VIVID Engineering Group, Inc.

1053 Elkton Drive, Colorado Springs, CO 80907

February 15, 2022

Mario DiPasquale, PE
JDS-Hydro Consultants, Inc.
5540 Tech Center Drive, Suite 100
Colorado Springs, CO 80919
mdipasquale@jdshydro.com

Subject: **Geotechnical Evaluation Report Update**
Widefield Water and Sanitation Pump Station
Vicinity of Metropolitan Street and Kipling Street
Widefield, Colorado

Reference: Geotechnical Evaluation Report
Widefield Water and Sanitation Pump Station
Vicinity of Metropolitan Street and Kipling Street
Widefield, Colorado
VIVID Project No. D19-2-253, dated October 22, 2019

Dear Mr. DiPasquale:

At your request, VIVID has completed this letter to update the 2019 Geotechnical Evaluation Report prepared by VIVID Engineering Group, Inc. for the proposed Pump Station. Based on our review of the 2019 geotechnical report and our understanding of the proposed construction, the recommendations of 2019 report remain valid for the Pump Station project and should be considered in its entirety for design and construction recommendations.

LIMITATIONS

The opinions and recommendations in this letter are based upon our review of the referenced geotechnical report and design/construction plans, field and laboratory testing, and on our experience with similar subsurface conditions and types of construction.

VIVID has prepared this letter for the exclusive use of JDS-Hydro Consultants, Inc. (Client) for the proposed Lift Station to be constructed in the vicinity of Metropolitan Street and Kipling Street in Widefield, Colorado. The letter may be used only by the Client, and only for the purposes stated, within a reasonable time of its issuance. Land use, site conditions (both on-and off-site) or other factors may change over time, so that additional investigation or revision of our recommendations may be required with passage of time. Any party other than the Client who wishes to use this letter must notify VIVID of such intended use. Based on that intended use of the letter, VIVID may require that additional work be performed and

that an updated letter be issued. Noncompliance with these requirements by the Client or anyone else will release VIVID from liability resulting from use of this letter by an unauthorized party.

CLOSING

We appreciate this opportunity to serve you, and we look forward to working with you again. Should you have any questions concerning this report, please contact the undersigned at 719.896.4356.

Sincerely,

2/15/2022

William (Bill) J. Barreire, PE
Senior Geotechnical Engineer

Brysen T. Mustain, PG
Engineering Geologist

Attachments:

A - Geotechnical Evaluation Report for the Widefield Water and Sanitation Pump Station, Vicinity of Metropolitan Street and Kipling Street, Widefield, Colorado, prepared by VIVID Engineering Group, Inc. (Project No. D19-2-253, report dated October 22, 2019)

Attachment A

Geotechnical Evaluation Report for the Widefield Water and Sanitation Pump Station, Vicinity of Metropolitan Street and Kipling Street, Widefield, Colorado, prepared by VIVID Engineering Group, Inc. (Project No. D19-2-253, report dated October 22, 2019)

10/22/2019

Geotechnical Evaluation Report

Widefield Water and Sanitation Pump Station

Vicinity of Metropolitan Street and Kipling Street

Widefield, Colorado

VIVID Project No.: D19-2-253

VIVID Engineering Group

October 22, 2019

Report prepared for:

Mario Dipasquale, PE
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GEOTECHNICAL EVALUATION REPORT
Widefield Water and Sanitation Pump Station
Vicinity of Metropolitan Street and Kipling Street
Widefield, Colorado
VIVID Project No.: D19-2-253

Prepared by:

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1.0 INTRODUCTION

1.1 GENERAL

This report presents the results of a geotechnical investigation performed for a proposed Water Booster Pump Station Building located near Metropolitan Street and Kipling Street in Widefield, Colorado. An attached Vicinity Map (Figure 1) shows the general location of the project. Our investigation was performed for JDS-Hydro Consultants Inc. and was authorized by Mr. Mario Dipasquale.

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 the construction of an approximate 2,600 square foot water booster pump station building located near Metropolitan Street and Kipling Street in Widefield, CO. The proposed site layout is shown on Figure 3, attached to this report. In addition, a new above-ground water storage tank is planned on this site. Recommendations for the tank structure are provided under separate report.

According to the existing borehole surface elevations and proposed grading plans, we believe that, in general, planned site grading cuts and fills to achieve finish site grades will be minimal, with 12-24 inches of fill material required to reach the proposed grades.

No structural loads were provided at the time this report was written. For the purposes of this report, we anticipate the generator and the pump station foundations will consist of shallow spread footings and slab-on-grade floors or mat-type foundations. Other construction related activities are anticipated to include the connection of the inflow and outflow pipelines, site grading, and installation of utilities. If the type of construction or actual building 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 various 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 one-call service to identify underground utility lines at the boring locations prior to our drilling;
- The drilling of 4 exploratory borings for the pump station building and generator at various locations on the property, which were selected 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 and floor slab 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 September 18 and 24, 2019 included drilling 4 exploratory borings, at the approximate locations indicated on the Boring Location Plans (Figures 2 and 3). Borings BP-1, BP-2 and BP-3 were drilled within/near the approximate footprint of the proposed pump station building. BP-2 was advanced to a depth of approximately 50 feet below the existing ground surface, while borings BP-1 and BP-3 were advanced to approximately 30 feet below ground surface. Boring Gen-1 was drilled within the proposed generator location and was advanced to a total depth of approximately 30 feet below the existing ground surface.

All 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 and 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 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 of Soils
- Sieve Analysis
- Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- Swell/Settlement Test
- Unconfined Compressive Strength

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 test:

- 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. Selected test results are also shown on the boring logs in Appendix A.

3.0 SITE CONDITIONS

3.1 SURFACE

At the time of our exploration, the subject site was a vacant property beside an existing tank and an existing building occupying the address 7010 Metropolitan Street, in Widefield, Colorado. The ground surface was relatively flat and sloped gently down towards the west. The site was within a residential area, bounded on the south by an existing tank and from the north and the west by a drainage feature.

3.2 GEOLOGY

Prior to drilling, the site geology was evaluated by reviewing available geologic information including the USGS Geologic Map of the Pueblo 1 degree x 2 degree Quadrangle, South-Central Colorado (Scott et al. 1976). Mapping indicates the surficial soils in the general area of the project site comprise predominantly Alluvium deposits of gravel, sand, silt, and clay underlain by claystone and shale bedrock of the Pierre Shale Formation. The mapping is generally consistent with our explorations. However, bedrock was not encountered during drilling.

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 profiles correspond with Site Class D 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
0.172	1.6

S_S = The mapped spectral accelerations for short periods (SEAOC/OSHPD Seismic Design Maps Tool, 2019)

F_a = Site coefficient (SEAOC/OSHPD Seismic Design Maps Tool, 2019)

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 (SEAOC/OSHPD Seismic Design Maps Tool, 2019)

F_v = Site coefficient SEAOC/OSHPD Seismic Design Maps Tool, 2019

3.4 SUBSURFACE

VIVID explored the subsurface conditions by drilling, logging and sampling 4 exploratory borings within or near the general area to be occupied by the proposed pump station building and generator as shown on Figures 2 and 3. These borings were drilled to depths ranging from approximately 30 to 50 feet below the existing ground surface. The general profile encountered in our borings consisted of:

Silt and Clay

Predominantly sandy to silty clay was encountered at the ground surface in all borings and extended to depths of approximately 14.5 to 24 feet below the ground surface. A layer of sandy silt was encountered in boring Gen-1 between depths of approximately 6 and 16 feet below the existing ground surface. The clay and silt was olive in color, dry to moist, and field penetration testing (blow counts) indicated the soil to be stiff to very stiff. Samples of the sandy clay soils exhibited low to high expansion and low to high compression potential when subject to wetting.

Sand

This unit comprised mainly of silty sand with thin layers of poorly graded sand and clayey sand and was encountered underlying the sandy clay deposit and extended to a depth approximately 30 to 35 feet below the ground surface. The sand soils were generally olive in color, slightly moist, and field penetration testing (blow counts) indicated the sand soils were medium dense. A layer of sandy clay was encountered underlying the sand soil in boring BP-2 and extended to the maximum depth of boring of 50 feet and has physical properties similar to that of the upper sandy clay layer mentioned above.

3.4.1 Groundwater

Groundwater was encountered at the time of drilling in boring BP-2 at a depth of approximately 40 feet below the ground surface. Groundwater at this depth is not anticipated to be a consideration for building construction. 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 development of the site essentially as planned, provided the recommendations in this report are incorporated into the design and construction of the project. Our recommendations for earthwork, foundations, and slabs are discussed further in the following sections of the report.

The primary geotechnical issues associated with development of this project as proposed is the presence of variable density of silt, clay and sandy soils at foundation and floor slab elevations that create the potential for differentiated foundation movement in the form of both heave and settlement over time. This movement will result in movement and damage to concrete foundation and slab elements unless mitigated.

Shallow foundation and slab-on-grade systems can be utilized with improvement of the existing subgrade to minimize the potential for structure damage. To minimize the potential for damage, it is recommended that foundations and slabs bear on a minimum 4-foot thick mat of engineered fill consisting of an imported, non-expansive, granular structural fill over 2 feet of moisture treated subgrade. This will require that the existing soils be removed to a depth of at least 4 feet below bottom of footing and slab elevation, 2 feet to be replaced with structural fill and 2 feet to be moisture treated. The over-excavation should also extend at least four feet beyond the edge of the footings. This improvement shall also be performed below piping into and out of the structure that would be sensitive to differential movement especially at its connection with the structure. This treatment should occur to a minimum distance of 10 feet from the building perimeter then transition to no treatment for another 10 feet.

Foundation system recommendations are described in more detail in Section 4.3.1. Slab-on-grade recommendations are described in more detail in Section 4.5. This includes subgrade preparation prior to placement of structural fill per Section 4.2.2.

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.

After performing the required excavations and prior to the placement of compacted fill, moisture treatment of the subgrade should be performed. Moisture treatment is the process of removing the soil, adding moisture until the soil moisture content is between -1 and +3 percent of optimum as determined

by (ASTM D 698), and compacted to at least 95 percent of maximum Standard Proctor density. 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.

4.2.3 Excavation Characteristics

According to the provided plans which indicates that the proposed booster pump station is 5770.50. We anticipate cuts are required in order to place the 4 feet structural fills as a mitigation for the swelling potential of the subgrade soil.

Based on our subsurface drilling information, we anticipate that excavations on the order of approximately 3 to 10-feet will be required for any connecting pipeline installation and to construct shallow foundations on compacted structural fill.

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 sand and clay 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 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 foundation and slab components, as well as wall backfill. Below footings and slabs, we are recommending a combination of moisture-treated on-site clay soil and an imported granular structural fill. Imported structural fill will be required at this site and should consist of a CDOT class 1 structure backfill. 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. Where piping/utilities enter and exist structures, additional subgrade treatment and structural fill requirements are needed to limit damage due to differential movement. Specific details are presented in section 4.1. Compact trench backfill as recommended in Section 4.2.6 of this report.

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 698)	MOISTURE CONTENT
Subgrade Preparation (after clearing, grubbing, excavation, and prior to placement of new fill and/or structural elements)	On-site Soils	95 minimum	-1 to +3 % of optimum
Structural Fill placed beneath foundations and slabs-on-grade	Moisture Treated On-site soils	95 minimum	-1 to +3% of optimum
	Imported Granular Soils (CDOT Class 1 Structural Backfill)	95 minimum	± 2 % of optimum
Exterior Wall Backfill	imported Granular Soils or On-site Soils (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.

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 building areas. 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 structures are 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 and Landscaping

Positive drainage away from the structure is essential to the performance of foundations and flatwork and should be provided during the life of the structure. Landscape areas within 10-feet of the structure should slope away at a minimum of 8 percent. Wherever possible, 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 a 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 SHALLOW FOUNDATIONS

Provided the following recommendations are complied with, the proposed pump station and the generator structures may be supported on shallow foundations. Our subsurface investigation indicates excavation for construction of shallow foundations for the proposed structure will expose stiff sandy clay materials that are subjected to both expansion as well as settlement at variable locations and depths. The pump station and generator loads are anticipated to be light with consideration of vibratory loading from the pump and generator operation.

4.3.1 Shallow Foundation Recommendations

To help reduce differential movement of the proposed structures, we recommend placement of at least 4 feet of properly compacted, structural fill beneath the proposed foundation elevations. This includes excavation to a depth of 4 feet below footing (and 4 feet beyond the edge). The lower 2 feet shall be replaced with a minimum of 2 feet of moisture treated on-site soils, and the upper 2 feet with imported granular structural fill. Acceptable structural fill material and compaction requirements are provided in Sections 4.2.4 and 4.2.6, respectively. In addition, structural design should address differential movement between the pump station structure and any proposed pipeline(s) and utilities to be connected to the structure. Section 4.1 provides a subgrade improvement and fill requirements. Measures to limit damage such as slip-joints or other connections that can tolerate some movement should be implemented, as appropriate.

- Foundations should be constructed on a minimum of 4 feet of compacted imported structural fill, as discussed above.
- Foundations bearing upon compacted structural fill should be designed for a maximum allowable soil bearing capacity of 3,500 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.
- 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.
- 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. 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 foundations may be partially 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 (foundation walls in this case) on 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. Passive lateral earth pressure applies to soils placed adjacent the inside edge of the pump station footing/wall beneath the floor slab. 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 and an internal friction angle of 30 degrees for imported granular structural fill materials and internal friction angle of 20 degrees for on-site soils.

Table 4
Lateral Earth Pressure Parameter Summary

Lateral Earth Pressure Parameter	Values for Imported Granular Structural Fill (ultimate values)	Values for On-site Soils (ultimate values)
At-Rest[1]	63 pcf	71 pcf
Active[2]	42 pcf	53 pcf
Passive[3]	375 pcf	220 pcf
Coefficient of Sliding Friction[3]	0.58	0.36

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 coefficients of friction for sliding and unfactored passive earth pressures. Due to the relatively large movements required to mobilize the passive pressure, we recommend a minimum factor of safety of 2.0 be utilized.
4. It should be noted that the above lateral earth pressures assume drained conditions behind the wall and a horizontal backfill surface without surcharges.

4.5 SLABS-ON-GRADE

As discussed in Section 4.1, to help reduce the potential for differential settlement we recommend slabs-on-grade bear on at least 4 feet of compacted structural fill for the pump station. Acceptable structural fill material and compaction requirements are provided in Sections 4.2.4 and 4.2.6, respectively. Subgrade preparation as described above for the interior slab shall be applied to exterior flatwork that is constructed adjacent the building structure as well.

The criteria presented below should be observed for design and construction of 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 200 pounds per cubic inch (pci) can be used for slabs bearing on at least 4 feet of imported structural fill. Additional reinforcement can also be used to help resist damage due to differential movement of slabs.

4.6 CORROSIVITY AND CONCRETE

4.6.1 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 (%)	pH	Redox Potential (mV)	Resistivity (ohm-cm)	Water Soluble Sulfate (%)	Sulfide Content
BP-2	4.0	0.0022	8.0	394	1,147	0.011	Negative

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.

4.6.2 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, 2017, 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 verity 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.

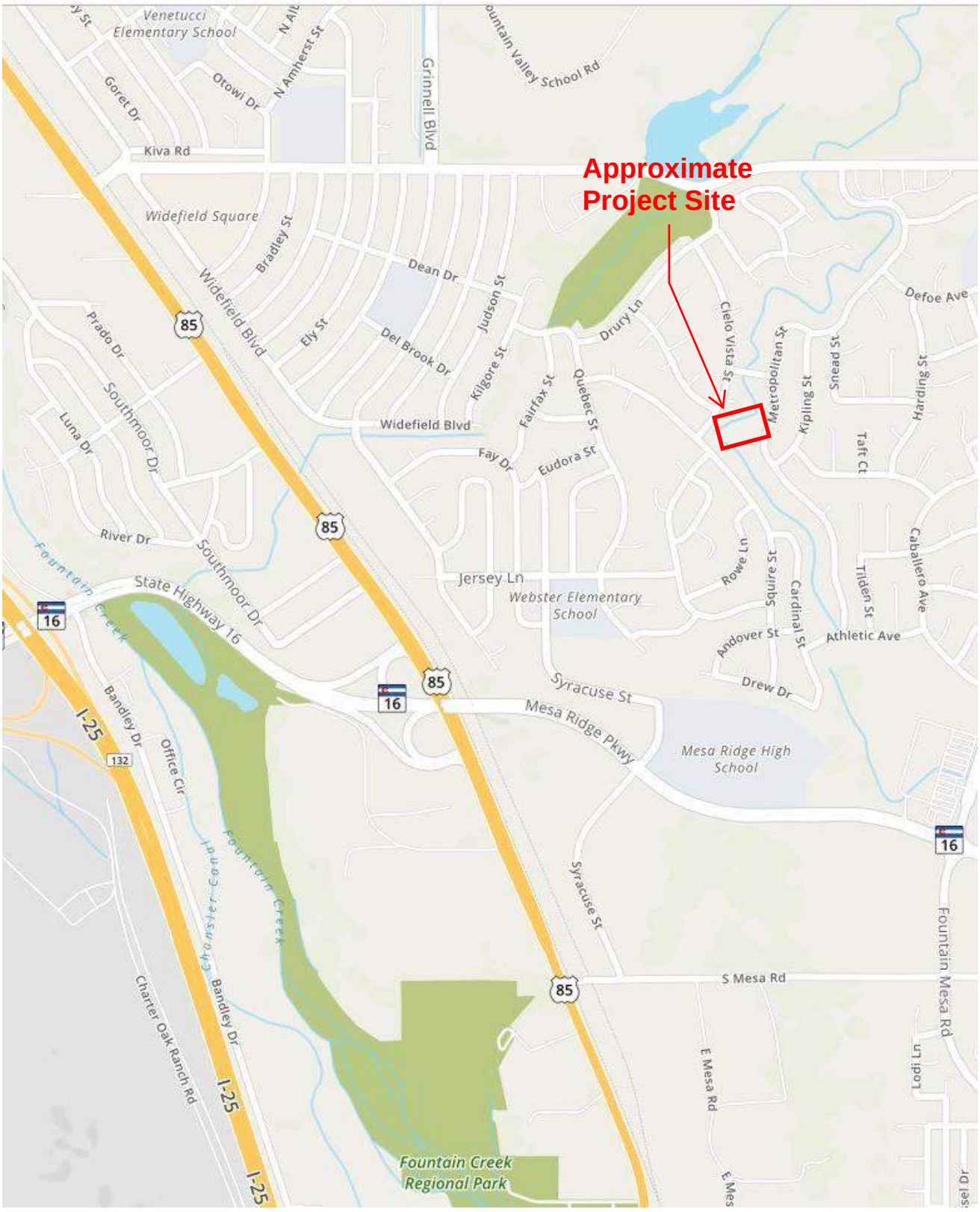
5.2 LIMITATIONS

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



Not to Scale. Base image obtained from www.mapquest.com, 2019

VIVID Engineering Group	Project No: D19-2-253	**VICINITY MAP**	Figure 1
	Date: Sept 17, 2019		
	Drawn by: AAE	Widefield Water and Sanitation Pump Station Vicinity of Metropolitan Street and Kipling Street Widefield, Colorado	
	Reviewed by: WJB		

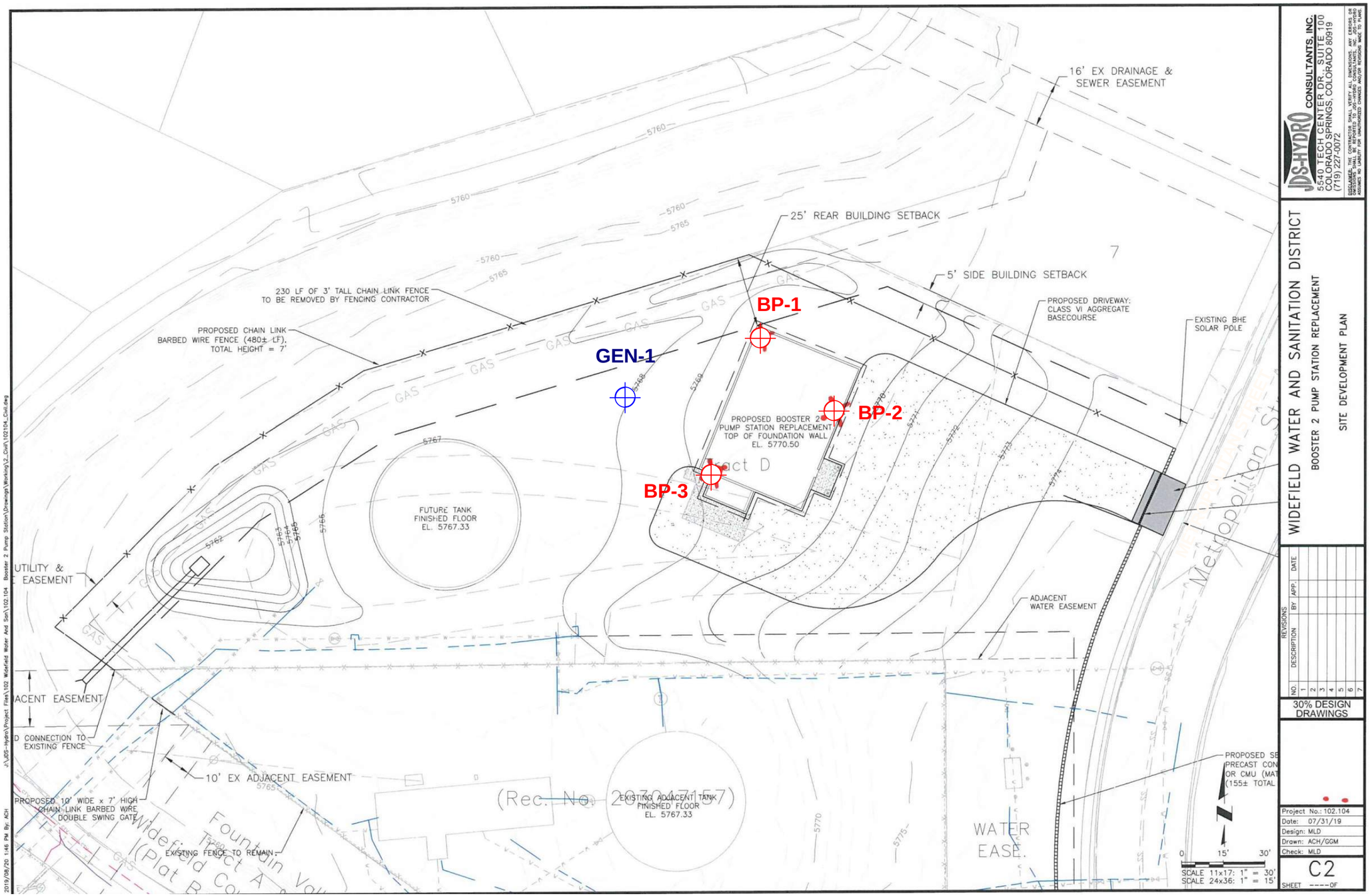
LEGEND

= APPROXIMATE LOCATION OF BUILDING BORING

= APPROXIMATE LOCATION OF GENERATOR BORING

Base image dated 10/19/2018 and obtained from Google Earth, 2019.

VIVID Engineering Group, Inc. 1053 Elkton Drive Colorado Springs, Colorado 80907 719.896.4356	Project No: D19-2-253 Date: Oct 16, 2019 Drawn by: AAE Reviewed by : BTM	**BORING LOCATION PLAN - AERIAL** Widefield Water and Sanitation Pump Station Vicinity of Metropolitan Street and Kipling Street, Widefield, Colorado	Figure **2**



LEGEND

= APPROXIMATE LOCATION OF BUILDING BORING

= APPROXIMATE LOCATION OF GENERATOR BORING

JDS-HYDRO CONSULTANTS, INC.
5540 TECH CENTER DR., SUITE 100
COLORADO SPRINGS, COLORADO 80919
(719) 227-0072

DISCLAIMER: THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS. ANY ERRORS OR OMISSIONS SHALL BE REPORTED TO JDS-HYDRO CONSULTANTS, INC. IMMEDIATELY. JDS-HYDRO ASSUMES NO LIABILITY FOR UNAUTHORIZED CHANGES AND/OR REVISIONS MADE TO PLANS.

WIDEFIELD WATER AND SANITATION DISTRICT
BOOSTER 2 PUMP STATION REPLACEMENT
SITE DEVELOPMENT PLAN

NO.	DESCRIPTION	BY	APP.	DATE
1				
2				
3				
4				
5				
6				
7				

30% DESIGN DRAWINGS

Project No.: 102.104
Date: 07/31/19
Design: MLD
Drawn: ACH/GGM
Check: MLD

SHEET C2 ----OF

N

Base image provided by JDH-Hydro on August 20, 2019.

VIVID Engineering Group, Inc. 1053 Elkton Drive Colorado Springs, Colorado 80907 719.896.4356	Project No: D19-2-253 Date: Oct 16, 2019 Drawn by: AAE Reviewed by : BTM	**BORING LOCATION PLAN - CONCEPTUAL** Widefield Water and Sanitation Pump Station Vicinity of Metropolitan Street and Kipling Street, Widefield, Colorado	Figure **3**

Appendix A

Logs of Exploratory Borings

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

KEY TO SYMBOLS

CLIENT JDS-Hydro

PROJECT NAME Widefield Water and Sanitation Pump Station

PROJECT NUMBER D19-2-253

PROJECT LOCATION Widefield, Colorado

LITHOLOGIC SYMBOLS
(Unified Soil Classification System)


CL: USCS Low Plasticity Clay


CLAYSTONE


CLS: USCS Low Plasticity Sandy Clay


SC: USCS Clayey Sand


SM: USCS Silty Sand


SP: USCS Poorly-graded Sand


SPG: USCS Poorly-graded Gravelly 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
UCS - UNCONFINED COMPRESSIVE STRENGTH


Water Level at Time of Drilling, or as Shown


Water Level at End of Drilling, or as Shown


Water Level After 24 Hours, or as Shown

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

BORING NUMBER BP-1

CLIENT JDS-Hydro
PROJECT NAME Widefield Water and Sanitation Pump Station
PROJECT NUMBER D19-2-253
PROJECT LOCATION Widefield, Colorado
DATE STARTED 9/18/19 **COMPLETED** 9/18/19
GROUND ELEVATION 5768.35 ft **HOLE SIZE** 4 inches
DRILLING CONTRACTOR Custom Auger Drilling (CME-55)
GROUND WATER LEVELS:
DRILLING METHOD 4" Solid Stem Auger
AT TIME OF DRILLING --- None Encountered
LOGGED BY B. Moore **CHECKED BY** B. Mustain
AT END OF DRILLING ---
NOTES Driller periodically added small amounts of water to keep hole open
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION	
0	GB				Sandy Silty CLAY, olive, dry to slightly moist, stiff Less clay content with increasing depth Precipitates from approx. 0 feet to 7 feet	
5	MC	6-8	MC = 10.3% DD = 98.7 pcf Compression = 0.4 % when wetted under 1.0 ksf			
10	SPT	5-6-8 (14)	MC = 9.7% LL = 23 PL = 17 Fines = 60.6%			
10.5						5757.9
					Sandy CLAY, olive, slightly moist, stiff Less clay content with increasing depth	
15	SPT	5-7-9 (16)				
20	MC	8-8	MC = 12.6%			
24.0						5744.4
25	MC	11-16			Silty SAND, olive, moist, medium dense	
30	SPT	6-9-10 (19)				
30.5						5737.9

Bottom of borehole at 30.5 feet.

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

BORING NUMBER BP-2

CLIENT JDS-Hydro
PROJECT NAME Widefield Water and Sanitation Pump Station
PROJECT NUMBER D19-2-253
PROJECT LOCATION Widefield, Colorado
DATE STARTED 9/18/19 **COMPLETED** 9/18/19
GROUND ELEVATION 5769.17 ft **HOLE SIZE** 4 inches
DRILLING CONTRACTOR Custom Auger Drilling (CME-55)
GROUND WATER LEVELS:
DRILLING METHOD 4" Solid Stem Auger
▽ **AT TIME OF DRILLING** 40.00 ft / Elev 5729.17 ft
LOGGED BY B. Moore **CHECKED BY** B. Mustain
AT END OF DRILLING ---
NOTES Driller periodically added small amounts of water to keep hole open
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
0	GB				Sandy CLAY, olive, dry to slightly moist, stiff Less clay content with increasing depth Precipitates from approx. 0 feet to 6 feet
5	SPT	4-4-9 (13)	Chloride = 0.0022 %, pH = 8.0, Redox = 394 mv, Resistivity =1147 ohm.com, Sulfate = 0.011%, Sulfide= Negative		
					6.0 5763.2 Sandy Lean CLAY, olive, dry to slightly moist, medium dense Less clay content with increasing depth
10	MC	10-12	MC = 12.9% DD = 100.7 pcf Swell = 1.5 % when wetted under 1.0 ksf		
15	SPT	12-10-12 (22)	MC = 7.2% LL = 23 PL = 14 Fines = 53.6%		Precipitates from approx. 16 feet to 28 feet
20	MC	10-11			21.0 5748.2 Silty SAND, olive, slightly moist, stiff
25	SPT	10-10-11 (21)			
					29.0 5740.2 29.5 5739.7 Poorly Graded SAND, olive and pink, slightly moist, medium dense
30	SPT	8-8-10 (18)			Silty SAND, olive, slightly moist to wet

(Continued Next Page)

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

BORING NUMBER BP-2

CLIENT JDS-Hydro **PROJECT NAME** Widefield Water and Sanitation Pump Station

PROJECT NUMBER D19-2-253 **PROJECT LOCATION** Widefield, Colorado

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION	
35					Silty SAND, olive, slightly moist to wet *(continued)*	
					35.0	5734.2
					Sandy CLAY, olive, very moist to wet, stiff based on drill rig observations	
40					▽	
45						
50					50.0	5719.2
					Bottom of borehole at 50.0 feet.	

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

BORING NUMBER BP-3

CLIENT JDS-Hydro
PROJECT NAME Widefield Water and Sanitation Pump Station
PROJECT NUMBER D19-2-253
PROJECT LOCATION Widefield, Colorado
DATE STARTED 9/24/19 **COMPLETED** 9/27/19
GROUND ELEVATION 5769.11 ft **HOLE SIZE** 4 inches
DRILLING CONTRACTOR Custom Auger Drilling (CME-55)
GROUND WATER LEVELS:
DRILLING METHOD 4" Solid Stem Auger
AT TIME OF DRILLING --- None Encountered
LOGGED BY B. Moore **CHECKED BY** B. Mustain
AT END OF DRILLING ---
NOTES Driller periodically added small amounts of water to keep hole open
AFTER DRILLING --- None Encountered

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION	
0	GB				Sandy Lean CLAY, olive, dry to slightly moist, very stiff Less clay content with increasing depth	
	SPT	9-14-16 (30)	MC = 7.7% LL = 25 PL = 14 Fines = 66.5%			
	GB					
5	MC	11-15	Compressive Strength = 9257 psf, Shear Strength = 4629 psf, Axial Strain = 3.1 %			
					8.0	5761.1
					Sandy CLAY, olive, dry to slightly moist, very stiff Less clay content with increasing depth Precipitates at approx. 9 feet	
10	SPT	9-12-14 (26)				
15	MC	14-17	MC = 5.1% DD = 100.7 pcf Compression = 0.1 % when wetted under 1.0 ksf		14.5	5754.6
					Silty SAND, olive, slightly moist, medium dense	
20	SPT	7-14-20 (34)				
25	SPT	8-12-14 (26)			25.0	5744.1
					Clayey SAND with some gravel, olive, slightly moist, medium dense	
30	MC	13-20			29.9	5739.2
					30.0 Poorly Graded SAND with gravel, olive and pink, slightly moist to moist, medium dense	5739.1
					Bottom of borehole at 30.0 feet.	

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

BORING NUMBER GEN-1

CLIENT JDS-Hydro
PROJECT NAME Widefield Water and Sanitation Pump Station
PROJECT NUMBER D19-2-253
PROJECT LOCATION Widefield, Colorado
DATE STARTED 9/18/19 **COMPLETED** 9/18/19
GROUND ELEVATION 5768.62 ft **HOLE SIZE** 4 inches
DRILLING CONTRACTOR Custom Auger Drilling (CME-55)
GROUND WATER LEVELS:
DRILLING METHOD 4" Solid Stem Auger
AT TIME OF DRILLING --- None Encountered
LOGGED BY B. Moore **CHECKED BY** B. Mustain
AT END OF DRILLING ---
NOTES Driller periodically added small amounts of water to keep hole open
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
0	GB				Sandy CLAY, olive, dry to slightly moist, stiff Less clay content with increasing depth Precipitates from approx. 0 feet to 11 feet
5	MC	9-9	MC = 15.7% DD = 100.7 pcf Swell = 5.1 when wetted under 500 psf		
6.0					5762.6
					Sandy SILT, olive, dry to slightly moist, very stiff Less silt content with increasing depth
10	SPT	11-13-15 (28)	MC = 6.4% LL = 20 PL = 17 Fines = 52.6%		
15	MC	16-16	MC = 6.5%		
16.0					5752.6
					Silty SAND, olive, slightly moist, dense to medium dense
20	SPT	13-18-18 (36)			Precipitates at approx. 19 feet
25	SPT	13-13-14 (27)			
30	MC	6-8			
30.0					5738.6
					Bottom of borehole at 30.0 feet.

Appendix B

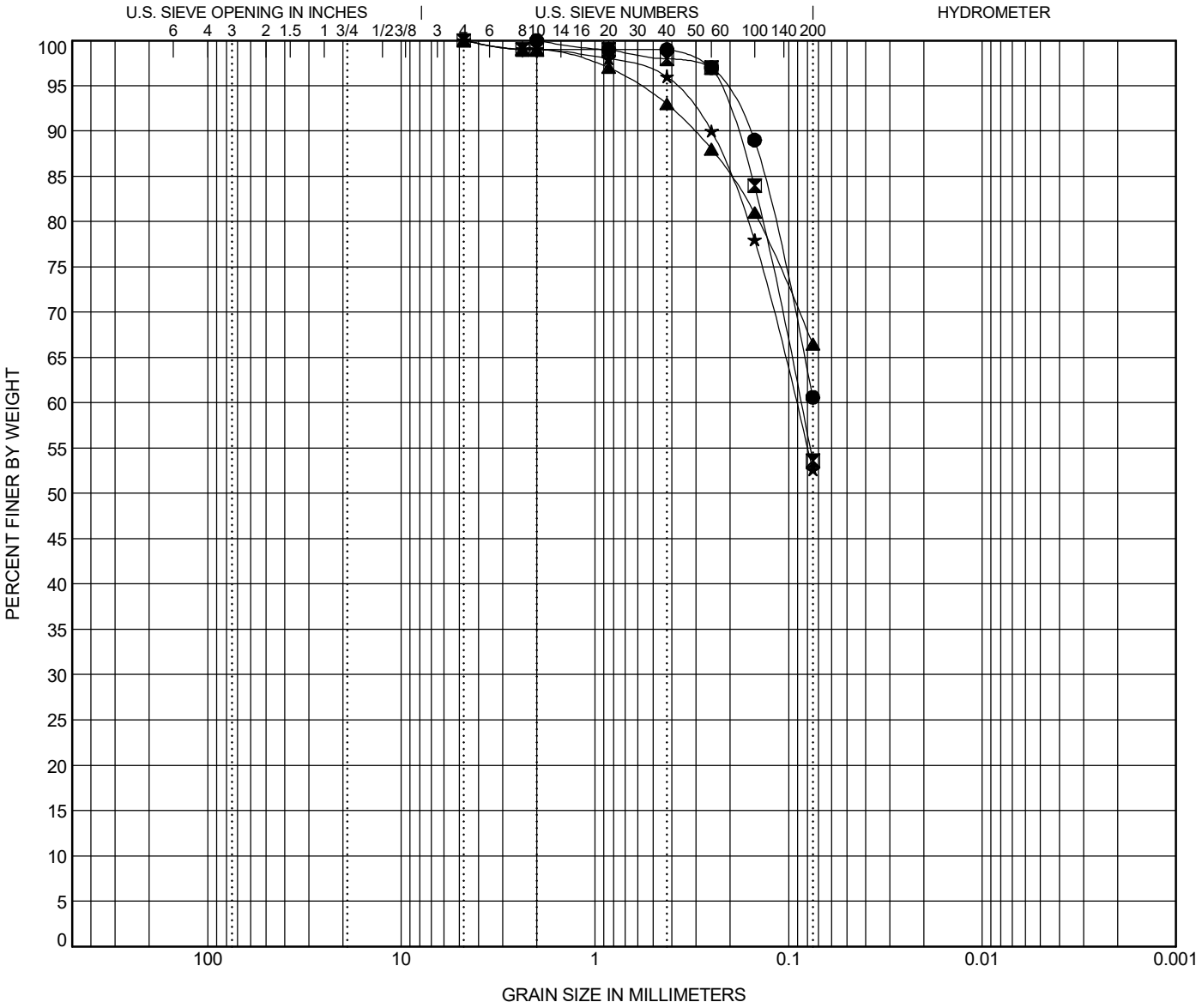
Geotechnical Laboratory Test Results

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

GRAIN SIZE DISTRIBUTION

CLIENT JDS-Hydro **PROJECT NAME** Widefield Water and Sanitation Pump Station

PROJECT NUMBER D19-2-253 **PROJECT LOCATION** Widefield, Colorado



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE		DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**BP-1**	**9.0**	**SANDY SILTY CLAY(CL-ML)**	**23**	**17**	**6**		
⊠	**BP-2**	**14.0**	**SANDY LEAN CLAY(CL)**	**23**	**14**	**9**		
▲	**BP-3**	**2.0**	**SANDY LEAN CLAY(CL)**	**25**	**14**	**11**		
★	**GEN-1**	**9.0**	**SANDY SILT(ML)**	**20**	**17**	**3**		

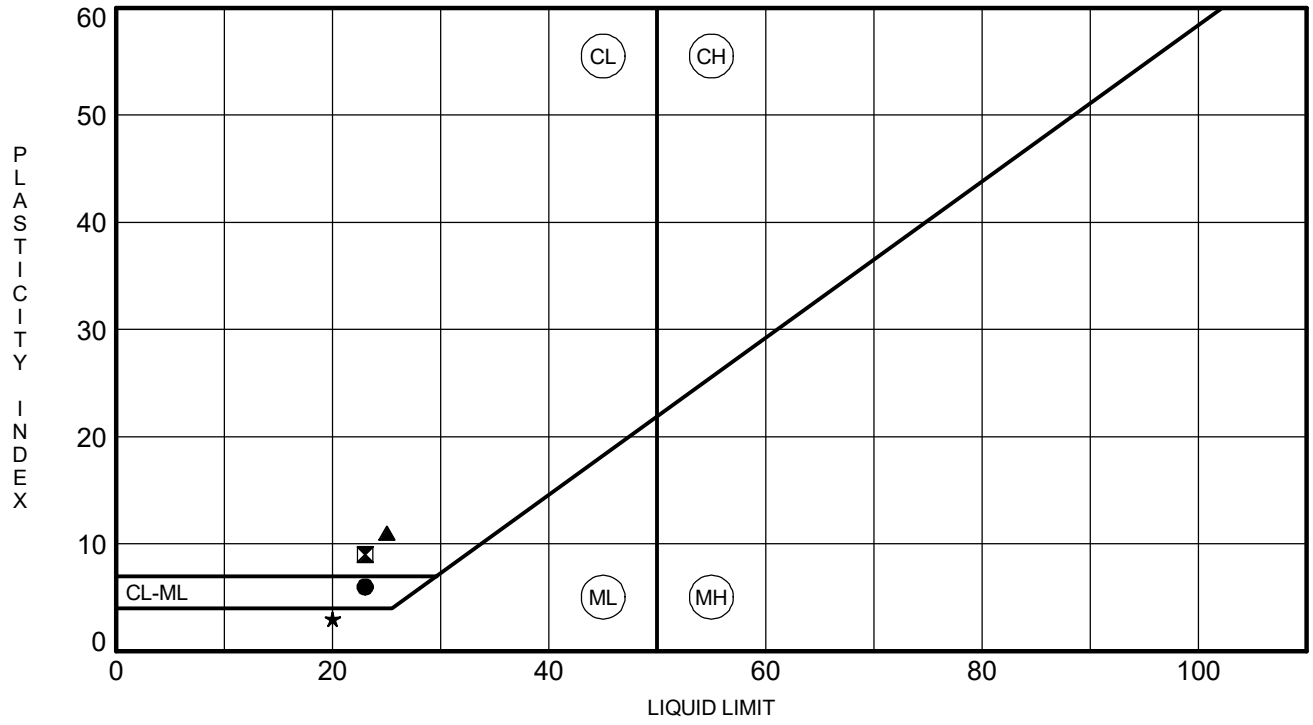
BOREHOLE		DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BP-1**	**9.0**	**2**				**0.0**	**39.4**	**60.6**	
⊠	**BP-2**	**14.0**	**4.75**	**0.087**			**0.0**	**46.4**	**53.6**	
▲	**BP-3**	**2.0**	**4.75**				**0.0**	**33.5**	**66.5**	
★	**GEN-1**	**9.0**	**4.75**	**0.092**			**0.0**	**47.4**	**52.6**	

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

ATTERBERG LIMITS' RESULTS

CLIENT JDS-Hydro **PROJECT NAME** Widefield Water and Sanitation Pump Station

PROJECT NUMBER D19-2-253 **PROJECT LOCATION** Widefield, Colorado

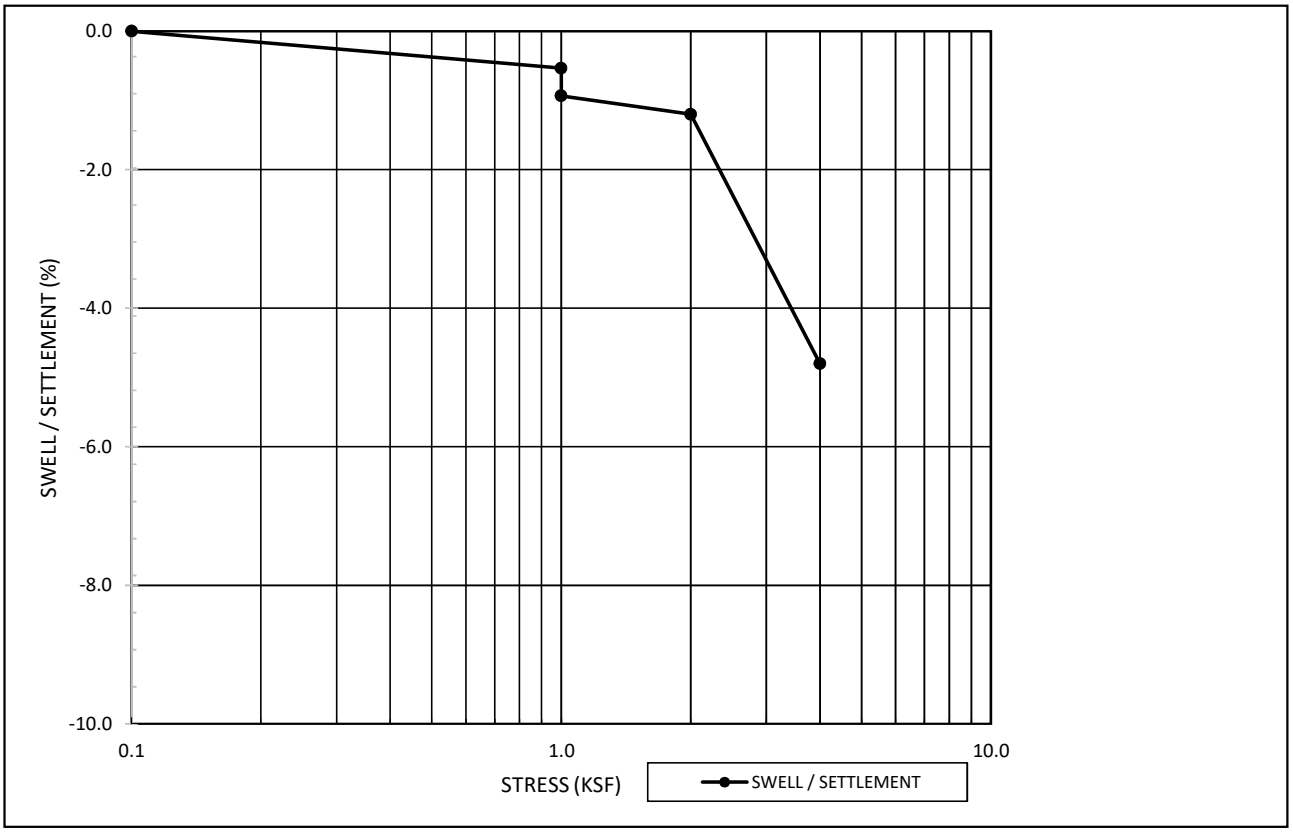


	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**BP-1**	**9.0**	**23**	**17**	**6**	**61**	**SANDY SILTY CLAY(CL-ML)**
⊠	**BP-2**	**14.0**	**23**	**14**	**9**	**54**	**SANDY LEAN CLAY(CL)**
▲	**BP-3**	**2.0**	**25**	**14**	**11**	**67**	**SANDY LEAN CLAY(CL)**
★	**GEN-1**	**9.0**	**20**	**17**	**3**	**53**	**SANDY SILT(ML)**

VIVID Engineering Group, Inc.

Project Name:	Widefield Water and Sanitation Pump Station	**Date**	9/20/2019
Project No.:	D19-2-253		
Boring ID.:	BP-1	**Sample Depth (ft)**	4
Sample Description:	Clay, Slightly Sandy, Light Brown to Brown		

	%
Compression @ Wetting Weight:	**-0.4**

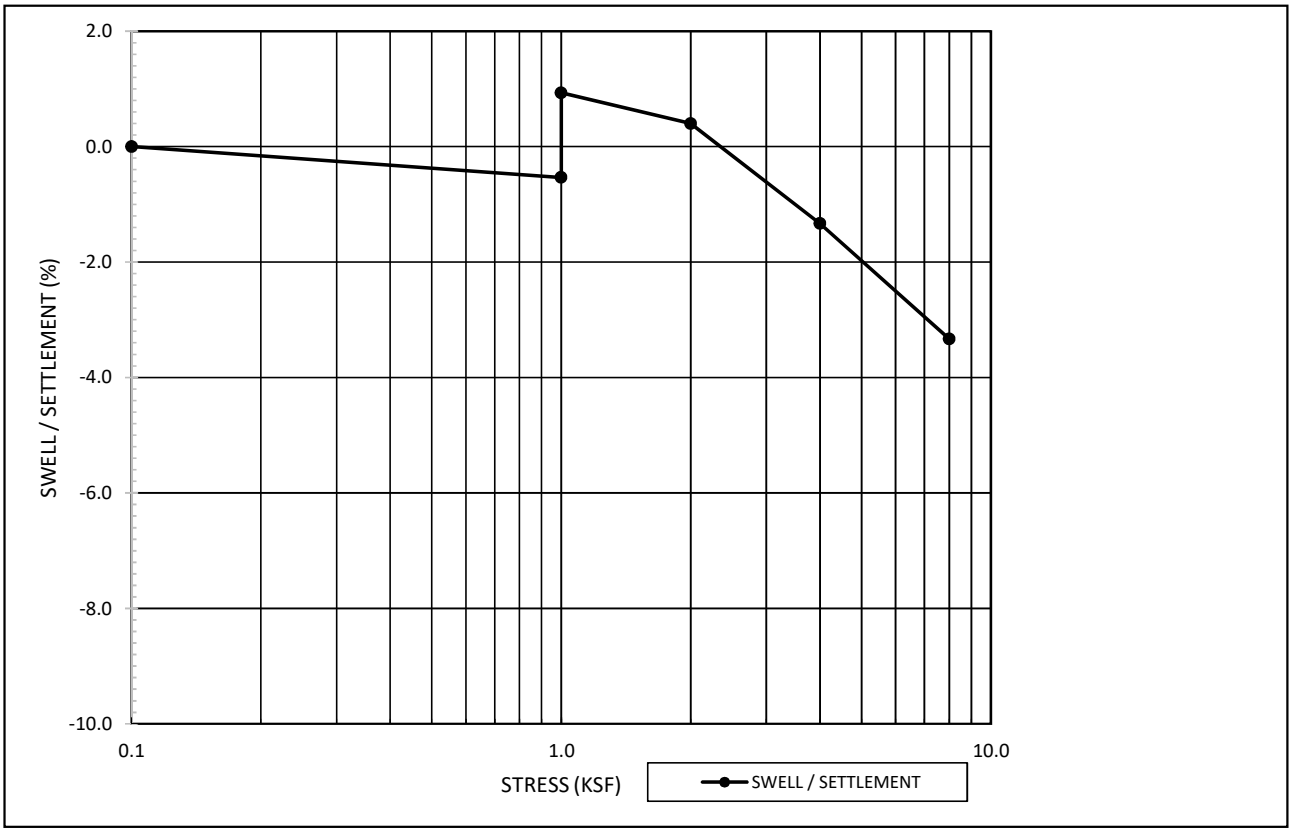


Initial Condition	
Moisture Content %	**10.3**
Dry Density (pcf)	**98.7**
Post-Swell Condition	
Moisture Content %	**23.3**

VIVID Engineering Group, Inc.

Project Name:	Widefield Water and Sanitation Pump Station	**Date**	9/20/2019
Project No.:	D19-2-253		
Boring ID.:	BP-2	**Sample Depth (ft)**	9
Sample Description:	Clay, Slightly Sandy, Brown, Pinholes		

	%
Swell @ Wetting Weight:	**1.5**

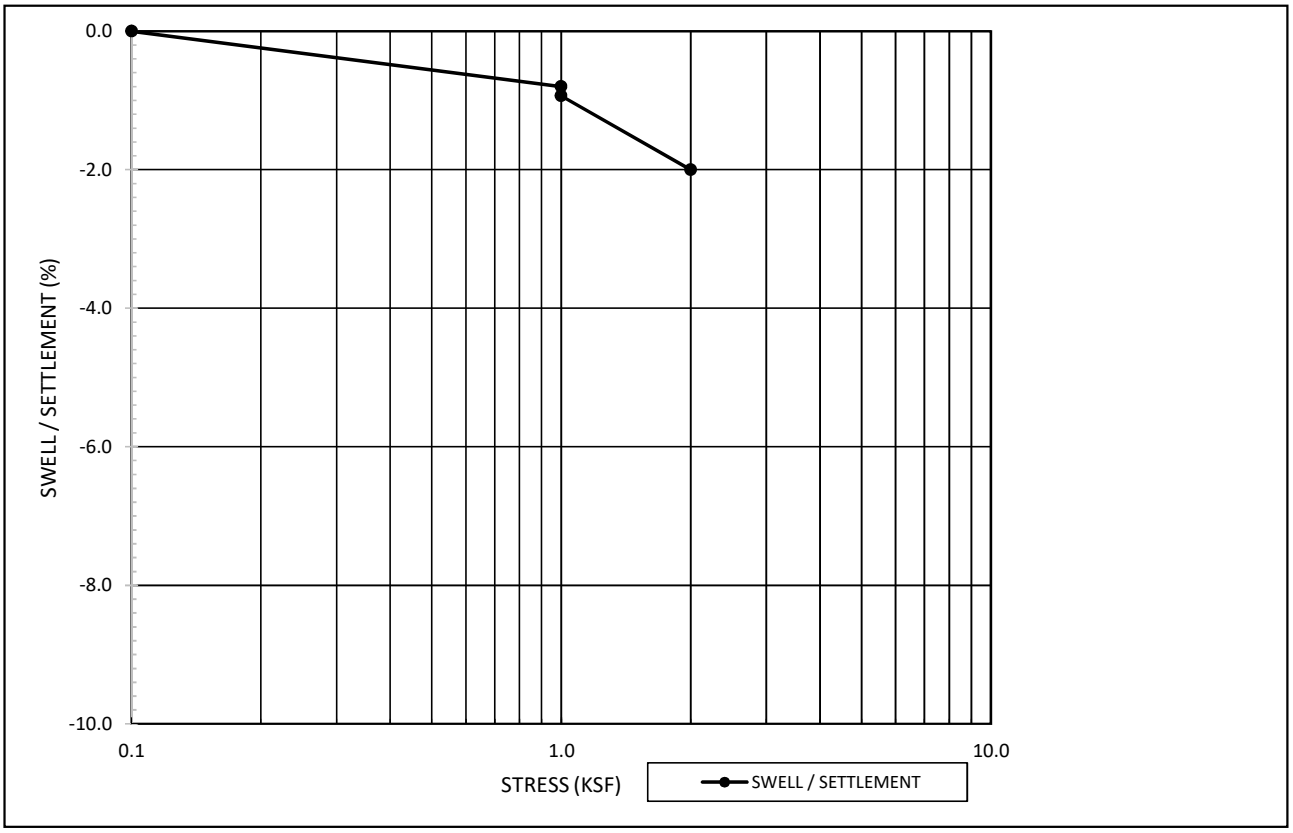


Initial Condition	
Moisture Content %	**12.9**
Dry Density (pcf)	**100.7**
Post-Swell Condition	
Moisture Content %	**24.5**

VIVID Engineering Group, Inc.

Project Name:	Widefield Water and Sanitation Pump Station	**Date**	9/20/2019
Project No.:	D19-2-253		
Boring ID.:	BP-3	**Sample Depth (ft)**	14
Sample Description:	Sandy Clay, Light Brown, Fine Grained		

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

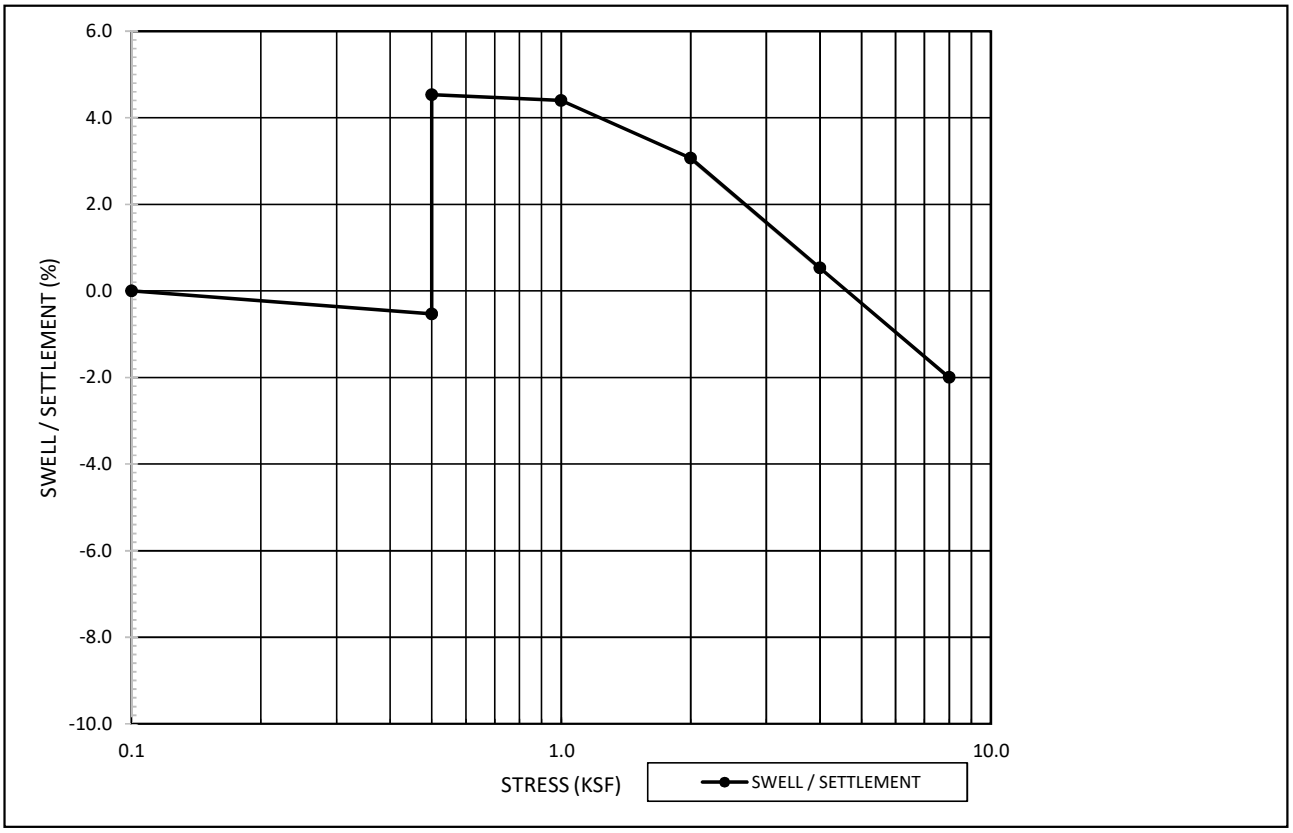


Initial Condition	
Moisture Content %	**5.1**
Dry Density (pcf)	**100.7**
Post-Swell Condition	
Moisture Content %	**22.6**

VIVID Engineering Group, Inc.

Project Name:	Widefield Water and Sanitation Pump Station	**Date**	9/20/2019
Project No.:	D19-2-253		
Boring ID.:	GEN-1	**Sample Depth (ft)**	4
Sample Description:	Clay, Slightly Sandy, Brown		

	%
Swell @ Wetting Weight:	**5.1**



Initial Condition	
Moisture Content %	**15.6**
Dry Density (pcf)	**100.7**
Post-Swell Condition	
Moisture Content %	**24.5**

UNCONFINED COMPRESSION TEST
ASTM D 2166

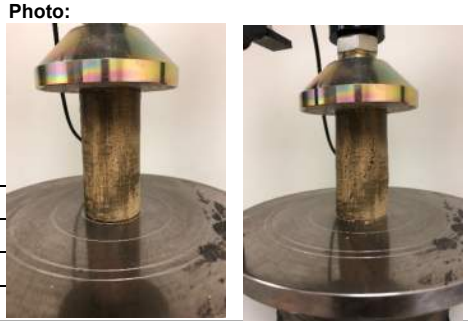
PROJECT NAME:	Widefield water and Sanitation Pump Station	PROJECT ENG.:	BTM
PROJECT NO. :	D19-2-253	DATE RECEIVED:	9/24/2019
CLIENT NAME:	JDS-Hydro	DATE TESTED:	9/25/2019
		TESTED BY:	BTM
BORING NO. :	BP-3	DATA ENTRY:	BTM
SAMPLE NO.:	253-11		
DEPTH, FT. :	4ft	DESCRIPTION:	Clay, Sandy, Light Brown
TEST SPECIMEN NO.:	#1		

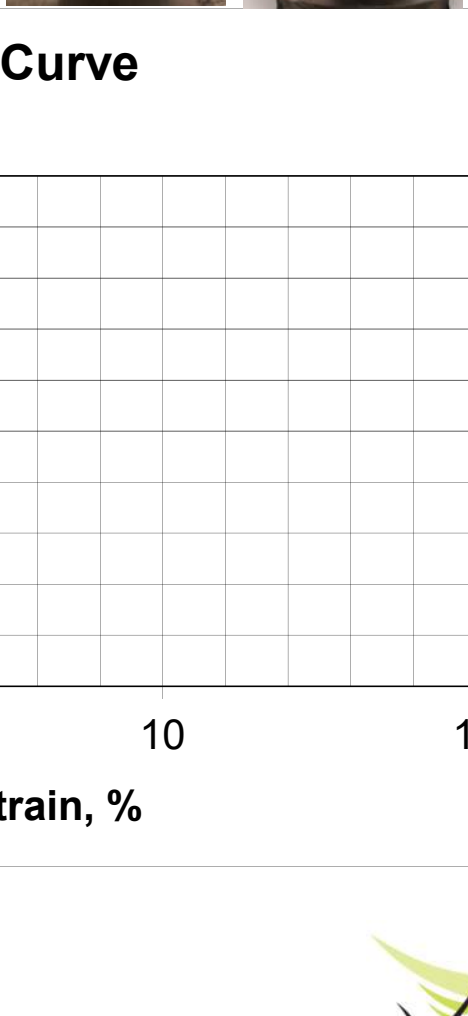
INITIAL DATA

Avg. Height, In.:	4.000
Avg. Diameter, In.:	1.924
L/D Ratio:	2.1
Moisture Content, %: (Sample, After test)	12.8
Dry Density, pcf:	104.5
Assumed Specific Gravity:	2.7
Saturation, %:	56.4
Void Ratio:	0.613
Rate of Strain, %/Minute:	1.0

	PSF	PSI
Compressive Strength @ Failure:	9257	64
Shear Strength @ Failure:	4629	32
Axial Strain @ Failure,%:	3.1	3.1

Photo:





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

SUMMARY OF LABORATORY RESULTS

CLIENT JDS-Hydro **PROJECT NAME** Widefield Water and Sanitation Tank

PROJECT NUMBER D19-2-253 **PROJECT LOCATION** Widefield, Colorado

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Class-ification	Water Content (%)	Dry Density (pcf)		
BP-1	4.0							10.3	98.7		
BP-1	9.0	23	17	6	2	61	CL-ML	9.7			
BP-1	19.0							12.6			
BP-2	9.0							12.9	100.7		
BP-2	14.0	23	14	9	4.75	54	CL	7.2			
BP-3	2.0	25	14	11	4.75	67	CL	7.7			
BP-3	14.0							5.1	100.7		
GEN-1	4.0							15.7	100.7		
GEN-1	9.0	20	17	3	4.75	53	ML	6.4			
GEN-1	14.0							6.5			

Appendix C

Analytical Laboratory Test Results

Colorado Analytical LABORATORIES, INC.

Analytical Results

TASK NO: 190923002

Company: Vivid Engineering Group, Inc.
1053 Elkton Drive
Colorado Springs CO 80907

Task No.: 190923002
Client PO:
Client Project: Widefield Pump Station D19-2-253

Date Received: 9/23/19
Date Reported: 9/30/19
Matrix: Soil - Geotech

Customer Sample ID BP-2 @ 4ft
Lab Number: 190923002-01

Test	Result	Method
Chloride - Water Soluble	**0.0022 %**	AASHTO T291-91/ ASTM D4327
pH	**8.0 units**	AASHTO T289-91
Redox Potential	**394 mv**	ASTM D1498
Resistivity	**1147 ohm.cm**	AASHTO T288-91
Sulfate - Water Soluble	**0.011 %**	CDOT CP-L 2103 / ASTM D4327
Sulfide	**Negative**	AWWA C105

Abbreviations/ References:

AASHTO - American Association of State Highway and Transportation Officials.
ASTM - American Society for Testing and Materials.
ASA - American Society of Agronomy.
DIPRA - Ductile Iron Pipe Research Association Handbook of Ductile Iron Pipe.

DATA APPROVED FOR RELEASE BY

Appendix D

Site Photos

DRILLING BORING BP-1 - LOOKING EAST

DRILLING BORING BP-2 - LOOKING SOUTH WEST

VIVID Engineering Group	Project No: D19-2-253 Date: 10/8/2019 Drawn by: AAE Reviewed by: WJB	**SITE PHOTOS** Widefield Water and Sanitation Pump Station Vicinity of Metropolitan St. and Kipling St. Widefield, Colorado	FIGURE **D-1**

DRILLING BORING BP-3 - LOOKING SOUTH

DRILLING BORING GEN-1 - LOOKING WEST

VIVID Engineering Group	Project No: D19-2-253 Date: 10/8/2019 Drawn by: AAE Reviewed by: WJB	**SITE PHOTOS** Widefield Water and Sanitation Pump Station Vicinity of Metropolitan St. and Kipling St. Widefield, Colorado	FIGURE **D-2**

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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