APPENDIX C-2

Geotechnical Engineering Investigation Report

GEOTECHNICAL ENGINEERING INVESTIGATION REPORT
HDD GAS PIPELINE
EAST OF EEL RIVER AND SR-101
RIO DELL, CALIFORNIA

BSK PROJECT G00001255

PREPARED FOR:

CHARGE
2880 GATEWAY OAKS DRIVE, SUITE 150
SACRAMENTO, CALIFORNIA 95833

DECEMBER 18, 2023

GEOTECHNICAL ENGINEERING INVESTIGATION REPORT
HDD GAS PIPELINE
EAST OF EEL RIVER AND SR-101
RIO DELL, CALIFORNIA

Prepared for:

Charge
2880 Gateway Oaks Drive, Suite 150
Sacramento, California 95833

BSK Project: G00001255

December 15, 2023

Prepared by:

Adrian Sizemore, EIT
Staff Professional II

Neva Popenoe, PE, GE
Fresno Branch Manager

BSK Associates
691 N Laverne Avenue, Suite 101
Fresno, California 93727
(559) 497-2880
www.bskassociates.com

Distribution: Ben Reader, Charge, pdf (b.reader@chargeepc.com)

Table of Contents

TABLES

FIGURES

APPENDICES

1 INTRODUCTION

1.1 General

This report presents the results of our geotechnical engineering investigation for the proposed alignment of an underground gas pipeline to extend beneath the Eel River, east of SR-101, and south of Northwestern Avenue in Rio Dell, California. This report was prepared in substantial conformance to our proposal G00001255 dated June 8, 2023 and November 16, 2023. The approximate location of the proposed pipeline alignment and boring locations are shown on Figure 2, Boring Location Map.

1.2 Project Description

BSK understands that the project consists of directional drill and installation of an underground line with casing to extend beneath the Eel River, east of SR-101, and south of Northwestern Avenue in Rio Dell, California. The size of the line and casing was not provided at the time of this report, but is anticipated to be less than 12 inches. In order to facilitate the utility installation, information on the subsurface soil conditions is necessary.

1.3 Purpose and Scope of Services

The objective of the geotechnical engineering investigation is to assess the subsurface soil conditions at the planned utility alignment to provide pertinent geotechnical recommendations for the subject project. The scope of the investigation included a field exploration, laboratory testing, engineering analyses, and report preparation.

2 FIELD INVESTIGATION AND LABORATORY TESTING

2.1 General

The field exploration, conducted on October 3, 2023 through October 4, 2023, and November 28, 2023 through December 1, 2023 consisted of a site reconnaissance and drilling four (4) exploratory test borings to approximate depths of 21.5 to 150 feet below ground surface (bgs). The borings were drilled adjacent to the planned alignment using a truck-mounted drill rig equipped with hollow stem augers, mud rotary and rock coring equipment. The approximate boring locations are presented on Figure 2. Details of the field exploration and the boring logs are provided in Appendix A. Approximate boring locations and depths are presented in Table 1.

Table 1: Approximate Boring Locations			
Boring Number	**Approximate Station**	**Approximate Elevation (feet)**	**Approximate Boring Depth BGS (feet)**
B-1	23+40	86	130
B-2	23+55	86	21.5
B-3	10+45	96	150
B-4	9+55	103	36.5

2.2 Laboratory Testing

Laboratory testing of selected soil samples were performed to evaluate certain physical, chemical, and engineering characteristics and properties. The testing program included: in-situ moisture and density; gradation, shear strength, Atterberg Limits, unconfined compressive strength, and corrosion potential. The in-situ moisture and dry density test results are presented on the boring logs in Appendix A. Descriptions of the laboratory test methods and test results are provided in Appendix B.

3 SITE CONDITIONS

The following sections address site description, surface and subsurface conditions, and groundwater conditions within the proposed project area.

3.1 Site Description

The project site is situated east of SR-101 between the north and south bank of the Eel River in Rio Dell, California. The proposed alignment is planned to cross below the River. The site topography at the proposed entry/receiving location on the north and south banks were located at at an unpaved roadways. Generally, trees and dense vegetation were present on the banks of the river.. The bottom of the river is approximately 60 feet below adjacent grade. The river is unlined at this location and was flowing at the time of our exploration.

3.2 Subsurface Conditions

Subsurface deposits encountered in the northern test borings consisted of alluvial and older river terrace deposits consisting of gravel, silty sand, clay with varying sand content, clayey gravel with sand, and sand with varying gravel and silt content to the depth explored, 130 feet bgs. Subsurface deposits encountered

in the southern test borings consisted of alluvial deposits consisting of gravels, silty and clayey sands, sandy clay, and silt with varying sand content, underlain by siltstone, sandy siltstone, clayey sandstone, and shale extending to the maximum boring depth of 150 feet bgs. The relative consistency of the fine-grained soil was medium stiff to hard. The relative density of the coarse-grained soils was medium dense to very dense. Encountered bedrock had consistency from weak to strong. Summaries of pertinent soil characteristics for design are shown in Tables 2 and 3.

Table 2: Soil Parameters – B-1 (North)

Material	Depth (ft)	Total Unit Weight (pcf)	Cohesion (psf)	Friction Angle (degrees)	Shear Modulus (psi)
Poorly Graded Gravel with Sand (GP)	0 – 3.5	116	0	25	100
Sandy Silt (ML)	3.5 – 9	120	170	39	100
Silty Sand (SM)	9 – 10.5	98	10	25	100
Clay (CL)	10.5 – 11.5	120	100	25	90
Silty Sand (SM)	11.5 – 14	98	10	25	100
Poorly Graded Sand (SP)	14 – 16	120	0	25	100
Sandy Lean Clay (CL)	16 – 19	120	100	25	100
Silty Sand (SM)	19 – 26	98	10	36	160
Sandy Lean Clay (CL)	26 – 30	120	100	25	100
Poorly Graded Gravel with Sand (GP)	30 – 39	126	0	35	800
Poorly Graded Gravel with Clay and Sand (GP-GC)	39 – 45	120	10	35	1400
Poorly Graded Gravel with Sand (GP)	45 – 50	116	0	35	800
Clayey Gravel with Sand (GC)	50 – 54.5	120	10	35	1700
Poorly Graded Gravel with Clay and Sand (GP-GC)	54.5 – 56	120	10	35	1800
Poorly Graded Gravel with Sand (GP)	56 – 62	120	0	35	1300
Poorly Graded Gravel (GP)	62 – 80	120	0	35	1300
Poorly Graded Sand with Gravel (GP)	80 – 100	139	0	35	1400
Poorly Graded Sand (SP)	100 – 104.5	120	0	35	800
Poorly Graded Sand with Gravel (SP)	104.5 – 110	120	0	35	800
Poorly Graded Sand (SP)	110 – 130	120	0	35	1300

Table 3: Soil Parameters – B-3 (South)					
Material	**Depth (ft)**	**Total Unit Weight (pcf)**	**Cohesion (psf)**	**Friction Angle (degrees)**	**Shear Modulus (psi)**
Silty Sand (SM)	0 – 4.5	98	10	30	300
Sandy Clay (CL)	4.5 – 9.5	120	100	33	300
Clayey Gravel with Sand (GC)	9.5 – 15	139	10	33	300
Fat Clay (CL)	15 – 24.5	129	100	31	200
Poorly Graded Gravel with Clay and Sand (GP-GC)	24.5 – 36	120	10	35	1050
Elastic Silt with Sand (MH)	36 – 40.5	120	10	35	1400
Elastic Silt (MH)	40.5 - 67	120	10	35	1340
Bedrock Suspected	67 – 150	-	5440	-	2600

The boring logs in Appendix A provide a more detailed description of the soils encountered in each boring, and the applicable Unified Soil Classification System symbols. The approximate locations of the soil borings are shown on Figure 2.

3.3 Groundwater Conditions

Groundwater was encountered at approximately 41 feet bgs at Boring B-1 at the time of our field exploration. Groundwater is anticipated to approximately coincide with the water elevation of the Eel River. However, fluctuations in the groundwater level or the presence of perched groundwater may occur due to the elevation of water in River, variations in rainfall, irrigation, seasonal factors, pumping from wells and other factors that were not evident at the time of our investigation.

3.4 Scour Potential

Residual soils overlying bedrock are considered subject to erosion, degradation, and/or scour. Bedrock was encountered at approximate elevation of 29 on the south side of Eel River, but was not encountered on the north side of Eel River. Scour potential is recommended to be completed as part of a hydraulic analysis. D_{50} and D_{90} results can be used by the hydraulic engineer for use in scour/erosion calculations and are presented in Table 4.

Table 4: Percent Finer Gradation for Scour Analysis		
Sample Location	D_{50} (mm)	D_{90} (mm)
B-1 @ 30-31.5 feet bgs	6.5	23
B-1 @ 60-61.5 feet bgs	5.5	30
B-1 @ feet bgs	4	10

Hydraulic analysis has not been completed at the time of this report. However, it is recommended pipelines should be designed to be a minimum of 20 feet below the anticipated maximum scour depth. Results of the final hydraulic analysis should be reviewed in regards to scour potential prior to final design.

3.5 Liquefaction

Settlement of the ground surface with consequential differential movement of structures is a major cause of seismic damage for structures founded on alluvial deposits, and may cause empty pipelines to float or become damaged. Vibration settlement of relatively dry and loose granular deposits beneath structures can be readily induced by the horizontal components of ground shaking associated with even moderate intensity earthquakes. Silver and Seed (1971) have demonstrated that settlement of dry sands due to cyclic loading is a function of 1) the relative density of the soil; 2) the magnitude of the cyclic shear stress; and 3) the number of strain cycles. As indicated above, seismically-induced ground settlement can also occur due to the liquefaction of relatively loose, saturated granular deposits.

In order for liquefaction triggering to occur due to ground shaking, it is generally accepted that four conditions will exist:

1. The subsurface soils are in a relatively loose state
2. The soils are saturated
3. The soils have low plasticity
4. Ground shaking is of sufficient intensity to act as a triggering mechanism

Based on encountered groundwater elevations, liquefaction/seismic settlement analysis was performed for each soil profile.

Input parameters for the liquefaction and settlement analysis were based upon:

- Soil densities estimated from soil boring data.
- Assumed some clay to be non-liquefiable.
- Assumed rock (Pleistocene aged or older) to be non-liquefiable.
- PGA based upon the geometric mean peak ground acceleration or 1.158g.
- Magnitude 9.12 of controlling earthquake from Deaggregation of the seismic hazard.
- Assumed depth to groundwater as encountered (41 feet bgs).
- A Factor-of-Safety of 1.3 was used for analysis.

The results of our liquefaction and seismic settlement analysis based upon data from soil borings indicate the potential for liquefaction is considered negligible. However, loose materials at the site are present above approximate elevation 60 feet. Therefore, if the groundwater levels rise above approximate elevation 60 feet, the proposed pipeline may experience liquefaction, buoyancy of the pipe within liquefied zones, and related effects. Analysis is based on limited subsurface testing and may vary along the alignment and at other depths.

3.6 Soil Corrosivity

Based on test results, on-site, near-surface soils have low soluble sulfate and chloride contents, low minimum resistivity and are alkaline. Thus, the on-site soils are considered to have a mild corrosion potential with respect to buried concrete and moderate corrosion potential with respect to unprotected metal conduits.

The water-soluble sulfate content severity class and the water-soluble chloride ion content severity class are considered not severe to concrete (Exposure Category S0 and C0 per Table 19.3.1.1 of ACI 318-14). BSK recommends that a Type II cement be used in the formulation of concrete and that buried reinforcing steel protection be provided with a minimum concrete cover required by the American Concrete Institute (ACI) Building Code for Structural Concrete, ACI 318, Chapter 7.7. Buried metal conduits must have protective coatings in accordance with the manufacturer's specifications. If detailed recommendations for corrosion protection are desired, a corrosion specialist should be consulted.

4 CONCLUSIONS AND RECOMMENDATIONS

4.1 General

Based upon the data collected during this investigation and from a geotechnical engineering standpoint, it is our opinion that there are no soil conditions that would preclude the construction of the proposed pipeline provided that the recommendations presented in this report are incorporated into the project design and construction.

4.2 Seismic Design Criteria

There are no known active fault zones within the vicinity of the project site. In accordance with Section 1613.2.2 of the 2022 California Building Code (CBC) and Table 20.3-1 of ASCE 7-16, the site can be classified as Site Class D (default).

Use of the 2022 California Building Code (CBC) seismic design criteria is considered appropriate and the following parameters are considered applicable for the structural design of foundations.

Table 5: Seismic Design Parameters			
Seismic Design Parameter	**2022 CBC Value**		**Reference**
MCE Mapped Spectral Acceleration (g)	S_S = 2.572	S_1 = 1.065	USGS Mapped Value
Amplification Factors (Site Class D)	F_a = 1	F_v = null[1](1.7)[2]	ASCE Table 11.4
Site Adjusted MCE Spectral Acceleration (g)	S_{MS} = 2.572	S_{M1} = null[1](1.811)[2]	ASCE Equations 11.4.1-2
Design Spectral Acceleration (g)	S_{DS} = 1.714	S_{D1} = null[1] (1.207)[2]	ASCE Equations 11.4.1-4
Geometric Mean PGA (g)	PGA_M = 1.158		Section 11.8.3, ASCE 7-16
Site Short Period – T_s (seconds)	T_s = 0.704		$T_s = S_{D1}/ S_{DS}$
Site Long Period – T_L (seconds)	T_L = 12		USGS Mapped Value

Notes: [1] Requires site-specific ground motion procedure or exception as per ASCE 7-16 Section 11.4.8.

[2] Values from ASCE 7-16 supplement shall only be used to calculate T_s. Values provided based on use of exception, as provided in Section 11.4.8.2 to Site-Specific Ground Motion Procedures and assumes the value of the seismic response coefficient C_s is determined by Eq. 12.8-2 for values of $T \leq 1.5T_s$ and taken as equal to 1.5 times the value computed in accordance with either Eq. 12.8-3 for $T_L \geq T > 1.5T_s$ or Eq. 12.8-4 for $T > T_L$. The 1.5 increase has not been applied to the values presented.

As shown above, the short period design spectral response acceleration coefficient, S_{DS}, is greater than 0.5, therefore the Site lies in Seismic Design Category D as specified in Section 1613.2.5 of the 2022 CBC. The long period design spectral response acceleration coefficient, S_{D1}, is greater than 0.2, therefore the Site lies in Seismic Design Category D as specified in Section 1613.2.5 of the 2022 CBC. In accordance with the 2022 CBC, each structure shall be assigned to the more severe seismic design category in accordance with Table 1613.2.5(1) or 1613.2.5(2), irrespective of the fundamental period of vibration of the structure.

4.3 Launch and Receiving Pits

The depths of launch and receiving pits for the implementation of directional drilling are estimated to not exceed 10 feet. Soils in this upper zone, as observed in the test boring, consisted of poorly graded gravel with sand, sandy silt, silty sand and sandy clay.

Pit excavation can be accomplished by laying slopes back not steeper than 1.5:1 (horizontal to vertical) or with the installation of a shoring system.

Groundwater is not anticipated to be encountered in the pits. Availability of construction dewatering provisions are not anticipated to be required for the duration of the project, unless water in the adjacent River is at or above the proposed pit elevation.

4.4 Lateral Earth Pressures and Frictional Resistance

4.4.1 Lateral Earth Pressures

Lateral loads applied against foundations may be resisted by a combination of passive resistance against the vertical faces of the foundations and friction between the structure bottom and the supporting subgrade. The parameters shown in the table below are for drained conditions of select engineered fill or undisturbed native soil.

Table 6:
Recommended Unfactored Lateral Earth Pressures

Lateral Pressure Condition	Pressure (psf)
Active Pressure	25
At-Rest Pressure	40
Passive Pressure	500

An unfactored coefficient of friction of 0.73 may be used between soil subgrade and the structure bottom. The coefficient of friction and passive earth pressure values given above represent ultimate soil strength values. BSK recommends that a safety factor consistent with the design conditions be included in their usage. For resistance against lateral sliding that is countered solely by the passive earth pressure against footings or friction along the bottom of footings, a minimum safety factor of 1.5 is recommended. For stability against lateral sliding that is resisted by combined passive pressure and frictional resistance, a minimum safety factor of 2.0 is recommended. For lateral resistance against seismic loading conditions, a minimum safety factor of 1.2 is recommended. We based these lateral resistance values on the assumption that the concrete for the foundations is either placed directly against undisturbed soils or that the voids created from the use of forms are backfilled with engineered fill or other approved materials, such as lean concrete. Passive resistance in the upper foot of soil cover below finished grades should be neglected unless the ground surface is confined by concrete slabs, pavements, or other such positive protection.

4.4.2 Frictional Resistance

Table 6 presents the friction factor between the pipe with a resistant coating and the borehole wall. The friction factor represents the ratio of the normal force between the pipe and borehole wall with the axial force required to pull the pipe along the wall. For steel pipe, the PRCI Guidelines (Installation of Pipelines Beneath Levees Using Horizontal Directional Drilling) recommend friction factors of 0.2 to 0.3. Due to the presence of very dense soils, an abrasion resistant coating is recommended for steel pipes and generally required for natural gas pipelines. The coating material is similar in texture to smooth, formed concrete. The values listed below are for formed concrete against various soils from NAVFAC DM 7.02, Chapter 3, Table 1. The friction factors reported below do not account for the presence of a drilling fluid filter cake.

Table 7: Ultimate Friction Factors for Pipelines		
Interface Material	**Friction Factor (tan ϕ)**	**Friction Angle, ϕ (deg.)**
Clean gravel, gravel-sand mixture, well-graded rock fill with spalls	0.40 – 0.50	22 to 26
Clean sand, clayey sand-gravel mixture, single size hard rock fill	0.30 – 0.40	17 to 22
Silty sand, gravel or sand mixed with silt or clay	0.30	17
Fine sandy silt, nonplastic silt	0.25	14

4.5 Temporary Shoring

Where there is insufficient space to layback slopes, temporary shoring will be necessary. Lateral earth pressures for cantilevered or braced shoring supporting level ground are presented in the following table.

Table 8: Lateral Earth Pressures for Temporary Shoring	
Parameter	**Pressure**
Active Pressure	26 psf/ft
Braced Pressure	17H psf
Allowable Passive Pressure	
Solid Sheeting	380 psf/ft
Isolated Soldier Pile	570 psf/ft

Notes: [1] H is shored height in feet
[2] Values for isolated soldier piles already include an increase for arching, no further consideration should be applied.

In areas where the stability of adjoining improvements could be compromised by excavation operations, support systems such as shoring, bracing or underpinning may be required to provide stability and to protect personnel working within the excavation. Shoring, bracing, or underpinning required for the project (if any), should be designed by a professional engineer registered in the State of California.

4.6 Excavation Stability

Soils encountered within the upper 10-feet are generally Type C soil in accordance with OSHA (Occupational Safety and Health Administration). The slopes surrounding or along temporary excavations may be 1.5H:1V for excavations that are less than 5-feet deep and exhibit no indication of potential caving but must be no steeper than 2H:1V for excavations that are deeper than 5-feet, to a maximum depth of 10-feet. Temporary excavations for the project construction must be left open for as short a time as possible and must be protected from water runoff. Slope height, slope inclination, and excavation depths (including utility trench excavations) must in no case exceed those specified in local, state, or federal

safety regulations (e.g., OSHA Health and Safety Standards for Excavations 29 CFR Part 1926, or successor regulations). These excavation recommendations are based on soil characteristics derived from the borings. Variations in soil conditions will likely be encountered during excavation. At the time of construction, BSK must be afforded the opportunity to observe and document sloping and shoring conditions, and the opportunity to provide review of actual field conditions to account for condition variations not otherwise anticipated in the preparation of these recommendations.

4.7 Potential HDD Hazards and Mitigation Methods

In general, potential hazards from HDD may include proper tool selection, hole instability, pilot moving in transition between soft and hard or dense layers, lack of resistance in loose soils resulting in loss of drilling fluids or uncontrolled movement of the pilot bit. Below we address some of the potential hazards.

4.7.1 Proper Tool Selection

Subsurface materials encountered within the borings include silty and clayey sands, silts and clays, gravels, and bedrock including siltstone, sandstone, and shale. Layers of gravels are anticipated to be between 10 and 50 feet thick. Gravel size ranged from pea gravel size up to cobble sized, See Appendix A for more detail. . Drill tools should be selected appropriately.

4.7.2 Hole Instability

Poorly graded sand, gravels and silty sand were encountered at various depths, which may be prone to instability in the HDD borehole. The contractor should be prepared to utilize drill fluid for gravels, sandy, silty, and clayey soils. Drilling fluid viscosity, pressure and volume must be adjusted to match the conditions of the soil.

4.7.3 Difficulty Steering

Materials anticipated to be encountered include very soft to stiff sandy clays, soft to hard sandy silts, loose clayey sands, very loose to medium dense silty sands, dense to very dense gravelly sands, medium dense to very dense clayey and sandy gravels, and bedrock. Variations in soil type and density are anticipated to cause some difficulty steering.

The direction and location of the pilot hole must be monitored during installation.

4.7.4 Hydraulic Fracturing and Inadvertent Fluid Releases

Drill mud is injected during various stages of the HDD process. The method requires the drill mud to maintain a certain pressure. However, the pressure must be within tolerances to prevent hydraulic fracturing of the materials surrounding the HDD boring. The maximum allowable effective mud pressure

of soils is dependent on pore pressure and soil type. The Delft Geotechnics[1] maximum drilling mud pressure equation was utilized to calculate the allowable borehole pressure. Results are presented in Figure 4.7.1.

Results indicate generally the cover depth of the pipeline is sufficient. However, it is recommended care be taken at the entry and exit points of the HDD as well as below the river, reduce the flow rate of the fluid at entry and exits, and decrease speed of drilling at entry and exits. Drilling fluid, pressure and volume must be adjusted to match the conditions of the soil. In addition, entry and exit pits, containment areas and other countermeasures are recommended to mitigate for potential fluid releases.

4.7.5 Loss of Drilling Returns

Significant layers of gravels and sands were encountered in our investigation; therefore, loss of drilling returns due to gravel layers is anticipated. Loss of drilling returns or plugging of the hole with sands or gravels may result in higher fluid pressures, leading to hydraulic fracturing or inadvertent fluid returns to the ground surface. The contractor must develop means and methods to prevent hole collapse and use a proper fluid mix to allow drilling returns.

5 PLANS AND SPECIFICATIONS REVIEW

BSK recommends that it be retained to review the draft plans and specifications for the project, with regard to foundations and earthwork, prior to being finalized and issued for construction bidding.

6 CONSTRUCTION TESTING AND OBSERVATIONS

Geotechnical testing and observation during construction is a vital extension of this geotechnical investigation. BSK recommends that it be retained for those services. Field review during site preparation and grading allows for evaluation of the exposed soil conditions and confirmation or revision of the assumptions and extrapolations made in formulating the design parameters and recommendations. BSK's observations must be supplemented with periodic compaction tests to establish substantial conformance with these recommendations. BSK must also be called to the site to observe foundation excavations, prior to placement of reinforcing steel or concrete, to assess whether the actual bearing conditions are compatible with the conditions anticipated during the preparation of this report. BSK must also be called to the site to observe placement of foundation and slab concrete.

If a firm other than BSK is retained for these services during construction, that firm must notify the owner, project designers, governmental building officials, and BSK that the firm has assumed the responsibility for all phases (i.e., both design and construction) of the project within the purview of the geotechnical

[1] *Installation of Pipelines Beneath Levees Using Horizontal Directional Drilling, CPAR-GL-98-1*. US Army Corps of Engineers, April 1998.

engineer. Notification must indicate that the firm has reviewed this report and any subsequent addenda, and that it either agrees with BSK's conclusions and recommendations, or that it will provide independent recommendations.

7 LIMITATIONS

The analyses and recommendations submitted in this report are based upon the data obtained from the test borings performed at the locations shown on Figure 2. The report does not reflect variations which may occur between or beyond the borings. The nature and extent of such variations may not become evident until additional exploration and testing is performed or construction is initiated. If variations then appear, a re-evaluation of the recommendations of this report will be necessary after performing on-site observations during the excavation period and noting the characteristics of the variations.

The validity of the recommendations contained in this report is also dependent upon an adequate testing and observation program during the construction phase. BSK assumes no responsibility for construction compliance with the design concepts or recommendations unless it has been retained to perform the testing and observation services during construction as described above.

The findings of this report are valid as of the present. However, changes in the conditions of the site can occur with the passage of time, whether caused by natural processes or the work of man, on this property or adjacent property. In addition, changes in applicable or appropriate standards may occur, whether they result from legislation, governmental policy or the broadening of knowledge.

BSK has prepared this report for the exclusive use of the Client and members of the project design team. The report has been prepared in accordance with generally accepted geotechnical engineering practices which existed in Humboldt County at the time the report was written. No other warranties either express or implied are made as to the professional advice provided under the terms of BSK's agreement with Client and included in this report.

FIGURES

C:\Users\tgonzalez\BSK Associates\BSK Documents - GEO\G000001255-Rio Dell Feeder\Graphics\G000001255.dwg User:tgonzalez Plotted:Dec 15, 2023 - 12:12pm Last Save:Dec 15, 2023 - 12:02pm

REFERENCE IMAGE: Google Earth

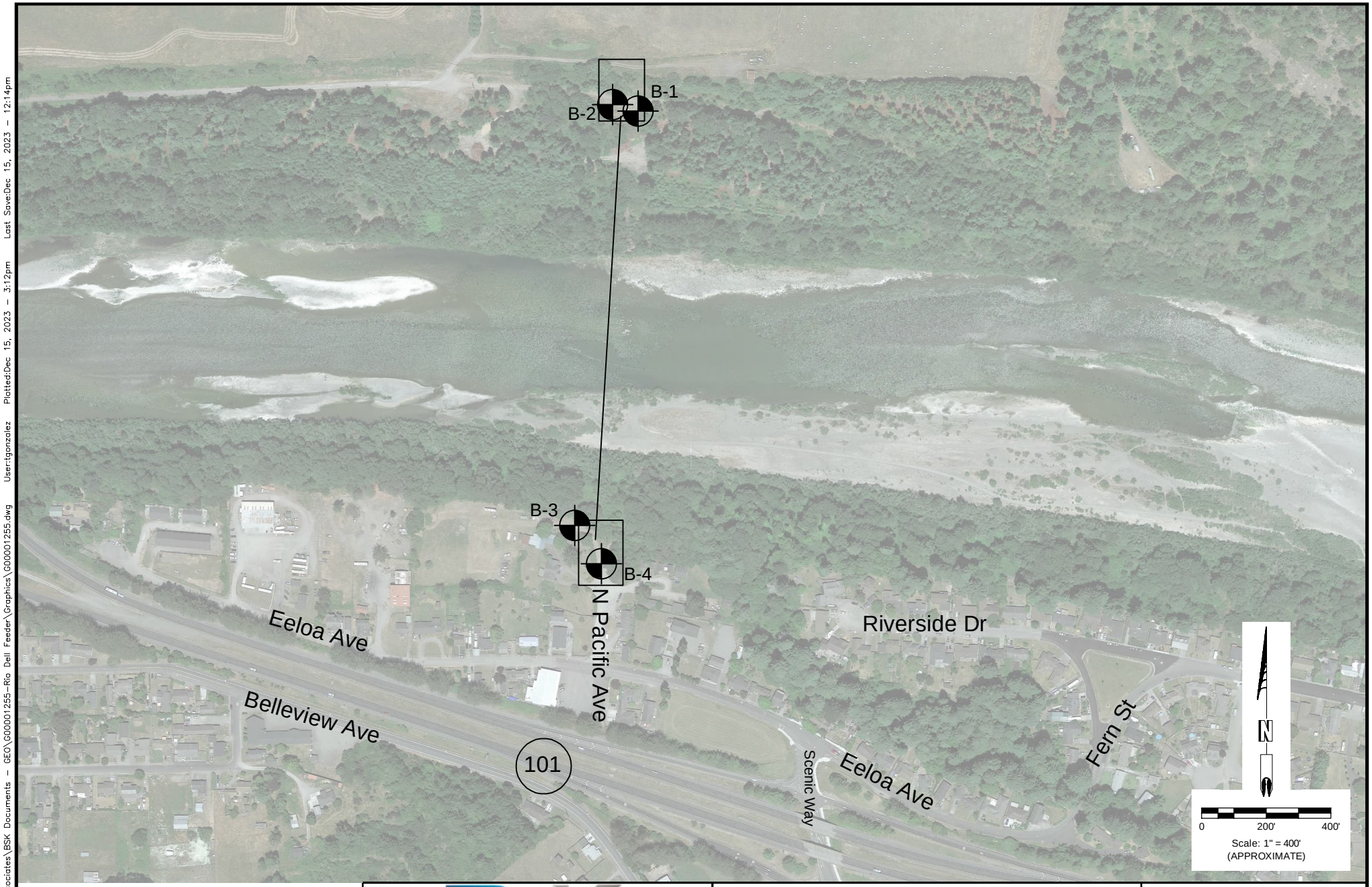
BSK ASSOCIATES
691 N. Laverne Avenue
Fresno, California 93727
Tel. (559) 497-2880

SITE VICINITY MAP

Rio Dell Feeder
Rio Dell, California

FIGURE 1

JOB NO. G00-001-255
DATE December 15, 2023
DR. BY TG
CH. BY NP
SCALE AS SHOWN
SHEET NO. 1
OF 1 SHEETS



LEGEND:

B-4 APPROXIMATE BORING LOCATIONS

REFERENCE IMAGE: Google Earth

ASSOCIATES
691 N. Laverne Avenue
Fresno, California 93727
Tel. (559) 497-2880

BORING LOCATION MAP

Rio Dell Feeder
Rio Dell, California

FIGURE 2

JOB NO. G00-001-255
DATE December 15, 2023
DR. BY TG
CH. BY NP
SCALE AS SHOWN
SHEET NO. 1
OF 1 SHEETS

APPENDIX A

FIELD EXPLORATION

APPENDIX A
Field Exploration

The field exploration, conducted on October 3, 2023 through October 4, 2023, and November 28, 2023 through December 1, 2023 consisted of a site reconnaissance and drilling four (4) exploratory test borings to an approximate depth of 21.5 to 150 feet below ground surface (bgs). The borings were drilled within the planned alignment using a truck-mounted drill rig equipped with hollow stem augers. The approximate boring locations are presented on Figure 2, Boring Location Map.

The soil materials encountered in the test borings were visually classified in the field and logs were recorded during the drilling and sampling operations. Visual classification of the materials encountered in the test borings were made in general accordance with the Unified Soil Classification System (ASTM: D2487). A soil classification chart is presented herein. Boring logs are presented herein and should be consulted for more details concerning subsurface conditions. Stratification lines were approximated by the field staff based on observations made at the time of drilling while the actual boundaries between different soil types may be gradual and soil conditions may vary at other locations.

Subsurface samples were obtained at the successive depths shown on the boring logs by driving samplers which consisted of a 2.5-inch inside diameter (I.D.) California Sampler or a 1.4-inch I.D. Standard Penetration Test (SPT) Sampler. The samplers were driven 18 inches using a 140-pound, automatic hammer dropping 30 inches. The number of blows required to drive the last 12 inches was recorded as the blow count (blows/foot) on the log of borings. The relatively undisturbed soil core samples were capped at both ends to preserve the samples at their natural moisture content. Disturbed soil samples were obtained using the Split-Spoon Sampler (marked X in logs) and were placed and sealed in polyethylene bags. Rock samples were also obtained at the successive depths shown in the boring logs where rock was encountered and typical soil sampling methods were not feasible. The core samples were obtained using a 2.5 inch coring bit in 1 to 6 foot sections. The core samples were packed in boxes and foam was used to hold smaller sections in place to prevent disturbance.

At the completion of the field exploration, the test borings were backfilled with the neat cement grout and soil cuttings and capped with concrete tinted black, as set forth in BSK's proposal.

It should be noted that the use of terms such as "loose", "medium dense", "dense" or "very dense" to describe the consistency of a soil is based on sampler blow count and is not necessarily reflective of the in-place density or unit weight of the soils being sampled. The relationship between sampler blow count and consistency is provided in the following Tables A-1 and A-2 for coarse grained (sandy and gravelly) soils and fine grained (silty and clayey) soils, respectively.

Table A-1: Density of Coarse-Grained Soil versus Sampler Blow Count		
Consistency	**SPT Blow Count Blows / Foot)**	**2.5" I.D. Cal. Sampler (Blows / Foot)**
Very Loose	<4	<6
Loose	4 – 10	6 – 15
Medium Dense	10 – 30	15 – 45
Dense	30 – 50	45 – 80
Very Dense	>50	>80

Table A-2: Consistency of Fine-Grained Soil versus Sampler Blow Count		
Consistency	**SPT Blow Count (Blows / Foot)**	**2.5" I.D. Cal. Sampler (Blows / Foot)**
Very Soft	<2	<3
Soft	2 – 4	3 – 6
Medium Stiff	4 – 8	6 – 12
Stiff	8 – 15	12 – 24
Very Stiff	15 – 30	24 – 45
Hard	>30	>45

MAJOR DIVISIONS				TYPICAL NAMES
COARSE GRAINED SOILS More than Half > #200 sieve	GRAVELS MORE THAN HALF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES
			GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES
		GRAVELS WITH OVER 15% FINES	GM	SILTY GRAVELS, POORLY GRADED GRAVEL-SAND-SILT MIXTURES
			GC	CLAYEY GRAVELS, POORLY GRADED GRAVEL-SAND-CLAY MIXTURES
	SANDS MORE THAN HALF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE	CLEAN SANDS WITH LITTLE OR NO FINES	SW	WELL GRADED SANDS, GRAVELLY SANDS
			SP	POORLY GRADED SANDS, GRAVELLY SANDS
		SANDS WITH OVER 15% FINES	SM	SILTY SANDS, POOORLY GRADED SAND-SILT MIXTURES
			SC	CLAYEY SANDS, POORLY GRADED SAND-CLAY MIXTURES
FINE GRAINED SOILS More than Half < #200 sieve	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS, OR CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC CLAYS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACIOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS			Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS

■	Modified California	RV	R-Value
⊠	Standard Penetration Test (SPT)	SA	Sieve Analysis
☒	Split Spoon	SW	Swell Test
◪	Pushed Shelby Tube	TC	Cyclic Triaxial
▯	Auger Cuttings	TX	Unconsolidated Undrained Triaxial
✋	Grab Sample	TV	Torvane Shear
⊘	Sample Attempt with No Recovery	UC	Unconfined Compression
CA	Chemical Analysis	(1.2)	(Shear Strength, ksf)
CN	Consolidation	WA	Wash Analysis
CP	Compaction	(20)	(with % Passing No. 200 Sieve)
DS	Direct Shear	▽	Water Level at Time of Drilling
PM	Permeability	▼	Water Level after Drilling(with date measured)
PP	Pocket Penetrometer		

SOIL CLASSIFICATION CHART AND LOG KEY

Figure A-1

BSK ASSOCIATES

BSK Associates
691 N. Laverne Avenue, Suite 101
Fresno, CA 93727
Telephone: 559-497-2880

Project: Rio Dell HDD Pipeline
Location: Rio Dell, California
Project No.: G00-001-255
Logged By: K. Yang
Checked By: N. Popenoe

Boring: **B-1**

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
1–4								GP	**Poorly Graded GRAVEL with Sand** - brown-dark brown, moist, medium, fine grained sand, fine to coarse grained gravel, subrounded gravel	
5–9			7	101.1	18.9			ML	**Sandy SILT** - dark bluish brown, moist, low plasticity, fine grained sand, fine grained gravel (subrounded)	
10								SM	**Silty SAND** - dark bluish brown, moist, fine grained sand, very loose	
11			4					CL	**CLAY** - dark bluish brown, medium plasticity, soft, trace silt	
12–14								SM	**Silty SAND** - dark bluish brown, moist, fine grained sand	
15								SP	**Poorly Graded SAND** - brown, moist, very loose, fine to medium grained sand, pourous	
16–19			4					CL	**Sandy Lean CLAY** - grayish brown, moist, fine grained sand, weakly cemented	
20–24			10	80.4	22.3			SM	**Silty SAND** - grayish brown, moist, loose, fine grained sand, weakly cemented	
25–29			4					CL	**Sandy Lean CLAY** - grayish brown, moist, medium plasticity, firm, fine grained sand, oxidation staining	
30–34			30					GP	**Poorly Graded GRAVEL with Sand** - blush gray-grayish brown, moist, medium dense, fine to coarse grained gravel (subangular-angular), medium grained sand	
35–39			82	119.2	5.7			GP-GC	... very dense, medium to coarse grained sand	

Drilling Contractor: Taber
Drilling Method: Hollow Stem Auger
Drilling Equipment: CME 55
Date Started: 11/28/23
Date Completed: 11/28/23

Surface Elevation: 0.0
Sample Method: 2.5" Modified Cal & 1.5" I.D. SPT Split Spoon
Groundwater Depth: 41 Feet
Completion Depth: 131.5 Feet
Borehole Diameter: 8"

* See key sheet for symbols and abbreviations used above.

GEO_BORING LOGS.GPJ BSK.GDT 12/18/23

BSK Associates
691 N. Laverne Avenue, Suite 101
Fresno, CA 93727
Telephone: 559-497-2880

Project: Rio Dell HDD Pipeline
Location: Rio Dell, California
Project No.: G00-001-255
Logged By: K. Yang
Checked By: N. Popenoe

Boring: **B-1**

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
41			58			16			**Poorly Graded GRAVEL with Clay and Sand** - brown-grayish brown, moist, dense, fine grained sand, wet, angular gravel, lense of clay matrix=low plasticity *(continued)*	▽
42										
43										
44										
45								GP	**Poorly Graded GRAVEL with Sand** - bluish gray, wet, dense, fine to coarse grained gravel, subrounded-rounded gravel, fine to medium grained sand	
46			50	109.4	6.2					
47										
48										
49										
50								GC	**Clayey GRAVEL with Sand** - bluish gray, wet, dense, medium grained sand, subangular-subrounded gravel, pourous, moderately cemented, clay matrix=low plasticity, fine grained gravel	
51			64			7				
52										
53										
54										
55								GP-GC	**Poorly Graded GRAVEL with Clay and Sand** - medium sand, wet, very dense, round-subround gravel	
56			96	128.0	8.8			GP	**Poorly Graded GRAVEL with Sand** - bluish gray, wet, fine grained sand, dense, sandstone pieces	
57										
58										
59										
60			50/ 4							
61										
62								GP	**Poorly Graded GRAVEL** - bluish gray, wet, angular-subangular, fine to coarse grained gravel, sandstone pieces	Run 1: Recevery=10", RQD=0
63										
64										Run 2: Recevery=0", RQD=0
65										
66										
67										Run 3: Recevery=11", RQD=0
68									... reddish brown	
69										
70										Run 4: Recevery=15", RQD=0
71									... bluish, sand matrix	
72										
73										Run 5: Recevery=7", RQD=0
74										
75										
76										
77										Run 6: Recevery=22", RQD=0
78										
79										

Drilling Contractor: Taber
Drilling Method: Hollow Stem Auger
Drilling Equipment: CME 55
Date Started: 11/28/23
Date Completed: 11/28/23

Surface Elevation: 0.0
Sample Method: 2.5" Modified Cal & 1.5" I.D. SPT Split Spoon
Groundwater Depth: 41 Feet
Completion Depth: 131.5 Feet
Borehole Diameter: 8"

* See key sheet for symbols and abbreviations used above.

BSK Associates
691 N. Laverne Avenue, Suite 101
Fresno, CA 93727
Telephone: 559-497-2880

Project: Rio Dell HDD Pipeline
Location: Rio Dell, California
Project No.: G00-001-255
Logged By: K. Yang
Checked By: N. Popenoe

Boring: **B-1**

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
81			76					SP	**Poorly Graded SAND with Gravel** - bluish gray, wet, rounded fine grained gravel, fine grained sand	
82										
83										
84										
85										
86			62							
87										
88										
89										
90			50/							
91			5			13			... low plasticity clay matrix	
92										
93										
94										
95										
96			95							
97										
98										
99										
100								SP	**Poorly Graded SAND** - bluish gray, dense, wet, fine grained sand	
101			50		16.4					
102										
103										
104										
105								SP	**Poorly Graded SAND with Gravel** - bluish gray, wet, dense, fine grained sand, cobbles- coarse grained gravel	
106			50		17.4					
107										
108										
109										
110			50/					SP	**Poorly Graded SAND** - bluish gray, wet, dense, fine grained sand	
111			3.5							
112										
113										
114										
115			50/						... medium to coarse grained sand (sandstone)	
116			2							
117										
118										
119										

Drilling Contractor: Taber
Drilling Method: Hollow Stem Auger
Drilling Equipment: CME 55
Date Started: 11/28/23
Date Completed: 11/28/23

Surface Elevation: 0.0
Sample Method: 2.5" Modified Cal & 1.5" I.D. SPT Split Spoon
Groundwater Depth: 41 Feet
Completion Depth: 131.5 Feet
Borehole Diameter: 8"

* See key sheet for symbols and abbreviations used above.

BSK Associates
691 N. Laverne Avenue, Suite 101
Fresno, CA 93727
Telephone: 559-497-2880

Project: Rio Dell HDD Pipeline

Location: Rio Dell, California

Project No.: G00-001-255

Logged By: K. Yang

Checked By: N. Popenoe

Boring: **B-1**

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
121			50/ 3.5					SP	**Poorly Graded SAND** - bluish gray, wet, dense, fine grained sand, pourous (sandstone)	
125			50/ 2							
130			50/ 1.5						Boring terminated at approximately 130 feet bgs. Groundwater Encountered at approximately 41 feet bgs. Boring backfilled with neat cement and soil cuttings.	

Drilling Contractor: Taber
Drilling Method: Hollow Stem Auger
Drilling Equipment: CME 55
Date Started: 11/28/23
Date Completed: 11/28/23

Surface Elevation: 0.0
Sample Method: 2.5" Modified Cal & 1.5" I.D. SPT Split Spoon
Groundwater Depth: 41 Feet
Completion Depth: 131.5 Feet
Borehole Diameter: 8"

* See key sheet for symbols and abbreviations used above.

GEO_BORING LOGS.GPJ_BSK.GDT 12/18/23

BSK Associates
691 N. Laverne Avenue, Suite 101
Fresno, CA 93727
Telephone: 559-497-2880

Project: Rio Dell HDD Pipeline

Location: Rio Dell, California

Project No.: G00-001-255

Logged By: K. Yang

Checked By: N. Popenoe

Boring: **B-2**

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
1–4								GP-GM	**Poorly Graded GRAVEL with Silt and Sand** - dark brown, moist, fine grained sand, coarse grained gravel	
5–14	X		5					CL	**Sandy Lean CLAY** - bluish gray-dark bluish gray, moist, medium plasticity, soft, fine grained sand	
10–14	X		6							
15–16	X		3					SM	**Silty SAND** - dark bluish gray, moist, fine grained sand, soft	
16–17								CL	**Sandy Lean CLAY** - dark bluish gray, moist, medium plasticity, soft	
17–20								SM	**Silty SAND** - dark bluish gray, moist, medium plasticity, soft, fine grained sand	
20–21	X		5							
21–39									Boring terminated at approximately 21.5 feet bgs. No groundwater encountered. Boring backfilled with neat cement and soil cuttings.	

Drilling Contractor: Taber
Drilling Method: Hollow Stem Auger
Drilling Equipment: CME 55
Date Started: 12/1/23
Date Completed: 12/1/23

Surface Elevation: 0.0
Sample Method: 2.5" Modified Cal & 1.5" I.D. SPT Split Spoon
Groundwater Depth: Not Encountered
Completion Depth: 21.5 Feet
Borehole Diameter: 8"

* See key sheet for symbols and abbreviations used above.

GEO_BORING LOGS.GPJ_BSK.GDT_12/18/23

BSK Associates
691 N. Laverne Avenue, Suite 101
Fresno, CA 93727
Telephone: 559-497-2880

Project: Rio Dell HDD Pipeline
Location: Rio Dell, California
Project No.: G00-001-255
Logged By: K. Yang
Checked By: N. Popenoe

Boring: **B-3**

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
1–4								SM	**Silty SAND** - dark brown, moist, medium dense, fine grained sand, fine grained gravel	
3			24							
5–7								CL	**Sandy CLAY** - brown, moist, medium plasticity, fine grained sand	
6			22							
10–14								GC	**Clayey GRAVEL with Sand** - greenish black, wet, medium dense, angular-subangular, fine coarse gravel	
11			22	126.8	9.7					
15–24								CH	**Fat CLAY** - bluish gray, medium plasticity, moist, firm ... cuttings lean clay, brown-bluish gray, medium-high plasticity	
16			13	106.0	22.3					
21			12							
25–35								GP-GC	**Poorly Graded GRAVEL with Clay and Sand** - brown to dark brown, wet, dense, medium grained sand, fine gravel, angular gravel (clay matrix) ... subangular gravel	
26			41							
31			44							
36			52							
36–39								MH	**Elastic SILT with Sand** - bluish gray, moist, medium plasticity, firm to hard	

Drilling Contractor: Taber
Drilling Method: Hollow Stem Auger
Drilling Equipment: CME 55
Date Started: 10/3/23
Date Completed: 10/3/23

Surface Elevation: 0.0
Sample Method: 2.5" Modified Cal & 1.5" I.D. SPT Split Spoon
Groundwater Depth: Not Encountered
Completion Depth: 150 Feet
Borehole Diameter: 8"

* See key sheet for symbols and abbreviations used above.

BSK Associates
691 N. Laverne Avenue, Suite 101
Fresno, CA 93727
Telephone: 559-497-2880

Project: Rio Dell HDD Pipeline
Location: Rio Dell, California
Project No.: G00-001-255
Logged By: K. Yang
Checked By: N. Popenoe

Boring: **B-3**

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
41			97					MH	**Elastic SILT** - bluish gray, moist, hard	
44								Sltstn	**SILTSTONE** bluish gray, slightly unweathered, weakly cemented, unfractured, no filling	Run 1: Recovery=26", RQD=48%
45					8.9					
48					12.2				... siltstone, blush gray, slightly weathered, fractured, weakly cemented, no filling	Run 2: Recovery=7", RQD=30%
52					13.9					Run 3: Recovery=41", RQD=76%
56					12.4				siltstone, bluish gray, unweathered, tight aperture, no fill, fine grained sand, Joint 55 degrees VRC=4-6	Run 4: Recovery=32", RQD=100%
60									Joint=55, fine gravel, fine bedding from 56' - 56.5', weak	Run 5: Recovery=49", RQD=98%
65										Run 6: Recovery=58", RQD=98% Run 7: Recovery=51", RQD=85%
67								Sltstn	**Sandy SILTSTONE** - bluish gray, unweathered tight aperture, no fill, very fine grained sand,weak	
70										Run 8: Recovery=59", RQD=93%
75								Sndstn	**Clayey SANDSTONE** - bluish gray, fine grained sand, Jointed=50" @ 75.2ft bgs, weak, tight aperture, JRC=4-6	
78										Run 9: Recovery=61", RQD=93%

Drilling Contractor: Taber
Drilling Method: Hollow Stem Auger
Drilling Equipment: CME 55
Date Started: 10/3/23
Date Completed: 10/3/23

Surface Elevation: 0.0
Sample Method: 2.5" Modified Cal & 1.5" I.D. SPT Split Spoon
Groundwater Depth: Not Encountered
Completion Depth: 150 Feet
Borehole Diameter: 8"

* See key sheet for symbols and abbreviations used above.

BSK Associates
691 N. Laverne Avenue, Suite 101
Fresno, CA 93727
Telephone: 559-497-2880

Project: Rio Dell HDD Pipeline
Location: Rio Dell, California
Project No.: G00-001-255
Logged By: K. Yang
Checked By: N. Popenoe

Boring: **B-3**

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
81–96									**Clayey SANDSTONE** - bluish gray, fine grained sand, Jointed=50" @ 75.2ft bgs, weak, tight aperture, JRC=4-6 *(continued)* jointed =50" @ 80' bgs and 40 degrees @ 82.9' bgs ... weak ... very weak	Run 10: Recovery=55", RQD=90% Run 11: RQD=35% Run 12 and 13 samples disturbed, Total recovery=58" Run 12: RQD=30%
96										Run 13: Recovery=22", RQD=71%
96–99								Sltstn	**Clayey SILTSTONE** - bluish gray, fine, unweathered, weak, no infilling	
99–102								Sndstn	**Clayey SANDSTONE** - bluish gray, fine sand, unweathered, weak, no infilling	Run 14: Recovery=58", RQD=50%
102–108								Sltstn	**SILTSTONE** - bluish gray, unweathered, Silt & Clay, weak, no infilling, moderately fractured, JRC=4-6, Joint 50 degress @ 103.5' bgs ... laminated foliation	Run 15: Recovery=59", RQD=100% Run 16: Recovery=6", RQD=100%
108–118					7.4			Sndstn	**Clayey SANDSTONE** - bluish gray, unweathered, weak, no filling, slightly unfracture, JRC=2-4 Silt bedding, laminated, fine grained sand Joint 60 @ 112' bgs	Run 17: Recovery=58", RQD=100% Run 18: Recovery=55", RQD=98%
118								Sltstn	**SILTSTONE** - clayey sandstone, bluish gray, unweathered, weak, no filling, slightly fractured, very fine grained sand, JRC=2-4, no visible bedding	
118–119										

Drilling Contractor: Taber
Drilling Method: Hollow Stem Auger
Drilling Equipment: CME 55
Date Started: 10/3/23
Date Completed: 10/3/23

Surface Elevation: 0.0
Sample Method: 2.5" Modified Cal & 1.5" I.D. SPT Split Spoon
Groundwater Depth: Not Encountered
Completion Depth: 150 Feet
Borehole Diameter: 8"

* See key sheet for symbols and abbreviations used above.

BSK Associates
691 N. Laverne Avenue, Suite 101
Fresno, CA 93727
Telephone: 559-497-2880

Project: Rio Dell HDD Pipeline
Location: Rio Dell, California
Project No.: G00-001-255
Logged By: K. Yang
Checked By: N. Popenoe

Boring: **B-3**

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
121–123									**SILTSTONE** - clayey sandstone, bluish gray, unweathered, weak, no filling, slightly fractured, very fine grained sand, JRC=2-4, no visible bedding *(continued)*	Run 19: Recovery=61", RQD=87%
123–129								Sltstn	**SILTSTONE** - bluish gray, very fine grained sand, unweathered, weak, slightly fractured, tight aperture, JRC= 2-4, no infilling	Run 20: Recovery=62, RQD=95%
129–135									**SHALE** - bluish gray, fine very fine grained, unweathered, slightly fractured, tight aperture, JRC=2-4, no infilling	Run 21: Recovery=54, RQD=98%
135–137					11.3				Joint=50 @ 135.3', 135.5', 136', 136.5'	Run 22: Recovery=60", RQD=77%
137–145										Run 23: Recovery=50", RQD=81%
145–147										Run 24: Recovery=34", RQD=88%
147–150									... Shale, bluish gray, fine very fine grained, unweathered, weak, slightly fractured, tight aperture, JRC = 2-4, no infilling	Run 25: Recovery=56, RQD=91%
150–159									Boring terminated at approximately 150 feet bgs. No groundwater encountered. Boring backfilled with neat cement and soil cuttings.	

Drilling Contractor: Taber
Drilling Method: Hollow Stem Auger
Drilling Equipment: CME 55
Date Started: 10/3/23
Date Completed: 10/3/23

Surface Elevation: 0.0
Sample Method: 2.5" Modified Cal & 1.5" I.D. SPT Split Spoon
Groundwater Depth: Not Encountered
Completion Depth: 150 Feet
Borehole Diameter: 8"

* See key sheet for symbols and abbreviations used above.

BSK Associates
691 N. Laverne Avenue, Suite 101
Fresno, CA 93727
Telephone: 559-497-2880

Project: Rio Dell HDD Pipeline
Location: Rio Dell, California
Project No.: G00-001-255
Logged By: K. Yang
Checked By: N. Popenoe

Boring: **B-4**

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
1–4								GP	**Poorly Graded GRAVEL with Sand** - moist, coarse gravel, medium dense (fill)	
3	■		23							
4–10								CL	**Sandy Lean CLAY** - brown, moist, medium plasticity, soft-firm, trace fine gravel, fine grained sand	
5–6	■		7							
10–11	■		11						... cuttings; sandy clay (CL)	no recovery
13–15								SP-SC	**Poorly Graded SAND with Clay** - brown, low plasticity, moist, loose, fine grained sand	
15–16	⊠		7							
20–21	■		14					CL	**Sandy Lean CLAY** - brown, medium plasticity, moist, soft	
24–25								SC	**Clayey SAND** - brown, moist, loose, non-plastic, fine grained sand	
25–26	■		15							
29–30	■		50/ 5.5					GP-GC	**Poorly Graded GRAVEL with Clay and Sand** - brown with yellowish red staining, wet, dense, fine coarse gravel, coarse sand	
35–36	⊠		50						... fine gravel	
36									Boring terminated at approximately 36.5 feet bgs. No groundwater encountered. Boring backfilled with neat cement and soil cuttings.	

Drilling Contractor: Taber
Drilling Method: Hollow Stem Auger
Drilling Equipment: CME 55
Date Started: 10/3/23
Date Completed: 10/3/23

Surface Elevation: 0.0
Sample Method: 2.5" Modified Cal & 1.5" I.D. SPT Split Spoon
Groundwater Depth: Not Encountered
Completion Depth: 36.5 Feet
Borehole Diameter: 8"

* See key sheet for symbols and abbreviations used above.

GEO_BORING LOGS.GPJ_BSK.GDT_12/18/23

APPENDIX B

LABORATORY TESTING

APPENDIX B
Laboratory Testing

The results of laboratory testing performed in conjunction with this project are contained in this Appendix. The following laboratory tests were performed on soil samples in general conformance with applicable standards.

In-Situ Moisture and Density

The field moisture content and in-place dry density determinations were performed on relatively undisturbed samples obtained from the test borings. The field moisture content, as a percentage of dry weight of the soils, was determined by weighing the samples before and after oven drying in accordance with ASTM D2216 test procedures. Dry densities, in pounds per cubic foot, were also determined for undisturbed core samples in accordance with ASTM D2937 test procedures. Test results are presented on the boring logs in Appendix A.

Gradation

Three (3) Sieve Analysis tests were performed on a selected soil samples in the area of planned construction. The test was performed in general accordance with Test Method ASTM D422. The results of the tests are presented on Figures B-1 through B-3.

Atterberg Limits Test

Five (5) Atterberg Limits Test were performed on soil samples obtained at the time of drilling in the area of planned construction. The tests were performed in general accordance with ASTM D4829. The test results are presented on Figures B-4 through B-7.

Direct Shear Test

Two (2) direct shear tests were performed on test specimens trimmed from selected soil samples. The three-point shear tests were performed in general accordance with ASTM D3080, Direct Shear Test for Soil under Consolidated Drained Conditions. The test specimens, each 2.42 inches in diameter and 1 inch in height, were subjected to shear along a plane at mid-height after allowing for pore pressure dissipation. The results of this test are presented on Figures B-8 and B-9.

Unconfined Compressive Strength

Three (3) Unconfined compressive strength tests were performed on test specimens trimmed from selected samples. The tests were performed in accordance with ASTM D2166. The test specimens, each 2.30 to 2.50 inches in diameter and 4.30 to 5.30 inches in length, were subjected to axial loading until failure. The results of these tests are presented on Figure B-10.

Soil Corrosivity

The results of chemical analyses performed on bulk soil samples using California Test Method 643 (for pH and minimum resistivity) and California Test Methods 422 and 417 (for soluble sulfate and chlorides, respectively) are presented in Table B-1.

Table B-1: Summary of Corrosion Test Results

Sample Location	pH	Sulfate (mg/kg)	Chloride (mg/kg)	Minimum Resistivity (ohms-cm)
B-1 @ 15 – 16.5’	7.05	Not Detected	Not Detected	5,290
B-3 @ 3.5 – 6.5’	7.0	Not Detected	Not Detected	4,160

BSK ASSOCIATES

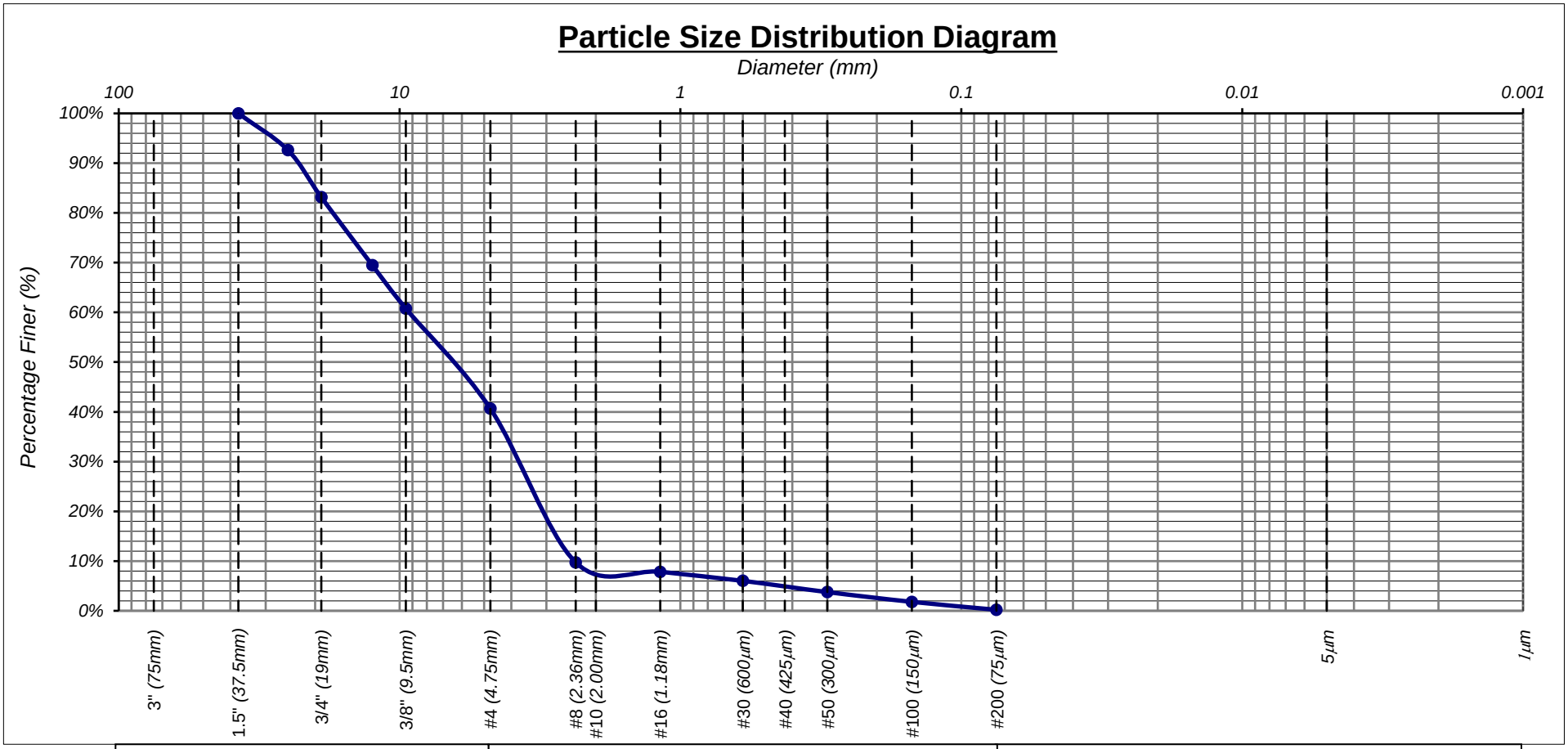
691 N Laverne Ave,
Suite 101
Fresno, CA 93727
Ph: (559) 497-2880

Gradation Analysis Report
ASTM D-422 / ASTM C-136

FIGURE B-1

Project Name:	Rio Dell HDD Gas Pipeline	**Project Number:**	G00001255	**Report Date:**	12/12/2023
Sample Location:	B - 1 @ 30' - 31.5'	**Sample Lab ID:**	N/A	**Sample Date:**	11/28/2023
Sample Description:	Poorly Graded Gravel with Sand (GP) - bluish gray - grayish brown, moist, medium dense, fine to coarse sand, fine to coarse gravel			**Test Date:**	12/11/2023

Particle Size Distribution Diagram



Clear Square Openings (ASTM C-136)			US Standard Series (ASTM D-422)			Hydrometer Readings (ASTM D-422)
Cobble	Gravel		Sand			Silt (Non-Plastic) to Clay (Plastic)
	Coarse	Fine	Coarse	Medium	Fine	

% Gravel = 59% **% Sand = 40%** **% Fines = 0%**

ASSOCIATES

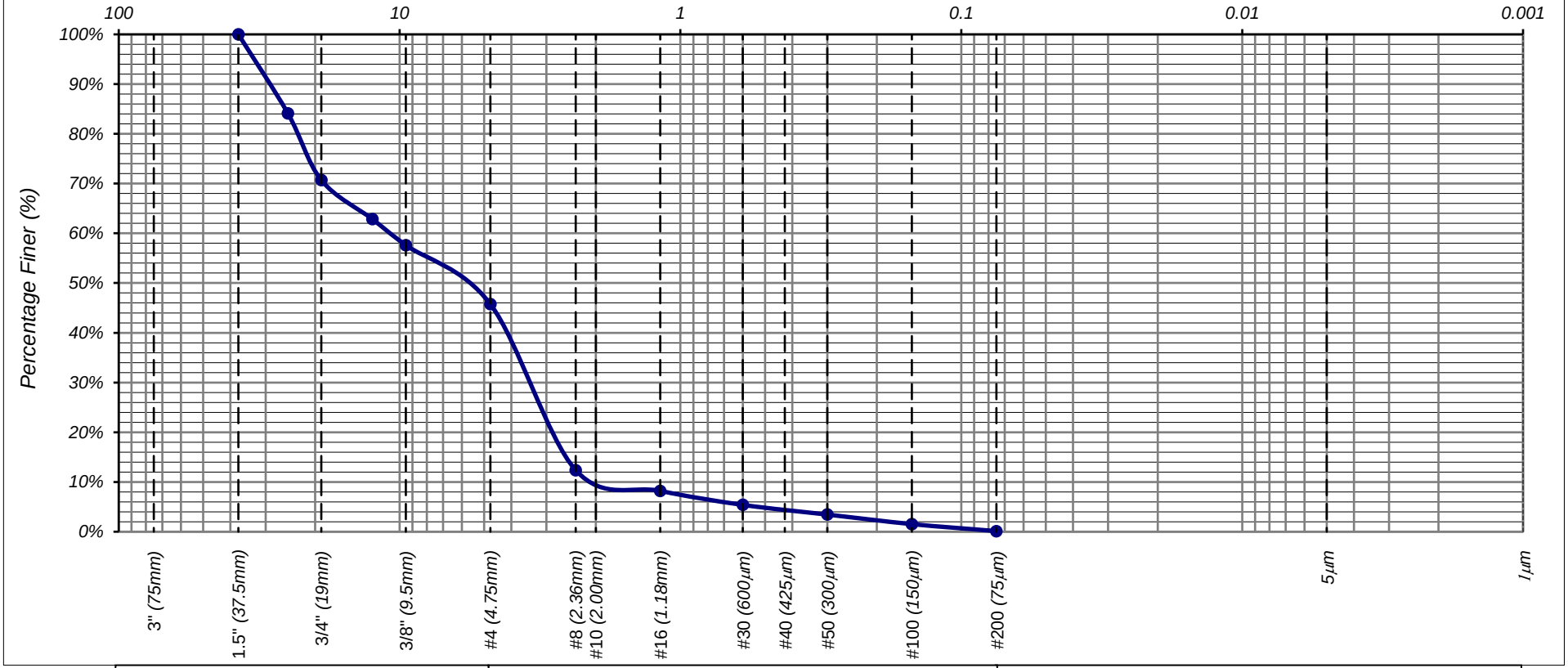
691 N Laverne Ave,
Suite 101
Fresno, CA 93727
Ph: (559) 497-2880

Gradation Analysis Report
ASTM D-422 / ASTM C-136

FIGURE B-2

Project Name:	Rio Dell HDD Gas Pipeline	**Project Number:**	G00001255	**Report Date:**	12/12/2023
Sample Location:	B - 1 @ 60' - 61.5'	**Sample Lab ID:**	N/A	**Sample Date:**	11/28/2023
Sample Description:	Poorly Graded Gravel with Sand (GP) - bluish gray, wet, dense, fine grained sand, fine to coarse gravel			**Test Date:**	12/11/2023

Particle Size Distribution Diagram



Clear Square Openings (ASTM C-136)			US Standard Series (ASTM D-422)			Hydrometer Readings (ASTM D-422)
Cobble	Gravel		Sand			Silt (Non-Plastic) to Clay (Plastic)
	Coarse	Fine	Coarse	Medium	Fine	

% Gravel = 54% **% Sand = 46%** **% Fines = 0%**

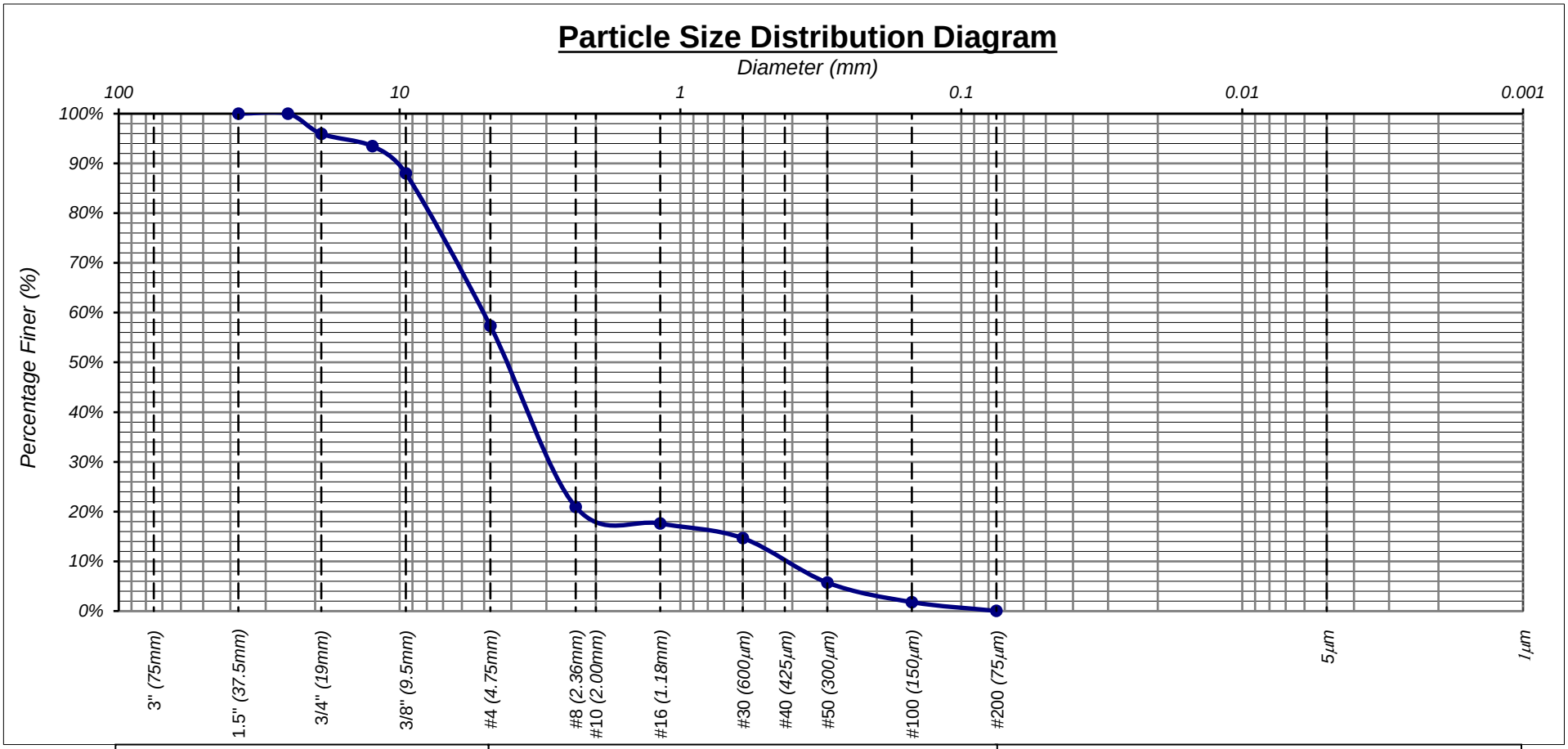
BSK ASSOCIATES
691 N Laverne Ave,
Suite 101
Fresno, CA 93727
Ph: (559) 497-2880

Gradation Analysis Report
ASTM D-422 / ASTM C-136

FIGURE B-3

Project Name:	Rio Dell HDD Gas Pipeline	**Project Number:**	G00001255	**Report Date:**	12/12/2023
Sample Location:	B - 1 @ 85' - 86.5'	**Sample Lab ID:**	N/A	**Sample Date:**	11/28/2023
Sample Description:	Poorly Graded Sand with Gravel (SP) - bluish gray, wet, very dense, fine grained sand, fine rounded gravel			**Test Date:**	12/11/2023

Particle Size Distribution Diagram



Clear Square Openings (ASTM C-136)			US Standard Series (ASTM D-422)			Hydrometer Readings (ASTM D-422)
Cobble	Gravel		Sand			Silt (Non-Plastic) to Clay (Plastic)
	Coarse	Fine	Coarse	Medium	Fine	

% Gravel = 43% **% Sand = 57%** **% Fines = 0%**

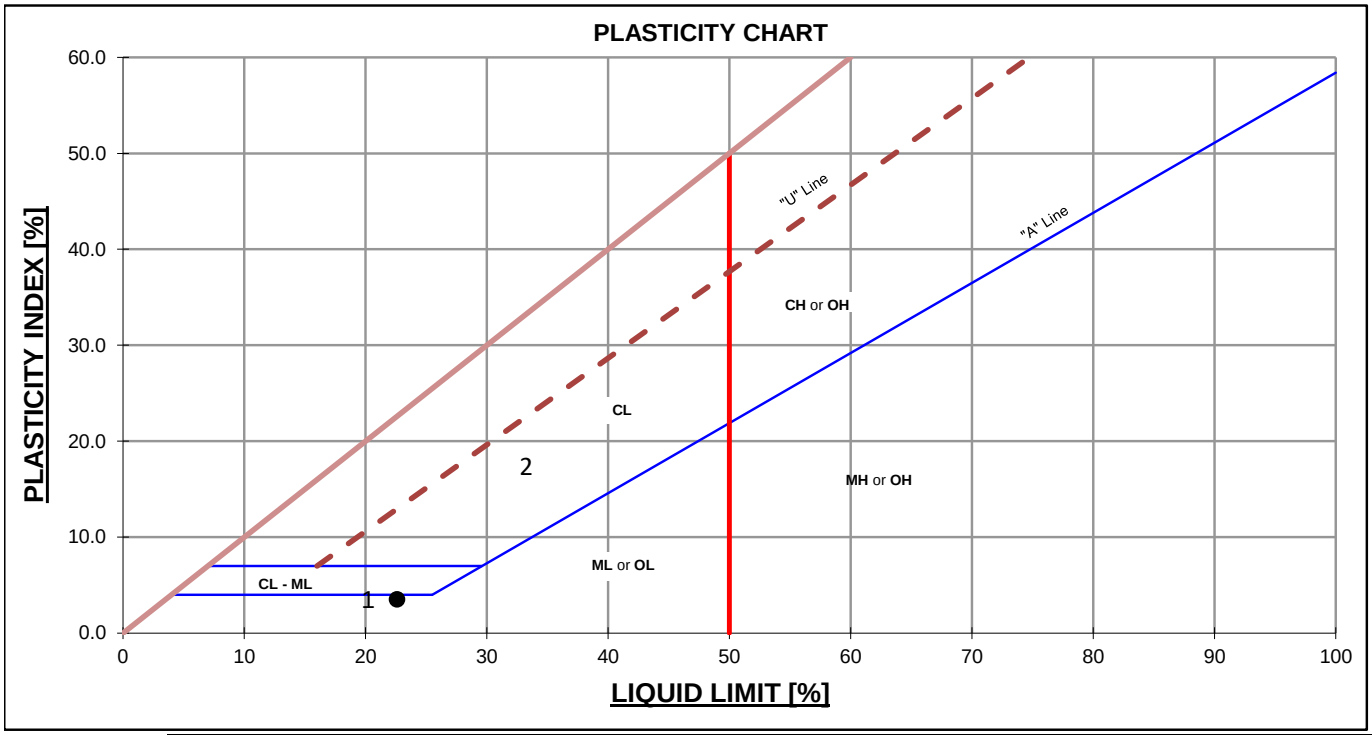
BSK ASSOCIATES
691 W. Laverne Avenue,
Suite 101
Fresno, CA 93727
Ph: (559) 497-2868

LIQUID LIMIT (LL), PLASTIC LIMIT (PL), AND PLASTICITY INDEX (PI) OF SOILS

ASTM D-4318

Figure B-4

Project Name:	Rio Dell HDD Gas Pipeline		**Report Date:** 12/13/2023
Project Number:	G00001255		**Sample Date:** 12/6/2023
Sampled By:	K. Yang	**Tested By:** D.Messfin	**Test Date:** 12/11/2023



Sample #	1			2			3		
Sample ID Location Description	B - 1 @ 6'								
	Liquid Limit Data								
Wet+Tare (g)	21.00	20.22	21.02						
Dry+Tare (g)	18.58	18.10	18.86						
Tare (g)	8.46	8.48	8.56						
Spec. Blows	25-35	20-30	15-25	25-35	20-30	15-25	25-35	20-30	15-25
No. of Blows	33	22.00	15						
LL	23.9	22.0	21.0						
Corrected LL									
	Plastic Limit Data								
Wet+Tare (g)	29.83	30.19							
Dry+Tare (g)	28.27	28.60							
Tare (g)	20.13	20.19							
M.C.	19.2	18.9							
	Results	**Specification**		**Results**	**Specification**		**Results**	**Specification**	
AVG L.L.	22.6								
AVG P.L.	19.0								
P.I.	4								
USCS Symbol									

Remarks: _____

Reviewed By: _____ **Date:** _____

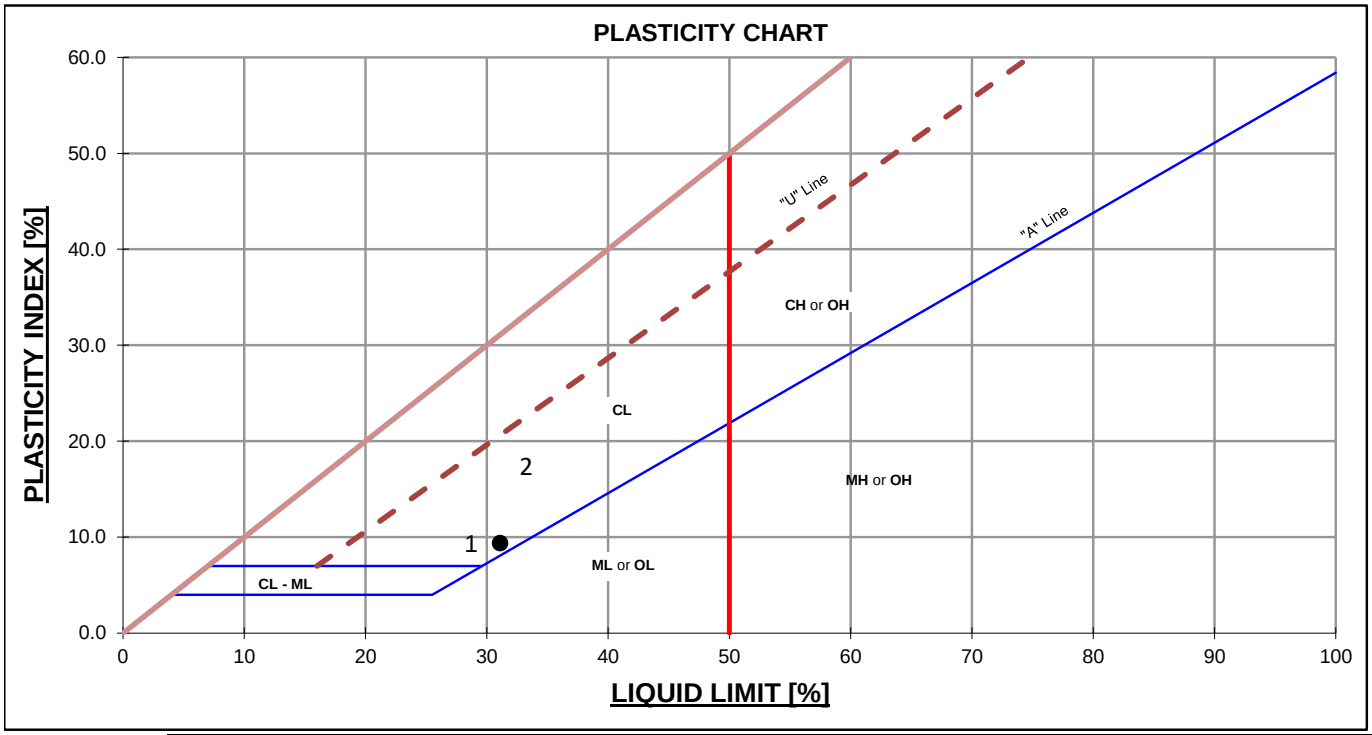
BSK ASSOCIATES
691 W. Laverne Avenue,
Suite 101
Fresno, CA 93727
Ph: (559) 497-2868

LIQUID LIMIT (LL), PLASTIC LIMIT (PL), AND PLASTICITY INDEX (PI) OF SOILS

ASTM D-4318

Figure B-5

Project Name:	Rio Dell HDD Gas Pipeline		**Report Date:** 12/13/2023
Project Number:	G00001255		**Sample Date:** 12/6/2023
Sampled By:	K. Yang	**Tested By:** D.Messfin	**Test Date:** 12/11/2023



Sample #	1			2			3		
Sample ID Location Description	B-1 @ 25' - 26.5'								
	Liquid Limit Data								
Wet+Tare (g)	19.06	18.79	15.18						
Dry+Tare (g)	16.57	16.33	12.95						
Tare (g)	8.48	8.47	6.11						
Spec. Blows	25-35	20-30	15-25	25-35	20-30	15-25	25-35	20-30	15-25
No. of Blows	28	22.00	15						
LL	30.8	31.3	32.6						
Corrected LL									
	Plastic Limit Data								
Wet+Tare (g)	30.62	30.35							
Dry+Tare (g)	28.77	28.52							
Tare (g)	20.20	20.13							
M.C.	21.6	21.8							
	Results	**Specification**		**Results**	**Specification**		**Results**	**Specification**	
AVG L.L.	31.1								
AVG P.L.	21.7								
P.I.	9								
USCS Symbol									

Remarks: _____

Reviewed By: _____ **Date:** _____

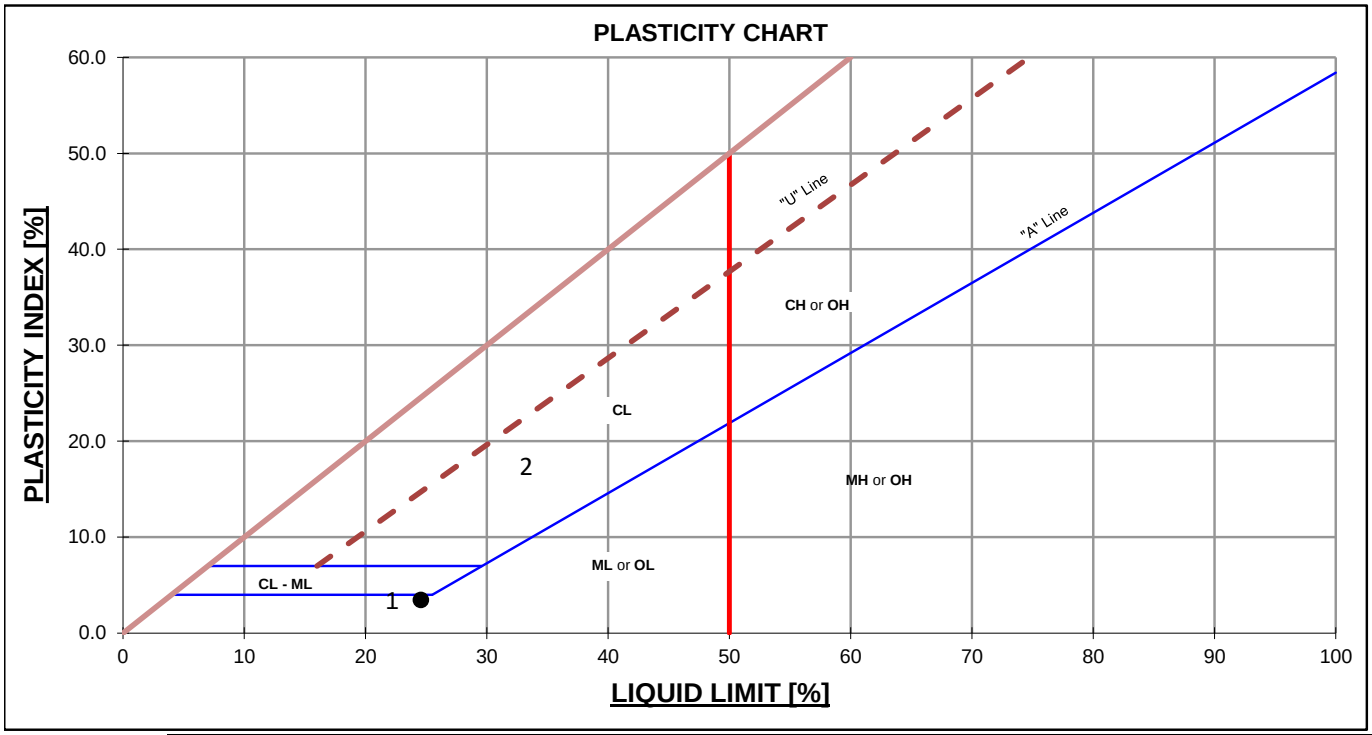
BSK ASSOCIATES
691 W. Laverne Avenue,
Suite 101
Fresno, CA 93727
Ph: (559) 497-2868

LIQUID LIMIT (LL), PLASTIC LIMIT (PL), AND PLASTICITY INDEX (PI) OF SOILS

ASTM D-4318

Figure B-6

Project Name:	Rio Dell HDD Gas Pipeline		**Report Date:** 12/13/2023
Project Number:	G00001255		**Sample Date:** 12/6/2023
Sampled By:	K. Yang	**Tested By:** D.Messfin	**Test Date:** 12/11/2023



Sample #	1			2			3		
Sample ID Location Description	B-1 @ 40' - 41.5'						B - 1 @ 50' - 51.5'		
Liquid Limit Data									
Wet+Tare (g)	18.04	14.49	14.68						
Dry+Tare (g)	15.76	12.84	12.93						
Tare (g)	6.43	6.32	6.47				8.50	8.48	8.47
Spec. Blows	25-35	20-30	15-25	25-35	20-30	15-25	25-35	20-30	15-25
No. of Blows	26	21.00	15						
LL	24.4	25.3	27.1						
Corrected LL									
Plastic Limit Data									
Wet+Tare (g)	29.80	30.27							
Dry+Tare (g)	28.11	28.52							
Tare (g)	20.09	20.22					20.20	20.14	
M.C.	21.1	21.1							
	Results	**Specification**		**Results**	**Specification**		**Results**	**Specification**	
AVG L.L.	24.6						NON PLASTIC		
AVG P.L.	21.1								
P.I.	3								
USCS Symbol									

Remarks: _____

Reviewed By: _____ **Date:** _____

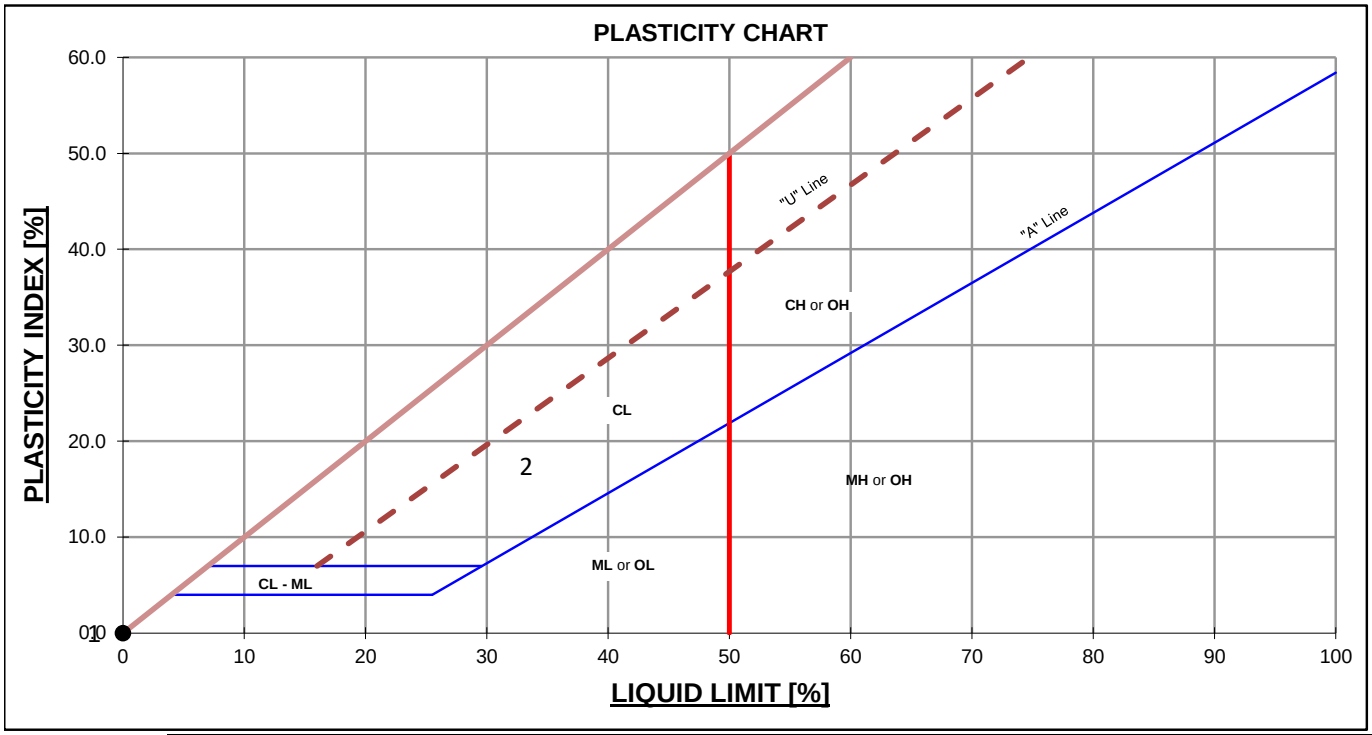
BSK ASSOCIATES
691 W. Laverne Avenue,
Suite 101
Fresno, CA 93727
Ph: (559) 497-2868

LIQUID LIMIT (LL), PLASTIC LIMIT (PL), AND PLASTICITY INDEX (PI) OF SOILS

ASTM D-4318

Figure B-7

Project Name:	Rio Dell HDD Gas Pipeline	**Report Date:**	12/13/2023
Project Number:	G00001255	**Sample Date:**	12/6/2023
Sampled By:	K. Yang **Tested By:** D.Messfin	**Test Date:**	12/11/2023



Sample #	1			2			3		
Sample ID Location Description	B - 1 @ 96' - 96.5'								
Liquid Limit Data									
Wet+Tare (g)									
Dry+Tare (g)									
Tare (g)	8.46	8.48	8.56						
Spec. Blows	25-35	20-30	15-25	25-35	20-30	15-25	25-35	20-30	15-25
No. of Blows									
LL									
Corrected LL									
Plastic Limit Data									
Wet+Tare (g)									
Dry+Tare (g)									
Tare (g)	20.13	20.19							
M.C.									
	Results	**Specification**		**Results**	**Specification**		**Results**	**Specification**	
AVG L.L.									
AVG P.L.									
P.I.									
USCS Symbol	**NON PLASTIC**								

Remarks: _____

Reviewed By: _____ **Date:** _____

BSK ASSOCIATES
691 N Laverne Ave
Fresno, CA 93727
Ph: (559) 497-2880

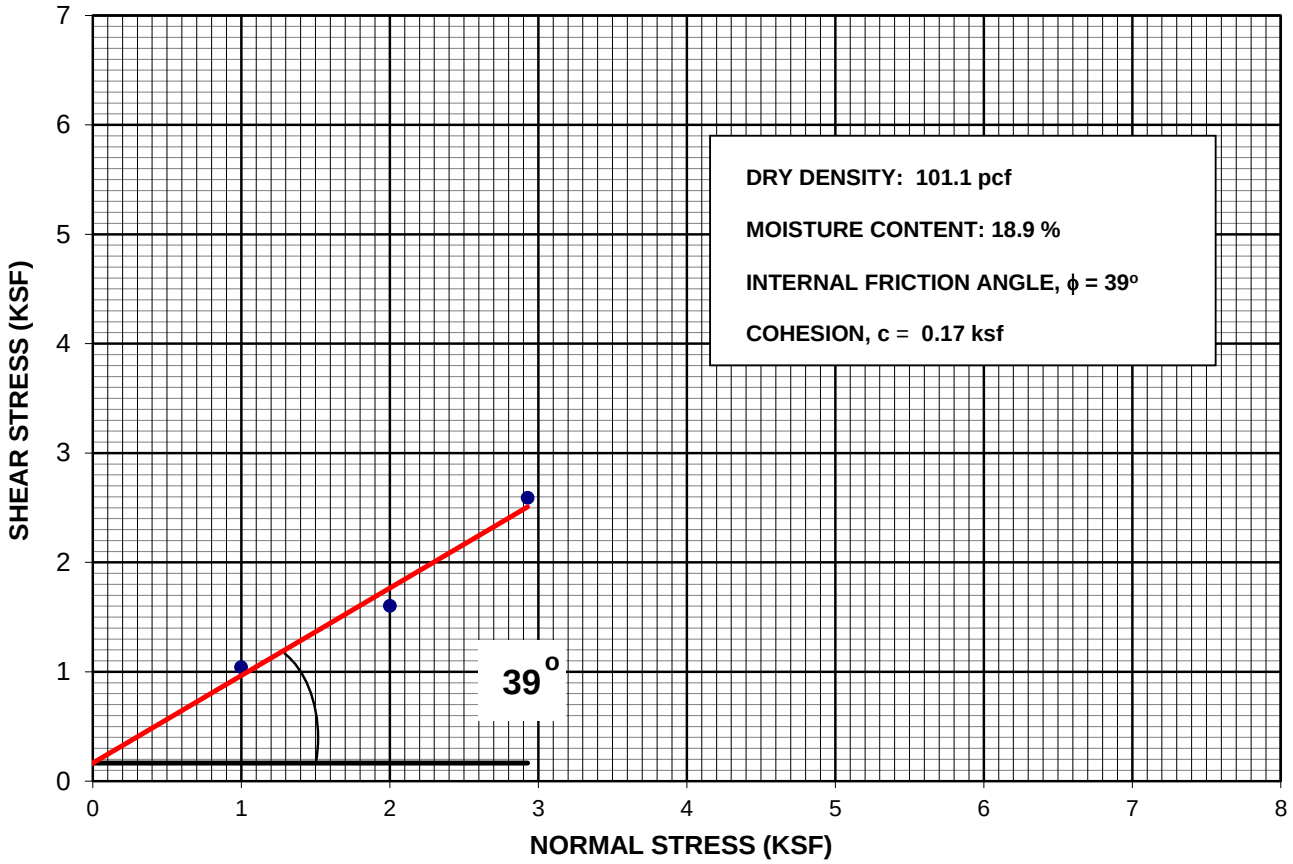
FIGURE B-8

Direct Shear Test

ASTM D-3080

Project Name:	Rio Dell HDD Gas Pipeline	**Sampled By:**	K. Yang	**Sample Date:**	11/28/2023
		Tested By:	D. Messfin	**Test Date:**	12/5/2023
Project Number:	G00001255	**Lab Tracking ID:**	N/A	**Report Date:**	12/11/2023
Sample Location:	B-1 @ 6'	**Sample Description:**	Sandy Silt (ML) - dark bluish brown, moist, loose, fine grained sand, fine grained subrounded gravel		

SHEAR STRENGTH DIAGRAM



BSK ASSOCIATES
691 N Laverne Ave
Fresno, CA 93727
Ph: (559) 497-2880

Direct Shear Test

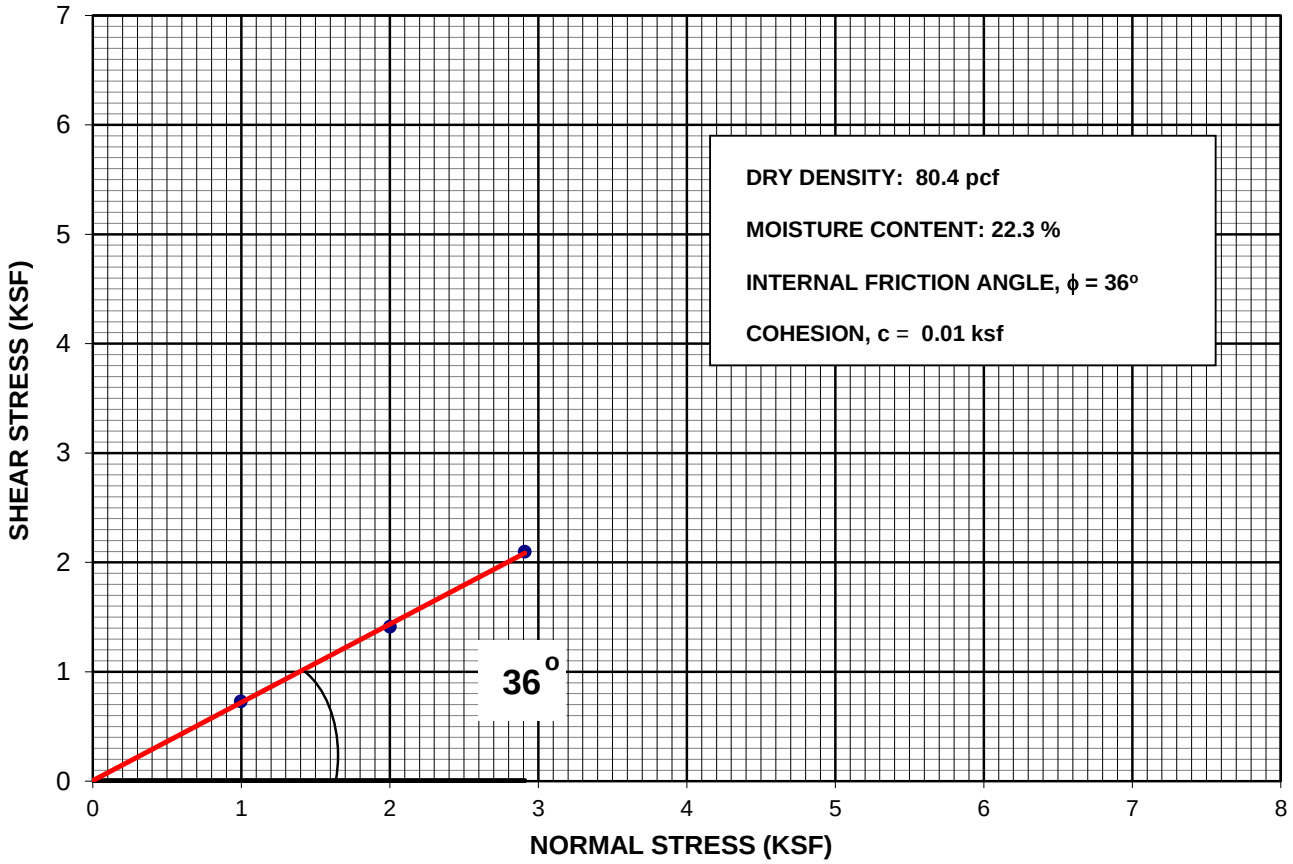
ASTM D-3080

FIGURE B-9

Project Name:	Rio Dell HDD Gas Pipeline	**Sampled By:**	K. Yang	**Sample Date:**	11/28/2023
		Tested By:	D. Messfin	**Test Date:**	12/6/2023
Project Number:	G00001255	**Lab Tracking ID:**	N/A	**Report Date:**	12/11/2023

Sample Location: B-1 @ 21' **Sample Description:** Silty Sand (SM) - grayish brown, moist, loose, fine grained sand, weakly cemented

SHEAR STRENGTH DIAGRAM



691 N Laverne Avenue,
Suite 101
Fresno, CA 93727
Phone: 559-497-2880

Unconfined Compressive Strength of Cohesive Soils

ASTM D2166

BSK Project No.: G00001255
Report Date: 12/18/2023
Specimen ID No.: N/A

Subject: **Unconfined Compression Test**
Project: Rio Dell HDD Gas Pipeline

Location of Work: N/A
Sample Location: B-1
Date Sampled: 12/2/2023
Test Date: 11/14/2023

Sample ID	Date Tested	Tested By	Unconfined Compressive Strength (psf)	Max. Load, (lbs)	Length of specimen (in)	Diameter or Dimension, (in)	Area in inches (squared)	Break Type
B-3 @ 54'	11/14/23	D. Messfin	15,614.46	450	5.3	2.30	4.15	2
B-3 @ 107.5'	11/14/23	D. Messfin	13,539.82	425	5.20	2.40	4.52	2
B-3 @ 132'	11/14/23	D. Messfin	10,880.65	371	4.30	2.50	4.91	2

TYPE 1 = CONE
TYPE 2 = CONE/SPLIT
TYPE 3 = COLUMNAR
TYPE 4 = SHEAR
TYPE 5 = SIDE FRACTURES AT TOP OR BOTTOM
TYPE 6 = SIMILAR TO TYPE 5 BUT END OF CYLINDER IS POINTED

Figure B-10