8/12/2022

Geotechnical Evaluation Report

Proposed Triview NDS Pump Station

Vicinity of Old Northgate Road and Highway 83

Colorado Springs, Colorado

VIVID Project No.: D21-2-457

VIVID Engineering Group

Report prepared for:

Gwen Dall, P.E.
JDS-Hydro Consultants, Inc.
5540 Tech Center Drive, Suite 100
Colorado Springs, CO 80919
gdall@jdshydro.com

GEOTECHNICAL EVALUATION REPORT
Proposed Triview NDS Pump Station
Vicinity of Old Northgate Road and Highway 83
Colorado Springs, Colorado
VIVID Project No.: D21-2-457

Prepared by:

Brysen T. Mustain, P.G.
Engineering Geologist

Thomas J. Nevin, P.E.
Senior Geotechnical Engineer

VIVID Engineering Group, Inc.
1053 Elkton Drive
Colorado Springs, CO 80907
(719) 896-4356
(719) 896-4357 fax

Table of Contents

1.0 INTRODUCTION

1.1 GENERAL

This report presents the results of a geotechnical investigation performed for the proposed Triview Metropolitan District NDS Pump Station to be constructed in the vicinity of Old Northgate Road and Highway 83 in Colorado Springs, Colorado. An attached Vicinity Map (Figure 1) shows the general location of the project site. Our investigation was performed for JDS-Hydro Consultants Inc. and was authorized by Ms. Gwen Dall, P.E.

This report includes our recommendations relating to the geotechnical aspects of project design and construction. The conclusions and recommendations stated in this report are based upon the subsurface conditions found at the locations of our exploratory borings at the time our exploration was performed. They also are subject to the provisions stated in the report section titled **Additional Services & Limitations**. Our findings, conclusions, and recommendations should not be extrapolated to other areas or used for other projects without our prior review. Furthermore, they should not be used if the site has been altered, or if a prolonged period has elapsed since the date of the report, without VIVID's prior review to determine if they remain valid.

1.2 PROJECT DESCRIPTION

We understand the proposed project consists of constructing a new pump station building southeast of the existing water tank in the vicinity of Old Northgate Road and Highway 83 in Colorado Springs, Colorado. The pump station is planned to be a metal building with a partial stone veneer with plan dimensions of approximately 37 feet by 47 feet, and will house a pumping system, piping, electrical and controls equipment. Water pipeline infrastructure will connect to the pump station.

No grading plans were available for our review when this report was prepared; however, we estimate general site grading will be limited to providing proper drainage away from the site improvements and preparing the foundation and below grade construction excavations for the pump station. We understand a portion of the building will be a below-grade/recessed area planned to be approximately 9 feet below main level. The main level will be near the existing ground surface. No structural loads were provided at the time this report was written. If the type of construction or actual structure loads vary significantly from those assumed above, VIVID should be notified in order to revise our recommendations, if required.

1.3 PURPOSE AND SCOPE

The purpose of our investigation was to explore and evaluate subsurface conditions at the pump station site and, based upon the conditions found, to develop recommendations relating to the geotechnical aspects of project design and construction. Our conclusions and recommendations in this report are based upon analysis of the data from our field exploration, laboratory tests, and our experience with similar soil and geologic conditions in the area.

VIVID's scope of services included:

- A visual reconnaissance to observe surface and geologic conditions at the project site;

- Notification of the Utility Notification Center of Colorado (UNCC)/Colorado 811 one-call service to identify underground utility lines at the boring location prior to our drilling;
- The drilling of two exploratory borings within or near the proposed pump station footprint; selected and marked by JDS-Hydro and based upon the proposed site layout, access, and location of existing structures and utilities;
- Laboratory testing of selected samples obtained during the field exploration to evaluate relevant physical and engineering properties of the soil;
- Evaluation and engineering analysis of the field and laboratory data collected to develop our geotechnical conclusions and recommendations; and
- Preparation of this report, which includes a description of the proposed project, a description of the surface and subsurface site conditions found during our investigation, our conclusions and recommendations as to foundation design and construction, and other related geotechnical issues, and appendices which summarize our field and laboratory investigations.

2.0 FIELD EXPLORATION AND LABORATORY TESTING

2.1 FIELD EXPLORATION

A field exploration performed on July 13, 2022, included drilling two exploratory borings within or near the proposed pump station footprint at the approximate locations indicated on the attached Field Exploration Plans (Figures 2 and 3). Each boring was advanced to a depth of approximately 29 feet below the existing ground surface.

The borings were advanced using a truck-mounted CME-55 drill rig equipped with 4-inch diameter, continuous-flight, solid-stem auger. Samples were taken with a standard split-spoon (SPT) sampler, California-type sampler (2.0-inch I.D./2.5-inch O.D.) and by bulk methods. Penetration tests were obtained at the various sample depths as well.

Appendix A to this report includes logs describing the subsurface conditions. The lines defining boundaries between soil and rock types on the logs are based upon drill behavior and interpolation between samples and are therefore approximate. Transition between soil types may be abrupt or may be gradual.

2.2 GEOTECHNICAL LABORATORY TESTING

Laboratory tests were performed on selected soil samples to estimate their relative engineering properties. Tests were performed in general accordance with the following methods of ASTM or other recognized standards-setting bodies, and local practice:

- Description and Identification of Soils (Visual-Manual Procedure)
- Classification of Soils for Engineering Purposes
- Moisture Content and Unit Weight
- Sieve Analysis
- Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- Denver Swell Test

Results of the geotechnical laboratory tests are presented in the report text, where applicable, and included in Appendix B of this report. Selected test results are also shown on the boring logs in Appendix A.

2.3 ANALYTICAL LABORATORY TESTING

Analytical testing for soil corrosivity was performed on one select sample and included the following tests:

- pH
- Resistivity
- Redox Potential
- Water-soluble Chlorides
- Sulfides
- Water-soluble Sulfate Content

Results of the analytical laboratory tests are included in Appendix C of this report.

3.0 SITE CONDITIONS

3.1 SURFACE

The proposed pump station location is planned to be near the southeast side of the existing above-ground water tank. A gravel access road bordered the site to the north. The pump station site sloped down gently from the access road toward a natural drainage located southeast of the pump station site. The ground surface was covered and grass and small trees. The property surrounding the pump station was generally vacant, except for the existing water tank located to the northwest of the site.

3.2 GEOLOGY

Prior to drilling, the site geology was evaluated by reviewing available geologic information including the Colorado Geologic Society (CGS) Geologic Map of the Monument Quadrangle, El Paso County, Colorado (Thorson and Madole, 2004). Mapping indicates the surficial soils in the general area of the project site comprise predominantly alluvium deposits of sand and gravel underlain by sandstone and claystone bedrock of the Dawson Formation. The mapping is generally consistent with our explorations. However, man-made fill was encountered at the ground surface in both borings and is presumably associated with construction of the nearby water tank.

3.3 SEISMICITY

Based upon the geologic setting, subsurface soil conditions, and low seismic activity in this region, liquefaction is not expected to be a hazard at the site. Based on correlation of blow count data (N-values) from the boring advanced during this evaluation, the subsurface soil profile corresponds with Site Class C of the 2015 International Building Code (IBC). The intermediate design acceleration values from IBC are presented below.

Table 1
Design Acceleration for Short Periods

S_S	F_a
0.181	1.2

S_S = The mapped spectral accelerations for short periods (ATC website, accessed 7/14/2022)

F_a = Site coefficient from ATC website, accessed 7/14/2022

Table 2
Design Acceleration for 1-Second Period

S_1	F_V
0.06	1.7

S_1 = The mapped spectral accelerations for 1 second period (ATC website, accessed 7/14/2022)

F_v = Site coefficient from ATC website, accessed 7/14/2022

3.4 SUBSURFACE

VIVID explored the subsurface conditions by drilling, logging and sampling two exploratory borings within or near the proposed pump station as shown on Figures 2 and 3. The borings were drilled at locations chosen by JDS-Hydro to depths of approximately 29 feet below the existing ground surface.

Existing Fill

Fill materials comprised of clayey sand and silty sand were encountered in both borings at the ground surface and extended to depths ranging from approximately 6 to 7 feet below the ground surface. The fill soils were generally dark brown, moist, and field penetration testing (blow counts) indicated the fill soils were loose to medium dense in relative density.

Sand and Clay

Silty sand with clay lenses were encountered below the fill materials in boring BH-1 and clayey sand was encountered below the fill materials in boring BH-2. The sand soils extended to depths of approximately 11 and 10 feet below the ground surface in borings BH-1 and BH-2, respectively. The sand soils were generally light brown, light gray, and moist to wet with field penetration testing (blow counts) indicating the sand soils are loose to medium dense in relative density.

Thin lenses of clay were encountered within the silty sand layer in boring BH-1. The clay soils were light brown, very moist, and field penetration testing (blow counts) indicated the clay soils are medium stiff dense in consistency.

Sandstone and Claystone Bedrock

Sandstone and claystone bedrock of the Dawson Formation was encountered underlying the units described above in both borings at depths of approximately 10 to 11 feet below the ground surface and extended to the maximum depth explored. The sandstone was gray to grayish-brown, moist, and hard to very hard based on field penetration testing (blow counts). The claystone was gray, moist, and medium hard to very hard based on field penetration testing (blow counts).

Swell testing of three bedrock samples indicated compression of 0.1 to 0.3 percent when wetted under a load of 1,000 pounds per square foot (psf).

The boring logs in Appendix A should be reviewed for more detailed descriptions of the subsurface conditions at the boring location explored.

3.4.1 Groundwater

Groundwater was encountered in both of the borings at the time of drilling at a depth of approximately 10 feet below the ground surface. When checked approximately 24 hours after the completion of drilling, groundwater was measured at a depth of approximately 8 feet below the ground surface in both borings. **Groundwater will be a construction consideration for this project when constructing the lower level of the pump station building.**

Soil moisture levels and groundwater levels commonly vary over time and space depending on seasonal precipitation, irrigation practices, land use, and runoff conditions. These conditions and the variations that they create often are not apparent at the time of field investigation. Accordingly, the soil moisture and groundwater data in this report pertain only to the locations and times at which exploration was performed. They can be extrapolated to other locations and times only with caution. It should also be noted that VIVID has not performed a hydrologic study to verify the seasonal high-water level.

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 GEOTECHNICAL FEASIBILITY OF PROPOSED CONSTRUCTION

VIVID found no subsurface conditions during this investigation that would preclude construction of the pump station essentially as planned, provided the recommendations in this report are incorporated into the design and construction of the project. Our recommendations for earthwork and foundations are discussed further in the following sections of the report.

Shallow Groundwater

The primary geotechnical issue associated with development of this project as proposed is the presence of groundwater near the proposed foundation and floor elevations. Seasonal changes in groundwater conditions would indicate that construction (short-term) dewatering will likely be required. For the long-term solution one of the following options should be considered:

- A permanent dewatering system, or
- Designing the below-grade spaces to resist buoyancy and hydrostatic pressures of the groundwater including an appropriate waterproofing system.

Prior to construction of the pump station structure, improvement of the existing subgrade to minimize the potential for structure damage should be performed. To minimize the potential for damage, it is recommended that the structure bear on a properly prepared subgrade as described below in Section 4.2.2. Additional stabilization of the subgrade may be necessary and is also described in more detail in Section 4.2.2.

Presence of Undocumented Fill

Approximately 6 to 7 feet of fill was encountered in the borings. Density testing of the fill was not provided to our office during this investigation, therefore we must consider it to be uncontrolled and of suspect quality. Therefore, all existing fill must be removed to expose native sand or bedrock under all structural elements (foundation, slab) and may be re-used/reprocessed (moisture conditioned and compacted) to achieve final grade elevations provided any organics, roots and other deleterious materials are removed.

Excavation into Bedrock

Hard to very hard bedrock was encountered in each boring at depths of approximately 10 and 11 feet below the existing ground surface. Therefore, heavy duty equipment will be required for excavations that extend into bedrock.

Foundation/slab system recommendations are described in more detail in Sections 4.3, and 4.5. Subgrade preparation and placement of structural fill is detailed in Sections 4.2.2, and 4.2.4 respectively.

4.2 CONSTRUCTION CONSIDERATIONS

4.2.1 General

All site preparation and earthwork operations should be performed in accordance with applicable codes, safety regulations and other local, State or Federal guidelines.

4.2.2 Site Preparation and Grading

Initial site work should consist of completely removing all organic material and other deleterious materials from all areas to be filled and areas to be cut. All material should be removed for offsite disposal in accordance with local laws and regulations or, if appropriate, stockpiled in proposed non-structural areas for future use. Areas to receive fill should be evaluated by the geotechnical engineer prior to the placement of any fill materials.

Existing fill material was encountered in each borings to depths of approximately 6 and 7 feet below the existing ground surface. The existing fill must be removed to expose native sands or bedrock below any structural elements including slabs and foundations. Existing fill may be re-used as structural fill provided any organics, roots and other deleterious materials are removed. After performing the required excavations and prior to the placement of compacted fill, preparation of the exposed subgrade shall be performed. Preparation includes scarifying the soil to a depth of 8 inches, moisture conditioning and recompacting. **If bedrock is exposed at the planned bottom of excavation elevation, it should be scraped clean and relatively flat (bedrock should not be scarified).** All fill materials should be placed on a horizontal plane and placed in loose lifts not to exceed 8 inches in thickness, unless otherwise accepted by the geotechnical engineer. Compaction requirements are presented in Section 4.2.6 of this report.

Due to groundwater levels encountered in the borings, soft subgrade may be encountered at the base of the excavations. Use of stabilization rock, or combination of geo-grid and aggregate, can be used to stabilize areas that cannot otherwise be properly prepared for support of additional fill or structural elements. The optimal type and thickness of stabilization can only be evaluated when the conditions and magnitude of instability are exposed, but construction planning should address this need so it can be implemented when necessary.

If bedrock is not encountered at bottom of footing elevation throughout the entire building footprint, we recommend over-excavating a minimum of one foot below footing elevation and replacing with structural fill (Section 4.2.4 of this report) in order to create a more uniform layer and minimize differential movement. An alternative is to extend all footings to bedrock.

VIVID should observe excavations to evaluate if actual conditions are similar to that assumed based on our subsurface data.

4.2.3 Excavation Characteristics

All excavations must comply with applicable local, State and Federal safety regulations, and particularly with the excavation standards of the Occupational Safety and Health Administration (OSHA). Construction site safety, including excavation safety, is the sole responsibility of the Contractor as part of its overall responsibility for the means, methods and sequencing of construction operations. VIVID's recommendations for excavation support are intended for the Client's use in planning the project, and in no way relieve the Contractor of its responsibility to construct, support and maintain safe slopes. Under no circumstances should the following recommendations be interpreted to mean that VIVID is assuming responsibility for either construction site safety or the Contractor's activities.

We believe that the surficial sand soils on this site will classify as Type C using OSHA criteria. OSHA requires that unsupported cuts be laid back to ratios no steeper than 1½:1 (horizontal to vertical) for Type C materials. We believe the bedrock on this site will classify as Type B materials. OSHA requires that unsupported cuts for Type B materials be laid back to ratios no steeper than 1:1 (horizontal to vertical). In general, we believe that these slope ratios for the soils provided above will be temporarily stable under unsaturated conditions. If groundwater seepage was to occur, flatter slopes may be appropriate. Please note that the actual determination of soil type and allowable sloping must be made in the field by an OSHA-qualified "competent person."

4.2.4 Structural Fill

Structural fill refers to material that is appropriate for placement beneath structural components, if necessary, as well as wall backfill. The on-site granular (sand) materials are considered suitable for reuse as structural fill beneath the proposed pump station and for use as wall backfill provided they are devoid of debris, organics, contamination, or other deleterious materials. Imported structural fill, if required, should consist of material meeting the requirements of a CDOT Class 1 Structure Backfill with the exception that the fines content (% passing the no. 200 sieve) is between 10 and 30 percent. A sample of any imported fill material should be submitted to our office for approval and testing at least 1 week prior to stockpiling at the site.

Structural fill should be moisture-treated and compacted according to the recommendations in Section 4.2.6 of this report. We recommend that a qualified representative of VIVID visit the site during excavation and during placement of the structural fill to verify the soils exposed in the excavations are consistent with those encountered during our subsurface exploration and that proper foundation subgrade preparation and placement is performed.

4.2.5 Utility Trench Backfill

Backfill material should be essentially free of plant matter, organic soil, debris, trash, other deleterious matter and rock particles larger than 4 inches. However, backfill material in the "pipe zone" (from the trench floor to 1 foot above the top of pipe) should not contain rock particles larger than 1 inch. Strictly observe any requirements specified by the utility agency for bedding and pipe-zone fill. In general, backfill above the pipe zone in utility trenches should be placed in lifts of 6 to 8 inches, and compacted using power equipment designed for trench work. Backfill in the pipe zone should be placed in lifts of 8 inches or less and compacted with hand-held equipment.

4.2.6 Compaction Requirements

Fill materials should be placed in horizontal lifts compatible with the type of compaction equipment being used, moisture conditioned, and compacted in accordance with the following criteria:

Table 3
Compaction Specifications

FILL LOCATION [1]	MATERIAL TYPE	PERCENT COMPACTION[2] (ASTM D 1557)	MOISTURE CONTENT
Subgrade Preparation (See Section 4.2.2)	On-site Soils (NOT INCLUDING BEDROCK)	92 minimum	± 2 % of optimum
Below Foundations/Slabs-on-grade	On-site Granular Soils or Imported Structural Fill (CDOT Class 1 Structural Backfill)	95 minimum	± 2 % of optimum
Exterior Wall Backfill	On-site Granular Soils or Imported Structural Fill (CDOT Class 1 Structural Backfill)	92 minimum	± 2 % of optimum
Utility Trenches	On-site Soils	92 minimum	± 2 % of optimum

1) Where two or more "Fill Locations" coincide, the more stringent specification should be used.
2) In non-structural or landscaped areas, the compaction specification may be reduced to 90 percent.
3) Bedrock should be scraped clean and relatively flat and should NOT be scarified and recompacted.

Structural fill should be placed in level lifts not exceeding 8 inches in loose thickness and compacted to the specified percent compaction to produce a firm and unyielding surface. If field density tests indicate the required percent compaction has not been obtained, the fill material should be reconditioned as necessary and re-compacted to the required percent compaction before placing any additional material.

4.2.7 Construction in Wet or Cold Weather

During construction, grade the site such that surface water can drain readily away from the pump station. Promptly pump out or otherwise remove any water that may accumulate in excavations or on subgrade surfaces and allow these areas to dry before resuming construction. The use of berms, ditches and similar means may be used to prevent stormwater from entering the work area and to convey any water off site efficiently.

If earthwork is performed during the winter months when freezing is a factor, no grading fill, structural fill or other fill should be placed on frosted or frozen ground, nor should frozen material be placed as fill. Frozen ground should be allowed to thaw or be completely removed prior to placement of fill. A good practice is to cover the compacted fill with a "blanket" of loose fill to help prevent the compacted fill from freezing.

If the pump station is erected during cold weather, foundations, concrete slabs-on-grade, or other concrete elements should not be constructed on frozen soil. Frozen soil should be completely removed from beneath the concrete elements, or thawed, scarified and recompacted. The amount of time passing between excavation or subgrade preparation and placing concrete should be minimized during freezing conditions to prevent the prepared soils from freezing. The use of blankets, soil cover or heating as required may be utilized to prevent the subgrade from freezing.

4.2.8 Construction Testing and Observation

Testing and construction observation should take place under the direction of VIVID to support that engineer's professional opinion as to whether the earthwork does or does not substantially conform to the recommendations in this report. Furthermore, the opinions and conclusions of a geotechnical report are based upon the interpretation of a limited amount of information obtained from the field exploration. It is therefore not uncommon to find that actual site conditions differ somewhat from those indicated in the report. The geotechnical engineer should remain involved throughout the project to evaluate such differing conditions as they appear, and to modify or add to the geotechnical recommendations, as necessary.

4.2.9 Surface Drainage

Positive drainage away from the structure is essential to the performance of foundations and slabs and should be provided during the life of the structure. Non-paved areas within 10 feet of the structure should slope away at a minimum of 8 percent. Areas where pavements or slabs are constructed adjacent to the structure should slope away at a minimum grade of 2 percent. All downspouts from roof drains should be tight-lined to an on-site stormwater system or, at a minimum, cross all backfilled areas such that they discharge all water away from the backfill zone and the structure. Drainage should be created such that water is diverted off the site and away from backfill areas of adjacent buildings. Landscaping improvements requiring supplemental watering are not recommended adjacent to improved areas including foundations, pavements or slabs.

4.2.10 Permanent Cut and Fill Slopes

If required, permanent cut and fill slopes exposing the materials encountered in our borings are anticipated to be stable at slope ratios as steep as 3:1 (horizontal to vertical) under dry conditions. We believe that slope ratios of 4:1 or flatter are more reliable if subjected to wetting, and present less of a maintenance problem. New slopes should be revegetated as soon as possible after completion to reduce erosion problems.

4.3 FOUNDATION RECOMMENDATIONS

We recommend the pump station shallow foundation elements, as required, be placed on a properly prepared subgrade or directly on undisturbed bedrock as described in Section 4.2.2 of this report, **but not a combination of both as that will result in differential foundation support conditions**. Section 4.1 provides subgrade improvement and fill requirements for utility connections. **As discussed in Section 4.2.2 of this report, soft and wet subgrade conditions may be encountered at footing elevations requiring stabilization.** We recommend the shallow foundations be designed and constructed in accordance with the following criteria:

- Foundations bearing upon a properly prepared subgrade may be designed for a maximum allowable bearing capacity of 3,000 pounds per square foot (psf). A one-third increase in bearing capacity is allowable for transient loads (e.g. wind loads). All foundations should be proportioned as much as practicable to minimize differential settlement.
- If existing fill is encountered at the bottom of foundation elevations, it must be removed to expose natural sand or bedrock, and if needed, be replaced with moisture conditioned on-site sand or

imported granular fill as described in Section 4.2.4 of this report and compacted to specification described in Table 3.

- Foundation sizes should be determined by a structural engineer. However, as a minimum, continuous footings should have a minimum width of 18 inches and isolated column footings should have a minimum width of 24 inches. The actual footing sizes should be determined by a qualified structural engineer based on the soil bearing capacity and actual structural loads.
- The foundation elements should have at least 36 inches of cover above the bottom of the foundation for frost protection or that required by the local building code, whichever is greater.
- The foundation subgrade and compacted structural fill should be protected from wetting and drying prior to and after concrete placement. Foundations should be backfilled as soon as practical after concrete placement.
- We estimate total movement for foundations will be less than 1 inch, with differential movement on the order of ½ to ¾ of the total movement based upon typical loads for a one-story building.
- Utilities that are penetrating through the foundation/foundation walls should be designed with flexible connections to mitigate damage due to differential settlement.
- VIVID should observe excavations to evaluate if actual conditions are similar to that assumed based on our subsurface data. All fill should be tested as described herein.

4.4 FLOOR SYSTEMS

4.4.1 Slab-on-Grade Floor System

Slab-on-grade floor systems are considered acceptable provided the owner is willing to risk some slab movement. Due to the suspect quality of the existing fill, the existing fill below the slabs must be removed to a depth to expose native sand or bedrock. Once the native sand or bedrock is exposed, the existing fill, on-site sands or import structural fill, as described in Section 4.2.4 of this report, should be moisture conditioned and compacted to achieve final grade elevations. Compaction requirements for structural fill is presented in Table 3, Section 4.2.6 of this report.

The criteria presented below should be observed for design and construction of floor slabs on this site. The construction details should be considered when preparing the project documents.

- For concrete slab-on-grade design purposes, a modulus of subgrade reaction of 150 pounds per cubic inch (pci) may be used in design of slabs placed on properly prepared compacted on-site soils or imported granular structural fill as described herein.
- Floor slabs should be separated from all bearing walls and columns with expansion joints that allow unrestrained vertical movement. At door thresholds only, both interior and exterior slabs can be dowelled into the foundation stem wall to resist movement that can create a trip hazard or impede proper door operation.
- Provided all our recommendations are followed, the total movement of slab-on-grade constructed as described above are projected to be on the order of less than 1 inch, with differential movement about half of the total movement.
- Floor slab control joints should be used to reduce damage due to shrinkage cracking. Control joint spacing is a function of slab thickness, aggregate size, slump and curing conditions. The requirements for concrete slab thickness, joint spacing and reinforcement should be established

by the designer based on experience, recognized design guidelines and the intended slab use. Placement and curing conditions will have a strong impact on the final concrete slab integrity.

- Utility lines should be provided with flexible joints or oversized sleeves where they penetrate floor slabs to prevent breakage caused by differential movement.
- Under no circumstances may the slabs be installed on non-engineered fill, topsoil, soft or disturbed soils, construction debris, frozen soil, moisture sensitive soils, or within ponded water. If bearing soils or structural fill upon which the slabs are to be constructed become loose or disturbed, the subgrade should be recompacted to the requirements of structural fill or excavated to firmer, undisturbed soils and replaced with structural fill or CLSM.

If vibrating machinery will be installed in the structure, the machine foundations should be physically isolated from other foundations and slabs to reduce vibration damage. The design of such foundations requires special analysis that is beyond the scope of this investigation. Please contact VIVID for additional analysis and recommendations if machine vibrations will be an issue at this building.

4.5 LATERAL EARTH PRESSURES

We anticipate below-grade construction is planned, therefore walls will be backfilled with soil on one side and will therefore be subjected to lateral earth pressures. The design and construction criteria presented below should be observed for earth retention systems this site with flat back slopes. Active and at-rest lateral earth pressures apply to the structural fill soils that are "retained" by the foundation walls. The sliding coefficient applies to the friction between the base of the foundation and the underlying soil. The following values were estimated assuming a moist unit weight of 125 pounds per cubic foot (pcf) and an internal friction angle of 32 degrees for imported granular structural fill materials and internal friction angle of 30 degrees and a moist unit weight of 125 pcf for on-site granular soils.

Table 4
Lateral "Equivalent Fluid" Earth Pressure Parameter Summary

Parameter	CDOT Class I Structure Backfill (Above Groundwater)	CDOT Class I Structure Backfill (Below Groundwater)	On-Site Sand Soils (Above Groundwater)	On-Site Sand Soils (Below Groundwater)
At-Rest[1]	59 pcf	92 pcf	63 pcf	94 pcf
Active[2]	38 pcf	82 pcf	42 pcf	83 pcf
Passive[3]	407 pcf	204 pcf	375pcf	188 pcf
Unfactored Coefficient of Sliding Friction[3]	0.62	0.62	0.58	0.58

Notes: 1. Retaining walls that are laterally supported (structurally restrained from rotation) can be expected to undergo only a slight amount of deflection. These walls should be designed for an "at-rest" lateral earth pressure.

2. Retaining structures which can deflect sufficiently to mobilize the full "active" earth pressure condition should be designed for an "active" lateral earth pressure.

3. Lateral loads may be resisted using these unfactored coefficients of sliding friction and unfactored passive earth pressures presented above. Because significant movement is required to fully mobilize passive earth pressure, we recommend a minimum factor of safety of 2 be applied for design purposes.

4. It should be noted that the hydrostatic water pressure (62.4 pcf) was already included in the pressure values for below groundwater condition.

4.6 FOUNDATION WALL DRAINAGE

To reduce the potential for perched groundwater to impact the foundation wall and the foundation bearing soils, a subsurface drain system should be installed behind any retaining walls. A drainage system should consist of a minimum 4-inch diameter perforated or slotted pipe, embedded in free-draining gravel, placed in a trench at the bottom of the wall. Alternatively, a prefabricated drainage structure such as geocomposite may also be used.

4.7 CORROSIVITY AND CONCRETE

4.7.1 Corrosion Potential

Laboratory testing was completed to provide data regarding corrosivity of onsite soils. Our scope of services does not include corrosion engineering and, therefore, a detailed analysis of the corrosion test results is not included. A qualified corrosion engineer should be retained to review the test results and design protective systems that may be required.

Laboratory chloride concentration, sulfate concentration, sulfide concentration, pH, oxidation reduction potential, and electrical resistivity tests were performed on a sample of onsite materials obtained during our field investigation. The results of the tests are included in Appendix C to this report and are summarized below in Table 5.

Table 5
Summary of Laboratory Soil Corrosivity Testing

Boring No.	Sample Depth (ft)	Water Soluble Chloride (mg/kg)	pH	Redox Potential (mV)	Resistivity (ohm-cm)	Water Soluble Sulfate (%)	Sulfide Content
BH-1	5	0	7.6	250	2,520	0.0130	ND
BH-1	19	--	--	--	--	0.0229	ND

Metal and concrete elements in contact with soil, whether part of a foundation system or part of a supported structure, are subject to degradation due to corrosion or chemical attack. Therefore, buried metal and concrete elements should be designed to resist corrosion and degradation based on accepted practices.

Based on the “10-point” method developed by the American Water Works Association (AWWA) in standard AWWA C105/A21.5, the corrosivity test results indicate that the onsite soils have corrosive potential. We recommend that a corrosion engineer be consulted to recommend appropriate protective measures, if required.

4.7.2 Chemical Sulfate Susceptibility and Concrete Type

The degradation of concrete or cement grout can be caused by chemical agents in the soil or groundwater that react with concrete to either dissolve the cement paste or precipitate larger compounds within the concrete, causing cracking and flaking. The concentration of water-soluble sulfates in the soils is a good indicator of the potential for chemical attack of concrete or cement grout. The American Concrete Institute (ACI) in their publication Guide to Durable Concrete (ACI 201.2R-08) provides guidelines for this assessment.

The concentration of water-soluble sulfates measured on subsurface materials submitted for testing represents a Class 0 exposure of sulfate attack on concrete exposed to the soils per CDOT Standard Specifications for Road and Bridge Construction, 2021, Section 601.04.

5.0 ADDITIONAL SERVICES & LIMITATIONS

5.1 ADDITIONAL SERVICES

Attached to this report is a document by the Geoprofessional Business Association (GBA) that summarizes limitations of geotechnical reports as well as additional services that are required to further confirm subgrade materials are consistent with that encountered at the specific boring locations presented in this report. This document should be read in its entirety before implementing design or construction activities. Examples of other services beyond completion of a geotechnical report are necessary or desirable to complete a project satisfactorily include:

- Review of design plans and specifications to verify that our recommendations were properly interpreted and implemented.
- Attendance at pre-bid and pre-construction meetings to highlight important items and clear up misunderstandings, ambiguities, or conflicts with design plans and specifications.
- Performance of construction observation and testing which allows verification that existing materials at locations beyond our borings are consistent with that presented in our report, construction is compliant with the requirements/recommendations, evaluation of changed conditions.

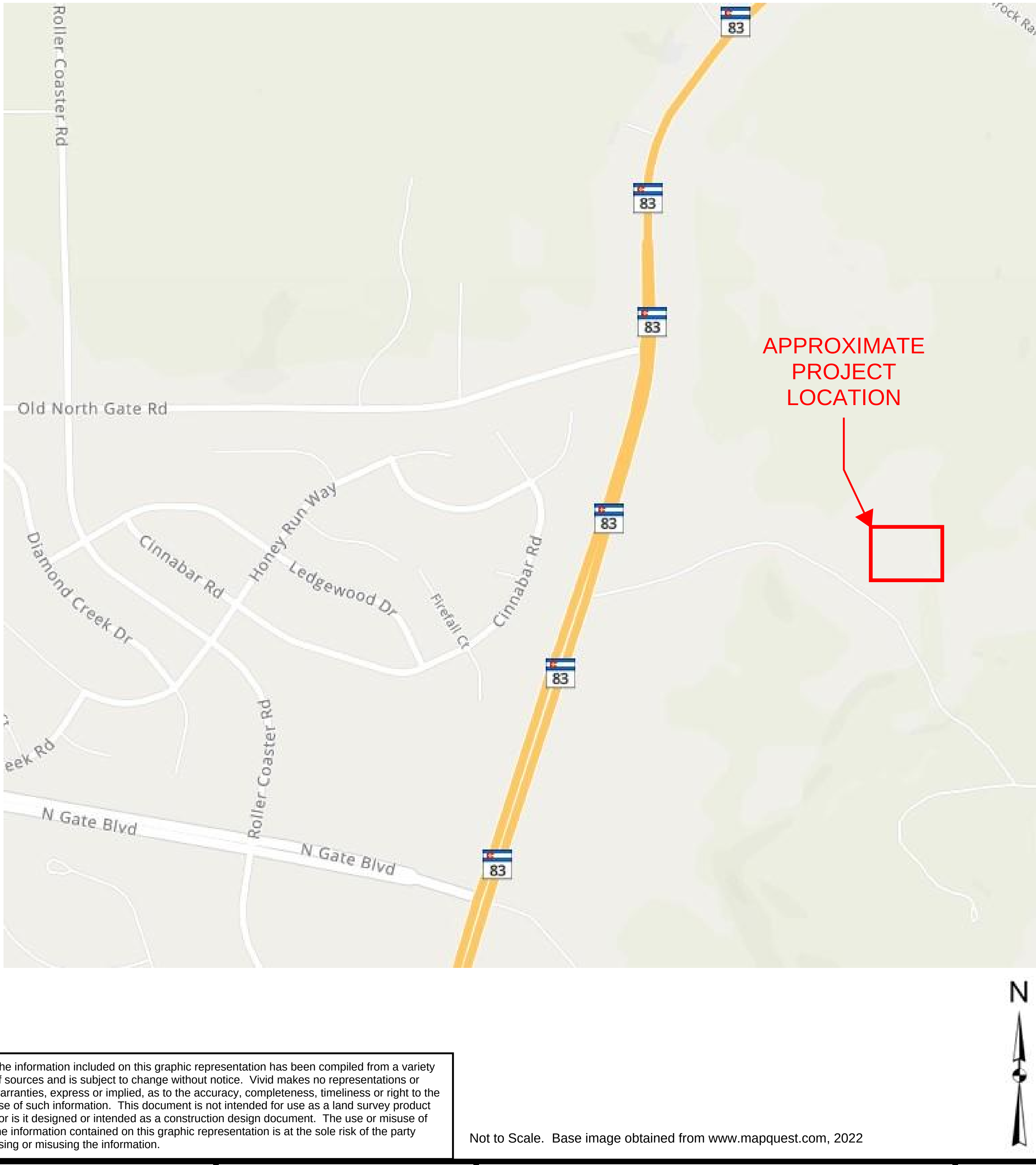
5.2 LIMITATIONS

This work was performed in a manner consistent with that level of care and skill ordinarily exercised by other members of VIVID’s profession practicing in the same locality, under similar conditions and at the date the services are provided. Our conclusions, opinions, and recommendations are based on a limited number of observations and data. It is possible that conditions could vary between or beyond the data evaluated. VIVID makes no other representation, guarantee, or warranty, express or implied, regarding the services, communication (oral or written), report, opinion, or instrument of service provided.

This report may be used only by the Client and the registered design professional in responsible charge and only for the purposes stated for this specific engagement within a reasonable time from its issuance, but in no event later than two (2) years from the date of the report.

The work performed was based on project information provided by Client. If Client does not retain VIVID to review any plans and specifications, including any revisions or modifications to the plans and specifications, VIVID assumes no responsibility for the suitability of our recommendations. In addition, if there are any changes in the field to the plans and specifications, Client must obtain written approval from VIVID’s engineer that such changes do not affect our recommendations. Failure to do so will vitiate VIVID’s recommendations.

Figures



The information included on this graphic representation has been compiled from a variety of sources and is subject to change without notice. Vivid makes no representations or warranties, express or implied, as to the accuracy, completeness, timeliness or right to the use of such information. This document is not intended for use as a land survey product nor is it designed or intended as a construction design document. The use or misuse of the information contained on this graphic representation is at the sole risk of the party using or misusing the information.

Not to Scale. Base image obtained from www.mapquest.com, 2022

VIVID Engineering Group

Project No: D21-2-457	**VICINITY MAP**	Figure
Date: July 14, 2022		1
Drawn by: BTM	Proposed Triview NDS Pump Station Vicinity of Old Northgate Road and HWY 83 Colorado Springs, Colorado	
Reviewed by: WJB		

LEGEND

= APPROXIMATE LOCATION OF EXPLORATORY BORING

N

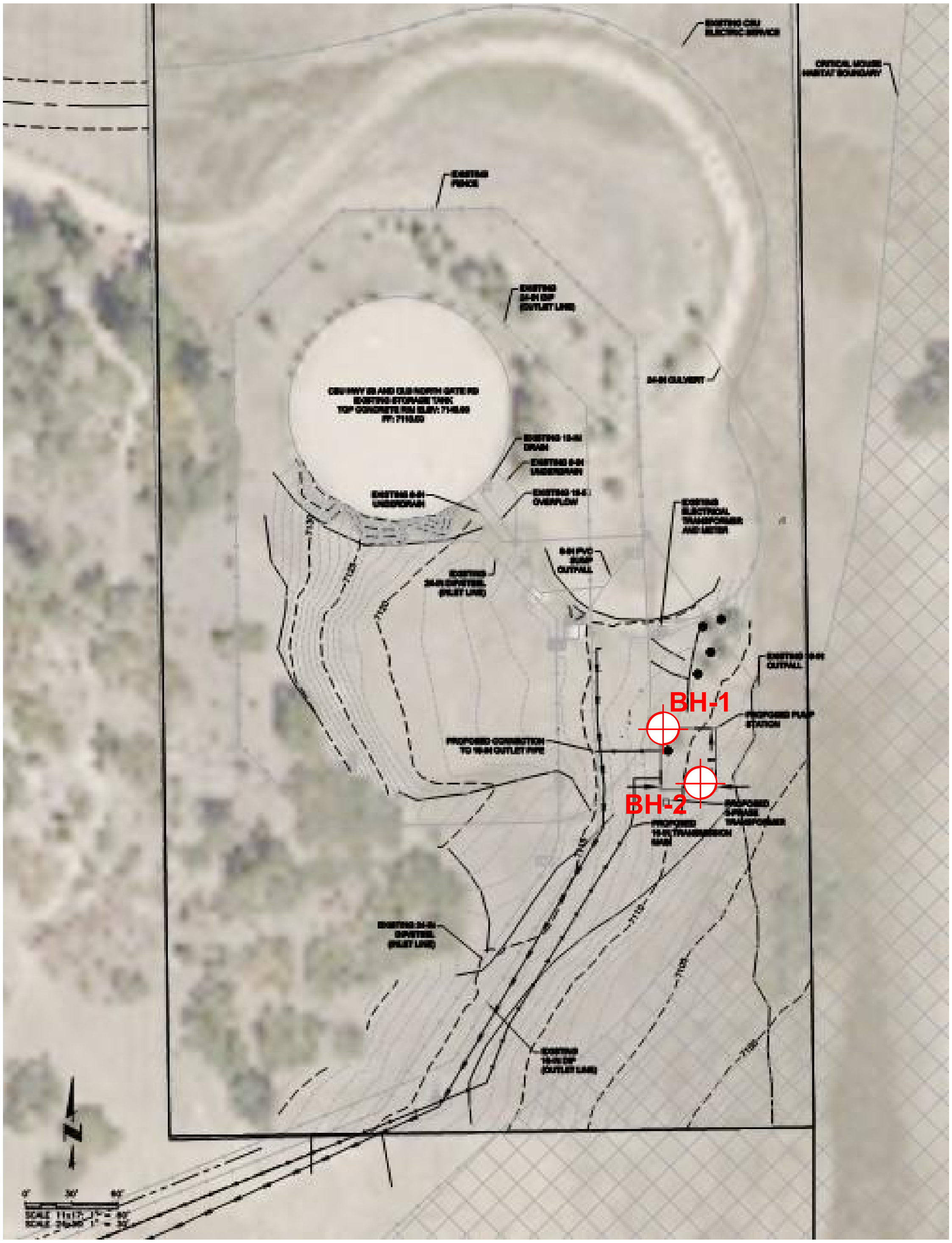
The information included on this graphic representation has been compiled from a variety of sources and is subject to change without notice. Vivid makes no representations or warranties, express or implied, as to the accuracy, completeness, timeliness or right to the use of such information. This document is not intended for use as a land survey product nor is it designed or intended as a construction design document. The use or misuse of the information contained on this graphic representation is at the sole risk of the party using or misusing the information.

Not to Scale. Base image dated 10/6/2019 obtained from Google Earth, 2022

VIVID Engineering Group	Project No: D21-2-457	**FIELD EXPLORATION PLAN - AERIAL**	Figure
	Date: July 14, 2022		2
	Drawn by: BTM	Proposed Triview NDS Pump Station Vicinity of Old Northgate Road and HWY 83 Colorado Springs, Colorado	
	Reviewed by: WJB		

LEGEND

⌖ = APPROXIMATE LOCATION OF EXPLORATORY BORING



Base image obtained from JDS-Hydro, Inc.

VIVID Engineering Group	Project No: D21-2-457	**FIELD EXPLORATION PLAN - CONCEPTUAL**
	Date: July 14, 2022	
	Drawn by: BTM	Proposed Triview NDS Pump Station Vicinity of Old Northgate Road and HWY 83 Colorado Springs, Colorado
	Reviewed by: WJB	

Figure

3

Appendix A

Logs of Exploratory Borings

Vivid Engineering Group, Inc.
1053 Elkton Drive
Colorado Springs, Colorado 80907
Telephone: 719-896-4356
Fax: 719-896-4357

KEY TO SYMBOLS

CLIENT JDS-Hydro Consultants, Inc.
PROJECT NAME Proposed Triview NDS Pump Station
PROJECT NUMBER D21-2-457
PROJECT LOCATION Old Northgate Rd and HWY 83, Colorado Springs, CO

LITHOLOGIC SYMBOLS
(Unified Soil Classification System)

CLAYSTONE

FILL

SANDSTONE

SC: USCS Clayey Sand

SM: USCS Silty Sand

SAMPLER SYMBOLS

2" I.D. Modified California Sampler (MC)

Standard Penetration Test (SPT)

ABBREVIATIONS

LL - LIQUID LIMIT (%)
PI - PLASTIC INDEX (%)
MC - MOISTURE CONTENT (%)
DD - DRY DENSITY (PCF)
NP - NON PLASTIC
FINES- PERCENT PASSING NO. 200 SIEVE

Water Level at Time Drilling, or as Shown

Water Level After 24 Hours, or as Shown

Vivid Engineering Group, Inc.
1053 Elkton Drive
Colorado Springs, Colorado 80907
Telephone: 719-896-4356
Fax: 719-896-4357

BORING NUMBER BH-1

CLIENT JDS-Hydro Consultants, Inc.
PROJECT NAME Proposed Triview NDS Pump Station
PROJECT NUMBER D21-2-457
PROJECT LOCATION Old Northgate Rd and HWY 83, Colorado Springs, CO
DATE STARTED 7/13/22 **COMPLETED** 7/13/22
GROUND ELEVATION **HOLE SIZE** 4 inches
DRILLING CONTRACTOR Custom Auger Drilling (CME-55)
GROUND WATER LEVELS:
DRILLING METHOD 4" Solid Stem Auger
AT TIME OF DRILLING 10.00 ft
LOGGED BY M. Ray **CHECKED BY** B. Mustain
AT END OF DRILLING ---
NOTES
AFTER DRILLING 8.00 ft 24 hours after drilling

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
0					**Existing Fill** Silty SAND, fine to coarse-grained, trace gravel, dark brown, slightly moist, medium dense
	MC	19-19	MC = 6.3% DD = 128.3 pcf LL = NP PL = NP Fines = 23.0%		
5	SPT	10-10-10 (20)	pH = 7.6, Resistivity = 2,520 ohm-cm, Redox = 250 mV, Sulfide = ND, Choride = 0 mg/kg, Sulfate = 0.0130%	6.0	Silty SAND, fine to coarse-grained, trace gravel and CLAY lenses, light brown, moist to wet, loose to medium dense
	MC	3-3			
10	SPT	4-5-39 (44)	MC = 26.1% DD = 95.2 pcf Compression = 0.3% when wetted under 1,000 psf load	11.0	**Dawson Formation** Clayey SANDSTONE, gray, slightly moist to moist, hard to very hard
15	MC	50/4"	MC = 14.4% LL = NP PL = NP Fines = 26.0%		
			MC = 11.7% DD = 116.8 pcf Compression = 0.1% when wetted under 1,000 psf load		
20	SPT	50/7"	Sulfates = 0.0229%	19.0	**Dawson Formation** Sandy CLAYSTONE, gray, moist, hard to very hard
25	MC	50/4"		26.0	**Dawson Formation** Clayey to Silty SANDSTONE, gray, moist, very hard
	MC	50/2"		29.2	Bottom of borehole at 29.2 feet.

Approximate Floor Slab/Top of Foundation Elevation of Below-Grade Building Area

GENERAL BH / TP / WELL - MODIFIED - GINT STD US LAB.GDT - 8/4/22 08:21 - C:\USERS\BRYSEN MUSTAIN\VIVID ENGINEERING GROUP\GEO - DOCUMENTS\PROJECTS_2021\D21-2-457_JDS-HYDRO_TRIVIEW NDS PUMP STATION\6 - DRAFTING\D21-2-457.GPJ

Vivid Engineering Group, Inc.
1053 Elkton Drive
Colorado Springs, Colorado 80907
Telephone: 719-896-4356
Fax: 719-896-4357

BORING NUMBER BH-2

CLIENT JDS-Hydro Consultants, Inc.
PROJECT NAME Proposed Triview NDS Pump Station
PROJECT NUMBER D21-2-457
PROJECT LOCATION Old Northgate Rd and HWY 83, Colorado Springs, CO
DATE STARTED 7/13/22 **COMPLETED** 7/13/22
GROUND ELEVATION **HOLE SIZE** 4 inches
DRILLING CONTRACTOR Custom Auger Drilling (CME-55)
GROUND WATER LEVELS:
DRILLING METHOD 4" Solid Stem Auger
AT TIME OF DRILLING 10.00 ft
LOGGED BY M. Ray **CHECKED BY** B. Mustain
AT END OF DRILLING ---
NOTES
AFTER DRILLING 8.00 ft 24 hours after drilling

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
0					**Existing Fill** Clayey SAND, fine to coarse-grained, trace gravel, dark brown, moist, loose to medium dense
	SPT	6-4-4 (8)	MC = 11.0% LL = 32 PL = 13 Fines = 38.0%		
5	MC	6-12	MC = 13.3% DD = 118.2 pcf		
7.0					Clayey SAND, fine to coarse-grained, trace gravel, light gray, moist, medium dense
	SPT	8-10-6 (16)			
10.0					**Dawson Formation** CLAYSTONE, gray, moist, medium hard
	MC	13-33	MC = 13.5% DD = 116.6 pcf		
13.0					**Dawson Formation** Clayey SANDSTONE, grayish-brown, slightly moist to moist, very hard
15	MC	50/6"	MC = 12.0% DD = 110.4 pcf		
20	MC	50/4"			
25	MC	50/3"	MC = 12.5% DD = 112.0 pcf Compression = 0.3% when wetted under 1,000 psf load		
29.3	MC	50/4"			Bottom of borehole at 29.3 feet.

Approximate Floor Slab/Top of Foundation Elevation of Below-Grade Building Area

Appendix B

Geotechnical Laboratory Test Results

Vivid Engineering Group, Inc.
1053 Elkton Drive
Colorado Springs, Colorado 80907
Telephone: 719-896-4356
Fax: 719-896-4357

SUMMARY OF LABORATORY RESULTS

CLIENT JDS-Hydro Consultants, Inc.

PROJECT NAME Proposed Triview NDS Pump Station

PROJECT NUMBER D21-2-457

PROJECT LOCATION Old Northgate Rd and HWY 83, Colorado Springs, CO

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Class-ification	Water Content (%)	Dry Density (pcf)		
BH-1	2.5	NP	NP	NP	9.5	23	SM	6.3	128.3		
BH-1	7.5							26.1	95.2		
BH-1	10.0	NP	NP	NP	19	26	SM	14.4			
BH-1	14.0							11.7	116.8		
BH-2	2.5	32	13	19	9.5	38	SC	11.0			
BH-2	5.0							13.3	118.2		
BH-2	10.0							13.5	116.6		
BH-2	14.0							12.0	110.4		
BH-2	24.0							12.5	112.0		

Vivid Engineering Group, Inc.
1053 Elkton Drive
Colorado Springs, Colorado 80907
Telephone: 719-896-4356
Fax: 719-896-4357

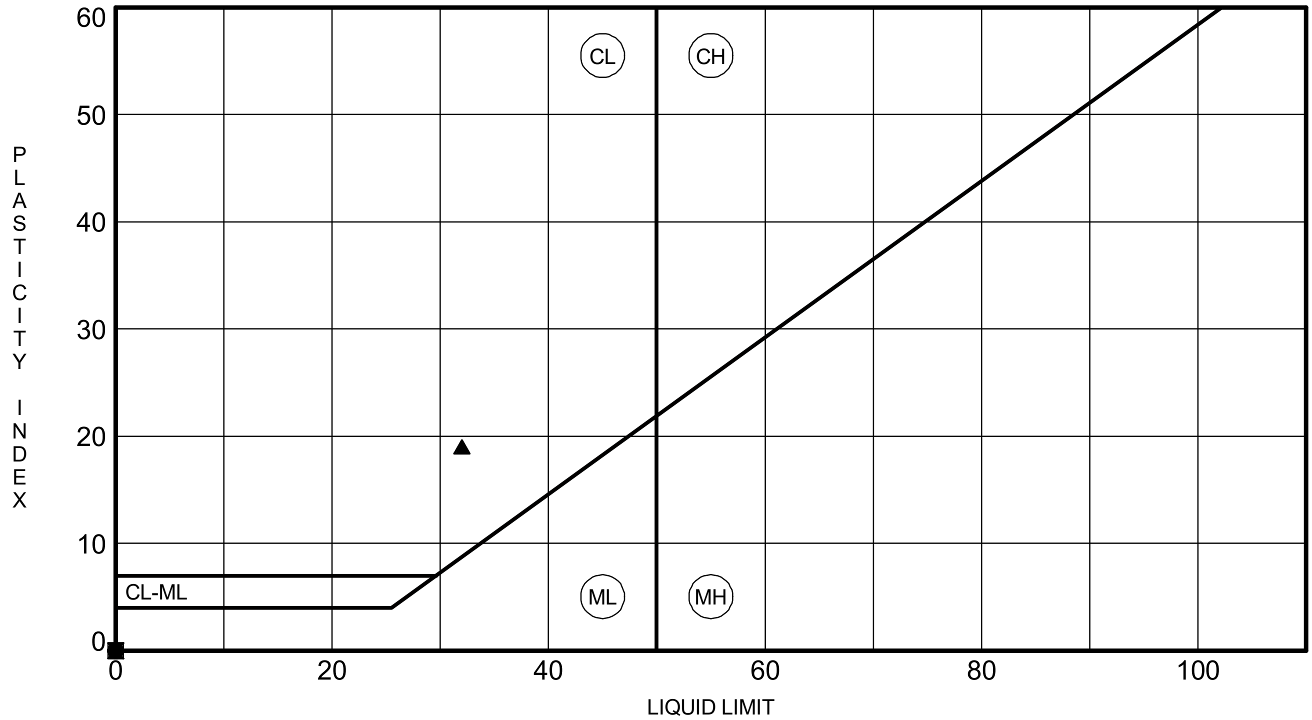
ATTERBERG LIMITS' RESULTS

CLIENT JDS-Hydro Consultants, Inc.

PROJECT NAME Proposed Triview NDS Pump Station

PROJECT NUMBER D21-2-457

PROJECT LOCATION Old Northgate Rd and HWY 83, Colorado Springs, CO



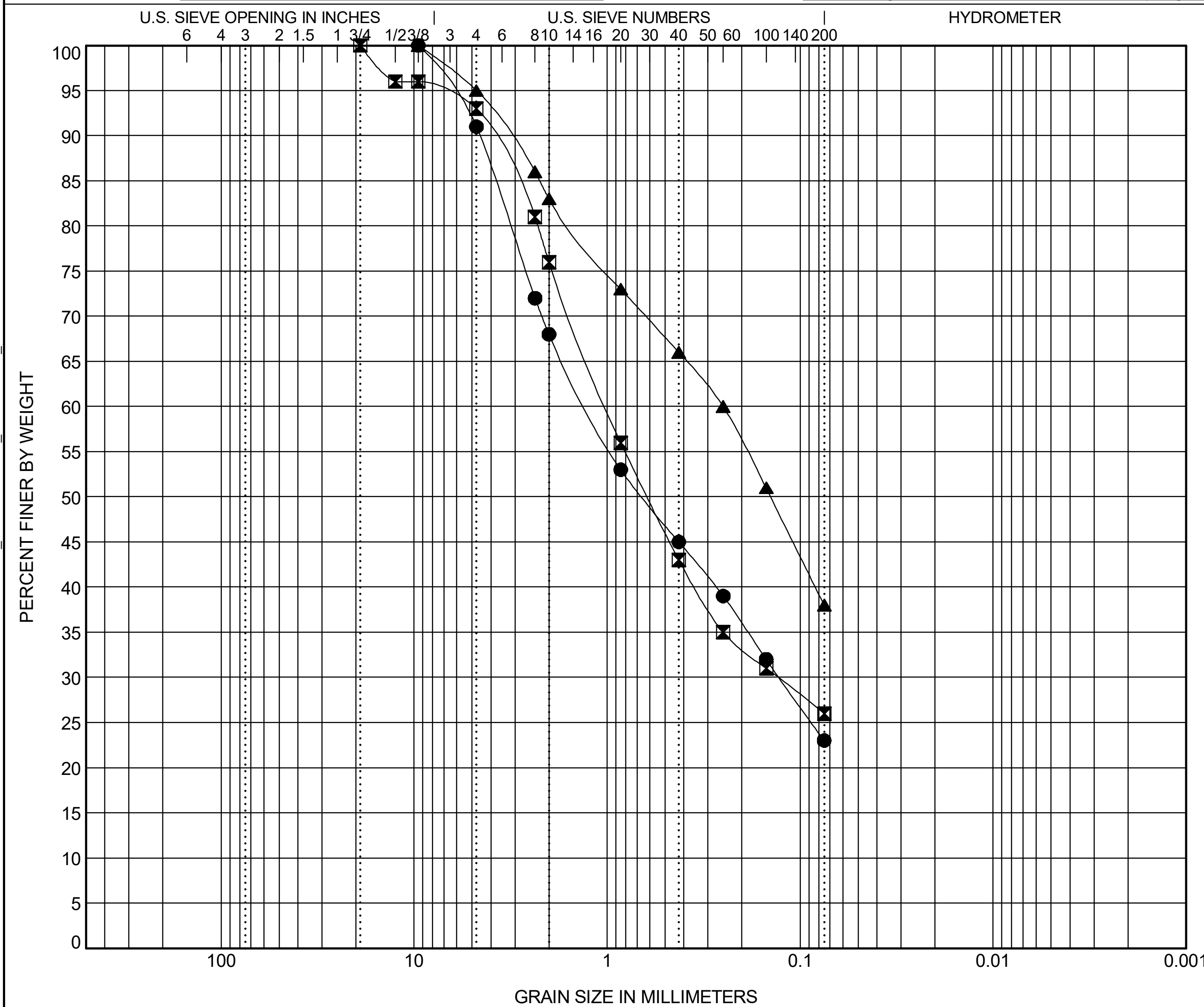
	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**BH-1**	**2.5**	**NP**	**NP**	**NP**	**23**	**SILTY SAND(SM)**
⊠	**BH-1**	**10.0**	**NP**	**NP**	**NP**	**26**	**SILTY SAND(SM)**
▲	**BH-2**	**2.5**	**32**	**13**	**19**	**38**	**CLAYEY SAND(SC)**

Vivid Engineering Group, Inc.
1053 Elkton Drive
Colorado Springs, Colorado 80907
Telephone: 719-896-4356
Fax: 719-896-4357

GRAIN SIZE DISTRIBUTION

CLIENT JDS-Hydro Consultants, Inc. **PROJECT NAME** Proposed Triview NDS Pump Station

PROJECT NUMBER D21-2-457 **PROJECT LOCATION** Old Northgate Rd and HWY 83, Colorado Springs, CO



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

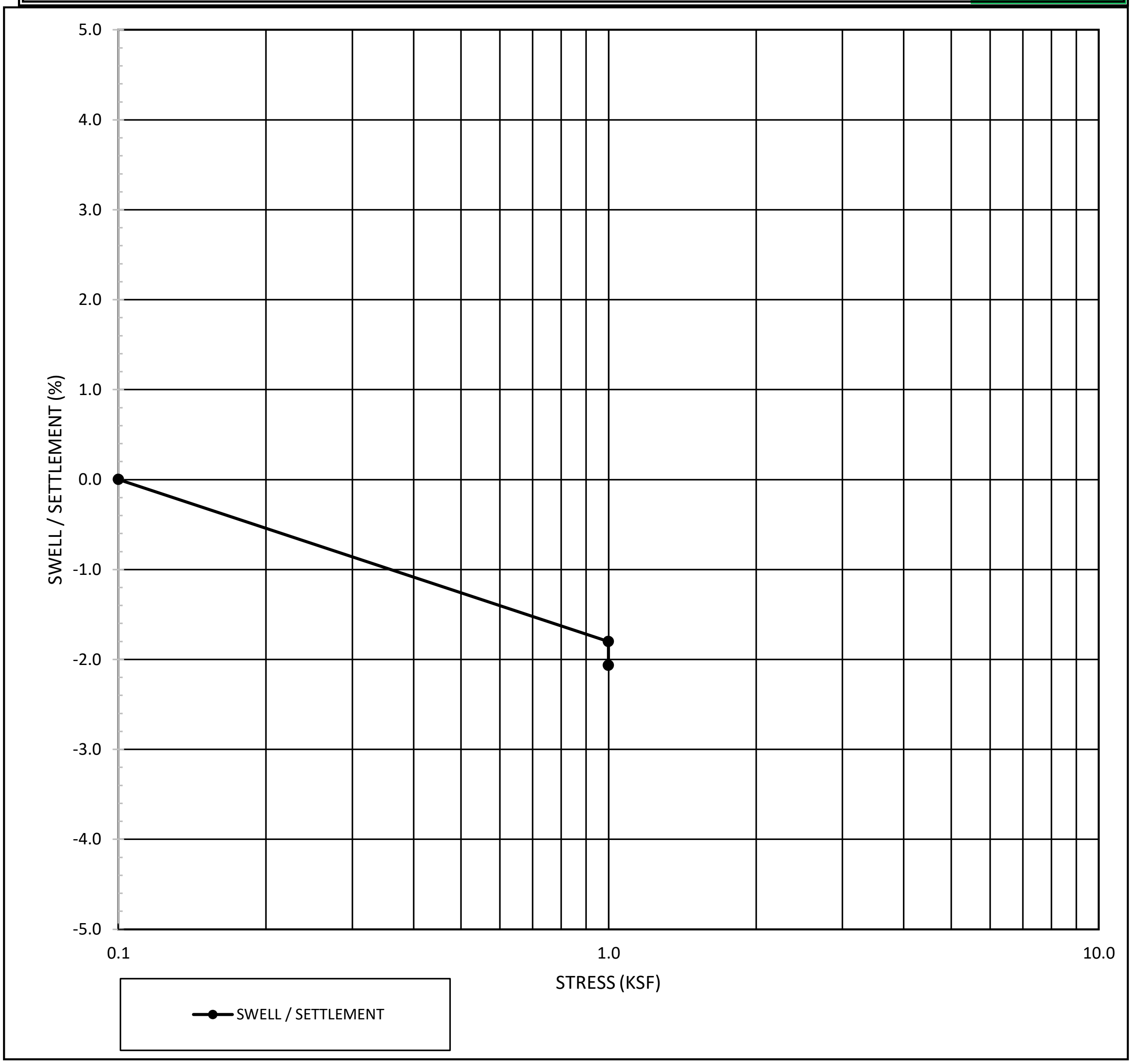
	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**BH-1**	**2.5**	**SILTY SAND(SM)**	**NP**	**NP**	**NP**		
⌧	**BH-1**	**10.0**	**SILTY SAND(SM)**	**NP**	**NP**	**NP**		
▲	**BH-2**	**2.5**	**CLAYEY SAND(SC)**	**32**	**13**	**19**		

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BH-1**	**2.5**	**9.5**	**1.267**	**0.129**		**9.0**	**68.0**	**23.0**	
⌧	**BH-1**	**10.0**	**19**	**1.009**	**0.131**		**7.0**	**67.0**	**26.0**	
▲	**BH-2**	**2.5**	**9.5**	**0.25**			**5.0**	**57.0**	**38.0**	

GRAIN SIZE - GINT STD US LAB.GDT - 8/4/22 08:07 - C:\USERS\BRYSEN MUSTAIN\VIVID ENGINEERING GROUP\GEO - DOCUMENTS\PROJECTS_2021\D21-2-457_JDS-HYDRO_TRIVIEW NDS PUMP STATION\6 - DRAFTING\D21-2-457.GPJ

Project Name:	NDS Pump Station	**Date**	7/22/2022
Project No.:	D21-2-457		
Boring ID.:	BH-1	**Sample Depth (ft)**	7.5
Sample Description:	Silty SAND, light brown, moist		

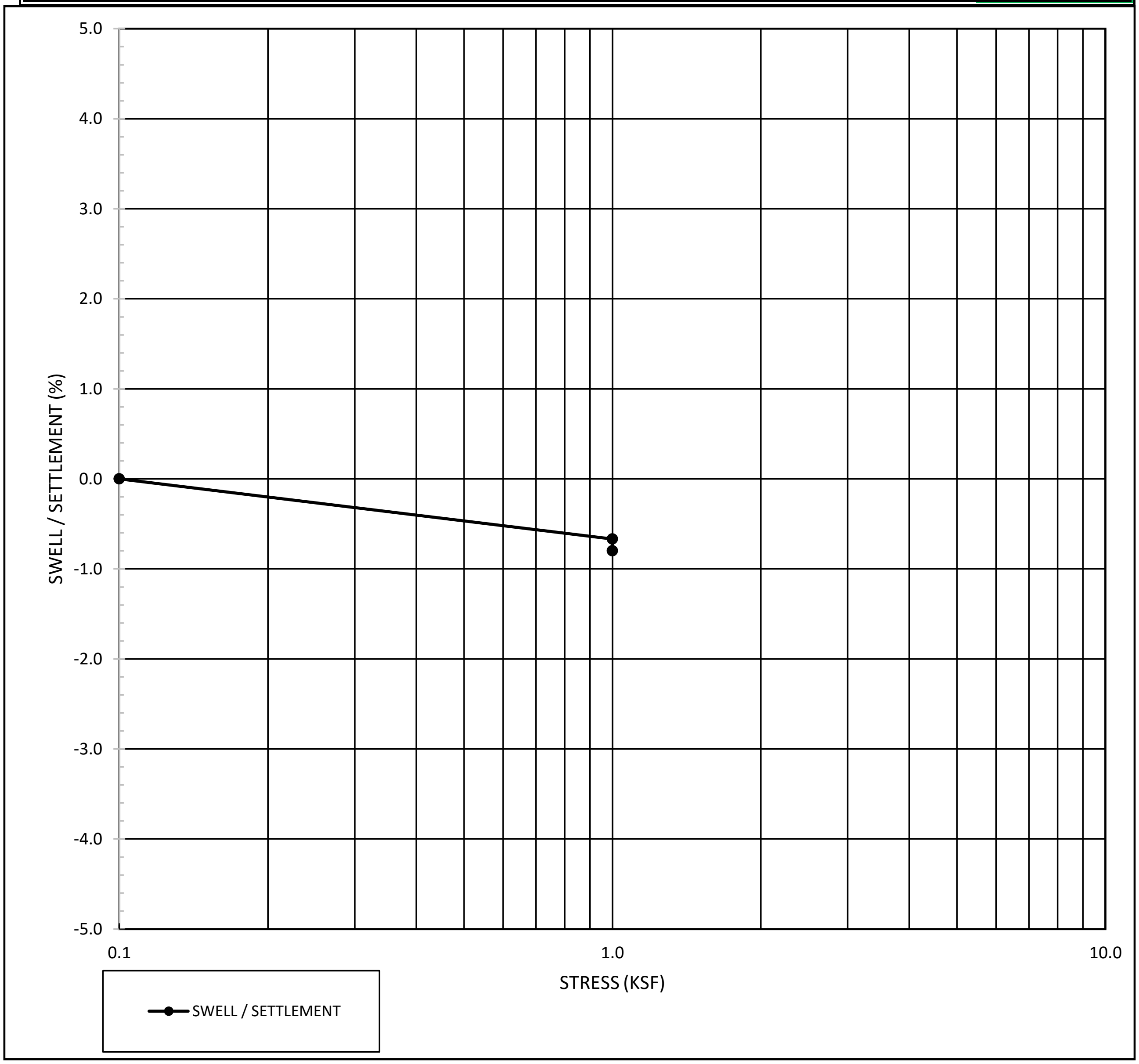
Compression @ Wetting Weight: % -0.3



Initial Condition	
Moisture Content %	**26.1**
Dry Density (pcf)	**95.2**
Post-Swell Condition	
Moisture Content %	**26.0**

Project Name:	NDS Pump Station	**Date**	7/22/2022
Project No.:	D21-2-457		
Boring ID.:	BH-1	**Sample Depth (ft)**	14
Sample Description:	Clayey SANDSTONE, gray, moist		

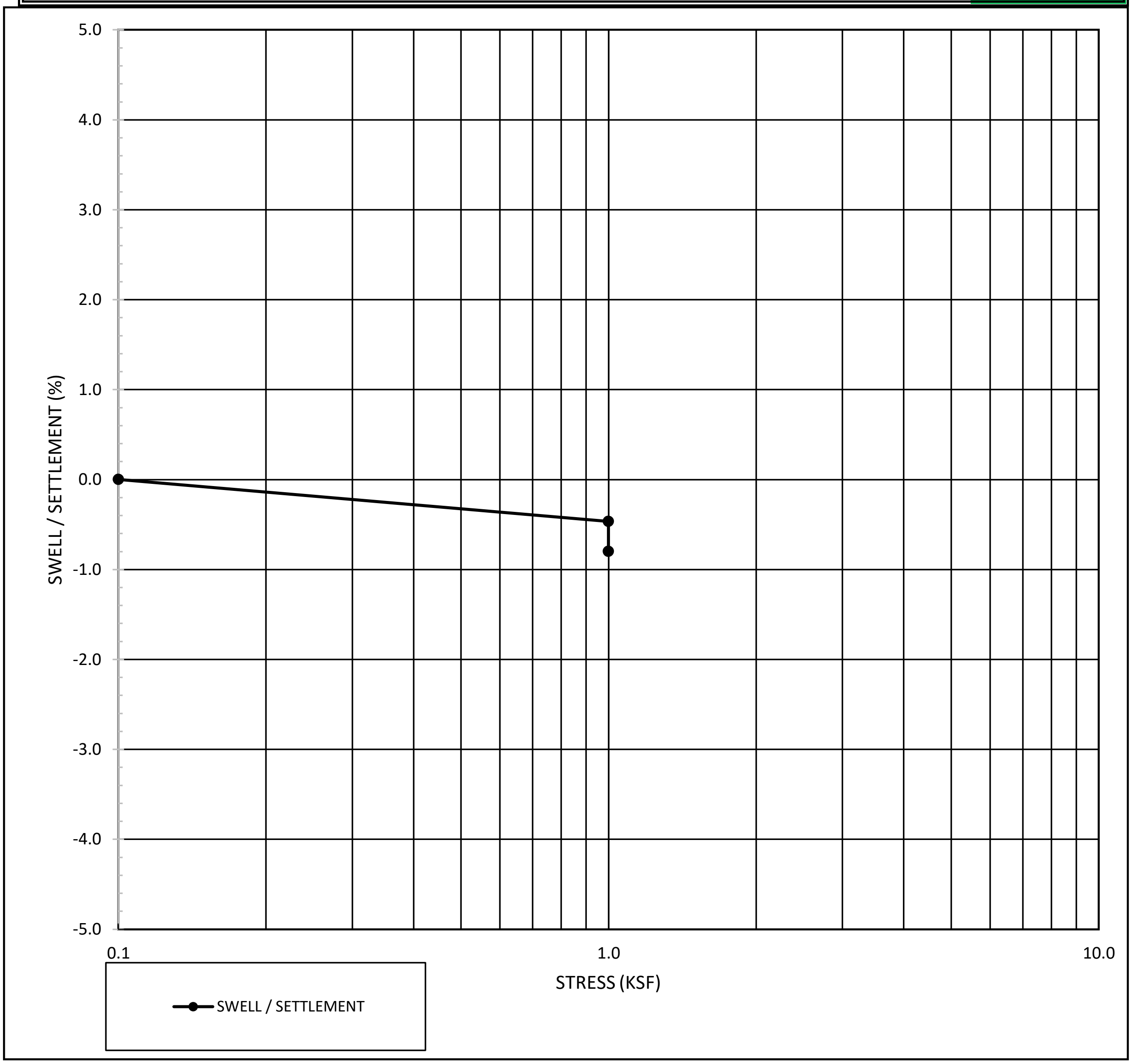
	%
Compression @ Wetting Weight:	**-0.1**



Initial Condition	
Moisture Content %	**11.7**
Dry Density (pcf)	**116.8**
Post-Swell Condition	
Moisture Content %	**14.6**

Project Name:	NDS Pump Station	**Date**	7/26/2022
Project No.:	D21-2-457		
Boring ID.:	BH-2	**Sample Depth (ft)**	24
Sample Description:	Clayey SANDSTONE, grayish-brown, moist		

	%
Compression @ Wetting Weight:	**-0.3**



Initial Condition	
Moisture Content %	**12.5**
Dry Density (pcf)	**112.0**
Post-Swell Condition	
Moisture Content %	**16.8**

Appendix C

Analytical Laboratory Test Results

WELD LABORATORIES, INC.

1527 First Avenue • Greeley, Colorado 80631
Phone: (970) 353-8118 • Fax: (970) 353-1671
www.weldlabs.com

July 26, 2022

Vivid Engineering, Inc
Attn: Brysen Mustain
1053 Elkton Drive
Colorado Springs, CO 80907

Project No.: NDS Pump Station D21-2-457
Sample ID: BH-1 19'

Laboratory No.: E22196-4B	Results[1,3]	10-Point System[2]
pH (SI)	NA	NA
AASHTO T 289-91 (ASTM G51 available for some soil)		
Conductivity (mmhos/cm)	NA	NA
Resistivity (ohm-m)	--	
USDA Handbook 60, temperature corrected conductivity probe		
Minimum Lab Resistivity (ohm-cm)	NA	0
Minimum Lab Resistivity (ohm-m)		
via Miller Box, Tinker & Razor SR-2 (AASHTO T 288-12)[4]		
Redox (mV vs. Ag/AgCl)	NA	0
ASTM G200 (ASTM D1498 if soil is low in moisture)		
Free Sulfide (mg/kg DMB)	NA	NA
EPA 9030B+9034, prescreened with lead acetate paper		
Chloride (mg/kg DMB)	NA	NA
AASHTO T 291-94		
Sulfate (mg/kg DMB)	229	3
CP-L 2103		
Sulfate (% DMB)	0.0229	
Sulfate-S (mg/kg DMB)	76.2	

1. NA = Not Analyzed; ND = Not Detected. DMB = Dry Matter Basis. Measurements taken at 25°C.
2. 10-point Corrosion system based on: Appendix A of ANSI/AWWA C105/A21.5 Standard "Polyethylene Encasement for Ductile Iron Pipe Systems." The Cl- points adapted from the DIPRA design decision model. Sulfate is penalized at half the rate of chloride: A. A. Sagüés et. al. (https://rosap.ntl.bts.gov/view/dot/17493)
3. pH, Conductivity, and Redox are generally read on a 1:1 soil:water mixture if the soil is dry.
4. ASTM G57 4-Electrode Method used unless 2-electrode method is requested.

Project Manager ______________________ Date 7/26/2022

Sampling procedures can affect the value of analytical results – customers are advised to use appropriate sampling protocol to ensure samples are truly representative of the bulk sample.

WELD LABORATORIES, INC.

1527 First Avenue • Greeley, Colorado 80631
Phone: (970) 353-8118 • Fax: (970) 353-1671
www.weldlabs.com

July 26, 2022

Vivid Engineering, Inc
Attn: Brysen Mustain
1053 Elkton Drive
Colorado Springs, CO 80907

Project No.: NDS Pump Station D21-2-457
Sample ID: BH-1 5'

Laboratory No.: E22196-4A	Results[1,3]	10-Point System[2]
pH (SI) AASHTO T 289-91 (ASTM G51 available for some soil)	7.6	0
Conductivity (mmhos/cm)	0.153	NA
Resistivity (ohm-m) USDA Handbook 60, temperature corrected conductivity probe	65.4	
Minimum Lab Resistivity (ohm-cm)	2520	1
Minimum Lab Resistivity (ohm-m) via Miller Box, Tinker & Razor SR-2 (AASHTO T 288-12)[4]	25.2	
Redox (mV vs. Ag/AgCl) ASTM G200 (ASTM D1498 if soil is low in moisture)	250	0
Free Sulfide (mg/kg DMB) EPA 9030B+9034, prescreened with lead acetate paper	ND	0
Chloride (mg/kg DMB) AASHTO T 291-94	0	0
Sulfate (mg/kg DMB) CP-L 2103	130	1
Sulfate (% DMB)	0.0130	
Sulfate-S (mg/kg DMB)	43.2	

1. NA = Not Analyzed; ND = Not Detected. DMB = Dry Matter Basis. Measurements taken at 25°C.
2. 10-point Corrosion system based on: Appendix A of ANSI/AWWA C105/A21.5 Standard "Polyethylene Encasement for Ductile Iron Pipe Systems." The Cl- points adapted from the DIPRA design decision model. Sulfate is penalized at half the rate of chloride: A. A. Sagüés et. al. (https://rosap.ntl.bts.gov/view/dot/17493)
3. pH, Conductivity, and Redox are generally read on a 1:1 soil:water mixture if the soil is dry.
4. ASTM G57 4-Electrode Method used unless 2-electrode method is requested.

Project Manager

7/26/2022
Date

Sampling procedures can affect the value of analytical results – customers are advised to use appropriate sampling protocol to ensure samples are truly representative of the bulk sample.

Appendix D

Site Photos

DRILLING BORING BH-1 - LOOKING NORTHWEST

DRILLING BORING BH-2 - LOOKING NORTHEAST

VIVID Engineering Group	Project No:	D21-2-457	**SITE PHOTOS**	FIGURE
	Date:	8/4/2022	Proposed Triview NDS Pump Station	**D-1**
	Drawn by:	BTM	Vicinity of Old Northgate Road and HWY 83	
	Reviewed by:	WJB	Colorado Springs, Colorado	

Appendix E

Important Information About This Geotechnical Engineering Report

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, clients can benefit from a lowered exposure to the subsurface problems that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed below, contact your GBA-member geotechnical engineer. Active involvement in the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Geotechnical-Engineering Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. *Those who rely on a geotechnical-engineering report prepared for a different client can be seriously misled.* No one except authorized client representatives should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one – not even you – should apply this report for any purpose or project except the one originally contemplated.*

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read it *in its entirety*. Do not rely on an executive summary. Do not read selected elements only. *Read this report in full.*

You Need to Inform Your Geotechnical Engineer about Change

Your geotechnical engineer considered unique, project-specific factors when designing the study behind this report and developing the confirmation-dependent recommendations the report conveys. A few typical factors include:

- the client's goals, objectives, budget, schedule, and risk-management preferences;
- the general nature of the structure involved, its size, configuration, and performance criteria;
- the structure's location and orientation on the site; and
- other planned or existing site improvements, such as retaining walls, access roads, parking lots, and underground utilities.

Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

This Report May Not Be Reliable

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, that it could be unwise to rely on a geotechnical-engineering report whose reliability may have been affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If your geotechnical engineer has not indicated an "apply-by" date on the report, ask what it should be*, and, in general, *if you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying it. A minor amount of additional testing or analysis – if any is required at all – could prevent major problems.

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface through various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing were performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgment to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team from project start to project finish, so the individual can provide informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, *they are not final*, because the geotechnical engineer who developed them relied heavily on judgment and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* revealed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a full-time member of the design team, to:

- confer with other design-team members,
- help develop specifications,
- review pertinent elements of other design professionals' plans and specifications, and
- be on hand quickly whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction observation.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for informational purposes only*. To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report, but they may rely on the factual data relative to the specific times, locations, and depths/elevations referenced. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely*. Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures*. If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. As a general rule, *do not rely on an environmental report prepared for a different client, site, or project, or that is more than six months old.*

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, none of the engineer's services were designed, conducted, or intended to prevent uncontrolled migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration.*** Confront the risk of moisture infiltration by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are not building-envelope or mold specialists.***

GEOPROFESSIONAL BUSINESS ASSOCIATION

Telephone: 301/565-2733
e-mail: info@geoprofessional.org   www.geoprofessional.org

6/29/2022

Geotechnical Evaluation Report

Triview Metro District NDS Water Pipeline

Roller Coaster Road between

Baptist Road and Old Northgate Road

El Paso County, Colorado

Vivid Project No.: D22-2-508

Vivid Engineering Group

June 29, 2022

Vivid Project No.: D22-2-508

Report prepared for:

Gwen Dall, P.E.
JDS-Hydro Consultants, Inc.
5540 Tech Center Drive., Suite 100
Colorado Springs, Colorado 80919
gdall@jdshydro.com

GEOTECHNICAL EVALUATION REPORT
Proposed Triview Metro District NDS Water Pipeline
Roller Coaster Road between
Baptist Road and Old Northgate Road
El Paso County, Colorado
VIVID Project No. D22-2-508

Prepared by:

Brysen T. Mustain, P.G.
Engineering Geologist

COLORADO REGISTERED PROFESSIONAL ENGINEER WILLIAM J. BARREIRE 32045

6/29/2022

William J. Barreire, P.E.
Senior Geotechnical Engineer

VIVID Engineering Group, Inc.
1053 Elkton Drive
Colorado Springs, CO 80907
(719) 896-4356 phone
(719) 896-4357 fax

Table of Contents

1.0 INTRODUCTION

1.1 GENERAL

This report presents the results of a geotechnical investigation performed for the proposed 16-inch diameter water pipeline to be constructed within an approximate 1,200' portion of Baptist Road west of Roller Coaster Road, and within the entire segment of Roller Coaster Road from Baptist Road extending south to Old Northgate Road in El Paso County, Colorado. An attached Vicinity Map (Figure 1) and Field Exploration Plans (Figures 2.1 and 2.2) show the general location of the project. Our investigation was performed for JDS-Hydro, Inc.

This report includes our recommendations relating to the geotechnical aspects of project design and construction. The conclusions and recommendations stated in this report are based upon the subsurface conditions found at the locations of our exploratory borings at the time our exploration was performed. They also are subject to the provisions stated in the report sections titled **Additional Services** and **Limitations**. Our findings, conclusions, and recommendations should not be extrapolated to other areas or used for other projects without our prior review. Furthermore, they should not be used if the site has been altered, or if a prolonged period has elapsed since the date of the report, without VIVID's prior review to determine if they remain valid.

1.2 PROJECT DESCRIPTION

We understand the proposed project consists of the construction of water pipeline infrastructure to be installed by open-trench methods along the project alignment, which is located within an approximate 1,200' portion of Baptist Road west of Roller Coaster Road, and within the entire segment of Roller Coaster Road from Baptist Road extending south to Old Northgate Road in El Paso County, Colorado. We also understand that these roadway segments will receive a new asphalt pavement section upon completion of the pipeline installation.

Proposed construction plans were not provided. We understand that trench excavations will be on the order of 10 feet or less for installation of the pipeline infrastructure and that areas of trenchless pipeline installation are not planned for this project.

If the type of construction varies significantly from those assumed above, VIVID should be notified immediately in order to revise our recommendations, if required.

1.3 PURPOSE AND SCOPE

The purpose of our investigation was to explore and evaluate subsurface conditions at widely-spaced locations on the site and, based upon the conditions found, to develop recommendations relating to the geotechnical aspects of project design and construction. Our conclusions and recommendations in this report are based upon analysis of the data from our field exploration, laboratory tests, and our experience with similar soil and geologic conditions in the area.

VIVID's scope of services included:

- A visual reconnaissance to observe surface and geologic conditions at the project site and locating the exploratory borings;

- Notification of the Utility Notification Center of Colorado (UNCC)/Colorado 811 to identify underground utility lines at the boring locations prior to our drilling;
- The drilling of 15 exploratory borings at various widely-spaced locations along the proposed pipeline alignment, which were selected based upon the proposed construction plans, access, and utilities;
- Laboratory testing of selected samples obtained during the field exploration to evaluate relevant physical and engineering properties of the soil;
- Evaluation and engineering analysis of the field and laboratory data collected to develop our geotechnical conclusions and recommendations; and
- Preparation of this report, which includes a description of the proposed project, a description of the surface and subsurface site conditions found during our investigation, our conclusions and recommendations as to pipeline installation design and construction, pavement section thickness design and construction, other related geotechnical issues, and appendices which summarize our field and laboratory investigations.

2.0 FIELD EXPLORATION AND LABORATORY TESTING

2.1 FIELD EXPLORATION

A field exploration performed on May 16 and 17, 2022 included drilling 15 exploratory borings at the approximate locations indicated on the Field Exploration Plans (Figures 2.1 and 2.2). Boring B-1 was performed within the eastbound lane of Baptist Road, approximately 650' west of the intersection with Roller Coaster Road. Borings B-2 through B-15 were spaced approximately 1,000 feet apart and drilled within either the southbound or northbound lane (depending on existing utility conflicts) of Roller Coaster Road between Baptist Road and Old Northgate Road. **The boring spacing of 1,000 feet, which is a deviation from the El Paso County pavement design specifications, was approved by El Paso County.**

Borings B-1 through B-14 were advanced to a depth of approximately 15 feet below the ground surface using a truck-mounted Diedrich D-90 drill rig equipped with 4-inch diameter, continuous-flight, solid-stem auger. Samples were taken with a standard penetration (SPT) sampler, California-type sampler (2.5-inch O.D./2.0-inch I.D.), and by bulk methods. Penetration tests were obtained at the various sample depths as well. Boring B-15 was advanced to a depth of 3 feet below the ground surface with a 3-inch diameter hand auger system due to utility locate conflicts.

Appendix A to this report includes logs describing the subsurface conditions. The lines defining boundaries between soil and bedrock types on the logs are based upon drill behavior and interpolation between samples and are therefore approximate. Transition between soil and bedrock types may be abrupt or may be gradual.

2.2 GEOTECHNICAL LABORATORY TESTING

Laboratory tests were performed on selected soil samples to estimate their relative engineering properties. Tests were performed in general accordance with the following methods of ASTM or other recognized standards-setting bodies, and local practice:

- Description and Identification of Soils (Visual-Manual Procedure)
- Classification of Soils for Engineering Purposes
- Moisture Content and Unit Weight
- Sieve Analysis of Fine and Coarse Aggregates
- Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- Swell Test
- R-Value

Results of the geotechnical laboratory tests are included in Appendix B of this report. Selected test results are also shown on the boring logs in Appendix A.

2.3 ANALYTICAL LABORATORY TESTING

Analytical testing for soil corrosivity was performed on select samples and included the following tests:

- pH
- Resistivity
- Redox Potential
- Water-soluble Chlorides

- Sulfides
- Water-soluble Sulfate Content

Results of the analytical laboratory tests are included in Appendix C of this report.

3.0 SITE CONDITIONS

3.1 SURFACE

The pipeline alignment is comprised of existing, asphalt-paved El Paso County right-of-way surrounded by ponderosa pine tree forest. The asphalt pavement was observed to be in fair condition with occasional cracking and patched locations. Fox Run Park was located on the south side of Baptist Road/west side of Roller Coaster Road for nearly half of the alignment. Scattered residential properties surrounded by forest were also located within the adjacent properties of the roads/pipeline alignment. Topography along the alignment comprised mostly of rolling hills.

3.2 GEOLOGY

Prior to drilling, the site geology was evaluated by reviewing geologic maps including the Colorado Geological Survey Geologic Map of the Monument Quadrangle, El Paso County, Colorado (Thorson & Madole, 2004). Mapping in the area indicates minimal surficial soils in the general area of the pipeline alignment comprised of weathered sandstone/claystone of the Dawson Formation underlain by Dawson Formation sandstone with interbeds of claystone. The mapping is generally consistent with our explorations.

3.3 SEISMICITY

Based upon the geologic setting, subsurface soil conditions, and low seismic activity in this region, liquefaction is not expected to be a hazard at the site. Based on correlation of blow count data (N-values) from the borings advanced during this evaluation, the subsurface soil and bedrock profiles are estimated to correspond with Site Class D of the 2015 International Building Code (IBC), Seismic Risk Category IV. The intermediate design acceleration values from IBC are presented below.

Table 1
Design Acceleration for Short Periods

S_S	F_a
0.182	1.6

S_S = The mapped spectral accelerations for short periods (OSHPD Seismic Design Website, 2022)

F_a = Site coefficient (OSHPD Seismic Design Website, 2022)

Table 2
Design Acceleration for 1-Second Period

S_1	F_V
0.06	2.4

S_1 = The mapped spectral accelerations for 1 second period (OSHPD Seismic Design Website, 2022)

F_v = Site coefficient (OSHPD Seismic Design Website, 2022)

3.4 SUBSURFACE

VIVID explored the subsurface conditions by drilling, logging and sampling 15 exploratory borings along the approximate pipeline alignment as shown on Figures 2.1 and 2.2. These borings were drilled to a depth of approximately 15 feet below the existing ground surface. The general profile encountered in our borings consisted of:

Existing Pavement Section

Approximately 7 to 9 inches (average 8 inches) of existing asphalt was encountered at the ground surface in each boring location. Approximately 2 to 9 inches of base course materials were encountered underlying the asphalt in three boring locations only. The base course materials generally comprised silty sand with gravel, was reddish-brown in color, and moist.

Existing Fill

Fill materials comprised of poorly graded sand with clay, clayey sand, silty sand, and silty-clayey sand were encountered in seven borings underlying the pavement section and extended to depths between 2 and 9 feet below the ground surface. The fill materials were olive-gray, light to dark brown, reddish-brown and dark gray, slightly moist to moist, and field penetration testing (blow counts) indicated the fill soils were very loose to medium dense in relative density. Swell testing was performed on three samples of the existing fill, exhibiting compression to low swell potential (-0.1 to 0.2 percent) when wetted under a 200 pounds per square foot load.

Sand and Clay

Predominantly silty to silty-clayey sand was present either underlying the pavement section or the fill materials described above and extended to approximate depths of 1.5 to 15.5 feet below the ground surface. The sand soils were fine to coarse-grained, varied from light brown to dark brown, slightly moist to moist, and field penetration testing (blow counts) indicated the sand soils were loose to medium dense in relative density. A thin layer of clay was encountered in one boring (boring B-6) between the approximate depths of 1 and 3 feet below the ground surface. The clay soils were olive-brown, moist, and field penetration testing (blow counts) indicated the clay soils were stiff in consistency.

Sandstone

Dawson Formation sandstone with varying amounts of silt and clay was encountered in all but six borings underlying the units described above and extended to the maximum depth explored. The sandstone was fine to coarse-grained, varied in color from light brown to grayish-brown, gray, reddish-brown to orangish-brown, and olive-brown, slightly moist to moist, and was hard to very hard based on blow counts. The sandstone also exhibited uncemented to weak cementation characteristics. Swell testing was performed on one sample of the sandstone, and the materials exhibited compression (-0.1 percent) when wetted under a 200 pounds per square foot load.

The boring logs in Appendix A should be reviewed for more detailed descriptions of the subsurface conditions at each of the boring locations explored.

3.4.1 Groundwater

Groundwater was not encountered in the borings at the time of drilling. For safety purposes, the borings were backfilled and patched upon the completion of drilling, preventing subsequent measurements. Although groundwater was not encountered in the borings at the time drilling, based on the proximity of the alignment to some minor drainage features and the proposed construction, it is anticipated that groundwater will be a construction consideration in the areas near these minor natural drainage features.

Based on our experience in the area, localized groundwater seepage can be encountered at random locations and elevations within the soils and bedrock formations as well.

Soil moisture levels and groundwater levels commonly vary over time and space depending on seasonal precipitation, irrigation practices, land use, and runoff conditions. These conditions and the variations that they create often are not apparent at the time of field investigation. Accordingly, the soil moisture and groundwater data in this report pertain only to the locations and times at which exploration was performed. They can be extrapolated to other locations and times only with caution. It should also be noted that VIVID has not performed a hydrologic study to verify the seasonal highwater level.

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 GEOTECHNICAL FEASIBILITY OF PROPOSED CONSTRUCTION

Based on the information obtained during our exploration, it is VIVID's opinion that construction of the proposed Triview Metro District NDS Water Pipeline as planned is feasible, provided that the recommendations in this report are incorporated into the design and construction of the project. We did not identify geotechnical conditions we believe will preclude construction of the pipeline as planned.

The primary geotechnical considerations associated with development of this project as proposed includes difficult excavation of sandstone bedrock and instability of trench sidewalls due to relatively clean zones of the surficial sand soils. Consideration regarding these and additional design and construction considerations are provided in following report sections.

4.2 CONSTRUCTION CONSIDERATIONS

4.2.1 General

All site preparation and earthwork operations should be performed in accordance with applicable codes, safety regulations and other local, State or Federal guidelines.

4.2.2 Site Preparation

Initial site work should consist of completely removing all asphalt, organic material and other deleterious materials from all areas to be filled and areas to be cut. This material should be removed for offsite disposal in accordance with local laws and regulations or, if appropriate, stockpiled in proposed landscaped areas for future use. Materials containing organic materials should not be utilized as compacted trench backfill.

After performing the required excavations and prior to the placement of compacted fill (if any) and pipeline infrastructure, processing of the subgrade should be performed. This should include scarifying the subgrade to a depth of at least 8 inches, moisture conditioning, and compacting as recommended in Section 4.2.5 of this report. All fill materials should be placed on a horizontal plane and placed in loose lifts not to exceed 8 inches in thickness, unless otherwise accepted by the geotechnical engineer.

4.2.3 Trench Excavation Characteristics

Excavation into the overburden soil material can likely be accomplished utilizing conventional standard duty earth moving equipment. The majority of the surficial overburden soil consisted of sand soils and uncemented to weakly cemented sandstone bedrock. Sloughing/collapse of trench sidewalls in areas that have clean sand materials and uncemented sandstone is likely. Based on this information, and depending on the depth of trenching, shoring is likely to be needed in these locations and where appropriate sloping cannot be achieved.

For trenches extending into bedrock, heavy duty excavation equipment will be required. However, as most of the bedrock encountered was uncemented to weakly cemented, the need for rock-specific excavation equipment such as hoe rams, etc., should be limited.

Groundwater was not encountered in the borings during this investigation, as presented in Section 3.4.1. However, based on our experience in the area, localized groundwater seepage can also be encountered at random locations and elevations within the soils and bedrock formations and is subject to seasonal precipitation. Where trenching operations encounter groundwater, construction dewatering will be required. Utilizing appropriate construction dewatering equipment/systems, such as well points, sumps, and trenches, will be the responsibility of the trenching contractor.

All excavations must comply with applicable local, State and Federal safety regulations, and particularly with the excavation standards of the Occupational Safety and Health Administration (OSHA). Construction site safety, including excavation safety, is the sole responsibility of the Contractor as part of its overall responsibility for the means, methods and sequencing of construction operations. VIVID's recommendations for excavation support are intended for the Client's use in planning the project, and in no way relieve the Contractor of its responsibility to construct, support and maintain safe slopes. Under no circumstances should the following recommendations be interpreted to mean that VIVID is assuming responsibility for either construction site safety or the Contractor's activities.

We believe that the soils on this site will classify as Type C materials using OSHA criteria. OSHA requires that unsupported cuts be laid back to ratios no steeper than 1½:1 (horizontal to vertical)in Type C materials. However, the hard and intact on-site bedrock may be classified as Type B material. OSHA requires that unsupported cuts up to 20 feet in height be laid back to ratios no steeper than 1H:1V (horizontal to vertical) for a Type B material. In general, we believe that these slope ratios will be temporarily stable under unsaturated conditions. Where groundwater seepage occurs, flatter slopes will be appropriate. Please note that the actual determination of soil type and allowable sloping must be made in the field by an OSHA-qualified "competent person."

4.2.4 Structural Fill and Trench Backfill

Based upon our subsurface investigation and laboratory testing, the on-site granular soils may be reused as trench backfill or structural fill. If imported structural fill is required at this site, it should consist of a non-expansive, granular material with a maximum particle size of 2 inches, a liquid limit of less than 30 percent, and a plasticity index of less than 10 percent. The fill should have between about 6 and 30 percent passing the No. 200 sieve. A sample of any imported fill material should be submitted to our office for approval and testing at least 1 week prior to stockpiling at the site.

Imported aggregate base course materials for use below new pavements should meet specifications for CDOT Class 6 Aggregate Base Course. A sample of any imported fill material should be submitted to our office for approval and testing at least 1-week prior to stockpiling at the site.

Backfill material should be essentially free of plant matter, organic soil, debris, trash, other deleterious matter and rock particles larger than 4 inches. However, backfill material in the "pipe zone" (from the trench floor to 1 foot above the top of pipe) should not contain rock particles larger than 1 inch. Strictly observe any requirements specified by the utility agency for bedding and pipe-zone fill. In general, backfill above the pipe zone in utility trenches should be placed in lifts of 6 to 8 inches, and compacted using power equipment designed for trench work. Backfill in the pipe zone should be placed in lifts of 8 inches or less and compacted with hand-held equipment.

Fill should be compacted according to the recommendations in Section 4.2.5 of this report. We recommend that a qualified representative of VIVID visit the site during excavation and during placement of the structural fill to verify the soils exposed in the excavations are consistent with those encountered during our subsurface exploration and that proper foundation subgrade preparation and placement is performed.

4.2.5 Compaction Requirements

Fill materials should be placed in horizontal lifts compatible with the type of compaction equipment being used, moisture conditioned, and compacted in accordance with the following criteria:

Table 3
Compaction Specifications

Fill Location	Material Type	Percent Compaction[1]	Moisture Content
Subgrade Preparation (after clearing, grubbing, excavation, and prior to placement of new fill and/or structural elements)	On-site Soils	92 minimum ASTM D1557	± 2 % of optimum
Existing Pavement Subgrade	On-site Soils	95 minimum ASTM D1557	± 2 % of optimum
Aggregate Base Course	CDOT Class 6 Aggregate Base Course	95 minimum AASHTO T-180	± 2 % of optimum
Utility Trench Backfill	On-site Soils/ Imported Granular Structural Fill (See Section 4.2.4)	95 minimum ASTM D1557	± 2 % of optimum

1) In non-structural/landscaped areas, the compaction specification may be reduced to 90 percent of ASTM D1557. The higher compaction criteria should be utilized where two or more "fill locations" coincide.

Compacted fill should be placed in level lifts not exceeding 8 inches in loose thickness and compacted to the specified percent compaction to produce a firm and unyielding surface. If field density tests indicate the required percent compaction has not been obtained, the fill material should be reconditioned as necessary and re-compacted to the required percent compaction before placing any additional material.

4.2.6 Construction in Wet or Cold Weather

During construction, grade the site such that surface water can drain readily away from the pipeline alignment area. Promptly pump out or otherwise remove any water that may accumulate in excavations or on subgrade surfaces and allow these areas to dry before resuming construction. The use of berms, ditches and similar means may be used to prevent stormwater from entering the work area and to convey any water off site efficiently.

If earthwork is performed during the winter months when freezing is a factor, no grading fill, structural fill or other fill should be placed on frosted or frozen ground, nor should frozen material be placed as fill. Frozen ground should be allowed to thaw or be completely removed prior to placement of fill. A good practice is to cover the compacted fill with a "blanket" of loose fill to help prevent the compacted fill from freezing.

If the pipeline and associated structures are constructed during cold weather, foundations or other concrete elements should not be constructed on frozen soil. Frozen soil should be completely removed from beneath the concrete elements, or thawed, scarified and recompacted. The amount of time passing between excavation or subgrade preparation and placing concrete should be minimized during freezing conditions to prevent the prepared soils from freezing. The use of blankets, soil cover or heating as required may be utilized to prevent the subgrade from freezing.

4.2.7 Construction Testing and Observation

Testing and construction observation should take place under the direction of VIVID to support that engineer's professional opinion as to whether the earthwork does or does not substantially conform to the recommendations in this report. Furthermore, the opinions and conclusions of a geotechnical report are based upon the interpretation of a limited amount of information obtained from the field exploration. It is therefore not uncommon to find that actual site conditions differ somewhat from those indicated in the report. The geotechnical engineer should remain involved throughout the project to evaluate such differing conditions as they appear, and to modify or add to the geotechnical recommendations as necessary.

4.3 THRUST BLOCK, VAULT AND FOUNDATION RECOMMENDATIONS

As discussed in this report, we recommend vaults, thrust blocks and other shallow foundation elements for pipeline installation, as required, be placed on a properly prepared subgrade comprising 8 inches of properly prepared subgrade or new, properly compacted structural fill.

We recommend vault/thrust block foundations be designed and constructed with the following criteria:

- Foundations should be constructed on a minimum of 8 inches of properly prepared subgrade or new, properly compacted structural fill. Existing subgrade should be scarified to a depth of at least 8 inches, moisture conditioned, and re-compacted as described in Sections 4.2.2 and 4.2.5.
- If the soils at foundation elevation are soft and/or wet, or otherwise unstable, some stabilization will be required to create a firm foundation subgrade. This type of stabilization typically includes rock stabilization that includes "pushing" and locking together a zone of angular rock, use of aggregate and geogrid, or similar approaches to bridge the softer subgrade materials. The type, thickness, aggregate/rock size will vary depending on the magnitude of instability and can only be determined in the field at the time of construction.
- Foundations bearing upon properly prepared subgrade or new compacted fill should be designed for a maximum allowable soil bearing capacity of 3,000 psf.
- Exterior foundations must be protected from frost action. We recommend footings be protected with at least 36 inches of soil cover or that which is required by local building codes, whichever is greater. Foundation components must not be placed on frozen soils.
- A representative of VIVID should observe all foundation excavations prior to placement of fill and/or concrete. Additionally, the placement and compaction of structural fill should be observed and tested by a representative of our firm.

4.4 LATERAL EARTH PRESSURES

We assume any vaults will be backfilled with soil on one side and will therefore be subjected to lateral earth pressures. In addition, thrust blocks will rely on soil resistance to minimize any pipe movement/deflection at bends in the pipe. Active and at-rest lateral earth pressures apply to the structural fill soils that are "retained" by the foundation walls. Passive lateral earth pressure applies to soils placed adjacent to the inside edge of the footings or thrust blocks to resist movement. The sliding coefficient applies to the friction between the base of the structural elements/foundations and the underlying soil. The following values were estimated assuming a moist unit weight of 125 pounds per cubic foot (pcf) and an internal friction angle of 32 degrees for on-site sand soils and imported granular structural fill materials. The values below apply to flat backslope and toe slopes.

Table 4
Lateral "Equivalent Fluid" Earth Pressure Parameter Summary

Parameter	Imported Granular Fill or On-Site Soils (Above Groundwater)	Imported Granular Fill or On-Site Soils (Below Groundwater)[4]
At-Rest[1]	59 pcf	92 pcf
Active[2]	38 pcf	82 pcf
Passive[3]	407 pcf	204 pcf
Unfactored Coefficient of Sliding Friction[3]	0.60	0.60

Notes: 1. Retaining walls that are laterally supported (structurally restrained from rotation) can be expected to undergo only a slight amount of deflection. These walls should be designed for an "at-rest" lateral earth pressure.

2. Retaining structures which can deflect sufficiently to mobilize the full "active" earth pressure condition should be designed for an "active" lateral earth pressure.

3. Lateral loads may be resisted using these unfactored coefficients of sliding friction and unfactored passive earth pressures presented above. Because significant movement is required to fully mobilize passive earth pressure, we recommend a minimum factor of safety of 2 be applied for design purposes.

4. It should be noted that the hydrostatic water pressure (62.4 pcf) was already included in the pressure values for below groundwater condition.

4.5 CORROSIVITY AND CONCRETE

4.5.1 Corrosion Potential

Laboratory testing was completed to provide data regarding corrosivity of onsite soils. Our scope of services does not include corrosion engineering and, therefore, a detailed analysis of the corrosion test results is not included. A qualified corrosion engineer should be retained to review the test results and design protective systems that may be required.

Laboratory chloride concentration, sulfate concentration, sulfide concentration, pH, oxidation reduction potential, and electrical resistivity tests were performed on a sample of onsite materials obtained during our field investigation. The results of the tests are included in Appendix C to this report and are summarized below in Table 5.

Table 5
Summary of Laboratory Soil Corrosivity Testing

Boring No.	Sample Depth (ft)	Lithology	pH	Lab Resistivity (ohm-cm)	Redox Potential (mV)	Sulfide Content* (mg/kg)	Water Soluble Chloride (mg/kg)	Water Soluble Sulfate (%)
B-1	0-4	Fill – Clayey SAND	8.5	1440	151	0.1	46	0.0148
B-2	9	SANDSTONE	7.8	1970	131	ND	73	0.0177
B-3	0-4	Silty SAND	8.2	1310	135	ND	68	0.0334
B-4	0-4	Silty SAND	7.8	1570	117	ND	35	0.0146
B-5	0-4	Fill – Silty, Clayey SAND	8.0	990	155	0.1	282	0.0149
B-6	9	SANDSTONE	7.1	1200	137	ND	44	0.0131
B-7	0-4	Silty SAND/ SANDSTONE	8.1	2090	141	0.1	79	0.0241
B-8	9	Silty SAND	6.9	960	155	ND	239	0.0163
B-9	0-4	Silty SAND	8.6	1220	134	0.1	164	0.0409
B-10	0-4	Silty, Clayey SAND	8.7	2520	159	0.15	157	0.0157
B-11	0-4	Silty SAND	8.8	2150	157	0.05	26	0.0148
B-12	4	Silty, Clayey SAND	6.1	1850	150	ND	40	0.0186
B-13	0-4	SANDSTONE	8.7	1720	174	ND	66	0.0116
B-14	0-4	SANDSTONE	8.2	1180	180	0.4	175	0.0128
B-15	0-3	Silty, Clayey SAND	9.4	1290	154	0.9	148	0.0157

*ND = Not Detected

Metal and concrete elements in contact with soil, whether part of a foundation system or part of a supported structure, are subject to degradation due to corrosion or chemical attack. Therefore, buried metal and concrete elements should be designed to resist corrosion and degradation based on accepted practices.

Based on the "10-point" method developed by the American Water Works Association (AWWA) in standard AWWA C105/A21.5, the corrosivity test results indicate that the onsite materials have corrosive potential based on the low resistivity test results alone. We recommend a corrosion engineer be consulted to recommend appropriate protective measures, if required.

4.5.2 Chemical Sulfate Susceptibility and Concrete Type

The degradation of concrete or cement grout can be caused by chemical agents in the soil or groundwater that react with concrete to either dissolve the cement paste or precipitate larger compounds within the concrete, causing cracking and flaking. The concentration of water-soluble sulfates in the soils is a good indicator of the potential for chemical attack of concrete or cement grout. The American Concrete Institute (ACI) in their publication Guide to Durable Concrete (ACI 201.2R-08) provides guidelines for this assessment.

The concentration of water-soluble sulfates measured on subsurface materials submitted for testing represents a Class 0 exposure of sulfate attack on concrete exposed to the soils per CDOT Standard Specifications for Road and Bridge Construction, 2021, Section 601.04. If there is not a significant difference in cost, Type II cement can be considered for added benefit for concrete in contact with soils.

4.6 PAVEMENT RECOMMENDATIONS

4.6.1 General

A pavement section is a layered system designed to distribute concentrated traffic loads to the subgrade. Performance of the pavement structure is directly related to the physical properties of the subgrade soils and traffic loadings. Soils are represented for pavement design purposes by means of a soil support value. Pavement design procedures are based on strength properties of the subgrade and pavement materials, along with the design traffic conditions.

We understand that new pavement areas on this site will include reconstruction of the existing asphalt pavement after completion of open-trench construction. Included herein are options for flexible pavement section thickness design that meet the El Paso County Pavement Design Criteria requirements, including the minimum required pavement section thickness for a 20-year design based on the roadway classification/traffic loading (ESAL) and subgrade soil modulus.

4.6.2 Anticipated Pavement Subgrade Material

VIVID performed borings at widely-spaced locations (1,000' spacing approved by El Paso County) within Baptist Road and Roller Coaster Road to obtain subsurface information to support the design of the proposed pavement sections. Our borings indicate the pavement subgrade soils will comprise predominantly granular materials. Granular types of soils are generally considered to provide fair to good support for pavements, while clayey soils are generally considered to provide poor support for pavements.

Under the AASHTO classification system, the soils tested predominantly classified as A-1-b, A-2-6, and A-2-4 soils. A-6 soils were encountered at two boring locations only (borings B-6 and B-14). Hveem stabilometer (R-Value) tests were performed on bulk soil samples of the A-1-b and A-2-4/A-2-6 materials and the resulting R-values were 25 and 29, respectively. Due to the similar nature of the subsurface materials encountered in each boring, an R-value of 25 was utilized for design. A resilient modulus (M_R)

value of 5,760 psi was calculated from the appropriate AASHTO R-value conversion formula referenced within the El Paso County Pavement Design Criteria.

Swell testing on pavement subgrade was performed in areas of more clayey/fine-grained subgrade materials. Three samples of existing fill soils were found to exhibit compression to low swell potential (-0.1 to 0.2 percent), and one sample of sandstone exhibited compression (-0.1 percent) when wetted under a 200 pounds per square foot (psf) surcharge load. According to Section D.2.4 of the El Paso County Pavement Design Criteria, subgrade soils with swell percentages less than 2 percent do not require mitigation. Therefore, we believe the potential risk for future vertical movement and associated impact to surface rideability is low.

The following sections describe in more detail the pavement section thickness design recommendations for areas requiring new pavement section construction.

4.6.3 Pavement Design Parameter Summary

Our pavement investigation and thickness calculations were performed in general accordance with El Paso County Pavement Design Criteria, which is based on the 1993 American Association of State and Highway Transportation Officials (AASHTO) Guide for Design of Pavement Structures.

Based upon information provided by El Paso County, the above-referenced pavement design criteria, and the subgrade strength values based on materials obtained in the borings, the following table presents the pavement design parameters that were utilized in our design. These parameters were utilized to calculate required thickness of new Hot Mix Asphalt (HMA) and Aggregate Base Course (ABC) layers. The roadway classifications and associated ESAL values were provided by JDS-Hydro.

Table 6
Summary of Pavement Design Parameters
Areas Requiring New Flexible (HMA) Composite Pavement Section Construction

Flexible Pavement Design Parameters			
Roadway Segment	Baptist Road (West of Roller Coaster Road)	Roller Coaster Road (Baptist Road to Stella Drive)	Roller Coaster Road (Stella Drive to Old Northgate Road)
Roadway Classification[2]	Rural – Minor Arterial	Rural – Major Collector	Rural – Minor Arterial
Required Min. HMA [in.][1]	4	3	4
Required Min. ABC [in.][1]	8	8	8
Design Serviceability Loss (ΔPSI)[1]	2.0	2.0	2.0
Overall Standard Deviation[1]	0.45	0.45	0.45
Reliability [%][1]	80	80	80
20-year, 18-kip ESAL[2]	689,850	273,750	689,850
Design R-Value	25		
Resilient Modulus (M_R) [psi]	5,760		

Flexible Pavement Design Parameters	
Strength Coefficients	
New Hot Mix Asphalt[1]	0.44
Existing Bituminous Pavement[1]	0.30
New Aggregate Base Course[1]	0.11
Existing Aggregate Base Course[1]	0.09

1) Indicates pavement design parameter(s) obtained from El Paso County Pavement Design Criteria.

2) Indicates default ESAL value provided by JDS-Hydro for each roadway classification.

If traffic estimates vary significantly from those assumed, we should be contacted to re-evaluate our recommendations. The following pavement sections were designed using the AASHTO design methods for flexible pavements and El Paso County Pavement Design Criteria. All pavement thickness recommendations are based on ESAL values for mainlines only. Specific adjustments for turn-lanes, acceleration/deceleration lanes, shoulders, etc. are not included.

4.6.4 Design Sections

Our recommended pavement sections below are for the new pavement proposed for the roadway areas on Baptist Road and Roller Coaster Road. Material requirements and compaction specifications for HMA, ABC, and subgrade materials are presented in Section 4.6.7. The following describes our recommended design sections that include the required thickness of HMA and ABC layers.

Table 7
Pavement Section Thicknesses

Roadway Segment	20-year Design Composite Flexible Section Thickness (HMA/ABC)
Baptist Road – West of Roller Coaster Road Design R = 25 Flexible ESAL = 689,850	5” HMA / 10” ABC
Roller Coaster Road – Baptist Road to Stella Drive Design R = 25 Flexible ESAL = 273,750	5” HMA / 8” ABC
Roller Coaster Road – Stella Drive to Old Northgate Road Design R = 25 Flexible ESAL = 689,850	5” HMA / 10” ABC

Notes:

1. The pavement sections will overlie a properly prepared subgrade as described in Sections 4.2.2 and 4.6.8.
2. Pavement Section Thicknesses were calculated using El Paso County Pavement Design Criteria Manual, which is based on the 1993 American Association of State and Highway Transportation Officials (AASHTO) Guide for Design of Pavement Structures.
3. All pavement thickness recommendations based on existing pavement subgrade strength parameters and ESAL values for mainlines only. Specific adjustments for turn-lanes, acceleration/deceleration lanes, shoulders, etc. not included.

4.6.5 Rehabilitation (Mill and Overlay) Design Options

Mill and overlay is a rehabilitation approach to extend the life of the existing pavement before full reconstruction becomes necessary. Based on the condition of the existing pavement and subgrade conditions, the life expectancy of a mill and overlay for the majority of the road is expected to be on the order of 10 to 20 years before additional rehabilitation or reconstruction efforts are required. In any case, mill and overlay will require heavier maintenance than pavement reconstruction.

If a mill and overlay option is chosen, mitigation measures to minimize and delay reflective cracking exist. Use of crack fill and fiberglass grid across existing transverse and longitudinal cracks have shown success in mitigating reflective cracking. This type and other mitigation measures can be implemented and should be considered to help prevent pre-mature pavement distress related to reflective cracking.

The following table presents the ESAL capacity (a.k.a. traffic capacity) ranges for a 2-inch mill and 2-inch overlay versus what the default traffic ESALs are for a 20-year design life for general comparison purposes.

Table 8
Calculated ESAL Capacity vs. 20-yr Design ESAL
2-inch Mill and 2-inch Overlay

	Baptist Road (West of Roller Coaster Road)	Roller Coaster Road (Baptist Road to Stella Drive)	Roller Coaster Road (Stella Drive to Old Northgate Road)
Calculated ESAL Capacity Range[1]	93,000	195,000 to >273,750	93,000 to >689,850
20-yr Design ESAL	689,850	273,750	689,850

Notes:

1) Calculated ESAL capacity is based on a 2-inch mill and 2-inch overlay and varies based on the existing pavement thickness and subgrade support values.

4.6.6 Pavement Construction Considerations

All site preparation, earthwork operations and construction materials should be performed in accordance with applicable codes, safety regulations and other local, State or Federal guidelines as applicable including, but not limited to:

- El Paso County Engineering Standard Specifications;
- El Paso County Pavement Design Criteria;
- Pikes Peak Region Asphalt Paving Specifications Manual, and;
- Colorado Department of Transportation (CDOT), as applicable, and included by reference.

Of particular importance are those specifications directed towards embankment construction, subgrade compaction, base course compaction, and utility trench compaction. Prior to pavement construction, the prepared subgrade should be proof-rolled with heavy construction equipment. A fully loaded water truck would be acceptable for this purpose. During proof-rolling, particular attention should be directed to the area immediately adjacent to manholes, valves, catch basins, and other similar surface features. Areas which exhibit excessive deflection during proof-rolling should be over-excavated and stabilized as required. If soil is imported to the subject site for final grading, the soil materials must be of a character similar to those described in this report.

Proper drainage is of paramount importance in enhancing pavement performance. To avoid distress to pavement from wet subgrade soils, we recommend the maintenance of good drainage away from all pavements. Possible water sources include storm runoff, irrigation of landscaping adjacent the pavement and localized groundwater seepage, among others. Landscaping adjacent to the pavements should be avoided. Joints in the pavement or at asphalt/concrete interfaces should be sealed. Any cracks or openings in the finished pavement surface should be sealed and/or repaired as quickly as possible

4.6.7 Pavement Materials

The asphalt pavement should consist of a bituminous plant mix composed of a mixture of aggregate and bituminous material that meets the requirements of a job-mix formula established by a qualified engineer. We recommend Grading SX (75 gyrations) with PG 64-22 mix be utilized. Hot Mix Asphalt (HMA) design and construction shall conform to the requirements of the current Pikes Peak Region Asphalt Paving Specifications Manual. The HMA pavement should be placed in lifts not to exceed 3 inches in thickness, unless otherwise accepted by the project engineer, and be compacted to between 92 percent and 96 percent of its maximum theoretical (Rice) density.

Portland Cement Concrete (PCC) shall conform to the requirements of the El Paso County Specifications.

Aggregate Base Course (ABC) materials should conform to CDOT Class 6 ABC specifications. The ABC material should be placed in a uniform layer without segregation of size to a compacted maximum lift thickness of 6 inches. ABC should be moisture conditioned and compacted as described in Section 4.2.5 of this report.

Use of blankets, soil cover, or heating may be required to help prevent the subgrade from freezing if construction occurs during cold weather.

4.6.8 Pavement Subgrade Preparation

Any obviously unsuitable materials present (e.g. debris, organic materials, waste) should be completely removed. Remove the stripped materials for offsite disposal in accordance with local laws and regulations.

Prior to placement of new pavement sections, processing of the subgrade should be performed as described in Sections 4.2.2. Prior to placing the pavement section, the prepared subgrade should be proof-rolled with a heavily loaded pneumatic-tired vehicle (such as a fully-loaded water truck) after preparation. Areas that pump or deform significantly under heavy wheel loads are not stable and should be stabilized prior to paving. The method and extent of stabilization should conform to El Paso County Pavement

Design Criteria and Specifications. The final stabilization approach/method and depth shall be approved by the Engineer.

5.0 ADDITIONAL SERVICES & LIMITATIONS

5.1 ADDITIONAL SERVICES

Attached to this report is a document by the Geoprofessional Business Association (GBA) that summarizes limitations of geotechnical reports as well as additional services that are required to further confirm subgrade materials are consistent with that encountered at the specific boring locations presented in this report. This document should be read in its entirety before implementing design or construction activities. Examples of other services beyond completion of a geotechnical report are necessary or desirable to complete a project satisfactorily include:

- Review of design plans and specifications to verify that our recommendations were properly interpreted and implemented.
- Attendance at pre-bid and pre-construction meetings to highlight important items and clear up misunderstandings, ambiguities, or conflicts with design plans and specifications.
- Performance of construction observation and testing which allows verification that existing materials at locations beyond our borings are consistent with that presented in our report, construction is compliant with the requirements/recommendations, evaluation of changed conditions.

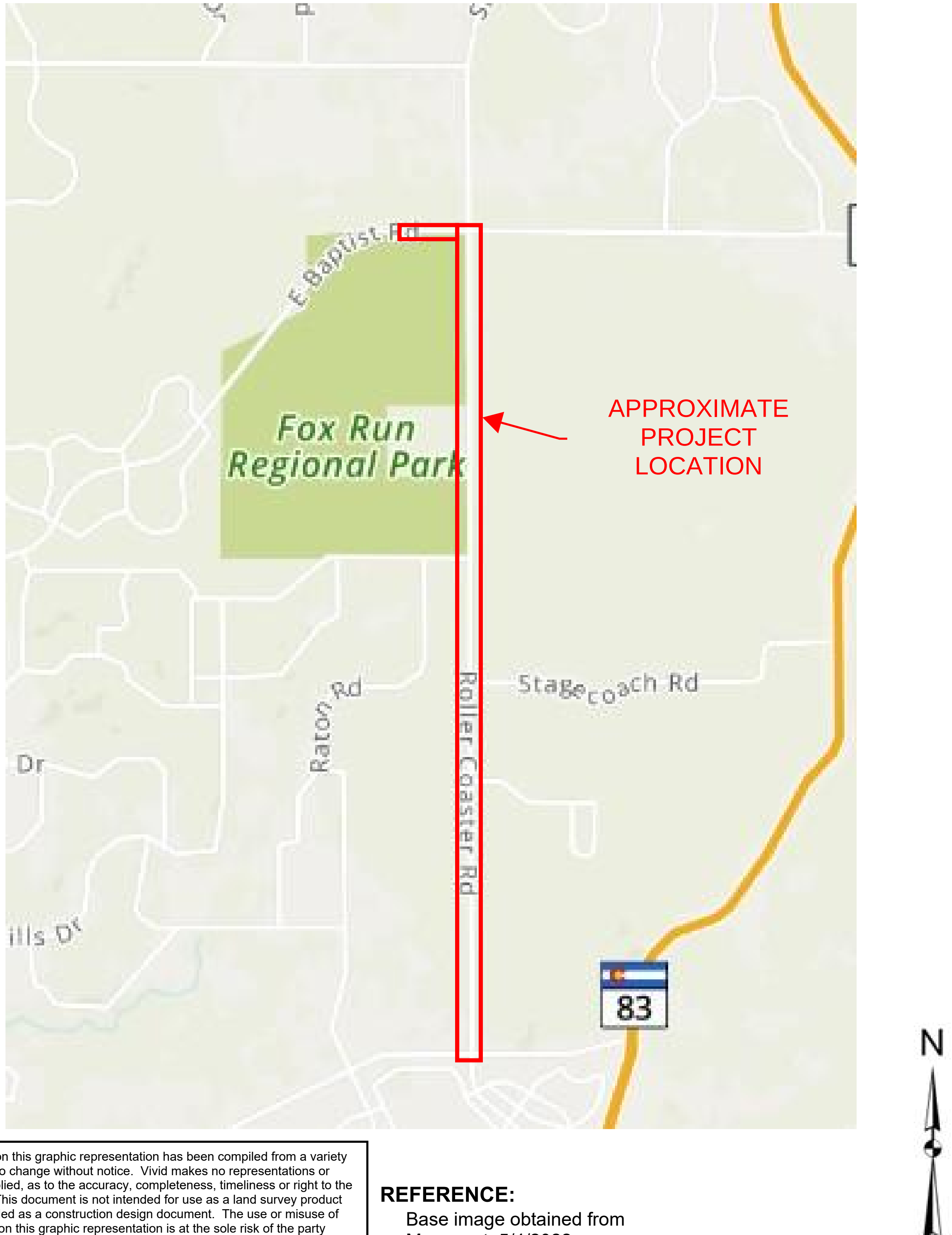
5.2 LIMITATIONS

This work was performed in a manner consistent with that level of care and skill ordinarily exercised by other members of VIVID's profession practicing in the same locality, under similar conditions and at the date the services are provided. Our conclusions, opinions, and recommendations are based on a limited number of observations and data. It is possible that conditions could vary between or beyond the data evaluated. VIVID makes no other representation, guarantee, or warranty, express or implied, regarding the services, communication (oral or written), report, opinion, or instrument of service provided.

This report may be used only by the Client and the registered design professional in responsible charge and only for the purposes stated for this specific engagement within a reasonable time from its issuance, but in no event later than two (2) years from the date of the report.

The work performed was based on project information provided by Client. If Client does not retain VIVID to review any plans and specifications, including any revisions or modifications to the plans and specifications, VIVID assumes no responsibility for the suitability of our recommendations. In addition, if there are any changes in the field to the plans and specifications, Client must obtain written approval from VIVID's engineer that such changes do not affect our recommendations. Failure to do so will vitiate VIVID's recommendations.

Figures



The information included on this graphic representation has been compiled from a variety of sources and is subject to change without notice. Vivid makes no representations or warranties, express or implied, as to the accuracy, completeness, timeliness or right to the use of such information. This document is not intended for use as a land survey product nor is it designed or intended as a construction design document. The use or misuse of the information contained on this graphic representation is at the sole risk of the party using or misusing the information.

REFERENCE:
Base image obtained from Mapquest, 5/4/2022

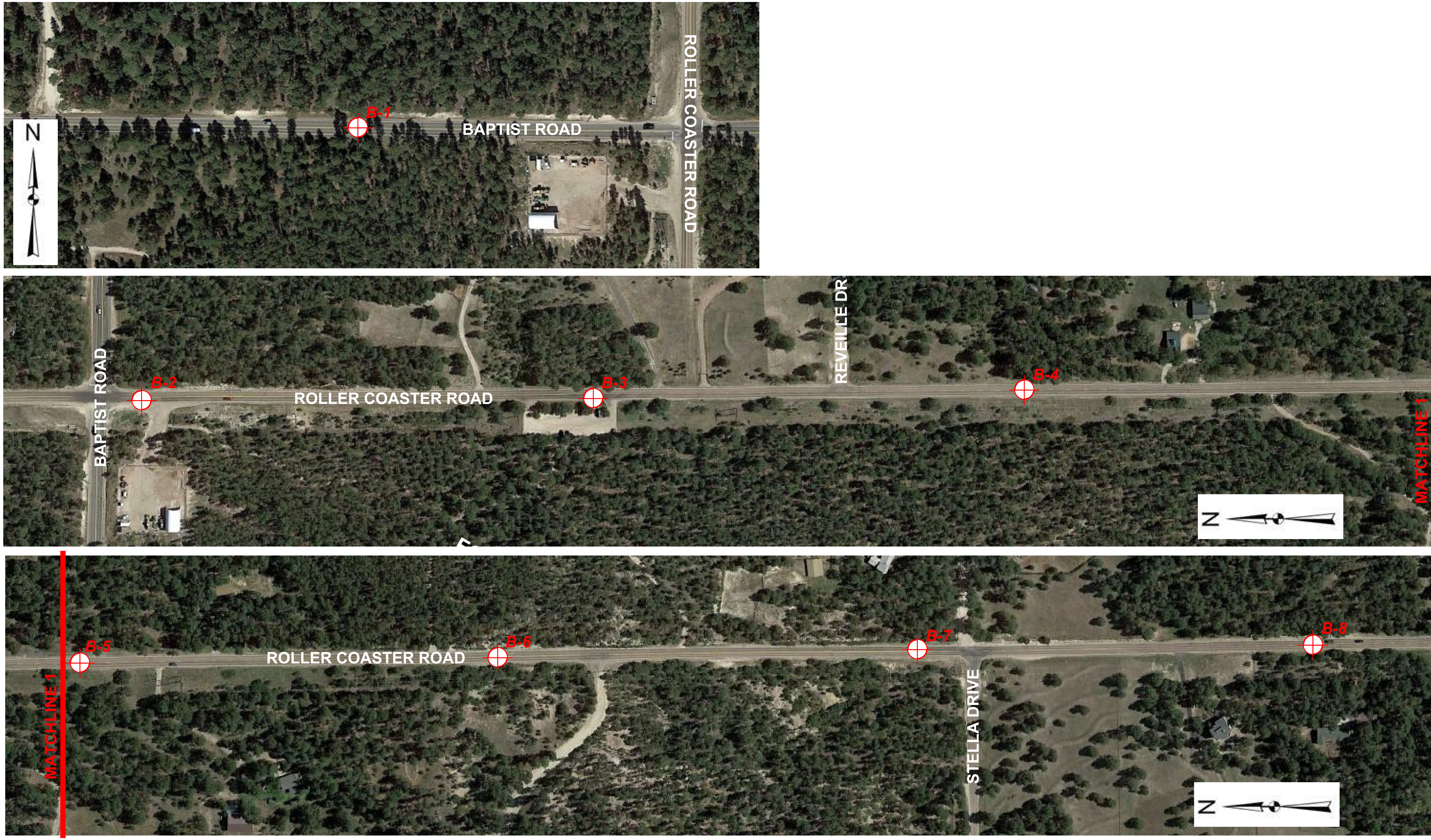
VIVID Engineering Group, Inc.
1053 Elkton Drive
Colorado Springs, CO 80907
719-896-4356

Project No.	D22-2-508
Date:	May 4, 2022
Drawn by:	BTM
Reviewed by:	WJB

VICINITY MAP

Triview Metro District NDS Water Pipeline
Roller Coaster Road between
Baptist Road and Old Northgate Road
El Paso County, Colorado

FIGURE
1



NOT TO SCALE

The information included on this graphic representation has been compiled from a variety of sources and is subject to change without notice. Vivid makes no representations or warranties, express or implied, as to the accuracy, completeness, timeliness or right to the use of such information. This document is not intended for use as a land survey product nor is it designed or intended as a construction design document. The use or misuse of the information contained on this graphic representation is at the sole risk of the party using or misusing the information.

REFERENCE:
Base image obtained from Google Earth Pro
Dated: 10/6/2019

LEGEND
B-1 Approximate Boring Location

VIVID Engineering Group
VIVID Engineering Group, Inc.
1053 Elkton Drive
Colorado Springs, CO 80907
719-896-4356

Project No. D22-2-508
Date: May 4, 2022
Drawn by: BTM
Reviewed by: WJB

FIELD EXPLORATION PLAN

Triview Metro District NDS Water Pipeline
Roller Coaster Road between
Baptist Road and Old Northgate Road
El Paso County, Colorado

FIGURE
2.1

NOT TO SCALE

The information included on this graphic representation has been compiled from a variety of sources and is subject to change without notice. Vivid makes no representations or warranties, express or implied, as to the accuracy, completeness, timeliness or right to the use of such information. This document is not intended for use as a land survey product nor is it designed or intended as a construction design document. The use or misuse of the information contained on this graphic representation is at the sole risk of the party using or misusing the information.

REFERENCE:
Base image obtained from
Google Earth Pro
Dated: 10/6/2019

LEGEND
B-1 Approximate Boring Location

VIVID Engineering Group

VIVID Engineering Group, Inc.
1053 Elkton Drive
Colorado Springs, CO 80907
719-896-4356

Project No. D22-2-508
Date: May 4, 2022
Drawn by: BTM
Reviewed by: WJB

FIELD EXPLORATION PLAN

Triview Metro District NDS Water Pipeline
Roller Coaster Road between
Baptist Road and Old Northgate Road
El Paso County, Colorado

FIGURE
2.2

Appendix A

Logs of Exploratory Borings

VIVID Engineering Group, Inc.
1053 Elkton Drive
Colorado Springs, Colorado 80907
Telephone: 719-896-4356
Fax: 719-896-4357

KEY TO SYMBOLS

CLIENT JDS-Hydro Consultants, Inc.
PROJECT NAME Triview NDS Pipeline - Roller Coaster Road
PROJECT NUMBER D22-2-508
PROJECT LOCATION Black Forest, CO

LITHOLOGIC SYMBOLS (Unified Soil Classification System)

- ASPHALT
- CL: USCS Low Plasticity Clay
- FILL
- SANDSTONE
- SC: USCS Clayey Sand
- SC-SM: USCS Clayey Sand
- SM: USCS Silty Sand

SAMPLER SYMBOLS

- Grab Sample
- 2" I.D. Modified California Sampler (MC)
- Standard Penetration Test (SPT)

ABBREVIATIONS

LL - LIQUID LIMIT (%)
PI - PLASTIC INDEX (%)
MC - MOISTURE CONTENT (%)
DD - DRY DENSITY (PCF)
NP - NON PLASTIC
FINES - PERCENT PASSING NO. 200 SIEVE

VIVID Engineering Group, Inc.
1053 Elkton Drive
Colorado Springs, Colorado 80907
Telephone: 719-896-4356
Fax: 719-896-4357

BORING NUMBER B-1

CLIENT JDS-Hydro Consultants, Inc.
PROJECT NAME Triview NDS Pipeline - Roller Coaster Road
PROJECT NUMBER D22-2-508
PROJECT LOCATION Black Forest, CO
DATE STARTED 5/16/22 **COMPLETED** 5/16/22
GROUND ELEVATION **HOLE SIZE** 4 inches
DRILLING CONTRACTOR GDI Drilling, Inc. (Diedrich D-90 Truck)
GROUND WATER LEVELS:
DRILLING METHOD 4" Solid Stem Auger
AT TIME OF DRILLING ---
LOGGED BY M. Ray **CHECKED BY** B. Mustain
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
0				0.6	**Asphalt - 7 inches**
	MC	4-2	MC = 11.9% DD = 108.5 pcf Swell = 0.2% when wetted under 200 PSF load		**Existing Fill** Clayey SAND, fine to coarse-grained, dark brown, olive-gray, slightly moist to moist, loose to very loose
	GB		MC = 16.7% DD = 107.1 pcf LL = 34 PL = 16 Fines = 30.0%		
5	MC	1-1		7.0	
					Dawson Formation Clayey and Silty SANDSTONE, light brown, grayish-brown, moist, hard to very hard
10	MC	50/8"			
	SPT	50/5"		14.4	

Bottom of borehole at 14.4 feet.

VIVID Engineering Group, Inc.
1053 Elkton Drive
Colorado Springs, Colorado 80907
Telephone: 719-896-4356
Fax: 719-896-4357

BORING NUMBER B-2

CLIENT JDS-Hydro Consultants, Inc.
PROJECT NAME Triview NDS Pipeline - Roller Coaster Road
PROJECT NUMBER D22-2-508
PROJECT LOCATION Black Forest, CO
DATE STARTED 5/16/22 **COMPLETED** 5/16/22
GROUND ELEVATION **HOLE SIZE** 4 inches
DRILLING CONTRACTOR GDI Drilling, Inc. (Diedrich D-90 Truck)
GROUND WATER LEVELS:
DRILLING METHOD 4" Solid Stem Auger
AT TIME OF DRILLING ---
LOGGED BY M. Ray **CHECKED BY** B. Mustain
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
0				0.7	**Asphalt - 8.25 inches**
	MC	14-11	MC = 15.2% DD = 109.2 pcf Compression = 1.1% when wetted under 200 PSF load		**Existing Fill** Silty, Clayey SAND, fine to coarse-grained, light to dark brown, slightly moist to moist, medium dense to loose
	GB		MC = 8.6% DD = 110.3 pcf LL = NP PL = NP Fines = 19.0%		
5	MC	6-5			
				9.0	**Dawson Formation** Silty SANDSTONE, orangish-brown, moist, hard
10	SPT	19-22			
	SPT	50/9"		14.8	

Bottom of borehole at 14.8 feet.

VIVID Engineering Group, Inc.
1053 Elkton Drive
Colorado Springs, Colorado 80907
Telephone: 719-896-4356
Fax: 719-896-4357

BORING NUMBER B-3

CLIENT JDS-Hydro Consultants, Inc.
PROJECT NAME Triview NDS Pipeline - Roller Coaster Road
PROJECT NUMBER D22-2-508
PROJECT LOCATION Black Forest, CO
DATE STARTED 5/16/22 **COMPLETED** 5/16/22
GROUND ELEVATION **HOLE SIZE** 4 inches
DRILLING CONTRACTOR GDI Drilling, Inc. (Diedrich D-90 Truck)
GROUND WATER LEVELS:
DRILLING METHOD 4" Solid Stem Auger
AT TIME OF DRILLING ---
LOGGED BY M. Ray **CHECKED BY** B. Mustain
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
0				0.7	**Asphalt - 8 inches**
	MC	17-19	MC = 4.8% DD = 123.9 pcf LL = NP PL = NP Fines = 15.0%	2.5	**Existing Fill** Silty SAND, fine to coarse-grained, dark brown, brown, slightly moist, medium dense
	GB				Silty SAND, fine to coarse-grained, light brown, slightly moist, loose to medium dense
5	MC	6-5			
10	MC	7-7	MC = 10.3% DD = 114.0 pcf		
15	SPT	12-15-20 (35)		15.5	

Bottom of borehole at 15.5 feet.

VIVID Engineering Group, Inc.
1053 Elkton Drive
Colorado Springs, Colorado 80907
Telephone: 719-896-4356
Fax: 719-896-4357

BORING NUMBER B-4

CLIENT JDS-Hydro Consultants, Inc.
PROJECT NAME Triview NDS Pipeline - Roller Coaster Road
PROJECT NUMBER D22-2-508
PROJECT LOCATION Black Forest, CO
DATE STARTED 5/16/22 **COMPLETED** 5/16/22
GROUND ELEVATION **HOLE SIZE** 4 inches
DRILLING CONTRACTOR GDI Drilling, Inc. (Diedrich D-90 Truck)
GROUND WATER LEVELS:
DRILLING METHOD 4" Solid Stem Auger
AT TIME OF DRILLING ---
LOGGED BY M. Ray **CHECKED BY** B. Mustain
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
0				0.7	**Asphalt - 8.25 inches**
	MC	7-7		2.5	**Existing Fill** Silty SAND, light to dark brown, slightly moist, medium dense
	GB		MC = 4.5% LL = NP PL = NP Fines = 22.0%		Silty SAND, fine to coarse-grained, light brown, slightly moist, medium dense to loose
5	MC	6-6			
10	SPT	5-3-4 (7)			
15	SPT	7-11-19 (30)		15.5	

Bottom of borehole at 15.5 feet.

VIVID Engineering Group, Inc.
1053 Elkton Drive
Colorado Springs, Colorado 80907
Telephone: 719-896-4356
Fax: 719-896-4357

BORING NUMBER B-5

CLIENT JDS-Hydro Consultants, Inc.
PROJECT NAME Triview NDS Pipeline - Roller Coaster Road
PROJECT NUMBER D22-2-508
PROJECT LOCATION Black Forest, CO
DATE STARTED 5/16/22 **COMPLETED** 5/16/22
GROUND ELEVATION **HOLE SIZE** 4 inches
DRILLING CONTRACTOR GDI Drilling, Inc. (Diedrich D-90 Truck)
GROUND WATER LEVELS:
DRILLING METHOD 4" Solid Stem Auger
AT TIME OF DRILLING ---
LOGGED BY M. Ray **CHECKED BY** B. Mustain
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
0				0.7	**Asphalt - 8.5 inches**
	MC	8-5	MC = 13.9% DD = 111.8 pcf		**Existing Fill** Silty, Clayey SAND, dark gray, brown, slightly moist to moist, medium dense to loose
	GB		MC = 9.1% LL = 24 PL = 16 Fines = 31.0%		
5	MC	3-3	MC = 10.5% DD = 107.6 pcf	5.0	Silty, Clayey SAND with clay layers, light brown, moist, loose
10	MC	3-3			
15	SPT	2-2-3 (5)		15.5	-CLAY layer from approximately 14 to 15 feet below the existing ground surface

Bottom of borehole at 15.5 feet.

VIVID Engineering Group, Inc.
1053 Elkton Drive
Colorado Springs, Colorado 80907
Telephone: 719-896-4356
Fax: 719-896-4357

BORING NUMBER B-6

CLIENT JDS-Hydro Consultants, Inc.
PROJECT NAME Triview NDS Pipeline - Roller Coaster Road
PROJECT NUMBER D22-2-508
PROJECT LOCATION Black Forest, CO
DATE STARTED 5/16/22 **COMPLETED** 5/16/22
GROUND ELEVATION **HOLE SIZE** 4 inches
DRILLING CONTRACTOR GDI Drilling, Inc. (Diedrich D-90 Truck)
GROUND WATER LEVELS:
DRILLING METHOD 4" Solid Stem Auger
AT TIME OF DRILLING ---
LOGGED BY M. Ray **CHECKED BY** B. Mustain
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
0				0.7	**Asphalt - 8 inches**
				0.9	**Aggregate Base Course - 3 inches** Silty SAND with gravel, reddish-brown, slightly moist
	MC	12-8	MC = 9.4% DD = 113.8 pcf		Sandy Lean CLAY, olive-brown, moist, stiff
	GB		MC = 13.4% LL = 33 PL = 15 Fines = 52.0%	3.0	**Dawson Formation** Clayey SANDSTONE, fine to medium-grained, light brown, moist, hard
5	MC	50/12"			
10	MC	50/11"			
				11.0	**Dawson Formation** Silty SANDSTONE, fine to coarse-grained, light gray, moist, very hard
	MC	50/6"		14.5	

Bottom of borehole at 14.5 feet.

GENERAL BH / TP / WELL - MODIFIED - GINT STD US LAB.GDT - 6/14/22 11:27 - C:\USERS\BRYSEN MUSTAIN\VIVID ENGINEERING GROUP\GEOTECH GROUP VIVID ENGINEERING - DOCUMENTS\PROJECTS_2022\D22-2-508_JDS-HYDRO_NDS PIPELINE\6 - DRAFTING\

VIVID Engineering Group, Inc.
1053 Elkton Drive
Colorado Springs, Colorado 80907
Telephone: 719-896-4356
Fax: 719-896-4357

BORING NUMBER B-7

CLIENT JDS-Hydro Consultants, Inc.
PROJECT NAME Triview NDS Pipeline - Roller Coaster Road
PROJECT NUMBER D22-2-508
PROJECT LOCATION Black Forest, CO
DATE STARTED 5/16/22 **COMPLETED** 5/16/22
GROUND ELEVATION **HOLE SIZE** 4 inches
DRILLING CONTRACTOR GDI Drilling, Inc. (Diedrich D-90 Truck)
GROUND WATER LEVELS:
DRILLING METHOD 4" Solid Stem Auger
AT TIME OF DRILLING ---
LOGGED BY M. Ray **CHECKED BY** B. Mustain
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
0				0.7	**Asphalt - 8 inches**
				0.8	**Aggregate Base Course - 2 inches** Silty SAND with gravel, reddish-brown, slightly moist
	MC	12-9	MC = 11.3% DD = 113.2 pcf Swell = 0.1% when wetted under 200 PSF load	2.0	**Existing Fill** Poorly Graded SAND with Clay, fine to coarse-grained, light brown, slightly moist, medium dense
	GB				
5	MC	50/7"	MC = 7.3% LL = 26 PL = 13 Fines = 7.9%		**Dawson Formation** Silty, Clayey SANDSTONE, light brown, gray, moist, hard to very hard
10	MC	50/6"			
	SPT	50/11"		14.9	

Bottom of borehole at 14.9 feet.

VIVID Engineering Group, Inc.
1053 Elkton Drive
Colorado Springs, Colorado 80907
Telephone: 719-896-4356
Fax: 719-896-4357

BORING NUMBER B-8

CLIENT JDS-Hydro Consultants, Inc.
PROJECT NAME Triview NDS Pipeline - Roller Coaster Road
PROJECT NUMBER D22-2-508
PROJECT LOCATION Black Forest, CO
DATE STARTED 5/16/22 **COMPLETED** 5/16/22
GROUND ELEVATION **HOLE SIZE** 4 inches
DRILLING CONTRACTOR GDI Drilling, Inc. (Diedrich D-90 Truck)
GROUND WATER LEVELS:
DRILLING METHOD 4" Solid Stem Auger
AT TIME OF DRILLING ---
LOGGED BY M. Ray **CHECKED BY** B. Mustain
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
0				0.7	**Asphalt - 7.75 inches**
	MC	14-13			Silty SAND with gravel and clayey layers, light brown, slightly moist, medium dense to loose
	GB		MC = 4.0% LL = NP PL = NP Fines = 22.0%		
5	MC	4-3	MC = 7.6% DD = 111.4 pcf		
10	SPT	2-2-2 (4)			
15	SPT	3-2-3 (5)		15.5	

Bottom of borehole at 15.5 feet.

VIVID Engineering Group, Inc.
1053 Elkton Drive
Colorado Springs, Colorado 80907
Telephone: 719-896-4356
Fax: 719-896-4357

BORING NUMBER B-9

CLIENT JDS-Hydro Consultants, Inc.
PROJECT NAME Triview NDS Pipeline - Roller Coaster Road
PROJECT NUMBER D22-2-508
PROJECT LOCATION Black Forest, CO
DATE STARTED 5/16/22 **COMPLETED** 5/16/22
GROUND ELEVATION **HOLE SIZE** 4 inches
DRILLING CONTRACTOR GDI Drilling, Inc. (Diedrich D-90 Truck)
GROUND WATER LEVELS:
DRILLING METHOD 4" Solid Stem Auger
AT TIME OF DRILLING ---
LOGGED BY M. Ray **CHECKED BY** B. Mustain
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
0				0.6	**Asphalt - 7 inches**
	MC	9-14	MC = 4.5% DD = 115.0 pcf LL = NP PL = NP Fines = 14.0%		Silty SAND with gravel, light brown, slightly moist, medium dense
	GB				
5	MC	8-5			
				7.0	**Dawson Formation** Silty SANDSTONE, light brown, moist, hard to very hard
10	MC	50/8"			
	MC	50/5"		14.4	

Bottom of borehole at 14.4 feet.

VIVID Engineering Group, Inc.
1053 Elkton Drive
Colorado Springs, Colorado 80907
Telephone: 719-896-4356
Fax: 719-896-4357

BORING NUMBER B-10

CLIENT JDS-Hydro Consultants, Inc.
PROJECT NAME Triview NDS Pipeline - Roller Coaster Road
PROJECT NUMBER D22-2-508
PROJECT LOCATION Black Forest, CO
DATE STARTED 5/16/22 **COMPLETED** 5/16/22
GROUND ELEVATION **HOLE SIZE** 4 inches
DRILLING CONTRACTOR GDI Drilling, Inc. (Diedrich D-90 Truck)
GROUND WATER LEVELS:
DRILLING METHOD 4" Solid Stem Auger
AT TIME OF DRILLING ---
LOGGED BY M. Ray **CHECKED BY** B. Mustain
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
0				0.7	**Asphalt - 8 inches**
	MC	7-10	MC = 7.7% DD = 113.8 pcf		Silty, Clayey SAND, light brown, slightly moist, medium dense
	GB		MC = 4.9% LL = 21 PL = 13 Fines = 34.0%		
5	MC	8-6			
10	SPT	4-4-6 (10)			
				13.0	**Dawson Formation** Clayey SANDSTONE, olive-brown, moist, hard
15	SPT	22-50		15.4	

Bottom of borehole at 15.4 feet.

GENERAL BH / TP / WELL - MODIFIED - GINT STD US LAB.GDT - 6/14/22 11:27 - C:\USERS\BRYSEN MUSTAIN\VIVID ENGINEERING\VIVID ENGINEERING GROUP\GEOTECH GROUP VIVID ENGINEERING - DOCUMENTS\PROJECTS_2022\D22-2-508_JDS-HYDRO_NDS PIPELINE\6 - DRAFTING\

VIVID Engineering Group, Inc.
1053 Elkton Drive
Colorado Springs, Colorado 80907
Telephone: 719-896-4356
Fax: 719-896-4357

BORING NUMBER B-11

CLIENT JDS-Hydro Consultants, Inc.
PROJECT NAME Triview NDS Pipeline - Roller Coaster Road
PROJECT NUMBER D22-2-508
PROJECT LOCATION Black Forest, CO
DATE STARTED 5/16/22 **COMPLETED** 5/16/22
GROUND ELEVATION **HOLE SIZE** 4 inches
DRILLING CONTRACTOR GDI Drilling, Inc. (Diedrich D-90 Truck)
GROUND WATER LEVELS:
DRILLING METHOD 4" Solid Stem Auger
AT TIME OF DRILLING ---
LOGGED BY M. Ray **CHECKED BY** B. Mustain
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
0				0.7	**Asphalt - 8 inches**
	MC	20-17	MC = 6.5% DD = 123.5 pcf LL = NP PL = NP Fines = 17.0%		Silty SAND, light brown, slightly moist, medium dense to loose
	GB				
5	MC	12-12			
10	MC	4-4			
15	SPT	7-5-6 (11)		15.5	

Bottom of borehole at 15.5 feet.

GENERAL BH / TP / WELL - MODIFIED - GINT STD US LAB.GDT - 6/14/22 11:28 - C:\USERS\BRYSEN MUSTAIN\VIVID ENGINEERING GROUP\GEOTECH GROUP VIVID ENGINEERING - DOCUMENTS\PROJECTS_2022\D22-2-508_JDS-HYDRO_NDS PIPELINE\6 - DRAFTING\

VIVID Engineering Group, Inc.
1053 Elkton Drive
Colorado Springs, Colorado 80907
Telephone: 719-896-4356
Fax: 719-896-4357

BORING NUMBER B-12

CLIENT JDS-Hydro Consultants, Inc.
PROJECT NAME Triview NDS Pipeline - Roller Coaster Road
PROJECT NUMBER D22-2-508
PROJECT LOCATION Black Forest, CO
DATE STARTED 5/16/22 **COMPLETED** 5/16/22
GROUND ELEVATION **HOLE SIZE** 4 inches
DRILLING CONTRACTOR GDI Drilling, Inc. (Diedrich D-90 Truck)
GROUND WATER LEVELS:
DRILLING METHOD 4" Solid Stem Auger
AT TIME OF DRILLING ---
LOGGED BY M. Ray **CHECKED BY** B. Mustain
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
0				0.8	**Asphalt - 9 inches**
	MC	13-12			Silty, Clayey SAND, brown, dark brown, slightly moist, medium dense to loose
	GB		MC = 5.9% LL = 24 PL = 14 Fines = 28.0%		
5	MC	8-6			
10	SPT	2-1-1 (2)		14.0	
	SPT	50/11"		14.9	**Dawson Formation** Silty SANDSTONE, brown, slightly moist, hard

Bottom of borehole at 14.9 feet.

VIVID Engineering Group, Inc.
1053 Elkton Drive
Colorado Springs, Colorado 80907
Telephone: 719-896-4356
Fax: 719-896-4357

BORING NUMBER B-13

CLIENT JDS-Hydro Consultants, Inc.
PROJECT NAME Triview NDS Pipeline - Roller Coaster Road
PROJECT NUMBER D22-2-508
PROJECT LOCATION Black Forest, CO
DATE STARTED 5/16/22 **COMPLETED** 5/16/22
GROUND ELEVATION **HOLE SIZE** 4 inches
DRILLING CONTRACTOR GDI Drilling, Inc. (Diedrich D-90 Truck)
GROUND WATER LEVELS:
DRILLING METHOD 4" Solid Stem Auger
AT TIME OF DRILLING ---
LOGGED BY M. Ray **CHECKED BY** B. Mustain
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
0				0.7	**Asphalt - 8 inches**
				0.9	**Aggregate Base Course - 9 inches** Silty SAND with gravel, reddish-brown, slightly moist
	MC	22-24	MC = 4.8% DD = 110.7 pcf Compression = 0.1% when wetted under 200 PSF load		**Dawson Formation** Silty, Clayey SANDSTONE, light brown, reddish-brown, moist, hard
	GB				
5	MC	50/8"	MC = 9.7% DD = 123.4 pcf LL = 35 PL = 16 Fines = 13.0%		
10	MC	50/7"			
	MC	50/9"		14.8	

Bottom of borehole at 14.8 feet.

VIVID Engineering Group, Inc.
1053 Elkton Drive
Colorado Springs, Colorado 80907
Telephone: 719-896-4356
Fax: 719-896-4357

BORING NUMBER B-14

CLIENT JDS-Hydro Consultants, Inc.
PROJECT NAME Triview NDS Pipeline - Roller Coaster Road
PROJECT NUMBER D22-2-508
PROJECT LOCATION Black Forest, CO
DATE STARTED 5/16/22 **COMPLETED** 5/16/22
GROUND ELEVATION **HOLE SIZE** 4 inches
DRILLING CONTRACTOR GDI Drilling, Inc. (Diedrich D-90 Truck)
GROUND WATER LEVELS:
DRILLING METHOD 4" Solid Stem Auger
AT TIME OF DRILLING ---
LOGGED BY M. Ray **CHECKED BY** B. Mustain
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
0				0.7	**Asphalt - 8 inches**
	MC	7-20		1.5	Clayey SAND, brown, slightly moist
	GB		MC = 8.7% LL = 30 PL = 13 Fines = 36.0%		**Dawson Formation** Silty, Clayey SANDSTONE, gray, brown, slightly moist, hard to very hard
5	MC	50/7"	MC = 9.7% DD = 116.4 pcf		
10	MC	50/9"			
	MC	50/5"		14.4	

Bottom of borehole at 14.4 feet.

VIVID Engineering Group, Inc.
1053 Elkton Drive
Colorado Springs, Colorado 80907
Telephone: 719-896-4356
Fax: 719-896-4357

BORING NUMBER B-15

CLIENT JDS-Hydro Consultants, Inc.
PROJECT NAME Triview NDS Pipeline - Roller Coaster Road
PROJECT NUMBER D22-2-508
PROJECT LOCATION Black Forest, CO
DATE STARTED 5/16/22 **COMPLETED** 5/16/22
GROUND ELEVATION **HOLE SIZE** 3 inches
DRILLING CONTRACTOR VIVID Engineering Group (Hand Auger)
GROUND WATER LEVELS:
DRILLING METHOD 3" Hand Auger
AT TIME OF DRILLING ---
LOGGED BY M. Ray **CHECKED BY** B. Mustain
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	GRAPHIC LOG		MATERIAL DESCRIPTION
0				0.7	**Asphalt - 8 inches**
	GB	MC = 5.1% LL = 22 PL = 15 Fines = 23.0%		3.0	**Existing Fill** Silty, Clayey SAND, dark brown, slightly moist

Bottom of borehole at 3.0 feet.

Appendix B

Geotechnical Laboratory Test Results

VIVID Engineering Group, Inc.
1053 Elkton Drive
Colorado Springs, Colorado 80907
Telephone: 719-896-4356
Fax: 719-896-4357

SUMMARY OF LABORATORY RESULTS

CLIENT JDS-Hydro Consultants, Inc. **PROJECT NAME** Triview NDS Pipeline - Roller Coaster Road

PROJECT NUMBER D22-2-508 **PROJECT LOCATION** Black Forest, CO

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Class-ification	Water Content (%)	Dry Density (pcf)		
B-1	1.0							11.9	108.5		
B-1	4.0	34	16	18	9.5	30	SC	16.7	107.1		
B-2	1.0							15.2	109.2		
B-2	4.0	NP	NP	NP	12.5	19	SM	8.6	110.3		
B-3	1.0	NP	NP	NP	12.5	15	SM	4.8	123.9		
B-3	9.0							10.3	114.0		
B-4	2.0	NP	NP	NP	19	22	SM	4.5			
B-5	1.0							13.9	111.8		
B-5	2.0	24	16	8	9.5	31	SC	9.1			
B-5	4.0							10.5	107.6		
B-6	1.0							9.4	113.8		
B-6	2.0	33	15	18	9.5	52	CL	13.4			
B-7	1.0							11.3	113.2		
B-7	2.0	26	13	13	9.5	8	SP-SC	7.3			
B-8	2.0	NP	NP	NP	9.5	22	SM	4.0			
B-8	4.0							7.6	111.4		
B-9	1.0	NP	NP	NP	9.5	14	SM	4.5	115.0		
B-10	1.0							7.7	113.8		
B-10	2.0	21	13	8	12.5	34	SC	4.9			
B-11	1.0	NP	NP	NP	12.5	17	SM	6.5	123.5		
B-12	2.0	24	14	10	12.5	28	SC	5.9			
B-13	1.0							4.8	110.7		
B-13	4.0	35	16	19	12.5	13	SC	9.7	123.4		
B-14	2.0	30	13	17	9.5	36	SC	8.7			
B-14	4.0							9.7	116.4		
B-15	0.7	22	15	7	12.5	23	SC-SM	5.1			

ATTERBERG LIMITS - GINT STD US LAB.GDT - 6/14/22 11:29 - C:\USERS\BRYSEN MUSTAIN\VIVID ENGINEERING GROUP\GEOTECH GROUP VIVID ENGINEERING - DOCUMENTS\PROJECTS_2022\D22-2-508_JDS-HYDRO_NDS PIPELINE\6 - DRAFTING\D22-2-508.GPJ

VIVID Engineering Group, Inc.
1053 Elkton Drive
Colorado Springs, Colorado 80907
Telephone: 719-896-4356
Fax: 719-896-4357

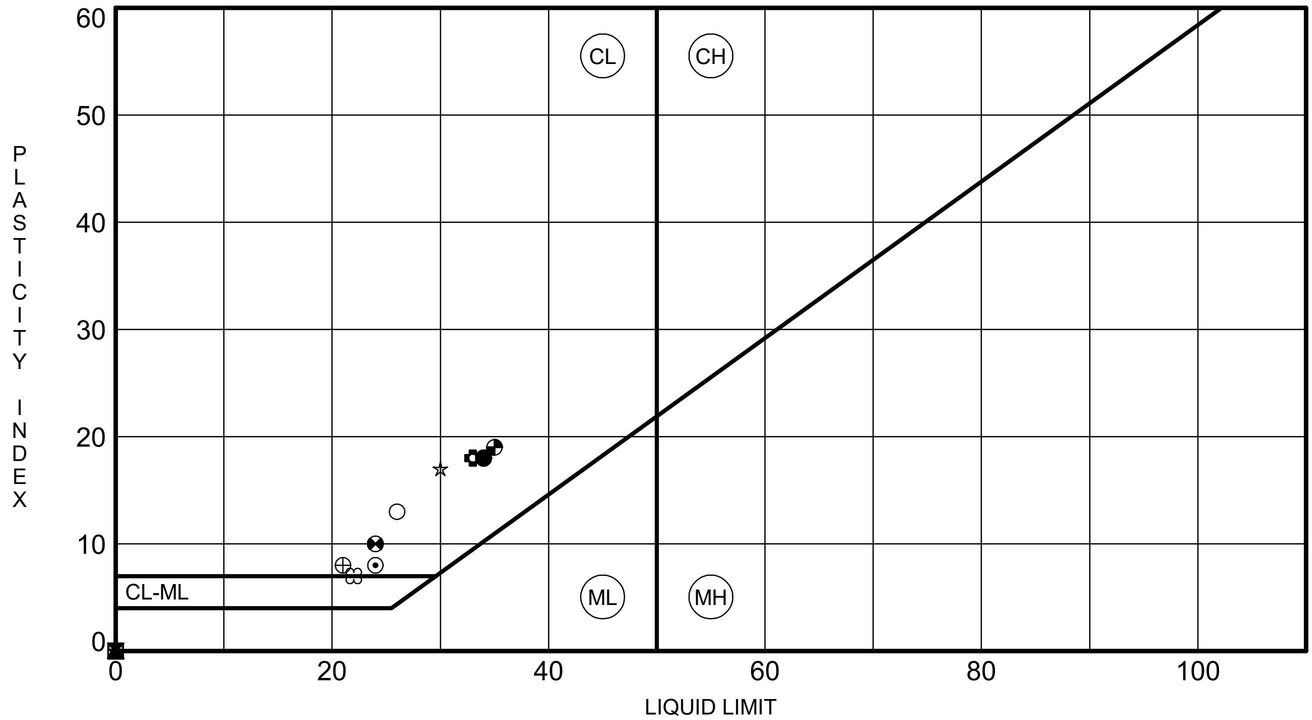
ATTERBERG LIMITS' RESULTS

CLIENT JDS-Hydro Consultants, Inc.

PROJECT NAME Triview NDS Pipeline - Roller Coaster Road

PROJECT NUMBER D22-2-508

PROJECT LOCATION Black Forest, CO



	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**B-1**	**4.0**	**34**	**16**	**18**	**30**	**CLAYEY SAND(SC)**
⧗	**B-2**	**4.0**	**NP**	**NP**	**NP**	**19**	**SILTY SAND(SM)**
▲	**B-3**	**1.0**	**NP**	**NP**	**NP**	**15**	**SILTY SAND(SM)**
★	**B-4**	**2.0**	**NP**	**NP**	**NP**	**22**	**SILTY SAND(SM)**
⊙	**B-5**	**2.0**	**24**	**16**	**8**	**31**	**CLAYEY SAND(SC)**
✿	**B-6**	**2.0**	**33**	**15**	**18**	**52**	**SANDY LEAN CLAY(CL)**
○	**B-7**	**2.0**	**26**	**13**	**13**	**8**	**POORLY GRADED SAND with CLAY(SP-SC)**
△	**B-8**	**2.0**	**NP**	**NP**	**NP**	**22**	**SILTY SAND(SM)**
⊗	**B-9**	**1.0**	**NP**	**NP**	**NP**	**14**	**SILTY SAND(SM)**
⊕	**B-10**	**2.0**	**21**	**13**	**8**	**34**	**CLAYEY SAND(SC)**
□	**B-11**	**1.0**	**NP**	**NP**	**NP**	**17**	**SILTY SAND(SM)**
⊗	**B-12**	**2.0**	**24**	**14**	**10**	**28**	**CLAYEY SAND(SC)**
◕	**B-13**	**4.0**	**35**	**16**	**19**	**13**	**CLAYEY SAND(SC)**
☆	**B-14**	**2.0**	**30**	**13**	**17**	**36**	**CLAYEY SAND(SC)**
✿	**B-15**	**0.7**	**22**	**15**	**7**	**23**	**SILTY, CLAYEY SAND(SC-SM)**

VIVID Engineering Group, Inc.
1053 Elkton Drive
Colorado Springs, Colorado 80907
Telephone: 719-896-4356
Fax: 719-896-4357

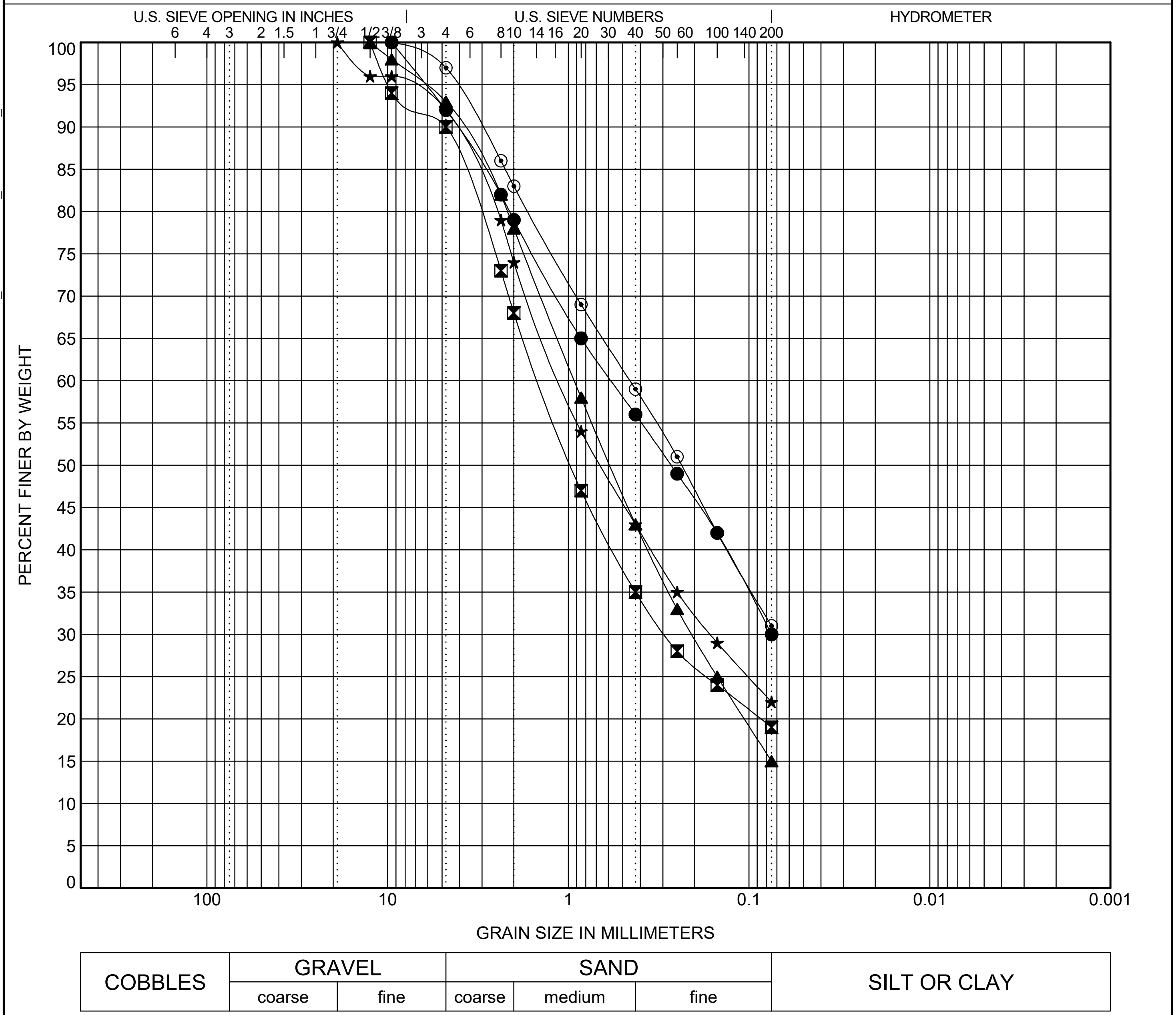
GRAIN SIZE DISTRIBUTION

CLIENT JDS-Hydro Consultants, Inc.

PROJECT NAME Triview NDS Pipeline - Roller Coaster Road

PROJECT NUMBER D22-2-508

PROJECT LOCATION Black Forest, CO



BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
● B-1	4.0	**CLAYEY SAND(SC)**	34	16	18		
⊠ B-2	4.0	**SILTY SAND(SM)**	NP	NP	NP		
▲ B-3	1.0	**SILTY SAND(SM)**	NP	NP	NP		
★ B-4	2.0	**SILTY SAND(SM)**	NP	NP	NP		
⊙ B-5	2.0	**CLAYEY SAND(SC)**	24	16	8		

BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-1	4.0	9.5	0.578	0.075		8.0	62.0	30.0	
⊠ B-2	4.0	12.5	1.444	0.291		10.0	71.0	19.0	
▲ B-3	1.0	12.5	0.926	0.206		7.0	78.0	15.0	
★ B-4	2.0	19	1.099	0.163		8.0	70.0	22.0	
⊙ B-5	2.0	9.5	0.456			3.0	66.0	31.0	

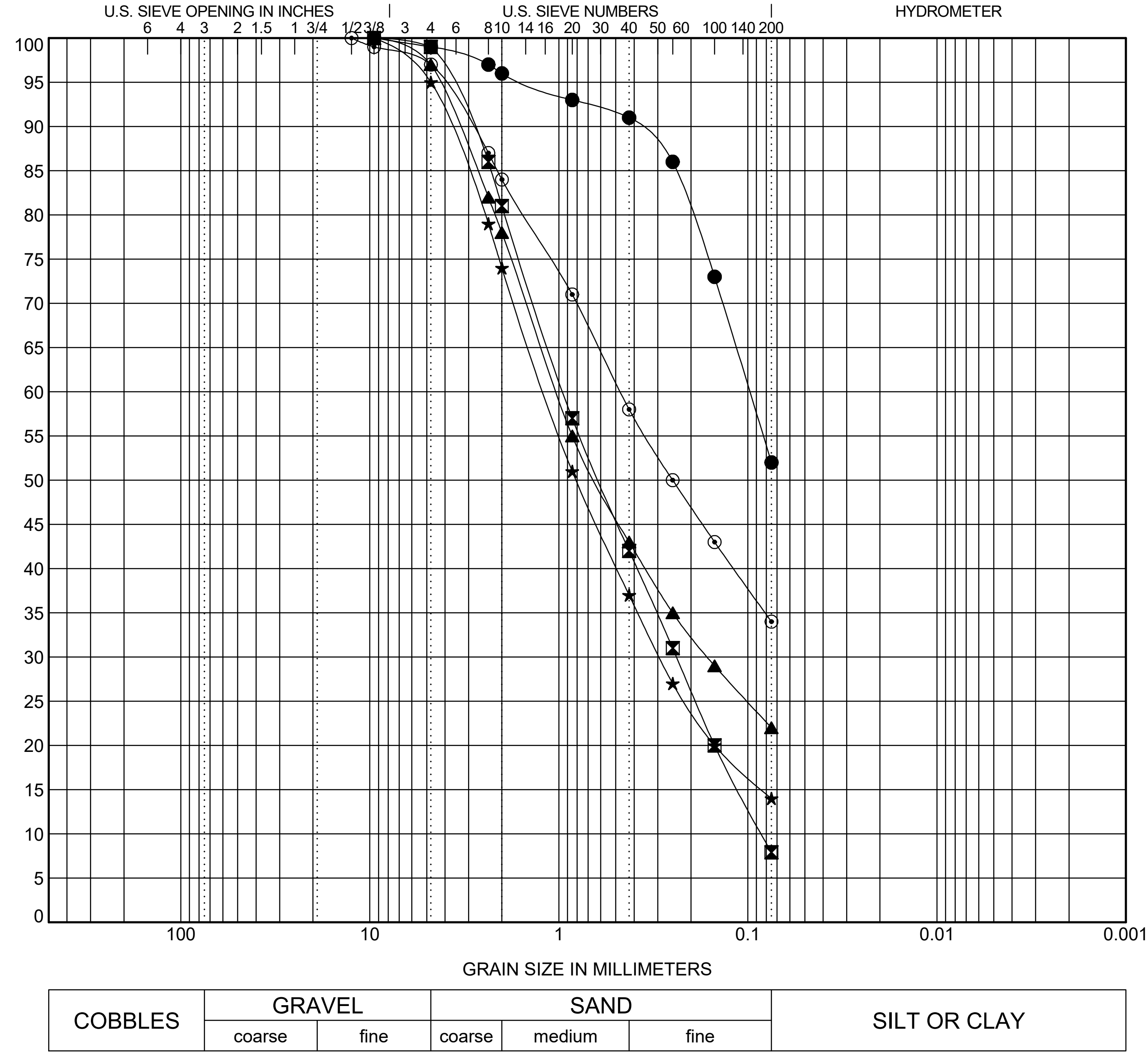
GRAIN SIZE - GINT STD US LAB.GDT - 6/14/22 11:28 - C:\USERS\BRYSEN MUSTAIN\VIVID ENGINEERING GROUP\VIVID ENGINEERING GROUP\GEOTECH GROUP VIVID ENGINEERING - DOCUMENTS\PROJECTS_2022\D22-2-508_JDS-HYDRO_NDS PIPELINE\6 - DRAFTING\D22-2-508.GPJ

VIVID Engineering Group, Inc.
1053 Elkton Drive
Colorado Springs, Colorado 80907
Telephone: 719-896-4356
Fax: 719-896-4357

GRAIN SIZE DISTRIBUTION

CLIENT JDS-Hydro Consultants, Inc. **PROJECT NAME** Triview NDS Pipeline - Roller Coaster Road

PROJECT NUMBER D22-2-508 **PROJECT LOCATION** Black Forest, CO



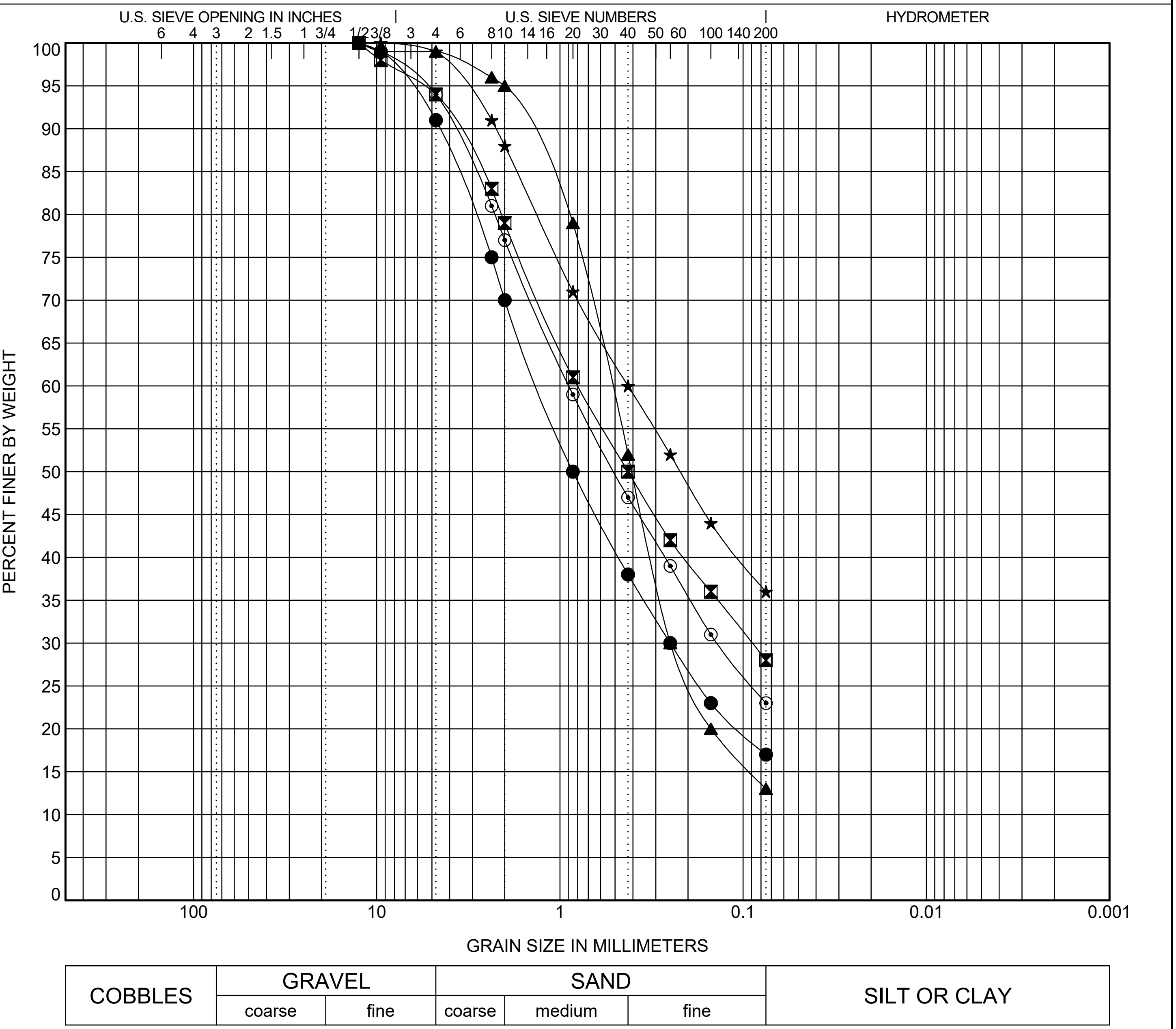
	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	B-6	2.0	SANDY LEAN CLAY(CL)	33	15	18		
⊠	B-7	2.0	POORLY GRADED SAND with CLAY(SP-SC)	26	13	13	0.71	11.18
▲	B-8	2.0	SILTY SAND(SM)	NP	NP	NP		
★	B-9	1.0	SILTY SAND(SM)	NP	NP	NP		
⊙	B-10	2.0	CLAYEY SAND(SC)	21	13	8		

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-6	2.0	9.5	0.098			1.0	47.0	52.0	
⊠	B-7	2.0	9.5	0.946	0.239	0.085	1.0	91.1	7.9	
▲	B-8	2.0	9.5	1.024	0.163		3.0	75.0	22.0	
★	B-9	1.0	9.5	1.188	0.293		5.0	81.0	14.0	
⊙	B-10	2.0	12.5	0.473			3.0	63.0	34.0	

VIVID Engineering Group, Inc.
1053 Elkton Drive
Colorado Springs, Colorado 80907
Telephone: 719-896-4356
Fax: 719-896-4357

GRAIN SIZE DISTRIBUTION

CLIENT JDS-Hydro Consultants, Inc.
PROJECT NAME Triview NDS Pipeline - Roller Coaster Road
PROJECT NUMBER D22-2-508
PROJECT LOCATION Black Forest, CO



BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
● **B-11**	**1.0**	**SILTY SAND(SM)**	**NP**	**NP**	**NP**		
⊠ **B-12**	**2.0**	**CLAYEY SAND(SC)**	**24**	**14**	**10**		
▲ **B-13**	**4.0**	**CLAYEY SAND(SC)**	**35**	**16**	**19**		
★ **B-14**	**2.0**	**CLAYEY SAND(SC)**	**30**	**13**	**17**		
⊙ **B-15**	**0.7**	**SILTY, CLAYEY SAND(SC-SM)**	**22**	**15**	**7**		

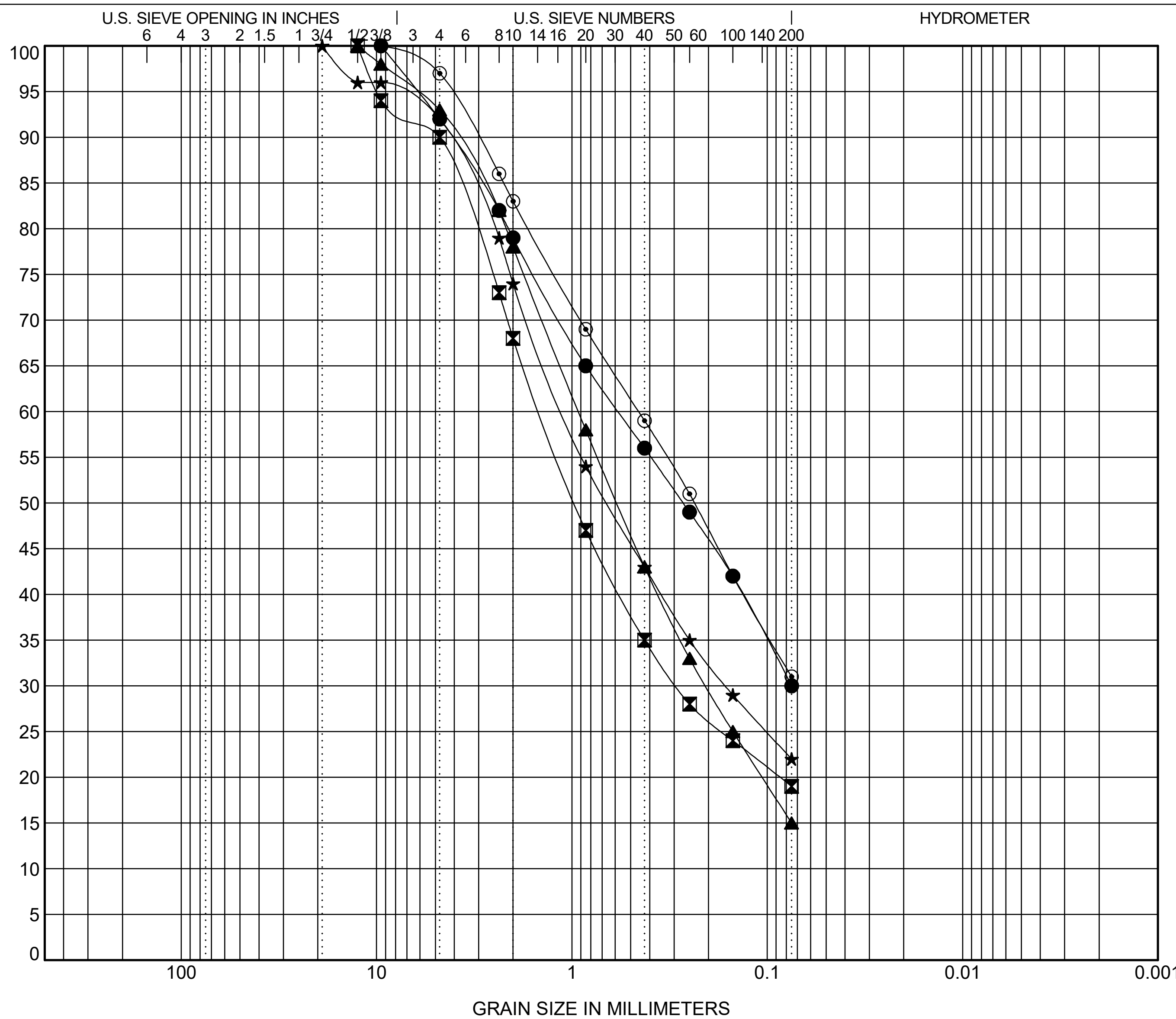
BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● **B-11**	**1.0**	**12.5**	**1.304**	**0.25**		**9.0**	**74.0**	**17.0**	
⊠ **B-12**	**2.0**	**12.5**	**0.798**	**0.089**		**6.0**	**66.0**	**28.0**	
▲ **B-13**	**4.0**	**12.5**	**0.522**	**0.25**		**1.0**	**86.0**	**13.0**	
★ **B-14**	**2.0**	**9.5**	**0.425**			**1.0**	**63.0**	**36.0**	
⊙ **B-15**	**0.7**	**12.5**	**0.891**	**0.138**		**6.0**	**71.0**	**23.0**	

VIVID Engineering Group, Inc.
1053 Elkton Drive
Colorado Springs, Colorado 80907
Telephone: 719-896-4356
Fax: 719-896-4357

GRAIN SIZE DISTRIBUTION

CLIENT JDS-Hydro Consultants, Inc. **PROJECT NAME** Triview NDS Pipeline - Roller Coaster Road

PROJECT NUMBER D22-2-508 **PROJECT LOCATION** Black Forest, CO



	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-1**	**4.0**	**(A-2-6)**	**34**	**16**	**18**		
⊠	**B-2**	**4.0**	**(A-1-b)**	**NP**	**NP**	**NP**		
▲	**B-3**	**1.0**	**(A-1-b)**	**NP**	**NP**	**NP**		
★	**B-4**	**2.0**	**(A-1-b)**	**NP**	**NP**	**NP**		
⊙	**B-5**	**2.0**	**(A-2-4)**	**24**	**16**	**8**		

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-1**	**4.0**	**9.5**	**0.578**	**0.075**		**8.0**	**62.0**	**30.0**	
⊠	**B-2**	**4.0**	**12.5**	**1.444**	**0.291**		**10.0**	**71.0**	**19.0**	
▲	**B-3**	**1.0**	**12.5**	**0.926**	**0.206**		**7.0**	**78.0**	**15.0**	
★	**B-4**	**2.0**	**19**	**1.099**	**0.163**		**8.0**	**70.0**	**22.0**	
⊙	**B-5**	**2.0**	**9.5**	**0.456**			**3.0**	**66.0**	**31.0**	

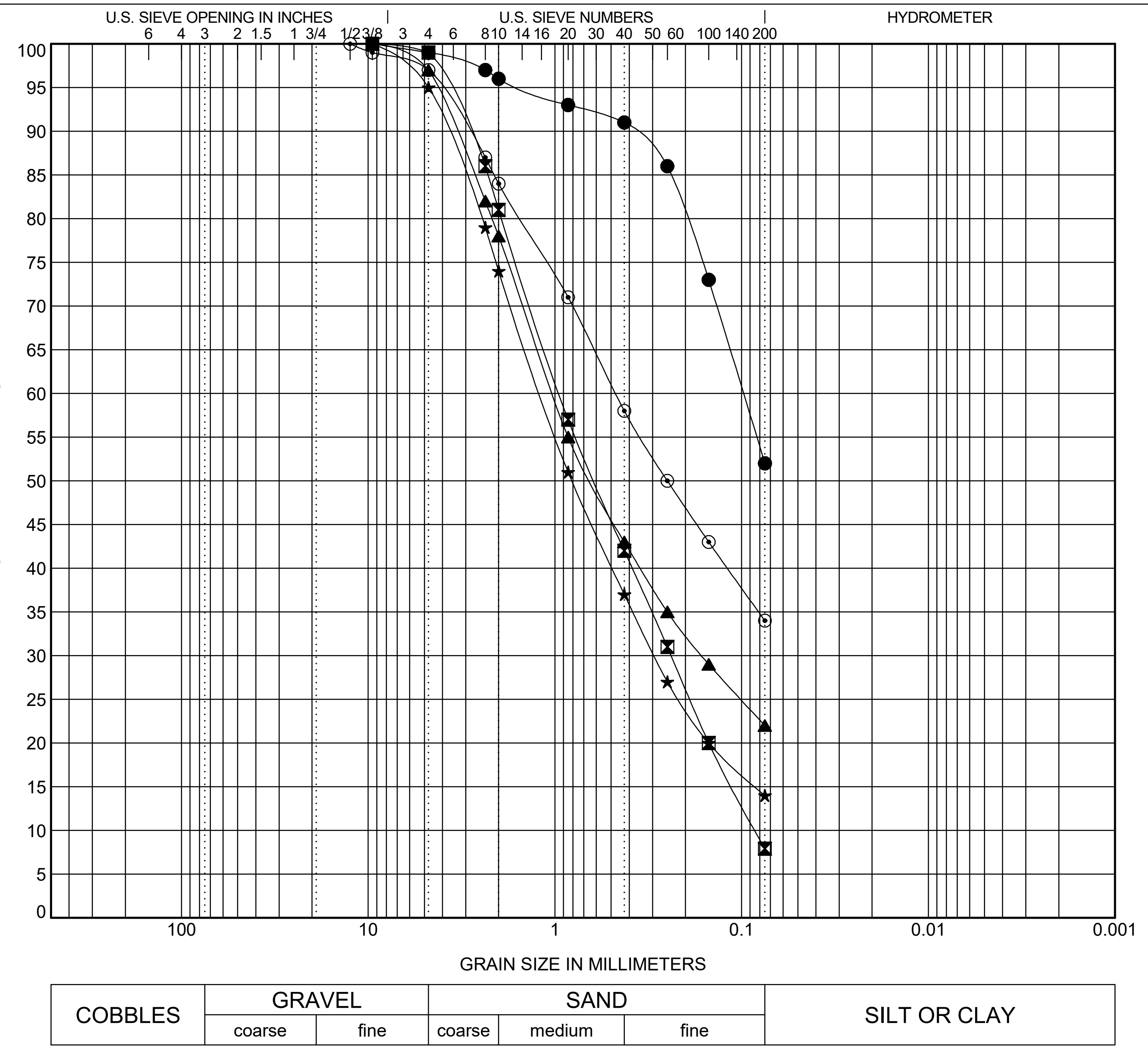
GRAIN SIZE - AASHTO - GINT STD US LAB.GDT - 6/14/22 11:28 - C:\USERS\BRYSEN MUSTAIN\VIVID ENGINEERING GROUP\GEOTECH GROUP VIVID ENGINEERING - DOCUMENTS\PROJECTS_2022\D22-2-508_JDS-HYDRO_NDS PIPELINE\6 - DRAFTING\D22-2-508.GPJ

VIVID Engineering Group, Inc.
1053 Elkton Drive
Colorado Springs, Colorado 80907
Telephone: 719-896-4356
Fax: 719-896-4357

GRAIN SIZE DISTRIBUTION

CLIENT JDS-Hydro Consultants, Inc. **PROJECT NAME** Triview NDS Pipeline - Roller Coaster Road

PROJECT NUMBER D22-2-508 **PROJECT LOCATION** Black Forest, CO



	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	B-6	2.0	(A-6)	33	15	18		
⊠	B-7	2.0	(A-2-6)	26	13	13	0.71	11.18
▲	B-8	2.0	(A-1-b)	NP	NP	NP		
★	B-9	1.0	(A-1-b)	NP	NP	NP		
⊙	B-10	2.0	(A-2-4)	21	13	8		

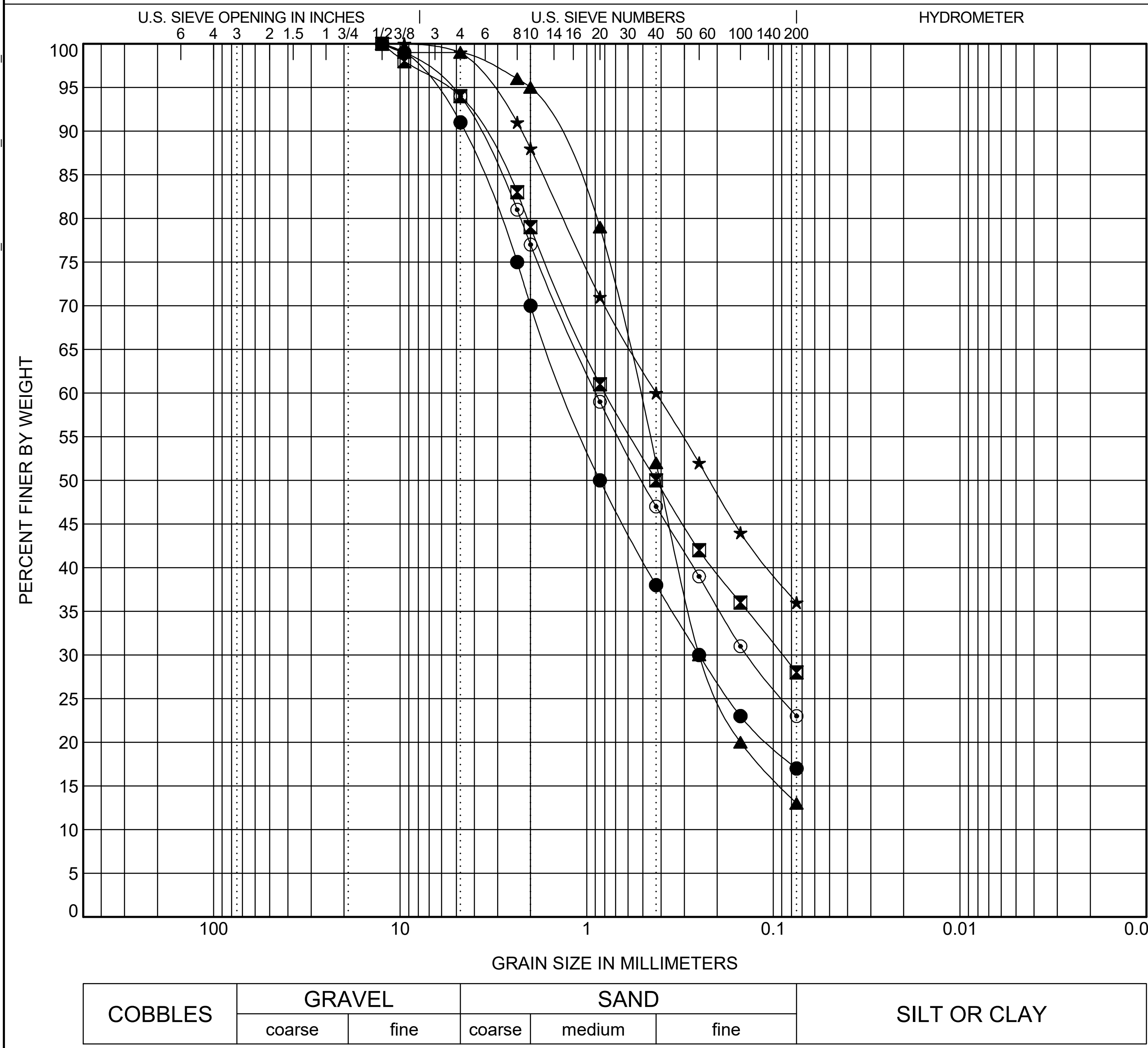
	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-6	2.0	9.5	0.098			1.0	47.0	52.0	
⊠	B-7	2.0	9.5	0.946	0.239	0.085	1.0	91.1	7.9	
▲	B-8	2.0	9.5	1.024	0.163		3.0	75.0	22.0	
★	B-9	1.0	9.5	1.188	0.293		5.0	81.0	14.0	
⊙	B-10	2.0	12.5	0.473			3.0	63.0	34.0	

GRAIN SIZE AASHTO - GINT STD US LAB.GDT - 6/14/22 11:29 - C:\USERS\BRYSEN MUSTAIN\VIVID ENGINEERING GROUP\GEOTECH GROUP VIVID ENGINEERING - DOCUMENTS\PROJECTS_2022\D22-2-508_JDS-HYDRO_NDS PIPELINE\6 - DRAFTING\D22-2-508.GPJ

VIVID Engineering Group, Inc.
1053 Elkton Drive
Colorado Springs, Colorado 80907
Telephone: 719-896-4356
Fax: 719-896-4357

GRAIN SIZE DISTRIBUTION

CLIENT JDS-Hydro Consultants, Inc.
PROJECT NAME Triview NDS Pipeline - Roller Coaster Road
PROJECT NUMBER D22-2-508
PROJECT LOCATION Black Forest, CO



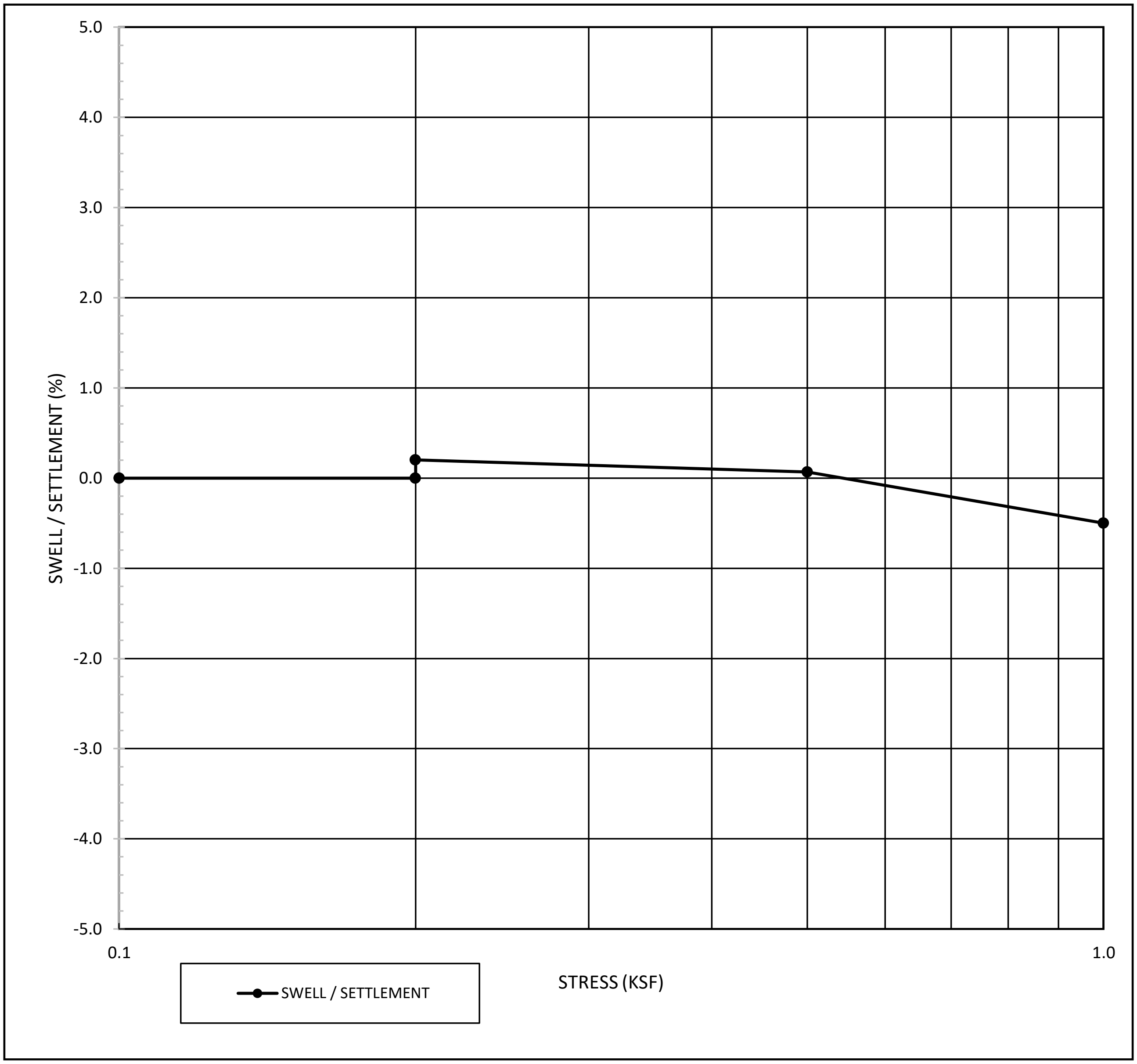
	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-11**	**1.0**	**(A-1-b)**	**NP**	**NP**	**NP**		
⊠	**B-12**	**2.0**	**(A-2-4)**	**24**	**14**	**10**		
▲	**B-13**	**4.0**	**(A-2-6)**	**35**	**16**	**19**		
★	**B-14**	**2.0**	**(A-6)**	**30**	**13**	**17**		
⊙	**B-15**	**0.7**	**(A-2-4)**	**22**	**15**	**7**		

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-11**	**1.0**	**12.5**	**1.304**	**0.25**		**9.0**	**74.0**	**17.0**	
⊠	**B-12**	**2.0**	**12.5**	**0.798**	**0.089**		**6.0**	**66.0**	**28.0**	
▲	**B-13**	**4.0**	**12.5**	**0.522**	**0.25**		**1.0**	**86.0**	**13.0**	
★	**B-14**	**2.0**	**9.5**	**0.425**			**1.0**	**63.0**	**36.0**	
⊙	**B-15**	**0.7**	**12.5**	**0.891**	**0.138**		**6.0**	**71.0**	**23.0**	

VIVID Engineering Group, Inc.

Project Name:	Triview NDS Pipeline - Roller Coaster Road	**Date**	5/31/2022
Project No.:	D22-2-508		
Boring ID.:	B-1	**Sample Depth (ft)**	1
Sample Description:	Clayey SAND, dark brown, slightly moist		

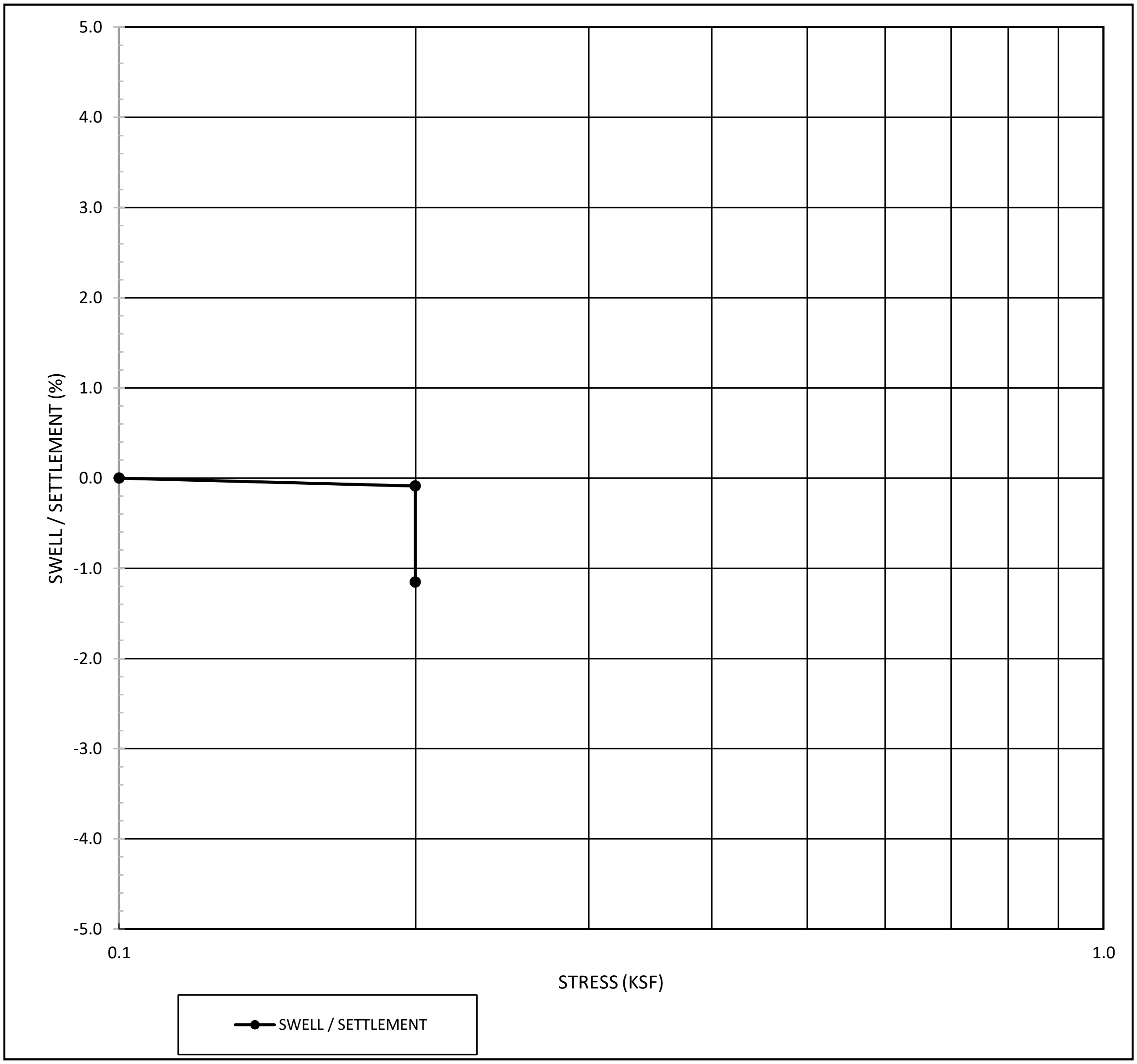
Swell @ Wetting Weight: **0.2** %



Initial Condition	
Moisture Content %	**11.9**
Dry Density (pcf)	**108.5**
Post-Swell Condition	
Moisture Content %	**17.0**

Project Name:	Triview NDS Pipeline - Roller Coaster Road	**Date**	5/31/2022
Project No.:	D22-2-508		
Boring ID.:	B-2	**Sample Depth (ft)**	1
Sample Description:	Silty, Clayey SAND, light to dark brown, moist		

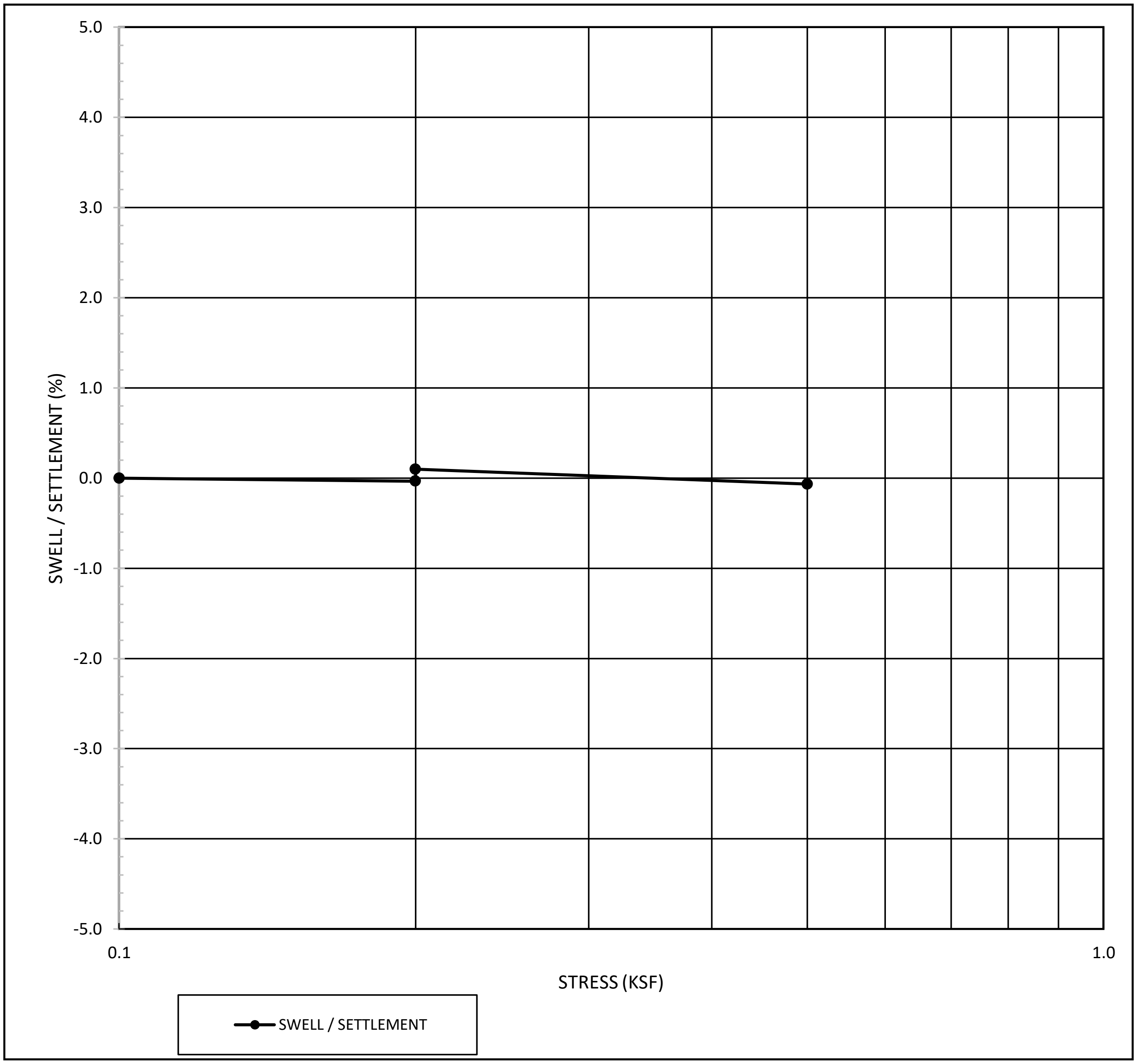
	%
Compression @ Wetting Weight:	**-1.1**



Initial Condition	
Moisture Content %	**15.2**
Dry Density (pcf)	**109.2**
Post-Swell Condition	
Moisture Content %	**19.6**

VIVID Engineering Group, Inc.

Project Name:	Triview NDS Pipeline - Roller Coaster Road			**Date**	5/31/2022
Project No.:	D22-2-508				
Boring ID.:	B-7	**Sample Depth (ft)**	1		
Sample Description:	Silty SAND with Gravel, reddish-brown, slightly moist				
				Swell @ Wetting Weight:	**0.1** %

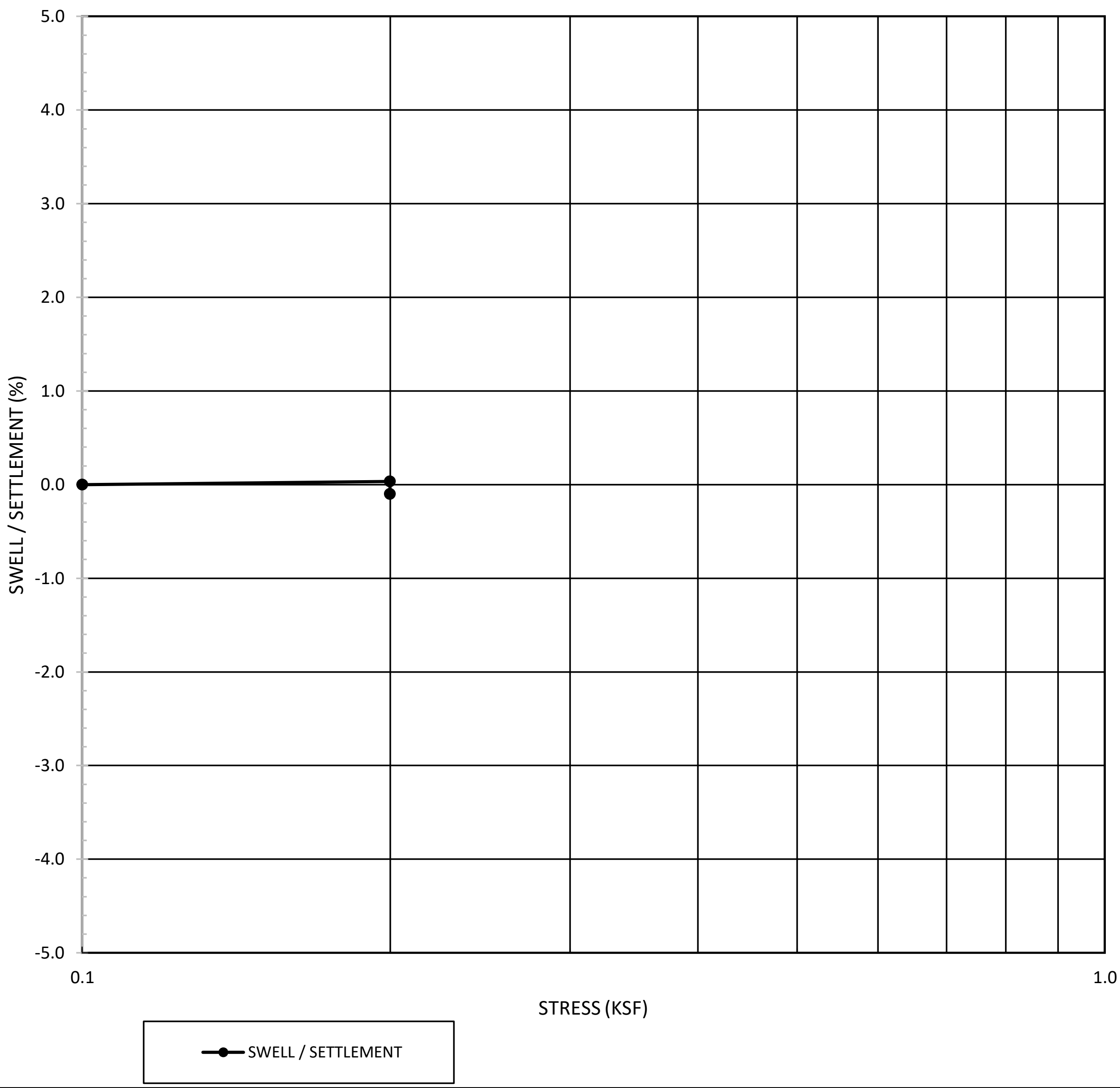


Initial Condition	
Moisture Content %	**11.3**
Dry Density (pcf)	**113.2**
Post-Swell Condition	
Moisture Content %	**15.7**

VIVID Engineering Group, Inc.

Project Name:	Triview NDS Pipeline - Roller Coaster Road	**Date**	5/31/2022
Project No.:	D22-2-508		
Boring ID.:	B13	**Sample Depth (ft)**	1
Sample Description:	Silty, Clayey SANDSTONE, light brown, slightly moist		

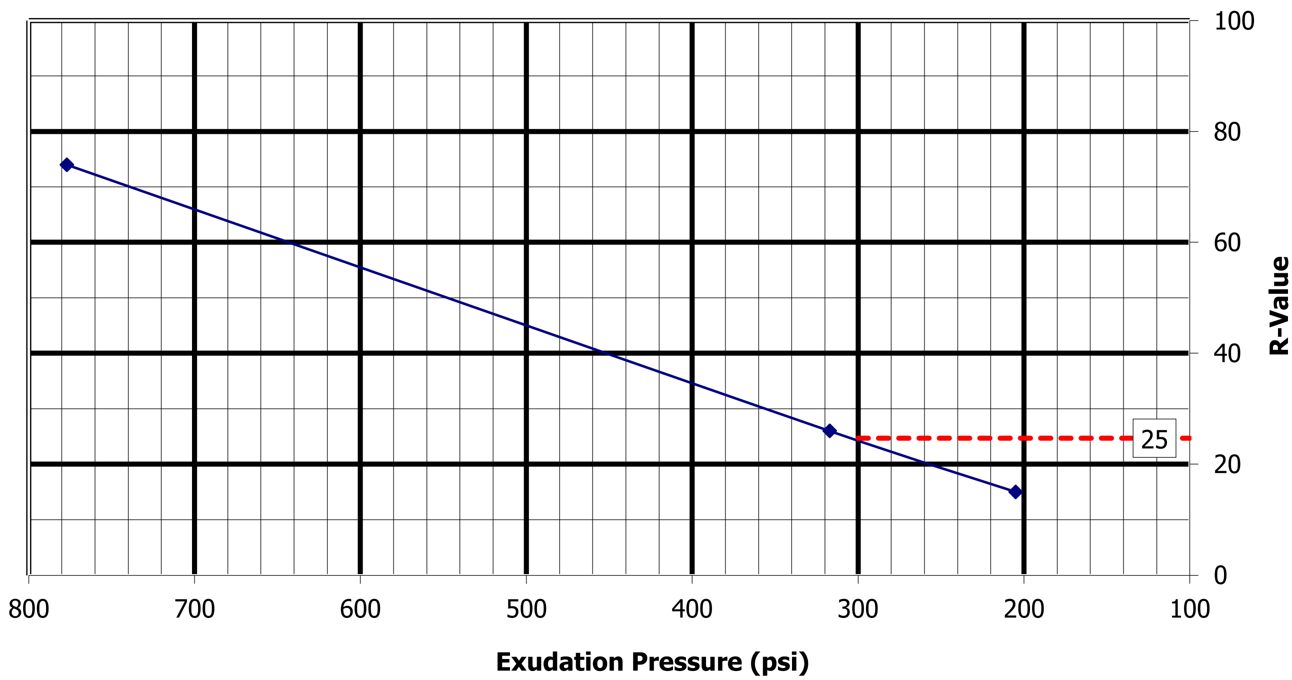
Compression @ Wetting Weight: **-0.1** **%**



Initial Condition	
Moisture Content %	**4.8**
Dry Density (pcf)	**110.7**
Post-Swell Condition	
Moisture Content %	**13.9**

R-VALUE TEST GRAPH (ASTM D2844)

Project Number:	22.019, Vivid Engineering Group, Inc.	Date:	23-Jun-22
Project Name:	Triview ND Pipeline (Vivid Engineering No. D22-2-508)	Technician:	J. De Los Santos
Lab ID Number:	222800	Reviewer:	G. Hoyos
Sample Location:	Composite: B-2, B-3, B-4, B-8, B-9, and B-11 at 0 to 4 feet		
Visual Description:	SAND, silty, with gravel, brown		



R-Value @ Exudation Pressure 300 psi:	**25**
Specification:	

CDOT Pavement Design Manual, 2011.
Eq. 2.1 & 2.2, page 2-3.

$S_1 = [(R-5)/11.29]+3$ **S_1 = 4.74**

$M_R = 10^{[(S_1+18.72)/6.24]}$ **M_R = 5,760**

M_R = Resilient Modulus, psi

S_1 = the Soil Support Value

R = the R-Value obtained

Test Specimen:	1	2	3
Moisture Content, %:	7.2	7.9	9.2
Expansion Pressure, psi:	0.18	0.09	0.03
Dry Density, pcf:	131.4	130.3	127.6
R-Value:	74	26	15
Exudation Pressure, psi:	777	317	205

Note: The R-Value is measured; the M_R is an approximation from correlation formulas.

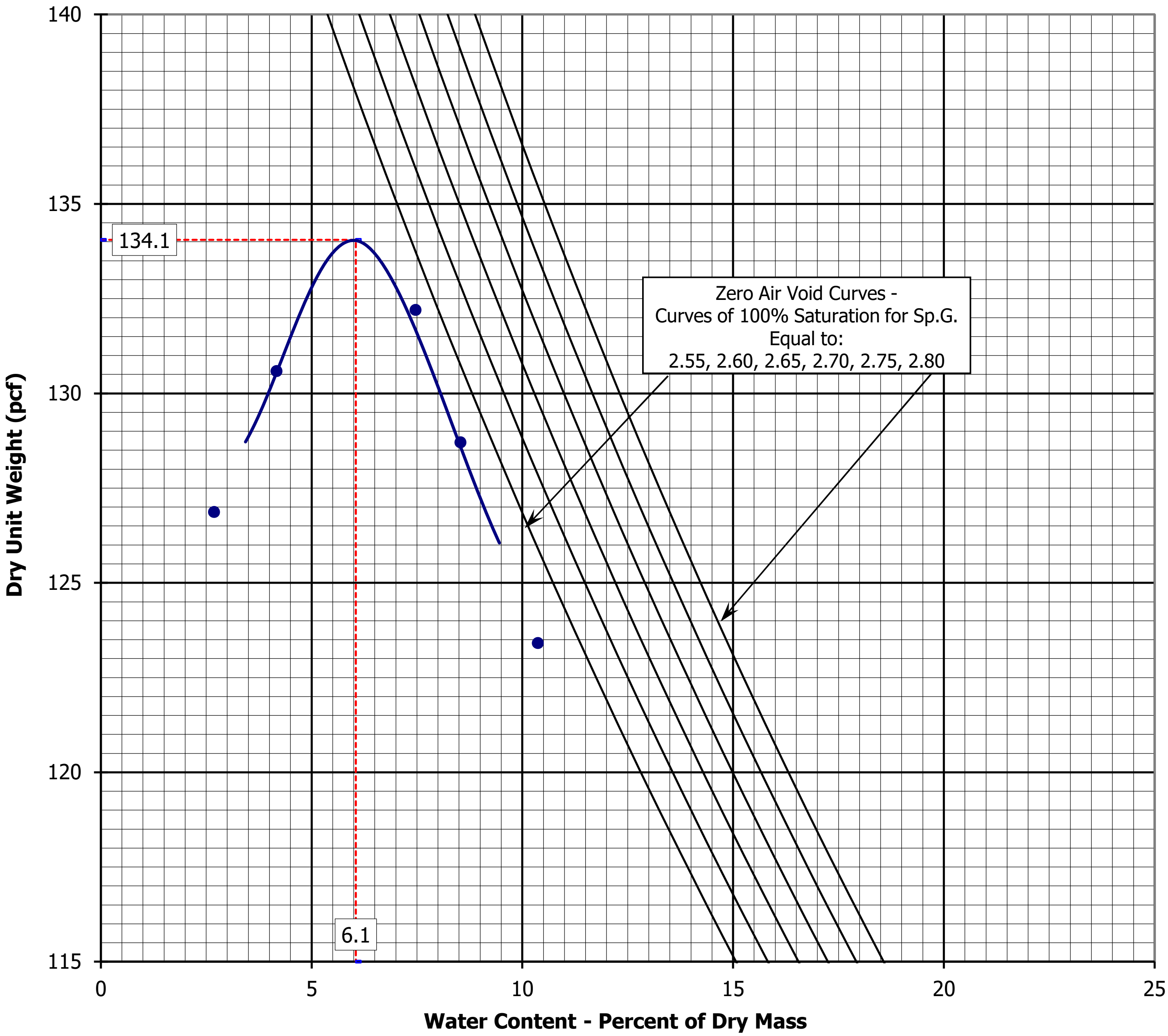
CESARE, INC. Geotechnical Engineers & Construction Materials Consultants | CMT TECHNICAL SERVICES

AASHTO ACCREDITED

Project number	22.019, Vivid Engineering Group	Date	June 23, 2022
Project name	Triview ND Pipeline (Vivid Project No. D22-2-508)	Technician	J. Holiman
Lab ID number	222800	Reviewer	G. Hoyos
Sample location	Composite: B-2, B-3, B-4, B-8, B-9, and B-11 at 0 to 4 feet		
Visual description	SAND, silty, with gravel, brown		

Test Procedures and Methods		**Optimum Proctor Values and Correction Factors**			
ASTM/AASHTO compaction test procedure designation	**ASTM D1557 (Modified)**	Laboratory maximum dry unit weight (pcf)			**134.1**
Method	**B**	Laboratory optimum moisture content (%)			**6.1**
Classification		**Minus No. 200 (%)**	**LL**	**PL**	**PI**
USCS					
AASHTO					

Moisture/Density Relationship Plot

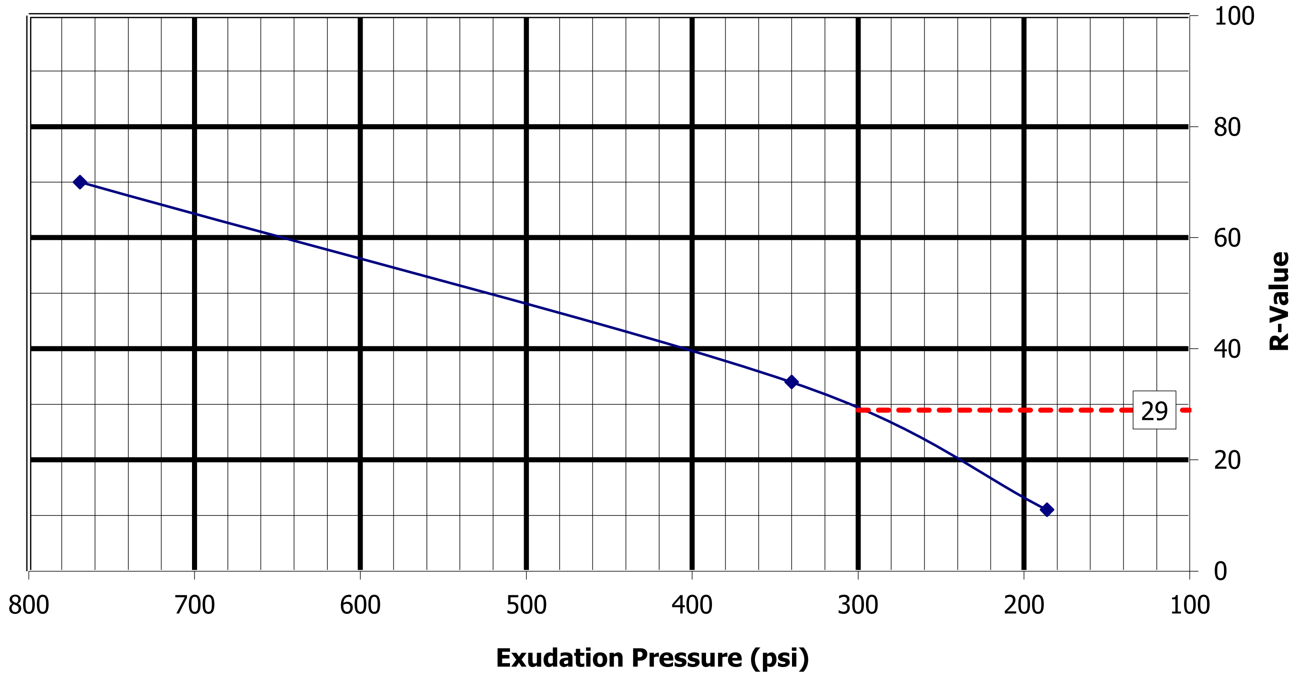


CESARE, INC. Geotechnical Engineers & Construction Materials Consultants | CMT TECHNICAL SERVICES

AASHTO ACCREDITED

R-VALUE TEST GRAPH (ASTM D2844)

Project Number:	22.019, Vivid Engineering Group, Inc.	Date:	23-Jun-22
Project Name:	Triview ND Pipeline (Vivid Engineering No. D22-2-508)	Technician:	J. De Los Santos
Lab ID Number:	222801	Reviewer:	G. Hoyos
Sample Location:	Composite: B-1, B-5, B-7, B-10, B-12, B-13, and B-15 at 0 to 4 feet		
Visual Description:	SAND, silty, with gravel, brown		



R-Value @ Exudation Pressure 300 psi:	**29**
Specification:	

CDOT Pavement Design Manual, 2011.
Eq. 2.1 & 2.2, page 2-3.

$S_1 = [(R-5)/11.29]+3$ **S_1 = 5.13**

$M_R = 10^{[(S_1+18.72)/6.24]}$ **M_R = 6,629**

M_R = Resilient Modulus, psi

S_1 = the Soil Support Value

R = the R-Value obtained

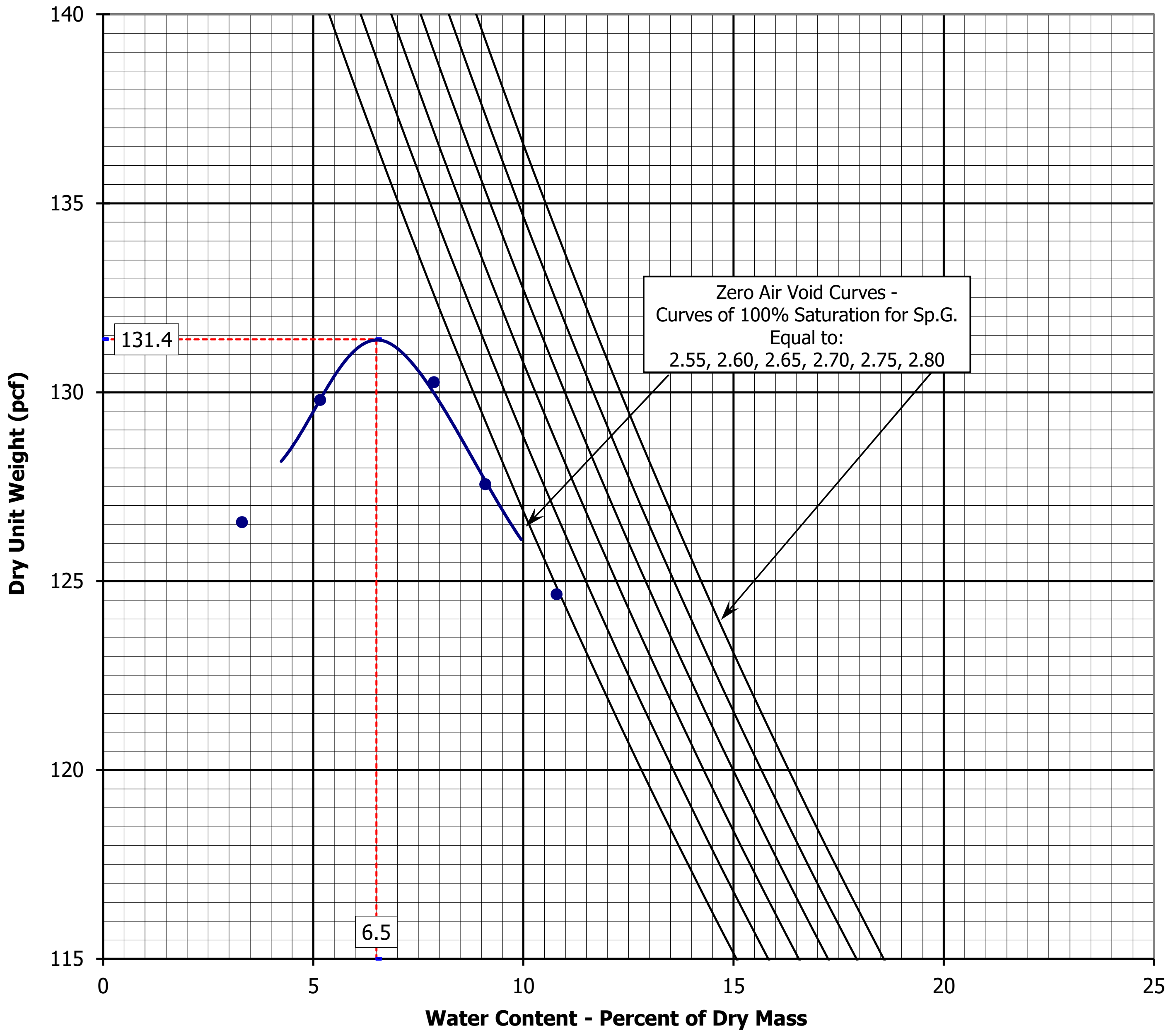
Test Specimen:	1	2	3
Moisture Content, %:	7.4	8.1	10.0
Expansion Pressure, psi:	0.09	0.06	0.03
Dry Density, pcf:	131.9	129.8	126.2
R-Value:	70	34	11
Exudation Pressure, psi:	769	340	186

Note: The R-Value is measured; the M_R is an approximation from correlation formulas.

Project number	22.019, Vivid Engineering Group	Date	June 23, 2022
Project name	Triview ND Pipeline (Vivid Project No. D22-2-508)	Technician	J. Holiman
Lab ID number	222801	Reviewer	G. Hoyos
Sample location	Composite: B-1, B-5, B-7, B-10, B-12, B-13, and B-15 at 0 to 4 feet		
Visual description	SAND, silty, with gravel, brown		

Test Procedures and Methods		**Optimum Proctor Values and Correction Factors**			
ASTM/AASHTO compaction test procedure designation	**ASTM D1557 (Modified)**	Laboratory maximum dry unit weight (pcf)			**131.4**
Method	**B**	Laboratory optimum moisture content (%)			**6.5**
Classification		**Minus No. 200 (%)**	**LL**	**PL**	**PI**
USCS					
AASHTO					

Moisture/Density Relationship Plot



Appendix C

Analytical Laboratory Test Results

WELD LABORATORIES, INC.

1527 First Avenue • Greeley, Colorado 80631
Phone: (970) 353-8118 • Fax: (970) 353-1671
www.weldlabs.com

June 10, 2022

Vivid Engineering, Inc
Attn: Brysen Mustain
1053 Elkton Drive
Colorado Springs, CO 80907

Project No.: NDS Pipeline D22-2-508
Sample ID: B-1 0-4'

Laboratory No.: E22144-11A	Results[1,3]	10-Point System[2]
pH (SI) AASHTO T 289-91 (ASTM G51 available for some soil)	8.5	0
Conductivity (mmhos/cm)	0.468	NA
Resistivity (ohm-m) USDA Handbook 60, temperature corrected conductivity probe	21.4	
Minimum Lab Resistivity (ohm-cm)	1440	10
Minimum Lab Resistivity (ohm-m) via Miller Box, Tinker & Razor SR-2 (AASHTO T 288-12)[4]	14.4	
Redox (mV vs. Ag/AgCl) ASTM G200 (ASTM D1498 if soil is low in moisture)	151	0
Free Sulfide (mg/kg DMB) EPA 9030B+9034, prescreened with lead acetate paper	0.1	2
Chloride (mg/kg DMB) AASHTO T 291-94	46	0
Sulfate (mg/kg DMB) CP-L 2103	148	1
Sulfate (% DMB)	0.0148	
Sulfate-S (mg/kg DMB)	49.2	

1. NA = Not Analyzed; ND = Not Detected. DMB = Dry Matter Basis. Measurements taken at 25°C.
2. 10-point Corrosion system based on: Appendix A of ANSI/AWWA C105/A21.5 Standard "Polyethylene Encasement for Ductile Iron Pipe Systems." The Cl- points adapted from the DIPRA design decision model.
Sulfate is penalized at half the rate of chloride: A. A. Sagüés et. al. (https://rosap.ntl.bts.gov/view/dot/17493)
3. pH, Conductivity, and Redox are generally read on a 1:1 soil:water mixture if the soil is dry.
4. ASTM G57 4-Electrode Method used unless 2-electrode method is requested.

Project Manager

6/10/2022
Date

WELD LABORATORIES, INC.

1527 First Avenue • Greeley, Colorado 80631
Phone: (970) 353-8118 • Fax: (970) 353-1671
www.weldlabs.com

June 10, 2022

Vivid Engineering, Inc
Attn: Brysen Mustain
1053 Elkton Drive
Colorado Springs, CO 80907

Project No.: NDS Pipeline D22-2-508
Sample ID: B-2 9'

Laboratory No.: E22144-11B	Results[1,3]	10-Point System[2]
pH (SI)	7.8	0
AASHTO T 289-91 (ASTM G51 available for some soil)		
Conductivity (mmhos/cm)	0.229	NA
Resistivity (ohm-m)	43.7	
USDA Handbook 60, temperature corrected conductivity probe		
Minimum Lab Resistivity (ohm-cm)	1970	5
Minimum Lab Resistivity (ohm-m)	19.7	
via Miller Box, Tinker & Razor SR-2 (AASHTO T 288-12)[4]		
Redox (mV vs. Ag/AgCl)	131	0
ASTM G200 (ASTM D1498 if soil is low in moisture)		
Free Sulfide (mg/kg DMB)	ND	0
EPA 9030B+9034, prescreened with lead acetate paper		
Chloride (mg/kg DMB)	73	1
AASHTO T 291-94		
Sulfate (mg/kg DMB)	177	1
CP-L 2103		
Sulfate (% DMB)	0.0177	
Sulfate-S (mg/kg DMB)	59.0	

1. NA = Not Analyzed; ND = Not Detected. DMB = Dry Matter Basis. Measurements taken at 25°C.
2. 10-point Corrosion system based on: Appendix A of ANSI/AWWA C105/A21.5 Standard "Polyethylene Encasement for Ductile Iron Pipe Systems." The Cl- points adapted from the DIPRA design decision model. Sulfate is penalized at half the rate of chloride: A. A. Sagüés et. al. (https://rosap.ntl.bts.gov/view/dot/17493)
3. pH, Conductivity, and Redox are generally read on a 1:1 soil:water mixture if the soil is dry.
4. ASTM G57 4-Electrode Method used unless 2-electrode method is requested.

Project Manager — Date: 6/10/2022

Sampling procedures can affect the value of analytical results – customers are advised to use appropriate sampling protocol to ensure samples are truly representative of the bulk sample.

WELD LABORATORIES, INC.

1527 First Avenue • Greeley, Colorado 80631
Phone: (970) 353-8118 • Fax: (970) 353-1671
www.weldlabs.com

June 10, 2022

Vivid Engineering, Inc
Attn: Brysen Mustain
1053 Elkton Drive
Colorado Springs, CO 80907

Project No.: NDS Pipeline D22-2-508
Sample ID: B-3 0-4'

Laboratory No.: E22144-11C	Results[1,3]	10-Point System[2]
pH (SI)	8.2	0
AASHTO T 289-91 (ASTM G51 available for some soil)		
Conductivity (mmhos/cm)	0.383	NA
Resistivity (ohm-m)	26.1	
USDA Handbook 60, temperature corrected conductivity probe		
Minimum Lab Resistivity (ohm-cm)	1310	10
Minimum Lab Resistivity (ohm-m)	13.1	
via Miller Box, Tinker & Razor SR-2 (AASHTO T 288-12)[4]		
Redox (mV vs. Ag/AgCl)	135	0
ASTM G200 (ASTM D1498 if soil is low in moisture)		
Free Sulfide (mg/kg DMB)	ND	0
EPA 9030B+9034, prescreened with lead acetate paper		
Chloride (mg/kg DMB)	68	1
AASHTO T 291-94		
Sulfate (mg/kg DMB)	334	3
CP-L 2103		
Sulfate (% DMB)	0.0334	
Sulfate-S (mg/kg DMB)	111.3	

1. NA = Not Analyzed; ND = Not Detected. DMB = Dry Matter Basis. Measurements taken at 25°C.
2. 10-point Corrosion system based on: Appendix A of ANSI/AWWA C105/A21.5 Standard "Polyethylene Encasement for Ductile Iron Pipe Systems." The Cl- points adapted from the DIPRA design decision model. Sulfate is penalized at half the rate of chloride: A. A. Sagüés et. al. (https://rosap.ntl.bts.gov/view/dot/17493)
3. pH, Conductivity, and Redox are generally read on a 1:1 soil:water mixture if the soil is dry.
4. ASTM G57 4-Electrode Method used unless 2-electrode method is requested.

Project Manager

6/10/2022
Date

Sampling procedures can affect the value of analytical results – customers are advised to use appropriate sampling protocol to ensure samples are truly representative of the bulk sample.

WELD LABORATORIES, INC.

1527 First Avenue • Greeley, Colorado 80631
Phone: (970) 353-8118 • Fax: (970) 353-1671
www.weldlabs.com

June 10, 2022

Vivid Engineering, Inc
Attn: Brysen Mustain
1053 Elkton Drive
Colorado Springs, CO 80907

Project No.: NDS Pipeline D22-2-508
Sample ID: B-4 9'

Laboratory No.: E22144-11D	Results[1,3]	10-Point System[2]
pH (SI)	7.8	0
AASHTO T 289-91 (ASTM G51 available for some soil)		
Conductivity (mmhos/cm)	0.137	NA
Resistivity (ohm-m)	73.0	
USDA Handbook 60, temperature corrected conductivity probe		
Minimum Lab Resistivity (ohm-cm)	1570	8
Minimum Lab Resistivity (ohm-m)	15.7	
via Miller Box, Tinker & Razor SR-2 (AASHTO T 288-12)[4]		
Redox (mV vs. Ag/AgCl)	117	0
ASTM G200 (ASTM D1498 if soil is low in moisture)		
Free Sulfide (mg/kg DMB)	ND	0
EPA 9030B+9034, prescreened with lead acetate paper		
Chloride (mg/kg DMB)	35	0
AASHTO T 291-94		
Sulfate (mg/kg DMB)	146	1
CP-L 2103		
Sulfate (% DMB)	0.0146	
Sulfate-S (mg/kg DMB)	48.5	

1. NA = Not Analyzed; ND = Not Detected. DMB = Dry Matter Basis. Measurements taken at 25°C.
2. 10-point Corrosion system based on: Appendix A of ANSI/AWWA C105/A21.5 Standard "Polyethylene Encasement for Ductile Iron Pipe Systems." The Cl- points adapted from the DIPRA design decision model. Sulfate is penalized at half the rate of chloride: A. A. Sagüés et. al. (https://rosap.ntl.bts.gov/view/dot/17493)
3. pH, Conductivity, and Redox are generally read on a 1:1 soil:water mixture if the soil is dry.
4. ASTM G57 4-Electrode Method used unless 2-electrode method is requested.

Project Manager   6/10/2022 Date

Sampling procedures can affect the value of analytical results – customers are advised to use appropriate sampling protocol to ensure samples are truly representative of the bulk sample.

WELD LABORATORIES, INC.

1527 First Avenue • Greeley, Colorado 80631
Phone: (970) 353-8118 • Fax: (970) 353-1671
www.weldlabs.com

June 10, 2022

Vivid Engineering, Inc
Attn: Brysen Mustain
1053 Elkton Drive
Colorado Springs, CO 80907

Project No.: NDS Pipeline D22-2-508
Sample ID: B-5 0-4'

Laboratory No.: E22144-11E	Results[1,3]	10-Point System[2]
pH (SI)	8.0	0
AASHTO T 289-91 (ASTM G51 available for some soil)		
Conductivity (mmhos/cm)	0.787	NA
Resistivity (ohm-m)	12.7	
USDA Handbook 60, temperature corrected conductivity probe		
Minimum Lab Resistivity (ohm-cm)	990	10
Minimum Lab Resistivity (ohm-m)	9.9	
via Miller Box, Tinker & Razor SR-2 (AASHTO T 288-12)[4]		
Redox (mV vs. Ag/AgCl)	155	0
ASTM G200 (ASTM D1498 if soil is low in moisture)		
Free Sulfide (mg/kg DMB)	0.1	2
EPA 9030B+9034, prescreened with lead acetate paper		
Chloride (mg/kg DMB)	282	3
AASHTO T 291-94		
Sulfate (mg/kg DMB)	149	1
CP-L 2103		
Sulfate (% DMB)	0.0149	
Sulfate-S (mg/kg DMB)	49.8	

1. NA = Not Analyzed; ND = Not Detected. DMB = Dry Matter Basis. Measurements taken at 25°C.
2. 10-point Corrosion system based on: Appendix A of ANSI/AWWA C105/A21.5 Standard "Polyethylene Encasement for Ductile Iron Pipe Systems." The Cl- points adapted from the DIPRA design decision model.
Sulfate is penalized at half the rate of chloride: A. A. Sagüés et. al. (https://rosap.ntl.bts.gov/view/dot/17493)
3. pH, Conductivity, and Redox are generally read on a 1:1 soil:water mixture if the soil is dry.
4. ASTM G57 4-Electrode Method used unless 2-electrode method is requested.

Project Manager: [signature] Date: 6/10/2022

WELD LABORATORIES, INC.

1527 First Avenue • Greeley, Colorado 80631
Phone: (970) 353-8118 • Fax: (970) 353-1671
www.weldlabs.com

June 10, 2022

Vivid Engineering, Inc
Attn: Brysen Mustain
1053 Elkton Drive
Colorado Springs, CO 80907

Project No.: NDS Pipeline D22-2-508
Sample ID: B-6 9'

Laboratory No.: E22144-11F	Results[1,3]	10-Point System[2]
pH (SI)	7.1	0
AASHTO T 289-91 (ASTM G51 available for some soil)		
Conductivity (mmhos/cm)	0.197	NA
Resistivity (ohm-m)	50.8	
USDA Handbook 60, temperature corrected conductivity probe		
Minimum Lab Resistivity (ohm-cm)	1200	10
Minimum Lab Resistivity (ohm-m)	12	
via Miller Box, Tinker & Razor SR-2 (AASHTO T 288-12)[4]		
Redox (mV vs. Ag/AgCl)	137	0
ASTM G200 (ASTM D1498 if soil is low in moisture)		
Free Sulfide (mg/kg DMB)	ND	0
EPA 9030B+9034, prescreened with lead acetate paper		
Chloride (mg/kg DMB)	44	0
AASHTO T 291-94		
Sulfate (mg/kg DMB)	131	1
CP-L 2103		
Sulfate (% DMB)	0.0131	
Sulfate-S (mg/kg DMB)	43.5	

1. NA = Not Analyzed; ND = Not Detected. DMB = Dry Matter Basis. Measurements taken at 25°C.
2. 10-point Corrosion system based on: Appendix A of ANSI/AWWA C105/A21.5 Standard "Polyethylene Encasement for Ductile Iron Pipe Systems." The Cl- points adapted from the DIPRA design decision model. Sulfate is penalized at half the rate of chloride: A. A. Sagüés et. al. (https://rosap.ntl.bts.gov/view/dot/17493)
3. pH, Conductivity, and Redox are generally read on a 1:1 soil:water mixture if the soil is dry.
4. ASTM G57 4-Electrode Method used unless 2-electrode method is requested.

Project Manager — Date: 6/10/2022

WELD LABORATORIES, INC.

1527 First Avenue • Greeley, Colorado 80631
Phone: (970) 353-8118 • Fax: (970) 353-1671
www.weldlabs.com

June 10, 2022

Vivid Engineering, Inc
Attn: Brysen Mustain
1053 Elkton Drive
Colorado Springs, CO 80907

Project No.: NDS Pipeline D22-2-508
Sample ID: B-7 0-4'

Laboratory No.: E22144-11G	Results[1,3]	10-Point System[2]
pH (SI)	8.1	0
AASHTO T 289-91 (ASTM G51 available for some soil)		
Conductivity (mmhos/cm)	0.454	NA
Resistivity (ohm-m)	22.0	
USDA Handbook 60, temperature corrected conductivity probe		
Minimum Lab Resistivity (ohm-cm)	2090	5
Minimum Lab Resistivity (ohm-m)	20.9	
via Miller Box, Tinker & Razor SR-2 (AASHTO T 288-12)[4]		
Redox (mV vs. Ag/AgCl)	141	0
ASTM G200 (ASTM D1498 if soil is low in moisture)		
Free Sulfide (mg/kg DMB)	0.1	2
EPA 9030B+9034, prescreened with lead acetate paper		
Chloride (mg/kg DMB)	79	1
AASHTO T 291-94		
Sulfate (mg/kg DMB)	241	3
CP-L 2103		
Sulfate (% DMB)	0.0241	
Sulfate-S (mg/kg DMB)	80.3	

1. NA = Not Analyzed; ND = Not Detected. DMB = Dry Matter Basis. Measurements taken at 25°C.
2. 10-point Corrosion system based on: Appendix A of ANSI/AWWA C105/A21.5 Standard "Polyethylene Encasement for Ductile Iron Pipe Systems." The Cl- points adapted from the DIPRA design decision model. Sulfate is penalized at half the rate of chloride: A. A. Sagüés et. al. (https://rosap.ntl.bts.gov/view/dot/17493)
3. pH, Conductivity, and Redox are generally read on a 1:1 soil:water mixture if the soil is dry.
4. ASTM G57 4-Electrode Method used unless 2-electrode method is requested.

Project Manager

6/10/2022
Date

WELD LABORATORIES, INC.

1527 First Avenue • Greeley, Colorado 80631
Phone: (970) 353-8118 • Fax: (970) 353-1671
www.weldlabs.com

June 10, 2022

Vivid Engineering, Inc
Attn: Brysen Mustain
1053 Elkton Drive
Colorado Springs, CO 80907

Project No.: NDS Pipeline D22-2-508
Sample ID: B-8 9'

Laboratory No.: E22144-11H	Results[1,3]	10-Point System[2]
pH (SI)	6.9	0
AASHTO T 289-91 (ASTM G51 available for some soil)		
Conductivity (mmhos/cm)	0.596	NA
Resistivity (ohm-m)	16.8	
USDA Handbook 60, temperature corrected conductivity probe		
Minimum Lab Resistivity (ohm-cm)	960	10
Minimum Lab Resistivity (ohm-m)	9.6	
via Miller Box, Tinker & Razor SR-2 (AASHTO T 288-12)[4]		
Redox (mV vs. Ag/AgCl)	155	0
ASTM G200 (ASTM D1498 if soil is low in moisture)		
Free Sulfide (mg/kg DMB)	ND	0
EPA 9030B+9034, prescreened with lead acetate paper		
Chloride (mg/kg DMB)	239	3
AASHTO T 291-94		
Sulfate (mg/kg DMB)	163	1
CP-L 2103		
Sulfate (% DMB)	0.0163	
Sulfate-S (mg/kg DMB)	54.4	

1. NA = Not Analyzed; ND = Not Detected. DMB = Dry Matter Basis. Measurements taken at 25°C.
2. 10-point Corrosion system based on: Appendix A of ANSI/AWWA C105/A21.5 Standard "Polyethylene Encasement for Ductile Iron Pipe Systems." The Cl- points adapted from the DIPRA design decision model. Sulfate is penalized at half the rate of chloride: A. A. Sagüés et. al. (https://rosap.ntl.bts.gov/view/dot/17493)
3. pH, Conductivity, and Redox are generally read on a 1:1 soil:water mixture if the soil is dry.
4. ASTM G57 4-Electrode Method used unless 2-electrode method is requested.

Project Manager

6/10/2022
Date

WELD LABORATORIES, INC.

1527 First Avenue • Greeley, Colorado 80631
Phone: (970) 353-8118 • Fax: (970) 353-1671
www.weldlabs.com

June 10, 2022

Vivid Engineering, Inc
Attn: Brysen Mustain
1053 Elkton Drive
Colorado Springs, CO 80907

Project No.: NDS Pipeline D22-2-508
Sample ID: B-9 0-4'

Laboratory No.: E22144-11 I	Results[1,3]	10-Point System[2]
pH (SI) AASHTO T 289-91 (ASTM G51 available for some soil)	8.6	3
Conductivity (mmhos/cm)	0.629	NA
Resistivity (ohm-m) USDA Handbook 60, temperature corrected conductivity probe	15.9	
Minimum Lab Resistivity (ohm-cm)	1220	10
Minimum Lab Resistivity (ohm-m) via Miller Box, Tinker & Razor SR-2 (AASHTO T 288-12)[4]	12.2	
Redox (mV vs. Ag/AgCl) ASTM G200 (ASTM D1498 if soil is low in moisture)	134	0
Free Sulfide (mg/kg DMB) EPA 9030B+9034, prescreened with lead acetate paper	0.1	2
Chloride (mg/kg DMB) AASHTO T 291-94	164	3
Sulfate (mg/kg DMB) CP-L 2103	409	3
Sulfate (% DMB)	0.0409	
Sulfate-S (mg/kg DMB)	136.3	

1. NA = Not Analyzed; ND = Not Detected. DMB = Dry Matter Basis. Measurements taken at 25°C.
2. 10-point Corrosion system based on: Appendix A of ANSI/AWWA C105/A21.5 Standard "Polyethylene Encasement for Ductile Iron Pipe Systems." The Cl- points adapted from the DIPRA design decision model. Sulfate is penalized at half the rate of chloride: A. A. Sagüés et. al. (https://rosap.ntl.bts.gov/view/dot/17493)
3. pH, Conductivity, and Redox are generally read on a 1:1 soil:water mixture if the soil is dry.
4. ASTM G57 4-Electrode Method used unless 2-electrode method is requested.

Project Manager

6/10/2022
Date

Sampling procedures can affect the value of analytical results – customers are advised to use appropriate sampling protocol to ensure samples are truly representative of the bulk sample.

WELD LABORATORIES, INC.

1527 First Avenue • Greeley, Colorado 80631
Phone: (970) 353-8118 • Fax: (970) 353-1671
www.weldlabs.com

June 10, 2022

Vivid Engineering, Inc
Attn: Brysen Mustain
1053 Elkton Drive
Colorado Springs, CO 80907

Project No.: NDS Pipeline D22-2-508
Sample ID: B-10 0-4'

Laboratory No.: E22144-11J	Results[1,3]	10-Point System[2]
pH (SI)	8.7	3
AASHTO T 289-91 (ASTM G51 available for some soil)		
Conductivity (mmhos/cm)	0.323	NA
Resistivity (ohm-m)	31.0	
USDA Handbook 60, temperature corrected conductivity probe		
Minimum Lab Resistivity (ohm-cm)	2520	1
Minimum Lab Resistivity (ohm-m)	25.2	
via Miller Box, Tinker & Razor SR-2 (AASHTO T 288-12)[4]		
Redox (mV vs. Ag/AgCl)	159	0
ASTM G200 (ASTM D1498 if soil is low in moisture)		
Free Sulfide (mg/kg DMB)	0.15	2
EPA 9030B+9034, prescreened with lead acetate paper		
Chloride (mg/kg DMB)	58	1
AASHTO T 291-94		
Sulfate (mg/kg DMB)	157	1
CP-L 2103		
Sulfate (% DMB)	0.0157	
Sulfate-S (mg/kg DMB)	52.2	

1. NA = Not Analyzed; ND = Not Detected. DMB = Dry Matter Basis. Measurements taken at 25°C.
2. 10-point Corrosion system based on: Appendix A of ANSI/AWWA C105/A21.5 Standard "Polyethylene Encasement for Ductile Iron Pipe Systems." The Cl- points adapted from the DIPRA design decision model. Sulfate is penalized at half the rate of chloride: A. A. Sagüés et. al. (https://rosap.ntl.bts.gov/view/dot/17493)
3. pH, Conductivity, and Redox are generally read on a 1:1 soil:water mixture if the soil is dry.
4. ASTM G57 4-Electrode Method used unless 2-electrode method is requested.

Project Manager

6/10/2022
Date

Sampling procedures can affect the value of analytical results – customers are advised to use appropriate sampling protocol to ensure samples are truly representative of the bulk sample.

WELD LABORATORIES, INC.

1527 First Avenue • Greeley, Colorado 80631
Phone: (970) 353-8118 • Fax: (970) 353-1671
www.weldlabs.com

June 10, 2022

Vivid Engineering, Inc
Attn: Brysen Mustain
1053 Elkton Drive
Colorado Springs, CO 80907

Project No.: NDS Pipeline D22-2-508
Sample ID: B-11 0-4

Laboratory No.: E22144-11K	Results[1,3]	10-Point System[2]
pH (SI) AASHTO T 289-91 (ASTM G51 available for some soil)	8.8	3
Conductivity (mmhos/cm)	0.275	NA
Resistivity (ohm-m) USDA Handbook 60, temperature corrected conductivity probe	36.4	
Minimum Lab Resistivity (ohm-cm)	2150	2
Minimum Lab Resistivity (ohm-m) via Miller Box, Tinker & Razor SR-2 (AASHTO T 288-12)[4]	21.5	
Redox (mV vs. Ag/AgCl) ASTM G200 (ASTM D1498 if soil is low in moisture)	157	0
Free Sulfide (mg/kg DMB) EPA 9030B+9034, prescreened with lead acetate paper	0.05	2
Chloride (mg/kg DMB) AASHTO T 291-94	26	0
Sulfate (mg/kg DMB) CP-L 2103	148	1
Sulfate (% DMB)	0.0148	
Sulfate-S (mg/kg DMB)	49.3	

1. NA = Not Analyzed; ND = Not Detected. DMB = Dry Matter Basis. Measurements taken at 25°C.
2. 10-point Corrosion system based on: Appendix A of ANSI/AWWA C105/A21.5 Standard "Polyethylene Encasement for Ductile Iron Pipe Systems." The Cl- points adapted from the DIPRA design decision model. Sulfate is penalized at half the rate of chloride: A. A. Sagüés et. al. (https://rosap.ntl.bts.gov/view/dot/17493)
3. pH, Conductivity, and Redox are generally read on a 1:1 soil:water mixture if the soil is dry.
4. ASTM G57 4-Electrode Method used unless 2-electrode method is requested.

Project Manager   6/10/2022 Date

WELD LABORATORIES, INC.

1527 First Avenue • Greeley, Colorado 80631
Phone: (970) 353-8118 • Fax: (970) 353-1671
www.weldlabs.com

June 10, 2022

Vivid Engineering, Inc
Attn: Brysen Mustain
1053 Elkton Drive
Colorado Springs, CO 80907

Project No.: NDS Pipeline D22-2-508
Sample ID: B-12 4'

Laboratory No.: E22144-11L	Results[1,3]	10-Point System[2]
pH (SI)	6.1	0
AASHTO T 289-91 (ASTM G51 available for some soil)		
Conductivity (mmhos/cm)	0.155	NA
Resistivity (ohm-m)	64.5	
USDA Handbook 60, temperature corrected conductivity probe		
Minimum Lab Resistivity (ohm-cm)	1850	5
Minimum Lab Resistivity (ohm-m)	18.5	
via Miller Box, Tinker & Razor SR-2 (AASHTO T 288-12)[4]		
Redox (mV vs. Ag/AgCl)	150	0
ASTM G200 (ASTM D1498 if soil is low in moisture)		
Free Sulfide (mg/kg DMB)	ND	0
EPA 9030B+9034, prescreened with lead acetate paper		
Chloride (mg/kg DMB)	40	0
AASHTO T 291-94		
Sulfate (mg/kg DMB)	186	1
CP-L 2103		
Sulfate (% DMB)	0.0186	
Sulfate-S (mg/kg DMB)	61.9	

1. NA = Not Analyzed; ND = Not Detected. DMB = Dry Matter Basis. Measurements taken at 25°C.
2. 10-point Corrosion system based on: Appendix A of ANSI/AWWA C105/A21.5 Standard "Polyethylene Encasement for Ductile Iron Pipe Systems." The Cl- points adapted from the DIPRA design decision model. Sulfate is penalized at half the rate of chloride: A. A. Sagüés et. al. (https://rosap.ntl.bts.gov/view/dot/17493)
3. pH, Conductivity, and Redox are generally read on a 1:1 soil:water mixture if the soil is dry.
4. ASTM G57 4-Electrode Method used unless 2-electrode method is requested.

Project Manager

6/10/2022
Date

Sampling procedures can affect the value of analytical results – customers are advised to use appropriate sampling protocol to ensure samples are truly representative of the bulk sample.

WELD LABORATORIES, INC.

1527 First Avenue • Greeley, Colorado 80631
Phone: (970) 353-8118 • Fax: (970) 353-1671
www.weldlabs.com

June 10, 2022

Vivid Engineering, Inc
Attn: Brysen Mustain
1053 Elkton Drive
Colorado Springs, CO 80907

Project No.: NDS Pipeline D22-2-508
Sample ID: B-13 0-4'

Laboratory No.: E22144-11M	Results[1,3]	10-Point System[2]
pH (SI)	8.7	3
AASHTO T 289-91 (ASTM G51 available for some soil)		
Conductivity (mmhos/cm)	0.368	NA
Resistivity (ohm-m)	27.2	
USDA Handbook 60, temperature corrected conductivity probe		
Minimum Lab Resistivity (ohm-cm)	1720	8
Minimum Lab Resistivity (ohm-m)	17.2	
via Miller Box, Tinker & Razor SR-2 (AASHTO T 288-12)[4]		
Redox (mV vs. Ag/AgCl)	174	0
ASTM G200 (ASTM D1498 if soil is low in moisture)		
Free Sulfide (mg/kg DMB)	ND	0
EPA 9030B+9034, prescreened with lead acetate paper		
Chloride (mg/kg DMB)	66	1
AASHTO T 291-94		
Sulfate (mg/kg DMB)	116	1
CP-L 2103		
Sulfate (% DMB)	0.0116	
Sulfate-S (mg/kg DMB)	38.7	

1. NA = Not Analyzed; ND = Not Detected. DMB = Dry Matter Basis. Measurements taken at 25°C.
2. 10-point Corrosion system based on: Appendix A of ANSI/AWWA C105/A21.5 Standard "Polyethylene Encasement for Ductile Iron Pipe Systems." The Cl- points adapted from the DIPRA design decision model. Sulfate is penalized at half the rate of chloride: A. A. Sagüés et. al. (https://rosap.ntl.bts.gov/view/dot/17493)
3. pH, Conductivity, and Redox are generally read on a 1:1 soil:water mixture if the soil is dry.
4. ASTM G57 4-Electrode Method used unless 2-electrode method is requested.

Project Manager

6/10/2022
Date

WELD LABORATORIES, INC.

1527 First Avenue • Greeley, Colorado 80631
Phone: (970) 353-8118 • Fax: (970) 353-1671
www.weldlabs.com

June 10, 2022

Vivid Engineering, Inc
Attn: Brysen Mustain
1053 Elkton Drive
Colorado Springs, CO 80907

Project No.: NDS Pipeline D22-2-508
Sample ID: B-14 0-4'

Laboratory No.: E22144-11N	Results[1,3]	10-Point System[2]
pH (SI)	8.2	0
AASHTO T 289-91 (ASTM G51 available for some soil)		
Conductivity (mmhos/cm)	0.490	NA
Resistivity (ohm-m)	20.4	
USDA Handbook 60, temperature corrected conductivity probe		
Minimum Lab Resistivity (ohm-cm)	1180	10
Minimum Lab Resistivity (ohm-m)	11.8	
via Miller Box, Tinker & Razor SR-2 (AASHTO T 288-12)[4]		
Redox (mV vs. Ag/AgCl)	180	0
ASTM G200 (ASTM D1498 if soil is low in moisture)		
Free Sulfide (mg/kg DMB)	0.4	2
EPA 9030B+9034, prescreened with lead acetate paper		
Chloride (mg/kg DMB)	175	3
AASHTO T 291-94		
Sulfate (mg/kg DMB)	128	1
CP-L 2103		
Sulfate (% DMB)	0.0128	
Sulfate-S (mg/kg DMB)	42.8	

1. NA = Not Analyzed; ND = Not Detected. DMB = Dry Matter Basis. Measurements taken at 25°C.
2. 10-point Corrosion system based on: Appendix A of ANSI/AWWA C105/A21.5 Standard "Polyethylene Encasement for Ductile Iron Pipe Systems." The Cl- points adapted from the DIPRA design decision model. Sulfate is penalized at half the rate of chloride: A. A. Sagüés et. al. (https://rosap.ntl.bts.gov/view/dot/17493)
3. pH, Conductivity, and Redox are generally read on a 1:1 soil:water mixture if the soil is dry.
4. ASTM G57 4-Electrode Method used unless 2-electrode method is requested.

Project Manager — Date: 6/10/2022

WELD LABORATORIES, INC.

1527 First Avenue • Greeley, Colorado 80631
Phone: (970) 353-8118 • Fax: (970) 353-1671
www.weldlabs.com

June 10, 2022

Vivid Engineering, Inc
Attn: Brysen Mustain
1053 Elkton Drive
Colorado Springs, CO 80907

Project No.: NDS Pipeline D22-2-508
Sample ID: B-15 0-4'

Laboratory No.: E22144-11 O	Results[1,3]	10-Point System[2]
pH (SI) AASHTO T 289-91 (ASTM G51 available for some soil)	9.4	3
Conductivity (mmhos/cm)	0.572	NA
Resistivity (ohm-m) USDA Handbook 60, temperature corrected conductivity probe	17.5	
Minimum Lab Resistivity (ohm-cm)	1290	10
Minimum Lab Resistivity (ohm-m) via Miller Box, Tinker & Razor SR-2 (AASHTO T 288-12)[4]	12.9	
Redox (mV vs. Ag/AgCl) ASTM G200 (ASTM D1498 if soil is low in moisture)	154	0
Free Sulfide (mg/kg DMB) EPA 9030B+9034, prescreened with lead acetate paper	0.9	2
Chloride (mg/kg DMB) AASHTO T 291-94	148	3
Sulfate (mg/kg DMB) CP-L 2103	157	1
Sulfate (% DMB)	0.0157	
Sulfate-S (mg/kg DMB)	52.2	

1. NA = Not Analyzed; ND = Not Detected. DMB = Dry Matter Basis. Measurements taken at 25°C.
2. 10-point Corrosion system based on: Appendix A of ANSI/AWWA C105/A21.5 Standard "Polyethylene Encasement for Ductile Iron Pipe Systems." The Cl- points adapted from the DIPRA design decision model. Sulfate is penalized at half the rate of chloride: A. A. Sagüés et. al. (https://rosap.ntl.bts.gov/view/dot/17493)
3. pH, Conductivity, and Redox are generally read on a 1:1 soil:water mixture if the soil is dry.
4. ASTM G57 4-Electrode Method used unless 2-electrode method is requested.

Project Manager — Date: 6/10/2022

Appendix D

Pavement Calculations

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product

19168474535

Flexible Structural Design Module

Baptist Road - West of Roller Coaster Road
Roller Coaster Road (Stella Drive to Old Northgate Road)
R = 25
New Flexible Composite

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	689,850
Initial Serviceability	4.5
Terminal Serviceability	2.5
Reliability Level	80 %
Overall Standard Deviation	0.45
Roadbed Soil Resilient Modulus	5,760 psi
Stage Construction	1
Calculated Design Structural Number	3.26 in

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	HMA	0.44	1	5	-	2.20
2	ABC	0.11	1	10	-	1.10
Total	-	-	-	15.00	-	3.30

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare Computer Software Product

19168474535

Flexible Structural Design Module

Roller Coaster Road - Baptist Road to Stella Drive
R = 25
New Flexible Composite

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	273,750
Initial Serviceability	4.5
Terminal Serviceability	2.5
Reliability Level	80 %
Overall Standard Deviation	0.45
Roadbed Soil Resilient Modulus	5,760 psi
Stage Construction	1
Calculated Design Structural Number	2.82 in

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	HMA	0.44	1	5	-	2.20
2	ABC	0.11	1	8	-	0.88
Total	-	-	-	13.00	-	3.08

Appendix E

Important Information About This Geotechnical Engineering Report

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, clients can benefit from a lowered exposure to the subsurface problems that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed below, contact your GBA-member geotechnical engineer. Active involvement in the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Geotechnical-Engineering Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. *Those who rely on a geotechnical-engineering report prepared for a different client can be seriously misled*. No one except authorized client representatives should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one – not even you – should apply this report for any purpose or project except the one originally contemplated.*

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read it *in its entirety*. Do not rely on an executive summary. Do not read selected elements only. *Read this report in full.*

You Need to Inform Your Geotechnical Engineer about Change

Your geotechnical engineer considered unique, project-specific factors when designing the study behind this report and developing the confirmation-dependent recommendations the report conveys. A few typical factors include:

- the client's goals, objectives, budget, schedule, and risk-management preferences;
- the general nature of the structure involved, its size, configuration, and performance criteria;
- the structure's location and orientation on the site; and
- other planned or existing site improvements, such as retaining walls, access roads, parking lots, and underground utilities.

Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

This Report May Not Be Reliable

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, that it could be unwise to rely on a geotechnical-engineering report whose reliability may have been affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If your geotechnical engineer has not indicated an "apply-by" date on the report, ask what it should be*, and, in general, *if you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying it. A minor amount of additional testing or analysis – if any is required at all – could prevent major problems.

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface through various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing were performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgment to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team from project start to project finish, so the individual can provide informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, *they are not final*, because the geotechnical engineer who developed them relied heavily on judgment and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* revealed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a full-time member of the design team, to:

- confer with other design-team members,
- help develop specifications,
- review pertinent elements of other design professionals' plans and specifications, and
- be on hand quickly whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction observation.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for informational purposes only*. To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report, but they may rely on the factual data relative to the specific times, locations, and depths/elevations referenced. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely*. Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures*. If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. As a general rule, *do not rely on an environmental report prepared for a different client, site, or project, or that is more than six months old.*

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, none of the engineer's services were designed, conducted, or intended to prevent uncontrolled migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration.*** Confront the risk of moisture infiltration by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are not building-envelope or mold specialists.***

GEOPROFESSIONAL BUSINESS ASSOCIATION

Telephone: 301/565-2733
e-mail: info@geoprofessional.org www.geoprofessional.org