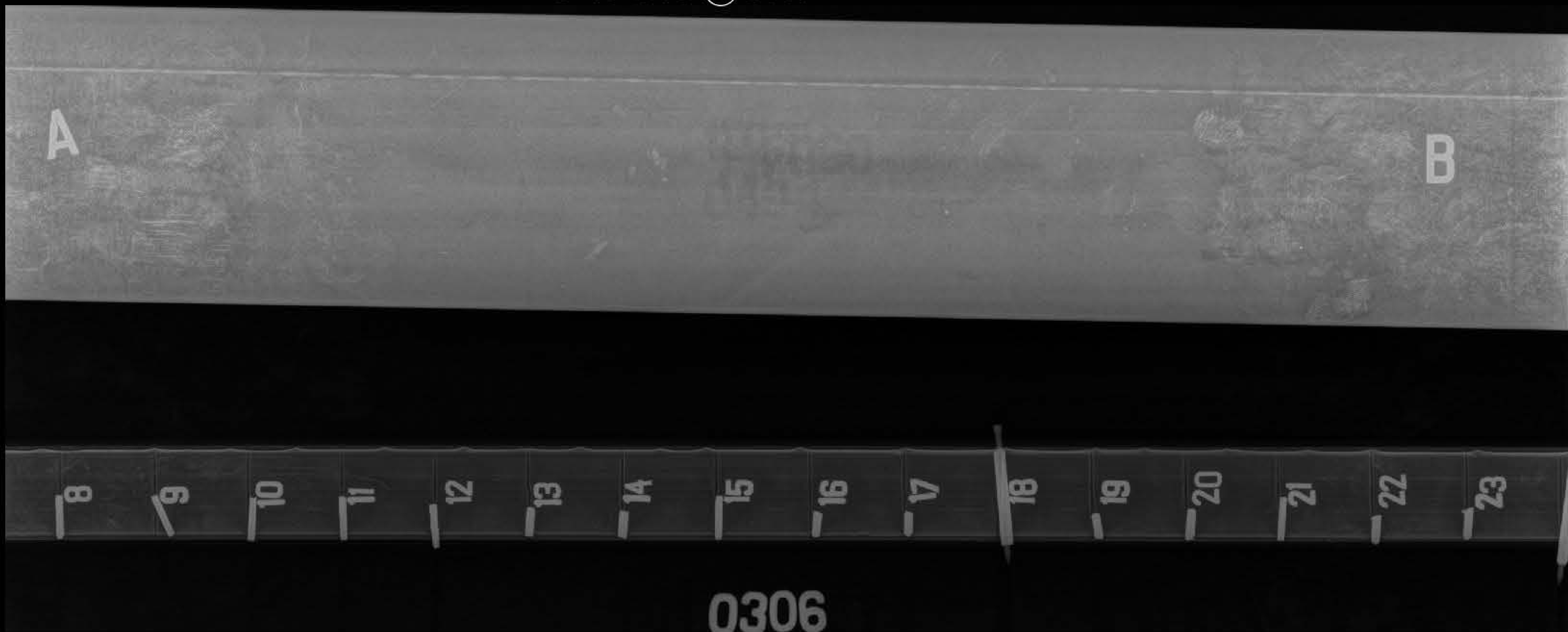
BC-02 S06 @ 19.5'

BC-02 S08 @ 34.5'

CTL# 020-251
AECOM
Klamath River Dam Removal
60537920

Scale in inches
0 = Top of Tube

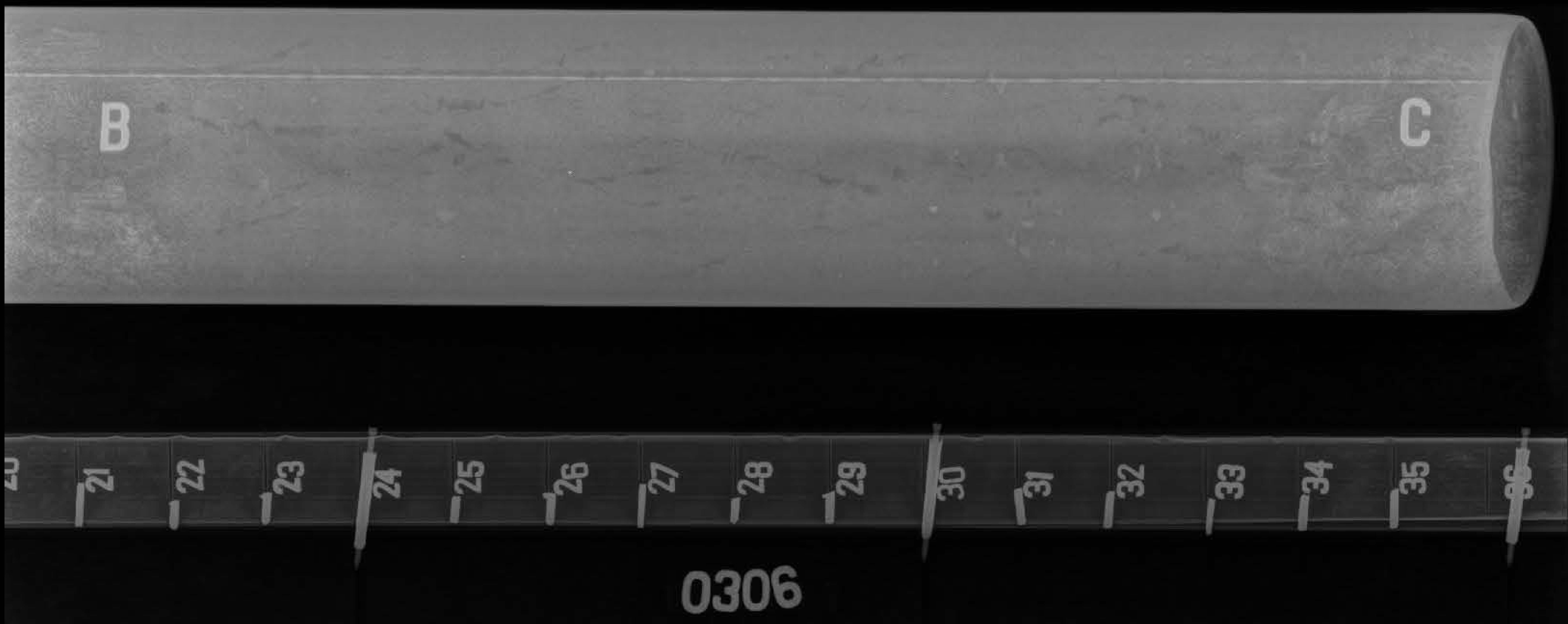
BC-03 S06 @ 39.5'



CTL# 020-251
AECOM
Klamath River Dam Removal
60537920

Scale in inches
0 = Top of Tube

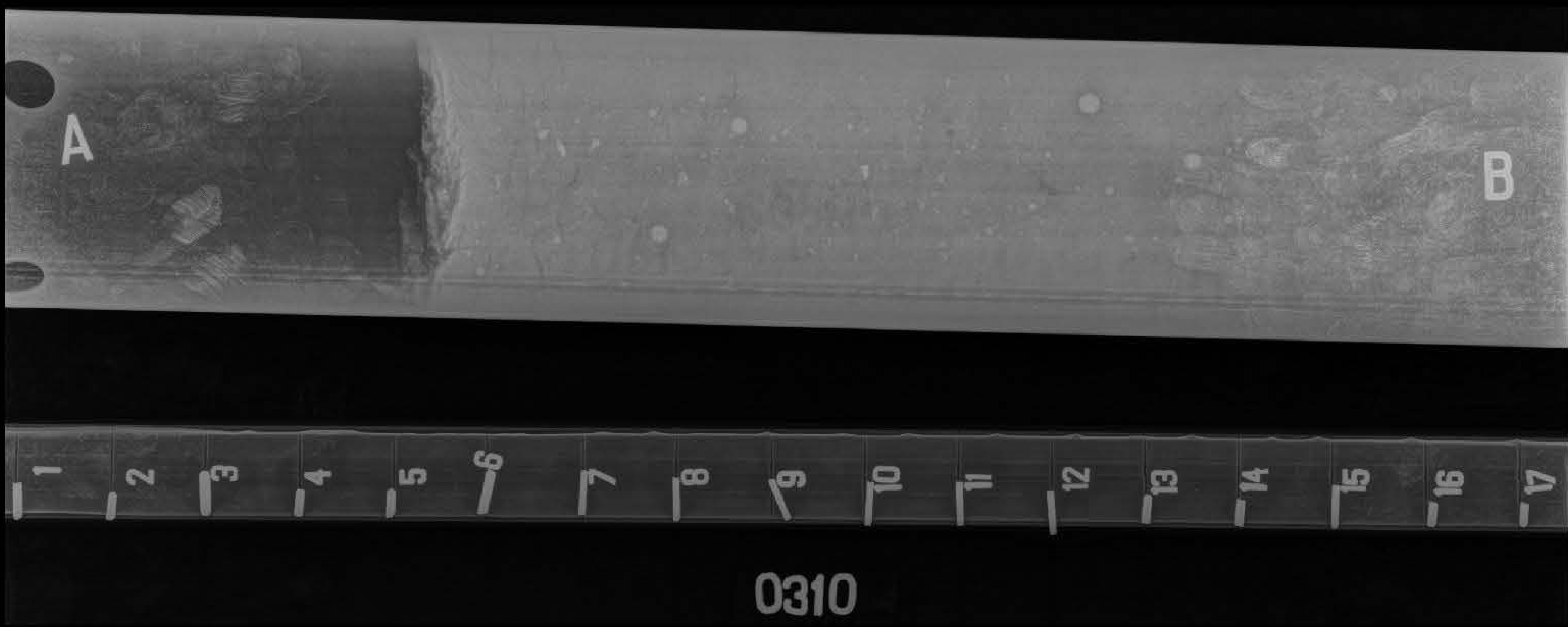
BC-03 S06 @ 39.5'



CTL# 020-251
AECOM
Klamath River Dam Removal
60537920

Scale in inches
0 = Top of Tube

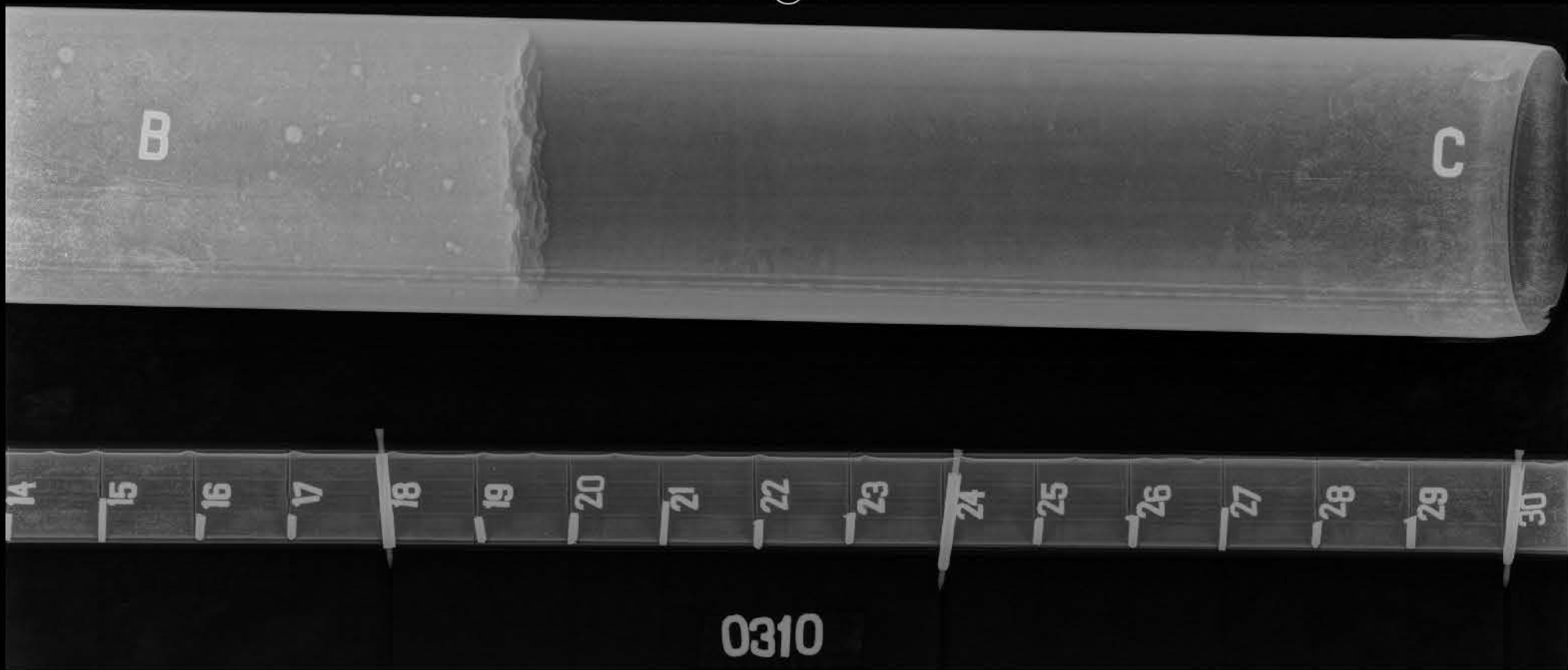
BC-03 S10 @ 90'



CTL# 020-251
AECOM
Klamath River Dam Removal
60537920

Scale in inches
0 = Top of Tube

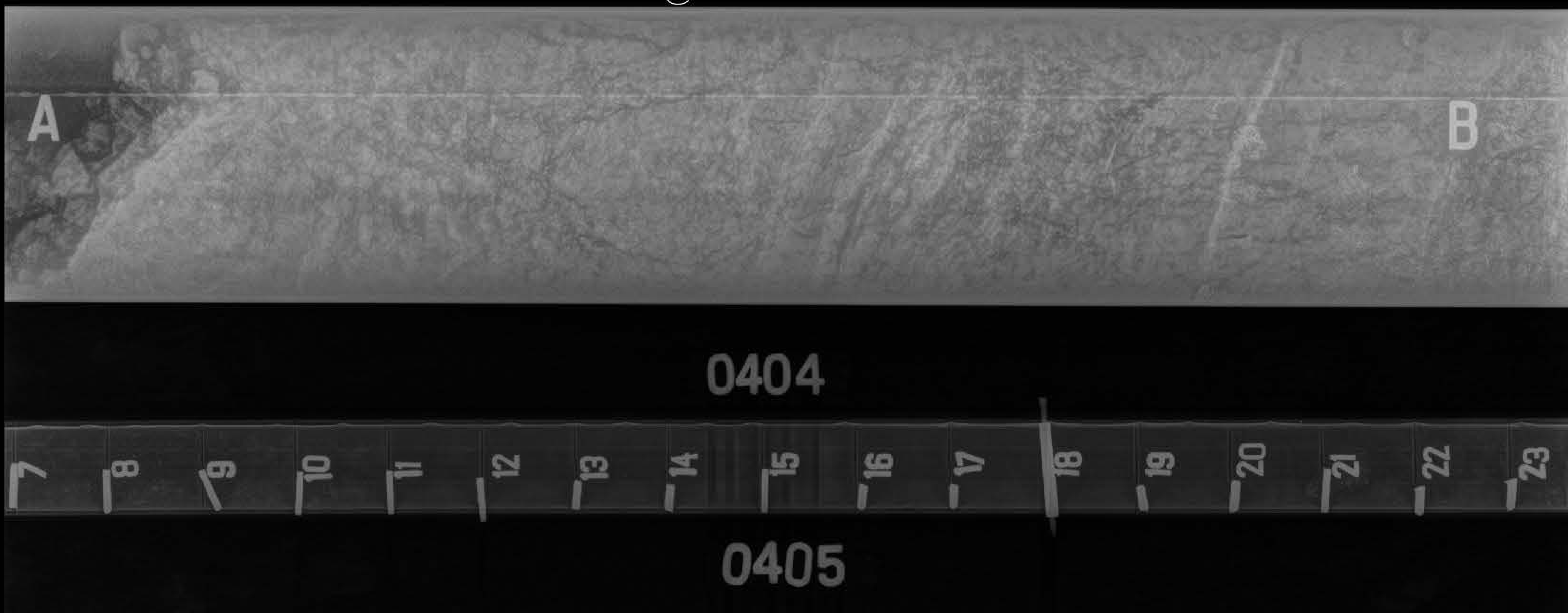
BC-03 S10 @ 90'



CTL# 020-251
AECOM
Klamath River Dam Removal
60537920

Scale in inches
0 = Top of Tube

BC-04 S04 @ 12.5'



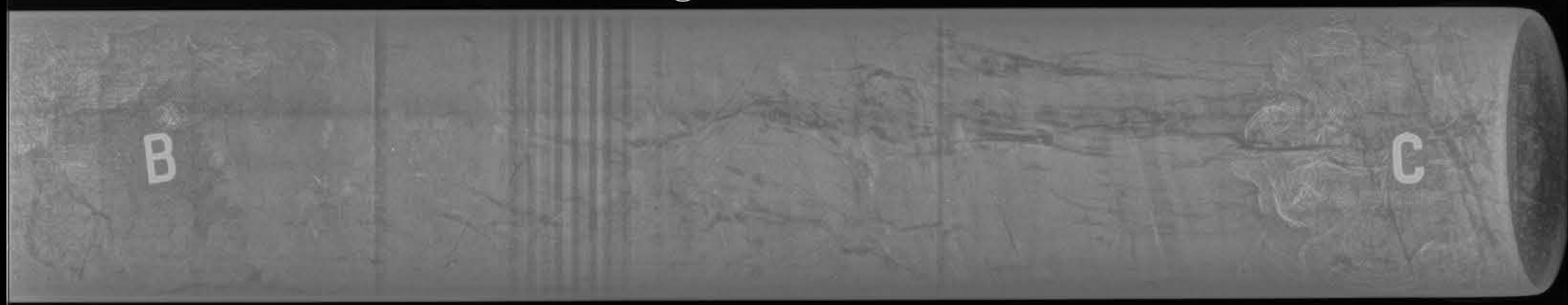
BC-04 S05 @ 17.5'

CTL# 020-251
AECOM
Klamath River Dam Removal
60537920

Scale in inches
0 = Top of Tube

BC-04 S04 @ 12.5'

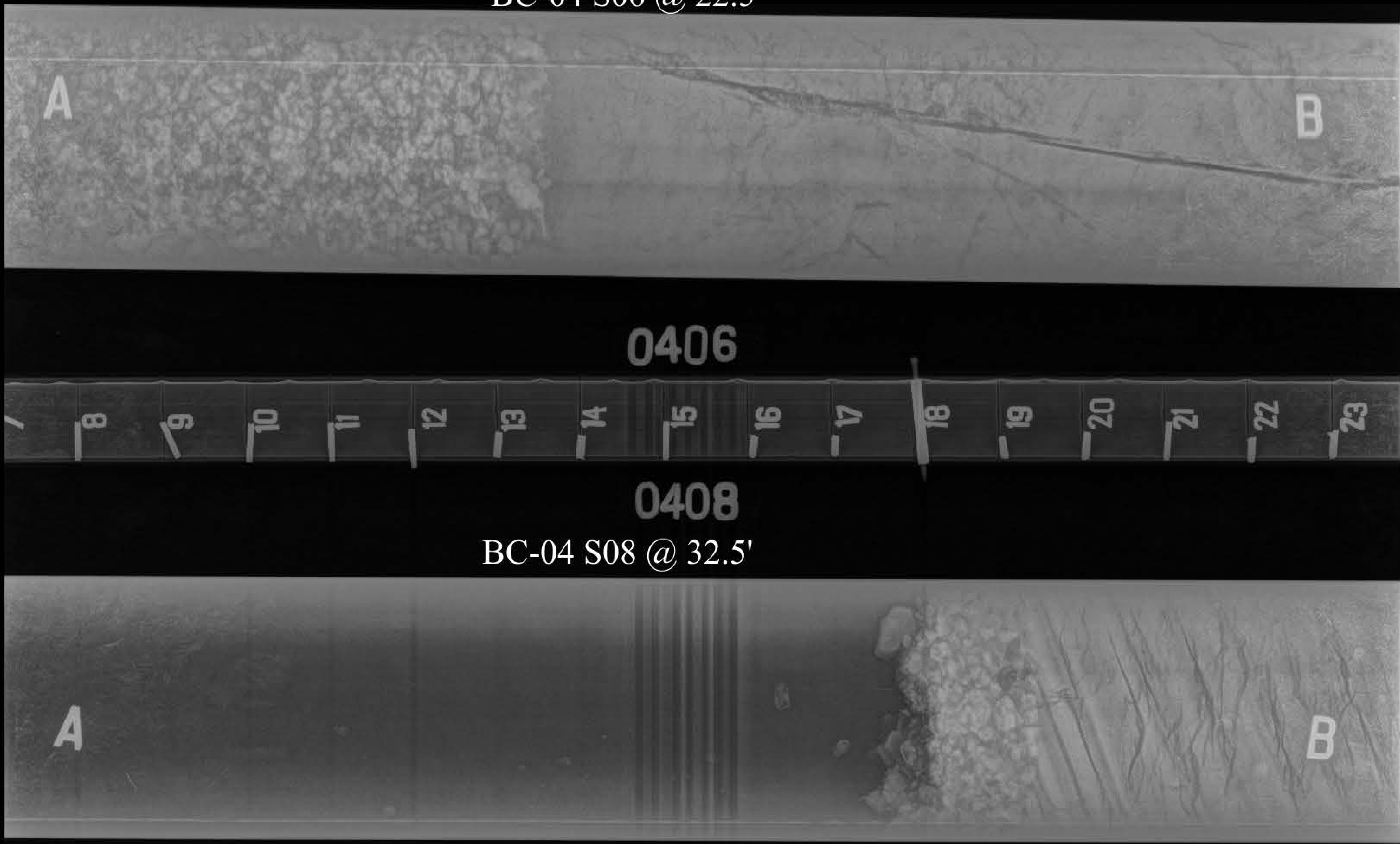
BC-04 S05 @ 17.5'



CTL# 020-251
AECOM
Klamath River Dam Removal
60537920

Scale in inches
0 = Top of Tube

BC-04 S06 @ 22.5'



BC-04 S08 @ 32.5'

CTL# 020-251
AECOM
Klamath River Dam Removal
60537920

Scale in inches
0 = Top of Tube

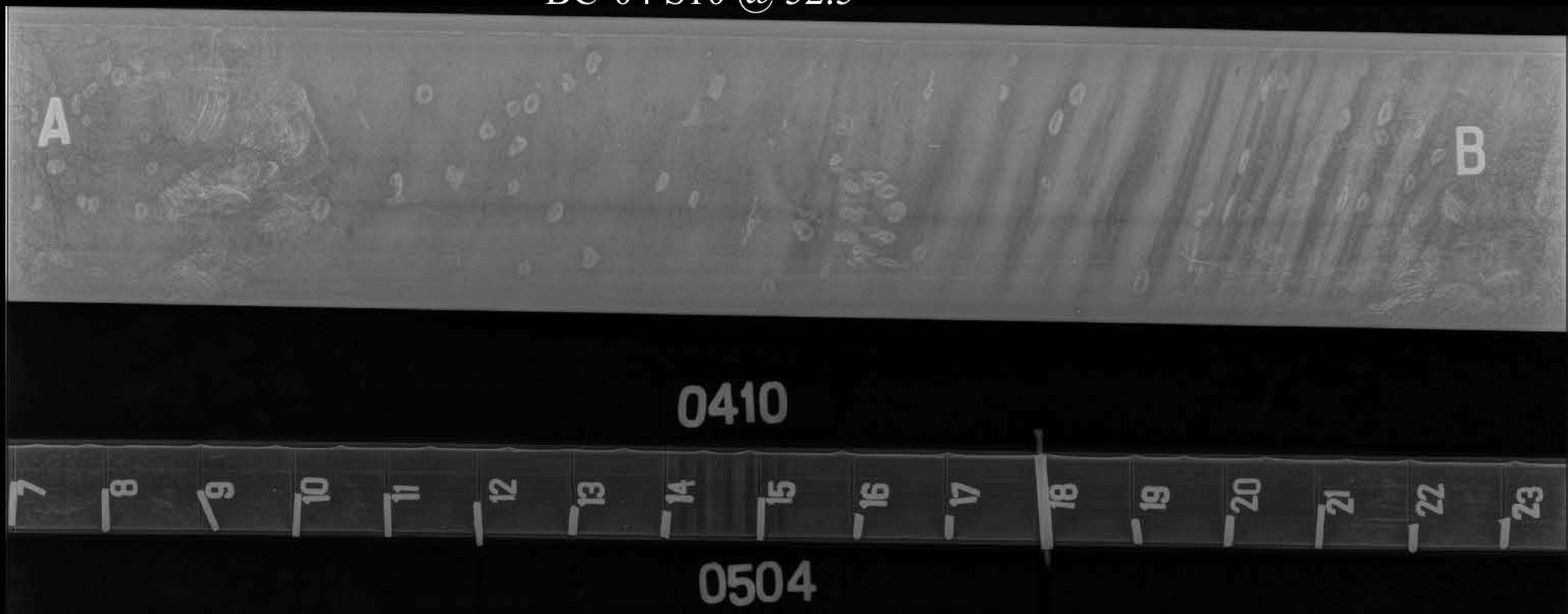
BC-04 S06 @ 22.5'

BC-04 S08 @ 32.5'

CTL# 020-251
AECOM
Klamath River Dam Removal
60537920

Scale in inches
0 = Top of Tube

BC-04 S10 @ 52.5'

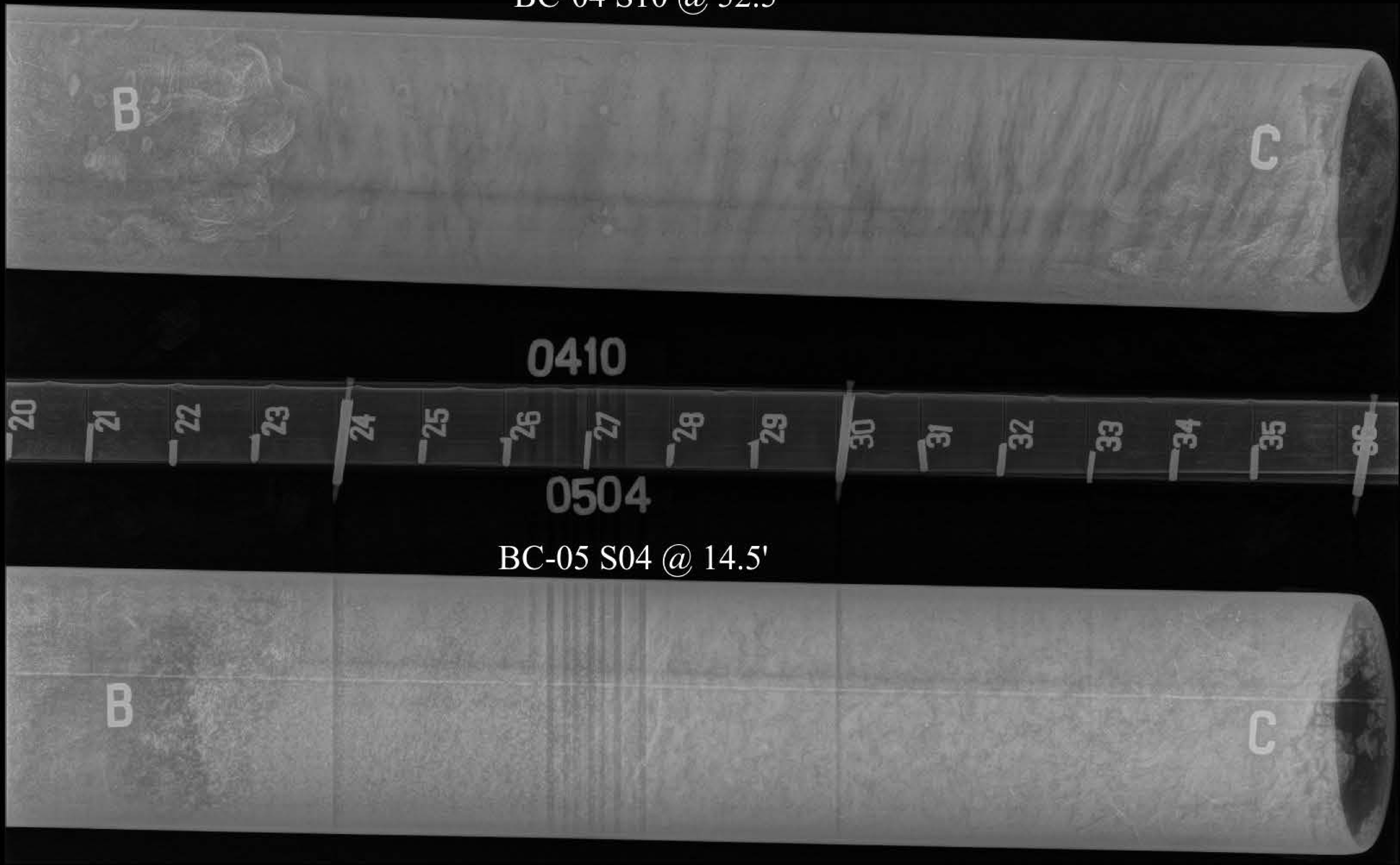


BC-05 S04 @ 14.5'

CTL# 020-251
AECOM
Klamath River Dam Removal
60537920

Scale in inches
0 = Top of Tube

BC-04 S10 @ 52.5'

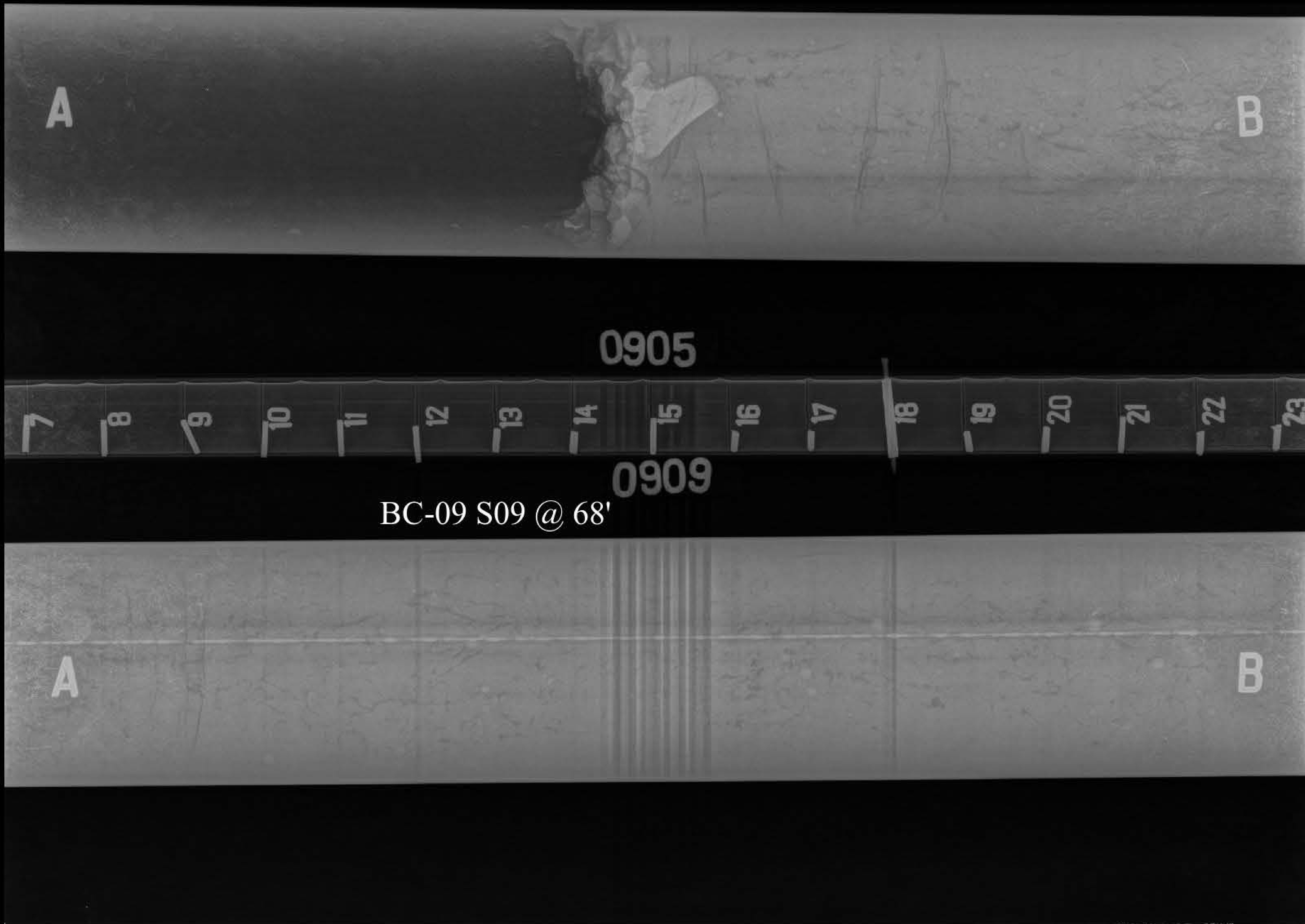


BC-05 S04 @ 14.5'

CTL# 020-251
AECOM
Klamath River Dam Removal
60537920

Scale in inches
0 = Top of Tube

BC-09 S05 @ 23'



BC-09 S09 @ 68'

CTL# 020-251
AECOM
Klamath River Dam Removal
60537920

Scale in inches
0 = Top of Tube

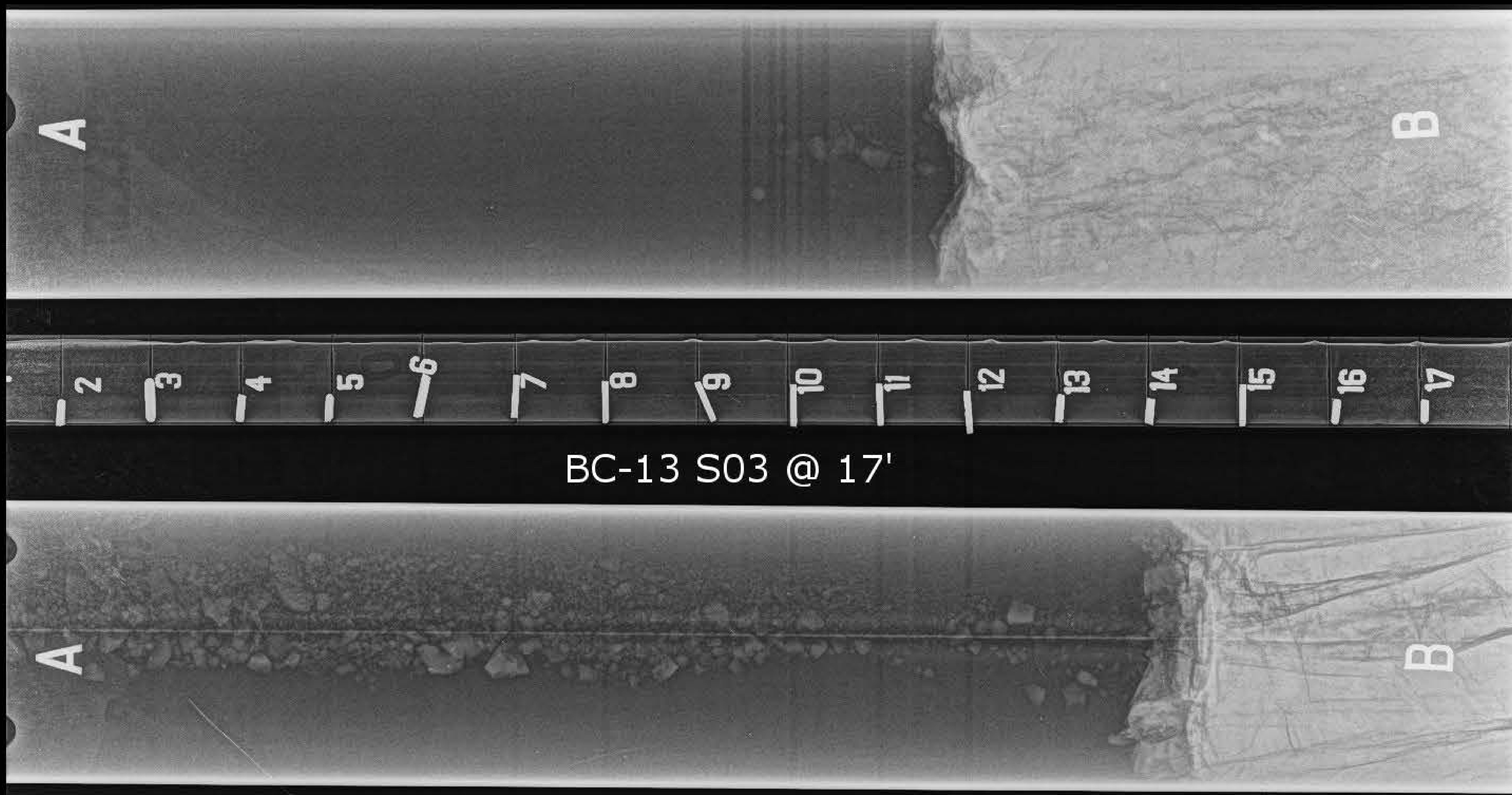
BC-09 S05 @ 23'

BC-09 S09 @ 68'

CTL# 020-271
AECOM
Klamath River Dam
Removal Project
60537920

Scale in inches
0 = Top of Tube

BC-13 S02 @ 12'

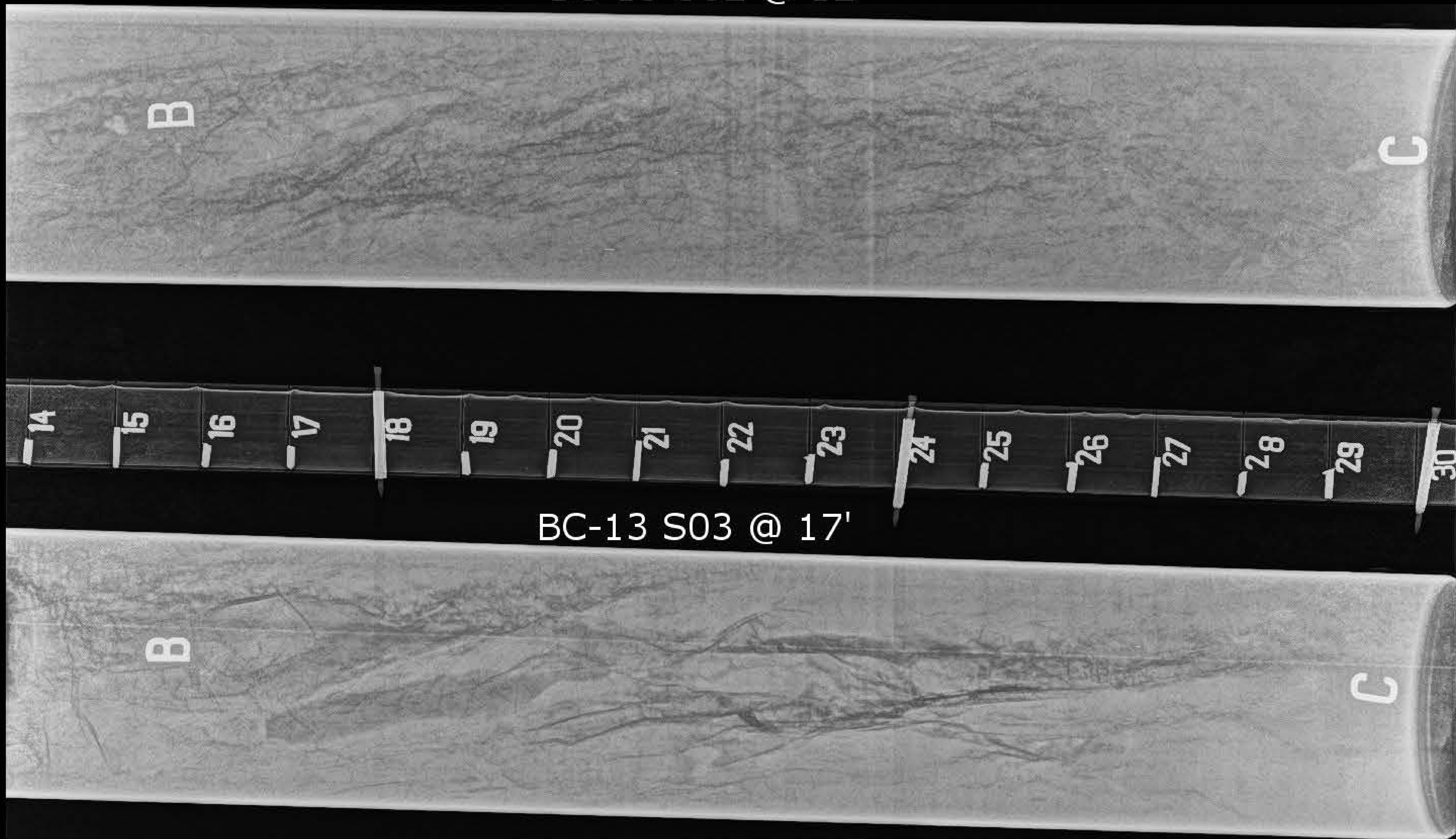


BC-13 S03 @ 17'

CTL# 020-271
AECOM
Klamath River Dam
Removal Project
60537920

Scale in inches
0 = Top of Tube

BC-13 S02 @ 12'

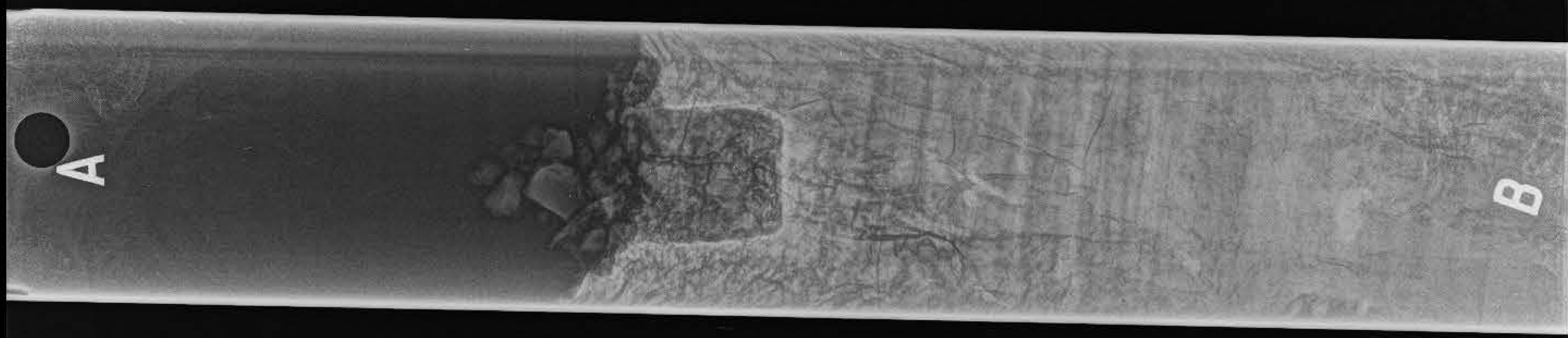


CTL# 020-271
AECOM
Klamath River Dam
Removal Project
60537920

Scale in inches
0 = Top of Tube

BC-13 S04 @ 22'

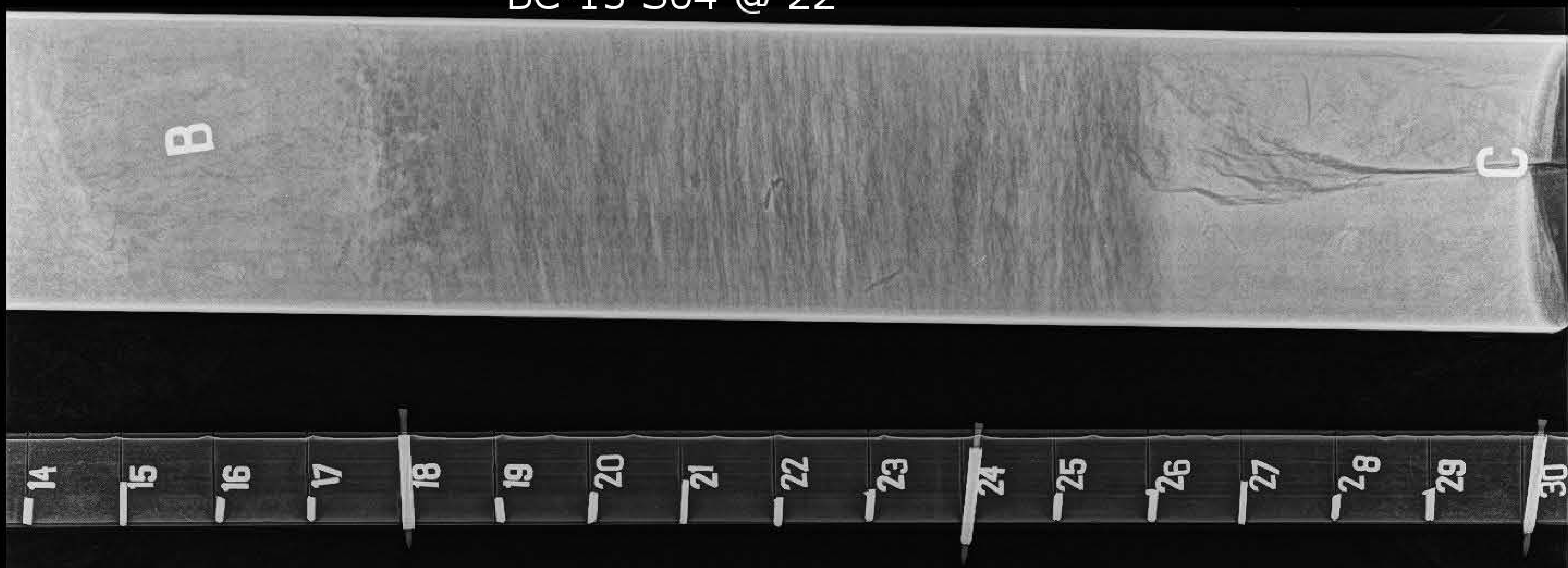
BC-13 S05 @ 30.5'



CTL# 020-271
AECOM
Klamath River Dam
Removal Project
60537920

Scale in inches
0 = Top of Tube

BC-13 S04 @ 22'

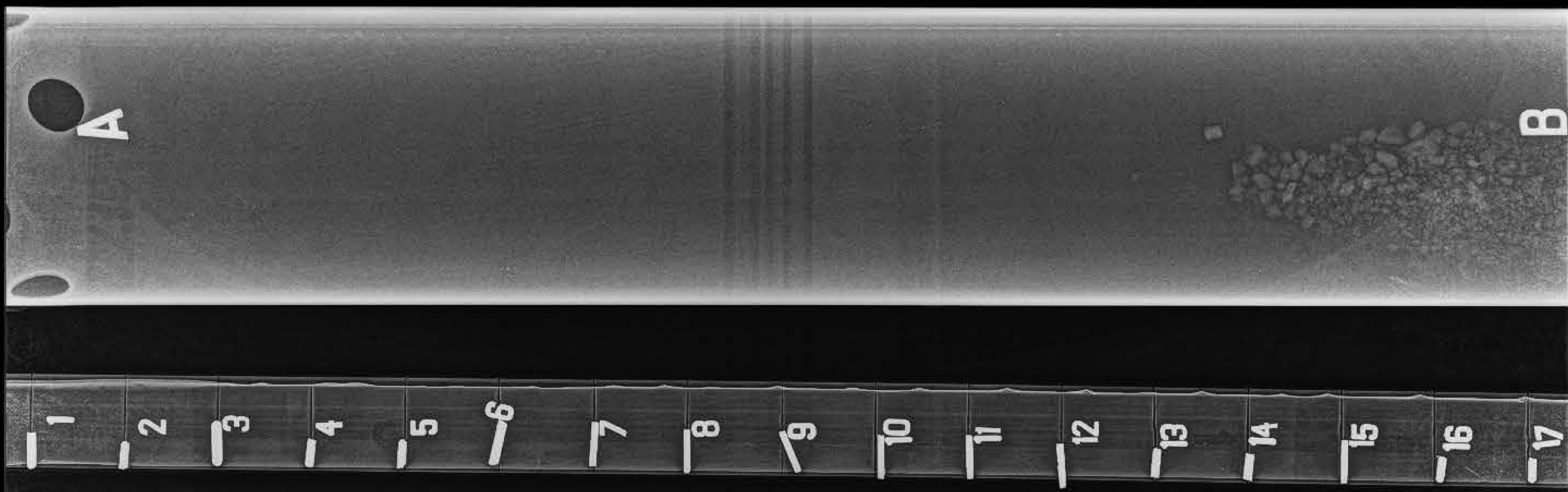


BC-13 S05 @ 30.5'

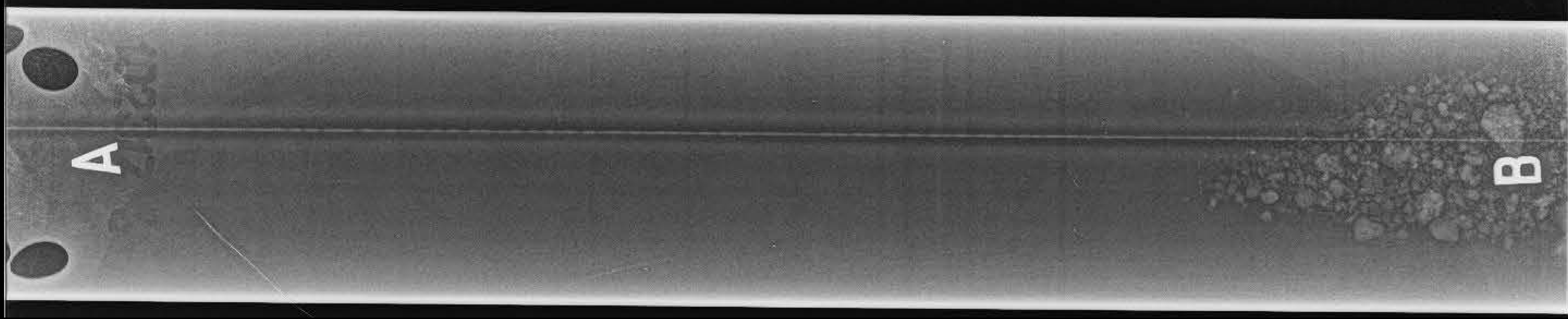
CTL# 020-271
AECOM
Klamath River Dam
Removal Project
60537920

Scale in inches
0 = Top of Tube

BC-14 S01 @ 5'



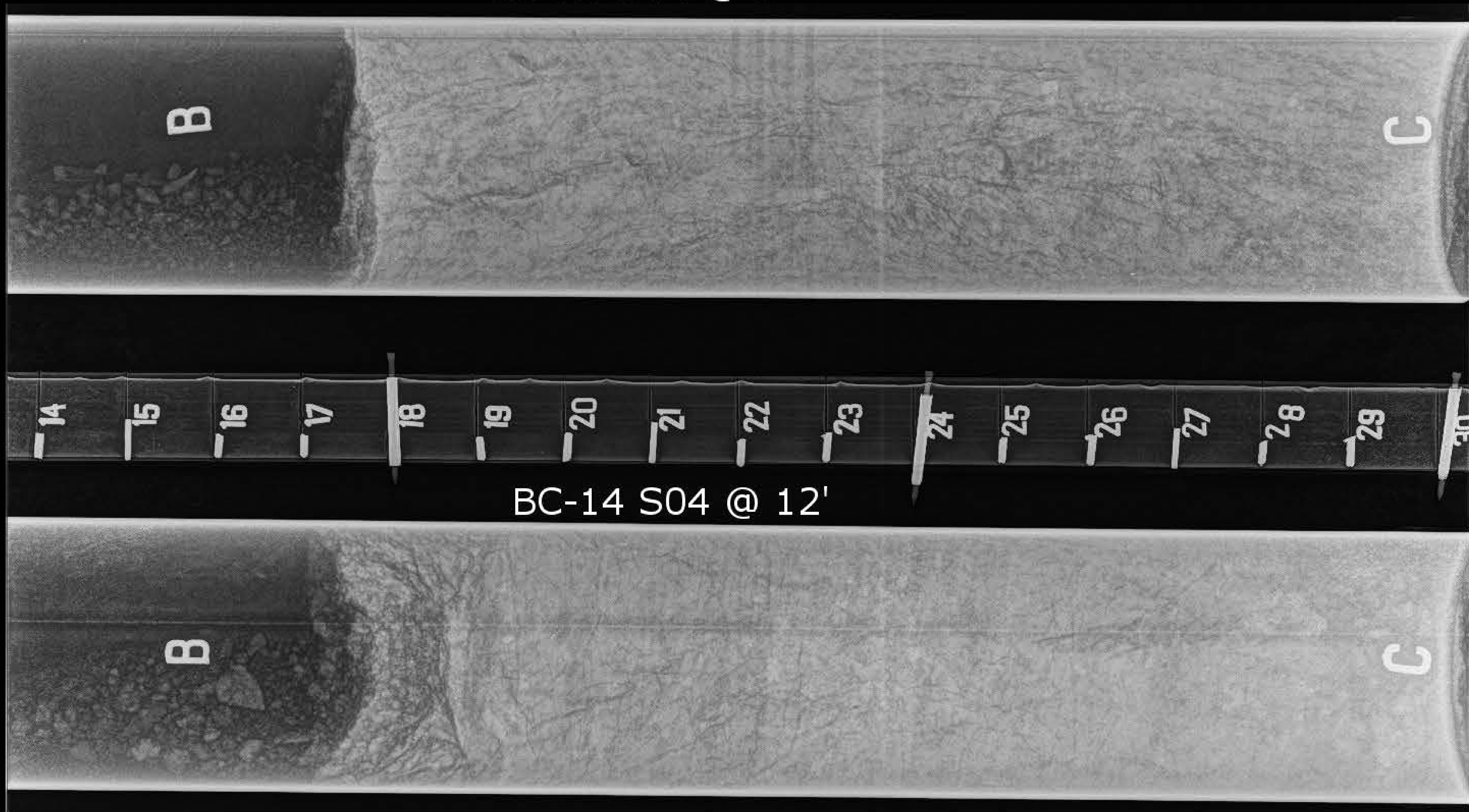
BC-14 S04 @ 12'



CTL# 020-271
AECOM
Klamath River Dam
Removal Project
60537920

Scale in inches
0 = Top of Tube

BC-14 S01 @ 5'



BC-14 S04 @ 12'

Moisture Content
ASTM D2216-10

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.	2018-22-4-1
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.
Phone: +1-512-200-3051
E-mail: fulvio@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.

Moisture Content
ASTM D2216-10

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.	2018-22-4-3
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.

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.	2018-22-4-4
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.

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

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.

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.	2018-22-3-1
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.

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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

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.	2018-22-3-3
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

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

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

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Austin, TX 78741

Laboratory Director: Dr. Fulvio Tonon, P.E.
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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.	2018-22-3-4
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

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

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Austin, TX 78741

Laboratory Director: Dr. Fulvio Tonon, P.E.
Phone: +1-512-200-3051
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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

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

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Austin, TX 78741

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

Point Load Strength Test
ASTM D 5731 - 08

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.	2018-22-1
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
Austin, TX 78741

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

POINT LOAD TEST RESULTS
BI-02 and BI-03

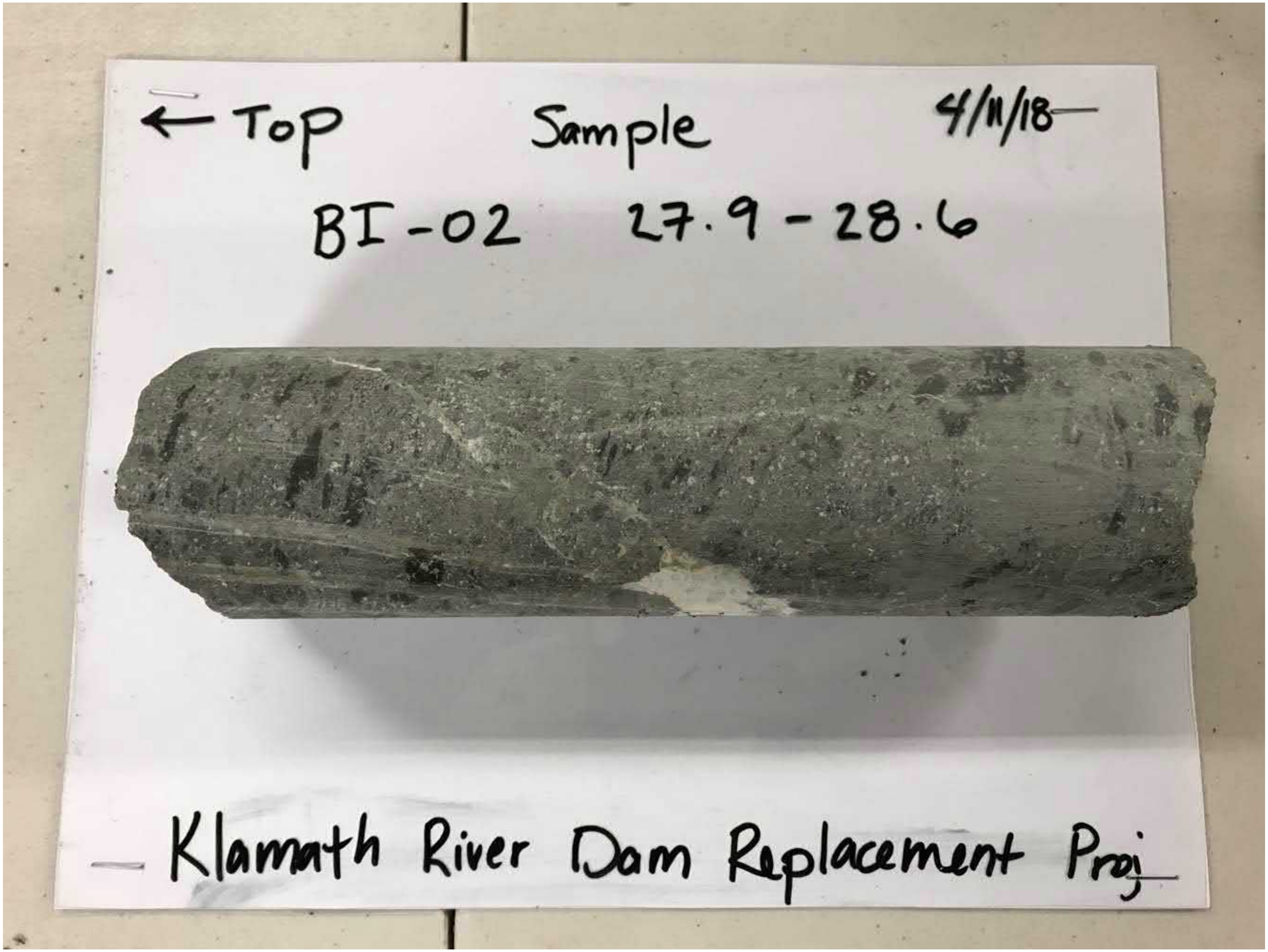
Test Number	Test Order	Depth of Test	Boring Number	Date	Depth Interval Bottom	Depth Interval Top	Rock Type[1]	Diameter (D) (mm)	Diameter (D) (in)	Distance Between Contact Points (cm)	Distance Between Contact Points (in)	Length - Contact Points to End of Sample, L (in)	L/D[2]	Test Type[3]	Failure Load, 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


←Top
Sample
4/11/18
BI-02 21.9-22.6
Klamath River Dam Removal


←Top Sample 4/11/18
BI-02 21.9-22.6
Klamath River Dam Removal



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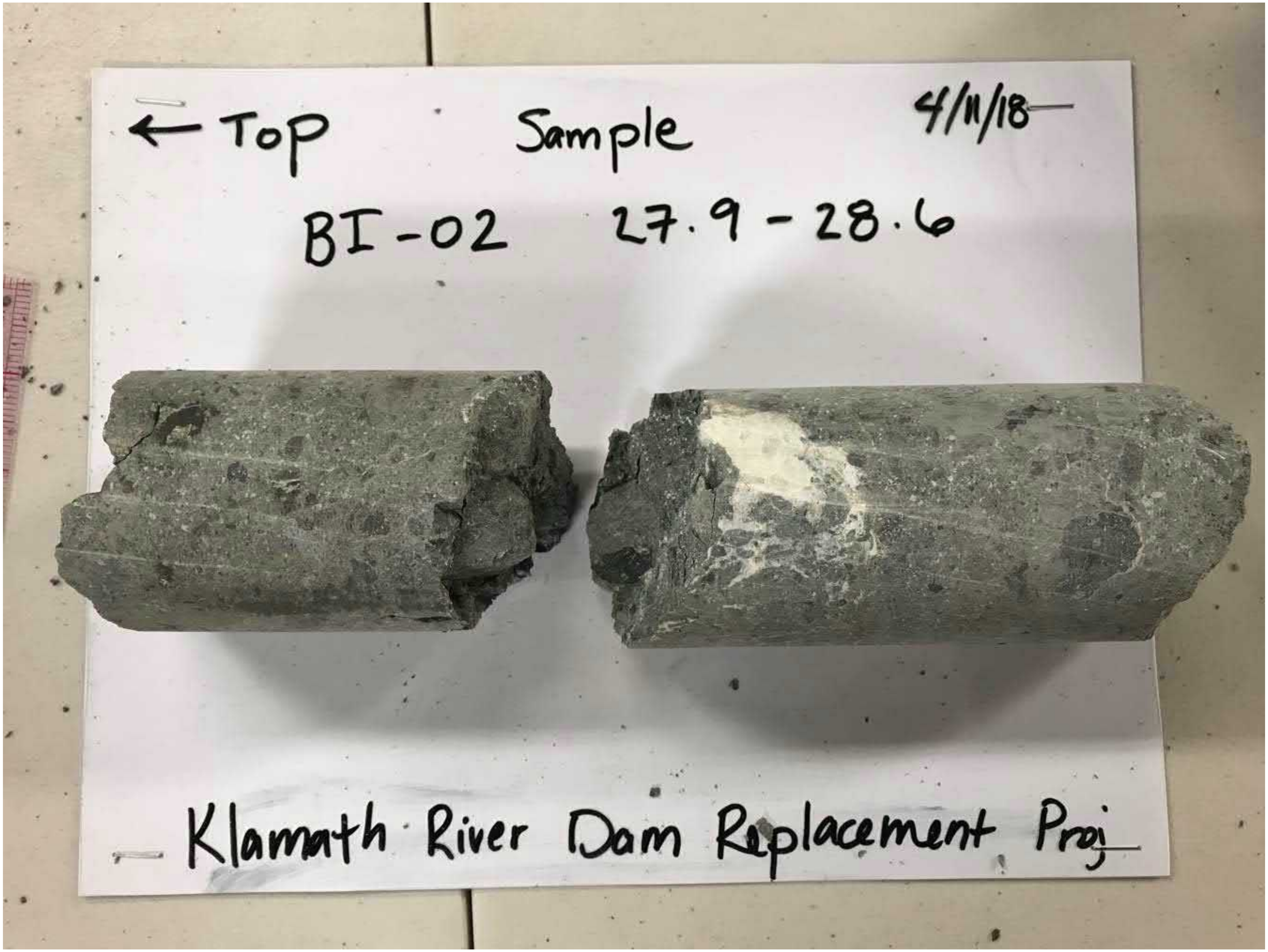
Sample
4/11/18
BI-02 27.9 - 28.6
Klamath River Dam Replacement Proj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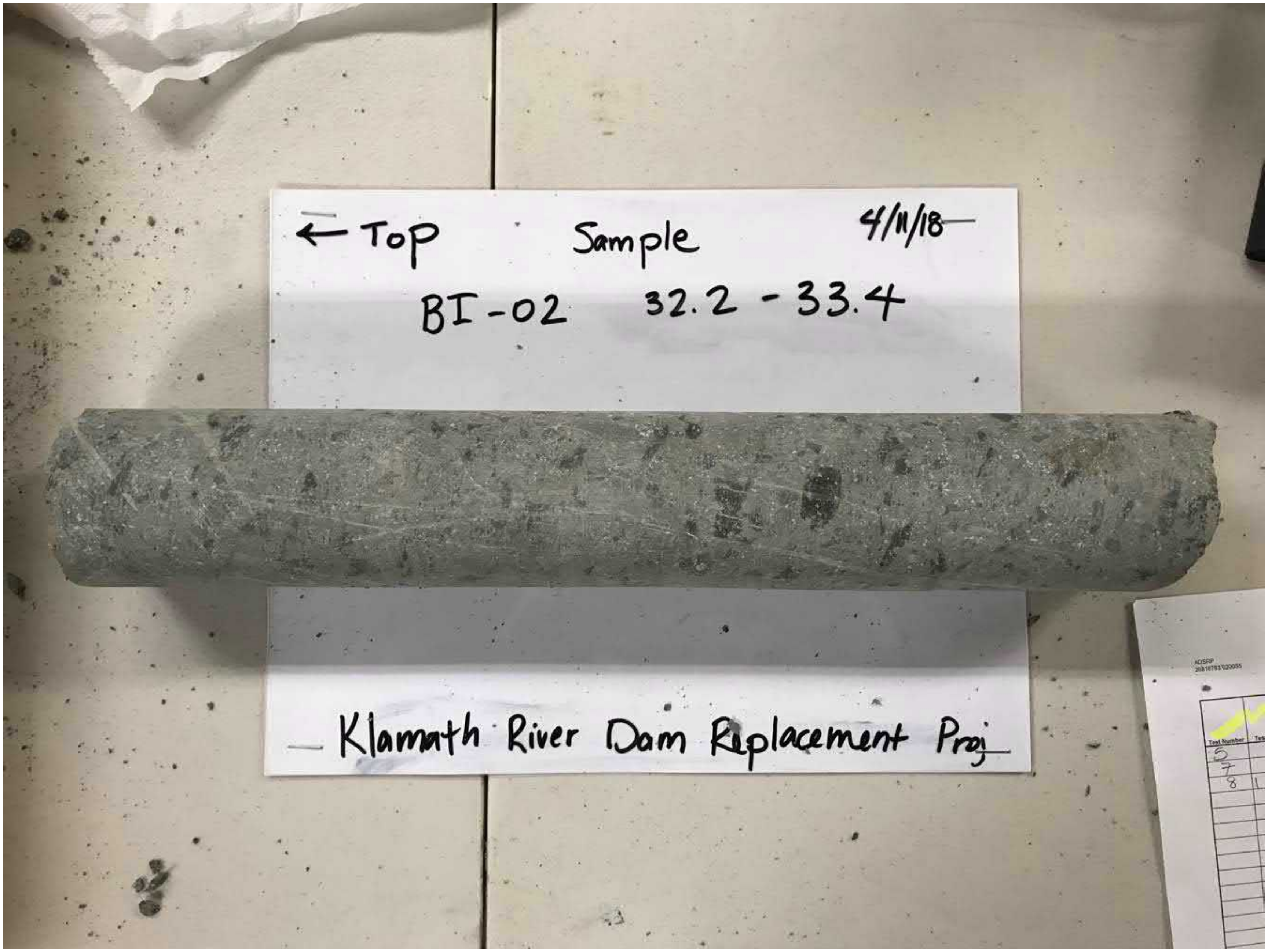
Sample
4/11/18
BI-02 27.9 - 28.6
Klamath River Dam Replacement Proj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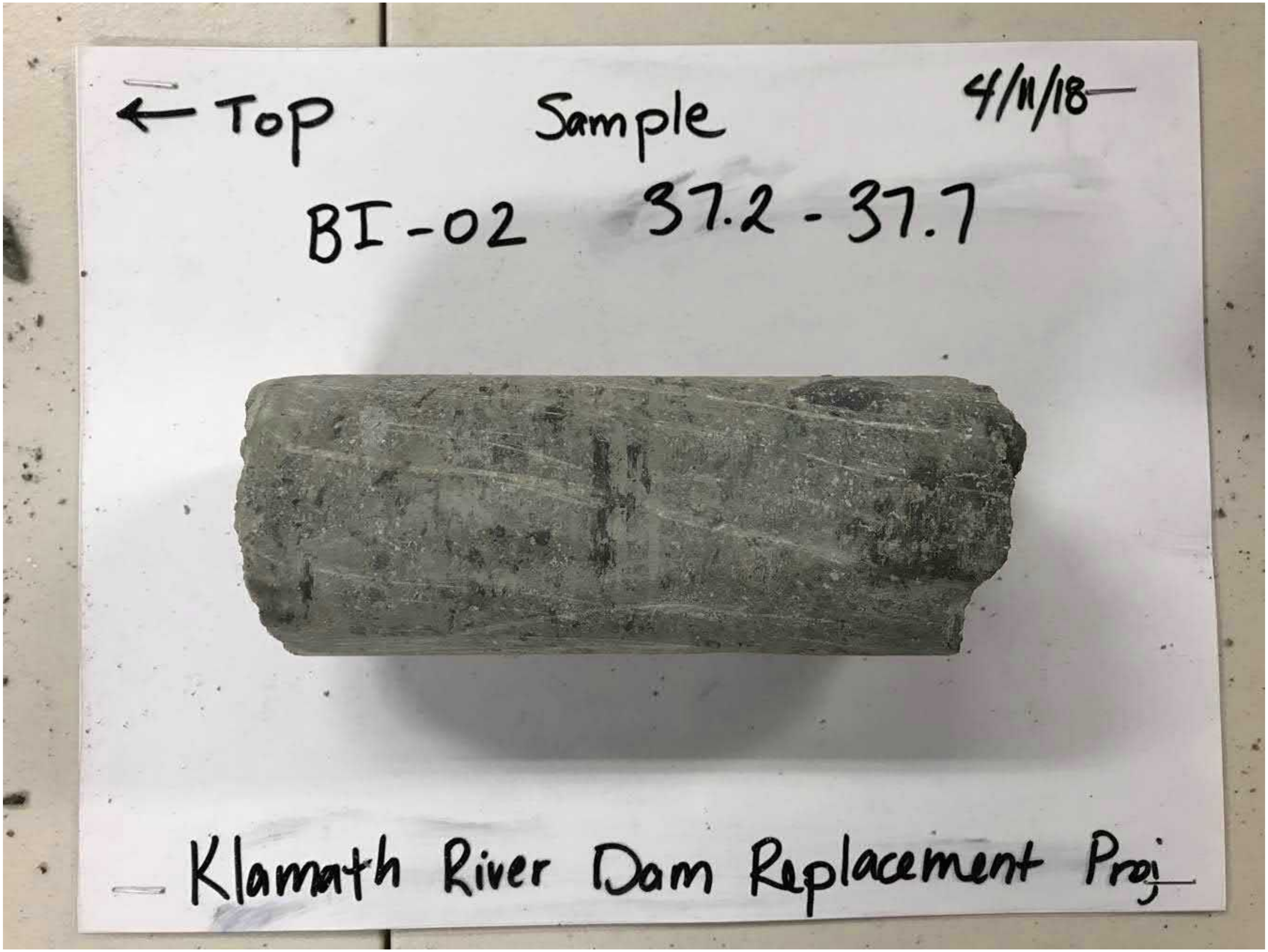
Sample
4/11/18
BI-02 32.2 - 33.4
Klamath River Dam Replacement Proj

← Top Sample 4/11/18
BI-02 32.2 - 33.4
Klamath River Dam Replacement Proj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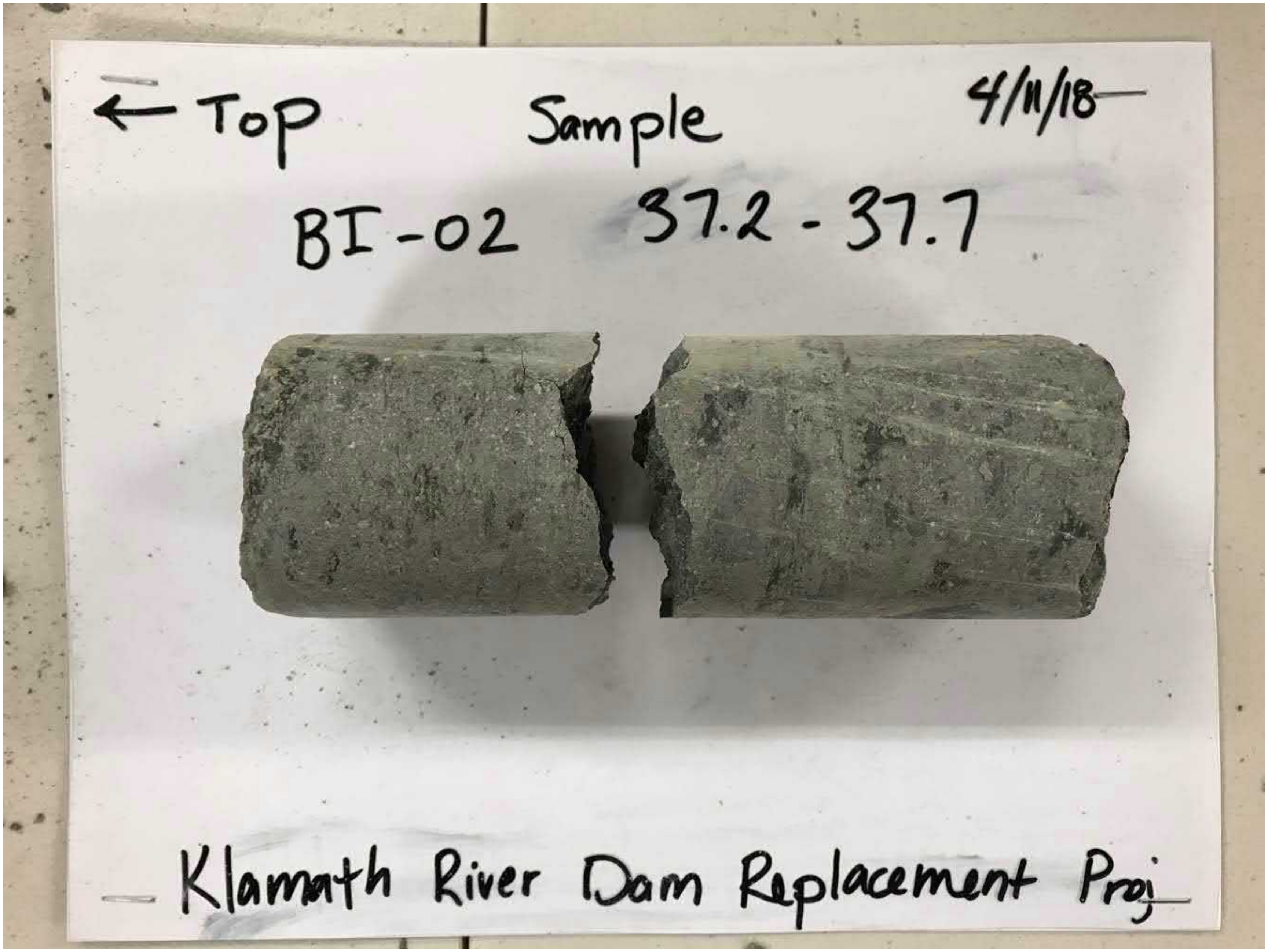
Sample
4/11/18
BI-02 37.2 - 37.7
Klamath River Dam Replacement Proj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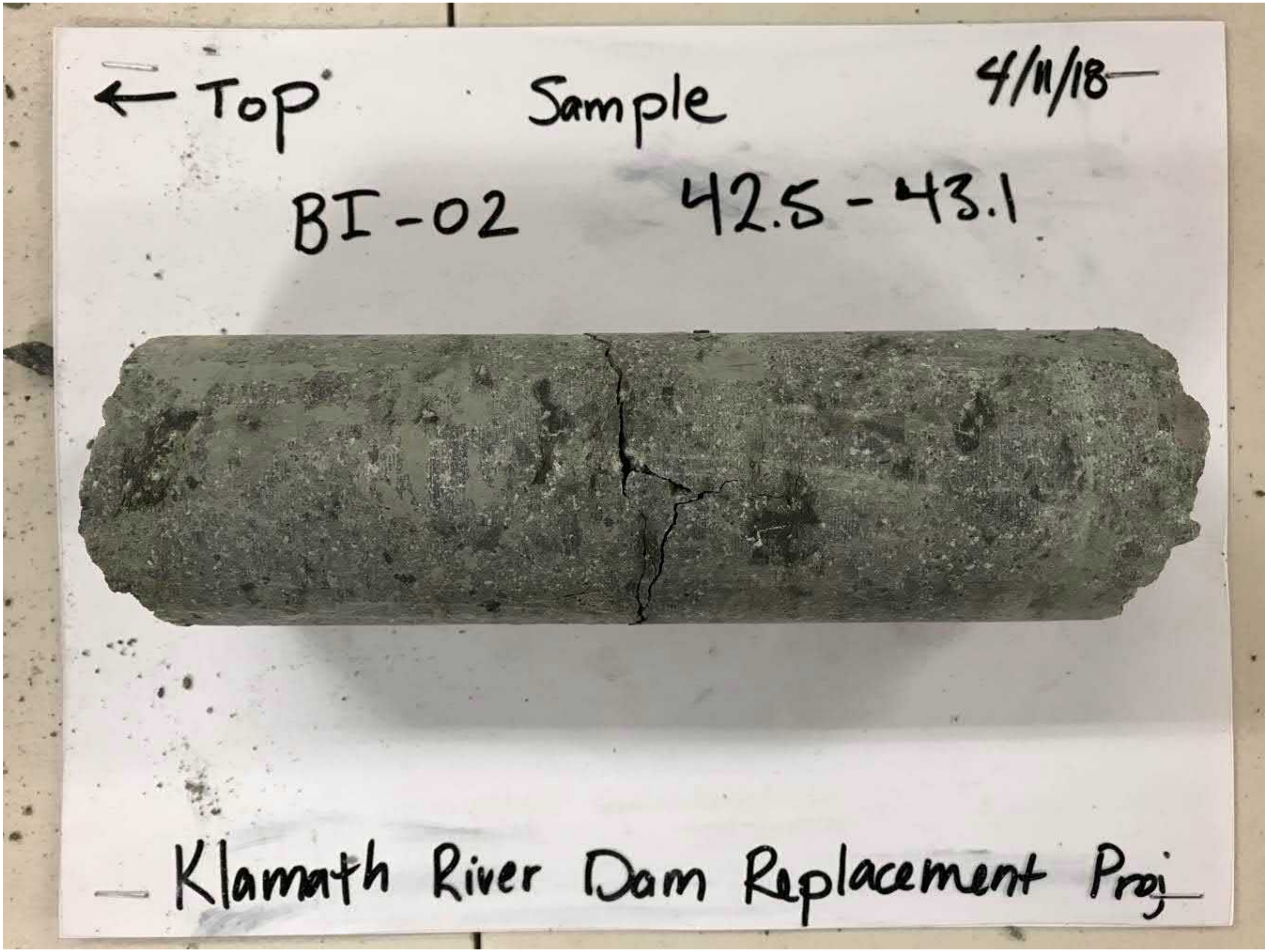
Sample
4/11/18
BI-02 37.2 - 37.7
Klamath River Dam Replacement Proj


← Top
Sample
4/11/18
BI-02
42.5 - 43.1
Klamath River Dam Replacement Proj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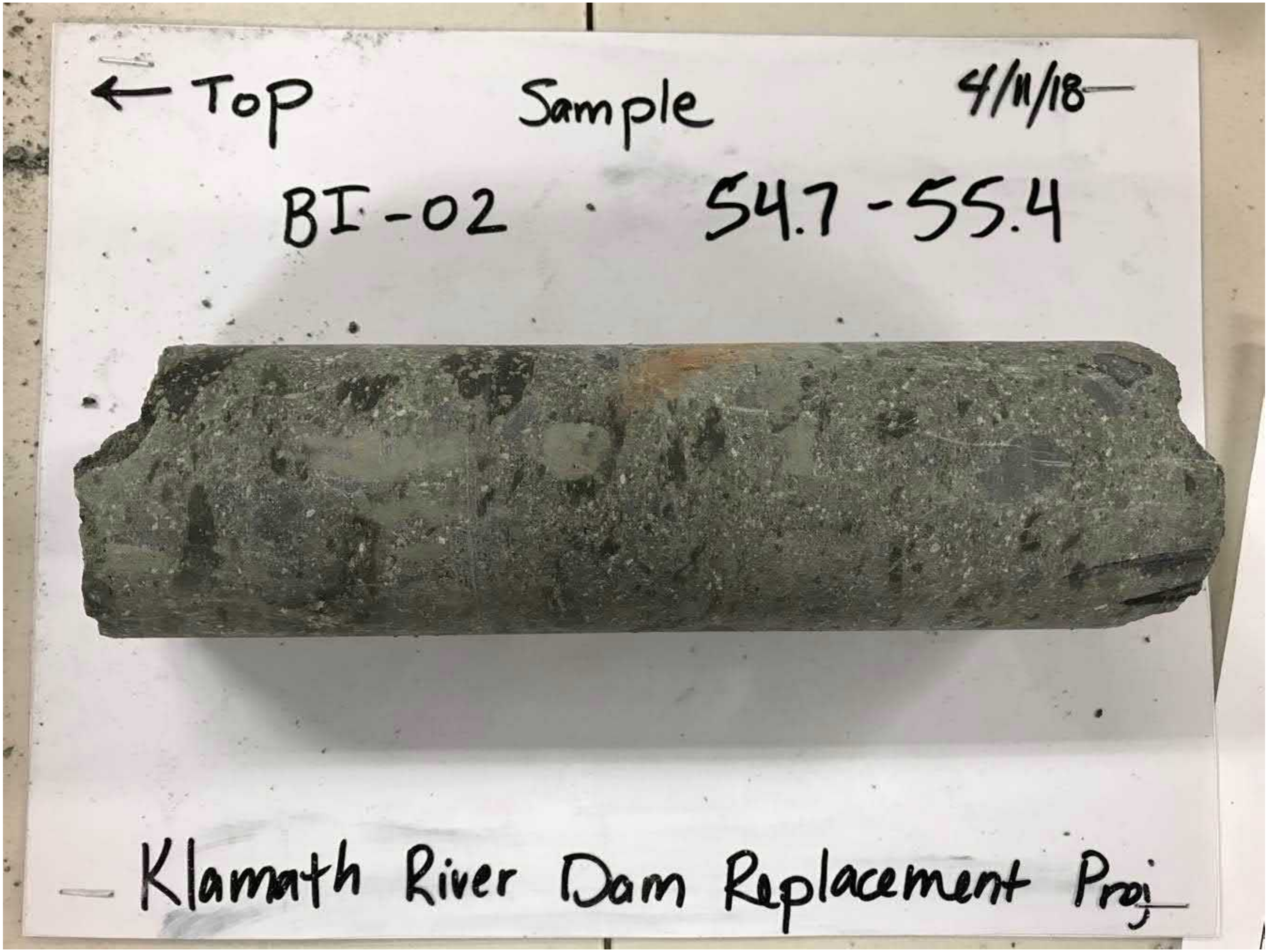
Sample
4/11/18
BI-02
42.5 - 43.1
Klamath River Dam Replacement Proj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Sample
4/11/18
BI-02
54.7 - 55.4
Klamath River Dam Replacement Proj


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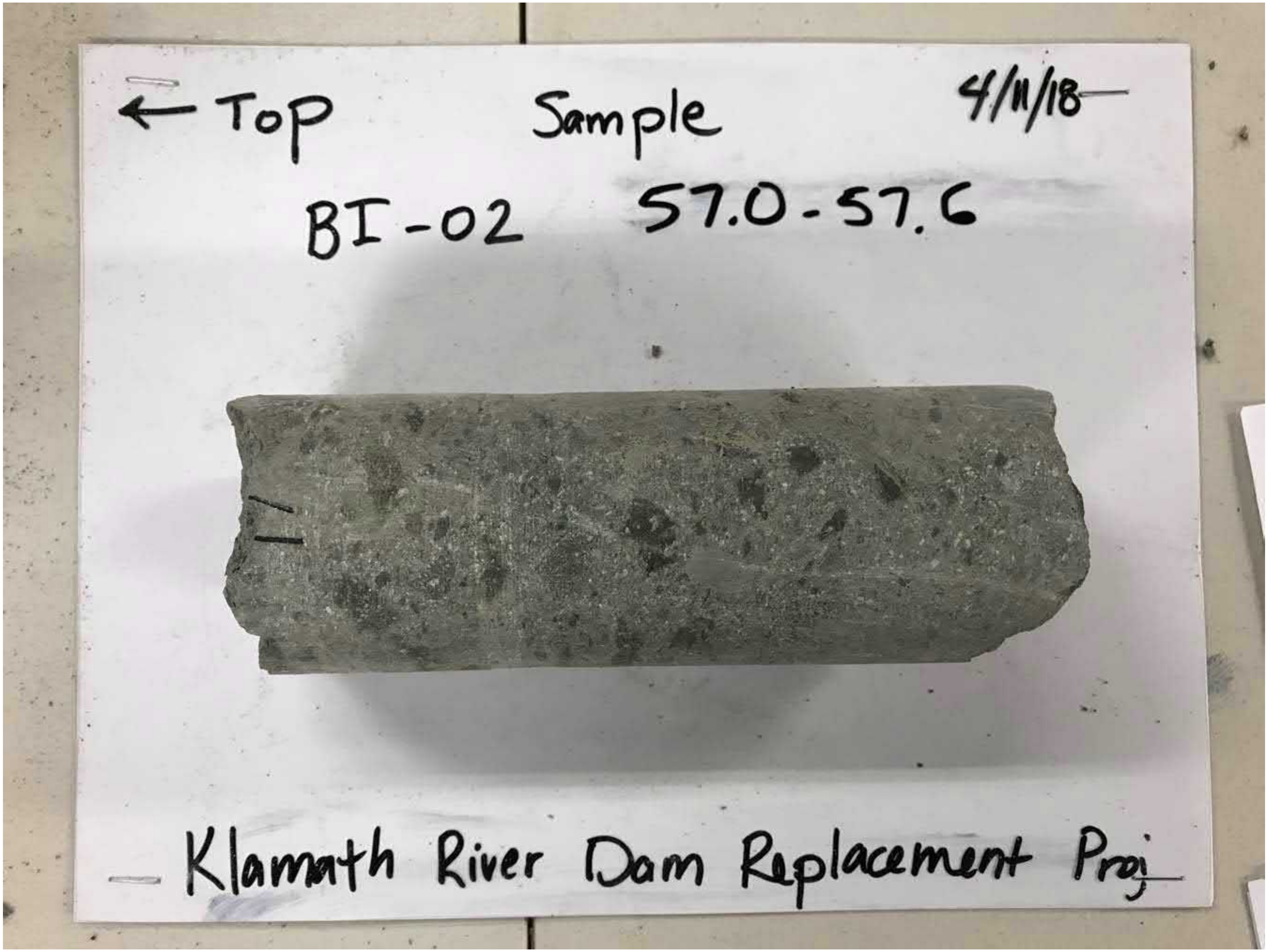
Sample
4/11/18
BI-02
54.7 - 55.4
Klamath River Dam Replacement Proj



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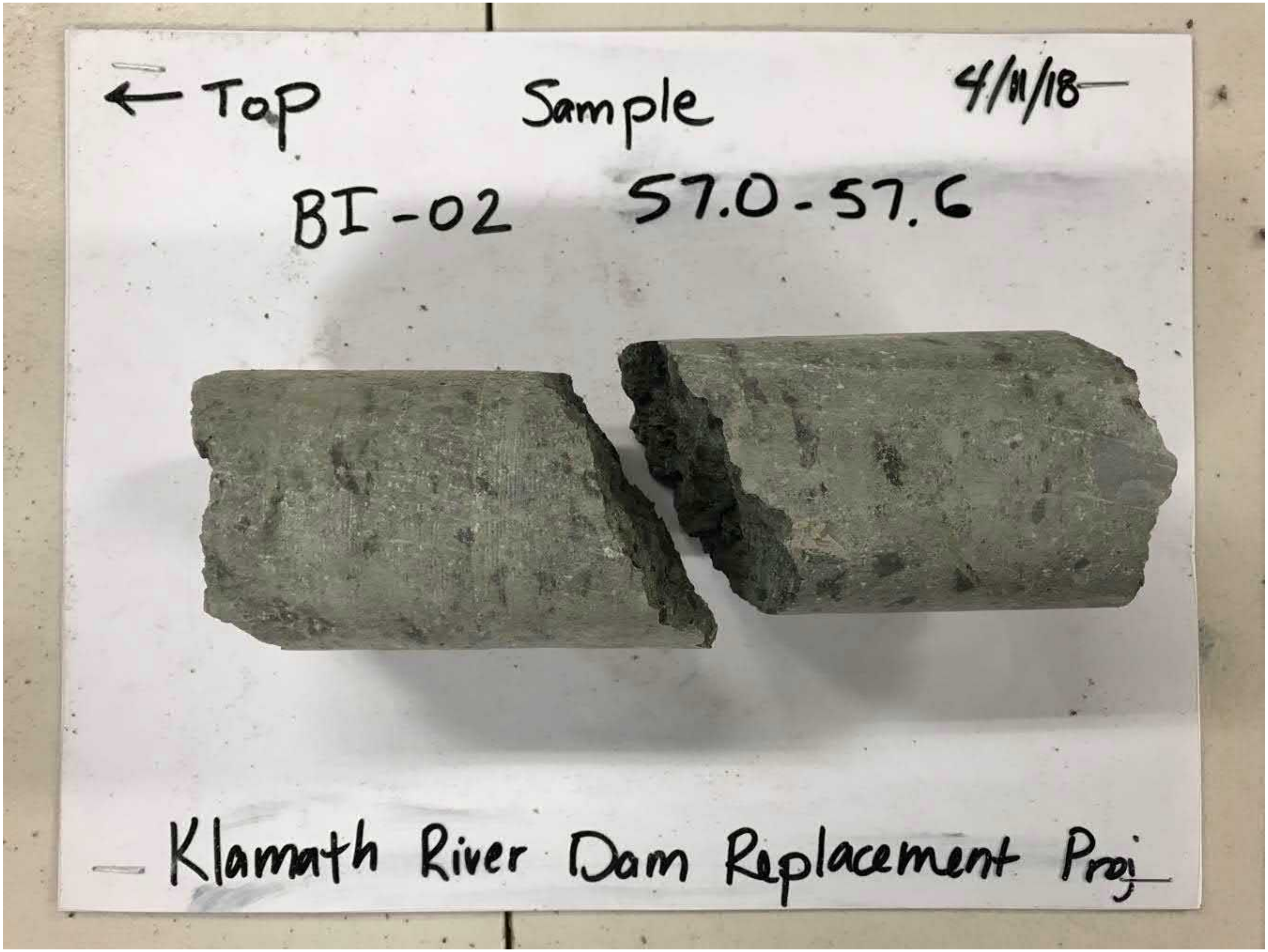
Sample
4/11/18
BI-02 57.0-57.6
Klamath River Dam Replacement Proj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Sample
4/11/18
BI-02 57.0-57.6
Klamath River Dam Replacement Proj


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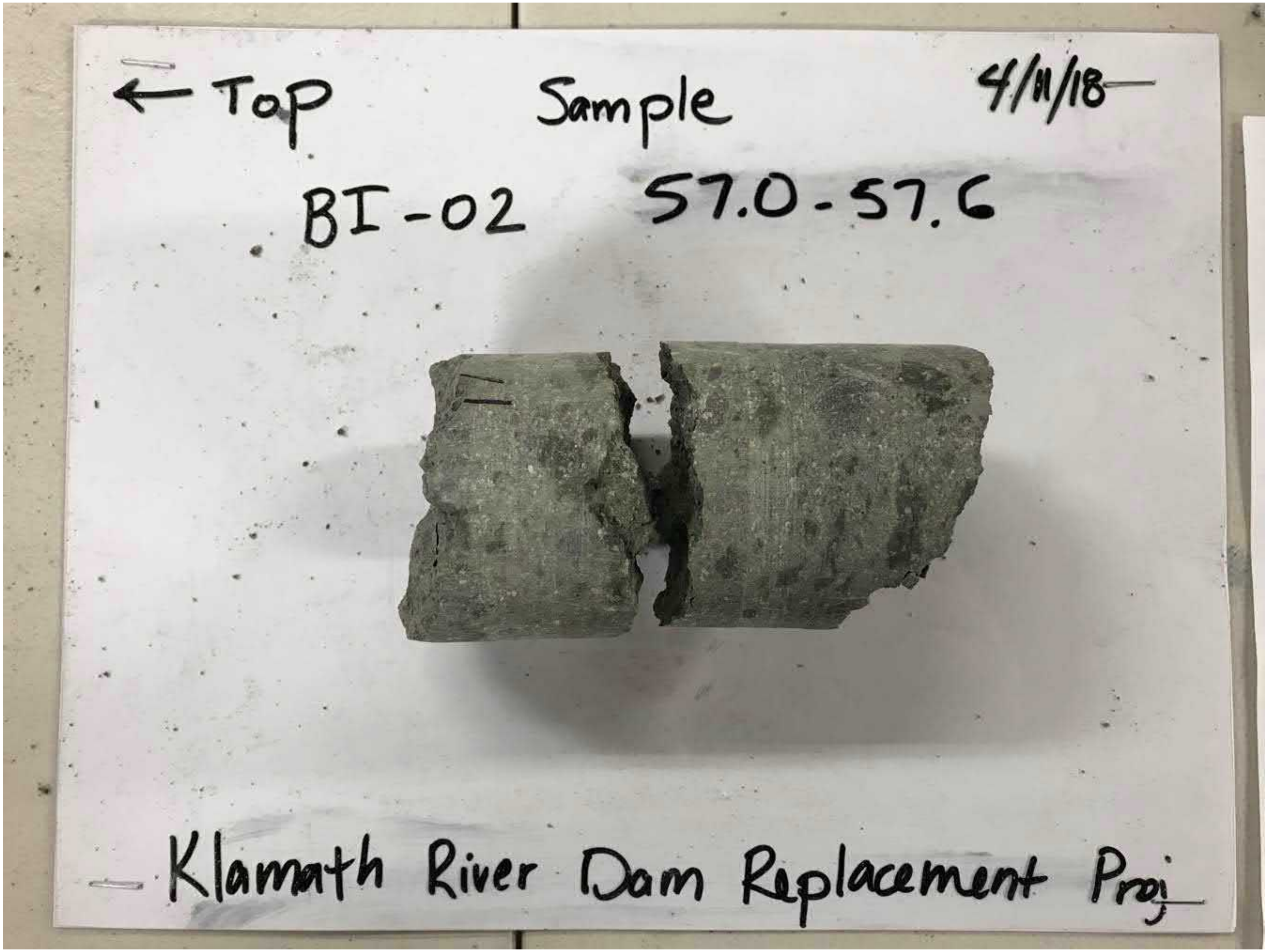
Sample
4/11/18
BI-02
57.0-57.6
Klamath River Dam Replacement Proj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Sample
4/11/18
BI-02 57.0-57.6
Klamath River Dam Replacement Proj

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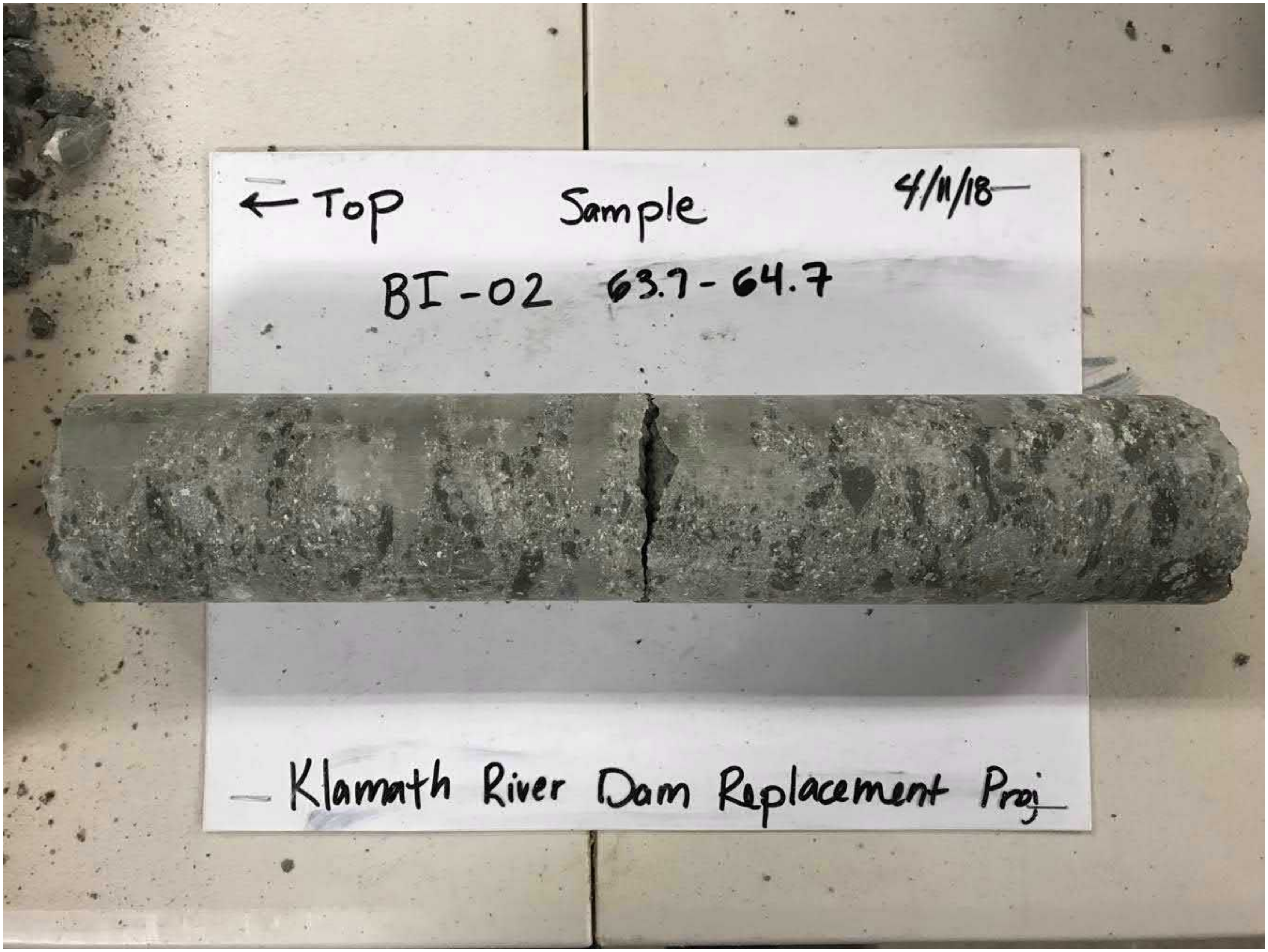
Sample
4/11/18
BI-02 63.7-64.7
Klamath River Dam Replacement Proj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Sample
4/11/18
BI-02 63.7-64.7
Klamath River Dam Replacement Proj


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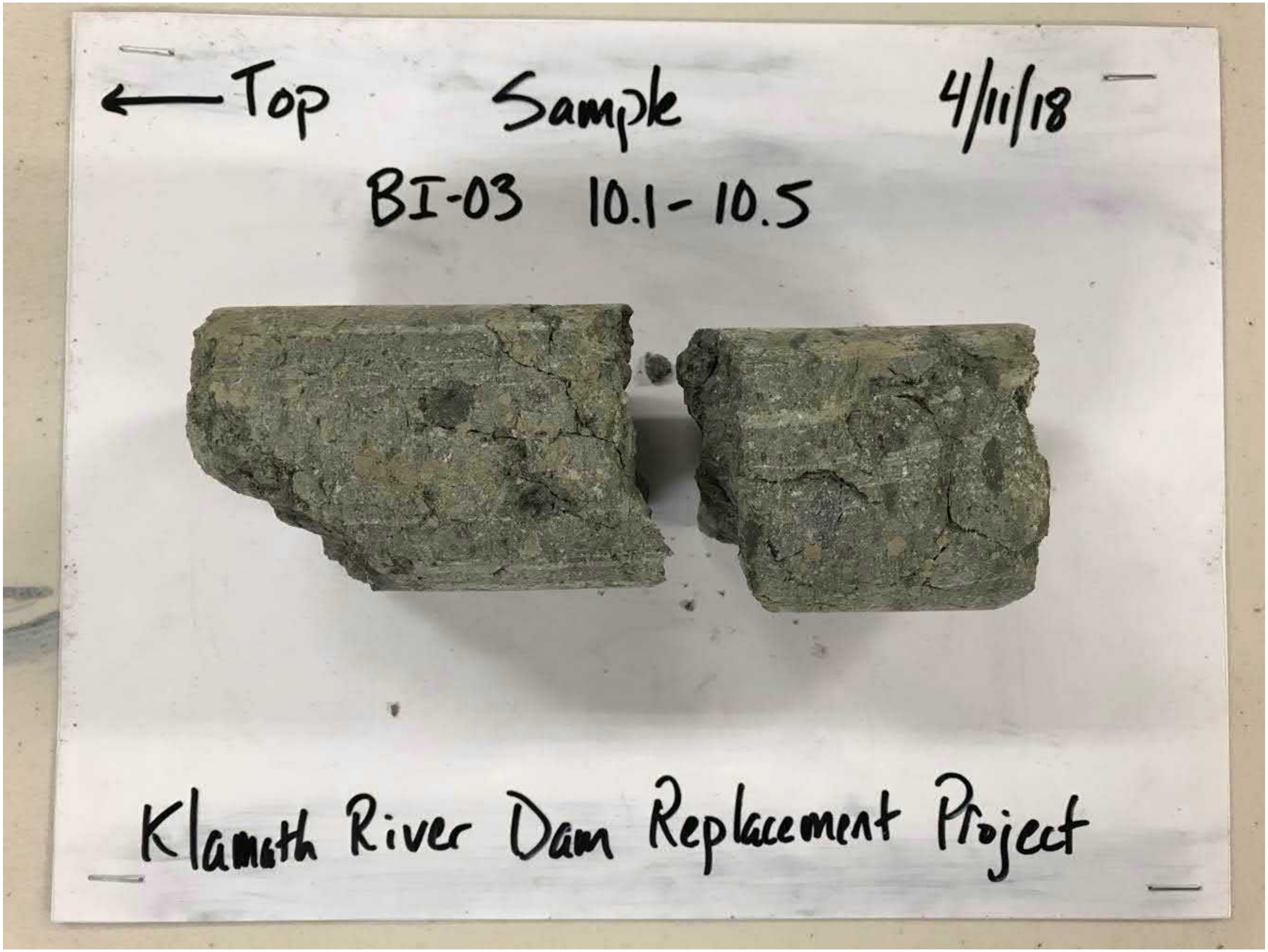
Sample
4/11/18
BI-03 10.1 - 10.5
Klamath River Dam Replacement Proj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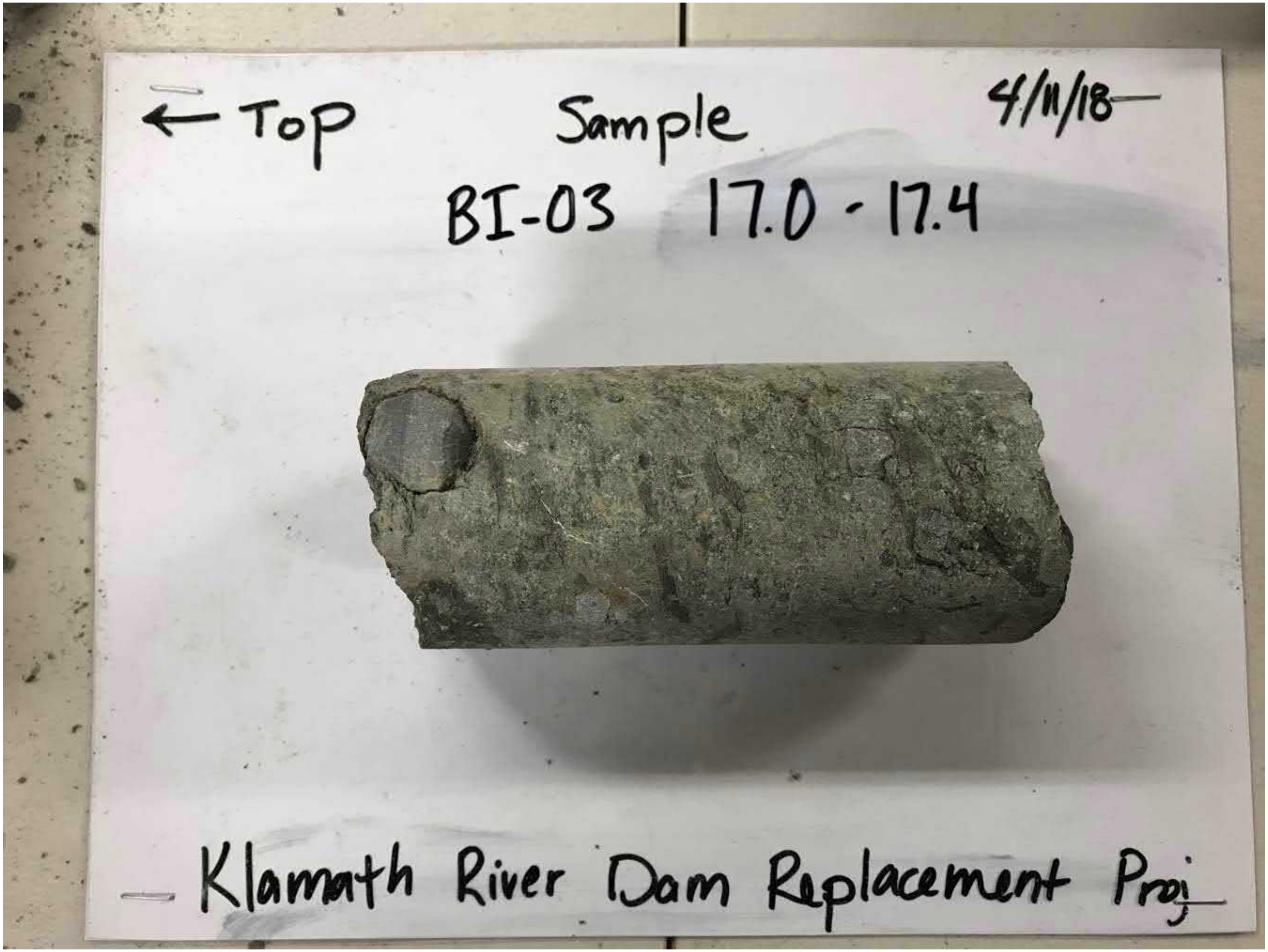
Sample
4/11/18
BI-03 10.1- 10.5
Klamath River Dam Replacement Project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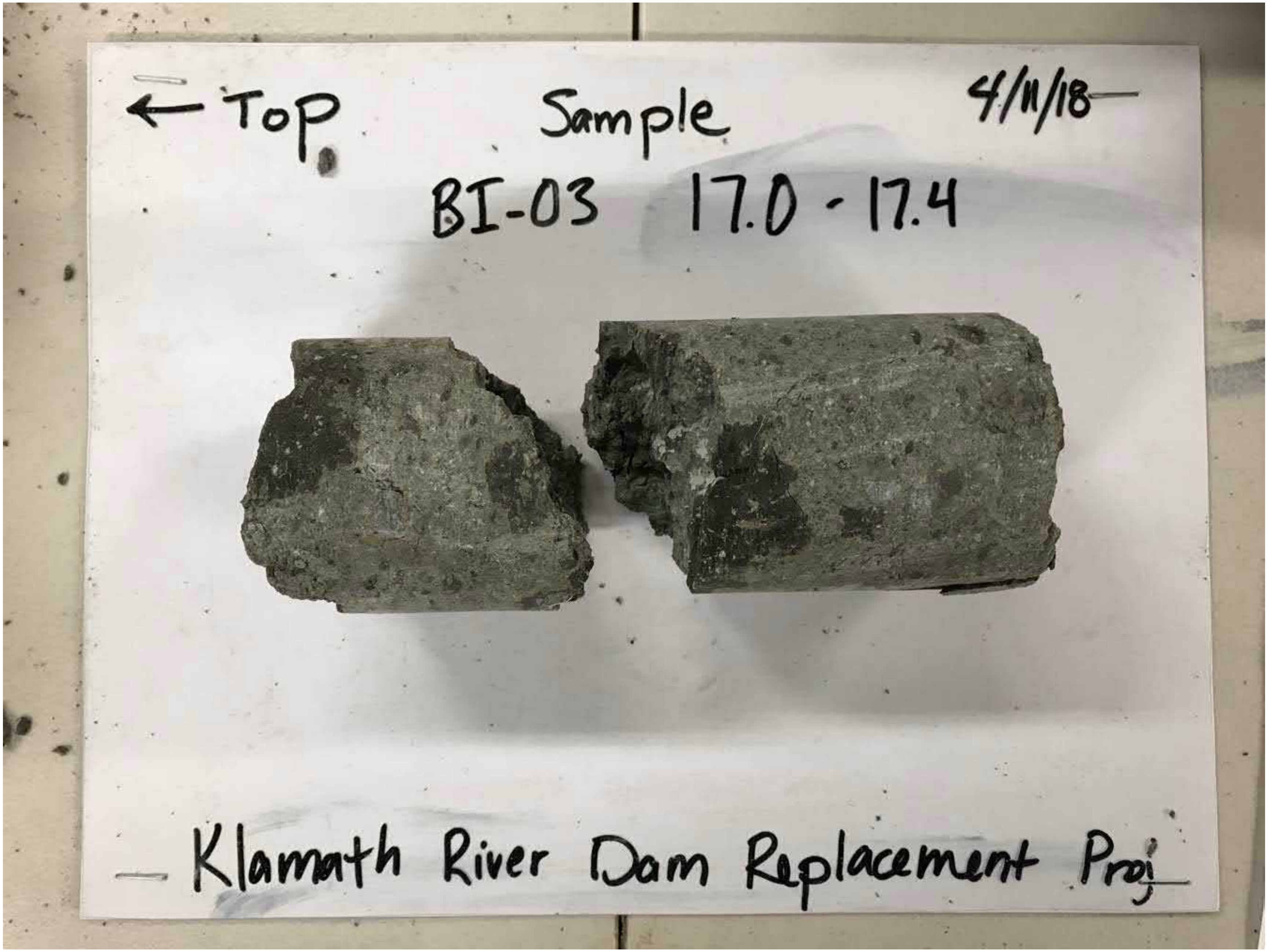
Sample
4/11/18
BI-03 17.0 - 17.4
Klamath River Dam Replacement Proj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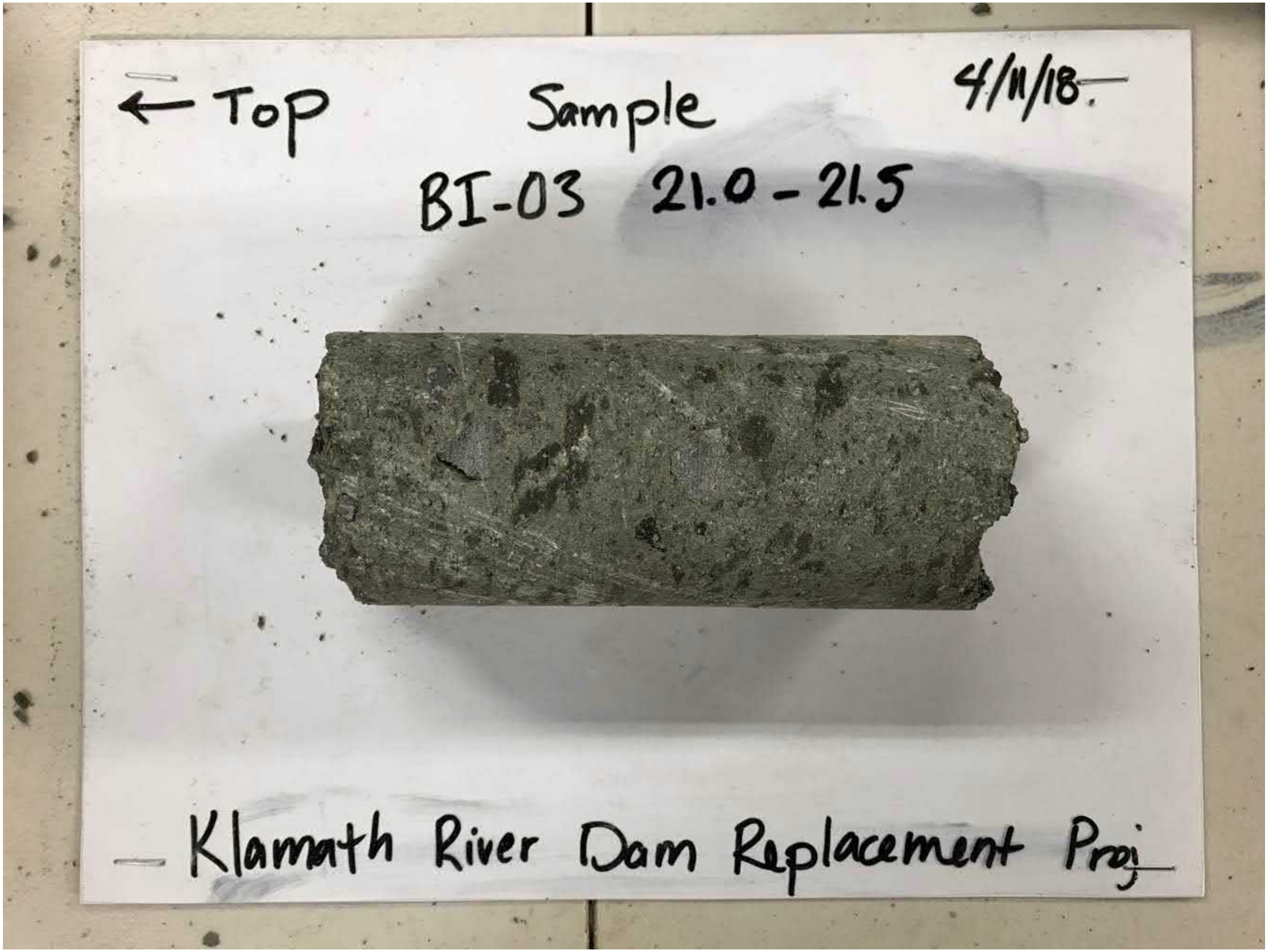
Sample
4/11/18
BI-03 17.0 - 17.4
Klamath River Dam Replacement Proj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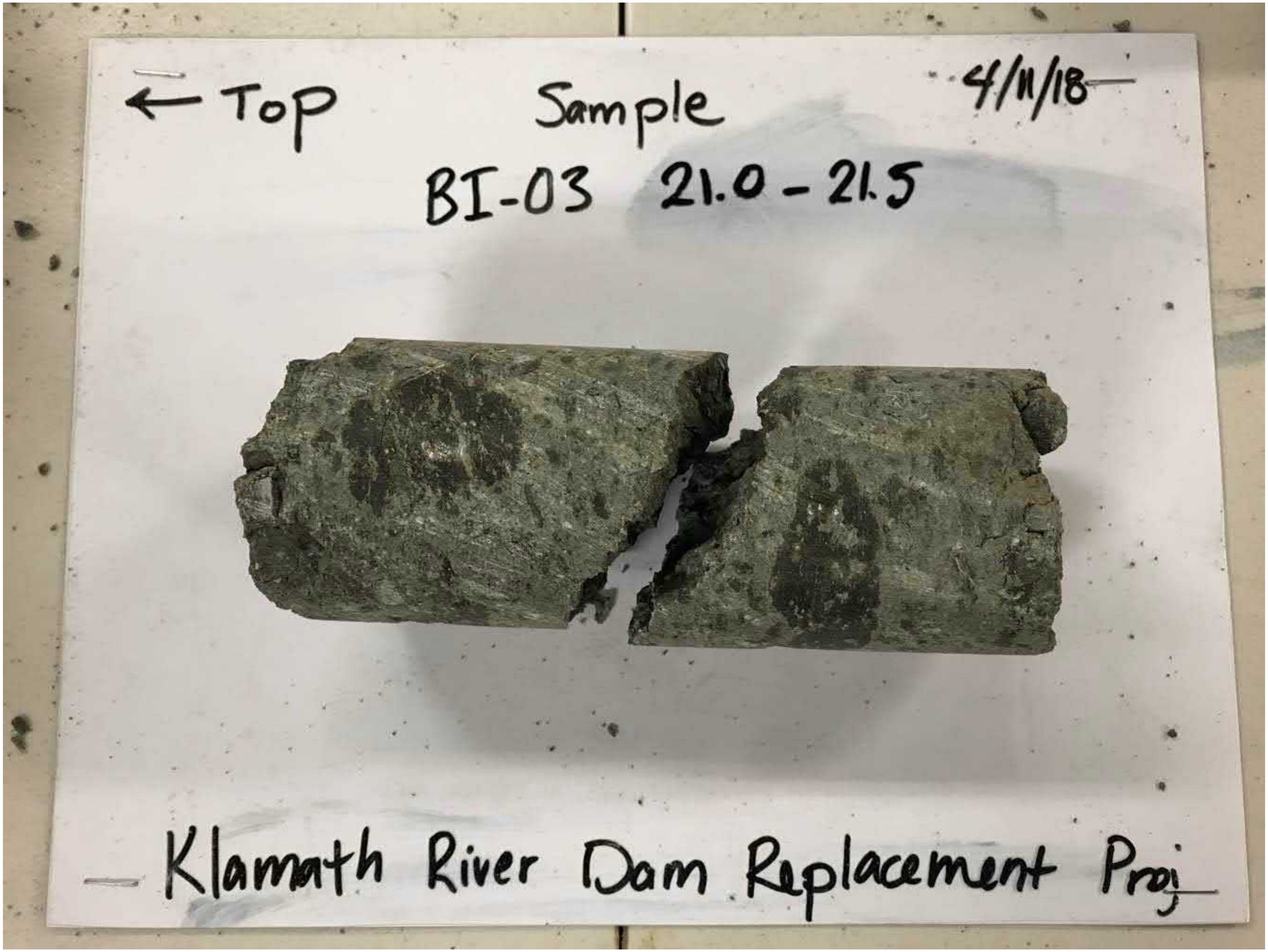
Sample
4/11/18
BI-03 21.0 - 21.5
Klamath River Dam Replacement Proj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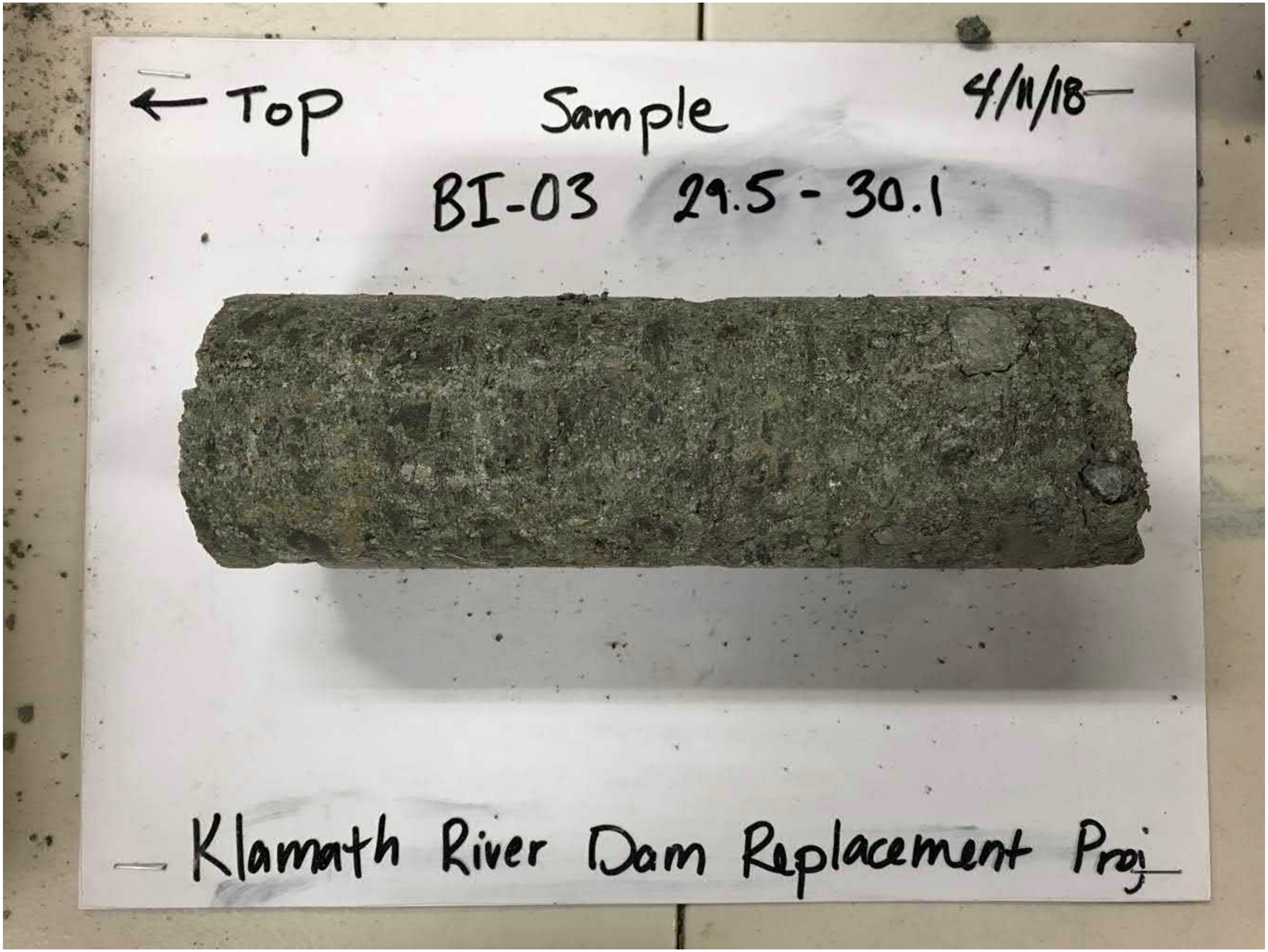
Sample
4/11/18
BI-03 21.0 - 21.5
Klamath River Dam Replacement Proj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Sample
4/11/18
BI-03 29.5 - 30.1
Klamath River Dam Replacement Proj

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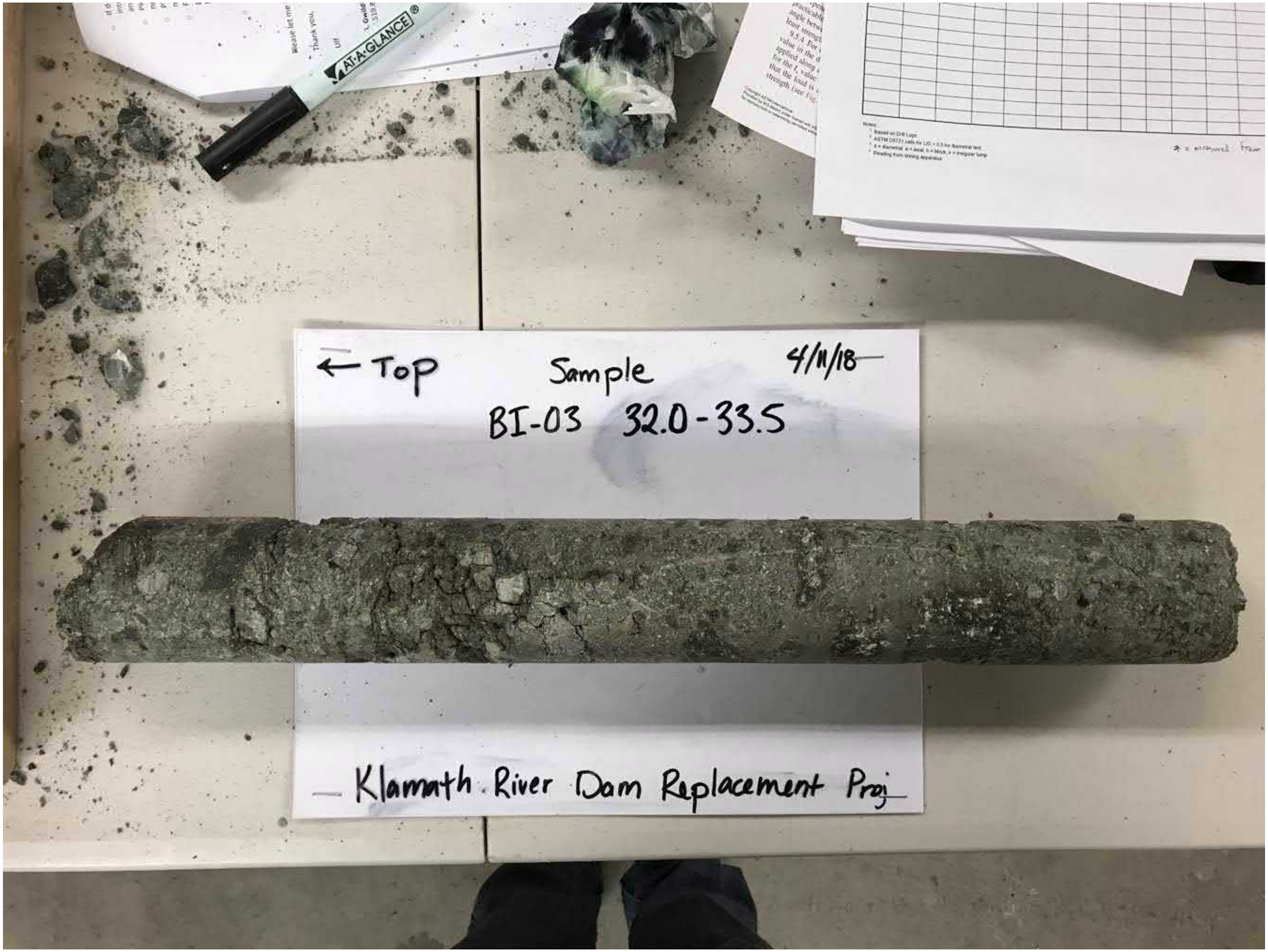
Sample
4/11/18
BI-03 29.5 - 30.1
Klamath River Dam Replacement Proj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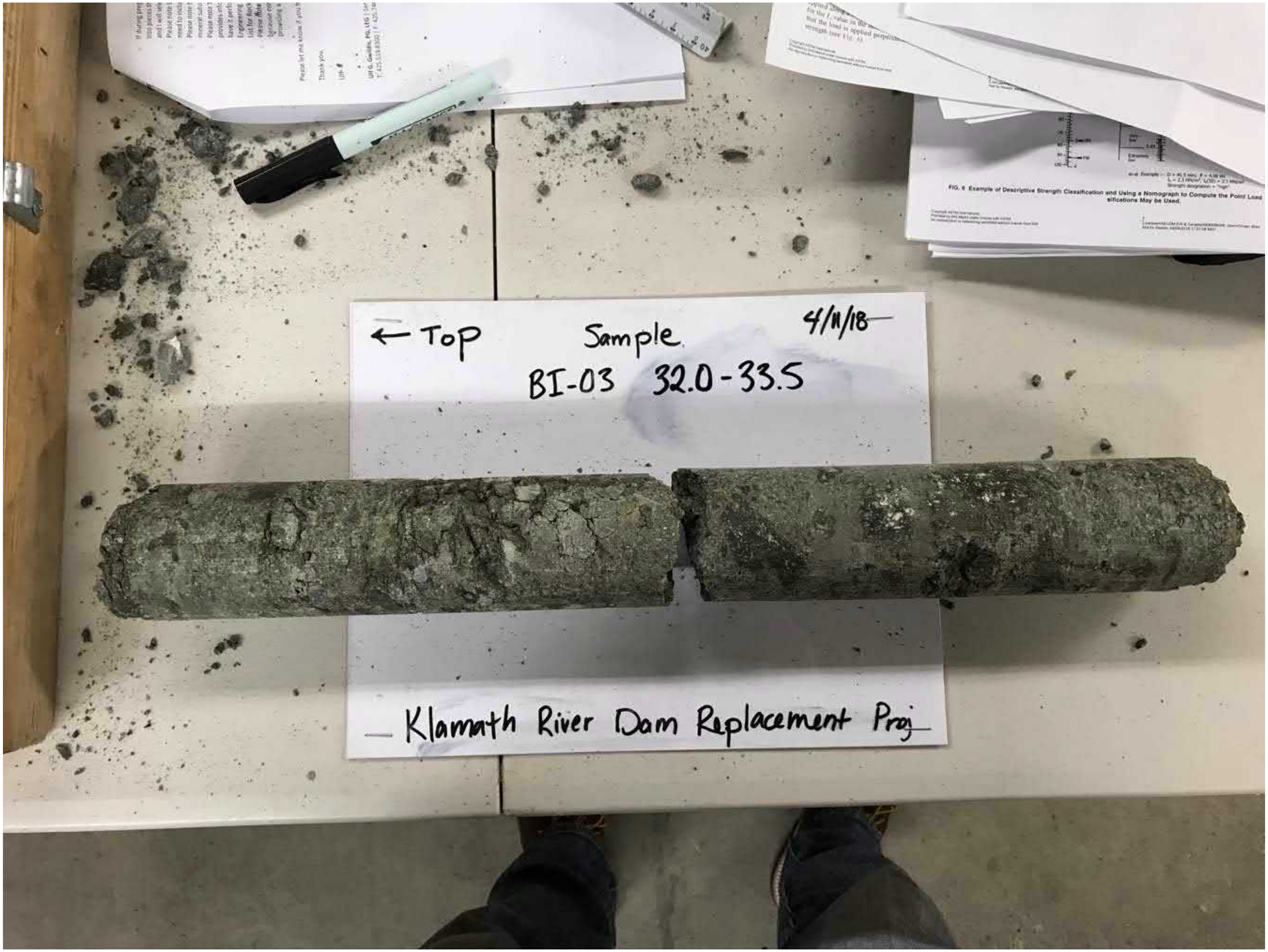
Sample
4/11/18
BI-03 32.0-33.5
Klamath River Dam Replacement Proj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Sample
4/11/18
BI-03 32.0-33.5
Klamath River Dam Replacement Proj

POINT LOAD STRENGTH INDEX OF ROCK - ASTM D 5731

COOPER TESTING LABORATORY

CTL Job No: 020-277 **Project No.:** 60537920
Client: AECOM **Date:** 3/12/2019
Project Name: Klamath River Renewal Project **By:** PJ

Boring:	B-01					
Sample:	R5					
Depth, ft:	15.6					
Visual Description:	Brown Rock					
Test Type	Diametral					
Test Type ID	1					
FOR ANISOTROPIC ROCK:						
Bedding Angle Relative to Axis	None					
Loading Orientation Rel. to Bedding	N/A					
SAMPLE DIMENSIONS						
Width Perpendicular to loading, W, mm	60					
Length Perpendicular to Loading, L, mm	30					
Diameter Parallel to Loading, D, mm	60					
Diameter at Failure, D', mm	54					
STRENGTH DATA						
Peak Load, P, kN	0.17					
Peak Load, P, lbs	38.2					
Uncorr. Pt. Load Strength Index, I_S, MPa	0.052					
Uncorr. Pt. Load Strength Index, I_S, psi	**7.6**					
Size Correction Factor, F	1.06					
Corr. Pt. Load Strength Index, $I_{S(50)}$, Mpa	0.06					
Corr. Pt. Load Strength Index, $I_{S(50)}$, psi	**8**					
MOISTURE CONTENT DATA						
Moisture Condition of Specimen	As Received					
Pan No.						
Pan wt. (g)	20.16					
Total wet wt. (g)	142.33					
Total dry wt (g)	131.89					
Moisture Content, %	**9.3**					
Comments:						

Test types: 1- Diametral, 2- Axial, 3- Block,4- Irregular Lump
Diametral - L/D ratio>1
Axial - L/D ratio 1/3 to 1
Block or Irregular Lumps, D= 30-85 mm; D/W between 1/3 and 1

POINT LOAD STRENGTH INDEX OF ROCK - ASTM D 5731

COOPER TESTING LABORATORY

CTL Job No:	020-277	**Project No.:**	60537920
Client:	AECOM	**Date:**	3/12/2019
Project Name:	Klamath River Renewal Project	**By:**	PJ

Boring:	B-01	B-01	B-01	B-01		
Sample:	R6	R6	R6	R6		
Depth, ft:	17.2-17.5	17.2-17.5	17.2-17.5	17.2-17.5		
Visual Description:	Brown Rock	Brown Rock	Brown Rock	Brown Rock		
Test Type	Diametral	Axial	Axial	Axial		
Test Type ID	1	2	2	2		
FOR ANISOTROPIC ROCK:						
Bedding Angle Relative to Axis	None	None	None	None		
Loading Orientation Rel. to Bedding	N/A	N/A	N/A	N/A		
SAMPLE DIMENSIONS						
Width Perpendicular to loading, W, mm	58	58	58	58		
Length Perpendicular to Loading, L, mm	30					
Diameter Parallel to Loading, D, mm	58	40	35	23		
Diameter at Failure, D', mm	55	40	30	20		
STRENGTH DATA						
Peak Load, P, kN	0.148	0.346	0.272	0.187		
Peak Load, P, lbs	33.3	77.8	61.1	42.0		
Uncorr. Pt. Load Strength Index, I_S, MPa	0.046	0.117	0.123	0.127		
Uncorr. Pt. Load Strength Index, I_S, psi	**6.7**	**17.0**	**17.8**	**18.4**		
Size Correction Factor, F	1.06	1.04	0.97	0.89		
Corr. Pt. Load Strength Index, $I_{S(50)}$, Mpa	0.05	0.12	0.12	0.11		
Corr. Pt. Load Strength Index, $I_{S(50)}$, psi	**7**	**18**	**17**	**16**		
MOISTURE CONTENT DATA						
Moisture Condition of Specimen	As Received	As Received	As Received	As Received		
Pan No.						
Pan wt. (g)	20.56	20.56	20.56	20.56		
Total wet wt. (g)	152.32	152.32	152.32	152.32		
Total dry wt (g)	145.93	145.93	145.93	145.93		
Moisture Content, %	**5.1**	**5.1**	**5.1**	**5.1**		
Comments:						

Test types: 1- Diametral, 2- Axial, 3- Block,4- Irregular Lump
Diametral - L/D ratio>1
Axial - L/D ratio 1/3 to 1
Block or Irregular Lumps, D= 30-85 mm; D/W between 1/3 and 1

POINT LOAD STRENGTH INDEX OF ROCK - ASTM D 5731

COOPER TESTING LABORATORY

CTL Job No: 020-277 **Project No.:** 60537920
Client: AECOM **Date:** 3/12/2019
Project Name: Klamath River Renewal Project **By:** PJ

Boring:	B-04					
Sample:	R5					
Depth, ft:	26.2-26.5					
Visual Description:	Brown Rock					
Test Type	Diametral					
Test Type ID	1					
FOR ANISOTROPIC ROCK:						
Bedding Angle Relative to Axis	None					
Loading Orientation Rel. to Bedding	N/A					
SAMPLE DIMENSIONS						
Width Perpendicular to loading, W, mm	60					
Length Perpendicular to Loading, L, mm	30					
Diameter Parallel to Loading, D, mm	60					
Diameter at Failure, D', mm	69					
STRENGTH DATA						
Peak Load, P, kN	0.137					
Peak Load, P, lbs	30.8					
Uncorr. Pt. Load Strength Index, I_S, MPa	0.033					
Uncorr. Pt. Load Strength Index, I_S, psi	**4.8**					
Size Correction Factor, F	1.12					
Corr. Pt. Load Strength Index, $I_{S(50)}$, Mpa	0.04					
Corr. Pt. Load Strength Index, $I_{S(50)}$, psi	**5**					
MOISTURE CONTENT DATA						
Moisture Condition of Specimen	As Received					
Pan No.						
Pan wt. (g)	19.85					
Total wet wt. (g)	116.78					
Total dry wt (g)	107.55					
Moisture Content, %	**10.5**					
Comments:	Invalid point. Did not fail through both loading points.					

Test types: 1- Diametral, 2- Axial, 3- Block, 4- Irregular Lump
Diametral - L/D ratio>1
Axial - L/D ratio 1/3 to 1
Block or Irregular Lumps, D= 30-85 mm; D/W between 1/3 and 1

POINT LOAD STRENGTH INDEX OF ROCK - ASTM D 5731

COOPER TESTING LABORATORY

CTL Job No: 020-277 **Project No.:** 60537920
Client: AECOM **Date:** 3/12/2019
Project Name: Klamath River Renewal Project **By:** PJ

Boring:	B-05	B-05	B-05	B-05	B-05	B-05
Sample:	R7	R7	R7	R7	R7	R7
Depth, ft:	26.2-26.9	26.2-26.9	26.2-26.9	26.2-26.9	26.2-26.9	26.2-26.9
Visual Description:	Gray Rock	Gray Rock	Gray Rock	Gray Rock	Gray Rock	Gray Rock
Test Type	Diametral	Diametral	Diametral	Diametral	Axial	Axial
Test Type ID	1	1	1	1	2	2
FOR ANISOTROPIC ROCK:						
Bedding Angle Relative to Axis	None	None	None	None	None	None
Loading Orientation Rel. to Bedding	N/A	N/A	N/A	N/A	N/A	N/A
SAMPLE DIMENSIONS						
Width Perpendicular to loading, W, mm	60	60	60	60	60	60
Length Perpendicular to Loading, L, mm	30	30	30	30		
Diameter Parallel to Loading, D, mm	60	60	60	60	26	43
Diameter at Failure, D', mm	54	54	56	55	30	38
STRENGTH DATA						
Peak Load, P, kN	26.016	27.563	24.68	19.511	19.242	21.155
Peak Load, P, lbs	5848.6	6196.4	5548.3	4386.2	4325.8	4755.8
Uncorr. Pt. Load Strength Index, I_S, MPa	8.030	8.507	7.345	5.912	8.396	7.287
Uncorr. Pt. Load Strength Index, I_S, psi	**1164.6**	**1233.9**	**1065.3**	**857.5**	**1217.7**	**1056.9**
Size Correction Factor, F	1.06	1.06	1.07	1.06	0.98	1.03
Corr. Pt. Load Strength Index, $I_{S(50)}$, Mpa	8.51	9.02	7.85	6.29	8.23	7.54
Corr. Pt. Load Strength Index, $I_{S(50)}$, psi	**1235**	**1308**	**1139**	**913**	**1194**	**1093**
MOISTURE CONTENT DATA						
Moisture Condition of Specimen	As Received	As Received	As Received	As Received	As Received	As Received
Pan No.						
Pan wt. (g)	22.43	22.43	22.43	22.43	22.43	22.43
Total wet wt. (g)	187.35	187.35	187.35	187.35	187.35	187.35
Total dry wt (g)	186.12	186.12	186.12	186.12	186.12	186.12
Moisture Content, %	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**
Comments:						

Test types: 1- Diametral, 2- Axial, 3- Block,4- Irregular Lump
Diametral - L/D ratio>1
Axial - L/D ratio 1/3 to 1
Block or Irregular Lumps, D= 30-85 mm; D/W between 1/3 and 1

POINT LOAD STRENGTH INDEX OF ROCK - ASTM D 5731

COOPER TESTING LABORATORY

CTL Job No:	020-277	**Project No.:**	60537920
Client:	AECOM	**Date:**	3/12/2019
Project Name:	Klamath River Renewal Project	**By:**	PJ

Boring:	B-05	B-05	B-05	B-05		
Sample:	R11	R11	R11	R11		
Depth, ft:	36.9-37.3	36.9-37.3	36.9-37.3	36.9-37.3		
Visual Description:	Gray Rock	Gray Rock	Gray Rock	Gray Rock		
Test Type	Diametral	Diametral	Axial	Axial		
Test Type ID	1	1	2	2		
FOR ANISOTROPIC ROCK:						
Bedding Angle Relative to Axis	None	None	None	None		
Loading Orientation Rel. to Bedding	N/A	N/A	N/A	N/A		
SAMPLE DIMENSIONS						
Width Perpendicular to loading, W, mm	60	60	60	60		
Length Perpendicular to Loading, L, mm	30	30				
Diameter Parallel to Loading, D, mm	60	60	30	40		
Diameter at Failure, D', mm	56	55	26	32		
STRENGTH DATA						
Peak Load, P, kN	33.123	32.033	14.521	18.344		
Peak Load, P, lbs	7446.3	7201.3	3264.5	4123.9		
Uncorr. Pt. Load Strength Index,I_S, MPa	9.858	9.707	7.311	7.504		
Uncorr. Pt. Load Strength Index,I_S, psi	**1429.8**	**1407.9**	**1060.3**	**1088.3**		
Size Correction Factor, F	1.07	1.06	0.95	0.99		
Corr. Pt. Load Strength Index,$I_{S(50)}$, Mpa	10.54	10.33	6.94	7.47		
Corr. Pt. Load Strength Index,$I_{S(50)}$, psi	**1528**	**1499**	**1007**	**1083**		
MOISTURE CONTENT DATA						
Moisture Condition of Specimen	As Received	As Received	As Received	As Received		
Pan No.						
Pan wt. (g)	22.95	22.95	22.95	22.95		
Total wet wt. (g)	152.73	152.73	152.73	152.73		
Total dry wt (g)	152.3	152.3	152.3	152.3		
Moisture Content, %	**0.3**	**0.3**	**0.3**	**0.3**		
Comments:						

Test types: 1- Diametral, 2- Axial, 3- Block,4- Irregular Lump
Diametral - L/D ratio>1
Axial - L/D ratio 1/3 to 1
Block or Irregular Lumps, D= 30-85 mm; D/W between 1/3 and 1

POINT LOAD STRENGTH INDEX OF ROCK - ASTM D 5731

COOPER TESTING LABORATORY

CTL Job No: 020-277 **Project No.:** 60537920
Client: AECOM **Date:** 3/12/2019
Project Name: Klamath River Renewal Project **By:** PJ

Boring:	B-05	B-05	B-05	B-05	B-05	B-05
Sample:	R15	R15	R15	R15	R15	R15
Depth, ft:	46.1-46.8	46.1-46.8	46.1-46.8	46.1-46.8	46.1-46.8	46.1-46.8
Visual Description:	Gray Rock	Gray Rock	Gray Rock	Gray Rock	Gray Rock	Gray Rock
Test Type	Diametral	Diametral	Diametral	Diametral	Axial	Axial
Test Type ID	1	1	1	1	2	2
FOR ANISOTROPIC ROCK:						
Bedding Angle Relative to Axis	None	None	None	None	None	None
Loading Orientation Rel. to Bedding	N/A	N/A	N/A	N/A	N/A	N/A
SAMPLE DIMENSIONS						
Width Perpendicular to loading, W, mm	60	60	60	60	60	60
Length Perpendicular to Loading, L, mm	30	30	30	30		
Diameter Parallel to Loading, D, mm	60	60	60	60	36	34
Diameter at Failure, D', mm	56	56	57	56	35	28
STRENGTH DATA						
Peak Load, P, kN	24.093	33.912	27.929	24.365	22.269	21.115
Peak Load, P, lbs	5416.3	7623.7	6278.7	5477.5	5006.3	4746.8
Uncorr. Pt. Load Strength Index, I_S, MPa	7.171	10.093	8.166	7.251	8.329	9.871
Uncorr. Pt. Load Strength Index, I_S, psi	**1040.0**	**1463.8**	**1184.4**	**1051.7**	**1208.0**	**1431.7**
Size Correction Factor, F	1.07	1.07	1.07	1.07	1.02	0.97
Corr. Pt. Load Strength Index, $I_{S(50)}$, Mpa	7.66	10.79	8.76	7.75	8.46	9.53
Corr. Pt. Load Strength Index, $I_{S(50)}$, psi	**1112**	**1565**	**1271**	**1124**	**1226**	**1382**
MOISTURE CONTENT DATA						
Moisture Condition of Specimen	As Received	As Received	As Received	As Received	As Received	As Received
Pan No.						
Pan wt. (g)	19.79	19.79	19.79	19.79	19.79	19.79
Total wet wt. (g)	138.47	138.47	138.47	138.47	138.47	138.47
Total dry wt (g)	137.97	137.97	137.97	137.97	137.97	137.97
Moisture Content, %	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**
Comments:						

Test types: 1- Diametral, 2- Axial, 3- Block,4- Irregular Lump
Diametral - L/D ratio>1
Axial - L/D ratio 1/3 to 1
Block or Irregular Lumps, D= 30-85 mm; D/W between 1/3 and 1

COOPER TESTING LABORATORY

POINT LOAD STRENGTH INDEX OF ROCK - ASTM D 5731

CTL Job No: 020-277 **Project No.:** 60537920
Client: AECOM **Date:** 3/12/2019
Project Name: Klamath River Renewal Project **By:** PJ

Boring:	B-07					
Sample:	R6					
Depth, ft:	29.3-29.6					
Visual Description:	Red Rock					
Test Type	Diametral					
Test Type ID	1					
FOR ANISOTROPIC ROCK:						
Bedding Angle Relative to Axis	None					
Loading Orientation Rel. to Bedding	N/A					
SAMPLE DIMENSIONS						
Width Perpendicular to loading, W, mm	60					
Length Perpendicular to Loading, L, mm	30					
Diameter Parallel to Loading, D, mm	60					
Diameter at Failure, D', mm	56					
STRENGTH DATA						
Peak Load, P, kN	0.22					
Peak Load, P, lbs	49.5					
Uncorr. Pt. Load Strength Index, I_S, MPa	0.065					
Uncorr. Pt. Load Strength Index, I_S, psi	**9.5**					
Size Correction Factor, F	1.07					
Corr. Pt. Load Strength Index, $I_{S(50)}$, Mpa	0.07					
Corr. Pt. Load Strength Index, $I_{S(50)}$, psi	**10**					
MOISTURE CONTENT DATA						
Moisture Condition of Specimen	As Received					
Pan No.						
Pan wt. (g)	21.71					
Total wet wt. (g)	148.91					
Total dry wt (g)	139.87					
Moisture Content, %	**7.7**					
Comments:	Invalid point. Did not fail through both loading points.					

Test types: 1- Diametral, 2- Axial, 3- Block, 4- Irregular Lump
Diametral - L/D ratio>1
Axial - L/D ratio 1/3 to 1
Block or Irregular Lumps, D= 30-85 mm; D/W between 1/3 and 1

POINT LOAD STRENGTH INDEX OF ROCK - ASTM D 5731

COOPER TESTING LABORATORY

CTL Job No:	020-277	**Project No.:**	60537920
Client:	AECOM	**Date:**	3/12/2019
Project Name:	Klamath River Renewal Project	**By:**	PJ

Boring:	B-08	B-08	B-08			
Sample:	R1	R1	R1			
Depth, ft:	37.1-37.6	37.1-37.6	37.1-37.6			
Visual Description:	Gray Rock	Gray Rock	Gray Rock			
Test Type	Diametral	Diametral	Axial			
Test Type ID	1	1	2			
FOR ANISOTROPIC ROCK:						
Bedding Angle Relative to Axis	None	None	None			
Loading Orientation Rel. to Bedding	N/A	N/A	N/A			
SAMPLE DIMENSIONS						
Width Perpendicular to loading, W, mm	60	60	60			
Length Perpendicular to Loading, L, mm	30	30				
Diameter Parallel to Loading, D, mm	60	60	36			
Diameter at Failure, D', mm	58	59	46			
STRENGTH DATA						
Peak Load, P, kN	0.692	0.484	0.327			
Peak Load, P, lbs	155.6	108.8	73.5			
Uncorr. Pt. Load Strength Index,I_S, MPa	0.199	0.137	0.093			
Uncorr. Pt. Load Strength Index,I_S, psi	**28.8**	**19.8**	**13.5**			
Size Correction Factor, F	1.08	1.08	1.08			
Corr. Pt. Load Strength Index,$I_{S(50)}$, Mpa	0.21	0.15	0.10			
Corr. Pt. Load Strength Index,$I_{S(50)}$, psi	**31**	**21**	**15**			
MOISTURE CONTENT DATA						
Moisture Condition of Specimen	As Received	As Received	As Received			
Pan No.						
Pan wt. (g)	19.25	19.25	19.25			
Total wet wt. (g)	168.79	168.79	168.79			
Total dry wt (g)	156.2	156.2	156.2			
Moisture Content, %	**9.2**	**9.2**	**9.2**			
Comments:						

Test types: 1- Diametral, 2- Axial, 3- Block,4- Irregular Lump
Diametral - L/D ratio>1
Axial - L/D ratio 1/3 to 1
Block or Irregular Lumps, D= 30-85 mm; D/W between 1/3 and 1

POINT LOAD STRENGTH INDEX OF ROCK - ASTM D 5731

COOPER TESTING LABORATORY

CTL Job No: 020-277 **Project No.:** 60537920
Client: AECOM **Date:** 3/12/2019
Project Name: Klamath River Renewal Project **By:** PJ

Boring:	B-08					
Sample:	R2					
Depth, ft:	38.6-38.9					
Visual Description:	Gray Rock					
Test Type	Diametral					
Test Type ID	1					
FOR ANISOTROPIC ROCK:						
Bedding Angle Relative to Axis	None					
Loading Orientation Rel. to Bedding	N/A					
SAMPLE DIMENSIONS						
Width Perpendicular to loading, W, mm	60					
Length Perpendicular to Loading, L, mm	30					
Diameter Parallel to Loading, D, mm	60					
Diameter at Failure, D', mm	58					
STRENGTH DATA						
Peak Load, P, kN	1.122					
Peak Load, P, lbs	252.2					
Uncorr. Pt. Load Strength Index, I_S, MPa	0.322					
Uncorr. Pt. Load Strength Index, I_S, psi	**46.8**					
Size Correction Factor, F	1.08					
Corr. Pt. Load Strength Index, $I_{S(50)}$, Mpa	0.35					
Corr. Pt. Load Strength Index, $I_{S(50)}$, psi	**50**					
MOISTURE CONTENT DATA						
Moisture Condition of Specimen	As Received					
Pan No.						
Pan wt. (g)	20.6					
Total wet wt. (g)	298.27					
Total dry wt (g)	282.19					
Moisture Content, %	**6.1**					
Comments:						

Test types: 1- Diametral, 2- Axial, 3- Block,4- Irregular Lump
Diametral - L/D ratio>1
Axial - L/D ratio 1/3 to 1
Block or Irregular Lumps, D= 30-85 mm; D/W between 1/3 and 1

POINT LOAD STRENGTH INDEX OF ROCK - ASTM D 5731

COOPER TESTING LABORATORY

CTL Job No:	020-277	**Project No.:**	60537920
Client:	AECOM	**Date:**	3/13/2019
Project Name:	Klamath River Renewal Project	**By:**	PJ

Boring:	B-08					
Sample:	R4					
Depth, ft:	50.2-50.6					
Visual Description:	Gray Rock					
Test Type	Diametral					
Test Type ID	1					
FOR ANISOTROPIC ROCK:						
Bedding Angle Relative to Axis	None					
Loading Orientation Rel. to Bedding	N/A					
SAMPLE DIMENSIONS						
Width Perpendicular to loading, W, mm	60					
Length Perpendicular to Loading, L, mm	30					
Diameter Parallel to Loading, D, mm	60					
Diameter at Failure, D', mm	59					
STRENGTH DATA						
Peak Load, P, kN	3.384					
Peak Load, P, lbs	760.8					
Uncorr. Pt. Load Strength Index, I_S, MPa	0.956					
Uncorr. Pt. Load Strength Index, I_S, psi	**138.6**					
Size Correction Factor, F	1.08					
Corr. Pt. Load Strength Index, $I_{S(50)}$, Mpa	1.03					
Corr. Pt. Load Strength Index, $I_{S(50)}$, psi	**150**					
MOISTURE CONTENT DATA						
Moisture Condition of Specimen	As Received					
Pan No.						
Pan wt. (g)	22.27					
Total wet wt. (g)	391.5					
Total dry wt (g)	378.35					
Moisture Content, %	**3.7**					
Comments:						

Test types: 1- Diametral, 2- Axial, 3- Block,4- Irregular Lump
Diametral - L/D ratio>1
Axial - L/D ratio 1/3 to 1
Block or Irregular Lumps, D= 30-85 mm; D/W between 1/3 and 1

POINT LOAD STRENGTH INDEX OF ROCK - ASTM D 5731

COOPER TESTING LABORATORY

CTL Job No: 020-277 **Project No.:** 60537920
Client: AECOM **Date:** 3/13/2019
Project Name: Klamath River Renewal Project **By:** PJ

Boring:	B-10					
Sample:	R1					
Depth, ft:	30.4-30.7					
Visual Description:	Gray Rock					
Test Type	Diametral					
Test Type ID	1					
FOR ANISOTROPIC ROCK:						
Bedding Angle Relative to Axis	None					
Loading Orientation Rel. to Bedding	N/A					
SAMPLE DIMENSIONS						
Width Perpendicular to loading, W, mm	60					
Length Perpendicular to Loading, L, mm	30					
Diameter Parallel to Loading, D, mm	60					
Diameter at Failure, D', mm	56					
STRENGTH DATA						
Peak Load, P, kN	9.55					
Peak Load, P, lbs	2146.9					
Uncorr. Pt. Load Strength Index, I_S, MPa	2.842					
Uncorr. Pt. Load Strength Index, I_S, psi	**412.2**					
Size Correction Factor, F	1.07					
Corr. Pt. Load Strength Index, $I_{S(50)}$, Mpa	3.04					
Corr. Pt. Load Strength Index, $I_{S(50)}$, psi	**441**					
MOISTURE CONTENT DATA						
Moisture Condition of Specimen	As Received					
Pan No.						
Pan wt. (g)	22.44					
Total wet wt. (g)	267.19					
Total dry wt (g)	259.78					
Moisture Content, %	**3.1**					
Comments:						

Test types: 1- Diametral, 2- Axial, 3- Block,4- Irregular Lump
Diametral - L/D ratio>1
Axial - L/D ratio 1/3 to 1
Block or Irregular Lumps, D= 30-85 mm; D/W between 1/3 and 1

POINT LOAD STRENGTH INDEX OF ROCK - ASTM D 5731

COOPER TESTING LABORATORY

CTL Job No: 020-277 **Project No.:** 60537920
Client: AECOM **Date:** 3/13/2019
Project Name: Klamath River Renewal Project **By:** PJ

Boring:	B-10	B-10				
Sample:	R3	R3				
Depth, ft:	33.4-33.7	33.4-33.7				
Visual Description:	Gray Rock	Gray Rock				
Test Type	Diametral	Axial				
Test Type ID	1	2				
FOR ANISOTROPIC ROCK:						
Bedding Angle Relative to Axis	None	None				
Loading Orientation Rel. to Bedding	N/A	N/A				
SAMPLE DIMENSIONS						
Width Perpendicular to loading, W, mm	60	60				
Length Perpendicular to Loading, L, mm	30					
Diameter Parallel to Loading, D, mm	60	44				
Diameter at Failure, D', mm	56	42				
STRENGTH DATA						
Peak Load, P, kN	0.374	0.101				
Peak Load, P, lbs	84.1	22.7				
Uncorr. Pt. Load Strength Index,I_S, MPa	0.111	0.031				
Uncorr. Pt. Load Strength Index,I_S, psi	**16.1**	**4.6**				
Size Correction Factor, F	1.07	1.06				
Corr. Pt. Load Strength Index,$I_{S(50)}$, Mpa	0.12	0.03				
Corr. Pt. Load Strength Index,$I_{S(50)}$, psi	**17**	**5**				
MOISTURE CONTENT DATA						
Moisture Condition of Specimen	As Received	As Received				
Pan No.						
Pan wt. (g)	22.32	22.32				
Total wet wt. (g)	159.18	159.18				
Total dry wt (g)	144.98	144.98				
Moisture Content, %	**11.6**	**11.6**				
Comments:						

Test types: 1- Diametral, 2- Axial, 3- Block,4- Irregular Lump
Diametral - L/D ratio>1
Axial - L/D ratio 1/3 to 1
Block or Irregular Lumps, D= 30-85 mm; D/W between 1/3 and 1

POINT LOAD STRENGTH INDEX OF ROCK - ASTM D 5731

CTL Job No:	020-277	**Project No.:**	60537920
Client:	AECOM	**Date:**	3/13/2019
Project Name:	Klamath River Renewal Project	**By:**	3/13/2019

Boring:	B-10	B-10	B-10	B-10		
Sample:	R4	R4	R4	R4		
Depth, ft:	37.1-37.4	37.1-37.4	37.1-37.4	37.1-37.4		
Visual Description:	Gray Rock	Gray Rock	Gray Rock	Gray Rock		
Test Type	Diametral	Diametral	Axial	Axial		
Test Type ID	1	1	2	2		
FOR ANISOTROPIC ROCK:						
Bedding Angle Relative to Axis	None	None	None	None		
Loading Orientation Rel. to Bedding	N/A	N/A	N/A	N/A		
SAMPLE DIMENSIONS						
Width Perpendicular to loading, W, mm	60	60	60	60		
Length Perpendicular to Loading, L, mm	30	30				
Diameter Parallel to Loading, D, mm	60	60	37	36		
Diameter at Failure, D', mm	58	56	33	28		
STRENGTH DATA						
Peak Load, P, kN	0.435	0.521	0.225	0.313		
Peak Load, P, lbs	97.8	117.1	50.6	70.4		
Uncorr. Pt. Load Strength Index,I_S, MPa	0.125	0.155	0.089	0.146		
Uncorr. Pt. Load Strength Index,I_S, psi	**18.1**	**22.5**	**12.9**	**21.2**		
Size Correction Factor, F	1.08	1.07	1.00	0.97		
Corr. Pt. Load Strength Index,$I_{S(50)}$, Mpa	0.13	0.17	0.09	0.14		
Corr. Pt. Load Strength Index,$I_{S(50)}$, psi	**20**	**24**	**13**	**20**		
MOISTURE CONTENT DATA						
Moisture Condition of Specimen	As Received	As Received	As Received	As Received		
Pan No.						
Pan wt. (g)	22.12	22.12	22.12	22.12		
Total wet wt. (g)	154	154	154	154		
Total dry wt (g)	140.19	140.19	140.19	140.19		
Moisture Content, %	**11.7**	**11.7**	**11.7**	**11.7**		
Comments:						

Test types: 1- Diametral, 2- Axial, 3- Block,4- Irregular Lump
Diametral - L/D ratio>1
Axial - L/D ratio 1/3 to 1
Block or Irregular Lumps, D= 30-85 mm; D/W between 1/3 and 1

COOPER TESTING LABORATORY

POINT LOAD STRENGTH INDEX OF ROCK - ASTM D 5731

CTL Job No: 020-277 **Project No.:** 60537920
Client: AECOM **Date:** 3/13/2019
Project Name: Klamath River Renewal Project **By:** PJ

Boring:	B-10	B-10				
Sample:	R7	R7				
Depth, ft:	49-49.5	49-49.5				
Visual Description:	Gray Rock	Gray Rock				
Test Type	Diametral	Axial				
Test Type ID	1	2				
FOR ANISOTROPIC ROCK:						
Bedding Angle Relative to Axis	None	None				
Loading Orientation Rel. to Bedding	N/A	N/A				
SAMPLE DIMENSIONS						
Width Perpendicular to loading, W, mm	60	60				
Length Perpendicular to Loading, L, mm	30					
Diameter Parallel to Loading, D, mm	60	30				
Diameter at Failure, D', mm	58	29				
STRENGTH DATA						
Peak Load, P, kN	2.077	1.996				
Peak Load, P, lbs	466.9	448.7				
Uncorr. Pt. Load Strength Index, I_S, MPa	0.597	0.901				
Uncorr. Pt. Load Strength Index, I_S, psi	**86.6**	**130.7**				
Size Correction Factor, F	1.08	0.97				
Corr. Pt. Load Strength Index, $I_{S(50)}$, Mpa	0.64	0.88				
Corr. Pt. Load Strength Index, $I_{S(50)}$, psi	**93**	**127**				
MOISTURE CONTENT DATA						
Moisture Condition of Specimen	As Received	As Received				
Pan No.						
Pan wt. (g)	22.33	22.33				
Total wet wt. (g)	379.89	379.89				
Total dry wt (g)	357.27	357.27				
Moisture Content, %	**6.8**	**6.8**				
Comments:						

Test types: 1- Diametral, 2- Axial, 3- Block,4- Irregular Lump
Diametral - L/D ratio>1
Axial - L/D ratio 1/3 to 1
Block or Irregular Lumps, D= 30-85 mm; D/W between 1/3 and 1

POINT LOAD STRENGTH INDEX OF ROCK - ASTM D 5731

COOPER TESTING LABORATORY

CTL Job No:	020-277	**Project No.:**	60537920
Client:	AECOM	**Date:**	3/13/2019
Project Name:	Klamath River Renewal Project	**By:**	PJ

Boring:	B-13	B-13	B-13	B-13	B-13	
Sample:	R4	R4	R4	R4	R4	
Depth, ft:	11.9-12.4	11.9-12.4	11.9-12.4	11.9-12.4	11.9-12.4	
Visual Description:	Gray Rock	Gray Rock	Gray Rock	Gray Rock	Gray Rock	
Test Type	Diametral	Diametral	Diametral	Axial	Axial	
Test Type ID	1	1	1	2	2	
FOR ANISOTROPIC ROCK:						
Bedding Angle Relative to Axis	None	None	None	None	None	
Loading Orientation Rel. to Bedding	N/A	N/A	N/A	N/A	N/A	
SAMPLE DIMENSIONS						
Width Perpendicular to loading, W, mm	60	60	60	60	60	
Length Perpendicular to Loading, L, mm	30	30	30			
Diameter Parallel to Loading, D, mm	60	60	60	46	40	
Diameter at Failure, D', mm	59	57	59	45	36	
STRENGTH DATA						
Peak Load, P, kN	12.808	20.405	17.108	16.519	15.518	
Peak Load, P, lbs	2879.4	4587.2	3846.0	3713.6	3488.6	
Uncorr. Pt. Load Strength Index, I_S, MPa	3.618	5.966	4.833	4.805	5.643	
Uncorr. Pt. Load Strength Index, I_S, psi	**524.8**	**865.4**	**700.9**	**696.9**	**818.4**	
Size Correction Factor, F	1.08	1.07	1.08	1.07	1.02	
Corr. Pt. Load Strength Index, $I_{S(50)}$, Mpa	3.91	6.40	5.23	5.16	5.76	
Corr. Pt. Load Strength Index, $I_{S(50)}$, psi	**567**	**929**	**758**	**749**	**836**	
MOISTURE CONTENT DATA						
Moisture Condition of Specimen	As Received	As Received	As Received	As Received	As Received	
Pan No.						
Pan wt. (g)	22.32	22.32	22.32	22.32	22.32	
Total wet wt. (g)	215.87	215.87	215.87	215.87	215.87	
Total dry wt (g)	215.69	215.69	215.69	215.69	215.69	
Moisture Content, %	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	
Comments:						

Test types: 1- Diametral, 2- Axial, 3- Block,4- Irregular Lump
Diametral - L/D ratio>1
Axial - L/D ratio 1/3 to 1
Block or Irregular Lumps, D= 30-85 mm; D/W between 1/3 and 1

POINT LOAD STRENGTH INDEX OF ROCK - ASTM D 5731

COOPER TESTING LABORATORY

CTL Job No: 020-277 **Project No.:** 60537920
Client: AECOM **Date:** 3/13/2019
Project Name: Klamath River Renewal Project **By:** PJ

Boring:	B-14	B-14	B-14	B-14	B-14	B-14
Sample:	R6	R6	R6	R6	R6	R6
Depth, ft:	14.2-14.9	14.2-14.9	14.2-14.9	14.2-14.9	14.2-14.9	14.2-14.9
Visual Description:	Gray Rock	Gray Rock	Gray Rock	Gray Rock	Gray Rock	Gray Rock
Test Type	Diametral	Diametral	Diametral	Axial	Axial	Axial
Test Type ID	1	1	1	2	2	2
FOR ANISOTROPIC ROCK:						
Bedding Angle Relative to Axis	None	None	None	None	None	None
Loading Orientation Rel. to Bedding	N/A	N/A	N/A	N/A	N/A	N/A
SAMPLE DIMENSIONS						
Width Perpendicular to loading, W, mm	60	60	60	60	60	60
Length Perpendicular to Loading, L, mm	30	30	30			
Diameter Parallel to Loading, D, mm	60	60	60	49	50	41
Diameter at Failure, D', mm	56	57	58	39	48	36
STRENGTH DATA						
Peak Load, P, kN	0.196	0.188	0.169	0.046	0.053	0.054
Peak Load, P, lbs	44.1	42.3	38.0	10.3	11.9	12.1
Uncorr. Pt. Load Strength Index, I_S, MPa	0.058	0.055	0.049	0.015	0.014	0.020
Uncorr. Pt. Load Strength Index, I_S, psi	**8.5**	**8.0**	**7.0**	**2.2**	**2.1**	**2.8**
Size Correction Factor, F	1.07	1.07	1.08	1.04	1.09	1.02
Corr. Pt. Load Strength Index, $I_{S(50)}$, Mpa	0.06	0.06	0.05	0.02	0.02	0.02
Corr. Pt. Load Strength Index, $I_{S(50)}$, psi	**9**	**9**	**8**	**2**	**2**	**3**
MOISTURE CONTENT DATA						
Moisture Condition of Specimen	As Received	As Received	As Received	As Received	As Received	As Received
Pan No.						
Pan wt. (g)	21.71	21.71	21.71	21.71	21.71	21.71
Total wet wt. (g)	209.08	209.08	209.08	209.08	209.08	209.08
Total dry wt (g)	195.76	195.76	195.76	195.76	195.76	195.76
Moisture Content, %	**7.7**	**7.7**	**7.7**	**7.7**	**7.7**	**7.7**
Comments:						

Test types: 1- Diametral, 2- Axial, 3- Block,4- Irregular Lump
Diametral - L/D ratio>1
Axial - L/D ratio 1/3 to 1
Block or Irregular Lumps, D= 30-85 mm; D/W between 1/3 and 1

POINT LOAD STRENGTH INDEX OF ROCK - ASTM D 5731

COOPER TESTING LABORATORY

CTL Job No: 020-277 **Project No.:** 60537920
Client: AECOM **Date:** 3/13/2019
Project Name: Klamath River Renewal Project **By:** PJ

Boring:	B-14					
Sample:	R7					
Depth, ft:	20.8-21.2					
Visual Description:	Gray Rock					
Test Type	Diametral					
Test Type ID	1					
FOR ANISOTROPIC ROCK:						
Bedding Angle Relative to Axis	None					
Loading Orientation Rel. to Bedding	N/A					
SAMPLE DIMENSIONS						
Width Perpendicular to loading, W, mm	58					
Length Perpendicular to Loading, L, mm	30					
Diameter Parallel to Loading, D, mm	58					
Diameter at Failure, D', mm	56					
STRENGTH DATA						
Peak Load, P, kN	0.284					
Peak Load, P, lbs	63.8					
Uncorr. Pt. Load Strength Index, I_S, MPa	0.087					
Uncorr. Pt. Load Strength Index, I_S, psi	**12.7**					
Size Correction Factor, F	1.06					
Corr. Pt. Load Strength Index, $I_{S(50)}$, Mpa	0.09					
Corr. Pt. Load Strength Index, $I_{S(50)}$, psi	**13**					
MOISTURE CONTENT DATA						
Moisture Condition of Specimen	As Received					
Pan No.						
Pan wt. (g)	21.98					
Total wet wt. (g)	194.83					
Total dry wt (g)	185.6					
Moisture Content, %	**5.6**					
Comments:						

Test types: 1- Diametral, 2- Axial, 3- Block,4- Irregular Lump
Diametral - L/D ratio>1
Axial - L/D ratio 1/3 to 1
Block or Irregular Lumps, D= 30-85 mm; D/W between 1/3 and 1

POINT LOAD STRENGTH INDEX OF ROCK - ASTM D 5731

COOPER TESTING LABORATORY

CTL Job No: 020-277 **Project No.:** 60537920
Client: AECOM **Date:** 3/13/2019
Project Name: Klamath River Renewal Project **By:** PJ

Boring:	B-14					
Sample:	R8					
Depth, ft:	23.7-23.9					
Visual Description:	Gray Rock					
Test Type	Axial					
Test Type ID	2					
FOR ANISOTROPIC ROCK:						
Bedding Angle Relative to Axis	None					
Loading Orientation Rel. to Bedding	N/A					
SAMPLE DIMENSIONS						
Width Perpendicular to loading, W, mm	60					
Length Perpendicular to Loading, L, mm						
Diameter Parallel to Loading, D, mm	51					
Diameter at Failure, D', mm	49					
STRENGTH DATA						
Peak Load, P, kN	0.037					
Peak Load, P, lbs	8.3					
Uncorr. Pt. Load Strength Index, I_S, MPa	0.010					
Uncorr. Pt. Load Strength Index, I_S, psi	**1.4**					
Size Correction Factor, F	1.10					
Corr. Pt. Load Strength Index, $I_{S(50)}$, Mpa	0.01					
Corr. Pt. Load Strength Index, $I_{S(50)}$, psi	**2**					
MOISTURE CONTENT DATA						
Moisture Condition of Specimen	As Received					
Pan No.						
Pan wt. (g)	22.23					
Total wet wt. (g)	109.95					
Total dry wt (g)	104.99					
Moisture Content, %	**6.0**					
Comments:	Invalid test. Did not fail through both loading points.					

Test types: 1- Diametral, 2- Axial, 3- Block,4- Irregular Lump
Diametral - L/D ratio>1
Axial - L/D ratio 1/3 to 1
Block or Irregular Lumps, D= 30-85 mm; D/W between 1/3 and 1

POINT LOAD STRENGTH INDEX OF ROCK - ASTM D 5731

COOPER TESTING LABORATORY

CTL Job No: 020-277 **Project No.:** 60537920
Client: AECOM **Date:** 3/13/2019
Project Name: Klamath River Renewal Project **By:** PJ

Boring:	B-14	B-14				
Sample:	R9	R9				
Depth, ft:	26.1-26.4	26.1-26.4				
Visual Description:	Grayish Brown Rock	Grayish Brown Rock				
Test Type	Diametral	Axial				
Test Type ID	1	2				
FOR ANISOTROPIC ROCK:						
Bedding Angle Relative to Axis	None	None				
Loading Orientation Rel. to Bedding	N/A	N/A				
SAMPLE DIMENSIONS						
Width Perpendicular to loading, W, mm	60	60				
Length Perpendicular to Loading, L, mm	30					
Diameter Parallel to Loading, D, mm	60	51				
Diameter at Failure, D', mm	57	49				
STRENGTH DATA						
Peak Load, P, kN	1.627	2.247				
Peak Load, P, lbs	365.8	505.1				
Uncorr. Pt. Load Strength Index,I_S, MPa	0.476	0.600				
Uncorr. Pt. Load Strength Index,I_S, psi	**69.0**	**87.1**				
Size Correction Factor, F	1.07	1.10				
Corr. Pt. Load Strength Index,$I_{S(50)}$, Mpa	0.51	0.66				
Corr. Pt. Load Strength Index,$I_{S(50)}$, psi	**74**	**95**				
MOISTURE CONTENT DATA						
Moisture Condition of Specimen	As Received	As Received				
Pan No.						
Pan wt. (g)	22.3	22.3				
Total wet wt. (g)	127.05	127.05				
Total dry wt (g)	124.19	124.19				
Moisture Content, %	**2.8**	**2.8**				
Comments:						

Test types: 1- Diametral, 2- Axial, 3- Block,4- Irregular Lump
Diametral - L/D ratio>1
Axial - L/D ratio 1/3 to 1
Block or Irregular Lumps, D= 30-85 mm; D/W between 1/3 and 1

POINT LOAD STRENGTH INDEX OF ROCK - ASTM D 5731

COOPER TESTING LABORATORY

CTL Job No:	020-277	**Project No.:**	60537920
Client:	AECOM	**Date:**	3/13/2019
Project Name:	Klamath River Renewal Project	**By:**	PJ

Boring:	B-15	B-15	B-15	B-15	B-15	B-15
Sample:	R4	R4	R4	R4	R4	R4
Depth, ft:	33-33.5	33-33.5	33-33.5	33-33.5	33-33.5	33-33.5
Visual Description:	Gray Rock	Gray Rock	Gray Rock	Gray Rock	Gray Rock	Gray Rock
Test Type	Diametral	Diametral	Diametral	Axial	Axial	Axial
Test Type ID	1	1	1	2	2	2
FOR ANISOTROPIC ROCK:						
Bedding Angle Relative to Axis	None	None	None	None	None	None
Loading Orientation Rel. to Bedding	N/A	N/A	N/A	N/A	N/A	N/A
SAMPLE DIMENSIONS						
Width Perpendicular to loading, W, mm	60	60	60	60	60	60
Length Perpendicular to Loading, L, mm	30	30	30			
Diameter Parallel to Loading, D, mm	60	60	60	44	45	30
Diameter at Failure, D', mm	59	57	57	42	39	26
STRENGTH DATA						
Peak Load, P, kN	0.72	0.84	1.048	1.447	1.044	0.099
Peak Load, P, lbs	161.9	188.8	235.6	325.3	234.7	22.3
Uncorr. Pt. Load Strength Index, I_S, MPa	0.203	0.246	0.306	0.451	0.350	0.050
Uncorr. Pt. Load Strength Index, I_S, psi	**29.5**	**35.6**	**44.4**	**65.4**	**50.8**	**7.2**
Size Correction Factor, F	1.08	1.07	1.07	1.06	1.04	0.95
Corr. Pt. Load Strength Index, $I_{S(50)}$, Mpa	0.22	0.26	0.33	0.48	0.36	0.05
Corr. Pt. Load Strength Index, $I_{S(50)}$, psi	**32**	**38**	**48**	**69**	**53**	**7**
MOISTURE CONTENT DATA						
Moisture Condition of Specimen	As Received	As Received	As Received	As Received	As Received	As Received
Pan No.						
Pan wt. (g)	21.63	21.63	21.63	21.63	21.63	21.63
Total wet wt. (g)	128.99	128.99	128.99	128.99	128.99	128.99
Total dry wt (g)	124.4	124.4	124.4	124.4	124.4	124.4
Moisture Content, %	**4.5**	**4.5**	**4.5**	**4.5**	**4.5**	**4.5**
Comments:						

Test types: 1- Diametral, 2- Axial, 3- Block,4- Irregular Lump
Diametral - L/D ratio>1
Axial - L/D ratio 1/3 to 1
Block or Irregular Lumps, D= 30-85 mm; D/W between 1/3 and 1

POINT LOAD STRENGTH INDEX OF ROCK - ASTM D 5731

COOPER TESTING LABORATORY

CTL Job No: 020-277 **Project No.:** 60537920
Client: AECOM **Date:** 3/13/2019
Project Name: Klamath River Renewal Project **By:** PJ

Boring:	B-15	B-15	B-15	B-15	B-15	B-15
Sample:	R6	R6	R6	R6	R6	R6
Depth, ft:	43.1-43.6	43.1-43.6	43.1-43.6	43.1-43.6	43.1-43.6	43.1-43.6
Visual Description:	Gray Rock	Gray Rock	Gray Rock	Gray Rock	Gray Rock	Gray Rock
Test Type	Diametral	Diametral	Diametral	Axial	Axial	Axial
Test Type ID	1	1	1	2	2	2
FOR ANISOTROPIC ROCK:						
Bedding Angle Relative to Axis	None	None	None	None	None	None
Loading Orientation Rel. to Bedding	N/A	N/A	N/A	N/A	N/A	N/A
SAMPLE DIMENSIONS						
Width Perpendicular to loading, W, mm	60	60	60	60	60	60
Length Perpendicular to Loading, L, mm	30	30	30			
Diameter Parallel to Loading, D, mm	60	60	60	32	35	30
Diameter at Failure, D', mm	57	57	55	30	32	27
STRENGTH DATA						
Peak Load, P, kN	1.129	1.549	1.129	1.336	1.359	0.771
Peak Load, P, lbs	253.8	348.2	253.8	300.3	305.5	173.3
Uncorr. Pt. Load Strength Index, I_S, MPa	0.330	0.453	0.342	0.583	0.556	0.374
Uncorr. Pt. Load Strength Index, I_S, psi	**47.9**	**65.7**	**49.6**	**84.5**	**80.6**	**54.2**
Size Correction Factor, F	1.07	1.07	1.06	0.98	0.99	0.96
Corr. Pt. Load Strength Index, $I_{S(50)}$, Mpa	0.35	0.49	0.36	0.57	0.55	0.36
Corr. Pt. Load Strength Index, $I_{S(50)}$, psi	**51**	**70**	**53**	**83**	**80**	**52**
MOISTURE CONTENT DATA						
Moisture Condition of Specimen	As Received	As Received	As Received	As Received	As Received	As Received
Pan No.						
Pan wt. (g)	20.45	20.45	20.45	20.45	20.45	20.45
Total wet wt. (g)	238.89	238.89	238.89	238.89	238.89	238.89
Total dry wt (g)	228.86	228.86	228.86	228.86	228.86	228.86
Moisture Content, %	**4.8**	**4.8**	**4.8**	**4.8**	**4.8**	**4.8**
Comments:						

Test types: 1- Diametral, 2- Axial, 3- Block,4- Irregular Lump
Diametral - L/D ratio>1
Axial - L/D ratio 1/3 to 1
Block or Irregular Lumps, D= 30-85 mm; D/W between 1/3 and 1

POINT LOAD STRENGTH INDEX OF ROCK - ASTM D 5731

COOPER TESTING LABORATORY

CTL Job No: 020-277 **Project No.:** 60537920
Client: AECOM **Date:** 3/13/2019
Project Name: Klamath River Renewal Project **By:** PJ

Boring:	B-17	B-17	B-17	B-17	B-17	B-17
Sample:	R3	R3	R3	R3	R3	R3
Depth, ft:	25.1-25.7	25.1-25.7	25.1-25.7	25.1-25.7	25.1-25.7	25.1-25.7
Visual Description:	Gray Rock	Gray Rock	Gray Rock	Gray Rock	Gray Rock	Gray Rock
Test Type	Diametral	Diametral	Diametral	Axial	Axial	Axial
Test Type ID	1	1	1	2	2	2
FOR ANISOTROPIC ROCK:						
Bedding Angle Relative to Axis	None	None	None	None	None	None
Loading Orientation Rel. to Bedding	N/A	N/A	N/A	N/A	N/A	N/A
SAMPLE DIMENSIONS						
Width Perpendicular to loading, W, mm	60	60	60	60	60	60
Length Perpendicular to Loading, L, mm	30	30	30			
Diameter Parallel to Loading, D, mm	60	60	60	33	41	34
Diameter at Failure, D', mm	59	60	59	30	38	29
STRENGTH DATA						
Peak Load, P, kN	0.583	0.78	0.413	1.206	2.038	1.52
Peak Load, P, lbs	131.1	175.4	92.8	271.1	458.2	341.7
Uncorr. Pt. Load Strength Index, I_S, MPa	0.165	0.217	0.117	0.526	0.702	0.686
Uncorr. Pt. Load Strength Index, I_S, psi	**23.9**	**31.4**	**16.9**	**76.3**	**101.8**	**99.5**
Size Correction Factor, F	1.08	1.09	1.08	0.98	1.03	0.97
Corr. Pt. Load Strength Index, $I_{S(50)}$, Mpa	0.18	0.24	0.13	0.52	0.73	0.67
Corr. Pt. Load Strength Index, $I_{S(50)}$, psi	**26**	**34**	**18**	**75**	**105**	**97**
MOISTURE CONTENT DATA						
Moisture Condition of Specimen	As Received	As Received	As Received	As Received	As Received	As Received
Pan No.						
Pan wt. (g)	20.98	20.98	20.98	20.98	20.98	20.98
Total wet wt. (g)	165.97	165.97	165.97	165.97	165.97	165.97
Total dry wt (g)	158.36	158.36	158.36	158.36	158.36	158.36
Moisture Content, %	**5.5**	**5.5**	**5.5**	**5.5**	**5.5**	**5.5**
Comments:						

Test types: 1- Diametral, 2- Axial, 3- Block,4- Irregular Lump
Diametral - L/D ratio>1
Axial - L/D ratio 1/3 to 1
Block or Irregular Lumps, D= 30-85 mm; D/W between 1/3 and 1

POINT LOAD STRENGTH INDEX OF ROCK - ASTM D 5731

COOPER TESTING LABORATORY

CTL Job No: 020-277 **Project No.:** 60537920
Client: AECOM **Date:** 3/20/2019
Project Name: Klamath River Renewal Project **By:** PJ

Boring:	B-19					
Sample:	R1					
Depth, ft:	31.3-32.2					
Visual Description:	Brown Rock					
Test Type	Diametral					
Test Type ID	1					
FOR ANISOTROPIC ROCK:						
Bedding Angle Relative to Axis	None					
Loading Orientation Rel. to Bedding	N/A					
SAMPLE DIMENSIONS						
Width Perpendicular to loading, W, mm	61					
Length Perpendicular to Loading, L, mm	30					
Diameter Parallel to Loading, D, mm	61					
Diameter at Failure, D', mm	59					
STRENGTH DATA						
Peak Load, P, kN	0.582					
Peak Load, P, lbs	130.8					
Uncorr. Pt. Load Strength Index, I_S, MPa	0.162					
Uncorr. Pt. Load Strength Index, I_S, psi	**23.5**					
Size Correction Factor, F	1.09					
Corr. Pt. Load Strength Index, $I_{S(50)}$, Mpa	0.18					
Corr. Pt. Load Strength Index, $I_{S(50)}$, psi	**25**					
MOISTURE CONTENT DATA						
Moisture Condition of Specimen	As Received					
Pan No.						
Pan wt. (g)	19.52					
Total wet wt. (g)	97.66					
Total dry wt (g)	91.38					
Moisture Content, %	**8.7**					
Comments:						

Test types: 1- Diametral, 2- Axial, 3- Block,4- Irregular Lump
Diametral - L/D ratio>1
Axial - L/D ratio 1/3 to 1
Block or Irregular Lumps, D= 30-85 mm; D/W between 1/3 and 1

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

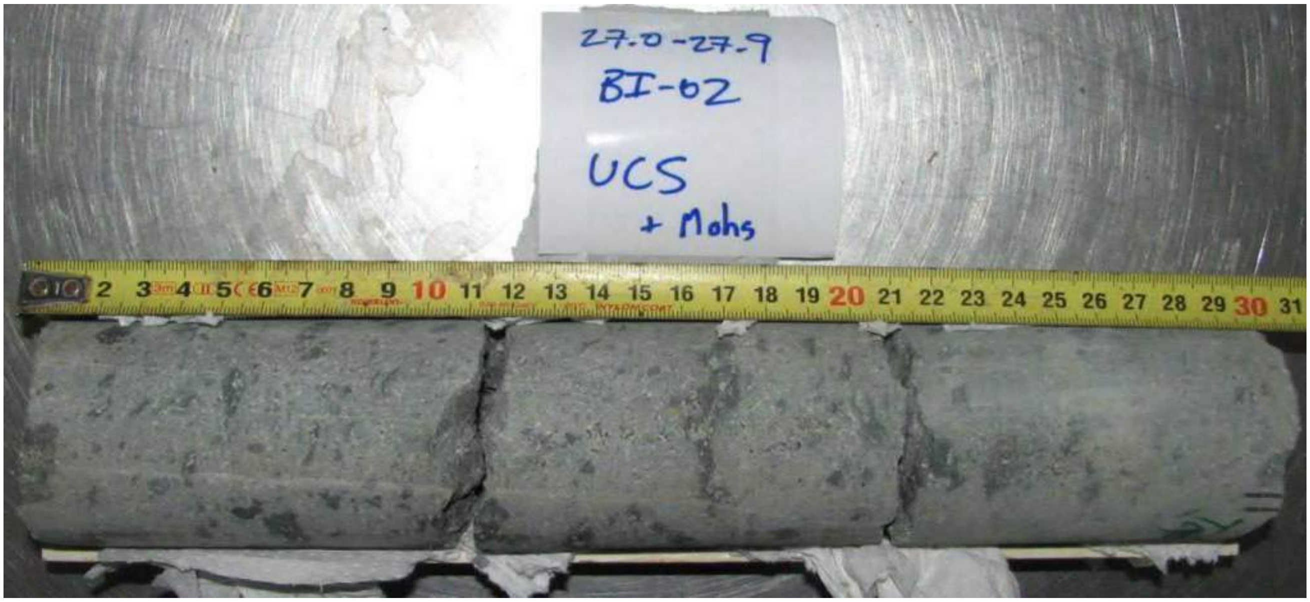
Photo After Test

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

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

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



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.

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.

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

Tonon USA:
Engineering, Measuraments and Testing, LLC

Web: tononeng.com

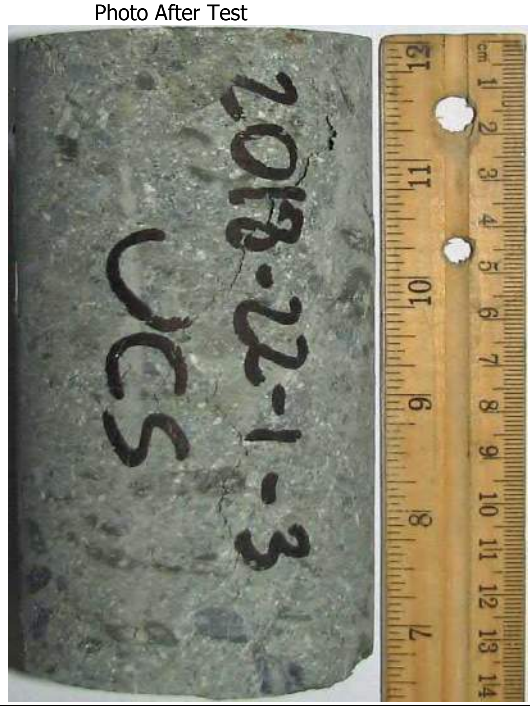
Project Name	Klamath River Dam Removal
Location	Klamath River
Client	Klamath River Renewal Corporation
Client Project No.	60537920
Registry No.	2018-22
Report No.	2018-22-1-3
Report Date	5/17/2018
Drill hole and Depth	BI-02; 55.4-56.3 ft
Rock Type	Volcanic Breccia
Geologic Unit	N/A
Moisture Condition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



Tested 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

Uniaxial Compression Test without Stress-Strain Curves and Moduli
ASTM D7012 - 14e1

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

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.	2018-22-1-4
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.

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

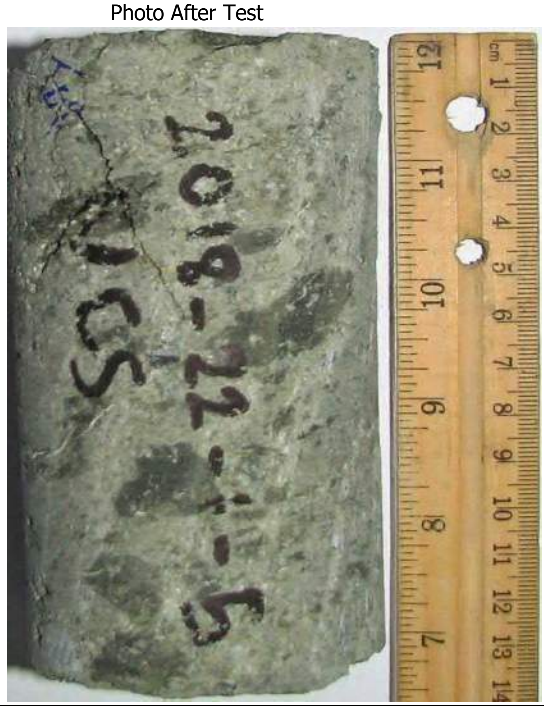
Project Name	Klamath River Dam Removal
Location	Klamath River
Client	Klamath River Renewal Corporation
Client Project No.	60537920
Registry No.	2018-22
Report No.	2018-22-1-5
Report Date	5/17/2018
Drill hole and Depth	BI-03; 21.5-22.9 ft
Rock Type	Volcanic Breccia
Geologic Unit	N/A
Moisture Condition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



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

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

COOPER TESTING LABORATORY	**Unconfined Compressive Strength and Young's Modulus of Rock Core (ASTM D7012D)**

CTL Job No.:	020-277B	Boring:	B-05	Date:	3/12/2019
Client:	AECOM	Sample:	R4	By:	PJ
Project Name:	Klamath River Renewal Project	Depth,ft.:	19.6-20.2	Checked:	DC
Project No.:	60537920				

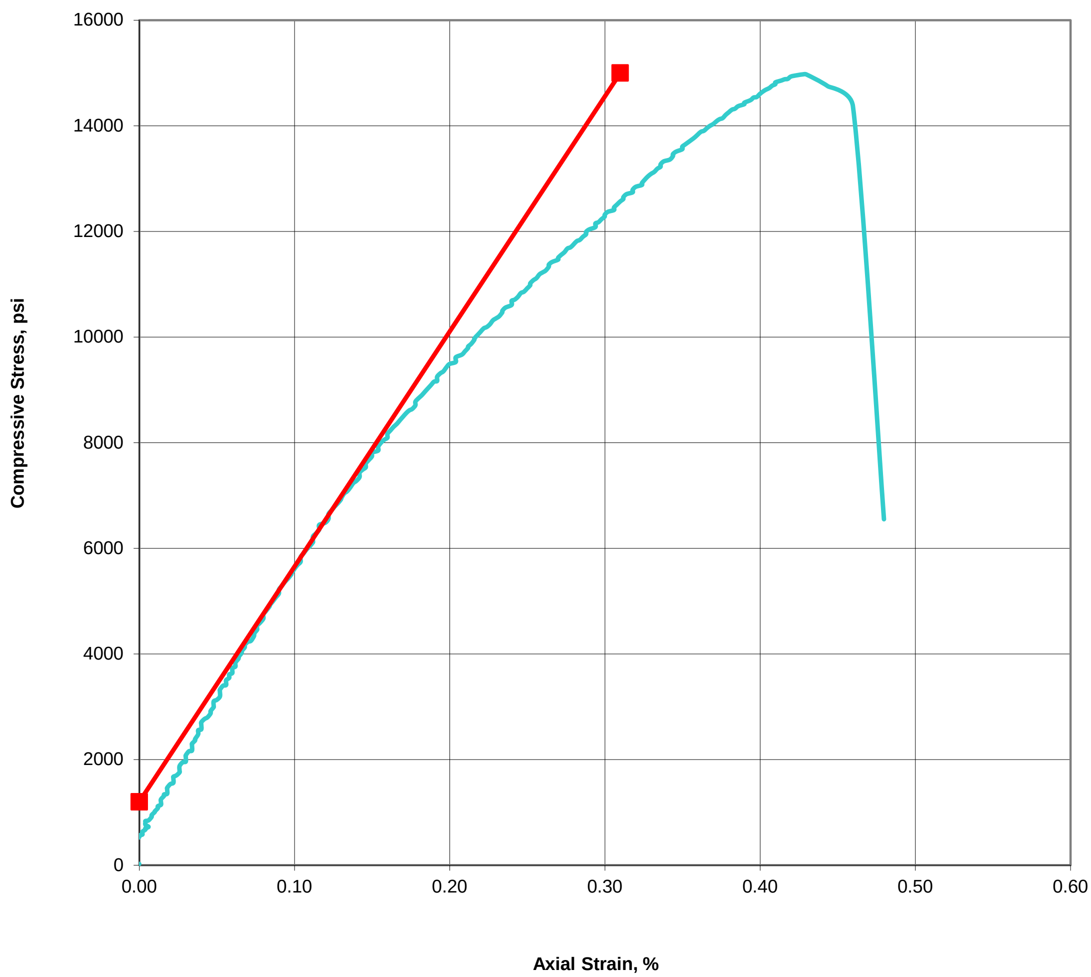
Visual Description: Gray Rock

Moisture Condition at Test: Sample was washed and in a moist state.

Test Temperature, (^oC): Ambient

Remarks:

Sample Height, in.	5.00	**Unconfined Compressive Strength (psi)**	**14975**
Sample Diameter, in.	2.39		
Height / Diameter	2.1		
Sample Area, in^2	4.50		
Wet Density, pcf	160.2	**Young's Modulus (E) (psi)**	**4,450,000**
Dry Density, pcf	159.1		
Moisture Content, %	0.7		
Strain Rate, % / min	0.25		



COOPER TESTING LABORATORY

Unconfined Compressive Strength and Young's Modulus of Rock Core (ASTM D7012D)

CTL Job No.:	020-277C	Boring:	B-08	Date:	3/12/2019
Client:	AECOM	Sample:	R3	By:	PJ
Project Name:	Klamath River Renewal Project	Depth,ft.:	46.1-47	Checked:	DC
Project No.:	60537920				

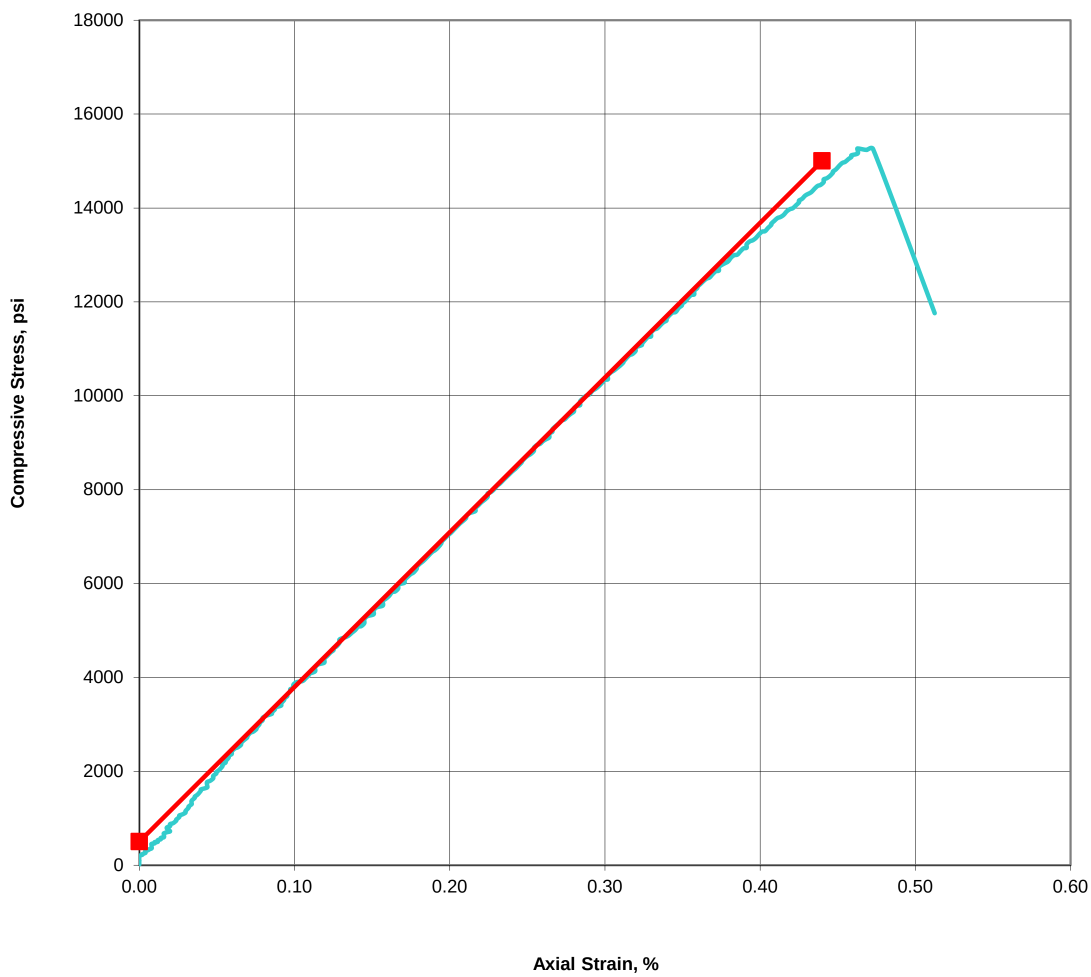
Visual Description: Gray Rock

Moisture Condition at Test: Sample was washed and in a moist state.

Test Temperature, (^oC): Ambient

Remarks:

Sample Height, in.	5.03	**Unconfined Compressive Strength (psi)**	**15268**
Sample Diameter, in.	2.40		
Height / Diameter	2.1		
Sample Area, in^2	4.54		
Wet Density, pcf	162.2	**Young's Modulus (E) (psi)**	**3,300,000**
Dry Density, pcf	159.3		
Moisture Content, %	1.8		
Strain Rate, % / min	0.25		



COOPER TESTING LABORATORY

Unconfined Compressive Strength and Young's Modulus of Rock Core (ASTM D7012D)

CTL Job No.:	020-277E	Boring:	B-13	Date:	3/12/2019
Client:	AECOM	Sample:	R5	By:	PJ
Project Name:	Klamath River Renewal Project	Depth,ft.:	17.6-18.5	Checked:	DC
Project No.:	60537920				

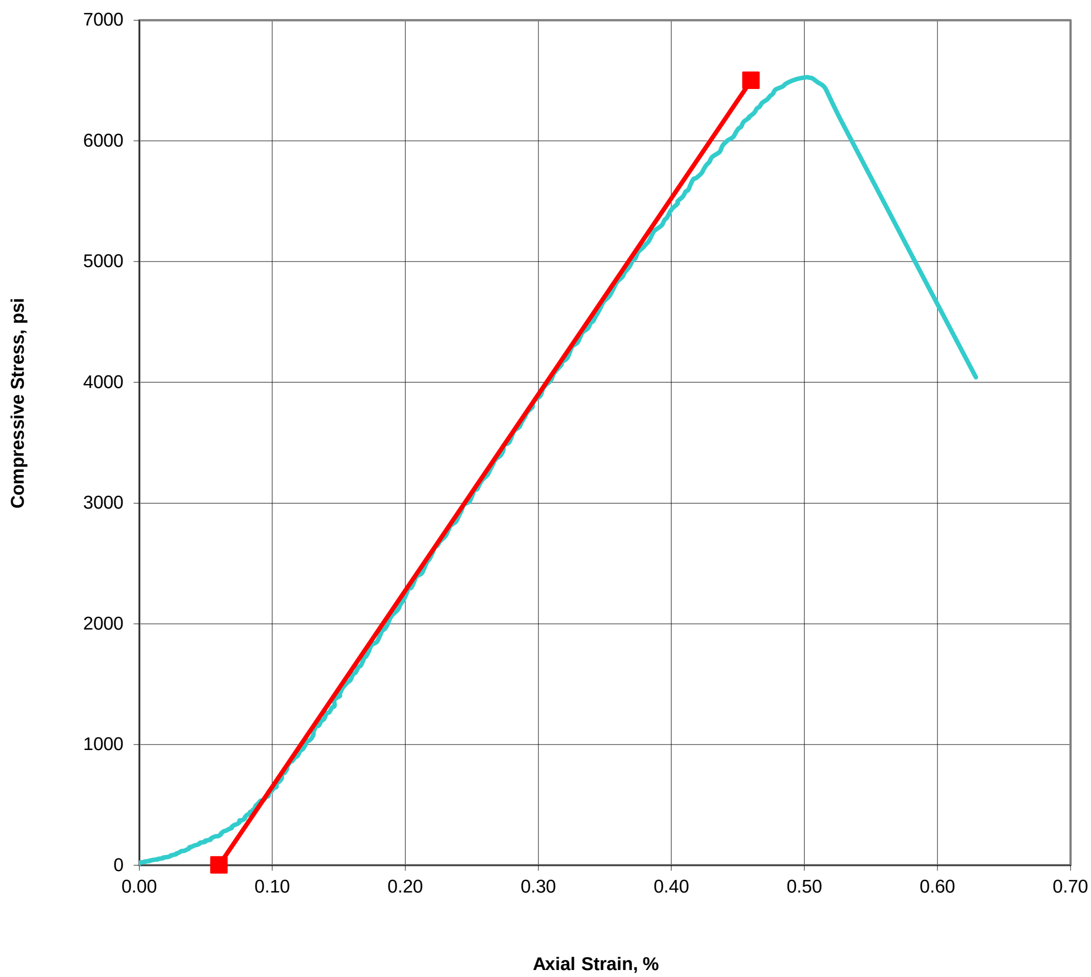
Visual Description: Gray Rock

Moisture Condition at Test: Sample was washed and in a moist state.

Test Temperature, (^{o}C): Ambient

Remarks:

Sample Height, in.	5.04	**Unconfined Compressive Strength (psi)**	**6528**
Sample Diameter, in.	2.40		
Height / Diameter	2.1		
Sample Area, in^2	4.52		
Wet Density, pcf	141.3	**Young's Modulus (E) (psi)**	**1,630,000**
Dry Density, pcf	140.1		
Moisture Content, %	0.9		
Strain Rate, % / min	0.25		



Unconfined Compressive Strength and Young's Modulus of Rock Core (ASTM D7012D)

CTL Job No.:	020-277H	Boring:	B-20	Date:	3/12/2019
Client:	AECOM	Sample:	R1	By:	PJ
Project Name:	Klamath River Renewal Project	Depth,ft.:	40.1-40.6	Checked:	DC
Project No.:	60537920				

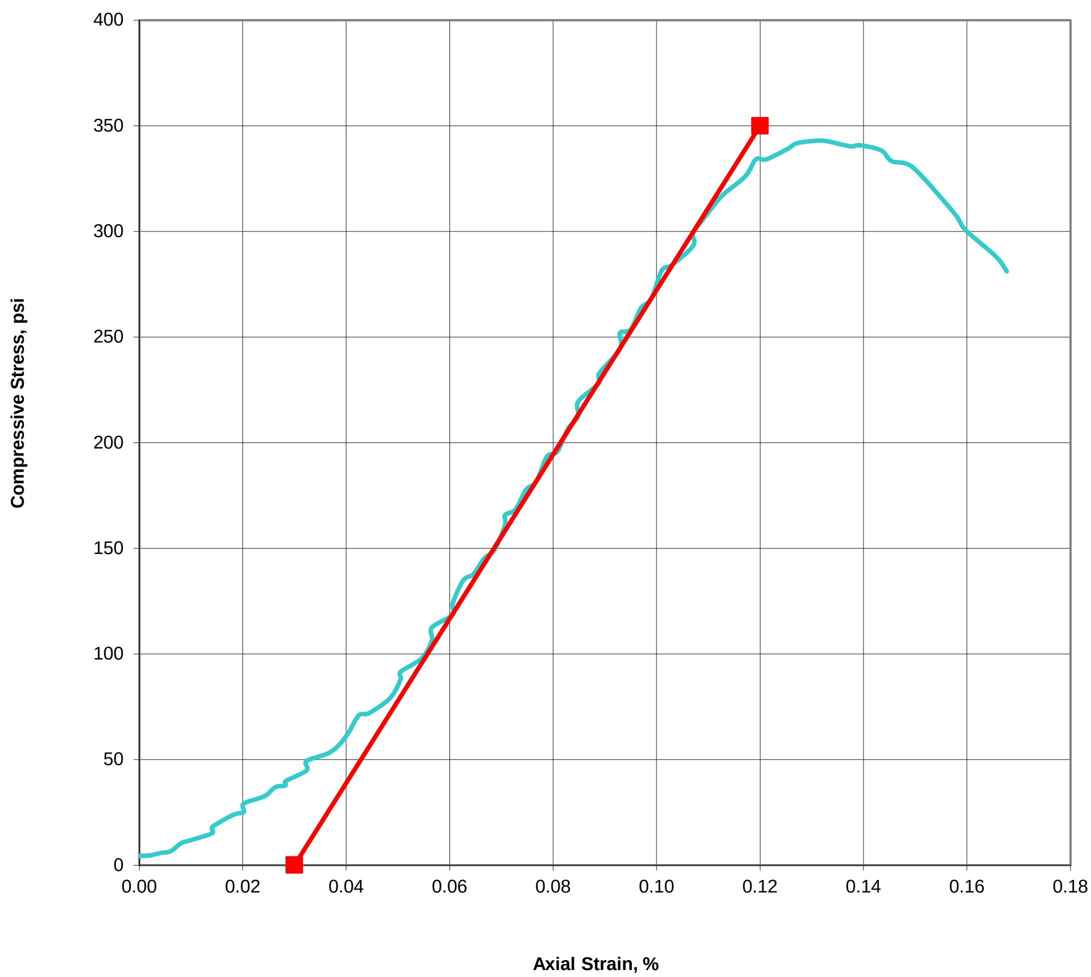
Visual Description: Gray Rock

Moisture Condition at Test: Sample was washed and in a moist state.

Test Temperature, (^{o}C): Ambient

Remarks: Spalling occurred at ends of sample during trimming. Therefore, the measured density is approximate.

Sample Height, in.	4.95	**Unconfined Compressive Strength (psi)**	**343**
Sample Diameter, in.	2.40		
Height / Diameter	2.1		
Sample Area, in^2	4.53		
Wet Density, pcf	163.7	**Young's Modulus (E) (psi)**	**388,900**
Dry Density, pcf	157.9		
Moisture Content, %	3.7		
Strain Rate, % / min	0.25		



COOPER TESTING LABORATORY

Unconfined Compressive Strength and Young's Modulus of Rock Core (ASTM D7012D)

CTL Job No.:	020-277I	Boring:	B-20	Date:	3/12/2019
Client:	AECOM	Sample:	R2	By:	PJ
Project Name:	Klamath River Renewal Project	Depth,ft.:	45.3-46.3	Checked:	DC
Project No.:	60537920				

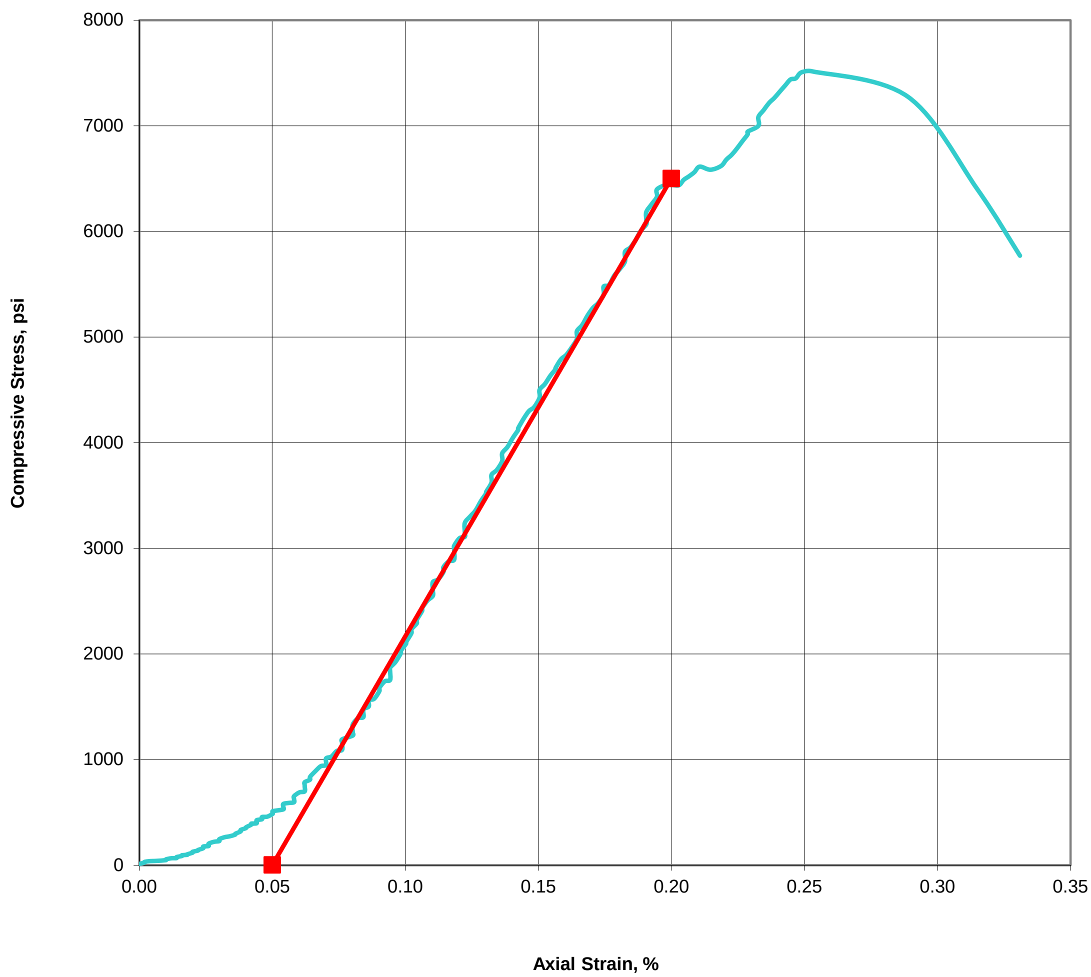
Visual Description: Gray Rock

Moisture Condition at Test: Sample was washed and in a moist state.

Test Temperature, (^{o}C): Ambient

Remarks: Spalling occurred at ends of sample during trimming. Therefore, the measured density is approximate.

Sample Height, in.	4.98	**Unconfined Compressive Strength (psi)**	**7517**
Sample Diameter, in.	2.40		
Height / Diameter	2.1		
Sample Area, in^2	4.54		
Wet Density, pcf	165.7	**Young's Modulus (E) (psi)**	**4,330,000**
Dry Density, pcf	160.3		
Moisture Content, %	3.4		
Strain Rate, % / min	0.25		



COOPER TESTING LABORATORY

Unconfined Compressive Strength and Young's Modulus of Rock Core (ASTM D7012D)

CTL Job No.:	020-277J	Boring:	B-15	Date:	3/12/2019
Client:	AECOM	Sample:	R6/R7	By:	PJ
Project Name:	Klamath River Renewal Project	Depth,ft.:	46.5-47.1	Checked:	DC
Project No.:	60537920				

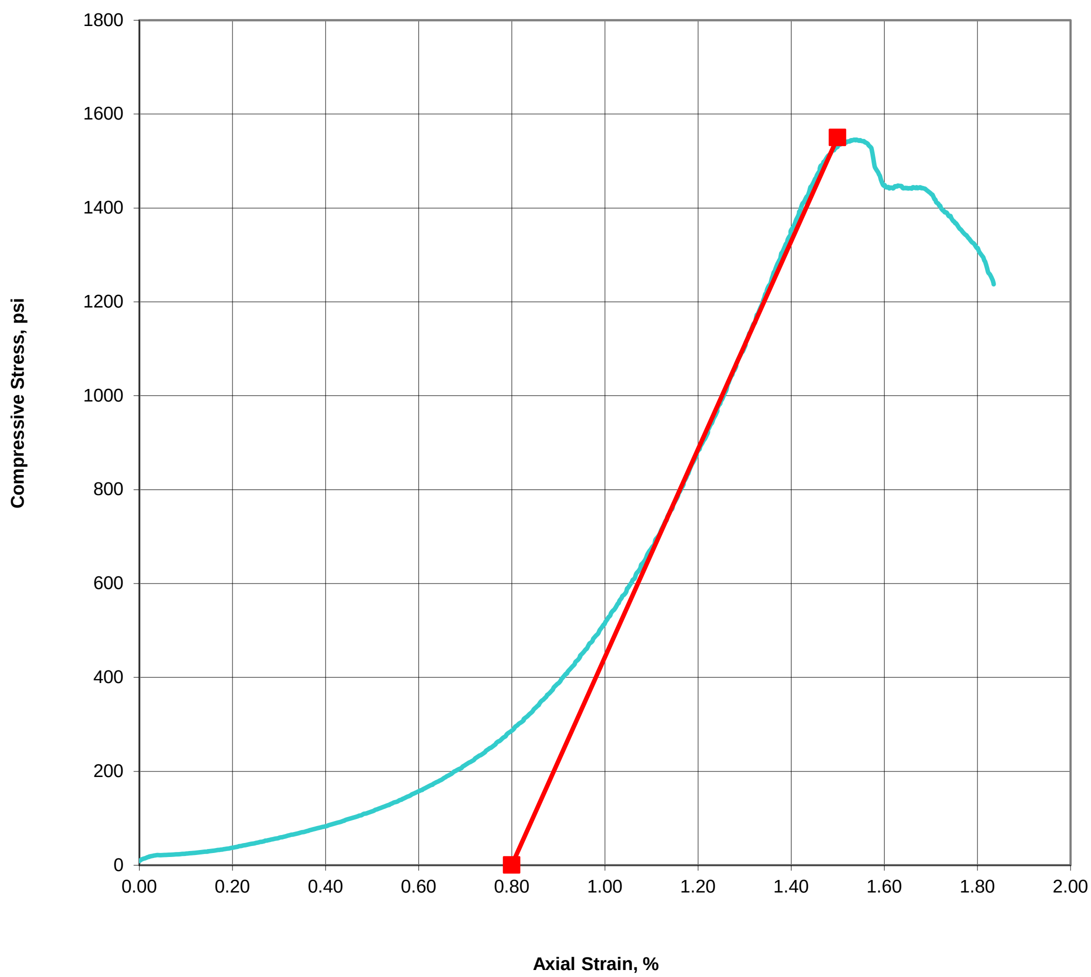
Visual Description: Gray Rock

Moisture Condition at Test: Sample was washed and in a moist state.

Test Temperature, (^oC): Ambient

Remarks: Spalling occurred at ends of sample during trimming. Therefore, the measured density is approximate.

Sample Height, in.	4.95	**Unconfined Compressive Strength (psi)**	**1546**
Sample Diameter, in.	2.34		
Height / Diameter	2.1		
Sample Area, in^2	4.30		
Wet Density, pcf	144.2	**Young's Modulus (E) (psi)**	**221,400**
Dry Density, pcf	136.3		
Moisture Content, %	5.8		
Strain Rate, % / min	0.25		



Unconfined Compressive Strength and Young's Modulus of Rock Core (ASTM D7012D)

CTL Job No.:	020-277L	Boring:	B-17	Date:	3/12/2019
Client:	AECOM	Sample:	R2	By:	PJ
Project Name:	Klamath River Renewal Project	Depth,ft.:	40-41.5	Checked:	DC
Project No.:	60537920				

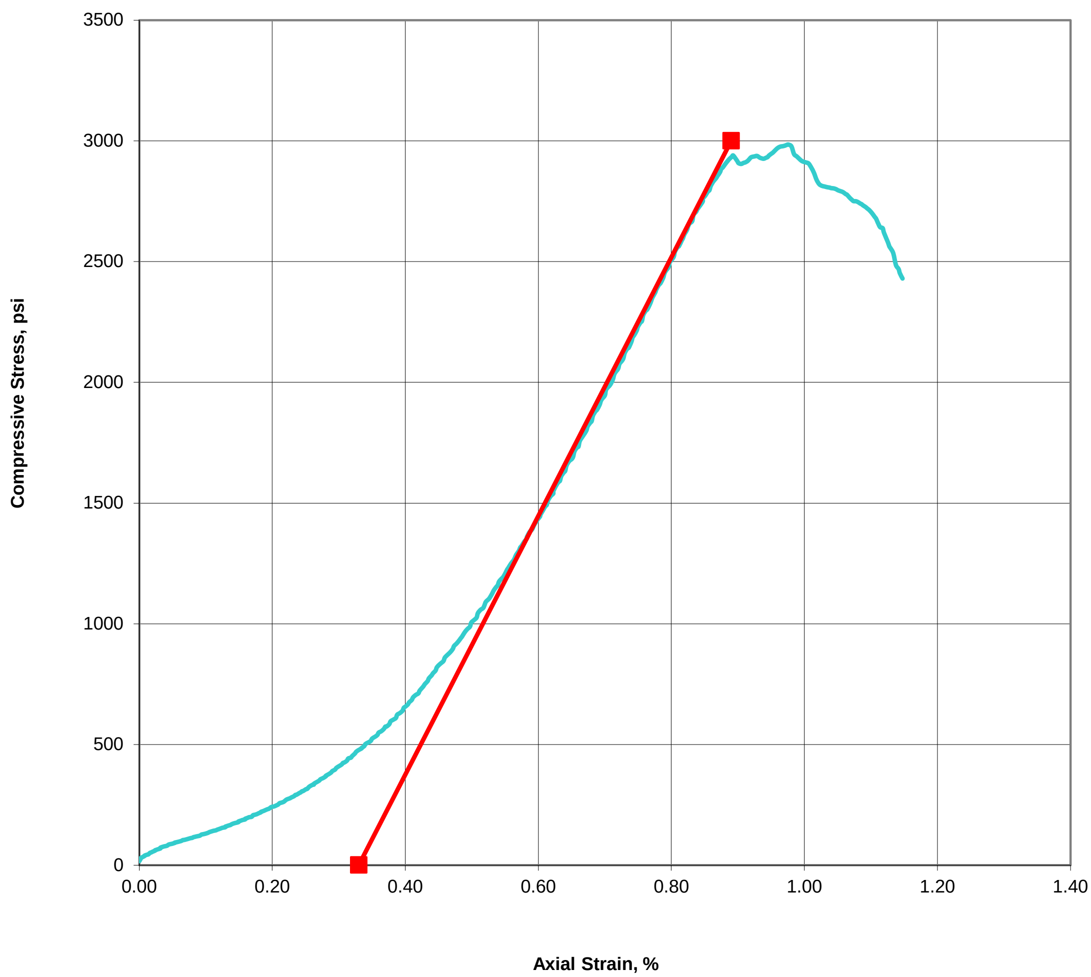
Visual Description: Gray Rock

Moisture Condition at Test: Sample was washed and in a moist state.

Test Temperature, (^{o}C): Ambient

Remarks: Spalling occurred at ends of sample during trimming. Therefore, the measured density is approximate.

Sample Height, in.	5.03	**Unconfined Compressive Strength (psi)**	**2985**
Sample Diameter, in.	2.37		
Height / Diameter	2.1		
Sample Area, in^2	4.41		
Wet Density, pcf	145.6	**Young's Modulus (E) (psi)**	**535,700**
Dry Density, pcf	140.1		
Moisture Content, %	3.9		
Strain Rate, % / min	0.25		



COOPER TESTING LABORATORY

Unconfined Compressive Strength and Young's Modulus of Rock Core (ASTM D7012D)

CTL Job No.:	020-277M	Boring:	B-17	Date:	3/12/2019
Client:	AECOM	Sample:	R2	By:	PJ
Project Name:	Klamath River Renewal Project	Depth,ft.:	17.9-18.6	Checked:	DC
Project No.:	60537920				

Visual Description: Gray Rock

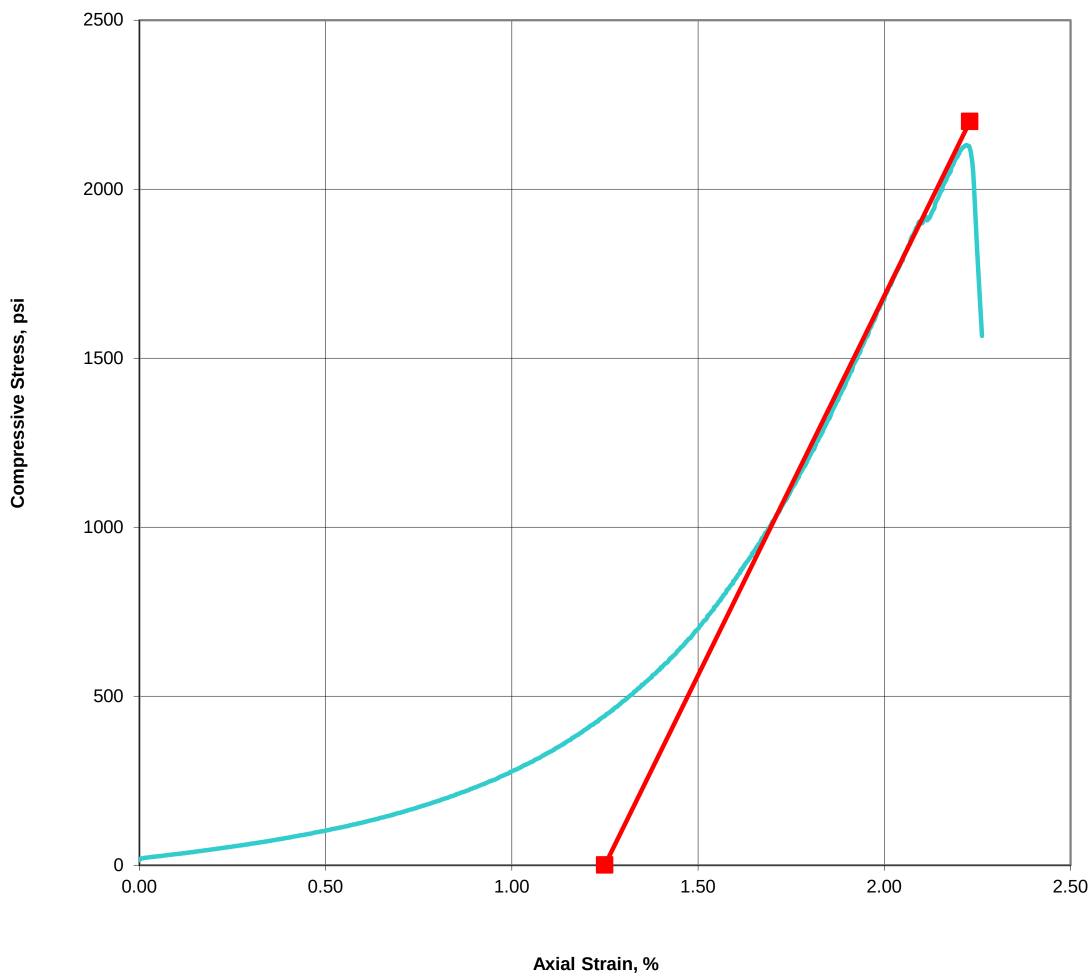
Moisture Condition at Test: Sample was washed and in a moist state.

Test Temperature, (^oC): Ambient

Remarks: Spalling occurred at ends of sample during trimming. Therefore, the measured density is approximate.

Sample Height, in.	5.09
Sample Diameter, in.	2.35
Height / Diameter	2.2
Sample Area, in^2	4.33
Wet Density, pcf	142.9
Dry Density, pcf	134.9
Moisture Content, %	5.9
Strain Rate, % / min	0.25

Unconfined Compressive Strength (psi)	**2130**
Young's Modulus (E) (psi)	**224,500**



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) $\sigma_t = 2P/\pi t D$	N/A	N/A
Tensile strength (curved platens) $\sigma_t = 1.272P/\pi t D$	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.

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

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
	

Tested 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

Project Name	Klamath River Dam Removal
Location	Klamath River
Client	Klamath River Renewal Corporation
Client Project No.	60537920
Registry No.	2018-22
Report No.	2018-22-2-4
Report Date	5/17/2018
Drill Hole and Depth	BI-03; 22.9-24.2 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)	60.26 mm	2.37 in
Thickness (t)	33.83 mm	1.33 in
Maximum Load (P)	0.55 kN	124 lbf
Tensile strength (flat platens) $\sigma_t = 2P/\pi tD$	N/A	N/A
Tensile strength (curved platens) $\sigma_t = 1.272P/\pi tD$	0.11 MPa	16 psi
Direction of Loading	Orthogonal to the Borehole Axis	
Type of Failure	Non-Structural	
Conformance to dimensional Requirements $0.2 \le \frac{t}{D} \le 0.75$	$\frac{t}{D} =$ 0.56	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.

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.	2018-22-5-1
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.

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

Laboratory Director: Dr. Fulvio Tonon, P.E., Ph.D.
Phone: +1-512-200-3051
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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.	2018-22-5-2
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.

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

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	-	

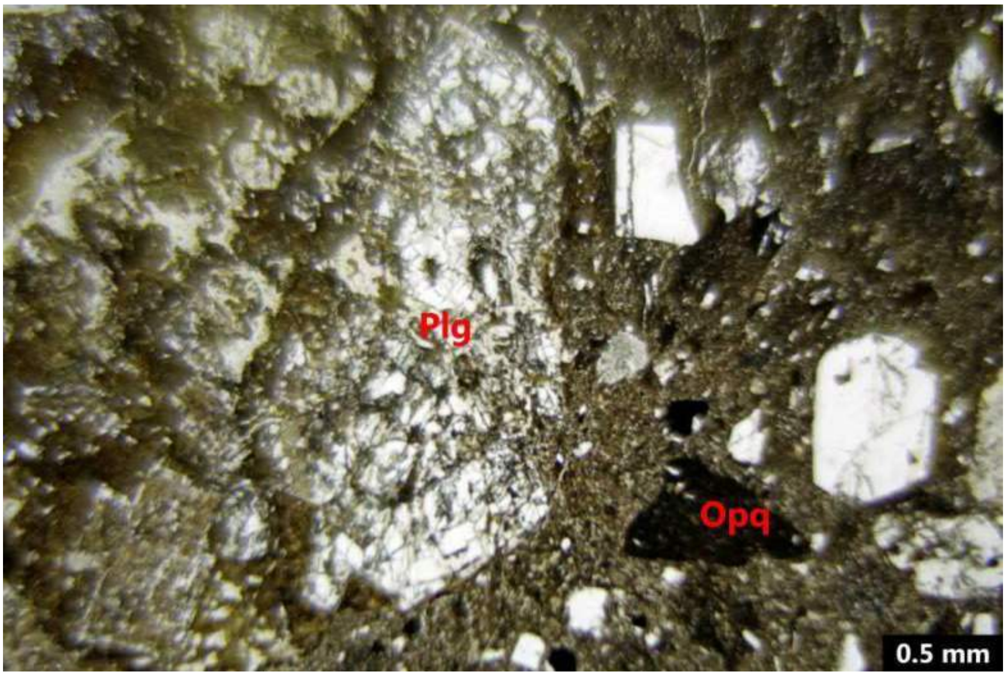

Fig. 2 - Plane polarized light. Field of view = 4 mm wide (magnification 4X). A view of the studied sample, showing an altered Plagioclase (Plg) crystal near to a big Hematite crystal (Opq).

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

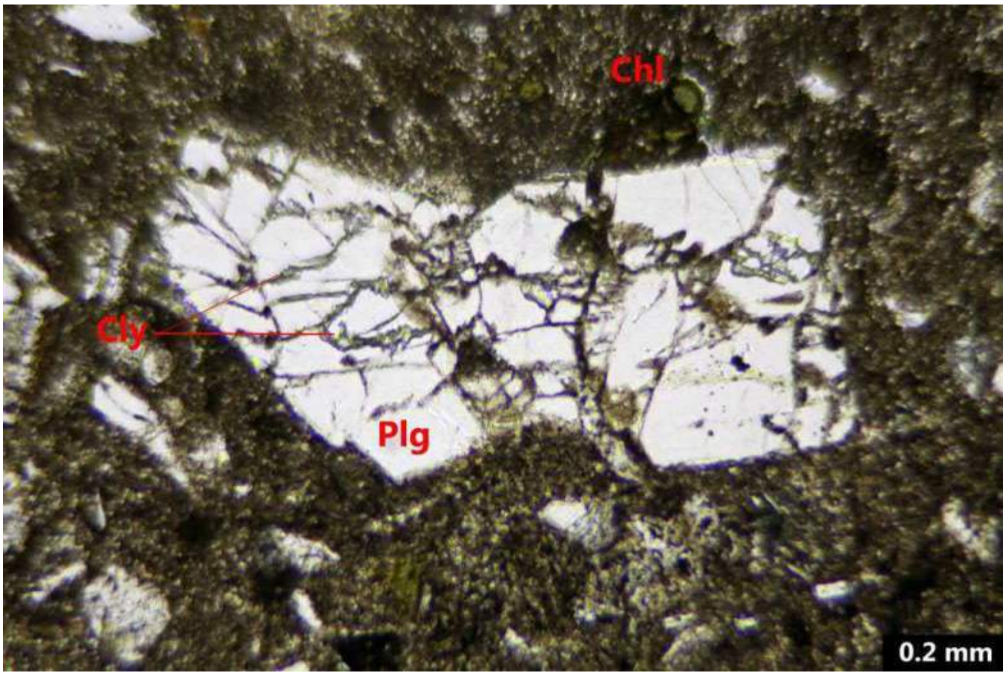

Fig. 4 - Plane polarized light. Field of view = 1.7 mm wide (magnification 10X). A detail of a Plagioclase grain, crossed by many fractures, all filled with Clay Minerals (Cly). Some Chlorite individuals (Chl) may be identified in the upper part of the picture.

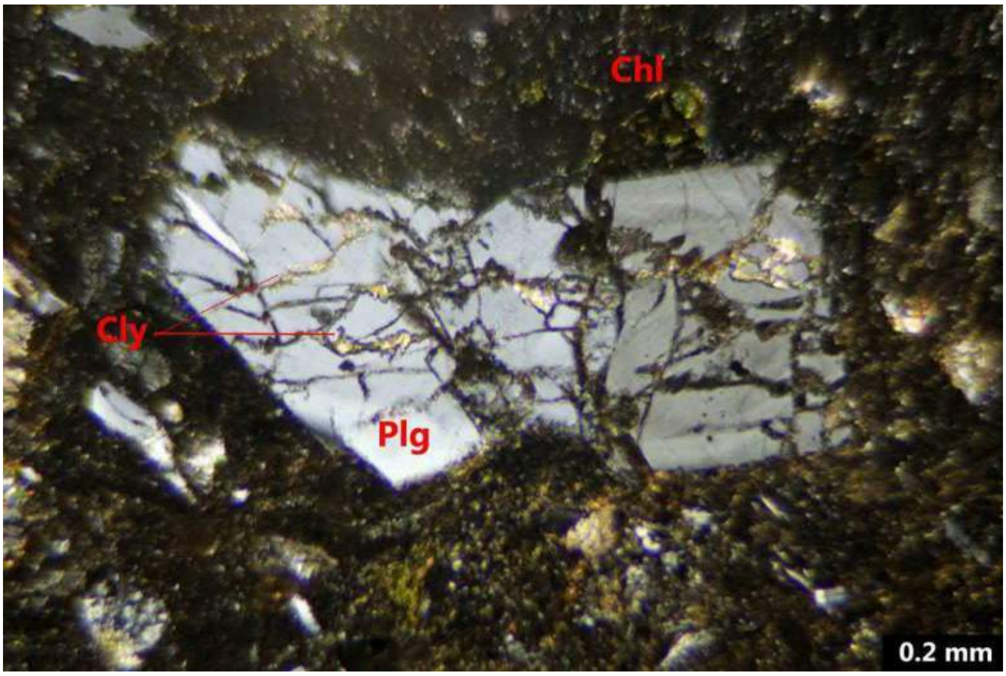

Fig. 5 - Cross polarized light. Field of view = 1.7 mm wide (magnification 10X). Same as Figure 4, but under crossed polars.

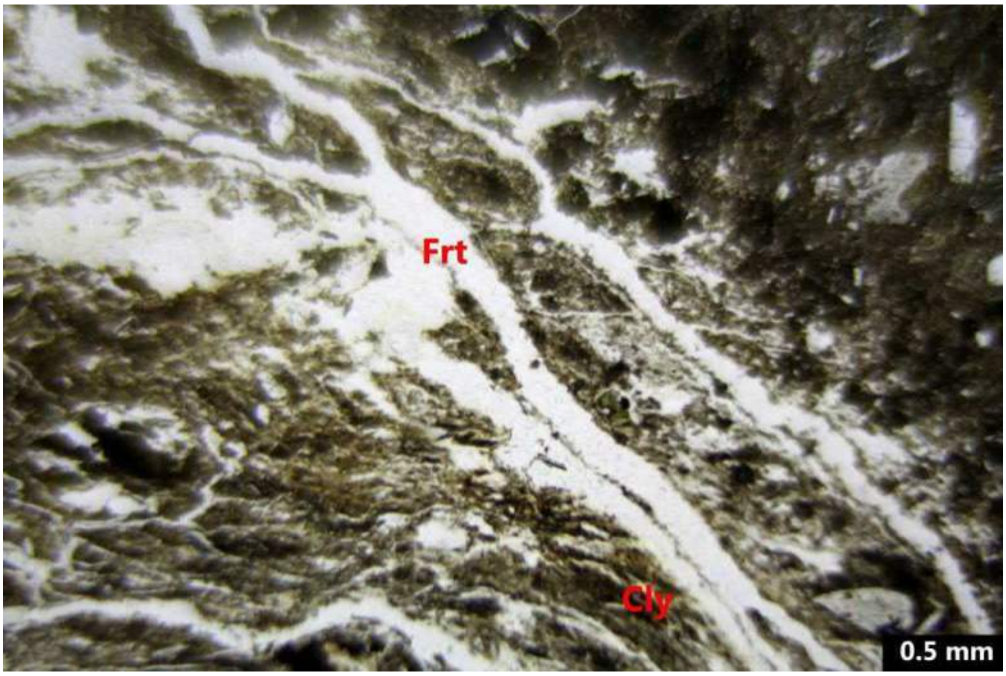

Fig. 6 - Plane polarized light. Field of view = 4 mm wide (magnification 4X). A selected area of the section with a well-developed fracture system (Frt).

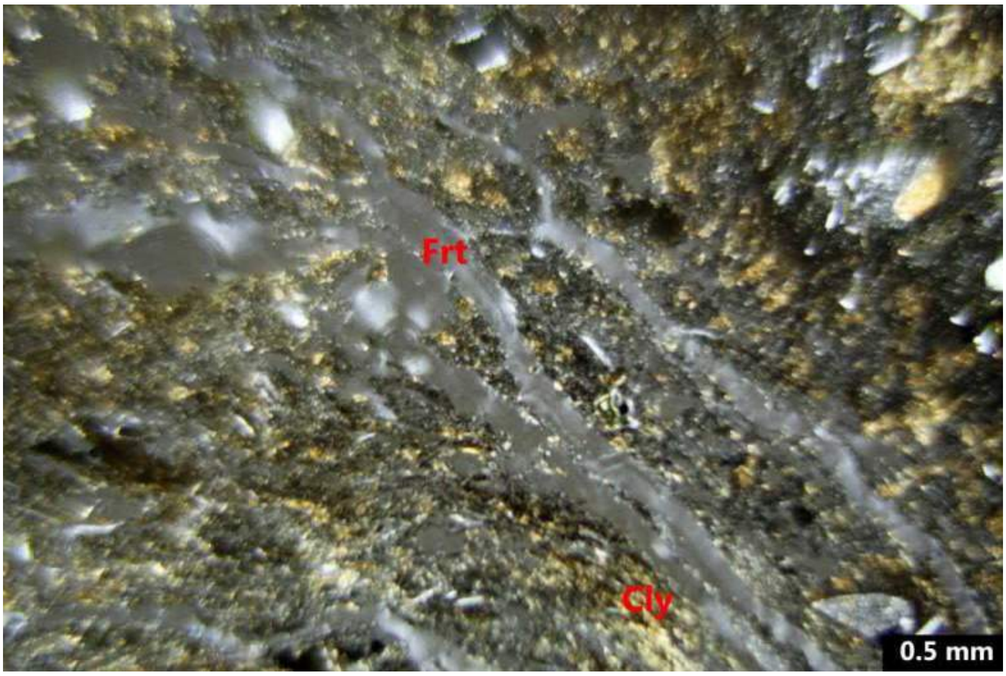

Fig. 7 - Cross polarized light. Field of view = 4 mm wide (magnification 4X). Same as Figure 6, but under crossed polars.

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	-	

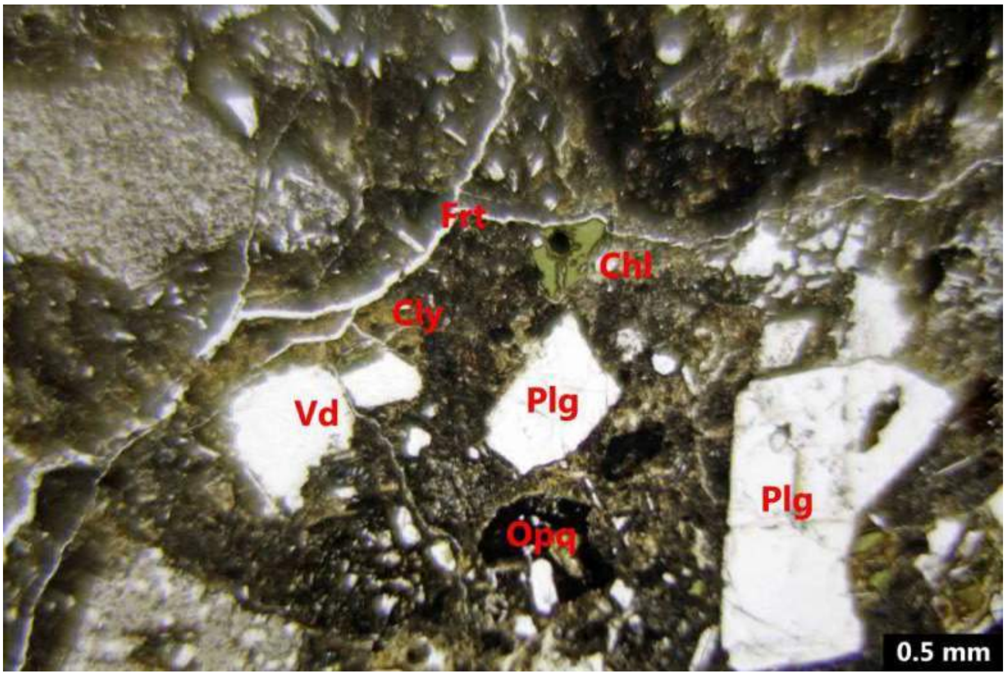

Fig. 2 - Plane polarized light. Field of view = 4 mm wide (magnification 4X). A view of the studied sample. The most common minerals are: Plagioclase (Plg), Clay Minerals (Cly), Opaque Minerals (Opq), and Chlorite (Chl). Also highlighted here are some structural features, such as fractures (Frt) and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

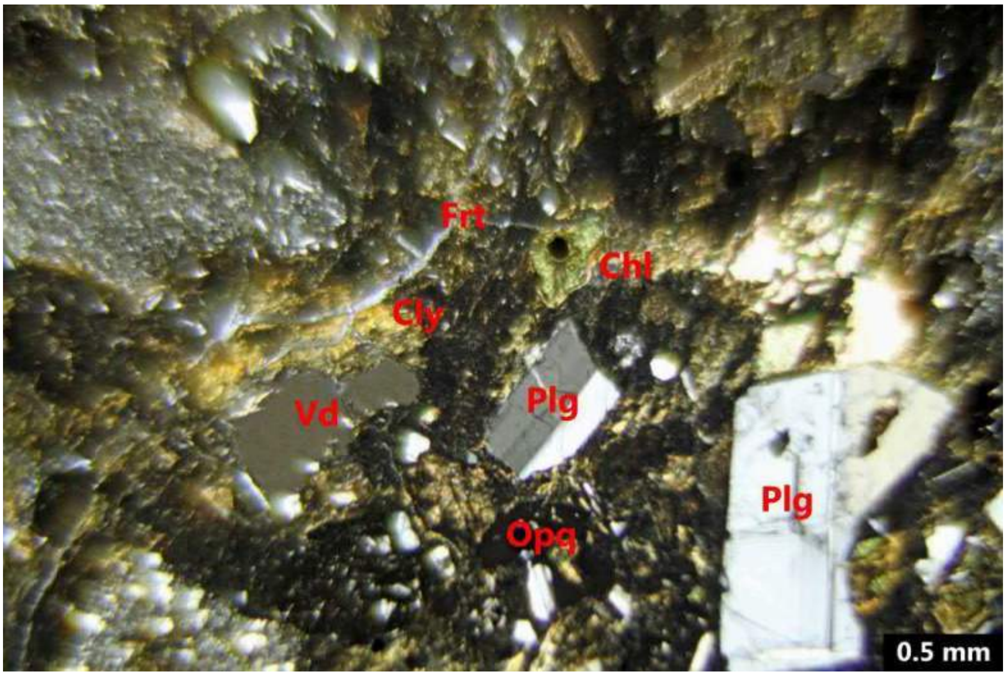

Fig. 3 - Cross polarized light. Field of view = 4 mm wide (magnification 4X). Same as Figure 2, but under crossed polars.

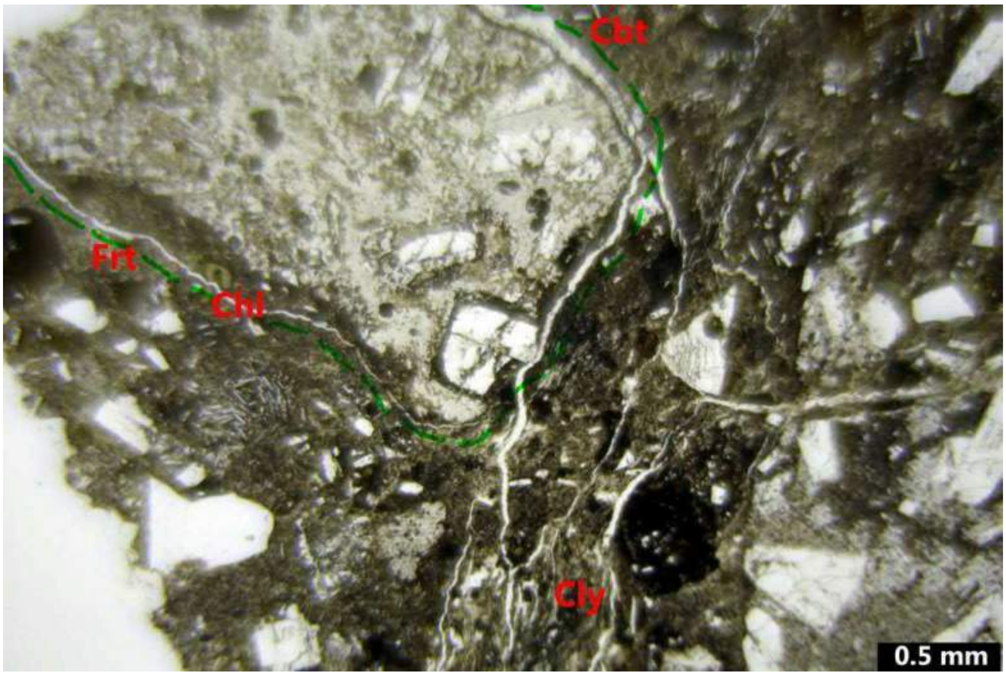

Fig. 4 - Plane polarized light. Field of view = 4 mm wide (magnification 4X). A view of a volcanic clast. A common feature of all the clasts in this thin section is the presence of fractures surrounding clast boundaries (follow the green dashed line). In this case the fracture is filled with secondary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

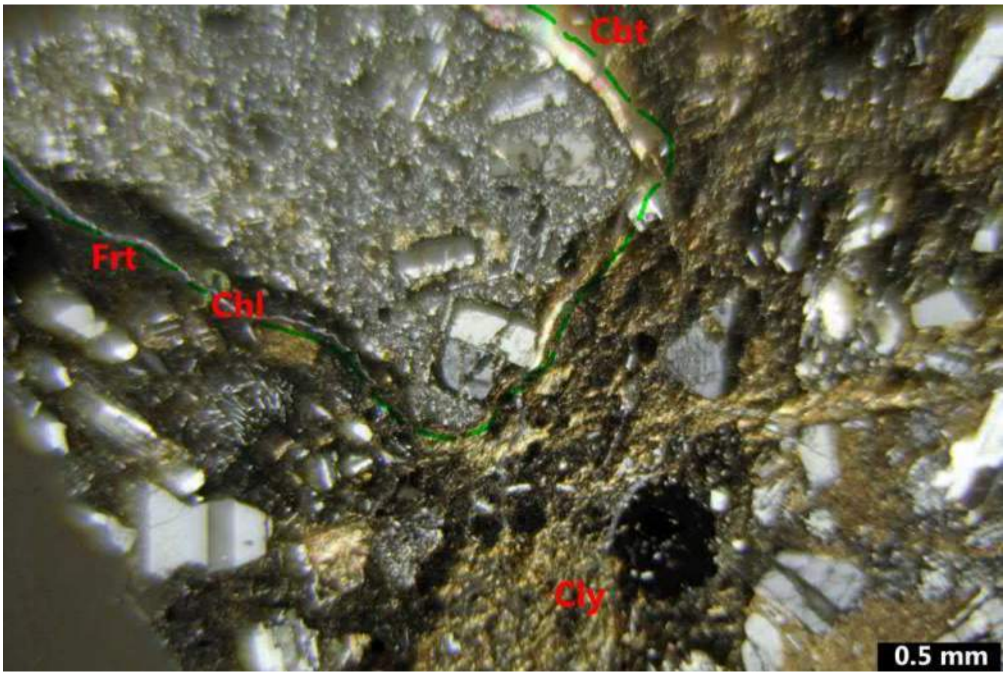

Fig. 5 - Cross polarized light. Field of view = 4 mm wide (magnification 4X). Same as Figure 4, but under crossed polars.

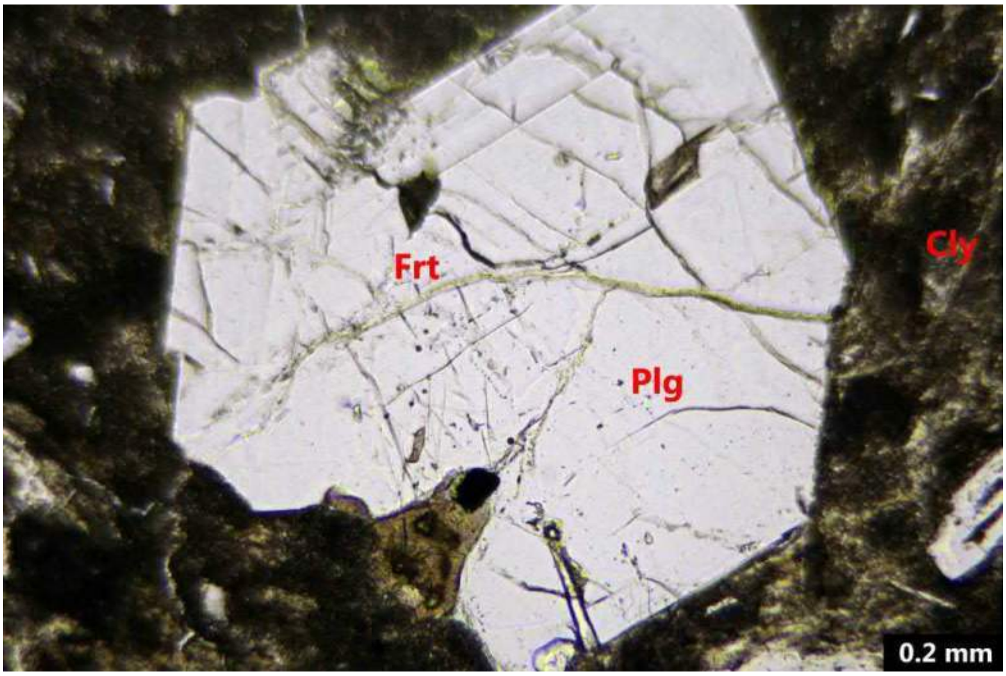

Fig. 6 - Plane polarized light. Field of view = 1.7 mm wide (magnification 10X). A detail of a Plagioclase crystal, showing grain alteration and suturing features: fractures cross the crystal and are also filled with Clay Minerals.

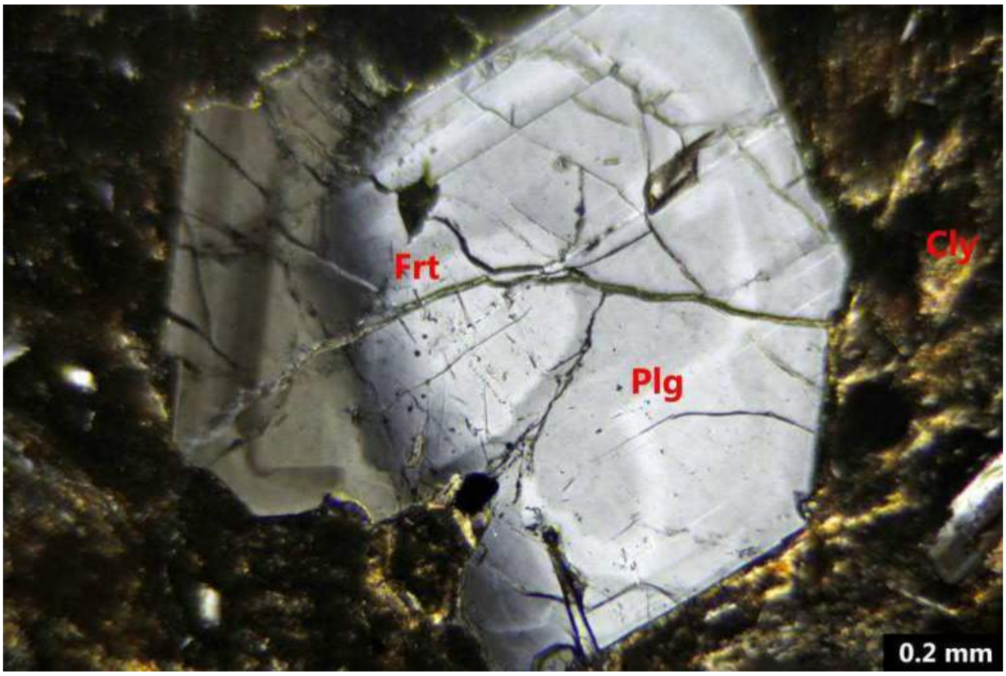

Fig. 7 - Cross polarized light. Field of view = 1.7 mm wide (magnification 10X). Same as Figure 6, but under crossed polars.

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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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Laboratory Director:Dr. Fulvio Tonon, P.E., Ph.D.
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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.	2018-22-8-2
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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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.

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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.	2018-22-8-5
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

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	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

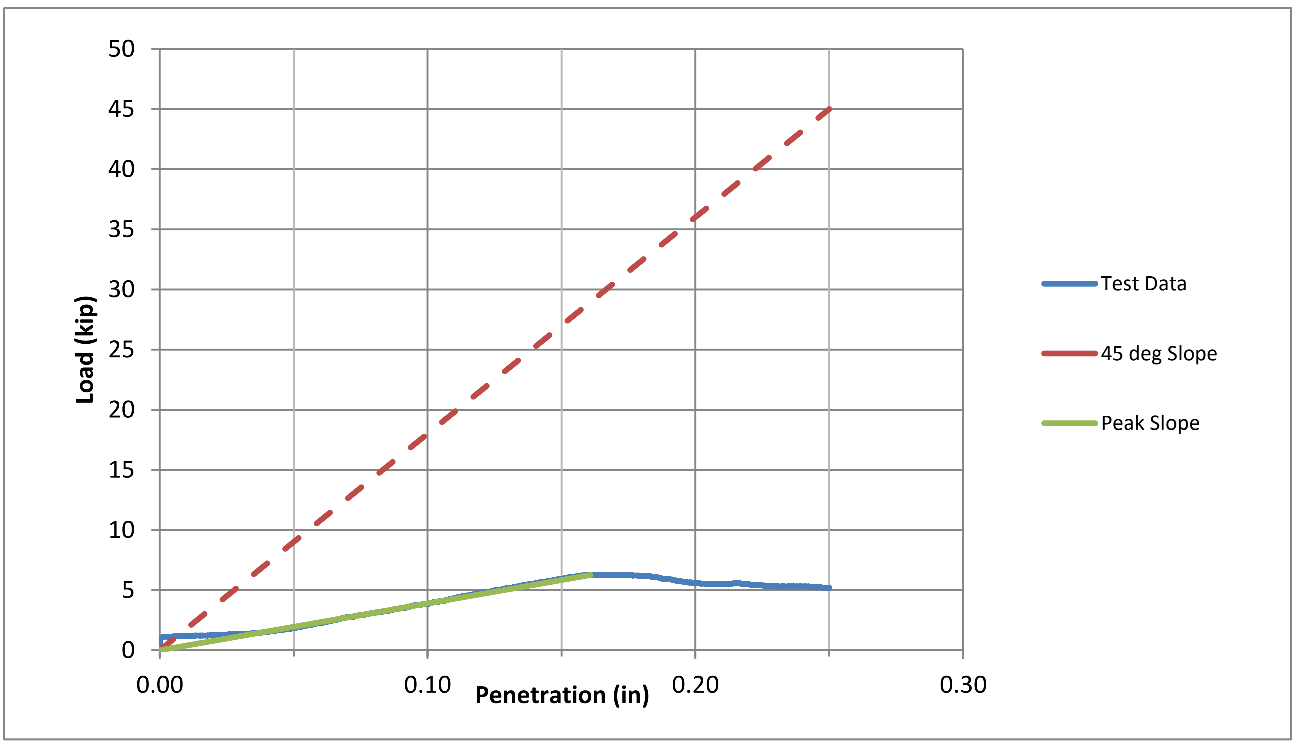

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Photo After Test

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

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

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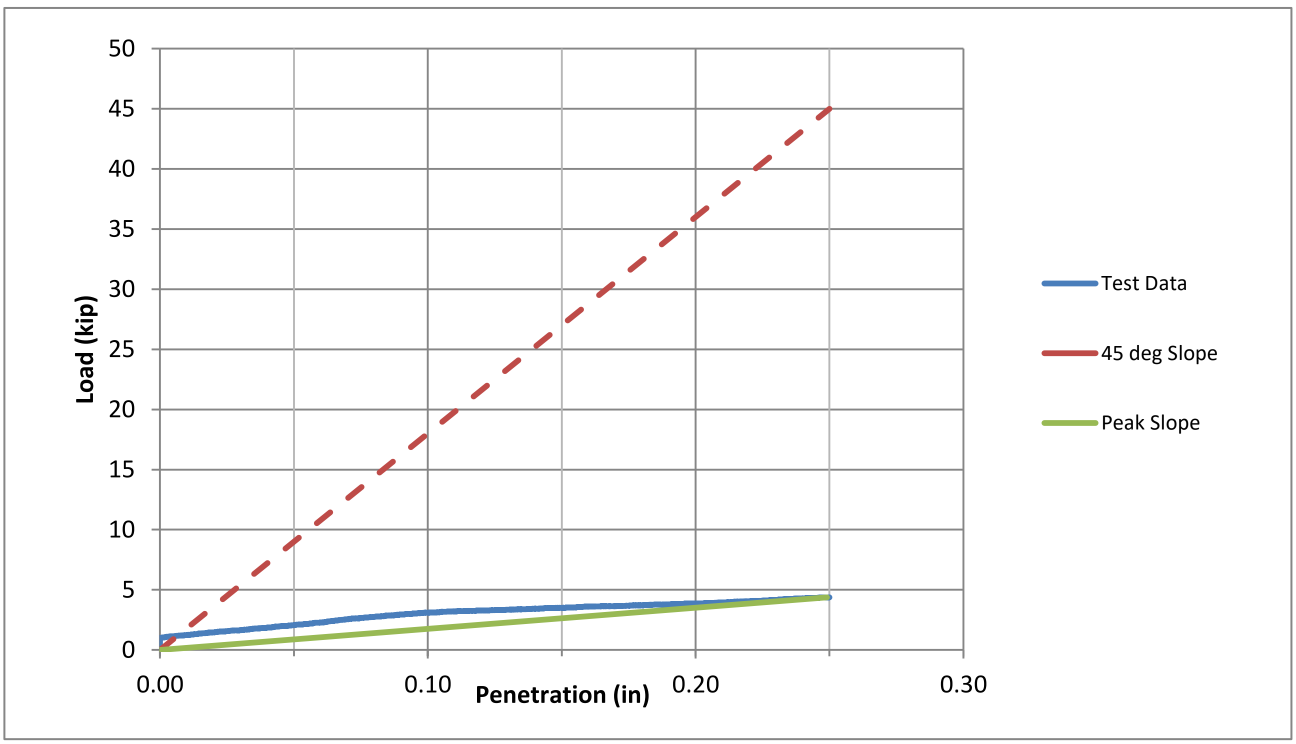
Project Name	Klamath River Dam Removal	Penetration rate	0.001 in/sec			
Location	Klamath River	Diameter of specimen	60.4	mm	2.38	in
Client	Klamath River Renewal Corporation	Height of specimen	67.53	mm	2.66	in
Client Project No.	60537920	Load at peak	19.46	kN	4,373	lbf
Registry No.	2018-22	45 Degree (Standard) 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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APPENDIX E CORE BOX PHOTOGRAPHS

B-01: 9.0 feet to 25.5 feet Depth (Box 1 of 1)

B-03: 22.3 feet to 27.3 feet Depth (Box 1 of 1)

AECOM	Klamath River Renewal Project	Rock Core Photos Borings B-01 and B-03 Box 1	Appendix E-1
	Project No. 6038551		

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B-04: 11.0 feet to 31.5 feet Depth (Box 1 of 1)

AECOM	Klamath River Renewal Project	Rock Core Photos Boring B-04 Box 1	Appendix E-2
	Project No. 6038551		

B-05: 7.0 feet to 37.3 feet Depth (Box 1 of 2)

B-05: 37.3 feet to 50.0 feet Depth (Box 2 of 2)

AECOM	Klamath River Renewal Project	Rock Core Photos Boring B-05 Box 1 and 2	Appendix E-3
	Project No. 6038551		

B-06: 52.0 feet to 57.0 feet Depth (Box 1 of 1)

B-07: 19.0 feet to 31.8 feet Depth (Box 1 of 1)

AECOM	Klamath River Renewal Project	Rock Core Photos Borings B-06 and B-07 Box 1	Appendix E-4
	Project No. 6038551		

B-08: 35.8 feet to 47.8 feet Depth (Box 1 of 2)

B-07: 47.8 feet to 52.8 feet Depth (Box 2 of 2)

AECOM	Klamath River Renewal Project Project No. 6038551	Rock Core Photos Boring B-08 Box 1 and 2	Appendix E-5

B-10: 29.5 feet to 44.3 feet Depth (Box 1 of 2)

B-10: 44.3 feet to 52.0 feet Depth (Box 2 of 2)

AECOM	Klamath River Renewal Project	Rock Core Photos Boring B-10 Box 1 and 2	Appendix E-6
	Project No. 6038551		

B-13: 2.0 feet to 21.1 feet Depth (Box 1 of 1)

B-14: 8.0 feet to 28.6 feet Depth (Box 1 of 1)

AECOM	Klamath River Renewal Project Project No. 6038551	Rock Core Photos Borings B-13 and B-14 Box 1	Appendix E-7

B-15: 21.0 feet to 40.6 feet Depth (Box 1 of 2)

B-15: 40.6 feet to 51.5 feet Depth (Box 2 of 2)

AECOM	Klamath River Renewal Project Project No. 6038551	Rock Core Photos Boring B-15 Box 1 and 2	Appendix E-8

B-16: 0.0 feet to 15.4 feet Depth (Box 1 of 2)

B-16: 15.4 feet to 24.5 feet Depth (Box 2 of 2)

AECOM	Klamath River Renewal Project Project No. 6038551	Rock Core Photos Boring B-16 Box 1 and 2	Appendix E-9

B-17: 15.0 feet to 29.1 feet Depth (Box 1 of 2)

B-17: 29.1 feet to 41.5 feet Depth (Box 2 of 2)

AECOM	Klamath River Renewal Project Project No. 6038551	Rock Core Photos Boring B-17 Box 1 and 2	Appendix E-10

B-19: 30.0 feet to 37.5 feet Depth (Box 1 of 1)

B-20: 40.0 feet to 47.0 feet Depth (Box 1 of 1)

AECOM	Klamath River Renewal Project	Rock Core Photos Borings B-19 and B-20 Box 1	Appendix E-11
	Project No. 6038551		

B-201: 23.5 feet to 37.5 feet Depth (Box 1 of 2)

B-201: 37.5 feet to 50.5 feet Depth (Box 2 of 2)

AECOM	Klamath River Renewal Project Project No. 6038551	Rock Core Photos Boring B-201 Box 1 and 2	Appendix E-12

B-202: 14 feet to 45 feet Depth (Box 1 of 6)

B-202: 45.5 feet to 61.3 feet Depth (Box 2 of 6)

AECOM	Klamath River Renewal Project	Rock Core Photos Boring B-202 Box 1 and 2	Appendix E-13
	Project No. 6038551		

B-202: 61.3 feet to 71.7 feet Depth (Box 3 of 6)

B-202: 71.7 feet to 83.9 feet Depth (Box 4 of 6)

AECOM	Klamath River Renewal Project Project No. 6038551	Rock Core Photos Boring B-202 Box 3 and 4	Appendix E-14

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B-202: 83.9 feet to 95.5 feet Depth (Box 5 of 6)

B-202: 95.5 feet to 100.5 feet Depth (Box 6 of 6)

AECOM	Klamath River Renewal Project Project No. 6038551	Rock Core Photos Boring B-202 Box 5 and 6	Appendix E-15

B-203: 2.0 feet to 31.5 feet Depth (Box 1 of 7)

B-203: 31.5 feet to 46.5 feet Depth (Box 2 of 7)

AECOM	Klamath River Renewal Project Project No. 6038551	Rock Core Photos Boring B-203 Box 1 and 2	Appendix E-16

B-203: 46.5 feet to 60.5 feet Depth (Box 3 of 7)

B-203: 60.5 feet to 75.5 feet Depth (Box 4 of 7)

AECOM	Klamath River Renewal Project Project No. 6038551	Rock Core Photos Boring B-203 Box 3 and 4	Appendix E-17

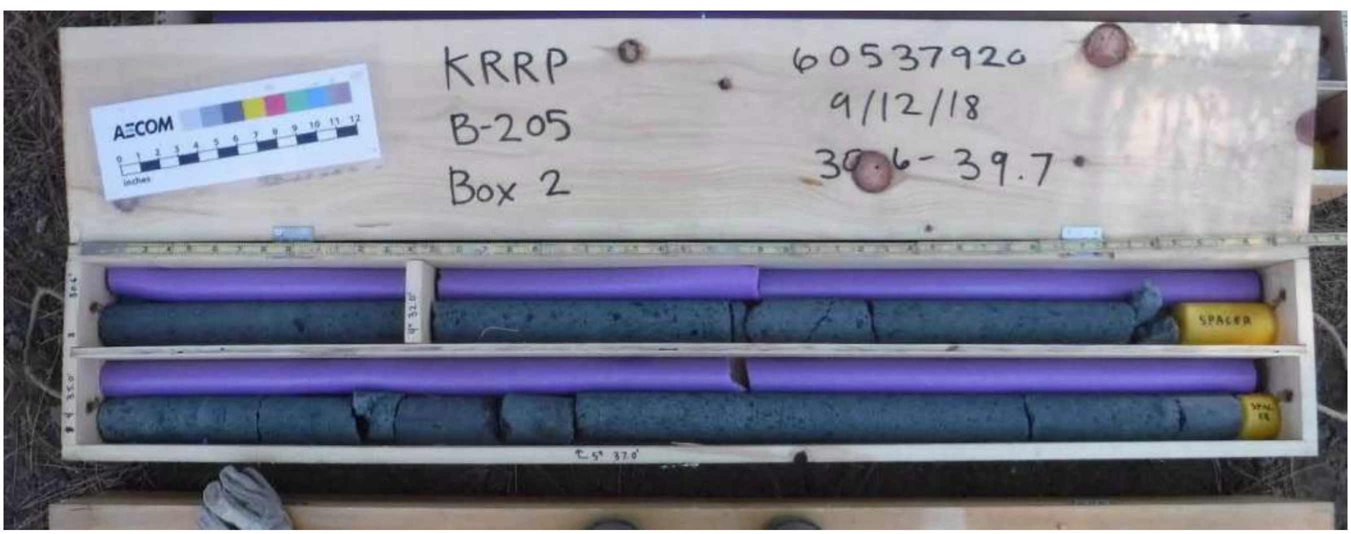
B-203: 75.5 feet to 90.5 feet Depth (Box 5 of 7)

B-203: 90.5 feet to 105.5 feet Depth (Box 6 of 7)

AECOM	Klamath River Renewal Project	Rock Core Photos Boring B-203 Box 5 and 6	Appendix E-18
	Project No. 6038551		

B-203: 105.5 feet to 120 feet Depth (Box 7 of 7)

B-205: 19.5 feet to 30.6 feet Depth (Box 1 of 5)



B-205: 30.6 feet to 39.7 feet Depth (Box 2 of 5)

AECOM	Klamath River Renewal Project	Rock Core Photos Boring B-205 Box 1 and 2	Appendix E-20
	Project No. 6038551		

B-205: 39.7 feet to 49.5 feet Depth (Box 3 of 5)

B-205: 49.5 feet to 59.5 feet Depth (Box 4 of 5)

AECOM	Klamath River Renewal Project Project No. 6038551	Rock Core Photos Boring B-205 Box 3 and 4	Appendix E-21

B-205: 59.5 feet to 62 feet Depth (Box 5 of 5)

AECOM	Klamath River Renewal Project	Rock Core Photos Boring B-205 Box 5	Appendix E-22
	Project No. 6038551		

B-206: 20 feet to 36.5 feet Depth (Box 1 of 6)

B-206: 36.5 feet to 47.4 feet Depth (Box 2 of 6)

AECOM	Klamath River Renewal Project	Rock Core Photos Boring B-206 Box 1 and 2	Appendix E-23
	Project No. 6038551		

B-206: 47.4 feet to 60.0 feet Depth (Box 3 of 6)

B-206: 60.0 feet to 73.6 feet Depth (Box 4 of 6)

AECOM	Klamath River Renewal Project Project No. 6038551	Rock Core Photos Boring B-206 Box 3 and 4	Appendix E-24

B-206: 73.6 feet to 88.8 feet Depth (Box 5 of 6)

B-206: 88.8 feet to 100.0 feet Depth (Box 6 of 6)

AECOM	Klamath River Renewal Project	Rock Core Photos Boring B-206 Box 5 and 6	Appendix E-25
	Project No. 6038551		

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B-207: 15.2 feet to 30.8 feet Depth (Box 1 of 5)

B-207: 30.8 feet to 49.4 feet Depth (Box 2 of 5)

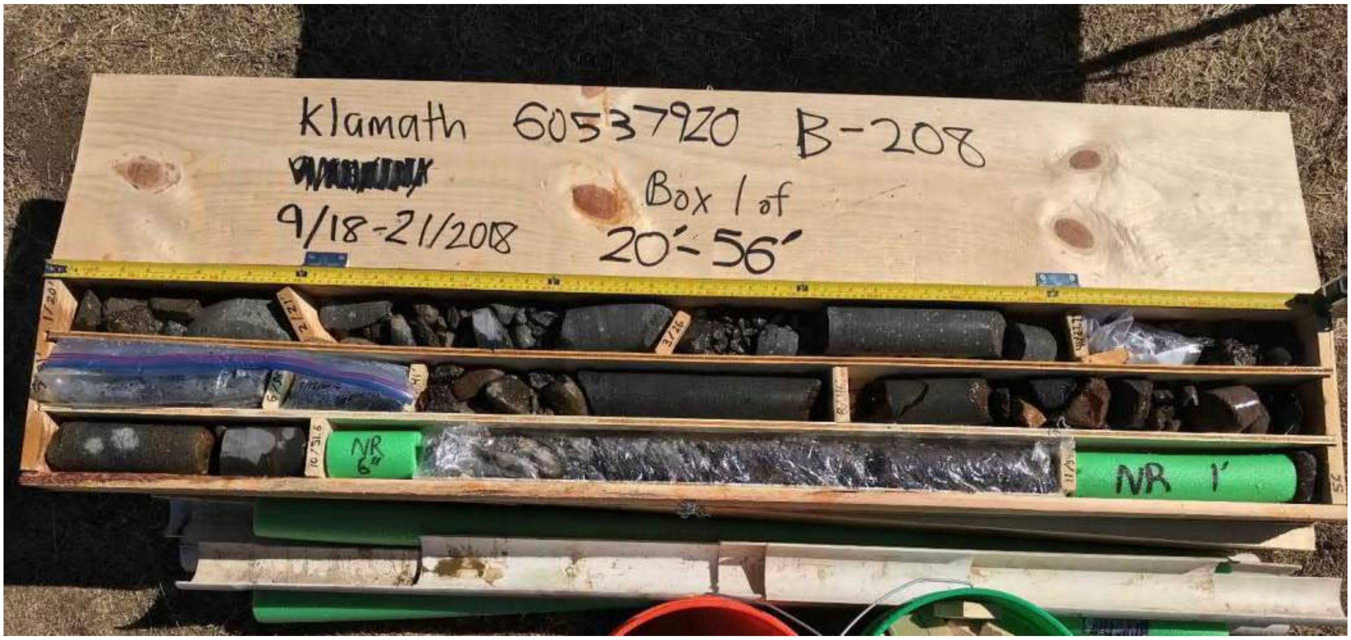
AECOM	Klamath River Renewal Project	Rock Core Photos Boring B-207 Box 1 and 2	Appendix E-26
	Project No. 6038551		

B-207: 49.4 feet to 62.0 feet Depth (Box 3 of 5)

B-207: 62.0 feet to 77.0 feet Depth (Box 4 of 5)

AECOM	Klamath River Renewal Project	Rock Core Photos Boring B-207 Box 3 and 4	Appendix E-27
	Project No. 6038551		

B-207: 77.0 feet to 81.1 feet Depth (Box 5 of 5)



B-208: 20.0 feet to 56.0 feet Depth (Box 1 of 3)

B-208: 56.0 feet to 72.5 feet Depth (Box 2 of 3)

AECOM	Klamath River Renewal Project Project No. 6038551	Rock Core Photos Boring B-208 Box 1 and 2	Appendix E-29

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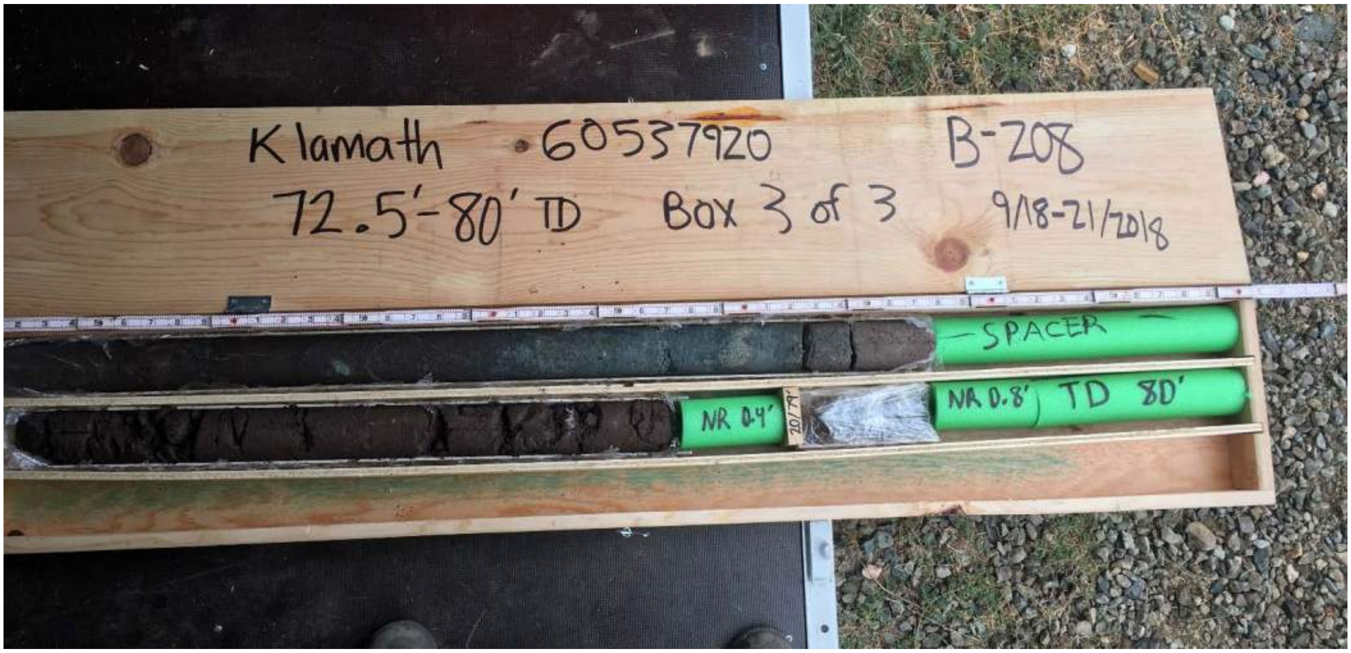

B-208: 72.5 feet to 80.0 feet Depth (Box 3 of 3)

BI-02: 17.5 feet to 34.0 feet Depth (Box 1 of 4)

BI-02: 34.0 feet to 46.7 feet Depth (Box 2 of 4)

BI-02: 46.7 feet to 61.1 feet Depth (Box 3 of 4)

BI-02: 61.1 feet to 67.0 feet Depth (Box 4 of 4)

AECOM	Klamath River Renewal Project Project No. 6038551	Rock Core Photos Boring BI-02 Box 3 and 4	Appendix E-32

BI-03: 5.5 feet to 20.1 feet Depth (Box 1 of 2)

BI-03: 20.1 feet to 35.1 feet Depth (Box 2 of 2)

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