FINAL GEOTECHNICAL REPORT

City of Fort Bragg Raw Water Pipeline Replacement - Segment 2 - 5 Design Project

Fort Bragg, California

Prepared by:

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March 2022

Prepared for:

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March 30, 2022
Crawford File No. 19-514.1

Mr. Simon Gray, PE
Coleman Engineering
1358 Blue Oaks Blvd., Suite 200
Roseville, CA 95678

Subject: **FINAL GEOTECHNICAL REPORT**
City of Fort Bragg Raw Water Pipeline Replacement- Segment 2 - 5 Design Project
Fort Bragg, California

Dear Mr. Gray,

Attached is our Final Geotechnical Report for the City of Fort Bragg Raw Water Pipeline Replacement – Segments 2 – 5 Design Project in Fort Bragg, California. We prepared this report to provide geotechnical data, conclusions, and recommendations for advancing the project through design and construction. Crawford & Associates, Inc. (Crawford) completed this report in accordance with our agreement dated March 11, 2019. The report supersedes our Draft Geotechnical Report, dated December 24, 2020.

Please call if you have questions or require additional information.

Sincerely,

Crawford & Associates, Inc.,

Keiko Lewis, PE
Senior Engineer

Reviewed by:

Benjamin Crawford, PE, GE
Principal Geotechnical Engineer

Taber
Since 1954

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1 INTRODUCTION

1.1 PURPOSE

Crawford & Associates, Inc. (Crawford) prepared this Final Geotechnical Report for the City of Fort Bragg Raw Water Pipeline Replacement – Segments 2 - 5 Design Project in Fort Bragg, California. This report is to provide geotechnical and geologic data and provide conclusions and recommendations exclusively developed for design aspects of the project. This report supersedes our Draft Geotechnical Report, dated December 24, 2020.

1.2 SCOPE OF SERVICES

To prepare this report, Crawford:

- discussed the project with representatives of Coleman Engineering (Coleman) and the City of Fort Bragg;
- reviewed available geologic, topographic, soils, and seismic maps pertaining to the proposed pipe alignment;
- reviewed "Raw Water Line Replacement Project – Final Project Practicality Report" prepared by Coleman Engineering, dated January 24, 2020;
- reviewed "Geotechnical Engineering Investigation Report for Summers Lane Reservoir" prepared by Holdrege & Kull, dated February 6, 2010;
- reviewed "Raw Water Line Replacement Project" plans, dated December 1, 2021, prepared by Coleman;
- logged and sampled seven (7) test pits on June 10 and June 11, 2020 to depth a maximum depth of 9.0 feet (ft) below the ground surface (bgs);
- performed twenty-five (25) hand augured borings to a maximum depth of 5.0 ft bgs in an evaluation of shallow subsurface conditions along the proposed pipeline alignment;
- performed laboratory testing on soil samples recovered from the field explorations; and
- performed geotechnical engineering analysis and developed conclusions and recommendations based on the data and test results.

2 SITE AND PROJECT DESCRIPTION

2.1 PROJECT LOCATION

The project is located in the City of Fort Bragg in the western portion of Mendocino County, California. The project alignment comprises approximately 15,000 linear feet (LF) of raw water transmission line from the City's Water Treatment Plant to Summers Lane Reservoir (Segment 2 and 3) and from the intersection of Highway 20 and Dwyer Lane to Forest Road 450 via the existing Hare Creek Crossing (Segment 4 and 5). The project vicinity and proposed alignment is shown on Figure 1 in Appendix I.

2.2 SITE AND PROJECT DESCRIPTION

The City of Fort Bragg plans to replace the existing raw water transmission line that conveys water from Waterfall Gulch and Newman Gulch to the Water Treatment Plant (WTP) at the

intersection of Sherwood Road and Monsen Way. The existing pipeline crosses areas of steep, heavily-wooded and landslip-prone gorges that are difficult to access. Shallow groundwater is evident throughout the area by the vegetation and springs/seeps. Portions of the existing pipeline have been in place for decades with some sections partially buried with the pipe crown exposed as well as supported above ground on a deteriorating wooden trestle. Sections of the transmission pipe are reaching the end of their service life with pipe failures becoming more regular and widespread. Replacement of these sections of pipeline will increase the reliability and provide more resilience to the raw water supply system for the City.

Currently, the Raw Water Pipeline Project has been separated into five segments for design and construction as shown in Table 1. Segment 2 and 3 runs from the WTP to Summers Lane Reservoir; where Segment 4 and 5 runs from the north-side of Highway 20 to Forest Road 450. At the time of this report, Segment 1, from Summers Lane Reservoir to Highway 20, was completed in 2013 and is not part of this project. Pipeline crossings at Hare Creek and Noyo River, and the section from Waterfall Gulch intake to Road 450, are also not part of this project.

More specifically, the proposed alignment at each segment consist of the following:

- **Segment 2**: Follows an existing narrow access road in the subdivisions south of Sherwood Road from starting after the Noyo River floodplain to the WTP, which as at the intersection of Sherwood Road and Monsen Way.
- **Segment 3**: Extends from the Noyo River floodplain traveling under the Noyo River to the Georgia Pacific Haul Road. The alignment follows Georgia Pacific Haul Road generally to the west and travels along an old logging skid trail to Newman Gulch, then heads to Summers Lane Reservoir. Segment 3 is within the Coastal Zone.
- **Segment 4**: Begins south of Highway 20 following along Dwyer Lane and a Forest Road to an existing portion of the pipeline north of the Covington Gulch Crossing then travels south to reach the Hare Creek Crossing.
- **Segment 5**: Extends from Hare Creek Crossing to Forest Road 450 via an existing logging road

The proposed replacement transmission line for Segments 2 - 5 will be approximately 11,000 linear feet of PVC pipe with the diameters below in Table 1 and constructed with a minimum of 3 feet of cover. Concrete trench dams are proposed along Segments 2 - 5 to prevent piping occurring in the pipe backfill materials. Figure 2 in Appendix I shows the pipeline alignment.

TABLE 1: RAW WATER REPLACEMENT PROJECT SEGMENTS

Segment	Location	Approx. Length (ft)	Pipeline Stationing	Pipeline Outer Diameter (in)
1	Highway 20 (N) to Summers Lane Reservoir	7,000	--	10
2	Noyo River floodplain to WTP	2,500	2+40 to 27+40	10
3	Summers Lane Reservoir / Newman Gulch Intake to Noyo River floodplain	4,440	1+00 to 45+40	10
4	Hare Creek Crossing (N) to Highway 20 (N)	2,810	1+00 to 29+10	10
5	Road 450 to Hare Creek Crossing (S)	1,018	1+00 to 11+18	10

Key geotechnical issues associated with this project are considered to be (1) steep terrain (ranging from 1H:1V to 4H:1V along the pipeline alignment) with slopes prone to landslides and/or creeping, (2) varying degrees of weathering and hardness in the underlying bedrock, and (3) potential for seepage between the soil/rock transition zone.

3 GEOLOGIC SETTING

3.1 REGIONAL GEOLOGY

The project is within the Coast Ranges Geomorphic Province of California[1], which is characterized by a series of northwest trending mountain ranges sub-parallel to the San Andreas Fault. The Coast Ranges are composed of thick Mesozoic and Cenozoic sedimentary strata. The northern Coast Ranges are dominated by the irregular, knobby, landslide-topography of the Franciscan Complex. The project site is located on the coastal plain between the Coast Ranges and the Pacific, about 30 miles north of the point where the San Andreas Fault intersects the coast at Point Arena.

3.2 SITE GEOLOGY

Published regional geologic mapping[2] shows surface materials as two distinct geologic units in the project vicinity. These consist of Pleistocene-age marine and marine terrace deposits overlying undivided Cretaceous-age marine deposits. We present a Geologic Map as Figure 3 in Appendix I.

[1] California Geologic Survey (2002), *California Geomorphic Province*, Note 36
[2] Jennings, C.W. and Strand, R.G.,1960, Geologic Map of California: Ukiah Sheet: California Division of Mines and Geology, GAM24, scale 1:250,000.

A ground water study[3] of the coastal plain from 1982 describes the Cretaceous-age marine (K) as Franciscan Complex, comprising Coastal Belt rocks and mélange. These rocks generally consist of graywacke sandstone and shale. Compared to the mélange, the Coastal Belt rocks are relatively undeformed, and comprise a thick (about 32,000 feet) sequence forming the bedrock base east of the San Andreas Fault.

Mapping by the California Division of Mines and Geology from 1983[4] describes the Pleistocene-age marine terrace deposits (Qm) at the project site as well sorted quartz sand with minor gravel. The wave-cut terraces resulted from tectonic uplift associated with development of the Coast Ranges, and extend inland about 0.2 to 5 miles. Locally, Holocene-age sand dune deposits lie on top of the marine terrace deposits. The sand dunes are described as medium to fine grained, principally quartz sand. The dunes are described as having an elongate profile that generally trending northwest. Dunes do not appear to have been mapped in the vicinity of the project alignment.

3.3 SITE LANDSLIDING

Landslide mapping of the Fort Bragg 7.5 quadrangle (Figure 4A/B) indicates no landslides within the project area. However, the steep slopes adjacent to the upper part of Newman Gulch and all of Covington Gulch and Hare Creek are mapped as “inner gorge”. This is a geomorphic feature formed by debris slide processes over time that are activated periodically by downcutting of the stream channel bottom, and generally have slopes of 65% or greater. Vegetation is vital in order for these slope-types to maintain stability. Slope cuts have the potential to re-activate downslope movement.

As part of the project, we understand slope creep along the proposed Segment 2 pipeline alignment was observed by the City in 2017 and 2020 and extents above and below the roadway. Repair of this slope creep is addressed in a separate Geotechnical Memo prepared by this office dated March 30, 2022. We understand that the repair of this slope creep will be completed during or prior to the installation of the Segment 2 pipeline. No evidence of larger (i.e., deep-seated) failures were observed along the proposed pipeline alignment during this investigation.

3.4 FAULTS AND SEISMIC ACTIVITY

The project alignment does not lie within an Alquist-Priolo Earthquake Fault Zone and no known active faults are mapped within or through the project area. According to the California Geologic Survey (CGS) fault data[5], the nearest mapped fault is a pre-Quaternary-age fault that runs along Simpson Lane between FR450 and State Route (SR) 1, about 0.8 miles southwest of the Segment 4 pipeline section. A Quaternary-age trace of the San Andreas Fault Zone (Shelter Cove Section) is located off-shore, about 7.5 miles from the pipeline. Both of these faults are not considered “active” per CGS.

[3] Department of Water Resources, 1982, Mendocino County Coastal Ground Water Study.
[4] Kilbourne, R.T., 1983, Geology and geomorphic features related to landsliding, Fort Bragg 7.5’ Quadrangle, Mendocino County, California: California Department of Mines and Geology, Open File Report 83-5 S.F., scale 1:24,000.
[5] California Geologic Survey, 2010 Fault Activity Map of California, GIS data

A Fault Activity Map is provided in Figure 5 in Appendix I.

4 EXPLORATION

Crawford completed seven (7) test pits and twenty-one (21) hand augers, in June 2020. Crawford completed four (4) hand augers at Segment 5 in December 2020. Jerry Beatty Tree Surgery & Tractors performed the test pits under the supervision of a Crawford field engineer along accessible areas in Segment 2 and 4. Crawford personnel completed hand auger explorations in inaccessible areas of the proposed alignment. A summary of explorations is provided below in Table 2 below. See attached Figure 2 in Appendix I for the Exploration Location Map.

TABLE 2: SUMMARY OF EXPLORATIONS

I.D	Date	Segment	Depth (ft)	Exploration Equipment
HA-20-001	06/08/20	2	5.0	Hand Auger, 4” diameter
T-20-002	06/10/20	2	9.0	Backhoe, 24” Bucket
T-20-003	06/10/20	2	6.0	Backhoe, 24” Bucket
T-20-004	06/10/20	2	8.0	Backhoe, 24” Bucket
T-20-005	06/10/20	2	8.0	Backhoe, 24” Bucket
T-20-006	06/10/20	2	8.0	Backhoe, 24” Bucket
T-20-007	06/11/20	4	8.0	Backhoe, 24” Bucket
T-20-008	06/11/20	4	8.0	Backhoe, 24” Bucket
HA-20-011	06/11/20	4	5.0	Hand Auger, 4” diameter
HA-20-013	06/11/20	4	3.0	Hand Auger, 4” diameter
HA-20-014	06/11/20	4	3.0	Hand Auger, 4” diameter
HA-20-015	06/11/20	4	5.0	Hand Auger, 4” diameter
HA-20-016	06/11/20	5	1.5	Hand Auger, 4” diameter
HA-20-017	06/11/20	5	4.5	Hand Auger, 4” diameter
HA-20-018	06/11/20	5	5.0	Hand Auger, 4” diameter
HA-20-022	06/08/20	2	5.0	Hand Auger, 4” diameter
HA-20-023	06/08/20	3	2.0	Hand Auger, 4” diameter
HA-20-024	06/09/20	3	5.0	Hand Auger, 4” diameter
HA-20-025	06/09/20	3	2.5	Hand Auger, 4” diameter
HA-20-026	06/09/20	3	2.5	Hand Auger, 4” diameter
HA-20-027	06/09/20	3	4.5	Hand Auger, 4” diameter

I.D	Date	Segment	Depth (ft)	Exploration Equipment
HA-20-028	06/09/20	3	4.8	Hand Auger, 4” diameter
HA-20-029	06/09/20	3	4.0	Hand Auger, 4” diameter
HA-20-030	06/09/20	3	5.0	Hand Auger, 4” diameter
HA-20-031	06/09/20	3	3.0	Hand Auger, 4” diameter
HA-20-032	06/09/20	3	3.5	Hand Auger, 4” diameter
HA-20-033	06/11/20	4	2.0	Hand Auger, 4” diameter
HA-20-034	06/11/20	5	5.0	Hand Auger, 4” diameter
HA-20-035	12/14/20	5	4.0	Hand Auger, 4” diameter
HA-20-036	12/14/20	5	4.5	Hand Auger, 4” diameter
HA-20-037	12/14/20	5	4.5	Hand Auger, 4” diameter
HA-20-038	12/14/20	5	5.0	Hand Auger, 4” diameter

Crawford’s project engineer logged the exploratory locations consistent with the Unified Soil Classification System (USCS) and the 2010 Caltrans Logging Manual. Selected portions of recovered soil samples were retained in sealed containers for laboratory testing and reference. Groundwater observations were recorded during field operations when/if encountered. At completion, the test pit locations were backfilled using native materials. Additionally, the test pits located at Dwyer lane were backfilled and compacted using native materials and a top layer of coarse rock base was added after field operations.

Test pits were excavated to depths of approximately 6 to 9 ft along accessible portions of the proposed alignment to evaluate the near surface soils. The test pits were excavated using a Kubota KX91-3 excavator equipped with a 24-inch bucket. At each test pit location, representative bulk samples were obtained for laboratory testing. Proposed test pit locations TP-20-009 and TP-20-010 were not accessible at the time of our field investigation and were not performed.

Hand augers were completed along the proposed alignment to evaluate the near surface soils. Soil samples were recovered using 4-inch diameter auger, and a maximum of 5 feet in depth was attempted at each location. Hard augering was encountered throughout the alignment in Segment 3, 4, and 5. Auger refusal was mainly due to encountering large roots, rocks, and cemented soils. No hand auger was performed at the proposed HA-20-012 and HA-20-019 through HA-20-021.

See Figure 2 in Appendix I for location of all test pits and hand augered locations. See Appendix II for the test pit logs and hand auger logs for specific details.

5 LABORATORY TESTING

5.1 GEOTECHNICAL SOILS TESTING

We completed the following laboratory tests on representative soil samples obtained from the exploratory borings:

- Material Finer than No. 200 Sieve (ASTM D1140)
- Particle Size Analysis, Gradation (ASTM D6913)
- Atterberg Limits (ASTM D4318)
- Sulfate/Chloride Content (CTM 417/422)
- pH/Minimum Resistivity (CTM 643)

We show test results on the logs and in Appendix III.

6 SURFACE AND SUBSURFACE CONDITIONS

6.1 SOIL/ROCK CONDITIONS

Based on our subsurface investigation, the soil/rock encountered along the alignment is considered consistent with the cited published geologic mapping. For more detailed boring information/data refer to the logs provided in Appendix II.

Along Segment 2, we typically encountered clayey sand to lean clay to maximum depth explored. Intensely to slightly weathered sedimentary rock was encountered in our TP-20-006 location at a depth of approximately 3.5 ft bgs to the maximum depth explored.

We encountered mostly silty to clayey sand with interbedded silt and clay layers along Segment 3 and 4. Along the north part of Segment 4, TP-20-007 and TP-20-008 along Dwyer Lane encountered poorly graded sand to the maximum depth explored. Auger refusal along the Segment 3 and 4 was generally encountered at a depth of 2.0 to 4.0 ft bgs.

Soils along Segment 5 generally consisted of clayey sand, sandy silt, and sandy lean clay. Auger refusal was also encountered generally at a depth of 4.0 to 4.5 ft bgs along the alignment.

6.2 GROUNDWATER

Groundwater was not encountered in the test pits or hand augered borings during our field exploration.

The northernmost portion of Segment 3 is in the vicinity of the Noyo River and we expect the groundwater elevation will fluctuate with the level of the river in this area. The southernmost portion of Segment 4 and the northernmost portion of Segment 5 is in the vicinity of Hare Creek and we expect the groundwater elevation will fluctuate with the level of the river in this area.

Based on the shallow excavations required for the majority of the pipeline, we do not expect groundwater to adversely impact the majority of pipeline construction during the dry season (Summer/Fall). Some perched water maybe encountered between the soil and rock transition zone.

6.3 CORROSION TESTING RESULTS

Soil corrosivity tests were completed on two soil samples obtained from the field exploration. Results of the soil corrosion tests are summarized in Table 3.

TABLE 3: SOIL CORROSION TEST SUMMARY

I.D. / Sample Number	Depth (ft)	pH	Minimum Resistivity (Ohm-cm)	Chloride Content (ppm)	Sulfate Content (ppm)
HA-20-029 / 4	2.0-2.5	4.26	10,990	8.7	3.1
HA-20-34 / 4	2.5-3.0	3.99	4,290	10.2	15.1

[1]Red indicates test results beyond the corrosive threshold

According to Caltrans Corrosion Guidelines, a site is considered corrosive to foundation elements if one or more of the following conditions exist: Chloride concentration is greater than or equal to 500 ppm, sulfate concentration is greater than or equal to 1500 ppm, or the pH is 5.5 or less (Caltrans, Memo to Designers 3-1, June 2014). Except for MSE wall design, Caltrans does not include minimum resistivity as a parameter to define a corrosive area for structures (Caltrans Corrosion Guidelines Version 3.0, March 2018).

Based on the soil types we encountered, test results, and Caltrans guidelines, the soils along the proposed alignment are considered **"corrosive"** to structural steel materials. The soils along the project alignment are considered **"non-corrosive"** to structural concrete materials.

Since the majority of the project will consist of PVC piping with metallic connections, corrosion protection should be considered to protect the metallic connections for long term corrosion protection. These tests are only an indicator of soil corrosivity and the designer should consult with a corrosion engineer if these values are considered significant. Section 12 of Caltrans Corrosion Guidelines Version 3.0, March 2018 provides information regarding corrosion mitigation measures for structural elements and lists additional Caltrans guideline documents regarding corrosion mitigation.

7 SITE SEISMICITY

7.1 FAULT RUPTURE

The project alignment does not lie within an Alquist–Priolo Earthquake Fault Zone and no known active faults are mapped within or through the project area. The California Geologic Survey (CGS) considers a fault to be active if it has shown evidence of ground displacement during the Holocene period, defined as the last 11,700 years. According to the CGS, the nearest "active" fault is the San Andreas Fault Zone (North Coast Section), which is located about 20 to

25 miles south, near Manchester. In our opinion, the potential for surface fault rupture within the project limits is considered low to non-existent and is therefore not a design consideration for this project.

7.2 LIQUEFACTION AND SEISMICALLY INDUCED SETTLEMENT

Liquefaction can occur when saturated, loose to medium dense, granular soils (generally within 50 feet of the surface), or specifically defined cohesive soils, are subjected to ground shaking. Based on the encountered soils and lack of a uniform water table, we consider the potential for soil liquefaction and seismically induced settlements along the project alignment to be low.

8 CONCLUSIONS AND RECOMMENDATIONS

Based on the above data, we conclude that the alignment is suitable for construction of the proposed pipeline provided the recommendations presented below are included in design and construction. Key geotechnical considerations associated with design and construction of this project included presence of (1) steep terrain (ranging from 1H:1V to 4H:1V along the pipeline alignment) with slopes mapped as inner gorge which are prone to landslides and/or creeping, (2) varying degrees of weathering and hardness in the residual soil and underlying rock, and 3) potential for seepage between the soil/rock transition zone.

The risk of fault rupture hazard is considered to be low. No over-riding hazards (e.g., faulting, settlement, soft soils, subsidence, etc.) were identified by either published geologic mapping or site reconnaissance performed for this study.

8.1 OPEN-CUT PIPELINE RECOMMENDATIONS

Generally, the open-cut portions of the pipeline will have a minimum of 3 feet of cover along the all the segments of the pipeline.

We provide the following Geotechnical design properties for pipe design.

8.1.1 SOIL LOADS ON FLEXIBLE BURIED PIPES

Soil loads on flexible buried pipes should be analyzed as well. Based on AWWA M11, if the flexible pipe is buried in a trench less than two times the width of the pipe, the load is computed as:

$$W_c = C_d \gamma {B_d}^2 (\frac{B_c}{B_d})$$

Where:

W_c = dead load on the conduit (lb/lin ft)
C_d = load coefficient based on ${K_\mu}'$
K = rankine's lateral earth pressure coefficient
μ' = friction coefficient between fill material and sides of trench
γ = moist unit weight of backfill material (pcf)
B_d = width of trench at top of pipe (ft)
B_c = diameter of pipe (ft)

Use a moist unit weight of 120 pcf for the above calculation.

Similar to Composite Modulus of Soil Reaction, the backfill material and compaction, trench width, and installation depth are components to designing the pipeline. For an open cut installation with a ratio of the backfill depth to trench width at the top of the pipe (H/B_d) of at least 1 (i.e. backfill depth is greater than the trench width) and for a trench width at top of pipe no greater than 3 times the pipe diameter, C_d[6] may be calculated by:

$$C_d = \frac{1 - e^{-2K\mu' \frac{H}{B}}}{2K\mu'}$$

Where:

K = rankine's lateral earth pressure coefficient
μ' = friction coefficient between fill material and sides of trench
H = backfill height above the pipe crown (feet)

The combined $K_\mu{}'$ value is dependent on backfill type, compaction, and moisture content. Using the backfill recommendations in this report, the estimate $K_\mu{}'$ values are 0.120 for clay, 0.130 for silt, and 0.150 for sands and aggregate base.

If the flexible pipe is installed with trenchless techniques or a wide trench (i.e. trench width is greater than two times the width of the pipe):

$$W_c = \gamma H B_c$$

Where:

W_c = dead load on the conduit (lb/lin ft)
γ = moist unit weight of backfill material (pcf)
H = height of fill above top of pipe (ft)
B_c = diameter of pipe (ft)

8.1.2 THRUST RESTRAINT

Unbalanced thrust forces develop in a pipeline due to internal pressures, particularly around change of direction in the pipeline alignment. For large diameter pipelines, these thrust forces are typically counteracted by frictional resistance along the pipe and restrained joints.

Restrained joints resist thrust forces through friction between the pipe and the soil surrounding it. Per AWWA M11, the length of pipeline required to restrain each side of an alignment bend is:

$$L = \frac{PA(cos\Delta)}{\mu(W_e + W_w + W_p)}$$

Where:

L = length of restrained or harnessed joints on each side of the bend or elbow (ft)
P = internal pressure (psi)
A = cross-sectional area of the pipe (in^2)

[6] American Concrete Pipe Association (2000)

Δ = bend or elbow deflection (degrees), 0° to 90°
μ = coefficient of friction between the pipe and the soil
W_e = horizontal bends: two times the weight of the prism of soil over the pipe (lb/ft of pipe length)
= vertical bends: weight of the prism of soil over the pipe (lb/ft of pipe length)
W_p = weight of the pipe (lb/ft)
W_w = weight of the contained water (lb/ft)

The coefficient of friction between a steel pipe and the surrounding soil is modeled as: $\mu = tan\,(0.6\phi)$, where ϕ is the soil friction angle. Assuming a soil friction angle of 34° for compacted coarse grained, angular backfill soil, we recommend using a coefficient of friction of 0.37.

Although likely unnecessary for the majority of this project, thrust blocks may also be used if additional thrust resistance is needed. Thrust block design is governed by two factors – the total thrust force and the allowable passive pressure of the soil. Allowable passive pressure will be variable throughout the alignment due to varying soil conditions. We calculated passive pressures to assess trending values along the alignment. Based on this trend, we recommend a passive pressure of 166 pcf for thrust block design. Reduce this passive pressure value during a seismic event to 105 pcf.

8.1.3 COMPOSITE MODULUS OF SOIL REACTION

Semi-rigid and flexible pipes are designed to withstand a certain amount of deflection from applied earth loads. One of the input parameters to pipe deflection equations is the Composite Modulus of Soil Reaction (CMSR). The CMSR value is influenced by native soil properties, backfill soil properties, and trench/pipe geometry. We calculated composite modulus of soil reaction values using the Howard (2011) and AWWA M11 and M45 method. This approach multiplies the modulus of soil reaction for the embedment soil (i.e. trench backfill) by a soil support combining factor, S. Using the above parameters, we selected our S values from Table 1 of "Amster Howard, TECH NOTE, A supplement to Pipeline Installation," dated October 3, 2011. For these calculations we used the City of Fort Bragg Standard Trench Detail No. 300 Type A, B, and E. We provide a brief summary of the specifications below:

Trench Geometry

- For pipe diameters, less than 18-inches, the trench width will be between 12 and 18-inches greater than the pipe diameter. We calculated the CMSR using a minimum trench width equal to 28-inches wider (9-inches per side) than the pipe diameter.

Backfill Material

- Sand or aggregate base course

Compaction

- Pipe bedding will have a relative compaction (per ASTM D1557) greater than or equal to 90%
- Trench backfill will have a relative compaction (per ASTM D1557) greater than or equal to 95% for Type A and B and 85% for Type E

Using these assumptions, pipe depth, size, installation type, and the geotechnical information presented herein, we calculated Composite Modulus of Soil Reaction values along the project alignment.

We assumed a sand backfill and applied an E_b' (trench backfill Modulus of Soil Reaction) value of 2,000 psi. Native Moduli of Soil Reaction likely varies from 500 to 1,500 psi in the onsite soils along the pipeline. Based on the above a composite modulus of soil reaction of 1000 to 1600 psi is likely appropriate for design of the pipeline.

8.1.4 TRENCH SEEPAGE

We understand that concrete trench dams are being considered for pipeline construction in areas with steeper slopes. Typically, trench dams are used when the slope grade exceeds 10% and when there is a water source identified in an attempt to help prevent piping occurring in the pipe backfill materials. Trench dams can reduce the velocity of water in the backfill and reduce the potential for piping.

Concrete trench dams are recommended to be embedded at least 6 inches below the pipeline excavation into the underlying native soils/weathered bedrock and 12 inches horizontally into competent/native materials. For slopes between 10% to 30%, spacing of the trench dams should be no more than 250 feet apart. For slopes greater than 30%, spacing of the trench dams should be no more than 150 feet apart.

In lieu of concrete trench dams, the City could consider the use of cohesive/low permeable material as a trench plug at similar intervals to the concrete trench dam or the use of flowable fill such as CLSM.

With the exception of the portion of the pipeline near Hare Creek, we expect some perch groundwater may be encountered during construction but can likely be controlled with sump pumps. At the Hare Creek Crossing location diverting/piping and/or damming the channel may be required during construction.

8.1.5 SLOPE EROSION

The proposed pipeline alignment meanders through steep slopes with a few areas mapped as inner gorge which are prone to landslides, erosion, and creeping. Based on our review of the project plans, the slopes are shown to range from 1H:1V to 4H:1V along the pipeline alignment. Observations along the proposed alignment showed the existing slopes are performing adequately and consist of heavily established vegetation. Following the completion of construction, overly steepened areas (such as between Station 125+00 through 126+60 and Station 130+00 through 132+00) where vegetation is being removed will be susceptible to erosion and may require periodic maintenance while the vegetation is reestablished. The following options should be considered to limit the impacts on the pipeline in over-steepened areas (with slopes steeper then 2:1) while the vegetation reestablish itself:

- deepen of the pipeline to a minimum of 5 feet below grade,
- flatting oversteered slopes along the pipeline alignment to at least 2:1,
- use of jute erosion control mats and staking, or

- using controlled low strength materials as backfill to prevent pipe from being exposed during erosion.

Some of the above options could be combined to better protect the pipeline alignment from being exposed following construction.

8.2 EARTHWORK AND CONSTRUCTION CONSIDERATIONS

8.2.1 CLEARING

Prior to grading, demolish and clear the site to remove structures, fences, vegetation, tree roots, debris, abandoned utilities, soft or unstable areas, and other deleterious materials.

8.2.2 EXCAVATABILITY

Based on the conditions observed in our subsurface explorations and our experience, the on-site soil should be excavatable with typical equipment such as backhoes and excavators. However, there could be areas of weathered rock layers within the trench that may require the use of larger excavators with a rock bucket or pneumatic hammers. Ultimately, the contractor should evaluate the logs and surface materials to determine the appropriate equipment for the project.

8.2.3 FILL PLACEMENT AND COMPACTION

Backfill trenches per manufacturers' recommendations and the City of Fort Bragg Standard Specification No 300 Type A, B and/or E. The onsite soils likely will not meet the City of Fort Bragg pipe bedding requirements but are considered expectable for use as trench backfill requirements.

8.2.4 SHORING AND TEMPORARY CONSTRUCTION SLOPES

At a minimum, all shoring and temporary construction slopes should be in accordance with current OSHA requirements. Our limited explorations indicate Cal OSHA Soil Type B can be expected along the majority project alignment with the exception of the intensely to slightly weathered rock encountered in the southern end of Segment 2. It is expected that temporary slopes at 1H:1V will generally be stable during construction. The presence of seepage may require flattening of the temporary slopes. The contractor is responsible for all shoring and temporary slope design based on actual excavation conditions encountered during construction.

Due to the vegetation and difficult terrain (some of which is relatively steep) present along the proposed pipeline alignment, we recommend potential contractors visit and walk the alignment during the bidding process. Some pre-grading and flattening of the terrain will be required prior to trench excavation. The contractor will need to use care to prevent destabilization of the surrounding slopes.

The City and Design team should require the submittal of a shoring and excavation plan for review prior to construction.

9 RISK MANAGEMENT

Our experience and that of our profession clearly indicates that the risk of costly design, construction, and maintenance problems can be significantly lowered by retaining the Geotechnical Engineer of Record to provide additional services during design and construction. For this project, Crawford should be retained as the Geotechnical Engineer of Record to:

- Review and provide comments on the civil plans and specifications prior to construction.
- Observe and test pipeline backfill and compaction.
- Review and provide comments on the contractor's shoring and excavation plan submittal.
- Update this report if design changes occur, 2 years or more lapse between this report and construction, and/or site conditions have changed.

If CAInc is not retained to perform the above applicable services, we are not responsible for any other party's interpretation of our report, and subsequent addendums, letters, and discussions.

10 LIMITATIONS

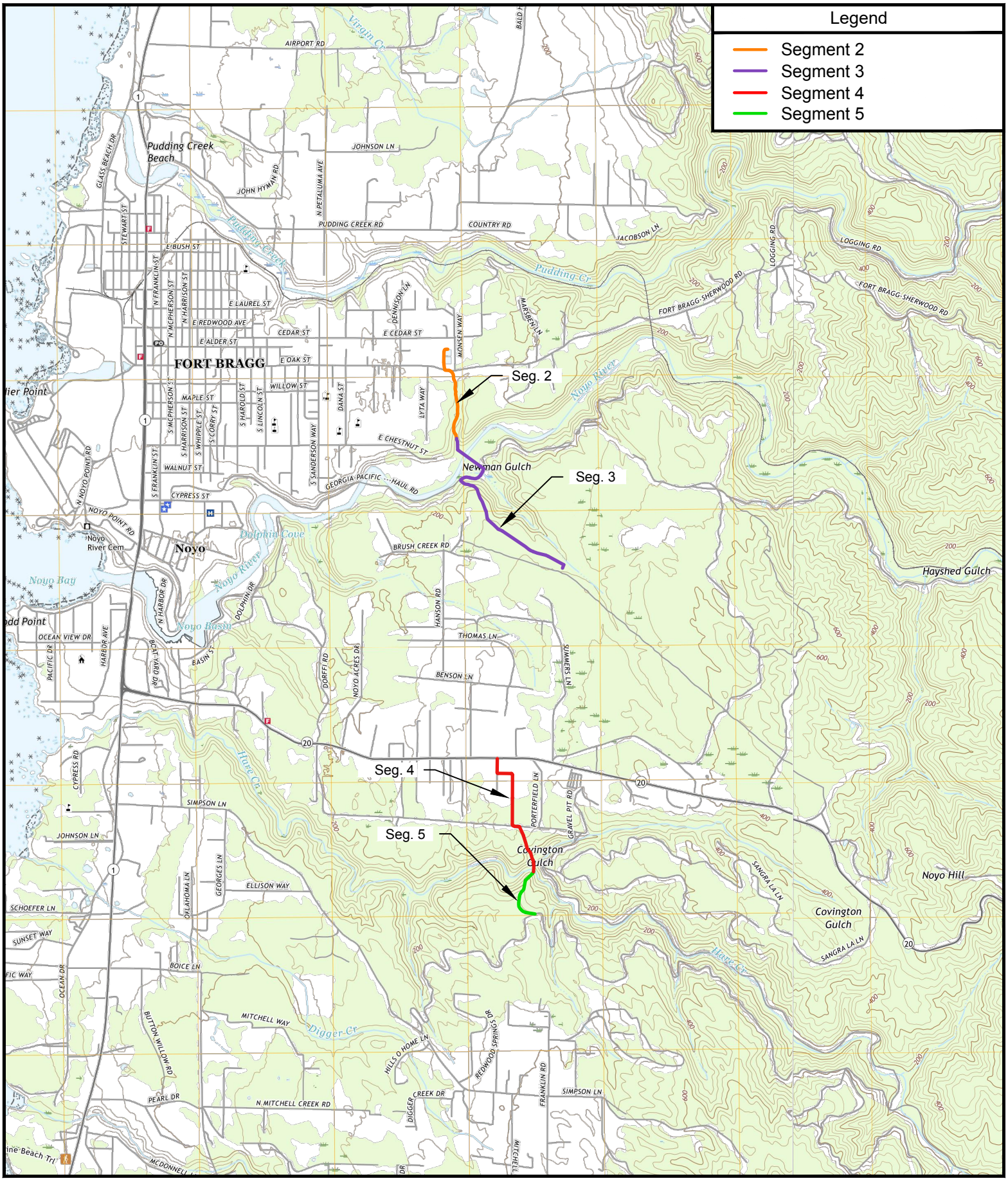
Crawford performed services in accordance with generally accepted geotechnical engineering principles and practices currently used in this area. Do not use this report for different locations and/or projects without the written consent of Crawford. Where referenced, we used ASTM or Caltrans standards as a general (not strict) *guideline* only. Crawford based this report on the site conditions in 2020. We assumed the soil and groundwater conditions are representative of the subsurface conditions on the site. Actual conditions between explorations could vary along the project alignment.

Our scope did not include evaluation of on-site hazardous materials.

Logs of our explorations are presented as Appendix II. The lines designating the interface between soil types are approximate. The transition between soil types may be abrupt or gradual. Our recommendations are based on the final logs, which represent our interpretation of the field logs and general knowledge of the site and geological conditions.

Modern design and construction are complex, with many regulatory sources/restrictions, involved parties, construction alternatives, etc. It is common to experience changes and delays. The owner should set aside a reasonable contingency fund based on complexities and cost estimates to cover changes and delays.

APPENDIX I - FIGURES



North

Source:
USGS 7.5' Topographic Maps, Fort Bragg, Mendocino County, California, Year 2018, Scale: 1: 24,000

USGS 7.5' Topographic Maps, Noyo Hill, Mendocino County, California, Year 2018, Scale: 1: 24,000

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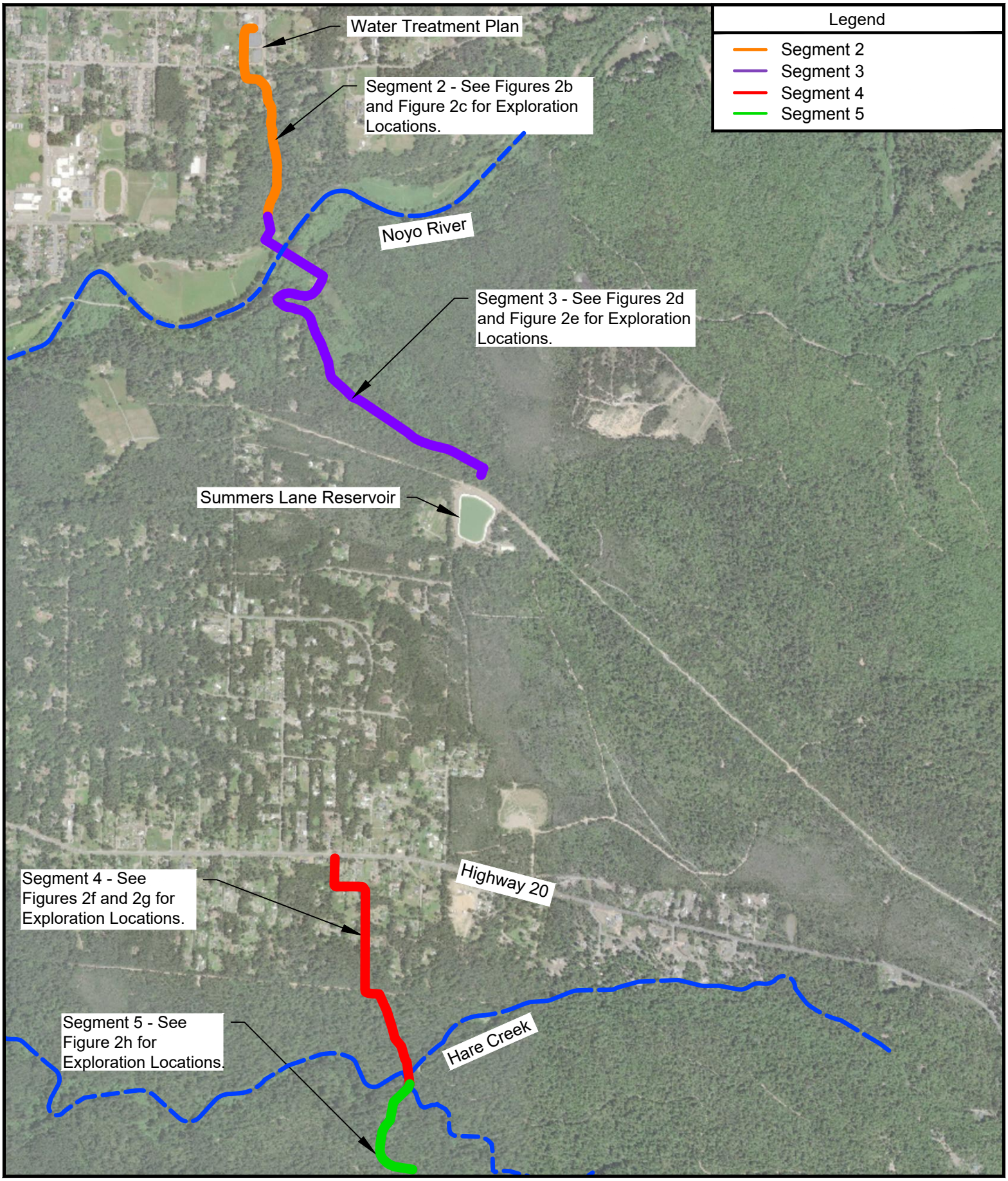
City of Fort Bragg Raw Water Pipeline Replacement

Fort Bragg, CA

Figure 1
Vicinity Map

Proj. No:	19-514.1
Scale:	1"=4,000'
Date:	3/25/22



North

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City of Fort Bragg Raw Water Pipeline Replacement

Fort Bragg, CA

Figure 2a
Full Alignment

Proj. No:	19-514.1
Scale:	1"=4,000'
Date:	3/25/22

North

Legend

T-20-001 Test Pit Location

HA-20-001 Hand Auger Location

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Figure 2b
Exploration Map - Segment 2

Proj. No:	19-514.1
Scale:	1"=150'
Date:	3/25/22

North

Legend

T-20-001 Test Pit Location

HA-20-001 Hand Auger Location

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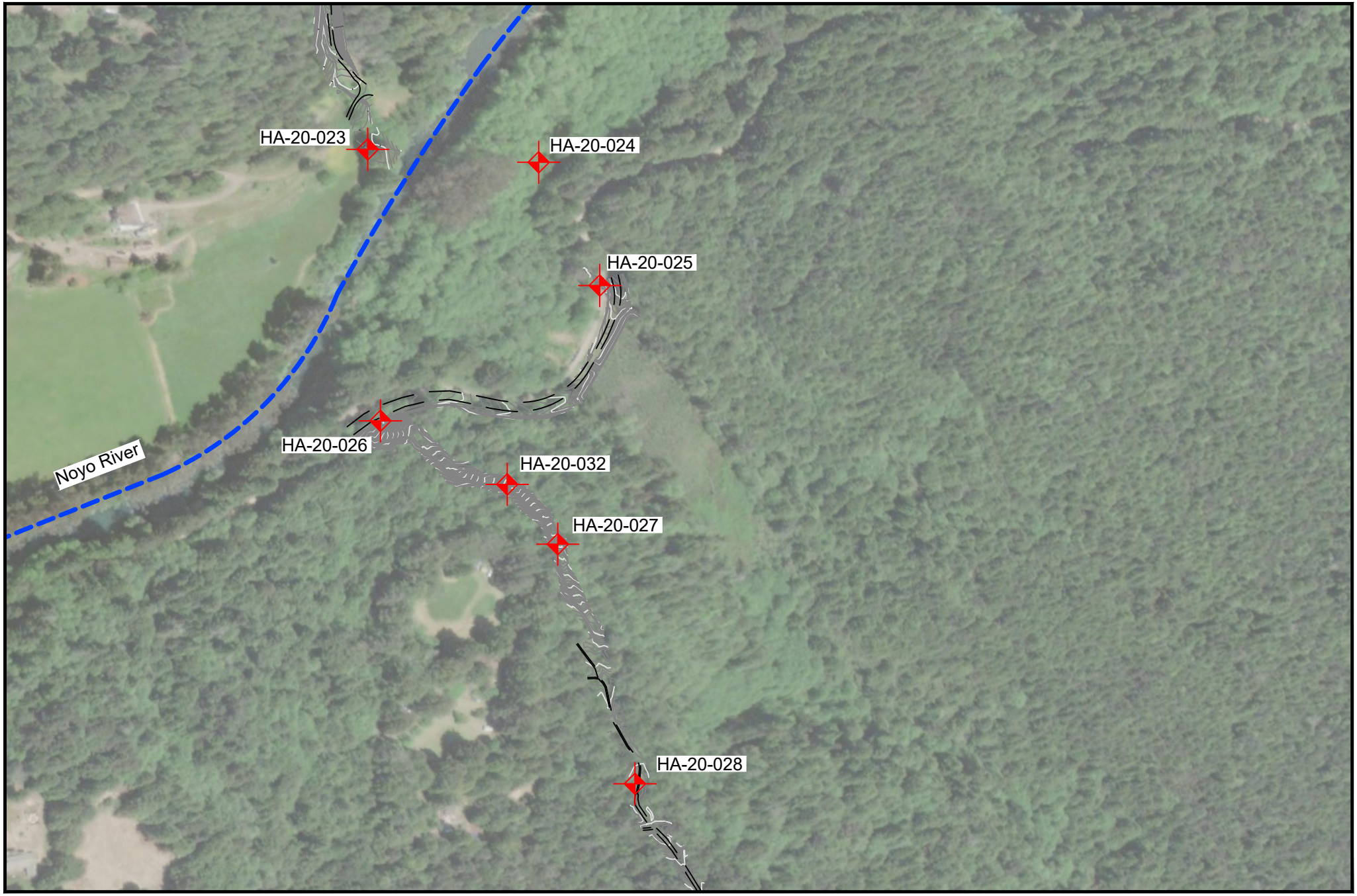
Figure 2c
Exploration Map - Segment 2

Proj. No:	19-514.1
Scale:	1"=150'
Date:	3/257/22



North

Legend

HA-20-001 Hand Auger Location

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Figure 2d
Exploration Map - Segment 3

Proj. No:	19-514.1
Scale:	1"=500'
Date:	3/25/22

North

Legend

T-20-001 Test Pit Location

HA-20-001 Hand Auger Location

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Fort Bragg, CA

Figure 2e
Exploration Map - Segment 3

Proj. No:	19-514.1
Scale:	1"=300'
Date:	3/25/22

North

Legend

T-20-001 Test Pit Location

HA-20-001 Hand Auger Location

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City of Fort Bragg Raw Water Pipeline Replacement

Fort Bragg, CA

Figure 2f
Exploration Map - Segment 4

Proj. No:	19-514.1
Scale:	1"=150'
Date:	3/25/22

North

Legend

HA-20-001
Hand Auger Location

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City of Fort Bragg Raw Water Pipeline Replacement

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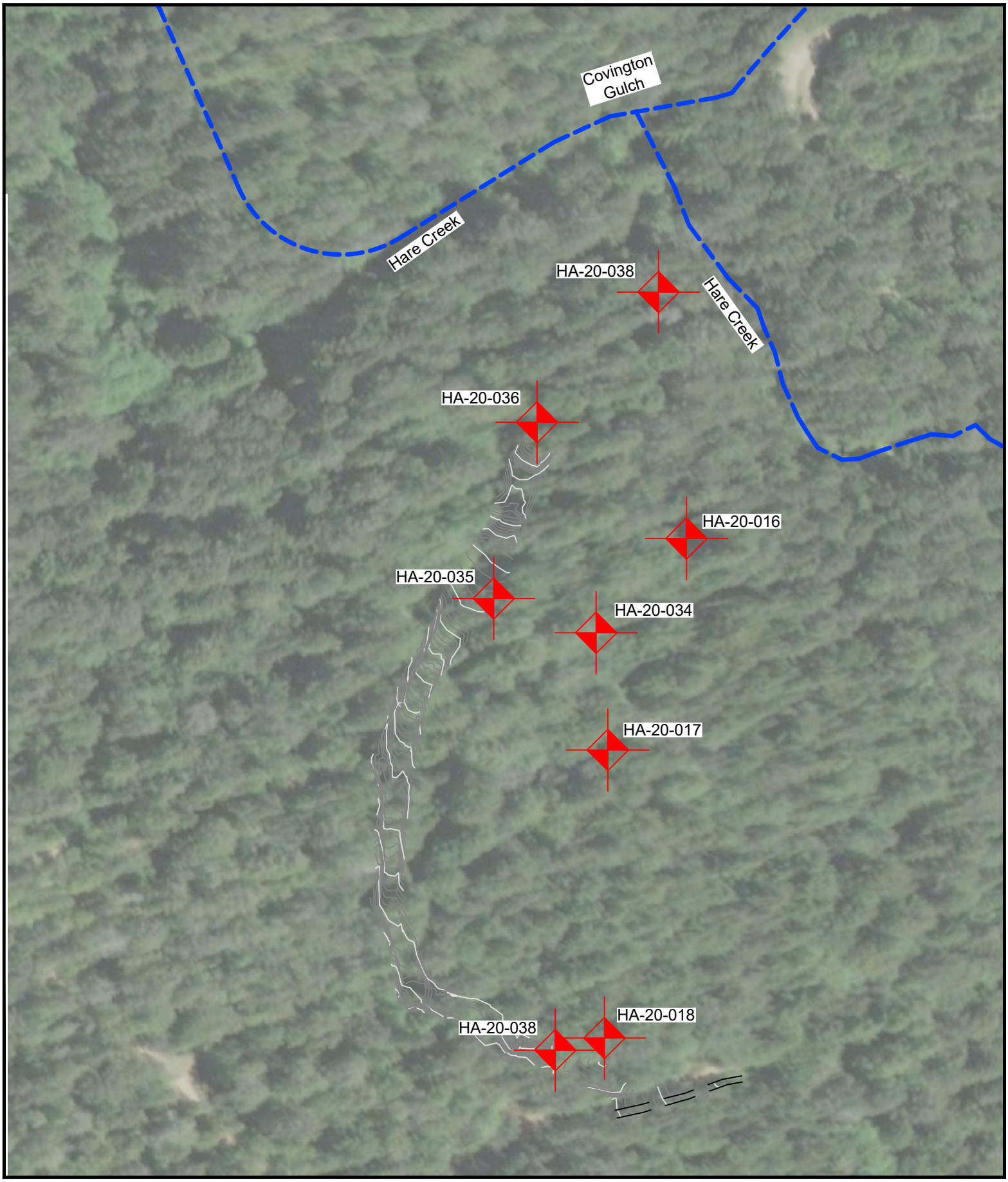
Figure 2g
Exploration Map - Segment 4

Proj. No:	19-514.1
Scale:	1"=150'
Date:	3/25/22



North

Legend

HA-20-001 Hand Auger Location

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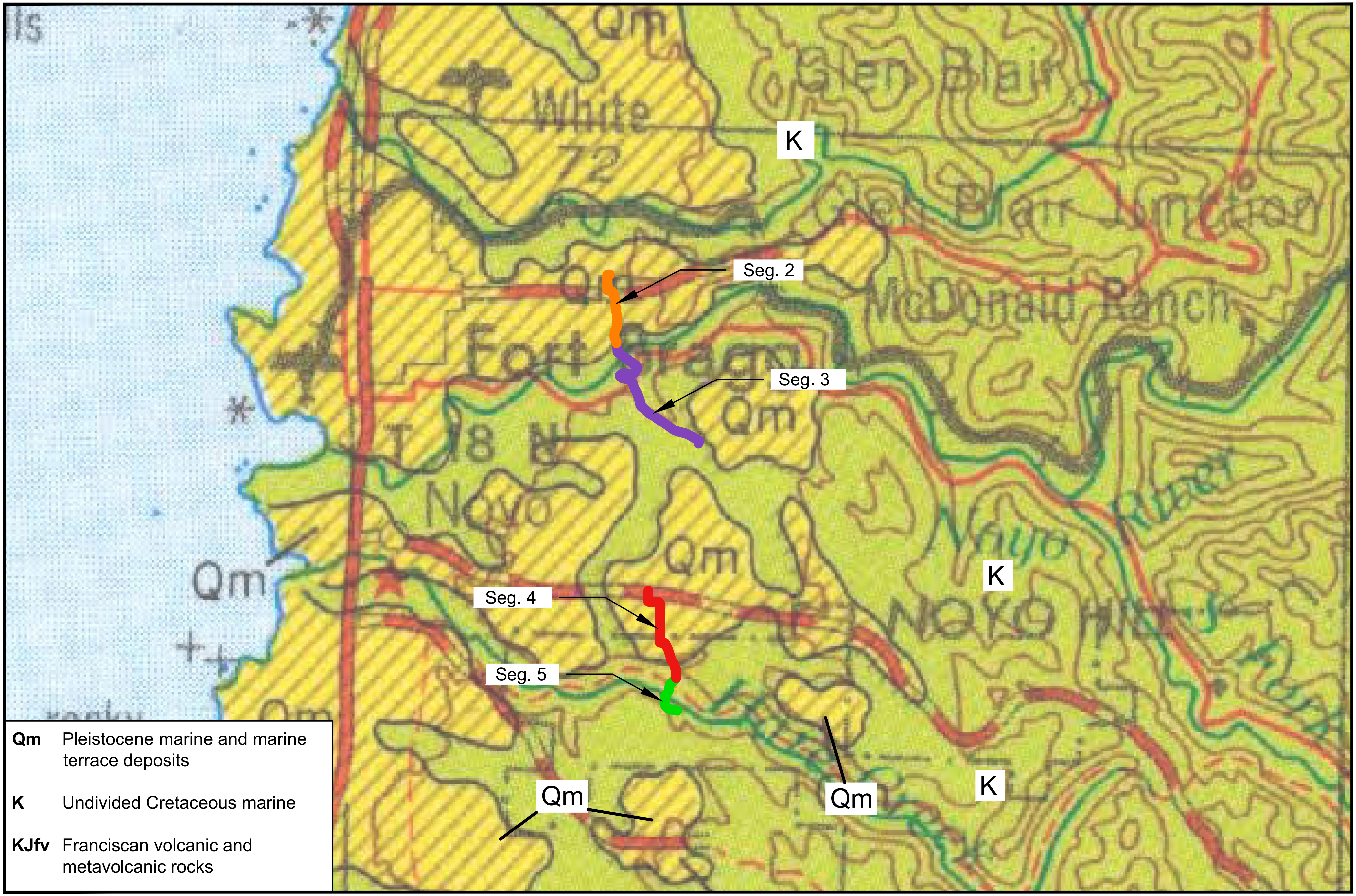
City of Fort Bragg Raw Water Pipeline Replacement

Fort Bragg, CA

Figure 2h
Exploration Map - Segment 5

Proj. No:	19-514.1
Scale:	1"=150'
Date:	3/25/22



North

Source: Jennings, CW., and Strand, R.G., Geologic Map of California: Ukiah Sheet. Scale 1:250,000, California Division of Mines and Geology, 1960

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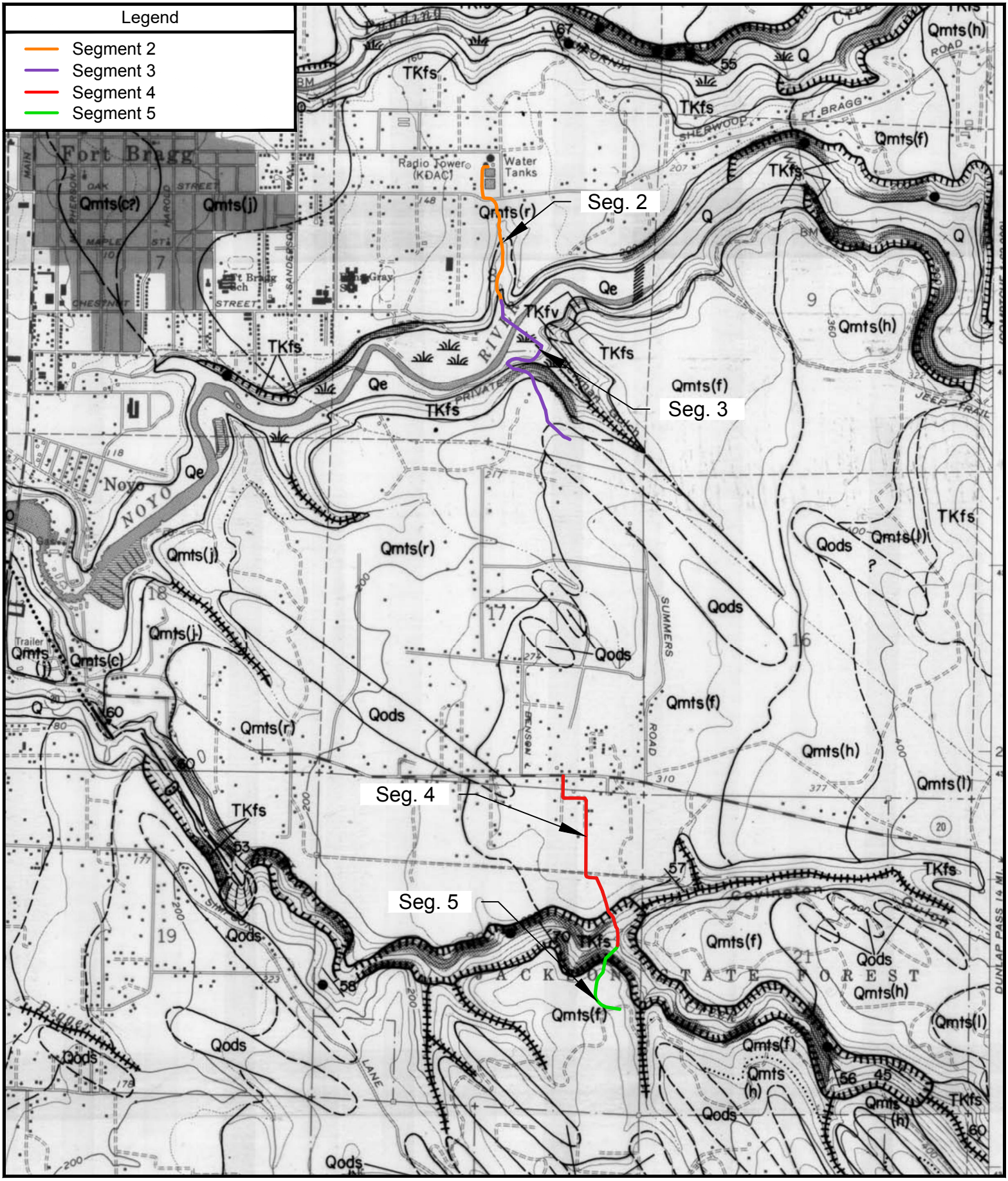
City of Fort Bragg Raw Water Pipeline Replacement

Fort Bragg, CA

Figure 3
Geology Map

Proj. No:	19-514.1
Scale:	1"=5,000'
Date:	3/25/22



North

Source: Kilbourne, Richard, Geologic and Geomorphic Features Related to Landsliding: Fort Bragg 7.5' Quadrangle, Mendocino County, California, Scale 1:24,000, California Division of Mines and Geology, 1982

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City of Fort Bragg Raw Water Pipeline Replacement

Fort Bragg, CA

Figure 4a
Landslide and Geologic Map

Proj. No:	19-514.1
Scale:	1"=4,000'
Date:	3/25/22

EXPLANATION

FORT BRAGG 7.5' QUADRANGLE
OFR 83-5 S.F.

DEBRIS SLIDE: includes scarp and slide deposits; solid where active, dashed where dormant.

DEBRIS FLOW/TORRENT TRACK: solid where active, dashed where dormant.

DEBRIS SLIDE AMPHITHEATER/SLOPE

INNER GORGE: +++ where too narrow to delineate at this scale.

ACTIVE SLIDE: too small to delineate at this scale.

Q ALLUVIUM (Holocene): unconsolidated, fine-grained sand and silt along modern river flood plains; minor amounts of gravel in channel areas.

Qbs BEACH SAND (Holocene): unconsolidated medium- to coarse-grained quartz sand with lesser amounts of shell fragments and Coastal Belt Franciscan (TKfs) cobbles.

Qe ESTUARINE DEPOSITS (Holocene): unconsolidated dark grey silt and fine sand along intertidal salt marsh estuaries; generally gradational contact with alluvium (Q).

Qds DUNE SAND (Holocene): medium- to fine-grained principally quartz sand; active and unvegetated.

Qods OLDER DUNES (Pleistocene): well-sorted, semi-consolidated, fine- to medium-grained quartz sand overlying various marine terrace deposits (Qmts); recognized by subdued elongate dune profile, generally trending NW; dune deposits tend to be better drained than underlying units.

Qmts MARINE TERRACE DEPOSITS undifferentiated, progressively older with increased elevation (Pleistocene): deposits generally consist of well-sorted quartz sand with minor gravel and have coarser textures near major drainages; may include some dune sands. Elevations of terrace deposits listed below are approximate and, due to minor regional deformation, apply only to map area.

Qmts(c) CASPAR POINT marine terrace sediments: name is from stratigraphically equivalent deposits exposed at Caspar Point (W1/2 of Section 1, T17N, R18W) on the Mendocino 7.5' quadrangle; thickness 0 to 30 feet, mostly unconsolidated fine sand, Indian midden deposits common, native arboreal vegetation absent, found from modern sea cliff to an elevation of generally 100(±15) feet.

Qmts(j) JUG HANDLE FARM marine terrace sediments: name is from stratigraphically equivalent deposits exposed at Jug Handle Farm (SE1/4 of Section 36, T18N, R18W) on the Mendocino 7.5' quadrangle; thickness 0 to 10 feet, with frequent relict stacks of TKfs, sporadically forested, elevation generally 100 to 160(±10) feet.

Qmts(r) RAILROAD marine terrace sediments: name is from stratigraphically equivalent deposits exposed along old Caspar railroad right-of-way (Section 31, T18N, R17W) on the Fort Bragg 7.5' quadrangle; elevation generally 160 to 220(±20) feet.

Qmts(f) FERN CREEK marine terrace sediments: name is from stratigraphically equivalent deposits exposed along Fern Creek Road (Section 6, T17N, R17W) on the Mendocino 7.5' quadrangle; hardpan sporadically developed in map area; elevation generally 220 to 320(±20) feet.

Qmts(h) HANS JENNY PIT marine terrace sediments: name is from stratigraphically equivalent deposits exposed in soil test pits along Gibney Lane (NE1/4 of Section 5, T17N, R17W) on the Mendocino 7.5' quadrangle; hardpan well developed in map area; elevation 320 to 415(±25) feet.

Qmts(l) LOWER CASPAR ORCHARD marine terrace sediments: name is from stratigraphically equivalent deposits exposed at Caspar Orchard (SW1/4 of NW1/4 of Section 10, T17N, R17W) on the Mendocino and Glenblair SW 7.5' quadrangles; hardpan usually broken in map area; elevation 415 to 515(±25) feet.

Qmts(u) UPPER CASPAR ORCHARD marine terrace sediments: name is from stratigraphically equivalent deposits exposed at Caspar Orchard (NE1/4 of NW1/4 of Section 10, T17N, R17W) on the Glenblair SW 7.5' quadrangle; elevation generally 515 to 680 (±30) feet.

TKfs COASTAL BELT FRANCISCAN (Tertiary-Cretaceous): well-consolidated clastic sedimentary rocks; mainly sandstone and shale with minor limestone and conglomerate; NW trending streams tend to lie in more sheared shale.

TKfv COASTAL BELT FRANCISCAN (Tertiary-Cretaceous): volcanic rocks; greenstone and metamorphosed tuffaceous sandstone.

LITHOLOGIC CONTACT: dashed where approximately located, dotted where projected or inferred.

GRADATIONAL CONTACT

FAULT: showing direction of dip and up (U) and downthrown (D) sides; dotted where concealed.

LINEAMENT: linear feature of unknown origin observed on aerial photographs.

50 STRIKE AND DIP OF BEDDING: when appearing in Quaternary units the symbol represents the underlying bedrock.

BORROW PIT

SPRING

MARSH

SLOPES > 70 PERCENT: compiled from map contours, aerial photo interpretation, and field reconnaissance.

REFERENCES

California Department of Forestry, 1981, Cal Aero Photos: Photos CDF-ALL-UK; Flight 7/9/81; Frames 5-6 to 5-12 and 7-11 to 7-17; black and white, scale 1:24,000.

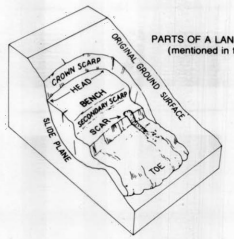
California Division of Mines and Geology, 1976-1982, Geologic Review of Timber Harvesting Plans: Unpublished field studies conducted for the California Department of Forestry.

Henderson, C., and Olmsted,J., 1979, Jug Handle Ecological Staircase: Published by California Institute of Man in Nature, Caspar, California, map scale 1:9,400.

Kramer, J.C., 1976, Geology and tectonic implications of the Coastal Belt Franciscan, Ft. Bragg-Willits area, northern Coast Ranges, California: Unpublished Ph.D. thesis, University of California, Davis, 128 p., map scale 1:48,000.

SOURCES OF GEOLOGIC DATA

Geologic data was compiled from aerial photo interpretation, field reconnaissance, and the modification of published and unpublished geologic maps listed in references above. The author was assisted in the field and office studies by Anibal Mata-Sol and Peter H. Griffith.



ACTIVITY OF LANDSLIDES

Active or probably active - presently moving or recently moved. Distinct topographic slide features present i.e., sharp barren scarps, cracks, jackstrawed trees. Major revegetation has not occurred.

Dormant - little evidence of recent movement. Slide features modified by weathering and erosion. Vegetation generally well established. Some mass movements may have developed under climatic conditions different from today. Causes of failure may remain and movement could be renewed.

RATES OF LANDSLIDE MOVEMENT*

10 ft/sec or more	= extremely rapid
1 ft/min-10 ft/min	= very rapid
5 ft/day-1 ft/min	= rapid
5 ft/mo-5 ft/day	= moderate
5 ft/yr-5 ft/mo	= slow
1 ft/5yr-5 ft/yr	= very slow
1 ft/5yr or less	= extremely slow

*Modified from: Varnes, D.J., 1978, Slope movement types and processes *in* Landslides: Analysis and Control, Transportation Research Board, National Academy of Sciences, Washington, D.C., Special Report 176, Figure 2.1.

North

Source: Kilbourne, Richard, Geologic and Geomorphic Features Related to Landsliding: Fort Bragg 7.5' Quadrangle, Mendocino County, California, Scale 1:24,000, California Division of Mines and Geology, 1982

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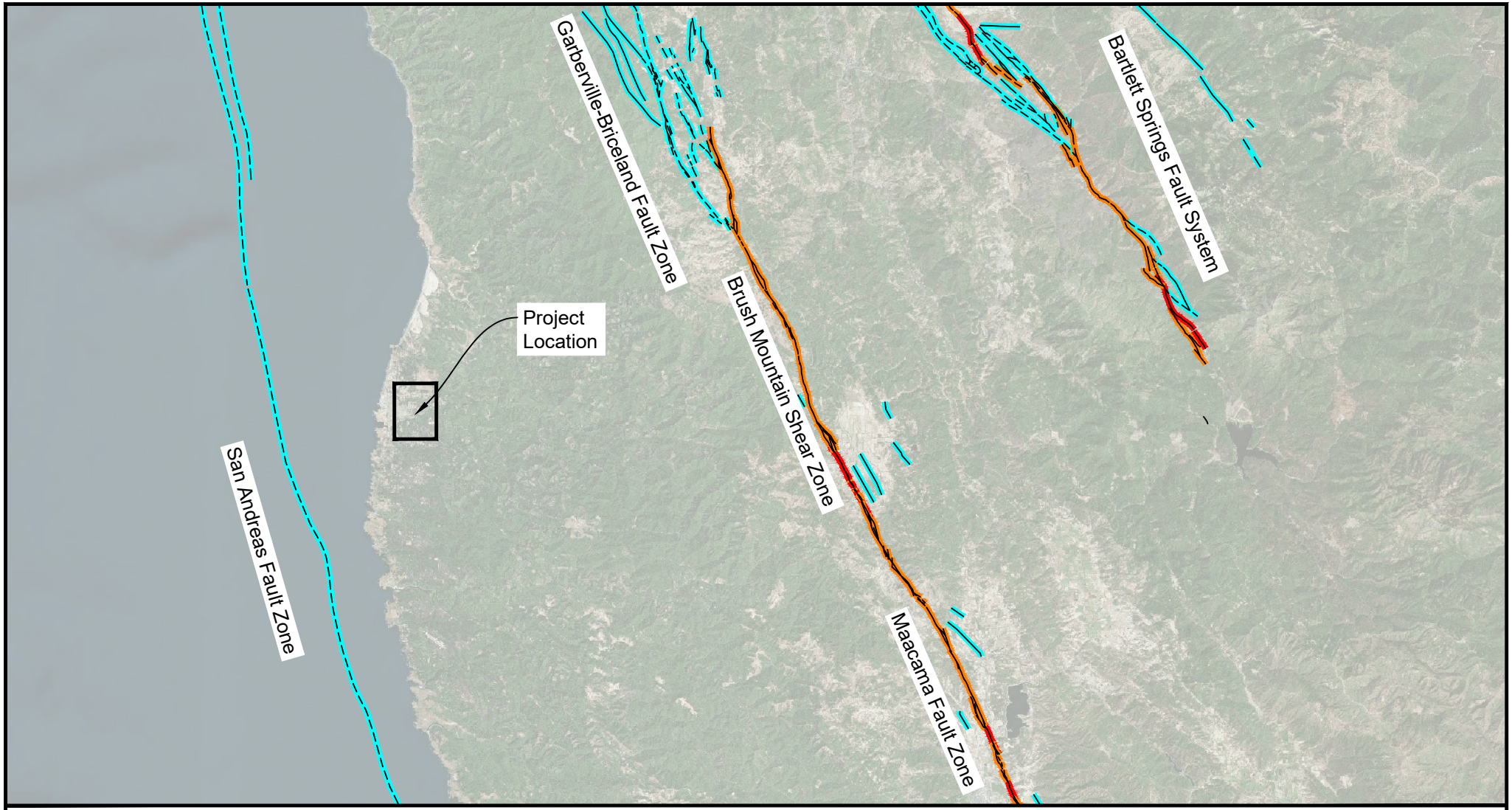
Fort Bragg, CA

Figure 4b
Landslide and Geologic Map Legend

Proj. No:	19-514.1
Scale:	No Scale
Date:	3/25/22



LEGEND

Quaternary Fault (Age)	Quaternary Fault (Age)	Location
<150 years	<750,000 years	Well Constrained
<15,000 years	<1.6 million years	Moderately Constrained
<130,000 years		Inferred

North

Source:
Basemap: AutoCAD Civil3D Geolocation Tool, using Bing Maps

Fault Data: USGS GIS Data

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Figure 5
Fault Activity Map

Proj. No:	19-514.1
Scale:	1"=40,000'
Date:	3/25/22

APPENDIX II

BORING AND TEST PIT LEGEND
TEST PIT LOGS
HAND AUGER LOGS

UNIFIED SOIL CLASSIFICATION (ASTM D 2487)

MATERIAL TYPES	CRITERIA FOR ASSIGNING SOIL GROUP NAMES			GRAPHIC SYMBOL	GROUP SYMBOL	SOIL GROUP NAMES
COARSE-GRAINED SOILS >50% RETAINED ON NO. 200 SIEVE	GRAVELS >50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS <5% FINES	Cu ≥ 4 AND 1 ≤ Cc ≤ 3		GW	WELL-GRADED GRAVEL
			Cu < 4 AND/OR 1 > Cc > 3		GP	POORLY-GRADED GRAVEL
		GRAVELS WITH FINES >12% FINES	FINES CLASSIFY AS ML OR MH		GM	SILTY GRAVEL
			FINES CLASSIFY AS CL OR CH		GC	CLAYEY GRAVEL
	SANDS <50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN SANDS <5% FINES	Cu ≥ 6 AND 1 ≤ Cc ≤ 3		SW	WELL-GRADED SAND
			Cu < 6 AND/OR 1 > Cc > 3		SP	POORLY-GRADED SAND
		SANDS WITH FINES >12% FINES	FINES CLASSIFY AS ML OR MH		SM	SILTY SAND
			FINES CLASSIFY AS CL OR CH		SC	CLAYEY SAND
FINE-GRAINED SOILS >50% PASSING NO. 200 SIEVE	SILTS AND CLAYS LIQUID LIMIT <50	INORGANIC	PI>7 AND PLOTS ON OR ABOVE "A" LINE		CL	LEAN CLAY
			PI>4 AND PLOTS BELOW "A" LINE		ML	SILT
		ORGANIC	LL (oven dried)<0.75/LL (not dried)		OL	ORGANIC CLAY OR SILT
	SILTS AND CLAYS LIQUID LIMIT >50	INORGANIC	PI PLOTS ON OR ABOVE "A" LINE		CH	FAT CLAY
			PI PLOTS BELOW "A" LINE		MH	ELASTIC SILT
		ORGANIC	LL (oven dried)<0.75/LL (not dried)		OH	ORGANIC CLAY OR SILT
HIGHLY ORGANIC SOILS		PRIMARILY ORGANIC MATTER, DARK COLOR, ORGANIC ODOR			PT	PEAT

NOTE: $Cu = D_{60}/D_{10}$

$Cc = (D_{30})^2 / D_{10} \times D_{60}$

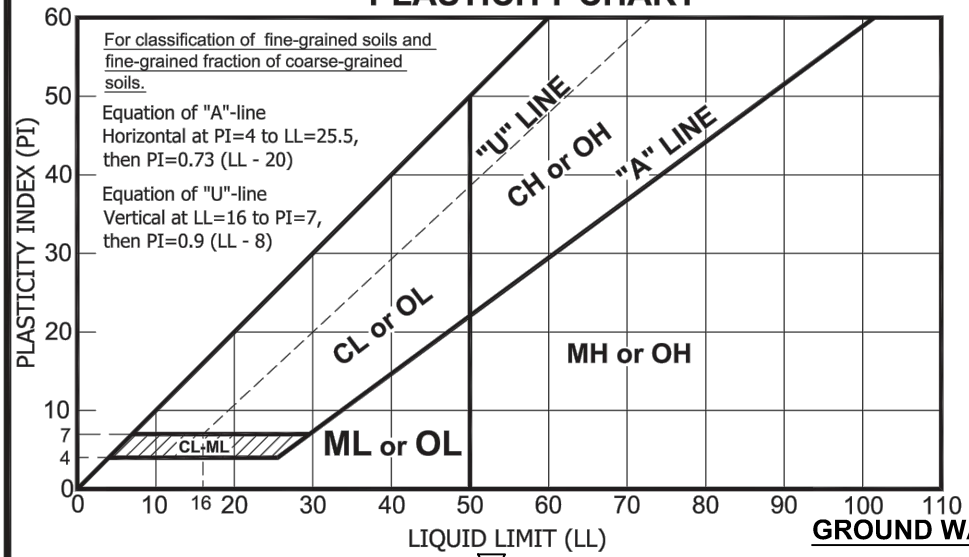
BLOW COUNT

The number of blows of a 140-lb. hammer falling 30-inches required to drive the sampler the last 12-inches of an 18-inch drive. The notation 50/4 indicates 4-inches of penetration achieved in 50 blows.

SAMPLE TYPES

- Auger or backhoe cuttings
- Shelby tube
- Standard Penetration (SPT)
- Bulk Sample
- Modified California 2.5"
- California Standard 2"
- Rock core

PLASTICITY CHART



ADDITIONAL TESTS

C	- Consolidation
CP	- Compaction Curve
CR	- Corrosivity Testing
CU	- Consolidated Undrained Triaxial
DS	- Direct Shear
EI	- Expansion Index
P	- Permeability
PA	- Partical Size Analysis
PI	- Plasticity Index
PP	- Pocket Penetrometer
R	- R-Value
SE	- Sand Equivalent
SG	- Specific Gravity
SL	- Shrinkage Limit
SW	- Swell Potential
TV	- Pocket Torvane Shear Test
UC	- Unconfined Compression
UU	- Unconsolidated Undrained Triaxial

GROUND WATER LEVELS

- First Water Level Reading (during drilling)
- Static Water Level Reading (short-term)
- Static Water Level Reading (long-term)

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BORING LOG / TEST PIT LEGEND AND SOIL DESCRIPTIONS

LOG OF BORING HA-20-001

PROJECT NO: 19-514.1
PROJECT: Fort Bragg Raw Water Line
LOCATION: Fort Bragg, CA
COUNTY: Mendocino
CLIENT: Coleman Engineering
LOGGED BY: MCC/BJU
DEPTH OF BORING: 5(ft)

BEGIN DATE: 6/8/2020
COMPLETION DATE: 6/8/2020
SURFACE ELEVATION: 181.1(ft)
SURFACE CONDITION: Soil
WATER DEPTH: Not Encountered
READING TAKEN: 6/8/2020
HAMMER EFFICIENCY: N/A(%)

DRILLING CONTRACTOR: N/A
DRILLING METHOD: Hand Auger
DRILL RIG: N/A
HAMMER TYPE: N/A
SAMPLER TYPE & SIZE: BULK
BOREHOLE DIAMETER: 6 inches
BACKFILL METHOD: Native soil

FIELD									LABORATORY							
ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD / CASING DEPTH	REMARKS
			1					CLAYEY SAND (SC); light gray; dry to moist; mostly fine SAND; some fines.	100								
	1		2					SANDY lean CLAY (CL); gray; moist; some fine SAND; mostly fines.	100								
179	2		3					Lean CLAY with SAND (CL); multicolored; gray; strong brown; moist; little fine SAND; mostly fines.	100								
			4					SANDY fat CLAY (CH); multicolored; light gray; strong brown; moist; some fine SAND; mostly fines.	100								
	3		5					Fat CLAY with SAND (CH); multicolored; light gray; strong brown; moist; little fine SAND; mostly fines.	100		25	66					
177	4		6					SANDY fat CLAY (CH); multicolored; gray; strong brown; moist; some fine SAND; mostly fines.	100								
			7					CLAYEY SAND (SC); strong brown; mostly fine SAND; some fines.	100								
	5							Bottom of borehole at 5.0 ft bgs									

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PROJECT NUMBER: 19-514.1
PROJECT: Fort Bragg Raw Water Line
BORING: HA-20-001
ENTRY BY: MCC
CHECKED BY: KKL SHEET 1 of 1

LOG OF BORING T-20-002

PROJECT NO: 19-514.1
PROJECT: Fort Bragg Raw Water Line
LOCATION: Fort Bragg, CA
COUNTY: Mendocino
CLIENT: Coleman Engineering
LOGGED BY: MCC/BJU
DEPTH OF BORING: 9(ft)

BEGIN DATE: 6/10/2020
COMPLETION DATE: 6/10/2020
SURFACE ELEVATION: 161.8(ft)
SURFACE CONDITION: Soil
WATER DEPTH: Not Encountered
READING TAKEN: 6/10/2020
HAMMER EFFICIENCY: N/A(%)

DRILLING CONTRACTOR: Jerry Beaty
DRILLING METHOD: Test Pit
DRILL RIG: Backhoe
HAMMER TYPE: N/A
SAMPLER TYPE & SIZE: BULK
BOREHOLE DIAMETER: N/A(in.)
BACKFILL METHOD: Native soil

FIELD										LABORATORY							
ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD	CASING DEPTH	REMARKS
	0		1					CLAYEY GRAVEL with SAND (GC); dark brown; moist; mostly coarse to fine GRAVEL; some coarse to fine SAND; little low plasticity, low toughness fines.	100									
	1					4.25												
160	2		2					SANDY lean CLAY with GRAVEL (CL); brown; moist; little coarse to fine GRAVEL; some coarse to fine SAND; mostly medium plasticity, medium toughness fines; trace rootlets.	100									Grazed storm drain; No Damage. Moved test pit 5-10 feet east
	3		3					CLAYEY SAND with GRAVEL (SC); yellowish brown; moist; mostly coarse to fine SAND; little low plasticity, low toughness fines; trace rootlets.	100									
158	4		4						100									
	5		5					Some coarse to fine GRAVEL.	100									
156	6		6						100									
	7		7					SANDY lean CLAY with GRAVEL (CL); yellowish brown; little coarse to fine GRAVEL; some coarse to fine SAND; mostly medium plasticity, medium toughness fines.	100									
154	8		8					SANDY lean CLAY (CL); multicolored; gray; strong brown; some fine SAND; mostly medium plasticity, medium toughness fines.	100									
	9							Bottom of borehole at 9.0 ft bgs										

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PROJECT NUMBER: 19-514.1
PROJECT: Fort Bragg Raw Water Line
TEST PIT: T-20-002
ENTRY BY: MCC
CHECKED BY: KKL SHEET 1 of 1

LOG OF BORING T-20-003

PROJECT NO: 19-514.1
PROJECT: Fort Bragg Raw Water Line
LOCATION: Fort Bragg, CA
COUNTY: Mendocino
CLIENT: Coleman Engineering
LOGGED BY: MCC/BJU
DEPTH OF BORING: 6(ft)

BEGIN DATE: 6/10/2020
COMPLETION DATE: 6/10/2020
SURFACE ELEVATION: 130.8(ft)
SURFACE CONDITION: Soil
WATER DEPTH: Not Encountered
READING TAKEN: 6/10/2020
HAMMER EFFICIENCY: N/A(%)

DRILLING CONTRACTOR: Jerry Beaty
DRILLING METHOD: Test Pit
DRILL RIG: Backhoe
HAMMER TYPE: N/A
SAMPLER TYPE & SIZE: BULK
BOREHOLE DIAMETER: N/A(in.)
BACKFILL METHOD: Native soil

FIELD									LABORATORY								
ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD	CASING DEPTH	REMARKS
	0		1					CLAYEY SAND (SC); brown; dark brown; moist; mostly coarse to fine SAND; some low plasticity, low toughness fines; trace rootlets.	100								
	1																	
129	2		3						100									
	3		4						100						43			
127	4		5					SANDY lean CLAY (CL); brown; dark brown; moist; some coarse to fine SAND; mostly low to medium plasticity, low to medium toughness fines.	100								
	5		6					Little coarse to fine SAND.	100								
125	6							Bottom of borehole at 6.0 ft bgs									
	7																
123	8																
	9																

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PROJECT NUMBER: 19-514.1
PROJECT: Fort Bragg Raw Water Line
TEST PIT: T-20-003
ENTRY BY: MCC
CHECKED BY: KKL SHEET 1 of 1

LOG OF BORING T-20-004

PROJECT NO: 19-514.1
PROJECT: Fort Bragg Raw Water Line
LOCATION: Fort Bragg, CA
COUNTY: Mendocino
CLIENT: Coleman Engineering
LOGGED BY: MCC/BJU
DEPTH OF BORING: 8(ft)

BEGIN DATE: 6/10/2020
COMPLETION DATE: 6/10/2020
SURFACE ELEVATION: 121.0(ft)
SURFACE CONDITION: Soil
WATER DEPTH: Not Encountered
READING TAKEN: 6/10/2020
HAMMER EFFICIENCY: N/A(%)

DRILLING CONTRACTOR: Jerry Beaty
DRILLING METHOD: Test Pit
DRILL RIG: Backhoe
HAMMER TYPE: N/A
SAMPLER TYPE & SIZE: BULK
BOREHOLE DIAMETER: N/A(in.)
BACKFILL METHOD: Native soil

FIELD									LABORATORY							
ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD / CASING DEPTH	REMARKS
			1					Poorly graded SAND with GRAVEL (SP); dark brown; moist; little coarse to fine GRAVEL; mostly coarse to fine SAND; trace low plasticity, low toughness fines.	100							
	1		2						100							
119	2		3			3.5		SANDY lean CLAY with GRAVEL (CL); light brown; moist; little coarse to fine GRAVEL; some coarse to fine SAND; mostly low to medium plasticity, low to medium toughness fines; trace rootlets.	100		20	36				
	3		4						100							
117	4		5					SANDY lean CLAY (CL); light brown; moist; trace fine GRAVEL; some coarse to fine SAND; mostly low plasticity, low toughness fines; trace rootlets.	100						56	
	5		6						100							
115	6		7					No gravel.	100							
	7		8					SANDY lean CLAY (CL); multicolored; brown; strong brown; gray; moist; little medium to fine SAND; mostly medium plasticity, medium toughness fines; trace organics.	100							
113	8							Bottom of borehole at 8.0 ft bgs								
	9															

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PROJECT NUMBER: 19-514.1
PROJECT: Fort Bragg Raw Water Line
TEST PIT: T-20-004
ENTRY BY: MCC
CHECKED BY: KKL SHEET 1 of 1

LOG OF BORING T-20-005

PROJECT NO: 19-514.1
PROJECT: Fort Bragg Raw Water Line
LOCATION: Fort Bragg, CA
COUNTY: Mendocino
CLIENT: Coleman Engineering
LOGGED BY: MCC/BJU
DEPTH OF BORING: 8(ft)

BEGIN DATE: 6/10/2020
COMPLETION DATE: 6/10/2020
SURFACE ELEVATION: 101.4(ft)
SURFACE CONDITION: Soil
WATER DEPTH: Not Encountered
READING TAKEN: 6/10/2020
HAMMER EFFICIENCY: N/A(%)

DRILLING CONTRACTOR: Jerry Beaty
DRILLING METHOD: Test Pit
DRILL RIG: Backhoe
HAMMER TYPE: N/A
SAMPLER TYPE & SIZE: BULK
BOREHOLE DIAMETER: N/A(in.)
BACKFILL METHOD: Native soil

FIELD									LABORATORY								
ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD	CASING DEPTH	REMARKS
			1					CLAYEY SAND (SC); reddish brown; moist; few coarse to fine GRAVEL; mostly coarse to fine SAND; little low plasticity, low toughness fines; trace cobbles.	100								
	1		2					Trace rootlets.	100								
99	2		3			2.0			100								
	3		4					No cobbles.	100								
97	4		5						100								
	5		6					Lean CLAY with SAND (CL); multicolored; gray; reddish-brown; moist; trace fine GRAVEL; little coarse to fine SAND; mostly medium plasticity, medium toughness fines. Trace organics.	100								
95	6		7						100								
	7		8					CLAYEY SAND (SC); gray; moist; mostly medium to fine SAND; some low to medium plasticity, low to medium toughness fines.	100								
93	8							Bluish gray; moist to wet; trace cobbles. Bottom of borehole at 8.0 ft bgs									
	9																

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PROJECT NUMBER: 19-514.1
PROJECT: Fort Bragg Raw Water Line
TEST PIT: T-20-005
ENTRY BY: MCC
CHECKED BY: KKL SHEET 1 of 1

LOG OF BORING T-20-006

PROJECT NO: 19-514.1
PROJECT: Fort Bragg Raw Water Line
LOCATION: Fort Bragg, CA
COUNTY: Mendocino
CLIENT: Coleman Engineering
LOGGED BY: MCC/BJU
DEPTH OF BORING: 8(ft)

BEGIN DATE: 6/10/2020
COMPLETION DATE: 6/10/2020
SURFACE ELEVATION: 73.0(ft)
SURFACE CONDITION: Soil
WATER DEPTH: Not Encountered
READING TAKEN: 6/10/2020
HAMMER EFFICIENCY: N/A(%)

DRILLING CONTRACTOR: Jerry Beaty
DRILLING METHOD: Test Pit
DRILL RIG: Backhoe
HAMMER TYPE: N/A
SAMPLER TYPE & SIZE: BULK
BOREHOLE DIAMETER: N/A(in.)
BACKFILL METHOD: Native soil

FIELD									LABORATORY							
ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD / CASING DEPTH	REMARKS
			1					Poorly graded SAND with GRAVEL (SP); dark brown; moist; some coarse to fine GRAVEL; mostly coarse to fine SAND; few low plasticity, low toughness fines; trace cobbles.	100								
	1		2						100								
71	2		3			2.5			100								
								Poorly graded GRAVEL with SAND (GP); dark brown; moist; mostly coarse to fine GRAVEL; some coarse to fine SAND; few low plasticity, low toughness fines.									
	3		4						100								
69	4		5					SEDIMENTARY ROCK (GRAYWACKE), reddish-orangish brown, intensely to moderately weathered, moderately hard, intensely fractured, fine-medium grained; No bedding observed.	100								
	5		6						100								
67	6		7						100								
	7		8					SEDIMENTARY ROCK (CLAYSTONE), fine-grained, dark gray, slightly weathered, moderately hard, intensely to moderately fractured, No bedding observed.	100								
65	8							Bottom of borehole at 8.0 ft bgs									
	9																

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PROJECT NUMBER: 19-514.1
PROJECT: Fort Bragg Raw Water Line
TEST PIT: T-20-006
ENTRY BY: MCC
CHECKED BY: KKL

LOG OF BORING T-20-007

PROJECT NO: 19-514.1
PROJECT: Fort Bragg Raw Water Line
LOCATION: Fort Bragg, CA
COUNTY: Mendocino
CLIENT: Coleman Engineering
LOGGED BY: MCC/BJU
DEPTH OF BORING: 8(ft)

BEGIN DATE: 6/11/2020
COMPLETION DATE: 6/11/2020
SURFACE ELEVATION: 294.2(ft)
SURFACE CONDITION: Soil
WATER DEPTH: Not Encountered
READING TAKEN: 6/11/2020
HAMMER EFFICIENCY: N/A(%)

DRILLING CONTRACTOR: Jerry Beaty
DRILLING METHOD: Test Pit
DRILL RIG: Backhoe
HAMMER TYPE: N/A
SAMPLER TYPE & SIZE: BULK
BOREHOLE DIAMETER: N/A(in.)
BACKFILL METHOD: Native soil

FIELD									LABORATORY							
ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD / CASING DEPTH	REMARKS
			1					Poorly graded SAND (SP); gray; moist; few coarse to fine GRAVEL; mostly coarse to fine SAND; trace cobbles.	100								
	1		2						100								
292	2		3			4.5		Weak cementation; no gravel.	100								
	3		4					Dark brown; gray; medium to fine SAND.	100								
290	4		5					Reddish brown; moderate cementation.	100								
	5		6					Orange.	100								
288	6		7						100								
	7		8					Orange; yellowish-brown.	100								
286	8							Bottom of borehole at 8.0 ft bgs									
	9																

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PROJECT NUMBER: 19-514.1
PROJECT: Fort Bragg Raw Water Line
TEST PIT: T-20-007
ENTRY BY: MCC
CHECKED BY: KKL SHEET 1 of 1

LOG OF BORING T-20-008

PROJECT NO: 19-514.1
PROJECT: Fort Bragg Raw Water Line
LOCATION: Fort Bragg, CA
COUNTY: Mendocino
CLIENT: Coleman Engineering
LOGGED BY: MCC/BJU
DEPTH OF BORING: 8(ft)

BEGIN DATE: 6/11/2020
COMPLETION DATE: 6/11/2020
SURFACE ELEVATION: 299.5(ft)
SURFACE CONDITION: Soil
WATER DEPTH: Not Encountered
READING TAKEN: 6/11/2020
HAMMER EFFICIENCY: N/A(%)

DRILLING CONTRACTOR: Jerry Beaty
DRILLING METHOD: Test Pit
DRILL RIG: Backhoe
HAMMER TYPE: N/A
SAMPLER TYPE & SIZE: BULK
BOREHOLE DIAMETER: N/A(in.)
BACKFILL METHOD: Native soil

FIELD									LABORATORY							
ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD	CASING DEPTH	REMARKS
			1					Poorly graded SAND with GRAVEL (SP); grayish brown; moist; some coarse to fine GRAVEL; mostly coarse to fine SAND; few low plasticity, low toughness fines.	100									
	1		2						100									
								Poorly graded SAND with CLAY (SP-SC); gray; moist; mostly fine SAND; some low plasticity, low toughness fines; moderate cementation.										
298	2		3						100									
								Poorly graded SAND (SP); gray; moist; mostly medium to fine SAND; few low plasticity, low toughness fines; moderate cementation.										
	3		4						100						13			
296	4		5					Multicolored; orange-ish brown; gray.	100									
	5		6						100									
								Poorly graded SAND with CLAY (SP-SC); multicolored; orange-ish brown; gray; light yellowish brown; moist; mostly medium to fine SAND; some low plasticity, low toughness fines; moderate cementation.										
294	6		7						100									
								Poorly graded SAND (SP); orange-ish brown; moist; mostly medium SAND; moderate cementation.										
	7		8						100									
292	8							Bottom of borehole at 8.0 ft bgs										
	9																	

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PROJECT NUMBER: 19-514.1
PROJECT: Fort Bragg Raw Water Line
TEST PIT: T-20-008
ENTRY BY: MCC
CHECKED BY: KKL SHEET 1 of 1

LOG OF BORING HA-20-011

PROJECT NO: 19-514.1
PROJECT: Fort Bragg Raw Water Line
LOCATION: Fort Bragg, CA
COUNTY: Mendocino
CLIENT: Coleman Engineering
LOGGED BY: MCC/BJU
DEPTH OF BORING: 5(ft)

BEGIN DATE: 6/11/2020
COMPLETION DATE: 6/11/2020
SURFACE ELEVATION: 294.5(ft)
SURFACE CONDITION: Soil
WATER DEPTH: Not Encountered
READING TAKEN: 6/11/2020
HAMMER EFFICIENCY: N/A(%)

DRILLING CONTRACTOR: N/A
DRILLING METHOD: Hand Auger
DRILL RIG: N/A
HAMMER TYPE: N/A
SAMPLER TYPE & SIZE: BULK
BOREHOLE DIAMETER: 6 inches
BACKFILL METHOD: Native soil

FIELD									LABORATORY							
ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD / CASING DEPTH	REMARKS
			1					Poorly graded SAND with SILT (SP-SM); dark brown; dry to moist; mostly medium to fine SAND; few fines; trace rootlets.	100							
	1		2					CLAYEY SAND (SC); yellowish brown; moist; mostly medium to fine SAND; little fines; trace rootlets.	100							
293	2																
			3					SANDY lean CLAY (CL); yellowish brown; moist; some medium to fine SAND; mostly fines; `.	100		24	49				
	3																
								CLAYEY SAND (SC); light reddish brown; moist; mostly medium to fine SAND; some fines.								
291	4																
	5							Bottom of borehole at 5.0 ft bgs								

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PROJECT NUMBER: 19-514.1
PROJECT: Fort Bragg Raw Water Line
BORING: HA-20-011
ENTRY BY: MCC
CHECKED BY: KKL SHEET 1 of 1

LOG OF BORING HA-20-013

PROJECT NO: 19-514.1
PROJECT: Fort Bragg Raw Water Line
LOCATION: Fort Bragg, CA
COUNTY: Mendocino
CLIENT: Coleman Engineering
LOGGED BY: MCC/BJU
DEPTH OF BORING: 3(ft)

BEGIN DATE: 6/11/2020
COMPLETION DATE: 6/11/2020
SURFACE ELEVATION: 286.8(ft)
SURFACE CONDITION: Soil
WATER DEPTH: Not Encountered
READING TAKEN: 6/11/2020
HAMMER EFFICIENCY: N/A(%)

DRILLING CONTRACTOR: N/A
DRILLING METHOD: Hand Auger
DRILL RIG: N/A
HAMMER TYPE: N/A
SAMPLER TYPE & SIZE: BULK
BOREHOLE DIAMETER: 6 inches
BACKFILL METHOD: Native soil

ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	LABORATORY: PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD	CASING DEPTH	REMARKS
			1					CLAYEY SAND (SC); light brown; moist; mostly medium to fine SAND; little fines.	100									
	1		2					SANDY SILT (ML); very dark brown; moist; some SAND; mostly fines; trace rootlets.	100									
			3						100									
285	2		4					Lean CLAY with SAND (CL); multicolored; light brown; strong brown; gray; moist; little fine SAND; mostly fines.	100									
			5						100									
								Poorly graded SAND with SILT (SP-SM); brown; dry to moist; mostly medium to fine SAND; few fines.										
	3							Bottom of borehole at 3.0 ft bgs Auger refusal										
283	4																	
	5																	

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PROJECT NUMBER: 19-514.1
PROJECT: Fort Bragg Raw Water Line
BORING: HA-20-013
ENTRY BY: MCC
CHECKED BY: KKL SHEET 1 of 1

LOG OF BORING HA-20-014

PROJECT NO: 19-514.1
PROJECT: Fort Bragg Raw Water Line
LOCATION: Fort Bragg, CA
COUNTY: Mendocino
CLIENT: Coleman Engineering
LOGGED BY: MCC/BJU
DEPTH OF BORING: 3(ft)

BEGIN DATE: 6/11/2020
COMPLETION DATE: 6/11/2020
SURFACE ELEVATION: 285.2(ft)
SURFACE CONDITION: Soil
WATER DEPTH: Not Encountered
READING TAKEN: 6/11/2020
HAMMER EFFICIENCY: N/A(%)

DRILLING CONTRACTOR: N/A
DRILLING METHOD: Hand Auger
DRILL RIG: N/A
HAMMER TYPE: N/A
SAMPLER TYPE & SIZE: BULK
BOREHOLE DIAMETER: 6 inches
BACKFILL METHOD: Native soil

ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	LABORATORY: PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD	CASING DEPTH	REMARKS
								SILTY SAND (SM); very dark brown; moist; mostly fine SAND; little fines; some rootlets.										
			1						100									
	1		2					CLAYEY SAND (SC); light brown; moist; mostly fine SAND; some fines; weak cementation.	100									
			3					SANDY lean CLAY (CL); strong brown; moist; some medium to fine SAND; mostly fines; moderate cementation.	100									
283	2																	
			4						100									
	3							Bottom of borehole at 3.0 ft bgs Auger refusal										
281	4																	
	5																	

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PROJECT NUMBER: 19-514.1
PROJECT: Fort Bragg Raw Water Line
BORING: HA-20-014
ENTRY BY: MCC
CHECKED BY: KKL SHEET 1 of 1

LOG OF BORING HA-20-015

PROJECT NO: 19-514.1
PROJECT: Fort Bragg Raw Water Line
LOCATION: Fort Bragg, CA
COUNTY: Mendocino
CLIENT: Coleman Engineering
LOGGED BY: MCC/BJU
DEPTH OF BORING: 5(ft)

BEGIN DATE: 6/11/2020
COMPLETION DATE: 6/11/2020
SURFACE ELEVATION: 229.3(ft)
SURFACE CONDITION: Soil
WATER DEPTH: Not Encountered
READING TAKEN: 6/11/2020
HAMMER EFFICIENCY: N/A(%)

DRILLING CONTRACTOR: N/A
DRILLING METHOD: Hand Auger
DRILL RIG: N/A
HAMMER TYPE: N/A
SAMPLER TYPE & SIZE: BULK
BOREHOLE DIAMETER: 6 inches
BACKFILL METHOD: Native soil

FIELD										LABORATORY							
ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD	CASING DEPTH	REMARKS
			1					Poorly graded SAND (SP); light brown; dry; mostly coarse to fine SAND; trace fines; weak cementation.	100								
	1		2					CLAYEY SAND (SC); light yellowish brown; moist; mostly coarse to fine SAND; little fines; moderate cementation.	100								
227	2																	
	3		3					Yellowish brown; dry to moist; medium to fine SAND; some fines.	100						22			
225	4																	
	5							Bottom of borehole at 5.0 ft bgs										

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PROJECT NUMBER: 19-514.1
PROJECT: Fort Bragg Raw Water Line
BORING: HA-20-015
ENTRY BY: MCC
CHECKED BY: KKL SHEET 1 of 1

LOG OF BORING HA-20-016

PROJECT NO: 19-514.1
PROJECT: Fort Bragg Raw Water Line
LOCATION: Fort Bragg, CA
COUNTY: Mendocino
CLIENT: Coleman Engineering
LOGGED BY: MCC/BJU
DEPTH OF BORING: 1.5(ft)

BEGIN DATE: 6/11/2020
COMPLETION DATE: 6/11/2020
SURFACE ELEVATION: 163(ft)
SURFACE CONDITION: Soil
WATER DEPTH: Not Encountered
READING TAKEN: 6/11/2020
HAMMER EFFICIENCY: N/A(%)

DRILLING CONTRACTOR: N/A
DRILLING METHOD: Hand Auger
DRILL RIG: N/A
HAMMER TYPE: N/A
SAMPLER TYPE & SIZE: BULK
BOREHOLE DIAMETER: 6 inches
BACKFILL METHOD: Native soil

FIELD										LABORATORY							
ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD	CASING DEPTH	REMARKS
			1					SANDY ORGANIC SOIL (OL/OH); light olive brown; dry to moist; little fine SAND; mostly organic soil.	100									
	1		2					CLAYEY SAND (SC); light olive brown; dry to moist; mostly fine SAND; little fines; trace rootlets.	100									
								Bottom of borehole at 1.5 ft bgs Auger refusal										
161	2																	
	3																	
159	4																	
	5																	

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PROJECT NUMBER: 19-514.1
PROJECT: Fort Bragg Raw Water Line
BORING: HA-20-016
ENTRY BY: MCC
CHECKED BY: KKL

LOG OF BORING HA-20-017

PROJECT NO: 19-514.1
PROJECT: Fort Bragg Raw Water Line
LOCATION: Fort Bragg, CA
COUNTY: Mendocino
CLIENT: Coleman Engineering
LOGGED BY: MCC/BJU
DEPTH OF BORING: 4.5(ft)

BEGIN DATE: 6/11/2020
COMPLETION DATE: 6/11/2020
SURFACE ELEVATION: 209.2(ft)
SURFACE CONDITION: Soil
WATER DEPTH: Not Encountered
READING TAKEN: 6/11/2020
HAMMER EFFICIENCY: N/A(%)

DRILLING CONTRACTOR: N/A
DRILLING METHOD: Hand Auger
DRILL RIG: N/A
HAMMER TYPE: N/A
SAMPLER TYPE & SIZE: BULK
BOREHOLE DIAMETER: 6 inches
BACKFILL METHOD: Native soil

FIELD										LABORATORY							
ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD	CASING DEPTH	REMARKS
			1					SILTY SAND (SM); light gray; dry to moist; some fine SAND; some fines; weak cementation.	100									
	1		2					Lean CLAY with SAND (CL); light gray; moist; little fine SAND; mostly fines.	100									
207	2																	
	3		3					CLAYEY SAND (SC); light gray; dry to moist; mostly fine SAND; some fines; weak cementation.	100						43			
205	4		4						100									
								Bottom of borehole at 4.5 ft bgs Auger refusal										
	5																	

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PROJECT NUMBER: 19-514.1
PROJECT: Fort Bragg Raw Water Line
BORING: HA-20-017
ENTRY BY: MCC
CHECKED BY: KKL SHEET 1 of 1

LOG OF BORING HA-20-018

PROJECT NO: 19-514.1
PROJECT: Fort Bragg Raw Water Line
LOCATION: Fort Bragg, CA
COUNTY: Mendocino
CLIENT: Coleman Engineering
LOGGED BY: MCC/BJU
DEPTH OF BORING: 5(ft)

BEGIN DATE: 6/11/2020
COMPLETION DATE: 6/11/2020
SURFACE ELEVATION: 273.3(ft)
SURFACE CONDITION: Soil
WATER DEPTH: Not Encountered
READING TAKEN: 6/11/2020
HAMMER EFFICIENCY: N/A(%)

DRILLING CONTRACTOR: N/A
DRILLING METHOD: Hand Auger
DRILL RIG: N/A
HAMMER TYPE: N/A
SAMPLER TYPE & SIZE: BULK
BOREHOLE DIAMETER: 6 inches
BACKFILL METHOD: Native soil

FIELD										LABORATORY							
ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD	CASING DEPTH	REMARKS
								CLAYEY SAND (SC); multicolored; yellowish-brown; brown; moist; mostly coarse to fine SAND; some fines; trace rootlets.										
			1						100						38			
	1																	
271	2																	
	3																	
269	4		2						100									
	5							Bottom of borehole at 5.0 ft bgs										

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PROJECT NUMBER: 19-514.1
PROJECT: Fort Bragg Raw Water Line
BORING: HA-20-018
ENTRY BY: MCC
CHECKED BY: KKL SHEET 1 of 1

LOG OF BORING HA-20-022

PROJECT NO: 19-514.1
PROJECT: Fort Bragg Raw Water Line
LOCATION: Fort Bragg, CA
COUNTY: Mendocino
CLIENT: Coleman Engineering
LOGGED BY: MCC/BJU
DEPTH OF BORING: 5(ft)

BEGIN DATE: 6/8/2020
COMPLETION DATE: 6/8/2020
SURFACE ELEVATION: 46.2(ft)
SURFACE CONDITION: Soil
WATER DEPTH: Not Encountered
READING TAKEN: 6/8/2020
HAMMER EFFICIENCY: N/A(%)

DRILLING CONTRACTOR: N/A
DRILLING METHOD: Hand Auger
DRILL RIG: N/A
HAMMER TYPE: N/A
SAMPLER TYPE & SIZE: BULK
BOREHOLE DIAMETER: 6 inches
BACKFILL METHOD: Native soil

FIELD										LABORATORY							
ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD	CASING DEPTH	REMARKS
			1					CLAYEY GRAVEL with SAND (GC); brown; moist; mostly coarse to fine GRAVEL; some coarse to fine SAND; little fines.	100									
			2						100									
	1		3					Little SAND; some fines.	100									
			4					SANDY lean CLAY with GRAVEL (CL); brown; moist; little coarse to fine GRAVEL; some coarse to fine SAND; mostly fines.	100									
44	2																	
			5						100									
	3																	
42	4																	
	5							Bottom of borehole at 5.0 ft bgs										

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PROJECT NUMBER: 19-514.1
PROJECT: Fort Bragg Raw Water Line
BORING: HA-20-022
ENTRY BY: MCC
CHECKED BY: KKL SHEET 1 of 1

LOG OF BORING HA-20-023

PROJECT NO: 19-514.1
PROJECT: Fort Bragg Raw Water Line
LOCATION: Fort Bragg, CA
COUNTY: Mendocino
CLIENT: Coleman Engineering
LOGGED BY: MCC/BJU
DEPTH OF BORING: 2(ft)

BEGIN DATE: 6/8/2020
COMPLETION DATE: 6/8/2020
SURFACE ELEVATION: 16.0(ft)
SURFACE CONDITION: Soil
WATER DEPTH: Not Encountered
READING TAKEN: 6/8/2020
HAMMER EFFICIENCY: N/A(%)

DRILLING CONTRACTOR: N/A
DRILLING METHOD: Hand Auger
DRILL RIG: N/A
HAMMER TYPE: N/A
SAMPLER TYPE & SIZE: BULK
BOREHOLE DIAMETER: 6 inches
BACKFILL METHOD: Native soil

FIELD										LABORATORY							
ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD	CASING DEPTH	REMARKS
								SILTY SAND (SM); dark brown; dry to moist; mostly fine SAND; some fines.										
	1		1						100									
								Poorly graded SAND with SILT (SP-SM); dark brown; dry to moist; mostly fine SAND; few fines.	100									
14	2		2					Bottom of borehole at 2.0 ft bgs Auger refusal										
	3																	
12	4																	
	5																	

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PROJECT NUMBER: 19-514.1
PROJECT: Fort Bragg Raw Water Line
BORING: HA-20-023
ENTRY BY: MCC
CHECKED BY: KKL SHEET 1 of 1

LOG OF BORING HA-20-024

PROJECT NO: 19-514.1
PROJECT: Fort Bragg Raw Water Line
LOCATION: Fort Bragg, CA
COUNTY: Mendocino
CLIENT: Coleman Engineering
LOGGED BY: MCC/BJU
DEPTH OF BORING: 5(ft)

BEGIN DATE: 6/9/2020
COMPLETION DATE: 6/9/2020
SURFACE ELEVATION: (ft)
SURFACE CONDITION: Soil
WATER DEPTH: Not Encountered
READING TAKEN: 6/9/2020
HAMMER EFFICIENCY: N/A(%)

DRILLING CONTRACTOR: N/A
DRILLING METHOD: Hand Auger
DRILL RIG: N/A
HAMMER TYPE: N/A
SAMPLER TYPE & SIZE: BULK
BOREHOLE DIAMETER: 6 inches
BACKFILL METHOD: Native soil

FIELD									LABORATORY							
ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD / CASING DEPTH	REMARKS
	0		1					SILT (ML); brown; moist to wet; few fine SAND; mostly fines.	100								
	1																
	2																
	3		2						100								
	4																
	5							Bottom of borehole at 5.0 ft bgs									

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PROJECT NUMBER: 19-514.1
PROJECT: Fort Bragg Raw Water Line
BORING: HA-20-024
ENTRY BY: MCC
CHECKED BY: KKL SHEET 1 of 1

LOG OF BORING HA-20-025

PROJECT NO: 19-514.1
PROJECT: Fort Bragg Raw Water Line
LOCATION: Fort Bragg, CA
COUNTY: Mendocino
CLIENT: Coleman Engineering
LOGGED BY: MCC/BJU
DEPTH OF BORING: 2.5(ft)

BEGIN DATE: 6/9/2020
COMPLETION DATE: 6/9/2020
SURFACE ELEVATION: 17.8(ft)
SURFACE CONDITION: Soil
WATER DEPTH: Not Encountered
READING TAKEN: 6/9/2020
HAMMER EFFICIENCY: N/A(%)

DRILLING CONTRACTOR: N/A
DRILLING METHOD: Hand Auger
DRILL RIG: N/A
HAMMER TYPE: N/A
SAMPLER TYPE & SIZE: BULK
BOREHOLE DIAMETER: 6 inches
BACKFILL METHOD: Native soil

FIELD									LABORATORY								
ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD	CASING DEPTH	REMARKS
			1					CLAYEY SAND with GRAVEL (SC); brown; moist; some coarse to fine GRAVEL; mostly coarse to fine SAND; little fines.	100								
	1																	
			2					Little fine GRAVEL; some fines.	100								
16	2																	
								Bottom of borehole at 2.5 ft bgs									
								Auger refusal									
	3																	
14	4																	
	5																	

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PROJECT NUMBER: 19-514.1
PROJECT: Fort Bragg Raw Water Line
BORING: HA-20-025
ENTRY BY: MCC
CHECKED BY: KKL SHEET 1 of 1

LOG OF BORING HA-20-026

PROJECT NO: 19-514.1
PROJECT: Fort Bragg Raw Water Line
LOCATION: Fort Bragg, CA
COUNTY: Mendocino
CLIENT: Coleman Engineering
LOGGED BY: MCC/BJU
DEPTH OF BORING: 2.5(ft)

BEGIN DATE: 6/9/2020
COMPLETION DATE: 6/9/2020
SURFACE ELEVATION: 37.2(ft)
SURFACE CONDITION: Soil
WATER DEPTH: Not Encountered
READING TAKEN: 6/9/2020
HAMMER EFFICIENCY: N/A(%)

DRILLING CONTRACTOR: N/A
DRILLING METHOD: Hand Auger
DRILL RIG: N/A
HAMMER TYPE: N/A
SAMPLER TYPE & SIZE: BULK
BOREHOLE DIAMETER: 6 inches
BACKFILL METHOD: Native soil

FIELD									LABORATORY							
ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD / CASING DEPTH	REMARKS
			1					SILT (ML); dark brown; moist to wet; few coarse to fine SAND; mostly fines.	100							
	1		2					Lean CLAY (CL); multicoolored; brown; light brown; moist to wet; few coarse to fine SAND; mostly fines.	100							
35	2															
								Bottom of borehole at 2.5 ft bgs Auger refusal								
33	3															
	4															
	5															

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PROJECT NUMBER: 19-514.1
PROJECT: Fort Bragg Raw Water Line
BORING: HA-20-026
ENTRY BY: MCC
CHECKED BY: KKL SHEET 1 of 1

LOG OF BORING HA-20-027

PROJECT NO: 19-514.1
PROJECT: Fort Bragg Raw Water Line
LOCATION: Fort Bragg, CA
COUNTY: Mendocino
CLIENT: Coleman Engineering
LOGGED BY: MCC/BJU
DEPTH OF BORING: 4.5(ft)

BEGIN DATE: 6/9/2020
COMPLETION DATE: 6/9/2020
SURFACE ELEVATION: 184.2(ft)
SURFACE CONDITION: Soil
WATER DEPTH: Not Encountered
READING TAKEN: 6/9/2020
HAMMER EFFICIENCY: N/A(%)

DRILLING CONTRACTOR: N/A
DRILLING METHOD: Hand Auger
DRILL RIG: N/A
HAMMER TYPE: N/A
SAMPLER TYPE & SIZE: BULK
BOREHOLE DIAMETER: 6 inches
BACKFILL METHOD: Native soil

FIELD									LABORATORY								
ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD	CASING DEPTH	REMARKS
								SANDY SILT (ML); brown; dry to moist; some coarse to fine SAND; mostly fines.										
			1						100									
	1																	
182	2																	
			2					CLAYEY SAND (SC); reddish brown; dry to moist; mostly coarse to fine SAND; some fines; trace rootlets.	100									
	3																	
180	4																	
								Bottom of borehole at 4.5 ft bgs Auger refusal										
	5																	

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PROJECT NUMBER: 19-514.1
PROJECT: Fort Bragg Raw Water Line
BORING: HA-20-027
ENTRY BY: MCC
CHECKED BY: KKL SHEET 1 of 1

LOG OF BORING HA-20-028

PROJECT NO: 19-514.1
PROJECT: Fort Bragg Raw Water Line
LOCATION: Fort Bragg, CA
COUNTY: Mendocino
CLIENT: Coleman Engineering
LOGGED BY: MCC/BJU
DEPTH OF BORING: 4.75(ft)

BEGIN DATE: 6/9/2020
COMPLETION DATE: 6/9/2020
SURFACE ELEVATION: 233.4(ft)
SURFACE CONDITION: Soil
WATER DEPTH: Not Encountered
READING TAKEN: 6/9/2020
HAMMER EFFICIENCY: N/A(%)

DRILLING CONTRACTOR: N/A
DRILLING METHOD: Hand Auger
DRILL RIG: N/A
HAMMER TYPE: N/A
SAMPLER TYPE & SIZE: BULK
BOREHOLE DIAMETER: 6 inches
BACKFILL METHOD: Native soil

FIELD										LABORATORY							
ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD	CASING DEPTH	REMARKS
			1					CLAYEY SAND (SC); light reddish brown; dry to moist; few fine GRAVEL; mostly coarse to fine SAND; little fines.	100									
	1		2					Lean CLAY with SAND (CL); strong brown; moist; some medium to fine SAND; mostly fines.	100									
231	2																	
	3							Gray.										
			3					SANDY SILT (ML); multicolored; strong brown; light gray;; dry to moist; some medium to fine SAND; mostly fines.	100		28	38					
229	4																	
								Bottom of borehole at 4.8 ft bgs										
	5							Auger refusal										

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PROJECT NUMBER: 19-514.1
PROJECT: Fort Bragg Raw Water Line
BORING: HA-20-028
ENTRY BY: MCC
CHECKED BY: KKL SHEET 1 of 1

LOG OF BORING HA-20-029

PROJECT NO: 19-514.1
PROJECT: Fort Bragg Raw Water Line
LOCATION: Fort Bragg, CA
COUNTY: Mendocino
CLIENT: Coleman Engineering
LOGGED BY: MCC/BJU
DEPTH OF BORING: 4(ft)

BEGIN DATE: 6/9/2020
COMPLETION DATE: 6/9/2020
SURFACE ELEVATION: 264.6(ft)
SURFACE CONDITION: Soil
WATER DEPTH: Not Encountered
READING TAKEN: 6/9/2020
HAMMER EFFICIENCY: N/A(%)

DRILLING CONTRACTOR: N/A
DRILLING METHOD: Hand Auger
DRILL RIG: N/A
HAMMER TYPE: N/A
SAMPLER TYPE & SIZE: BULK
BOREHOLE DIAMETER: 6 inches
BACKFILL METHOD: Native soil

ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	LABORATORY: PLASTIC LIMIT	LABORATORY: LIQUID LIMIT	LABORATORY: MOISTURE (%)	LABORATORY: D. DENSITY (PCF)	LABORATORY: % PASSING 200 SIEVE	DRILL METHOD	CASING DEPTH	REMARKS
			1					CLAYEY SAND (SC); light olive brown; dry to moist; trace coarse to fine GRAVEL; mostly medium to fine SAND; little fines; trace rootlets.	100									
			2					SANDY lean CLAY (CL); olive brown; moist; little medium to fine SAND; mostly fines.	100									
	1																	
			3					Lean CLAY with SAND (CL); olive brown; moist; some medium to fine SAND; mostly fines.	100									
263	2		4					Lean CLAY (CL); multicolored; light olive brown; strong brown; moist; few medium to fine SAND; mostly fines.	100									Chemical Analysis pH = 4.26 Min. Res. = 10990 ohm-cm Chloride = 8.7 ppm Sulfate = 3.1 ppm
	3																	
261	4							Bottom of borehole at 4.0 ft bgs Auger refusal										
	5																	

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PROJECT NUMBER: 19-514.1
PROJECT: Fort Bragg Raw Water Line
BORING: HA-20-029
ENTRY BY: MCC
CHECKED BY: KKL SHEET 1 of 1

LOG OF BORING HA-20-030

PROJECT NO: 19-514.1
PROJECT: Fort Bragg Raw Water Line
LOCATION: Fort Bragg, CA
COUNTY: Mendocino
CLIENT: Coleman Engineering
LOGGED BY: MCC/BJU
DEPTH OF BORING: 5(ft)

BEGIN DATE: 6/9/2020
COMPLETION DATE: 6/9/2020
SURFACE ELEVATION: 273.3(ft)
SURFACE CONDITION: Soil
WATER DEPTH: Not Encountered
READING TAKEN: 6/9/2020
HAMMER EFFICIENCY: N/A(%)

DRILLING CONTRACTOR: N/A
DRILLING METHOD: Hand Auger
DRILL RIG: N/A
HAMMER TYPE: N/A
SAMPLER TYPE & SIZE: BULK
BOREHOLE DIAMETER: 6 inches
BACKFILL METHOD: Native soil

FIELD										LABORATORY							
ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD	CASING DEPTH	REMARKS
								Lean CLAY with SAND (CL); olive brown; dry to moist; little medium to fine SAND; mostly fines; trace rootlets.										
			1						100									
	1		2					CLAYEY SAND (SC); yellowish brown; moist; mostly medium to fine SAND; little fines; weak cementation.	100									
			3					Lean CLAY with SAND (CL); multicolored; light gray; brown; moist; little fine SAND; mostly fines.	100									
271	2		4						100		23	47						
	3																	
269	4		5					Poorly graded SAND with CLAY (SP-SC); orangeish brown; moist; mostly medium to fine SAND; few fines; moderate cementation.	100									
	5							Bottom of borehole at 5.0 ft bgs										

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PROJECT NUMBER: 19-514.1
PROJECT: Fort Bragg Raw Water Line
BORING: HA-20-030
ENTRY BY: MCC
CHECKED BY: KKL SHEET 1 of 1

LOG OF BORING HA-20-031

PROJECT NO: 19-514.1
PROJECT: Fort Bragg Raw Water Line
LOCATION: Fort Bragg, CA
COUNTY: Mendocino
CLIENT: Coleman Engineering
LOGGED BY: MCC/BJU
DEPTH OF BORING: 3(ft)

BEGIN DATE: 6/9/2020
COMPLETION DATE: 6/9/2020
SURFACE ELEVATION: (ft)
SURFACE CONDITION: Soil
WATER DEPTH: Not Encountered
READING TAKEN: 6/9/2020
HAMMER EFFICIENCY: N/A(%)

DRILLING CONTRACTOR: N/A
DRILLING METHOD: Hand Auger
DRILL RIG: N/A
HAMMER TYPE: N/A
SAMPLER TYPE & SIZE: BULK
BOREHOLE DIAMETER: 6 inches
BACKFILL METHOD: Native soil

FIELD									LABORATORY							
ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD / CASING DEPTH	REMARKS
	0		1					CLAYEY SAND (SC); light olive brown; dry to moist; mostly medium to fine SAND; some fines; moderate cementation; trace rootlets.	100								
	1							No cementation.									
			2						100								
			3					CLAYEY SAND with GRAVEL (SC); light brown; dry to moist; little coarse to fine GRAVEL; mostly coarse to fine SAND; little fines; trace rootlets.	100								
	2		4					SILTY SAND (SM); gray; dry to moist; mostly fine SAND; some fines.	100								
			5					CLAYEY SAND (SC); light olive brown; dry to moist; mostly medium to fine SAND; some fines; moderate cementation.	100								
	3							Bottom of borehole at 3.0 ft bgs Auger refusal									
	4																
	5																

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PROJECT NUMBER: 19-514.1
PROJECT: Fort Bragg Raw Water Line
BORING: HA-20-031
ENTRY BY: MCC
CHECKED BY: KKL SHEET 1 of 1

LOG OF BORING HA-20-032

PROJECT NO: 19-514.1
PROJECT: Fort Bragg Raw Water Line
LOCATION: Fort Bragg, CA
COUNTY: Mendocino
CLIENT: Coleman Engineering
LOGGED BY: MCC/BJU
DEPTH OF BORING: 3.5(ft)

BEGIN DATE: 6/9/2020
COMPLETION DATE: 6/9/2020
SURFACE ELEVATION: 136.6(ft)
SURFACE CONDITION: Soil
WATER DEPTH: Not Encountered
READING TAKEN: 6/9/2020
HAMMER EFFICIENCY: N/A(%)

DRILLING CONTRACTOR: N/A
DRILLING METHOD: Hand Auger
DRILL RIG: N/A
HAMMER TYPE: N/A
SAMPLER TYPE & SIZE: BULK
BOREHOLE DIAMETER: 6 inches
BACKFILL METHOD: Native soil

FIELD										LABORATORY							
ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD	CASING DEPTH	REMARKS
			1					CLAYEY SAND (SC); strong brown; dry to moist; mostly coarse to fine SAND; some fines; trace rootlets.	100									
135	2		2					Medium to fine SAND; moderate cementation.	100						30			
								Bottom of borehole at 3.5 ft bgs Auger refusal										
133	4																	

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PROJECT NUMBER: 19-514.1
PROJECT: Fort Bragg Raw Water Line
BORING: HA-20-032
ENTRY BY: MCC
CHECKED BY: KKL SHEET 1 of 1

LOG OF BORING HA-20-033

PROJECT NO: 19-514.1
PROJECT: Fort Bragg Raw Water Line
LOCATION: Fort Bragg, CA
COUNTY: Mendocino
CLIENT: Coleman Engineering
LOGGED BY: MCC/BJU
DEPTH OF BORING: 2(ft)

BEGIN DATE: 6/11/2020
COMPLETION DATE: 6/11/2020
SURFACE ELEVATION: 138.6(ft)
SURFACE CONDITION: Soil
WATER DEPTH: Not Encountered
READING TAKEN: 6/11/2020
HAMMER EFFICIENCY: N/A(%)

DRILLING CONTRACTOR: N/A
DRILLING METHOD: Hand Auger
DRILL RIG: N/A
HAMMER TYPE: N/A
SAMPLER TYPE & SIZE: BULK
BOREHOLE DIAMETER: 6 inches
BACKFILL METHOD: Native soil

ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	LABORATORY: PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD	CASING DEPTH	REMARKS
								SANDY ORGANIC SOIL (OL/OH); very dark brown; moist; some fine SAND; mostly organic soil.										
			1						100									
	1																	
			2					CLAYEY GRAVEL with SAND (GC); brown; dry to moist; mostly coarse GRAVEL; some coarse to fine SAND; little fines.	100									Hard to auger
								CLAYEY SAND with GRAVEL (SC); brown; dry to moist; mostly coarse to fine SAND.										
			3						100									
137	2							Bottom of borehole at 2.0 ft bgs Auger refusal										
	3																	
135	4																	
	5																	

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PROJECT NUMBER: 19-514.1
PROJECT: Fort Bragg Raw Water Line
BORING: HA-20-033
ENTRY BY: MCC
CHECKED BY: KKL SHEET 1 of 1

LOG OF BORING HA-20-034

PROJECT NO: 19-514.1
PROJECT: Fort Bragg Raw Water Line
LOCATION: Fort Bragg, CA
COUNTY: Mendocino
CLIENT: Coleman Engineering
LOGGED BY: MCC/BJU
DEPTH OF BORING: 5(ft)

BEGIN DATE: 6/11/2020
COMPLETION DATE: 6/11/2020
SURFACE ELEVATION: 206.5(ft)
SURFACE CONDITION: Soil
WATER DEPTH: Not Encountered
READING TAKEN: 6/11/2020
HAMMER EFFICIENCY: N/A(%)

DRILLING CONTRACTOR: N/A
DRILLING METHOD: Hand Auger
DRILL RIG: N/A
HAMMER TYPE: N/A
SAMPLER TYPE & SIZE: BULK
BOREHOLE DIAMETER: 6 inches
BACKFILL METHOD: Native soil

FIELD										LABORATORY							
ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD	CASING DEPTH	REMARKS
			1					Poorly graded GRAVEL with CLAY (GP-GC); dark brown; dry to moist; mostly coarse to fine GRAVEL; some coarse to fine SAND; few fines; trace organics.	100								
	1		2					SANDY SILT (ML); multicolored; gray; light gray; moist; some SAND; mostly fines.	100								
			3						100									
205	2																	
			4					Lean CLAY (CL); multicolored; gray; strong brow; moist; few fine SAND; mostly fines.	100								Chemical Analysis pH = 3.99 Min. Res. = 4290 ohm-cm Chloride = 10.2 ppm Sulfate = 15.1 ppm
	3		5					SILTY GRAVEL (GM); light olive brown; dry to moist; mostly coarse to fine GRAVEL; some fines; trace rootlets.	100								
			6					Lean CLAY with SAND (CL); multicolored; gray; orange; moist; little fine SAND; mostly fines.	100		13	26					
203	4																	
	5							Bottom of borehole at 5.0 ft bgs									

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PROJECT NUMBER: 19-514.1
PROJECT: Fort Bragg Raw Water Line
BORING: HA-20-034
ENTRY BY: MCC
CHECKED BY: KKL SHEET 1 of 1

LOG OF BORING HA-20-035

PROJECT NO: 19-514.1
PROJECT: Fort Bragg Raw Water Line
LOCATION: Fort Bragg, CA
COUNTY: Mendocino
CLIENT: Coleman Engineering
LOGGED BY: MCC/AC
DEPTH OF BORING: 4(ft)

BEGIN DATE: 12/14/2020
COMPLETION DATE: 12/14/2020
SURFACE ELEVATION: 232.9(ft)
SURFACE CONDITION: Soil
WATER DEPTH: Not Encountered
READING TAKEN: 12/14/2020
HAMMER EFFICIENCY: N/A(%)

DRILLING CONTRACTOR: N/A
DRILLING METHOD: Hand Auger
DRILL RIG: N/A
HAMMER TYPE: N/A
SAMPLER TYPE & SIZE: BULK
BOREHOLE DIAMETER: 4 inches
BACKFILL METHOD: Native soil

FIELD										LABORATORY							
ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD	CASING DEPTH	REMARKS
			1					CLAYEY SAND (SC); light brown; moist; trace fine GRAVEL; some fine SAND; mostly fines; trace rootlets.	100									Difficulty augering
	1																	
231	2		2						100									decomposed root
			3					SANDY SILT (ML); light gray; moist; some fine SAND; mostly fines.	100									
	3																	
229	4							Bottom of borehole at 4.0 ft bgs Auger refusal due to high cementation. Difficulty advancing hand auger.									
	5																	

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PROJECT NUMBER: 19-514.1
PROJECT: Fort Bragg Raw Water Line
BORING: HA-20-035
ENTRY BY: MCC
CHECKED BY: KKL SHEET 1 of 1

LOG OF BORING HA-20-036

PROJECT NO: 19-514.1
PROJECT: Fort Bragg Raw Water Line
LOCATION: Fort Bragg, CA
COUNTY: Mendocino
CLIENT: Coleman Engineering
LOGGED BY: MCC/AC
DEPTH OF BORING: 4.5(ft)

BEGIN DATE: 12/14/2020
COMPLETION DATE: 12/14/2020
SURFACE ELEVATION: (ft)
SURFACE CONDITION: Soil
WATER DEPTH: Not Encountered
READING TAKEN: 12/14/2020
HAMMER EFFICIENCY: N/A(%)

DRILLING CONTRACTOR: N/A
DRILLING METHOD: Hand Auger
DRILL RIG: N/A
HAMMER TYPE: N/A
SAMPLER TYPE & SIZE: BULK
BOREHOLE DIAMETER: 4 inches
BACKFILL METHOD: Native soil

FIELD									LABORATORY							
ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD / CASING DEPTH	REMARKS
	0		1					SANDY lean CLAY (CL); tan; moist; trace fine GRAVEL; some fine SAND; mostly fines.	100								2" of mulch on
	1																Hard augering. Encoutering roots until 1.5'
	2		2					SANDY lean CLAY with GRAVEL (CL); light reddish brown; dry to moist; little fine GRAVEL; some coarse to fine SAND; mostly fines.	100								Hard augering. Hole caving.
	3																
	4		3						100								
								Bottom of borehole at 4.5 ft bgs Auger refusal									
	5																

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PROJECT NUMBER: 19-514.1
PROJECT: Fort Bragg Raw Water Line
BORING: HA-20-036
ENTRY BY: MCC
CHECKED BY: KKL SHEET 1 of 1

LOG OF BORING HA-20-037

PROJECT NO: 19-514.1
PROJECT: Fort Bragg Raw Water Line
LOCATION: Fort Bragg, CA
COUNTY: Mendocino
CLIENT: Coleman Engineering
LOGGED BY: MCC/AC
DEPTH OF BORING: 4.5(ft)

BEGIN DATE: 12/14/2020
COMPLETION DATE: 12/14/2020
SURFACE ELEVATION: (ft)
SURFACE CONDITION: Soil
WATER DEPTH: Not Encountered
READING TAKEN: 12/14/2020
HAMMER EFFICIENCY: N/A(%)

DRILLING CONTRACTOR: N/A
DRILLING METHOD: Hand Auger
DRILL RIG: N/A
HAMMER TYPE: N/A
SAMPLER TYPE & SIZE: BULK
BOREHOLE DIAMETER: 4 inches
BACKFILL METHOD: Native soil

FIELD									LABORATORY								
ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD	CASING DEPTH	REMARKS
	0		1					SANDY lean CLAY with GRAVEL (CL); light reddish brown; little GRAVEL; some coarse to fine SAND; mostly fines.	100									Hard augering
	1																	
	2		2						100									
	3																	Softer layer. Hole caving. Difficulty advancing hand auger.
	4		3						100									
	5							Bottom of borehole at 4.5 ft bgs Auger refusal. Hole caved at approximately 2.5 feet.									

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PROJECT NUMBER: 19-514.1
PROJECT: Fort Bragg Raw Water Line
BORING: HA-20-037
ENTRY BY: MCC
CHECKED BY: KKL

LOG OF BORING HA-20-038

PROJECT NO: 19-514.1
PROJECT: Fort Bragg Raw Water Line
LOCATION: Fort Bragg, CA
COUNTY: Mendocino
CLIENT: Coleman Engineering
LOGGED BY: MCC/AC
DEPTH OF BORING: 5(ft)

BEGIN DATE: 12/14/2020
COMPLETION DATE: 12/14/2020
SURFACE ELEVATION: 281.4(ft)
SURFACE CONDITION: Soil
WATER DEPTH: Not Encountered
READING TAKEN: 12/14/2020
HAMMER EFFICIENCY: N/A(%)

DRILLING CONTRACTOR: N/A
DRILLING METHOD: Hand Auger
DRILL RIG: N/A
HAMMER TYPE: N/A
SAMPLER TYPE & SIZE: BULK
BOREHOLE DIAMETER: 4 inches
BACKFILL METHOD: Native soil

FIELD										LABORATORY							
ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD	CASING DEPTH	REMARKS
			1					CLAYEY SAND (SC); light brown; dry to moist; mostly fine SAND; some fines; trace rootlets.	100									
	1																	
			2					Lean CLAY with SAND (CL); gray and reddish brown; moist; little coarse to fine SAND; mostly fines.	100									
279	2																	
	3							Lean CLAY (CL); gray and reddish brown; moist; few fine SAND; mostly fines.										
			3						100									
277	4																	Softer material to auger through.
	5							Bottom of borehole at 5.0 ft bgs										

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PROJECT NUMBER: 19-514.1
PROJECT: Fort Bragg Raw Water Line
BORING: HA-20-038
ENTRY BY: MCC
CHECKED BY: KKL SHEET 1 of 1

APPENDIX III

Laboratory Summary

Laboratory Test Results

Project Name: **City of Fort Bragg Raw Water Pipeline Replacement**
Project No: **19-514.1**
Date: **8/7/2020**

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Laboratory and Field Test Summary

Boring I.D.	Sample I.D.	Sample Type (inch)	Sampled Depth (ft)	Retained Sample Depth (ft)	USCS	Field Blows N (bpf)	SPT Blows N_{60} (bpf)	Moisture/Density			Classification						Strength						Chemical Analysis			
								Dry Density (pcf)	Moist. Content (%)	In-Situ Density (pcf)	Atterberg Limits			Gravel (%)	Sand (%)	Fines (%)	Pocket Pent. (tsf)	Uncon. Comp. (psf)	Direct Shear		Triaxial-UU (Staged)		pH	Minimum Resistivity (ohm-cm)	Chloride Content (ppm)	Sulfate Content (ppm)
											Liquid Limit	Plastic Limit	Plasticity Index						φ (deg)	c (psf)	φ (deg)	c (psf)				
HA-20-001	1	BULK	0.0 - 1.0	0.0 - 0.5	SC	--	--																			
HA-20-001	2	BULK	1.0 - 2.0	1.0 - 1.5	CL	--	--																			
HA-20-001	3	BULK	2.0 - 2.5	2.0 - 2.5	CL	--	--																			
HA-20-001	4	BULK	2.5 - 3.5	2.5 - 3.0	CH	--	--																			
HA-20-001	5	BULK	3.5 - 4.5	3.5 - 4.0	CH	--	--				66	25	41													
HA-20-001	6	BULK	4.5 - 4.8	4.5 - 4.8	CH	--	--																			
HA-20-001	7	BULK	4.8 - 5.0	4.8 - 5.0	SC	--	--																			
HA-20-011	1	BULK	0.0 - 1.0	0.0 - 0.5	SP-SM	--	--																			
HA-20-011	2	BULK	1.0 - 2.5	1.0 - 1.5	SC	--	--																			
HA-20-011	3	BULK	2.5 - 3.5	2.5 - 3.0	CL	--	--				49	24	25													
HA-20-013	1	BULK	0.0 - 1.0	0.0 - 0.5	SC	--	--																			
HA-20-013	2	BULK	1.0 - 1.8	1.0 - 1.5	ML	--	--																			
HA-20-013	3	BULK	1.8 - 2.0	1.8 - 2.0	CL	--	--																			
HA-20-013	4	BULK	2.0 - 2.5	2.0 - 2.5	CL	--	--																			
HA-20-013	5	BULK	2.5 - 3.0	2.5 - 3.0	SP-SM	--	--																			
HA-20-014	1	BULK	0.0 - 1.0	0.3 - 0.8	SM	--	--																			
HA-20-014	2	BULK	1.0 - 1.5	1.0 - 1.5	SC	--	--																			
HA-20-014	3	BULK	1.5 - 2.5	1.5 - 2.0	CL	--	--																			
HA-20-014	4	BULK	2.5 - 3.0	2.5 - 3.0	CL	--	--																			
HA-20-015	1	BULK	0.0 - 1.0	0.3 - 0.8	SP	--	--																			
HA-20-015	2	BULK	1.0 - 3.0	1.0 - 1.5	SP-SC	--	--																			
HA-20-015	3	BULK	3.0 - 5.0	3.0 - 3.5	SC	--	--									22										
HA-20-016	1	BULK	0.0 - 1.0	0.3 - 0.8	OL	--	--																			
HA-20-016	2	BULK	1.0 - 1.5	1.0 - 1.5	SC	--	--																			
HA-20-017	1	BULK	0.0 - 1.0	0.3 - 0.8	SM	--	--																			
HA-20-017	2	BULK	1.0 - 3.3	1.0 - 1.5	CL	--	--																			
HA-20-017	3	BULK	3.3 - 4.0	3.3 - 3.8	SC	--	--									43										
HA-20-017	4	BULK	4.0 - 4.5	4.0 - 4.5	SC	--	--																			
HA-20-018	1	BULK	0.0 - 4.0	0.5 - 1.0	SC	--	--									38										
HA-20-018	2	BULK	4.0 - 5.0	4.0 - 4.5	SC	--	--																			
HA-20-022	1	BULK	0.0 - 0.5	0.0 - 0.5	GC	--	--																			
HA-20-022	2	BULK	0.5 - 1.0	0.5 - 1.0	GC	--	--																			
HA-20-022	3	BULK	1.0 - 1.5	1.0 - 1.5	GC	--	--																			
HA-20-022	4	BULK	1.5 - 2.0	1.5 - 2.0	CL	--	--																			
HA-20-022	5	BULK	2.5 - 5.0	2.5 - 3.0	CL	--	--																			
HA-20-023	1	BULK	0.0 - 1.0	0.5 - 1.0	SM	--	--																			
HA-20-023	2	BULK	1.5 - 2.0	1.5 - 2.0	SP-SM	--	--																			
HA-20-024	1	BULK	0.0 - 3.0	0.0 - 0.5	ML	--	--																			
HA-20-024	2	BULK	3.0 - 5.0	3.0 - 3.5	ML	--	--																			
HA-20-025	1	BULK	0.0 - 1.5	0.0 - 0.5	SC	--	--																			
HA-20-025	2	BULK	1.5 - 2.5	1.5 - 2.0	SC	--	--																			
HA-20-026	1	BULK	0.0 - 0.5	0.0 - 0.5	ML	--	--																			
HA-20-026	2	BULK	0.5 - 2.5	0.5 - 1.0	CL	--	--																			
HA-20-027	1	BULK	0.0 - 2.5	0.5 - 1.0	ML	--	--																			
HA-20-027	2	BULK	2.5 - 4.5	2.5 - 3.0	SC	--	--																			
HA-20-028	1	BULK	0.0 - 1.0	0.0 - 0.5	SC	--	--																			
HA-20-028	2	BULK	1.0 - 3.5	1.0 - 1.5	CL	--	--																			
HA-20-028	3	BULK	3.5 - 4.8	3.5 - 4.0	ML	--	--				38	28	10													
HA-20-029	1	BULK	0.0 - 0.3	0.0 - 0.3	SC	--	--																			
HA-20-029	2	BULK	0.3 - 1.5	0.3 - 0.8	CL	--	--																			
HA-20-029	3	BULK	1.5 - 2.0	1.5 - 2.0	CL	--	--																			
HA-20-029	4	BULK	2.0 - 4.0	2.0 - 2.5	CL	--	--																	4.26	10,990	8.7	3.1
HA-20-030	1	BULK	0.0 - 1.0	0.5 - 1.0	CL	--	--																			
HA-20-030	2	BULK	1.0 - 1.5	1.0 - 1.5	SC	--	--																			
HA-20-030	3	BULK	1.5 - 2.0	1.5 - 2.0	CL	--	--																			
HA-20-030	4	BULK	2.0 - 4.0	2.0 - 2.5	CL	--	--				47	23	24													
HA-20-030	5	BULK	4.0 - 5.0	4.0 - 4.5	SP-SC	--	--																			
HA-20-031	1	BULK	0.0 - 1.3	0.0 - 0.5	SC	--	--																			
HA-20-031	2	BULK	1.3 - 1.5	1.3 - 1.5	SC	--	--																			
HA-20-031	3	BULK	1.5 - 2.0	1.5 - 2.0	SC	--	--																			
HA-20-031	4	BULK	2.0 - 2.5	2.0 - 2.5	SM	--	--																			
HA-20-031	5	BULK	2.5 - 3.0	2.5 - 3.0	SC	--	--																			
HA-20-032	1	BULK	0.0 - 2.0	0.0 - 0.5	SC	--	--																			

Project Name: **City of Fort Bragg Raw Water Pipeline Replacement**
Project No: **19-514.1**
Date: **8/7/2020**

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Laboratory and Field Test Summary

Boring I.D.	Sample I.D.	Sample Type (inch)	Sampled Depth (ft)	Retained Sample Depth (ft)	USCS	Field Blows N (bpf)	SPT Blows N_{60} (bpf)	Moisture/Density			Classification						Strength						Chemical Analysis			
								Dry Density (pcf)	Moist. Content (%)	In-Situ Density (pcf)	Atterberg Limits			Gravel (%)	Sand (%)	Fines (%)	Pocket Pent. (tsf)	Uncon. Comp. (psf)	Direct Shear		Triaxial-UU (Staged)		pH	Minimum Resistivity (ohm-cm)	Chloride Content (ppm)	Sulfate Content (ppm)
											Liquid Limit	Plastic Limit	Plasticity Index						φ (deg)	c (psf)	φ (deg)	c (psf)				
HA-20-032	2	BULK	2.0 - 3.5	2.0 - 2.5	SC	--	--									30										
HA-20-033	1	BULK	0.0 - 1.0	0.3 - 0.8	OL	--	--																			
HA-20-033	2	BULK	1.0 - 1.5	1.0 - 1.3	GC	--	--																			
HA-20-033	3	BULK	1.8 - 2.0	1.8 - 2.0	SC	--	--																			
HA-20-034	1	BULK	0.0 - 0.8	0.3 - 0.8	GP-GC	--	--																			
HA-20-034	2	BULK	0.8 - 1.0	0.8 - 1.0	ML	--	--																			
HA-20-034	3	BULK	1.0 - 2.5	1.0 - 1.5	ML	--	--																			
HA-20-034	4	BULK	2.5 - 3.0	2.5 - 3.0	CL	--	--																	3.99	4,290	10.2	15.1
HA-20-034	5	BULK	3.0 - 3.5	3.0 - 3.5	GM	--	--																			
HA-20-034	6	BULK	3.5 - 5.0	3.5 - 4.0	CL	--	--				26	13	13													
T-20-002	1	BULK	0.0 - 2.0	0.0 - 1.0	GC	--	--																			
T-20-002	2	BULK	2.0 - 3.0	2.0 - 3.0	CL	--	--																			
T-20-002	3	BULK	3.0 - 4.0	3.0 - 4.0	SC	--	--																			
T-20-002	4	BULK	4.0 - 5.0	4.0 - 5.0	SC	--	--																			
T-20-002	5	BULK	5.0 - 6.0	5.0 - 6.0	SC	--	--																			
T-20-002	6	BULK	6.0 - 7.0	6.0 - 7.0	SC/CL	--	--																			
T-20-002	7	BULK	7.0 - 8.0	7.0 - 8.0	CL	--	--																			
T-20-002	8	BULK	8.0 - 9.0	8.0 - 9.0	CL	--	--																			
T-20-003	1	BULK	0.0 - 2.0	0.0 - 0.5	SC	--	--																			
T-20-003	3	BULK	2.0 - 3.0	2.0 - 3.0	SC	--	--																			
T-20-003	4	BULK	3.0 - 4.0	3.0 - 4.0	SC	--	--									43										
T-20-003	5	BULK	4.0 - 5.0	4.0 - 5.0	CL	--	--																			
T-20-003	6	BULK	5.0 - 6.0	5.0 - 6.0	CL	--	--																			
T-20-004	1	BULK	0.0 - 1.0	0.0 - 1.0	SP	--	--																			
T-20-004	2	BULK	1.0 - 2.0	1.0 - 2.0	SP/CL	--	--																			
T-20-004	3	BULK	2.0 - 3.0	2.0 - 3.0	CL	--	--				36	20	16													
T-20-004	4	BULK	3.0 - 4.0	3.0 - 4.0	CL/SC	--	--																			
T-20-004	5	BULK	4.0 - 5.0	4.0 - 5.0	SC	--	--							5	39	56										
T-20-004	6	BULK	5.0 - 6.0	5.0 - 6.0	SC	--	--																			
T-20-004	7	BULK	6.0 - 7.0	6.0 - 7.0	SC/CL	--	--																			
T-20-004	8	BULK	7.0 - 8.0	7.0 - 8.0	CL	--	--																			
T-20-005	1	BULK	0.0 - 1.0	0.0 - 1.0	SC	--	--																			
T-20-005	2	BULK	1.0 - 2.0	1.0 - 2.0	SC	--	--																			
T-20-005	3	BULK	2.0 - 3.0	2.0 - 3.0	SC	--	--																			
T-20-005	4	BULK	3.0 - 4.0	3.0 - 4.0	SC	--	--																			
T-20-005	5	BULK	4.0 - 5.0	4.0 - 5.0	SC/CL	--	--																			
T-20-005	6	BULK	5.0 - 6.0	5.0 - 6.0	CL	--	--																			
T-20-005	7	BULK	6.0 - 7.0	6.0 - 7.0	CL/SC	--	--																			
T-20-005	8	BULK	7.0 - 8.0	7.0 - 8.0	SC	--	--																			
T-20-006	1	BULK	0.0 - 1.0	0.0 - 1.0	SP	--	--																			
T-20-006	2	BULK	1.0 - 2.0	1.0 - 2.0	SP	--	--																			
T-20-006	3	BULK	2.0 - 3.0	2.0 - 3.0	SP/GP	--	--																			
T-20-006	4	BULK	3.0 - 4.0	3.0 - 4.0	GP/SP	--	--																			
T-20-006	5	BULK	4.0 - 5.0	4.0 - 5.0	SP/GP	--	--																			
T-20-006	6	BULK	5.0 - 6.0	5.0 - 6.0	GP	--	--																			
T-20-006	7	BULK	6.0 - 7.0	6.0 - 7.0	GP/RX	--	--																			
T-20-006	8	BULK	7.0 - 8.0	7.0 - 8.0	RX	--	--																			
T-20-007	1	BULK	0.0 - 1.0	0.0 - 1.0	SP	--	--																			
T-20-007	2	BULK	1.0 - 2.0	1.0 - 2.0	SP	--	--																			
T-20-007	3	BULK	2.0 - 3.0	2.0 - 3.0	SP	--	--																			
T-20-007	4	BULK	3.0 - 4.0	3.0 - 4.0	SP	--	--																			
T-20-007	5	BULK	4.0 - 5.0	4.0 - 5.0	SP	--	--																			
T-20-007	6	BULK	5.0 - 6.0	5.0 - 6.0	SP	--	--																			
T-20-007	7	BULK	6.0 - 7.0	6.0 - 7.0	SP	--	--																			
T-20-007	8	BULK	7.0 - 8.0	7.0 - 8.0	SP	--	--																			
T-20-008	1	BULK	0.0 - 1.0	0.0 - 1.0	SP	--	--																			
T-20-008	2	BULK	1.0 - 2.0	1.0 - 2.0	SP/SP-SC	--	--																			
T-20-008	3	BULK	2.0 - 3.0	2.0 - 3.0	SP-SC/SP	--	--																			
T-20-008	4	BULK	3.0 - 4.0	3.0 - 4.0	SP	--	--									13										
T-20-008	5	BULK	4.0 - 5.0	4.0 - 5.0	SP	--	--																			
T-20-008	6	BULK	5.0 - 6.0	5.0 - 6.0	SP/SP-SC	--	--																			
T-20-008	7	BULK	6.0 - 7.0	6.0 - 7.0	SP-SC/SP	--	--																			
T-20-008	8	BULK	7.0 - 8.0	7.0 - 8.0	SP	--	--																			

Crawford & Associates, Inc.
Geotechnical Engineering, Design and Construction Services

Project Name: Raw Water Pipeline Replacement Design
CAInc File No: 19-514.1
Date: 7/29/2020
Technician: LAD

200 Wash - ASTM D1140

Method A

Max Particle Size (100% Passing)	Standard Sieve Size	Recommended Min Mass of Test Specimens
2 mm or less	No. 10	20 g
4.75 mm	No. 4	100 g
9.5 mm	3/8 "	500 g
19.0 mm	3/4 "	2.5 kg
37.5 mm	1 1/2 "	10 kg
75.0 mm	3 "	50 kg

Table from 6.2 of ASTM D1140

Sample No.	T-20-003-4	T-20-008-4	HA-20-015-3	HA-20-017-3	HA-20-018-1
USCS Symbol	SC	SC	SC	SC	SC
Depth (ft.)	3	3	3	3.3	0.5
Tare No.	2011	1012	2009	2004	2001
Tare (g)	122.8	126.1	122.9	125.8	125.6
Dry Soil + Tare (g)	308.3	379.6	328.4	363.5	353.8
Dry Mass before (g)	185.5	253.5	205.5	237.7	228.2
Dry Mass after (g)	106.6	221.8	159.3	136.5	141.7
Percent Fines (%)	43	13	22	43	38

Notes:

Crawford & Associates, Inc.
Geotechnical Engineering, Design and Construction Services

Project Name: Raw Water Pipeline Replacement Design
CAInc File No: 19-514.1
Date: 7/29/2020
Technician: LAD

200 Wash - ASTM D1140

Method A

Max Particle Size (100% Passing)	Standard Sieve Size	Recommended Min Mass of Test Specimens
2 mm or less	No. 10	20 g
4.75 mm	No. 4	100 g
9.5 mm	3/8 "	500 g
19.0 mm	3/4 "	2.5 kg
37.5 mm	1 1/2 "	10 kg
75.0 mm	3 "	50 kg

Table from 6.2 of ASTM D1140

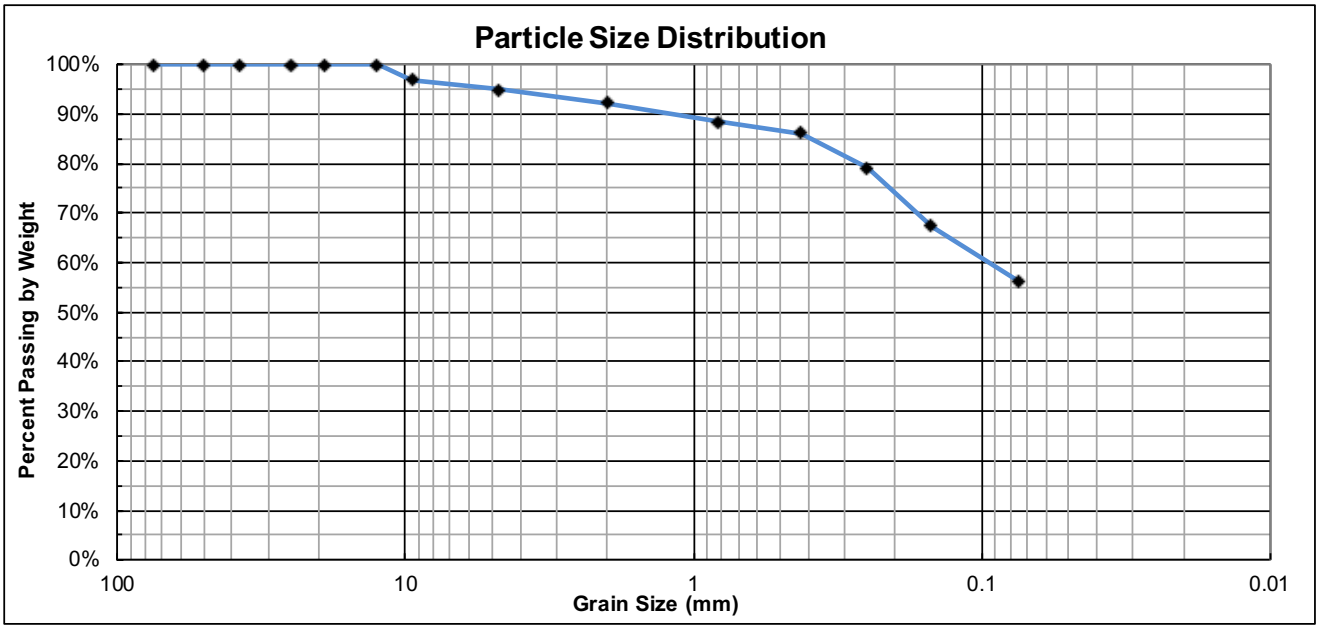
Sample No.	HA-20-032-2				
USCS Symbol	SC				
Depth (ft.)	2				
Tare No.	1010				
Tare (g)	125.7				
Dry Soil + Tare (g)	316.2				
Dry Mass before (g)	190.5				
Dry Mass after (g)	132.8				
Percent Fines (%)	30				

Notes:

Crawford & Associates, Inc.
Geotechnical Engineering, Design and Construction Services

Project Name: Raw Water Pipeline Replacement Design
CAInc File No: 19-514.1
Date: 7/28/20
Technician: CAP
Sample ID: T-20-004-5
Depth (ft): 4
USCS Classification: Sandy Lean Clay (CL)

ASTM 6913 - Method A



% Cobble	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	Silt/Clay
	0	5	3	6	30	
0	**5**		**39**			**56**

		Sieve #	Opening mm	Cummulative Mass Retained (g)	% Passing %
Cobbles		**3"**	75	0.0	100%
Gravel	Coarse	**2"**	50	0.0	100%
		1-1/2"	37.5	0.0	100%
		1"	25.0	0.0	100%
		3/4"	19.0	0.0	100%
	Fine	**1/2"**	12.5	0.0	100%
		3/8"	9.50	6.0	97%
		#4	4.75	10.0	95%
Sand	Coarse	**#10**	2.00	15.1	92%
	Medium	**#20**	0.825	22.5	88%
		#40	0.425	27.2	86%
	Fine	**#60**	0.250	40.7	79%
		#100	0.150	63.7	67%
		#200	0.075	84.9	56%

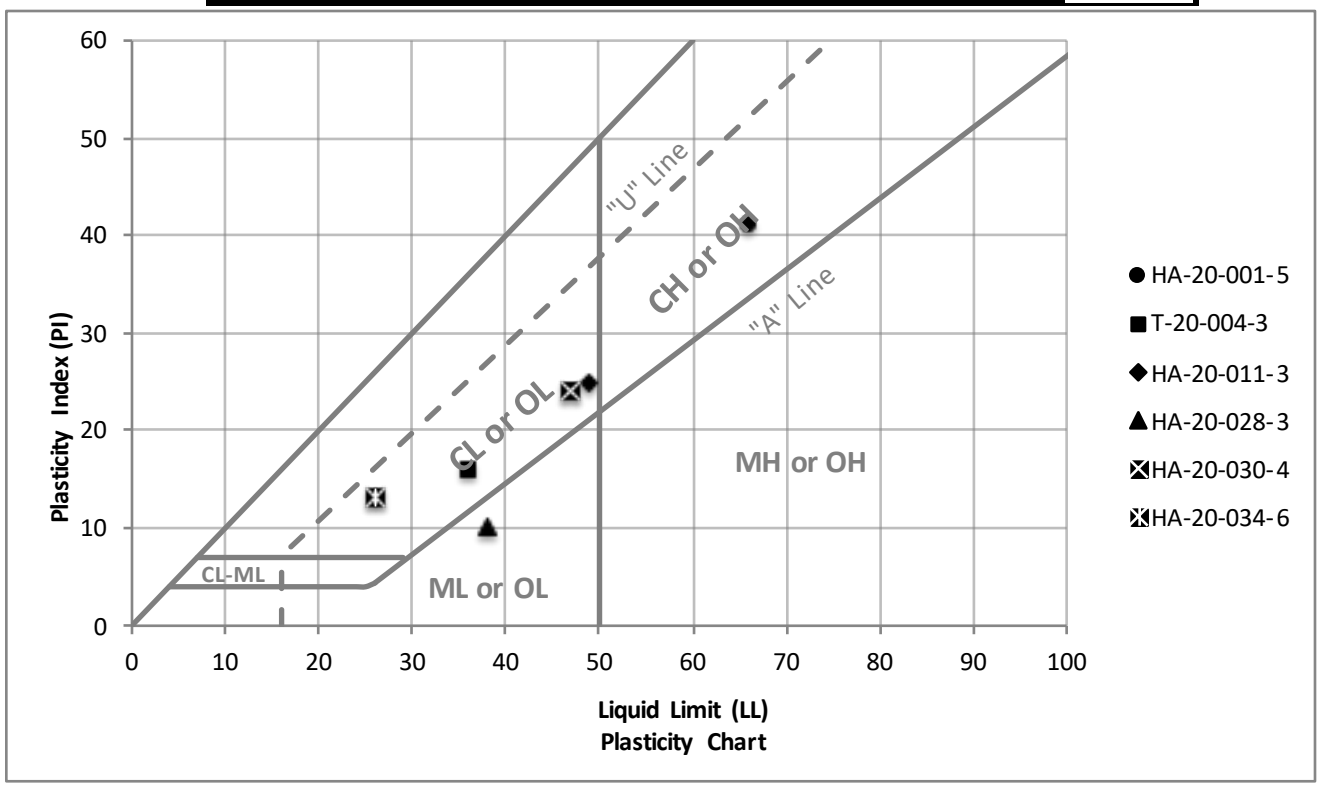
Coefficient of Uniformity	Coefficient of Curvature
Cu = NA	Cc = NA

Crawford & Associates, Inc.
Geotechnical Engineering, Design and Construction Services

Project Name: Raw Wter Pipeline Replacement Design
CAInc File No: 19-514.1
Date: 7/28/20
Technician: LAD,CAP

Plastic Index - ASTM D4318

Sample ID	Depth (ft)	Liquid Limit	Plastic Limit	PI
HA-20-001-5	3.5-4	66	25	41
T-20-004-3	2.0-3.0	36	20	16
HA-20-011-3	2.5-3	49	24	25
HA-20-028-3	3.5-4.0	38	28	10
HA-20-030-4	2.0-2.5	47	23	24
HA-20-034-6	3.5-4.0	26	13	13



Sunland Analytical
11419 Sunrise Gold Circle, #10
Rancho Cordova, CA 95742
(916) 852-8557

Date Reported 07/24/2020
Date Submitted 07/20/2020

To: Carmelo Pagan
Crawford & Associates, Inc.
1100 Corporate Way Suite 230
Sacramento, CA 95831

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : HA20-029-4 @ 2.0-2.5 Site ID : 19-514.1.
Thank you for your business.

* For future reference to this analysis please use SUN # 82600-172504.

EVALUATION FOR SOIL CORROSION

Soil pH	4.26	
Minimum Resistivity	10.99 ohm-cm (x1000)	
Chloride	8.7 ppm	00.00087 %
Sulfate	3.1 ppm	00.00031 %

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422m

Sunland Analytical
11419 Sunrise Gold Circle, #10
Rancho Cordova, CA 95742
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1100 Corporate Way Suite 230
Sacramento, CA 95831

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : HA20-034-4 @ 2.5-3.0 Site ID : 19-514.1.
Thank you for your business.

* For future reference to this analysis please use SUN # 82600-172505.

EVALUATION FOR SOIL CORROSION

Soil pH	3.99	
Minimum Resistivity	4.29 ohm-cm (x1000)	
Chloride	10.2 ppm	00.00102 %
Sulfate	15.1 ppm	00.00151 %

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422m