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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:

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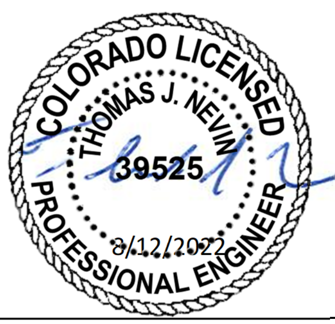

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1.0 INTRODUCTION

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.

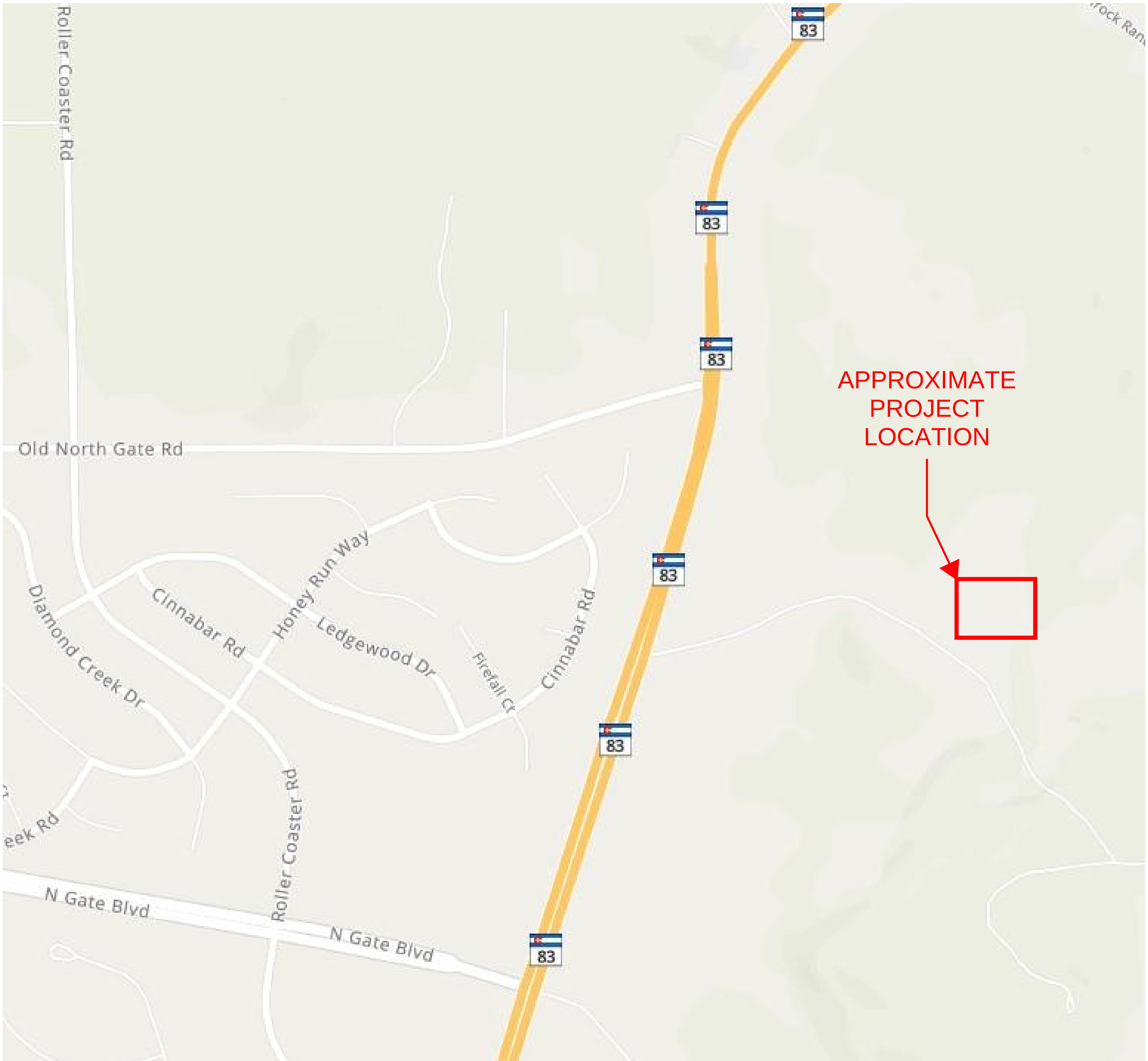
5.2 LIMITATIONS

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



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

VIVID Engineering Group

Project No: D21-2-457

Date: July 14, 2022

Drawn by: BTM

Reviewed by: WJB

VICINITY MAP

Proposed Triview NDS Pump Station
Vicinity of Old Northgate Road and HWY 83
Colorado Springs, Colorado

Figure

1

LEGEND

= APPROXIMATE LOCATION OF EXPLORATORY BORING

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

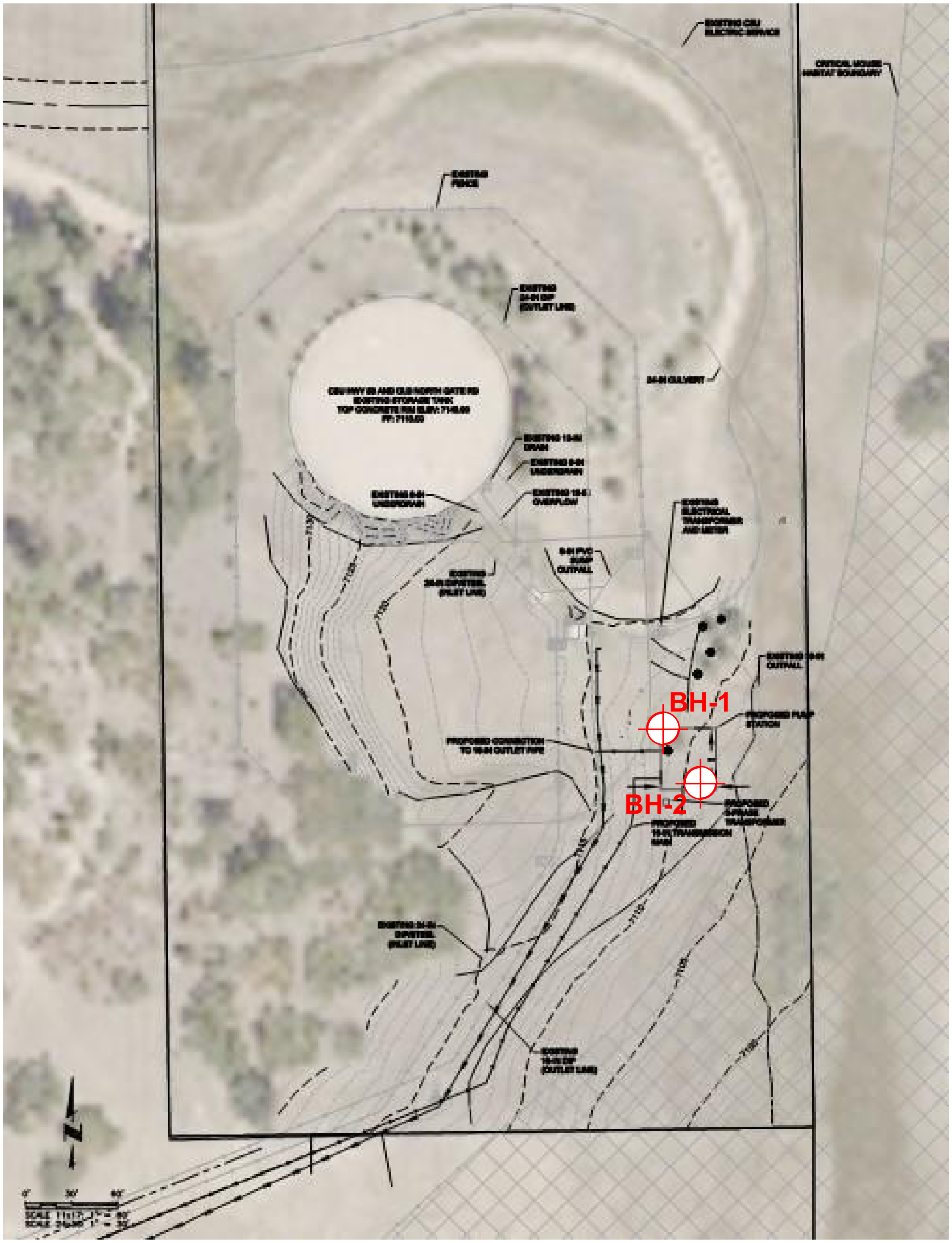
N

VIVID Engineering Group

Project No: D21-2-457	FIELD EXPLORATION PLAN - AERIAL	Figure 2
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		

LEGEND

= APPROXIMATE LOCATION OF EXPLORATORY BORING



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Base image obtained from JDS-Hydro, Inc.

VIVID Engineering Group

Project No: D21-2-457	**FIELD EXPLORATION PLAN - CONCEPTUAL**	Figure 3
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		

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	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	
19.0				**Dawson Formation** Sandy CLAYSTONE, gray, moist, hard to very hard
20	SPT	50/7"	Sulfates = 0.0229%	
25	MC	50/4"		
26.0				**Dawson Formation** Clayey to Silty SANDSTONE, gray, moist, very hard
29.2	MC	50/2"		Bottom of borehole at 29.2 feet.

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

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

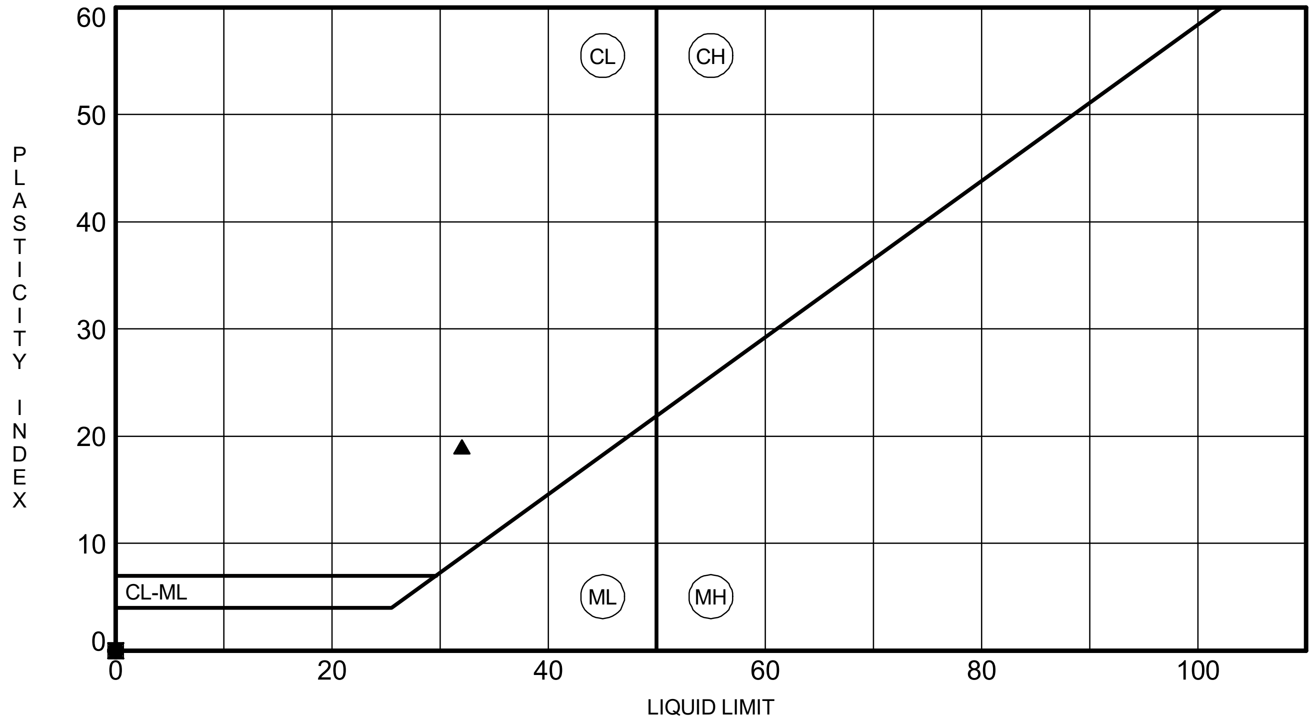
CLIENT JDS-Hydro Consultants, Inc.
PROJECT NAME Proposed Triview NDS Pump Station
PROJECT NUMBER D21-2-457
PROJECT LOCATION Old Northgate Rd and HWY 83, Colorado Springs, CO

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



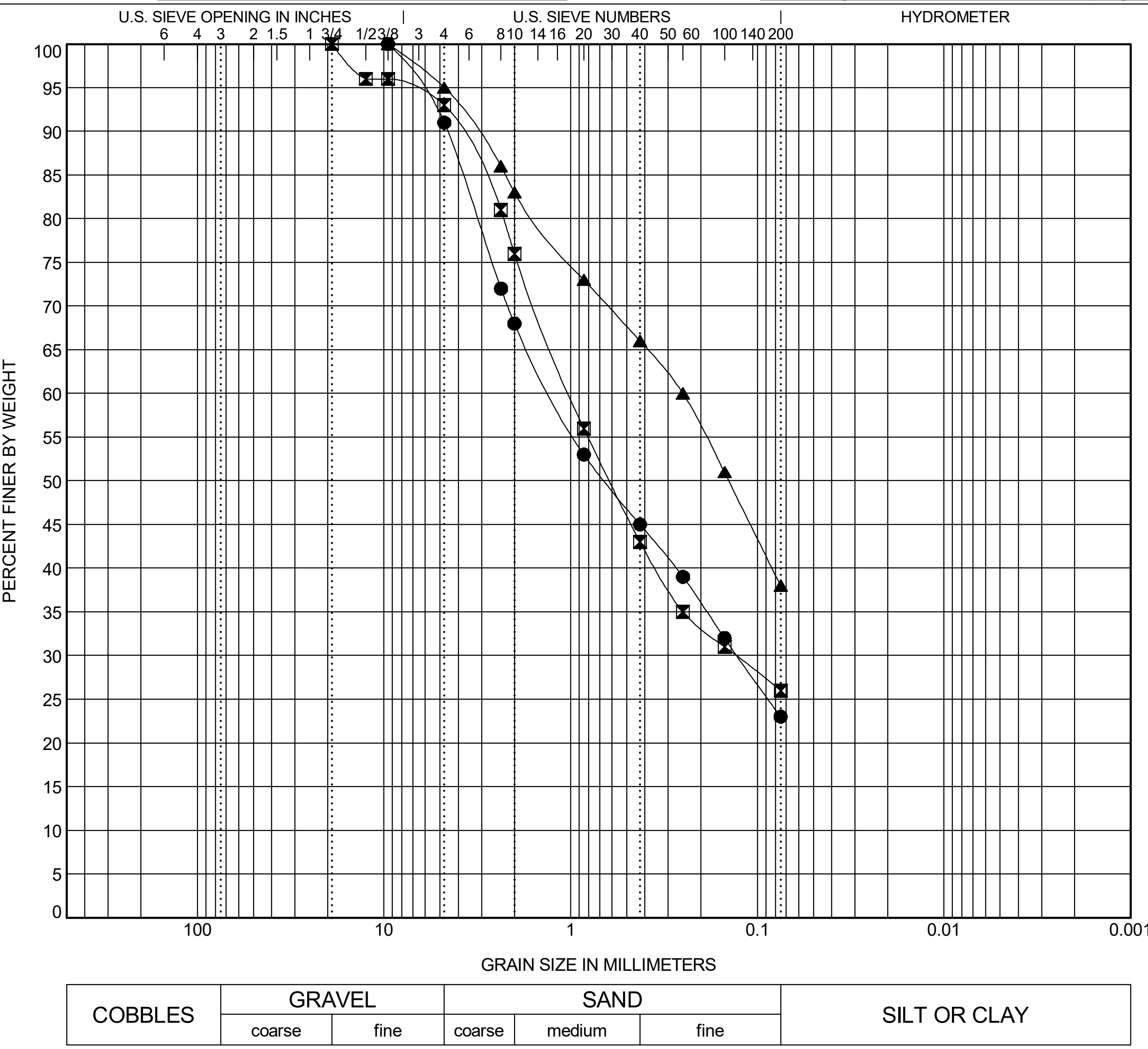
	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**BH-1**	**2.5**	**NP**	**NP**	**NP**	**23**	**SILTY SAND(SM)**
⊠	**BH-1**	**10.0**	**NP**	**NP**	**NP**	**26**	**SILTY SAND(SM)**
▲	**BH-2**	**2.5**	**32**	**13**	**19**	**38**	**CLAYEY SAND(SC)**

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

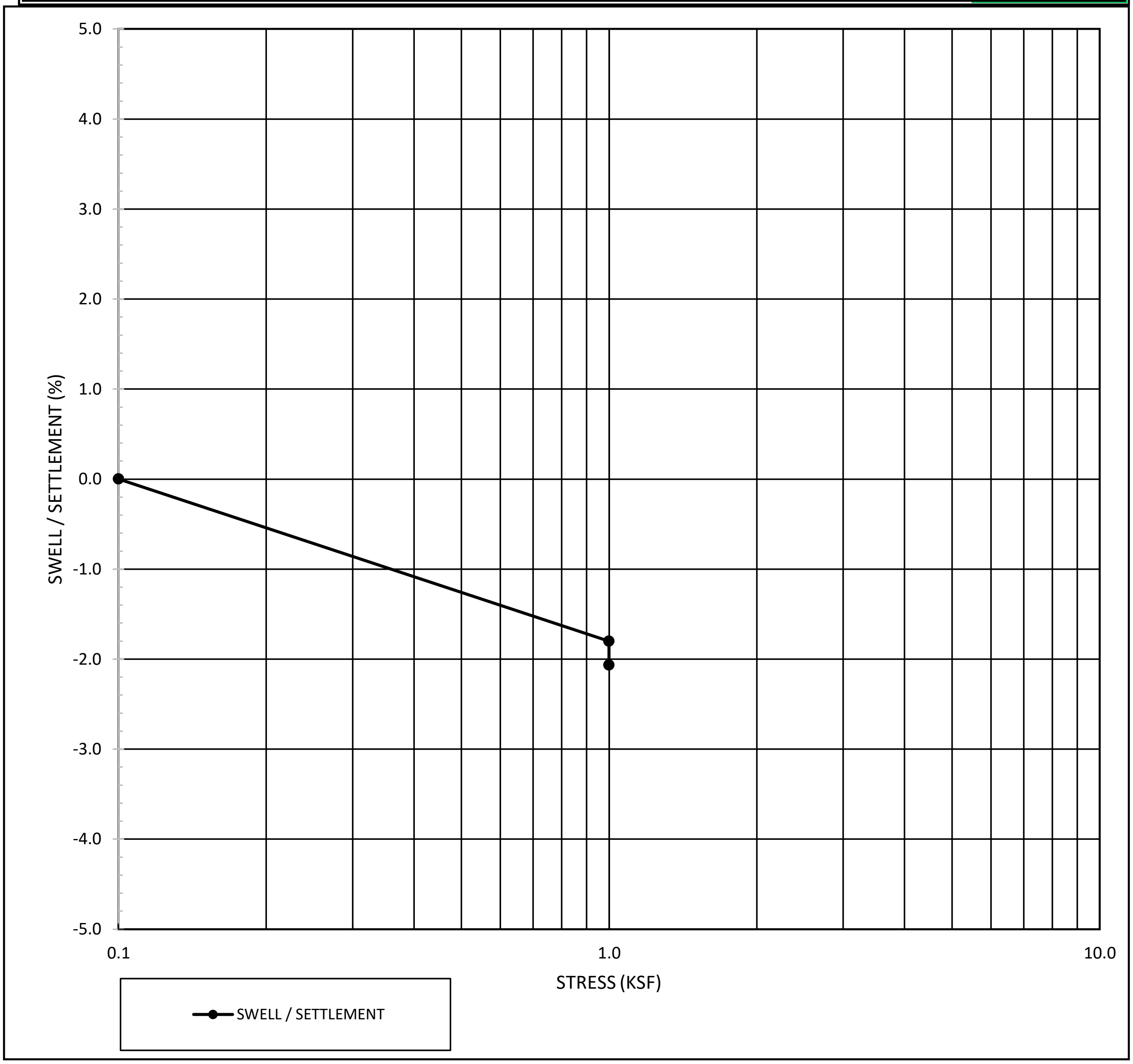


	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**BH-1**	**2.5**	**SILTY SAND(SM)**	**NP**	**NP**	**NP**		
⧗	**BH-1**	**10.0**	**SILTY SAND(SM)**	**NP**	**NP**	**NP**		
▲	**BH-2**	**2.5**	**CLAYEY SAND(SC)**	**32**	**13**	**19**		

	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**	

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		

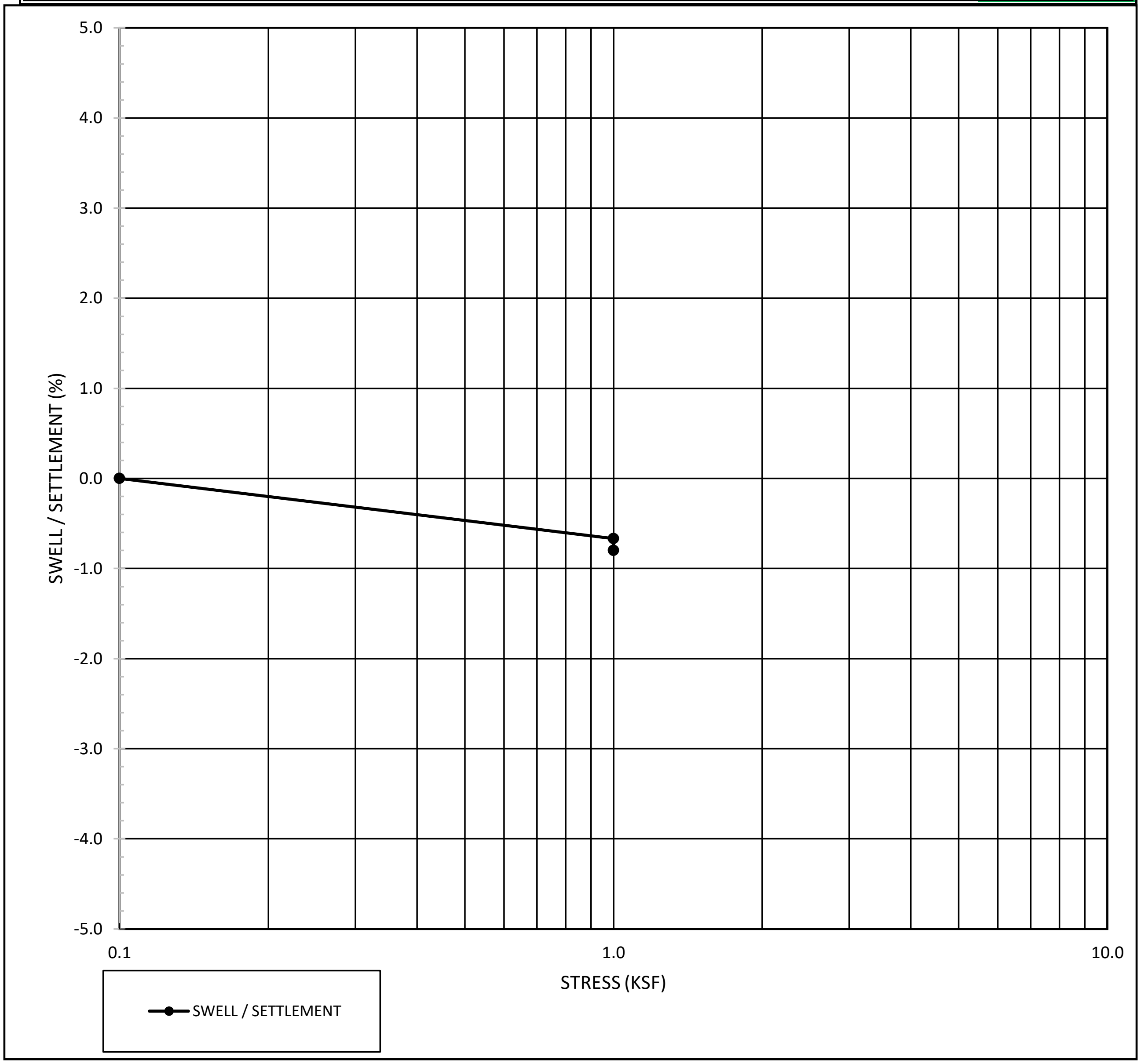
	%
Compression @ Wetting Weight:	**-0.3**



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		

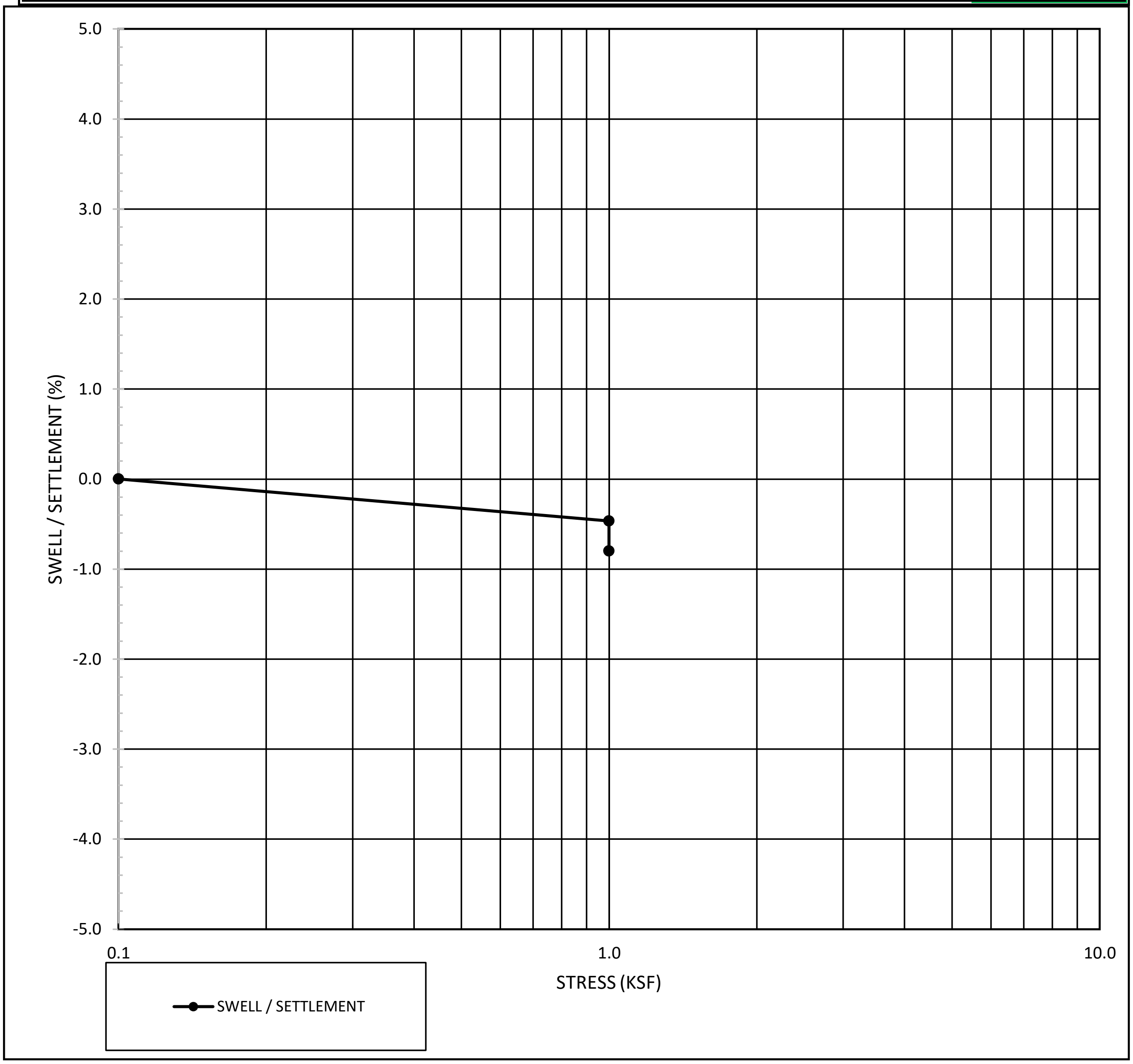
	%
Compression @ Wetting Weight:	**-0.1**



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) AASHTO T 289-91 (ASTM G51 available for some soil)	NA	NA
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) ASTM G200 (ASTM D1498 if soil is low in moisture)	NA	0
Free Sulfide (mg/kg DMB) EPA 9030B+9034, prescreened with lead acetate paper	NA	NA
Chloride (mg/kg DMB) AASHTO T 291-94	NA	NA
Sulfate (mg/kg DMB) CP-L 2103	229	3
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: 7/26/22

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

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	

Vivid Engineering Group

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.***

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